



Member of the FM Global Group

Approval Standard for Programmable Logic Control (PLC) Based Burner Management Systems

Class Number 7605

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Foreword

The FM Approvals certification mark is intended to verify that the products and services described will meet FM Approvals' stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of Approval Standards is to present the criteria for FM Approval of various types of products and services, as guidance for FM Approvals personnel, manufacturers, users and authorities having jurisdiction.

Products submitted for certification by FM Approvals shall demonstrate that they meet the intent of the Approval Standard, and that quality control in manufacturing shall ensure a consistently uniform and reliable product. Approval Standards strive to be performance-oriented. They are intended to facilitate technological development.

For examining equipment, materials and services, Approval Standards:

- a) must be useful to the ends of property conservation by preventing, limiting or not causing damage under the conditions stated by the Approval listing; and
- b) must be readily identifiable.

Continuance of Approval and listing depends on compliance with the Approval Agreement, satisfactory performance in the field, on successful re-examinations of equipment, materials, and services as appropriate, and on periodic follow-up audits of the manufacturing facility.

FM Approvals LLC reserves the right in its sole judgment to change or revise its standards, criteria, methods, or procedures.

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1. INTRODUCTION

1.1 Purpose

- 1.1.1 This standard states FM Approval criteria for programmable logic control (PLC) based burner management systems.
- 1.1.2 FM Approval criteria may include, but are not limited to, performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a follow-up audit program.

1.2 Scope

- 1.2.1 This standard sets Approval requirements for PLC based systems used in conjunction with safety controls for commercial and industrial heating equipment. These systems incorporate programmable electronic components. These electronic components use software and/or electronic hardware to set operating and safety parameters, and to implement the operating and safety logic.
- 1.2.2 The management system shall provide safe start, safe operation, and safe shutdown under normal or abnormal conditions.
- 1.2.3 The system may or may not be supplied with safety controls such as combustion safeguards, flame sensing devices, pressure and temperature limit controls, and combustion airflow interlocks. If safety controls are provided they shall be FM Approved. If controls are not provided, the system input/output modules shall be compatible with FM Approved controls.
Note: If the manufacturer desires to provide currently un-approved safety controls, such equipment shall be required to conform to Approval requirements for that equipment. Approval of such equipment shall be handled as a separate project.
- 1.2.4 The requirements of this Standard shall be used to measure and describe the performance of electronic hardware and software in response to exposure from heat, cold, abnormalities, electromagnetic interference, 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 FM Approval. Equipment having characteristics not anticipated by this Standard may be Approved if performance equal, or superior, to that required by this Standard is demonstrated, or if the intent of the Standard is met. Alternatively, equipment which meets all of the requirements identified in this Standard may not be Approved if other conditions which adversely affect performance exist or if the intent of this Standard is not met.

1.4 Basis for FM Approval

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

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

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

1.4.2 Compliance of the hardware and software to the requirements of IEC 61508 Standard on Functional Safety of Programmable Electronic Systems

1.4.3 An examination of the manufacturing facilities and audit of quality control procedures is made to evaluate the manufacturer's ability to produce the product which was examined and tested, and the marking procedures used to identify the product. These examinations are repeated as part of FM Approvals' product follow-up program.

1.5 Basis for Continued Approval

Continued Approval is based upon:

- production or availability of the product as currently Approved;
- the continued use of acceptable quality assurance procedures;
- satisfactory field experience;
- compliance with the terms stipulated in the Approval Agreement;
- satisfactory re-examination of production samples for continued conformity to requirements; and
- satisfactory Facilities and Procedures Audits (F&PAs) conducted as part of FM Approvals' product follow-up program.

Also, as a condition of retaining Approval, manufacturers may not change a product or service without prior authorization by FM Approvals.

1.6 Effective Date

The effective date of an Approval standard mandates that all products tested for Approval after the effective date shall satisfy the requirements of that standard. Products Approved prior to the publication of this standard shall comply with the standard by the effective date or forfeit Approval.

The effective date of this Standard is the date of publication 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. Appendix A lists the selected units and conversions to SI units for measures appearing in this standard. Conversion of U.S. customary units is in accordance with ANSI/IEEE/ASTM SI 10-1997, “*Standard for Use of the International System of Units (SI)*.”

1.8 Applicable Documents

The latest versions of the following standards, test methods, and practices are referenced in this standard:

- A. FM Approvals Class 7610, Combustion Safeguards and Flame Sensing Systems.
- B. IEC 61508, Standard on Functional Safety of Programmable Electronic safety-related systems.

1.9 Abbreviations Used in this Standard

| | |
|--------|---|
| ANSI | American National Standards Institute |
| ASTM | American Society for Testing and Materials |
| BMS | Burner Management System |
| DIN | German Industrial Standard |
| EEPROM | Electrically Erasable Programmable Read Only Memory |
| EN | European Norm |
| EPROM | Erasable Programmable Read Only Memory |
| IEC | International Electrotechnical Commission |
| IEEE | Institute of Electrical and Electronics Engineers |
| PLC | Programmable Logic Control |
| PrEN | Provisional European Norm |
| PROM | Programmable Read Only Memory |

2. GENERAL INFORMATION

Approval Application Requirements

To apply for an Approval examination the manufacturer, or its authorized representative, should submit a request to the Electrical Group Manager at FM Approvals, 1151 Boston-Providence Turnpike, PO Box 9102, Norwood, MA 02062, U.S.A.

If the product has been issued certificates of compliance to any or all standards listed in Appendix C, Sections 2 and 3, FM Approvals should be so notified in the request letter.

3. GENERAL REQUIREMENTS

3.1 Drawings/Plans/Specifications

The manufacturer shall provide assembly drawings, component drawings, evidence of functional safety, materials lists, brochures, sales literature, specification sheets, etc. for FM Approvals examination. In addition, drawings or samples of all labels and the FM Approval Mark, including information as to their location, shall be provided. If FM Approval is granted, all controlled documentation, listed in the Documentation Section of the Approval Report, shall state in bold print that any revisions require FM Approval prior to implementation. The manufacturer's specification shall include an emergency stop pushbutton, and master fuel trip relay. A master fuel trip relay is defined as an electrical relay or group of relays whose purpose is to isolate power to critical boiler end devices, such as the fuel shutoff valves, pilot gas valves and spark igniters.

The control hardware and software of the burner management system shall be so designed and implemented that they are not affected by failures in the hardware or software of other systems (such as combustion control, auxiliaries, etc.). The evidence for functional safety must demonstrate this degree of independence.

3.2 Physical, Structural, and Operational Requirements

3.2.1 PLC based burner management systems shall be available as complete and identifiable assemblies. They shall perform in all respects to the manufacturer's specifications.

3.2.2 The system shall conform at a specified Safety Integrity Level (SIL) to IEC 61508, Part 1, General Requirements. The hardware architecture shall include self-checking firmware, external and internal watchdog systems, redundant processors, and dual I/O cards as required to achieve the specified SIL. Software architecture shall include communications drivers, fault handling, executive software, input/output functions, and derived functions as required to achieve the specified SIL. Diverse design of hardware and/or software may be used as a means to achieve the specified SIL.

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

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

3.2.5 Redundant components shall be separated so as to reduce common cause failures.

3.2.6 Safety-related operating characteristics such as purge times, trial for ignition times, flame failure response times, etc., shall not be readily accessible by the operator. These characteristics shall not be adjustable when the safety system is online. These characteristics shall be located in a PROM, EPROM, EEPROM, or other non-volatile memory. Provision shall be made to warn the operator if programming changes will impact safety functions or add delays to scan rate timings.

3.2.7 Failure to satisfy, or loss of, permissives such as proof of purge air, combustion air, and closed fuel valve(s); proper fuel pressure; and absence of a flame signal at startup, prior to the ignition cycle, shall result in burner safety shutdown and burner lockout.

Burner shutdown is defined as the normal operating shutdown procedure for a burner or boiler to be taken out of service by an operator. Burner safety shutdown is defined as the automatic emergency shutdown of all fuel shutoff valves, pilot gas valves, and spark igniters. Burner lockout is defined to mean that the system must be reset by an operator before the burner is permitted to re-start automatically.

- 3.2.8 Failure to establish a pilot or main flame within the trial-for-ignition period shall result in burner safety shutdown and burner lockout.
- 3.2.9 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).
- 3.2.10 Flame sensing and combustion safeguard systems shall be immediately operable when the main power to the burner management system is turned on. A combustion safeguard system is defined as a system required by boiler drum level and combustion control systems to maintain stable burner flame and operating conditions.
- 3.2.11 The control system, in conjunction with its flame sensor, shall react to flame failure within 4 seconds or less.
- 3.2.12 The available trial-for-ignition period, for pilot flames, shall not exceed 10 seconds.
- 3.2.13 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. (4 sec for direct electric ignition)
 - 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) 2,800,000 Btu/hr (820 kW) or more — No. 5, 6 oil: 15 sec.
- 3.2.14 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 Approved burner management systems shall be permanently marked to include the name and location of the manufacturer, distinctive type or model designation, electrical ratings, and operating temperature range.
- 3.3.2 The FM Approval Mark (see Appendix B) shall be displayed visibly and permanently on the equipment. The manufacturer shall not use this Mark on any other product unless such product is covered by separate agreement with FM Approvals.
- 3.3.3 All hardware markings shall be legible and durable.
- 3.3.4 The software shall contain the following text: “FM Approvals certified for compliance to IEC 61508”. The software shall also contain a means of verifying its identity in order to ascertain that the software is the same as that certified by FM Approvals. The software shall contain text describing the boiler and burner particulars including the manufacturer(s), model numbers, site location, unit identification, design pressure and temperature.

3.4 Manufacturer's Operation Instructions

The manufacturer shall provide detailed instructions and illustrations showing the correct method of installing and testing the equipment for proper function. In addition, the manufacturer shall provide detailed operating and upgrade procedures for this equipment. A parts/repair list shall be included together with required maintenance instructions. The manufacturer shall make the BMS logic program available in a fully documented format as part of the BMS package. The owner shall be able to view the BMS logic program either off-line in read only mode, or on-line via communication link.

3.5 Calibration

All examinations and tests performed in evaluation to this Standard shall use calibrated measuring instruments traceable and certified to acceptable national standards.

4. PERFORMANCE REQUIREMENTS

Note: Unless otherwise specified the examinations and tests noted below shall be conducted at the manufacturer's facility or other mutually agreed upon site.

4.1 Examination and Tests of Systems

Requirement and Test/Verification

Reference Appendix C for Industry Specific Requirements per IEC 61508.

4.2 Examination and Tests of Hardware

Requirement and Test/Verification

Reference Appendix C for Industry Specific Requirements per IEC 61508.

4.3 Examination and Assessment of Software

Requirement and Test/Verification

Reference Appendix C for Industry Specific Requirements per IEC 61508.

5. OPERATIONS REQUIREMENTS

A quality assurance program is required to assure that subsequent burner management systems produced by the manufacturer at an authorized location shall present the same quality and reliability as the specific systems 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 Approval Report.
- Continued conformance to this Standard is verified by the Facilities and Procedures Audits (F&PA).
- Quality of performance is determined by field performance and as necessary by periodic re-examination and testing.

5.1 Demonstrated Quality Control Program

5.1.1 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 discrepant materials.

5.1.2 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.

5.1.3 Records

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

5.1.4 Drawing and Change Control

The manufacturer shall establish a system of product configuration control that shall allow no unauthorized changes to the product. Changes to critical documents, identified in the Approval Report, must be reported to, and authorized by, FM Approvals prior to implementation for production.

The manufacturer shall assign an appropriate person or group to be responsible for, and require that, proposed changes to Approved or Listed products be reported to FM Approvals before implementation. The manufacturer shall notify FM Approvals of changes in the product or of persons responsible for keeping FM Approvals advised by means of FM Approvals Form 797, Approved Product Revision Report or Address/ Contact Change Notice.

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

5.2 Demonstrated Management of Functional Safety

5.2.1 Management of functional safety is required to assure that systems designed and developed by the manufacturer shall have the required levels of safety. Areas of primary concern include, but are not limited to, management of safety, safety life cycle, documentation, and assessment of safety.

5.2.2 Management of safety is determined by consideration of:

- management of safety requirements, including the process of allocating requirements to hardware and software;
- assignment of responsibilities to appropriate organizations and individuals;
- selection of techniques and measures to ensure safety;
- procedures which ensure that hazardous incidents are analyzed, and that information is used to minimize the probability of recurrence;
- procedures for analyzing operations and maintenance performance;
- requirements for periodic safety audits; and
- procedures for initiating modifications to safety related systems.

5.2.3 Safety life cycle is determined by the existence of clearly defined phases of activity, each with identified inputs, outputs, and tasks to be performed. There are clear cut procedures for transition between phases.

5.2.4 Documentation is assessed by:

- the content of sufficient information required for the management of functional safety, organized so as to be useful to those who need it;
- suitability to the purpose for which it is intended; and
- accessibility and maintenance.

5.2.5 Assessment of safety shall be determined by the manufacturer's practices used, and the thoroughness employed, to arrive at a judgement of the functional safety achieved by the safety related system.

5.3 Facilities and Procedures Audit (F&PA)

5.3.1 An audit of the design and manufacturing facility is part of the Approval investigation 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 Approved.

5.3.2 These audits shall be conducted annually by FM Approvals or its representatives. Where jurisdictional requirements so dictate, more frequent audits shall be conducted.

5.3.3 FM Approved products or services shall be produced or provided at or from the location(s) audited by FM Approvals and as specified in the Approval Report. Manufacture of products bearing the FM Approval Mark is not permitted at any other location without prior written authorization by FM Approvals.

5.4 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 FM Approvals.

APPENDIX A

UNITS OF MEASUREMENT

LENGTH:

in. – “inches”
(mm – “millimeters”)

$$\text{mm} = \text{in.} \times 25.4$$

ft – “feet”;
(m – “meters”)

$$\text{m} = \text{ft} \times 0.3048$$

PRESSURE:

psi – “pounds per square inch”
(kPa – “kilopascals”)

$$\text{kPa} = \text{psi} \times 6.8948$$

bar – “bar”;
(kPa – “kilopascals”)

$$\text{bar} = \text{kPa} \times 0.01$$

$$\text{bar} = \text{psi} \times 0.06895$$

TEMPERATURE:

°F – “degrees Fahrenheit”
(°C – “degrees Celsius”)

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 0.556$$

APPENDIX B

APPROVAL MARKS

REPRODUCTION ART: FM Approval Marks

For use on nameplates, in literature, advertisements, packaging and other graphics.



- 1) The FM Approvals diamond mark is acceptable to FM Approvals as an Approval mark when used with the word "Approved."
- 2) The FM Approval logomark has no minimum size requirement, but should always be large enough to be readily identifiable.
- 3) Color should be black on a light background or a reverse may be used on a dark background.

For Cast-On Marks



- 4) Where reproduction of the mark described above is impossible because of production restrictions, a modified version of the diamond is suggested. Minimum size specifications are the same as for printed marks. Use of the word "Approved" with this mark is optional.

NOTE: These Approval marks are to be used only in conjunction with products or services that have been FM Approved. The FM Approval marks should never be used in any manner (including advertising, sales or promotional purposes) that could suggest or imply FM Approval or endorsement of a specific manufacturer or distributor. Nor should it be implied that Approval extends to a product or service not covered by written agreement with FM Approvals. The Approval marks signify that products or services have met certain requirements as reported by FM Approvals.

Additional reproduction art is available through

FM Approvals
P.O. Box 9102,
Norwood, Massachusetts 02062
U.S.A.

APPENDIX C

APPLICATION SPECIFIC REFERENCES TO IEC 61508

The following are some Burner Management Applications Specific Safety Functions that FM Approvals will review during the assessment of a PLC based Burner Management System.

| <i>Ref.</i> | | <i>Requirement</i> | <i>Test Method</i> |
|-------------|--------|---|---|
| IEC 61508 | Part 1 | All clauses of this part apply | Review of the documentation for: (1.) Definition of EUC and environment. (2.) Overall safety requirements, (3.) Safety Requirements Allocation and Safety Integrity Level (SIL) for each Safety Function (4.) Operation and Maintenance Plan (5.) Installation Plan. (6.) Review of Quality Management |
| IEC 61508 | Part 2 | Clause 7.2.2 Clause 7.3.2 Clause 7.4.2 to 7.4.9 Clause 7.7.2 | Review of documentation for E/E/PES safety requirements and software safety requirements Review of documentation for the safety validation plan Review of the hardware design of the E/E/PES Review of the FMEDA Review of the Markov Model Review of the PFD calculations for SIL determination Combustion Safeguards: 1) Testing of the Combustion Safeguard in conjunction with a flame sensing system 2) Testing for shut down and lock out if flame is detected prior to the ignition cycle or upon failure to establish flame during the ignition cycle. 3) Proper response to loss of flame signal by opening the safety shutoff valve circuit and, if so configured, shall attempt only one automatic retrieval for ignition 4) If applicable, the PLC 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 |
| IEC 61508 | Part 2 | Clause 7.7.2 | Flame Sensing System: <u>Requirement:</u> The flame detector (scanner) in a flame sensing system shall be activated immediately upon application of power to the system. <u>Test:</u> 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. <u>Requirement:</u> The system shall operate properly in accordance with the manufacturer's specifications for methods of flame detection (infra-red, rectification, ultra-violet) and flame signal strength <u>Test:</u> 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. <u>Requirement:</u> 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 <u>Test:</u> The system shall lock out and open the flame relay output circuit when the self-check feature is disabled. |

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| IEC 61508 | Part 2 | Clause 7.7.2 | <p>Flame Failure Response Time (FFRT): <u>Requirement:</u> A combination 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. <u>Test:</u> 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.</p> |
| IEC 61508 | Part 2 | Clause 7.7.2 | <p>Trial for ignition (TFI): <u>Requirement:</u> The trial for ignition period shall not exceed the limits specified in Sections 3.2.11 and 3.2.12 <u>Test:</u> Trial for ignition 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 trial for ignition, whichever is less.</p> |
| IEC 61508 | Part 2 | Clause 7.7.2 | <p>Purge Cycle: <u>Requirement:</u> The actual purge cycle time, whether fixed or selectable, shall not be less than the manufacturer's specified value. <u>Test:</u> 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.</p> |
| IEC 61508 | Part 2 | Clause 7.7.2 | <p>Durability: <u>Requirement:</u> Output devices in the flame detection and/or safety shutoff valve circuits shall be capable of enduring 100,000 operational cycles without undue wear or failure. <u>Test:</u> The output device(s) shall be subjected to a minimum of 100,000 operational cycles at rated voltage and maximum specified electrical load {the above does not apply to equipment that uses solid state relays (switches) in the flame and valve circuits}.</p> |
| IEC 61508 | Part 2 | Clause 7.7.2 | <p>Voltage Variation: <u>Requirement:</u> The combustion safeguard and/or flame sensing system shall operate properly over a range of 85 to 110 percent of rated input voltage. <u>Test:</u> 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.</p> |
| IEC 61508 | Part 2 | Clause 7.7.2 | <p>Electrical Insulation: <u>Requirement:</u> All electrical components of this equipment shall be capable of withstanding the high potential between input terminals and ground for 1 minute without arcing or breakdown. <u>Test:</u> For an operating voltage of 60V or less, the potential of 500VAC shall be applied between input terminals and the enclosure ground for 1 minute. For an operating voltage greater than 60 V, the potential shall be 1000VAC plus twice the rated voltage. 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.</p> |
| IEC 61508 IEC 68 | Part 2 Parts 1, 2, 3, 14, 26, 30 | Clause 7.7.2 | <p>Ambient Temp. Effects: <u>Requirement:</u> The equipment shall be capable of operating reliably and consistently at temperatures ranging from 32°F (0°C) to 140°F (60°C). <u>Test:</u> The combustion safeguard and/or flame sensing system shall be conditioned, for a minimum of 4 hours at 32°F (0°C) to 140°F (60°C). The equipment shall operate properly at these temperatures and upon return to room temperature. FFRT at these temperatures shall not increase more than 10 percent beyond the actual value recorded previously and shall not exceed 4 seconds.</p> |

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| IEC 61508 | Part 2 | Clause 7.7.2 | <p>Safety Related Operating Characteristics: Requirement: 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. Test: 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 is not acceptable. Adjustments that require special tools, removal of external housing, or a special program access code are generally considered acceptable.</p> |
| IEC 61508 | Part 3 | Clause 6.2 | Review functional safety planning with respect to software procurement, development, integration, verification, validation, and modification. Review software configuration management scheme. |
| IEC 61508 | Part 3 | Clause 7.1.2 | Review safety life cycle, quality and safety assurance procedures satisfy figure 3 and table 1. |
| IEC 61508 | Part 3 | Clause 7.2.2 | Review software safety requirements specification, if used. |
| IEC 61508 | Part 3 | Clause 7.3.2 | Review software safety validation planning wrt modes of operation, technical strategy, environment, and pass/ fail criteria. |
| IEC 61508 | Part 3 | Clause 7.4.2 to 7.4.8 | Review software architecture Review tools, languages, and coding standards Review software design and development documentation Review results of module testing |
| IEC 61508 | Part 3 | Clause 7.5.2 | Review integration of software and hardware |
| IEC 61508 | Part 3 | Clause 7.6.2, and 7.8.2 | Review procedures for modification of software, and Review any modifications that have been done |
| IEC 61508 | Part 3 | Clause 7.7.2 | Review results of software safety validation |
| IEC 61508 | Part 3 | Clause 7.9.2 | Review results of software verification |
| IEC 801 | Parts 3, 4, 5, 6 | EMC for Industrial Process Measurement and control | Review Documentation relating to the EMC testing and test results |
| IEC 61000 | Parts 4-4, and 4-6 | EMC | Review Documentation relating to the EMC testing and test results |
| EN 50081 | | EMC Emission Std. | Review Documentation of test results |
| EN 55011 | | EMC Emission Power Line | Review Documentation of test results |
| ANSI/IEEE C62.41 | | Immunity, Power Line Surge | Review Documentation of test results |
| ANSI/IEEE C37.90 | | Immunity, Elect. Fast Transients | Review Documentation of test results |
| ANSI/ISA S71.04 | | Corrosives | Review Documentation of test results |
| EMC Directive 89/336/EEC | | EMC European std. | Review Documentation of test results |
| EN 50082-1 | | EMC — Immunity | Review Documentation of test results |
| 72/23/EWG | | Low Voltage Directive | Review Documentation of test results |

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| EN 61010 Part 1 | | Safety Requirements for Electrical Equipment for mea- surement, control and laboratory use; General Require- ments | Review Documentation of test results |
| ANSI/ISA S82 | | National Version EN 61010 Part 1 | If used, then Review Documentation of test results |
| NFPA 8502 | | Boiler Standard | Review Documentation of test results |
| IEC 61131 | Part 1, 2, 3 | PLC Design Standards | Documentation referencing recommended design practices outlined in this spec. |

**General National (German)
Standards Relevant to Approval of
BMS with programmable elements**

| <i>Identification of Standard</i> | <i>Description of Standard</i> |
|-------------------------------------|---|
| DIN 31000 Part 2 | Concepts of safety technology; Basic concepts |
| DIN V 19250 | Control technology, fundamental safety aspects to be considered for measurement and control equipment |
| DIN V VDE 0801 Inc. Amendment A1 | Principles for computers in safety related systems |
| DIN V 19251 | Process control technology — MC protection equipment — requirements and measures for safeguarded function |

**Application Specific
International and National
Standards Relevant to Approval
BMS with programmable elements**

| <i>Identification of Standard</i> | <i>Description of Standard</i> |
|-----------------------------------|---|
| 90/ 396/ EEC | Gas Directive |
| DIN VDE 0116 | Electrical equipment for furnaces |
| EN 230 | Monobloc oil burner Safety, control, and regulation devices, and safety times |
| EN 298 | Automatic gas burner control systems for gas burners and gas burning appliances with or without fans |
| EN 60730 -1, -2, -5 | Automatic electronic controls for household and similar use |
| PrEN 50156-1 | Electrical equipment for furnaces; Requirements for design and installation |
| PrEN 676 | Automatic forced draft burners for gaseous fuels |
| PrEN 746-2 | Industrial thermoprocessing equipment Safety requirements for combustion and fuel handling systems |
| PrEN 1954 | Internal and external fault behavior of safety related electronic parts of gas appliances |

Note: There is some duplication and overlap among these standards. The usual history is to write Standards A, B, C, etc., with a mixture of very specific requirements and quite general requirements. Then the general requirements are consolidated into Standard X. Eventually, Standard A will be revised to contain only the specific requirements, and will refer to Standard X for the general requirements. However, Standard A may not be revised for some time. In the mean while, there is duplication among standards.