

# UL 867

## Electrostatic Air Cleaners



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UL Standard for Safety for Electrostatic Air Cleaners, UL 867

Fourth Edition, Dated October 9, 2000

Revisions: This Standard contains revisions through and including December 21, 2007.

### **Summary of Topics**

***This revision of UL 867 is being issued to clarify ozone testing of electrostatic air cleaners and ionizers as described in Sections 28A, 37 and 37A. References to obsolete Standards in Appendix A have also been updated.***

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The following table lists the future effective dates with the corresponding item.

| Future Effective Date | References          |
|-----------------------|---------------------|
| June 30, 2008         | Sections 37 and 37A |

The new and/or revised requirements are substantially in accordance with UL's Proposal(s) on this subject dated June 22, 2007 and September 21, 2007.

The revisions dated December 21, 2007 include a reprinted title page (page1) for this Standard.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: <http://ulstandardsinfo.net/ul.com/ulforeword.html>

As indicated on the title page (page 1), this UL Standard for Safety is an American National Standard. Attention is directed to the note on the title page of this Standard outlining the procedures to be followed to retain the approved text of this ANSI/UL Standard.

As indicated on the title page (page1), this UL Standard for Safety has been adopted by the Department of Defense.

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This Standard consists of pages dated as shown in the following checklist:

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| 26 .....      | October 9, 2000   |
| 27 .....      | December 21, 2007 |
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| 47 .....      | December 21, 2007 |
| 48-53 .....   | October 9, 2000   |
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| A1-A2 .....   | December 21, 2007 |
| SR1-SR2 ..... | December 21, 2007 |

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**OCTOBER 9, 2000**  
(Title Page Reprinted: December 21, 2007)



**ANSI/UL 867-2007**

**1**

**UL 867**

**Standard for Electrostatic Air Cleaners**

First Edition – December, 1980  
Second Edition – October, 1989  
Third Edition – March, 1995

**Fourth Edition**

**October 9, 2000**

The most recent designation of ANSI/UL 867 as an American National Standard (ANSI) occurred on December 21, 2007.

This ANSI/UL Standard for Safety, which consists of the Fourth Edition with revisions through December 21, 2007 is under continuous maintenance, whereby each revision is ANSI approved upon publication.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc. and is not part of the ANSI standard.

The Department of Defense (DoD) has adopted UL 867 on June 11, 1992. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <http://csds.ul.com>.

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## INTRODUCTION

### 1 Scope

1.1 These requirements cover electrostatic air cleaners rated at 600 volts or less, intended to remove dust and other particles from the air and intended for use in accordance with the National Electrical Code, ANSI/NFPA 70.

1.2 These requirements do not cover electrostatic air cleaners for use in hazardous locations or to clean atmospheres defined as hazardous by the National Electrical Code, ANSI/NFPA 70.

1.3 These requirements do not cover air cleaners intended to remove particles other than dust and other particles normally found in heating and ventilating systems.

1.4 Requirements for the installation of duct-type electrostatic air cleaners are included in the Standard for the Installation of Air Conditioning and Ventilating Systems, NFPA 90A; and the Standard for the Installation of Warm Air Heating and Air Conditioning Systems, NFPA 90B.

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

### 2 General

#### 2.1 Components

2.1.1 Except as indicated in 2.1.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components used in the products covered by this standard.

2.1.2 A component is not required to comply with a specific requirement that:

- a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or
- b) Is superseded by a requirement in this standard.

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

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

## 2.2 Units of measurement

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

## 2.3 Undated references

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

## 3 Glossary

3.1 For the purposes of this standard the following definitions apply.

3.2 ACCESSIBLE PART – A part located so that it can be contacted by a person either directly or by means of a probe as specified in Accessibility of Uninsulated Live Parts and Moving Parts, Section 6.

3.3 AIR CLEANERS – An air cleaner is defined as one of the following:

a) Duct type – A fixed or stationary type air cleaner intended for installation in and at adjoining ducts of heating, air conditioning, and ventilating systems. The air cleaner is not provided with a fan, and the duct may provide part or all of the overall enclosure.

b) Fixed type – A self-contained or duct type air cleaner intended to be permanently connected electrically.

c) Portable type – A cord-and-plug-connected, self-contained type air cleaner that:

- 1) Can be easily moved from one place to another for use and
- 2) Has no provision for permanent mounting.

d) Self-contained type – A fixed, portable, or stationary type air cleaner that includes all parts necessary for its intended operation, including active cell, fan, and the overall enclosure.

e) Stationary type – A cord-and plug-connected, self-contained or duct type air cleaner that is constructed to be fastened in place or located in a dedicated space.

3.4 ELECTROSTATIC AIR CLEANER (AIR CLEANER) – A product intended to remove dust and other particles from the air. The complete product consists of an assembly of a power pack, controls, ionizer-collector cell, and other components.

3.5 EXPOSED PART – A part that is subjected to handling in normal use without removing parts such as doors, covers, or other parts if removal requires the use of a tool.

3.6 HIGH-VOLTAGE CIRCUIT – A circuit involving a potential of more than 600 volts.

3.7 ISOLATED-LIMITED-ENERGY CIRCUIT – A circuit derived from an isolated-secondary winding of a transformer having a maximum capacity of 100 volt-amperes and an open-circuit-secondary voltage rating not exceeding 600 volts.

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

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

**3.10 PARTIALLY PROTECTED PART** – A part that is exposed only during user servicing, with voltage and current limitations as specified in Partially Protected Parts, Section 34.

**3.11 POWER SUPPLY** – A unit consisting of a high-voltage transformer and other electrical component. The unit may also contain controls for the air cleaner.

**3.12 USER SERVICING** – The replacing, cleaning, or adjusting of filters or adjustment of controls and the like intended to be done by the user.

## **CONSTRUCTION**

### **4 General**

4.1 The construction of a product shall be such that all of the following conditions are met:

- a) Normal use and user servicing do not result in a risk of electric shock, fire, or injury to persons.
- b) The materials and component are used within their electrical, mechanical, and temperature limits.
- c) The assembly protects the components and wiring from being displaced or damaged.

### **5 Frame and Enclosure**

#### **5.1 General**

5.1.1 Electrical parts shall be provided with an enclosure.

5.1.2 Other than as noted in 5.1.3, an air-inlet or an air-outlet opening of a duct-type product may be considered enclosed by the adjacent duct work if an insulated or an uninsulated live part accessible without the duct work installed is at an energy level equal to or below that of a partially-protected part as specified in Partially Protected Parts, Section 34.

5.1.3 An air-inlet or an air-outlet opening not always intended to be attached to duct work is not considered to be enclosed.

5.1.4 The enclosure and parts of the enclosure such as doors, covers, and the like, shall be provided with means for securing them in place.

5.1.5 An enclosure or enclosure part shall be formed and assembled so that it will have the strength and rigidity necessary to resist the abuses to which it is likely to be subjected, without increasing its risk of fire, electric shock, or injury to persons due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

5.1.6 A cast-metal or die-cast metal enclosure shall be investigated to determine that it is equivalent to sheet metal.

5.1.7 A nonmetallic enclosure shall be evaluated in accordance with the Standard for Polymeric Materials – Use In Electrical Equipment Evaluations, UL 746C.

5.1.8 Among the factors taken into consideration when evaluating the acceptability of a nonmetallic enclosure are:

- a) The mechanical strength,
- b) Resistance to impact,
- c) Moisture-absorptive properties,
- d) Combustibility, and
- e) Resistance to distortion at temperatures to which the material may be subjected under conditions of normal or abnormal usage.

5.1.9 Glass covering an observation opening shall be secured in place so that it cannot be readily displaced in service, and shall provide mechanical protection for the enclosed parts.

5.1.10 Glass for an opening not more than 4 inches (102 mm) in any dimension shall not be less than 0.055 inch (1.40 mm) thick. Glass for a larger opening, but not more than 144 square inches (929 cm<sup>2</sup>) in area and having no dimensions greater than 12 inches (305 mm), shall not be less than 0.115 inch (2.92 mm) thick.

5.1.11 Glass used to cover an opening larger than 144 square inches (929 cm<sup>2</sup>) shall be investigated to determine that it has the necessary mechanical strength and is otherwise suitable for the purpose.

## 5.2 High-voltage power supply

5.2.1 A high-voltage power supply shall be housed within its own enclosure or within a separate compartment of the main enclosure of the product or comply with the requirements specified in 45.4.1 – 45.5.1.

5.2.2 A power-supply enclosure shall be:

- a) Uncoated sheet steel not less than 0.026 inch (0.66 mm) thick;
- b) Zinc-coated sheet steel not less than 0.029 inch (0.74 mm) thick;
- c) Copper, brass, or aluminum not less than 0.036 inch (0.91 mm) thick; or
- d) A polymeric material complying with the applicable requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

## 5.3 Stationary or fixed products

5.3.1 Other than as noted in 5.3.2, the thickness of a sheet-metal enclosure of a control panel, a duct door, or a similar component shall be as specified in Tables 5.1 and 5.2.

*Exception: Table 5.3 may be used for products that are only intended for ceiling mounting.*

**Table 5.1**  
**Minimum thickness of carbon steel or stainless steel enclosures**

Table 5.1 revised February 27, 2004

| Without supporting frame <sup>a</sup> |                                      |                                        | With supporting frame or equivalent reinforcing <sup>a</sup> |                                      |                                        | Minimum thickness for uncoated, |      | Minimum thickness for coated, |      |
|---------------------------------------|--------------------------------------|----------------------------------------|--------------------------------------------------------------|--------------------------------------|----------------------------------------|---------------------------------|------|-------------------------------|------|
| Maximum width, <sup>b</sup><br>inches | Maximum length, <sup>c</sup><br>(cm) | Maximum length, <sup>c</sup><br>inches | Maximum width, <sup>b</sup><br>inches                        | Maximum length, <sup>c</sup><br>(cm) | Maximum length, <sup>c</sup><br>inches |                                 |      |                               |      |
| 4.0                                   | 10.2                                 | Not limited                            | 6.25                                                         | 15.9                                 | Not limited                            | 0.020 <sup>d</sup>              | 0.51 | 0.023 <sup>d</sup>            | 0.58 |
| 4.75                                  | 12.1                                 | 5.75 14.6                              | 6.75                                                         | 17.1                                 | 8.25 21.0                              |                                 |      |                               |      |
| 6.0                                   | 15.2                                 | Not limited                            | 9.5                                                          | 24.1                                 | Not limited                            | 0.026 <sup>d</sup>              | 0.66 | 0.029 <sup>d</sup>            | 0.74 |
| 7.0                                   | 17.8                                 | 8.75 22.2                              | 10.0                                                         | 25.4                                 | 12.5 31.8                              |                                 |      |                               |      |
| 8.0                                   | 20.3                                 | Not limited                            | 12.0                                                         | 30.5                                 | Not limited                            | 0.032                           | 0.81 | 0.034                         | 0.86 |
| 9.0                                   | 22.9                                 | 11.5 29.2                              | 13.0                                                         | 33.0                                 | 16.0 40.6                              |                                 |      |                               |      |
| 12.5                                  | 31.8                                 | Not limited                            | 19.5                                                         | 49.5                                 | Not limited                            | 0.042                           | 1.07 | 0.045                         | 1.14 |
| 14.0                                  | 35.6                                 | 18.0 45.7                              | 21.0                                                         | 53.3                                 | 25.0 63.5                              |                                 |      |                               |      |
| 18.0                                  | 45.7                                 | Not limited                            | 27.0                                                         | 68.6                                 | Not limited                            | 0.053                           | 1.35 | 0.056                         | 1.42 |
| 20.0                                  | 50.8                                 | 25.0 63.5                              | 29.0                                                         | 73.7                                 | 36.0 91.4                              |                                 |      |                               |      |
| 22.0                                  | 55.9                                 | Not limited                            | 33.0                                                         | 83.8                                 | Not limited                            | 0.060                           | 1.52 | 0.063                         | 1.60 |
| 25.0                                  | 63.5                                 | 31.0 78.7                              | 35.0                                                         | 88.9                                 | 43.0 109.2                             |                                 |      |                               |      |
| 25.0                                  | 63.5                                 | Not limited                            | 39.0                                                         | 99.1                                 | Not limited                            | 0.067                           | 1.70 | 0.070                         | 1.78 |
| 29.0                                  | 73.7                                 | 36.0 91.4                              | 41.0                                                         | 104.1                                | 51.0 129.5                             |                                 |      |                               |      |
| 33.0                                  | 83.8                                 | Not limited                            | 51.0                                                         | 129.5                                | Not limited                            | 0.080                           | 2.03 | 0.084                         | 2.13 |
| 38.0                                  | 96.5                                 | 47.0 119.4                             | 54.0                                                         | 137.2                                | 66.0 167.6                             |                                 |      |                               |      |
| 42.0                                  | 106.7                                | Not limited                            | 64.0                                                         | 162.6                                | Not limited                            | 0.093                           | 2.36 | 0.097                         | 2.46 |
| 47.0                                  | 119.4                                | 59.0 149.9                             | 68.0                                                         | 172.7                                | 84.0 213.4                             |                                 |      |                               |      |
| 52.0                                  | 132.1                                | Not limited                            | 80.0                                                         | 203.2                                | Not limited                            | 0.108                           | 2.74 | 0.111                         | 2.82 |

Table 5.1 Continued

| Without supporting frame <sup>a</sup>                                                                                                                                                                                                                                      |       |                              |       | With supporting frame or equivalent reinforcing <sup>a</sup> |       |                              |       | Minimum thickness for uncoated, |      | Minimum thickness for coated, |      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------------------------|-------|--------------------------------------------------------------|-------|------------------------------|-------|---------------------------------|------|-------------------------------|------|
| Maximum width, <sup>b</sup>                                                                                                                                                                                                                                                |       | Maximum length, <sup>c</sup> |       | Maximum width, <sup>b</sup>                                  |       | Maximum length, <sup>c</sup> |       |                                 |      |                               |      |
| inches                                                                                                                                                                                                                                                                     | (cm)  | inches                       | (cm)  | inches                                                       | (cm)  | inches                       | (cm)  | inch                            | (mm) | inch                          | (mm) |
| 60.0                                                                                                                                                                                                                                                                       | 152.4 | 74.0                         | 188.0 | 84.0                                                         | 213.4 | 103.0                        | 261.6 | 0.123                           | 3.12 | 0.126                         | 3.20 |
| 63.0                                                                                                                                                                                                                                                                       | 160.0 | Not limited                  |       | 97.0                                                         | 246.4 | Not limited                  |       |                                 |      |                               |      |
| 73.0                                                                                                                                                                                                                                                                       | 185.4 | 90.0                         | 228.6 | 103.0                                                        | 261.6 | 127.0                        | 322.6 |                                 |      |                               |      |
| <sup>a</sup> See 5.3.4 and 5.3.5.                                                                                                                                                                                                                                          |       |                              |       |                                                              |       |                              |       |                                 |      |                               |      |
| <sup>b</sup> The width is the smaller dimension of a rectangular sheet metal piece which is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.                                                             |       |                              |       |                                                              |       |                              |       |                                 |      |                               |      |
| <sup>c</sup> For panels which are not supported along one side, for example, side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide. |       |                              |       |                                                              |       |                              |       |                                 |      |                               |      |
| <sup>d</sup> Sheet metal for an enclosure intended for outdoor use – rainproof – shall not be less than 0.034 inch (0.86 mm) thick if zinc-coated and not less than 0.032 inch (0.81 mm) thick if uncoated.                                                                |       |                              |       |                                                              |       |                              |       |                                 |      |                               |      |

**Table 5.2**  
**Thickness of sheet metal for enclosures of aluminum, copper, or brass**

| Without supporting frame <sup>a</sup>      |                                             | With supporting frame or equivalent reinforcing <sup>a</sup> |                                             |                                             |             | Minimum thickness,<br>inch (mm) |       |       |      |
|--------------------------------------------|---------------------------------------------|--------------------------------------------------------------|---------------------------------------------|---------------------------------------------|-------------|---------------------------------|-------|-------|------|
| Maximum width, <sup>b</sup><br>inches (cm) | Maximum length, <sup>c</sup><br>inches (cm) | Maximum width, <sup>b</sup><br>inches (cm)                   | Maximum length, <sup>c</sup><br>inches (cm) | Maximum length, <sup>c</sup><br>inches (cm) |             |                                 |       |       |      |
| 3.0                                        | 7.6                                         | Not limited                                                  | 7.0                                         | 17.8                                        | Not limited | 0.023 <sup>d</sup>              | 0.58  |       |      |
| 3.5                                        | 8.9                                         | 4.0                                                          | 10.2                                        | 8.5                                         | 21.6        |                                 |       | 9.5   | 24.1 |
| 4.0                                        | 10.2                                        | Not limited                                                  | 10.0                                        | 25.4                                        | Not limited |                                 |       |       |      |
| 5.0                                        | 12.7                                        | 6.0                                                          | 15.2                                        | 10.5                                        | 26.7        | 13.5                            | 34.3  | 0.029 | 0.74 |
| 6.0                                        | 15.2                                        | Not limited                                                  | 14.0                                        | 35.6                                        | Not limited |                                 |       | 0.036 | 0.91 |
| 6.5                                        | 16.5                                        | 8.0                                                          | 20.3                                        | 15.0                                        | 38.1        | 18.0                            | 45.7  |       |      |
| 8.0                                        | 20.3                                        | Not limited                                                  | 19.0                                        | 48.3                                        | Not limited |                                 |       |       |      |
| 9.5                                        | 24.1                                        | 11.5                                                         | 29.2                                        | 21.0                                        | 53.3        | 25.0                            | 63.5  | 0.045 | 1.14 |
| 12.0                                       | 30.5                                        | Not limited                                                  | 28.0                                        | 71.1                                        | Not limited |                                 |       | 0.058 | 1.47 |
| 14.0                                       | 35.6                                        | 16.0                                                         | 40.6                                        | 30.0                                        | 76.2        | 37.0                            | 94.0  |       |      |
| 18.0                                       | 45.7                                        | Not limited                                                  | 42.0                                        | 106.7                                       | Not limited |                                 |       |       |      |
| 20.0                                       | 50.8                                        | 25.0                                                         | 63.4                                        | 45.0                                        | 114.3       | 55.0                            | 139.7 | 0.075 | 1.91 |
| 25.0                                       | 63.5                                        | Not limited                                                  | 60.0                                        | 152.4                                       | Not limited |                                 |       | 0.095 | 2.41 |
| 29.0                                       | 73.7                                        | 36.0                                                         | 91.4                                        | 64.0                                        | 162.6       | 78.0                            | 198.1 |       |      |
| 37.0                                       | 94.0                                        | Not limited                                                  | 87.0                                        | 221.0                                       | Not limited |                                 |       |       |      |
| 42.0                                       | 106.7                                       | 53.0                                                         | 134.6                                       | 93.0                                        | 236.2       | 114.0                           | 289.6 | 0.122 | 3.10 |
| 52.0                                       | 132.1                                       | Not limited                                                  | 123.0                                       | 312.4                                       | Not limited |                                 |       | 0.153 | 3.89 |
| 60.0                                       | 152.4                                       | 74.0                                                         | 188.0                                       | 130.0                                       | 330.2       | 160.0                           | 406.4 |       |      |

<sup>a</sup> See 5.3.4 and 5.3.5.

<sup>b</sup> The width is the smaller dimension of a rectangular sheet metal piece which is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

<sup>c</sup> For panels which are not supported along one side, for example, side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide.

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

**Table 5.3**  
**Thickness of sheet metal for an enclosure of a ceiling-mounted product or an ionizer-collector frame assembly**

| Maximum dimension, inches (mm) |     | Maximum area of any surface, feet <sup>2</sup> (m <sup>2</sup> ) |      | Minimum thickness,       |                     |                        |                     |                                                 |                     |                        |                     |                                     |                                                            |
|--------------------------------|-----|------------------------------------------------------------------|------|--------------------------|---------------------|------------------------|---------------------|-------------------------------------------------|---------------------|------------------------|---------------------|-------------------------------------|------------------------------------------------------------|
|                                |     |                                                                  |      | Steel                    |                     |                        |                     |                                                 |                     |                        |                     | Copper, brass, or aluminum          |                                                            |
|                                |     |                                                                  |      | Without supporting frame |                     |                        |                     | With supporting frame or equivalent reinforcing |                     |                        |                     | Without supporting frame,           |                                                            |
|                                |     |                                                                  |      | Zinc coated, inch (mm)   | Uncoated, inch (mm) | Zinc coated, inch (mm) | Uncoated, inch (mm) | Zinc coated, inch (mm)                          | Uncoated, inch (mm) | Zinc coated, inch (mm) | Uncoated, inch (mm) | Without supporting frame, inch (mm) | With supporting frame or equivalent reinforcing, inch (mm) |
| 60                             | 1.5 | 10.42                                                            | 0.97 | 0.034                    | 0.86                | 0.032                  | 0.81                | 0.029                                           | 0.74                | 0.026                  | 0.66                | 0.045                               | 0.66                                                       |
| 90                             | 2.3 | 10.42                                                            | 0.97 | 0.045                    | 1.14                | 0.034                  | 1.14                | 0.034                                           | 0.86                | 0.032                  | 0.81                | 0.058                               | 0.81                                                       |
| Greater than 90                | 2.3 | 10.42                                                            | 0.97 | 0.056                    | 1.42                | 0.053                  | 1.35                | 0.045                                           | 1.14                | 0.042                  | 1.07                | 0.075                               | 1.07                                                       |

5.3.2 A sheet-metal wall to which a wiring system is to be connected in the field shall have a thickness of not less than:

- a) 0.032 inch (0.81 mm) if uncoated steel,
- b) 0.034 inch (0.86 mm) if galvanized steel, or
- c) 0.045 inch (1.14 mm) if nonferrous.

5.3.3 Tables 5.1 and 5.2 are based on a uniform deflection of the enclosure surface for any given load concentrated at the center of the surface regardless of metal thickness.

5.3.4 With reference to Tables 5.1 – 5.3, a supporting frame is an angled structure, or channel, or a folded rigid section of sheet metal that is:

- a) Rigidly attached to the enclosure surface,
- b) Has essentially the same outside dimensions as the enclosure surface, and
- c) Has sufficient torsional rigidity to resist the bending moments that may be applied by the enclosure surface if it is deflected.

5.3.5 Equivalent reinforcing may be accomplished by constructions that will produce a structure as rigid as one that is built with a frame of angles or channels. Construction types without a supporting frame include:

- a) A single sheet with single formed flanges – formed edges;
- b) A single sheet that is corrugated or ribbed; or
- c) An enclosure surface loosely attached to a frame, for example, with spring clips.

5.3.6 The thickness of a sheet-steel enclosure of an ionizer-collector frame assembly shall be as specified in 5.3.2 and Table 5.3.

5.3.7 A duct-mounted product shall be provided with flanges that are acceptable for connection to a duct system on the air-inlet and air-outlet sides.

*Exception: In place of flanges, holes may be provided in the sides of the ionizer-collector frame assembly for the attachment of flanges or equivalent means to mount the product to the duct system.*

## 5.4 Portable products

5.4.1 A sheet-metal enclosure shall be evaluated with respect to its size, shape, thickness of metal, and its suitability for the application, considering the intended use of the complete air cleaner. The thickness of sheet steel shall not be less than 0.026 inch (0.66 mm) if uncoated or 0.030 inch (0.76 mm) if galvanized. Other sheet metal shall have a thickness not less than 0.036 inch (0.91 mm) except for small areas or for surfaces that are curved or otherwise reinforced.

5.4.2 A wooden enclosure shall not be less than 1/2 inch (12.7 mm) thick.

## 6 Accessibility of Uninsulated Live Parts and Moving Parts

6.1 An opening in an enclosure shall comply with the following to reduce the likelihood of unintentional contact that may involve a risk of electric shock from an uninsulated live part or film-coated (magnet) wire, or injury to persons from a moving part:

- a) With regard to 6.5, for an opening that has a minor dimension less than 1 inch (25.4 mm), such a part or wire shall not be contacted by the probe illustrated in Figure 6.1.

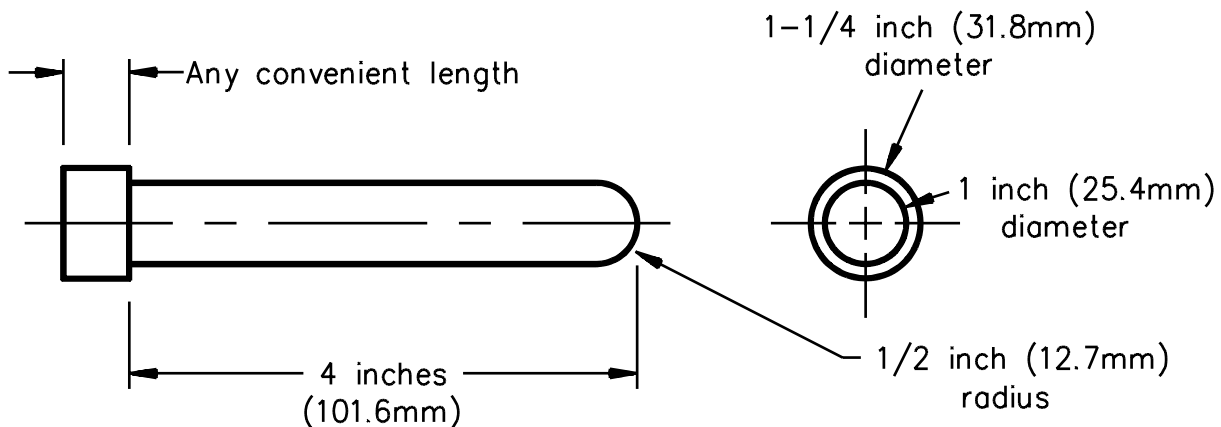
*Exception: For a product only intended to be ceiling mounted, the probe illustrated in Figure 6.2 shall not contact moving part.*

- b) For an opening that has a minor dimension of 1 inch or more, such a part or wire shall be spaced from the opening as specified in Table 6.1.

*Exception: A motor need not comply with the requirements in (a) or (b) if it complies with the requirements in 6.2.*



**Figure 6.2**  
**Probe for moving parts of a ceiling mounted air cleaner**



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**Table 6.1**  
**Minimum distance from an opening to a part that may involve a risk of electric shock or injury to persons**

| Minor dimension of opening, <sup>a,b</sup> |      | Minimum distance from opening to part <sup>b</sup> , |       |
|--------------------------------------------|------|------------------------------------------------------|-------|
| inches                                     | (mm) | inches                                               | (mm)  |
| 3/4 <sup>c</sup>                           | 19.1 | 4-1/2                                                | 114.0 |
| 1 <sup>c</sup>                             | 25.4 | 6-1/2                                                | 165.0 |
| 1-1/4                                      | 31.8 | 7-1/2                                                | 190.0 |
| 1-1/2                                      | 38.1 | 12-1/2                                               | 318.0 |
| 1-7/8                                      | 47.6 | 15-1/2                                               | 394.0 |
| 2-1/8                                      | 54.0 | 17-1/2                                               | 444.0 |
| See footnote d                             |      | 30                                                   | 762.0 |

<sup>a</sup> See 6.5.  
<sup>b</sup> Between 3/4 and 2-1/8 inches, interpolation is to be used to determine a value between values specified in the table.  
<sup>c</sup> Any dimension less than 1 inch applies to a motor only.  
<sup>d</sup> More than 2-1/8 inches, but not more than 6 inches (152.0 mm).

6.2 Regarding a part or wire in an integral enclosure of a motor as mentioned in the Exception to 6.1:

a) An opening, as specified in 6.5, that has a minor dimension less than 3/4 inch (19.1 mm) may be used if:

1) A moving part cannot be contacted by the probe illustrated in Figure 6.3.

- 2) Film-coated (magnet) wire cannot be contacted by the probe illustrated in Figure 6.4.
  - 3) No uninsulated live part in a directly accessible motor, as described in 6.7, can be contacted by the probe illustrated in Figure 6.5.
  - 4) No uninsulated live part in an indirectly accessible motor, as described in 6.6, can be contacted by the probe illustrated in Figure 6.3.
- b) An opening that has a minor dimension of  $\frac{3}{4}$  inch or more may be used if a part or wire is spaced from the opening as specified in Table 6.1.

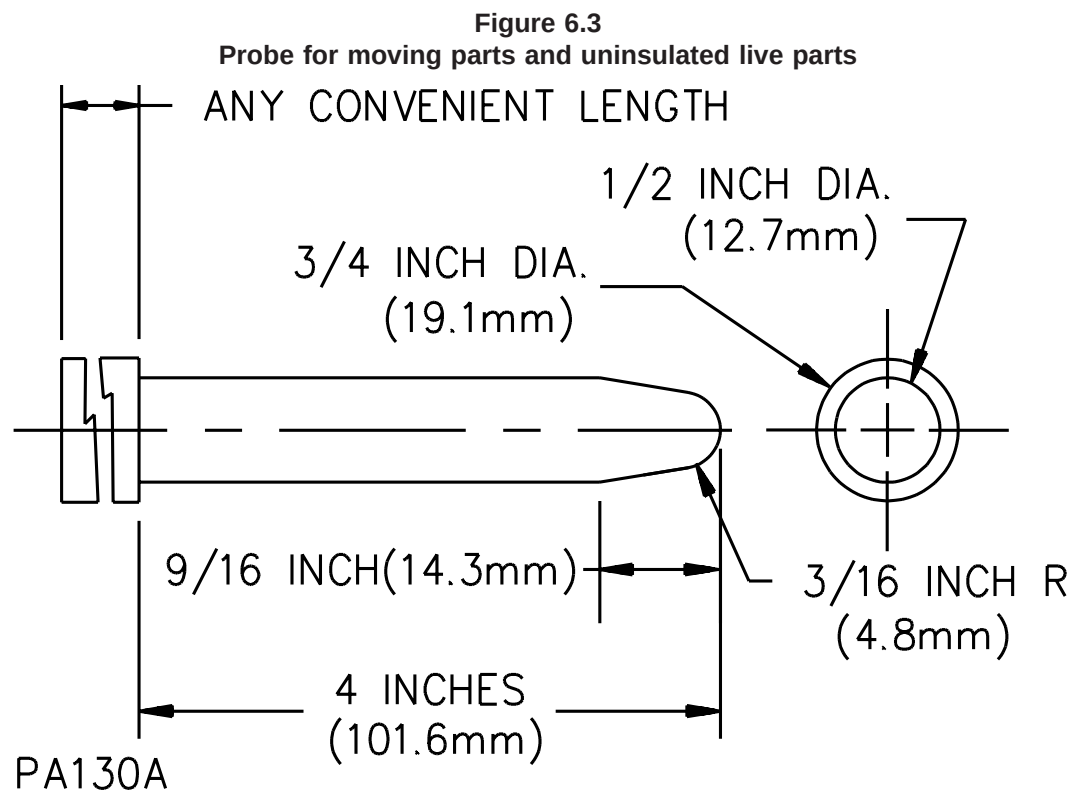


Figure 6.4  
Probe for film-coated (magnet) wire

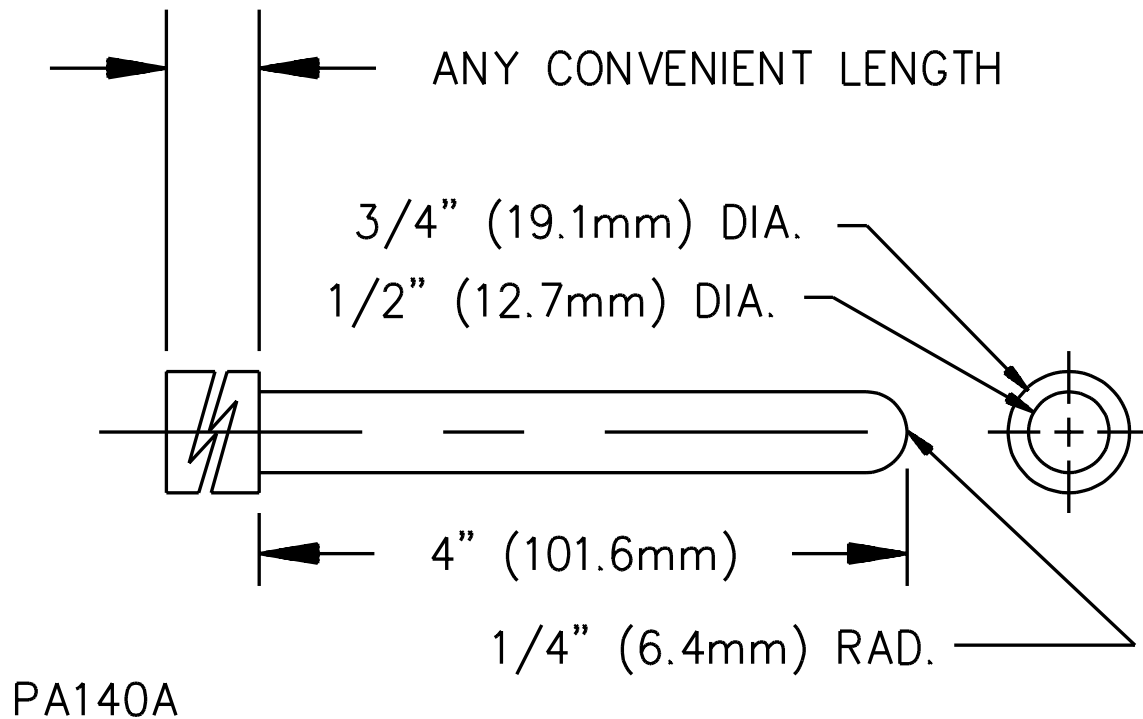
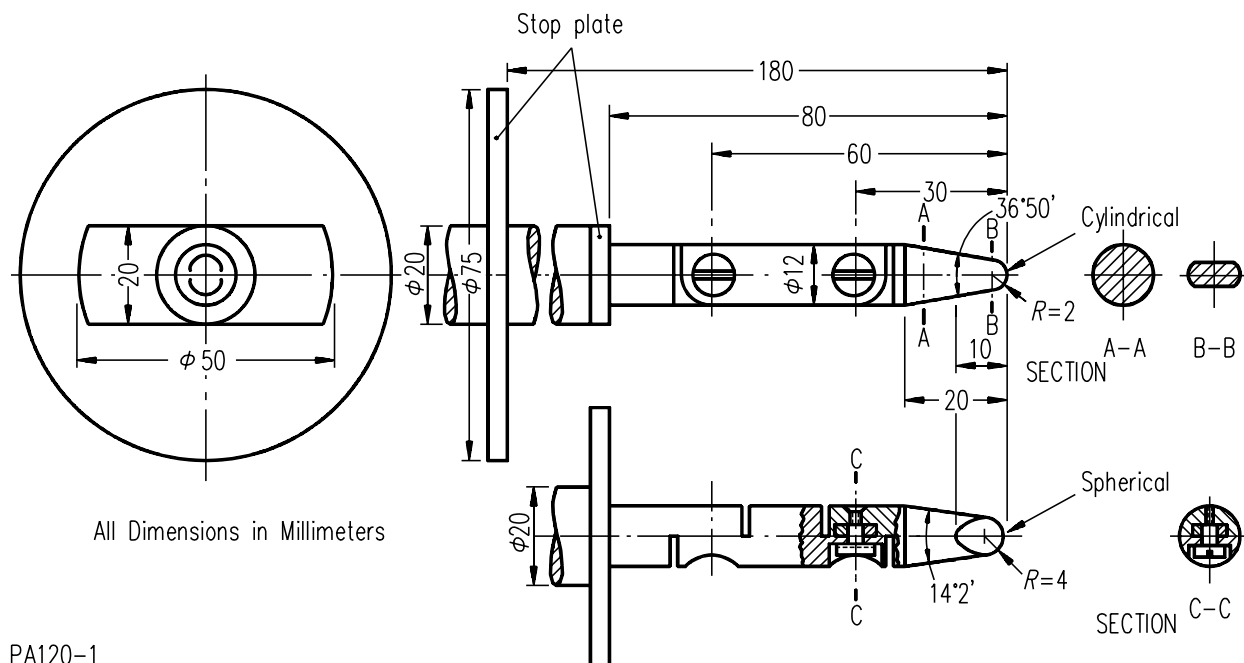


**Figure 6.5**  
**Articulate probe**



6.3 The probes mentioned in 6.1 and 6.2 and illustrated in Figures 6.1 – 6.5 shall be applied to any depth that the opening will permit. They shall be rotated or angled before, during, and after insertion through the opening to any position that is necessary to examine the enclosure. The probes illustrated in Figures 6.1 and 6.5 shall be applied in any possible configuration. If necessary, the configuration shall be changed after insertion through the opening.

6.4 The probes mentioned in 6.3 and 6.5 are to be used as measuring instruments to evaluate the accessibility provided by an opening, and not as instruments to evaluate the strength of a material. They are to be applied with the minimum force necessary to determine accessibility.

6.5 With reference to the requirements in 6.1 and 6.2, the minor dimension of an opening is the diameter of the largest cylindrical probe having a hemispherical tip that can be inserted through the opening.

6.6 With reference to the requirements in 6.2, an indirectly accessible motor is a motor that is:

- a) Accessible only by opening or removing a part of the outer enclosure, such as a guard or panel, that can be opened or removed without using a tool or
- b) Located at such a height or is otherwise guarded or enclosed so that it is unlikely to be contacted.

6.7 A directly accessible motor is a motor that:

- a) Can be contacted without opening or removing any part or
- b) Is located so as to be accessible to contact.

6.8 During the examination of a product to determine whether it complies with the requirements in 6.1 or 6.2, a part of the enclosure that may be opened or removed by the user without using a tool (to attach an accessory, to make an operating adjustment, or for other reasons) is to be opened or removed.

6.9 With reference to the requirements in 6.1 and 6.2, insulated brush caps are not required to be additionally enclosed.

6.10 If the opening or removal of a door, a cover, or any other component required for user servicing permits access to a part that is considered to present a risk of electric shock (see 34.1), the door, cover, or component shall be provided with an interlock switch as specified in 28.2.1 – 28.2.5 to de-energize the primary circuit of the high-voltage power supply.

6.11 Unless a mechanical means is provided to discharge to ground any residual charge existing in the high-voltage parts after the primary circuit is de-energized, a time-delay feature shall be provided so that live parts do not become accessible until residual charges decay as required in 43.1.

## 7 Mechanical Assembly

### 7.1 General

7.1.1 A product shall be assembled so that it will not be adversely affected by the vibration of normal operation.

7.1.2 Provision shall be made for mounting a product securely. Bolts, screws, or other parts used for mounting the product shall be independent of those used for securing components of the product to the frame, base, or panel.

7.1.3 The mounting assembly shall be capable of supporting four times the weight of the product for 1 minute.

*Exception: A product that is intended to be mounted to a duct system need not comply with this requirement.*

7.1.4 A switch, a lampholder, an attachment-plug receptacle, a motor-attachment plug, or similar component shall be mounted securely and shall be prevented from turning.

*Exception No. 1: A switch need not be prevented from turning if all four of the following conditions are met:*

- a) The switch is of a plunger or other type that does not tend to rotate. A toggle switch is considered to be subjected to forces that turn the switch during its normal operation.*
- b) It is unlikely that the operation of the switch will loosen its mounting means.*
- c) Spacings are not reduced below the minimum values if the switch rotates.*
- d) Normal operation of the switch is by mechanical means rather than by direct contact by persons.*

*Exception No. 2: A lampholder of the type in which the lamp cannot be replaced, such as for a neon pilot or indicator light in which the lamp is sealed by a nonremovable jewel, need not be prevented from turning if rotation cannot reduce the spacings below the minimum required values.*

7.1.5 Means for preventing the turning mentioned in 7.1.4 is to consist of more than friction between surfaces. For instance, a properly applied lock washer can be used as a means to prevent a small stem-mounted switch or other device having a single-hole mounting means from turning.

7.1.6 If a vertically-mounted switch or circuit breaker is such that movement of the operating handle results in one position being above the other position, the upper position shall be the on position.

*Exception: This requirement does not apply to horizontally- or rotationally-mounted switches, or switching devices with more than one on position, such as a double-throw or timer switch.*

## 7.2 Assembly for shipping

7.2.1 A product shall be completely assembled when it is shipped from the factory.

*Exception: A product may be shipped partially disassembled to facilitate packing or installation if the intended assembly can be accomplished readily without introduction of risk of fire, electric shock, or injury to persons.*

7.2.2 If mismatching of components of a product that is shipped disassembled presents a risk of fire, electric shock, or injury to persons, the parts shall be marked as specified in 52.2. See also 7.2.4.

7.2.3 If a cord-connected product is shipped partially disassembled, internal connections that must be made in the field shall be made by plug and receptacle connections. If a product intended for permanent connection to the power supply is shipped partially disassembled, internal connections that must be made in the field shall be made in accordance with 11.1.1.1 – 11.1.5.5 or by plug and receptacle connections.

7.2.4 A product that is shipped from the factory partially disassembled shall be shipped in a single shipping container or marked in accordance with 52.2.

## 8 Live Parts

8.1 A current-carrying part shall have the necessary mechanical strength and ampacity, and shall be made of a metal that can be used for the application.

8.2 An uninsulated live part shall be secured to its supporting surface by a means other than friction between surfaces so that it will be prevented from turning or shifting in position if such motion may result in a reduction of spacings below the minimum required values. The construction of a contact assembly shall be such that the alignment of the contacts will be maintained.