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Examination Standard for Combustion Safeguards and Flame Sensing Systems

Class Number 7610

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Foreword

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

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

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Purpose

1.1.1 This standard states testing and certification criteria for combustion safeguards and flame sensing systems.

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 sets performance requirements for combustion safeguards and flame sensing systems used as safety controls for commercial and industrial heating equipment. They may be independent non- programmable or programmable.

Note: A programmable combustion safeguard is one that allows a limited selection of safety parameters such as purge, trial for ignition, and flame failure response time. Programmable logic controllers used for burner management are not included in this standard.

1.2.2 A combustion safeguard is a device intended to provide safe start, safe operation, and safe shutdown under normal or abnormal conditions. This device is used in conjunction with a flame sensing system.

1.2.3 A flame sensing system detects the presence and absence of flame. It may be of the flame rectification, infra-red, or ultra-violet type. Sensors may be capable of monitoring coal, gas, and/or oil flames, and are a primary component of a combustion control system.

1.2.4 The requirements of this standard shall be used to measure and describe the performance of combustion safeguards and flame sensing equipment in response to exposure from heat, cold, abnormalities, etc., under controlled laboratory conditions. The results of these controlled exposures shall not be used to describe or appraise actual exposure conditions since such conditions will vary widely.

1.3 Basis for Requirements

1.3.1 The requirements of this standard are based on experience, research and testing, or the standards of other national and international organizations. The advice of manufacturers, users, trade associations, and loss control specialists was also considered.

1.3.2 The requirements of this standard reflect tests and practices used to examine characteristics of the subject equipment for the purpose of obtaining Certification. Equipment 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 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, 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 agencies 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 this standard.

The effective date of this Standard is eighteen (18) months after the publication date of the standard for compliance with all requirements.

1.7 System of Units

Units of measurement used in this Standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate. Conversion of U.S. customary units is in accordance with ANSI/IEEE/ASTM SI 10.

1.8 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the cited edition applies.

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

1.9 Terms and Definitions

For purposes of this standard, the following terms apply:

Combustion safeguard - a safety control that is directly responsive to flame properties. It senses the presence of flame and causes the fuel to be shut off if the flame fails.

Flame failure response time – the time for the flame sensing system to react to a loss of flame.

Flame supervision - the detection of the presence or absence of flame.

Pilot-flame establishing period - that interval of time during lighting-off when a safety control circuit permits the pilot fuel safety shutoff valve to remain open before the combustion safeguard is required to prove the presence of the pilot flame.

Purge time - the time it takes the control unit to expel any remaining combustible fluid or gas from the fuel carrying components.

Safety shutdown - occurs when a safety interlocks(s) stops burner operation by shutting off all fuel and ignition energy to the furnace. It requires a manual re-start.

Trial-for-ignition period - that time during lighting-off when a safety control circuit permits the main burner fuel safety shutoff valve to remain open before the combustion safeguard is required to supervise the main burner flame alone.

2. GENERAL INFORMATION

2.1 Product Information

Combustion safeguards and flame sensing equipment is comprised of electronic components that when combined in accordance with the manufacturer's instructions make up part of or a complete Combustion Safeguards and Flame Sensing System. They may be fabricated and shipped as complete assemblies or sub-assemblies.

2.2 Certification Application Requirements

The manufacturer shall provide the following preliminary information with any request for certification consideration:

- A complete list of all models, types, sizes, and options for the products or services being submitted for certification consideration;
- General assembly drawings, complete set of manufacturing drawings, materials list, anticipated marking format, piping and electrical schematics, nameplate format, brochures, sales literature, spec. sheets, installation, operation and maintenance procedures, and
- the number and location of manufacturing facilities.
- All documents shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level. All 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. 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, such as those which may be required to evaluate the combustion safeguards and flame sensing systems.

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, Structural, and Operational Requirements

3.2.1 Combustion safeguards and flame detection systems shall be available as complete and identifiable assemblies. They shall perform in all respects to the manufacturer's specifications.

3.2.2 The operating temperature range shall be at least 32°F (0°C) to 140°F (60°C).

3.2.3 Electrical contacts, terminals, and other vulnerable components shall be adequately protected from damage and expected atmospheric conditions.

3.2.4 Relays in the interlock and safety shutdown circuit(s) shall be capable of operating reliably and consistently, at maximum rated electrical load, for a minimum of 100,000 operational cycles.

3.2.5 For programmable combustion safeguards, safety-related operating characteristics such as purge times, trial for ignition times, flame failure response times, etc., shall not be readily accessible or alterable by the operator.

3.2.6 Presence of a flame signal (real or due to a fault) prior to the ignition cycle shall result in shutdown and lockout.

3.2.7 Failure to establish a pilot or main flame within the trial-for-ignition period shall result in shutdown and lockout.

3.2.8 A single, automatic retrial for ignition is allowable if flame failure occurs during the normal firing cycle. Automatic recycle is not allowed for gas burners with a fuel input greater than 2,500,000 Btu/hr (730 kW) or oil burners with a fuel input greater than 2,800,000 Btu/hr (820 kW).

3.2.9 A combustion safeguard, in conjunction with its flame sensor, shall react to flame failure within 4 seconds or less.

3.2.10 Flame sensors shall be immediately operable when the main power to the detection/combustion safeguard system is turned on.

3.2.11 The available trial-for-ignition period, for pilot flames, shall not exceed 10 seconds.

3.2.12 The available trial-for-ignition period, for main flames, shall not exceed the following:

A. Gas burners

1. 2,500,000 Btu/hr (730 kW) or less: 15 sec.

2. Greater than 2,500,000 Btu/hr (730 kW): 10 sec.

B. Oil burners

1. Less than 2,800,000 Btu/hr (820 kW): 15 sec.

2. 2,800,000 Btu/hr (820 kW) or more - No.1 - No.4 oil: 10 sec.

3. 2,800,000Btu/hr (820 kW) or more - No.5, 6 oil: 15 sec.

3.2.13 The equipment shall be capable, as a minimum, of operation at 85 and 110 percent of nominal rated input voltage.

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, type of flame detection, electrical ratings, operating temperature range, and terminal identification etc., as appropriate.

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 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 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 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 Examination of Sample(s)

4.1.1 The sample(s) submitted for examination and test shall conform to the manufacturer's drawings and specifications, along with the applicable certification requirements noted in Section 3.2.

4.1.2 The sample(s) shall be examined and compared to the manufacturer's drawings and specifications and applicable certification requirements noted in Sections 3.2.1, 3.2.2, 3.2.8, 3.2.11, and 3.2.12.

4.2 Operating Characteristics—Combustion Safeguards

4.2.1 The equipment shall operate properly in accordance with the manufacturer's specifications and applicable certification requirements noted in Sections 3.2.6, 3.2.7, 3.2.8, and 3.2.10 under normal and abnormal conditions.

4.2.2 A combustion safeguard shall be operationally tested in conjunction with a flame sensing system. The sample shall operate properly through its specified normal start-up and shut-down procedure. The flame sensing system shall be activated immediately upon application of power to the safeguard.

4.2.3 The safeguard shall shut down and lock out if flame is detected prior to the ignition cycle or upon failure to establish flame during the ignition cycle.

4.2.4 The safeguard shall react properly to loss of flame signal by opening the safety shutoff valve circuit and, if so configured, shall attempt only one automatic retrial for ignition.

4.2.5 If so configured, the safeguard shall shut down and lock out if safety interlocks for airflow, pressure, temperature, and valve position are not in the proper state either upon startup or during the burner operating cycle.

4.3 Operating Characteristics—Flame Sensing Systems

4.3.1 The flame detector (scanner) in a flame sensing system shall be activated immediately upon application of power to the system.

4.3.2 The system shall operate properly in accordance with the manufacturer's specifications for method of flame detection (infra-red, rectification, ultra-violet) and flame signal strength.

4.3.3 Systems equipped with a self-checking provision shall lock out and open the flame relay output circuit upon detection of an abnormal condition. Self checking is normally accomplished by periodically interrupting the flame signal for a specified amount of time, either mechanically or electronically.

4.3.4 The detector shall be aimed at an actual or simulated flame. Power shall then be applied to the system. The system shall immediately indicate presence of flame by a signal light, meter indication, lockout, and/or activation of the flame relay output circuit.

4.3.5 The detector shall be subjected to an actual or simulated flame that can be varied in intensity, wavelength, or ''flicker'' frequency as applicable to the particular detection method. The detector shall not indicate presence of flame or activate the flame relay when subjected to signals outside of its specified wavelength or frequency bandwidth or at a signal level below the specified threshold value.

4.3.6 The system shall lock out and open the flame relay output circuit when the self-check feature is

disabled.

4.4 Timings

Note: If a hand-held stopwatch is used for timing, reaction time will add approximately 0.1 second to the actual time.

4.4.1 Flame Failure Response Time (FFRT)

A. A combustion safeguard and/or flame sensing system shall react to loss of flame, within 4 seconds or less, by deactivating the flame relay output circuit and/or opening the safety shutoff valve circuit.

B. FFRT shall be measured for at least ten operational cycles. The average of the ten measurements plus three standard deviations shall not exceed 4 seconds

Note: 1: The FFRT of some systems may be essentially instantaneous. Time measurements for these systems are not necessary.

2. If the FFRT specified by the manufacturer is in the range of 0.8 sec to 3 Sec, the average of ten measurements plus three standard deviations shall not exceed 110% of the specified time.

4.4.2 Trial for Ignition (TFI)

A. The trial-for-ignition period shall not exceed the limits specified in Sections 3.2.11 and 3.2.12

B. TFI shall be measured for at least ten operational cycles. The average of the ten measurements plus three standard deviations shall not exceed the aforementioned limits or 110 percent of the manufacturer's specified TFI, whichever is *less*

4.4.3 Purge Cycle (if Provided)

A. The actual purge cycle time, whether fixed or selectable, shall not be less than the manufacturer's specified value

B. Purge time shall be measured for at least ten operational cycles. The average of the ten measurements, minus three standard deviations, shall not be less than the specified value

4.5 Durability

4.5.1 Output relays in the flame detection and/or safety shutoff valve circuits shall be capable of enduring 100,000 operational cycles without undue wear or failure

4.5.2 The relay(s) shall be subjected to a minimum of 100,000 operational cycles at rated voltage and maximum specified electrical load

EXCEPTION

The above does not apply to equipment that uses solid state relays (switches) in the flame and valve output circuits.

4.6 Voltage Variation

4.6.1 The combustion safeguard and/or flame sensing system shall operate properly over a range of 85 to 110 percent of rated input voltage

4.6.2 Input voltage shall be varied from 85 to 110 percent of rated voltage. There shall be no change in operating characteristics or any significant change in FFRT, TFI, and purge times

4.7 Electrical Insulation

4.7.1 All electrical components of this equipment shall be capable of withstanding a high potential between input terminals and ground for 1 minute without arcing or breakdown

4.7.2 For an operating voltage of 60 V or less, a potential of 500 Vac shall be applied between input terminals and the enclosure ground for 1 minute.

4.7.3 For an operating voltage greater than 60 V the potential shall be 1000 Vac plus twice the rated voltage.

4.7.4 No arcing or breakdown shall occur. Leakage current shall not exceed 0.5 mA.

CAUTION

Some combustion safeguards may be equipped with voltage surge protection or suppression. Application of a high potential may result in disablement or a false indication of breakdown.

4.8 Ambient Temperature Effects

4.8.1 The equipment shall be capable of operating reliably and consistently at temperatures ranging from 32°F (0°C) to 140°F (60°C)

4.8.2 The combustion safeguard and/or flame sensing system shall be conditioned, for a minimum of 4 hours at 32°F (0°C) and 140°F (60°C). The equipment shall operate properly at these temperatures and upon return to room temperature.

4.8.3 FFRT at these temperatures shall not increase more than 10 percent beyond the actual value recorded under Section 4.1.1 and shall not exceed 4 seconds.

EXCEPTION

If specified temperature limits are outside of the above noted range, and the sample is tested at these limits, the FFRT shall not exceed 4.4 seconds.

4.9 Safety Related Operating Characteristics

4.9.1 Safety related operating characteristics such as purge times, FFRT, TFI time, pressure limits, temperature limits, etc. shall not be readily accessible or alterable by an operator

4.9.2 A programmable combustion safeguard shall be examined to determine whether an operator can readily alter safety characteristics. Alteration by manipulation of external adjustments or a keyboard are not acceptable. Adjustments that require special tools, removal of external housings, or a special program access code are generally considered acceptable

5. OPERATIONS REQUIREMENTS

5.1 Demonstrated Quality Control Program

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

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

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

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

5.1.3 Documentation/Manual

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

5.1.4 Records

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

5.1.5 Drawing and Change Control

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

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

5.2 Surveillance Audit

5.2.1 An audit of the manufacturing facility may be part of the certification 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 Manufacturer's Responsibilities

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.

6. BIBLIOGRAPHY

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

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