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Halon 1301 Recovery/ Recycling Equipment

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UL Standard for Safety for Halon 1301 Recovery/Recycling Equipment, UL 2083

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Summary of Topics

The revisions dated June 1, 2006, were issued to delete the ANSI approval information from the title page.

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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.

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INTRODUCTION

1 Scope

1.1 These requirements cover Halon 1301 recovery/recycling equipment rated 600 volts or less, and intended to be used in ordinary locations in accordance with the National Electrical Code, NFPA 70.

1.2 Halon 1301 recovery/recycling equipment covered by these requirements is intended for commercial use at a recycling facility to recover/recycle Halon 1301 from fire equipment/extinguishing system containers.

1.3 These requirements apply to equipment intended for indoor use only.

1.4 These requirements include an evaluation to determine that the equipment recycles Halon 1301 that complies with the requirements of Table 42.1 of this standard.

1.5 Halon 1301 recovery/recycling equipment covered by these requirements is comprised of a single unitized recovery/recycling system or separate, independently operating systems which perform specific tasks such as halon 1301/nitrogen transfer, nitrogen removal, contaminant removal, or combinations of the various required functions.

1.5 revised September 27, 1996

1.6 A product that contains features, characteristics, components, materials, or systems new or different from those in use when the standard was developed, 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 level of safety for the user of the product as originally anticipated by the intent 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 generally 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 If a value for measurement is followed by a value in other units in parentheses, the first stated value is the requirement.

2.2.1 revised September 27, 1996

2.2.2 Unless indicated otherwise, all voltage and current values mentioned in this standard are rms.

2.3 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.

2.4 Terminology

2.4.1 The term "product" refers to any equipment covered by the Scope of this standard.

3 Glossary

3.1 For the purpose of these requirements, the following definitions apply.

3.2 CIRCUITS, ELECTRICAL:

a) High-Voltage – A circuit involving a potential of not more than 600 volts and having circuit characteristics in excess of those of a low-voltage circuit.

b) Low-Voltage – A circuit involving a potential of not more than 30 volts alternating current, 42.4 volts peak or direct current, and supplied by:

1) A primary battery,

2) Standard Class 2 transformer, or

3) A combination of a transformer and fixed impedance which, as a unit, complies with all performance requirements for a Class 2 transformer.

3.3 DESIGN PRESSURE – The maximum acceptable working pressure for which the equipment or a specific part is designed.

3.4 PIPING – Includes pipe, flanges, bolting, gaskets, valves, fittings, the pressure-containing parts of other components, such as strainers and devices that serve such purposes as mixing, separating, muffling, snubbing, distributing, metering, or controlling flow.

3.5 RECOVERED HALON 1301 – Halon 1301 that has been removed from fire equipment/extinguishing system containers for the purpose of storage, recycling, or transportation.

3.6 RECOVERY – The act of removing Halon 1301 in any condition from fire equipment/extinguishing system containers for storage without necessarily testing or processing it in any way.

3.7 RECYCLE – The act of removing contaminants in recovered Halon 1301 by single or multiple passes through devices, such as replaceable core filter-driers, that reduce moisture, acidity and particulate matter. Recycling usually occurs at a recycling facility.

4 Installation and Operating Instructions

4.1 The equipment shall be provided with installation and operating instructions. The instructions shall contain such directions and information that the manufacturer considers necessary for installation, maintenance, and use of the equipment.

4.2 A copy of the manufacturer's operating and installation instructions, or equivalent information, intended to accompany the equipment is to be furnished with the sample submitted for investigation. These instructions are to be used as a guide in the examination and test of the equipment. For this purpose, a printed edition is not required initially if rough draft instructions or information as to what the instructions will include are submitted for review as part of the investigation.

4.3 The instructions shall describe the procedures necessary to transfer halon between the fire equipment/extinguishing system containers being emptied and storage containers with a minimum halon retention efficiency as specified in 43.1.

4.4 The instructions shall specify that the operator is to conduct a screening test on the material inside the container to be emptied before processing to identify the type of material and its oil content. This shall include the procedures necessary to conduct the screening tests, such as a boiling point test for material identification and an oil residue test to determine oil content, and adequate information to evaluate the results. See 4.10.

4.5 The instructions shall include specific information concerning the periodic maintenance necessary to ensure that the equipment will continue to recycle Halon 1301 that complies with the requirements of Table 42.1 of this standard. They shall outline the procedure for maintenance, such as filter-drier replacement, in a manner that will minimize the release of halon to the atmosphere.

4.6 The instructions shall include a service hose evacuation procedure to be followed after each recovery and recycling operation.

4.7 The instructions shall include the manufacturer's recommended safety practices for use of the equipment and suggestions for handling Halon 1301 during the recovery/recycling operations.

4.8 The instructions shall include information concerning suitable extension cords that are to be used, consistent with the requirements in 10.2.1 – 10.2.5, and the need to keep such cords at a minimal length.

4.8 revised September 27, 1996

4.9 The instructions shall specify that storage containers not provided with the equipment that are intended to receive the halon during the recovery/recycling operation are to be:

a) ASME marked pressure vessels or:

- 1) Constructed, tested, and marked in accordance with the applicable DOT shipping container specifications, and
- 2) Provided with a pressure relief device as required by the applicable DOT regulations.

The design or service pressure rating shall be suitable for the maximum pressure developed at 130°F (55°C), but in no case less than 1000 psi (69 bar), and

b) Sized for the largest fire equipment/extinguishing system units being emptied to reduce the risk of over filling the containers and shall contain adequate information to make sure that the storage container will not be charged to a filling density at 70°F (21.1°C) of greater than 75 lb/ft³ (1201 Kg/m³).

4.10 With reference to 4.4, if the sample tested exceeds 0.05 volume percent oil, the instructions shall specify that a new filter or filter core be installed in the equipment before processing the sample.

4.11 The instructions shall specify that the operator is to disconnect the equipment immediately after the recovery/recycling operation is completed as controlled by pressure indication of 13 psia (maximum indicated residue pressure). See 6.1.8.

4.12 The instructions shall include information that all storage containers to be used must be rated for the low temperatures associated with using Halon 1301 and cautions must be made concerning refilling operations that reduce the temperature of the container. As such, the instructions shall include the marking "WARNING: The container can fracture at low temperatures. A container will cool as it is being emptied. Risk of container fracture. Do not expose containers to temperatures below 40°F (4.4°C)."

4.12 revised September 27, 1996

CONSTRUCTION

5 General

5.1 A product shall employ materials found by investigation to be acceptable for the intended application.

6 Assembly

6.1 Recovery/recycling system

6.1.1 The equipment shall incorporate a moisture indicator that indicates the moisture content of Halon 1301 and with:

- a) A color chart, mounted adjacent to the indicator, that relates the moisture content to the color of the indicator, and
- b) A marking by the indicator warning the user that the indicator may become ineffective if fouled with alcohol and what actions should be taken to avoid this possibility.

6.1.2 The equipment shall be provided with a filter-drier(s) that is intended to remove acids, moisture, oils, and particulate matter.

6.1.3 The equipment shall reliably indicate when the filter-drier(s) needs replacement.

6.1.4 The equipment shall be provided with a minimum of two transfer hoses, each having a minimum length of 6 ft (1.8 m), to permit connection to the fire equipment/extinguishing system containers being emptied and to the storage container. The hoses shall be provided with Compressed Gas Association (CGA) Type 320, 660, or 668 connections.

6.1.5 The equipment pressure system shall incorporate a self-restoring type pressure relief valve(s). The start-to-discharge pressure setting of the pressure relief valve(s) shall relieve excessive pressures automatically on all components and the reclose pressure setting shall be at a pressure of no less than 80 percent of the start-to-discharge pressure.

6.1.6 Equipment having provision for the storage of halon containers and similar equipment shall be provided with a means, such as the use of scales and a shutoff device, to terminate the recovery/recycle operation when or before the container filling density is 75 lb/ft³ (1201 Kg/m³) at 70°F (21.1°C).

6.1.6 revised September 27, 1996

6.1.7 Pressure-containing parts shall be factory connected with piping or tubing complying with the requirements specified in Table 29.1.

6.1.8 The equipment shall be provided with a reliable means of indication to inform the user when the recovery/recycling operation is completed or have an automatic shutoff of the recovery/recycling activity.

6.2 Mechanical protection

6.2.1 A product shall be assembled so that it will not be adversely affected by the vibration of operation. Brush caps shall be tightly threaded or otherwise constructed to prevent loosening.

6.2.2 A switch other than a through-cord switch, a lampholder, an attachment-plug receptacle, a motor-attachment plug, or similar component shall be mounted securely and shall be prevented from turning. See 6.2.3.

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 when operated. A toggle switch is considered to be subject to forces that tend to turn the switch during operation of the switch.*
- b) The means for mounting the switch make it unlikely that operation of the switch will loosen it.*
- c) The spacings are not reduced below the minimum required values if the switch rotates.*
- d) The 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 a neon pilot or indicator light in which the lamp is sealed in a nonremovable jewel, need not be prevented from turning or shifting in position, if such motion does not result in a reduction of spacings below the minimum acceptable values.

6.2.3 Uninsulated live parts shall be secured to the base or mounting surface so that they will be prevented from turning or shifting in position, if such motion results in a reduction of spacings below the minimum required values.

6.2.3 revised September 27, 1996

6.2.4 The means for preventing the turning or shifting mentioned in 6.2.1 and 6.2.2 shall consist of more than friction between surfaces – for example, a properly applied lock washer is acceptable as the means for preventing a small stem-mounted switch or other device, having a single-hole mounting means, from turning.

7 Enclosure

7.1 General

7.1.1 A product 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 resulting in a 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 defects.

7.2 Metal enclosures

7.2.1 Cast and sheet-metal portions of an enclosure shall not be thinner than the applicable values specified in Table 7.1.

Exception: Thinner metal meets the intent of this requirement when the surface being evaluated is curved, ribbed, or otherwise reinforced to provide mechanical strength equivalent to that required.

7.2.1 revised September 27, 1996

Table 7.1
Thickness of enclosure metal

Metal	Minimum thickness, inch (mm)			
	At small, flat unreinforced, surface and at a surfaces of a shape or size to provide mechanical strength		At a relatively large unreinforced flat surface	
Die-cast metal	3/64	(1.2)	5/64	(2.0)
Cast malleable iron	1/16	(1.6)	3/32	(2.4)
Other cast metal	3/32	(2.4)	1/8	(3.2)
Uncoated sheet steel	0.026	(0.66)	0.026	(0.66)
Galvanized sheet steel	0.029	(0.74)	0.029	(0.74)
Nonferrous sheet metal	0.036	(0.91)	0.036	(0.91)

7.3 Polymeric enclosures

7.3.1 A polymeric material used as enclosure material shall comply with the applicable requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

7.3.2 In addition to the requirement in 7.3.1, an enclosure of polymeric material having in any single unbroken section an exposed surface greater than 10 square feet (0.93 m²) or a single dimension greater than 6 feet (1.83 m) shall have a maximum flame spread rating (see 7.3.3) of two hundred for a portable product.

7.3.3 The flame spread rating mentioned in 7.3.2 shall be determined in accordance with the requirements in the Standard for Test for Surface Burning Characteristics of Building Materials, UL 723, or with the radiant panel test requirement in accordance with the Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source, ASTM E162-94.

7.3.3 revised September 27, 1996

7.4 Enclosure integrity

7.4.1 The enclosure shall prevent molten metal, burning insulation, flaming particles, and similar material from falling on flammable materials, including the surface upon which the product is supported.

7.4.1 revised September 27, 1996

7.4.2 The requirement in 7.4.1 will necessitate that a switch, a relay, a solenoid, and similar components be individually and completely enclosed, except for terminals, unless it can be shown that malfunction of the component would not result in a risk of fire, or there are no openings in the bottom of the product enclosure. It will also necessitate the use of a barrier of nonflammable material:

a) Under a motor unless:

1) The structural parts of the motor or of the product provide the equivalent of such a barrier;

2) The protection provided with the motor is such that no burning insulation or molten material falls to the surface that supports the product when the motor is energized under each of the following fault conditions:

i) Open main winding,

ii) Open starting winding,

iii) Starting switch short-circuited, and

iv) Capacitor of permanent-split capacitor motor short circuited – the short-circuit is to be applied before the motor is energized, and the rotor is to be locked;

3) The motor is provided with a thermal motor protector – a protective device that is sensitive to temperature and current – that will prevent the temperature of the motor windings from exceeding 125°C (257°F) under the maximum load under which the motor will run without causing the protector to cycle and from exceeding 150°C (302°F) with the rotor of the motor locked; or

4) The motor complies with the requirements for impedance-protected motors in the Standard for Motor-Operated Appliances, UL 73, and the temperature of the motor winding will not exceed 150°C (302°F) during the first 72 hours of operation with the rotor of the motor locked.

b) Under wiring, unless it is neoprene- or thermoplastic-insulated.

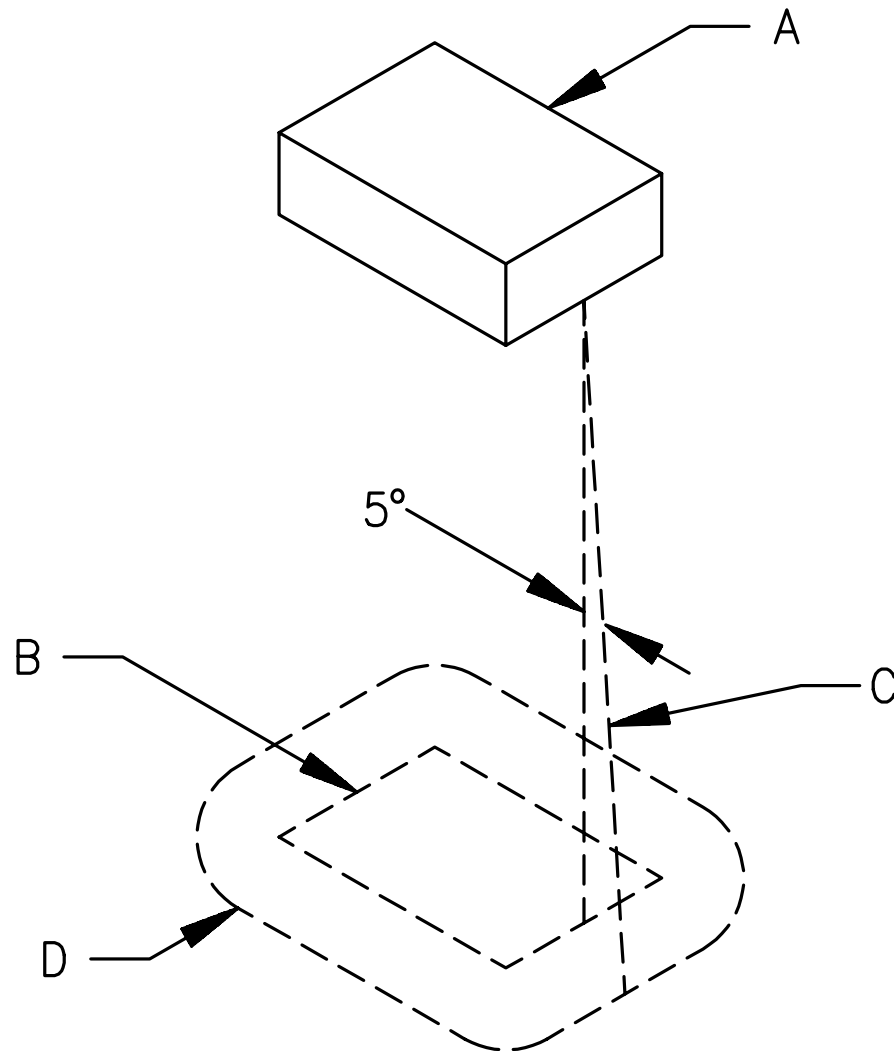
7.4.2 revised September 27, 1996

7.4.3 The barrier mentioned in 7.4.2 shall be horizontal, shall be located as indicated in Figure 7.1, and shall not have an area less than that described in that illustration. Openings for drainage, ventilation, and the like are not prohibited from being employed in the barrier, but such openings shall not permit molten metal, burning insulation, and similar material to fall on flammable material.

7.4.3 revised September 27, 1996

Figure 7.1
Location and extent of barrier

Figure 7.1 revised March 30, 1998



SA0604-1

A – Region to be shielded by barrier. This will consist of the entire component if it is not otherwise shielded and will consist of the unshielded portion of a component that is partially shielded by the component enclosure or equivalent.

B – Projection of outline of component on horizontal plane.

C – Inclined line that traces out minimum area of barrier. The line is always tangent to the component, 5 degrees from the vertical, and oriented so that the area traced out on a horizontal plane is maximum.

D – Location (horizontal) and minimum area for barrier. The area is that included inside the line of intersection traced out by the inclined line C and the horizontal plane of the barrier.

7.5 Doors and covers

7.5.1 A door or a cover of an enclosure that provides access to any overload-protective device that requires resetting or renewal shall be hinged or otherwise attached in an equivalent manner.

7.5.2 Means shall be provided for holding the door or cover over a fuseholder in a closed position, and the door or cover shall be tight-fitting.

8 Protection Against Corrosion

8.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means, if corrosion of such unprotected parts would be likely to result in a risk of fire, electric shock, or injury to persons.

Exception No. 1: Surfaces of sheet-steel and cast-iron parts within an enclosure are not required to be protected against corrosion when the oxidation of the metal due to the exposure to air and moisture is determined not to be appreciable. The thickness of metal and temperature are also to be considered.

Exception No. 2: Bearings, laminations, or minor parts of iron or steel, such as washers, screws, and similar parts.

8.1 revised September 27, 1996

8.2 Metal shall be used in combinations that are galvanically compatible.

9 Accessibility of Uninsulated Live Parts and Film-Coated Wire

9.1 To reduce the risk of unintentional contact that involves a risk of electric shock from an uninsulated live part or film-coated wire, an opening in an enclosure shall comply with either (a) or (b).

- a) For an opening that has a minor dimension (see 9.5) less than 1 inch (25.4 mm), such a part or wire shall not be contacted by the probe illustrated in Figure 9.1.
- 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 9.1.

Exception: A motor need not comply with these requirements if it complies with the requirements in 9.2.

9.1 revised September 27, 1996

9.2 With respect to a part or wire as mentioned in 9.1, in an integral enclosure of a motor as mentioned in the exception to 9.1:

- a) An opening that has a minor dimension (see 9.5) less than 3/4 inch (19.1 mm) is acceptable if:
 - 1) A moving part cannot be contacted by the probe illustrated in Figure 9.2;

- 2) Film-coated wire cannot be contacted by the probe illustrated in Figure 9.3;
- 3) In a directly accessible motor (see 9.6), an uninsulated live part cannot be contacted by the probe illustrated in Figure 9.4; and
- 4) In an indirectly accessible motor (see 9.6), an uninsulated live part cannot be contacted by the probe illustrated in Figure 9.2.
- b) An opening that has a minor dimension of 3/4 inch or more is acceptable if a part or wire is spaced from the opening as specified in Table 9.1.

Table 9.1
Minimum acceptable distance from an opening to a part that involves a risk of electric shock

Table 9.1 revised September 27, 1996

Minimum dimension of opening ^a		Minimum distance from opening to part	
Inches ^b	(mm) ^b	Inches ^b	(mm) ^b
3/4 ^c	(19.1)	4-1/2	(114.0)
1 ^c	(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)
d		30	(762.0)

^a See 9.5.

^b Between 3/4 inch and 2-1/8 inches, interpolation is to be used to determine a value between values specified in the table.

^c Any dimension less than 1 inch applies to a motor only.

^d More than 2-1/8 inches, but not more than 6 inches (152.0 mm).

Figure 9.2
Probe for moving parts and uninsulated live parts

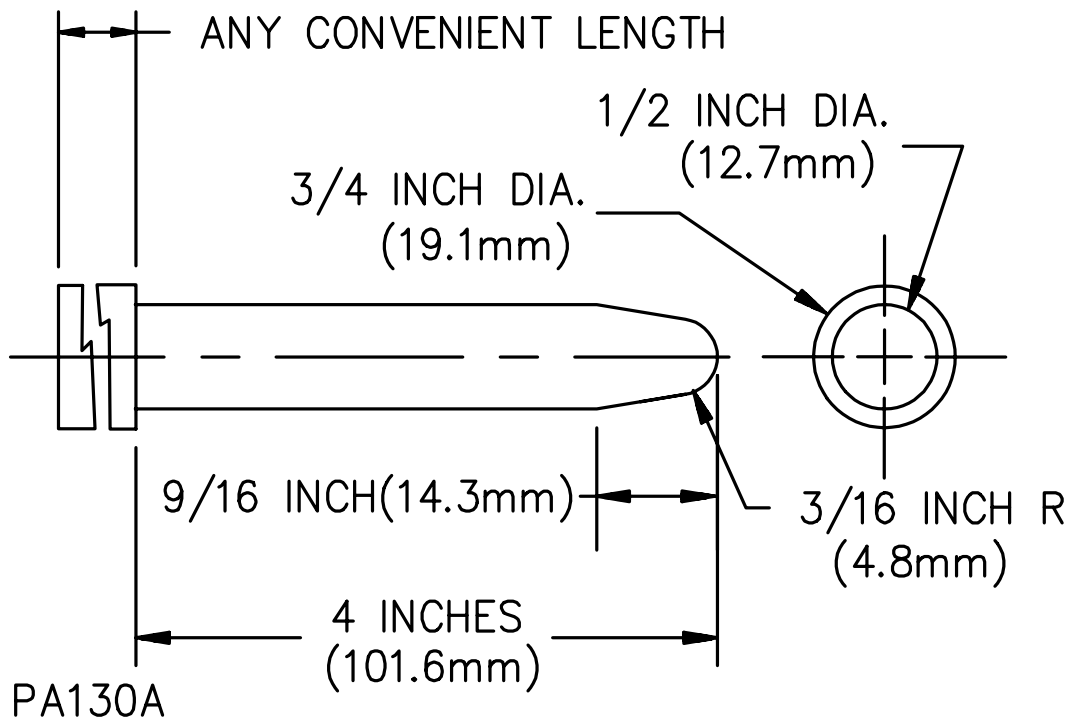


Figure 9.3
Probe for film-coated wire

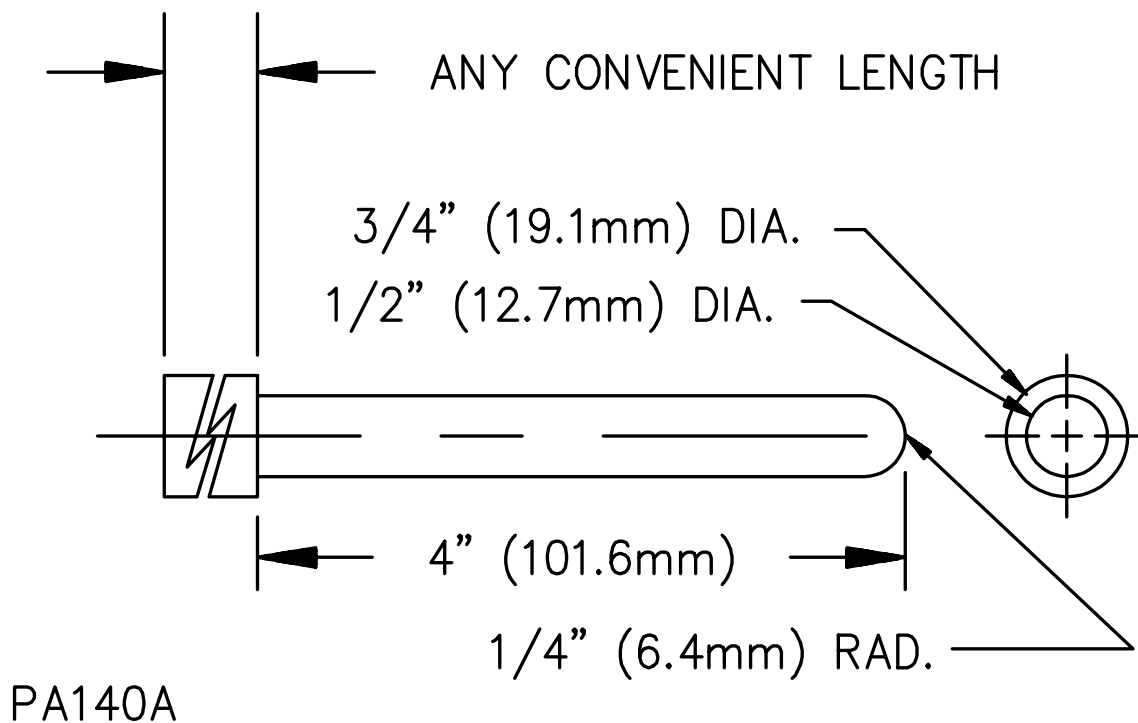
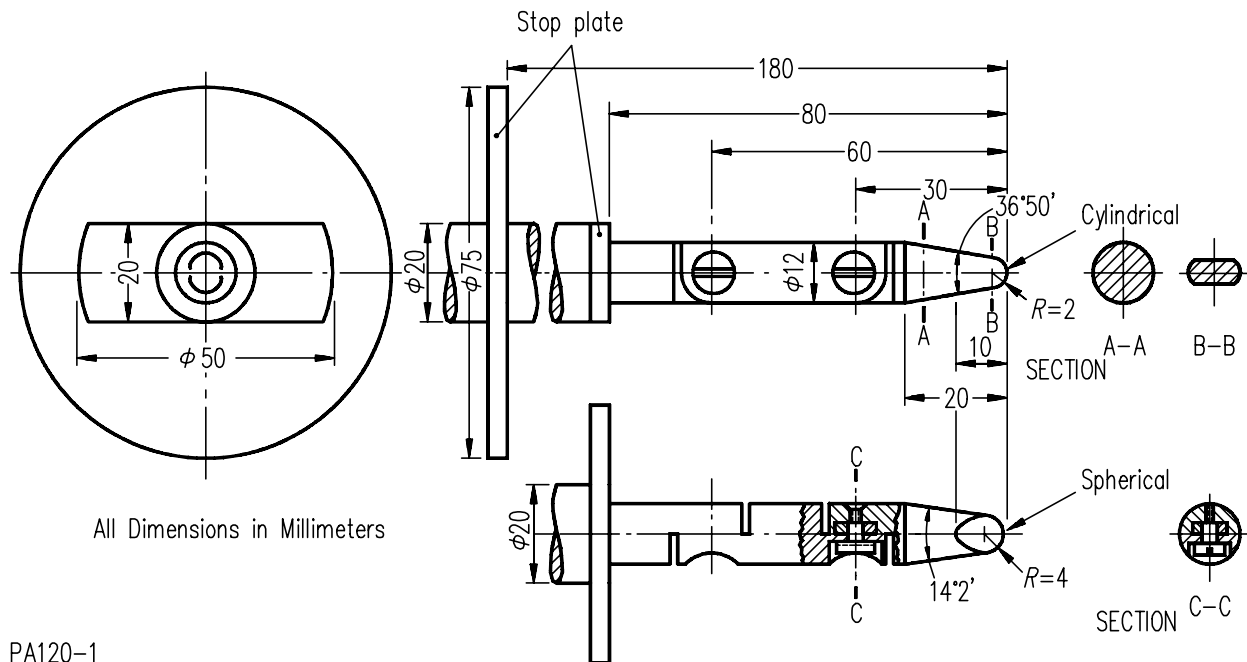


Figure 9.4
International Electrotechnical Commission (IEC) articulate accessibility probe with stop plate



9.3 The probes mentioned in 9.1 and 9.2 and illustrated in Figures 9.1 – 9.4 shall be applied to any depth that the opening will permit, and 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 9.1 and 9.4 shall be applied in any possible configuration; and, if necessary, the configuration shall be changed after insertion through the opening.

9.4 The probes mentioned in 9.1 and 9.2 shall be used as measuring instruments to judge the accessibility provided by an opening, and not as instruments to judge the strength of a material; they shall be applied with the minimum force necessary to determine accessibility.

9.5 With reference to the requirements in 9.1 and 9.2, 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.

9.6 With reference to the requirements in 9.2, an indirectly accessible motor is a motor:

- a) That is 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) That is located at such a height or is otherwise guarded or enclosed so that it is unlikely to be contacted.

A directly accessible motor is a motor that can be contacted without opening or removing any part or that is located so as to be accessible to contact.

9.7 During the examination of an appliance to determine whether it complies with the requirements in 9.1 or 9.2, a part of the enclosure that is capable of being opened or removed by the user without a tool (to make an operating adjustment or for other reasons) is to be opened or removed.

9.7 revised September 27, 1996

9.8 With reference to the requirements in 9.1 and 9.2, insulated brush caps are not required to be additionally enclosed.

10 Supply Connections

10.1 General

10.1.1 A single-pole switching device shall not be connected to the identified grounded conductor.

Exception: An automatic control that does not have a marked "off" position is not required to comply with this requirement.

10.2 Cord-connected equipment

10.2.1 Equipment intended for cord connection to the power supply shall be equipped with:

- a) A flexible cord of a type, length, and ampacity and
- b) An attachment plug of a type and rating complying with the requirements of 10.2.2 – 10.2.6.

10.2.2 The marked rating of cord-connected equipment, see 58.1, shall not exceed 80 percent of the rating of the attachment plug.

10.2.3 Cord-connected equipment shall employ a grounding-type attachment plug that complies with the ANSI/NEMA standard designated in Table 10.1.

Exception: Equipment rated 250 volts or less and intended for connection to circuits rated:

- a) other than 60 hertz,*
- b) other than the voltages specified in 37.1(a) or (b), or*
- c) both,*

shall be considered acceptable when employing a grounding-type attachment plug acceptable for the circuit involved.

10.2.3 revised September 27, 1996

Table 10.1
Attachment plugs

Nameplate Rating			Attachment Plug	
Volts	Phase	Amperes ^a	Rating	ANSI Designation ^b
110 – 120	1	12.0	15 amperes, 125 volts	5 – 15P
110 – 120	1	16.0	20 amperes, 125 volts	5 – 20P
110 – 120	1	24.0	30 amperes, 125 volts	5 – 30P
110 – 120	1	40.0	50 amperes, 125 volts	5 – 50P
200 – 240	1	12.0	15 amperes, 250 volts	6 – 15P
200 – 240	1	16.0	20 amperes, 250 volts	6 – 20P
200 – 240	1	24.0	30 amperes, 250 volts	6 – 30P
200 – 240	1	40.0	50 amperes, 250 volts	6 – 50P
110 – 120/200 – 240	1	12.0	15 amperes, 125/250 volts	14 – 15P
110 – 120/200 – 240	1	16.0	20 amperes, 125/250 volts	14 – 20P
110 – 120/200 – 240	1	24.0	30 amperes, 125/250 volts	14 – 30P
110 – 120/200 – 240	1	40.0	50 amperes, 125/250 volts	14 – 50P
200 – 240	3	12.0	15 amperes, 250 volts	15 – 15P
200 – 240	3	16.0	20 amperes, 250 volts	15 – 20P
200 – 240	3	24.0	30 amperes, 250 volts	15 – 30P
200 – 240	3	40.0	50 amperes, 250 volts	15 – 50P

^a Ampere rating is maximum permitted to be marked on product nameplate for attachment plug indicated. See 10.2.2.

^b Standard for Wiring Devices – Dimensional Requirements, ANSI/NEMA WD6-1988.

10.2.4 Cord connected equipment shall employ Type SEO, SO, SOO, STO, STOO, SJEO, SJO, SJOO, SJTO, or SJTOO power-supply cord rated for use at a voltage not less than the rated voltage of the equipment. The ampacity of the cord as given in the National Electrical Code, ANSI/NFPA 70-1996, shall be not less than that required by the ampere input measured in the Temperature Test, Section 41. The ampere input value shall include the loads for convenience outlets. See 56.7 and 56.8.

10.2.4 revised September 27, 1996

10.2.5 Equipment rated over 16 amperes is not prohibited from being provided with a supply cord if it is intended to be moved from place to place in normal service and if the equipment complies with (a) – (d).

- a) The equipment is self-contained.
- b) The equipment does not require connection to water lines, or similar apparatus.
- c) The equipment is permanently equipped with casters.
- d) The electrical rating of the equipment does not exceed 40 amperes, 250 volts, single phase.

10.2.5 revised September 27, 1996

10.2.6 The length of a power-supply cord shall be not less than 6 feet (1.8 m) nor more than 10 feet (3.0 m). The length is to be measured between the attachment plug and any point at which the cord exits the equipment cabinet or the last strain relief, whichever is shorter.

10.2.7 The power-supply cord shall be provided with strain relief means so that a stress on the cord will not be transmitted to terminals, splices, or internal wiring. See Strain Relief Test, Section 46. A metallic strain relief shall not contact uninsulated live parts or reduce spacings within the enclosure if the cord is moved inward. The cord shall not be subject to damage by moving parts if it can be moved inward.

10.2.8 The edges of the entry hole for the power-supply cord, including the cord entry hole in a bushing, shall be smooth and rounded without burrs, fins, or sharp edges that might damage the cord insulation. The power-supply cord shall be routed to prevent damage to the cord insulation.

10.2.9 The ampacity of a power supply cord on equipment intended for connection to a branch circuit which exceeds the limitations specified in 20.4 shall be not less than 80 percent of the maximum continuous current of the compressor motor, plus the sum of all other loads, including accessories, which operate concurrently.

Exception: The ampacity of the power supply cord need not be greater than the ampere rating of the attachment plug.

10.2.9 revised September 27, 1996

10.3 Permanently connected equipment

10.3.1 Equipment of the following types shall have provision for permanent connection to the power supply:

- a) Equipment rated in excess of 250 volts.
- b) Polyphase equipment.
- c) Equipment employing a water-cooled condenser.
- d) Equipment having a rated-load current exceeding 16 amperes. The largest sum of concurrent rated loads shown on the nameplate is to be used to determine the rating.

Exception: Equipment complying with 10.2.5 is not prohibited from employing a power supply cord.

- e) Equipment other than of the self-contained type.

10.3.1 revised September 27, 1996

10.3.2 As used in 10.3.3 - 10.3.21, field-wiring terminals are considered to be the terminals to which power supply, control, or equipment grounding connections will be made in the field when the equipment is installed.

10.3.3 Equipment shall have provision for connection of one of the wiring systems, in accordance with the National Electrical Code, ANSI/NFPA 70-1996, that would be acceptable for it.

10.3.3 revised September 27, 1996

10.3.4 A knockout for connection of a field-wiring system to a field-wiring compartment shall accommodate conduit of the trade size determined by applying Table 10.2.

Table 10.2
Trade size of conduit in inches (mm OD)

Table 10.2 revised September 27, 1996

Wire size		Number of wires									
AWG	(mm ²)	2	3	4	5	6					
14	(2.1)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)
12	(3.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	3/4	(26.7)	3/4	(26.7)
10	(5.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	3/4	(26.7)	3/4	(26.7)
8	(8.4)	3/4	(26.7)	3/4	(26.7)	1	(33.4)	1	(33.4)	1-1/4	(42.3)
6	(13.3)	3/4	(26.7)	1	(33.4)	1	(33.4)	1-1/4	(42.3)	1-1/4	(42.3)
4	(21.2)	1	(33.4)	1	(33.4)	1-1/4	(42.3)	1-1/4	(42.3)	1-1/2	(48.3)
3	(26.7)	1	(33.4)	1-1/4	(42.3)	1-1/4	(42.3)	1-1/2	(48.3)	1-1/2	(48.3)
2	(33.6)	1	(33.4)	1-1/4	(42.3)	1-1/4	(42.3)	1-1/2	(48.3)	2	(60.3)
1	(42.4)	1-1/4	(42.3)	1-1/4	(42.3)	1-1/2	(48.3)	2	(60.3)	2	(60.3)

NOTE – This table is based on the assumption that all conductors will be of the same size and there will be no more than six conductors in the conduit. If more than six conductors will be involved or if all of them are not of the same size, the internal cross-sectional area of the smallest conduit that shall be used is determined by multiplying by 2.5 the total cross-sectional area of the wires, based on the cross-sectional area of Type THW wire.

10.3.5 Space shall be provided in the field-wiring compartment or outlet box for installation of conductors of the number and size required by 10.3.8. The space provided shall permit the required number and size of at least 6-inch (150-mm) lengths of Type TW or THW wire brought into the wiring compartment. If necessary, a trial installation is to be made.

Exception: Conductors other than Type TW or THW are acceptable if specified in the installation instructions.

10.3.5 revised September 27, 1996

10.3.6 The location of a terminal box or compartment in which power supply connections are to be made shall permit these connections to be inspected after the equipment is installed. The connections are to be accessible without removing parts other than a service cover or panel and the cover of the outlet box or compartment in which the connections are made.

10.3.7 A terminal compartment intended for the connection of a supply raceway shall be secured in position and shall be secured in position and shall be prevented from turning.

10.3.8 The equipment shall be provided with field-wiring terminals or leads for the connection of conductors having an ampacity of not less than that indicated in 57.10. It is to be assumed that branch circuit conductors rated 60°C (140°F) will be used when the required circuit ampacity is 100 amperes or less and that conductors rated 75°C (167°F) will be used when the required ampacity is more than 100 amperes.

10.3.9 A field-wiring terminal shall be secured in position and prevented from turning or shifting by means other than friction between surfaces. This shall be accomplished by two screws or rivets; by square shoulders or mortices; by a dowel pin, lug, or offset; by a connecting strap or clip fitted into an adjacent part; or by some equivalent method.

10.3.9 revised September 27, 1996

10.3.10 For No. 8 AWG (8.4 mm²) and larger conductors, pressure wire connectors shall be used. For No. 10 AWG (5.3 mm²) and smaller conductors, the parts to which wiring connections are to be made shall consist of clamps or wire binding screws with supped washers, terminal plates, or the equivalent to hold the wire in position.

10.3.10 revised September 27, 1996

10.3.11 A wire binding screw at a field-wiring terminal shall not be smaller than No. 10 (4.8 mm diameter), except that a No. 8 (4.2 mm diameter) screw is acceptable for the connection of a conductor no larger than No. 14 AWG (2.1 mm²) and a No. 6 (3.5 mm diameter) screw for the connection of a No. 16 or 18 AWG (1.2 or 0.8 mm²) control circuit conductor.

10.3.11 revised September 27, 1996

10.3.12 It should be noted that according to the National Electrical Code, ANSI/NFPA 70-1996, No. 14 AWG (2.1 mm²) is the smallest conductor that the installer is to use for branch circuit wiring and thus is the smallest conductor that is to be anticipated at a terminal for the connection of a power supply wire.

10.3.12 revised September 27, 1996

10.3.13 A terminal plate for a wire binding screw shall be of metal not less than 0.030 inch (0.76 mm) thick for a No. 14 AWG (2.1 mm²) or smaller wire and not less than 0.050 inch (1.27 mm) thick for a wire larger than No. 14 AWG. In either case, there shall be not less than two full threads in the metal.

10.3.14 A terminal plate formed from stock having the minimum required thickness is not prohibited from having the metal extruded at the hole tapped for the binding screw to provide two full threads.

Exception: Two full threads are not required if a lesser number of threads results in a connection in which the threads will not strip when tightened in accordance with the torques indicated in the Standard for Wire Connectors and Soldering Lugs for Use with Copper Conductors, UL 486A and Wire Connectors for Use with Aluminum Conductors, UL 486B.

10.3.14 revised September 27, 1996

10.3.15 Upturned lugs or a cupped washer shall retain a conductor of the size mentioned in 10.3.8, but no smaller than No. 14 AWG (2.1 mm²), under the head of the screw or the washer.

10.3.16 A wire binding screw shall thread into metal.

10.3.17 A field-wiring terminal intended for the connection of a grounded conductor shall be of a metal, or plated with a metal, substantially white in color and shall be readily distinguishable from the other terminals, or identification of that terminal shall be shown in some other manner, such as on an attached wiring diagram. A lead intended for the connection of a grounded conductor shall be finished to show a white or natural gray color, shall be readily distinguishable from other leads, and no other lead shall be so identified.

10.3.18 The length of a lead inside an outlet box or wiring compartment shall be 6 inches (152 mm) or more if the lead is intended for field connection to an external circuit.

Exception: A lead less than 6 inches in length meets the intent of this requirement if it is evident that the use of a longer lead results in a risk of fire or electric shock.

10.3.18 revised September 27, 1996

10.3.19 Leads intended for connection to field-installed conductors shall be provided with strain relief if stress on the lead is able to be transmitted to terminals, splices, or internal wiring. See Strain Relief Test, Section 46.

10.3.19 revised September 27, 1996

10.3.20 Leads provided for spliced connections to an external high-voltage circuit shall not be connected to wire binding screws or pressure wire connectors located in the same compartment as the splice unless the screws or connectors are rendered unusable for field-wiring connections or the leads are insulated at the unconnected ends.