FM Approvals

CLASS NUMBER 7745

Examination Standard for Liquid Leak Detectors

September 2021

Foreword

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

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

TABLE OF CONTENTS

1. INTRODUCTION

1.1. PURPOSE

1.1.1. This standard states testing and certification requirements for hydrocarbon leak detectors and water leak detectors.

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 states testing and certification requirements for the following applications:

- hydrocarbon liquid leak detectors for above ground
- hydrocarbon liquid leak detectors for below ground
- water leak detectors
- water leak detectors based on water usage pattern
- water leak detectors for roof assemblies
- water supply shutoff valves based on leak detection
- water supply shutoff valves based on water usage pattern

1.2.2. This standard includes design and performance requirements for hydrocarbon leak detectors that can provide point, linear, or area detection of hydrocarbon liquid floating on the surface of water or pooling on a flat surface. The hydrocarbon leak detector shall be certified for the specific hydrocarbon liquid that it is claimed to be capable of detecting. Alternate test liquids (if any) will be determined as part of the certification examination.

1.2.3. This standard includes design and performance requirements for water leak detectors that can provide point, linear, or area leak detection for water pooling on flat surfaces or within the insulation surrounding pipes. Leak detectors can also be based on a meter that measures and profiles water usage. In addition, leak detector systems that include an optional valve to shut off water flow may also be evaluated with this standard.

1.2.4. This standard includes design and performance requirements for water leak detectors used in roof assemblies. This standard applies to two types of detection systems to detect water leakage through the roof membrane of a roof assembly. One type is constantly monitored using a control panel with sensors built into the roof assembly. The second type is performed by a technician conducting a scan of the roof surface using a low or high voltage electronic scanning system over the surface of the roof membrane. The manual scanning device is used to measure the electrical path between the wetted membrane and a conductive layer under the membrane.

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, and loss control specialists was also considered.

1.3.2. The requirements of this standard reflect tests and practices used to examine characteristics of hydrocarbon or water leak detectors for the purpose of obtaining certification. Hydrocarbon or water leak detectors having characteristics not anticipated by this standard may be certified if performance equal, or superior, to that required by this standard is demonstrated.

1.4. BASIS FOR CERTIFICATION

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

1.4.1. Examination and tests on production samples shall be performed to evaluate

- the suitability of the product;
- the performance of the product as specified by the manufacturer and required for certification; and as far as practical,
- the durability and reliability of the product.

1.4.2. An examination of the manufacturing facilities and audit of quality control procedures is made to evaluate the manufacturer's ability to consistently produce the product which is examined and tested, and the marking procedures used to identify the product. Subsequent surveillance may be required by the certification agency in accordance with the certification scheme to ensure ongoing compliance.

1.5. BASIS FOR CONTINUED CERTIFICATION

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

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

1.6. EFFECTIVE DATE

The effective date of this certification standard mandates that all products tested for certification after the effective date shall satisfy the requirements of that 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/IEC 60529 – Degrees of Protection Provided by Enclosures (IP Code)

ANSI/UL 60079-0 – Electrical Apparatus for Use in Class I, Zones 0, 1 & 2 Hazardous (Classified) Locations: General Requirements

ASTM D7877 - Standard Guide for Electronic Methods for Detecting and Locating Leaks in Waterproof Membranes

ASTM D8231 - Standard Practice for the Use of a Low Voltage Electronic Scanning System for Detecting and Locating Breaches in Roofing and Waterproofing Membranes

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

FM 3600 – Electrical Equipment for Use In Hazardous (Classified) Locations – General Requirements

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

UL 50 Standard for Safety – Enclosures for Electrical Equipment, Non-Environmental Considerations

2. GENERAL INFORMATION

2.1. PRODUCT INFORMATION

2.1.1. A liquid leak detection system consists of a control unit and one or more sensors. Sensors may also be certified for use with a suitable certified control unit. A voltage free dry contact is typically used to provide the indication a leak, other communication formats can also be used subject to evaluation. The system can be configuration of nodes in the protected area and a control unit or gateway that communicates to other Internet of Things (IoT) devices. The connection between the sensors (nodes) and the gateway may be wired or wireless or a combination of the two.

2.1.2. Hydrocarbon leak detectors may be for the detection of hydrocarbon liquid floating on the surface of water or pooling on a flat surface. The hydrocarbon leak detector shall be certified for the specific hydrocarbon to be detected. Alternate test liquids (if any) will be determined as part of the certification examination.

2.1.3. Water leak detectors are for detection of water pooling on a surface, leaking from an overhead pipe, leaking between a pipe and the pipe insulation or leaking through a roof membrane.

2.1.4. Roof membrane liquid leak detectors consist of a control unit and sensors to continuously monitor the roof assembly for leaks. The roof assembly is built and tested with sensors installed in the assembly. Continuously monitored sensors may also be certified for use with a suitable certified control unit.

2.1.5. Low or High Voltage Electronic Scanning Systems are used to verify the integrity of a roof membrane after installation or during the service life of the membrane. The system requires an operator to manually scan the surface of the roof with the scanning system. Manual verification systems alert the operator to the presence of a leak with audible and visual indicators.

2.1.6. System components may be tested and certified as a system or can be certified separately, for use with other certified system components. Compatibility between separate system components must be verified by a compatibility evaluation of the electrical characteristics of each component or may require testing and examination if compatibility cannot be established. A system interconnection diagram must be provided for system configurations of separately certified system components. Evaluations of “component only” certification requests will be at the discretion of the certification agency.

2.1.7. For systems that incorporate a water meter or valve to shut off water flow, this standard allows designs for use with nominal pipe sizes ranging from NPS 1/2 through 2 inch (DN15 – DN50). Examination of sizes outside this range will be on a case-by-case basis.

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 and electrical schematics, nameplate format, brochures, sales literature, spec. sheets, installation, operation and maintenance procedures.
- 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.

- Test samples shall be a complete assembly with all components mounted in a manner consistent with the manufacturer’s instructions and intended application.
- 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 required to test their specific design.

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 final certification.

3.2. REQUIRED FEATURES

3.2.1. Permanently connected equipment and wireless equipment shall be provided with means to mount the detector securely and independently of the wiring and sensing elements.

3.2.2. The detector shall be capable of withstanding normal handling and installation.

3.2.3. Means shall be provided to display the following status indications of the detector

A. Power

B. Fault

C. Alarm

These indicators shall be adequately labeled to show their functions.

If only a single indicator is provided the priority of reporting/indication shall be Alarm, Fault, Power.

3.2.4. The detector and enclosure shall be suitable for the intended environmental exposures as determined by testing in accordance with acceptable national, regional, or international electrical codes.

3.2.5. Detectors rated at or above 30 V ac and 60 V dc require a proper ground terminal to be provided.

3.2.6. The detector shall provide an output that will produce a detection signal to a remotely located control within the time limits defined below on exposure to hydrocarbon liquid or water. The detector shall also produce a signal within the time limits defined below when a power failure or fault disables the detector.

TABLE 3.2.5a – Hydrocarbon Detector Response Times

Hydrocarbon Leak Detectors				
Indication	***Above Ground Hydrocarbon Leak Detectors***	***Below Ground Hydrocarbon Leak Detectors Category 1***	***Below Ground Hydrocarbon Leak Detectors Category 2***	***Below Ground Hydrocarbon Leak Detectors Category 3***
Alarm	*30 seconds*	*10 minutes*	*1 hour*	*2 hours*
Power Failure *Low Battery* *Fault* *Loss of Comm.*	*200 seconds*			

TABLE 3.2.5b – Water Detector Response Times

Water Leak Detection			
Indication	***Water Leak Detectors***	***Continuously Monitored Roof Leak Detectors***	***Portable Scanning Roof Leak Detectors***
Alarm	*30 seconds*	*8 hours*	*30 seconds*
Power Failure *Low Battery* *Fault* *Loss of Comm.*	*300 seconds*	*8 hours*	*300 seconds*

3.2.7. In addition to this standard, equipment intended for use in Hazardous (Classified) Locations shall comply with FM 3600. Additionally, the equipment shall comply to ANSI/UL 60079-0 when intended for installations in Class I, Zone 0, 1 or 2 Hazardous (Classified) Locations.

3.2.8. Hydrocarbon sensors shall be properly rated for use in Class I, Division 1 or Zone 0, 1 Hazardous (Classified) Locations when intended for use with liquids with a closed cup flash point less than or equal to 100°F (37.8°C) or when used in areas where ignitable liquids can be heated above their flash points.

3.2.9. Battery powered equipment shall have a battery life of one year or more. Battery life shall be calculated based on normal operation with no alarms present.

3.2.10. Battery powered equipment shall produce a low battery indication. The detector shall continue to operate for 7 days under the low battery indication. At the end of 7 days the detector shall be capable of generating an alarm indication.

3.2.11. Sensing cables used for nonstandard protection alarm times must respond with 3 feet (1 meter) or less of wetted cable length.

3.2.12. Optional components such as water meters or valves to shut off water flow shall be rated for the intended water service pressure. Minimum rated working pressure for these components shall be 150 psi (1035 kPa).

3.2.13. For systems that incorporate a water meter or valve to shut off water flow, this standard allows designs for use with nominal pipe sizes ranging from NPS 1/2 through 2 inch (DN15 – DN50). Examination of sizes outside this range will be on a case-by-case basis.

3.2.14. For systems that include a valve to shut off water flow, the operation of the valve shall be performed using electric or pneumatic controlled valve operator. When the valve is closed there shall be a notification.

3.2.15. Water supply shut off valves shall be exercised no less than every 30 days to ensure proper operation and the results of those test should be recorded and available.

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;
- model number, size, ratings, and applicable precautionary information.

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 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. "FM 7745" to represent conformance to the performance standard.

3.3.5. 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, maintenance, and operation of the product;
- Provide facilities for repair of the product and supply replacement parts; and
- Provide services to ensure proper installation, inspection, or maintenance for products of such nature that it would not be reasonable to expect the average user to be able to provide such installation, inspection, or maintenance.

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 as traceable to the National Institute of Standards and Technology (NIST) or traceable to other acceptable reference standards 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. GENERAL REQUIREMENTS (ALL DETECTORS)

4.1.1. Minimum Detection Level

Based on amounts specified by the manufacturer, the detector shall respond to the defined liquid exposure according to Section 3.2.5. Certain detector samples will be subjected to a baseline sensitivity test to establish sensitivity by which the results of other tests in the program will be measured. This will establish baseline sensitivity.

4.1.2. Detector Failure Modes

Any failure of the detector shall result in a fault indication. Tests will be conducted by introducing short circuit faults, open circuit faults and any other type of faults deemed to be appropriate for the construction of the detector. Sensor connections extending less than three inches from the detector electronics are not subject to short circuit or open circuit faults.

4.1.3. Resettable Detectors

Detectors that can be reset and reused after going into an alarm state shall be capable of restoring operation without any changes to the operating characteristics. The baseline sensitivity detection time shall remain less than 30 seconds following 500 detection/reset cycles. (EXCEPTION – This requirement does not apply to Continuously Monitoring Roof Membrane Leak Detection Systems and Low Voltage Electronic Scanning Systems).

4.1.4. Humidity Cycling and Conditioning

A. The detector sensor shall remain functional and produce no false indication of alarm when subjected to a change from 50% relative humidity at 70°F (21°C), to 90% relative humidity at 100°F (38°C) in 15 minutes. (EXCEPTION – This requirement does not apply to Continuously Monitoring Roof Membrane Leak Detection Systems and Low Voltage Electronic Scanning Systems).

B. The detector and control unit shall remain functional, with no trouble signal or change in operating characteristics, detection time shall comply with Section 3.2.5, and shall produce no false indication of alarm when subjected to a humidity test as follows:

- For detectors intended solely for indoor dry environments, a relative humidity of 93%±2% and temperature of 90°F±3°F (32°C±2°C) for a period of 24 hours.
- For detectors intended for indoor/outdoor damp or wet environments, a relative humidity of 95%±3% and temperature of 140°F±3°F (60°C±2°C) for a period of 24 hours.

C. The detector and control unit shall remain functional, with no trouble signal or change in operating characteristics, detection time shall comply with Section 3.2.5, and shall produce no false indication of alarm when subjected to 4 hours at the rated high and low ambient temperature rating.

4.1.5. Voltage Range

The device shall produce no trouble signal or false detection and detection time shall comply with Section 3.2.5 when operated between 85% and 110% of rated input voltage. If an absolute voltage range, beyond the 85% and 110% of nominal, is specified by the manufacturer, the unit will be tested at the extremes of the range.

4.1.6. Vibration

The detector assembly shall be subjected to 24 hours duration at a total displacement of 0.02 in. (0.5 mm) while swept every 30 seconds through a vibration frequency range of 10 to 30 Hz. No impairment of function is allowed; the detector shall operate properly after this exposure.

4.1.7. Dielectric Strength

The detector assembly shall be capable of withstanding a high potential between input/output terminals and ground, for one minute without arcing or breakdown.

A. For an operating voltage of 30Vac (60Vdc) or less, a potential of 500Vac (710Vdc) shall be applied between input/output terminals and enclosure ground for one minute.

B. For an operating voltage greater than 30Vac (60Vdc), a potential of 1000Vac + twice the rated voltage shall be applied between input/output terminals and enclosure ground for one minute.

4.1.8. Bonding

Any accessible conductive surface which is likely to become energized in the event of a fault shall be bonded to the protective ground terminal with a circuit resistance of less than or equal to 0.1 ohm. This requirement applies to detectors in which the maximum voltage is greater than 30 V rms or 60 V dc. The bonding conductor(s) shall be green or green with one or more yellow stripes. The size of the bonding conductor(s) shall be at least equivalent in size to the primary circuit conductors.

4.1.9. Dust Test

The sensitivity of the detector shall not be reduced by the accumulation of dust. Two detector samples are placed un-energized in the air tight dust chamber. Approximately 2 ounces (0.06kg) of cement dust, maintained in an ambient room temperature of approximately 73.4°F +/- 3.6K (23°C +/- 2K) at 20-50% relative humidity and capable of passing through a 200 mesh screen, are to be circulated for 15 minutes by means of compressed air or blower to completely envelop the sample in the chamber. The air flow is maintained at an air velocity of at least 50fpm (0.25m/s). The detection time shall comply with Section 3.2.5 following this exposure. (EXCEPTION – This requirement does not apply to Continuously Monitoring Roof Membrane Leak Detection Systems and Low Voltage Electronic Scanning Systems).

4.1.10. Static Discharge Test

The intended performance of the detector shall not be impaired or a false detection obtained when the detector is subjected to static electric discharges. Two detector samples are mounted on the underside of a 3⁄4 inch (19.1 mm) thick plywood panel in its intended mounting position and connected to a nominal power source in accordance with the manufacturers instructions. If an electrical junction box is normally employed, it shall be properly connected to earth ground for the purpose of this test. A 250 Pico farad low leakage capacitor, is charged through a 1,500 ohm resistor for a minimum of 2 seconds to a 10,000 Vdc power source. Once charged, it is then discharged through an insulated 3 ft (0.91 m). long probe with 1⁄2 in. (12.7 mm) spherical ends by attaching one probe to the detector and the other to earth ground. Discharges shall be applied at 5 minute intervals to different positions on the surface of the detector as well as locations accessible during cleaning or field adjustments. A total of 10 discharges are made with the probe, with an additional 10 discharges to the accessible internal locations unless the detector is marked that no field servicing is possible.

4.1.11. Extraneous Transients

No false signal will be generated when the detector is subjected to extraneous transients from sources which are described below:

One powered sample of the detector will be subjected to extraneous transients described below at a distance of 24 inches.

A. radio frequency transmissions with radiation power levels equivalent to 5 Watts at 24 inches (0.6 m) in the 27 MHz, 150-174 MHZ, 450-467 MHZ, 850-870 MHz, and 900-920 MHz bands.

B. a sequential arc (Jacob's ladder) generated between two 15 in. (0.4 m) long, No. 14 AWG (2.1 mm) solid copper conductors attached rigidly in a vertical position to the output terminals of an oil burner ignition transformer or gas tube transformer rated 120 volts, 60 hertz primary; 10,000 volts, 60 hertz, 23 mA secondary. The two wires are to be formed in a taper, starting with a ⅛ in. (3.2 mm) separation at the bottom (adjacent to terminals) and extending to 1.25 in (32 mm) at the top.

C. operation of an electric drill rated 120 V, 60 Hz, 2.5 A.

D. operation of a soldering gun rated 120 V, 60 Hz, 2.5 A.

E. peration of a 6 in (150 mm) diameter solenoid-type vibrating bell with no arc suppression and rated 24 V dc.

The detector will produce no false detection or trouble signal in the presence of these extraneous transients, and it will respond satisfactorily to a baseline test in the presence of the extraneous transients.

4.1.12. Surge Transient Tests

Protection against line surge transients will be a requirement for each submitted detector. One powered sample of the detector will be subjected to transient waveforms having peak levels of 100, 500, 1000, 1500, and 2400 V dc, as delivered into a 200-ohm load. This requirement applies to all field wiring terminals that have a possibility of being subjected to line-induced voltage (i.e., initiating device circuits, power circuits, and remote/auxiliary connections). Wireless connections are excluded from this requirement.

4.1.13. Enclosure Requirements (including Polymeric)

The detector enclosure (control panel) shall meet Type 1 enclosure ratings as defined in UL 50 or IP40 defined in ANSI/IEC 60529 as a minimum for indoor applications. If the detector enclosure is mounted in the area where the sensors are installed the enclosure shall meet Type 3R enclosure ratings as defined in UL 50 or IPX4 defined in ANSI/IEC 60529 as a minimum for indoor applications. It is not necessary to mark the product for Type 1 enclosures. Additional claims made by the manufacturer will be verified according to appropriate enclosure classifications.

4.2. HYDROCARBON LEAK DETECTOR REQUIREMENTS

4.2.1. Minimum detection level, dry floor

This requirement applies to detectors intended to detect a pool of hydrocarbon liquid on a dry level floor. The detector sample shall be installed on a flat dry surface. Hydrocarbon liquid shall be introduced to establish the baseline sensitivity according to the manufacturer's performance claims which shall represent a minimum exposure that the detector will respond to consistently.

4.2.2. Minimum detectable film of hydrocarbon liquid floating on water

This requirement applies to detectors intended to detect a pool of hydrocarbon liquid floating on the surface of water. The detector sample shall be installed in a water filled sump. The hydrocarbon liquid shall be introduced to establish the baseline sensitivity according to the manufacturer's performance claims which shall represent a minimum exposure that the detector will respond to consistently.

4.2.3. Maximum/Minimum height of water in sump

The range of water depth that detector can be installed and still respond to a detectable film of hydrocarbon liquid floating on water shall be specified by the manufacturer. The detector will be tested at the maximum and minimum water depths specified by the manufacturer. The baseline sensitivity detection time shall remain less than 30 seconds at the extremes of the water depth range.

4.2.4. Stability – Thermal Cycling

The detector shall be able to withstand in standby operation with the ambient temperature cycled between the rated temperature extremes for a total of 180 cycles. The test sample shall remain for 30 minutes at each extreme once thermal equilibrium is reached. The detector shall operate properly as described in Section 3.2.5 and there shall be no false detection nor any evidence of instability. The test shall be conducted consistent with the manufacturer's intended installation environment (outdoor, submerged in water, buried…etc.) Detectors for use in locations where water may be present shall be submerged in water for this test.

4.2.5. Durability and corrosion resistance: in sea water, in mild acids

The detector shall be compatible with the corrosion and acidic atmospheres that are specified by the manufacturer's claims. The manufacturer's installation instructions shall include suitable warnings if the detector is not compatible with salt exposure or acidic atmospheres.

A. Detectors specified for use in sea water or in environments that may have salt exposure shall be subjected to the Corrosion Protection Test defined in UL 50.

B. Detectors specified for use where solvent exposure is possible shall be resistant to chemical or physical change due to solvent exposure. As a result of chemical compatibility testing, there shall be no permanent change in baseline test response. The specific test chemicals shown below will be used for testing to represent the corresponding representative chemical family.

Chemical Families

Test Chemical	***Representative Chemical Family***
Acetone	*Ketones*
Gasoline	*Aliphatic Hydrocarbons*
Hexane	*Aliphatic Hydrocarbons*
Methanol	*Alcohols*
Ethyl Acetate	*Esters*
Acetic Acid	*Acids*

EXCEPTIONS

Materials not passing the required chemical compatibility test for one or more of the six test chemicals may be considered satisfactory if the product nameplate or installation manual shows the exclusion of the chemical family(ies) from the rating of the equipment.

4.3. WATER LEAK DETECTOR REQUIREMENTS

4.3.1. Minimum detection level, dry floor

This requirement applies to detectors intended to detect a pool of liquid on a dry level floor. The detector sample shall be installed on a flat dry surface. Liquid shall be introduced to establish the baseline sensitivity according to the manufacturer's performance claims which shall represent a minimum exposure that the detector will respond to consistently.

4.3.2. Minimum level for detector designed for attachment on or in pipes

This requirement applies to detectors designed for attachment to overhead pipes. The detector sample shall be installed according to the manufacturer's instructions. Liquid shall be introduced to establish the baseline sensitivity according to the manufacturer's performance claims which shall represent a minimum exposure that the detector will respond to consistently.

4.3.3. Stability – Thermal Cycling

The detector shall be able to withstand in standby operation with the ambient temperature cycled between the rated temperature extremes for a total of 180 cycles. The test sample shall remain for 30 minutes at each extreme once thermal equilibrium is reached. The detector shall operate properly as described in Section 3.2.5 and there shall be no false detection nor any evidence of instability. The test shall be conducted consistent with the manufacturer's intended installation environment.

4.3.4. Durability and corrosion resistance: in sea water, in mild acids

The detector shall operate properly after exposure to corrosive or acid exposure. The manufacturer's installation instructions shall include suitable warnings if the detector is not compatible with salt or mild acid exposure.

A. Detectors specified for use in sea water or in environments that may have salt exposure shall be subjected to the Corrosion Protection Test defined in UL 50.

B. Detectors that are subject to mild acids shall be resistant to chemical or physical change due to acid exposure. Samples shall be immersed each in a 90% water 10% acid solution for 24 hours at a depth within the detection zone. One solution is 10% Sulfuric Acid (H_2SO_4) the other solution is 10% Nitric Acid (HNO_3). The exposure shall be conducted under normal laboratory conditions where the temperature average is 20°C ± 3°C. The detector shall operate properly following this exposure.

4.4. INLINE WATER LEAK DETECTOR REQUIREMENTS

4.4.1. Minimum detection level for inline leakage sensors

The inline leakage sensor system shall be installed according to the manufacturer's instructions. Liquid flow shall be started from zero and increased slowly in order to establish the minimum flow at which the water meter registers activity. Samples of each nominal size submitted for evaluation shall be tested.

4.4.2. Performance of Inline Leak Detection Systems

Using the information provided by the manufacturer regarding control unit triggers, the test plan will subject the system to a variety of flow conditions in order to determine performance. The test plan will incorporate a period of repeatable flow rates and durations of flow that would be consistent with the "normal" use of downstream appliances. After the initial period, the repeatable flow rates and durations will continue, but will be joined with additional durations of "test leaks" which will vary from just below the minimum to twice the minimum sensitivity from Section 4.4.3. The "test leaks" will be timed to happen both during period of no other planned flow, and in conjunction of planned flows. The inline leak detection system shall demonstrate that it can identify all "test leaks" during the performance testing.

4.4.3. Flow Accuracy

Samples shall be subjected to the range of flow rates in Table 4.4.3.1 in both increasing and decreasing values of flow. At each data collection point the flow shall be allowed to stabilize and then the measurement taken. A minimum of five points shall be used to establish the performance of the meter across the range. Meter shall register not less than 97 percent and not more than 103 percent of the water that actually passes through the meter. If the manufacturer's literature states performance capabilities beyond the test range limits stated in Table 4.4.3.1, then the test shall be performed using the wider range.

TABLE 4.4.3.1 – Flow Ranges

Nominal Device Size		***Normal Flow and Test Range Limits***	
in.	***DN***	***gpm***	***L/min***
½, ¾	*20*	*1 - 25*	*3.8 – 95*
1	*25*	*1 - 40*	*3.8 – 150*
1-1/4	*32*	*2 - 70*	*7.5 – 265*
1-1/2	*40*	*3 - 95*	*11.5 – 360*
2	*50*	*5 - 155*	*19 – 585*

4.4.4. Hydrostatic Strength

Samples shall be subjected to an internal hydrostatic pressure of 600 psi (4135 kPa) or four times the rated working pressure, whichever is greater, for a duration of five minutes. There shall be no visible rupture, cracking or permanent deformation as a result of this test.

4.5. SHUT OFF VALVE REQUIREMENTS

4.5.1. Seat Leakage

Samples shall be brought to the closed position. With one side open to atmosphere, the other side of the valve shall be filled with water and pressurized to 30 psi, 100 psi and the greater of rated working pressure and 150 psi (205, 690 and 1035 kPa) for a duration of five minutes at each pressure. Unless the valve is unidirectional, this test shall be repeated for each direction of flow.

4.5.2. Ball or Disc Strength

Samples of valves shall be brought to the closed position. One side of the test sample shall be filled with water and pressurized to twice the rated working pressure or 300 psi (2070 kPa), whichever is greater. The opposite side shall be open to atmosphere. The test pressure shall be held for five minutes, and then the valve shall be visibly examined for damage. If the valve is bi-directional, then this test shall be performed for each flow direction. After this testing, the valve shall still meet the requirements of Section 4.5.1, Seat Leakage.

4.5.3. Stem Seal

Samples shall be placed in the partially open position and subjected to an internal hydrostatic pressure equal to the rated working pressure. The sample shall be cycled between OPEN and CLOSE positions twelve times over the course of the 5-minute test duration. There shall be no observed leakage past the stem seal.

4.5.4. Hydrostatic

Sample shall be brought to the open position, filled with water and internally pressurized to a hydrostatic pressure equal to 600 psi (4135 kPa) or four times the rated working pressure, for a duration of five minutes. Following the test the valve shall be visually inspected for damage as a result of this test.

4.5.5. Durability

Prior to the start of the Durability testing, samples shall have been subjected to Section 4.5.1, Seat Leakage testing in order to establish initial performance. The sample shall then be installed so that it is subjected to an upstream pressure equal to the rated working pressure when in the CLOSE position, and downstream side open to atmospheric pressure (0 psi, 0 kPa). During the testing the cycling speed shall be five to ten cycles per minute. After completion of the cycling test, the valve shall comply with Section 4.5.1, Seat Leakage and Section 4.5.3, Stem Seal testing.

4.6. ROOF MEMBRANE LEAK DETECTION SYSTEMS, CONTINUOUSLY MONITORED SYSTEMS AND SCANNING TYPE SYSTEMS

4.6.1. Standard Leaks

A. Leak Detection Systems with Leak Detecting Elements Installed Directly Below the Roof Cover:

A simulated breach is introduced through the top surface of the roof covering system using a 10 gauge 1/8 in. (3.2 mm) steel needle at a location a maximum of 2 in. (51 mm) from the leak sensing element as applicable. A Stainless steel flange with a 41/2 in. (114 mm) diameter opening and a height of 11/4 in. (32 mm) is placed with the opening centered over the breach and affixed to the top surface of the roof covering system with high-vacuum seal O-ring grease. The amount of water to be used is 6 ounces (177ml). The leak shall be allowed to set for up to 24 hours before the alarm detection time is measured.

B. Leak Detection Systems with Leak Detecting Elements Installed Within or Below the Insulating Layers of the Roof Assembly:

Water is introduced to the test sample via a funnel/tubing system. The funnel shall be made up of the following: 11/2 to 1 in. (38 to 25 mm) straight reducer, 1 to 1/2 in. (25 to 13 mm) straight reducer, 90 degree 1/2 to 3/8 in. (13 to 9.5 mm) compression fitting, and tubing with a 1/4 in. (6.4 mm) inside diameter opening. The amount of water to be used is 6 to 45 oz. (0.18 to 1.3 L). The leak shall be allowed to set for up to 24 hours before the alarm detection time is measured.

4.6.2. Stability – Thermal Cycling

A small scale sample of the specific roof assembly shall be able to withstand in standby operation with the ambient temperature cycled between the manufacturers rated temperature extremes, stabilized at each extreme for one hour, for a total of 180 cycles. The test sample shall remain for 30 minutes at each extreme once thermal equilibrium is reached. The detector shall operate properly as described in Section 3.2.5 and there shall be no false detection nor any evidence of instability. Following this exposure a the sample shall be subjected to the approprate leak described in Section 4.4.1 of this standard and respond as described in Section 3.2.5.

4.6.3. Wind Cycle

A sample shall be prepared with water sensing elements installed in the subject 5x9 ft roof assembly according to the Leak Detection System manufacturer's instructions. The sample shall be unpowered during the test. The roof assembly shall be subjected to wind cycling in accordance with FM Approvals "5x9 ft. Wind Uplift Tests for Single-Ply and Multi-Ply Roof Coverings Using Positive Static Pressure" or "5x9 ft. Wind Uplift Tests for Single-Ply and Multi-Ply Roof Coverings Using Reduced Static Pressure" requirements, as applicable. The sample shall be loaded to a pressure equivalent to half the certified Wind Uplift Rating up to a maximum 90 psf for a minimum of 60 seconds. Pressure shall be released back to 0 psf prior to continuing. Following this exposure, the sample shall be subjected to the appropriate leak described in Section 4.4.1 of this standard and respond as described in Section 3.2.5.

4.7. ROOF MEMBRANE VOLTAGE ELECTRONIC SCANNING SYSTEMS

4.7.1. Functional Testing

Functional testing of low voltage electronic scanning systems for water leak from above the roof deck shall be in accordance with Standard Practice for the Use of a Low Voltage Electronic Scanning System for Detecting and Locating Breaches in Roofing, ASTM D8231 or Standard Guide for Electronic Methods for Detecting and Locating Leaks in Waterproof Membranes, ASTM D7877, ASTM International.

4.8. ADDITIONAL REQUIREMENTS

Additional tests may be required, at the discretion of the certification agency, depending on design features and results of any foregoing tests.

5. OPERATIONS REQUIREMENTS

5.1. DEMONSTRATED QUALITY CONTROL PROGRAM

5.1.1. A quality control program is required to assure that subsequent detectors produced by the manufacturer at an authorized location, shall present the same quality and reliability as the specific detectors 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.

Each apparatus shall be provided with an instruction manual that includes the following information:

A. complete instructions, drawings and diagrams for safe and proper operation, installation and servicing of the apparatus,

B. operating instructions and adjustment procedures,

C. recommendations for initial checking and calibration/verification of the apparatus on a routine basis, including instructions for the use of the field calibration kit, if provided

D. details of operational limitations including, where applicable, the following:

- liquids for which the apparatus is suitable,
- information that describes the sensitivities to other liquids to which the apparatus is responsive,
- temperature limits,
- humidity ranges,
- supply voltage limits,
- maximum power consumption,
- relevant characteristics and construction details of required interconnecting cables,
- warm-up time,
- stabilization time

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

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

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

5.2. SURVEILLANCE AUDIT

5.2.1. An audit of the manufacturing facility may be part of the certification 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.

5.2.2. 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. INSTALLATION INSPECTIONS

Field inspections may be conducted to review an installation. The inspections are conducted to assess ease of application, and conformance to written specifications. When more than one application technique is used, one or all may be inspected at the discretion of the certification agency.

5.4. 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.

5.5. MANUFACTURING AND PRODUCTION TESTS

Detectors 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 1000 V ac, 60 Hz, or 1400 V dc with respect to the protective ground lead. Alternatively, test potentials 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 under controlled conditions, and by persons knowledgeable of the potential hazards of such testing to minimize the likelihood of shock and/or fire.