

SUMMARY OF TOPICS

The following changes in requirements to the Standard for Electrostatic Air Cleaners, UL 867, are being proposed:

- 1. Proposed Clarifications and Addition of Alternate Method For Evaluating Protective Electronic Circuits and Controls Using Requirements Based on UL 60335-1***
- 2. Addition of Requirements for Remotely Operated Electrostatic Air Cleaners***
- 3. Update of Motor-Protection Requirements***
- 4. Clarifying and Simplifying Wording of Ozone Test Requirements***
- 5. Nonmetallic Parts Requirements***
- 6. Clarifications to the Permanently and Cord-Connected Requirements***
- 7. Alternate Power Supplies***
- 8. Transformers and Insulating Materials***
- 9. Addition of Reference to New Capacitor Standard***
- 10. Rain and Gasket Tests***
- 11. Strain Relief Test***
- 12. Requirements Specifying Minimum Circuit Ampacity and Maximum Overcurrent Protective Device Size***
- 13. Universal Serial Bus (USB) Powered Products***
- 14. Dielectric Voltage Withstand Test Clarifications***
- 15. Openings Underneath Wiring***
- 16. Wiring Subjected to Movement***
- 17. Protection Against Injury to Persons***
- 18. Permanently-Connected Products Located in Concealed Space of a Building***
- 19. Cord-Connected Conversion to Permanently-Connected Products***

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20. Spacings**21. Editorial Clarifications****22. Clarification to Marking Requirements****STP BALLOTS AND ALL COMMENTS DUE: APRIL 16th, 2018**

For your convenience in review, proposed additions to existing requirements are shown underlined and proposed deletions are shown ~~lined-out~~.

1. Proposed Clarifications and Addition of Alternate Method For Evaluating Protective Electronic Circuits and Controls Using Requirements Based on UL 60335-1**RATIONALE**

Proposal submitted by: Barry Karnes, UL

One part of this proposal provides an additional—and optional—method for evaluating protective electronic controls and circuits. These proposed requirements are based on and consistent with those presently in the Standard for Safety of Household and Similar Electrical Appliances, Part 1: General Requirements, UL 60335-1. These proposals include 13A.19 as well as new Sections 49A and 54A. Similar requirements have already been or are being proposed to other UL Appliance and Heating, Air Conditioning and Refrigeration Standards.

Proposals are also being made to better distinguish between the requirements applying to protective (limiting) controls and those applying to operating (regulating) controls. These include the proposed revisions to 13A.3 and deletion of 13A.4. These proposals also include the addition of 13A.3.1 – 13A.3.9, Table 13A.1 and 13A.13 – 13A.18.

Several proposed revisions, additions and deletions are intended to clarify the present requirements, including 13A.1, 13A.2, 13A.2.1, 13A.2.2, 13A.5, 13A.6 and 13A.8 – 13A.12.

Several requirements are being proposed to provide additional options. These include the new proposed Section 23.6 entitled “Alternate spacings – clearances and creepage distances” and Section 46C entitled “Endurance Test – Switching Devices”.

Other proposed changes include relocating the “definition” for motor-controller from 13A.10 to proposed 3.11.1 located in the Glossary.

Proposed 13A.3.8, 49A.2.5, 49A.3.1(a) and new proposed Appendix B reference a new 40.1.6 which is being proposed as part of Topic 4.

Consistent with the changes being proposed to the requirements applying to controls, several new definitions are also being proposed for addition to Section 3, Glossary, of UL 867.

The proposals do not change the intent of any requirements presently in UL 867 but provide additional compliance options, clarify requirements and reflect present practice.

PROPOSAL

3.4.1 COMPONENT – A device or fabricated part of a product covered by the scope of a safety standard dedicated to that purpose. If incorporated in a product, a part that is 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 aluminum or copper, are not considered components. Generally, components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under specific, limited conditions, such as certain temperatures not exceeding specified limits.

3.4.2 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 risk of electric shock, is considered an operating control and in this example could also be called a “regulating control”. Operating controls can also include other controlling devices such as switches, contactors, relays and similar devices. Appendix B specifies control functions that are not considered to result in a risk of fire, electric shock or injury to persons.

3.4.3 CONTROL, PROTECTIVE – A device or assembly of devices, the operation of which is intended to reduce the risk of fire, electric shock or injury to persons during normal and reasonably anticipated abnormal operation of the product. 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” or “safety controls” and are investigated under normal and single-fault conditions. Appendix B specifies control functions that are considered to result in a risk of fire, electric shock or injury to persons.

3.4.4 ELECTRONIC COMPONENT – A part in which electrical conduction is achieved principally by electrons moving through a vacuum, gas or semiconductor. A Metal Oxide Varistor (MOV) is considered to be an electronic component, but neon indicators are not.

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3.4.5 ELECTRONIC DISCONNECTION - The de-energizing of a load within a product by an electronic device of a circuit. No electro-mechanical component having an air gap, such as a switch, contactor or relay is used to de-energize the load.

3.11.1 MOTOR CONTROLLER – Any device normally used to start and stop a motor, such as a switch, thermostat, pressure limiting control, or the like.

3.13.1 PROTECTIVE ELECTRONIC CIRCUIT (PEC) – An electronic circuit that prevents a risk of fire, electric shock or injury to persons under abnormal operating conditions.

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3.14.2 THERMISTOR – A thermally sensitive semiconductor resistor, which shows over at least part of its resistance/temperature characteristic a significant non-linear change in its electrical resistance with a change in temperature. A thermistor may be either of the positive temperature coefficient (PTC) type or of the negative temperature coefficient (NTC) type.

13A Switches, Including Motor and Controllers

13A.1 A Except as specified in 13A.6 or 13A.8, a switch or other control device shall have a rating not less than that of the load that it controls. Items to consider in determining the device rating could include the voltage, current, power factor, control device ambient temperature and other similar parameters. Power factor requirements for each specific load type are specified in 46C.5.:

- a) Be acceptable for the application;

Exception: A switch or other device that controls a motor that has not been previously investigated for its suitability of controlling a motor shall be subjected to the Switches and Interlocks Tests, Section 29.

- b) Have a current and voltage rating not less than that of the load that it controls; and

- c) Be located within the confines of the frame or enclosure of the appliance or be additionally protected so as to reduce the likelihood of contact by external objects.

Exception: The actuating part of a switch is not required to be located within the confines of the frame or enclosure.

13A.2 A switch or other control device, other than as specified in 13A.2.1 13A.4, shall be located within the confines of the frame, cabinet or enclosure of the product or be additionally protected so as to reduce the likelihood of contact by external objects, comply with the:

- a) Standard for Fan Speed Controls, UL 1917;
- b) Standard for Industrial Control Equipment, UL 508;
- c) Standard for Power Conversion Equipment, UL 508C; or
- d) Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1.

13A.2.1 In reference to 13A.2, if the actuating part of a switch or other control device is not located within the confines of the frame, cabinet or enclosure of the product:

- a) Unintentional operation of the switch or other control device shall not result in a risk of injury to persons; or,
- b) The actuating part shall be guarded such as by recessing, ribs or barriers.

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13A.2.2 A protective control shall be an integral part of the product and control the load either,

a) Directly; or,

b) Indirectly through a switching device which is an integral part of the product and that complies with the endurance test requirements for protective controls in 13A.3 or 13A.3.1.

13A.3 Switches~~A protective control~~ shall comply with one of the following, ~~as applicable:~~

~~a) Standard for Special-Use Switches, UL 1054;~~

a) 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 Automatic Electrical Pressure Sensing Controls Including Mechanical Requirements, UL 60730-2-6. The endurance cycle requirements in Table AA.1DV of UL 60730-2-6 for cut-outs shall be applied.

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 Temperature Sensing Controls, UL 60730-2-9. The endurance cycle requirements in Table CC.2 of UL 60730-2-9 for cut-outs shall be applied.

c) Standard for Industrial Control Equipment, UL 508.

d) Standard for Power Conversion Equipment, UL 508C

~~e) Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1;~~

~~f) Standard for General-Use Snap Switches, UL 20; or~~

~~g) Standard for Nonindustrial Photoelectric Switches for Lighting Control, UL 773A.~~

h) Standard for Fan Speed Controls, UL 1917.

i) 13A.19 and the protective electronic circuits tests in Protective Circuit Tests, Section 49A.

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.~~

13A.3.1 In reference to 13A.3(c) – (i), the endurance cycle requirements in the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9, Table CC.2 for cut-outs shall be applied to such controls.

13A.3.2 In reference to 13A.3(a), (b), (e) and (i), when determining the acceptability of a protective control, the control pollution degree shall be as specified in 23.6.3(a) – (e).

13A.3.3 If the protective control has a protective electronic circuit, the factors outlined in Table 13A.1 shall be considered.

13A.3.4 Software which is a required part of a protective electronic circuit shall comply with one of the following:

- a) The Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1, as well as the specific applicable Part 2 and with the requirements for a Class B or C control function;
- b) Annex R of the Standard for Safety of Household and Similar Electrical Appliances, Part 1: General Requirements, UL 60335-1 and be for a software Class B control function; or
- c) Not create any risk of fire, electric shock, or injury to persons under abnormal conditions with the software rendered ineffective, e.g., use of independent redundant protective devices.

13A.3.5 In reference to 13A.3, a device providing motor overload protection shall comply with the requirements in Motors and Motor Overcurrent Protection, Section 20.

13A.3.6 The cutout calibration temperature of a heater protective (temperature-limiting) control shall be $\pm 10^{\circ}\text{F}$ ($\pm 6^{\circ}\text{C}$) of its maximum marked set-point temperature.

13A.3.7 The cutout calibration pressure of a pressure protective (limiting) control shall not exceed 105 percent of its maximum marked setting.

13A.3.8 The cutout calibration setting of ozone-monitoring circuitry in which the circuitry is relied upon to limit the ozone in accordance with 40.1.6 shall not permit the concentration of ozone to exceed the values specified in 40.1.2.

Table 13A.1
Factors to be considered when evaluating protective electronic circuits

NO.	FACTOR
1	<u>Conducting failure-mode and effect analysis (FMEA) for the protective circuits and functions.</u>
2	<u>Electrical supervision of critical components resulting in the control becoming permanently inoperative and disconnecting power.</u>
3	<u>Temperature ranges as follows:</u> Indoor Equipment: <u>32.0 ±3.6°F (0.0 ±2°C) and 104 ±3.6°F (40.0 ±2°C)</u> Outdoor Equipment: <u>-31.0 ±3.6°F (-35.0 ±2°C) and 104 ±3.6°F (40.0 ±2°C)</u>
4	<u>Cycling test duration: 14 days</u>
5	<u>Endurance test duration: 100,000 cycles</u>
6	<u>Radio-frequency electromagnetic field immunity:</u> <u>A. To conducted disturbances – test level 3</u> <u>B. To radiated electromagnetic fields – Evaluate in accordance with 49A.3.4 and 49A.3.2</u>
7	<u>Humidity exposure:</u> Indoor Equipment: <u>70 – 80°F (21.1 – 26.7°C) and minimum 50 percent relative humidity</u> Outdoor Equipment: <u>70 – 80°F (21.1 – 26.7°C) and minimum 98 percent relative humidity</u>
8	<u>Electrical fast transient/burst immunity:</u> Outdoor Equipment: <u>test level 4</u> Indoor Equipment: <u>test level 3</u>
9	<u>Surge immunity:</u> Outdoor Equipment: <u>installation Class 4</u> Indoor Equipment: <u>installation Class 3</u>
10	<u>Electrostatic Discharge with a Severity Level of 3 having:</u> <u>A. Contact discharge at 6 kV to accessible metal parts, and;</u> <u>B. Air discharge at 8 kV to accessible parts of insulating material</u>
11	<u>Voltage Dips and Interruptions: Evaluate in accordance with 49A.3.8 and 49A.3.2</u>
12	<u>Harmonics and Interharmonics: Evaluate in accordance with 49A.3.9 and 49A.3.2.</u>
13	<u>Calibration (deviation and drift): Evaluate in accordance with 13A.3.6 for a temperature protective control or 13A.3.7 for a pressure protective control.</u>

13A.3.9 Except as specified in 13A.13, an operating control, including of the electronic type, shall comply with:

- a) One of the standards specified in 13A.3:
- b) The requirements in this Standard as far as they reasonably apply; or,
- c) One of the following standards:
 - 1) Standard for Solid-State Controls for Appliances, UL 244A; or,
 - 2) Standard for Clock-Operated Switches, UL 917.

~~13A.4 A switch or control intended to be located between the branch circuit and the appliance must comply with one of the following:~~

- ~~a) The Standard for General-Use Snap Switches, UL 20;~~
- ~~b) The Standard for Solid-State Fan Speed Controls, UL 1917; or~~

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c) ~~Other equivalent standards intended to determine compliance of the switches or controls for branch circuit installation.~~

13A.5 ~~The device box within which a switch as described in 13A.4 is installed, and the accompanying coverplate, shall comply with the applicable standards within the UL 514 series: Metallic Outlet Boxes, UL 514A; Conduit, Tubing, and Cable Fittings, UL 514B; Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers, UL 514C; Cover Plates for Flush-Mounted Wiring Devices, UL 514D.~~

13A.6 ~~With reference to the requirement in 22.1, the current rating of a A switch that controls an inductive load, other than a motor, such as a transformer or a fluorescent-lamp ballast, shall have a current rating of not be less than twice the rated full-load current of the transformer or ballast, unless the switch is known to be acceptable for the particular application.~~

13A.8 A switch used ~~is considered to be acceptable for controlling a tungsten-filament lamp load shall:when:~~

- a) ~~It has a~~Be provided with a T or L rating and a current rating at least equal to the tungsten-filament lamp load; or
- b) ~~It has~~Have an alternating-current rating at least six times, or a direct-current rating at least ten times greater than that of the tungsten-filament lamp load.

13A.9 ~~A switch provided for the control of a fluorescent lamp and not integral with the lampholder shall have a current rating at least twice the primary rating of the ballast. Each ballast is to be considered as requiring its rated input current.~~

13A.10 ~~When an A cord-connected product/appliance provided with a direct-plug-in power-supply cord and an attachment plug employs a incorporating a motor rated more than 250 watts (1/3 horsepower) output shall be provided with a motor controller, a motor controller — a device for starting and stopping the motor — shall be provided in the appliance.~~

13A.11 A speed-control switch shall be provided as part of a product~~with that~~ employs a variable-speed or multispeed motor — a motor with a winding capable of various pole groupings.

13A.12 ~~The construction of a switch shall be such that only one circuit can be energized at a time.~~

~~Exception: A switch that is constructed to energize more than one circuit at a time shall not be employed unless it has been investigated and found acceptable for such use.~~

13A.13 An operating control not complying with 13A.3.9 shall:

- a) Comply with 13A.14(a), if the control is electronic; and,
- b) Be powered entirely by no more than one low-voltage circuit; comply with the Limiting Impedance Test in UL 508; or comply with the low-power circuit requirement determined as specified in 19.11.1 of the Standard for Safety of Household and Similar Electrical Appliances, Part 1: General Requirements, UL 60335-1.

13A.14 An operating control that complies with 13A.3.9 shall also comply with all the following:

- a) For electronic controls – Installation Class 2 for electromagnetic compatibility (EMC) shall be in accordance with the voltage surge testing in 49A.3.6 and comply with the results specified in 49A.3.2.;
- b) Category II shall be the overvoltage category;
- c) Insulating materials shall have a minimum comparative tracking index (CTI) of 100 (Material Group III);
- d) The applicable pollution degree shall be as specified in 23.6.3(a) – (e); and,
- e) The operating control (limiter) endurance cycle requirements specified by either:
 - 1) Table CC.2 of the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9, with the operating control (limiters) endurance cycle requirements being applied; or,
 - 2) Endurance Test – Switching Devices, Section 46C.

13A.15 If an operating control complying with 13A.3.9 indirectly controls the load through a switching device, the endurance cycle requirements in 13A.14(e) shall be applied to the switching device.

13A.16 Appendix B, Operating and Protective (“Safety Critical”) Control Functions, shall be referenced to determine whether a control function is considered to result in a risk of fire, electrical shock or injury to persons.

13A.17 If a control can be used to reduce the risk of fire, electric shock or injury to persons under abnormal operating conditions of the product, but a redundant control (of similar or different design) operates to perform the identical function, the circuit shall be evaluated to determine which control will be relied upon as the protective control. The control determined to be the protective control shall comply with the protective control requirements in 13A.3. The control determined to be the operating control is not required to comply with the protective control requirements but shall comply with the operating control requirements in 13A.13 or with 13A.3.9 and 13A.14.

13A.18 A thermistor shall comply with Annex J of the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1 or the Standard for Thermistor-Type Devices, UL 1434. The calibration shall be as specified in 13A.3.6. If a thermistor is used:

- a) To reduce the risk of fire, electric shock or injury to persons under abnormal operating conditions of the product, the minimum number of endurance cycles shall be 100,000.
- b) In other sensing applications of the product, the minimum number of endurance cycles shall be 6,000.

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13A.19 A protective control as referenced in 13A.3(i) and having a protective electronic circuit:

- a) in which electronic disconnection of the circuit could fail, shall have at least two components whose combined operation provides the load disconnection;
- b) shall prevent a risk of fire, electric shock or injury to persons under the relevant fault conditions specified in 49A.2;
- c) in which an overcurrent protective device opens during application of any of the fault conditions specified in 49A.2, shall utilize an overcurrent protective device complying with the requirements applicable to that component. The fault condition causing the overcurrent protective device to open shall be repeated and the overcurrent protective device shall again open the protective electronic circuit. If the overcurrent protective device complies with the Standard for Miniature Fuses: Part 1, Definitions for Miniature Fuses and General Requirements for Miniature Fuse-Links, IEC 60127-1, as well as an applicable Part 2, then the protective device shall additionally comply with the Fuse-Link Test in 49A.5;
- d) in which a conductor of the printed wiring board becomes open-circuited during the fault conditions test in 49A.2, then:
 - 1) the printed wiring board shall comply with the Needle-Flame Test in Annex E of Standard for Safety of Household and Similar Electrical Appliances, Part 1: General Requirements, UL 60335-1 or have a minimum flammability rating of V-0 when tested in accordance with the vertical flame test described in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94;
 - 2) any loosened conductor shall not reduce spacings below the values specified in relevant 23.1, 23.3, 23.6; and,
 - 3) the specific test in which the printed wiring became open-circuited shall be repeated a second time. There shall be no risk of fire, electric shock or injury to persons and spacings shall not be reduced below the values specified in relevant 23.1, 23.3, 23.6;
- e) shall maintain its required functions when subjected to the EMC related stresses specified in the Electromagnetic Compatibility (EMC) Tests, 49A.3; and,
- f) that relies upon a programmable component for one or more of its safety functions shall be subjected to the Programmable Component Reduced Supply Voltage Test, Section 49A.4, unless restarting at any point in the operating cycle after interruption of operation due to a supply voltage dip will not result in a risk of fire, electric shock or injury to persons. The test shall be carried out after removal of all batteries and other components intended to maintain the programmable component supply voltage during supply source (mains) voltage dips, interruptions and variations.

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23.6 Alternate spacings – clearances and creepage distances

23.6.1 Except as specified in 23.6.2, the spacings requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, are applicable as an alternative to the specified spacings requirements in the following:

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- a) Line-voltage circuits, 23.1 and 23.3: and
- b) Low voltage and isolated-limited-energy circuits, 23.2.

23.6.2 The spacings requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840 shall not be used for spacings between field wiring terminals or between uninsulated live parts and a metal cabinet or enclosure.

23.6.3 (a) – (g) shall be considered when evaluating a product to the requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840:

- a) Hermetically sealed or encapsulated enclosures are identified as pollution degree 1.
- b) Coated printed wiring boards are identified as pollution degree 1 if they comply with one of the following:
 - 1) Printed wiring board coating performance test of UL 840; or
 - 2) Conformal coating requirements as outlined in the Standard for Polymeric Materials– Industrial Laminates, Filament Wound Tubing, Vulcanized Fibre, and Materials Used in Printed Wiring Boards, UL 746E.
- c) Any areas not in contact with the airstream within an indoor use product are identified as pollution degree 2 unless they comply with (a) or (b).
- d) Any areas in contact with the airstream within an indoor use product are identified as pollution degree 3 unless they comply with (a) or (b).
- e) All areas of an outdoor use product are identified as pollution degree 3 unless they comply with (a) or (b).
- f) Category II is the overvoltage category.
- g) Printed wiring boards are considered as having a minimum comparative tracking index (CTI) of 100 unless further investigated for a higher CTI index.

23.6.4 Clearance B (Controlled Overvoltage) clearances as specified in Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840 shall be achieved by providing an overvoltage device or system as an integral part of the product.

29 Switches and Interlocks

29.1 Switches

~~29.1.1 If unintentional operation of a switch can result in risk of injury to persons, the actuator of the switch shall be located or guarded so that such operation is unlikely.~~

~~29.1.2 The actuator of a switch may be guarded by recessing, ribs, barriers, or the like.~~

29.2 Interlocks

~~29.2.4 An interlock that is required to reduce a risk of electric shock or injury to persons shall withstand 100,000 cycles of operation controlling a load not less than that controlled in the air cleaner, and shall function normally upon completion of the test.~~

a) Withstand 100,000 cycles of operation controlling a load not less than that controlled in the air cleaner, and shall function normally upon completion of the test; or,

b) Comply with the protective control requirements in Section 13A, Switches and Controllers.

~~29.2.5 An interlock that is required to reduce the risk of electric shock shall open all supply conductors:~~

a) all supply conductors; or;

b) the ungrounded conductors if the unit is permanently connected to the electrical supply source.

~~Exception: For a permanently electrically connected unit (fixed type), the interlock need only open the ungrounded conductors.~~

46C Endurance Test – Switching Devices

46C.1 This test applies to switches or other similar operating controls as specified in 13A.14(e)(2).

46C.2 A switching device in a product shall perform acceptably when tested as follows for endurance. There shall be no electrical or mechanical failure nor undue burning, pitting or welding of contacts, or striking of an arc to dead metal parts.

46C.3 The tests on switching devices shall be conducted by:

a) Operating the switching device mechanisms within the product in accordance with 46C.4 and 46C.5 except using the normal switching device loads of the product; or,

b) Cycling the switching devices individually or collectively while controlling the loads specified in 46C.5.

46C.4 If the test in 46C.3(a) is conducted, the:

a) Enclosure of the product shall be connected through a 30 ampere cartridge fuse to the electrical test circuit pole considered least likely to strike (arc) to ground;

b) Switching device shall be mounted as intended in service; and,

c) Test cycling shall be as specified in 46C.5 unless a slower rate is required by the design of the product. A faster rate may be used if agreeable to all concerned.

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46C.5 A switching device shall be subjected to an endurance test at the ambient temperature for which it is intended. The endurance test shall consist of making and breaking the connected load for 6000 cycles of operation, with 1 second ON and 9 seconds OFF. The voltage shall be as specified in 34.2.

a) Noninductive load(s) - 100 percent of the total connected load current. The power factor shall be 1.0.

b) One or more motors together with one or more other loads – 100 percent of the locked-rotor current of the largest motor plus 100 percent of the full load current of all other motors and/or other loads. The power factor shall be 0.4 – 0.5.

c) One or more inductive loads, such as a transformer or ballast, with or without other noninductive or pilot duty loads – 100 percent of the total inductive and other noninductive/pilot duty loads. The power factor shall be 0.7 – 0.8.

d) One or more pilot duty loads, such as coils within a relay or electric valve – 100 percent of the total connected pilot duty loads. The power factor shall not exceed 0.35.

46C.6 At the conclusion of the test in 46C.3, each switching device shall be subjected to the Dielectric Voltage-Withstand Test, Section 46.

49A Protective Electronic Circuit Tests

49A.1 General

49A.1.1 The tests in 49A.2 – 49A.5 are applicable to products provided with a protective electronic circuit and intended to comply with 13A.3(i).

49A.1.2 User adjustable controls shall be adjusted to their most unfavorable setting.

49A.2 Fault conditions abnormal test

49A.2.1 Following the application of the operational fault conditions in accordance with 49A.2.2 – 49A.2.5, there shall be no risk of fire, electric shock or injury to persons. Electrical live parts or moving parts shall not be exposed. The product shall comply with the Dielectric Voltage Withstand Test in Section 46.

49A.2.2 In accordance with 13A.19(b), a product provided with a protective electronic circuit intended to comply with 13A.3(i) shall be operated as specified in the Temperature Test, Section 45 except the room ambient shall be maintained at 70 – 80°F (21.1 – 26.7°C). The product protective electronic circuit shall then be subjected to any one of the following relevant operational fault conditions, each consecutively applied one at a time:

a) Open circuit at the terminals of any component;

b) Short circuit of capacitors, unless they 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;

c) Short circuit of any two terminals of an electronic component, including a metal oxide varistor (MOV). For the test applicable to an integrated circuit, see (e);

d) Failure of triacs in the diode mode;

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e) Failure of microprocessors and integrated circuits except components such as thyristors and triacs. All possible output signals occurring within the component which may result in the product not complying with 49A.2.1 shall be considered;

f) Failure of an electronic power switching device, such as a field effect transistor and a bipolar transistor (including the insulated gate type) in a partial turn-on mode with loss of gate (base) control;

g) Short-circuiting of any circuit that differs in voltage from the supply source of the protective electronic circuit by connecting the different voltage circuit to the supply source.

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49A.2.3 In reference to 49A.2.2, the following shall be considered:

a) If the fault specified in 49A.2.2(c) is not applied:

1) Between two circuits of an optical isolator, then the optical isolator shall comply with UL 1577 , the Standard for Optical Isolators.

2) To the short circuiting of an electronic surge protective device, such as a metal oxide varistor (MOV), then the MOV shall comply with the Type 4 requirements in the Standard for Surge Protective Devices, UL 1449.

b) For evaluating encapsulated or similar components, if the circuit and/or components cannot be evaluated by other methods, then 49A.2.2(e) shall be applied.

c) For evaluating the components in 49A.2.2(f), one method for simulating this mode is to disconnect the electronic power switching device gate (base) terminal and then connect an external adjustable power supply between the gate (base) terminal and the source (emitter) terminal of the electronic power switching device. The power supply can then be varied to obtain the current which is the most severe but which does not damage the electronic power switching device.

d) Step-function positive temperature coefficient thermistors (PTC-S) shall be short-circuited unless they comply with the DC PTC Thermistors section in the Standard for Audio, Video and Similar Electronic Apparatus – Safety Requirements, UL 60065.

e) If more than one of the operational fault conditions in 49A.2.2(a) – (g) are applicable to the product, the product shall be allowed to cool down to room temperature after the application of each fault condition unless such cooling is determined not to adversely impact the test results.

49A.2.4 The operational fault conditions specified in 49A.2.2(a) – (g) shall be considered completed if a manual reset (non-self-resetting) device opens the supply circuit. If the supply circuit is not opened by such a device, then the fault conditions shall be applied until thermal equilibrium is established.

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49A.2.5 A product provided with a protective electronic circuit intended to comply with 13A.3(i) shall additionally be operated as specified 49A.2.2 except that the product shall first be subjected to the relevant abnormal condition(s) addressed by Sections 7, 20, 21, 27, 33, 40.1.6, 45, 49. The product protective electronic circuit shall then be subjected to any one of the relevant operational fault conditions as outlined in 49A.2.2(a) – (g), each consecutively applied one at a time.

49A.3 Electromagnetic compatibility (EMC) tests

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49A.3.1 In accordance with 13A.19(e), a product having a protective electronic circuit intended to comply with 13A.3(i) shall be subjected to the electromagnetic phenomena specified in 49A.3.3 – 49A.3.9, each applied one at a time. Each test shall be carried out:

- a) After a protective electronic circuit has operated during the relevant abnormal condition(s) addressed by Sections 7, 20, 21, 27, 33, 40.1.6, 45, 49 taking into account the most severe results (e.g., highest temperatures, pressures, etc.):
- b) At conditions specified in the Temperature Test, Section 45 except that the room ambient shall be maintained at 70 - 80°F (21.1 – 26.7°C) unless different conditions are required by the specific abnormal condition being applied; and,
- c) With surge protective devices disconnected unless they incorporate spark gaps.

49A.3.2 Following the application of each electromagnetic stress, a protective electronic circuit shall continue to operate as intended. In addition, there shall be no risk of fire, electric shock or injury to persons. Electrical live parts or moving parts shall not be exposed. The product shall comply with the Dielectric Voltage Withstand Test in Section 46.

49A.3.3 Electrostatic discharges shall be applied in accordance with the IEC 61000-4-2, Standard for Electromagnetic compatibility (EMC) – Part 4-2: Testing and Measurement Techniques – Electrostatic Discharge Immunity Test, test level 4 being applicable. Ten discharges having a positive polarity and ten discharges having a negative polarity shall be applied at each preselected point.

49A.3.4 Radiated fields shall be applied in accordance with the IEC 61000-4-3, Standard for Electromagnetic compatibility (EMC) – Part 4-3: Testing and Measurement Techniques – Radiated, Radio-Frequency Electromagnetic Field Immunity Test. The frequency ranges tested shall be 80 MHz to 1000 MHz, test level 3; 1.4 GHz to 2.0 GHz, test level 3; and 2.0 GHz to 2.7 GHz, test level 2. The dwell time for each frequency shall be sufficient to observe a possible malfunction of the protective electronic circuit.

49A.3.5 Fast transient bursts shall be applied in accordance with the IEC 61000-4-4, Standard for Electromagnetic compatibility (EMC) – Part 4-4: Testing and Measurement Techniques – Electrical Fast Transient/Burst Immunity Test. Test level 3 with a repetition rate of 5 kHz is applicable for signal and control lines. Test level 4 with a repetition rate of 5 kHz is applicable for the power supply lines. The bursts are applied for 2 min with a positive polarity and for 2 min with a negative polarity.

49A.3.6 Voltage surges shall be applied to the product power supply terminals in accordance with the IEC 61000-4-5, Standard for Electromagnetic compatibility (EMC) – Part 4-5: Testing and Measurement Techniques – Surge Immunity Test with five positive impulses and five negative impulses being applied at the selected points. An open circuit test voltage of 2 kV is applicable for the line-to-line coupling mode, a generator having a source impedance of 2 ohms being used. An open circuit test voltage of 4 kV is applicable for the line-to-ground coupling mode, a generator having a source impedance of 12 ohms being used. Sheathed heating elements in which a metal sheath is bonded in accordance with 14.1.2 shall be electrically disconnected during this test. For products having surge arresters incorporating spark gaps, the test shall be repeated at a level that is 95 percent of the flashover voltage. If a feedback system depends on inputs related to a disconnected heating element, an artificial network may be needed.

49A.3.7 Injected currents shall be applied in accordance with the IEC 61000-4-6, Standard for Electromagnetic compatibility (EMC) – Part 4-6: Testing and Measurement Techniques – Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields, test level 3 being applicable. During the test, all frequencies between 0.15 MHz to 80 MHz shall be covered. The dwell time for each frequency shall be sufficient to observe a possible malfunction of the protective electronic circuit.

49A.3.8 Voltage dips and interruptions specified as test level Class 3 shall be applied in accordance with:

a) The IEC 61000-4-11, Standard for Electromagnetic compatibility (EMC) – Part 4-11: Testing and Measurement Techniques – Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests, for products having a rated current not exceeding 16 A. The values specified in Table 1 and Table 2 of IEC 61000-4-11 shall be applied at zero crossing of the supply voltage; or,

b) The IEC 61000-4-34, Standard for Electromagnetic compatibility (EMC) – Part 4-34: Testing and Measurement Techniques – Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests for Equipment with Input Current More Than 16 A Per Phase for products having a rated current exceeding 16 A. The values specified in Table 1 and Table 2 of IEC 61000-4-34 shall be applied at zero crossing of the supply voltage.

49A.3.9 Supply source (mains) signals shall be tested in accordance with the IEC 61000-4-13, Standard for Electromagnetic compatibility (EMC) – Part 4-13: Testing and Measurement Techniques – Harmonics and Interharmonics Including Mains Signalling at a.c. Power Port, Low Frequency Immunity Tests. Table 11 with test level Class 2 using the frequency steps according to Table 10 of IEC 61000-4-13 shall be applied.

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49A.4 Programmable component reduced supply voltage test

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49A.4.1 In accordance with 13A.19(f), the following test is applicable to a product provided with a protective electronic circuit intended to comply with 13A.3(i) and having a programmable component for one or more of its safety functions.

49A.4.2 Following the voltage changes specified in 49A.4.3, a product shall continue to either operate normally from the same point in its operating cycle at which the voltage decrease occurred or a manual operation shall be required to restart the product. In addition, there shall be no risk of fire, electric shock or injury to persons. Electrical live parts or moving parts shall not be exposed. The product shall comply with the Dielectric Voltage Withstand Test in Section 46.

49A.4.3 The product shall be operated at rated voltage and at conditions specified in the Temperature Test, Section 45 except that the room ambient shall be maintained at 70 – 80°F (21.1 – 26.7°C) until thermal equilibrium occurs. The power supply voltage shall then be changed, by approximately 10 V/s until the voltage reductions or increases specified in (a) – (d) are attained. The power supply voltage shall then be maintained at each voltage condition for not less than 60 s as follows:

- a) Voltage shall be reduced until the product ceases to respond to user inputs or parts controlled by the programmable component cease to operate, whichever occurs first. This value of supply voltage shall be recorded.
- b) Voltage shall be increased to rated voltage so that the product operates as intended.
- c) Voltage shall be reduced to a value that is approximately 10 percent less than the recorded voltage.
- d) Voltage shall be increased so that the product operates as intended.

49A.5 Fuse-link test

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49A.5.1 In accordance with 13A.19(c), the following test is applicable to a product provided with a protective electronic circuit intended to comply with 13A.3(i) and in which a miniature fuse-link opens during the application of one or more of the operational fault conditions specified in 49A.2.

49A.5.2 The fault condition in which the miniature fuse-link opened shall be repeated in accordance with the relevant parts of 49A.2 except with the fuse replaced by an ammeter. The current in the circuit shall be measured.

49A.5.3 The resistance of the fuse-link shall be measured so that the rated current through the fuse can be determined. The current measured by the ammeter described by 49A.5.2 is to be multiplied by the ammeter internal resistance and then divided by the resistance of the fuse link to obtain the rated current of the fuse-link for making the determinations specified in 49A.5.4.

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49A.5.4 If the calculation determined in accordance with 49A.5.3:

a) Is at least 2.75 times the rated current of the fuse-link, the circuit is considered to be protected and the results obtained during the tests of 49A.2 with the fuse-link in the circuit can be used to determine compliance with 49A.2.1.

b) Is between 2.1 times and 2.75 times the rated current of the fuse-link, the relevant fault condition(s) in accordance with 49A.2 shall be repeated with the fuse-link short-circuited. The test shall be conducted until the lesser of one of the following occurs and the results shall comply with 49A.2.1:

- 1) 2 minutes for time lag fuse-links; or
- 2) 30 minutes for quick acting fuse-links; or
- 3) until thermal equilibrium is achieved.

c) Is 2.1 times the rated current of the fuse-link or less, the circuit shall not be considered to be protected and the relevant fault condition(s) in accordance with 49A.2 shall be repeated with the fuse-link short-circuited. The results shall comply with 49A.2.1.

54A Protective Electronic Circuit Test

54A.1 The manufacturer shall periodically verify that protective electronic circuits evaluated in accordance with 13A.19 and Section 49A, Protective Electronic Circuits Tests, are functional for protecting against conditions that could cause risk of fire, electric shock or injury to persons.

Appendix B – (Normative) – Operating and Protective (“Safety Critical”) Control Functions

<u>Purpose of control:</u>	<u>Control function results in a risk of fire, electric shock or injury to persons?</u>
<u>De-energizes product in the event of motor-locked rotor operation.</u>	<u>No</u>
<u>Prevents loss of product operation while equipment is energized and operating as intended.</u>	<u>No</u>
<u>Operates motors, solenoids or similar components used to retain doors or panels in the closed position if the doors or panels provide protection of:</u>	<u>Yes</u>
<u>a) uninsulated live parts, film-coated wire or moving parts capable of causing injury in accordance with Section 7; or</u>	
<u>b) moving parts capable of causing injury in accordance with Section 27; or</u>	
<u>c) thermally hot parts in accordance with Sections 33 and 45.</u>	
<u>Prevents motor overload (over-temperature or overcurrent) as required by Sections 20.</u>	<u>Yes</u>
<u>Prevents the ionizer circuitry on duct-type products from operating if the system is being washed as required by 21.1(a).</u>	<u>Yes</u>
<u>Prevents the blower or fan circuit on duct-type products from being energized if the system is being washed as required by 21.1(b).</u>	<u>Yes</u>
<u>For duct-type products which have a means for applying adhesive to the ionizer-collector frame assembly, the control prevents the ionizer power and blower or fan circuit from being energized while the adhesive is being applied as required by 21.2.</u>	<u>Yes</u>
<u>Ozone-monitoring circuitry in which the circuitry is relied upon to limit the ozone in accordance with 40.1.6.</u>	<u>Yes</u>
<u>Prevents automatic restarting after operation of a protective circuit which de-energizes the product (or part of the product) where there is a risk of injury due to moving parts.</u>	<u>Yes</u>
<u>Regulates motor speed only (not combined with a motor overload or motor protective control).</u>	<u>No</u>
<u>Regulates motor speed and is combined with a motor overload or motor protective control.</u>	<u>Yes</u>
<u>Limits temperatures within the product during abnormal conditions or under conditions not intended for the normal operation of the product in accordance with Section 49.</u>	<u>Yes</u>
<u>Limits pressure in a vessel.</u>	<u>Yes</u>
<u>Regulates temperatures within the product during normal, intended conditions of use.</u>	<u>No</u>
<u>Clogged filter sensing</u>	<u>No</u>

2. Addition of Requirements for Remotely Operated Electrostatic Air Cleaners

RATIONALE

Proposal submitted by: Barry Karnes, UL

Many products and equipment now have capability for remotely receiving and/or sending operational commands for monitoring and automatically adjusting the operation of the product or equipment. The controls enabling this remote operation may come in several forms, but one of the common features is the ability to receive and react to communication data relating to power billing rate or demand response, or communications signals from a remote user interface, such as a smartphone or computer. A primary safety concern is that use of these remote controls cannot conflict with the safe usage of the product or equipment.

This proposal reflects present practice and documents the safety requirements for electrostatic air cleaners that may be remotely operated or monitored.

This proposal does not change the intent of any requirements presently in UL 867 and is consistent with similar requirements being added to other UL Safety Standards.

PROPOSAL

3.6.2 GROUNDING, FUNCTIONAL – Grounding of a point in a product which is necessary for a purpose other than safety.

14.1.5 Functional grounding shall not be relied upon for equipment grounding or bonding.

4A.13 Information technology equipment

4A.13.1 Information technology equipment such as a printer, visual display unit, router, communication connectors/data ports or computer shall comply with the Standard for Information Technology Equipment, Part 1: General Requirements, UL 60950-1.

13B Remotely Operated Electrostatic Air Cleaners

13B.1 Any function of a product enabled in response to external communication or data signals shall be considered when determining normal and abnormal conditions of the product.

13B.2 Except as specified in 13B.3, a manual control shall be provided on a product such that actuation of the control is required before the product can be operated in any mode that permits remote operation, external communication or receiving/sending data signals.

13B.3 In reference to 13B.2, a product not provided with a manual control for actuating remote operation, external communication or receiving/sending data signals shall be:

- a) Capable of remote operation, external communication or receiving/sending data signals only within line-of-sight; or,
- b) Limited only to monitoring external communication or data signals.

13B.4 A product shall include a means to manually disconnect, disable or override any remote operation commands, external communication or data signals. If the product attachment plug and receptacle serve as the manual means to disconnect data signals or remote operation commands, the product shall comply with 59.9.

13B.5 A control that operates in response to remote operation commands, external communication or data signals shall not introduce an operating condition or state that could lead to a risk of fire, electric shock or injury to persons. In addition, such a control shall not:

- a) Render inoperative any protective control or protective control function within the product;
- b) Alter the order of control response such as by forcing a protective control to operate instead of another control that would normally be intended to respond;
- c) Reset any protective manual reset feature;
- d) Supersede the response of any protective control; or
- e) Alter the response to or expected performance of;

- 1) User actuation of controls, movement of doors, covers, grills, filters or the like; or,
- 2) User interaction with any parts of the product that could result in exposure of hazardous electrical parts, moving parts, hot parts or radiation.

13B.6 Compliance with 13B.5 shall be determined by one of the following:

- a) Using methods appropriate for determining the performance and reliability of protective control functions in accordance with Section 13A, Switches and Controllers; or,
- b) Examining the product circuit diagram(s) to determine that a control which operates in response to remote operation commands, external communication or data signals operates wholly independent of the protective controls of the product and therefore is incapable of adversely affecting the operation of any protective controls.

59.9 In reference to 13B.4, the instructions for a product intended to be remotely operated and in which the attachment plug of the product and receptacle serve as the manual means for disconnecting remote operation commands, external communication or data signals shall specify that unplugging the product disconnects the remote functions.

3. Update of Motor-Protection Requirements

RATIONALE

Proposal submitted by: Barry Karnes, UL

A revision to 20.3 is being proposed to provide additional compliance paths for motors if they comply with the Standards for Impedance Protected Motors, UL 1004-2, Thermally Protected Motors, UL 1004-3, or Electronically Protected Motors, UL 1004-7.

An additional proposal would permit electronic motor protection to comply with the requirements in Section 13A, Switches and Controllers.

As part of the update to 20.3, the exception underneath sub-item (a) is being proposed for deletion from 20.3 and added as a new 20.3.1 since this exception is actually an alternate compliance path.

The revisions are intended to clarify the requirements and do not change the intent of any requirements presently in UL 867. These proposals reflect present practice.

PROPOSAL

20.3 Each motor shall be provided with at least one of the following:

- a) Thermal protection complying with the applicable requirements in the Standard for Thermally Protected Motors, UL 1004-3.

~~Exception:—Exception: A motor intended to move air only by means of an air-moving fan that is integrally attached, keyed, or otherwise fixed to the motor shaft is not required to have running overload protection.~~

- b) Impedance protection complying with the applicable requirements in the Standard for Motor-Operated Appliances, UL 73, when the motor is tested as used in the product under locked-rotor conditions.

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c) Impedance protection complying with the Standard for Impedance Protected Motors, UL 1004-2.

d) Electronic protection complying with either the Standard for Electronically Protected Motors, UL 1004-7 or with the requirements in Section 13A, Switches and Controllers, applying to protective electronic circuits.

ee) Other protection that is shown by tests to be equivalent to the protection mentioned in (a) – (d).

20.3.1 In reference to 20.3(a) and (d), a motor that moves air by means of a fan that is not integrally attached, keyed, or otherwise fixed to the motor shaft shall be evaluated for running heating protection.

4. Clarifying and Simplifying Wording of Ozone Test Requirements

RATIONALE

Proposal submitted by: Barry Karnes, UL

Some of the Ozone Test requirements are intended to outline the manner in which a product is to be tested using different air filters. The proposed revisions to Section 40 are intended to clarify these requirements.

This proposal includes revisions to specify that the intent of the Ozone Test is also to test a product in a manner in which the ozone emission is the greatest. This could be with devices such as fans, emitters, and other similar equipment energized or de-energized during the test.

In addition, the Peak Ozone Emission Location Determination test requirements presently located in Section 41 have been proposed for inclusion within the body of Section 40 since this “determination” is a necessary part of the Ozone Test. Section 41 is then proposed to be deleted.

Proposed 59.10 is also being proposed under Topic 5 due to the reference to 45.1.2 which is being proposed under Topic 5.

This proposal reflects present practice and is not intended to change the intent of any requirements presently in Section 40 or 41.

PROPOSAL

40.1.1 Two samples of the product shall be supplied for testing. The test described in 40.2 – 40.4 40.1.1 – 40.4.11 shall be conducted on: a total of two samples of each air cleaning product.

a) One sample, if the measured maximum ozone concentration is less than 0.030 parts per million; or

b) A second sample, if the measured maximum ozone level from the first sample tested is 0.030 ppm or more.

Exception: Only one sample shall be subjected to this test when the maximum ozone concentration of the first sample tested measures less than 0.030 parts per million.

40.1.2 When tested as described in 40.2 – 40.4, aA portable air cleaning product for household use shall not produce a concentration of ozone that exceeds;exceeding 0.050 parts per million by volume when tested as described in 40.2 – 40.4.11. A transitory concentration in excess of 0.050 ppm but less than 0.100 ppm is acceptable if the average of any five consecutive one minute average measurements is less than 0.050 parts per million.

- a) 0.050 parts per million (ppm) by volume; or,
- b) 0.100 ppm by volume if the average of any five consecutive one minute average measurements are less than 0.050 ppm.

40.1.3 A product shall be tested in accordance with 40.2 – 40.4 under the most severe conditions for generating the maximum amount of ozone, taking into account all intended operating modes of the product. These conditions shall include the following:

- a) High fan speed;
- b) Low fan speed; and,
- c) Any other operating conditions that could include, but are not limited to: fan(s) inoperative, emitters(s)/ionizer(s) on, UV lamps on or other special features activated or inactivated.

40.1.4 In reference to 40.1.3, the testing in 40.2 – 40.4 shall include the product operating with:

- a) Only one operating mode occurring at a time if the product is intended to operate in this manner; or,
- b) Multiple operating modes occurring simultaneously if simultaneous operation of the product in different modes is intended and testing the product in multiple operating modes represents the most severe condition(s) for maximizing ozone emission.
- c) All air filter(s) removed unless an interlock switch causes ozone production to stop if the air filter(s) are removed, as specified in 40.1.5.

40.1.5 In reference to 40.1.4(c), for a product having an interlock switch causing ozone production to decrease or stop if an air filter is removed:

- a) The testing in 40.2 – 40.4 shall be conducted with the interlock switch bypassed; or,
- b) The interlock switch shall comply with Section 29, Interlocks, and the operating instructions of the product shall specify the intended filter(s), including replacement filters, in accordance with 59.10.

40.1.6 If ozone-monitoring circuitry is provided as part of the product, the test described in 40.2 – 40.4 shall be conducted with the circuitry bypassed unless the circuitry complies with the protective control requirements in Section 13A, Switches and Controllers.

40.4.1 Prior to testing, the product shall be subjected to the Peak Ozone Emission Location Determination test of Section 41 and a 48 hour run-in period. Run-in shall be conducted in a room with a controlled temperature in the range of 25 ±5°C and a supply of filtered air. During the run-in period the product shall be operated at maximum ozone output, speed, etc. If a UV light or other ozone generating special feature is provided, it shall be operated during this period. Prior to testing, the location of the peak ozone emission on a product shall be determined in accordance with 40.4.1.1 – 40.4.1.6.

40.4.1.1 The product shall be located in accordance with 40.4.4 and:

- a) Within the test chamber specified in 40.2; or,
- b) In an area where the local airflow across the surface of the product is not greater than 4 inches/s (0.1 m/s) and which has minimum dimensions of 10 feet (3 m) per side and not less than 8 feet (2.4 m) high.

40.4.1.2 The air stream discharge area shall be determined by measuring the air stream in a plane parallel to and 2 inches (50.8 mm) from the surface of the product air discharge grille. Each ozone sampling point shall be along this plane.

40.4.1.3 The location and number of ozone sampling points for a product shall be determined based on the discharge area of the air stream as follows:

- a) One ozone sampling point shall be allotted for and be directly in line with each ozone generating source.
- b) One ozone sampling point shall be located in the geometric center of the air stream discharge area with additional ozone sampling points provided based on the overall area of the air stream discharge of the product as follows:
 - 1) For an air stream discharge area less than 16 in² (103 cm²) – minimum of 4 sampling points.
 - 2) For an air stream discharge area equal to or greater than 16 in² (103 cm²) – minimum of 8 sampling points.

40.4.1.4 For the sampling points specified in 40.4.1.3(b)(1) and (2), the air stream discharge shall be divided into equal sized zones so that the number of ozone sampling points equals the number of zones. The ozone sampling point shall be located in the geometric center of each zone.

40.4.1.5 The product shall be subjected to a 48 hour run-in period. Run-in and determining the location of peak ozone emission shall be conducted with the room at a controlled temperature in the range of 77 ±9°F (25 ±5°C) and a supply of filtered air.

40.4.1.6 At the completion of the run-in period, the location of peak ozone emission shall be determined by measuring the emission of ozone at each sampling point for a minimum of 2 minutes. The ozone sampling device shall point directly into the air stream. Ozone values shall be allowed to stabilize between measurements.

40.4.1.7 The tests in 40.4.2 – 40.4.6 shall be conducted on a product to determine compliance with 40.1.2.

40.4.5 A single ozone monitor sampling tube is to be positioned with the sample tube opening located 2 inches (50 mm) from the air outlet of the product and at the sampling point that provides the peak ozone emission as determined by 40.4.1 – 40.4.1.6. The sample tube is to point directly into the air stream. Monitoring shall occur where ozone emissions are highest as determined by the Peak Ozone Emission Location Determination test of Section 41.

40.4.6 To determine the concentration of ozone, the ozone ~~The emission of ozone is to be monitored for not less than: 24 hours to determine the concentration.~~

a) 24 hours; or,

b) 8 hours if the measured ozone concentration when plotted against time between the 7th and 8th hour of monitoring has:

1) A negative or zero slope and fluctuation not greater than ± 10 percent or 2 parts per billion (ppb) around the mean, whichever is greater;

2) A positive slope with the mean ozone concentration of less than 20 ppb and fluctuation not greater than ± 2 ppb around the mean; or,

3) A positive slope with the mean ozone concentration greater than or equal to 20 ppb and less than 38 ppb and with a normalized slope (slope divided by hourly mean) that is less than or equal to 0.0153 ppb/hr per mean ppb, and fluctuation not greater than ± 10 percent around the mean.

Exception: The monitoring of ozone can be stopped after 8 hours if the measured chamber ozone concentration has reached steady-state. For the purpose of this measurement steady state is defined as:

a) Negative or zero slope for the plot of chamber ozone concentration vs. time ($[C(t)]$ vs. t), during hour 7 to 8 of monitoring, and fluctuation not greater than ± 10 percent or 2 ppb around the mean, whichever is greater during the same time period;

b) Positive slope for the plot of chamber ozone concentration vs. time ($[C(t)]$ vs. t), during hour 7 to 8 of monitoring, mean ozone concentration less than 20 ppb, and fluctuation not greater than ± 2 ppb around the mean, during the same time period; or

c) Positive slope for the plot of chamber ozone concentration vs. time ($[C(t)]$ vs. t), during hour 7 to 8 of monitoring, mean ozone concentration greater than or equal to 20 ppb and less than 38 ppb, a normalized slope (slope divided by hourly mean) for hour 7–8 less than or equal to 0.0153 (ppb/hr)/mean ppb, and fluctuation not greater than ± 10 percent around the mean during the same time period.

40.4.7 If the appliance is designed for use with multiple filter media technologies, the test described in 40.1 – 40.4.6 and 40.4.9 shall be:

a) Conducted with the standard filter media in place and

b) Repeated in the highest ozone operating mode (high or low fan speed, special features “on”) as determined in (a), with all remaining media combinations.

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