UL 2930

STANDARD FOR SAFETY

Cord-and-Plug-Connected Health Care Facility Outlet Assemblies

UL Standard for Safety for Standard for Cord-and-Plug-Connected Health Care Facility Outlet Assemblies, UL 2930

First Edition, Dated August 11, 2023

Summary of Topics

The is the First edition of ANSI/UL 2930, Standard for Cord-and-Plug-Connected Health Care Facility Outlet Assemblies, dated August 11, 2023 and applies to indoor-use-cord-and-plug-connected health care facility receptacle outlet assemblies rated 250 V AC or less and 20 Amperes or less.

The new requirements are substantially in accordance with Proposal(s) on this subject dated May 12, 2023.

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Standard for Cord-and-Plug-Connected Health Care Facility Outlet Assemblies

First Edition

August 11, 2023

This ANSI/UL Standard for Safety consists of the First Edition.

The most recent designation of ANSI/UL 2930 as an American National Standard (ANSI) occurred on August 11, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover indoor-use cord-and-plug-connected Health Care Facility receptacle outlet assemblies (HCOA) rated 250 V AC or less and 20 Amperes or less. HCOA are for use as a movable power supply connection for cord-and-plug-connected medical electrical utilization equipment in accordance with the National Electrical Code, NFPA 70, Article 517 Health Care Facilities, and with NFPA 99, Health Care Facilities Code, for use in Category 2 (General Patient Care) Spaces or Category 1 (Critical Patient Care) Spaces, including Patient Care Vicinities equipped with Patient Equipment Grounding Points and an Attachment Plug with an Integral Patient Equipment Grounding Connection.

1.2 HCOAs are intended to supply cord-and-plug-connected medical equipment complying with applicable requirements of the:

a) Standard for Medical Electrical Equipment, Part 1: General Requirements for Safety, UL 60601-1;

b) Medical electrical equipment – Part 1: General requirements for basic safety and essential performance, IEC 60601-1; and

c) Medical Electrical Equipment – Part 1-2: General Requirements for basic safety and essential performance – Collateral standard: Electromagnetic disturbances – Requirements and tests, AAMI 60601-1-2.

1.3 These requirements cover HCOA consisting of an NEMA WD 6-configuration Hospital Grade attachment plug and a length of non-detachable flexible cord terminated in an enclosure in which are mounted NEMA WD 6-configuration Hospital Grade individual receptacle outlets (duplex or single) which are connected conductively to an integral patient equipment grounding terminal or jack provided for user connection of a discrete patient equipment grounding conductor to Patient Equipment Grounding Points, installed in the Patient Care Vicinities of a Health Care Facility.

1.4 These requirements also cover an HCOA provided with an attachment plug with an integral patient equipment grounding connection. Once inserted into a duplex receptacle outlet, this equipment provides the Patient Equipment Grounding Point connection, in the Patient Care Vicinities of a Health Care Facility.

1.5 An HCOA is not intended for Home Health Care Use.

1.6 These requirements do not cover cord-connected, Relocatable Power Taps (RPT) intended only for indoor use as a temporary extension of a grounding alternating-current branch circuit for general use, covered by the Standard for Relocatable Power Taps, UL 1363. RPT are not suitable for use in Category 2 (General Patient Care) Spaces or Category 1 (Critical Patient Care) Spaces or Patient Care Vicinities.

1.7 These requirements do not cover cord-connected, Special Purpose Relocatable Power Taps (SPRPT); covered by the Outline of Investigation for Special Purpose Relocatable Power Taps, UL 1363A. SPRPT are power distribution components intended to supply power to plug-connected components of movable equipment assemblies that are rack, table, or pedestal-mounted. SPRPT are intended for use as components of complete equipment submitted for investigation rather than for direct separate installation in the field. The SPRPT shall be an integral part of the equipment assembly and permanently attached to the equipment assembly only by those qualified to assemble medical electrical equipment systems compliant with Medical electrical equipment – Part 1: General requirements for basic safety and essential performance, IEC 60601-1. SPRPT are not suitable for use in Patient Care Vicinities.

1.8 These requirements do not cover cord-connected, Furniture Power Distribution Units (FPDU), intended for indoor use that provide power for and are intended to be installed in furnishings. FPDU are covered by the Standard for Furniture Power Distribution Units, UL 962A.

2 Use

2.1 A HCOA is intended to be connected temporarily to a permanently-installed branch circuit Hospital Grade receptacle outlet and, where the health care facility's governing body has determined that use of Patient Equipment Grounding Points are essential in Patient Care Vicinities, to patient equipment grounding points permanently installed in the patient care spaces of a Health Care Facility.

2.2 A HCOA is intended for cord-and-plug connection of medical utilization equipment that has been authorized by the Health Care Facility in which the HCOA is deployed and the medical utilization equipment has been verified as having touch and leakage current suitably low for patient care use.

2.3 A HCOA is intended to be mounted to benches, stands, carts, or other areas containing multiple cord-and-plug-connected medical electrical utilization equipment that is intended and authorized for use in that patient care use location.

2.4 A HCOA is not intended to be series-connected ("daisy chained") to:

a) Other HCOA's;

b) Relocatable Power Taps;

c) Furniture Power Distribution Units, or;

d) Extension cords.

A HCOA is not intended to be connected via a grounding adapter or via a current tap to a receptacle outlet.

2.5 A HCOA is not intended to be placed directly upon the floor of a patient care space.

2.6 A HCOA is not intended to be used within Hazardous (Classified) Anesthetizing Locations or any other Hazardous (Classified) Locations as defined by NFPA 70.

3 Components

3.1 Except as indicated in 3.2, a component of a product covered by this standard shall comply with the requirements for that component.

3.2 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.

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

3.4 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.

4 Units of Measurement

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

4.2 Unless otherwise indicated, all voltage and current values mentioned in this standard are root-mean-square (rms).

5 Referenced Publications

5.1 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.

5.2 The following publications are reference in this Standard:

AAMI 60601-1-2, *Medical Electrical Equipment – Part 1-2: General Requirements for Basic Safety and Essential Performance – Collateral Standard: Electromagnetic Disturbances – Requirements and Tests*

ASTM E230/E230M, *Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples*

IEC 60601-1, *Medical Electrical Equipment – Part 1: General Requirements for Basic Safety and Essential Performance*

NFPA 70, *National Electrical Code*

NFPA 99, *Health Care Facilities Code, for use in Category 2 (General Patient Care) Spaces or Category 1 (Critical Patient Care) Spaces, including Patient Care Vicinities equipped with Patient Equipment Grounding Points and an Attachment Plug with an Integral Patient Equipment Grounding Connection*

UL 94, *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*

UL 498, *Attachment Plugs and Receptacles*

UL 514A, *Metallic Outlet Boxes*

UL 746C, *Polymeric Materials – Use in Electrical Equipment Evaluations*

UL 796, *Printed-Wiring Boards*

UL 817, *Cord Sets and Power-Supply Cords*

UL 962A, *Furniture Power Distribution Units*

UL 969, *Marking and Labeling Systems*

UL 1283, *Electromagnetic Interference Filters*

UL 1310, *Class 2 Power Units*

UL 1363, *Relocatable Power Taps*

UL 1363A, *Outline of Investigation for Special Purpose Relocatable Power Taps*

UL 1449, *Surge Protective Devices*

UL 60384-14, *Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains*

UL 60601-1, *Medical Electrical Equipment, Part 1: General Requirements*

6 Glossary

6.1 For the purpose of this Standard the following definitions apply.

6.2 ANESTHETIZING LOCATION – Any area of a facility that has been designated to be used for the administration of any flammable or nonflammable inhalation anesthetic agent in the course of examination or treatment, including the use of such agents for relative analgesia.

6.3 ATTACHMENT PLUG – A male contact device for the temporary connection of a flexible cord or cable to a receptacle outlet or cord connector.

6.4 ATTACHMENT PLUG WITH INTEGRAL PATIENT EQUIPMENT GROUNDING CONNECTION – Same as an attachment plug except employs an additional grounding pin and conductor. The additional grounding pin and conductor is independent and separate from the branch-circuit grounding pin and conductors. This additional grounding pin and conductor serves as an internal connection forming the Patient Equipment Grounding Point connection when inserted into an NEMA WD6 duplex receptacle only, installed in a patient care space of a Health Care Facility.

6.5 CURRENT TAP FITTING – An attachment plug with a pass-through outlet located within the body of the attachment plug. Not permitted in any HCOA device.

6.6 HEALTH CARE FACILITY OUTLET ASSEMBLY (HCOA) – A metallic electrical enclosure provided with an attached power supply cord, attachment plug for connection to a permanently installed branch circuit receptacle outlet and provided with either a patient equipment grounding terminal or jack for connection to a permanently installed Patient Equipment Grounding Point or an attachment plug with integral patient equipment grounding connection. The electrical enclosure may be provided with one to six individual receptacle outlets (duplex or single). The HCOA may also be provided in any combination of the following configurations:

a) Provided with indicator lights.

b) Provided with a surge protective device (SPD) that complies with 10.2.

c) Provided with an electromagnetic interference (EMI) filter that complies with the requirements of 10.1.

6.7 HEALTH CARE FACILITY'S GOVERNING BODY – The person or persons who have the overall legal responsibility for the operation of a health care facility, including risk assessment policies, resources, and risk management processes, building components (such as the availability and function of a patient equipment grounding terminal).

6.8 MEANS FOR MOUNTING – A method of securement of the HCOA to another object.

6.9 NOMINAL DISCHARGE CURRENT (In) – Peak value of the current, selected by the manufacturer, through a Surge Protective Device (SPD) having a current wave shape of 8/20 where the SPD remains functional after 15 surges.

6.10 PATIENT CARE VICINITY – A Health Care Facility space, within a location intended for the examination and treatment of patients, extending 6 ft (1.8 m) beyond the normal location of the patient bed, chair, table, treadmill, or other device that supports the patient during examination and treatment, and extending vertically to 7 ft 6 in. (2.3 m) above the floor.

6.11 PATIENT EQUIPMENT GROUNDING CONDUCTOR – A user-connected insulated conductor, other than supplied in the power supply cord, to provide a return grounding path connection from the mounting yokes of Hospital Grade receptacles of the HCOA and also from the unenergized accessible metal parts of the HCOA to a permanently-installed Patient Equipment Grounding Point of the Health Care Facility.

6.12 PATIENT EQUIPMENT GROUNDING CONDUCTOR INTEGRAL – An additional insulated conductor, supplied within the power supply cord, connected to an attachment plug with an additional grounding pin, to provide a return grounding path connection from the mounting yoke of Hospital Grade receptacle of the HCOA and also from the unenergized accessible metal parts of the HCOA to a permanently-installed Patient Equipment Grounding Point of a Health Care Facility.

6.13 PATIENT EQUIPMENT GROUNDING POINT – A Health Care Facility terminal or jack that serves as the collection point for return grounding of electrical appliances serving a patient care vicinity or for grounding other items in order to eliminate electromagnetic interference problems.

6.14 PATIENT EQUIPMENT GROUNDING TERMINAL – A terminal or jack bonded to the HCOA enclosure and conductively connected to the mounting yokes of Hospital Grade receptacles of the HCOA for user-connection of a patient equipment grounding conductor provided as a return ground path to the permanently-installed patient equipment grounding point of the Health Care Facility.

6.15 RECEPTACLE OUTLET – A female contact device mounted within an electrical enclosure to allow a detachable electrical connection of an attachment plug. A duplex receptacle consists of two female contact devices on the same receptacle yoke and is considered to be two receptacle outlets for the purpose of requirements in this standard.

6.16 SUPPLEMENTARY PROTECTOR DEVICE – A device intended for use as overcurrent, over- or under-voltage, or over-temperature protection within electrical equipment where branch circuit overcurrent protection is already provided.

6.17 8/20 CURRENT WAVE – Current surge with a virtual front time of 8 µs and a time to half-value of 20 µs delivered into a short circuit.

CONSTRUCTION

7 General

7.1 A HCOA that has an electromagnetic interference filter shall also comply with applicable requirements for cord-connected EMI Filters in the Standard for Electromagnetic Interference Filters, UL 1283. Electromagnetic Interference Filters used in HCOA shall not be connected to either the equipment grounding conductor or the patient equipment grounding terminal (i.e. No L-G or N-G connection mode).

7.2 A HCOA employing surge protective components shall also comply with the applicable requirements for cord-connected, Type 3 Surge Protective Device (SPD) in UL 1449. The allowable leakage current or touch current shall not exceed 0.1 mA.

7.3 A HCOA employing surge protective components shall also comply with a minimum 3 kA Nominal Discharge Current Rating In when tested in accordance with UL 1449.

7.4 Component Surge Protective devices installed in a HCOA shall only be connected between the ungrounded (line) and grounded (neutral) conductors. Component Surge Protective devices shall not be connected between the ungrounded (line) conductor and the grounding conductor (patient equipment ground), nor between the grounded (neutral) conductor and the grounding conductor (patient equipment ground).

7.5 A HCOA shall not have either a manual or automatic switch that disconnects power from any of the HCOA receptacle outlets.

7.6 A HCOA shall not be provided with any supplementary protection device that disconnects power from any of the HCOA receptacle outlets.

7.7 A HCOA shall not be provided with any Circuit-Interrupter device that disconnects power from any receptacle outlet. Examples of circuit interrupter devices include but are not limited to:

a) Ground-Fault Circuit Interrupters (GFCI);

b) Appliance Leakage-Current Interrupters (ALCI);

c) Arc-Fault Circuit Interrupters (AFCI); and

d) Equipment Leakage-Current Interrupters (ELCI).

7.8 A HCOA that is provided with an integral power supply with one or more Class 2 output connectors shall comply with the applicable requirements of UL 1310. A HCOA that employs receptacles provided with an integral power supply with Class 2 output connectors shall comply with the applicable requirements in Supplements SC and SE of UL 498. Where provided, the Class 2 output connectors shall be investigated to the Leakage Current Test, Section 27, and comply with its leakage current limits.

7.9 An HCOA shall not be provided with a current tap fitting.

8 Enclosures

8.1 General

8.1.1 The enclosure shall be formed of metal only and assembled so that it has the strength and rigidity required to resist the abuses to which it is 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 serious defects. See the Enclosure Integrity Test, Section 35. See Sections 31 – 37.

8.1.2 The enclosure shall not have any openings or knockouts that are capable of being used for connection to a permanent wiring system.

8.1.3 A keyhole slot, notch, or similar means for mounting shall be located and configured so that the supporting screws or the like cannot damage any electrical insulation, reduce spacings to live parts, or permit fluid to enter the enclosure of an HCOA.

8.1.4 A barrier that covers a mounting hole and thereby forms part of the required enclosure shall be subjected to the Mounting Hole Barrier Tests, Section 31.

8.1.5 Enclosure parts shall be secured together by a positive means. Press fit alone is not considered a positive means of securement.

8.1.6 The enclosure shall be provided with a means for mounting. The mounting means shall comply with Mounting Means, Section 11.

8.2 Metallic

8.2.1 A HCOA shall have a metal enclosure with a minimum thickness in accordance with Table 8.1.

Table 8.1
Minimum Thicknesses of Enclosure Metal

Metal	At small, flat unreinforced surfaces and at surfaces of a shape or size to provide adequate mechanical strength		At relatively larger unreinforced flat surfaces	
	in	(mm)	in	(mm)
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)

9 Mechanical Assembly

9.1 A HCOA shall be formed and assembled so as to reduce the risk of contact with any sharp edges, fins, burrs or the like that are capable of increasing the risk of injury to persons or causing abrasion of the insulation on conductors.

9.2 A lampholder, power-supply cord and its strain-relief bushing, receptacle, or similar component shall be mounted securely and, except as noted in 9.3, shall be restrained from turning. See 9.4.

9.3 A lampholder of a type in which the lamp is not intended to be replaced, such as a neon pilot or an LED indicator light in which the lamp is sealed, is not required to be restrained from turning where the rotation is not capable of reducing spacings below the minimum acceptable values.

9.4 The means by which the turning specified in 9.2 is prevented is to include more than friction between surfaces. For example, a lock washer, properly applied, is not prohibited from being used as a means to restrain turning of a device having a single-hole mounting means.

10 Accessibility of Live Parts

10.1 The electrical parts of a HCOA that do not require use of a tool for access shall be located or enclosed so that persons are protected against inadvertent contact with uninsulated live parts and film-coated magnet wire.

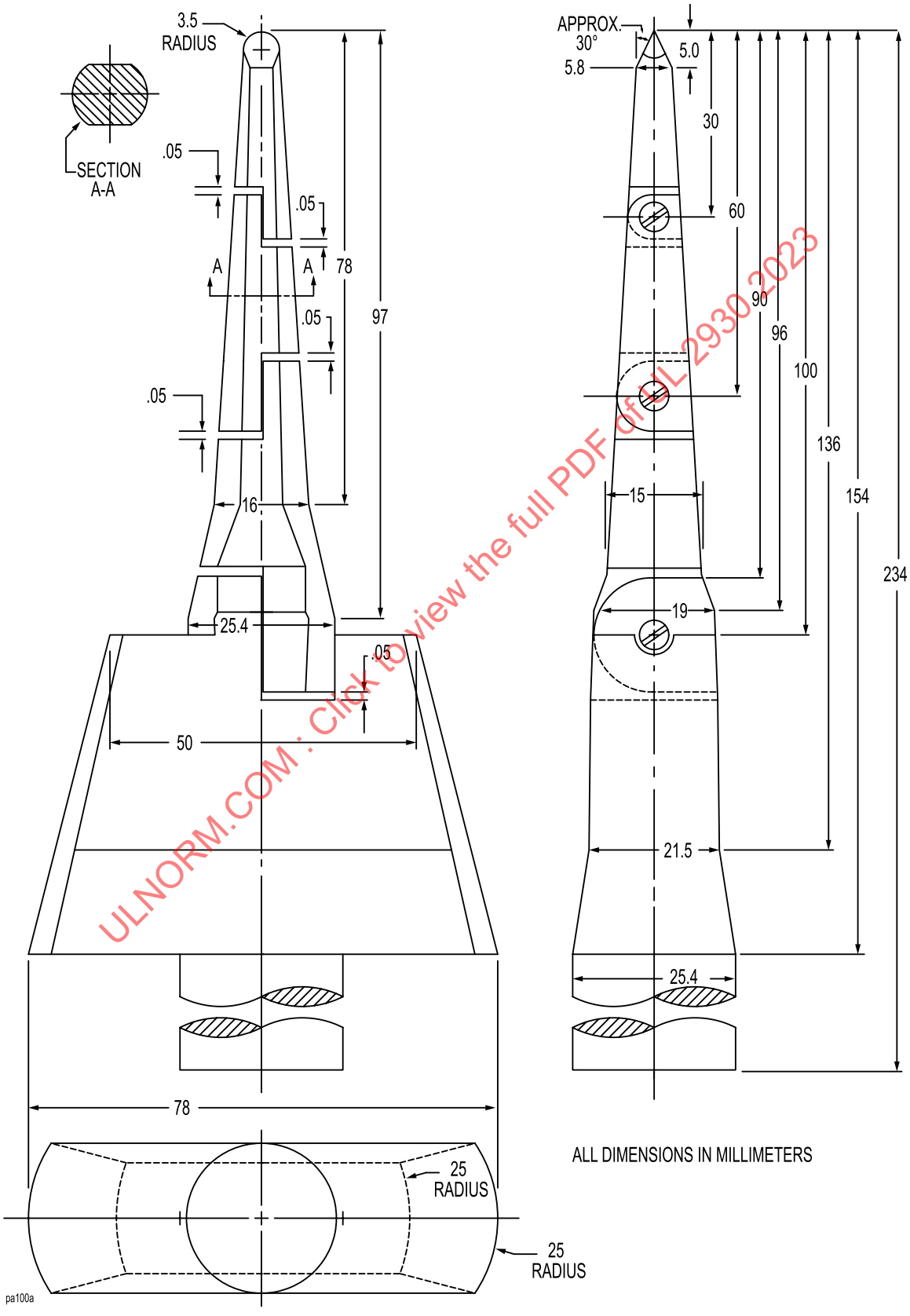
10.2 An opening in the enclosure of a HCOA is not prohibited where an uninsulated live part or film-coated magnet wire is not capable of being contacted by the probe shown in Figure 10.1. The probe shall

be applied to any depth that the opening permits, and shall be rotated or angled before, during, and after insertion through the opening to any position that is required to examine the enclosure. The probe shall be applied in any possible configuration; and, when required, the configuration shall be changed after insertion through the opening.

10.3 The probe shall be used as a measuring instrument to evaluate the accessibility provided by an opening, and not as an instrument to evaluate the strength of a material; it shall be applied with a force of not more than 6.7 lbf (30 N) to determine accessibility.

Figure 10.1

Accessibility Probe



10.4 Openings in an enclosure shall prevent insertion of a test rod having a diameter of 1/16 in ±0.0005 in. (1.6 mm ±0.005 mm). The test rod is to be applied with a force of not more than 0.5 lbf (2.2 N) and is to be angled during application to any position that is necessary to examine the enclosure. The contacts of a receptacle outlet shall not be evaluated.

11 Mounting Means

11.1 A HCOA shall incorporate a means for permanent mounting. An HCOA may also incorporate an additional means for relocatable mounting.

11.2 A keyhole slot, notch, or similar means for mounting shall employ a barrier (see Figure 31.1) that shall be sealed to prevent fluid from entering into the enclosure of an HCOA.

11.3 The mounting means shall comply with the Mounting Hole Barrier Tests, Section 31, and the Adequacy of Mounting Test, Section 36.

12 Corrosion Protection

12.1 Iron and steel parts or other parts not inherently corrosion resistant shall be protected against corrosion by painting, enameling, galvanizing, powder coating, plating, or other equivalent means and shall also comply with UL 514A, for corrosion protection as applicable.

Exception: Minor parts of iron or steel, such as washers, screws and the like that are not in the grounding conductor path are not required to comply with this requirement.

13 Insulating Materials

13.1 A barrier or integral part, such as an insulating washer or bushing, and a base or support for the mounting of live parts, shall be of a moisture-resistant material that will not be damaged by the temperature and stresses to which it will be subjected under conditions of actual use.

13.2 An insulating material is to be investigated with regard to its acceptability for the application in accordance with UL 746C. Materials, such as mica, ceramic, or some molded compounds are capable of being used as the sole support of live parts. When it is required to investigate a material to determine its acceptability, consideration is to be given to such factors as its mechanical strength, resistance to ignition sources, dielectric strength, insulation resistance, and heat-resistant properties in both the aged and unaged conditions, the degree to which it is enclosed, and any other features affecting the risk of fire and electric shock.

13.3 Vulcanized fiber, industrial laminates, polymeric films or similar materials are capable of being used for insulating bushings, washers, separators, and barriers, but not as sole support for uninsulated live parts. Hard rubber is not to be used.

Exception: Industrial laminates that have been investigated for the purpose are capable of being used as sole support for uninsulated live parts.

14 Power-Supply Cord

14.1 General

14.1.1 The power supply cord shall be of the grounding type and shall employ one of the following flexible cord Types: SJ, SJE, SJO, SJT, SJTO, SJEO, S, SE, SO, ST, STO, SEO, or equivalent.

14.1.2 A detachable power supply cord shall not be used.

14.1.3 The minimum conductor size of the power supply cord shall be 12 AWG copper when the HCOA employs four or more 15 ampere receptacle outlets (or two or more 15 ampere duplex receptacles, counting as four or more receptacle outlets) and 14 AWG copper when the HCOA employs three or less 15 ampere receptacle outlets. The minimum conductor size of the power supply cord shall be 12 AWG copper when the HCOA employs 20 ampere receptacle outlets.

14.1.4 The power supply cord used in an HCOA employing an attachment plug with an integral patient equipment grounding connection shall be of the type identified in 14.1.1, except shall employ a four-conductor flexible cord construction.

14.1.5 The insulated conductor designated as the patient equipment grounding conductor when provided in an attachment plug with an integral patient equipment grounding connection shall be a minimum 10 AWG conductor size.

14.1.6 All insulated conductors except for the conductor designated and identified as patient equipment grounding conductor are to be sized according to 14.1.3. The insulated conductor designated and identified as patient equipment grounding conductor shall be a minimum of 10 AWG conductor size.

14.1.7 The length of a power-supply cord – as measured from the outside surface of the enclosure of the HCOA to the plane of the face of the attachment plug shall not exceed 15 ft (4.57 m) nor be less than 2 ft (610 mm).

14.1.8 The power-supply cord shall not include a through-cord switch.

14.1.9 The power supply cord shall be provided with a 20 ampere rated Hospital Grade attachment plug that complies with UL 498, Supplement SC for Hospital Grade Devices.

Exception: A HCOA provided only with 15 ampere rated receptacle outlets may be provided with a 15 ampere rated Hospital Grade attachment plug that complies with UL 498, Supplement SC for Hospital Grade Devices.

14.1.10 A power supply cord provided with an integrally molded-on attachment plug fitting shall comply with the Hospital Grade Attachment Plug Program of UL 817.

14.1.11 An attachment plug with an integral patient equipment grounding connection shall be wired so that each grounding pin is independently connected to a separately provided insulated conductor.

14.2 Attachment Plug with Integral Patient Equipment Grounding Connection

14.2.1 An attachment plug with Integral Patient Equipment Grounding Connection shall comply with UL 498, Supplement SC for Hospital Grade Devices or in the case of molded-on attachment plug fitting shall comply with the Hospital Grade Attachment Plug Program of UL 817.

15 Strain Relief

15.1 Strain relief shall be provided so that a mechanical stress on a power supply cord or on the external Patient Equipment Grounding Terminal is not transmitted to terminals, splices, or internal wiring. See Strain Relief Test, Section 32.

15.2 The strain relief means shall be provided with a means to prevent rotational forces (twisting) applied to the cord from being transmitted to terminals, splices, or internal wiring.

15.3 The strain relief means shall not damage the insulation or cord jacket. The normal compressive deformation inherent in providing strain relief is not considered to be damage.

16 Receptacles

16.1 General

16.1.1 The receptacle outlets of a HCOA shall have a current rating of 15 or 20 A and a voltage rating of 125 or 250 V. The contact components of a receptacle shall have a voltage and current rating equal to that of the attachment plug on the power-supply cord.

Exception: A 15 A receptacle is not prohibited from being employed in a HCOA rated 20 A with a 20 A attachment plug.

16.1.2 All of the receptacle outlets of a HCOA shall be of the grounding type.

16.1.3 The receptacle outlets of a HCOA shall comply with the applicable requirements in UL 498, Supplement SC for Hospital Grade Devices.

16.1.4 An isolated ground receptacle shall not be employed in a HCOA.

16.1.5 The maximum number of receptacle outlets allowed in a HCOA shall be six single outlets or three duplex outlets.

16.1.6 A tamper-resistant receptacle that complies with the applicable requirements in UL 498, including Supplement SC for Hospital Grade Devices, may be employed in a HCOA.

16.1.7 A receptacle outlet shall not be secured to a HCOA enclosure by a single mounting screw.

16.1.8 A HCOA employing receptacle outlets that are red in color shall be marked in accordance with 41.16 and the receptacles shall be provided with indicator lights or illuminated faces to indicate when the receptacle outlets are energized.

16.1.9 A receptacle outlet shall be secured and bonded directly to the same metal part of an HCOA enclosure to which the Patient Equipment Grounding Terminal is mounted and bonded.

16.2 Receptacle covers

16.2.1 HCOA receptacle outlets shall be provided with a cover or covers to impede ready access without the use of a tool or key to the receptacle outlet(s).

16.2.2 A receptacle outlet cover shall comply with the Receptacle Outlet Cover Test when in the secured closed position. See Section 37.

16.2.3 The cover or covers impeding ready access to the HCOA receptacle outlets, or the HCOA enclosure adjacent to the cover(s), shall be marked in accordance with 41.12.

16.2.4 A tamper-resistant receptacle outlet that complies with the applicable requirements in UL 498, and that is not additionally provided with a cover to prevent access to the receptacle outlet(s) is considered to not comply with the requirements of 16.2.1 and 16.2.2.

17 Supplementary Protection Device

17.1 Supplementary protection devices, if provided in a HCOA, shall not disconnect power from any receptacle outlet.

NOTE: Supplementary protection devices may be provided as part of a USB circuit or Surge Protective Device, but are not permitted to be connected such that opening of a supplementary protection device would also disconnect power from a receptacle outlet.

18 Live Parts

18.1 Current-carrying parts shall have adequate ampacity, and shall be of copper, a copper-base alloy, or other material determined to be acceptable for the use.

18.2 Uninsulated live parts shall be secured to the base or mounting surface so that they do not turn or shift in position, when such motion results in a reduction of spacings below the minimum acceptable values.

18.3 Friction between surfaces is not to be used as the sole means to prevent shifting or turning of live parts. A lock washer is not prohibited from being used in such a manner.

19 Internal Wiring

19.1 The internal conductors shall be minimum 14 AWG copper when provided with a 15 ampere rated attachment plug and shall be 12 AWG when a 20 ampere rated attachment plug is provided.

19.2 Internal wiring shall be routed and secured to reduce the risk of mechanical damage to the insulation or stress on wiring terminations. The internal wiring shall be positively routed away from any exposed screw threads.

19.3 Screw threads, including those of sheet metal screws, shall not be exposed for more than 3/16 in (4.76 mm) inside a compartment containing wiring and shall be located so that contact with conductor insulation is unlikely.

19.4 Where a Printed Wiring Board (PWB) is used for internal conductors, the PWB shall comply with Printed Wiring Boards, Section 22.

19.5 All splices and connections shall be mechanically secure and shall provide sufficient ampacity. A soldered connection shall be made mechanically secure before being soldered.

Exception: Printed-wiring board joints positioned in the ungrounded or grounded conductor path (neutral), are not required to be mechanically secure before soldering. A printed-wiring board joint in any grounding path shall be mechanically secured before soldering.

19.6 A lead is considered to be mechanically secure when it is:

a) Wrapped at least halfway (180 degrees) around a terminal;

b) Provided with at least one right angle bend when passed through an eyelet or opening; or

c) Twisted with other conductors.

19.7 A splice shall be provided with insulation at least equivalent to the conductor insulation.

19.8 In determining whether splice insulation consisting of coated-fabric, thermoplastic, or another type of tape or tubing is capable of being used, consideration is to be given to such factors as mechanical strength, dielectric properties, heating and moisture-resistant characteristics, and the equivalent.

19.9 Where stranded wiring is connected to a wire-binding screw, the construction shall be such that any loose strand of wire is prevented from contacting live parts of opposite polarity or dead metal parts that may be grounded. This can be accomplished by use of upturned lugs on the terminal plate, pressure terminal connectors, soldering lugs, crimped eyelets, or equivalent means.

19.10 Soldered stranded (bunch tinned/solder dipped/tinned bonded) wire shall not be used with the terminals of a receptacle unless the receptacle has been investigated for such use.

20 Physical Protection of Conductors

20.1 The point where a flexible cord passes through an opening in a wall, barrier, or enclosure, shall be an opening that is free from sharp edges, burrs, and fins that are able to damage the insulation.

20.2 A cord shall be provided with mechanical means that prevents the cord from being pushed inside the enclosure and contacting:

a) A heated surface;

b) A sharp edge; or

c) A moving part.

20.3 Cord or wiring that passes through tubing or contacts the edge of a sheet-metal wall shall be reliably held away from the edges of the metal or shall be protected by a non rubber bushing, a grommet or by rolling the edge of the metal not less than 120 degrees.

20.4 Where the material through which the cord or wiring passes is porcelain, phenolic composition, or other insulating material, not less than 3/64 in (1.2 mm) thick, a smoothly rounded surface is determined to be equivalent to a bushing.

20.5 Ceramic materials and molded urea, phenolic, and melamine compositions are determined to meet the intent of the requirement for insulating bushings; a bushing of wood or rubber is not usable. Other compositions may be used when they have been investigated and found suitable for the application.

20.6 A hard-fiber bushing may be employed where the bushing is not less than 3/64 in (1.2 mm) thick.

20.7 An insulated metal grommet is usable in place of an insulating bushing where the insulating material used is not less than 1/32 in (0.8 mm) thick and completely fills the space between the grommet and the metal in which it is mounted.

20.8 Polymeric sleeving shall not be used for reducing the risk of cutting or abrasion of conductor insulation.

20.9 Fiberglass sleeving not less than 0.010 in (0.25 mm) thick is capable of being used for mechanical protection to reduce the risk of cutting or abrasion of conductor insulation.

20.10 A bushing shall be securely held in place.

21 Spacings

21.1 The spacings of a HCOA shall comply with the requirements of Table 21.1.

Table 21.1
Minimum Spacings

Potential involved in volts		Minimum spacing					
		0 – 50 V		51 – 125 V		126 – 250 V	
		in	(mm)	in	(mm)	in	(mm)
Between any uninsulated live part and an uninsulated live part of opposite polarity, uninsulated grounded part other than the enclosure, or exposed metal part[a, b]	Through air	3/64	(1.2)	1/16	(1.6)	3/32	(2.4)
	Over surface	3/64	(1.2)	1/16	(1.6)	3/32	(2.4)
Between any uninsulated live part and the walls of a metal enclosure[a, b]	Shortest distance	3/64	(1.2)	1/4	(6.4)	1/4	(6.4)

[a] A printed-wiring board intended to be completely encapsulated in a suitable potting compound, epoxy, or be conformal coated shall not have any spacing less than 1/32 in (0.8 mm).

[b] For the purpose of this requirement, a metal piece or component attached to the enclosure is considered to be a part of the enclosure when deformation of the enclosure reduces the spacing between the metal piece or component and uninsulated live parts.

21.2 A barrier or liner of insulating material used in areas where spacings do not comply with the requirements in this standard shall be evaluated and determined to comply with the requirements for internal barriers outlined in UL 746C, and shall be secured in place or its position fixed by space limitations. An adhesive used to position a barrier shall be investigated for the effects of temperature, humidity, and cyclic conditions outlined in UL 746C.

21.3 Vulcanized fiber not less than 0.028 in (0.71 mm) thick is not prohibited from being used as a barrier or liner.

Exception: Where required spacings are insufficient but at least 1/2 of the required spacing is provided, the vulcanized fiber is not prohibited from being 0.016 in. (0.40 mm) thick.

22 Printed-Wiring Boards

22.1 A printed-wiring board (PWB) shall comply with the requirements in UL 796, and shall be classed V-0, V-1, or V-2 in accordance with the requirements in UL 94.

22.2 A resistor, capacitor, inductor, or other part that is mounted on a printed-wiring board to form a printed-wiring assembly shall be secured to reduce the risk of electric shock or fire as the result of displacement from forces exerted on it during assembly, normal operation, or servicing.

22.3 Where the contacts of a receptacle outlet are directly affixed to a PWB, the receptacle outlet of a HCOA shall comply with the applicable requirements in UL 498 and Supplement SC for Hospital Grade devices.

22.4 A HCOA that has a receptacle grounding path through traces on a printed-wiring board shall comply with the Fault Current Test, Section 29, and the Overcurrent Test, Section 30.

22.5 A HCOA that has a load-current carrying circuit conductor path through traces on a printed-wiring board shall comply with the Overcurrent Test, Section 30.

23 Grounding

23.1 General

23.1.1 A metallic enclosure and other unenergized metal parts that are exposed to contact by persons shall be conductively connected to the grounding conductor of the power-supply cord, to the ground terminal of a receptacle outlet and to the patient equipment grounding terminal.

Exception No. 1: Unenergized metal parts that are isolated from grounded metal and are not accessible are not required to be connected to the grounding conductor of the power-supply cord, to the patient equipment grounding terminal or to the ground terminal of a receptacle outlet.

Exception No. 2: A small metal part, such as an adhesive-attached foil label, a screw, or the like, that is on the exterior of the enclosure and separated from all electrical components by grounded metal or is electrically isolated from all components, is not required to be connected to the grounding conductor of the power-supply cord, to the patient equipment grounding terminal or to the ground terminal of a receptacle outlet.

23.1.2 Connections in the HCOA grounding conductor path from the receptacle grounding contact to the grounding conductor of the power-supply cord and of the patient equipment grounding terminal or the patient equipment grounding conductor shall be welded, bolted, mechanically secured and soldered, or made by equivalent positive means. A quick-connect, or similar friction-fit connector shall not be used in the grounding conductor path. A receptacle that employs separable terminal(s) that complies with the applicable requirements in UL 498, is considered to be equivalent positive means.

23.1.3 The HCOA grounding conductor of the power-supply cord shall be green with or without one or more yellow stripes and of the same size as the current carrying conductors. No other lead in the power-supply cord shall be so identified. The HCOA ground conductor shall be secured to the metallic enclosure of the HCOA by a reliable means, such as a screw, that is not removed during ordinary servicing not involving the power supply cord. The grounding connection shall penetrate nonconductive coatings, such as paint or powder coating. All conductors in the grounding circuit of a HCOA shall be green with or without one or more yellow stripes.

23.1.4 Faceplate mounting screw(s) of the receptacle shall not be used to provide or maintain the grounding means of the receptacle or enclosure of a HCOA.

23.1.5 Where a receptacle used in a HCOA is provided with a grounding screw, this screw shall be used to provide the ground connection to the receptacle originating from the HCOA power supply cord. The grounded mounting means of a receptacle and the metal part of the HCOA enclosure to which it is secured shall provide the ground return connection to the patient equipment grounding terminal.

23.1.6 A HCOA grounding conductor shall be of copper, copper alloy, or other material that has been investigated for use as an electrical conductor. A ferrous metal part in the grounding path shall be protected against corrosion.

23.1.7 A copper-base-alloy rivet that is used to secure parts in the grounding path, or that forms a part of the grounding path, shall contain not less than 80 % copper.

23.1.8 The ungrounded (line) and grounded circuit conductor (neutral) shall not be connected to the grounding circuit conductor path.

Exception: Connection between the line or neutral conductor path and the grounding conductor path are able to be made when the components are investigated for the application (such as an across-the-line capacitor investigated to UL 60384-14) and comply with the 0.1 mA leakage current requirements. Metal

oxide varistors (MOVs) shall not be connected from the ungrounded or grounded circuit conductor to the grounding circuit conductor path or to the patient equipment grounding terminal.

23.2 Bonding

23.2.1 Accessible unenergized metal or other conductive parts not connected directly to the grounding conductor of the power supply cord shall be bonded to grounded parts by clamps, rivets, bolts, screws, brazes, welds, or an equivalent positive means.

23.2.2 A corrosion resistant bonding strap or jumper providing positive electrical connection is capable of being used.

23.2.3 A bonding conductor shall be of copper, copper alloy, aluminum or other material that has been investigated for use as an electrical conductor. A ferrous metal part in the grounding path shall be protected against corrosion.

23.2.4 Metal parts in a bonding path shall be galvanically compatible so as to reduce electrolytic action between dissimilar metals.

23.2.5 A bonding member shall:

a) Be protected from mechanical damage;

b) Not be secured by a removable fastener used for any purpose other than bonding unless the bonding conductor is not capable of being omitted after removal or replacement of the fastener; and

c) Have the flexibility required to withstand mechanical stress.

23.2.6 Where a bonding means depends on screw thread, two or more screws shall be employed, or at least two full threads of a single screw shall engage metal.

23.2.7 A bonding connection shall penetrate a nonconductive coating such as paint or powder coating.

23.2.8 A bonding conductor shall not be spliced.

23.3 Patient equipment grounding terminal

23.3.1 The patient equipment grounding terminal or jack shall be bonded directly to the same metallic part of the HCOA enclosure to which the grounded mounting means of the HCOA receptacle outlets are secured. This ground connection shall be mechanically independent of the termination of the grounding conductor of the HCOA power supply cord.

23.3.2 The patient equipment grounding terminal shall require a tool to remove the patient equipment grounding conductor.

23.3.3 The patient equipment grounding terminal shall be suitable for connection of a 10 AWG copper stranded conductor.

23.3.4 The patient equipment grounding terminal with the patient equipment grounding conductor secured to the terminal shall comply with the strain relief test. See 32.2(b).

23.3.5 The patient equipment grounding terminal shall be marked as indicated in 41.14.

23.3.6 The patient equipment grounding terminal shall be accessible without the use of tools or a key.

23.3.7 For field attachment of a protective earth conductor, the patient equipment grounding terminal shall be located on the HCOA enclosure where it is accessible without removal of the HCOA from its mounting and without the use of tools or a key.

23.3.8 For an attachment plug with an integral patient equipment grounding connection, the patient equipment grounding terminal or jack is omitted and replaced by an integral bonding connection between the metallic part of the HCOA enclosure and designated patient equipment ground pin connection. The patient equipment ground pin shall be mechanically independent of the termination between the supply grounding pin and grounding conductor of the HCOA power supply cord.

23.4 Patient equipment grounding conductor

23.4.1 Where a HCOA is provided with a Patient Equipment Grounding Conductor or an Attachment Plug with an Integral Patient Equipment Grounding Connection, it shall be a minimum 10 AWG copper single conductor SJ, SJE, SJO, SJT, SJTO, SJEO, SE, SO, ST, STO or SEO type cord insulated color of green with or without one or more yellow stripes and shall be secured to the Patient Equipment Grounding Terminal mounted on the exterior of the enclosure. For an attachment plug with an integral patient equipment ground connection, the insulated conductor insulation shall be colored other than black, white or gray, but may be colored green with or without one or more yellow stripes.

23.4.2 Where provided, the patient equipment grounding conductor shall be secured to the enclosure so that it is replaceable and requires a tool to remove the conductor from the patient equipment grounding terminal.

23.4.3 The patient equipment grounding conductor when provided shall be a minimum 6 ft (1.8 m) long and maximum 25 ft (7.6m) long as measured from the HCOA enclosure to the patient equipment grounding terminal specified in 23.3.

23.4.4 For an attachment plug with an integral patient equipment ground connection, the patient equipment grounding conductor minimum and maximum length described in 23.4.3 do not apply. The integral patient equipment ground conductor shall be the same length of the power supply cord.

PERFORMANCE

24 General

24.1 Where the use of cheesecloth is specified, the cloth to be used is to be a bleached cheesecloth running 14 – 15 yd^2/lb (approximately 26 – 28 m^2/kg) and having what is known as "a count of 32 by 28," that is, for any square in, 32 threads in one direction and 28 threads in the other direction (for any square centimeter, 13 threads by 11 threads).

24.2 A HCOA shall be subjected to the applicable tests specified in Sections 25 – 39. A separate sample shall be used for each test. Additional samples may be required for investigations of constructions incorporating surge protection.

24.3 For tests in which the HCOA is to be connected to a power-supply circuit, the branch circuit shall be protected by a branch-circuit overcurrent protective device rated 20 A, and the power-supply voltage is to be the voltage rating of the HCOA.

24.4 The frequency of the power-supply circuit is to be 50 – 60 Hz.

25 Temperature Test

25.1 A HCOA shall be subjected to the temperature test described in 25.2 – 25.9.

25.2 The temperature of a HCOA shall not adversely affect any materials employed, or exceed the temperatures indicated in Table 25.1. The temperature test shall be performed using the complete assembly.

Table 25.1
Maximum Temperatures[a]

Materials and components	°C	(°F)
1 Varnished-cloth insulation	85	(185)
2 Fiber, and other similar electrical insulation	90	(194)
3 Phenolic composition employed as electrical insulation or as a part whose malfunction would result 3 in a risk of fire or electric shock	150[b]	(302[b])
4 Insulated wires and cables	60[b]	(140[b])
5 On the surface of a capacitor casing:		
Electrolytic	65[c]	(149[c])
Other types	90[c]	(194[c])
6 Receptacle contacts	55	(135)
7 Metal enclosure surface that is contacted in normal use	70	(158)
8 Polymeric enclosure surface that is contacted in normal use	95	(203)
9 Ambient – See 25.5.		

[a] Previously investigated attachment plugs are not subjected to the temperature test requirements.

[b] The limitations on phenolic composition and on wire insulations do not apply to compounds that have been investigated and determined to be in compliance for higher temperatures.

[c] A capacitor operating at a temperature higher than indicated is not prohibited from being evaluated on the basis of its marked temperature rating, or if not marked with a temperature rating, is capable of being investigated to determine its compliance at the higher temperature.

25.3 The HCOA shall be subjected to the rated voltage and 20 Amp current draw by connecting a resistive load by means of a solid-blade attachment plug to the last receptacle and any other receptacle that attains higher temperatures as determined by their proximity to heat-producing components. When the last receptacle outlet rating is less than the rating of the attachment plug rating for the HCOA the last receptacle shall be loaded to its maximum current rating and the receptacle outlet electrically adjacent to the last receptacle shall be loaded to the balance of the attachment plug rating. Example: A 5-20P attachment plug is provided and 5-15R receptacles are provided. Load the last receptacle outlet to 15 Amps and the next farthest receptacle from the supply outlet to 5 Amps.

25.4 Measurements are to be made until there is thermal equilibrium as demonstrated by three successive temperature readings indicating no change taken at intervals of 5 min, or more.

25.5 The temperatures specified in Table 25.1 are based on an assumed ambient temperature of 25 °C (77 °F). A test is capable of being conducted at an ambient temperature within the range of 10 – 40 °C (50 – 104 °F), and the observed temperature shall be corrected for a room temperature of 25 °C (77 °F). An observed temperature is to be corrected by addition [when the ambient temperature is lower than 25 °C (77 °F)], or subtraction [when the ambient temperature is higher than 25 °C] of the difference between 25 °C and the ambient temperature.

25.6 Temperature readings are to be obtained by means of thermocouples consisting of 28 – 32 AWG (0.08 – 0.032 mm^2) iron and constantan wires. Whenever referee temperatures are required, 30 AWG (0.05 mm^2) iron and constantan wires and a potentiometer-type of indicating instrument are to be used.

25.7 The thermocouples and related instruments are to be accurate and calibrated in accordance with good laboratory practice. The thermocouple wire is to comply with the requirements specified in the Tolerances on Initial Values of EMF versus Temperature tables in ASTM E230/E230M.

25.8 A thermocouple junction and the adjacent thermocouple lead wire are to be securely held in good thermal contact with the surface of the material whose temperature is being measured. In most cases, acceptable thermal contact results from securely taping or cementing the thermocouple in place but, when a metal surface is involved, brazing or soldering the thermocouple to the metal may be required.

25.9 To facilitate conducting the test on a totally enclosed – encapsulated – component of a HCOA, thermocouples are to be attached to internal components prior to the addition of potting materials and are to be routed through holes made in the enclosure for this purpose.

26 Dielectric Voltage-Withstand Test

26.1 Immediately following the temperature test while still heated the insulation and spacings of a HCOA shall withstand for 1 minute without breakdown the test potential specified in 26.2.

26.2 A 60-hertz essentially sinusoidal potential is to be applied between electrically energized parts conductively connected to the supply circuit, ungrounded supply conductor(s), grounded supply conductor(s), and dead metal parts. The applied potential is to be 1,250 volts rms, or 1,000 volts plus two times the supply voltage, whichever is higher. The supply source is to have sufficient capacity to maintain the potential specified, except in case of breakdown. The voltage is to be increased gradually from zero until the prescribed test potential is reached or until breakdown occurs. The potential shall be applied between:

a) The supply wiring and dead metal parts; and

b) Any two conductors. This test is to be continued until each conductor has been tested with respect to every other conductor.

26.3 Suppressor elements and across-the-line connected components are to be disconnected or removed during this test.

26.4 The test equipment for conducting the dielectric voltage-withstand test is to have the following features and characteristics:

a) A means for indicating the test voltage that is being applied to the HCOA under test (this is accomplished by sensing the voltage at the test leads or by an equivalent means);

b) An output voltage that has a sinusoidal waveform, a frequency that is within the range of 40 – 70 Hz, and a peak value of the waveform that is not less than 1.3 and not more than 1.5 times the root-mean-square value;

c) A sensitivity of the test equipment that is such that when a resistor of 120,000 Ω is connected across the output, the test equipment does not indicate unacceptable performance for any output voltage less than the specified test voltage, and the test equipment does indicate unacceptable performance for any output voltage equal to or greater than the specified test value. The resistance of the calibrating resistor is to be adjusted as close to 120,000 Ω as instrumentation accuracy provides, but never more than 120,000 Ω.

Exception: The sensitivity of the test equipment is capable of being increased, and a higher value of calibrating resistance is capable of being used, when agreeable to those concerned.

27 Leakage Current Test

27.1 The leakage current of the HCOA when tested in accordance with 27.2 – 27.8 shall not be more than 0.1 mA.

27.2 The leakage current of the HCOA incorporating a surge protective device when tested in accordance with UL 1449, shall not be more than 0.1 mA.

27.3 The leakage current of the HCOA incorporating an integral power supply with one or more Class 2 outputs connector when tested in accordance with UL 1310, shall not be more than 0.1 mA. The leakage current of the HCOA that employs receptacles provided with an integral power supply with Class 2 output connectors when tested in accordance with UL 1310, shall not be more than 0.1 mA.

27.4 The HCOA shall be preconditioned as specified in 27.5 before conducting the leakage current test.

27.5 The humidity preconditioning treatment shall be performed in a humidity cabinet containing air with a relative humidity of 93 ±3 %. The temperature of the air in the cabinet shall be maintained within 2 °C of any convenient value in the range of 20 – 32 °C. Before being placed in the humidity cabinet the HCOA shall be brought to a temperature between 20 °C and 36 °C, and kept at this temperature for at least 4 h before the humidity treatment. The HCOA shall be kept in the humidity cabinet for 2 days (48 h).

27.6 The measurements shall be carried out with the HCOA located in an environment with a temperature approximately equal to the temperature of the humidity cabinet. The HCOA shall be tested at relative humidity between 45 – 65 % and shall commence 1 h – 1.25 hrs after the end of the humidity preconditioning treatment.

27.7 The measurements which do not energize the HCOA shall be made first. The HCOA shall be placed on a surface isolated from earth ground. The HCOA is to be connected to an electrical supply with a voltage equal to 110 % of the highest rated mains voltage.

27.8 The test sequence, with reference to the measuring circuit in Figure 27.2, is to be as follows:

a) With switch S1 and S3 open, S4 closed the HCOA is to be connected to the measuring circuit. Leakage current is to be measured using both positions of switch S2.

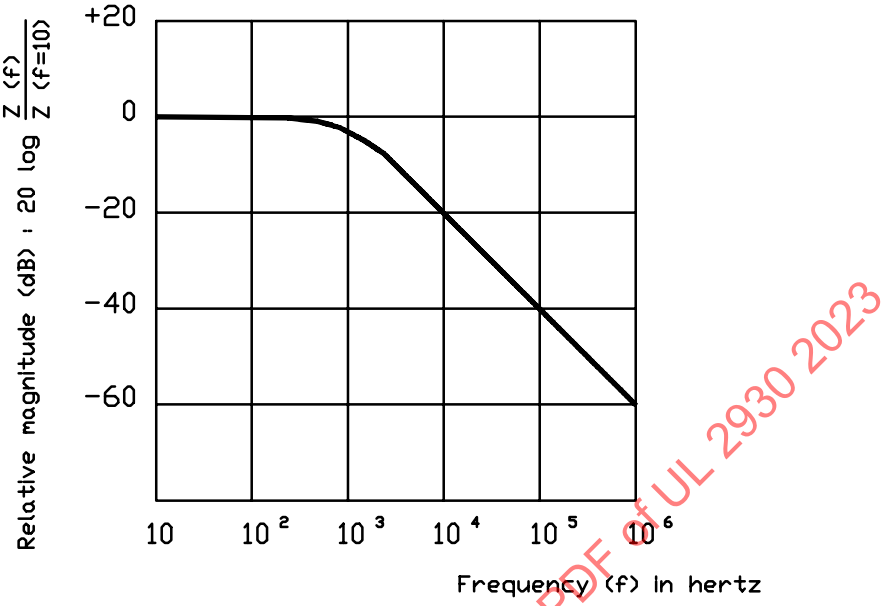
b) With switch S1 and S4 open, S3 closed the HCOA is to be connected to the measuring circuit. Leakage current is to be measured using both positions of switch S2.

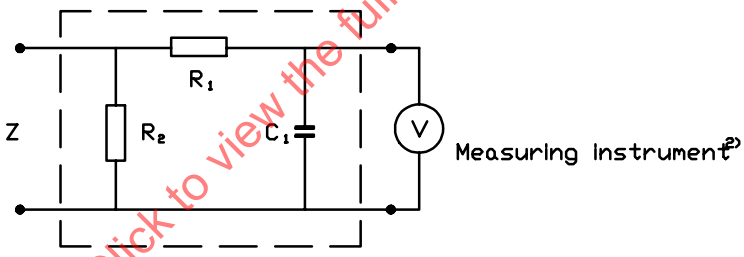
c) Switch S1 is then to be closed, S3 open, S4 closed energizing the HCOA, and within 60 s, the leakage current is to be measured using both positions of switch S2 and with the HCOA switching devices in all their normal operating positions.

d) The HCOA is to be electrically loaded as indicated in the Temperature Test, Section 25 and leakage current is to be measured as specified in (c) and (d) until thermal stabilization. Both positions of switch S2 are to be used in determining this measurement.

Figure 27.1

Leakage Current Measurement Device Circuit





R_1 = 10kΩ ± 5%[1)]
R_2 = 1kΩ ± 1%[1)]
C_1 = 0.015μF ± 5%[1)]

[1)] Non-inductive components
[2)] Impedance » measuring impedance Z

Equivalent to the above in subsequent figures.

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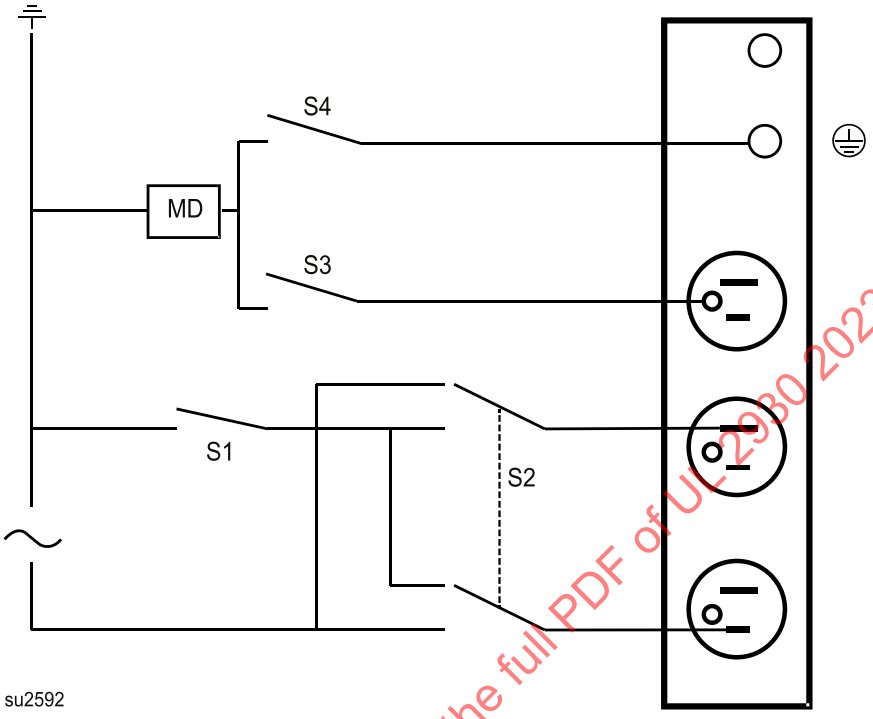
Figure 27.2

Leakage Current Measurement Circuit



⏚ – Patient Equipment Grounding Conductor and Terminal (Dual-fed Ground)

~ – Alternating Current Source 125 or 250 Volts, 60Hz

MD – Measurement device shown in Figure 27.1

28 Grounding Continuity Test

28.1 A previously untested HCOA is to be subjected to the Grounding Continuity Test as described in 28.2. A HCOA shall have a grounding-path resistance of 0.1 Ω or less.

28.2 The resistance of the grounding path is to be determined by the use of a resistance measuring instrument or calculated by measuring the voltage drop between the power-supply cord grounding pin and:

a) Each receptacle outlet grounding contact; and

b) Any point on a metal enclosure.

28.3 Resistance is to be determined with a 25 A, 60 Hz, alternating current being passed from the grounding pin to each receptacle grounding contact or the enclosure, and dividing the measured voltage by the test current. In the event that unacceptable results are recorded using a resistance measuring instrument, the voltage drop method shall be used as the referee method. The current power-supply source shall be at any convenient voltage, not exceeding 6 V.

29 Fault Current Test

29.1 General

29.1.1 Where a PWB is used as specified in 22.4, three samples of previously untested HCOA's are to be subjected to the Fault Current Test as described in 29.1.2 – 29.2.1. The HCOA shall comply with the requirements in 29.1.3. Each HCOA shall be tested once.

29.1.2 Each HCOA shall be tested on a circuit calibrated in accordance with 29.2.1. The available current capacity of the circuit is to be 1000 Amps. The frequency of the test circuit is to be 60 ±12 Hz. The grounding or bonding circuit is to be connected in series with a circuit breaker or time-delay non-current limiting fuse that is rated for the maximum ampacity of the circuit in which the HCOA is intended to be installed, suitable for branch circuit protection, and connected directly to the test circuit. The circuit breaker or fuse shall open when the test circuit is closed.

29.1.3 A HCOA shall have a grounding-path resistance of 0.1 Ω or less after the test described in 29.1.2. See 28.2. Also, during and following the Fault Current Test, the following conditions shall not occur:

a) Emission of flame, molten metal, or glowing or flaming particles through any openings (pre-existing or created as a result of the test) in the product;

b) Charring, glowing, or flaming of the supporting surface;

c) Ignition of the enclosure;

d) Creation of any openings in the enclosure that result in accessibility of live parts, when evaluated in accordance with Accessibility of Live Parts, Section 10; and

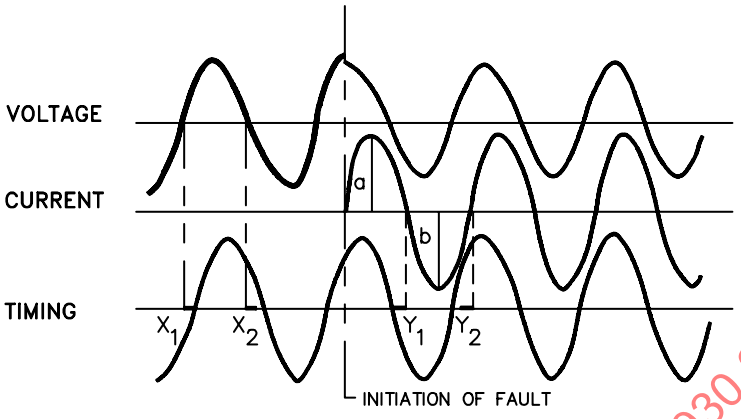
e) There shall not be evidence of degradation or separation of the trace from the printed-wiring board.

29.2 Calibration of test circuits

29.2.1 The current is to be the rms value of the first complete cycle – see Figure 29.1 – when the circuit is closed to produce a symmetrical current waveform. The direct-current component is not to be added to the value obtained when measured as illustrated. In order to obtain the required symmetrical waveform of a single-phase test circuit, controlled closing is recommended although random closing methods may be used. The power factor is to be determined by referring the open-circuit voltage wave to the two adjacent zero points at the end half of the first complete current cycle by transposition through a required timing wave. The power factor is to be computed as an average of the values obtained by using the two current zero points.

Figure 29.1

Determination of Current and Power Factor



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30 Overcurrent Test

30.1 Where a PWB is used as specified in 22.4, three previously untested HCOA are to be subjected to the Overcurrent Test as described in 30.2 – 30.6. The HCOA shall comply with the requirements in 30.5 and 30.6. Each HCOA shall be tested once.

30.2 The resistance of each circuit conductor path shall be determined by measuring the voltage drop when a current of 25 A, derived from a 60 Hz source with a no-load voltage not exceeding 6 V, is passed between the input port and output port connectors of each conductor path.

30.3 The HCOA is to be mounted so as to provide free air flow around all sides and the top. The ambient temperature is to be 25 ±5 °C (77 ±9 °F). The load current and time duration is to be as indicated in 30.4. Rated frequency is to be used. Any voltage not higher than the rated voltage may be used.

30.4 The overload current is to be 40 Amps. The overcurrent test current is to be applied for 2 minutes.

30.5 During and following this test, the following conditions shall not occur:

a) Emission of flame, molten metal, or glowing or flaming particles through any openings (existing or created as a result of the test) in the product;

b) Charring, glowing, or flaming of the supporting surface;

c) Ignition of the enclosure;

d) Creation of any openings in the enclosure that result in accessibility of live parts, when evaluated in accordance with Accessibility of Live Parts, Section 10; and

e) There shall be no evidence of degradation or separation of the trace from the printed-wiring board.

30.6 After the sample has cooled to room temperature, the resistance of each circuit conductor path is to be determined as specified in 30.2. The resistance of each conductor path shall not increase by more than 10 %. Additionally, the resistance of the grounding circuit shall not exceed 0.1 Ω.

31 Mounting Hole Barrier Tests

31.1 General

31.1.1 Where penetration or deflection of a barrier behind a mounting hole of the HCOA increases the risk of fire, electric shock, or injury to persons, the HCOA is to be subjected to the Mounting Hole Barrier Tests as described in 31.2.1 – 31.3.1 without any occurrence of the following due to the penetration or deflection of the barrier:

a) Creation of any openings in the enclosure that result in accessibility of live parts, when evaluated in accordance with Accessibility of Live Parts, Section 10;

b) A reduction of spacings below the values specified in Spacings, Section 21;

c) Transient distortion that results in contact with live parts causing energization of a metallic enclosure;

d) Any condition that is capable of affecting the intended mechanical performance of the HCOA; and

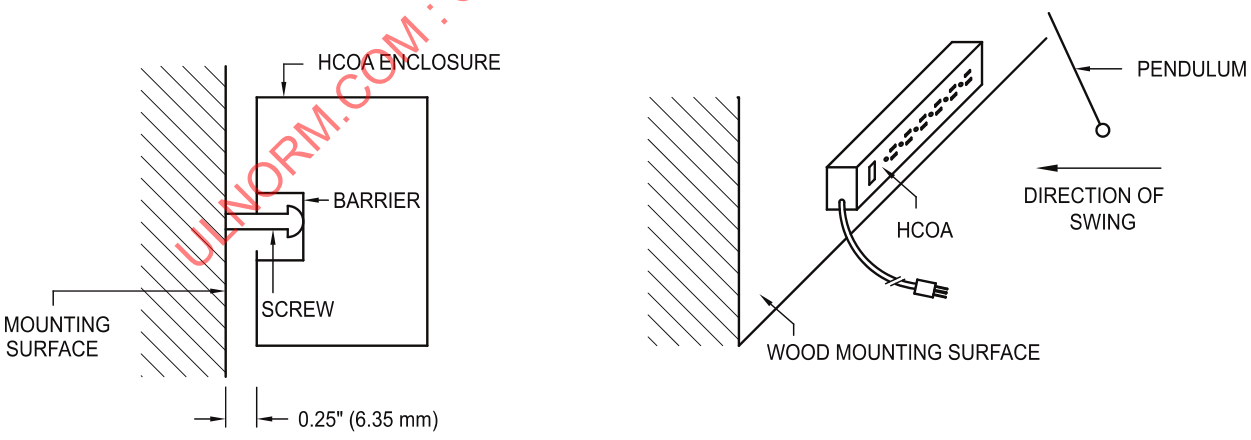
e) Any other condition that increases the risk of electric shock.

31.2 Mounting hole barrier impact test

31.2.1 The HCOA is to be mounted on a vertical surface using the hardware supplied or the hardware recommended by the manufacturer. When no hardware is supplied or recommended, the HCOA is to be mounted using a No. 8 × 3/4-in wood screw. When the screws are resting against the barrier there is to be 1/4 in (6.35 mm) clearance between the back of the enclosure and the mounting surface. See Figure 31.1.

Figure 31.1

Test Set-up for Mounting Hole Barrier Impact Test



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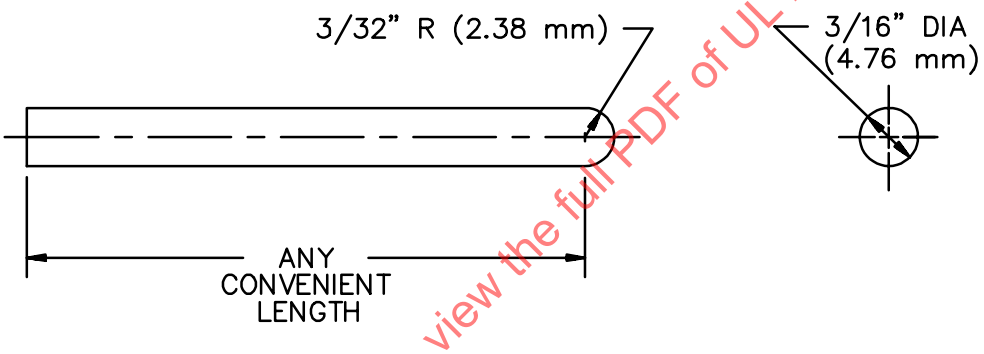
31.2.2 Each mounting hole configuration of the HCOA shall be subjected to a single impact of 5 ft-lbf (6.8 J) to the HCOA mounted as specified in 31.2.1. This impact is to be produced by a steel sphere, 2 in (50.8 mm) in diameter and weighing 1.18 lb (0.535 kg), suspended by a cord and swung as a pendulum, dropping through a vertical distance of 51 in (1.29 m) to cause it to strike the HCOA with the specified impact as shown in Figure 31.1. Each impact shall be applied to a point on the HCOA surface that is evaluated as being the most severe for the mounting hole configuration under test.

31.3 Mounting hole barrier probe test

31.3.1 1 Each barrier of an untested sample of a HCOA shall withstand a force of 20 lbf (89 N). The force is to be applied by means of the barrier probe shown in Figure 31.2.

Figure 31.2

Barrier Probe



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32 Strain Relief Test

32.1 A HCOA power supply cord and patient equipment grounding conductor shall be tested for strain relief as described in 32.2.

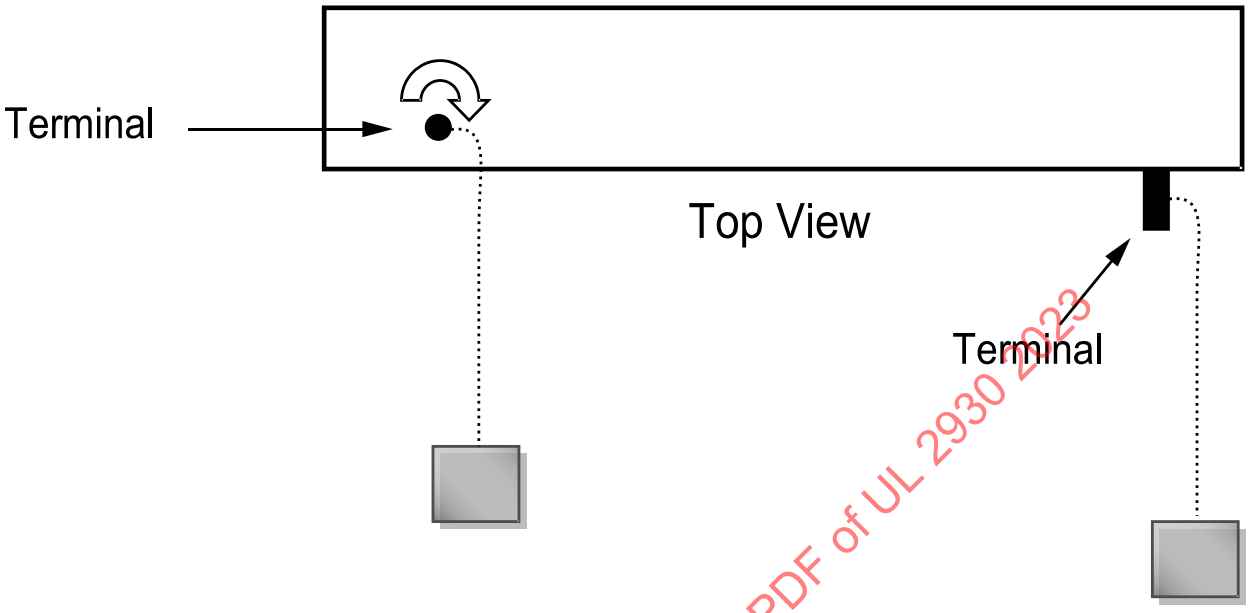
32.2 The HCOA shall be held securely in place in a position that allows a pull on the cord or patient equipment grounding conductor in directions that produce the most severe stresses.

a) Power supply cord – The power-supply conductors shall be cut at the terminations within the HCOA enclosure. The HCOA shall be mounted as specified in the instructions. The power-supply cord is to withstand a direct pull of 35 lbf (158 N) applied to the cord for 1 min. There shall be no movement of the power-supply conductors at the cut end that indicates transmission of stress to the internal connections.

b) Patient equipment grounding terminal and equipotential earth terminal – The HCOA is to be mounted in accordance with the instructions. A 10 AWG conductor is to be secured to the terminal. The method of securement is not specified but shall be consistent with the type of terminal provided. The securement of the terminal to the enclosure is to withstand a direct pull of 35 lbf (158 N) applied to the conductor at any angle to the terminal. There shall be no visible signs of damage to the terminal. The terminal shall not rotate when the conductor and force are applied about the axis of the terminal to the enclosure. See Figure 32.1. The terminal shall remain securely fixed to the enclosure.

Figure 32.1

Test Set-up for Patient Equipment Grounding Terminal Test



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33 Enclosure Tests

33.1 General

33.1.1 A HCOA is to be subjected to the impact tests described in 33.2.1 – 33.3.1 without any occurrence of the following:

a) Creation of any openings in the enclosure that result in accessibility of live parts, when evaluated in accordance with Accessibility of Live Parts, Section 10;

b) Any condition that is capable of affecting the intended mechanical performance of the HCOA;

c) Any other condition that increases the risk of electric shock; and

d) Spacings shall not be less than those described in Spacings, Section 21.

33.1.2 With reference to 33.1.1(c), the HCOA is to comply with the Dielectric Voltage-Withstand Test, Section 26, and the Leakage Current Test, Section 27 after being subjected to the impact tests described in this section.

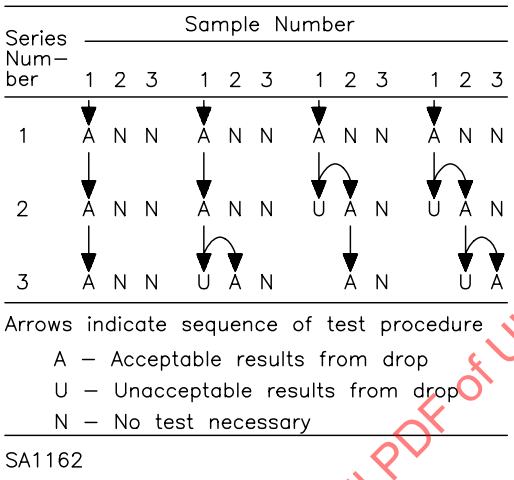
33.2 Drop impact test

33.2.1 Each of three samples of the HCOA is to be subjected to an impact that results from the sample being dropped three times (a series) through a distance of 3 ft (0.91 m) from the bottom of the HCOA to strike a concrete surface in the positions that produce adverse results. In each drop, the sample is to strike in a position on the enclosure different from those of each of the other two drops in the series.

Exception: When agreeable to those concerned, fewer samples are not prohibited from being used in accordance with Figure 33.1 wherein each series consists of three drops of the sample. The overall performance is acceptable upon completion of any one of the sequences represented in the figure.

Figure 33.1

Drop Impact Test



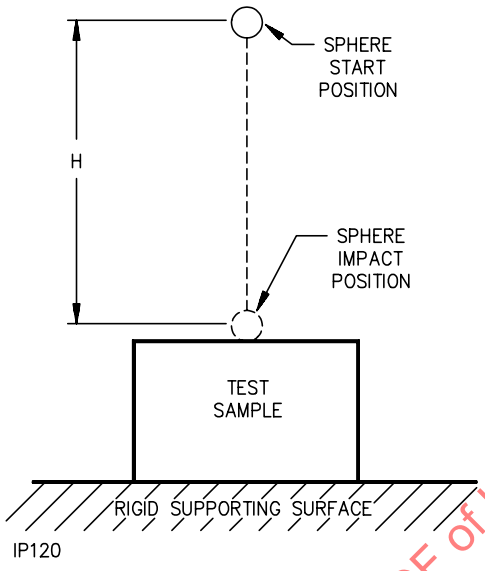
33.3 Steel sphere impact test

33.3.1 Each of three samples of the HCOA shall be subjected to a single impact of 5 ft lbf (6.8 J). Each impact shall be applied to an enclosure surface not impacted previously in the test sequence. Each impact is to be imparted by dropping a steel sphere 2 in (50.8 mm) in diameter, and weighing 1.18 lb (0.535 kg), from a height that produces the specified impact as shown in Figure 33.2. The ball shall not impact on a receptacle face, overcurrent protective device, switch, pilot light or similar component. For surfaces other than the top on an enclosure, the steel sphere is to be suspended by a cord and swung as a pendulum, dropping through the vertical distance required to cause it to strike the surface with the specified impact as shown in Figure 33.3. Three samples are to be used for the tests in the equipment restrained mode.

Exception: When agreeable to those concerned, fewer than three samples are not prohibited from being used for the tests in accordance with Figure 33.1 in which each series of impacts is to consist of one impact. The overall performance is acceptable upon completion of any one of the sequences represented in the figure.

Figure 33.2

Ball Drop Impact Test

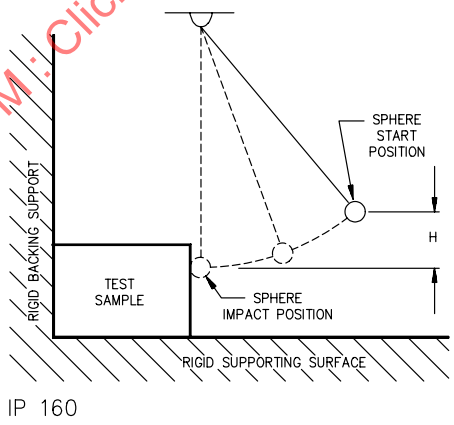


1 – H indicates the vertical distance the sphere must travel to produce the desired impact.

2 – The supporting surface is to consist of a layer of tongue-and-groove oak flooring mounted on two layers of 3/4 in (19 mm) plywood. The oak flooring is nominally 3/4 in thick (actual size 3/4 by 2-1/4 in or 19 by 57 mm). The assembly is to rest on a concrete floor. An equivalent non-resilient supporting surface is not prohibited from being used.

Figure 33.3

Ball Pendulum Impact Test



1 – H indicates the vertical distance the sphere must travel to produce the desired impact.

2 – For the ball pendulum impact test the sphere is to contact the test sample when the string is in the vertical position as shown.

3 – The supporting surface is to consist of a layer of tongue-and-groove oak flooring mounted on two layers of 3/4 in (19 mm) plywood. The oak flooring is nominally 3/4 in thick (actual size 3/4 by 2-1/4 in or 19 by 57 mm). The assembly is to rest on a concrete floor. An equivalent non-resilient supporting surface is not prohibited from being used.

4 – The backing surface is to consist of 3/4 in (19 mm) plywood over a rigid surface of concrete. An equivalent nonresilient backing surface is not prohibited from being used.

34 Crushing Test

34.1 A HCOA employing a metallic enclosure is to be subjected to the crush test described in 35.4 without any occurrence of the following:

a) Creation of any openings in the enclosure that result in accessibility of live parts, when evaluated in accordance with Accessibility of Live Parts, Section 10;

b) Any condition that is capable of affecting the intended mechanical performance of the HCOA; and

c) Any other condition that increases the risk of electric shock.

34.2 With reference to 34.1(b), the enclosure shall not crack or dent or affect the function of any features or strain relief. Cracking or denting of the enclosure is not to result in exposure of moving parts capable of causing injury to persons.

34.3 With reference to 34.1(c), the HCOA is to comply with the Dielectric Voltage-Withstand Test, Section 26.

34.4 A previously untested sample of a HCOA shall be placed on a 1/2-in (12.7-mm) thick, horizontal maple board, and a crushing force of 150 lbf (667.2 N) is to be applied to three different locations of the HCOA by means of a horizontal 3/4-in (19.1-mm) diameter steel rod. The rod is to be placed across the center of the smaller dimension of the test surface of the HCOA, perpendicular to the long axis of the HCOA. The length of the rod is to span the smaller dimension of the surface being tested. Force is to be gradually applied and maintained for a period of 1 min. The crushing force is not to be applied to protruding members of receptacles, switch toggles/triggers, indicator lamps and OCP reset members.

34.5 At the end of the tests described in 34.1 – 34.4, spacings shall not be less than those described in Spacings, Section 21.

35 Enclosure Integrity Test

35.1 The purpose of this test is to evaluate the integrity of the receptacle outlet mounting to the enclosure, the mounting means of the enclosure to another surface and the integrity of the enclosure itself. A previously investigated Hospital Grade receptacle is investigated only to determine the integrity of its mounting and securement to and within the enclosure. There shall be no access to uninsulated live parts following the enclosure integrity test as determined by the probes specified in Accessibility of Live Parts, Section 10.

35.2 The HCOA is to be mounted vertically to a minimum 3/4 in (19.05 mm) thick rigid wood surface or similar rigid surface. The tests specified in 35.3 – 35.5 shall be conducted on the HCOA. A new sample of the HCOA may be used for each orientation.

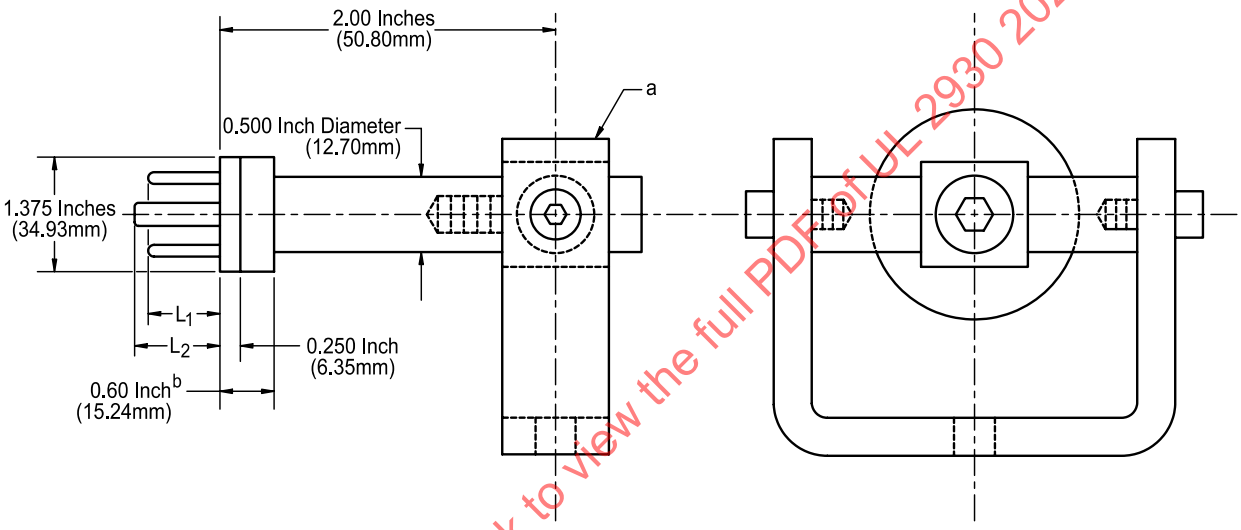
35.3 The HCOA is to be subjected to the abrupt plug removal as described in 35.5 in 4 mounting positions. The HCOA shall be mounted vertically with an orientation first at 0 then 90, 180 and 270 degrees. The test shall be conducted once at a far right receptacle outlet, once at a far left receptacle and if there are intermediate receptacles once to a receptacle at or near the center of the HCOA. A new sample of the HCOA may be used for each orientation.

35.4 Receptacle outlets rated 20 A that accept 15 A attachment plugs are to be tested using one half of the devices for testing with the 20 A plug configuration and the remaining devices with the 15 A plug configuration.

35.5 The HCOA is to be subjected to a series of abrupt plug removals as illustrated in Figure 35.1. The test plug shall use solid line blades made of brass and a U-shaped ground pin made of brass. Each abrupt removal is to consist of the full insertion of the test plug followed by the complete withdrawal by means of a 10 lb (4.4 kg) weight dropped from a height of 24 in (0.61 m) – measured from the bottom of the weight – onto a striker plate attached to the plug by a 1/4 in (6.4 mm) diameter guide rod and a flexible coupling. The guide rod shall be located vertically below the outlet being tested, and 2 in (50.8 mm) in front of the plane of the receptacle face (see Figure 35.2 and Figure 35.3). The applied force shall cause the removal of the test plug in one continuous motion. New brass line blades and ground pin are to be used in the test plug for each abrupt removal.

Figure 35.1

Typical Test Plug for Abrupt Plug Removals



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NOTES

Material: Tool Steel

Line Blades and Ground Pin Material: Brass

a – Universal coupling, details not specified, typical application shown.

b – Dimensions are for typical construction and can be varied, provided that the necessary support of the test blades is maintained.

L_1 = 0.625 in (15.88 mm) Max.

L_2 = 0.843 in (21.41 mm) Max

$L_2 – L_1$ = 0.125 in (3.18 mm) Min.