

APPENDIX III

28A Electronic Circuits

28A added December 21, 2007

28A.1 Ozone monitoring circuitry shall not be user-defeatable or user-adjustable.

37 Ozone Test

Revised 37 effective June 30, 2008

37.1 General

37.1.1 The test described in 37.1 - 37.4.10 shall be conducted on a total of two samples of each air cleaning product.

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.

37.1.2 A portable air cleaning product for household use shall not produce a concentration of ozone exceeding 0.050 parts per million by volume when tested as described in 37.2 - 37.4.10. 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.

37.2 Chamber specifications

37.2.1 The test is to be conducted in a chamber having a volume of 950 - 1100 cubic feet (26.9 - 31.1 m³) with a minimum side dimension of 8 feet (2.4 m) and a maximum height dimension of 10 feet (3.0 m) without openings. The test chamber walls, ceiling, and floor are to be surface treated (polished) stainless steel or other nonporous and non-reactive material. The suitability of chamber materials shall be validated by the half-life procedure of 37.2.3.

37.2.2 The following test chamber criteria shall be met:

a) The test chamber shall be sufficiently airtight to avoid uncontrolled air exchange. The chamber is considered sufficiently airtight if at least one of the following requirements is fulfilled:

- 1) the air leakage is less than 0.5 percent of the chamber volume per minute at an overpressure of 1000 Pa;
- 2) the air leakage is less than 5 percent of the supply airflow rate.

b) The test chamber shall have proper mixing verified via the mixing procedure of the Standard Practice for Full-Scale Chamber Determination of Volatile Organic Emissions from Indoor Materials/Products, ASTM D6670, Sections titled Air Distribution in the Chamber and Air-Mixing in a Chamber, and shall not create local airflow across the surface of the product under test exceeding 0.1 m/s.

c) The test chamber supply air system shall be equipped with sufficient carbon and HEPA media to remove particles, reactive VOCs, and ozone.

37.2.3 Performance of the test chamber shall be verified prior to each test and after any modification or cleaning through:

- a) Determination of the chamber ozone half-life at 0 forced air changes,
- b) Calculation of the chamber deposition velocity under these conditions using the equation defined in 37.2.4,
- c) Calculation of the air exchange rate necessary to maintain an overall chamber ozone removal rate (N_{apparent}) value of 1.33 using the equation defined in 37.2.5,
- d) Verification of the chamber ozone half-life of 31 ±2 minutes under the air exchange rate calculated in c), and if necessary, adjustment of the air exchange rate to achieve an ozone half-life of 31 ±2 minutes, repeating the verification as needed after adjustment of the air exchange rate.

The chamber ozone half-life is determined using an initial steady state concentration of 0.100 to 0.200 ppm ozone. For the purpose of this measurement, steady state is defined as a fluctuation not greater than ± 10 percent or 0.0020 ppm, whichever is greater, during a fifteen minute period.

37.2.4 The chamber deposition velocity (V_d) is defined by the following equation:

$$V_d = \left[\left(\frac{\ln \frac{C(t)}{C(0)}}{-t_{1/2}} \right) - AER \right] * \left(\frac{1}{A/V} \right)$$

in which:

V_d = Deposition Velocity (m/h)

C(t) = Ending Ozone Concentration

C(0) = Initial Ozone Concentration

t_{1/2} = Chamber Half-Life (h)

AER = Air Exchange Rate (1/h) = 0

A/V = Chamber Surface Area to Volume Ration (m²/m³)

37.2.5 The air exchange rate necessary to maintain an overall chamber ozone removal rate (N_{apparent}) value of 1.33 is defined by the following equation:

$$AER = N_{app} - V_d * A/V$$

in which:

AER = Air Exchange Rate (1/h)

N_{app} = N_{apparent} (1/h) = 1.33

$V_d = \text{Deposition Velocity (m/h)} = \text{Value determined in 37.2.3 and 37.2.4}$

$A/V = \text{Surface Area to Volume Ratio (m}^2/\text{m}^3)$

The chamber air exchange rate is defined as the ratio of the volume of clean air brought into the chamber per hour to the unloaded chamber volume.

37.3 Equipment specifications

37.3.1 Ozone analysis equipment shall meet the following criteria:

- a) Ranges of 0.02, 0.04, 0.1, 0.2, and 0.4 mg/m³ on the full scale (or have auto ranging capability);
- b) The capability to detect 4 µg/m³ or lower concentration;
- c) A precision of ± 2 percent from the mean value in the 0 mg/m³ to 0.2 mg/m³ range (i.e. 2 µg/m³ or 1 percent on the full scale);
- d) A sampling rate of not less often than once every 60 seconds;
- e) A sampling line of minimum length, not to exceed 13 feet (4 m), made of a flexible material that is inert, such as PTFE.

To prevent impact on the test, the ozone analysis equipment shall be placed outside of the chamber.

37.4 Test method

37.4.1 Prior to testing, the product shall be subjected to the Peak Ozone Emission Location Determination test of Section 37A 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.

37.4.2 During the test, the test chamber is to be maintained at a temperature of 25 \pm 2°C (77 \pm 4°F) and a relative humidity of 50 \pm 5 percent.

37.4.3 Prior to the start of each test, the ozone background level is to be measured with the product off. The background level shall be subtracted from the maximum measurement during the test. With respect to determining background level, the following measurement criteria shall be applied:

- a) The ozone background measurement shall not exceed 0.005 ppm at steady state. Measurements above this value may interfere with emissions determinations.
- b) Background measurements within the chamber shall be taken immediately prior to testing of the product.

For the purpose of this measurement, steady state is defined as a fluctuation not greater than ± 10 percent or 0.0020 ppm, whichever is greater, during a fifteen minute period.

37.4.4 The product is to be located in the center of the test chamber floor and

- a) 30 inches (762 mm) above the floor for table-mounted products.
- b) on the floor for floor mounted or supported products.
- c) attached to the ceiling or other horizontal non-reactive surface at a minimum height of 30 inches for ceiling-mounted products.
- d) attached to a non-reactive vertical surface at a minimum height of 30 inches for wall-mounted products.

37.4.5 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 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 37A.

37.4.6 The emission of ozone is to be monitored for 24 hours to determine the concentration.

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 no positive slope for the plot of chamber ozone concentration vs. time ($[C(t)]$ vs. t), during hour 7 to 8 of monitoring, and a fluctuation of less than 10% relative standard deviation in measured chamber ozone concentration over a fifteen minute period between hour 7 and hour 8.

37.4.7 If the filter cell or other high voltage component can be energized with any of its fans not functioning or with filters removed, the test described in 37.1 - 37.4.6 is to be repeated with the various components not operating or with filters removed.

37.4.8 If the appliance is provided with multiple speeds/output levels of operation, the test described in 37.1 - 37.4.6 is to be repeated on each speed/output level. For those appliances with continuous or near-continuous dial settings, tests shall be conducted at the minimum, middle, and maximum settings.

37.4.9 If ozone-monitoring circuitry is provided as part of the appliance, the test described in 37.1 - 37.4.6 shall be repeated with the circuitry bypassed unless its reliability has been demonstrated as described in 37.4.10. Air cleaners must comply with the requirements of 37.1 in both operational states (with and without circuitry).

37.4.10 For the sake of the test in 37.4.9, reliability is defined as compliance with the applicable requirements of the Standards for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991; Software in Programmable Components, UL 1998; or Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1A, whichever is most suitable.

37A Peak Ozone Emission Location Determination

37A added effective June 30, 2008

37A.1 The peak ozone location for monitoring shall be determined by testing the product in an open space with a minimum dimension in any direction of 10 feet (3.0 m). The air cleaner shall be placed in the center of the test space as described in 37.4.4. Lab ventilation shall not create local airflow across the surface of the unit under test greater than 4 inches/s (0.1 m/s).

37A.2 Using an anemometer or other appropriate means, the periphery of the air stream in a plane parallel to and 2 inches (50.8 mm) from the surface of the air cleaner discharge grille shall be established. If the air stream boundary is smaller than the discharge grille in either dimension, the corresponding discharge grille dimension shall be used to establish the air stream's boundary.

37A.3 The location and number of ozone sampling points shall be determined as follows:

- a) If the bounded air stream area is less than 16 inches² (103 cm²), it shall be subjected to 5 measurements, one in each quadrant of the air stream and one in the center of the air stream.
- b) If the bounded air stream area is greater than 16 inches², it shall be subjected to measurements spaced in a 4 inch x 4 inch (102 mm x 102 mm) grid pattern across the air stream. If this spacing results in greater than 10 measurement locations, 10 measurements shall be taken evenly spaced across the air stream. One additional measurement shall be taken in the center of the air stream.

37A.4 In addition to the sampling points described in 37A.3, measurements shall also be taken in the air stream directly in line with any ozone generating ionizing sources. These sources shall be identified through inspection.

37A.5 The ozone emitted from the air cleaner shall be measured at each location defined in 37A.3 and 37A.4. The air cleaner shall be operated on both the highest and lowest fan speed if so equipped. If the air cleaner is equipped with special ionizers or UV lamps that can be activated independently, they shall be "on" for purposes of the test. The sampling probe shall be positioned at a measurement location and allowed to operate for a minimum of 2 minutes, longer if necessary for equipment specific measurement stabilization, before recording the peak ozone level. The measurement location and operating condition that produced the highest ozone reading in the air stream shall be identified for use during the Ozone Test, Section 37.

Copyright © 2008 Underwriters Laboratories Inc.

UNDERWRITERS LABORATORIES INC. NOTICE

UL shall not be responsible to anyone for the use of or reliance upon a UL Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon a UL Standard.

This material is provided, with permission, from Underwriters Laboratories Inc. Standard for Safety for Electrostatic Air Cleaners Dated October 9, 2000, Copyright by Underwriters Laboratories Inc.

Revisions of UL Standards for Safety are issued from time to time. A UL Standard for Safety is current only if it incorporates the most recently adopted revisions. Copies of the entire current edition of UL 867 may be purchased from:

comm 2000
1418 Brook Drive
Downers Grove, IL 60515 USA
1-888-853-3503 in U.S. and Canada or
415-352-2168, outside the U.S. and Canada
Fax: 1-888-853-3512 in U.S. and Canada
Fax: 1-630-932-7387 outside the U.S. and Canada
<http://www.comm-2000.com>