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Examination Standard for Lithium-Ion Battery Off-Gas Detection

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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
1.1 Purpose 1
1.2 Scope 1
1.3 Basis for Requirements 1
1.4 Basis for Certification 1
1.5 Basis for Continued Certification 2
1.6 Effective Date 2
1.7 System of Units 2
1.8 Normative References 2
1.9 Terms and definitions 3

2 GENERAL INFORMATION 5
2.1 Product Information 5
2.2 Certification Application Requirements 5
2.3 Requirements for Samples for Examination 5

3 GENERAL REQUIREMENTS 6
3.1 Review of documentation 6
3.2 physical or structural features 6
3.3 Markings 6
3.4 Manufacturer's Installation and Operation Instructions 6
3.5 Calibration 8

4 PERFORMANCE REQUIREMENTS 9
4.1 sensitivity test 9
4.2 Verification of Rate of Rise Test 9
4.3 Repeatability Test (Excluding Single Use Sensors) 9
4.4 Functional Tests from ANSI/FM/UL 62990-1 10
4.5 Detector Without Field Calibration 10

5 MANUFACTURER'S REQUIREMENTS 11
5.1 Demonstrated Quality Control Program 11
5.2 Surveillance Audit 12
5.3 product modifications 12

6 BIBLIOGRAPHY 13

APPENDIX 1 14

1 INTRODUCTION

1.1 PURPOSE

1.1.1 This standard states testing and certification requirements for rate of rise gas detection instruments used in the detection of off gases from lithium-ion batteries generated in the first stage of a failing lithium-ion battery prior to thermal runaway.

Note 1: The testing and certification requirements for gas detection instruments with alarm functions based on reaching a threshold limit value for flammable gases and vapors are set out in ANSI/FM/UL 60079-29-1, Explosive Atmospheres – Part 29-1: Gas Detectors – Performance Requirements of Detectors for Flammable Gases.

Note 2: The testing and certification requirements for gas detection instruments with alarm functions based on reaching a threshold limit value for toxic gases and vapors are set out in ANSI/FM/UL 62990-1 - Workplace Atmospheres – Part 1: Gas Detectors – Performance Requirements of Detectors for Toxic Gases.

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 applies to any component intended to or for use to sense the presence of a rising concentration of battery electrolyte solvent vapor due to the off gassing of lithium-ion batteries generated in the first stage of a failing lithium-ion battery prior to thermal runaway or during thermal runaway.

1.2.2 This standard applies to line-voltage operated instruments rated at 250V nominal or less, and to portable, mobile, or stationary-type instruments supplied by battery of a non-rechargeable (primary) type or a rechargeable (secondary) type.

1.2.3 This standard does not apply to gas detection instruments that provide an indication or alarm when a specific threshold value has been met.

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 rate of rise gas detection instruments for the purpose of obtaining certification.

1.3.3 The construction, testing and marking required by this standard correspond, in general, to ANSI/FM/UL 62990-1.

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 the date of publication.

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 their content constitutes requirements of this document. For dated references, only the cited edition applies.

ANSI 2075 - *Standard For Safety Gas and Vapor Detectors and Sensors*

ANSI/FM/UL 62990-1 - *Workplace Atmospheres – Part 1: Gas Detectors – Performance Requirements of Detectors for Toxic Gases*

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

ANSI/ISA-61010-1 - *Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General requirements*

EN 50270 - *Electromagnetic compatibility. Electrical apparatus for the detection and measurement of combustible gases, toxic gases, or oxygen*

FM 3600 - *Examination Standard for Electrical Equipment for Use in Hazardous (Classified) Locations – General Requirements*

1.9 TERMS AND DEFINITIONS

For purposes of this standard, the following terms apply:

Alarm — An audible, visual, or physical presentation designed to alert the instrument user that a specific rate of rise of flammable gas concentration has been reached or exceeded.

Calibration — The act of adjusting an instrument to ‘‘zero’’ and setting the desired ‘‘span’’. This procedure is repeated frequently by the instrument user and included in certain tests called for in this standard. It verifies that the response of an instrument to a known gas concentration is within performance requirements of this standard. This may necessitate adjustment of zero, span, and alarm set point.

Calibration gas concentration — The concentration of the flammable gas in ambient air used to set the instrument span or alarm set point.

Flammable gas — Any flammable gas or vapor that, in sufficient concentration by volume in air, can become the fuel for an explosion or fire hazard. Materials that cannot produce sufficient gas or vapor to form a flammable mixture at ambient or operating temperatures and mists formed by the mechanical atomization of flammable liquids are NOT considered to be flammable gases.

Note: for convenience, the shorter term ‘‘gas’’ may be used as an abbreviation for ‘‘flammable gas or vapor’’ within this document.

Control unit — equipment intended to provide display indication, alarm functions, output contacts or alarm signal outputs or any combination when operated with remote sensor(s)

Dead space — An actual or potential area within a chamber where the gas is stagnant (not mixing and/or still).

Detector head — The gas responsive portion of a gas detection instrument located in the area where sensing the presence of gas is desired. It may be integral with or removed from its control unit.

Note: The detector head may incorporate, in the same housing, circuitry such as signal processing and amplifying components in addition to the gas sensing element (sensor).

Fault signal — Audible, visible, or other type of output, different from the alarm signal, permitting, directly or indirectly, a warning or indication that the apparatus is not working satisfactorily.

Note: the terms fault signals and trouble signals are deemed to be synonymous.

Flammable range	The range of flammable vapor concentrations or gas-air mixtures in which propagation of flame will occur on contact with a source of ignition. **Note 1**: The terms ‘‘Lower Flammable Limit (LFL)’’ AND ‘‘Lower Explosive Limit (LEL)’’ are deemed to be synonymous. The terms ‘‘Upper Flammable Limit (UFL)’’and ‘‘Upper Explosive Limit (UEL)’’are deemed to be synonymous. For ease of reference, the two abbreviations ‘‘LFL’’AND ‘‘UFL’’ are used hereinafter to denote these two sets of terms. It should be recognized that particular authorities having jurisdiction may prefer the use of one of the sets of terms and not the other. **Note 2**: The actual gas concentration corresponding to the lower flammable limit of the specific gas shall be the value shown for that gas in the latest edition of nationally recognized documents, for example, National Fire Protection Association (NFPA) 325 guide to fire hazard properties of flammable liquids, gases, and volatile solids (FORMERLY NFPA 325M).
Full-scale gas concentration	The gas concentration that equals maximum scale indication.
Gas detection instrument	An assembly of electrical and mechanical components (either a single integrated unit or a system comprised of two or more physically separate but interconnected component parts) which senses the presence of flammable gas and responds by providing an indication, alarm, or other output function. **Note:** For convenience, the term ‘‘instrument’’ is used as an abbreviation for ‘‘gas detection instrument’’ within this document.
Gas-sensing element (sensor)	The primary element in the gas detection system that responds to the presence of a flammable gas — including any reference or compensating unit, where applicable.
Range	The operable concentration region of the instrument or a selected subdivision of that region.
Response conversion data	Information, supplied and explained in the instrument instruction manual, enabling the instrument user to determine the concentration of the gas to be monitored that will produce the same response as a known concentration of another gas used for calibration.
Sample draw	Method by which the atmosphere being monitored is made to flow to the gas sensing element. This may involve a manual aspirator, an electrical pump, or some other means.
Span	The algebraic difference between the upper and lower values of a range.
Stationary instrument	A gas detection instrument intended for permanent installation in a fixed location.
Transmitter	Stand-alone gas detection apparatus for use with separate control units includes apparatus that provide a conditioned electronic signal or output indication intended to be used with stand-alone control units, separate signal processing, data acquisition, central monitoring or other similar systems which typically process information from various locations and sources including, but not limited to, gas detection instrumentation.
Zero	The lower calibration value, normally clean air.

2 GENERAL INFORMATION

2.1 PRODUCT INFORMATION

Lithium-ion battery off-gas detectors are intended to respond to the increasing electrolyte gas or vapor emissions generated in the off-gas stage of a failing lithium-ion battery prior to thermal runaway.

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 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 or control equipment that may be unique to their products.

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 Any portion of a gas detection instrument that is intended for installation or use in an area that has been classified as a Hazardous (classified) Location shall be suitable for use in Class I, Division 1 or 2 or Class I, Zone 0, 1 or 2 hazardous locations in accordance with the group classification of the gas. See FM Examination Standard 3600.

Note 1: In accordance with the National Electrical Code® (ANSI/NFPA 70), for fixed installation, only instruments which utilize Intrinsic Safety (ia) can be approved for use in Class I, Zone 0. Instruments which utilize Flameproof (d) either entirely or in conjunction with Intrinsic Safety, cannot be approved for use in Class I, Zone 0

Note 2: For portable and transportable equipment, instruments which utilize either Intrinsic Safety (ia) or flameproof (da) can be approved for use in Class I, Zone 0. Instruments which utilize flameproof (db or dc) either entirely or in conjunction with Intrinsic Safety or Flameproof (da), cannot be certified for use in Class I, Zone 0.

3.3 MARKINGS

3.3.1 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,
- specific model designation and serial number,
- electrical rating, in volts, amperes, or watts, and frequency,
- operating ambient temperature range,
- “FM 6540”,
- when hazard warnings are needed, the markings should be universally recognizable.

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 All markings shall be legible and durable.

3.4 MANUFACTURER’S INSTALLATION AND OPERATION INSTRUCTIONS

3.4.1 The manufacturer shall:

- prepare instructions for the installation, operation, and maintenance 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 products where it is not reasonable to expect the average user to be able to provide the installation, inspection, or maintenance.

3.4.2 In addition to the manufacturer's installation and operation instructions required in accordance with ANSI/FM/UL-62990-1, the installation and operation instructions shall include the following information:

- where the design or special nature of the instrument requires additional instructions that are in contradiction of, or in addition to, the requirements of this section, this consideration may take precedence over these requirements. Instructions shall be consistent with the marking requirements;
- a list of desensitizing or contaminating gases or substances known to the instrument manufacturer which may adversely affect proper operation of the instrument. Warning as to the effects, if any, of oxygen-enriched or oxygen-deficient atmospheres shall also be included;
- instructions of maintenance and calibration on a routine basis, following exposure of any of the contaminants referred to above and following exposure to concentrations causing operation of any alarm;
- details of accuracy limitations;
- a list of operational limitations which include, as applicable, maximum length of lines, loop resistance, and minimum wire size for wiring between the control unit and remote detector heads(s) needed for shielding of wiring, air velocity limitations, and temperature limitations, sensor life;
- a statement to the user to be aware that extended exposure of a sensor to certain concentrations of flammable gases in air may introduce stress to the sensor that could seriously affect its performance and that calibration should be conducted and/or the sensor replaced after an alarm due to indication of a high concentration;
- for sample-draw instruments, wording to provide for a clear indication that suitable flow proving devices must be provided at the time of installation, if applicable;
- for sample-draw instruments that are not provided with integral flow indicating devices, detailed instructions regarding one or more suitable techniques, not requiring special instruments;
- if applicable, the type of calibration gas or vapor mixture to be used. If the instrument is designated to monitor gases other than the one for which it is calibrated, include response conversion data with specific instructions as to its use;
- an evaluation procedure to determine the possible sources of malfunction and the corrective action to be taken;
- a listing of consumable parts, and recommendation of the storage type, environment, and installation instructions;
- if more than one type of sensor is supplied by the manufacturer, include a list stating the specific gas family or chemically similar gases for each sensor;
- for instruments which provide measurement outputs (e.g., 4-20 mA signal), the instruction manual shall provide graphs or other means to indicate the relationship between the input and the output;
- for stand-alone detector heads and instruments that provide measurement and/or alarm outputs (e.g., 4-20 mA signal, relay contacts), the following shall appear in the instruction manual:
- ''This certification does not include or imply certification of apparatus to which the subject instrumentation may be connected. To maintain a certified system, the apparatus to which this instrument is connected, must also be certified.''
- for stand-alone control units, the following shall appear in the instruction manual:
- ''This certification does not include or imply certification of gas detector heads or other apparatus to which the subject instrument may be connected. To maintain a certified system, the measurement input signal to which this instrument is connected must also be certified.''
- for instruments providing communications options that are not included in the certification examination, but which comply with ANSI/FM/UL-62990-1, the following shall appear in the instruction manual:

  ''As part of this certification, it was verified that optional communication functions of this gas detection instrument while operating at the maximum transaction rate do not adversely affect the gas detection operation and functions of the instrument. This certification, however, does not include or imply certification of the communications protocol or functions provided by the software of this instrument or of the communications apparatus or software connected to this instrument.''

3.5 CALIBRATION

3.5.1 Each piece of equipment used to verify the test parameters shall be calibrated within an interval determined based on 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.

4 PERFORMANCE REQUIREMENTS

4.1 SENSITIVITY TEST

Determine the minimum rate of change of off gases from lithium-ion batteries to initiate an alarm.

The face of the sensing element or sampling port shall be mounted in the center of one panel of a 5 liter rectangular enclosure. The enclosure shall have a gas inlet at the opposite end of a perpendicular panel and a gas outlet at the opposite end of the panel parallel to the one with the gas inlet. A two inch fan shall be mounted to the panel opposite sensing element or sampling port in the corner opposite the gas inlet.

The gas inlet shall be connected to two flow controllers, one connected to air and the other connected to the equipment identified in Annex 1 filled with a solvent to represent the electrolytes in the type of lithium-ion batteries identified by the manufacturer.

The two flow controllers shall have a combined flow rate of 2 LPM (liters per minute).

At the start of the test the air flow controller set at 2 LPM, the solvent vapor flow controller set to 0 LPM, and the fan shall be turned on a low flow to ensure a homogeneous mixture within the enclosure. The enclosure inlet and outlet shall be open. The setpoints on the flow controllers shall then be set at 90% of the minimum ramp rate, as defined by the manufacturer in ppm per second by decreasing the air flow controller and increasing the solvent vapor flow controller to maintain a combined flow rate of 2 LPM and continued for 10 minutes to ensure the enclosure has been filled with a homogeneous mixture.

The ratio of solvent vapor flow rate and air shall be increased until the minimum ratio of solvent to cause an alarm is identified. Each step change in ratio test shall be performed for 10 minutes to ensure the enclosure has been filled with a homogeneous mixture.

Upon alarm, the flow controllers shall be reset to their starting values to purge the enclosure. The flow controllers shall be reset to the setting which initiated an alarm, and the detector response time shall be recorded. If the detector does not go into alarm, the test shall be repeated and the ramp rate setpoint on each flow controller shall be increased until the detector alarms. This sequence shall be repeated until the appropriate ramp rate with the enclosure starting with clean air can be determined. The minimum ramp rate necessary to alarm and the associated response time shall be recorded.

Note: A smaller enclosure may be used provided the combined flow rate is reduced to replicate the same rate of change within the enclosure.

4.2 VERIFICATION OF RATE OF RISE TEST

Determine whether the detector alarms based on a rate or change.

With the sensing element or sampling port mounted to the fixture in Appendix 1 with the enclosure inlet and outlet open, the enclosure shall be filled with clean air. The flow controllers shall be set to the ratio identified to cause an alarm in section 4.1 and the time to alarm shall be recorded. Both the inlet and outlet shall be closed. With the fan still running for five minutes, the alarms shall be reset and shall not re-trigger over an additional five minute dwell time. Then, the inlet and outlet will be opened, the flow controllers restarted and the time to alarm shall be recorded. The two readings shall be within 5 seconds or 10% of the initial time whichever is greater.

4.3 REPEATABILITY TEST (EXCLUDING SINGLE USE SENSORS)

Determine whether the detector alarms are repeatable.

With the sensing element or sampling port mounted to the fixture in Appendix 1, the enclosure shall be filled with clean air. The flow controllers shall be set to a ratio where the solvent flow controller is 3% higher than the level identified to cause an alarm in section 4.1 and the time to alarm shall be recorded. At the conclusion of the test, the enclosure shall be filled with clean air and the remain in clean air for 5 minutes or the minimum time specified within the instructions manual whichever is greater. The test shall be repeated two additional times. All three readings shall be within 5 seconds or 10% of the average value whichever is greater.

4.4 FUNCTIONAL TESTS FROM ANSI/FM/UL 62990-1

Determine whether the equipment complies with the relevant functional test of ANSI/FM/UL 62990-1.

For functional tests from ANSI/FM/UL 62990-1 for safety monitoring equipment outlined below, the manufacturer shall provide at least one detector. If a single detector is provided, all testing shall be conducted on that sample. If more than one sample is provided, testing shall be in accordance with either column C or utilizing columns A and B. All detectors provided shall be deemed to be representative of the manufacturer's normal production regarding construction and calibration. Any combination of testing shall be performed. The sample completes all testing required in the sequence(s) provided in Table 1.

Table 1

Test Sample(s)			
Test	Sample(s)		
	A	B	C
Unpowered storage	1	1	1
Vibration	2	-	2
Drop (Portable equipment only)	3	-	3
Calibration kit	a	-	a
Temperature	a	-	a
Pressure	a	-	a
Humidity of test gas	a	-	a
Warm-up time	a	-	a
Addition of Sampling probe	a	-	a
Power supply variations	a	-	a
Stability	-	2	a
Extended operation in test gas	a	-	a
EMC	a†	-	a
Fault signal tests	a†	-	a
Software controlled equipment	a†	-	a
Flow Rate	a†	-	a
Orientation tests	a†	-	a
Protection against water	a†	-	a

[Numeric Value] Indicates the test is required, and in a specific sequence.

a Indicates that the test is required, in any order following the tests with a specific sequence.

- Indicates that the test is not required on the sample

† Indicates that an additional sample may be used for the test which may not be preconditioned with the unpowered storages test and the vibration test.

4.5 DETECTOR WITHOUT FIELD CALIBRATION

Determine the reliability of the detectors which do not require routine calibration in the field.

Detectors which do not require field calibration shall comply with the measurement of in-service reliability, alarm, sensor and/or detector reliability prediction and the manufacturing and production tests of ANSI/UL 2075. Detectors which do not require field calibration shall include a field test kit to ensure the functionality of the sensor by exposure to a target gas.

5 MANUFACTURER'S REQUIREMENTS

5.1 DEMONSTRATED QUALITY CONTROL PROGRAM

5.1.1 A quality assurance program is required to assure that subsequent flow test equipment for fire f protection systems 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.

5.3 SURVEILLANCE AUDIT

5.3.1 An audit of the manufacturing facility may be part of the certification agencies 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.

5.3.2 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.

5.4 PRODUCT MODIFICATIONS

5.4.1 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.

6 BIBLIOGRAPHY

ANSI/FM/UL 60079-29-1, *Explosive atmospheres – Part 29-1: Gas detectors – Performance requirements of detectors for flammable gases*.

ANSI/NFPA 70, *National Electrical Code*

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

NFPA 325 *Guide to Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids*.

APPENDIX A

