UL 372

STANDARD FOR SAFETY

Automatic Electrical Controls for Household and Similar Use – Part 2: Particular Requirements for Burner Ignition Systems and Components

UL Standard for Safety for Automatic Electrical Controls for Household and Similar Use – Part 2: Particular Requirements for Burner Ignition Systems and Components,UL 372

Sixth Edition, Dated July 31, 2007

Summary of Topics

This revision of UL 372 is being issued to remove the ANSI approval. No changes in requirements are involved. As noted in the Commitment for Amendments statement located on the back side of the title page, UL, CSA, and CSA America are committed to updating this harmonized standard jointly. However, the revision pages dated July 27, 2012 will not be jointly issued by UL, CSA, and CSA America, as these revision pages only address the removal of the ANSI approval from UL 372.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the preface. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

The following table lists the future effective dates with the corresponding item.

Future Effective Date	References
To be determined	Sixth Edition

Canadian Standards Association
CSA C22.2 No. 199
Third Edition

CSA America
ANSI Z21.20
Fifteenth Edition

Underwriters Laboratories Inc.
UL 372
Sixth Edition

Automatic Electrical Controls for Household and Similar Use – Part 2: Particular Requirements for Burner Ignition Systems and Components

July 31, 2007

(Title Page Reprinted: July 27, 2012)

Approved
by
Standards Council
of Canada

Commitment for Amendments

This standard is issued jointly by Canadian Standards Association (CSA), CSA America, and Underwriters Laboratories Inc. (UL). Comments or proposals for revisions on any part of the standard may be submitted to CSA or UL at any time. Revisions to this standard will be made only after processing according to the standards development procedures of CSA and UL. CSA and UL will issue revisions to this standard by means of a new edition or revised or additional pages bearing their date of issue.

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Preface

This ANSI Standard, ANSI Z21.20, Automatic Electrical Controls for Household and Similar Use – Part 2: Particular Requirements for Burner Ignition Systems and Components, is to be used in conjunction with the third edition of UL 60730-1A. The requirements for burner ignition systems and components are contained in this Part 2 Standard and UL 60730-1A.

This CSA Standard, CSA C22.2 No. 199, Automatic Electrical Controls for Household and Similar Use – Part 2: Particular Requirements for Burner Ignition Systems and Components, is to be used in conjunction with CAN/CSA–E60730-1. The requirements for burner ignition systems and components are contained in this Part 2 Standard and CAN/CSA–E60730-1.

This UL Standard 372, Automatic Electrical Controls for Household and Similar Use – Part 2: Particular Requirements for Burner Ignition Systems and Components, is to be used in conjunction with the third edition of UL 60730-1A. The requirements for burner ignition systems and components are contained in this Part 2 Standard and UL 60730-1A.

Requirements of this Part 2 Standard supplement or modify the requirements of UL 60730-1A and CAN/CSA–E60730-1.

Where a particular subclause of UL 60730-1A and CAN/CSA–E60730-1 is not mentioned in this Part 2 Standard, that subclause applies as far as reasonable.

NOTE: The following numbering system is used:

– Subclauses that are numbered starting from 101 are additional to those in Part 1.

– Those provisions throughout this publication which include uppercase ″A,″ ″B″ or ″C″ in the numbering system are coverage included in the proposed harmonized standard which was added from ANSI Z21.20, UL 372 or UL 8730.

The text, figures and tables of IEC publication Automatic Electrical Controls for Household and Similar Use – Part 2: Particular Requirements for Burner Ignition Systems and Components, IEC 60730-2-5, copyright 2000, are used in this Standard with consent of the IEC and the American National Standards Institute (ANSI). The IEC copyrighted material has been reproduced with permission from ANSI. ANSI should be contacted regarding the reproduction of any portion of the IEC material. Copies of IEC Publication 60730-2-5 may be purchased from ANSI, 25 West 43rd Street, New York, New York, 10036, (212) 642-4900.

This is a common CSA America, Inc., CSA and UL Standard for Automatic Electrical Controls for Household and Similar Use – Part 2: Particular Requirements for Burner Ignition Systems and Components, ANSI Z21.20/CSA C22.2 No. 199/UL 372. It is the fifteenth edition of ANSI Z21.20, the third edition of CSA C22.2 No. 199, and the sixth edition of UL 372. This edition of ANSI Z21.20 supersedes the previous edition published in 2005. This edition of CSA C22.2 No. 199 supersedes the previous edition published in 1989. This edition of UL 372 supersedes the previous edition published in 1994.

Although the CSA and UL standards contain identical requirements, and identical publication dates, the presentation and format of the standards material may differ between the two published standards.

This common Standard was prepared by CSA America, Inc., CSA and Underwriters Laboratories (UL).

This Standard is considered suitable for use for conformity assessment within the stated scope of the Standard.

NOTE: Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.

Level of harmonization

This standard is based on IEC 60730-2-5:2000 and its sections and annexes are numbered similarly to that IEC standard but it shall not be considered as equivalent to this IEC Standard. Therefore, while it is based on that IEC standard, it is not an adoption of it.

This Standard is published as an equivalent standard for CSA America, Inc., CSA and UL. An equivalent standard is a standard that is the same in technical content, except as follows. Technical national differences are allowed for national differences resulting in conflicts in codes and government regulations as well as those recognized as being in accordance with NAFTA Article 905, for example, because of fundamental climatic, geographical, technological, or infrastructure factors, scientific justification, or the level of protection that the country considers appropriate. Presentation is word for word except for editorial changes.

Interpretations

The interpretation by the standards development organization of an equivalent standard is based on the literal text to determine compliance with the standard in accordance with the procedural rules of the standards development organization. If more than one interpretation of the literal text has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

CSA Effective Date

The effective date for CSA will be announced through CSA Informs or a CSA certification notice.

UL Effective Date

The previous effective date (July 31, 2012) for UL 372 has been suspended. The effective date is to be determined.

1 Scope and normative references

This clause of part 1 is applicable except as follows:

1.1 ***Replacement:***

This standard modifies or amends the requirements of the Part 1 standard. In Canada the Part 1 standard applicable is CAN/CSA E60730-1, Automatic electrical controls for household and similar use – Part 1: General Requirements, and in the U.S. the Part 1 standard applicable is UL 60730-1A , Automatic electrical controls for household and similar use – Part 1: General Requirements, 3rd Edition.

This standard applies to newly produced automatic burner ignition systems and system components constructed entirely of new, unused parts and materials for the automatic control of burners for one or more of the following fuels:

oil,

natural gas,

manufactured gas,

mixed gas,

liquefied petroleum gas or,

LP gas-air mixtures

This standard is applicable to a complete burner ignition system, a separate programming unit, an oxygen depletion safety shutoff system and components that perform one or more of the following functions:

a) Ignite the fuel at the main burner(s), or at the pilot burner(s) so it can ignite the main burner(s);

b) Prove the presence of either the ignition source, the main burner flame, or both;

c) Automatically act to shut off the fuel supply to the main burner(s), or to the pilot and main burner(s), when the supervised flame or ignition source is not proved; and

d) Automatically act to shut off the gas supply to the pilot and main burner(s), when the oxygen content of the room in which the equipment is installed is reduced below a predetermined level.

Components can be, but are not limited to: automatic controls; pilot burners, thermoelectric devices, electrodes, ignition devices, ignition sources and flame detectors.

Throughout this standard the following terms shall be abbreviated as shown below:

1. ″system″ means ″burner ignition system.″

2. ″component″ means ″burner ignition system component.″

3. ″control″ means ″system″ or ″component.″

Requirements for separate ignition transformers are covered in Standard for Specialty Transformers, UL 506, and CSA C22.2 No. 13, the Standard for Luminous Tube Signs, Oil and Gas Burner Ignition Equipment, Cold-Cathode Interior Lighting.

1.1.1 *Replacement:*

This standard applies to inherent safety; to the manufacturer's declared operating values, operating times and operating sequences where such are associated with burner safety and to the testing of systems and components used in, on, or in association with burners.

Requirements for specific operating values, operating times, and operating sequences are given in the standards for appliances and equipment.

1.1.2 Replacement:

This standard applies to manual controls when such are electrically and/or mechanically integral with automatic systems.

1.1.3 Not Applicable.

1.1.4 Not Applicable.

1.1.5A *Addition:*

This standard applies to each component of an automatic burner ignition system shall be capable of operation throughout an ambient temperature range of 32°F (0°C) to 125°F (51.5°C). The manufacturer is allowed to specify temperatures below 32°F (0°C) and above 125°F (51.5°C).

a) For gas fired equipment rated 400,000 Btu/hr (117 228 W) or less, T_{min}, and T_{max} are as specified in 1.1.5A; and

b) For burner controls for all other equipment, T_{max}, declared at less than 150°F (65.5°C) shall be tested at 150°F (65.5°C) or higher as specified by the manufacturer.

1.3 Not Applicable.

1.3A *Addition:*

Compliance with this Part 2 standard does not imply that such a control is acceptable for use on fuel burning appliances or equipment without supplemental test with the device(s) applied to the particular appliance or equipment design.

1.3A.1 All specifications as to construction set forth herein may be satisfied by the construction actually prescribed or such other construction as will provide at least equivalent performance.

1.3A.2 If a value for measurement as given in this standard is followed by an equivalent value in other units, the first stated value is to be regarded as the specification.

1.4 Replacement:

This standard applies also to controls incorporating electronic devices, requirements for which are contained in annex H, Requirements for electronic systems and components.

1.5 *Addition:*

1.5.1 Normative references

The following normative reference documents contain provisions which, through reference in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid international Standards.

ANSI/ASME B1.20.1-1983 (R1992)
Pipe Threads, General Purpose (Inch).

ANSI Z21.21-2005/CSA 6.5-2005
Automatic Valves for Gas Appliances.

ANSI Z21.78-2005/CSA 6.20-2005
Combination Gas Controls for Gas Appliances.

ANSI Z223.1/NFPA 54-2006
National Fuel Gas Code.

CAN/CSA B140.2.1-M90 (R2005)
Oil Burners; Atomizing Type.

CAN/CSA E384-14-1-95 (R2004)
Fixed Capacitors in Electronic Equipment – Part 14: Blank Detail Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains.

CAN/CSA E60730-02
Automatic Electrical Controls for Household and Similar Use – Part 1: General Requirements,

CSA B 149.1-05
Natural Gas and Propane Installation Code.

CSA C22.1-06
Canadian Electrical Code, Part 1.

CSA C22.2 No. 0.15-01
Adhesive Labels.

CSA C22.2 No. 0.17-00 (R2004)
Evaluation of Properties of Polymeric Materials.

CSA C22.2 No. 3-M1988 (R2004)
Electrical Features of Fuel Burning Equipment.

CSA C22.2 No. 13-1962 (R2001)
Transformers for Luminous-Tube Signs, Oil- and Gas-Burner Ignition Equipment, Cold-Cathode Interior Lighting.

CSA C22.2 No. 49-98 (R2003)
Flexible Cords and Cables.

CSA C22.2 No. 65-03
Wire Connectors.

CSA C22.2 No. 66-1988 (R2001)
Specialty Transformers.

CSA C22.2 No. 94-M91 (R2001)
Specialty Purpose Enclosures.

CSA C22.2 No. 127-99 (R2004)
Equipment and Lead Wires.

CSA C22.2 No. 153-M1981 (R2003)
Quick-Connect Terminals.

CSA C22.2 No. 158-1987 (R2004)
Terminal Blocks.

CSA C22.2 No. 248.1-00 (R2005)
Low-Voltage Fuses – Part 1: General Requirements.

CAN/CSA-C22.2 No. 60065-03
Audio, video and similar electronic apparatus – Safety Requirements.

IEC 60068-2-6: 1995-03
Environmental testing – Part 2: Test Fc: Vibration (sinusoidal).

IEC 60068-2-75: 1997-08
Environmental testing – Part 2–75: Test Eh: Hammer tests.

IEC 60085: 2004-06
Electrical Insulation – Thermal classification.

IEC 60127-1: 2003-02
Miniature Fuses – Part 1: Definitions for Miniature Fuses and General Requirements for Miniature Fuse-links.

IEC 60264-1: 2005-04
Low-voltage Fuses – Part 1: General Requirements.

CAN/CSA-E60335-1/4-03
Household and similar electrical appliances, Safety – Part 1: General Requirements.

CAN/CSA-E60384-14-95 (R2004)
Fixed capacitors for use in electronic equipment – Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains.

IEC 61000-4-2: 2000-04
Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test.

IEC 61000-4-3: 2002-09
Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test.

IEC 61000-4-4: 1995-01
Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 4: Electrical fast transient burst immunity test.

IEC 61558-2-4: 1997-03
Safety of power transformers, power supply units and similar – Part 2: Particular requirements for isolating transformers for general use.

NFPA 70-2005,
National Electrical Code.

UL 50-1995
Enclosures for Electrical Equipment.

UL 248-1-2000
Low-Voltage Fuses.

UL 486A-1997
Wire Connectors and Soldering Lugs for Use With Copper Conductors.

UL 506-1994
Specialty Transformers.

UL 746C-2001
Polymeric Materials – Use in Electrical Equipment Evaluations.

UL 840-1993
Standard for Safety for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment.

UL 969-1995
Marking and Labeling Systems.

UL 1059-2001
Standard for Terminal Blocks.

UL 1414-2000
Across-the-Line, Antenna-Coupling and Line-by-Pass Capacitors for Radio- and Television-Type Appliances.

UL 1585-1998
Class 2 and Class 3 Transformers.

UL 1998
Standard for Software in Programmable Components.

UL 60065-2003
Standard for Audio, video and similar electronic apparatus – Safety requirements.

UL 60335-1-2004
Household and similar electrical appliances – Safety – Part 1: General requirements.

UL 60730-1A-2002
Standard for Safety for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements.

2 Definitions

This clause of Part 1 is applicable except as follows.

The following definitions apply for the purpose of this standard and may or may not be consistent with definitions used in other standards. Where the terms ″VOLTAGE″ and ″CURRENT″ are used, they imply r.m.s. values unless otherwise specified.

(See Appendix A for alphabetic listing of definitions.)

2.1 Definitions relating to ratings, voltages, currents and wattages

2.1.5A *Addition:*

CIRCUIT HIGH VOLTAGE: A circuit involving a potential of not more than 600 volts and having circuit characteristics in excess of those of an extra-low voltage or an isolated limited secondary circuit.

2.1.14A *Addition:*

HIGH TENSION CIRCUIT: An ignition circuit involving a potential of more than 600 volts supplied by a step-up transformer or by a suitable combination of devices which will increase high voltage to over 600 volts.

2.1.15A *Addition:*

EARTHING: Connected with an electrical ground; sometimes referred to as ″GROUNDING.″

2.1.16A *Addition:*

BONDED: Permanently and reliably connected to an earthing terminal.

2.1.17A *Addition:*

GROUNDING: **See 2.1.15A.**

2.2 Definitions of types of control according to purpose

2.2.1 ELECTRICAL CONTROL: Device used in, on or in association with an equipment for the purpose of varying or modifying the output from such equipment, and which embodies the aspects of initiation, transmission and operation. At least one of these aspects shall be electrical or electronic.

2.2.9 Void

2.2.10 Not Applicable.

2.2.11 Not Applicable.

2.2.12 ELECTRICALLY OPERATED CONTROL: Control in which the transmission is effected by an electrical prime mover and in which the operation controls an electric circuit, and is without intentional significant time-delay.

An example is a relay.

2.2.13 through 2.2.18 Not Applicable.

Addition:

2.2.101 BURNER CONTROL SYSTEM: A system which monitors the operation of fuel burners. It includes a programming unit and a flame detector, and may include and ignition source or ignition device.

The various functions of an automatic burner control system may be in more than one housing.

2.2.101.1A *Addition:*

BURNER IGNITION SYSTEM: A system which includes all the components necessary to perform the following functions:

a) Ignite the fuel at the main burner(s), or at the pilot burner(s) so it can ignite the main burner(s);

b) Prove the presence of either the ignition source, the main burner flame, or both; and

c) Automatically act to shut off the fuel supply to the main burner(s), or to the pilot and main burner(s), when the supervised flame or ignition source is not proved.

The various functions of a burner ignition system may be in more than one housing.

2.2.101.2A *Addition:*

BURNER IGNITION SYSTEM COMPONENT: A component which performs one or more of the functions of a burner ignition system.

Examples are pilot burners, electrodes, thermoelectric devices, ignition devices, ignition sources, flame detectors and flame sensors.

2.2.102 FLAME DETECTOR: A device which provides the programming unit with a signal indicating the presence or absence of flame.

It includes the flame sensor and may include an amplifier and a relay for signal transmission. The amplifier and relay may be in its own housing or combined with the programming unit.

2.2.103 FLAME SENSOR: A device which senses the flame and provides the input signal to the flame detector.

Examples are optical sensors and flame electrodes (flame rods).

2.2.104 IGNITION SOURCE: An electrical or electronic component which provides energy to an ignition device.

It may be separated from or incorporated in the programming unit. Examples are ignition transformers and electronic high tension circuits.

2.2.105 IGNITION DEVICE: A device mounted on or adjacent to a burner for igniting fuel at the burner.

Examples are pilot burners, spark electrodes and hot surface igniters.

2.2.106 PROGRAMMING UNIT: A device which controls the burner operation in a declared sequence from start-up to shutdown, and in response to signals from regulating, limiting and monitoring devices.

2.2.107 MULTITRY BURNER CONTROL SYSTEM: A system that allows more than one valve open period during its declared operating sequence.

2.3 Definitions relating to the function of controls

2.3.1 INITIATION: Alteration to that aspect of a control which is required to produce transmission and operation.

2.3.2 TRANSMISSION: Essential coupling between initiation and operation which is required to enable control to fulfill its purpose.

2.3.3 OPERATION: Change in that aspect of a control which modifies the input to the equipment or part of the equipment.

2.3.4 AUTOMATIC ACTION: That action of a control in which the transmission and operation are produced by initiation which is not the result of actuation.

2.3.5 Not Applicable

2.3.6 MANUAL ACTION: That action of a control in which the transmission and operation are produced by initiation which is the result of actuation.

2.3.7 ACTUATION: Movement of the actuating member of the control by physical contact of the user.

2.3.8 and 2.3.9 Not Applicable.

2.3.11 Not Applicable.

2.3.13 OPERATING SEQUENCE: Intended sequence, order or pattern in which the operation of the electrical or mechanical functions occur as a result of either an automatic or a manual action.

2.3.14 and 2.3.15 Not Applicable.

2.3.17 SETTING: Mechanical positioning of a part of a control in order to select an operating value.

2.3.22 and 2.3.23 Not Applicable.

2.3.26 through 2.3.28 Not Applicable.

2.3.30 T_{MAX}: The declared maximum continuous ambient temperature to which the system is intended to be exposed during normal operation.

2.3.30A *Addition:*

T_{MIN}: The declared minimum continuous ambient temperature to which the system is intended to be exposed during normal operation.

2.3.101 AUTOMATIC RECYCLING: The automatic repetition of the start-up procedure, without manual intervention, following loss of the supervised flame and subsequent-fuel supply shut off.

2.3.102 CONTROLLED SHUTDOWN: The de-energization of the fuel flow means as a result of the opening of a control loop by a control device such as a thermostat. The system returns to the start position.

2.3.103 FLAME DETECTOR RESPONSE TIME: The period of time between the loss of the sensed flame and the signal indicating the absence of flame.

2.3.104 FLAME DETECTOR OPERATING CHARACTERISTICS:

2.3.104.1 SIGNAL FOR PRESENCE OF FLAME (S_1): The minimum signal which indicates the presence of flame when there was previously no flame.

2.3.104.2 SIGNAL FOR ABSENCE OF FLAME (S_2): The maximum signal which indicates the loss of flame. S_2 is less than S_1.

2.3.104.3 MAXIMUM FLAME SIGNAL (S_{MAX}): The maximum signal which does not affect the timings or the sequence.

2.3.104.4 Not Applicable.

2.3.105 SELF-CHECKING FLAME DETECTOR: A flame detector which checks for correct operation of the flame detector and its associated electronic circuitry while the burner is in the running position.

2.3.106 FLAME DETECTOR SELF-CHECKING RATE: The frequency of the self-checking function of the flame detector (in number of operations per unit of time).

2.3.107 FLAME FAILURE LOCK-OUT TIME: The period of time between the signal indicating absence of flame and lock-out.

2.3.108 FLAME FAILURE REIGNITION TIME (RELIGHT TIME): The period of time between the signal indicating absence of flame and the signal to energize the ignition device. During this time period the fuel supply is not shut off.

2.3.108A *Addition:*

FLAME FAILURE RESPONSE TIME: The period of time between loss of supervised ignition source or the supervised main burner flame and the action to shut off the fuel supply.

2.3.109 FLAME SIGNAL: The output signal of the flame detector.

2.3.110 FLAME SIMULATION: A condition which occurs when the flame detector indicates the presence of flame when in reality no flame is present.

2.3.111 Not Applicable.

2.3.112 LOCK-OUT:

2.3.112.1 NON-VOLATILE LOCK-OUT: The condition of a control following safety shutdown such that a restart can only be accomplished by a manual reset and by no other cause.

2.3.112.2 VOLATILE LOCK-OUT: The condition of a control following safety shutdown such that a restart can be accomplished by either a manual reset or by an interruption of the power supply and its subsequent restoration.

2.3.112.3A *Addition:*

HARD LOCKOUT: The automatic action to end an ignition sequence. Reinitiating another ignition sequence requires a manual operation at the equipment or interruption of the main electrical power supply to the equipment.

2.3.112.4A *Addition:*

SOFT LOCKOUT: The automatic action to end an ignition sequence. Reinitiating another ignition sequence is accomplished by automatic or manual means either of which may be remote from the equipment.

2.3.113 MAIN FLAME ESTABLISHING PERIOD: That period of time between the signal to energize the main fuel flow means and the signal indicating presence of the main burner flame.

2.3.113A *Addition:*

TRIAL FOR IGNITION PERIOD: The period of time between energizing and de-energizing the fuel flow means, if proof of the supervised flame is not established.

For systems incorporating interrupted pilot ignition – also considered main burner flame establishing period.

2.3.114 PILOT FLAME ESTABLISHING PERIOD: The period of time between the signal to energize the pilot fuel flow means and the signal indicating presence of pilot flame.

2.3.115 POST IGNITION TIME: That period of time between the signal indicating presence of flame and the signal to de-energize the ignition device.

2.3.116 PRE-IGNITION TIME: That period of time between the signal to energize the ignition source and the signal to energize the fuel flow means.

2.3.117 PROVED IGNITER SYSTEM: A system in which the fuel flow means is energized only after the availability of sufficient electrical energy to ignite the fuel has been verified.

An example is a system using proved hot surface igniters.

2.3.117.1 PROVED IGNITER OPERATING VALUE: The signal which indicates that the proved igniter is capable of igniting the fuel.

2.3.117.2 IGNITER PROVING TIME: The period of time between the signal to energize the proved igniter and the signal to energize the fuel flow means.

2.3.117.3 IGNITER FAILURE RESPONSE TIME: The period of time between loss of the supervised proved igniter and the signal to de-energize the fuel flow means.

2.3.118 PURGE TIME: The period of time during which air is mechanically introduced to displace any remaining air/fuel mixtures or products of combustion from the combustion zone and flue ways.

2.3.118.1 POST-PURGE TIME: The purge time that takes place immediately following the shutting off of the fuel supply at the completion of an operating cycle.

2.3.118.2 PRE-PURGE TIME: The purge time that takes place between initiation of a system sequence and the action to energize the ignition means.

2.3.118.3A *Addition:*

INTER-PURGE TIME: On a multitry system, the purge time that takes place between the end of a trial for ignition period and reactivation of the ignition means if proof of the supervised flame is not established.

Inter-purge time is normally provided for burners where air for combustion is mechanically introduced for ventilation of the combustion chamber and flue passages before reenergizing the ignition means.

2.3.119 REIGNITION (RELIGHT): The process by which, following loss of the flame signal, the ignition device will be re-energized without interruption of the fuel flow means.

2.3.120 RECYCLE TIME: The period of time between the signal to de-energize the fuel flow means following the loss of flame and the signal to begin a new start-up procedure.

2.3.121 RUNNING POSITION: This position denotes that the main burner flame is established.

2.3.122 SAFETY SHUTDOWN: The deenergization of the main fuel flow means as the result of abnormal operating conditions or the detection of an internal fault of the system.

Examples of abnormal operating conditions include power interruption, fuel interruption, or conditions which cause action of a limiting control, etc.

2.3.123 START POSITION: Position which denotes that the system is not in the lock-out condition and has not yet received the start signal, but can proceed with the start-up sequence if required.

2.3.124 START SIGNAL: A signal, e.g., from a thermostat, which releases the system from its start position.

2.3.125A *Addition:*

LOCK-OUT TIME: The period of time between energizing the system and lockout if proof of the supervised main ignition source or the supervised main burner flame is not established.

2.3.126A *Addition:*

WAITING TIME:

a) The period between the start signal and the action to energize the ignition means; or;

b) The period between the end of a trial for ignition period and the reactivation of the ignition means if proof of the supervised flame is not established.

Waiting time is normally provided for burners where air for combustion is not mechanically introduced, but may require time for natural ventilation of the combustion chamber and flue passages before energizing the ignition means.

2.3.127 Not Applicable.

2.3.128 VALVE SEQUENCE PERIOD: For multitry systems, the sum valve open periods prior to lock-out, if proof of the supervised burner flame is not established.

2.3.129A *Addition:*

IGNITION ACTIVATION PERIOD: The period of time between energizing the main gas valve and deactivation of the ignition means during a trial for ignition period.

2.3.130A *Addition:*

AUTOMATIC RESTART TIME: The period of time between a soft lockout and the automatic action to initiate another ignition sequence.

2.3.131A *Addition:*

SAFE START CHECK: an action during each start-up sequence, where the system shall check for a flame signal before any fuel valve is energized. If a flame signal occurs, the system shall either:

a) not initiate the next step of the start-up sequence; or

b) proceed to safety shutdown.

2.4 Definitions relating to disconnection and interruption

2.4.5 and 2.4.6 Not Applicable.

2.5 Definitions of types of control according to construction

2.5.3 through 2.5.6 Not Applicable.

2.5.12A *Addition:*

ELECTRO-MECHANICAL CONTROL**: An electrical control which incorporates at least one electrically operated mechanical device or a mechanically operated device which controls an electrical circuit.**

2.6 Not Applicable.

2.7 Definitions relating to protection against electric shock

2.7.1.1 Not Applicable.

2.7.2 and 2.7.3 Not Applicable.

2.7.8 ACCESSIBLE PART OR SURFACE: Part or surface which can be touched by the test finger of figure 2A, when the control is mounted as in normal use, and after detachable parts have been removed.

2.8 Definitions relating to component parts of controls

2.8.1 Not Applicable.

2.8.5 Not Applicable.

2.8.7 Not Applicable.

2.9 Definitions of types of terminals and terminations of controls

2.9.9 Not Applicable.

2.10 Definitions relating to the connections to controls

2.10.5 and 2.10.6 Not Applicable.

2.11 Not Applicable.

2.13 Miscellaneous definitions

2.13.8A *Addition:*

CHEESECLOTH: Bleached cheesecloth 36 inches (914 mm) wide, running 14 – 15 yards per pound mass (approximately 28 – 30 m/kg mass) and having a count of 32 × 28 – that is, for any square inch, 32 threads in one direction and 28 threads in the other direction (for any square centimeter, 13 threads in one direction and 11 threads in the other direction).

2.13.9A *Addition:*

NORMAL BUTANE (N-BUTANE), TECHNICAL GRADE: A liquefied petroleum gas composed of a minimum of 95 percent n-butane (C_4H_{10}) which may contain other impurities such as isobutane, butylenes and propane not in excess of 5 percent.

PROPANE HD-5: A special grade of liquefied petroleum gas composed of a minimum of 90 percent liquid volume of propane (C_3H_8) and a maximum of 5 percent liquid volume of propylene (C_3H_6).

2.15 through 2.19 Not Applicable.

2.101 Definitions relating to the type of burner ignition

2.101.1 CONTINUOUS IGNITION: A type of ignition which, once placed in operation, is intended to remain energized continuously until it is manually interrupted.

2.101.2 CONTINUOUS PILOT: A pilot which, once placed in operation, is intended to remain ignited continuously until it is manually interrupted.

2.101.3 DIRECT IGNITION: A type of ignition which is applied directly to the main burner, without the use of a pilot.

2.101.4 EXPANDING PILOT: A form of continuous pilot where the pilot flame is increased or expanded when required to ignite the main burner and reduced either immediately after main burner ignition, or after the main flame is shut off.

2.101.5 FULL RATE START: A condition in which the main burner ignition and subsequent flame supervision occur at full fuel rate.

2.101.6 INTERMITTENT IGNITION: A type of ignition which is energized when an appliance is called on to operate and which remains continuously energized during each period of main burner operation. The ignition is de-energized when the main burner operating cycle is completed.

2.101.7 INTERMITTENT PILOT: A pilot which is automatically ignited when an appliance is called on to operate and which remains continuously ignited during each period of main burner operation. The pilot is automatically extinguished when each main burner operating cycle is completed.

2.101.8 INTERRUPTED IGNITION: A type of ignition which is energized prior to the admission of fuel to the main burner and which is de-energized after the main burner flame is established.

2.101.9 INTERRUPTED PILOT: A pilot which is automatically ignited prior to the admission of fuel to the main burner and which is automatically extinguished after the main flame is established.

2.101.10 LOW RATE START: A condition in which main burner ignition occurs at low fuel rate. Once ignition at low fuel rate occurs and the flame is proved, full main burner fuel rate may be admitted. (Low rate start is often referred to as low fire start.)

2.101.12A *Addition:*

PILOT BURNER: A burner which provides a flame to ignite a main burner(s).

Pilot burner is sometimes referred to as a pilot.

2.111.1A *Addition:*

ELEMENT AMBIENT TEMPERATURE LIMIT: The temperature below which the sensing element will act to shut off the fuel supply.

2.111.2A *Addition:*

INTERMITTENT/CONTINUOUS IGNITION: A type of ignition which is ignited or energized upon equipment user initiation of the operational cycle and which remains continuously ignited or energized during the equipment use cycle. The ignition source is extinguished or deenergized when the equipment use cycle is completed.

2.111.3A *Addition:*

INTERMITTENT/INTERRUPTED IGNITION: A type of ignition which is ignited or energized upon equipment user initiation of the operational cycle and which is extinguished or deenergized after the equipment use cycle has been initiated.

2.111.4A *Addition:*

OXYGEN DEPLETION SAFETY SHUTOFF SYSTEM (ODS): A system designed to shutoff the main burner and pilot gas to the equipment when the oxygen content of the room in which the equipment is installed is reduced below a predetermined level. This system may also serve as the automatic burner ignition system.

2.111.5A *Addition:*

MILLIVOLTAGE CIRCUIT: A circuit which receives its electrical energy by means of a thermocouple(s) or photovoltaic device(s).

2.111.6A *Addition:*

FAST-ACTING THERMOCOUPLE: A thermocouple type flame sensor and generator whose output voltage will decay from its maximum to specified minimum in 30 seconds or less after flame is extinguished.

3 General requirements

Replacement:

All markings required for compliance with this standard may need to be in other languages to conform with local language requirements where the product is sold.

Note: In Canada there are two official languages, English and French. Annex EE provides French translations of the markings specified in this Standard. All Markings required by this Standard may have to comply with the provided in other languages to conform with the language requirements of the country where the product is to be used.

Addition:

Construction of an ignition control, whether specifically covered by this standard or not shall be in accordance with reasonable concepts of safety, substantiality and durability.

4 General notes on tests

4.1 Conditions of test

4.1.1 Replacement:

Unless otherwise specified, the system and each system component are tested as delivered, having been mounted as declared in Table 7.2, requirement 31, in the most unfavorable position when more than one is declared.

When a separate system component is submitted, the manufacturer shall provide those other system components which may be necessary to perform the relevant tests.

4.1.2 Replacement:

If the test results are influenced by the room temperature, this shall be maintained at 77 ±10°F (25 ±5.5°C), hereinafter referred to as room temperature, unless otherwise specified in a particular clause.

Unless otherwise specified, tests conducted at other than room temperature, shall be within ±3°F (±1.5°C) of the specified value.

4.1.3 Not Applicable.

4.1.6 and 4.1.7 Not Applicable

4.2 Samples required

4.2.1 Unless otherwise specified, one sample shall be used for the tests of clauses 5, Rating, to 14, Heating, inclusive. A different sample(s) shall be used for the tests of clauses 15, Manufacturer Deviation and Drift, to 17, Endurance. At the option of the manufacturer, the tests of clauses 18, Mechanical Strength, to 26, Electromagnetic Compatibility (EMC), inclusive, may be conducted on a new sample or on the same sample(s) used in the tests of clauses 5 to 14, inclusive. The tests of clause 27, Abnormal Operation, shall be conducted on a new sample. (Also see H26.2.106 for tests on electronic controls.)

4.2.2 Void.

4.2.4 Not Applicable.

4.3 Instructions for tests

4.3.1 Not Applicable.

4.3.2 According to rating

4.3.2.6 For controls marked or declared for more than one rated voltage or rated current, the tests of clause 17, Endurance, are made at the rated voltage and associated current (or vice versa) which produces the most unfavorable combination.

4.3.3 According to protection against the risk of electric shock

4.3.4 According to manufacturing variants

4.3.4.2 Not Applicable

4.3.5 According to purpose

4.3.5.2 through 4.3.5.4 Not Applicable.

5 Rating (See 1.2)

This clause of Part 1 is applicable.

6 Classification

This clause of Part 1 is applicable except as follows:

A system or component is classified:

6.1 According to nature of supply.

6.1.1 Control for a.c. only

Replace explanatory matter as follows:

Systems intended for use on a.c. supply may only be used on a.c. supplies.

6.1.3 Not Applicable

6.3 According to their purpose

6.3.1 through 6.3.3 Not Applicable.

6.3.4 Void

6.3.5 through 6.3.13 Not Applicable.

6.3.101 – burner control system;

6.3.101.1A – burner ignition system;

6.3.101.2A – burner ignition system component;

6.3.102 – flame detector;

6.3.103 – programming unit;

6.3.104 – ignition device;

6.3.105 – electronic ignition source;

6.3.106 – flame sensor;

6.3.107A *Addition:*

– oxygen depletion system.

6.4 Not Applicable.

6.5 According to the control pollution situation

6.5.1 and 6.5.2 Not Applicable.

6.5.3 *Replacement:*

According to the pollution situation for which the control, without additional protection, is suitable:

– control suitable for use in a clean situation;

– control suitable for use in a normal pollution situation;

– control suitable for use in a dirty situation.

A control intended for use in a particular situation may always be used in a less polluted situation.

A control may be used in a more polluted situation than for which it is intended, if the appropriate protection is provided by the equipment, a cover or an enclosure.

Within a control intended for use in a particular situation, additional enclosures or sealing may be provided to enable the enclosed parts to use creepage distances and clearances appropriate to the protection afforded them. Thus, within a control classified for use in a dirty situation, some parts may be in a normal situation by virtue of a suitable cover, and other parts may be in a clean situation by virtue of sealing or encapsulation.

6.6 According to method of connection

6.6.2 Not Applicable

6.7 Not Applicable

6.8 According to protection against the risk of electrical shock

6.8.1 and 6.8.2 Not Applicable.

6.9 Not Applicable

6.10 According to number of cycles of actuation (M) of each manual action

6.10.1 through 6.10.3 Not Applicable

6.10.4 Replacement:

Minimum of 6 000 cycles required;

6.10.5 through 6.10.7 Not Applicable

6.11 According to number of automatic cycles (A) of each automatic action

Minimum values are:

6.11.1 and 6.11.2 Not Applicable

6.11.3 Replacement:

– 100 000 cycles;

6.11.4 Not Applicable

6.11.5A *Addition:*

– 25 000 cycles;

6.11.6 through 6.11.11 Not Applicable

6.11.12 – 1 cycle [1)]

[1]Applicable only to actions which require the replacement of a part after each operation.

For controls having more than one automatic action a different value may be declared for each.

6.12 Not Applicable.

6.14 According to period of electrical stress across insulating parts supporting live parts and between live parts and earthed metal

6.14.1 Not Applicable.

6.15 According to construction

6.15.3 Not Applicable.

6.15.5 Not Applicable.

6.16 through 6.18 Not Applicable.

6.101 According to type of fuel

6.101.1A *Addition:*

Oil

6.101.2A *Addition:*

Gas

a) Natural

b) Manufactured

c) Mixed

d) Liquefied petroleum

e) LP gas-air mixtures

6.102 *Addition:*

According to type of pilot

Not applicable.

6.103 *Addition:*

According to type of ignition

Not applicable.

6.104 *Addition:*

According to starting fuel rate

Not applicable.

7 Information

This clause of Part 1 is applicable except as follows:

7.2 Methods of providing information

This clause of Part 1 is applicable except as follows:

7.2.6 Not Applicable.

7.2.7 For controls in which lack of space prevents legible marking as specified, the control shall be marked with the manufacturer's name (or trade mark), model number and date code. The other marking required shall be included in documentation (D).

Modification: Replace or add the following requirements by:

Table 7.2

Information		Clause or subclause	Methods: C – Marking, D – Documentation, X – Declaration
4	Nature of supply (a.c. or d.c.)	4.3.2, 6.1	C
4A	Class of transformer required	2.1.6	D
5	Frequency, mHz	4.3.2	C
6A	Construction of control and whether the control is electronic	H2.5.7	X
15	Degree of protection provided by enclosure [8]	11.5	C
18	Not Applicable		
20 and 21 Not Applicable			
22	Ambient temperature limits of the system and system components, T_{MIN} and T_{MAX},	1.1.5A, 2.3.30, 2.3.30A, 14.5, 14.7, 29A	D
22A	Operating temperature limits of components, and points of measurement thereof, including, but not limited to the following:	29A	
Pilot burner tip			X
Pilot burner orifice fitting			X
Electric igniter			X
Flame sensor			X
The surface temperature in the area of hot and cold junction of thermoelectric types			X
Means that determine time(s) of operation			X
Electric component housing(s)			X
Mechanical component housing(s)			X
Sensing element ambient temperature limit(s)			X
23 through 29 Not Applicable			
31	Method of Installing the system and each component [5)]	4.1.1, 11.6, 17.16.105	D
32 through 44 Not Applicable			
46	Operating sequence	2.3.13, 11.3.108, 15	D
47 and 48 Not Applicable			
51	Not Applicable		
61 through 65 Not Applicable			

Table 7.2 Continued on Next Page

Table 7.2 Continued

	Information	Clause or subclause	Methods: C – Marking, D – Documentation, X – Declaration
101	Maximum flame detector response time (if applicable)	2.3.103, 15	D
102	Minimum flame detector self-checking rate (if applicable)	2.3.106, 15	D
103	Maximum flame failure lock-out time (if applicable)	2.3.107, 15	D
104	Maximum flame failure reignition time (if applicable)	2.3.108, 15	D
l04A	Maximum flame failure response time (if applicable)	2.3.108A, 15	D
105	Not Applicable		
106	Maximum trial for ignition period (if applicable)	2.3.113A, 15	D
107	Maximum pilot-flame establishing period (if applicable)	2.3.114, 15	D
108	Maximum post-ignition time (if applicable	2.3.115, 15	D
109	Maximum pre-ignition time (if applicable)	2.3.116, 15	D
110	Void		
110A	Minimum inter-purge time (if applicable)	2.3.118.3A	D
111	Minimum post-purge time (if applicable)	2.3.118.1, 15	D
112	Minimum pre-purge time (if applicable)	2.3.118.2, 15	D
113	Minimum recycle time (if applicable)	2.3.120, 15	D
114	Maximum lock-out time (if applicable)	2.3.125A, 15	D
115	Minimum waiting time (if applicable)	2.3.126A, 15	D
115A	Maximum ignition activation period (if applicable)	2.3.129A	D
115B	Minimum automatic restart time (if applicable)	2.3.130A, 15	D
116	Not Applicable		
117	Type of pilot	2.101.2, 2.101.4, 2.101.7, 2.101.9	D
118	Type of ignition	2.101	D
119	Void		
120	Means of protecting settings of timings	11.3.4	X
121	See annex H		
122	Resistance to vibration	17.1.3, 17.16.10	D
123	S_1 (signal for presence of flame, if applicable)	2.3.104.1, 15.5, 15.6, 15.7	D
124	S_2 (signal for absence of flame, if applicable)	2.3.104.2, 15.5, 15.6, 15.7	D
125	S_{max} (maximum flame signal, if applicable) [103)]	2.3.104.3, 15.5, 15.6, 15.7	D
126	Electronic Ignition spark gap [102)]	13.2.101	D
127	Other system components used with the submitted components to provide a complete system	2.2.101, 2.2.102, 2.2.104, 2.2.106	D
128	Not Applicable		
128A	For oxygen depletion safety shutoff systems, maximum and minimum oxygen cutoff points.	2.111.4A, 29A3.5	X
128B	For a thermoelectric type flame sensor: – available lead length(s) (nominal); – minimum and maximum electrical resistance for each lead length.	29A4.3.2	X

Table 7.2 Continued on Next Page

Table 7.2 Continued

	Information	Clause or subclause	Methods: C – Marking, D – Documentation, X – Declaration
128C	For thermoelectric devices: – minimum and maximum electrical resistance; – minimum and maximum pull-in current. – minimum and maximum drop-out current.	29A4.3	X
128D	Element ambient temperature limit	2.111.1A, 29A4.2.1	X
129	Maximum valve sequence period (if applicable)	2.3.128, 11.3.112, 15.5q	D
129A	Date code.	7.4.6A	C
130	Not Applicable.		
130A	Certifying agency symbol.	7.4.7A	C
131	For proved igniters, the characteristics (energy, current, voltage, resistance, temperature, etc.) which establish that the proved igniter is capable of igniting the fuel	23.117, 15.3, 15.4, 15.5, 15.7	D
131A	Whether the ignition system component is intended for direct exposure to flame envelopment.	29A5(c)	D
132	Proved igniter operating value (Minimum or maximum, as applicable)	2.3.117.1, 15.7, 17.16.108, H27.1.3	
132A	Fuel for which intended.	6.101	
133	Maximum igniter proving time (If applicable)	2.3.117.2, 15.5	D
133A	Gas input rate for pilot burners.	29A2.4.4	D
134	Maximum igniter failure response time (If applicable)	2.3.117.3, 15.5	D
134A	A failure mode and effects analysis (FMEA). 104A)	H27	X
135A	Documentation relative to the suitability of materials.	11.1, 29A2.1.3, 29A2.1.4	X
136A	Complete instructions for lighting, operating and field adjustments and electrical diagrams indicating external connections.	7.4.4	D
137A	Instruction per 7.5A.	7.5A	D
138A	Markings per 7.4.8A.	7.4.8A	C
139A	Markings per 8.1 (if applicable)	8.1.101	C

NOTES

3) and 4) Not Applicable

6) Not Applicable

8) Control enclosures shall be marked in accordance with the environmental enclosure requirements of UL 50 or CSA C22.2 No. 94.

Dust covers are not considered to be control enclosures, and need not be marked.

10) and 11) Not Applicable.

20) and 21) Not Applicable.

101) Not Applicable

102) If a range is declared, the maximum value is used for the test of 13.2.102 and 13.2.103.

103) S_{max} shall be declared for those controls in which the maximum flame signal affects timings or sequence.

104A) Typical FMEA form shown in Appendix B, Failure Mode and Effect Analysis.

7.3 Class II symbol

7.3.1 Replacement:

The symbol for class II construction shall be used only for controls classified according to 6.8.3.4.

Controls with double insulation are required to be marked: ″Double Insulation″ or ″Double Insulated.″ The double square symbol is permitted as an additional marking.

It is only required to mark: ″When servicing, use only identical replacement parts;″ and for equipment rated in the voltage range 220-250V, the following: ″Use only on circuits of 150 volts or less to ground.″

7.3.2.1 Replacement:

The length of the sides of the outer square of the symbol shall be not less than 0.20 inch (5 mm), unless the largest dimension of the control is 0.60 inch (15 mm) in the length or less, in which case the dimension of the symbol may be reduced but the length of its outer square shall be not less than 0.12 inch (3 mm).

7.4 Additional requirements for marking

7.4.1 Replacement:

Each separable component shall bear the marking specified in table 7.2.

Required markings shall be legible and durable.

Compliance is checked by the tests of Annex AA, Indelibility of Marking.

Add the following clauses:

7.4.101 Additional markings for independently mounted controls

7.4.101.1 In the U.S., refer to marking requirements in Automatic electrical controls for household and similar use – Part 1: General Requirements, UL 60730-1A, Annex DVC.

7.4.101.2 In Canada refer to marking requirements in Annex CC, Additional marking requirements for independently mounted controls.

7.4.2 Not Applicable.

7.4.3 Replacement:

Terminals intended exclusively for a grounded supply conductor shall be indicated by the letter ″N″ or the word ″Neutral.″

A terminal intended for connection of a grounded supply conductor shall be finished to show a white or natural grey color and shall be distinguishable from other parts.

A lead intended for connection of a grounded supply conductor shall be finished to show a white or natural grey color and shall be distinguishable from other leads.

7.4.3.1 Not Applicable.

7.4.3.2 Replacement:

All other terminals shall be suitably identified, their purpose self-evident or the control circuity visually apparent. The neutral or the earth designations shall not be used except as indicated in 7.2.9 or 7.4.3.

A wire-binding screw intended for the connection of an equipment earthing conductor shall have a slotted or hexagonal green-colored head. A pressure wire connector intended for connection of such a conductor shall be marked with the earth symbol, ″GR,″ ″GND,″ ″GROUND,″ ″GROUNDING″ or ″EARTH″ or by a marking on a wiring diagram provided on the control. The wire-binding screw or pressure wire connector shall be so located that it is unlikely to be removed during servicing of the control.

7.4.3.2A *Addition:*

Leads or terminals of an individual component, that are provided for making electrical connections and which are intended to be disconnected in order to replace or service the control, shall be marked by a number(s), letter(s), symbol(s) or combination thereof, in a color which contrasts with the background. This requirement does not apply when:

The individual component incorporates means which will physically prevent miswiring, or

The individual component incorporates only two terminals or leads, the interchange of which does not change the operation of the component.

7.4.3.3A *Addition:*

Field-wiring terminals of independently mounted controls shall be marked as follows or with equivalent wording:

″Use Copper Conductors Only″ or

″Use Aluminum Conductors Only″ or

″Use Aluminum or Copper-Clad Aluminum Conductors Only″ or

″Use Copper or Aluminum Conductors″ or

″Use Copper, Copper-Clad Aluminum, or Aluminum Conductors″

7.4.6A *Addition:*

Each separable component, with the exception of interconnecting wiring, shall bear a separate marking indicating the date of manufacture. This marking shall be as specified in ″a″, ″b″, or ″c″ below.

a) The date in the form of:

1) The month, day and year; or

2) The day, month and year.

The abbreviation of the month shall be at least the first three letters of the month. The day may be Monday for the week and the year shall be at least the last two digits of the year.

b) A four digit code consisting of:

1) The first and second digits indicating the calendar year in which the component was manufactured (e.g., 04 for 2004); and

2) The third and fourth digits indicating the week in which the component was manufactured (e.g., 03 for the third week of the year). For purposes of this marking, a week shall begin at 0001 hours on Sunday and end at 2400 hours on Saturday.

A four digit code may be used for more than one week; however, it shall not be used for more than four consecutive weeks, nor more than two weeks into the next calendar year.

If space limitations prevents the use of a four digit code, an alternate date code acceptable to the certifying agency shall be provided.

Additional numbers, letters or symbols may follow the four digit code. If additional numbers are used, they shall be separated from the four digit code.

c) A five digit code consisting of:

1) The first and second digits indicating the calendar year in which the component was manufactured (e.g., 03 for 2003); and

2) The third, fourth and fifth digits indicating the day of the year in which the component was manufactured (e.g., 183 for the one hundred and eighty third day in the year 2003, which is July 2, 2003).

Additional numbers, letters or symbols may follow the five digit code. If additional numbers are used, they shall be separated from the five digit code.

7.4.7A *Addition of a certification agency marking:*

Each separable component shall be marked with the symbol of the organization making the test for compliance with this standard, as applicable.

7.4.8A *Addition:*

When different parts are required for use with various gases, a marking which complies with Annex AA shall be provided to identify the type(s) of gas for which the part is intended.

7.5A *Additions:*

The following information or statements shall be included in the instructions:

7.5A.1 ″Caution: Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation.″

7.5A.2 A step by step functional checkout of a replacement component.

7.5A.3 A statement(s) that if electronic components are installed in an area subject to water (dripping, spraying, rain etc.), then means shall be provided to protect the components.

7.5A.4 Information identifying parts intended for field servicing and procedures for servicing or replacing such parts.

8 Protection against the risk of electric shock

This clause of Part 1 is applicable except as follows:

8.1 General requirements

8.1.6 Replacement:

For integrated and incorporated controls the test of 11.5A.1 to 11.5A.3, inclusive, is only applied to those parts of the control which are accessible when it is mounted in any position in accordance with the manufacturer's declarations and after removal of detachable parts.

8.1.7 Not Applicable.

8.1.8 Replacement:

For independently mounted controls the tests of 11.5A.1 to 11.5A.3, inclusive, are made when the control is mounted as in normal use, fitted with cable of the smallest or of the largest nominal cross-sectional area used in 10.1.4, whichever is more unfavorable, or with a rigid, pliable or flexible conduit. Detachable parts are removed, and hinged covers which can be opened with the use of a tool, are opened.

8.1.9 through 8.1.9.5 Not Applicable.

8.1.12 Not Applicable.

8.1.101 Addition of requirements covering ignition sources:

Provision shall be made for protection against contact with ignition sources.

The control manufacturer shall provide a warning that is visible when the ignition source is mounted as in normal use or the equipment manufacturer shall be advised of the need to provide such protection or a warning.

8.3 Capacitors

Not Applicable

8.4A *Addition of requirements covering mechanical servicing:*

8.4A.1 Paragraph 8.4A.2 is intended to provide a reasonable degree of protection to a serviceman performing a mechanical function on energized equipment. Such a service function does not in itself cause exposure to live parts or moving parts capable of causing injury to persons but it is commonly necessary to perform the function with the equipment energized.

8.4A.2 A live part or a moving part capable of causing injury to persons shall be located, guarded, or enclosed so as to reduce the risk of unintentional contact by a serviceman adjusting or resetting a control, or performing a mechanical service function that may have to be performed with equipment energized. (See CC.7A).

These requirements do not apply to a mechanical service function that is not normally performed with equipment energized.

8.4A.3 Mechanical service functions that may have to be performed with equipment energized include adjusting the setting of a temperature or pressure control; resetting a control trip mechanism; or operating a manual switch. A control that has the set point sealed at the factory as described in 11.3.4 and that does not have marking or instructions for adjustment, is not considered to be adjustable.

8.4A.4 An adjustable or resettable electrical control or manual-switching device may be located or oriented with respect to live parts so that manipulation of the mechanism for adjustment, resetting, or operation can be accomplished in the normal direction of access if live parts are not located in front (in direction of access) of the mechanism, and near any side or behind the mechanism, unless guarded.

8.4A.5 The requirements in paragraphs 8.4A.2 through 8.4A.4 do not apply to safety extra-low voltage circuits.

8.4B *Addition of requirements covering electrical servicing:*

8.4B.1 Paragraph 8.4B.2 requires the location of certain electrical components within an overall assembly so that the necessary space is provided for working on the components while the equipment is energized.

8.4B.2 An electrical component that may need to be examined, adjusted, serviced, or maintained while the equipment is energized shall be located and mounted with respect to other components and with respect to grounded metal parts so that it is accessible for electrical servicing without subjecting a serviceman to a risk of electric shock or a risk of injury by adjacent moving parts. Access to a component shall not be impeded by other components or by wiring.

8.4B.3 Compliance with the requirement in paragraph 8.4B.2 may be obtained by mounting control components in an assembly so that unimpeded access to each component is provided through an access cover or panel in the outer cabinet, if provided, and the cover of the control assembly enclosure.

8.4B.4 Electrical components to which paragraphs 8.4B.2 and 8.4B.3 apply include fuses; relays; adjustable or resettable pressure or temperature controllers; manual switching devices; clock timers and incremental-voltage taps. Such components in safety extra-low voltage circuits shall comply with the requirements of 8.4B.2 in their relation to live parts in a circuit of greater energy level and to moving parts which present a risk of injury to persons.

8.4B.5 The following are not considered to be live parts: coils of controllers, relays and solenoids, and transformer windings, if the coils and windings are provided with acceptable insulating overwraps at least 1/32 inch (0.8 mm) thick, or the equivalent, in accordance with the note to paragraph 20.3.A.18; enclosed motor windings; terminals and splices with acceptable insulation; and insulated wire.

9 Provisions for bonding and earthing

9.1 General requirements

Replacement:

Section numbers 9.1.1 through 9.1.1A1.8.3 apply to independently mounted controls only.

9.1.1 Accessible metal parts of independently mounted controls of class I which may become live in the event of an insulation fault, shall be permanently and reliably connected to an earthing terminal or termination within the control, or to the earthing contact of an equipment inlet.

The phrase ″permanently and reliably connected to an earthing terminal″ is synonymous with the term ″bonded.″

Parts separated from live parts by double insulation or reinforced insulation and parts screened from live parts by metal parts connected to an earthing terminal, earthing termination or earthing contact, are not regarded as likely to become live in the event of insulation fault.

9.1.1A1 *Addition:*

Parts shall be bonded by metal-to-metal attachment or by a separate bonding jumper in accordance with the following:

The ends of a bonding conductor shall be in metal-to-metal attachment with the parts to be bonded.

A splice shall not be employed in a wire used for bonding purposes.

9.1.1A1.1 There shall be provision for earthing all dead metal parts of the following controls that are exposed or that are likely to be touched by a person during normal operation or adjustment and that are likely to become energized through electrical fault.

– A control that is to be permanently connected electrically.

– A control provided with an earthing means, whether required or not.

9.1.1A1.2 To determine whether a part is likely to become energized, such factors as construction, the proximity of wiring, a dielectric voltage-withstand test after the overload and endurance tests and burnout tests are to be evaluated.

9.1.1A1.3 An equipment-earthing terminal or lead earthing point shall be connected to the frame or enclosure by a positive means, such as by a bolted or screwed connection.

9.1.1A1.4 An earthing connection shall reliably penetrate a nonconductive coating, such as paint or vitreous enamel.

9.1.1A1.5 An earthing point shall be located so that it is unlikely that the earthing means will be removed during normal servicing.

9.1.1A1.6 An independently mounted control that is to be permanently connected electrically shall be provided with one of the following means for earthing:

– an equipment earthing terminal or lead provided on the control. If the device is marked: ″Mount This Control only to a Earthed Metallic Box,″ the earthing terminal or lead need not be provided on the device as shipped.

– a knockout or equivalent opening in a metal enclosure of a control intended to be connected to a metal enclosed wiring system.

9.1.1A1.7 A device employing field-wiring leads in flexible metal conduit, where flexing of the conduit is required for adjustment or movement after installation, shall have an equipment earthing conductor of adequate size installed in the flexible conduit.

9.1.1A1.8 A metal part, such as an adhesive-attached metal-foil marking, a screw, or a handle that is (1) located on the outside of an enclosure or cabinet and isolated from electrical components and wiring by earthed metal parts so that it is not likely to become energized, or (2) separated from wiring and space from live parts as if it were an earthed part, need not comply with the requirement 9.1.1.

9.1.1A1.8.1 The requirement 9.1.1 does not apply to (1) small internal assembly screw, or other small fastener, such as a rivet, (2) a handle for a pull-out disconnect switch, or (3) a magnet or armature of a relay or contactor.

9.1.1A1.8.2 Live parts and wiring shall be held away from moving parts, such as relay and contactor magnets and armatures, by clamping, routing, or equivalent means that will provide permanent separation.

9.1.1A1.8.3 A metal panel or cover need not comply with the requirement of 9.1.1A1.8 provided:

The panel or cover is insulated from electrical components and wiring by an insulating barrier or vulcanized fiber, varnished cloth, phenolic composition, or other moisture-resistant material not less than 1/32 inch (0.8 mm) thick and reliably secured in place;

The panel or cover does not enclose live parts, and wiring is positively separated from the panel or cover so that it is not likely to become energized; or

The panel or cover is isolated from live parts and wiring by earthed or bonded interposing metal so that the interposing metal would be subject to an electrical fault before the isolated metal part in question.

9.3 Adequacy of earth connections

9.3.4A *Addition of requirements covering the size of accessible earthing leads:*

A flying lead for connection to an external earthing conductor shall have a free length of 6 inch (152 mm) and shall have the free end insulated – for example, shall have the end folded back and taped to the lead – unless the lead is located so that it cannot contact live parts in the event that the lead is not used in the field. It shall be not smaller than (1) the size specified in Table 9.3.4A, (2) the conductor supplying the motor or component, whichever is smaller or (3) shall be tested to determine that it withstands overload and short-circuit conditions.

Table 9.3.4A

Rating or setting of automatic overcurrent device in circuit ahead of equipment, conduit, etc., Not exceeding Amperes	Size of conductor [1)]			
	Copper wire AWG	Aluminum wire AWG	Rigid conduit or Pipe, inch	Electrical metallic tubing, inches
20	12	10	½	½
30	10	8	½	½
40	10	8	½	½
60	10	8	½	½
100	8	6	½	½
200	6	4	½	1

[1)] Or equivalent cross-sectional area.

9.6A *Addition:*

Individually covered or insulated earthing conductors shall have a continuous outer finish that is either green, or green with one or more yellow stripes and no other conductors visible to the installer in a field wiring compartment shall be so identified. Bare, covered or insulated earthing conductors shall be permitted.

The color coding requirement does not apply to a safety extra-low voltage circuit under the following conditions:

Leads or wiring to safety extra-low voltage terminals are remote from the location where the high voltage connections are made and connectors and live parts are segregated in accordance with paragraphs 20.3.A.21.1 to 20.3.A.21.5 inclusive.

Leads or safety extra-low voltage terminals are specifically marked with the intended use, such as ″Thermostat,″ so that reference to a wiring diagram is not necessary.

9.7A *Addition:*

Except as listed in 9.8A, the circuitry of a control shall be arranged so that the equipment-earthing connection or conductor, the enclosure, the frame, the component-mounting panel, and the earthing means do not carry current except in the instance of an electrical fault.

9.8A *Addition:*

A single-point reference ground may be employed in an extra-low voltage or isolated limited secondary circuit. The enclosure, frame, or panel, including bolted joints may carry the current of an extra-low voltage. In neither of these instances is such current to be carried through the field-equipment earthing means, the metallic raceway or other power-supply earthing means.

10 Terminals and terminations

10.1.4 Replacement:

Terminals for fixed wiring shall allow at least the connection of conductors having nominal cross-sectional areas as shown in table 10.1.4.

Compliance is checked by measurement and by fitting conductors of the smallest and largest cross-sectional areas specified or declared.

Table 10.1.4

Current carried by terminal A	Fixed wiring conductors	
	AWG [3]	Nominal cross-sectional area, [1] inches^2 (mm^2)
Up to and including 6 [2]	18 to 14	0.0013 to 0.0032 (0.8 to 2.0)
over 6 up to and including 10	18 to 12	0.0013 to 0.0052 (0.8 to 3.3)
over 10 up to and including 16	16 to 8	0.0020 to 0.0129 (1.3 to 8.3)
over 16 up to and including 25	14 to 6	0.0032 to 0.0206 (2.0 to 13.3)
over 25 up to and including 32	12 to 6	0.0052 to 0.0206 (3.3 to 13.3)
over 32 up to and including 40	10 to 4	0.0082 to 0.0327 (5.3 to 21.1)
over 40 up to and including 63	8 to 0	0.0129 to 0.0830 (8.3 to 53.5)

[1] The nominal cross sectional area of a conductor is related to the current being carried and shall be as stated in Article 310 and Article 400 of the National Electrical Code, NFPA 70, or the Canadian Electrical Code, CSA C22.1.

[2] The nominal cross-sectional areas specified do not apply to terminals in low voltage circuits carrying a current not in excess of 3 A.

[3] American Wire Gauge.

10.1.5.1 Modification:

In Canada, compliance with the Standard for Terminal Blocks, CSA C22.2 No. 158 meets the requirements of this subclause. In the U.S., compliance with the Standard for Terminal Blocks, UL 1059, meets the requirements of this subclause. The terminal block must satisfy the spacing requirements of this standard. (See Clause 20).

10.1.8.3 and 10.1.8.4 Not Applicable

10.1.11 and 10.1.12 Not Applicable

10.1.14 Replacement:

Screws and threaded parts of terminals shall be of metal.

The clause of Part 1 is applicable with the following addition:

A limited power safety extra-low voltage transformer (National Electrical Code, NFPA 70, Article 725, or Canadian Electrical Code, CSA C22.1, Part 1) may have terminal plates 0.030 inch (0.76 mm) thick for either primary or secondary connections.

A terminal plate tapped for a wire binding screw shall have two or more full threads which may be extruded to provide two full threads.

Two full threads are not required if fewer threads make a connection which does not strip when the torque as stated in the Standard for Wire Connectors and Soldering Lugs for Use With Copper Conductors, UL 486A or the Standard for Wire Connectors, CSA C22.2 No.65, is applied.

10.1.16.1 The clause of Part 1 is applicable with the following revision:

Compliance is checked by applying a pull of 20 pounds (89 N) on the leads for 1 minute.

10.2 Terminals and terminations for internal conductors

10.2.1 Replacement:

Terminals and terminations shall allow the connection of conductors having nominal cross-sectional areas as shown in table 10.2.1.

Table 10.2.1

Current carried by terminal or terminations A	Minimum conductor [1]	
	AWG [3]	Nominal cross-sectional area, inches^2 (mm^2)
Up to and including 3	[2]	
Over 3 up to and including 6	18	0.0013 (0.8)
Over 6 up to and including 10	17	0.0016 (1.0)
Over 10 up to and including 16	16	0.0020 (1.3)
Over 16 up to and including 25	14	0.0032 (2.0)
Over 25 up to and including 32	11	0.0065 (4.2)
Over 32 up to and including 40	10	0.0082 (5.3)
Over 40 up to and including 63	7	0.0163 (10.5)

[1] Internal wiring shall be suitable for the declared temperature, voltage and application.
[2] No minimum specified, but the manufacturer shall declare the conductor size for test purposes.
[3] American Wire Gauge.

10.2.4 The clause of Part 1 is applicable with the following addition:

In Canada, flat push-on connectors shall be constructed and tested in accordance with CSA C22.2 No. 153, Quick Connect Terminals, therefore subclauses 10.2.4.1 through 10.2.4.4 are not applicable.

10.2.4.1 and 10.2.4.2 Not Applicable.

Table 10.2.4.2 Not Applicable

10.2.4.3 Not Applicable.

10.2.4.4 Not Applicable

10.2.4.101 Addition of requirements covering direct plug-in connections:

Controls intended for direct plug-in connection to a subbase, or module that is intended for direct plug-in to the control shall be so constructed that they withstand the forces of normal insertion and withdrawal in such a manner that compliance with this standard is not impaired.

Compliance is checked by performing 10 insertions and withdrawals according to the manufacturer's instructions.

After this test, no significant displacement or damage shall occur.

The terminals used for direct plug-in connections between the control and its sub-base are not considered flat push-on connectors.

11 Constructional requirements

11.1 Materials

Replacement:

Requirements for insulating materials and polymeric enclosures are contained in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C or the Standard for Evaluation of Properties of Polymeric Materials, CAN/CSA C22.2 No. 0.17.

For integrated and incorporated controls – Dust covers are not considered to be enclosures.

11.1.2 Not Applicable

11.1.3 through 11.1.3.2 Not Applicable.

11.2 Protection against the risk of electric shock

11.2.3A.5 *Addition:*

Tubing shall not be subjected to sharp bends, tension, compression, or repeated flexing, and shall not contact sharp edges, projections, or corners. Tubing may be used in dry or damp locations but is not acceptable in wet locations.

11.2.4 Flexible cord sheaths

The clause of Part 1 is applicable with the following addition:

In Canada, reference standards are the Standard for Flexible Cords and Cables, CSA C22.2 No. 49 and the Standard for Equipment and Lead Wires, CSA C22.2 No. 127.

11.3 Actuation and operation

11.3.4 Setting by the manufacturer

Replacement:

Adjustment means used for the setting of timings shall be secured by means providing protection against access by uninstructed persons or shall be declared as requiring such protection in the application.

For example, such adjustment means may:

1) be sealed with a material suitable for the temperature range of the control such that tampering is apparent; or

2) consist of special parts only available from the manufacturer; or

3) be accessible only with the use of special purpose tools or access codes.

Where sealing is used, inspection is done before and after the tests of clause 17.

11.3.5 Contacts – General

The clause of Part 1 is applicable with the following addition of 11.3.101A through 11.3.113:

11.3.9 Not Applicable.

11.3.101A *Addition:*

The primary input circuit of a system shall be a two-wire, one-side-grounded system, having a voltage rating of not more than a nominal 120 volts. A switch or protective device shall be in the circuit electrically connected to the ungrounded supply conductor.

11.3.102 through 11.3.105 Not Applicable.

11.3.105A *Addition:*

If the system initiates a signal to energize the fuel flow means at less than 0.85 V_R for a.c. and 0.80 V_R for d.c., the operating sequence and timings measured at room temperature shall comply with the applicable declarations of Table 7.2, items 46, 101 to 115B and 132 to 134.

Compliance is checked by the following:

11.3.105A.1 The system may be connected to a test burner to simulate an appliance, or for test purposes, the flame operating characteristics may be artificially simulated.

The system shall be connected to a variable voltage means, and a voltmeter shall be connected across the terminals of the fuel flow means. The system shall be maintained at room temperature through 11.3.105A.4.

11.3.105A.2 The system shall be operated for 5 minutes at V_R. The system input voltage shall be gradually reduced until the voltmeter reading at the terminals of the fuel flow means is reduced to zero. The system input voltage shall be recorded.

11.3.105A.3 The system input voltage shall be restored to V_R and the system operated for 5 minutes. The system input voltage shall then be gradually reduced to the value identified in 11.3.105A.2. At this voltage the Flame Failure Response Time and, if applicable, the Flame Failure Reignition Time shall comply with the times declared in Table 7.2, items 104 and 104A.

11.3.105A.4 The system input voltage shall be shut off for 5 minutes and then restored to the value recorded in 11.3.105A.2. The voltmeter reading at the terminals of the fuel flow means shall be observed. The system shall be allowed to complete its declared sequence until the terminals of the fuel flow means are energized. If the initial input voltage is not sufficient to result in a voltage signal at the fuel flow means terminals, it shall be increased incrementally until a signal is observed.

After each voltage increase, the system shall be shut off for 5 minutes. The input voltage shall then be restored, and the system allowed to complete its declared sequence until a voltage signal is indicated at the terminals of the fuel flow means.

The minimum input voltage which results in a reading at the terminals of the fuel flow means shall be recorded. At this input voltage the sequence and applicable timings shall comply with the declarations made in Table 7.2, items 46, 101 to 115B and 132 to 134.

11.3.105A.4A For proved igniter systems where the igniter and automatic valve(s) are electrically in series and the opening and closing characteristics of the automatic valve are dependent on the electrical characteristics of the igniter, the proved igniter characteristics shall be verified at the lowest voltage that allows the valve to remain open.

Compliance is checked by the following.

11.3.105A.4A.1 The ignition control shall be placed in operation at room temperature and V_R at a flow rate of one-third rated pressure drop capacity of the automatic valve. The pressure shall be established at the reduced value specified in Table 29A2.2. A test burner shall be used to simulate an appliance pilot or main burner, as applicable. A means to vary the input voltage shall be used and the input voltage to the system shall be monitored throughout the test.

11.3.105A.4A.2 The system shall be operated for 5 minutes, after which the input voltage is to be reduced to 0.85 V_R. At one minute time intervals, the voltage shall be incrementally reduced by 0.02 V_R. The voltage shall be reduced until the ignition system shuts off the flow of gas to the burner. At this voltage, the proved igniter characteristics shall be verified.

11.3.105.5 Not Applicable.

11.3.105.6 Not Applicable.

11.3.106 The circuit of a system shall provide a safe start check that will cause a), b) or c) to occur if failure causes a flame signal when no flame is present.

a) The system shall fail to start the operating sequence;

b) The system shall lock-out within the time declared in table 7.2, requirement 103;

c) The system shall remain in pre-purge.

The system may remain in conditions a) or c) until the fault clears.

For systems which incorporate electronic devices, compliance is determined by the tests of H27, Abnormal Operation.

11.3.107 Not Applicable.

11.3.108 Systems shall perform the declared operating sequence.

11.3.108.1 The electric circuit of the actuating means of the lock-out device shall be checked during each start-up sequence.

11.3.108.2 Not applicable.

11.3.108.3 Reignition is only permitted when the system is in the running position.

11.3.108.4 Recycling is only permitted when the system is in the running position.

11.3.108.5 If no flame is detected at the end of the trial for ignition period or pilot flame establishing period, the system shall perform safety shutdown.

11.3.109 If the wiring diagram provided by the manufacturer indicates an input to the system from an external limiter or cut-out, then the operation of this external device shall lead to at least safety shut-down.

11.3.110 Not Applicable.

11.3.111 For multitry systems, the system shall go into lockout at the end of the declared operating sequence.

11.3.112 For multitry systems, additional trial for ignition periods may be initiated if proof of the supervised flame is not established during the initial trial for ignition period.

11.3.113 For multitry systems, the trial for ignition periods may have different values during the declared operating sequence.

11.4 Actions

11.4.1 through 11.4.16 Not Applicable.

11.4.103 Addition:

For systems with remotely mounted reset buttons, a short circuit between the connecting cables or between the connecting cables and earth shall not result in a reset.

11.5 Openings in Enclosures

11.5A *Addition:*

11.5A.1 An opening in an enclosure of a control is acceptable if an articulated probe as illustrated in Figure 2A, Articulated Probe, when inserted into the opening, cannot be made to touch any part that involves the risk of electric shock to the end-user or service personnel. However, in no case shall the opening be large enough to permit the entrance of a 1 inch (25.4 mm) diameter rod.

11.5A.2 The probe shall be articulated into any configuration and shall be rotated or angled to any position before, during, or after insertion into the opening, and the penetration shall be to any depth allowed by the opening size, including minimal depth combined with maximum articulation.

11.5A.3 If any part of the enclosure must be opened or removed for user servicing with or without the use of tools, or can be opened or removed without the use of tools, the probe is to be applied without the part in place.

11.6 Mounting of controls

11.6.3.7 Not Applicable.

11.7 and 11.8 Not Applicable.

11.9 Inlet openings

11.9.2 through 11.9.4 Not Applicable.

11.9.5 Replacement:

Enclosures of independently mounted controls intended to be permanently connected to fixed wiring shall have conduit entries, knockouts or glands which permit the connection of the appropriate conduit or external conductor.

The clause of Part 1 is applicable with the following additions:

A terminal box or compartment of the control that is to be permanently connected electrically shall be located so that wire connections therein will be accessible for inspection, without disturbing either line-voltage or safety-circuit wiring after the control is installed in the intended manner.

However, wire connections to the control intended to be mounted on an outlet box may be accessible upon removal of the control from the box.

A device which is acceptable for use with a fitting for only one type of wiring system shall be supplied with such a fitting.

11.10 Inlets and socket-outlets

11.10.2 and 11.10.3 Not Applicable.

11.11 Requirements during mounting, maintenance and servicing

11.11.1 Enclosure covers and their fixing

11.11.1.4 Not Applicable. (See 18.10A)

11.11.2A *Addition:*

An enclosure cover shall be hinged if it gives access to fuses, thermal cutouts, or any other overload-protective device, the functioning of which requires renewal, or if it is necessary to open the cover in connection with normal operation of the device. A cover shall not depend solely upon screws or other similar means requiring the use of a tool to hold it closed, but shall be provided with a spring latch or catch.

11.11.2A.1 A door or cover giving access to a fuse or thermal cutout in other than a low-voltage circuit shall (1) shut closely against a ¼ inch (6.35 mm) rabbet or the equivalent, (2) have turned flanges for the full length of four edges, or (3) have angle strips fastened to it.

11.11.2A.2 A strip used to provide a rabbet and an angle strip fastened to the edges of a door shall be secured at not less than two points, not more than 1-½ inches (38.1 mm) from each end of each strip and at points between these end fastenings not more than 6 inches (152.4 mm) apart.

11.11.3 Not Applicable.

11.11.6 Not Applicable.

11.11A *Addition of requirements covering wiring space:*

Ample space shall be provided within an enclosure for distribution of wires and cables required for the proper wiring of the device.

A test installation shall be conducted using wiring based upon the National Electrical Code, NFPA 70 or the Canadian Electrical Code, CAN/CSA C22.1 Part 1, but not smaller than 18 AWG (0.82 mm^2) unless the wiring is supplied as an integral part of a section of the control. The leads brought into the enclosure shall extend 6 inches (152.4 mm) beyond their entry into the enclosure. The wires shall be connected to their appropriate terminals and the excess wiring stowed within the enclosure. There shall be no intermingling of high-voltage and low-voltage wiring, wiring contacting moving parts, nor crimping of wires between the enclosure and cover.

11.11C *Addition of requirements covering manual reset:*

A manually reset device of a control shall provide a trip free mechanism in which the control is not permitted to function as an automatic reset device if the reset means is held in the ″reset″ position.

11.11C.1 A control shall not reset or be resettable without providing a safe start check.

11.11C.2 An integral manual reset mechanism of the control shall not reset as a result of ambient temperature changes above minus 31°F (minus 35°C).

11.11C.3 A control with a manual reset shall be resettable exterior to the control enclosure except that the manual reset may be accessible upon opening a cover if the cover construction complies with the requirements of 11.11.2A through 11.11.2A.2.

11.11C.4 A manually operated reset mechanism shall not subject the operating mechanism or means of support to undue strain.

11.11C.5 A manually reset mechanism is subjected to the lock-out and reset test of 17.16.105.

11.11D *Addition of requirements covering protection of control circuit conductors:*

11.11D.1 Conductors of control circuits that are connected to the load side of the branch-circuit short-circuit protective device – common control – shall be provided with overcurrent protection in accordance with Table 11.11D.1 by a protective device located within the controller. (see sub-clause 11.11D.2).

11.11D.1.1 If the rating of the intended branch-circuit short-circuit protective device is not more than the applicable value specified in Table 11.11D.2, additional protection is not required provided the controller is marked in accordance with the following:

A controller intended to comply with 11.11D.1.1 shall be marked with the maximum control-circuit protective-device rating corresponding to the size of control-circuit wire used within the equipment.

11.11D.1.2 A control circuit conductor that is the same size or larger than the main circuit conductors need not be protected.

11.11D.1.3 A limited-energy control circuit, such as a Class 2 circuit, need not be so protected.

11.11D.1.4 A short, direct lead – generally 12 inch (305 mm) long, such as transformer leads or a printed-wiring assembly having no connection external to the controller – need not be protected.

11.11D.1.5 Short, direct leads from contacts of a thermostat, pressure operated switch, or the like for connection within the enclosure to field wiring need not be protected in addition to the remote protective device that shall be provided for field wiring.

11.11D.1.6 A lead or a strap or bus that withstands the applicable short-circuit test in accordance with the requirements in sub-clause 21.7 need not be so protected.

11.11D.2 The protective device mentioned in sub-clause 11.11D.1 shall be either supplementary or a branch-circuit overcurrent protective device. A fuse shall be factory installed in a supplementary fuseholder, but may be omitted if a branch-type circuit type fuseholder is provided. The controller shall be marked as follows:

There shall be a marking near a fuseholder provided for a supplementary fuse specifying the voltage and current rating of the replacement fuse. The marking shall indicate the designation of the fuse but may include ″or equivalent″. A marking specifying the maximum fuse rating to be used shall be provided near a fuseholder for other than a supplementary fuse that will accept a fuse having a higher rating current than specified in Table 11.11D.1.

11.11D.3 Internal conductors of control circuits that are connected to a remote source of supply – not a common control – shall be provided with overcurrent protection in accordance with Table 11.11D.2 or the device shall be marked as follows:

A controller shall be marked with the maximum voltage and current rating of the branch-circuit overcurrent-protective device corresponding to the size of the internal wire.

The internal conductor shall not be smaller than 20 AWG (0.52 mm^2).

11.11D.4 Each control-circuit transformer shall be provided with an overcurrent protective device in the secondary circuit that is rated or set at not more than 200% of the rated secondary current of the transformer.

11.11D.4.1 A transformer protected by other means in accordance with the National Electrical Code, NFPA 70, or the Canadian Electrical Code, CAN/CSA C22.1, Part 1, need not be so protected.

11.11D.4.2 A limited-energy transformer, such as a Class 2 transformer, need not be so protected.

Table 11.11D.1

Control -circuit wire size, AWG (mm^2)	Maximum overcurrent protection device rating, Amperes
22 (0.32)	6
20 (0.52)	10
18 (0.82)	20
16 (1.3)	20
14 (2.1)	20
12 (3.3)	25

Table 11.11D.2

Control-circuit wire size AWG (mm^2)	Maximum rating of branch-circuit-protective device, Amperes	
	Conductors within enclosures	Conductors outside enclosure
22 (0.32)	12	9
20 (0.52)	20	15
18 (0.82)	25	20
16 (1.3)	40	20
14 (2.1)	80	45
12 (3.3)	100	60

11.11E The action of a device which proves the presence of either the ignition source, the main burner flame, or both shall not depend on the relative movement of exposed parts which could be held in fixed relation by corrosion or by accumulated deposits of foreign matter which might be expected to occur in its applications. Tests to determine compliance with this provision shall be performed at the discretion of the testing agency.

11.101 Flame detector constructional requirements

11.101.1 Flame detector devices using infra-red sensors shall only react to the flicker properties of the flame.

11.101.2 Flame detector devices using ionization sensors (flame rods) shall only make use of the rectification property of the flame.

11.101.3 Flame detector devices using UV-tubes shall have sufficient checks for aging of the UV-tubes.

Examples of suitable checks are:

– automatic periodic supervision of the sensor function;

– a check for the UV-tube during the purge time with a voltage 15% higher than that applied to the UV-tube during the remainder of the operating sequence; and

– a check that the flame relay has dropped out after each controlled shut-down with the amplifier continually energized.

11.101.4 An open circuit of the flame sensor or its connecting cables shall cause a loss of the flame signal.

11.101.5 Flame detectors using UV sensors other than UV tubes shall not react to infrared light. Such flame detectors shall not indicate a signal for presence of flame when the sensor is illuminated with 10 lux or less at a color temperature of 2865°K with the spectrum being cut off below the wavelength of 400 nM by means of a filter.

12 Moisture resistance

12.1 Not Applicable.

12.2 Protection against humid conditions

12.2.1 Modification:

Annex J is not applicable.

12.2.2 Replacement:

Compliance is checked by the test sequence described in 12.2.8 and 12.2.8A after the humidity treatment of 12.2.7.

12.2.3 Not applicable.

12.2.7 Replacement:

Before being placed in the humidity cabinet, one of the samples tested in clause 15.5 shall be conditioned for 4 hours at a temperature of 60 ±5°F (15.5 ±2.7°C). The sample is then immediately placed in the humidity cabinet. Immediately following humidity treatment, the electric strength test of 13.2 shall be conducted.

12.2.8 Replacement:

The humidity treatment is carried out in a humidity cabinet containing air with a relative humidity of 95 ±4 percent condensing. The temperature of the air, at all places where the samples can be located, is maintained at 104 ±4°F (40 ±2.2°C) for 48 hours without the sample(s) being operated. During the test, the sample(s) shall be protected from any dripping condensate. The sample(s), while in the cabinet, shall then be operated at rated voltage and cause either ″a,″ ″b″ or ″c″ to occur. If ″a″ or ″b″ occur, the test in 12.2.8A shall be conducted.

a) The control shall act to interrupt flow of fuel under its control.

b) The control shall complete that cycle of operation and will fail to start or lock out on the subsequent cycle.

c) The control shall continue to operate without exceeding the manufacturer's specified maximum timing for flame establishing period, flame failure response time, flame failure reignition time, lockout time, ignition activation period, trial for ignition period and valve sequence period, nor be less than the manufacturer's specified minimum timing for recycle time, automatic restart time and purge time.

For proved igniter systems, the igniter proving characteristics shall not exceed or be less than, as applicable, the value(s) specified by the manufacturer.

12.2.8A *Addition:*

When required by 12.2.8, the sample(s) shall be conditioned for 24 hours at a temperature of 104 ±4°F (40 ±2.2°C) at a relative humidity of 50 ±4 percent. The sample(s) shall then be conditioned for 48 hours, at 88 ±4 percent relative humidity noncondensing and 104 ±4°F (40 ±2.2°C) without the sample(s) being operated. While maintained at these conditions, the sample(s), shall then be operated at rated voltage and timings shall be retested as specified in clause 15, Manufacturer Deviation and Drift, and shall comply.

12.2.9 Not Applicable.

12.3 Not Applicable.

13 Electric strength and insulation resistance

13.1 Not Applicable.

Table 13.1 Not Applicable

13.2 Electric strength

13.2.1 Modification:

See clause 29A5.

13.2.1A.1 *Addition:*

Equipment shall withstand for 1 minute, without breakdown, the application of an alternating potential of 1000 volts plus twice maximum rated voltage:

Between line voltage live parts and grounded or exposed metal parts or the enclosure with the contacts open and closed,

Between line voltage live parts of opposite polarity with the contacts closed, and

Between live parts of line voltage circuits, extra-low voltage and different line voltage circuits.

13.2.1A.2 A device employing a safety extra-low voltage circuit, isolated from ground, shall withstand for 1 minute, without breakdown, the application of an alternating potential of 500 volts applied between safety extra-low voltage live parts of opposite polarity with contacts, if any, closed, and between safety extra-low voltage live parts and the enclosure and grounded dead metal parts.

A device not intended to be isolated from ground is exempt from this test.

13.2.1A.3 The opposite polarity dielectric voltage-withstand test may be omitted for a portion of a extra-low voltage, non-safety circuit that is beyond any fixed impedance and for thermo-electric devices.

13.2.1A.4 If a device involves a meter or meters, such instruments shall be disconnected from the circuit and the complete device subjected to a dielectric voltage withstand test as described in 13.2.1A.1 to 13.2.1A.4.

The meter or meters shall then be tested separately in accordance with the tests outlined in 13.2.1A.1 to 13.2.1A.2 – whichever is applicable – except that an ammeter in a line voltage circuit shall be tested at 1000 volts.

13.2.1A.5 The insulation of a flexible pigtail lead for a line voltage or a safety extra-low voltage safety-control circuit where breakdown will cause unsafe operation shall withstand for 1 minute, without breakdown, when dry, an alternating potential of 1000 volts plus twice the maximum rated voltage, and after exposure to moist air, such a lead shall withstand without breakdown an alternating potential of rated voltage plus 500 volts. A flexible pigtail lead for other extra-low voltage circuits shall comply with the requirements in 13.2.1A.2.

13.2.1A.6 A lead that is to be tested dry is to be conditioned for 24 hours in a desiccator with dry calcium chloride, and a lead that is to be tested after exposure to moist air is to be conditioned for 24 hours in air having a relative humidity of 85 ±5% at a temperature of 90 ±4°F (32 ±2°C).

13.2.1A.7 To determine if a lead complies with the requirement in 13.2.1A.5, the straight conductor is to be employed as one electrode and a 1 inch (25.4 mm) wide metal-foil wrap, located away from the ends of the sample, is to be the other electrode. The foil is to be located at three different positions or on three separate test samples.

13.2.1A.8 To determine whether a device complies with the requirement in 13.2.1A.1 to 13.2.1A.7, the device is to be tested using a 500 volt-ampere or larger capacity transformer the output of which is essentially sinusoidal and can be varied. The applied potential is to be increased from zero until the required test level is reached, and is held at that level for 1 minute. The increase in the applied potential is to be at a substantially uniform rate as rapidly as consistent with its value being correctly indicated by a voltmeter.

13.2.1A.9 Induced Potential Option – Each of three separate magnet-coil-winding samples shall withstand without breakdown and the test in 20.3.A.20 after constant temperatures have been reached as a result of operation under the conditions specified in Clause 14, Heating. While still heated, the coil winding shall be subjected to an alternating potential of which the rated voltage at any suitable frequency – typically 120 hertz or higher – for 7,200 electrical cycles or for 60 seconds, whichever is less. The required test voltage is obtained by starting at one-quarter or less of the full value and increasing to the full value in not more than 15 seconds. After being held for the time specified, the voltage is to be reduced within 5 seconds to one-quarter or less of the maximum value, and the circuit is to be opened.

13.2.1A.9.1 Induced Potential Option, Repeated – While heated following operation at 110% of rated voltage as specified in 17.2.3.1 and 17.2.3.2, each of three samples shall withstand without breakdown a repeated induced potential test at 65% of the potential applied in accordance with 13.2.1A.9.

13.2.1A.9.2 If the temperature that a coil winding reaches in the tests described in 13.2.1A.9 and 13.2.1A.9.1 is known, an oven may be set at the required temperature and used to condition the sample to that temperature before conducting the test.

13.2.3 and 13.2.4 Not Applicable.

13.2.101 The electric strength of the output side of a high tension circuit is checked by the tests of 13.2.102 to 13.2.103, which are conducted immediately after the humidity treatment of 12.2.7 and 12.2.8.

For electronic ignition sources which are built into the printed circuit board, additional details of the test methods are to be agreed between the manufacturer and the test agency.

13.2.102 The input supply terminals of the electronic ignition source are to be connected to a variable voltage supply at rated input mains frequency. The output voltage is measured at 1.0 V_R and 1.1 V_R with the spark gap as declared in requirement 126 of Table 7.2. Then the electronic ignition source is subjected to the following:

a) All connections to the output terminals are removed. Initially, a voltage not exceeding the rated voltage is applied. Then the input voltage is gradually increased until 150% of output voltage measured in 13.2.102 (at 1.0 V_R) is achieved. The output voltage is maintained at that value for 1 minute; or

b) With the input voltage at 1.1 V_R, the electrode gap is increased from that declared in requirement 126 of Table 7.2 until either 150% of the output voltage measured in 13.2.102 (at 1.0 V_R) is achieved or until the output voltage no longer increases, whichever occurs first. This output voltage is maintained for 1 minute; or

c) If test methods a) or b) can not be applied, a test method shall be agreed between manufacturer and test agency in order to achieve 150% of the output voltage measured in 13.2.102 at 1.0 V_R or the highest possible output voltage for the device. This output voltage is maintained for 1 minute.

13.2.103 Compliance is determined by measuring the output voltage with 1.1 V_R applied to the input terminal and with the spark gap restored to that declared in requirement 126 of Table 7.2, if applicable. The measured output voltage shall be within ± 10% of the value measured in 13.2.102 at 1.1 V_R.

For 13.2.102 a), b) and c) flashovers which occur at an air gap provided to protect the circuitry are ignored. Glow discharges at the output terminal are neglected.

Table 13.2 Not Applicable

13.3 Not Applicable.

14 Heating

14.2.1 through 14.3 Not Applicable.

14.4 Addition:

The ″in some countries″ clause is applicable to voltage sensitive controls. For current sensitive controls, the test is conducted at rated current.

14.4.2 Not Applicable

14.4.3 Modification:

Change last phrase to: ″current or the rated voltage of the circuit, whichever is appropriate.″ A low-potential supply source may be used for conducting temperature tests on other parts other than coils of transformer windings.

14.4.3.1 through 14.4.3.3 Not Applicable.

14.4.3.4 Replacement:

The most arduous operating sequence or segment of the operating sequence shall be selected.

14.4.4 Not Applicable.

14.5.1 Replacement:

The temperature of the control is maintained between T_{max} and (T_{max} + 9°F) [(T_{max} + 5°C)].

14.5.2 Not Applicable.

14.6 Replacement:

The temperature specified for the control and sensing element shall be attained in approximately 1 hour.

14.6.2 Not Applicable.

14.7 Replacement:

The temperature of the medium in which the control is located shall be measured as near as possible to the center of the space occupied by the samples and at a distance of approximately 2 inches (50 mm) from the control.

14.7.1 The temperature of the parts and surfaces indicated in table 14.1 shall be determined by thermocouples consisting of wires not larger than 24 AWG (0.20 mm^2) or equivalent means, so chosen and positioned, that they have the minimum effect on the temperature of the part under test.

14.7.2 Replacement:

Temperatures on surfaces are to be measured by thermocouples securely taped, cemented, brazed, or soldered to the surface in question.

Table 14.1 – This table contains maximum temperatures which include heat rise and an ambient of 77°F (25°C)

Parts	Maximum Temperature permitted [9] °F (°C)
Pins of appliance inlets and plug-in devices [1]:	
– for very hot conditions	311 (155)
– for hot conditions	248 (120)
– for cold conditions	149 (65)
Windings [8] [9] [10] [11] [13] and core laminations in contact therewith, if winding insulation is:	
– of class A material	212 (100) [194 (90)]
– of class E material	239 (115) [221 (105)]
– of class B material	248 (120) [230 (110)]
– of class F material	284 (140)
– of class H material	329 (165)
Terminals and terminations for external conductors [1] [7] [C]	185 (85)
Other terminals and terminations [1] [2]	185 (85)
Rubber or polyvinyl chloride insulation of conductors [1]:	
– if flexing occurs or is likely to occur	140 (60)
– if no flexing occurs or is unlikely to occur –	167 (75)
with temperature marking or temperature rating	value marked
Cord sheath used as supplementary insulation	140 (60)
Rubber other than synthetic when used for gaskets or other parts, the deterioration of which could impair compliance with this standard [12] [A]:	
– when used as supplementary insulation or as reinforced insulation	149 (65)
– in other cases	167 (75)
Materials used as insulation other than for wires [3] [5] [12]:	
– impregnated or varnished textile, paper or press board	203 (95)
– laminates bonded with: melamine formaldehyde, phenol-formaldehyde or phenol-furfural resins	230 (110) [392 (200)]
– urea formaldehyde resins	194 (90) [347 (175)]
– mouldings of [3]:	
phenol-formaldehyde, with cellulose filters	230 (110) [392 (200)]
phenol-formaldehyde, with mineral filters	275 (135)
melamine-formaldehyde	212 (100) [347 (175)]
urea-formaldehyde	194 (90) [347 (175)]
polyester with glass fiber reinforcement	275 (135)
pure mica and tightly sintered ceramic material when such products are used as supplementary or reinforced insulation	797 (425)
other thermosetting materials and all thermo-plastic material [4]	–
All accessible surfaces except those of actuating members, handles, knobs, grips and the like	185 (85)
Accessible surfaces of handles, knobs grips and the like use for carrying and transporting the control [B]:	Not Applicable
Accessible surfaces of actuating members, or of other handles, grips or the like which are held for short periods only:	
– of metal	140 (60)
– of porcelain or vitreous material	158 (70)
– of moulded material, rubber or wood [B]	185 (85)
Wood in general	194 (90)
Supporting painted plywood surfaces	185 (85)
Current carrying parts made of copper or brass [1]	446 (230)

Table 14.1 – This table contains maximum temperatures which include heat rise and an ambient of 77°F (25°C) Continued on Next Page

Table 14.1 – This table contains maximum temperatures which include heat rise and an ambient of 77°F (25°C) Continued

Parts	Maximum Temperature permitted [9] °F (°C)
Current carrying parts made of steel [1] [12]	752 (400)
Other current carrying parts [1] [6]	–
Points on or within a terminal box or compartment on which conductors to the control may rest [C]	140 (60)
Solid contacts, busses, and connected bars [D]	194 (90)
Fuses [G]	194 (90)
Power transformer enclosure	194 (90)
Sealing compounds [E]	–
Capacitors [F]	–

[1] For these parts, the test of this clause is repeated after clause 17. In some countries this clause does not apply. (Applicable in the U.S.)

[2] The temperature measured shall not exceed 185°F (85°C) unless a higher value had been declared by the manufacturer.

[3] The values in square brackets apply to those parts of material used for actuating members, handles, knobs, grips and the like and which are in contact with hot metal, but are not accessible.

[4] The maximum permissible temperatures shall not exceed those which can be shown to be acceptable in service for these materials. The temperatures shall be recorded for purposes of clause 21.

[5] Where a metal part is in contact with a part made of insulating material it is assumed that the temperature of the insulating material at the point of contact is the same as the temperature of the metal part.

[6] The maximum permissible temperature shall not exceed those which have been shown to be acceptable in service for these materials.

[7] For controls submitted in or on equipment, only the temperatures of terminals for fixed conductors are verified, as such equipment are not usually delivered with external conductors. For equipment with other than terminals for fixed conductors the temperature of the insulation of the external conductor is determined instead of the temperature of the terminals.

In some countries, the maximum temperature permitted is 167°F (75°C). Higher temperatures are permitted if the control is marked with the required T rating for the external conductors.

[8] The classification is in accordance with IEC 60085.

Examples of Class A material are: impregnated cotton, silk, artificial silk and paper; enamels based on oleo-or polyamide resins.

Examples of Class B material are: glass fiber, melamine and phenol formaldehyde resins.

Examples of Class E material are:

– moldings with cellulose fillers, cotton fabric laminates and paper laminates, bonded with melamine-formaldehyde, phenol-furfural resins

– cross linked polyester resins, cellulose triacetate films, polyethylene terephthalate films. varnished polyethylene terephthalate textile bonded with oil modified alkyd resin varnish.

More extensive accelerated temperature tests and, in addition, compatibility testing is required for insulation systems of Class B and higher temperature classes.

For totally enclosed motors using Class A, E and B material, the temperatures may be increased by 9°F (5°C).

A totally enclosed motor is a motor so constructed that the circulation of the air between the inside and the outside of the case is prevented but not necessarily sufficiently enclosed to be called airtight.

[9] To allow for the fact that the temperatures of the windings of universal motors, relays, solenoids, etc., is usually below the average at the points accessible to thermocouples, the figures without square brackets apply when the resistance method is used and those with square brackets apply only when the thermocouples are used. For windings of vibrator coils and a.c. motors, the figures without square brackets apply in both cases.

[10] The value of the temperature rise of copper winding is calculated from the formula:

$$\Delta t = [(R_2 - R_1)/R_1] \cdot (234.5 + t_1) - (t_2 - t_1)$$

In which:

Δt is the temperature rise.

Table 14.1 – This table contains maximum temperatures which include heat rise and an ambient of 77°F (25°C) Continued on Next Page

Table 14.1 – This table contains maximum temperatures which include heat rise and an ambient of 77°F (25°C) Continued

Parts	Maximum Temperature permitted [9] °F (°C)
R_1 is the resistance at the beginning of the test.	
R_2 is the resistance at the end of the test.	
t_1 is the working ambient temperature at the beginning of the test, to be set at T_{max}.	
t_2 is the working ambient temperature at the end of the test.	
At the beginning of the test, the windings are to be at T_{max}.	
It is recommended that the resistance of windings at the end of the test be determined by taking resistance measurements as soon as possible after switching off, and then at short intervals so that a curve of resistance against time can be plotted for ascertaining the resistance at the instant of switching off.	
The maximum temperature attained for the purposes of this clause is derived by adding the temperature rise to T_{max}.	
[11] In some countries, temperature limits are not specified for small synchronous motors and the like. It is considered that if the electric strength requirements of clause 13, Electric Strength and Insulation Resistance, are still met after the tests of clause 17, Endurance, then the insulation is adequate.	
[12] For small windings with a cross section, the minor dimension of which is no greater than 0.20 inches (5 mm), the maximum temperature permitted when measured by the resistance method is:	
Class °F (°C)	
A 221 (105)	
E 248 (120)	
B 266 (130)	
F 311 (155)	
H 356 (180)	
A) (See clause 12.1.6)	
B) During the heating test, the maximum temperature of a handle, a lever, a button or a knob that is contacted by a user during normal operation shall not exceed 140°F (60°C) for metal surface or 185°F (85°C) for a non-metallic surface.	
With reference to the above paragraph, a non-metallic handle, lever, button, knob or the like that is plated or clad with metal 0.005 inch (0.13 mm) thick or less is to be judged as a non-metallic part.	
The maximum temperatures specified do not apply to equipment intended specifically for use in an ambient temperature exceeding 185°F (85°C).	
C) The temperature observed on the terminals and at points within a terminal box of a control for use with other than a residential appliance that is rated for continuous use above 77°F (25°C) may exceed the values specified but may not attain a temperature higher than 194°F (90°C). See Annex CC, 101.13A.	
D) If contacts of any metal and their supporting blades, busses, and connecting bars attain a temperature greater than 194°F (90°C) where a high ambient temperature or other external temperature prevails, or where affected by a bi-metal heater or other heat source in the assembly, the control shall perform acceptably when subjected to overload and endurance tests conducted at the higher temperatures involved.	
Exception: Contacts of silver or a silver alloy that do not attain a temperature higher than 212°F (100°C) need not be subjected to overload and endurance tests conducted at the higher temperature.	
E) The maximum acceptable temperature, corrected to a 77°F (25°C) assumed ambient temperature, of a sealing compound is 27°F (15°C) less than the melting-point of the compound.	
F) For a capacitor, the maximum allowable temperature is the marked temperature limit of the capacitor.	
G) A fuse that has been investigated and found acceptable for use at a higher temperature may be used at that temperature.	

15 Manufacturer Deviation and Drift

Replace “Manufacturing Deviation and Drift” with “Timing, sequences and flame detector characteristics”

15.1 Systems shall have adequate consistency of manufacture with regard to their declared operating times, operating sequences, flame detector operating characteristics and proved igniter operating value.

15.2 Compliance is checked by the tests of this clause

15.3 The appropriate operating time, operating sequence, flame detector operating characteristics and proved igniter operating value shall be recorded for the sample.

Replacement:

15.4 For devices that use crystal or digital integrated circuit components to provide the timing functions, the tests specified in 15.5 shall be conducted once for each operating time declared. For all other devices, the tests specified in 15.5 shall be conducted three times. These tests shall be conducted for each operating sequence, flame detector operating characteristics and proved igniter operating value declared.

15.4.1 The number of samples shall be equal to the number required for the tests of clause 17, Endurance.

15.5 Operating times

Each of the following operating times which are declared applicable in table 7.2 shall be measured at a voltage of 0.85 V_R a.c. or 0.80 V_R for d.c. and at temperatures of T_{min} and T_{max}.

Measurements shall also be taken at a voltage of 1.1 V_R and at temperatures of T_{min} and T_{max}.

None of the times recorded shall exceed the manufacturers declared maximum operating times nor be less than the manufacturers declared minimum times, whichever is applicable.

a) flame detector response time;

b) flame detector self checking rate;

c) flame failure lock-out time;

d) flame failure reignition time (relight time);

e) Not Applicable

f) trial for ignition period;

g) pilot flame establishing period;

h) post-ignition time;

i) pre-ignition time;

j) inter-purge time;

k) post-purge time;

l) pre-purge time;

m) recycle time;

n) lock-out time;

o) waiting time;

p) Not Applicable;

q) valve sequence period;

r) igniter proving time;

s) igniter failure response time;

t) flame failure response time;

u) ignition activation period;

v) automatic restart time.

For test purposes, the flame detector operating characteristics (S_1 and/or S_2 and/or S_{max}) may be artificially simulated.

15.5.1 Replacement:

Test apparatus used shall be such that the control is mounted in a manner declared by the manufacturer.

15.5.2 through 15.5.7 Not Applicable.

15.6 Operating sequence

The operating sequence, as declared, shall be tested at a voltage of 0.85 V_R a.c. or 0.80 V_R for d.c. and at a temperature of T_{min}. A test shall also be conducted at a voltage of 1.1 V_R and a temperature of T_{max}.

The operating sequence shall be as declared.

The tests of 15.6 may be conducted in conjunction with 15.5.

For test purposes, the flame detector operating characteristics (S_1 and/or S_2 and/or S_{max}) may be artificially simulated.

15.7 Flame detector operating characteristics and proved igniters

Replacement:

The operating characteristics of flame detectors and proved igniter operating value shall be measured under the following conditions:

a) at V_R and 77 ±10°F (25 ±5.5°C); and

b) at 0.85 V_R and 32°F (0°C) or T_{min}, whichever is lower; and

c) at 1.1 V_R and 140°F (60°C) or T_{max}, whichever is higher.

The measured values shall be within the declarations of S_1, S_2 and S_{max} (if applicable).

The details of the measuring equipment shall be arranged between the manufacturer and test agency.

16 Not Applicable

17 Endurance

17.1.1 Controls, including those submitted in or with an equipment, shall withstand, without excessive wear or other harmful effect, mechanical, electrical and thermal stresses that occur in normal use.

17.1.2 Addition:

Compliance is checked by the tests indicated in 17.1.3.

For thermo-electric and system components other than electronic or electro-mechanical, tests referenced in clause 29A shall be conducted.

17.1.3 Test sequence and conditions

Replacement:

In general the sequence of tests is:

– for overload test of electronic and electro-mechanical controls as specified in 17.2.3.

– for electronic controls only, the thermal cycling test specified in 17.16.101;

– endurance test of electronic and electro-mechanical controls as specified in 17.16.102;

– vibration test of 17.16.103, if declared;

For test conditions, see 17.2 and the relevant tests of 17.16.

The number of operations performed during 17.16.101 and 17.16.102 is recorded. When the actual number of automatic cycles completed is equal to 100,000, this test sequence is concluded and the following performed.

– Vibration test of 17.16.103, if declared;

– Lock-out reset test of 17.16.105;

– electrical strength requirements specified in 17.16.107;

– evaluation of compliance specified in 17.16.108.

17.1.4 Not Applicable.

17.2 Electrical conditions for tests

17.2.1 Replacement:

Each circuit of the control shall be loaded according to the ratings declared by the manufacturer. Circuits and contacts which are not intended for external loads are operated with the designed load.

17.2.2 Not Applicable.

Table 17.2.1 Not Applicable

17.2.5 Not Applicable.

17.3 Thermal conditions for tests

17.3.1 The overload test shall be conducted at T_{max} + 9°F (T_{max} + 5°C) or 1.05 times T_{max}, whichever is greater.

17.4 to 17.6 Not Applicable.

17.7.3 Replacement:

The method and rate of operation shall be agreed between the testing agency and the manufacturer.

17.7.4 to 17.7.6 Not Applicable.

17.7.7 Replacement:

The number of cycles is 50.

17.8 to 17.15 Not Applicable

Table 17.2.2 – Electrical conditions for the tests of 17.2.1 (overload test)

Type of circuit	Operation	A.C. circuit			D.C. circuit	
		V	A	Power factor	V	V
Substantially resistive (classified 6.2.1)	Making and breaking	V_T	1.5 I_R	1.0	V_T	1.5 I_R
Inductive (non-motor)	Making and breaking	V_T	1.5 I_X	0.75–0.8	V_T	1.5 I_X
Declared motor load (classified 6.2.5)	Making and breaking	V_T	6 I_m or as declared	0.4–0.5	V_T	10 I_m or as declared
Pilot duty load (classified 6.2.6)	Making	1.1 V_T	11 VA/V_T	0.35 maximum	As declared	
	Breaking	1.1 V_T	1.1 VA/V_T			

The following abbreviations are used:

V_R is the rated voltage, V_T is the test voltage (see 17.2.3.1).

I_m is the rated current for motor load, I_R is the rated current for resistive load, I_X is the rated current for induction load.

NOTE – For test purposes a pilot duty load consists of an electromagnet representative of the magnet coil which is to be controlled. The normal current is that determined from the voltage and volt-ampere ratings of the electromagnet. The test current is the normal current and for an alternating current the power factor is to be 0.35 or less and the inrush current is to be ten times the normal current. The test contactor is to be free to operate i.e., not blocked by either the open or the closed position.

An alternating-current pilot duty rating may be determined for a control which has been tested for controlling an alternating-current motor on the following basis:

– during the overload test, the control was caused to make and break, for 50 cycles at a rate of 6 cycles per minute, a current having a value equivalent to six times the full-load motor current at a power factor of 0.5 or less, and

– the pilot duty inrush current rating (ten times the normal current rating) is to be not more than 67% of the current value for the overload test described above.

Table 17.2.3 – Electrical conditions for the tests of 17.16

Type of circuit	Operation	A.C. circuit			D.C. circuit	
		V	A	Power factor	V	A
Substantially resistive (classified 6.2.1)	Making and breaking	V_T	I_R	1.0	V_T	I_R
Inductive (non-motor)	Making and breaking	V_T	I_X	0.75–0.8	V_T	I_X
Declared motor load (classified 6.2.5)	Making and breaking	V_T	I_m	0.75–0.8	V_T	I_m
Pilot duty load (classified 6.2.6)	Making	V_T	10 VA/V_T	0.35 maximum	–	
	Breaking	V_T	VA/V_T			

The following abbreviations are used:

V_R is the rated voltage, V_T is the test voltage (see 17.2.3.1).

I_m is the rated current for motor load, I_R is the rated current for resistive load, I_X is the rated current for induction load.

NOTE – For test purposes a pilot duty load consists of an electromagnet representative of the magnet coil which is to be controlled. The normal current is that determined from the voltage and volt-ampere ratings of the electromagnet. The test current is the normal current and for an alternating current the power factor is to be 0.35 or less and the inrush current is to be ten times the normal current. The test contactor is to be free to operate i.e., not blocked by either the open or the closed position.

Table 17.2.3 – Electrical conditions for the tests of 17.16 Continued on Next Page

Table 17.2.3 – Electrical conditions for the tests of 17.16 Continued

Type of circuit	Operation	A.C. circuit			D.C. circuit	
		V	A	Power factor	V	A
An alternating-current pilot duty rating may be determined for a control which has been tested for controlling an alternating-current motor on the following basis: – during the overload test, the control was caused to make and break, for 50 cycles at a rate of 6 cycles per minute, a current having a value equivalent to six times the full-load motor current at a power factor of 0.5 or less, and – the pilot duty inrush current rating (ten times the normal current rating) is to be not more than 67% of the current value for the overload test described above.						

17.16 Tests for particular purpose controls

17.16.101 Thermal cycling test for electronic controls only

Electrical conditions for this test shall be per Table 17.2.3, unless otherwise specified.

The purpose of the test is to cycle components of an electronic circuit between the extremes of temperature likely to occur during normal use and which may result from ambient temperature variation, supply voltage variation, or the change from an operating condition to a non-operating condition and vice-versa.

The following conditions shall form the basis of the test:

a) Duration of test: 14 days

b) Electrical conditions

The control is loaded according to the ratings declared by the manufacturer, the voltage then being increased to 1.1 V_R, except that for thirty minutes during each 24 hour period of the test the voltage is reduced to 0.9 V_R. The change of voltage shall not be synchronized with the change of temperature. Each 24 hour period shall also include at least one period in the order of 30 seconds during which the supply voltage is switched off.

c) Thermal conditions

The ambient temperature is varied between T_{max} and T_{min} to cause the temperature of the components of the electronic circuit to be cycled between their resulting extremes. The rate of ambient temperature change shall be in the order of 2°F/minute (1°C/minute) and the extremes of temperature maintained for approximately 1 hour.

d) Rate of operation

During the test the control shall be cycled through its operational modes at the fastest rate possible up to a maximum of six cycles/minute subject to the need to cycle components between their temperature extremes.

Care shall be taken to avoid the occurrence of condensation during this test.

17.16.102 Endurance test of electronic and electro-mechanical systems at normal operating rate

17.16.102.1 Test sequence and conditions:

The test is carried out with the terminals loaded with the maximum rated current.

The system and its flame detector are tested under the following conditions:

a) 45,000 operations at V_R and 77 ±10°F (25 ±5.5°C) for electronic controls;

If the control is electro-mechanical, this test is performed at T_{max}.

b) 2,500 operations at T_{max} and 1.1 V_R or 1.1 times the upper limit of the rated voltage range;

c) 10,000 operations for electro-mechanical controls and 2,500 operations for electronic controls at T_{min} and 0.85 V_R or 0.85 times the lower limit of the rated voltage range for a.c. and 0.80 V_R or 0.80 times the lower limit of the rated voltage range for d.c.

d) The remaining number of required cycles shall be conducted at V_R, I_R and T_{max}.

17.16.103 Vibration test

Controls declared in Table 7.2, requirement 122 are subjected to the vibration test of IEC 60068-2-6 as follows:

Cycling rate:	as declared
Loaded at:	1.1 V_R
Frequency range:	10 – 150 Hz
Acceleration amplitude:	1g or higher if declared by the manufacturer
Sweep rate:	1 octave/minute
Number of sweep cycles:	10
Number of axes:	3, mutually perpendicular

17.16.104 Not Applicable.

17.16.105 Lock-out reset test

Tests shall be conducted at V_R, I_R and T_{max} with the same control sample as used in 17.16.101 and 17.16.102.

The control is also tested under the following lock-out conditions, mounted as declared in Table 7.2 requirement 31, for a total of 6,000 cycles.

– 3,000 cycles with the flame disappearing; and

– 3,000 cycles without flame presence.

The control is operated in such a way that the normal start-up sequence is performed.

The repetition of the sequence shall be compatible with the method of operation and shall be dependent on the cycling rate, if any, declared by the manufacturer.

17.16.105A *Addition of requirements covering continuous lockout for electro-mechanical controls and the method of test:*

Tests may be conducted with a new sample.

Timings shall not be adversely affected by prolonged energization of the lockout means.

One of the devices tested for compliance with clause 15, Manufacturer Deviation and Drift, shall be installed in an unheated test chamber and protected from drafts and extraneous sources of heat. The device shall be energized at 1.1 V_R for 48 hours.

At the end of this period, the device shall be deenergized for at least 1 hour. The lockout timing shall then be determined as specified in item c of 15.5. The readings shall not exceed the manufacturer's specified maximum Lockout Time (Table 7.2 item 114).

17.16.106 Test for particular purpose controls (See 29A, Construction/Performance for Pilot Burners, Oxygen Depletion Safety Shutoff Systems (DS) and Other Components.)

17.16.106.1 Not Applicable.

17.16.107 Electric strength requirements

After the tests of 17.16.101 to 17.16.105A, the requirements of 13.2 shall apply, with the exception that the samples are not subjected to the humidity treatment before the application of the test voltage.

17.16.108 Evaluation of compliance

After completion of all the applicable tests of 17.16.101 to 17.16.107 inclusive, the sample shall be retested according to Clause 15, Manufacturer Deviation and Drift. The operating times, operating sequence, flame detector characteristics and proved igniter operating value shall be as declared in Table 7.2.

18 Mechanical strength

18.1 General requirements

18.2 Impact resistance

18.2.1 For independently mounted controls, except as provided in 18.4 are checked by applying blows to the sample by means of the apparatus in IEC 60068-2-75, Environmental testing – Part 2-75: Tests Eh: Hammer tests, or the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations UL 746C, or CSA C22.2 No. 0.17, the Standard for Evaluation of Properties of Polymeric Materials.

The impact resistance of controls constructed of polymeric materials is determined during test in UL 746C or CAN/CSA C22.2 No. 0.17. The impact resistance of controls constructed of metallic materials is determined as indicated in 18.4.

18.2.4.1 Not Applicable.

18.4 Alternate compliance – Impact resistance

18.4A *Addition:*

A sheet-steel transformer enclosure shall have a thickness of not less than 0.026 inch (0.66 mm) if uncoated and not less than 0.029 inch (0.74 mm) if galvanized.

18.4A.1 *Addition:*

Sheet steel having a thickness of not less than 0.020 inch (0.51 mm) if uncoated and not less than 0.023 inch (0.58 mm) if galvanized may be used for a drawn end bell having maximum dimensions of 2-1/4 inches (57.2 mm) on the flat portion and 1-1/2 inches (38.1 mm) at the base of the drawn portion.

Table 18.4.1 *Modify the notes to Table 18.4.1 in the Part 1 as follows:*

At points at which a wiring system is to be connected, uncoated steel shall not be less than 0.032 inch (0.81 mm) thick, zinc-coated steel shall not be less than 0.034 inch (0.86 mm) thick.

Table 18.4.2 *Modify the notes to Table 18.4.2 in the Part 1 as follows:*

At points at which a wiring system is to be connected, nonferrous metal shall not be less than 0.045 inch (1.14 mm) thick.

18.5 through 18.8 Not Applicable

18.9 Actuating member and actuating means

18.9.1 through 18.9.3 Not Applicable.

18.9A *Addition:*

For a control that is operated by a push, pull, slide, toggle, or lever adjustment, a force is to be applied to the free end of the adjustment in line with the intended movement in each direction of operation. The force is to be 20 pounds (89 N) for a commercial or industrial control and 10 pounds (45 N) for a residential control. A separate sample is to be used for each test.

18.9A.1 A control adjustment operated as described in paragraph 18.9A and intended for use with an extended operator, handle, or lever is to be tested with an in-line force applied to the free end of an extension representing the intended end-use application.

18.9A.2 For a control that is operated by a rotary adjustment intended for use with a knob having a grip diameter or grip length of 1 inch (25.4 mm) or less, a torque is to be applied to the shaft in each direction of intended operation. The torque is to be 9 pound-inches (1.0 N·m) for a commercial or industrial control and 7 pound-inches (0.8 N·m) for a residential control. A separate sample is to be used for each test.

18.9A.3 A control that is operated by a rotary adjustment intended for use with a knob having a grip diameter or grip length of more than 1 inch (25.4 mm) is to be subjected to a torque that is proportionally greater than that specified in paragraph 18.9A.2, based on the larger grip diameter or grip length of the knob used; the value for the torque to be used is to be determined by the formula:

$$T = (D_1/D)K$$

in which:

T – the test torque in pound-inches (N·m)

D_1 – the grip diameter or grip length, as applicable in inches (mm)

D – 1 inch (25.4 mm)

K – 9 pound-inches (1.0 N·m) for a commercial or industrial control, or 7 pound-inches (0.8 N·m) for a residential control.

18.9A.4 If a lever arm is intended to be attached to a rotary-control shaft, the assembly is to be tested as described in 18.9A.1 with the force applied to the free end of the lever.

18.10A *Addition:*

18.10A.1 Windows

Glass covering an observation opening shall be reliably secured in place so that it cannot be readily displaced in service, and shall provide mechanical protection for the enclosed parts.

18.10A.2 Glass for an opening not more than 4 inch (101.6 mm) in any dimension shall not be less than 1/16 inch (1.6 mm) thick, and glass for a larger opening, but not more than 144 in^2 (929 cm^2) in area and having no dimension greater than 12 inch (304.8 mm), shall not be less than 1/8 inch (3.2 mm) thick. Glass that covers a larger area shall not be less than 1/8 inch (3.2 mm) thick and shall withstand a 2-1/2 foot-pound (2.41 J) impact from a 2 inch (50.8 mm) diameter, 1.18 pound (535 g) steel sphere without cracking or breaking to the extent that a piece is released or dropped from its normal position.

18.10A.3 A transparent material other than glass employed as a covering over an opening in an enclosure shall be investigated to determine if it has adequate mechanical strength and shall be investigated in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C or the Standard for Evaluation of Properties of Polymeric Materials, CAN/CSA C22.2 No. 0.17.

19 Threaded parts and connections

19.1.9 Not Applicable.

19.1.10 The clause of Part 1 is applicable with the following addition:

The tests of 19.1.11 to 19.1.15 are not applicable to metal screws in engagement with a thread of metallic material.

19.2 Current-carrying connections

Modification:

Delete fourth note to 19.2.2.

20 Creepage distances, clearances and distances through insulation

20.1 Replacement:

The creepage distances and clearances shall not be less than the appropriate value in Tables 20.3.2 to 20.3.4, inclusive.

20.1.1 through 20.1.10 Not Applicable.

Table 20.1 Not Applicable.

20.2 Not Applicable.

20.3 Modification:

Delete first paragraph.

20.3.1 Replacement:

The creepage distances and clearances shall not be less than the appropriate values in one of the following tables:

20.3.2 Replacement:

Compliance with 20.3.1 is checked by measurement, using the method of measurement given in Figure 17, Measurement of Crepage and Clearance, and Annex B, Measurement of creepage distances and clearances in air.

20.3.A.3 Addition:

The required dimensions which result from the tables minimum values must be maintained, both during production and during the expected life of the equipment.

Table 20.3.1 Void

Addition:

Table 20.3.2 – Creepage and clearance distances

Distance under consider-ation	Dimensions in inches (mm) required for working volts [1) 5) 9) 12)]									
	Up to 50 V		Over 51 V and up to 150 V		Over 151 V and up to 300 V		Over 301 V and up to 450 V		Over 451 V and up to 600 V	
	Creepage	Clearance	Creepage	Clearance	Creepage	Clearance	Creepage	Clearance	Creepage	Clearance
Opera-tional insulation										
Over 2000 VA	0.25 (6.4)	0.125 (3.2)	0.25 (6.4)	0.125 (3.2)	0.37 (9.5)	0.25 (6.4)	0.5 (12.7)	0.37 (9.5)	0.5 (12.7)	0.37 (9.5)
0–2000 VA	0.25 (6.4)	0.125 (3.2)	0.25 (6.4)	0.125 (3.2)	0.25 (6.4)	0.125 (3.2)	– –	– –	– –	– –
Basic insulation										
Over 2000 VA	0.25 (6.4)	0.125 (3.2)	0.25 (6.4)	0.125 (3.2)	0.37 (9.5)	0.25 (6.4)	0.5 (12.7)	0.37 (9.5)	0.5 (12.7)	0.37 (9.5)
0–2000 VA	0.25 (6.4)	0.125 (3.2)	0.25 (6.4)	0.125 (3.2)	0.25 (6.4)	0.125 (3.2)	– –	– –	– –	– –
Between any energized part and the enclosure including fittings										
Over 2000 VA	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)
0–2000 VA	0.25 (6.4)	0.25 (6.4)	0.25 (6.4)	0.25 (6.4)	0.25 (6.4)	0.25 (6.4)	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)
Between terminals for fixed wiring and between a terminal and grounded metal excluding an enclosure	0.25 (6.4)	0.25 (6.4)	0.25 (6.4)	0.25 (6.4)	0.37 (9.5)	0.25 (6.4)	0.5 (12.7)	0.37 (9.5)	0.5 (12.7)	0.37 (9.5)

1) If the working voltage across creepage distances and clearances for other than operational insulation is less than the rated voltage of the control, the working voltage is assumed to be equal to the rated voltage.

2) If the contact member is of the same material and design as the actual contact, the contact member is considered to be part of the contact.

Table 20.3.2 – Creepage and clearance distances Continued on Next Page

Table 20.3.2 – Creepage and clearance distances Continued

Distance under consider-ation	Dimensions in inches (mm) required for working volts [1) 5) 9) 12)]									
	Up to 50 V		Over 51 V and up to 150 V		Over 151 V and up to 300 V		Over 301 V and up to 450 V		Over 451 V and up to 600 V	
	Creepage	Clearance	Creepage	Clearance	Creepage	Clearance	Creepage	Clearance	Creepage	Clearance

3) Not Applicable.

4) The creepage distance and clearance to a metal enclosure do not apply to the frame of a control intended for installation within an equipment housing.

5) For controls the creepage distance and clearance between terminals for connection to fixed wiring of opposite polarity between such a terminal and an earthed or an accessible dead metal part shall not be less than ¼ inch (6.4 mm) if short-circuiting or earthing of such terminals may result from projecting strands of wire.

6) This table applies to low voltage controls if a short-circuit between parts in such a control may result in unsafe operation of the controlled equipment.

7) The creepage distance and clearance on opposite sides of a switching mechanism are creepage distance 1/16 inch (1.6 mm) and clearance 1/32 inch (0.8 mm) except at the contact points and except as noted for low voltage and isolated limited secondary circuits.

8) These values do not apply at the contact points.

9) The creepage distance and clearance between terminals for connection of fixed wiring regardless of polarity and between such a terminal and a dead metal part (including the enclosure which may be grounded when the device is installed) shall not be less than ¼ inch (6.4 mm) or larger where specified in the table.

10) This table applies to controls used in isolated limited secondary circuits if short-circuiting between parts in such a control regardless of polarity will not result in abnormal operation of the controlled equipment. These values apply only to spacings between components of the circuit under consideration, or between these components and dead metal. No reduction of spacings to other circuits of combination equipment is acceptable. If abnormal operation results from short-circuiting of parts involved, general spacings apply.

11) Not Applicable.

12) This table does not apply to low voltage.

13) Not Applicable.

14) Not Applicable.

15) Not Applicable.

16A) In measuring a spacing between a live part and a bushing installed in a knockout, it is to be assumed that a bushing, having a dimension in Table 20.3.4A, is in place and that a single locknut is installed on the outside of the enclosure.

Addition:

Table 20.3.3 – Creepage and clearance distances for low voltage, 100 volt-ampere maximum, Inches (mm) [6)]

Distance under consideration	0 V to 30 V	
	Creepage	Clearance
Operational insulation	0.031 (0.8)	0.031 (0.8)
Basic insulation	0.031 (0.8)	0.031 (0.8)
Across micro-interruption [2) 8)]	0.031 (0.8)	0.031 (0.8)
Between any energized part and the enclosure [4) 16A)]	0.125 (3.2)	0.125 (3.2)
Between a terminal for fixed wiring and the enclosure or a dead metal part which may be grounded when installed	0.25 (6.4)	0.25 (6.4)
Between terminals for fixed wiring	0.25 (6.4)	0.25 (6.4)

1) If the working voltage across creepage distances and clearances for other than operational insulation is less than the rated voltage of the control, the working voltage is assumed to be equal to the rated voltage.

2) If the contact member is of the same material and design as the actual contact, the contact member is considered to be part of the contact.

3) Not Applicable.

Table 20.3.3 – Creepage and clearance distances for low voltage, 100 volt-ampere maximum, Inches (mm) [6)] Continued on Next Page

Table 20.3.3 – Creepage and clearance distances for low voltage, 100 volt-ampere maximum, Inches (mm) [6] Continued

Distance under consideration	0 V to 30 V	
	Creepage	Clearance
4) The creepage distance and clearance to a metal enclosure do not apply to the frame of a control intended for installation within an equipment housing.		
5) For controls the creepage distance and clearance between terminals for connection to fixed wiring of opposite polarity between such a terminal and an earthed or an accessible dead metal part shall not be less than ¼ inch (6.4 mm) if short-circuiting or earthing of such terminals may result from projecting strands of wire.		
6) This table applies to low voltage controls if a short-circuit between parts in such a control may result in unsafe operation of the controlled equipment.		
7) The creepage distance and clearance on opposite sides of a switching mechanism are creepage distance 1/16 inch (1.6 mm) and clearance 1/32 inch (0.8 mm) except at the contact points and except as noted for low voltage and isolated limited secondary circuits.		
8) These values do not apply at the contact points.		
9) The creepage distance and clearance between terminals for connection of fixed wiring regardless of polarity and between such a terminal and a dead metal part (including the enclosure which may be grounded when the device is installed) shall not be less than ¼ inch (6.4 mm) or larger where specified in the table.		
10) This table applies to controls used in isolated limited secondary circuits if short-circuiting between parts in such a control regardless of polarity will not result in abnormal operation of the controlled equipment. These values apply only to spacings between components of the circuit under consideration, or between these components and dead metal. No reduction of spacings to other circuits of combination equipment is acceptable. If abnormal operation results from short-circuiting of parts involved, general spacings apply.		
11) Not Applicable.		
12) This table does not apply to low voltage.		
13) Not Applicable.		
14) Not Applicable.		
15) Not Applicable.		
16A) In measuring a spacing between a live part and a bushing installed in a knockout, it is to be assumed that a bushing, having a dimension in Table 20.3.4A, is in place and that a single locknut is installed on the outside of the enclosure.		

Addition:

Table 20.3.4 – Creepage and clearance distances for isolated limited secondary circuits, 100 volt-amperes maximum, Inches (mm)[10) 12)]

Dimension under consideration	Over 30 V to 600 V		Over 600 V up to 1000 V	
	Creepage	Clearance	Creepage	Clearance
Operational insulation	0.063 (1.6)	0.063 (1.6)	0.189 (4.8)	0.189 (4.8)
Basic insulation	0.063 (1.6)	0.063 (1.6)	0.189 (4.8)	0.189 (4.8)
Between uninsulated energized part and exposed isolated dead metal part	0.25 (6.4)	0.125 (3.2)	0.37 (9.5)	0.25 (6.4)
Across micro-interruption [2) 8)]	0.063 (1.6)	0.063 (1.6)	0.189 (4.8)	0.189 (4.8)
Between any energized part and the enclosure including fittings [4)]	0.25 (6.4)	0.25 (6.4)	0.5 (12.7)	0.5 (12.7)
1) If the working voltage across creepage distances and clearances for other than operational insulation is less than the rated voltage of the control, the working voltage is assumed to be equal to the rated voltage.				
2) If the contact member is of the same material and design as the actual contact, the contact member is considered to be part of the contact.				
3) Not Applicable.				
4) The creepage distance and clearance to a metal enclosure do not apply to the frame of a control intended for installation within an equipment housing.				

Table 20.3.4 – Creepage and clearance distances for isolated limited secondary circuits, 100 volt-amperes maximum, Inches (mm)[10) 12)] Continued on Next Page

Table 20.3.4 – Creepage and clearance distances for isolated limited secondary circuits, 100 volt-amperes maximum, Inches (mm)[10) 12)] Continued

Dimension under consideration	Over 30 V to 600 V		Over 600 V up to 1000 V	
	Creepage	Clearance	Creepage	Clearance
5) For controls the creepage distance and clearance between terminals for connection to fixed wiring of opposite polarity between such a terminal and an earthed or an accessible dead metal part shall not be less than ¼ inch (6.4 mm) if short-circuiting or earthing of such terminals may result from projecting strands of wire.				
6) This table applies to low voltage controls if a short-circuit between parts in such a control may result in unsafe operation of the controlled equipment.				
7) The creepage distance and clearance on opposite sides of a switching mechanism are creepage distance 1/16 inch (1.6 mm) and clearance 1/32 inch (0.8 mm) except at the contact points and except as noted for low voltage and isolated limited secondary circuits.				
8) These values do not apply at the contact points.				
9) The creepage distance and clearance between terminals for connection of fixed wiring regardless of polarity and between such a terminal and a dead metal part (including the enclosure which may be grounded when the device is installed) shall not be less than ¼ inch (6.4 mm) or larger where specified in the table.				
10) This table applies to controls used in isolated limited secondary circuits if short-circuiting between parts in such a control regardless of polarity will not result in abnormal operation of the controlled equipment. These values apply only to spacings between components of the circuit under consideration, or between these components and dead metal. No reduction of spacings to other circuits of combination equipment is acceptable. If abnormal operation results from short-circuiting of parts involved, general spacings apply.				
For controls used in isolated limited secondary circuits, creepage distance and clearance are not specified between live parts of opposite polarity and between such parts and dead metal that may be grounded in service. Instead, the creepage distance and clearance are based on acceptable performance of applicable electric strength tests of clause 13, Electric Strength and Insulation Resistance, and endurance tests of clause 17, Endurance.				
11) Not Applicable.				
12) This table does not apply to low voltage.				
13) Not Applicable.				
14) Not Applicable				
15) Not Applicable				
16A) In measuring a spacing between a live part and a bushing installed in a knockout, it is to be assumed that a bushing, having a dimension in Table 20.3.4A, is in place and that a single locknut is installed on the outside of the enclosure.				

Table 20.3.4A *Addition:*

Table 20.3.4A – Dimensions of bushings

Trade size of conduit, inches	Overall diameter, inches (mm)		Height, inches (mm)	
1/2	1	(25.4)	3/8	(9.5)
3/4	1-15/64	(31.4)	27/64	(10.7)
1-1/4	1-19/32	(40.5)	33/64	(13.1)
1-1/2	1-15/16	(49.2)	9/16	(14.3)
2	2-13/64	(56.0)	19/32	(15.1)
2-1/2	2-45/64	(68.7)	5/8	(15.9)
3	3-7/32	(81.8)	3/4	(19.1)
3-1/2	3-7/8	(98.4)	13/16	(20.6)
4	4-7/16	(112.7)	15/16	(23.8)
4-1/2	4-31/32	(126.2)	1	(25.4)
5	5-35/64	(140.9)	1-1/16	(27.0)
6	6-7/32	(158.0)	1-3/16	(30.2)
7	7-7/32	(183.4)	1-1/4	(31.8)

20.3.A.4 Addition:

Low voltage safety circuits shall have spacings as indicated in table 20.3.3 as specified if a short-circuit between the parts involved may result in unsafe operation of the controlled equipment. Otherwise, spacings are not specified.

For controls in low voltage circuits, creepage distances and clearance between uninsulated live parts of opposite polarity and between such parts and dead metal that may be grounded in service are not specified.

20.3.A.5 Void

20.3.A.6 Addition:

Compliance is checked by inspection and measurement. The measured distances shall not be less than those indicated in the tables.

Variations of dimensions due to manufacturing techniques or control of production are not taken into consideration in this clause because each possible variation will be dependent upon many factors and will differ with different manufacturing techniques and production control systems.

20.3.A.7 Void

20.3.A.7.1 Addition:

For controls with one or more terminals intended for the connection of external conductors, the measurements are made twice, once with conductors of the largest cross-sectional area used in 10.1.4 fitted and once without conductors fitted.

20.3.A.8 Addition:

Movable parts are placed in the most unfavorable positions; nuts, threaded parts, and screws with non-circular heads are assumed to have been tightened in the most unfavorable position.

20.3.A.9 Addition:

With the control mounted or placed in any declared position, the clearances between live parts and accessible metal parts are also measured with any threaded parts referred to in 10.1 unscrewed as far as possible; the clearances shall then be not less than 50% of the value shown in the appropriate table.

20.3.A.10 Addition:

Distances through slots or openings in accessible surfaces of insulating material are measured to metal foil in contact with the accessible surface. The foil is pushed into corners and the like by means of the articulated probe in Figure 2A, but is not pressed into openings.

20.3.A.11 Addition:

The articulated probe in Figure 2A is applied to apertures as specified in 8.1, the distance through insulation between live parts and the metal foil shall then not be reduced below the values specified.

20.3.A.12 If necessary, a force is applied to any point on bare interconnecting wiring which can be touched with the articulated probe of Figure 2A while the control is being mounted or connected and to the outside of any accessible surface in an endeavor to reduce the creepage distances and clearances while making the measurements. The force is applied by means of the tip of the articulated probe shown in Figure 2A and has a value of:

– 0.5 pounds (2 N) for bare conductors;

– 6.5 pounds (30 N) for accessible metal and for accessible non-metallic surfaces.

20.3.A.12.1 Addition:

The values specified do not apply to creepage distances and clearances for live parts in a circuit derived by connecting resistance in series with the supply circuit as a means of limiting voltage and current since such a circuit is not considered to be a low voltage or isolated secondary circuit.

20.3.A.13 Addition:

The creepage distances and clearances at wiring terminals for external conductors are to be measured with appropriate wires in place and connected to the terminals as in normal use and shall be not less than specified in the tables.

20.3.A.14 Addition:

Greater creepage distances and clearances may be required if the enclosure because of its size, shape, or the material used, is not considered to be sufficiently rigid to warrant the minimum spacings.

For the purpose of this standard, the enclosure is considered to be an inherent part of the control.

20.3.A.15 Addition:

The inherent creepage distances and clearances within a component device such as a snap switch, lampholder, motor or clock motor are judged under the appropriate component standard.

20.3.A.15.1 The creepage distances and clearances from such a component device to another component and to the enclosure, and the creepage distances and clearances at wiring terminals are to be judged under the requirements of this clause.

20.3.A.15.2 Addition:

Spacings of a supply fuse and fuse holder are to be measured with a fuse in place that has the maximum standard dimensions for the rating and such spacings are to be not less than those specified in Table 20.3.2, over 2000 VA.

20.3.A.16 Void

20.3.A.17 Addition:

A barrier or liner that is used to provide insulation shall be not less than 0.028 inch (0.71 mm) thick. A barrier or liner for insulation through air or oil that is used in conjunction with not less than one-half the required clearance may be not less than a minimum of 0.013 inch (0.33 mm), provided the barrier or liner is of suitable insulating material, resistant to moisture, of adequate mechanical strength, reliably held in place, and so located that it will not be affected adversely by operation of the equipment, particularly arcing.

20.3.A.18 Addition:

An insulating barrier or liner used as the only separation between live parts and earthed parts or between live parts of opposite polarity, shall be of a material that is suitable for the mounting of live parts and shall be not less than 0.028 inch (0.71 mm) thick. Otherwise, a barrier shall be used in conjunction with a clearance of 0.031 inch (0.8 mm).

See the Standard for Polymeric Materials – Use in Electrical Equipment Evaluation, UL 746C or the Standard for Evaluation of Properties of Polymeric Materials, CAN/CSA-C22.2 No. 0.17 for requirements for barriers.

Insulating material having a thickness less than that specified in 20.3.A.17 and 20.3.A.18 may be used if, upon investigation, it is found to be suitable for the particular application, and is equivalent in all respects to materials of the thickness contemplated in 20.3.A.17.

20.3.A.19 Addition:

Enamel-insulated wire is considered to be a live part in determining if a control complies with the creepage distances and clearances of this standard.

20.3.A.20 Addition:

Where required in place of spacings between a magnet coil winding and other live parts or earthed metal parts, the type of insulation may differ from that required in 20.3.A.18. The type and thickness of crossover lead insulation and insulation under coil terminals secured to the coil winding may be less than that specified in 20.3.A.18 provided the coil is capable of withstanding a dielectric test between coil-end leads after breaking the inner coil lead where it enters the layer, or an equivalent opposite polarity test. The application of the test potential is to be in accordance with clause 13, Electric Strength and Insulation Resistance.

A slot in a molded bobbin for guiding the crossover – or start lead – unspliced at the windings – or a magnet-coil is to be filled with an insulating material unless (1) the slot provides a graduated spacing in the winding, increasing to the end turns, and (2) the magnet-coil winding withstands the induced potential test in 13.2.1A.9 through 13.2.1A.9.2.

20.3.A.21 Addition:

All live parts connected to different circuits shall be spaced from one another as though they were parts of opposite polarity, in accordance with the requirements, and shall be judged on the basis of the highest voltage involved.

20.3.A.21.1 Addition:

Field-installed wiring of any circuit shall be segregated or separated by barriers from field-installed wiring, internal wiring and live parts of any other circuit of different voltage.

20.3.A.21.2 Addition:

Segregation of field-installed wiring from other field-installed wiring and from live parts of the device connected to different circuits may be accomplished by arranging the location of the openings in the enclosure for the various conductors, with respect to the terminals or other live parts, so that there is no likelihood of the intermingling of the conductors or parts of different circuits.

20.3.A.21.3 Addition:

To determine compliance of a device with 20.3.A.21.1 it shall be wired as it would be in service.

20.3.A.21.4 Addition:

If more than the minimum number of openings is provided, the device shall be wired successively in each possible manner to determine if conductors entering at points other than opposite the terminals to which they are intended to be connected can contact insulated conductors or live parts connected to a different circuit.

20.3.A.21.5 Addition:

If the number of openings in the enclosure does not exceed the minimum required for the proper wiring of the device, and if each opening is located opposite a set of terminals, it shall be assumed that the conductors entering each opening will be connected to the terminals opposite the opening.

20.3.A.22 Addition:

To determine if a device is within the 2000 VA limitations with respect to the spacing requirements in the tables, the volt-ampere consumption of the device is to be added to the volt-ampere consumption of the equipment which the device is intended to control. Accordingly, the sum of the inputs to and the switch ratings of the device is the value to be used to determine if the rating is within the 2000 VA limitation.

20.3.A.22.1 Addition:

For a multipole, or a multi-throw control, the volt-ampere rating is to be taken as the sum of the maximum consumption of the device and the maximum simultaneously controlled load at any one time.

20.3.A.22.2 Addition:

In multi-component control panels, the spacings from one component to another, and from any component to the enclosure or to other uninsulated dead metal parts excluding the component mounting surface, are based on the maximum voltage and total volt-ampere rating of the complete control panel, and not on the individual component ratings. The inherent spacings within an individual component such as a relay or a temperature controller (including spacings from a live part to the mounting surface other than the enclosure) are judged on the basis of the volt-ampere limitation of the individual component.

20.3.23 Separation of circuits

Addition:

Insulated conductors of different circuits within the control, unless provided with insulation suitable for the highest voltage involved, shall be separated by barriers or shall be segregated and shall, in any case, be so separated or segregated from live parts connected to different circuits.

Segregation of insulated conductors shall be accomplished by clamping, routing or equivalent means which ensures permanent separation from insulated or live parts of a different circuit.

20.4A *Addition of requirements covering alternate clearance and creepage distances:*

20.4A.1 As an alternate to the measurement method specified in clause 20, Creepage Distances, Clearances and Distances Through Insulation, the minimum acceptable clearances and creepage distances may be evaluated using the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840 as specified in clauses 20.4A.2 to 20.4A.3. The spacing requirements of UL 840 shall not be used for clearance and creepage between field wiring terminals and between live parts and a metal enclosure.

20.4A.2 When applying the requirements in UL 840, for unencapsulated assemblies and uncoated printed wiring boards, pollution degree 3 requirements are applicable. For encapsulated assemblies and for coated printed wiring boards complying with the printed wiring board coating performance test requirements, pollution degree 1 requirements are applicable. The pollution degrees are defined in UL 840 or CSA 60669.

20.4A.3 For Clearance B (controlled overvoltage) requirements in UL 840 or CSA 60669, the applicable overvoltage category for line voltage circuits is Category III. Category I is applicable to low voltage circuits if short circuiting between the parts involved may result in operation of the controlled equipment that increases the risk of fire or electric shock. Any overvoltage protection device to achieve these categories shall be provided as an integral part of the control.

21 Resistance to heat, fire and tracking See 11.1.

21.1 through 21.4 Not Applicable.

22 Resistance to corrosion

22.1 Resistance to rusting

22.1.1 Ferrous parts, including covers and enclosures, the corrosion of which might impair compliance with this standard, shall be protected against corrosion.

This requirement does not apply to:

a) Bearings, thermal elements, sliding surfaces of a hinge, or shaft, and the like, where such protection is impractical.

b) Small parts of iron or steel, such as washers, screws, bolts, and the like, that are not current carrying, if the corrosion of such parts would not likely result in a risk of fire, electric shock, or injury to persons.

23 Radio interference protection

Not applicable

24 Components

24.1 Transformers intended to supply power to a safety extra-low voltage circuit (SELV) shall be of the safety isolating type shall comply with the relevant requirements of the Standard for Specialty Transformers, UL 506 or the Standard for Class 2 and Class 3 Transformers, UL 1585, or the Standard for Specialty Transformers, CSA C22.2 No. 66.

Capacitors used to provide radio interference suppression shall comply with the requirements of Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, IEC 60384-14 or the Standard for Across-the-Line, Antenna-Coupling and Line-by-Pass Capacitors for Radio- and Television-Type Appliances, UL 1414 or the Standard for Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, CAN/CSA 384-14.

Fuses shall comply with the requirements of Miniature Fuses – Part 1: Definitions for Miniature Fuses and General Requirements for Miniature Fuse-Links, IEC 60127 or Low-Voltage Fuses – Part 1: General Requirements, IEC 60269-1, or the Standard for Low-Voltage Fuses – Part 1: General Requirements, UL 248 or the Standard for Low-Voltage Fuses – Part 1: General Requirements, CSA C22.2 No. 248, as appropriate.

24.1.1 Modification:

In Canada, add the following reference to the Standard for Specialty Transformers, CSA C22.2 No. 66.

24.2.1 Replacement:

A component of a product covered by this standard shall comply with the requirements for that component, and shall be used in accordance with its recognized rating and other limitations of use. A component need not comply with a specific requirement that:

a) Involves a feature or characteristic not needed in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

24.2A *Addition:*

A control switch, a lampholder, an attachment-plug receptacle, or plug connector provided as a part of a device shall be mounted securely and shall be prevented from turning by means other than friction between surfaces.

24.2A.1 A properly applied lock washer is an acceptable means to prevent a control switch from turning.

24.2B *Addition:*

A capacitor shall employ such material and shall be constructed such that it will not constitute a risk of fire. It shall not be adversely affected by the temperatures it reaches under the most severe conditions of normal use. A paper capacitor shall be impregnated or enclosed to exclude moisture. An electrolytic capacitor and a capacitor intended for connection directly across the line shall be acceptable for the application.

24.2B.1 A fuseholder shall be of either the cartridge-enclosed or plug-fuse type. Plug fuses are limited to use with equipment rated not more than 125 or 125/250 volts.

24.2C *Addition:*

A switch provided as part of a product intended to be connected to a power-supply circuit having a potential to ground of more than 150 volts shall be acceptable for the maximum potential to ground of the circuit.

24.2C.1 A nominal 208-volt, single or 3-phase or a 120/240 volt, single-phase product is considered to involve a potential to ground of less than 150 volts. A 2-wire, single-phase or a 3-wire, 3-phase product with a rating in the range of 220 – 250 volts is considered to involve a potential to ground in excess of 150 volts.

24.2C.2 A product marked in accordance with CC.20A and CC.21A need not comply with 24.2C.

24.2D *Addition:*

A coil winding shall resist the absorption of moisture. This may be accomplished by impregnating, dipping or brushing with varnish, or by other acceptable means.

24.2D.1 A coil winding made with film-coated wire need not have additional treatment to resist moisture absorption.

24.2E *Addition:*

The wall thickness of electrical insulating tubing shall comply with the requirements for such tubing, except that the thickness at any point for the smaller sizes of polyvinyl chloride tubing shall not be less than 0.017 inch (0.43 mm). Insulating tubing of other types shall have a wall thickness not less than that providing mechanical strength, dielectric properties, heat-and moisture-resistant characteristics, and the like, at least equal to those of 0.017 inch (0.43 mm) thick polyvinyl chloride tubing.

25 Normal Operation

Not applicable.

26 Electromagnetic compatibility (EMC) requirements – immunity

See Annex H, Requirements for Electronic Systems and Components

27 Abnormal operation

27.3 Over-voltage and under-voltage test (See 15.5)

Not Applicable.

27.4 Not Applicable.

28 Guidelines for use of electronic disconnection

Not applicable.

29A Construction/performance for pilot burners, oxygen depletion systems (ODS) and other components

29A2 *Addition of general requirements:*

29A1.1 When for connection to pipe, the inlet, outlet, pilot or other connections shall be provided with cleanly cut taper threads in accordance with the Standard for Pipe Threads, General Purpose (Inch), ANSI/ASME B1.20.1.

29A1.2 When for connection to semi-rigid tubing, the connection, together with the fittings used thereon, shall be in accordance with the fittings described in Volume 2, SAE Handbook.

29A1.3 An automatic valve utilized as a part of an automatic gas ignition system shall comply with the applicable provisions of the Standard for Automatic Valves for Gas Appliances, ANSI Z21.21/CGA 6.5 or the Standard for Combination Gas Controls for Gas Appliances, ANSI Z21.78/CGA 6.20.

29A1.4 Ignition sources having a spark gap(s) shall comply with the provisions of this standard throughout the spark gap range.

29A2 *Pilot burners*

29A2.1 Construction Requirements

29A2.1.1 Systems utilizing both a continuous pilot and an intermittent pilot shall be constructed so neither the pilots, gas tubing nor the orifices for the different pilots can be interchanged.

29A2.1.2 Pilot burners, except pilot burners of oxygen depletion safety shutoff systems, shall be provided with fixed orifices accessible for removal and replacement.

29A2.1.3 Tips of pilot burners having input ratings up to and including 2000 Btu per hour (586 W) shall be constructed of AISI 416 steel or material having at least equivalent heat- and corrosion-resistant characteristics.

29A2.1.4 Tips of pilot burners having input ratings greater than 2000 Btu per hour (586 W) shall be constructed of material having a melting point of not less than 2000°F (1093°C). Alloys of greater than 1.0 percent nickel content are not acceptable because of catalytic cracking effects.

29A2.2 Performance Requirements Covering Test Gases

In conducting the performance tests specified herein, gases with characteristics approximately as shown in Table 29A2.1, Characteristics of Test Gases, shall be used.

Table 29A2.1 – Characteristics of test gases

	Heating Value		Sp Gr
	(Btu/ft^3)	(MJ/m^3)	(Air = 1.0)
Gas A (Natural)	1075	(40.1)	0.65
Gas B (Manufactured)	535	(19.9)	0.38
Gas C (Mixed)	800	(29.8)	0.50
Gas D (n-Butane)	3200	(119.2)	2.00
Gas E (Propane HD-5)	2500	(93.1)	1.55
Gas F (Propane-Air)	700	(26.1)	1.16
Gas G (Butane-Air)	1400	(52.2)	1.42
Gas H (Propane-Air)	1400	(52.2)	1.30

29A2.2.1 A device submitted for use with natural gas shall have the tests specified herein conducted with test Gas A. Additional tests shall be conducted with test Gas G at normal test pressure with no change whatsoever to the natural gas adjustments, and shall comprise those tests specified in 29A2.4 and 15.5.

Compliance with these supplemental tests does not imply that the device has been examined under this standard for use with LP gas-air mixtures.

29A2.2.2 A device for use with manufactured gas shall have the tests specified herein conducted with test Gas B.

29A2.2.3 A device for use with mixed gas shall have the tests specified herein conducted with test Gas C.

29A2.2.4 A device for use with natural, manufactured and mixed gases shall be tested with test Gases A and G, as specified in 29A2.2.1, and test Gas B. The tests specified in 29A2.4 and 15.5 shall also be conducted with test Gas C (1) when the device incorporates as an integral part thereof different pilot burners for use with natural and manufactured gases, or (2) when a third pilot burner is supplied specifically for use with mixed gases. In the former case, the pilot burner equipment employed for mixed gas tests shall be that specified by the manufacturer.

29A2.2.5 A device for use with liquefied petroleum gases shall have the tests specified herein conducted with test Gas E. The tests specified in 29A2.4 shall also be conducted with test Gas D with no change whatever in orifice or adjustment.

29A2.2.6 A device for use with LP gas-air mixtures shall have the tests specified herein conducted with test Gas H. The tests specified in 29A2.4 and 15.5 shall also be conducted with test Gas F when readjusted for operation with this gas.

29A2.2.7 When use with more than one type of gas is desired, the tests, with the exception of those specified in 29A2.4 and 15.5, need be conducted with only one test gas, provided there are no changes in the device for use with different gases which, in the opinion of the testing agency, would affect the results of these tests.

29A2.3 Test Pressures and Pilot Burner Adjustments

29A2.3.1 Unless otherwise stated, each test specified shall consist of a series of three tests: one at normal inlet test pressure, one at reduced inlet test pressure and one at increased inlet test pressure, as shown in Table 29A2.2, Inlet Test Pressures. All test pressures shall be applied at the inlet of the device. If the device includes a gas pressure regulator, the outlet pressure of the regulator shall approximate that recommended by the manufacturer.

29A2.3.2 The gas rate to the device shall be adjusted to the manufacturer's specified Btu rating at normal inlet test pressure by use of a properly sized orifice furnished by the manufacturer or by the adjustment means incorporated within or supplied with the device. Such adjustments shall be within ±10 percent of the specified rating. Primary air adjustment means, when provided, shall be set to give a suitable flame at this adjustment, and neither pilot burner rates, unless otherwise specified herein, nor primary air adjustments shall be changed during a series of tests on any one test gas.

Table 29A2.2 – Inlet test pressures

Test Gas	Test Pressure – Inches Water Column (kPa)		
	Reduced	Normal	Increased
A	3.5 (0.87)	7.0 (1.74)	10.5 (2.61)
B	3.0 (0.75)	6.0 (1.49)	9.0 (2.24)
C	3.0 (0.75)	6.0 (1.49)	9.0 (2.24)
D	8.0 (1.99)	11.0 (2.74)	13.0 (3.23)
E	8.0 (1.99)	11.0 (2.74)	13.0 (3.23)
F	3.0 (0.75)	6.0 (1.49)	9.0 (2.24)
G	3.5 (0.87)	7.0 (1.74)	10.5 (2.61)
H	3.0 (0.75)	6.0 (1.49)	9.0 (2.24)

29A2.4 Pilot Operating Characteristics

29A2.4.1 A pilot burner shall not deposit carbon during any tests specified herein.

29A2.4.2 The flame of a pilot burner shall travel freely to all port openings when the gas is ignited at any one point.

Method of Test

This test shall be conducted with test gases as specified in 29A2.2.1 to 29A2.2.7, inclusive.

The pilot gas shall be ignited and the device allowed to operate for at least 10 minutes. The test pressure shall then be reduced to a point at which only sufficient gas is being consumed to cause the safety shutoff valve to remain in a position which will permit gas flow.

The device shall be allowed to operate at these turndown conditions for at least 15 minutes. The flame(s) shall then be extinguished, and the gas at any port shall be immediately reignited. The flame shall travel freely to all other port openings.

29A2.4.3 Unless a Bunsen type pilot burner is constructed so that gas cannot burn within the pilot burner, supplemental ignition tests with gas burning within the pilot burner must be conducted in each application.

29A2.4.4 Pilot burners for use with natural gas shall comply with 29A2.4.1 through 29A2.4.3 when operated at a pressure of 4.0 inches water column (995 Pa) with test Gas A. Pilot burners for use with manufactured gas shall comply with 29A2.4.1 through 29A2.4.3 when operated at a pressure of 2.0 inches water column (498 Pa) with test Gas B. The pilot burner shall be adjusted to the manufacturer's specified Btu rating by the use of a properly sized orifice or by the adjustment means incorporated within or supplied with the device. Such adjustments shall be within ±10 percent of the specified rating. Primary air adjustment means, when provided, shall be set to give a suitable flame.

29A3 *Oxygen depletion safety shutoff system (ODS)*

29A3.1 Pilot burner(s) of oxygen depletion safety shutoff systems shall be provided with a nonremovable fixed orifice.

29A3.2 No means shall be provided for field adjustment of the oxygen safety cutoff point of oxygen depletion safety shutoff systems.

29A3.3 An oxygen depletion safety shutoff system shall incorporate features which will prevent interchange of components which could negate or change the ″action to shut off″ function.

29A3.4 ODS pilot burners shall comply with 29A2, except for 29A2.1.2.

29A3.5 The oxygen cutoff point for the system shall be verified, prior to conduct of any other performance tests, as specified by the following Method of Test.

Method of Test

This test is to be conducted on each sample to be used for conduct of 29A5, Thermal Stress Test, at normal inlet test pressure to the system. Verification tests shall be conducted using test Gas A on systems for use with natural gas and using test Gas E on systems for use with liquified petroleum gases.

The ODS device shall be installed in the approximate center of the chamber, having a volume of at least 27 cubic feet (0.76 m^3) constructed so as to prevent infiltration of air. Provisions for continuous sampling of the chamber atmosphere shall be made at a point horizontally opposite and approximately 6 inches (152 mm) away from the ODS device. If more than one device is to be tested simultaneously, they shall be placed approximately 12 inches (305 mm) apart in a horizontal plane with the sampling point centrally located between them. The system shall be operated for 15 minutes with the door of the chamber open and the chamber completely ventilated. The door shall then be sealed and the ventilation stopped. During the test, the air temperature in the chamber shall be maintained at 80 ±5°F (26.5 ±3°C).

A sample of the atmosphere shall be withdrawn at the start of the test and analyzed for oxygen (O_2). The percent oxygen in the chamber atmosphere shall be continuously monitored during the entire test. When the system acts to shutoff the gas supply, the oxygen content of the atmosphere, expressed in percent volume, shall be within the range specified by the manufacturer (see Table 7.2 item 128A).

29A3.6 Following conduct of 29A5, Thermal Stress Tests, the oxygen cutoff point for the system shall be reverified, using the method of test specified in 29A3.5, and the observed oxygen cutoff point shall be within the range specified by the manufacturer (see Table 7.2 item 128A).

29A4 *Other components*

29A4.1 Construction Requirements

29A4.1.1 Electrode tips shall be constructed of high temperature alloy steel or equivalent material and shall be of such design that extreme burning will not result during the conduct of the tests specified herein.

29A4.2 Performance Requirements

29A4.2.1 If the device can act to hold the gas supply open solely as the result of exposure of the sensing element to a uniform ambient temperature, the manufacturer shall specify for each model of such device the temperature below which it will act to shut off the gas supply. This temperature shall be known as the element ambient temperature limit.

29A4.3 Operation of Thermoelectric Devices

29A4.3.1 In lieu of conduct of 15.5, for a thermoelectric device the pull-in current, as applicable, and the dropout current shall be within the manufacturer's specified values.

These tests shall be conducted prior to the conduct of 29A5, Thermal Stress Tests.

Method of Test

A direct current power source of appropriate voltage in series with an ammeter shall be used. Each device shall be tested three times under the following test conditions, as applicable:

a) Pull-in Current

For automatic pull-in devices the current shall be set at a value below the manufacturer's specified pull-in current. The current shall be slowly increased. The current at which the device pulls in shall not be less than the minimum or greater than the maximum value specified by the manufacturer.

b) Drop-out Current

The current shall be set at the manufacturer's specified maximum operating current. The resetting mechanism, if provided, shall be operated in accordance with the manufacturer's instructions. The current shall then be slowly decreased. The current at which the device drops out shall not be less than the minimum or greater than the maximum value specified by the manufacturer.

29A4.3.2 For a thermoelectric type flame sensor, the electrical characteristics, as determined in the following Method of Test, shall be within the manufacturer's specifications (see Table 7.2, item 128B).

Method of Test

The following determination is to be made using any appropriate measurement means having an accuracy within ±2 percent.

The electrical resistance of the device shall be determined and recorded. The observed resistance shall be within the range specified by the manufacturer (see Table 7.2, item 128B).

29A4.3.3 A fast-acting thermocouple shall exhibit a 75 percent reduction in open circuit output voltage within 30 seconds after the flame is extinguished.

Method of Test

The manufacturer shall provide the pilot burner or other appropriate test burner for use in the test indicated below.

Two new thermocouple samples shall be provided and tested. The thermocouple shall be mounted in the test burner in accordance with the manufacturer's instructions. The test burner shall be mounted in the upright position or as specified by the manufacturer in a draft-free ventilation chamber and supplied with natural gas. The burner shall be ignited and the pressure adjusted to heat the thermocouple hot junction (thermocouple tip) to the maximum temperature specified in 2.1.3 ±122°F (50°C).

After the thermocouple tip temperature has been at the manufacturer's maximum for 20 minutes, the open circuit voltage shall be measured. The gas shall be turned off and back on as soon as the flame is extinguished. The open circuit voltage shall be measured 30 seconds after the flame is extinguished. The open circuit voltage shall be less than or equal to 25 percent of the open circuit voltage measured at the maximum thermocouple tip temperature.

29A4.4 Accuracy and stability of flame sensing devices responsive to ambient temperature

A device which is constructed so it will hold the gas supply open solely as the result of a uniform high ambient temperature shall be accurately preset by the manufacturer and shall be sufficiently durable to resist normal service conditions as simulated in the following tests.

29A4.4.1 Calibration Point

The average ambient temperature below which the device will act to shut off the gas supply shall be determined and shall be used as the calibration point for the purpose of subsequent tests. The calibration point shall be higher than the element ambient temperature limit specified by the manufacturer in 29A4.2.1 by an amount not to exceed 50°F (10°C) or 10 percent of the calibration point temperature in degrees F (°C), whichever is greater.

Method of Test

The flame sensor shall be tested in a gradient-free temperature-controlled medium. This may take the form of a well-agitated liquid bath, if suitable, a well-circulated air bath or a well-insulated, close-fitting, heated aluminum or copper enclosure. The temperature of the medium shall be increased until the device acts to open the gas supply. The temperature of the medium shall then be decreased at a rate not to exceed 3°F (1.5°C) per minute, and the temperature at which the device acts to shut off the gas supply shall be recorded. The test shall be repeated and additional readings shall be recorded until five consecutive readings indicate that stability has been attained. For the purpose of these tests, stability is defined as the condition which exists when five consecutive readings fall within a temperature range of 10°F (5.5°C) or 2 percent of the calibration point temperature in degrees F (°C), whichever is greater. The average of the last five readings shall be

computed and shall be designated as the calibration point. No temperature reading recorded during the tests to determine the calibration point shall be lower than that specified by the manufacturer in 29A4.2.1.

29A4.4.2 Installation Stresses

The calibration of the device shall not change by more than ±25°F (14°C) as the result of stresses produced by external forces which could be expected to be applied in an installation.

Method of Test

The device used in 29A4.4.1 shall be tested with an external load(s) applied in a direction which examination of the construction details indicates could, as the result of stresses incurred in an installation, produce a calibration change. During this test, the device shall be secured by its normal mounting means. If the device is provided with wiring terminals, the external load shall consist of a 10 pound (4.5 kg) force applied in sequence to each terminal. If the device is provided with a metal capillary connection, a 10 pound (4.5 kg) load shall be applied to the capillary.

The calibration point shall be determined using the method outlined in 29A4.4.1 and shall not deviate more than ±25°F (±14°C) from the calibration point determined in 29A4.4.1, nor shall any temperature recorded be lower than that specified by the manufacturer in 29A4.2.1.

The above test shall be repeated with the direction of the external load(s) reversed and the same specifications for the calibration point shall apply.

29A4.5 Substantiality of sensing elements

Sensing elements of safety shutoff devices shall be constructed so they will not fail in an unsafe manner under the following conditions of test.

Method of Test

a) With the device mounted in its normal manner, a force of 5 pounds (22.2 N) shall be applied to the sensing element in the directions most likely to cause it to operate.

b) If the sensing element of the device is not supported within ¼ inch (6.4 mm) of its tip end, this end shall be subjected to a bending moment of up to 15 inch-pounds (1.69 N·m) applied by well-fitting jaws engaging the element for one-half of its exposed length but not exceeding ¾ inch (19.1 mm), with the center of the moment at the end of this engagement farthest from the tip. Any resultant bending shall be limited to 15 degrees (0.26 rad) from the original configuration.

After application of each of the above tests, the device shall be examined for evidence of failure. Following each of these series of tests, the device shall not act so as to cause or allow main burner gas to flow in the absence of the ignition source. In addition, a device constructed so as to hold the gas supply open solely as the result of a uniform high ambient temperature applied to the sensing

element, if operable after the above tests, shall have the calibration point again determined using the method outlined in 29A4.4.1, and the calibration point shall not be lower than that specified by the manufacturer in 29A4.2.1.

29A5 *Addition of requirements covering the thermal stress test:*

For electronic and electro-mechanical systems, tests referenced in clause 17, Endurance, shall be conducted.

Automatic gas ignition systems and components shall perform without failure, impairment of operation, or flashback of any pilot burner(s) used when cycled the number of times specified in Table 29A5.1 consistent with the specified ignition source.

(See Table 7.2, item 118).

Automatic gas ignition systems and components shall be tested in accordance with the following applicable test conditions:

a) All systems and components shall be tested as specified in Test Condition 1.

b) All components not exposed to combustion chamber atmosphere shall be tested as specified in Test Condition 2.

c) All components intended to be exposed to combustion chamber atmosphere shall be tested as specified in Test Condition 3 and 4 except that spark electrodes and flame sensors which are not thermally actuated shall not be tested under Test Condition 4.

d) All systems and components for which a Lockout Time is specified shall be tested as specified in Test Condition 5.

One device tested in 29A4.3 or 15.5, as applicable, shall be subjected to each of the applicable test conditions. At the manufacturer's option, these tests may be conducted concurrently using a different device for each applicable test, provided each device used has been first subjected to tests specified in 29A4.3 or 15.5, as applicable. Test Conditions 2 and 3 may be conducted simultaneously on a device having one portion exposed to combustion chamber atmosphere and another portion not exposed to combustion chamber atmosphere.

Test Condition 1

One device and, if necessary, its respective test burners shall be operated for a total of 720 hours in a test chamber(s) maintained at a temperature equal to the maximum operating temperature (within plus 5 percent) specified for the component parts (see Table 7.2, item 22A).

Test Condition 2

a) The component parts of one device not for exposure to combustion chamber atmosphere shall be placed in a test chamber(s) and cycled to permit and interrupt (alternately) gas flow to the test burner. The component parts shall be

maintained at a temperature equal to the maximum operating temperature (within plus 5 percent) specified for the component parts (see Table 7.2, item 22A) and cycled one-half of the total number of cycles specified in Table 29A5.1.

b) The component parts shall then be maintained at a temperature equal to the minimum operating temperature (within minus 5 percent) specified for the component parts (see Table 7.2, item 22A) for the remainder of the total number of cycles specified in Table 29A5.1.

Test Condition 3

a) The component parts of one device which is intended for exposure to combustion chamber atmosphere and, if necessary, their respective test burners shall be placed in a test chamber(s) and cycled to permit and interrupt (alternately) gas flow to the test burner. During the portion of the cycle permitting gas flow, the temperature of the component parts shall be raised to the maximum operating temperature (within plus 5 percent) specified for the component parts (see Table 7.2, item 22A). During the portion of the cycle with the gas flow interrupted, the test chamber heat source shall be interrupted and the component parts cooled either naturally or by passing room temperature air over the parts as specified by the manufacturer until the flame-responsive element temperature has been reduced to 250°F (121°C) or less. The component parts shall be cycled ¼ of the total number of cycles specified in Table 29A5.1 under this test condition.

b) The component parts shall be cycled for the remainder of the total number of cycles specified in Table 29A5.1 in the manner described in ″(a)″ above except that the flame-responsive element shall be reduced to a temperature just sufficient to cause the system to cycle during the portion of the cycle with the gas flow interrupted.

Dependent upon the manufacturer's installation instructions (see Table 7.2, item 31), these tests shall be conducted with or without the flame-responsive element directly exposed to flame envelopment.

During these tests, the ignition coils of devices intended for use only with the pilot of a Continuous, Intermittent/Continuous, or Intermittent/Interrupted Ignition Source (see clause 2, definitions) may be replaced after each 2,000 cycles, 7,500 cycles, or 7,500 cycles respectively.

Test Condition 4

Spark electrodes and flame sensors which are not thermally actuated shall not be subjected to this test. Component parts of one device which is intended for exposure to combustion chamber atmosphere and, if necessary, its respective test burners shall be placed in a test chamber and cycled 100 times to permit and interrupt (alternately) gas flow to the test burner. During the portion of the cycle with the gas flow interrupted, the temperature of the component under test shall be reduced to the minimum operating temperature (within minus 5 percent) specified for the component parts (see Table 7.2, item 22A). The portion of the cycle permitting gas flow shall be as short as possible to permit the component to perform its intended function.

Test Condition 5

One device or component for which a Lockout Time is specified shall be subjected to 6,000 complete lockout cycles. This test shall be conducted with all components at room temperature initially. With the gas manually shut off, the circuit shall be energized at rated voltage until lockout occurs. This procedure shall be repeated 6,000 times with a cool-down period as specified by the manufacturer following the attainment of each lockout condition.

After completion of each applicable continued performance Test Condition, each device shall be retested as specified in 13.2 and 29A4.3 or 15.5, as applicable, and shall comply.

A device which is constructed so it will hold the gas supply open solely as a result of a uniform high ambient temperature shall also be retested as described in 29A4.4.1 and shall comply.

At the conclusion of this test, each device shall be carefully checked to determine field replaceable parts such as orifice(s), flame sensors and thermocouples are capable of being removed and replaced.

Table 29A5.1 – Duration of thermal stress test

Specified Ignition Source*	Duration of Test								
	Hours	Number of Cycles							
	Test Condition	Test Condition 2			Test Condition 3			Test Condition	Test Condition
	1	a	b	Total	a	b	Total	4	5
Continuous	720	3,000	3,000	6,000	1,500	4,500	6,000	100	6,000
Intermittent/ Continuous	720	12,500	12,500	25,000	6,250	18,750	25,000	100	6,000
Intermittent	720	50,000	50,000	100,000	25,000	75,000	100,000	100	6,000
Intermittent/ Interrupted	720	12,500	12,500	25,000	6,250	18,750	25,000	100	6,000
Interrupted	720	50,000	50,000	100,000	25,000	75,000	100,000	100	6,000

* For definitions of Continuous, Intermittent/Continuous, Intermittent, Intermittent/Interrupted and Interrupted Ignition Source, see clause 2, Definitions.

30A Manufacturing and Production Tests

The manufacturer shall submit a plan which is mutually acceptable to the manufacturer and the testing authority and which describes the programs and test procedures specified in 30A.1, 30A.2 and 30A.3 and the records to be kept by the manufacturer.

The manufacturer shall use a program to qualify raw materials, parts, assemblies and purchased components.

30A.2 The manufacturer shall conduct the following tests on each device at room temperature (as applicable):

a) Timings (15).

b) Pull-in current and drop-out current for thermoelectric devices (29A4.3).

c) Verification of proved igniter characteristics (15).

30A.3 The manufacturer shall use a program which includes a mutually acceptable schedule(s) to conduct the following tests, as applicable:

a) Endurance (17);

b) Timings (15.5);

c) Effects of voltage variation (11.3.105A);

d) Pilot operating characteristics (29A2.4);

e) Substantiality of sensing elements (29A4.5);

f) Installation stresses (29A4.4.2);

g) Dielectric strength (13.2);

h) Calibration point (29A4.4.1); and

i) Conduct oxygen cutoff point tests for oxygen depletion systems (ODS) (29A3).

30A.4 The manufacturer's test methods shall be capable of relating back to the test(s) specified in this standard. For ease of reference, section numbers of the standard are provided in parentheses.

Figure 1 Not Applicable

Figure 1A *Addition:*

Figure 1A
Keyhole slot

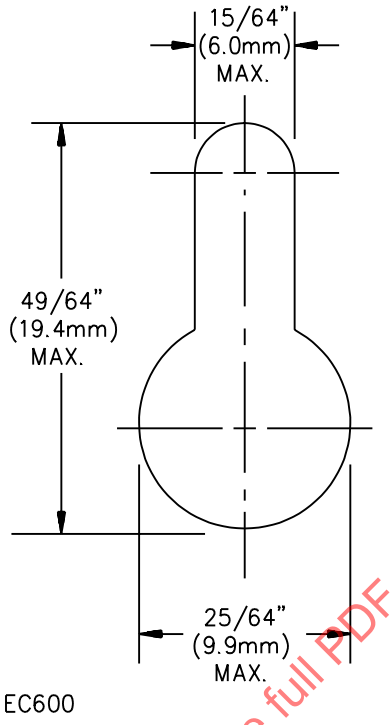

Figure 2 Not Applicable

Figure 2A ***Addition:***

Figure 2A
Articulate Probe

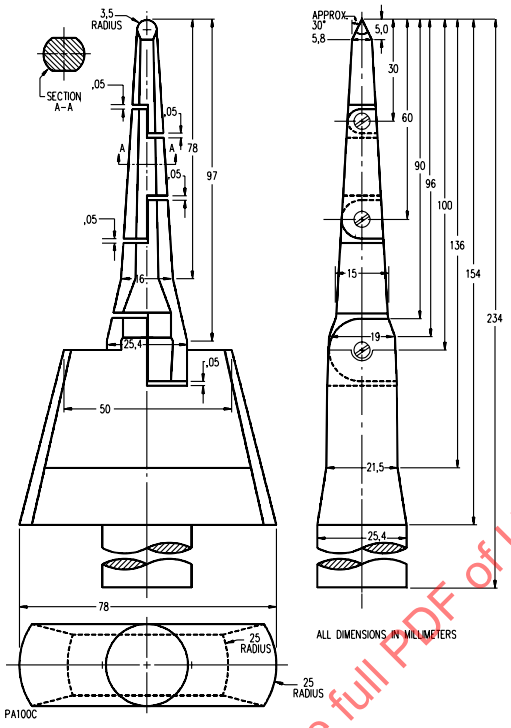

Figure 4 through 7 Not Applicable

Figure 9 Not Applicable

Figure 14 through 16 Not Applicable

Annex A

Indelibility of Markings

Replacement:

Marking and labeling systems complying with the Underwriters Laboratories Standard for Marking and Labeling Systems, UL 969 or Adhesive Labels, CSA C22.2 No. 0.15, shall be considered as complying with the provisions of Annex A.

A1.1 Markings which are not required need not be classified indelible.

A1.2 and A1.3 Not Applicable.

A2 Not Applicable.

A3 The adhesive quality of marking materials and the legibility of all marking materials shall not be adversely affected when checked by the following tests:

These tests shall be conducted on two devices as received and following the tests specified in 29A5 (Thermal Stress Test) or equivalent periods of time and temperature. The manufacturer shall have applied the marking materials to the devices as they would be applied in production.

A4A *Addition:*

Adhesive marking material shall exhibit no curling at the edges and good adhesion when scraped back and forth ten times across edges, with a downward force of approximately 2 pounds (8.9 N) using the edge of a 5/64 inch (2 mm) thick steel blade held at a right angle to the test surface. The portion of the blade contacting the test surface shall have a radius of curvature of 1.00 inch (25.4 mm) and the edges of the blade shall be rounded to a radius of 1/64 inch (0.4 mm). The back of the blade of a pocket knife conforming to the description indicated has been found to be suitable for performing this test.

A4.1A At the conclusion of these tests the marking material shall exhibit good adhesion and no curling at the edges.

A4.2A The manufacturer shall provide evidence that the marking materials and adhesives will not be adversely affected by water.

A4.3A Final acceptance of marking materials shall be based on the suitability of the application of the marking material to the device.

Annex C

Not Applicable.

Annex D

Not Applicable

Annex E

Not Applicable.

Annex F

Not Applicable.

Annex G

Not Applicable.

Annex H

(normative)

Requirements for electronic systems and components

(Also see clauses 12, Moisture Resistance, and 17, Endurance.)

This annex supplements or modifies the corresponding clauses of this standard.

H2 Definitions

H2.4 Definitions relating to disconnection and interruption

Not Applicable.

H2.5 Definitions of type of control according to construction

Add the following definition:

H2.5.101 HYBRID CIRCUIT: A circuit produced on ceramic substrate by means of thick film, thin film, thin film on surface mounted devices (SMD) technology, without accessible electrical connections except for I/O points, and with all internal connections constructed as part of a lead frame or other integral construction.

H2.16 through H2.19 Not Applicable.

H2.20 Definitions of software terminology – General

H2.20.1 through H2.20.5 Not Applicable.

Addition:

H2.20.6A SAFETY-RELATED SOFTWARE: Software whose failure could result in unsafe operation of the controlled equipment.

H4 General notes on test

Addition:

If the results of any of the prescribed tests can be determined beyond doubt by assessment, then the test or tests need not be performed.

H6 Classification

H6.4 According to features of automatic action

H6.4.3 Not Applicable.

H6.4.3.13 Not Applicable.

H6.18 According to software class

Not Applicable.

H7 Information

Modification:

Table 7.2

Information	Clause or Subclause	Method
36 Not Applicable.		
52 Not Applicable		
57 through 60 Not Applicable.		
66 through 72 Not Applicable.		
100A Documentation and risk assessment for safety-related software	H11.12	X
121 The effect on solid state outputs for motors, valves, etc. as a result of the tests of clause H26.	H26.2	X

H11 Constructional requirements

H11.2 Protection against the risk of electric shock

H11.2.5 Protective impedance shall consist of two or more impedances in series provided exclusively for purposes of protection. It shall consist of components in which the probability of a reduction of impedance during life can be ignored. The series chain of impedances shall be connected between live parts and an accessible part and shall contain no electronic devices or interconnection to such devices.

The impedances used to provide protective impedance shall be components of the type according to Annex AA, Failure Modes of Electrical/Electronic Systems and Components, where short circuits are excluded. Alternatively, if resistors which are not complying with Annex AA, but complying with the requirements of 14.1 of the Standard for Audio, Video and Similar Electronic Apparatus – Safety Requirements, IEC 60065, are used, then the protective impedance shall consist of two or more impedances in series provided exclusively for purposes of protection.

Compliance is checked by:

1) open-circuiting each impedance in turn;

2) applying a fault condition to any other part of the circuit which might influence the maximum leakage current with the protective impedances intact, e.g., failure of any circuit component, operation of a protective device or loss of one pole of the supply.

Short-circuiting of each impedance shall be carried out only when resistors complying with 14.1 of IEC 60065 are used.

Under these conditions, the equipment shall still comply with the requirements of H8.1.10.

H11.4 Not Applicable.

H11.12 Controls using software

Addition:

Controls employing safety-related software shall be evaluated using the Standard for Safety-Related Software, UL 1998, with the exception of sections 4, 5, 8, 12 and 15.

Replace Section 5 of UL 1998 with the following:

5.1 All tools used in the design, implementation, and verification of software shall be documented. The documentation shall include:

a) The name of the tool supplier or developer;

b) The model, application, or trade name of the tool;

c) The tool version identification;

d) A description of the purpose for which the tool is used; and

e) A list of identified errors, faults, or failures of the tool performance, such as a ″bug list″.

Replace Section 8 of UL 1998 with the following:

8.1 Appendix A of UL 1998 shall be considered normative.

8.2 Means shall be provided in critical sections of software to address physical features that occur in hardware as specified in Table A2.1 of Appendix A, UL 1998 for the appropriate software class as described in A3 based on the intended function of the critical section or as specified in the product standard. See Appendix A, UL 1998 for an example of the application of Table A2.1 to a product.

8.3 Measures other than those specified in Appendix A, UL 1998 are usable when they can be shown to provide equivalent coverage to that specified in Table A2.1. In determining whether or not the use of a particular measure provides the intended coverage, the measure shall be analyzed with respect to the coverage provided by the examples of measures specified in Table A2.1. The analysis shall include a comparison to one of the examples of measures specified in Table A2.1 and a determination of the effect of a failure in accordance with Section 3, Risk Analysis, UL 1998. The comparison shall show that there is no greater risk that the end product will enter a non-RA state.

Section 12 of UL 1998 is applicable except as follows:

12.2.2 Not applicable.

Section 15 of UL 1998 is applicable except as follows:

15.2 Not applicable.

In conducting this evaluation, each failure or fault shall be considered separately.

The investigation of the software shall include an integral investigation of the controlling hardware to perform its specified safety-related protective function in accordance with this standard.

Documentation as required in UL 1998 shall be provided, and a risk assessment, as described in UL 1998 shall be performed by the manufacturer and submitted to the certifying agency. In conducting the risk assessment, the hardware and safety-related software shall be considered as an integrated system. The requirements for software, Class 2, shall be applied. Detection of an error in the software shall result in ″-a,″ ″-b″ or -″c″ as specified in 11.3.106.

H11.12.7 Not Applicable.

Table H11.12.7 Not Applicable.

H.11.12A.1 When applying the requirements in the Standard for Software in Programmable Components, UL 1998, the software class shall be defined as Class 2.

H.11.12A.2 A failure in the software during its intended operation shall not result in a loss of declared protective function as specified by the manufacturer, and the following is to occur:

a) The overall control operates normally within the declared timings and sequence, or

b) The control operates to de-energize the fuel delivery circuit within the declared flame failure response time and either establishes safety shutdown or fails to subsequently initiate a burner startup, or completes the current burner operating cycle normally but will either fail to subsequently start the burner or will establish safety shutdown.

H13 Not Applicable.

H17 and H18 Not Applicable.

H20 Not Applicable.

(See Clause 20, Creepage distances, clearances and distances through insulation.)

H21 Not Applicable.

H25 Not Applicable.

H26 Electromagnetic compatibility (EMC) requirements – immunity

H26.2 Replacement:

Compliance is checked by the tests as detailed in H26.5 to H26.12 inclusive, according to the following criteria as indicated for each test.

H26.2.101 The system shall continue to operate in its declared normal operating sequence and timings as verified in clause 15, Manufacturer Deviation and Drift.

H26.2.102 The system shall act to de-energize the fuel flow means or both the fuel flow means and the ignition source.

H26.2.103 The system shall complete the current cycle with either fuel flow means de-energized or both the fuel flow means and the ignition source de-energized and shall fail to start the subsequent cycle.

H26.2.104 The system shall complete the current cycle with either fuel flow means de-energized or both the fuel flow means and the ignition source de-energized and shall initiate a new start-up procedure and thereafter operate as in H26.2.101.

H26.2.105 For disturbances applied during the normal running condition, the system may initiate a recycle or reignition procedure, if designed to do so, and thereafter shall operate as in H26.2.101.

H26.2.106 The system shall go to lock-out condition.

A separate sample, as submitted, is used for each test.

At the option of the control manufacturer, tests may be performed on a single sample.

H26.3 and H26.4 Not Applicable.

H26.5 Test of the influence of voltage dips and short voltage interruptions in the power supply network

H26.5.1 Not Applicable.

H26.5.4 Severity levels

Replacement:

The following test values shall be applied.

	ΔU	(V_r)	Duration
Voltage dips	30%	(0.70 V_R)	0.5 seconds
	60%	(0.40 V_R)	0.5 seconds
Voltage interruptions	100%	(0.0 V_R)	1 cycle *
			0.5 seconds
			60 seconds
* of supply waveform			

H26.5.4.101 Addition:

Each test is performed three times in each of the following operating conditions:

I during pre-purge or waiting time

II during the flame establishing period or the lock-out time

III during normal running condition