UL 873

STANDARD FOR SAFETY

Temperature-Indicating and -Regulating Equipment

UL Standard for Safety for Temperature-Indicating and -Regulating Equipment, UL 873

Twelfth Edition, Dated November 16, 2007

Summary of Topics

The revision dated February 6, 2015 is being issued to adopt the following proposal:

1. Revising the multiple disconnect caution marking text height requirement in 74.2.

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. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The new requirements are substantially in accordance with Proposal(s) on this subject dated November 5, 2014.

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 note following the affected item. 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that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

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1

UL 873

Standard for Temperature-Indicating and -Regulating Equipment

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This UL Standard for Safety consists of the Twelfth Edition including revisions through February 6, 2015.

The Department of Defense (DoD) has adopted UL 873 on January 17, 1992. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at http://csds.ul.com.

No Text on This Page

CONTENTS

INTRODUCTION

CONSTRUCTION

PERFORMANCE

No Text on This Page

MANUFACTURING AND PRODUCTION TESTS

RATING

MARKING

SPECIAL-PURPOSE DEVICES

No Text on This Page

INTRODUCTION

1 Scope

1.1 These requirements cover electrical equipment for control of air-conditioning, heating, cooking, refrigeration, and humidity, rated 600 volts or less, to be used in ordinary locations in accordance with the National Electrical Code, NFPA 70.

1.2 These requirements cover general-use equipment for field-installation and controls intended to be factory installed on or in certain appliances as safety, limiting, or operating controls. These controls respond directly or indirectly to changes in temperature, humidity, or pressure to effect control of equipment or appliance operation. Devices covered by these requirements include:

a) Refrigeration Controllers – Humidistats for factory installation on or in refrigeration equipment; pressure, temperature, pneumatic pressure, motor, timer, bimetallic-heater, magnetically-operated controls, and the like, and combinations thereof in control panels with or without transformers. See 1.4.

b) Industrial Operating Controls – Temperature controllers for industrial, farm, and boiler room applications; snow melting controls; return-duct humidistats; humidity controllers; pneumatic pressure regulators; transformer (low-voltage secondary) relays; pneumatic pressure, bimetallic-heater, motor, timer, and magnetically operated sequence switches; stoker controls; indicating and recording controls; and motor operators for actuating air dampers. These requirements do not cover output connected apparatus such as dampers, linkages, or valves.

c) Residential Operating Controls – Room thermostats, room humidistats, and other operating controls for residential heating and cooling appliances.

d) Controls for Factory Installation on or in Appliances –

1) Controls as mentioned in (a) – (c) but specifically intended for use on, in, or as a part of the end-use equipment.

2) Electric water-heater controls intended to regulate or limit water temperature.

3) Other controls including door-interlock thermostats for self-cleaning ovens; baseboard heater temperature-limiting controls; humidifier controls; fan thermostats; and temperature-regulating and -limiting thermostats for electric heating equipment such as clothes dryers, air heaters, household and commercial cooking appliances, beauty-parlor equipment, steam and dry bath heaters, and ranges (controlling oven or surface elements).

1.3 Certain safety controls, and safety control circuits on operating controls, are investigated under the requirements in this standard, insofar as they apply, and also under the applicable requirements for limit controls.

1.4 The following devices are among those considered to be refrigeration controllers:

a) A control that either directly or indirectly controls the starting and stopping of a compressor motor of refrigeration or air-conditioning equipment because of variations in temperature, pressure, refrigerant level, or the like.

b) A pressure limiting device and a defrost temperature-limiting device for refrigeration or air-conditioning equipment.

c) An auxiliary device, such as a defrost timing control, a defrost temperature regulating control, a start winding relay for a compressor motor, a control or defrost or heat pump change-over, fan or pump motor, vane or load capacity regulator, or a similar device that primarily serves refrigeration or air-conditioning equipment.

d) A control panel that, incorporates one or more of the functions described in (a) – (c) for programming refrigeration or air-conditioning equipment.

1.5 A wall-mounted room thermostat not intended for mounting in or on refrigeration or air-conditioning equipment is investigated as a thermostat and not as a refrigeration controller.

1.6 Industrial temperature-indicating and -regulating controls include controls that are intended, among other applications, for installation in or on industrial apparatus, or for boiler or furnace room, farm, outdoor, and comparable locations that may not always be clean and dry.

1.7 A residential control is one intended for indoor comfort control use in clean, dry, nonindustrial environments, such as dwellings, offices, and stores.

1.8 A humidistat is investigated in the same manner as a thermostat.

1.9 Requirements for controls intended to be factory installed on or in appliances may include requirements appropriate for the end-use appliance. The spacing requirements for several such controls are specified in Table 32.1.

1.10 These requirements do not cover primary safety or limit controls for gas, oil, or electric-fired central-heating furnaces or boilers; duct heaters; oil or gas burners; or stokers; nor do they cover controls for oil pumps and oil level regulators; boiler-feed or low-water cut-offs; or furnace fan or boiler circulators.

1.11 These requirements do not cover low-voltage thermostats, damper controls or similar devices intended for connection only to a low-voltage circuit of limited power supplied by a primary battery or by a Class 2 transformer. An assembly consisting of a line-voltage transformer with a low-voltage secondary incorporated as an integral part of a control, such as a thermostat or a damper control, is considered to be within the scope of these requirements. See 6.1.

1.12 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

2 Glossary

2.1 For the purpose of this standard the following definitions apply.

2.2 CLASS 2 TRANSFORMER – A stepdown transformer of the low-secondary-voltage type (30 volts or less) rated for use with Class 2 remote-control circuits, low-energy power circuits, and signal circuits (including bell or buzzer circuits and the like) in accordance with the National Electrical Code, ANSI/ NFPA 70-1993. Unless such a transformer is of the energy-limiting type having sufficient winding impedance to limit the current output to a specified maximum value, it is required to be provided with a fuse or other overcurrent-protective device rated for the application.

2.3 EQUIVALENT SELF-HEATING THERMAL PROTECTOR – A SHTP that is identified as being equivalent with another SHTP and is intended to be used in a lighting fixture interchangeably with the other SHTP without adversely affecting the compliance of the lighting fixture with the requirements for the fixture.

2.4 ISOLATED-LIMITED-ENERGY CIRCUIT – A circuit derived from an isolated secondary winding of a transformer having a maximum capacity of 100 volt-amperes and an open-circuit secondary voltage rating not exceeding 1000 volts.

2.5 LINE-VOLTAGE CIRCUIT – A circuit involving a potential of not more than 600 volts and having circuit characteristics in excess of a low-voltage or isolated-limited-energy circuit.

2.6 LOW-VOLTAGE CIRCUIT – A circuit involving a potential of not more than 30 volts and supplied by a primary battery, by a standard Class 2 transformer, or by a combination of a transformer and a fixed impedance that, as a unit, complies with all the performance requirements for a Class 2 transformer. A circuit derived from a line-voltage circuit by connecting resistance in series with the supply circuit as a means of limiting the voltage and current is not considered to be a low-voltage circuit.

2.7 PORTABLE EQUIPMENT – Cord and plug connected equipment that is capable of being carried or moved about.

2.8 SELF-HEATING THERMAL PROTECTOR (SHTP) – A thermal protective device consisting of a temperature sensitive switching element and a load voltage heater within a common housing. When mounted on a non-Type IC recessed fixture, the SHTP is intended to cycle under field related abnormal heating conditions.

2.9 STATIONARY EQUIPMENT – Cord and plug connected equipment that is intended to be fastened in place, or located in a dedicated space.

2.10 THERMAL PROTECTOR – A thermal protective device consisting of a temperature sensitive switching element with or without a series heater within a common housing.

2.11 COMPONENT – A device or fabricated part of the control equipment covered by the scope of the safety standard dedicated to the purpose. When incorporated in the ultimate use equipment, a product otherwise typically field installed (e.g. luminaire) is considered to be a component. Unless otherwise specified, materials that compose part of a device or a fabricated part of a device, such as thermoplastic or copper, are not considered components.

2.11 added January 6, 2012

2.12 CONTROL, OPERATING – A device or assembly of devices, the operation of which starts or regulates the end product during normal operation. For example, a thermostat, the failure of which a thermal cutout/limiter or another layer of protection would mitigate the potential hazard, is considered an operating control.

2.12 added January 6, 2012

2.13 CONTROL, SAFETY OR PROTECTIVE – A device or assembly of devices, the operation of which is intended to reduce the risk of electric shock, fire or injury to persons during normal and reasonably anticipated abnormal operation of the appliance. For example, a thermal cutout/limiter, or any other control/circuit relied upon for normal and abnormal conditions, is considered a safety or protective control.

2.13 added January 6, 2012

3 Units of Measurement

3.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

4 Components

4.1 *deleted January 6, 2012.*

4.2 *deleted January 6, 2012.*

4.3 *deleted January 6, 2012.*

4.4 *deleted January 6, 2012.*

5 References

5.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

CONSTRUCTION

5A Components

5A added January 6, 2012

5A.1 General

5A.1.1 A component of a product covered by this standard shall:

a) Comply with the requirements for that component as indicated in this standard;

b) Be used in accordance with its rating(s) established for the intended conditions of use;

c) Be used within its established use limitations; and

d) Additionally comply with the applicable requirements of this end product standard.

Exception No. 1: A component of a product covered by this standard is not required to comply with a specific component requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product, or

b) Is superseded by a requirement in this standard, or

c) Is separately evaluated when forming part of another component, provided the component is used within its established ratings and limitations.

Exception No. 2: A component complying with a component standard other than those cited in this standard is acceptable if:

a) The component also complies with the applicable component standard as cited in this standard; or

b) The component standard:

1) Is compatible with the ampacity and overcurrent protection requirements in the National Electrical Code, NFPA 70, where appropriate;

2) Considers long-term thermal properties of polymeric insulating materials in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, and

3) Any use limitations of the other component standard is identified and appropriately accommodated in the end use application. For example, a component used in a household application, but intended for industrial use and complying with the relevant component standard may assume user expertise not common in household applications.

5A.1.2 A component that is also intended to perform other functions, such as over current protection, ground-fault circuit-interruption, surge suppression, any other similar functions, or any combination thereof, shall comply additionally with the requirements of the applicable standard(s) that cover devices that provide those functions.

Exception: Where these other functions are not required for the application and not identified as part of markings, instructions, or packaging for the appliance, the additional component standard(s) need not be applied.

5A.1.3 A component not anticipated by the requirements of this standard, not specifically covered by the component standards as cited in this standard, and that involves a potential risk of electric shock, fire, or personal injury, shall be additionally investigated in accordance with the applicable standard, and shall comply with items (b) – (d) of 5A.1.1.

5A.1.4 With regard to a component being additionally evaluated, reference to construction and performance requirements in another end product standard is appropriate where that standard anticipates normal and abnormal use conditions consistent with the application of UL 873.

5A.1.5 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

5A.2 Attachment plugs, receptacles, connectors, and terminals

5A.2.1 Attachment plugs and receptacles shall comply with the Standard for Attachment Plugs and Receptacles, UL 498.

5A.2.2 Quick-connect terminals, both connectors and tabs, for use with one or two 22 – 10 AWG copper conductors, having nominal widths of 2.8, 3.2, 4.8, 5.2, and 6.3 mm (0.110, 0.125, 0.187, 0.205, and 0.250 in), intended for internal wiring connections in appliances, or for the field termination of conductors to the appliance, shall comply with the Standard for Electrical Quick-Connect Terminals, UL 310.

Exception: Other sizes of quick-connect terminals shall be investigated with respect to crimp pull out, insertion-withdrawal, temperature rise, and all tests shall be conducted in accordance with UL 310.

5A.2.3 Single and multipole connectors for use in data, signal, control and power applications within and between electrical equipment, and that are intended for factory assembly to copper or copper alloy conductors, or for factory assembly to printed wiring boards, shall comply with the Standard for Component Connectors for Data, Signal, Control and Power Applications, UL 1977.

5A.2.4 Wire connectors shall comply with the Standard for Wire Connectors, UL 486A-486B.

5A.2.5 Splicing wire connectors shall comply with the Standard for Splicing Wire Connectors, UL 486C.

5A.2.6 Multi-pole splicing wire connectors that are intended to facilitate the connection of hard-wired utilization equipment to the branch-circuit conductors of buildings shall comply with the Standard for Insulated Multi-Pole Splicing Wire Connectors, UL 2459. See 5A.2.9.

5A.2.6 revised February 6, 2015

5A.2.7 Equipment wiring terminals for use with all alloys of copper, aluminum, or copper-clad aluminum conductors, shall comply with Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E.

5A.2.8 Terminal blocks shall comply with the Standard for Terminal Blocks, UL 1059, and, if applicable, be suitably rated for field wiring.

Exception: A fabricated part performing the function of a terminal block need not comply with UL 1059 if the part complies with the requirements of Section 15, Insulating Material, Section 16, Supply Connections, Section 17, Current-Carrying Parts, and Section 32, Spacings. Sections 21, Low-Voltage External Wiring Requirements, and 22, Grounding, provide additional options as exceptions.

5A.2.9 Female devices (such as receptacles and connectors) that are intended, or that may be used, to interrupt current in the end product, shall be suitably rated for current interruption of the specific type of load, when evaluated with its mating plug or connector. For example, an appliance coupler that can be used to interrupt the current of a motor load shall have a suitable horsepower rating when tested with its mating plug.

5A.2.10 Bonding devices, ground clamps, grounding and bonding bushings and locknuts, and similar equipment, shall comply with the Standard for Grounding and Bonding Equipment, UL 467.

5A.3 Batteries

5A.3.1 A lithium ion (Li-On) single cell battery shall comply with the requirements for secondary lithium cells in the Standard for Lithium Batteries, UL 1642. A lithium ion muiltiple cell battery, and a lithium ion battery pack, shall comply with the applicable requirements for secondary lithium cells or battery packs in the Standard for Household and Commercial Batteries, UL 2054.

5A.3.2 Rechargeable nickel cadmium (Ni-Cad) cells and battery packs shall comply with the applicable construction and performance requirements of this standard.

5A.3.3 Rechargeable nickel metal-hydride (Ni-MH) battery cells and packs shall comply with the construction and performance requirements of this standard, or the applicable requirements for secondary cells or battery packs in the Standard for Household and Commercial Batteries, UL 2054.

5A.4 Electrical boxes and raceways

5A.4.1 Electrical boxes and the associated bushings and fittings, and raceways, of the types specified in Chapter 3 of the National Electrical Code, NFPA 70 and that comply with one of the following standards:

a) Standard for Metallic Outlet Boxes, UL 514A,

b) Standard for Conduit, Tubing, and Cable Fittings, UL 514B,

c) Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers, UL 514C, or

d) Standard for Cover Plates for Flush-Mounted Wiring Devices, UL 514D.

5A.5 Capacitors, filters and surge protective devices

5A.5.1 Capacitors

5A.5.1.1 A capacitor located in the line voltage circuit shall comply with the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14 or the Standard for Capacitors, UL 810.

5A.5.1.1 revised February 6, 2015

5A.5.2 Filters

5A.5.2.1 Electromagnetic interference filters with integral enclosures shall comply with the Standard for Electromagnetic Interference Filters, UL 1283.

5A.5.3 Surge Protective Devices

5A.5.3.1 Surge Protective Devices (SPDs), including air gaps and metal oxide varistors (MOVs), shall comply with the requirements in the Standard for Surge Protective Devices, UL 1449. Paragraphs 5A.5.3.2 through 5A.5.3.6 are applicable . Referenced ratings are per UL 1449.

Exception: These requirements do not apply to SPDs located in a Class 2 circuit unless the circuit is performing a safety function.

5A.5.3.2 Type 1, 2, or 3 SPDs and Type 1, 2 or 3 Component Assemblies SPDs shall:

a) Maintain a Maximum Continuous Operating Voltage (MCOV) rating equal to or greater than working voltage of the circuit connected, and

b) Maintain the appropriate Type Rating for the application in accordance with Table 5A.1.

Table 5A.1
Type 1, 2, or 3 Ratings

Application	Type Rating
Line side of service equipment	1
Load side of service equipment or feeder circuit applications	1 or 2
Branch circuit or control circuit applications	1 or 2 or 3

5A.5.3.3 Type 4 or Type 5 discrete component SPDs and Type 4 component assemblies shall have a Maximum Continuous Operating Voltage (MCOV) rating equal to or greater than the phase-to-phase (line-to-line) voltage of the system supply.

Exception: If the Type 4 or 5 discrete component SPDs and Type 4 component assemblies have been subjected to all the Current Tests in accordance with UL 1449, during its investigation, the MCOV may have a rating equal to or greater than the working voltage of the circuit connected.

5A.5.3.4 Type 4 or 5 discrete component SPDs and Type 4 Component Assemblies shall be rated in accordance with (a), (b) or (c):

a) A Type 4 discrete component SPD rated for use in Type 1 - 3 applications may be used in applications indicated in Table 5A.1, or

b) A Type 4 discrete component SPD rated for use in Type 1 - 3 applications or ″other″ rated applications shall have an Operating Duty Cycle Voltage (V_p) and Peak Current (A_p) in accordance with Table 5A.2, based on the working voltage of the circuit connected, or

Exception: For SPDs used in other than across-the-line applications such as in a non-isolated electronic circuit, the additional circuit impedance in series with the SPD can be considered when determining the required SPD ratings. The A_p rating of the SPD may be less than that defined Table 5A.2 provided the A_p rating is equal to or is greater than the surge current parameters

determine by a calculation that accounts for fixed series impedance inherent in the circuit. [The calculated A_p would be equal to V_p divided by the combined known impedance inherent in the circuit plus 2 ohms, which is the anticipated source impedance].

c) A Type 5 discrete component SPD or Type 4 component assemblies shall be rated with a Nominal Discharge Current, NDC (I_n) in accordance with Table 5A.2, based on the working voltage of the circuit connected.

Exception: For SPDs used in other than across-the-line applications such as in a non-isolated electronic circuit, the additional circuit impedance in series with the SPD can be considered when determining the required SPD ratings. The $I_n$of the SPD may be less than that defined Table 5A.2 provided the I_n rating is equal to or is greater than the surge current parameters determine by a calculation that accounts for fixed series impedance inherent in the circuit. [The calculated I_n would be equal to V_p divided by the combined known impedance inherent in the circuit plus 2 ohms, which is the anticipated source impedance].

Table 5A.2
Type 4 or 5 SPD Ratings

SPD Circuit Phase-to-Ground Voltage, Vac[a] by Overvoltage Category [b]				Ratings of Type 4 or 5 SPDs	
				Minimum Operating Duty Cycle Peak Voltage (kV_p)(1.2 x 50 µs)	Operating Duty Cycle Peak Current or Minimum Nominal Discharge Current, NDC (I_n) A
I	II	III	IV		
50	-	-	-	0.33	165
100	50	-	-	0.50	250
150	100	50	-	0.80	400
300	150	100	50	1.5	750
600	300	150	100	2.5	1250
-	600	300	150	4.0	2000
-	-	600	300	6.0	3000

[a] For ungrounded systems or systems with one phase grounded, the phase-to-ground voltage is considered to be the same as the phase-to-phase voltage for the purposes of using this table.

[b] Typical examples of categories for products are given below.

Category IV - Primary Supply Circuit Level. Overhead lines and cable systems including distribution and its associated overcurrent protective equipment (equipment installed at the service entrance).

Category III - Distribution Circuit Level. Fixed wiring and associated equipment (not electrical loads) connected to the primary supply level, Category IV.

Category II - Load Circuit Level. Appliances and portable equipment and the like connected to the distribution level, Category III.

Category I - Signal Circuit Level. Special equipment or parts of equipment such as low-voltage electronic logic systems, remote controls, signaling and power limited (per NEC Article 725) circuits connected to the load level, Category II.

5A.5.3.5 Electronic safety controls shall, in addition to the requirements noted in 5A.5.3.2 and 5A.5.3.3, be subjected to a subsequent transient overvoltage test sequence in the end-use equipment application as defined by the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, with the SPD installed as intended. To minimize testing of the end-use equipment involving multiple

alternate SPDs sources or types, the SPD with the highest Measured Limited Voltage rating or Voltage Protective Rating, as applicable, shall be tested in the transient overvoltage test sequence. The highest rated SPD can represent multiple alternate SPDs sources or types.

Exception: If the electronic safety control complies with the transient overvoltage test sequence when tested with the SPD removed, the SPD need only comply with 5A.5.3.2 and 5A.5.3.3.

5A.5.3.6 SPDs are not permitted to be used between line / mains / non-Class 2 circuits and Class 2 circuits.

5A.6 Thermistors and thermal links

5A.6.1 A temperature sensing positive temperature coefficient (PTC) or negative temperature coefficient (NTC) thermistor, that performs the same function as an operating or protective control shall comply with the Standard for Thermistor-Type Devices, UL 1434.

5A.6.2 A thermal link (thermal cutoff) shall comply with the Standard for Thermal-Links – Requirements and Application Guide, UL 60691.

5A.6.2 revised February 6, 2015

5A.7 Cords and cables

5A.7.1 A cord set or power supply cord shall comply with the Standard for Cord Sets and Power Supply Cords, UL 817.

5A.7.2 Flexible cords and cables shall comply with the Standard for Flexible Cords and Cables, UL 62. Flexible cord and cables are considered to fulfill this requirement when preassembled in a cord set or power supply cord complying with UL 817.

5A.8 Gaskets and seals

5A.8.1 Gaskets and seals shall comply with the Standard for Gaskets and Seals, UL 157.

Exception: Gaskets and seals, and the securing adhesive, that comply with the requirements of Section 54, Accelerated Aging Tests on Gaskets, Sealing Compounds, and Adhesives, are considered to fulfill this requirement.

5A.9 Ground-fault, arc-fault, and leakage current detectors/interrupters

5A.9.1 Ground-fault circuit-interrupters (GFCI) for protection against electrical shock shall comply with the Standard for Ground-Fault Circuit-Interrupters, UL 943, including any end-use equipment marking or instruction manual statement requirements.

5A.9.2 Appliance-leakage-current interrupters (ALCI) for protection against electrical shock shall comply with the Standard for Appliance-Leakage-Current Interrupters, UL 943B. An ALCI is not considered an acceptable substitute for a GFCI when a GFCI is required by the National Electrical Code, NFPA 70.

5A.9.3 Equipment ground-fault protective devices shall comply with the Standard for Ground-Fault Sensing and Relaying Equipment, UL 1053, and applicable requirements of the Standard for Ground-Fault Circuit-Interrupters, UL 943.

5A.9.4 Arc-fault circuit-interrupters (AFCI) shall comply with the Standard for Arc-Fault Circuit-Interrupters, UL 1699.

5A.9.5 Leakage-current detector-interrupters (LCDI) and any shielded cord between the LCDI and appliance shall comply with Standard for Arc-Fault Circuit-Interrupters, UL 1699.

5A.10 Heaters and heating elements

5A.10.1 Electric resistance heating elements shall comply with the construction requirements of:

a) The Standard for Electric Heating Appliances, UL 499; or

b) The Standard for Sheathed Heating Elements, UL 1030.

Exception: Heating wire (e.g. rope heater) that complies with the Standard for Appliance Wiring Material, UL 758, and the requirements of this end product standard are considered to fulfill this requirement.

5A.10.2 Thermistor-type heaters (e.g. PTC and NTC heaters) shall comply with the Standard for Thermistor-Type Devices, UL 1434.

5A.11 Insulation systems

5A.11.1 Materials used in an insulation system that operates above Class 105 (A) temperatures shall comply with the Standard for Systems of Insulating Materials – General, UL 1446.

5A.11.2 All insulation systems employing integral ground insulation shall comply with the requirements specified in the Standard for Systems of Insulating Materials – General, UL 1446.

5A.12 Light sources and associated components

5A.12.1 Lampholders and indicating lamps shall comply with the Standard for Lampholders, UL 496.

Exception: Lampholders forming part of a luminaire that complies with the applicable luminaire standard are considered to comply with this requirement.

5A.12.2 Lighting ballasts shall comply with:

a) The Standard for Fluorescent-Lamp Ballasts, UL 935, or

b) The Standard for High-Intensity Discharge Lamp Ballasts, UL 1029.

Exception No. 1: Ballasts forming part of a luminaire that complies with the applicable luminaire standard are considered to comply with this requirement.

Exception No. 2: Ballasts for other light sources shall comply with the applicable standard(s).

5A.12.3 Light emitting diode (LED) light sources shall comply with the Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products, UL 8750.

Exception No. 1: LED light sources forming part of a luminaire that complies with the applicable luminaire standard are considered to comply with this requirement.

Exception No. 2: Individual LED light sources mounted on printed wiring boards and intended for indicating purposes need not comply with Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products, UL 8750, but shall comply with the applicable requirements of this end product standard.

5A.12.3 revised February 6, 2015

5A.13 Marking and labeling systems

5A.13.1 A marking and labeling system shall comply with Standard for Marking and Labeling Systems, UL 969, under the specified environmental conditions.

Exception: A marking or labeling system that complies with Section 60, Permanence of Marking Test, of this standard is considered to fulfill the requirement.

5A.14 Overcurrent protection

5A.14.1 Fuses shall comply with the Standard for Low-Voltage Fuses – Part 1: General Requirements, UL 248-1, and the applicable Part 2 (e.g. UL 248-5). Defined use fuses that comply with UL 248-1 and another appropriate standard for the fuse are considered to comply with this requirement.

5A.14.2 Circuit breakers shall comply with the Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, UL 489.

Exception: Circuit breakers used in telecommunications circuitry that comply with the Standard for Circuit Breakers For Use in Communications Equipment, UL 489A, need not comply with UL 489.

5A.14.3 Circuit breakers having integral ground fault circuit interrupter capability for protection against electrical shock shall additionally comply with the Standard for Ground-Fault Circuit-Interrupters, UL 943.

5A.14.4 Supplementary protectors shall comply with the Standard for Supplementary Protectors for Use in Electrical Equipment, UL 1077.

5A.14.5 Fusing resistors shall comply with the Standard for Fusing Resistors and Temperature-Limited Resistors for Radio- and Television-Type Appliances, UL 1412.

5A.15 Power supplies

5A.15.1 A Class 2 power supply shall comply with one of the following:

a) The Standard for Class 2 Power Units, UL 1310;

b) The Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, with an output marked “Class 2”, or that complies with the limited power source (LPS) requirements and is marked “LPS”; or

c) The requirements in Section 36, Class 2 Power Sources and Circuits, and Section 68, Class 2 Power Sources and Circuits, and applicable Class 2 power source and circuit tests in Section 63, Class 2 Power Sources and Circuit Tests.

5A.15.1 revised February 6, 2015

5A.15.2 A non-Class 2 power supply shall comply with one of the following:

a) The Standard for Power Units Other Than Class 2, UL 1012; or

b) The Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1.

5A.15.2 revised February 6, 2015

5A.16 Printed wiring boards

5A.16.1 Printed wiring boards, including the coatings, shall comply with the Standard for Printed-Wiring Boards, UL 796.

Exception: A printed-wiring board in a Class 2 nonsafety circuit is not required to comply with the bonding requirements in UL 796 if the board is separated from parts of other circuits such that loosening of the bond between the foil conductor and the base material will not result in the foil conductors or components coming in contact with parts of other circuits of the control or of the end-use product.

5A.17 Power switching semiconductors, optical isolators, and electronic components

5A.17.1 A power switching semiconductor device that is relied upon to provide isolation to ground shall comply with the Standard of Safety for Electrically Isolated Semiconductor Devices, UL 1557. The dielectric voltage withstand tests required by UL 1557 shall be conducted applying the criteria of Section 47 of this standard.

5A.17.2 An optical isolator that is relied upon to provide isolation between primary and secondary circuits or between other circuits as required by this end product standard shall comply with the Standard for Safety for Optical Isolators, UL 1577. The dielectric voltage withstand tests required by UL 1577 shall be conducted applying the criteria of Section 47 of this standard.

5A.17.3 Where an electronic component is determined to be a critical component, the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, including environmental stress tests appropriate to the intended usage of the end-product and its follow-up program, shall be applied.

5A.17.4 A critical component is a component that performs one or more safety-related or protective functions whose failure results in a condition such as the risk of fire, electric shock, or injury to persons, in the end product application.

5A.17.5 A critical component may also be identified using a failure-mode and effect analysis (FMEA) in accordance with the Failure-Mode and Effect Analysis (FMEA) of the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991. Other equivalent failure mode techniques such as FMEDA or FTA may be used.

5A.17.6 Electronic safety/protective (limiting) type controls shall comply with the requirements in the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991. Some examples of electronic safety/protective type controls which include protective functions are temperature limiting controls, safety controls, water heater controls, refrigeration motor-compresor variable speed drive controls providing protective/safety functions, etc.

Exception: Controls complying with Annex H requirements in the Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1 are considered to be in compliance withUL 991 requirements.

5A.17.7 The test levels for the required environmental stress tests of UL 991, Sections 11 through 22, shall be as specified in the end-use equipment standard. When the end-use standard does not specify the test levels, the following identified test levels shall apply for the referenced tests:

a) Power supply voltage dips and short interruption – Per Section 11, UL 991;

b) Transient overvoltage – Per Table 12.2, UL 991;

c) Voltage (Ramp) variation - Per Table 13.1, UL 991;

d) Electromagnetic susceptibility –

1) Conducted Disturbances – Test Level 3,

2) Radiated Disturbances – Field Strength 3 V/m ;

e) Electrostatic discharge – Per Section 15, UL 991;

f) Composite operational and cycling test – Per Section 16, UL 991;

g) Test for effects of shipping and storage - Per Section 17, UL 991;

h) Humidity – Per Table 19.1, UL 991;

i) Dust – Per Section 20, UL 991. Applicable only for protective controls with an optical element, the obscuring of which would result in a loss of protective function;

j) Vibration – Class C;

k) Jarring - Per Section 22, UL 991.

5A.17.8 The composite operational and cycling test represents the thermal cycling test and the overvoltage and undervoltage test in UL 991.

5A.17.9 The computational investigation of critical components in UL 991 is conducted to determine the overall control system failure rate, λ_p, of the control system by appropriately combining the failure rates of all critical components. The end-use equipment standard shall specify the overall control system failure rate, λ_p. and the time and test ambient temperature for the Operational Test. When the end-use standard does not specify a control system failure rate, λ_p shall be 0 failures/10^6 hours for the entire control system. If the end-use standard does not specify a period of time and test ambient temperature for the Operational Test, the test shall be conducted for 14 days at the ambient temperature specified in UL 991.

5A.17.10 When there are critical components identified in the control system and the failure rate is not specified in the end-use standard, the demonstrated test method in UL 991 is required to be applied. The multiplier for the test acceleration factor for nonindustrial applications is to be 576.30 for intermittent end-use equipment, or 5763.00 for continuous end-use equipment. The multiplier for the test acceleration factor for industrial applications is to be 869.80 for intermittent end-use equipment, or 9698.00 for continuous end-use equipment. The test acceleration factor equation is to be based on the end-use equipment rated ambient.

5A.18 Supplemental insulation, insulating bushings, and assembly aids

5A.18.1 The requirements for supplemental insulation (e.g. tape, sleeving or tubing) shall comply with the following:

a) Insulating tape shall comply with the Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape, UL 510;

b) Sleeving shall comply with the Standard for Coated Electrical Sleeving, UL 1441;

c) Tubing shall comply with the Standard for Extruded Insulating Tubing, UL 224.

5A.18.2 Wire positioning devices shall comply with Sections 15, Insulating Materials, and 35, Separation of Circuits. A device that complies with the Standard for Positioning Devices, UL 1565, is considered to comply with this requirement.

5A.18.3 Insulating bushings that comply with 5A.1 and the Standard for Insulating Bushings, UL 635, are considered to comply with the requirements of this Standard. Tests specified in this standard (e.g. Strain Relief Test) shall be performed, as required, to confirm the combination of the insulating bushing and the supporting parts are suitable.

5A.19 Transformers

5A.19.1 General-purpose transformers shall comply with the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1; and the Standard for Low Voltage Transformers – Part 2: General Purpose Transformers, UL 5085-2.

Exception: A transformer that meets the applicable construction and performance requirements of Section 64, Isolated-Limited Secondary and Non-Class 2 Circuit Tests, meets the intent of this requirement.

5A.19.1 revised February 6, 2015

5A.19.2 Class 2 and Class 3 transformers shall comply with the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1; and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

Exception: A Class 2 and Class 3 transformer that meets the applicable construction and performance requirements of Section 36, Class 2 Power Sources and Circuits, and Section 68, Class 2 Power Sources and Circuits, and applicable Class 2 power source and circuit tests in Section 63, Class 2 Power Sources and Circuit Tests.

5A.19.2 revised February 6, 2015

5A.20 Valves (electrically operated) and solenoids

5A.20.1 Electrically operated valves shall comply with the:

a) Standard for Electrically Operated Valves, UL 429; or

b) Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Electrically Operated Water Valves, Including Mechanical Requirements, UL 60730-2-8.

5A.20.2 Solenoids shall comply with the applicable construction and performance requirements of this standard.

6 General

6.1 A temperature-indicating or -regulating device or system that falls within the scope of 1.11, but has a maximum secondary potential of more than 30 volts or a maximum secondary output more than that specified for a standard Class 2 transformer under any service condition or load shall be investigated under conditions of intended service to determine whether it is acceptable for the intended application.

6.2 *deleted January 6, 2012.*

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7 Frame and Enclosure

7.1 General

7.1.1 Temperature-indicating and -regulating equipment shall be formed and assembled so that it will have the strength and rigidity necessary to resist the abuses to which it may be subjected, without increasing the risk of fire, electric shock, or injury to persons due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

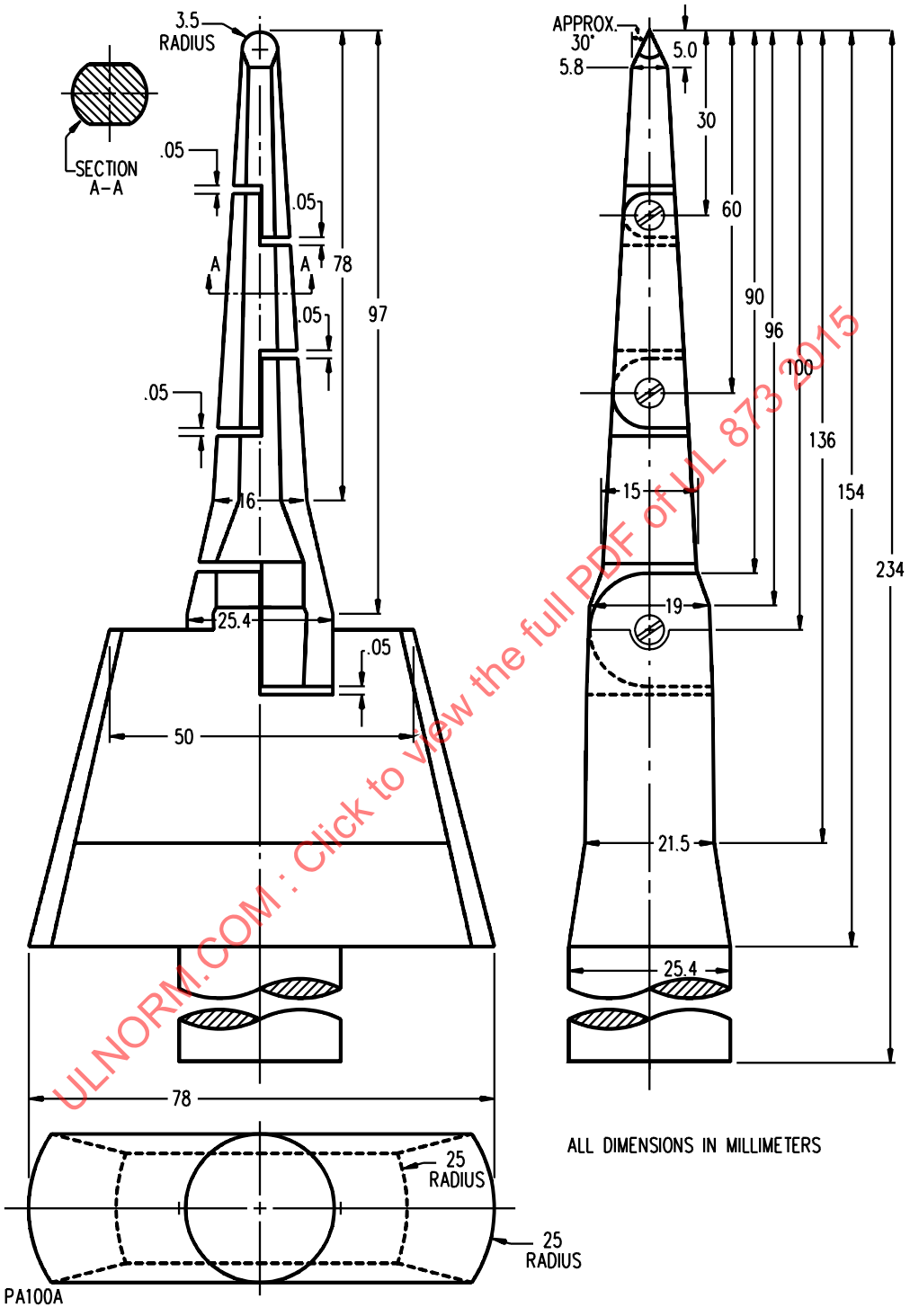
7.2 Accessibility of live parts

7.2.1 Electrical parts of a device, other than a supply cord or low-voltage terminals, shall be located or enclosed to reduce the risk of unintentional contact with an uninsulated live part. Additionally, electrical parts shall be located or enclosed so that protection against unintentional contact or shorting of live parts that could result in a malfunction of the controlled equipment is provided. For the purpose of these requirements, film-coated wire is considered to be an uninsulated live part.

Exception: An enclosure is not required for a device intended for assembly as part of another device.

7.2.2 An opening in an enclosure of a control is acceptable if an accessibility probe as illustrated in Figure 7.1, when inserted into the opening, cannot be made to touch any part that involves a 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.

Figure 7.1
Accessibility probe



Note: All length dimensions in millimeters

7.2.3 The accessibility 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.

7.2.4 If any part of the enclosure must be opened or removed as part of normal operation, regular adjustment, or regular or required maintenance (set point adjustment, timer or time of day clock adjustment, battery replacement, and the like) with or without the use of tools, or can be opened or removed without the use of tools, the accessibility probe is to be applied without the part in place.

7.3 Covers

7.3.1 An enclosure and a part of an enclosure such as a door, cover, or tank, shall be provided with means for firmly securing it in place.

7.3.2 Sheet-metal screws threading directly into metal shall not be used to attach a cover, door, or other part removed to install field wiring or for operation of the equipment. Sheet-metal screws may thread into sheet-metal nuts that are permanently mounted and protected against corrosion, and machine screws and self-tapping machine screws may thread directly into sheet-metal walls. See 19.12.

7.3.3 Sheet-metal screws mounting internal components that are not removed for installation or operation may thread directly into metal.

7.3.4 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 intended operation of the device.

7.3.5 A door or cover giving access to a fuse or thermal cutout in other than a low-voltage circuit shall shut closely against a 1/4-inch rabbet or the equivalent, have turned flanges for the full length of four edges, or have angle strips fastened to it. Flanges or angle strips shall fit closely with the outside of the walls of the box proper and shall overlap the edges of the box not less than 1/2 inch (12.7 mm). A construction that affords equivalent protection or a combination of flange and rabbet is acceptable.

7.3.6 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 1-1/2 inches (38.1 mm) from each end of each strip and at points between these end fastenings not more than 6 inches (152 mm) apart.

7.3.7 A hinged 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.

Exception: A cover that is hinged but is not required to be hinged for holding the cover may be held closed by a clasp, a sliding latch, or other means.

7.3.8 A snap-on cover that gives access to bare live parts and that does not require a tool for removal shall withstand the tests described in Snap-On Covers Test, Section 58.

7.3.9 The continuity of a bonding means for a snap-on or fastener-attached cover shall comply with the requirements in Bonding of Internal Parts, Section 22.

7.4 Transformers

7.4.1 A transformer shall be housed within its own enclosure, within the main enclosure of temperature-indicating and -regulating equipment, or within a combination of the two.

7.4.2 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.

Exception: 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.

7.4.3 A cast-metal transformer enclosure shall comply with the requirements in 7.5.1. A transformer enclosure of other material shall have strength and rigidity, and otherwise be rated for the purpose.

7.5 Cast metal

7.5.1 A cast-metal enclosure shall be at least 1/8 inch (3.2 mm) thick at every point, more than 1/8 inch thick at reinforcing ribs and door edges, and not less than 1/4 inch (6.4 mm) thick at tapped holes for conduit.

Exception: Other than at plain or threaded conduit holes, die-cast metal may be:

a) Not less than 3/32 inch (2.4 mm) thick for an area greater than 24 square inches (154.8 cm^2) or having dimensions more than 6 inches (152 mm).

b) Not less than 1/16 inch (1.6 mm) thick for an area of 24 square inches or less and having no dimensions more than 6 inches. The area limitation may be obtained by the provision of reinforcing ribs subdividing a larger area.

c) Not less than 0.035 inch (0.89 mm) thick if the enclosure will not be used as a splice box and if the voltage rating of the complete device is such that the voltage between any two conductors is 250 volts or less, and is limited to direct current or single-phase alternating current.

d) Not less than 0.028 inch (0.71 mm) thick if the enclosure houses only low-voltage circuits.

7.6 Sheet metal

7.6.1 Other than at points where a wiring system is to be connected, the thickness of a sheet-metal enclosure shall not be less than that specified in Tables 7.1 and 7.2.

Exception: A room thermostat shall be as specified in 7.9.3.

7.6.2 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, and nonferrous metal shall not be less than 0.045 inch (1.14 mm) thick.

7.6.3 Tables 7.1 and 7.2 are based on a uniform deflection of the enclosure surface for a given load concentrated at the center of the surface regardless of metal thickness.

7.6.4 With reference to Tables 7.1 and 7.2, a supporting frame is a structure of angle or channel or a folded rigid section of sheet metal that is rigidly attached to and has essentially the same outside dimensions as the enclosure surface, and that has sufficient torsional rigidity to resist the bending moments that may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure that is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes:

a) Single sheet with single formed flanges – formed edges,

b) A single sheet that is corrugated or ribbed,

c) An enclosure surface loosely attached to a frame, for example, with spring clips.

Table 7.1
Minimum thickness of sheet metal for enclosures– carbon steel or stainless steel

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness, inch (mm)			
Maximum width[b],		Maximum length[c],		Maximum width[b],		Maximum length,					
Inches	(cm)	Inches	(cm)	Inches	(cm)	Inches	(cm)	Uncoated		Metal coated	
4.0	(10.2)	Not limited		6.25	(15.9)	Not limited		0.020[d]	(0.51)	0.023[d]	(0.58)
4.75	(12.1)	5.75	(14.6)	6.75	(17.1)	8.25	(21.0)				
6.0	(15.2)	Not limited		9.5	(24.1)	Not limited		0.026[d]	(0.66)	0.029[d]	(0.74)
7.0	(17.8)	8.75	(22.2)	10.0	(25.4)	12.5	(31.8)				
8.0	(20.3)	Not limited		12.0	(30.5)	Not limited		0.032	(0.81)	0.034	(0.86)
9.0	(22.9)	11.5	(29.2)	13.0	(33.0)	16.0	(40.6)				
12.5	(31.8)	Not limited		19.5	(49.5)	Not limited		0.042	(1.07)	0.045	(1.14)
14.0	(35.6)	18.0	(45.7)	21.0	(53.3)	25.0	(63.5)				
18.0	(45.7)	Not limited		27.0	(68.6)	Not limited		0.053	(1.35)	0.056	(1.42)
20.0	(50.8)	25.0	(63.5)	29.0	(73.7)	36.0	(91.4)				
22.0	(55.9)	Not limited		33.0	(83.8)	Not limited		0.060	(1.52)	0.063	(1.60)
25.0	(63.5)	31.0	(78.7)	35.0	(88.9)	43.0	(109.2)				
25.0	(63.5)	Not limited		39.0	(99.1)	Not limited		0.067	(1.70)	0.070	(1.78)
29.0	(73.7)	36.0	(91.4)	41.0	(104.1)	51.0	(129.5)				
33.0	(83.8)	Not limited		51.0	(129.5)	Not limited		0.080	(2.03)	0.084	(2.13)
38.0	(96.5)	47.0	(119.4)	54.0	(137.2)	66.0	(167.6)				

Table 7.1 Continued on Next Page

Table 7.1 Continued

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness, inch (mm)			
Maximum width[b],		Maximum length[c],		Maximum width[b],		Maximum length,					
Inches	(cm)	Inches	(cm)	Inches	(cm)	Inches	(cm)	Uncoated		Metal coated	
42.0	(106.7)	Not limited		64.0	(162.6)	Not limited		0.093	(2.36)	0.097	(2.46)
47.0	(119.4)	59.0	(149.9)	68.0	(172.7)	84.0	(213.4)				
52.0	(132.1)	Not limited		80.0	(203.2)	Not limited		0.108	(2.74)	0.111	(2.82)
60.0	(152.4)	74.0	(188.0)	84.0	(213.4)	103.0	(261.6)				
63.0	(160.0)	Not limited		97.0	(246.4)	Not limited		0.123	(3.12)	0.126	(3.20)
73.0	(185.4)	90.0	(228.6)	103.0	(261.6)	127.0	(322.6)				

[a] See 7.6.4.

[b] The width is the smaller dimension of a rectangular sheet metal piece that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

[c] Not limited applies only if the edge of the surface is flanged at least 1/2 inch (12.7 mm) and fastened to adjacent surfaces not normally removed in use.

[d] Sheet steel for an enclosure intended for outdoor use – raintight or rainproof – shall not be less than 0.034 inch (0.86 mm) thick if zinc coated, and not less than 0.032 inch (0.81 mm) thick if uncoated.

Table 7.2
Minimum acceptable thickness of sheet metal for enclosures – aluminum, copper, or brass

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness inch (mm)
Maximum width[b],		Maximum length[c],		Maximum width[b],		Maximum length,		
Inches	(cm)	Inches	(cm)	Inches	(cm)	Inches	(cm)	
3.0	(7.6)	Not limited		7.0	(17.8)	Not limited		0.023[d]
3.5	(8.9)	4.0	(10.2)	8.5	(21.6)	9.5	(24.1)	(0.58)
4.0	(10.2)	Not limited		10.0	(25.4)	Not limited		0.029
5.0	(12.7)	6.0	(15.2)	10.5	(26.7)	13.5	(34.3)	(0.74)
6.0	(15.2)	Not limited		14.0	(35.6)	Not limited		0.036
6.5	(16.5)	8.0	(20.3)	15.0	(38.1)	18.0	(45.7)	(0.91)
8.0	(20.3)	Not limited		19.0	(48.3)	Not limited		0.045
9.5	(24.1)	11.5	(29.2)	21.0	(53.3)	25.0	(63.5)	(1.14)
12.0	(30.5)	Not limited		28.0	(71.1)	Not limited		0.058
14.0	(35.6)	16.0	(40.6)	30.0	(76.2)	37.0	(94.0)	(1.47)
18.0	(45.7)	Not limited		42.0	(106.7)	Not limited		0.075
20.0	(50.8)	25.0	(63.5)	45.0	(114.3)	55.0	(139.7)	(1.91)
25.0	(63.5)	Not limited		60.0	(152.4)	Not limited		0.095
29.0	(73.7)	36.0	(91.4)	64.0	(162.6)	78.0	(198.1)	(2.41)
37.0	(94.0)	Not limited		87.0	(221.0)	Not limited		0.122
42.0	(106.7)	53.0	(134.6)	93.0	(236.2)	114.0	(289.6)	(3.10)
52.0	(132.1)	Not limited		123.0	(312.4)	Not limited		0.153
60.0	(152.4)	74.0	(188.0)	130.0	(330.2)	160.0	(406.4)	(3.89)

[a] See 7.6.4.

[b] The width is the smaller dimension of a rectangular piece of sheet metal that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

[c] Not limited applies only if the edge of the surface is flanged at least 1/2 inch (12.7 mm) and fastened to adjacent surfaces not normally removed in use.

[d] Sheet copper, brass, or aluminum for an enclosure intended for outdoor use – raintight or rainproof – shall not be less than 0.029 inch (0.74 mm) thick.

7.7 Polymeric

7.7.1 A polymeric enclosure or enclosure part shall have mechanical strength and durability and be formed so that operating parts will be protected against damage, and shall resist the abuses likely to be encountered during installation and intended use and service.

7.7.2 An enclosure or enclosure part shall protect persons against a risk of electric shock. The enclosure material shall not create or contribute to a risk of fire, electric shock, or injury to persons.

7.7.3 Among the factors that are to be taken into consideration when investigating the acceptability of a polymeric enclosure are:

a) Mechanical strength;

b) Resistance to impact;

c) Moisture absorption;

d) Resistance to combustion and to ignition from electrical sources;

e) Dielectric properties, insulation resistance, and resistance to arc tracking; and

f) Resistance to distortion and creeping at temperatures to which the material may be subjected under conditions of normal or abnormal use.

7.7.4 A material shall not display a loss of the properties specified in 7.7.3 beyond the minimum acceptable level as a result of aging.

7.7.5 The tests for determining compliance of a polymeric enclosure used with equipment covered by this standard are described in Polymeric Materials Tests, Section 62.

Exception: The cover of a wall-mounted room thermostat need not comply with the requirements in Polymeric Materials Tests, Section 62, but will be subjected to an appropriate investigation.

7.7.6 The polymeric enclosure material shall be rated for the normal operating temperature encountered in service and have a temperature rating at least equal to the normal operating temperature as determined by the temperature test described in Temperature Test, Section 40.

7.7.7 If continuity of a grounding system relies on dimensional integrity of a nonmetallic material, the dimensional stability of the material shall be considered in addition to the factors mentioned in 7.7.3.

7.7.8 A part, such as a dial or nameplate, that is a part of an enclosure shall be metal or other material as specified for the enclosure in 7.5.1 – 7.7.6.

7.7.9 A nonmetallic part such as a reset knob, lever, or button that protrudes through a hole in the enclosure that is not larger than the area of a 7/8-inch (22.2-mm) diameter circle shall be made of a material classified as V-0, V-1, or V-2 in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

7.7.10 A nonmetallic part that protrudes through a hole larger than the area of a 7/8-inch (22.2-mm) diameter circle shall be made of a material that complies with the requirements in 7.7.1, 7.7.2, and 7.7.8. See 7.10.5.

7.7.11 A nonmetallic cover that gives access to bare live parts shall comply with the requirements in 7.3.8 and Snap-On Covers Test, Section 58 and there shall be no exposure of live parts.

7.7.12 A cover attached by screws shall comply with the requirements in 7.3.8 with the screws tightened, and with the screws loosened one full turn.

7.8 Windows

7.8.1 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.

7.8.2 Glass for an opening not more than 4 inches (102 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 square inches (929 cm^2) in area and having no dimension greater than 12 inches (305 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 thick and shall conform to one of the following:

a) The glass shall be of a nonshattering or tempered type that, when broken, shall conform to the performance specifications in the Safety Performance Specifications and Methods of Test for Safety Glazing Material Used in Buildings, ANSI Z97.1-1984; or

b) 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 intended position.

7.8.3 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 is otherwise acceptable for the purpose.

7.9 Room thermostats

7.9.1 A room thermostat intended for assembly on a flush-mounted box shall be provided with a box of sheet steel not less than 0.053 inch (1.35 mm) thick – 0.056 inch (1.42 mm) if zinc coated; or with a cast-metal box not less than 1/8 inch (3.2 mm) thick.

Exception: A room thermostat need not be furnished with a box if means for mounting on a standard outlet box – minimum inside width 1-13/16 inches (56.0 mm), minimum inside length 2-27/32 inches (72.2 mm) is provided and if, when so mounted on the intended box and when the full displacements and tolerances permitted by the mounting means are considered, at least the minimum required spacings are provided.

7.9.2 Zinc-base die-cast metal shall not be used for a flush box.

7.9.3 A residential room-thermostat cover having no dimension greater than 6 inches (152 mm) and having no surface greater than 18 square inches (116.1 cm^2) may be not less than 0.020 inch (0.51 mm) thick uncoated steel, 0.023 inch (0.58 mm) zinc-coated steel, 0.023 inch nonferrous metal, or 0.035 inch (0.89 mm) die-cast metal.

Exception No. 1: A 0.016-inch (0.41-mm) thick uncoated steel, 0.019-inch (0.48-mm) zinc-coated steel, 0.018-inch (0.46-mm) nonferrous metal, or 0.032-inch (0.81-mm) die-cast metal may be employed if there are no live parts exposed when the thermostat cover is removed.

Exception No. 2: The thickness of a cover that is decorative only is not specified; the mounting plate and mechanism shall comply with the enclosure requirements with the cover removed.

7.9.4 The enclosure of a room thermostat is to be formed so that its shape and means of support provide adequate mechanical strength.

7.10 Openings

7.10.1 An opening shall not be provided in an enclosure that houses a fuse or any portion of a circuit breaker other than the operating handle, unless the construction affords containment of electrical fault disturbances equivalent to that provided by an enclosure complying with the requirements in 7.3.5 – 7.3.7.

7.10.2 The following requirements apply to openings other than those provided in the enclosure of a room thermostat:

a) An opening shall not be provided in a compartment or part of an enclosure that contains field-wiring splices in a line-voltage circuit.

b) No openings shall be located in the mounting surface of an enclosure.

Exception: The following openings may be located in the mounting surface of an enclosure:

1) A mounting opening;

2) A maximum of four openings provided for the escape of air or paint during a painting process. The maximum dimension of such an opening shall not exceed 1/8 inch (3.2 mm); or

3) A maximum of four unused holes provided for mounting of internal components. The maximum dimension of such an opening shall not exceed 3/16 inch (4.8 mm).

c) If the bottom surface is not the mounting surface, an opening may be provided in the bottom surface of an enclosure if the opening does not permit materials to fall directly out from the interior of the unit. See Figure 7.2 for an example of a construction that may be used.

d) The shortest distance between an opening and the bottom of an enclosure or a wall-mounting surface shall be at least one-quarter of the enclosure height or depth, respectively, or 1 inch (25.4 mm), whichever is less.

e) There shall be no emission of flame or molten material, or manifestation of risk of fire, during normal or abnormal tests on the control, such as transformer burnout and burnout of a relay or solenoid with blocked armature.

f) Unless the construction of a device provided with forced ventilation is such that there is no direct path between live parts and the outlet opening, burnout tests in addition to those mentioned in (e) shall be conducted to determine that there is no emission of flame or molten material through that opening.

g) Air from an opening, either forced or otherwise, shall not be directed into a duct or into a concealed space in a building, against the mounting surface, and so that a disturbance would be propagated to other equipment.

h) No more than four holes for mounting an enclosure having a maximum dimension of 18 inches (457 mm); six holes for an enclosure with a maximum dimension of more than 18 inches, but less than 48 inches (1.2 m); eight holes for an enclosure with a maximum dimension of 48 inches or more. Four of the holes for mounting an enclosure with a maximum dimension of 12 inches (305 mm) may be keyhole slots having the configuration illustrated in Figure 7.3. The dimensions shown in Figure 7.3 may vary if the area is equivalent. Four of the holes for mounting a larger enclosure may be keyhole slots, the dimensions of which are not specified, and which shall be investigated with regard to the enclosure dimensions and configuration.

Figure 7.2
Bottom surface openings of enclosures

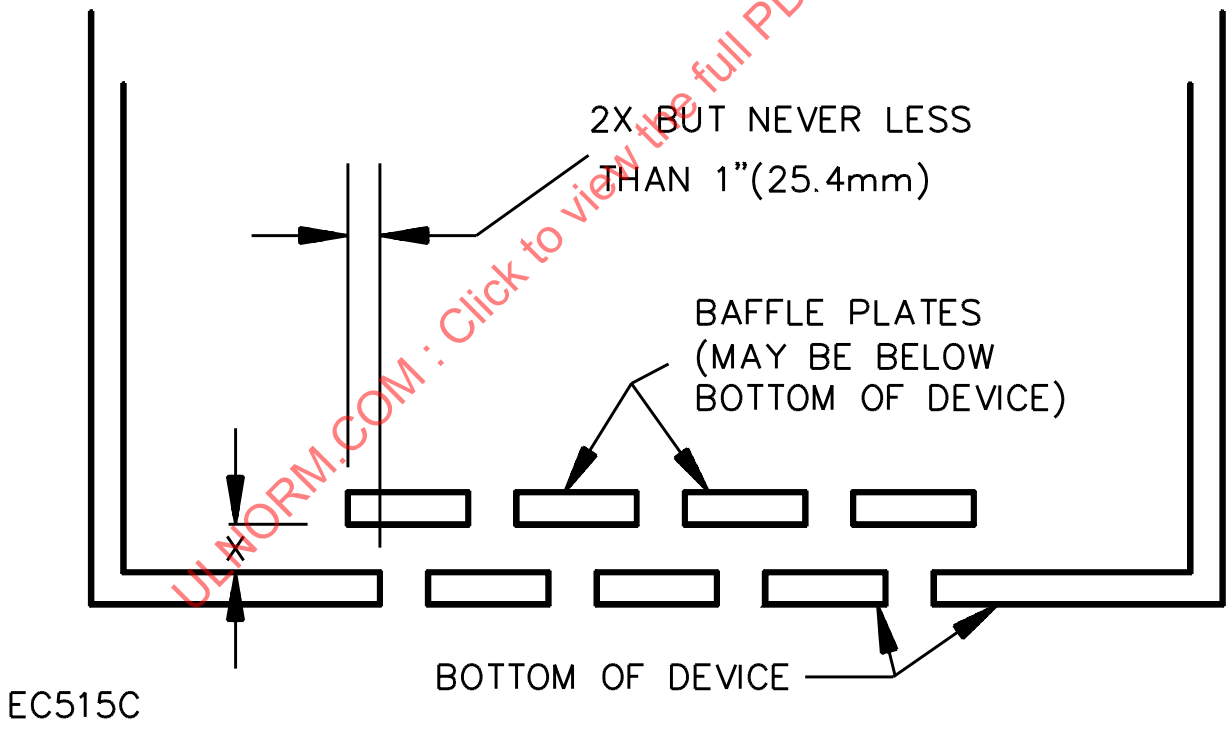
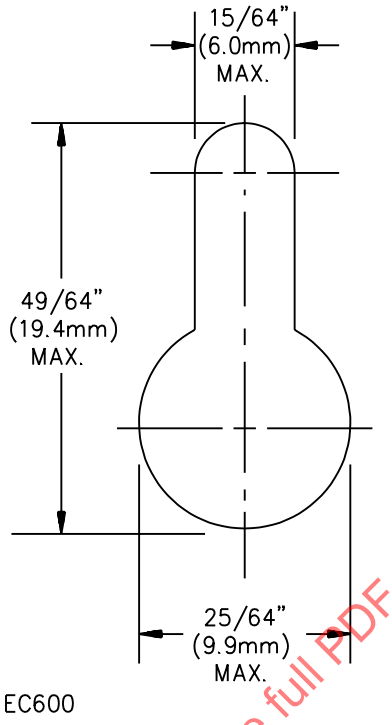


Figure 7.3
Keyhole slot



7.10.3 A room thermostat rated more than 300 volts, with the outer cover on or removed, shall comply with the requirements in 7.2.2.

7.10.4 An opening, such as a perforated hole, a louver, or an opening protected by wire screening, expanded metal, or a perforated cover, in the enclosure of a room thermostat the rating of which includes a value of 300 volts or less shall not permit passage of a 17/64-inch (6.7-mm) diameter rod.

Exception No. 1: If the distance between an uninsulated live part and the edge of an opening is 2-1/2 inches (63.5 mm) or more, the opening may permit passage of a 17/64-inch diameter rod but shall not permit passage of a 33/64-inch (13.1-mm) diameter rod.

Exception No. 2: If other means, such as an internal barrier or arrangement of parts provides equivalent protection, the maximum size of an individual opening in an enclosure is not specified.

7.10.5 The smaller dimension – width– of an opening in an enclosure around a dial, adjusting knob, lever, handle, pointer, or the like shall not be more than 1/8 inch (3.2 mm) for any setting or position of the dial, knob, or other members.

7.10.6 A plate or plug for an unused conduit opening or other hole in an enclosure shall have a thickness not less than 0.014 inch (0.36 mm) for steel or 0.019 inch (0.48 mm) for nonferrous metal for a hole having a 1/4-inch (6.4-mm) maximum dimension and 0.027-inch (0.69-mm) steel or 0.032-inch (0.81-mm) nonferrous metal for a hole having a 1-3/8-inch (34.9-mm) maximum dimension. A closure for a larger hole shall have a thickness equal to that required for the enclosure of the device or a standard knockout seal shall be used. Such a plate or plug shall be securely mounted.