UL 1067

STANDARD FOR SAFETY

Electrically Conductive Equipment and Materials for Use in Flammable Anesthetizing Locations

UL Standard for Safety for Electrically Conductive Equipment and Materials for Use in Flammable Anesthetizing Locations, UL 1067

Fifth Edition, Dated September 30, 2011

Summary of Topics

This revision of ANSI/UL 1067 dated December 15, 2020 includes revisions to permit the use of electronic medium for required documentation; 21.3 and Section 22

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

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated September 4, 2020 and October 23, 2020.

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Standard for Electrically Conductive Equipment and Materials for Use in Flammable Anesthetizing Locations

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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 https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover equipment and materials intended for installation and use in flammable anesthetizing locations where accumulation of static electricity presents a risk of fire or explosion due to the possibility of static sparks being generated in the presence of flammable anesthetic-air mixtures. These products provide an electrically conductive path from other electrically conductive objects and patients to ground.

1.2 The products covered by this standard include bonding appliances, casters, anesthesia face masks and anesthesia reservoir bags, breathing tubes, footwear, hose and tubing, mattresses and pads, sheeting, and restraint straps.

1.3 The products covered are for use in accordance with Article 517 of the National Electrical Code, NFPA 70, and Chapter 3 of the Standard for Health Care Facilities, NFPA 99.

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

2 Component

2.1 Except as indicated in 2.2, a component of a product covered by this standard shall comply with the requirements for that component.

2.2 A component need not comply with a specific requirement that:

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

b) Is superseded by a requirement in this standard.

2.3 A component shall be used in accordance with its recognized rating established for the intended conditions of use.

2.4 Specific components are recognized as being 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 for which they have been recognized.

3 Units of Measurement

3.1 When a value for measurement is followed by a value in other units in parentheses, the first stated value is the requirement.

4 Undated References

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

5 Glossary

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

5.2 CONDUCTIVE – Electrically conductive.

5.3 ELECTRICALLY CONDUCTIVE MATERIAL – A material electrically conductive to a degree that the product will discharge or prevent the accumulation of static electricity, or both, in accordance with these requirements.

5.4 NONCONDUCTIVE – Electrically nonconductive.

CONSTRUCTION

6 Material

6.1 A product need not be constructed of conductive material throughout. See 6.2 – 6.8 and the Test for Accumulation of Static Electricity, Section 17.

6.2 The conductive material of a bonding appliance, a caster, and footwear, when mounted or used in accordance with the manufacturer's instructions, shall contact the floor without interruption for a distance of at least 5/8 inch (15.9 mm) in at least one dimension. See 6.3.

6.3 The requirement in 6.2 necessitates that the conductive material of footwear contact the floor as specified, both at the sole and at the heel.

6.4 All exposed surfaces of a mattress and a pad shall be constructed of conductive material throughout. Nonconductive parts may be provided on the exposed surfaces, for example, fasteners, when the Test for Accumulation of Static Electricity, Section 17, shows such parts do not present a risk of explosion.

6.5 The method of closure of a mattress and a pad shall be such that metal parts are:

a) Electrically interconnected; or

b) Protected by conductive material.

6.6 All accessories on an anesthesia machine that are required to be resilient or flexible and that form part of an interconnecting electrically conductive pathway, such as tubing, inhalers, anesthesia reservoir bags, head straps, retainers, face masks, and similar items, shall be conductive material throughout.

6.7 To reduce the risk of percussion sparks, a product used on mobile equipment, such as a bonding appliance or a caster, shall employ a material such as aluminum, brass, or bronze, for metal parts that contact the floor or may be struck or strike against foreign objects when used as intended.

6.8 Footwear shall not have a metal part, such as a nail, that contacts the floor during intended use.

PERFORMANCE

7 General

7.1 When conductive equipment is intended for use under conditions other than those represented by the exposures described in this standard, such conditions are to be considered and necessitate additional evaluation.

8 Samples

8.1 Samples required for test are described in Table 8.1 and are to be complete unless otherwise noted in the table.

Table 8.1
Samples for tests

Product	Samples required
Anesthesia face mask	2 of each style; 2 of largest size; 2 of smallest size; 24 of median size; 6 of head harness
Anesthesia reservoir bag	2 of each size; 2 additional of largest size
Bonding appliance[a]	12 complete; 24 of the conductive material in the size employed
Breathing tubes	2 of each size, in the length manufactured; 24 of a median size, in the length manufactured
Caster	2 having wheels of largest diameter; 2 having wheels of smallest width; 6 having wheels of at least 2 inches (50.8 mm) diameter; 1 having each different mounting means not represented by any of the foregoing; and 24 wheels only having a diameter of at least 2 inches (50.8 mm)
Footwear: shoes	6 pairs of suitable size[b]; conductive material sufficient for 24 specimens, each nominally 1 by 7 inches (25.4 by 178 mm)
Footwear: shoe covers[c]	12 pairs
Mattress	1 of largest size; 1 additional for each different method of closure employed; conductive sheeting (cover material) 3 by 3 feet (0.91 by 0.91 m) or of an area equivalent to 9 square feet (0.84 m^2)
Pad	Same as for a mattress
Restraint strap	12
Sheeting	3 feet (0.91 m) length of the widest sheeting
Tubing, hose smooth-walled	10 feet (3.05 m) of each inside diameter; 10 feet of each wall thickness; 50 feet (15.25 m) of a median size

[a] One copy of instructions for installation of the appliance in the end-use equipment is required.

[b] Size is to be determined by shoe size of personnel available to conduct test.

[c] One copy of instructions for use of the shoe covers is required.

9 Cleansing Agents

9.1 Samples or specimens are to be subjected to two washings per day using a 2-percent solution, by volume, of liquid coconut-oil-based toilet soap in tap water that has a hardness of 110 – 170 parts per million of $CaCO_3$ and a pH between 6.0 – 8.0.

9.2 The samples or specimens are to be allowed to dry, without rinsings, before measurements are made.

9.3 Electrical resistance is to be measured:

a) For equipment not intended to be reused, after two washings.

b) For reusable equipment, after 12 washings and after 24 washings.

10 Antiseptics

10.1 Samples or specimens are to be treated twice daily, using separate samples or specimens for each antiseptic, with the following solutions:

a) Iodine, 2 percent by volume in distilled water and alcohol (44 – 50 percent alcohol).

b) Cresol-type disinfectant, 5 percent by volume in distilled water.

c) Phenol (carbolic acid), 5 percent by volume in distilled water.

10.2 The samples or specimens are to be allowed to dry without removing the antiseptics before measurements are made.

10.3 Electrical resistance is to be measured:

a) For equipment not intended to be reused, after two treatments.

b) For reusable equipment, after 12 treatments and after 24 treatments.

11 Oil

11.1 Samples or specimens are to be immersed in SAE 30 regular, nondetergent, ashless engine oil.

11.2 The excess oil is to be removed with a cloth before measurements are made.

11.3 Electrical resistance is to be measured:

a) For equipment not intended to be reused, after immersion for 8 hours.

b) For reusable equipment, after immersion for 120 hours.

12 Ethyl Ether

12.1 CAUTION – When testing with ethyl ether, vapor, or liquid, extreme precautions should be taken. Ethyl ether is extremely flammable. It is a severe fire and explosion hazard when exposed to heat or flame. It forms explosive peroxides, and has physiological effects through inhalation and skin absorption.

12.2 Samples or specimens are to be subjected to the applicable exposure tests specified in 12.4 – 12.8 – also see 12.3. Except as specified in 12.3 and 12.7, electrical resistance is to be measured during and immediately after exposure.

12.3 As an alternative to the exposure to saturated vapor as specified in 12.4 – 12.6 and 12.8, samples or specimens shall be immersed in liquid ethyl ether for 15 minutes, when agreeable to those concerned. Electrical resistance is to be measured immediately after exposure.

12.4 ANESTHESIA FACE MASKS, ANESTHESIA RESERVOIR BAGS, AND BREATHING TUBES – Samples are to be subjected for 24 hours to the saturated vapor of ethyl ether on internal surfaces at an ambient temperature of 32 ±3°C (90 ±5.4°F).

12.5 BREATHING TUBES – Breathing tubes are to be subjected for 24 hours to the saturated vapor of ethyl ether on internal surfaces at 32 ±3°C (90 ±5.4°F).

12.6 SMOOTH-WALLED TUBING – Except as noted in 12.7, the inside wall of a sample length of tubing not exceeding 5 feet (1.5 m) is to be subjected for 5 hours to ethyl ether in the liquid phase under a pressure of 26 inches (660.4 mm) of ethyl ether.

12.7 When the tubing is marked as indicated in 21.2, a sample length of tubing is to be subjected for 24 hours to the saturated vapor of ethyl ether at 32 ±3°C (90 ±5.4°F).

12.8 HOSE INTENDED FOR USE UNDER INTERNAL PRESSURE GREATER THAN 100 PSI (689 kPa) – Samples or specimens are to be exposed for 24 hours to the saturated vapor of ethyl ether at a temperature of 25 ±3°C (77 ±5.4°F) for 24 hours. Electrical resistance is to be measured after exposure.

13 Low Humidity

13.1 Samples or specimens are to be conditioned for at least 672 hours in a drying chamber containing calcium sulfate or an equivalent moisture-absorptive substance.

13.2 Electrical resistance is to be measured at weekly intervals during exposure and at the end of exposure.

14 Accelerated Aging

14.1 RUBBER AND SIMILAR MATERIALS – Samples or specimens are to be exposed in an air oven for 70 hours at 100°C±2°C (212°F ±3.6°F).

14.2 THERMOPLASTIC MATERIALS – Samples or specimens are to be conditioned for 1440 hours in an air-circulating oven at a temperature of 70 ±1°C (158 ±1.8°F), or at the manufacturer's option, for 168 hours at a temperature of 100 ±1°C (212 ±1.8°F).

14.3 Electrical resistance is to be measured after exposure as specified in 14.1 or 14.2. See also Tensile Strength and Elongation Tests, Section 19.

15 Usage

15.1 Bonding appliances and casters

15.1.1 One bonding appliance or two casters are to be mounted in accordance with instructions and subjected to simulated normal travel. The load on each appliance or caster is not to exceed that specified by the manufacturer. As an alternative to simulated travel for casters, a 1/4-inch (6.4-mm) thick layer of conductive material may be removed from the periphery of each of two wheels to simulate wear.

15.1.2 For the simulated-normal-travel method, electrical resistance is to be measured daily until the trend in change-of-resistance has been noted. The test is to be discontinued when two consecutive readings show that the resistance has stabilized or has reached an unacceptable value. For the alternative method for casters, the electrical resistance is to be measured using the remaining portions of the two wheels.

15.2 Footwear

15.2.1 Conductive shoes and shoe covers are to be subjected to 8 hours of wear per day with at least 4 hours of standing or walking on nonabrasive vinyl or asphalt surfaces. Shoe covers are to be worn in accordance with the instructions provided.

15.2.2 At least four pairs of shoes and at least one pair of shoe covers are to be conditioned as specified in 15.2.1.

15.2.3 Electrical resistance is to be measured (see 16.3.2.1):

a) For shoe covers (nonreusable), after 1 working day (8 hours).

b) For shoes, at weekly intervals until two consecutive measurements show that the resistance has stabilized or has reached an unacceptable value.

15.3 Anesthesia face masks, head harness

15.3.1 A sample is to be suspended from two rigid supports, by two straps on one side. A 2-pound (0.91-kg) weight is to be attached for 24 hours to the free end of each strap.

15.3.2 Electrical resistance is to be measured after conditioning as specified in 15.3.1.

15.4 Anesthesia reservoir bags

15.4.1 A sample is to be fully inflated using a supply of compressed air, and allowed to collapse.

15.4.2 Electrical resistance is to be measured after each 50 cycles of inflation and collapse until two consecutive measurements show that the resistance has stabilized or has reached an unacceptable value.

15.5 Restraint straps

15.5.1 A length of the conductive material is to be suspended from a rigid support and subjected for 24 hours to the constant tension provided by a 25-pound (11.3-kg) weight attached to the free end of the sample.

15.5.2 A length of the conductive material is to be suspended from a rigid support and subjected to the intermittent tension provided by a 25-pound (11.3-kg) weight attached to the free end of the sample, for 5 seconds of each minute, until the resistance has stabilized or has reached an unacceptable value.

15.5.3 Two specimens of the conductive material are to be autoclaved for 75 hours at a pressure of 15 psig (103 kPa) and a temperature of 250°F (121°C).

15.5.4 Electrical resistance is to be measured:

a) After the conditioning specified in 15.5.1;

b) At intervals during the conditioning specified in 15.5.2 until two consecutive measurements show that the resistance has stabilized or has reached an unacceptable value; and

c) After the specimens have been conditioned as specified in 15.5.3 and have been allowed to dry.

15.6 Mattresses, pads, sheeting

15.6.1 A specimen of the conductive material is to be drawn back and forth as far as possible over a 1-inch (25.4-mm) diameter pulley at a contact angle of 90 – 180 degrees, while held in tension by a 2-pound (0.91-kg) weight suspended from the free end of the sample.

15.6.2 Two specimens of the conductive material are to be autoclaved for 75 hours at a pressure of 15 psig (103 kPa) and a temperature of 250°F (121°C).

15.6.3 Electrical resistance is to be measured:

a) After each 50 cycles of the conditioning specified in 15.6.1 until two consecutive measurements show that the measurement has stabilized or has reached an unacceptable value; and

b) After the specimens conditioned as specified in 15.6.2 have been allowed to dry.

15.7 Tubing and hose

15.7.1 Except as noted in 15.7.2, a 5-foot (1.5-m) length of tubing or hose is to be fitted with the electrodes as specified in 16.2.1.3. The length of tubing or hose is to be drawn back and forth as far as possible over a 1-3/4-inch (44-mm) diameter pulley at a contact angle of 90 – 180 degrees while held in tension by a 5-pound (2.3-kg) weight suspended from the free end of the sample.

15.7.2 Breathing tubes are to be conditioned as specified in 15.7.1 except that an 8-inch (203-mm) diameter pulley is to be used.

15.7.3 Electrical resistance is to be measured after each 50 cycles of the conditioning as specified in 15.7.1 and 15.7.2 until two consecutive measurements show that the resistance has stabilized or has reached an unacceptable value.

15.8 Pressurized hose

15.8.1 Two samples of hose intended for use at internal pressure exceeding 100 psi (689 kPa) are to be subjected to rated pressure for periods of 5 minutes.

15.8.2 Electrical resistance is to be measured after each cycle of pressurization until two consecutive measurements show that the resistance has stabilized or has reached an unacceptable value.

16 Electrical Resistance Tests

16.1 General

16.1.1 The electrical resistance of conductive equipment and materials shall not be more than the applicable value specified in Table 16.1 before, during, and after the conditionings described in Sections 9 – 15.

Table 16.1
Maximum resistances

Product	Maximum resistance[a]
Bonding appliances and casters	1/4 megohm
Footwear	1/2 megohm measured per Table 16.2
	1 megohm measured per 16.3.2.1
High pressure hose used to connect gas anesthesia apparatus to central piping station outlets	100,000 ohms per linear foot (305 mm)
All other equipment and materials	1 megohm

[a] After exposure to oil, 11.1 – 11.3, these values may be exceeded when the product is marked as specified in 21.3.

16.2 Test equipment

16.2.1 Electrodes

16.2.1.1 Electrodes used in making resistance measurements are to be the intended electrodes specified in Table 16.2 and described in 16.2.1.2 – 16.2.1.7.

Table 16.2
Electrodes or surfaces between which resistances are measured

Product	Type of electrode[a] or other surface	
	No. 1	No. 2
Anesthesia face mask	A	B
Anesthesia reservoir bag	B	F
Bonding appliance, caster	A	b
Breathing tubes	B	B
Footwear (shoes and shoe covers)[c]	A	C
Head harness	D	D
Mattress, pad[d]	A	E
Restraint strap	D or F	D or F
Sheeting	E[e]	E[e]
Tubing, hose	B	B

[a] See 16.2.1.2 – 16.2.1.7.

[b] Measurement is to be made to a point on the mounting means of the appliance or caster.

[c] See 16.3.2.1 and 16.3.2.2 for additional measurement on wearer.

[d] Resistance of the outer covering is also to be measured as for sheeting.

[e] Measurement is to be made with both electrodes on the same surface, and with the electrodes in the middle of opposite surfaces.

16.2.1.2 TYPE A – The electrode is to be a clean flat stainless steel plate having an area large enough to permit uninterrupted contact of the conductive surface of the product as intended in actual usage.

16.2.1.3 TYPE B – The electrode is to be a clean brass fitting of the same outside diameter as the connector intended to be used to connect the sample (anesthesia face mask, hose, or the like) in service. The fitting is to be constructed so that it contacts the internal surface of the inlet of the sample for a distance of at least 1/2 inch (12.7 mm) when connected for test.

16.2.1.4 TYPE C – The electrode is to be oblong. The top is to be a rigid metal plate having a length of 8-1/2 inches (216 mm) and semicircular ends 1-1/4 – 2 inches (31.8 – 50.8 mm) wide bent to conform to the usual shape of the interior of a shoe. A cushioning elastomer layer 9/16 inch (14.3 mm) thick is to be attached to the undersurface of the metal plate. The surface of the contact area is to be either aluminum or tin foil, 0.0005 – 0.001 inch (0.013 – 0.03 mm) thick, formed around the electrode so that it contacts the periphery of the metal plate.

16.2.1.5 TYPE D – The electrode is to be a clamp consisting of two stainless steel plates, each 2-1/2 inches (63.5 mm) long, 1-1/2 inches (38.1 mm) wide, and at least 1/16 inch (1.6 mm) thick. The plates are to be clamped together by two screws tightened by wing nuts.

16.2.1.6 TYPE E – The electrode is to weigh at least 5 pounds (2.3 kg) and is to have a dry, flat circular contact area 2-1/2 inches (63.5 mm) in diameter. The surface of the contact area is to be either aluminum foil or tin foil, 0.0005 – 0.001 inch (0.013 – 0.03 mm) thick, backed by a layer of rubber 1/4 inch (6.4 mm) thick. The rubber is to have a hardness reading of 40 – 50 using a Shore Type A durometer or the equivalent in accordance with the Test Method for Rubber Property – Durometer Hardness, ASTM D2240-95.

16.2.1.7 TYPE F – The electrode is to be a clamp consisting of two stainless steel plates, each 5 inches (127 mm) long, 1-1/2 inches (38.1 mm) wide, and at least 1/16 inch (1.6 mm) thick. The plates are to be clamped together by two screws tightened by wing nuts.

16.2.2 Ohmmeter

16.2.2.1 For all resistance measurements, a calibrated ohmmeter having a minimum internal resistance of 100,000 ohms and a nominal open-circuit potential of 500 volts, direct current, is to be used.

16.3 Procedure

16.3.1 General

16.3.1.1 Except as noted in 12.6, two samples of a complete product or two specimens of the conductive material employed are to be exposed to the conditionings described in Sections 9 – 15. When the specific size of specimens is not described for the exposure, the specimens are to have a nominal length of 7 inches (177.8 mm) and a width not exceeding 1 inch (25.4 mm). The percentage change in resistance of the specimen is to be correlated with the initial resistance and acceptable resistance value for a complete sample.

16.3.1.2 Prior to conditioning, each sample is to be clean and dry. It is not to have any foreign coating that might affect conductivity.

16.3.1.3 The intended electrodes, see Table 16.2, are to be applied as specified in 16.3.1.4, and the electrical resistance is to be measured using the ohmmeter described in 16.2.2.1 at the intervals specified for each conditioning.

16.3.1.4 The methods to be used in applying the electrodes described in 16.2.1.2 – 16.2.1.7 are:

a) Type A – The sample is to rest on the plate.

b) Type B – The electrode is to contact the internal surface of the sample for a distance of at least 1/2 inch (12.7 mm) when connected for test.

c) Type C – The electrode is to be inserted in the footwear so that it contacts both the heel and sole of the footwear. Electrode C is to be applied with a dead weight of 50 pounds (22.7 kg) for women's