



UL 1559

STANDARD FOR SAFETY

Insect-Control Equipment – Electrocution Type

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UL Standard for Safety for Insect-Control Equipment – Electrocuting Type, UL 1559

Fifth Edition, Dated March 21, 2011

Summary of Topics

These revisions to ANSI/UL 1559 are being issued to address:

Insect-Electrocution Equipment which generates ultraviolet (UV) radiation

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 and revised requirements are substantially in accordance with Proposal(s) on this subject dated November 2, 2012.

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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that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

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UL 1559

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March 21, 2011

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The most recent designation of ANSI/UL 1559 as an American National Standard (ANSI) occurred on December 14, 2012. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or effective date information.

The Department of Defense (DoD) has adopted UL 1559 on February 25, 1989. 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>.

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INTRODUCTION

1 Scope

1.1 These requirements cover insect-electrocution equipment of the household and commercial types with an input rating of 250 V or less and are intended for use in ordinary locations in accordance with the National Electrical Code.

1.2 These requirements cover products that employ electrocution as the primary means of exterminating insects.

1.3 These requirements assume the use of an isolating type transformer for electrocuting insects. Constructions without such isolation may be investigated in accordance with these requirements and supplemented and modified by other appropriate requirements.

1.4 These requirements do not cover insect exterminators of the type that utilize chemicals, ultrasonic or mechanical trapping devices.

1.5 Insect-electrocution equipment generating ultraviolet (UV) radiation are intended for use in accordance with the Federal Radiation Control for Health and Safety Act, Title 21.

1.5 added December 14, 2012

2 Units of Measurement

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

2.2 Unless indicated otherwise all voltage and current values mentioned in this standard are root-mean-square (rms).

3 References

3.1 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.

4 Glossary

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

4.2 **APPLIANCE COUPLER** – A single-outlet, female contact device for attachment to a flexible cord as part of a detachable power-supply cord to be connected to an appliance inlet (motor attachment plug).

4.3 **APPLIANCE INLET (Motor Attachment Plug)** – A male contact device mounted on an end product appliance to provide an integral blade configuration for the connection of an appliance coupler or cord connector.

4.4 **APPLIANCE (FLATIRON) PLUG** – An appliance coupler type of device having a cord guard and a slot configuration specified for use with heating or cooking appliances.

4.5 **COMMERCIAL EQUIPMENT** – Equipment intended to be used on commercial, industrial or institutional premises, such as restaurants, motels, schools, public and commercial campsites, public swimming pools and beaches, golf courses, food processing plants, canneries, beverage bottling plants, farms and similar sites.

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

4.7 **CONTROL, AUTOMATIC ACTION** – A control in which at least one aspect is non-manual.

4.8 **CONTROL, AUXILIARY** – A device or assembly of devices that provides a functional utility, is not relied upon as an operational or protective control, and therefore is not relied upon for safety. For example, an efficiency control not relied upon to reduce the risk of electric shock, fire, or injury to persons during normal or abnormal operation of the end product is considered an auxiliary control.

4.9 **CONTROL, MANUAL** – A device that requires direct human interaction to activate or rest the control.

4.10 **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. Operating controls are also referred to as “regulating controls”.

4.11 **CONTROL, 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 protective control. Protective controls are also referred to as “limiting controls” and “safety controls”.

Note: During the evaluation of the protective control/circuit, the protective functions are verified under normal and single-fault conditions of the control.

4.12 **CONTROL, TYPE 1 ACTION** – The actuation of an automatic control for which the manufacturing deviation and the drift (tolerance before and after certain conditions) of its operating value, operating time, or operating sequence has not been declared and tested under this Standard.

4.13 CONTROL, TYPE 2 ACTION – The actuation of an automatic control for which the manufacturing deviation and the drift (tolerance before and after certain conditions) of its operating value, operating time, or operating sequence have been declared and tested under this Standard.

4.14 CORD CONNECTOR – A female contact device wired on flexible cord for use as an extension from an outlet to make a detachable electrical connection to an attachment plug or, as an appliance coupler, to an equipment inlet.

4.15 ELECTRODE TRANSFORMER – A transformer whose primary function is to supply the voltage and current necessary for electrocuting insects.

4.15.1 FIXED APPLIANCE – Appliance that is intended to be used while fastened to or hung from a support or while secured in a specific location.

4.15.1 added December 14, 2012

4.16 HOUSEHOLD EQUIPMENT – Equipment intended for use in or around a residence. Portable cord-connected insect-electrocution equipment intended for personal use during camping or similar activities is also considered household equipment.

4.17 INDOOR-USE EQUIPMENT – Equipment intended for use in a sheltered area that is not normally subject to dampness or wetness and not exposed to weather.

4.18 OUTDOOR-USE EQUIPMENT – Equipment intended for use in locations exposed to weather including partially protected locations under canopies, roofed open porches, barns and similar locations that may be damp or wet.

4.18.1 PORTABLE EQUIPMENT – Appliance that is intended to be moved while in operation or an appliance, other than a FIXED APPLIANCE, having a mass less than 18 kg.

4.18.1 added December 14, 2012

4.19 PRIMARY CIRCUIT – A circuit that is conductively connected to the branch circuit supply source.

4.20 SECONDARY CIRCUIT – A circuit that is conductively connected to a secondary winding of an isolating transformer.

4.21 STATIONARY APPLIANCE – FIXED APPLIANCE or an appliance which is not a PORTABLE APPLIANCE.

4.21 added December 14, 2012

CONSTRUCTION

5 General

5.1 A component of a product covered by this Standard shall:

- a) Comply with the requirements for that component as indicated in Sections 6 – 23;
- b) Be used in accordance with its rating(s) established for the intended conditions of use;
- c) Be used within its established use limitations or conditions of acceptability;
- d) Additionally comply with the applicable requirements of this end product standard; and
- e) Not contain mercury, with the exception of fluorescent tubes.

Note: 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.

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 investigated 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 UL component standard other than those cited in Sections 6 – 23 is acceptable if:

- a) The component also complies with the applicable component standard of Sections 6 – 23; or*
- b) The component standard:*
 - 1) Is compatible with the ampacity and overcurrent protection requirements 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*

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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.

5.2 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 UL 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.

5.3 A component not anticipated by the requirements of this standard, not specifically covered by the component standards of Sections 6 – 23, and that involves a potential risk of electric shock, fire, or personal injury, shall be additionally investigated in accordance with the applicable UL standard, and shall comply with 5.1 (b) – (d).

5.4 With regard to a component being additionally investigated, reference to construction and performance requirements in another UL end product standard is appropriate where that standard anticipates normal and abnormal use conditions consistent with the application of UL 1559.

6 Attachment Plugs, Receptacles, Connectors, and Terminals

6.1 Attachment plugs, receptacles, appliance couplers, appliance inlets (motor attachment plugs), and appliance (flatiron) plugs, shall comply with the Standard for Attachment Plugs and Receptacles, UL 498. See 6.9.

Exception: Attachment plugs and appliance couplers integral to cord sets or power supply cords are covered under the requirements of UL 817 and need not comply with UL 498.

6.2 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.

6.3 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. See 6.9.

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

6.4 revised October 10, 2011

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

6.6 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 Multi-Pole Splicing Wire Connectors, UL 2459. See 6.9.

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

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

6.9 Female devices (such as receptacles, appliance couplers, 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.

7 Boxes and Raceways

7.1 Electrical boxes and the associated bushings and fittings, and raceways, of the types specified in Chapter 3 of NFPA 70 and that comply with the relevant UL standard (such as UL 514A, UL 514C, UL 514D) and Section 5, are considered to fulfill the requirements of this Standard.

8 Filters

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

9 Controls

9.1 General

9.1.1 Auxiliary controls shall be evaluated using the applicable requirements of this end product Standard and the parameters in Section 44.

9.1.2 Operating (regulating) controls shall be evaluated using the applicable component standard requirements specified in 9.2 – 9.4, and if applicable, the parameters in Section 44, unless otherwise specified in this end product standard.

9.1.3 Operating controls that rely upon software for the normal operation of the end product where deviation or drift of the control may result in a hazard, such as a speed control unexpectedly changing its output, shall comply with the:

- a) Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991; and Standard for Software in Programmable Components, UL 1998; or

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b) Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1.

9.1.4 Protective (limiting) controls shall be evaluated using the applicable component standard requirements specified in 9.2 – 9.4, and if applicable, the parameters in Section 44, unless otherwise specified in this end product Standard.

9.1.5 Solid-state protective controls that do not rely upon software as a protective component shall comply with the:

a) Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991; or

b) Standard for Automatic Electrical Controls for Household and Similar Use, UL 60730-1, except Clause 11.12(h) (Controls using software).

9.1.6 Protective controls that rely upon software as a protective component shall comply with the:

a) Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991; and Standard for Software in Programmable Components, UL 1998; or

b) Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1.

9.1.7 An electronic, non-protective control that is simple in design need only be subjected to the applicable requirements of this end-product standard. A control that does not include an integrated circuit or microprocessor, but does consist of a discrete switching device, capacitors, transistors, and resistors, is considered simple in design. See Abnormal Operation Test, Section 53.

9.2 Electromechanical and electronic controls

9.2.1 A control, other than as specified in 9.2 – 9.4, shall comply with the:

a) Standard for Solid-State Controls for Appliances, UL 244A; or

b) Standard for Temperature-Indicating and -Regulating Equipment, UL 873; or

c) Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1.

9.2.1 revised October 10, 2011. UL 244A and UL 873 will be withdrawn on October 19, 2016.

9.3 Temperature controls

9.3.1 A temperature control shall comply with the:

- a) Standard for Solid-State Controls for Appliances, UL 244A;
- b) Standard for Temperature-Indicating and -Regulating Equipment, UL 873;
- c) Standard for Industrial Control Equipment, UL 508; or
- d) 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 Temperature Sensing Controls, UL 60730-2-9.

9.3.1 revised October 10, 2011. UL 244A and UL 873 will be withdrawn on October 19, 2016.

9.3.2 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.

9.3.3 A thermal cutoff shall comply with the Standard for Thermal-Links (Thermal Cutoffs) for Use in Electrical Appliances and Components, UL 60691.

9.4 Timer controls

9.4.1 A timer control shall comply with the:

- a) Standard for Solid-State Controls for Appliances, UL 244A; 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 Timers and Time Switches, UL 60730-2-7.

9.4.1 revised October 17, 2011. UL 244A will be withdrawn on October 19, 2016.

10 Cords, Cables, and Internal Wiring

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

10.2 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 the Standard for Cord Sets and Power Supply Cords, UL 817.

10.3 Internal wiring composed of insulated conductors shall comply with the Standard for Appliance Wiring Material, UL 758.

Exception No. 1: Insulated conductors need not comply with UL 758 if they comply with one of the following:

- a) Standard for Thermoset-Insulated Wires and Cables, UL 44;*
- b) Standard for Thermoplastic-Insulated Wires and Cables, UL 83;*

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c) Standard for Fixture Wire, UL 66; or

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d) the appropriate UL standard(s) for other insulated conductor types specified in Chapter 3 (Wiring Methods and Materials) of NFPA 70.

Exception No. 2: Insulated conductors for specialty applications (e.g. data processing or communications) and located in a low-voltage circuit not involving the risk of fire or personal injury need not comply with UL 758.

11 Film-Coated Wire (Magnet Wire)

11.1 The component requirements for film coated wire and Class 105 (A) insulation systems are not specified.

11.2 Film coated wire in intimate combination with one or more insulators, and incorporated in an insulation system rated Class 120 (E) or higher, shall comply with the magnet wire requirements in the Standard for Systems of Insulating Materials – General, UL 1446.

12 Gaskets and Seals

12.1 Gaskets and seals shall comply with the Standard for Gaskets and Seals, UL 157.

13 Ground-Fault, Arc-Fault, and Leakage Current Detectors / Interrupters

13.1 Ground-fault circuit-interrupters (GFCI) for protection against electrical shock shall comply with the Standard for Ground-Fault Circuit-Interrupters, UL 943. The following statement, or equivalent, shall be included as a marking near the GFCI, or as an instruction in the manual: “ Press the TEST button (then RESET button) every month to assure proper operation.”

13.2 Appliance-leakage-current interrupters (ALCI) for protection against electrical shock shall comply with the Standard for Appliance-Leakage-Current Interrupters, UL 943B.

Note: An ALCI is not considered an acceptable substitute for a GFCI when NFPA 70 requires a GFCI.

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

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

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

14 Light Sources and Associated Components

14.1 Lampholders and indicating lamps shall comply with the Standard for Lampholders, UL 496.

Exception: Lampholders forming part of a luminaire that complies with an appropriate UL luminaire standard are considered to fulfill this requirement.

14.2 Lighting ballasts shall comply with the:

- a) Standard for Fluorescent-Lamp Ballasts, UL 935; or
- b) Standard for High-Intensity Discharge Lamp Ballasts, UL 1029.

Exception No. 1: Ballasts forming part of a luminaire that complies with an appropriate UL luminaire standard are considered to fulfill this requirement.

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

14.3 Light emitting diode (LED) light sources shall comply with the Standard for Light Emitting Diode (LED) Light Sources For Use In Lighting Products, UL 8750.

Exception No. 1: LED light sources forming part of a luminaire that complies with an appropriate UL luminaire standard are considered to fulfill this requirement.

Exception No. 2: Individual LED light sources mounted on printed wiring boards and intended for indicating purposes need not comply with UL 8750, but shall comply with the applicable requirements of this end product standard.

14.4 Fluorescent lampholders and starter holders for fluorescent shall comply with the Standard for Lampholders, Starters, and Starter holders for Fluorescent Lamps, UL 542.

15 Marking and Labeling Systems

15.1 A marking and labeling system shall comply with UL 969(Marking and Labeling Systems) under the specified environmental conditions.

16 Overcurrent Protection

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

16.2 Fuseholders shall comply with the Standard for Fuseholders – Part 1: General Requirements, UL 4248-1, and the applicable Part 2 (e.g. UL 4248-9).

16.3 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.

16.4 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.

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

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

17 Polymeric Materials and Enclosures

17.1 Unless otherwise specified in this end product standard, polymeric electrical insulating materials and enclosures shall comply with the applicable requirements of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

17.2 Metallized or painted polymeric parts or enclosures shall comply with the applicable requirements of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. This requirement is not applicable to exterior surfaces of polymeric enclosure materials or parts provided that the metallized coating or paint does not offer a continuous path for an internal flame to propagate externally.

18 Power Supplies

18.1 A Class 2 power supply shall comply with one of the following:

- a) Standard for Class 2 Power Units, UL 1310; or
- b) Standard for Information Technology Equipment, 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".

18.2 A non-Class 2 power supply shall comply with one of the following:

- a) Standard for Power Units Other Than Class 2, UL 1012; or
- b) Standard for Information Technology Equipment, Part 1: General Requirements, UL 60950-1.

19 Printed-Wiring Boards

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

20 Semiconductors and Small Electronic Components

20.1 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 51, of this end product Standard.

20.2 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 51, of this end product Standard.

20.3 Except as specified in 20.4, component requirements are not specified for small electronic components on printed-wiring boards, including diodes, transistors, resistors, inductors, integrated circuits, and capacitors not directly connected to the supply source.

20.4 Where an electronic component is determined to be a critical component during the testing of UL 1559, Section 53 (Abnormal Operation Test), one of the following standards shall be applied. See 44.4 of this end product Standard for the test parameters to be used.

- a) Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, including its Follow-Up Program; and as applicable, the Standard for Software in Programmable Components, UL 1998 for controls that rely upon software as a protective component; or
- b) Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1.

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

20.6 A critical component may also be identified using a failure-mode and effect analysis (FMEA) in accordance with Failure-Mode and Effect Analysis (FMEA), Section 7 of UL 991.

20.7 Portions of a circuit comprised of a microcontroller or other programmable device that performs a back-up, limiting, or other safety function intended to reduce the risk of fire, electric shock, or injury to persons shall comply with the Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1, Annex H.

21 Supplemental Insulation, Insulating Bushings, and Assembly Aids

21.1 The requirements for supplemental insulation (e.g. tape, sleeving or tubing) are not specified unless the insulation or device is required to fulfill 33.3.3 or a performance requirement of this Standard. In such cases:

- 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.

21.2 Wire positioning devices shall comply with 33.4 and Section 34, Electrical Insulation. A device that complies with the Standard for Positioning Devices, UL 1565, is considered to fulfill this requirement.

21.3 Insulating bushings that comply with Section 5, General, of this end product Standard, and the Standard for Insulating Bushings, UL 635, are considered to fulfill the requirements of this Standard. Tests specified in this Standard (e.g. Strain Relief Test) may still need to be performed to confirm the combination of the insulating bushing and the supporting part are suitable.

22 Switches

22.1 Switches shall comply with one of the following, as applicable:

- a) Standard for Special-Use Switches, UL 1054;
- b) Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1;
- c) Standard for General-Use Snap Switches, UL 20; or
- d) Standard for Nonindustrial Photoelectric Switches for Lighting Control, UL 773A.

Exception: Switching devices that comply with the appropriate UL standard for specialty applications (e.g. transfer switch equipment), industrial use (e.g. contactors, relays, auxiliary devices), or are integral to another component (e.g. switched lampholder) need not comply.

22.2 A clock-operated switch, in which the switching contacts are actuated by a clock-work, by a gear-train, by electrically-wound spring motors, by electric clock-type motors, or by equivalent arrangements shall comply with one of the following:

- a) Standard for Clock-Operated Switches, UL 917; 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 Timers and Time Switches, UL 60730-2-7.

22.3 A timer or time switch, incorporating electronic timing circuits or switching circuits, with or without separable contacts, that functions as a protective control, shall comply with the requirements for a protective control; see 9.1.4.

23 Transformers

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

Exception No. 1: A transformer that is completely enclosed within the end product enclosure, and that meets the applicable construction and performance requirements of this end product Standard when tested in conjunction with the end product, meets the intent of this requirement.

Exception No. 2: : A transformer that complies with the Standard for Transformers and Motor Transformers for Use in Audio-, Radio-, and Television-Type Appliances, UL 1411, and that is used in a circuit involving an audio or video component, meets the intent of this requirement.

24 Frame and Enclosure

24.1 Insect-electrocution equipment shall be so formed and assembled that it will have the strength and rigidity necessary to resist the abuses that it is likely to be subjected to, without increasing the likelihood 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.

24.2 All electrical parts, except a supply cord, that may involve a risk of fire, electric shock, or injury to persons under any condition of use, shall be enclosed in an acceptable enclosure.

24.3 A knockout in a sheet metal enclosure shall be effectively secured and removable without undue deformation of the enclosure.

24.4 A knockout shall be surrounded by a flat surface to provide for seating of a conduit bushing or locknut of the appropriate size.

24.5 Sheet metal to which a wiring system is to be connected in the field shall have a minimum thickness of 0.032 inch (0.81 mm) if uncoated steel, 0.034 inch (0.86 mm) if galvanized steel, and 0.045 inch (1.14 mm) if nonferrous metal.

24.6 Cast metal to which a wiring system is to be connected in the field shall have an average thickness not less than 1/8 inch (3.2 mm).

24.7 The enclosure of insect-electrocution equipment for outdoor use shall be constructed so as to exclude a beating rain. See Water Spray Test, Section 54.

24.8 A gasket or seal relied upon to comply with the requirements in Water Spray Test, Section 54, shall comply with Section 12, Gaskets and Seals.

24.9 A polymeric enclosure, frame, or cover shall be evaluated with respect to mechanical strength, resistance to impact, moisture absorption properties, combustibility, resistance to arcing, dielectric strength, aging characteristics and other environmental conditions to which the enclosure may be subjected.

24.10 To determine compliance with 24.9, a polymeric enclosure, frame, or cover shall be evaluated in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, and other applicable tests in this standard.

24.11 A polymeric enclosure, frame, or cover of insect-electrocution equipment intended for outdoor use shall additionally be evaluated in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, for exposure to ultraviolet light and water.

24.11.1 A polymeric enclosure, frame or cover of insect-electrocution equipment which generate ultraviolet (UV) radiation shall be suitable for UV exposure or shall be suitably shielded if degradation would result in non-compliance with other requirements of this Standard.

24.11.1 added December 14, 2012

24.11.2 Components provided within the enclosure or enclosed by sleeving composed of non-metallic materials (ie. wiring, capacitors, etc.) exposed to direct or reflected ultraviolet (UV) radiation shall be suitable for UV exposure or shall be suitably shielded from UV exposure, if degradation would result in non-compliance with other requirements of this Standard.

24.11.2 added December 14, 2012

24.12 An insect catch tray shall be provided with insect-electrocution equipment not marked for “Outdoor Use Only” or the equivalent. The insect catch tray shall be removable without the use of a tool to facilitate insect disposal.

24.13 A polymeric enclosure, frame, cover or insect catch tray shall be classified not less than V-2 in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

24.14 A flame retardant coating on a polymeric enclosure shall not be used, unless the uncoated polymeric material complies with 24.13 and the coating complies with the applicable Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

24.15 A keyhole slot in the enclosure shall be provided with a barrier to protect against the likelihood of the hanger (nail, screw, or similar fasteners) from contacting live parts or falling into the enclosure, if an increase in the risk of fire or electric shock may result.

25 Protection Against Corrosion

25.1 General

25.1.1 Ferrous metal parts shall be protected against corrosion by enameling, galvanizing, plating, Sherardizing, or other equivalent means.

Exception No. 1: Ferrous parts not relied upon for maintaining the integrity of the product are not required to be protected against corrosion.

Exception No. 2: Parts made of stainless steel are not required to be additionally protected against corrosion.

25.2 Enclosure intended for outdoor use

25.2.1 A sheet steel enclosure intended for outdoor use shall be protected against corrosion by one of the following coatings:

a) Hot-dipped mill-galvanized sheet steel conforming with the coating Designation G90 in Table 1 of the Specification for Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M, with not less than 40 percent of the zinc on any side, based on the minimum single-spot test requirement in this ASTM designation. See 25.2.5.

b) A zinc coating, other than that provided on hot-dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00061 inch (0.0155 mm) on each surface with a minimum thickness of 0.00054 inch (0.0137 mm). See 25.2.6.

c) A zinc coating as specified in 25.2.1 (c)(1) or (2) below and with one coat of an organic finish of the epoxy or alkyd-resin type or other outdoor paint applied after forming on each side. The acceptability of the paint is to be determined by consideration of its composition or by corrosion tests if these are considered necessary.

1) Hot-dipped mill-galvanized sheet steel conforming with the coating Designation G60 or A60 in Table 1 of ASTM A653/A653M, with not less than 40 percent of the zinc on any side, based on the minimum single-spot test requirement in this ASTM specification. See 25.2.5.

2) A zinc coating, other than that provided on hot-dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00041 inch (0.0104 mm) on each surface with a minimum thickness of 0.00034 inch (0.009 mm).

d) A cadmium coating not less than 0.0010 inch (0.025 mm) thick on both surfaces. See 25.2.6.

e) A cadmium coating not less than 0.00075 inch (0.019 mm) thick on both surfaces with one coat of outdoor paint on both surfaces, or not less than 0.00051 inch (0.013 mm) thick on both surfaces with two coats of outdoor paint on both surfaces. The paint shall be as specified in (c). See 25.2.6.