UL 962A

STANDARD FOR SAFETY

Furniture Power Distribution Units

UL Standard for Safety for Furniture Power Distribution Units, UL 962A

Sixth Edition, Dated July 13, 2023

Summary of Topics

This new Sixth Edition of ANSI/UL 962A dated July 13, 2023 includes the following changes in requirements:

– Addition of Exception for More Than 8 Receptacles; 14.6

– Addition of Requirements Allowing Electronic Installation Instructions; 54.2 and 54.3

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated March 3, 2023 and May 22, 2023.

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Standard for Furniture Power Distribution Units

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The most recent designation of ANSI/UL 962A as an American National Standard (ANSI) occurred on July 13, 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 ULSE's 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 of permanently connected, furniture power distribution units (FPDU) rated 250 V AC or less and 20 Amperes or less. An FPDU may provide one or more receptacle outlets, inclusive of one current tap integral to the attachment plug, if provided, for connection of utilization equipment. An FPDU may include an integral Class 2 power supply employing integral output lead(s) and/or output connector(s) and may include receptacles with integral power supplies employing Class 2 output connector(s). FPDU's are for fixed mounting to portable or stationary furnishings as a power supply connection for cord and plug connected electrical utilization equipment in accordance with the National Electrical Code, NFPA 70.

1.2 In accordance with the National Electrical Code, NFPA 70, furniture power distribution units (FPDUs) shall not serve as fixed wiring of a structure or of fixed furnishings, such as but not limited to applications in permanent countertops of kitchens and bathrooms.

1.3 A cord-and-plug-connected product as described in 1.1 with less than three receptacle outlets and provided with a Luminaire is covered under the Standard for Portable Electric Luminaires, UL 153.

1.4 A cord-and-plug-connected product as described in 1.1 with less than three receptacle outlets and that employs an electromagnetic interference filter is covered under the Standard for Electromagnetic Interference Filters, UL 1283.

1.5 A cord-and-plug-connected product as described in 1.1 with less than three receptacle outlets and that employs a surge protective device (SPD) is covered under the Standard for Surge Protective Devices, UL 1449, for SPD Type 3.

1.6 A cord-and-plug-connected product as described in 1.1 that employs ground-fault protection is covered under the requirements for portable GFCIs in the Standard for Ground-Fault Circuit Interrupters, UL 943.

1.7 This standard does not cover FPDUs intended for use with medical equipment.

1.8 These requirements cover FPDUs provided with isolated secondary circuits.

1.9 These requirements cover FPDUs provided with batteries located in isolated secondary circuits.

1.10 A product that has a battery backup feature or other uninterruptible power supply equipment located in the Primary Circuit shall comply with the applicable requirements in the Standard for Uninterruptible Power Supply Equipment, UL 1778.

1.11 A FPDU with three or more receptacle outlets may employ a Light Emitting Diode (LED) Luminaire.

1.12 This standard contains the following Annexes:

a) Annex A – Furniture Power Distribution Units Incorporating Batteries.

b) Annex B – Furniture Power Distribution Units for Clustered Seating.

c) Annex C – Furniture Power Distribution Units for Kitchen and Bathroom Countertops.

d) Annex D – Furniture Power Distribution Units for Portable (Movable) Work Space Tables.

2 Components

2.1 Except as indicated in 2.2, a component of products covered by this standard shall comply with the requirements for that component. See Annex E for a list of standards covering components used in the products covered by this standard.

2.2 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.

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

2.4 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.

2.5 A FPDU that incorporates a LED Luminaire and LED components and subassemblies shall comply with the applicable requirements of UL 8750.

3 Use

3.1 A FPDU is intended to be connected to a permanently installed branch circuit receptacle outlet.

3.2 A FPDU is intended to be mounted to an indoor use portable or stationary furnishing. A FPDU is not intended to serve as fixed wiring of a structure or of fixed furnishings.

3.3 FPDU are not intended to be series connected (daisy chained) to other FPDUs to relocatable power taps or to extension cords.

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 referenced in this Standard:

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

ASTM G155, *Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials*

NEMA WD6, *Wiring Devices – Dimensional Specifications*

NFPA 70, *National Electrical Code*

UL 13, *Power-Limited Circuit Cables*

UL 20, *General-Use Snap Switches*

UL 44, *Thermoset-Insulated Wires and Cables*

UL 50E, *Enclosures for Electrical Equipment, Environmental Considerations*

UL 62, *Flexible Cords and Cables*

UL 83, *Thermoplastic-Insulated Wires and Cables*

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

UL 153, *Portable Electric Luminaires*

UL 157, *Gaskets and Seals*

UL 244A, *Solid-State Controls for Appliances*

UL 248-14, *Low-Voltage Fuses – Part 14: Supplemental Fuses*

UL 325, *Door, Drapery, Gate, Louver, and Window Operators and Systems*

UL 452, *Antenna-Discharge Units*

UL 467, *Grounding and Bonding Equipment*

UL 486C, *Splicing Wire Connectors*

UL 489, *Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures*

UL 497A, *Secondary Protectors for Communications Circuits*

UL 498, *Attachment Plugs and Receptacles*

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

UL 758, *Appliance Wiring Material*

UL 796, *Printed Wiring Boards*

UL 817, *Cord Sets and Power Supply Cords*

UL 840, *Insulation Coordination Including Clearance and Creepage Distances for Electrical Equipment*

UL 917, *Clock-Operated Switches*

UL 943, *Ground-Fault Circuit Interrupters*

UL 969, *Marking and Labeling Systems*

UL 969A, *Marking and Labeling Systems – Flag Labels, Flag Tags, Wrap-Around Labels and Related Products*

UL 1004-1, *Rotating Electrical Machines – General Requirements*

UL 1077, *Supplementary Protectors for Use in Electrical Equipment*

UL 1283, *Electromagnetic Interference Filters*

UL 1310, *Class 2 Power Units*

UL 1439, *Tests for Sharpness of Edges on Equipment*

UL 1449, *Surge Protective Devices*

UL 1492, *Audio-Video Products and Accessories*

UL 1642, *Lithium Batteries*

UL 1778, *Uninterruptible Power Supply Equipment*

UL 1977, *Component Connectors for Use in Data, Signal, Control and Power Applications*

UL 1989, *Standby Batteries*

UL 2054, *Household and Commercial Batteries*

UL 2238, *Cable Assemblies*

UL 2738, *Induction Power Transmitters and Receivers for Use with Low Energy Products*

UL 8750, *Light Emitting Diode (LED) Equipment for Use in Lighting Products*

UL 60065, *Audio, Video, and Similar Electronic Apparatus – Safety Requirements*

UL 60320-1, *Appliance Couplers for Household and Similar General Purposes – Part 1: General Requirements*

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 60730-1, *Automatic Electrical Controls – Part 1: General Requirements*

UL 60950-1, *Information Technology Equipment – Safety – Part 1: General Requirements*

UL 61058-1, *Switches for Appliances – Part 1: General Requirements*

UL 62368-1, *Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements*

6 Glossary

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

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

6.3 CLASS 2 LEAD – Consists of a factory-made, power-limited cable with an output connector at one end. The other end is secured within the housing or enclosure of the FPDU. The output connector is intended for connection to the Class 2 separable interface (such as Universal Serial Bus [USB] connectors).

6.4 CLASS 2 SEPARABLE INTERFACE – A separable component containing Class 2 low-voltage connector(s) only (such as Universal Serial Bus (USB) connectors).

6.5 CORD CONNECTOR – A female contact device assembled or molded on flexible cord to allow a detachable electrical connection to an attachment plug.

6.6 CURRENT TAP – A single-outlet contact device that is integral to the attachment plug of the FPDU power supply cord.

6.7 FIXED FURNISHING – Intended to be permanently connected electrically to a source of supply and meets any of the following:

a) Intended to be fastened in place and requiring tools for removal; or

b) Integrated into the structure as a permanent fixture, such as but not limited to permanent countertops of kitchens and bathrooms.

6.8 FURNITURE POWER DISTRIBUTION UNIT (FPDU) – An electrical enclosure provided with an attached power supply cord and attachment plug or current tap for connection to a permanently installed branch circuit receptacle outlet. The FPDU is provided with a mounting means for attachment to a furnishing. The electrical enclosure may be provided with one or more receptacle outlets. The FPDU may also be provided in any combination of the following configurations:

a) The electrical enclosure connected to the power supply cord and attachment plug may be supplied with up to six lengths of flexible cord not exceeding 6 feet in length; each length shall be terminated with a maximum of 3 receptacle outlets within an electrical enclosure or 3 cord connectors. Refer to 14.6 limiting the total number of outlets, Table 13.1 for overload requirements and 13.1.8 for interconnecting cord requirements.

b) Provided with supplementary overcurrent protection.

c) Provided with manual or automatic switch(es) such as an integral appliance timer to control all or some of the receptacle outlets.

d) Provided with indicator lights.

e) When provided with three or more receptacle outlets the FPDU may be provided with a surge protective device (SPD) or an electromagnetic interference (EMI) filter.

f) A FPDU may employ non-electrical decorative features. The decorative features may include various shapes such as rocks, birds and animals, etc.

g) A FPDU may employ telephone equipment and communication circuit protectors.

h) A FPDU may employ an antenna discharge unit or provide antenna connections for televisions and video products.

i) When provided with three or more receptacle outlets the FPDU may be provided with LED (Light Emitting Diode) Luminaire(s).

j) A FPDU may be provided with a wireless charging circuit.

k) Provided with isolated secondary circuits.

l) Provided with batteries located in isolated secondary circuits. See UL 962A Annex A – Furniture Power Distribution Units Incorporating Batteries.

m) Provided with an integral Class 2 lead and mating Class 2 separable interface, or an integral power supply with one or more Class 2 output connector(s).

n) Provided with receptacles with integral power supplies with Class 2 output connectors.

6.9 ISOLATED SECONDARY CIRCUIT – A circuit derived from an isolating source (such as a transformer, optical isolator, limiting impedance or electro-mechanical relay) and having no direct connection back to the primary circuit (other than through the grounding means). A secondary circuit that has a direct connection back to the primary circuit is considered part of the primary circuit.

6.10 PORTABLE FURNISHING – Meets all of the following:

a) Not secured to the building structure unless provided with a securement means that allows the furnishing to be removed without the use of tools, and

b) Connected electrically to an electrical source of supply with a power supply cord and plug.

Exception: A securement means to the structure or to stationary or fixed furnishings in order to prevent tipping of the portable furnishing that requires the use of tools is not prohibited from being employed.

6.11 PORTABLE GROUND-FAULT CIRCUIT INTERRUPTER (GFCI) CLASS A – A plug-in type ground-fault circuit interrupter provided with male blades or with a power-supply cord with an attachment plug. Portable GFCIs are constructed so that when any single supply conductor, including the neutral conductor, is opened protection to the user is maintained. Class A GFCIs trip when the current to ground has a value in the range of 4 through 6 mA.

6.12 PRIMARY CIRCUIT – A circuit in which the wiring and components are conductively connected to the AC power interface.

6.13 RECEPTACLE OUTLET – A female contact device mounted within an electrical enclosure to allow a detachable electrical connection of an attachment plug.

6.14 RISK OF FIRE – A risk of fire is considered to exist at any two points in a circuit where:

a) The open circuit voltage is more than 30 Vrms (42.4 V peak) and the energy available to the circuit under any condition of load including short circuit, results in a current of 8 A or more after 1 minute of operation; or

b) A power of more than 15 watts can be delivered into an external resistor connected between the two points.

6.15 STATIONARY FURNISHING – Intended to be relocatable and meets all of the following:

a) In normal use of the furnishing, not readily movable by an unaided individual due to the weight, size, or configuration of the furnishing, and

b) Not secured to the building structure unless provided with a securement means that allows the furnishing to be removed without the use of tools; and

c) Connected electrically to an electrical source of supply with a power supply cord and plug.

Exception: A securement means to the structure or to fixed or other stationary furnishings in order to prevent tipping of the stationary furnishing that requires the use of tools is not prohibited from being employed.

6.16 SUPPLEMENTARY PROTECTOR – A manually resettable device designed to open the circuit automatically on a predetermined value of time versus current or voltage within an appliance or other electrical equipment. It is permitted to be provided with a manual means for opening or closing the circuit.

CONSTRUCTION

7 Enclosure

7.1 General

7.1.1 The enclosure shall be formed 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.

7.1.2 An opening in an enclosure shall have such size and shape – or shall be so covered by screening or barrier or by an expanded, perforated, or louvered panel – that a test rod having a maximum diameter of 1/16 in (1.6 mm) shall be prevented from contacting live parts. See Accessibility Tests, Section 44.

7.1.3 A keyhole slot, notch, or similar means for mounting, when provided, shall be located so that the supporting screws or the like cannot damage any electrical insulation or reduce spacings to live parts.

7.1.4 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 35.

7.1.5 If a FPDU employs a decorative or ancillary feature, such as a rock, bird, animal, Luminaire, or a storage compartment, it shall be designed so that the addition of the decorative feature part(s) does not:

a) Interfere with the function or mounting means described in Section 10, Mounting Means;

b) Interfere with turning the power "on" or "off" using the switch provided on the FPDU; or

c) Interfere with an attachment plug from fully seating in the receptacle outlet slot(s) of the FPDU.

7.1.6 An FPDU that employs an enclosure cap or cover over the reset actuator (i.e. stem) of a supplementary protector shall not interfere with trip and/or reset function of the supplementary overcurrent protector.

7.1.7 A FPDU that incorporates devices such as an integral appliance timer to control all or some of the receptacles shall comply with UL 917 or UL 244A. Compliance with UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series fulfills the UL 244A requirements.

7.1.8 Products that employ timer(s) as specified in 6.5 shall be marked as specified in 53.23 to warn the user of the possible hazards.

7.1.9 Telephone equipment and communication circuit protectors included in a FPDU shall comply with the requirements in UL 60950-1 or UL 62368-1 and the requirements in UL 497A.

7.1.10 A FPDU that incorporates an antenna discharge unit or provides antenna connections to a television, a high-voltage video product, or antenna shall comply with the applicable requirements in UL 452, and UL 1492 or UL 60065, or UL 62368-1.

7.1.11 A cord-and-plug-connected FPDU with three or more receptacle outlets and that employs an electromagnetic interference filter shall also comply with UL 1283.

7.1.12 A cord-and-plug-connected FPDU with three or more receptacle outlets and that employs a surge protective device shall also comply with UL 1449, for SPD Type 3.

7.1.13 A FPDU that employs an uninterruptible power supply located in the primary circuit shall comply with the requirements in UL 1778.

7.1.14 The enclosure interior of a FPDU intended to be mounted on or inside a desk or similar furnishing surface shall be covered or otherwise protected from spillage while not in use. The FPDU enclosure interior containing power circuits shall comply with the Spill Test, Section 43. The FPDU enclosure interior portion containing solely Class 2 load circuits is not considered during this test.

Exception No. 1: When the instructed installation of the FPDU is for it to be mounted above the furnishing surface and oriented such that spilled liquid on the furnishing surface cannot enter any part of the FPDU, these requirements do not apply.

Exception No. 2: When the FPDU is provided with a portable GFCI Class A that complies with UL 943 and the GFCI is located at the attachment plug or within 12 in (305 mm) of the attachment plug compliance with the spill test is not required.

7.1.15 Removable knock-outs and pry-outs shall be fully concealed by any of the following:

a) A pressure-sensitive label that complies with UL 969, and includes markings or instructions, or

b) A blank pressure-sensitive label that complies with UL 969, provided that the FPDU also includes an installation instruction that complies with 54.6.

Exception: This requirement does not apply to removable knock-outs or pry-outs that, if removed, permit access solely to Class 2 wiring terminals or circuits.

7.2 Metallic

7.2.1 A metal enclosure of a FPDU shall have a minimum thickness in accordance with Table 7.1.

Table 7.1
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	
	inch	(mm)	inch	(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)

7.2.2 The enclosure shall comply with the strain relief, impact, and crush test requirements of Sections 36, 38, and 39 respectively, of this standard.

7.3 Nonmetallic

7.3.1 A polymeric enclosure of a FPDU for use in a portable furnishing shall comply with the flammability requirements in UL 746C, for non-attended, non-intermittent duty portable equipment and shall be marked in accordance with 53.15.

7.3.2 A polymeric enclosure of a FPDU for use in a stationary furnishing shall comply with the flammability requirements in UL 746C, for stationary equipment.

7.3.3 The enclosure shall comply with the strain relief, impact, crush and mold stress-relief test requirements of Sections 36, 38, 39 and 42 respectively, of this standard.

7.3.4 A decorative feature or mounting means of a FPDU which is constructed of polymeric material and does not function as an enclosure of live parts shall comply with the flammability requirements for an enclosure material as identified in UL 746C, for non-attended, non-intermittent duty portable equipment.

Exception: Decorative parts are not required to be made of a material classed 5VA, 5VB, V-0, V-1, V-2, or HB, providing the part does not occupy a volume greater than 2 cubic centimeters (0.122 cubic inch), does not have any dimension greater than 3 cm (1.18 inch), and is located so it cannot propagate flame from one area to another or bridge between a possible source of ignition and other ignitable parts.

7.3.5 A polymeric enclosure portion of a FPDU that houses solely an electrical part that is supplied from an isolated power supply of less than 42.4 volts AC or less than 60 volts DC and the power available is less than 15 watts shall comply with the flammability requirements for an enclosure material as identified in UL 746C, for non-attended, non-intermittent duty portable equipment.

8 Mechanical Assembly

8.1 A FPDU 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 abrade the insulation on conductors or otherwise damage wires.

8.2 A switch, a lampholder, a power-supply cord and its strain-relief bushing, receptacle, or similar component shall be mounted securely and, except as noted in 8.3 and 8.4, shall be restrained from turning. See 8.5.

8.3 The requirement that a switch be restrained from turning is capable of being waived when all of the following conditions are met:

a) The switch is to be of the plunger or other type whose actuator does not tend to rotate when operated (the actuator of a toggle or rocker switch is considered to be subject to forces that tend to turn the switch during operation of the switch).

b) The means of mounting the switch makes it unlikely that operation of the switch loosens it.

c) The spacings are not to be reduced below the minimum acceptable values when the switch rotates.

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

8.5 The means by which the turning specified in 8.2 is prevented is to include more than friction between surfaces. For example, a lockwasher, properly applied, is not prohibited from being used as a means to restrain turning of a device having a single-hole mounting means.

8.6 A FPDU with a retractable vertical tower, that has a horizontal platform area greater than 9 in^2 (58.1 cm^2) and is also provided with a means for locking the vertical tower in an open (upright) position must remain in the open (upright) position when subjected to the Retractable Force Test in Section 41. A retractable vertical tower is considered to have a means for locking in an open (upright) position when a separate mechanism or motion, other than pushing the tower straight down, is required to release the locking mechanism to allow for closing (lowering) of the vertical tower.

Exception: A FPDU with a retractable vertical tower not provided with a means for locking the vertical tower in an open (upright) position does not need to comply with the Retractable Force Test in Section 41.

8.7 A FPDU with a retractable vertical tower intended to be closed with power supply cord(s) connected to each receptacle, must be able to completely close and reopen with the intended power supply cord(s) connected and shall be constructed so as not to pinch, compress or damage the power supply cord jacket or insulation and shall comply with the Cycling Test, Section 48.

8.8 To prevent personal injury, the retracting mechanism of a FPDU with a retractable vertical tower must not be accessible. Compliance is determined using the accessibility probe in Figure 9.1.

9 Enclosure Accessibility and Accessibility of Live Parts

9.1 The electrical parts of a FPDU 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.

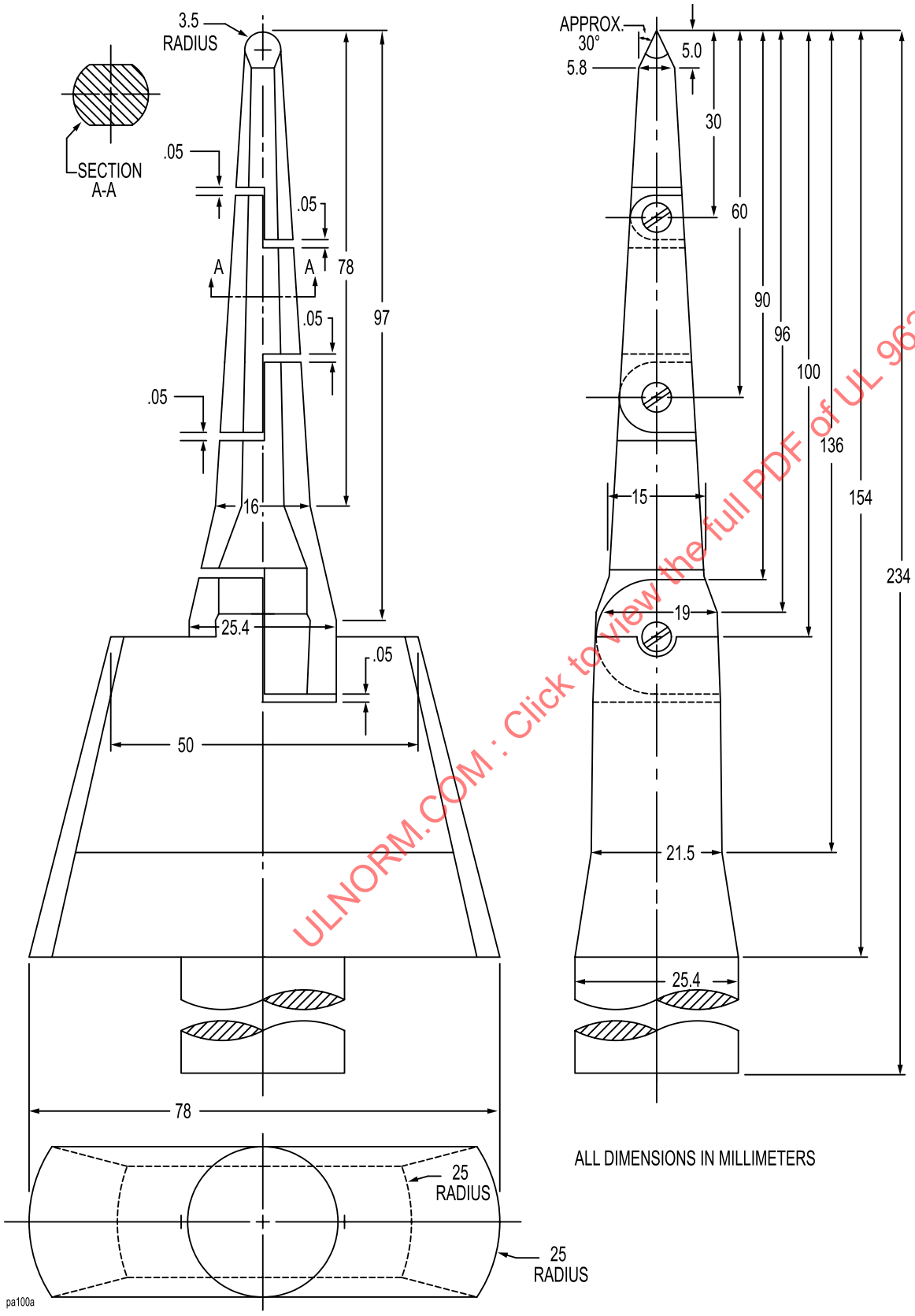
Exception: Connectors and contacts supplied by an isolated secondary circuit meeting Class 2 or Limited Power Circuit (LPS) power levels may be accessible to the user.

9.2 An opening in the enclosure of a FPDU is not prohibited when an uninsulated live part or film-coated magnet wire is not capable of being contacted by the probes specified in 44.1.2 and shown in Figure 9.1. The probes 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 probes shall be applied in any possible configuration; and, when required, the configuration shall be changed after insertion through the opening.

9.3 The probes 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 the minimum force required to determine accessibility in accordance with the Accessibility Tests, Section 44.

Figure 9.1

Accessibility Probe



10 Mounting Means

10.1 A FPDU shall be provided with a mounting means.

10.2 The mounting means shall comply with Section 35, Mounting Hole Barrier Test, and Section 40, Adequacy of Mounting Test.

10.3 Adhesive may be used to secure a FPDU when the adhesive complies with the Specialized Applications – General Adhesives, Functional Analysis, and Program of Investigation for Adhesives in UL 746C. When performing the adhesive investigations, the maximum force for the Program of Investigation – End-Product Evaluation of UL 746C shall be the weight of the FPDU. When a suitable adhesive is used to mount the FPDU, the Adequacy of Mounting test is not required to be conducted.

11 Corrosion Protection

11.1 Iron and steel parts or other parts not inherently corrosion resistant shall be protected against corrosion by painting, enameling, galvanizing, plating, or other equivalent means.

Exception: This requirement does not apply to minor parts of iron or steel, such as washers, screws and the like that are not in the grounding conductor path.

12 Insulating Materials

12.1 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.

12.2 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.

12.3 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.

13 Power-Supply Cord

13.1 General

13.1.1 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, or equivalent.

Exception: SPT-3 is not prohibited from being used on a FPDU rated 15 A or less when marked in accordance with 53.14.

13.1.2 A detachable power-supply cord shall not be used.

13.1.3 The minimum conductor size of the power-supply cord shall be as indicated in Table 13.1.

Table 13.1
Guide to Construction and Performance Requirements for Furniture Power Distribution Units

FPDU rating (A)	Minimum power cord size (AWG)	Number of receptacles	Supplementary OCP required?		Maximum supplementary OCP rating[a, d] (A)	Temperature test load (A)	Minimum internal wiring size[b] (AWG)
				When LED[i] luminaire or wireless charging circuits are incorporated			
≤ 20	12	<6	NO	YES	20[c]	20[l]	12
≤ 20	12	≥6	YES	YES	20	20[h]	12
≤ 15	14[g]	<4	NO	YES	15[c]	15[h]	14[g]
≤ 15	14[g]	≥4	YES[g]	YES	15	15[h]	14[g]
≤ 15	14[g]	<4	NO	YES	15[c]	15[e,f]	14[g]
≤ 15	14[g]	≥4	YES[g]	YES	15	OCP[f]	14[g]
≤12	16[g]	<4	NO	Not permitted	15	15	16[g]

[a] OCP shall not trip when the FPDU is operated at the FPDU marked rated current.

[b] Smaller AWG is not prohibited from being used when an OCP is provided and the results of the Temperature Test (Section 29), the Fault Current Test (Section 33), and the Overcurrent Test (Section 34) comply with the requirements of those tests using the smaller AWG wire. Isolated secondary conductors shall also comply with Sections 19 and 23.

[c] When provided with an OCP.

[d] Maximum rating. An OCP rated less than the Maximum Supplementary OCP rating and not less than the FPDU rating complies with the intent of this requirement. See note (a) above.

[e] Test is capable of being conducted at OCP rating when provided.

[f] When the OCP rating is greater than the FPDU rating, conduct the Temperature Test at the OCP rating. The OCP is not prohibited from being bypassed when nuisance tripping occurs during the Temperature Test. If the OCP is bypassed during the Temperature Test at OCP rating, then the Temperature Test needs to be repeated at FPDU rating to confirm that the OCP does not nuisance trip at this level. See note (a) above.

[g] An OCP is not required and/or the power supply cord is permitted to be 16 AWG and/or the internal wiring is permitted to be 16 AWG for a household (residential) FPDU as long as:

a) FPDU is not rated higher than 12 amps;

b) Either one, two, three or four receptacles are provided;

c) All other components are evaluated for use at 15 A;

d) The Temperature Test load is 15 A.

e) The FPDU is marked in accordance with 53.16, except for a FPDU with one receptacle.

f) No LED Luminaire is provided.

[h] The OCP is not prohibited from being bypassed when nuisance tripping occurs during the Temperature Test. If the OCP is bypassed during the Temperature Test at Temperature Test Load rating, then the Temperature Test needs to be repeated at FPDU rating to confirm that the OCP does not nuisance trip at this level. See note (a) above.

[i] A FPDU incorporating an LED Luminaire shall be provided with supplementary OCP as shown in the column "Maximum Supplementary OCP rating[a,d] (A)". The FPDU shall also be provided with instructions as indicated in 54.1.

13.1.4 The length of a power-supply cord – as measured from the outside surface of the enclosure of the FPDU to the plane of the face of the attachment plug – shall not exceed 25 ft (7.6 m) nor be less than 1.5 ft (0.46 m).

13.1.5 A power-supply cord shall have a voltage rating not less than the rated voltage of the FPDU and have an ampacity not less than the current rating of the FPDU.

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

13.1.7 An FPDU as described in 1.1 shall be constructed such that the total combined length of the power supply cord and the longest interconnecting cord shall not exceed 25 ft (7.6 m).

13.1.8 An interconnecting cord shall comply with all the requirements of power supply cords except 13.1.4 and cannot exceed 6 ft (1.8 m) in length.

13.1.9 The plug that is employed in a FPDU shall be molded-on or assembled-on to the flexible cord. The plug shall be the grounding type and shall comply with the requirements in UL 498 or UL 817. The molded-on or attachment plug is permitted to be hospital grade plugs complying with UL 817 or with Supplement SC of UL 498, respectively, but the FPDU shall be marked in shall be in accordance with 53.19.

13.2 Class 2 lead

13.2.1 A Class 2 lead may be one of the following types:

a) Type CL2 cable in accordance with UL 13.

b) An appliance wiring material with a maximum length of 10 feet (3.5 m), minimum of 26 AWG, rated minimum VW-1 flammability and minimum 300 V, in accordance with UL 758.

13.2.2 One end of a Class 2 lead shall be either molded-on or permanently attached to the FPDU housing or enclosure. Where the Class 2 lead passes into the interior of the FPDU housing or enclosure, the power-limited cable shall be separated in accordance with 23.1 from AC power circuit conductors and from conductive parts energized by AC power circuits.

13.2.3 The other end of a Class 2 lead shall terminate in a connector capable of being inserted into the mating connector of the Class 2 separable interface.

13.2.4 Permanently attached can be achieved by crimping, welding, riveting, or equivalent, to render the connector non-rewireable.

13.3 Bushings

13.3.1 Where the power-supply cord passes through an opening in the enclosure, a smooth, well-rounded surface shall be provided to protect the cord from damage.

13.4 Strain relief

13.4.1 Strain relief shall be provided so that a mechanical stress on a power-supply cord or a Class 2 lead is not transmitted to terminals, splices, or interior wiring. See Strain Relief Test, Section 36.

13.4.2 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.

13.5 Push back relief

13.5.1 Means shall be provided to prevent the supply cord or lead from being pushed into the enclosure of an appliance through the cord-entry hole when such displacement results in:

a) Subjecting the supply cord or lead to mechanical damage;

b) Exposing the supply cord or lead to a temperature higher than that for which it is rated;

c) Reducing spacings (such as to a metal strain-relief clamp) below the minimum required values; or

d) Damaging internal connections or components.

To determine compliance, the supply cord or lead shall be tested in accordance with Section 37, Push Back Relief Test.

14 Receptacles

14.1 The receptacle outlets of a FPDU 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 used with a FPDU with a 20 A attachment plug.

14.2 All of the receptacle outlets of a FPDU shall have the same current rating and shall be of the grounding type. They are not prohibited from being of the same or different slot configurations (locking and non-locking).

14.3 The receptacle outlets of a FPDU shall comply with the applicable requirements in UL 498. The grounding contact of the receptacle shall comply with the requirements of the Grounding Contact Test in UL 498. Receptacle outlets of a FPDU are permitted to be hospital grade receptacles complying with Supplement SC of UL 498 but the FPDU shall be marked in accordance with 53.19.

14.4 The receptacle outlets of a FPDU that also incorporates terminals for coaxial cable (TV/CATV) connection shall be marked in accordance with 53.13.

14.5 A FPDU intended to be mounted on or inside a desk or similar furnishing surface shall be covered or otherwise protected from spillage while not in use. The receptacle(s) shall comply with the Spill Test, Section 43; the Class 2 output connector(s) of receptacles with integral power supplies employing Class 2 output connector(s) is (are) not considered during this test.

Exception No. 1: When the instructed installation of the FPDU is for it to be mounted above the furnishing surface and oriented such that spilled liquid on the furnishing surface cannot enter any part of the FPDU, these requirements do not apply.

Exception No. 2: When the FPDU is provided with a portable GFCI Class A that complies with UL 943 and the GFCI is located at the attachment plug or within 12 in (305 mm) of the attachment plug compliance with the spill test is not required.

14.6 A FPDU shall be provided with a maximum of eight receptacles.

Exception No. 1: A FPDU is able to be provided with more than eight receptacles when the FPDU is provided with a circuit breaker that complies with the requirements in UL 489, and is in accordance with NFPA 70 branch circuit protection.

Exception No. 2: A FPDU is able to be provided with more than eight receptacles when the FPDU is provided with a supplementary overcurrent protection device that shall be capable of clearing a fault current of not less than that indicated in Table 16.1 and shall also comply with the requirements in UL 1077. The supplementary overcurrent protection device shall have been subjected to the overload test in UL 1077, tested for motor starting at 6 times the AC full load current rating.

14.7 A FPDU employing tamper-resistant receptacle outlets shall be marked "TR" or "Tamper Resistant" provided the receptacle outlets comply with the Tamper-Resistant Receptacle requirements, as specified in UL 498.

15 Current Tap

15.1 The outlet of a current tap shall have the same current rating of 15 or 20 Amps and the same voltage rating of either 125 or 250 V as the current tap's plug.

15.2 A current tap shall be of the grounding type. The current tap outlet may be the same or different slot configuration (locking and non-locking) as the plug.

15.3 A FPDU may employ a current tap fitting when the power supply cord size and the number of outlets, including the outlet of the current tap, do not require supplementary protection or the current tap is protected by the supplementary protection. A FPDU may not utilize a current tap when supplementary overcurrent protection is required.

15.4 The outlet of a current tap in a FPDU shall comply with the applicable requirements for a current tap outlet in UL 498. The grounding contact of the current tap outlet shall comply with the current tap requirements of the Grounding Contact Test in UL 498.

16 Supplementary Overcurrent Protection

16.1 A FPDU shall be provided with supplementary overcurrent protection as indicated in Table 13.1.

16.2 A supplementary protection device shall not open during the Temperature Test, Section 29.

16.3 A supplementary overcurrent protection device shall be capable of clearing a fault current of not less than that indicated in Table 16.1 and shall comply with the requirements in UL 1077. The supplementary overcurrent protection device shall have been subjected to the Overload Test in UL 1077, tested for motor starting at 6 times the AC full load current rating.

Exception No. 1: A fuse that is capable of clearing a fault current of not less than that indicated in Table 16.1, and that complies with the requirements in UL 248-14, is not prohibited from being used as a supplementary overcurrent protection device.

Exception No. 2: A circuit breaker that complies with the requirements in UL 489, and is in accordance with NFPA 70 for branch circuit protection, is not prohibited from being used in lieu of a supplementary overcurrent protection device.

Table 16.1
Circuit Capacity of Supply Source

Rating (VA)	Available fault current (A)
1875 or less	1000
More than 1875 to 3750	2000
More than 3750	3500

16.4 The overcurrent protective device shall be a supplementary protector of the trip-free type with a manual reset (i.e. rocker switch or push button), or a replaceable fuse installed in an extractor type fuse holder. An FPDU that is provided with fuses that are intended to be replaced in the field shall be marked in accordance with the requirements in 53.10.

Exception: A non-replaceable fuse is permitted if the enclosure of the FPDU is marked in accordance with the requirements in 53.28.

16.5 An FPDU that employs an enclosure cap or cover over the reset actuator (i.e. stem) of a supplementary overcurrent protector shall comply with Impact test 38.1.4 followed by the Supplementary Overcurrent Protector Check Test, 38.5.

16.6 A single-pole supplementary protection device shall be connected in the ungrounded (line) conductor of the supply circuit only. A double-pole device shall be connected on both the ungrounded and grounded (neutral) conductors such that when it operates, it opens both ungrounded and grounded conductors.

16.7 A supplementary protection device shall not be connected in the grounding conductor.

16.8 The ampere rating of the overcurrent protective device of 16.2 shall not be greater than the ampacity of:

a) The configuration of the receptacles it is to protect; or

b) That of the power-supply cord; or

c) Other electrical components, whichever is lower.

Exception: See note (g) of Table 13.1.

16.9 Where a single overcurrent protective device does not protect all receptacle outlets, more than one overcurrent protective device shall be used, and each receptacle outlet shall be marked to indicate the rating of the overcurrent protective device connected to it. See 53.7.

16.10 Thermal cutoff devices, thermal relays, and similar devices, shall not be used as supplementary overcurrent protection devices.

16.11 A FPDU incorporating LED Luminaires or wireless charging circuits shall be provided with supplementary overcurrent protection. See Table 13.1.

17 Switches

17.1 Each switch shall have a voltage and current rating not less than the load it is intended to control. A switch shall open all ungrounded circuit conductors and, in addition, is not prohibited from opening the grounded circuit conductor.

17.2 A switch provided in a FPDU shall comply with the requirements of UL 61058-1. The switch shall be rated for use with other than resistive (Res), AC Tungsten filament lamp (L), or AC and DC Tungsten filament lamp (T) loads.

Exception: A switch that complies with the requirements of UL 20, for a general-use AC switch is not prohibited from being used in a FPDU.

17.3 Each switch shall indicate to the user when its associated circuit is energized. See 53.9.

Exception: A FPDU is not prohibited from being equipped with indicator or pilot lights, such as neon-series-resistor, LED type, or similar items, to show which receptacles are live, or to indicate that the unit is energized.

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 lockwasher is not prohibited from being used in such a manner.

19 Internal Wiring

19.1 The minimum conductor size of the internal wiring of a FPDU shall be as indicated in Table 13.1. The internal wiring of a FPDU enclosure shall be rated for the maximum voltage, temperature, and other conditions of use encountered in that FPDU enclosure.

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 Metal clamps and guides used for routing wiring shall have smooth, well-rounded edges.

19.5 A hole through which insulated wires pass through a sheet-metal wall within the overall enclosure of a FPDU shall be provided with a smooth, well rounded bushing or any surfaces upon which the wire can bear shall be smooth and well-rounded.

19.6 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 are not required to be mechanically secure before soldering.

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

a) Wrapped at least halfway (180°s) 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.

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

19.9 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.

19.10 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.

19.11 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.

19.12 A conductor that passes through and/or is connected to a movable joint such that the conductor will be flexed, shall be subjected to the Flexing Endurance Test, Section 49.

20 Spacings

20.1 The spacings of a FPDU shall comply with the requirements of Table 20.1.

Exception No. 1: The spacings between the live parts of a receptacle or switch and the intended mounting surface for the receptacle or switch shall not be less than 3/64 in (1.2 mm).

Exception No. 2: As an alternative to Table 20.1, lesser spacings may be acceptable when determined in accordance with the requirements for Clearance and Creepage Distances – Isolated Secondary Circuits, Section 21.

Exception No. 3: The acceptability of the inherent spacings of a component shall be based on the requirements for the component.

Exception No. 4: Circuits that comply with the requirements for Isolated Secondary Circuits need not be evaluated for spacings. The spacing between these circuits and other circuits shall comply with Table 20.1.

Table 20.1
Minimum Spacings

Potential involved in volts		Minimum spacing					
		0 – 50		51 – 125		126 – 250	
		inch	(mm)	inch	(mm)	inch	(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[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[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 conformally 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.

20.2 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.

20.3 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 1/64 in (0.40 mm) thick.

20.4 All uninsulated live parts connected to different circuits shall be spaced from one another as though they were parts of opposite polarity, in accordance with the requirement in 20.6, and shall be investigated on the basis of the highest voltage involved.

20.5 An electrically energized screw head or nut on the underside of an insulating base shall be prevented from loosening.

20.6 In multicomponent equipment, the spacings from one component to another, from any component to the enclosure, or to other uninsulated dead metal parts excluding the component mounting surface, are based on the maximum voltage rating of the complete equipment and not on the individual component ratings. The inherent spacings within an individual component are investigated on the basis of the voltage used and controlled by the individual component. Spacings between metal oxide varistors, capacitors, and other components shall comply with the minimum spacing requirements in Table 20.1.

20.7 Spacings at a fuse and fuseholder are to be measured with a fuse in place that has the maximum standard dimensions for the rating, and such spacings are to not be less than those specified in Table 20.1.

21 Clearance and Creepage Distances – Isolated Secondary Circuits

21.1 As an alternative approach to the spacing requirements specified in 20.1, and other than as noted in 21.2, clearances and creepage distances in isolated secondary circuits of FPDU's are able to be evaluated in accordance with the requirements in UL 840, as described in 21.2.

21.2 In conducting evaluations in accordance with the requirements in UL 840, the following guidelines shall be used:

a) Unless specified elsewhere in this standard, the pollution degree within an FPDU housing, based on the presence of contaminants and possibility of condensation or moisture, shall be pollution degree 2 – Normal.

b) Pollution degree 2 exists on a printed wiring board between adjacent conductive material which is covered by any coating which provides an uninterrupted covering over at least one side and the complete distance up to the other side of conductive material;

c) Any printed wiring board which complies with the requirements in UL 796, shall be considered to provide a Comparative Tracking Index (CTI) of 100, and if it further complies with the requirements for Direct Support in UL 796 then it provides a CTI of 175;

d) For the purposes of compliance with the requirements for coatings of printed wiring boards used to achieve pollution degree 1 in accordance with UL 840, a coating which complies with the requirements for Conformal Coatings in UL 746C, complies with the requirements;

e) Pollution degree 1 is also achievable at a specific printed wiring board location by application of at least a 0.79 mm (1/32 inch) thick layer of silicone rubber or for a group of printed wiring boards through potting, without air bubbles, in epoxy or potting material.

f) Evaluation of clearances, only, to determine equivalence with current through air spacings requirements are able to be conducted in accordance with the requirements for Clearance A (Equivalency) of UL 840. An impulse test potential having a value as determined in UL 840 is to be applied across the same points of the device as would be required for the Dielectric Voltage-Withstand Test, Section 30;

g) As an alternative approach to the spacing requirements specified in 20.1 evaluation of clearances and creepage distances shall be conducted in accordance with the requirements in UL 840 for Clearance B (Controlled Overvoltage), and Creepage Distances;

h) The System Voltage used in the evaluation of the isolated secondary circuitry is able to be interpolated with interpolation continued across the table for the Rated Impulse Withstand Voltage Peak and Clearance; and

i) Determination of the dimensions of clearance and creepage distances shall be conducted in accordance with the requirements for Measurement of Clearance and Creepage Distances of UL 840.

22 Printed-Wiring Boards

22.1 A printed-wiring board shall comply with the requirements in UL 796, including direct support criteria, 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 A FPDU that has a receptacle grounding path through traces on a printed-wiring board shall comply with the Fault Current Test, Section 33, and the Overcurrent Test, Section 34.

22.4 A FPDU that has a load-current-carrying circuit conductor path through traces on a printed-wiring board shall comply with the Overcurrent Test, Section 34.

23 Separation of Circuits

23.1 A FPDU employing connection to telephone communication, or to data communication or incorporating isolated secondary circuits or a power-limited Class 2 circuit, shall be provided with a barrier, physically secured by means other than friction, that separates the AC power circuit conductors from the conductors of the other circuits. Bonding of the equipment grounding conductor and the referenced conductors of the telecommunication circuits is permissible.

Exception No. 1: A barrier is not required between conductors that are separated by a minimum spacing of 2 inches (50.8 mm), including lead dress.

Exception No. 2: Conductors that are suitably insulated for the maximum AC power circuit voltage involved are not required to be separated from the AC power circuit conductors, when breakage or loosening of a conductor at a terminal in either circuit cannot result in contact between uninsulated parts of one circuit and uninsulated or inadequately insulated parts of the other circuit.

Exception No. 3: For conductors other than AWM (traces on a printed-wiring board, terminals mounted on insulating blocks, and the like), the minimum separation between communication circuits and the AC power circuits shall be in accordance with Table 20.1.

24 Low Voltage Charging and Isolated Secondary Output Circuits

24.1 A FPDU provided with receptacles with integral power supplies with Class 2 output connectors shall comply with UL 498 and its Supplement SE – Receptacles with Integral Power Supplies with Class 2 Output Connectors.

25 Grounding

25.1 General

25.1.1 A metallic enclosure and other dead metal parts that are exposed to contact by persons shall be conductively connected to the grounding conductor of the power-supply cord.

Exception No. 1: Dead metal parts that are isolated from grounded metal and are not a part of the enclosure are not required to be connected to the grounding conductor of the power-supply cord.

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.

25.1.2 A FPDU having a 125/250 V rating shall not use the neutral circuit conductor as the equipment-grounding conductor.

25.1.3 The conductive connection of parts required by 25.1.1 shall be by a clamp, bolt, screw, braze, weld or an equivalent positive means that cannot be loosened from the outside and may include a corrosion resistant strap or jumper; see 25.2.2. Mechanical connections shall be secured. A solder connection is not prohibited from being used when the power-supply cord grounding lead is mechanically secure to the enclosure in accordance with 19.7. A push-in (screwless), quick-connect, or similar friction-fit connector shall not be used for this connection.

25.1.4 Connections in the equipment-grounding conductor path from the receptacle grounding contact to the equipment-grounding conductor of the power-supply cord 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.

Exception: A splicing wire connector that complies with UL 486C and UL 467 is acceptable within the ground path when located within the electrical enclosure and used in accordance with its ratings.

25.1.5 The equipment-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 equipment-grounding conductor shall be secured to the frame or enclosure of a metallic FPDU 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 vitreous enamel. All conductors in the grounding circuit of a FPDU shall be green with or without one or more yellow stripes.

25.1.6 The yoke or faceplate mounting screws of the receptacle shall not be used to provide or maintain the grounding means of the receptacle or enclosure of a FPDU.

25.1.7 When a receptacle used in a FPDU is provided with a grounding screw, this screw shall be used to provide the ground connection to the receptacle.

25.1.8 An equipment-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.

25.1.9 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.

25.1.10 The line and neutral circuit conductor path 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, or such as a transient voltage surge suppressor investigated to UL 1449).

25.1.11 A conductor utilized for grounding that passes through and/or is connected to a movable joint such that the conductor will be flexed, shall be subjected to the Flexing Endurance Test, Section 49.

25.2 Bonding

25.2.1 Accessible dead-metal or other conductive parts that become energized and not connected directly to the grounding conductor shall be bonded to grounded parts by clamps, rivets, bolts, screws, brazes, welds, or an equivalent positive means that is capable of including a corrosion-resistant strap or jumper.

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

25.2.3 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.

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

25.2.5 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 omitted after removal or replacement of the fastener; and

c) Have the flexibility required to withstand mechanical stress.

25.2.6 When 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.

25.2.7 A bonding connection shall penetrate a nonconductive coating such as paint.

25.2.8 A bonding conductor shall not be spliced.

Exception: A splicing wire connector that complies with UL 486C and UL 467 is acceptable within the bond path when located within the electrical enclosure and used in accordance with its ratings.

25.2.9 A strap or jumper utilized for bonding or grounding that passes through and/or is connected to a movable joint such that the conductor will be flexed, shall be subjected to the Flexing Endurance Test, Section 49.

26 Low Voltage Charging and Isolated Secondary Output Circuits

26.1 A charging circuit and/or isolated secondary output circuit provided in a FPDU, shall comply with UL 1310, UL 60950-1 or UL 62368-1 for Limited Power Circuits.

26.2 A FPDU provided with a wireless charging circuit shall comply with UL 2738.

PERFORMANCE

27 General

27.1 When 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 inch, 32 threads in one direction and 28 threads in the other direction (for any square centimeter, 13 threads by 11 threads).

27.2 A FPDU shall be subjected to the applicable tests specified in Sections 29 – 42. A separate sample shall be used for each test. Additional samples may be required for investigations of constructions, such as nonmetallic enclosures or components, that are not covered by this standard.

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

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

28 Motorized or Self-Propelled Movable Parts

28.1 A FPDU employing a motor to rotate, lower or raise the unit shall be subjected to the motor requirements in UL 325.

Exception: A motor supplied by an isolated power supply of less than 42.4 volts AC or less than 60 volts DC and the power available shall be less than 15 watts.

28.2 A FPDU that relies on electronic or solid-state circuitry to meet the requirements called out in 28.3 shall comply with the requirements in UL 1004-1.

Exception: If a recorded force of less than 15 lb (66.7 N) is recorded in 28.3 with the electronic or solid state circuitry by-passed, there is no need to evaluate the circuitry to UL 1004-1.

28.3 A FPDU employing a motorized or self-propelled mechanism such as a coil spring actuator shall not create a possible risk of personal injury during engagement or retraction of the moving part of the unit. There shall be no force greater than 15 lb (66.7 N) between any moving part and a stationary object placed into a slot or cavity accessible to the user during the engagement or retraction of the motorized or self-propelled movable feature of the unit when subjected to the Pinch Force Evaluation Test in Section 46.

28.4 A FPDU employing a motorized or self-propelled mechanism such as a coil spring actuator shall be subjected to the Sharp Edge Test in UL 1439.

28.5 A FPDU employing a motorized or self-propelled mechanism such as a coil spring actuator shall be subjected to the Normal Operation Test in Section 47.

29 Temperature Test

29.1 A FPDU shall be subjected to the temperature test described in 29.9 – 29.14.

29.2 An overcurrent protective device shall not open the circuit during the temperature test specified in 29.4.

29.3 The temperature of a FPDU, tested under the conditions of Table 13.1 shall not adversely affect any materials employed, or exceed the temperatures indicated in Table 29.1.

Table 29.1
Maximum Temperatures

Materials and components	°C	(°F)
1. Varnished-cloth insulation	85	(185)
2. Fiber, wood, and other similar electrical insulation	90	(194)
3. Phenolic composition employed as electrical insulation or as a part whose malfunction would result in a risk of fire or electric shock	150[a]	(302[a])
4. Insulated wires and cables	60[a]	(140[a])
5. On the surface of a capacitor casing:		
Electrolytic	65[b]	(149[b])
Other types	90[b]	(194[b])
6. Receptacle and current tap contacts	55	(135)
7. Fuses other than Class CC, G, J, T	90	(194)
8. Fuses Class CC, G, J, T	110	(230)

NOTE – See 29.7.

[a] 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.

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

29.4 The FPDU shall be loaded to the rated voltage and current level specified in the Temperature Test load column of Table 13.1 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.

29.5 The FPDU shall be tested in accordance with Table 13.1 at the rated voltage and test load current indicated within Table 13.1 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.

29.6 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.

29.7 The temperatures specified in Table 29.1 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 corrected for a room temperature of 25 °C (77 °F).

29.8 During a test conducted at an ambient temperature of 25 °C (77 °F), an observed temperature shall not exceed the required values specified in Table 29.1 and Table 29.2.

Table 29.2
Maximum Surface Temperatures

Location	Composition of surface	
	Metal	Nonmetallic
Enclosure surface that is contacted in normal use	70 °C (158 °F)	95 °C (203 °F)

29.9 When a test is conducted at an ambient temperature other than 25 °C (77 °F), an observed temperature shall be corrected as described in 29.10.

29.10 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 (77 °F)] of the difference between 25 °C (77 °F) and the ambient temperature.

29.11 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. 30 AWG (0.05 mm^2) iron and constantan wires and a potentiometer-type of indicating instrument are to be used whenever referee temperatures are required.

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

29.13 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.

29.14 To facilitate conducting the test on a totally enclosed – encapsulated – component of a FPDU, 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.

30 Dielectric Voltage-Withstand Test

30.1 A FPDU shall withstand a potential as follows:

a) For FPDU's rated 125 V AC or less – 1250 V AC or 1768 V DC;

b) For FPDU's rated 250 V AC or less – 1500 V AC or 2121 V DC,

between uninsulated live metal parts and the enclosure – a nonconductive enclosure is to be wrapped in conductive foil – and between live parts of opposite polarity.

30.2 To determine whether a FPDU complies with the requirements in 30.1, the test potential is to be applied as described in 30.4 by means of test equipment having the characteristics outlined in 30.3.

30.3 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 appliance 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 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.

30.4 The method of applying the test voltage to the FPDU is to be such that there are not any transient voltages that result in the instantaneous voltage applied to the FPDU exceeding 105 % of the peak value of the specified test voltage. The applied potential is to be increased from zero at a substantially uniform rate so as to arrive at the specified test potential in approximately 5 s, and then, is to be maintained at the test potential for 1 min. Manual control of the rate of rise is not prohibited from being used.

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

31 Leakage Current Test

31.1 General

31.1.1 The leakage current of a product rated for a nominal 250 V or less supply, when tested in accordance with 31.1.3 – 31.1.6, shall not be more than 0.5 mA.

31.1.2 Leakage current refers to all currents, including capacitively coupled currents, that may be conveyed between exposed conductive surfaces of the product and ground or other exposed conductive surfaces of the product.

31.1.3 All exposed conductive surfaces and the equipment-grounding conductor paths are to be tested for leakage currents. The leakage currents from exposed conductive surfaces and the receptacle grounding contacts are to be measured to the grounded supply conductor individually as well as collectively where simultaneously accessible, and from one surface to another where simultaneously accessible. Surfaces are considered to be simultaneously accessible when they can be readily contacted by one or both hands of a person at the same time.

31.1.4 When a material other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured using metal foil having an area of 10 by 20 cm (3.9 in by 7.9 in) in contact with the surface. When the surface has an area less than 10 by 20 cm (3.9 in by 7.9 in), the metal foil is to be the same size as the surface. The metal foil is not to remain in place long enough to affect the temperature of the product.

31.1.5 The measurement circuit for leakage current is to be as illustrated in Figure 31.1. The measurement instrument is defined in (a) – (d). The meter that is actually used for a measurement need only indicate the same numerical value for a particular measurement as would the defined instrument. The meter used need not have all the attributes of the defined instrument.

a) The meter is to have an input impedance of 1500 Ω resistive shunted by a capacitance of 0.15 μF.

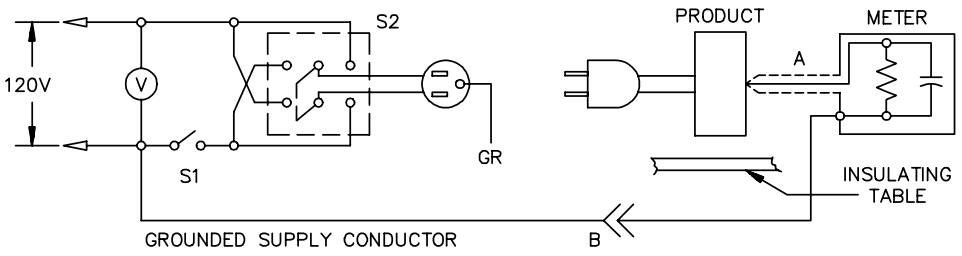
b) The meter is to indicate 1.11 times the average of the full-wave rectified composite waveform of the voltage across the resistor or current through the resistor.

c) Over a frequency range of 0 – 100 kHz, the measurement circuitry is to have a frequency response – ratio of indicated to actual value of current – equal to the ratio of the impedance of a 1500 Ω resistor shunted by a 0.15 μF capacitor to 1500 Ω. At an indication of 0.5 mA, the measurement is not to have an error of more than 5 % at 60 Hz.

d) Unless the meter is being used to measure leakage from one part of a product to another, the meter is to be connected between the accessible parts and the grounded power-supply conductor.

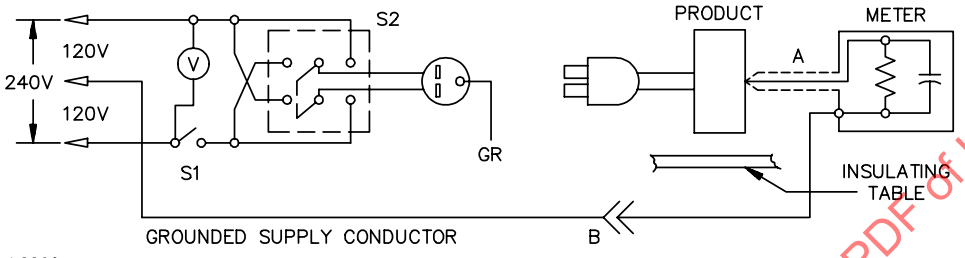
Figure 31.1

Leakage Current Measurement Circuits



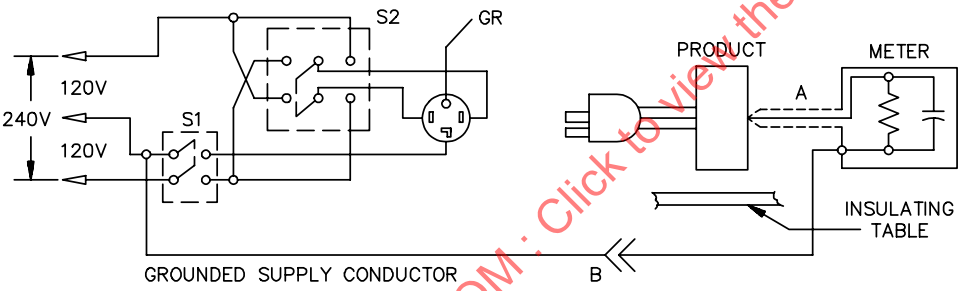
LC100

Products intended for connection to a 125-V power supply.



LC200

Product intended for connection to a 3-wire, grounded neutral power supply, as illustrated above.



LC300

Product intended for connection to a 3-wire, grounded neutral power supply, as illustrated above.

A – Probe with shielded lead.

B – Separated and used as a clip when measuring currents from one part of a product to another.

31.1.6 A sample of the FPDU is to be tested for leakage current in the as-received condition, without prior energization except as may occur as part of the production-line testing, but with the grounding conductor open at the attachment plug. The power-supply voltage is to be adjusted to the rated voltage of the FPDU. The test sequence, with reference to the measuring circuit in Figure 31.1, is to be as follows:

a) With the switch S1 open, the FPDU is to be connected to the measuring circuit. Leakage current is to be measured using both positions of switch S2, and with the FPDU switching devices in all their normal operating positions.

b) Switch S1 is then to be closed, energizing the FPDU, and within 5 s, the leakage current is to be measured using both positions of switch S2 and with the FPDU switching devices in all their normal operating positions.

c) The leakage current is to be monitored until thermal stabilization. Both positions of switch S2 are to be used in determining this measurement. Thermal stabilization is to be obtained by operation of the FPDU as in the Temperature Test by loading only the receptacle furthest from the power-supply cord.

31.2 Leakage current after humidity conditioning

31.2.1 At the end of the conditioning period specified in 31.2.2 a sample of a FPDU shall be subjected to the leakage current test specified in 31.1.3 – 31.1.6. The leakage current shall not be more than 0.5 mA.

31.2.2 A sample of a FPDU shall be heated to a temperature just above 34 °C (93 °F) to reduce the likelihood of condensation of moisture during conditioning. The heated sample is then to be placed in the humidity chamber and conditioned for 48 h in air having a relative humidity of 88 ±2 % and a temperature of 32 ±2 °C (90 ±4 °F).

31.2.3 Following the conditioning, the leakage current should be measured, as described in 31.1.6(a), on the sample while it is still in the humidity chamber. See 31.1.4 and 31.1.5.

31.2.4 The sample, either in or immediately after (within 1 min) removal from the humidity chamber, should be energized and tested as described in 31.1.6 (b) and (c).

32 Grounding Continuity Test

32.1 A previously untested FPDU is to be subjected to the Grounding Continuity Test as described in 32.2. A FPDU shall have a grounding-path resistance of 0.1 Ω or less.

32.2 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.

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.

33 Fault Current Test

33.1 General

33.1.1 When required by note (b) of Table 13.1, or 22.3, three samples of previously untested FPDU's are to be subjected to the Fault Current Test as described in 33.1.2, 33.1.3, and 33.2.1. The FPDU shall comply with the requirements in 33.1.3. Each FPDU shall be tested once.

33.1.2 Each FPDU shall be tested on a circuit calibrated in accordance with 33.2.1. The available current capacity of the circuit is to be as specified in Table 16.1. 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 FPDU 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.

33.1.3 A furniture power distribution unit shall have a grounding-path resistance of 0.1 Ω or less after the test described in 33.1.2. See 32.2. 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 Enclosure Accessibility and Accessibility of Live Parts, Section 9; and

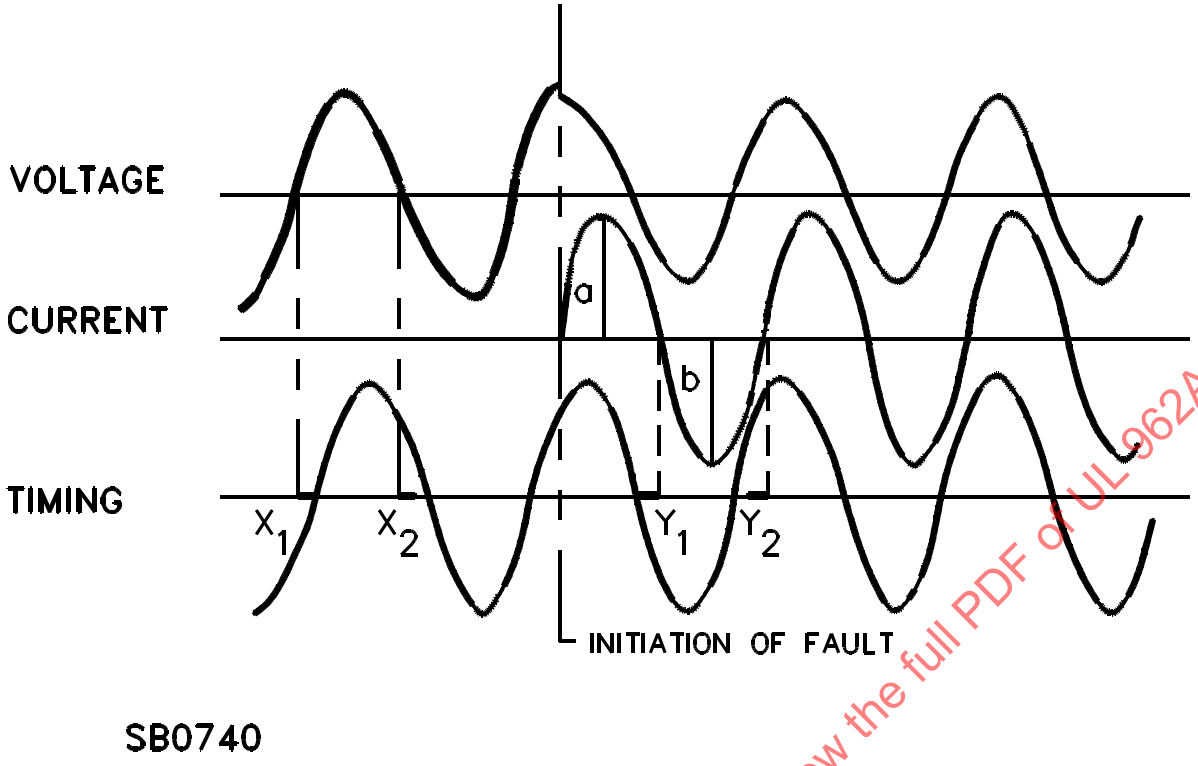
e) There shall not be evidence of degradation or separation of the trace from the printed-wiring board.

33.2 Calibration of test circuits

33.2.1 The current is to be the rms value of the first complete cycle – see Figure 33.1 – 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 33.1

Determination of Current and Power Factor



34 Overcurrent Test

34.1 When required by note (b) of Table 13.1, 22.3 or 22.4, three previously untested FPDU's are to be subjected to the Overcurrent Test as described in 34.2 – 34.6. The FPDU shall comply with the requirements in 34.6 and 34.7. Each FPDU shall be tested once.

34.2 All integral supplementary protection devices are to be shunted out of the circuit for this test.

34.3 The resistance of each circuit conductor path as specified in 22.3 and 22.4 is to 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.

34.4 The FPDU 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 34.5. Rated frequency is to be used. Any voltage not higher than the rated voltage is not prohibited from being used.

34.5 For a FPDU with integral overcurrent protection, the overload current is to be 200 % of the overcurrent device rating. For a FPDU without integral overcurrent protection, the overload current is to be 200 % of the current rating of the maximum size branch circuit to which the FPDU is intended to be connected. The overcurrent test current is to be applied for 2 min.

34.6 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 (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 Enclosure Accessibility and Accessibility of Live Parts, Section 9; and

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

34.7 After the sample has cooled to room temperature, the resistance of each circuit conductor path is to be determined as specified in 34.3. 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.

35 Mounting Hole Barrier Tests

35.1 General

35.1.1 When penetration or deflection of a barrier behind a mounting hole of the FPDU increases the risk of fire, electric shock, or injury to persons, the FPDU is to be subjected to the Mounting Hole Barrier Tests as described in 35.2.1 – 35.3.1 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 Enclosure Accessibility and Accessibility of Live Parts, Section 9;

b) A reduction of spacings below the values specified in Spacings, Section 20;

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 FPDU; and

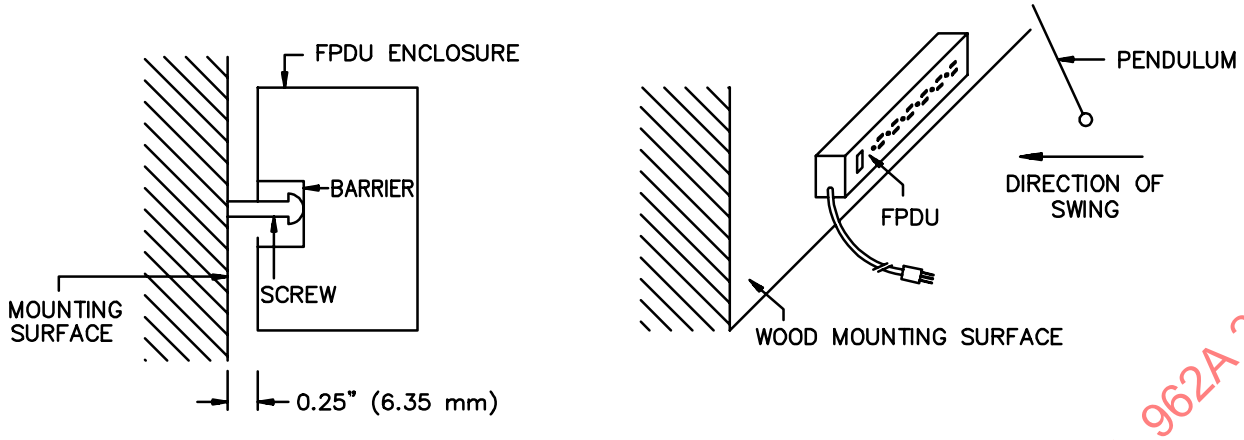
e) Any other condition that increases the risk of electric shock.

35.2 Mounting hole barrier impact test

35.2.1 The FPDU 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 FPDU is to be mounted using a No. 8 x 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 35.1.

Figure 35.1

Test Set-Up for Mounting Hole Barrier Impact Test



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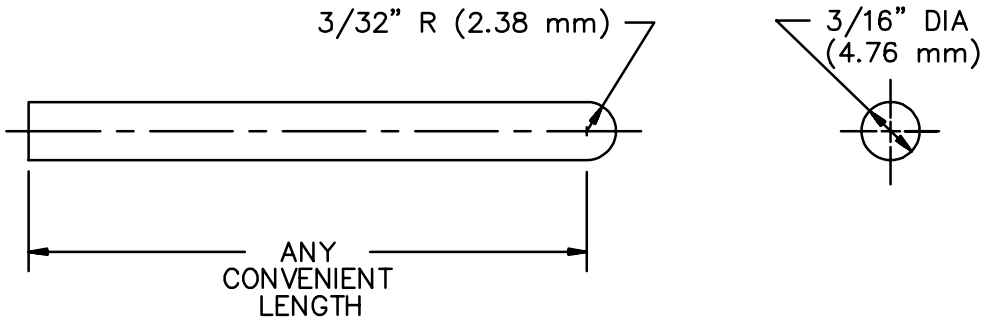
35.2.2 Each mounting hole configuration of the FPDU shall be subjected to a single impact of 5 ft-lbf (6.8 J) to the FPDU mounted as specified in 35.2.1. This impact is to be produced by a steel sphere, 2 inches (50.8 mm) in diameter and weighing 1.18 lb (0.535 kg), suspended by a cord and swung as a pendulum, dropping through a vertical distance of 51 inches (1.29 m) to cause it to strike the FPDU with the specified impact as shown in Figure 38.2. Each impact shall be applied to a point on the FPDU surface that is evaluated as being the most severe for the mounting hole configuration under test.

35.3 Mounting hole barrier probe test

35.3.1 Each barrier of an untested sample of a FPDU shall withstand a force of 20 lbf (89 N). The force is to be applied by means of the barrier probe shown in Figure 35.2.

Figure 35.2

Barrier Probe



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36 Strain Relief Test

36.1 A FPDU shall be tested for strain relief as described in 36.2.

36.2 The FPDU shall be held securely in place in a position that allows a pull on the cord in directions that produce the most severe stresses on the strain relief. The product is to be secured in a manner that does not affect the test results, and the power-supply conductors shall be cut at their terminations. The power-supply cord is to withstand a direct pull of 35 lbf (158 N) applied to the cord for 1 min without sufficient movement of the power-supply conductors at the cut end to indicate transmission of stress to internal connections.

36.3 An FPDU that is also provided with an integral Class 2 lead shall be additionally subjected to the testing method described in 36.2 except the pull values shown in Table 36.1 shall be applied to the Class 2 lead.

Table 36.1
Pull Values

Size of conductor		Pull force	
AWG	(mm^2)	lbf	(N)
32	(0.03)	0.5	(2.2)
30	(0.05)	1	(4.4)
28	(0.08)	2	(8.9)
26	(0.13)	4	(17.8)
24	(0.20)	6	(26.7)
20 – 22	(0.52 – 0.32)	8	(36)

37 Push Back Relief Test

37.1 With reference to 13.5.1, a FPDU shall be tested in accordance with 37.2 without occurrence of any of the following conditions:

a) Mechanical damage to the supply cord or lead;

b) Exposure of the supply cord or lead to a temperature higher than that for which it is rated;

c) Reduction of spacings (such as to a metal strain-relief clamp) below the minimum required values; or

d) Damage to internal connections or components.

37.2 The supply cord or lead is to be held 25 mm (1 in) from the point where the cord or lead emerges from the product and is then to be pushed back into the product. When a removable bushing which extends further than 25 mm (1 in) is present, it is to be removed prior to the test. When the bushing is an integral part of the cord, the test is to be carried out by holding the bushing. The cord or lead is to be pushed back into the product in 25-mm (1-in) increments until the cord buckles or the force to push the cord into the product exceeds 27 N (6 lbf). The supply cord or lead within the product is to be manipulated to determine compliance with 37.1.

38 Impact Tests

38.1 General

38.1.1 A FPDU employing a metallic or polymeric enclosure is to be subjected to the impact tests described in 38.2.1 – 38.5.7 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 Enclosure Accessibility and Accessibility of Live Parts, Section 9;

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

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

d) Spacings shall not be less than those described in Spacings, Section 20.

e) Prevention of either "trip" and/or "reset" function when an FPDU employs an enclosure cap or cover over the reset actuator (i.e. stem) of a supplementary overcurrent protector.

38.1.2 With reference to 38.1.1(b), there shall not be cracking or denting of the enclosure that affects the function of any features such as overcurrent protective devices or strain relief. Cracking or denting of the enclosure is not to result in exposure of moving parts capable of causing injury to persons.

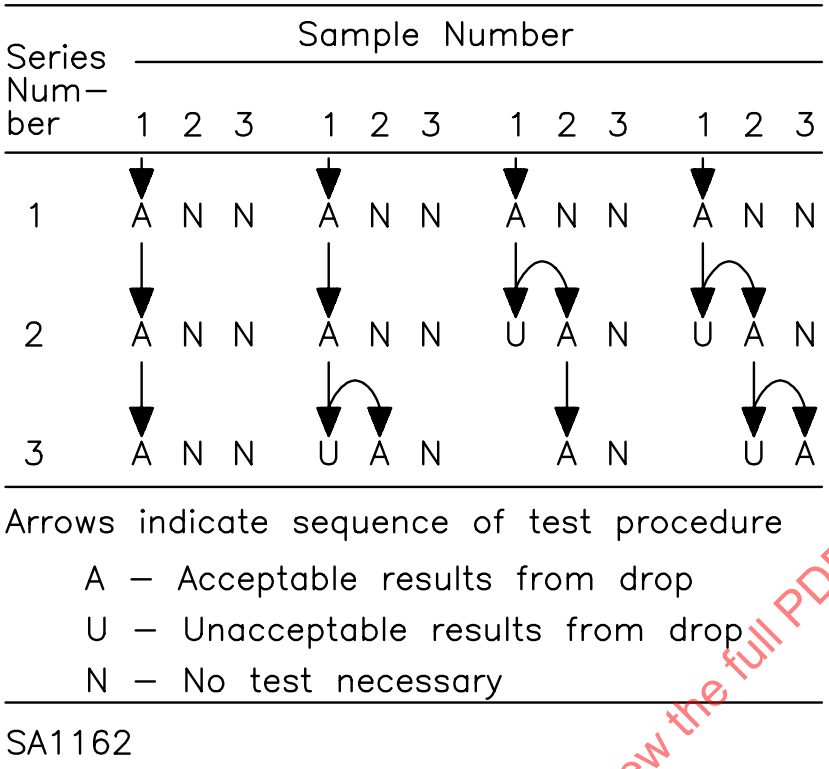
38.1.3 With reference to 38.1.1(c), the FPDU is to comply with the Dielectric Voltage-Withstand Test, Section 30, after being subjected to the impact tests described in this section.

38.1.4 With reference to 38.1.1(e), there shall not be cracking or denting of the enclosure that affects the function of the supplementary overcurrent protector as a result of the Drop Impact Test, 38.2. After being subjected to the Drop Impact Test described in 38.2, each device shall then be subjected to 38.5, Supplementary Overcurrent Protector Check Test.

38.1.5 For the impact tests, the rigid supporting surface is to consist of a layer of nominal 25 mm (1 in) tongue-and-groove oak flooring (actual size 18 by 57 mm or 3/4 by 2-1/4 in mounted on two layers of nominal 19 mm (3/4 in) plywood. The assembly is to rest on a concrete floor or an equivalent nonresilient floor during the test. The rigid backing surface is to consist of 19 mm (3/4 in) plywood over a rigid surface of concrete. An equivalent nonresilient backing surface may be used.

Figure 38.1

Procedure for Impact Test



38.2 Drop impact test

38.2.1 Each of three samples of the FPDU 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 FPDU to strike a hardwood 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 38.1 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.

38.3 Steel sphere impact test

38.3.1 Each of three samples of the FPDU 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 inches (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 38.2.

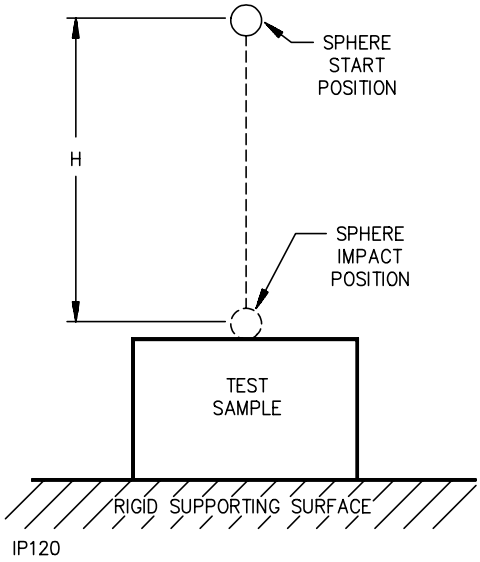
The ball shall not impact on a receptacle face, supplementary overcurrent protective device, switch, pilot light or similar component. For surfaces other than the top on an enclosure, the steel sphere is to be suspended by a cord and swung as a pendulum, dropping through the vertical distance required to cause it to strike the surface with the specified impact as shown in Figure 38.3. 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 38.1 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 38.2

Steel Sphere Drop Impact Test

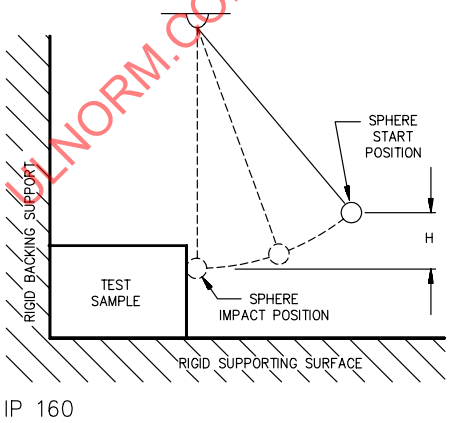


1 – H indicates the vertical distance the sphere must travel to produce the desired impact.

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 38.3

Steel Sphere 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.

38.4 Low-temperature steel sphere impact test

38.4.1 For a FPDU with a polymeric enclosure, three samples of a FPDU shall be cooled to a temperature of 0.0 ±2.0 °C (32.0 ±3.6 °F) and maintained at this temperature for 24 h. While the unit is still cold, within 1 min after removal from the temperature chamber, the samples are to be subjected to the impact described in 38.3.1.

38.5 Supplementary overcurrent protector check test

38.5.1 When tested in this section, the supplementary overcurrent protector shall operate as intended when the test circuit is closed.

38.5.2 Each of the three samples previously subjected to Drop Impact Test, 38.2, are to be tested through a mated shorted attachment plug.

38.5.3 A receptacle protected by a 20 A circuit breaker for branch circuit protection is to be connected to a flush receptacle installed in a flush device box with a metal faceplate.

38.5.4 The FPDU under test is to be plugged-into the flush receptacle.

38.5.5 An attachment plug shall be assembled to a 2-ft (0.6 m) length of 14 AWG (2.1 mm^2) flexible cord or cable. The load conductors shall be shorted together at the end. The plug shall then be inserted in the FPDU under test.

38.5.6 For all test operations, the test circuit shall be closed by an external switch on mated devices.

38.5.7 The supplementary overcurrent protector of the FPDU under test shall be reset and the test repeated five times.

39 Crushing Test

39.1 A FPDU employing a metallic or polymeric enclosure is to be subjected to the crush test described in 39.4 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 Enclosure Accessibility and Accessibility of Live Parts, Section 9;

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

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

39.2 With reference to 39.1(b), the enclosure shall not crack or dent or affect the function of any features such as overcurrent protective devices or strain relief. Cracking or denting of the enclosure is not to result in exposure of moving parts capable of causing injury to persons.

39.3 With reference to 39.1(c), the FPDU is to comply with the Dielectric Voltage-Withstand Test, Section 30, after being subjected to the crush tests described in this section.

39.4 A previously untested sample of a FPDU 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 FPDU 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 FPDU, perpendicular to the long axis of the

FPDU. 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.

39.5 At the end of the tests described in 39.1 – 39.4, spacings shall not be less than those described in Spacings, Section 20.

40 Adequacy of Mounting Test

40.1 To determine compliance with 40.2 and 40.3, a FPDU is to be mounted in accordance with manufacturer's installation instructions on any secure wall.

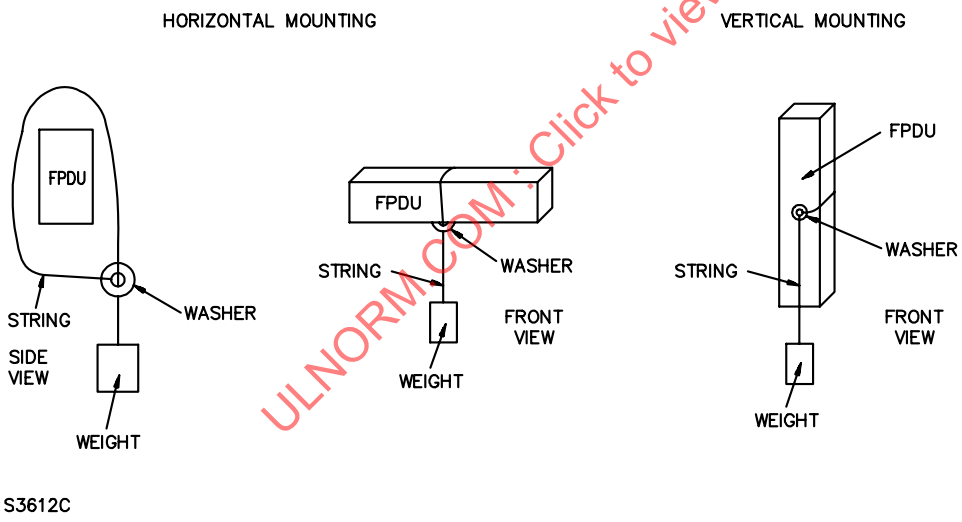
Exception No. 1: When the FPDU is not provided with installation instructions, the FPDU shall be tested in the most severe mounting configuration.

Exception No. 2: This test is not required when the FPDU is mounted with an adhesive that complies with 10.3.

40.2 After the FPDU has been installed according to manufacturer's instructions, a weight of four times the weight of the FPDU or 5 lbs (2.27 kg), whichever is greater, is to be hung from the center of the FPDU as shown in Figure 40.1 for each mounting configuration.

Figure 40.1

Test Method for Adequacy of Mounting Test



40.3 There shall be no occurrence of the following as a result of this test:

a) Creation of any openings in the enclosure that result in accessibility of live parts, when evaluated in accordance with Enclosure Accessibility and Accessibility of Live Parts, Section 9;

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

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

41 Retractable Force Test

41.1 A FPDU with a retractable vertical tower, that has a horizontal platform area greater than 9 in^2 (58.1 cm^2) and is also provided with a means for locking the vertical tower in an open (upright) position, shall be subjected to the test as described below without any occurrence of the following conditions:

a) Creation of any openings in the enclosure that result in accessibility of live parts, when evaluated in accordance with Enclosure Accessibility and Accessibility of Live Parts, Section 9;

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

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

41.2 With reference to 41.1(b), the vertical tower and locking means shall not crack or dent or any retraction of the tower platform resulting in exposure of moving parts capable of causing injury to persons.

41.3 With reference to 41.1(c), the FPDU with a retractable vertical tower shall also comply with the Dielectric Voltage-Withstand Test, Section 30, after being subjected to the test described in 41.4.

41.4 A previously untested sample of a FPDU with a retractable vertical tower shall be installed on a horizontal flat surface according to manufacturer's instructions. With the vertical tower fully extended and locked in the intended open (upright) position, a force of 150 lbf (667.2 N) shall be applied to the horizontal platform area in an attempt to retract the platform into the closed (downward) position. Force shall be gradually applied and maintained for a period of 1 min.

41.5 At the end of the tests described in 41.1 – 41.4, spacing shall not be less than those described in Spacing, Section 20.

42 Mold Stress-Relief Distortion Test

42.1 For a FPDU with a polymeric enclosure, conditioning of the equipment as described in 42.2 shall not result in softening of the material as determined by handling immediately after the conditioning, nor shall there be shrinkage, warpage, or other distortion as evaluated after cooling to room temperature, that results in any of the following:

a) Reduction of spacings between uninsulated live parts of opposite polarity, and uninsulated live parts and accessible dead or grounded metal below the minimum values specified in Spacings, Section 20;

b) Creation of any openings in the enclosure that result in accessibility of live parts, when evaluated in accordance with Enclosure Accessibility and Accessibility of Live Parts, Section 9, or defeating the integrity of the enclosure so that the required mechanical protection is not afforded to internal parts of the equipment;

c) A condition that results in the equipment not complying with the Strain Relief Test, Section 36, when applicable; and

d) Interference with the intended operation or servicing of the equipment.

Exception: The conditioning described in 42.2 is not required for rigid thermosetting materials or for low-pressure, foamed molded parts.

42.2 For equipment that has a polymeric enclosure, one sample of the equipment shall be conditioned in accordance with either (a) or (b) below:

a) One sample of the complete equipment (in the case of an enclosure) or the part under consideration, is to be placed in a full-draft, circulating-air oven maintained at a uniform temperature at least 10 °C (18 °F) higher than the maximum temperature of the material measured under actual operating conditions, but not less than 70 °C (158 °F) in any case. The sample is to remain in the oven for 7 h. After its careful removal from the oven and return to room temperature, the sample is to be investigated for compliance with 42.1.

b) One sample of the complete equipment is to be placed in a test cell. The circulation of air within the cell is to simulate actual room conditions. The air temperature within the cell, as measured at the supporting surface of the equipment, is to be maintained at 60 °C (140 °F). The equipment is to be operated in the same way as for the temperature test except for equipment that is not loaded or is not continuously loaded during the normal temperature test. Such equipment, although unloaded, shall be connected to 106 % or 94 % of normal rated voltage, whichever results in higher temperatures. In any case, the equipment is to be operated for 7 h. After its careful removal from the test cell, the sample is to be investigated for compliance with 42.1.

43 Spill Test

43.1 A FPDU shall be subjected to the test described in this section and, after the testing, shall be subjected to the Dielectric Voltage-Withstand Test, Section 30, 1 minute after the container is tipped over.

Exception No. 1: When the instructed installation of the FPDU is for it to be mounted above the furnishing surface and oriented such that spilled liquid on the furnishing surface cannot enter any part of the FPDU, these requirements do not apply.

Exception No. 2: When the FPDU is provided with a portable GFCI Class A that complies with UL 943, and the GFCI is located at the attachment plug or within 12 in (305 mm) of the attachment plug compliance with the spill test is not required.

43.2 Class 2 output connectors of receptacles with integral power supplies employing Class 2 output connector(s) are to be blocked from liquid ingress during this test. Openings to the FPDU enclosure interior portion(s) containing solely Class 2 load circuits are to be blocked from liquid ingress during this test. There shall be no additional blockage of openings to FPDU enclosure interior portions that contain any circuit(s) providing power to Class 2 power supplies.

43.3 The FPDU is to be mounted as instructed by the manufacturer. Any cover is to be opened to the position that allows the greatest egress of liquid. A cover that is self-closing or tends to close itself is to be allowed to fall to its natural resting position. If more than one receptacle is enclosed by such a self-closing cover, then a single power-supply cord is to be mated with one of the receptacles and the cord is to exit through the wiring channel from behind the cover as instructed.

43.4 A FPDU with a retractable vertical tower shall be subjected to the spill test with the retractable tower in the open and closed positions.

43.5 An acrylic cylinder 3 ±1/16 inches (76.2 ±1.6 mm) inside diameter by 4 ±1/16 inches (101.6 ±1.6 mm) overall height with 1/8 inch ±1/16 inch (3.2 ±1.6 mm) thick base and cylinder wall is to be filled with 8 ±0.25 fluid ounces (237 ±7.4 ml) of saline solution, consisting of 8 ±0.1 g of plain food grade Iodized table salt per 1 ±0.1 L of distilled water at ambient room temperature.

43.6 The test cup, as described in 43.5, is to be placed on a 45 – 47° incline plane from the horizontal surface. The incline plane is to be large enough to support the entire base of the cup. The leading edge of the test cup base is to be positioned on the test surface 4 to 4.25 inches (10.2 to 10.8 cm) in from the edge of the unit. See Figure 43.1 and Figure 43.2. The test cup is to be placed so that the rim of the cup, when tipped over, is aligned with the receptacle, or cord connector face. See Figure 43.3. If a plug is inserted, the cup is to be aligned with a receptacle or cord connector without the inserted plug. The cup is then to be manually tilted toward the receptacle or cord connector under test and allowed to fall by gravity toward the receptacle or cord connector.

Figure 43.1

Side View of Spill Test Fixture to Test Sample (drawing not to scale)

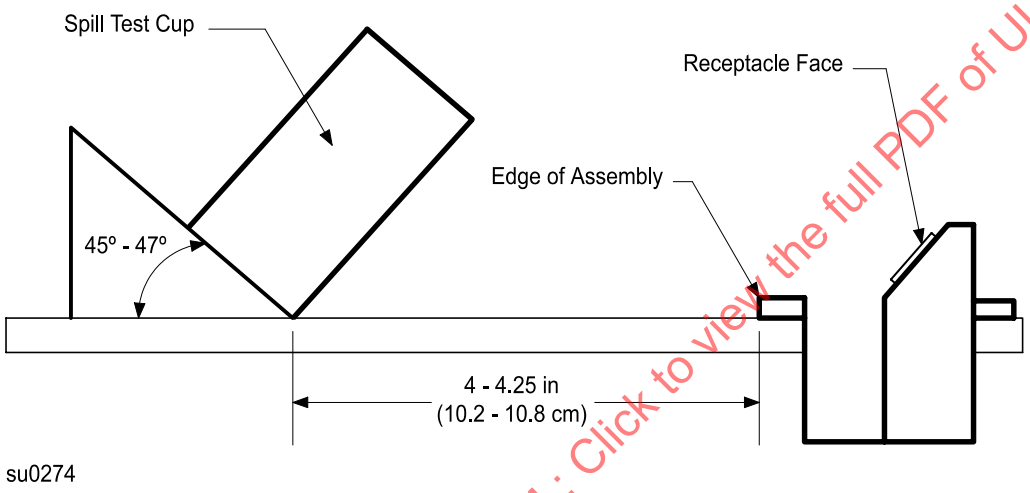


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Figure 43.2

Side View of Spill Test Fixture to Test Sample (drawing not to scale)

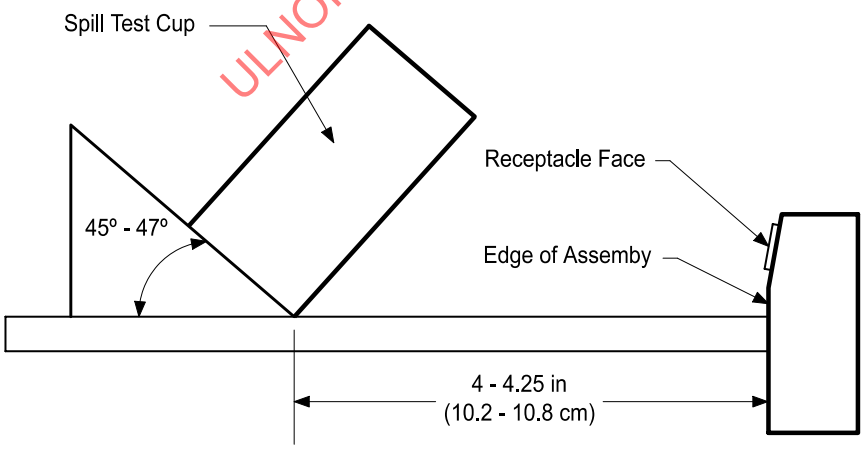

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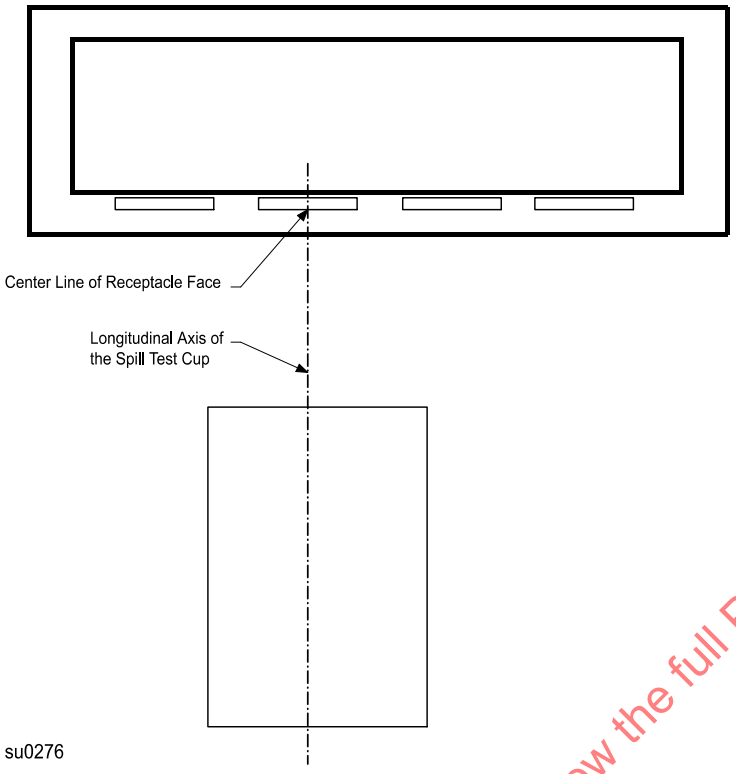
Figure 43.3

Top View of Spill Test Cup to Receptacle Face



44 Accessibility Tests

44.1 Enclosure accessibility test

44.1.1 The enclosure of a FPDU shall be subjected to the test in 44.1.2. As a result of the test, the test probe shall not contact any uninsulated current-carrying parts.

44.1.2 A straight test rod having a maximum diameter of 1.6 mm (1/16 in) and of any convenient length is to be inserted into each opening in the enclosure and rotated in any possible direction.

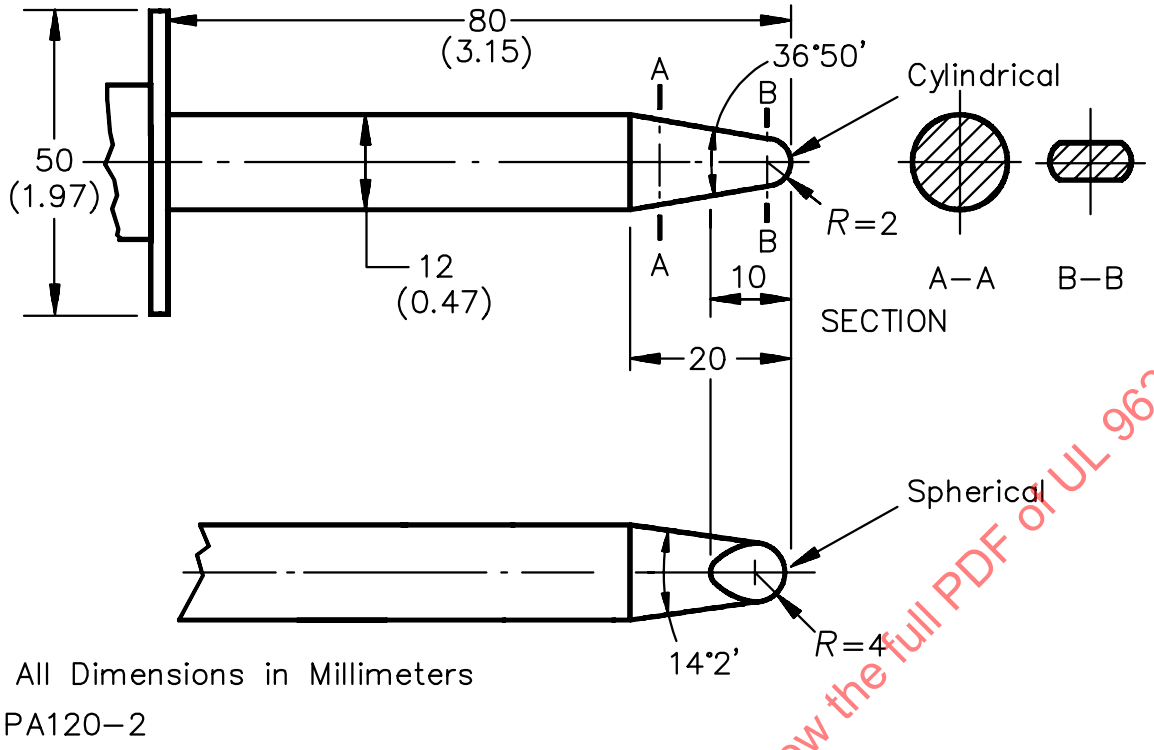
44.2 Accessibility of live parts test

44.2.1 An enclosure of a FPDU which prevents unintentional contact of current-carrying parts or of film-coated magnet wire in the enclosure of a FPDU shall be subjected to the test in 44.2.2. As a result of the test, the probes described in Figure 9.1 and Figure 44.1 shall not touch the current-carrying part or magnet wire.

44.2.2 The articulate probe, Figure 9.1, is to be inserted through any opening and rotated with movable sections straight and in any possible position resulting from bending one or more section in the same direction. The rigid probe, Figure 44.1, is to be applied with a maximum force of 30 N (6.75 lbf).

Figure 44.1

International Electrotechnical Commission (IEC) Rigid Accessibility Probe



45 Test for Permanence of Cord Tag

45.1 General

45.1.1 To determine compliance with 53.3 and 53.4, representative tags that have been subjected to the tests described in 45.2.1 – 45.3.1 shall meet the following requirements:

a) The tag shall resist tearing for longer than 1/16 in (1.6 mm) at any point;

b) The tag shall not separate from the cord set. A hang-type tag shall not separate from the securement strap, and the securement strap shall not separate from the cord set;

c) The tag or securement strap shall not slip or move along the length of the cord set more than 1/2 in (13 mm) and there shall not be any visible damage to the cord;

d) There shall not be any permanent shrinkage, deformation, cracking, or any other condition that will render the marking on the tag illegible; and

e) Overlamination, if provided, shall remain in place and shall not be torn or otherwise damaged. The printing shall remain legible.

45.2 Test conditions

45.2.1 For each type of conditioning mentioned in 45.2.2 – 45.2.4, three tags applied to the cord sets in the intended manner are to be used. If tags are applied by an adhesive, tests are to be conducted no sooner than 24 h after application of the tag.

45.2.2 Each of three tags is to be tested as received.

45.2.3 Each of three tags is to be tested after 30 min of conditioning at 23.0 ±2.0 °C (73.4 ±3.6 °F) and 50 ±5 % relative humidity, following 240 h of conditioning in an air-circulating oven at 60 ±1 °C (140 ±1.8 °F).

45.2.4 Each of three tags is to be tested within 1 min after being exposed for 72 h to a relative humidity of 85 ±5 % at a temperature of 32.0 ±2.0 °C (89.6 ±3.6 °F).

45.2.5 If the tag is intended to be applied to outdoor cord (W) it is to be conditioned as follows and in 45.2.6 – 45.2.8. Each of three tags is to be tested after 24 h of exposure conditioning at 23 ±2 °C (73.4 ±3.6 °F) and 50 ±5 % relative humidity, followed by 48 h of immersion to a depth of not less than 1/8 inch (3.2 mm) in demineralized water at a temperature of 23 °C (73.4 °F).

45.2.6 Each of three tags is to be tested after 24 h of exposure conditioning at 23.0 ±2.0 °C (73.4 ±3.6 °F) and 50 ±5 % relative humidity, followed by 10 d of exposure in an air-circulating oven at a temperature of 60 °C (140 °F).

45.2.7 Each of three tags is to be tested after 24 h of exposure conditioning at 23.0 ±2.0 °C (73.4 ±3.6 °F) and 50 ±5 % relative humidity, followed by 7 h of exposure in a cold box at a temperature of minus 10 ±2 °C (14.0 ±3.6 °F).

45.2.8 Each of three tags is to be tested after 24 h of exposure conditioning at 23.0 ±2.0 °C (73.4 ±3.6 °F) and 50 ±5 % relative humidity, followed by exposure to ultraviolet light and water spray with ultraviolet light by using a Xenon-Arc Weatherometer, (Type B or similar apparatus), as described in ASTM G155. Each of the tags is to be exposed to 1000 h of ultraviolet light and water spray with ultraviolet light. The exposure shall be in accordance with Method A, with continuous exposure to ultraviolet light and intermittent water spray with ultraviolet light, using a programmed cycle of 120 min (102 min ultraviolet light exposures and an 18 min exposure to water spray with ultraviolet light). The apparatus shall include a 6500 W, water-cooled xenon-arc lamp, borosilicate glass inner and outer optical filters, a spectral irradiance of 0.35 W/m^2 at 340 nm and a black-panel temperature of 63.0 ±3.0 °C (145.0 ±5.4 °F).

45.2.9 If the tag is intended to be applied to indoor or outdoor cord that is oil resistant (Type O or OO) it is to be conditioned as follows. Each of three tags is to be tested within 2 h after being immersed for 48 h in IRM 902 type oil at a temperature of 23.0 ±2.0 °C (73.4 ±3.6 °F).

45.3 Test method

45.3.1 Each test is to be performed on a length of cord set to which the tag has been applied. The cord set, with the attachment plug pointing up, is to be held taught in a vertical plane. A force of 5 lbf (22.2 N), which includes the weight of the clamp, is to be applied for 1 min to the uppermost corner of the tag farthest from the cord set, within 1/4 in (6.4 mm) of the vertical edge of the tag. The force is to be applied by affixing a C-clamp with a pad diameter of 3/8 in (9.5 mm) to the tag and securing the weight to the C-clamp. The force is to be applied vertically downward in a direction parallel to the major axis of the cord. To determine compliance with 45.1.1(d), manipulation is permissible, such as straightening of the tag by hand. To determine compliance with 45.1.1(e), each tag is to be scraped 10 times vertically across printed areas and edges, with a force of approximately 2 lbf (9 N), using the edge of a 5/64 in (2.0 mm) thick steel blade held at a right angle to the test surface. The edges of the steel blade are to be just rounded so as not to be sharp.

46 Pinch Force Evaluation Test

46.1 A FPDU provided with either a motorized or self-propelled mechanism such as a coil spring actuator shall be subjected to the pinch force evaluation test described in 46.2 and 46.3 without any forces greater than 15 lbf. measured at any location along the moving part.

46.2 The FPDU is to be installed and assembled as described in the manufacturer's installation instructions.

46.3 The motorized or self propelled moving part of the FPDU is to be operated at the maximum velocity or the velocity determined to be the most severe. All degrees of rotation and movement shall be considered in the evaluation. The force is to be measured with a gauge placed between the edge of the moving part and the fixed part of the module device. The force measurement is to be repeated three times, once in the center and once to the right and to the left side of the moving part.

47 Normal Operation Test

47.1 A FPDU, as required by 28.4, shall be mounted as intended and the movable part(s) shall be subjected to 2500 cycles of movement from one extreme position to the other extreme position.

47.2 The test rate shall be no faster than 10 cycles per minute.

47.3 Following the 2500 cycles, prior to examination as required in 47.4, the FPDU shall be subjected to and comply with the Temperature Test, Section 29, Dielectric Voltage-Withstand Test, Section 30 and Fault Current Test, Section 33.

47.4 Examination of FPDU shall not result in the following conditions:

a) Any condition that is capable of affecting the mechanical performance of the FPDU.

b) Any noticeable wear or damage to the jacket or insulation of the power supply cord or internal wiring.

c) Not completing the 2,500 cycles.

48 Cycling Test

48.1 A FPDU with a retractable vertical tower intended to be closed with power supply cord(s) connected to each receptacle, as required by 8.7 shall be mounted in accordance with the manufacturer's installation instruction and subjected to the Cycling test described in 48.2 – 48.7.

48.2 The test cord(s) plugged into each receptacle of the retractable vertical tower shall be capable of withstanding a minimum of 2,500 cycles when tested as described in 48.3 – 48.7.

48.3 A FPDU with a retractable vertical tower shall be subjected to cycling consisting of closing and opening the unit 2,500 times with a test power supply cord as described in 48.5 connected to each of the receptacles provided on the vertical tower.

48.4 Each test cord is to be subjected to complete flexing cycles until a conductor in each device has opened (as determined by a continuously-monitoring detection circuit), or until 2,500 cycles is reached, whichever comes first. The test rate shall be 10 cycles per minute.

48.5 A test power supply cord consisting of 18 AWG SPT-2 cord a minimum of 6 ft (182 cm) in length, rated 60 °C molded onto a NEMA 1-15P attachment plug shall be used as the test cord. The attachment

plug body measured from the plug face to cord entry shall be 1-9/16 – 1-13/16 inches (40 – 45 mm) in length.

48.6 Following the Cycling Test, prior to examination as required in 48.7, while the test power supply cords are still plugged in, the FPDU shall be subjected to and comply with the Dielectric Voltage-Withstand Test, Section 30, Ground Continuity Test, Section 32 and Overcurrent Test, Section 34.

48.7 Examination of FPDU and test power supply cord(s) shall not result in the following conditions:

a) Any condition that is capable of affecting the mechanical performance of the FPDU.

b) Any noticeable wear or damage to the jacket or insulation of the test power supply cord(s).

c) Not completing the 2,500 cycles.

d) Broken strands at the point of flexing that reduce the overall CMA (Circular Mils Area) of the copper conductor below 10 % of the minimum AWG size. For the test power supply cord(s) the CMA of the intact strands shall not fall below 1512 circular mils.

49 Flexing Endurance Test

49.1 Three samples of a FPDU, as required by 19.12, 25.1.11 and 25.2.9, shall be mounted as intended (if provided with a mounting means) and the movable part(s) shall be subjected to 6000 cycles of movement from one extreme position to the other extreme position. A cycle is one extreme position to the other extreme position returning to the starting position.

49.2 The test rate shall be no faster than 20 cycles per minute unless the manufacturer agrees to a faster cycle.

49.3 After the flexing endurance test, the three FPDU's shall comply with the following tests and inspection in the order shown in Table 49.1:

Table 49.1
Test Order

	SAMPLE 1	SAMPLE 2	SAMPLE 3
1	Temperature Test, Section 29	NA	NA
2	Dielectric Voltage Withstand Test, Section 30 conducted in the following manner – Between each conductor in relation to every other conductor. (L to N, L to G, N to G, L to L). The FPDU shall be flexed through 4 cycles of movement for each application of the test voltage, approximately 1 cycle every 15 seconds, while energized during the dielectric voltage withstand tests	Dielectric Voltage Withstand Test, Section 30 conducted in the following manner – Between each conductor in relation to every other conductor. (L to N, L to G, N to G, L to L). The FPDU shall be flexed through 4 cycles of movement for each application of the test voltage, approximately 1 cycle every 15 seconds, while energized during the dielectric voltage withstand tests	Dielectric Voltage Withstand Test, Section 30 conducted in the following manner – Between each conductor in relation to every other conductor. (L to N, L to G, N to G, L to L). The FPDU shall be flexed through 4 cycles of movement for each application of the test voltage, approximately 1 cycle every 15 seconds, while energized during the dielectric voltage withstand tests
3	Leakage Current Test, Section 31	Leakage Current Test, Section 31	Leakage Current Test, Section 31
4	Fault Current Test, Section 33	Fault Current Test, Section 33	Fault Current Test, Section 33
5	Overcurrent Test, Section 34	Overcurrent Test, Section 34	Overcurrent Test, Section 34
6	Grounding Continuity Test, Section 32. The FPDU shall be flexed	Grounding Continuity Test, Section 32. The FPDU shall be flexed	Grounding Continuity Test, Section 32. The FPDU shall be flexed

Table 49.1 Continued on Next Page

Table 49.1 Continued

	SAMPLE 1	SAMPLE 2	SAMPLE 3
	through 4 cycles of movement during the test. At any flexed position the grounding path resistance shall comply with 32.1	through 4 cycles of movement during the test. At any flexed position the grounding path resistance shall comply with 32.1	through 4 cycles of movement during the test. At any flexed position the grounding path resistance shall comply with 32.1
7	Impact Tests, Section 38	Impact Tests, Section 38	Impact Tests, Section 38
8	Crushing Test, Section 39	Crushing Test, Section 39	Crushing Test, Section 39
9	Adequacy of Mounting Test, Section 40	Adequacy of Mounting Test, Section 40	Adequacy of Mounting Test, Section 40
10	The Enclosure Accessibility and Accessibility of Live Parts, Section 9	The Enclosure Accessibility and Accessibility of Live Parts, Section 9	The Enclosure Accessibility and Accessibility of Live Parts, Section 9
11	Spacings, Section 20	Spacings, Section 20	Spacings, Section 20
12	No visual damage to the insulation of the conductors nor damage to the conductor, including grounding and bonding conductors	No visual damage to the insulation of the conductors nor damage to the conductor, including grounding and bonding conductors	No visual damage to the insulation of the conductors nor damage to the conductor, including grounding and bonding conductors

MANUFACTURING AND PRODUCTION-LINE TESTS

50 Dielectric Voltage-Withstand Test

50.1 Each FPDU shall be capable of withstanding without electrical breakdown, as a routine production-line test, the application of a potential between uninsulated live parts and accessible, dead-metal parts that become energized.

Exception: This requirement does not apply to a FPDU that employs a component that can be damaged by the dielectric potential.

50.2 The production-line test is to be in accordance with any of the alternatives of Table 50.1.

Table 50.1
Production-Line Dielectric Withstand Test Conditions for Furniture Power Distribution Units

Rating	Alternative A		Alternative B		Alternative C		Alternative D	
	Potential (V AC)	Time (s)	Potential (V AC)	Time (s)	Potential (V DC)	Time (s)	Potential (V DC)	Time (s)
125 V or less AC	1250	60	1500	1	1768	60	2121	1
125/250 V AC and 250 V AC or less	1500	60	1800	1	2121	60	2545	1

50.3 The test shall be conducted when the FPDU is complete (fully assembled). It is not intended that the FPDU be unwired, modified, or disassembled for the test.

50.4 The test equipment when adjusted for production-line testing, is to produce an output voltage that is not less than the factory test value specified, nor is the magnitude of the test voltage to be greater than 120 % of the specified test potential when the tester is used in each of the following conditions:

a) When the test duration is 1 s, the output voltage is to be maintained within the specified range when:

1) Only a voltmeter having an input impedance of at least 2 MΩ and a specimen of the product being tested are connected to the output terminals; and

2) A relatively high resistance is connected in parallel with the voltmeter and the product being tested, and the value of the resistance is gradually reduced to the point where an indication of unacceptable performance just occurs.

b) When the test duration is 1 min, the output voltage is to be maintained within the specified range (by manual or automatic means) throughout the 1-min duration of the test or until there is an indication of unacceptable performance.

50.5 The specified control of the applied voltage, manual or automatic, shall be maintained under conditions of varying line voltage. Higher test potentials are not prohibited from being used when the higher dielectric stress does not adversely affect the insulating systems of the product.

50.6 In addition to the characteristics indicated in 50.4, the test equipment is to have the following features and characteristics:

a) A means of indicating the test voltage that is being applied to the appliance 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 to be less than 1.3 and not more than 1.5 times the root-mean-square value.

c) A means of effectively indicating unacceptable performance. The indication is to be:

1) Auditory, when it can be readily heard above the background noise level;

2) Visual, when it commands the attention of the operator; or

3) A device that automatically rejects an unacceptable product. When the indication of unacceptable performance is auditory or visual, the indication is to remain active and conspicuous until the test equipment is reset manually.

d) When the test equipment is adjusted to produce the test voltage, and a resistance of 120,000 Ω is connected across the output, the test equipment is to indicate an unacceptable performance within 0.5 s. A resistance of more than 120,000 Ω is not prohibited from being used to produce an indication of unacceptable performance when the manufacturer elects to use a tester having higher sensitivity.

Exception: The sensitivity of the test equipment – and a lower value of resistance – is not prohibited from being used when testing an appliance intended to be permanently wired.

50.7 There shall not be any transient voltage applied to the FPDU under test that results in the instantaneous voltage applied to the FPDU exceeding 120 % of the peak value of the test voltage that the manufacturer elects to use for this test. This requirement applies for the entire duration of the test, including the time that the voltage is first applied to the FPDU and the time that the voltage is removed from the FPDU.

51 Grounding Continuity Test

51.1 Each FPDU shall be tested, as a routine production-line test, to determine grounding continuity between the grounding pin or terminal of the attachment plug and the accessible, dead-metal parts of the FPDU that become energized. The grounding contact of each receptacle, grounding pin of a supply-cord attachment plug, and other means for grounding on the load side are included in this test.

51.2 Compliance with 51.1 is determined by any appropriate device, such as an ohmmeter or a battery and buzzer combination, applied between the point of connection of the FPDU grounding means and the metal parts in question.

RATINGS

52 Details

52.1 A FPDU shall be rated in maximum AC current and AC voltage. The voltage rating shall not be higher than 250 V. The current rating shall not be higher than 20 A, the ampacity of the power-supply cord, nor the highest rating of the overcurrent protective device that is provided.

MARKINGS

53 Details

53.1 Unless otherwise indicated, all markings shall be clearly visible, readily legible, and placed on the outside of the enclosure in lettering not less than 3/32 in (2.4 mm) high.

53.2 Markings required by this standard shall be permanent. A permanent marking shall be molded, die-stamped, or paint-stenciled; stamped or etched metal that is permanently secured; or indelibly stamped on a pressure-sensitive label that complies with UL 969 or UL 969A or, provided on a cord tag that complies with 53.3. Ordinary usage, handling, storage, and the like of the unit are to be evaluated in determining whether a marking is permanent.

53.3 Markings may be on one of the following:

a) Printed on a doughnut-, flat-, or bracelet-type label.

b) Printed on a tag of tough paper, cloth, or the equivalent (of any color) having a hole large enough to accommodate the cord, and not resembling the shapes described in item c. The tag is not to be slit from the edge of the hole to the edge of the tag. The cord is to be passed through the hole in the tag prior to assembly to the FPDU.

c) Printed in a contrasting color on a background of a solid color other than blue, green, or yellow on one of the following:

1) A ring-shaped (doughnut) tag of tough paper, cloth, or the equivalent having a hole large enough to accommodate the cord. The tag is not to be slit from the edge of the hole to the edge of the tag. The cord is to be passed through the hole in the tag prior to the assembly to the FPDU.

2) A flag-type tag with an adhesive back. The tag is to be wrapped around and adhere to the cord, and the ends of the tag are to adhere to each other and project as a flag.

3) A bracelet wrapped around and affixed to the cord with an adhesive.

53.4 A tag in accordance with 53.3 used for markings required in Section 53, Details, shall be attached in a manner that it cannot be easily removed. The tag shall have the added marking in letters not less than 3/32 in (2.4 mm) high "Do not remove this tag."

53.5 A FPDU shall be marked with:

a) The manufacturer's name, trade name, trademark, or other descriptive marking by which the organization responsible for the product is identified;

b) The distinctive catalog number or equivalent;

c) The FPDU electrical rating in volts, amperes, and frequency; and

d) The date or other dating period of manufacture not exceeding any three consecutive months. Abbreviation of the date of manufacture complies with the intent of this requirement.

Exception: The date of manufacture that appears in a nationally-accepted conventional code or in a code affirmed by the manufacturer complies with the intent of this requirement when the code does not repeat in less than 10 years and does not require reference to the production records of the manufacturer to determine when the product was manufactured.

53.6 When a manufacturer produces or assembles a FPDU at more than one factory, each FPDU shall have a distinctive marking, that is not prohibited from being in code, by which it is identified as the product of a particular factory.

53.7 With regard to 16.8, a receptacle outlet or group of outlets of a FPDU shall be marked to indicate the rating of the overcurrent protective device that protects the receptacle outlet.

53.8 A receptacle outlet or group of outlets of a FPDU that is energized (relay or electronically activated) by the presence of a load in another outlet of the FPDU shall be marked to indicate that they are so controlled.

53.9 A switch employed on a FPDU, without an associated pilot light and as indicated in 18.3, shall be marked "on"/"off", "1"/"0", or the equivalent, to indicate to the user when the receptacles are energized when the FPDU is connected to a power-supply. The marking shall be either on the switch or on an adjacent part of the enclosure.

53.10 A FPDU having a fuse that is intended to be replaced in the field shall be marked to indicate the type, ampere, and voltage rating of the replacement fuse. In addition, the FPDU shall be marked with the word "WARNING" and the following or equivalent: "For continued protection against risk of fire, replace only with same type and rating of fuse." Lettering shall not be less than 3/32 in (2.4 mm) high. These markings shall be located adjacent to the fuseholder so as to be visible during fuse replacement.

53.11 A FPDU shall be marked to indicate that the product is intended for indoor use only, with the word "CAUTION:" and the following or equivalent: "To Reduce the Risk of Electric Shock – Use Only Indoors". Lettering shall not be less than 3/32 in (2.4 mm) high. This marking may appear on a cord tag that complies with Section 45, Test for Permanence of Cord Tag, permanently attached to the power supply cord.

53.12 A FPDU that incorporated terminals for secondary telecommunication equipment shall be marked to indicated "In" and "Out" or equivalent (such as "Wall", "Equip". or "Equipment") adjacent to the terminals.

53.13 A FPDU that incorporates terminals for coaxial cable (TV/CATV) connection shall be marked with (or provide on the smallest unit package) installation instructions for connection to the antenna system in accordance with NFPA 70 and shall comply with the antenna connection instruction requirements of UL 1492.

53.14 A FPDU that employs SPT-3 flexible cord for the power-supply cord shall be marked on the FPDU and on smallest unit package with the following or equivalent wording: "For Household Use Only".

53.15 A FPDU for use in a portable furnishing shall be marked "For use only in a portable furnishing." See 7.3.1.

53.16 A FPDU rated 15 A employing 2 – 4 receptacles and 16 AWG power supply cord without supplementary overcurrent protection shall be marked "Suitable for Household (Residential) use only." See note (g) of Table 13.1.

53.17 A FPDU with a retractable vertical tower shall be provided with the following marking and shall be visible when in the open position: "WARNING: To Reduce the Risk of Fire and Electric Shock – Unplug and remove all plugged in equipment before closing." or the equivalent.

Exception: The following marking may be used in place of the above marking if the FPDU with a retractable vertical tower complies with the requirements outlined in 8.7: "WARNING: To Reduce the Risk of Fire and Electric Shock – Route cord(s) away from track edge when closing tower. If the size of the cord/plug combination(s) prevents the tower from closing as intended, remove cord(s) before closing tower."

53.18 A FPDU as described in 6.8(a) shall be provided with installation instructions indicating that the FPDU is to be mounted on a single piece of furniture.

53.19 An FPDU that incorporates a molded-on or assembled-on hospital grade attachment plug or cord connector, a hospital grade power supply cord, or a hospital grade receptacle shall be marked with the following or equivalent wording: "CAUTION: Do not use Furniture Power Distribution Units in General Patient Care Areas or Critical Patient Care Areas. They have not been evaluated for use where Article 517 of the National Electrical Code requires Hospital Grade components."

53.20 The caution marking of 53.19 shall comply with 53.2 and be provided on a tag affixed to the FPDU power supply cord within 6 in (152 mm) of the attachment plug. The word CAUTION shall be a minimum of 9/64 in (3.6 mm) high and the remaining words shall be a minimum of 1/16 in (1.6 mm) high.

53.21 The cord tag of 53.20 shall be tear-resistant and shall comply with 53.22 and Section 45, Permanence of Cord Tag Test. The tag shall be permanently affixed to the cord.

Exception: A flag-type tag rated for the conditions of use and complying with the requirements for flag-type tags for use with cord sets and power supply cords is not required to be tested in accordance with Test for Permanence of Cord Tag, Section 45.

53.22 The cord tag of 53.20 shall be in either of the following forms:

a) A hang-type tag having a hole to permit securement to the cord by a plastic strap or equivalent. The strap shall not be removable without cutting; or

b) A flag-type tag with an adhesive back. The tag shall be wrapped around and adhere to the cord. The ends of the tag shall adhere to each other and project as a flag.

53.23 FPDU's as described in 6.8(c) shall be marked: "WARNING" and the following or the equivalent. "Timer could turn-on unexpectedly without the user being present. To Reduce the Hazardous Condition – Unplug the appliance that is plugged into the receptacle(s) controlled by the timer before servicing." Lettering shall not be less than 3/21 inch (2.4 mm) high. This marking shall be located adjacent to the timer so as to be visible during use.

53.24 A Class 2 lead or Class 2 separable interface shall be identified as being "Class 2" and marked with the output electrical rating. The "Class 2" and output electrical rating shall be permanently marked and visible after installation. The output electrical rating may be expressed in amperes and voltage, or wattage or in volt-ampere.

53.25 The output Class 2 connectors of receptacles with Class 2 integral power supplies shall be identified as being "Class 2" and marked with the output electrical rating. The output electrical rating shall be permanently marked and visible after installation of the FPDU enclosure or cover. The output electrical rating may be expressed in amperes and voltage, or wattage or in volt-ampere.

53.26 A FPDU as described in 7.1.15(b) shall be provided with a pressure-sensitive label that complies with UL 969, and marked "Do not remove this label" or equivalent wording.

53.27 A FPDU as described by 14.7 shall be marked with the phrase "Tamper Resistant" or the letters "TR". The letters "TR" shall be a minimum of 3/16 inch (4.8 mm) in height, placed on the device where visible after installation with the cover plate removed.

53.28 A FPDU with non-replaceable fuse shall be marked visible on the enclosure ″WARNING″ and the following or the equivalent statement: ″No User Serviceable Parts Inside″.

INSTRUCTIONS

54 Details

54.1 As required in note (i) of Table 13.1, the instructions shall include the following information or equivalent "A Furniture Power Distribution Unit provided with auxiliary lighting features is not for permanent installation. Do not remove the plug for permanent connection to the electrical system".

54.2 Installation instructions shall be provided with a Furniture Power Distribution Unit (FPDU).

54.3 When the FPDU manufacturer's web site is used to identify installation instruction information, the web address shall be marked on the FPDU, packaging and/or information sheet. The web address may be in the form of a Uniform Resource Locator (URL – http://www.___.com/___/), or as a Quick Response Code (QR code). The referenced web page shall be reviewed for accuracy and date of validation.

54.4 A FPDU as described in 7.1.15(b) shall include an installation instruction that identifies the location of the concealing blank label on the FPDU and instructs the installer to not remove the label.

54.5 A FPDU shall include in the instructions, packaging, or other literature accompanying the FPDU the following or equivalent wording: "A Furniture Power Distribution Unit is not for permanent installation as part of the building structure and not for mounting in a permanently-installed furnishing such as a fixed countertop.

54.6 A FPDU that incorporates a molded-on or assembled-on hospital grade attachment plug or hospital grade receptacle(s) shall include in the instructions, packaging, or other literature accompanying the FPDU the following or equivalent wording: "CAUTION: Do not use Furniture Power Distribution Units in General Patient Care (Category 2) Spaces or Critical Patient Care (Category 1) Spaces. They have not been evaluated for use where Article 517 of the National Electrical Code requires Hospital Grade components."

ANNEX A (normative) – FURNITURE POWER DISTRIBUTION UNITS INCORPORATING BATTERIES

INTRODUCTION

A1 Scope

A1.1 The requirements of this Annex address FPDU's incorporating non-rechargeable (primary) and rechargeable (secondary) batteries not exceeding 60 Vdc, 20 Ah.

A2 Glossary

A2.1 For the purposes of this Annex, the following definitions apply.

A2.2 BATTERY – General term for:

a) Any single cell, or

b) A group of cells connected together either in a series and/or parallel configuration.

c) The term "battery(ies)" shall refer to single or multicell batteries.

A2.3 BATTERY PACK – A single cell, or a group of cells connected together in a series and/or parallel configuration, with or without protective circuitry, which may be either:

a) Provided with its own protective enclosure and ready for installation and use as is by persons other than trained technicians; or

b) Incomplete in some manner such as not enclosed in a protective enclosure and installed as a component in the end product by a trained technician.

A2.4 BATTERY, PRIMARY – A battery that can only be discharged once. It is not designed to be electrically recharged and must be protected from a charging current.

A2.5 BATTERY, SECONDARY – A battery that is intended to be discharged and recharged many times in accordance with the manufacturer's recommendations.

A2.6 BATTERY, TRAINED TECHNICIAN-REPLACEABLE – A battery intended for use in a FPDU in which service and replacement of the battery will be done only by a person who has been trained to service and repair the product.

A2.7 CELL – The basic functional electrochemical unit containing an assembly of electrodes, electrolyte, container, terminals and separators, that is a source of electrical energy by direct conversion of chemical energy. Cells may be utilized as a component of a battery pack, or assembled within end products. Lithium ion cells are for replacement only by a trained technician.

A2.8 VENTING – A condition that occurs when the battery or cell releases excessive internal pressure in a manner intended by design to preclude rupture, explosion or self-ignition.

A3 General

A3.1 A battery powered FPDU circuit shall comply with requirements in UL 962A except as modified by the requirements of Annex A.

A3.2 A FPDU incorporating primary (non-rechargeable) batteries that are limited to a maximum of 15 watts total combined power under any condition of operation (Open Circuit, Loaded, and Short Circuit) and that meet the following requirements are not subjected to the performance tests:

a) AAAA, AAA, AA, C, D, or 9 V standardized single cell battery configurations, and

b) Are of a zinc-carbon, zinc-chloride, alkaline/manganese, or silver-oxide type composition.

A4 Battery Chargers and Circuits

A4.1 A battery charging circuit integral with the FPDU shall comply with UL 1310 or as a Power Limited Circuit (LPS) in accordance with UL 60950-1.

CONSTRUCTION

A5 Batteries

A5.1 General

A5.1.1 Safe operation of the FPDU shall not be dependent upon the condition of the battery(ies) or stored power in the battery(ies) or battery circuit.

A5.1.2 Batteries of a type other than specified in A3.2 shall comply with the requirements of UL 2054, if of the lead acid storage battery type, shall additionally comply with the Pressure Release Test, Flame Arrester and Vent Cap Tests in UL 1989.

A5.1.3 Rechargeable lithium-ion cells shall comply with the requirements for secondary lithium cells outlined in UL 1642. Rechargeable lithium-ion battery packs shall comply with the requirements for secondary battery packs outlined in UL 2054.

A5.1.4 A battery shall be located and mounted so that the terminals of cells will be prevented from coming into contact with terminals of adjacent cells unless designed to do so or with metal parts of the battery compartment as the result of shifting of the battery. Cells constructed of conductive material shall be installed in trays of nonconductive material.

A5.1.5 A battery shall be protected by an enclosure in accordance with Section 7, Enclosures, and with an enclosure or casing in accordance with UL 2054.

A5.2 Non-replaceable batteries

A5.2.1 A FPDU provided with batteries that are not intended to be replaced by the user shall be located within the FPDU enclosure and be non accessible to the user without disassembly of the enclosure. The FPDU shall be marked in accordance with A12.3 and provide instructions as specified in A13.1.

A5.3 Technician replaceable batteries

A5.3.1 A FPDU provided with batteries that are not intended to be replaced by the user shall be located within the FPDU enclosure and be non accessible to the user without disassembly of the enclosure. The FPDU shall be marked in accordance with A12.3 and provide instructions as specified in A13.1.

A5.4 User replaceable batteries

A5.4.1 User replaceable batteries shall require a tool to remove the batteries.

A5.4.2 A FPDU provided with a replaceable battery shall be marked as indicated in A12.1 and provided with instructions as specified in A13.2.

A5.5 Battery packs

A5.5.1 A battery pack shall comply with the enclosure and performance requirements in UL 962A and any additional requirements specified for the specific battery type.

A5.5.2 A Lithium-ion Battery Pack shall comply with the tests specified in A11.

A5.6 Lithium-ion battery cells or packs

A5.6.1 Compatibility between lithium-ion battery cells or packs, and the equipment including the charging system(s), shall be verified and documented by the equipment manufacturer. Verification documentation shall include:

a) The battery manufacturer's specifications noted in A5.6.2; and

b) A failure modes and effects analysis demonstrating that the battery manufacturer's specifications noted in A5.6.2 are not exceeded, as noted.

A5.6.2 The following specifications from the lithium-ion cell manufacturer shall not be exceeded in the equipment:

a) Rated charging current, charging voltage and cutoff current, with compliance verified in under normal and single fault conditions within the system;

b) Rated discharge current/rate and endpoint voltage, with compliance verified under normal and single fault conditions within the system;

c) Maximum charging current and charging voltage limit (established as part of the battery abnormal charging test of UL 2054), with compliance verified under double fault conditions within the system; and

d) The upper and lower ambient temperature ranges for charging and discharging.

A5.6.3 Equipment with a rechargeable lithium-ion battery pack, intended for installation and replacement by other than trained technicians, shall:

a) Be designed to prevent misalignment, reverse polarity, damage upon connection, and accessibility of insulated parts during use; and

b) Provide a battery securement means to prevent inadvertent disconnection or damage during use.

A5.6.4 Lithium-ion batteries required to provide a limited power source shall comply with the limited power test requirements of UL 2054.

A6 Battery Compartments

A6.1 A battery compartment with user replaceable batteries shall have no accessible contact with internal wiring or circuits in excess of Class 2 or LPS power levels. Accessibility is determined by the Enclosure Accessibility and Accessibility of Live Parts, Section 9.

A6.2 A technician replaceable battery compartment with internal wiring, circuits and components other than operating at a Class 2 or LPS power level shall be provided with a Caution Marking, see A12.2, to unplug the FPDU before replacing the batteries.

A6.3 A circuit operating above a Class 2 or LPS power level shall discharge any accessible electrical components in the battery compartment within 2 seconds; other than the battery. See Discharge Test A10.

A6.4 A battery compartment provided with replaceable batteries shall comply with Section 7, Enclosure.

A6.5 A FPDU that utilizes a battery that contains liquid or gel electrolyte shall be provided with a tray that is capable of retaining any liquid that could leak as a result of internal pressure build-up in the battery. The requirement to provide a battery tray does not apply if the construction of the battery is such that leakage of the electrolyte from the battery is unlikely.

A6.6 If battery tray is required, its capacity shall be at least equal to the volume of electrolyte of all the cells of the battery, or the volume of a single cell if the design of the battery is such that simultaneous leakage from multiple cells is unlikely.

A6.7 An enclosure or part of an enclosure that also serves as a compartment for a rechargeable vented battery shall be provided with ventilated openings to permit dispersion of gases from the battery.

A6.8 Battery polarity installation shall be shown in diagrammatic form in the battery compartment. Black conductor insulation shall be used for negative battery leads and red conductor insulation shall be used for positive battery leads if visible to the user or technician.

A7 Battery Circuits

A7.1 A current carrying conductor or component in the battery circuit shall be capable of carrying the full short circuit current of the battery without risk of fire or electric shock.

Exception: Suitable overcurrent protective devices rated for the available current shall be installed in the circuit.

A8 Battery Charging

A8.1 A FPDU with replaceable (secondary) rechargeable batteries where it is possible to install the batteries in reverse polarity and when so doing completes the battery circuit shall be provided with back feed protection. The back feed protection may be either integral with the battery charger or the battery charging circuit within the FPDU.

A8.2 The output characteristics of a battery charging circuit shall be compatible with its rechargeable battery. The FPDU manufacturer shall provide technical documentation on the compatibility of the rechargeable (secondary) battery with the battery charging circuit.

PERFORMANCE

A9 Temperature Test

A9.1 General

A9.1.1 The Temperature Test shall be conducted with the FPDU configured as described in the Temperature Test, Section 29. The temperatures shall comply with the limits as specified in Table 29.1. Batteries shall not exceed the battery manufactures temperature limits and battery chargers and charging circuits shall comply with Section A4 requirements.

A9.1.2 During the temperature test, the temperature of a surface that may be contacted by the user shall not be more than the value specified in Table A9.1. If the test is conducted at a room temperature of other than 25 °C (77 °F), the results are to be corrected to 25 °C (77 °F).

Table A9.1

Location	Composition of surface[a]			
	Metal		Nonmetallic	
Handles, knobs, enclosures that are grasped for lifting, carrying, or holding.	50 °C	(122 °F)	60 °C	(140 °F)
Handles or knobs that are contacted but do not involve lifting, carrying, or holding; and other surfaces subject to contact and user maintenance.	60 °C	(140 °F)	85 °C	(185 °F)
Surfaces other than a heating function surface and known to be hot due to proximity to the heating function surface.[b]	70 °C	(158 °F)	95 °C	(203 °F)

[a] A handle, knob, or the like, made of a material other than metal, that is plated or clad with metal having a thickness of 0.005 inch (0.127 mm) or less is considered to be, and is judged as, a nonmetallic part.

[b] Also refer to Table 29.2.

A9.2 Temperature test method I

A9.2.1 A FPDU with provision for installation of a battery shall be tested using the manufacturer's rated capacity charging and discharging specifications or as specified below if the manufacturers data is not provided. The battery is to be installed in the FPDU and tested in an ambient temperature of 25 ±5 °C (77 ±9 °F):

a) If the FPDU is provided with a zinc-carbon, zinc-chloride, alkaline/manganese, or silver-oxide type composition battery is to be discharged to 0.9 volts per cell – measured with the load connected.

b) If the FPDU is provided with a typical 1.2 volts per cell nickel cadmium or nickel metal hydride battery, each battery is to be discharged to 0.9 volts per cell – measured with the load connected.

c) If the FPDU is provided with a lithium-ion battery system the temperature test series as specified in UL 1642 shall be applied.

A9.2.2 The FPDU is to be energized and shall be under electrical load as specified in Section 28, Motorized or Self-Propelled Movable Parts, and the batteries shall be allowed to fully charge if of the rechargeable type.

A9.3 Temperature test method II

A9.3.1 A FPDU with provision for installation of a battery shall have new fully charged batteries installed. The FPDU shall be operated as specified in the Temperature Test, Section 29, with the maximum electrical load on the output of the battery circuit.

A9.4 Temperature test method III

A9.4.1 A FPDU with provision for installation of a battery shall have new fully charged batteries installed. The FPDU shall be disconnected from the primary power source with the maximum electrical load on the output of the battery circuit.

A10 Discharge Test

A10.1 To determine compliance with A6.3 the FPDU shall be tested as described in A10.2 – A10.3.

A10.2 The FPDU shall be operated until all electrical storage products (capacitors and the like) are fully charged.

A10.3 The battery shall be removed and the time it takes for the circuit to fully discharge (no current flow in the circuit) shall not exceed 2 seconds. All accessible electrical circuits in the battery compartment shall be measured.

A11 Lithium-ion Batteries

A11.1 Lithium-ion battery abnormal tests

A11.1.1 During abnormal testing specified in this standard which may affect the temperature of a lithium-ion battery, the battery shall not result in any of the conditions specified in A11.1.3. Blocked ventilation and disconnected fan are among the abnormal conditions that may affect battery temperature. In addition, specific abnormal testing for determining effects on the lithium-ion battery shall be performed in accordance with A11.1.2.

Exception: Testing in accordance with A11.1.2 is not required if:

a) The testing has been addressed by prior evaluation of the battery, or

b) Circuit analysis demonstrates that the limits outlined in A5.6.2 will not be exceeded in the equipment and that the equipment does not present a hazard under the conditions.

A11.1.2 The combination of battery pack, charger and equipment shall be operated under the following abnormal conditions.

a) Operated in charging mode with a fully discharged battery, under simulation of component faults likely to result in charging parameters outside the battery specifications as outlined in A5.6.2. Components may be opened or short circuited as a test condition. Each fault condition test shall be operated continuously for 7 hours or until ultimate results are obtained.

Note: Some types of protectors such as PTCs may allow "let through" current under operation, which may result in low-level charging and potential overcharge. For these situations, sufficient test time shall be allowed to obtain ultimate results.

b) Operated in discharging mode with a fully charged battery, under simulation of single component faults likely to result in discharging conditions outside the battery specifications as outlined in A5.6.2. Components may be opened or short circuited as a test condition. Each fault condition test shall be operated until the battery case temperatures begin to decrease.

c) Operated in discharging mode with a fully charged battery, under the equipment operating conditions representing foreseeable overloading of the battery pack. These conditions may include motor running overload, motor stalled rotor, short-circuiting of any battery loads, USB outputs, including motors or lamps, operation from any settings of user controls, and similar conditions. Each test condition shall be operated until the battery case temperatures begin to decrease.

d) Operated in charging mode under the most severe battery conditions and under the equipment operating conditions representing foreseeable force charging of the battery pack. These equipment operating conditions may include operation resulting from any user adjustable voltage settings or similar conditions. Each test condition shall be operated for 7 hours.

A11.1.3 The tests shall not result in any of the following:

a) Identification of a battery condition in the equipment that is outside the specifications as outlined in A5.6.2;

b) Chemical leaks caused by cracking, rupturing or bursting of the cell casing or battery pack enclosure;

c) Explosion resulting in a cell casing or battery pack enclosure violently opening;

d) Or components of the cell or battery pack being forcibly expelled;

e) Emission of flame or expulsion of molten metal to the outside of the battery pack or equipment enclosure; or

f) Any other conditions in the equipment that could result in a fire, explosion or other hazard.

A11.2 Impact tests

A11.2.1 A FPDU with a removable battery pack shall be subjected to the impact tests as specified in Section 38 both with the battery pack installed and with the battery pack removed from the FPDU.

A11.2.2 The battery pack shall be subjected to the impact tests specified in Section 38 when separated from the FPDU. The tests shall not result in any of the following:

a) Identification of a battery condition in the equipment that is outside the specifications as outlined in A5.6.2;

b) Chemical leaks caused by cracking, rupturing or bursting of the cell casing or battery pack enclosure;

c) Explosion resulting in a cell casing or battery pack enclosure violently opening;

d) Or components of the cell or battery pack being forcibly expelled;

e) Emission of flame or expulsion of molten metal to the outside of the battery pack

Note: Care shall be taken when opening the enclosure as the fully charged cells may explode or catch fire as a result of damage that may have occurred from the drops.

A12 Markings

A12.1 A FPDU with a replaceable battery shall be marked where visible to the individual replacing the battery with the type of battery to be used as follows: "WARNING:" and following or equivalent wording: "Replace only with (Manufacturer) (voltage) type battery, risk of fire or explosion if battery is replaced by an incorrect type. See Instructions." or an equivalent statement.

A12.2 For FPDU with circuits as described in A6.2 and A6.3, the product shall be marked adjacent to the battery compartment; "WARNING" and the following or the equivalent – "Risk of Shock – Unplug the FPDU before replacing batteries".

A12.3 A FPDU with non replaceable or trained technician replaceable batteries shall be marked visible to the user adjacent to the battery compartment "WARNING" and the following or the equivalent. "No User Serviceable Parts Inside."

A13 Installation and Operation Instructions

A13.1 FPDU with non replaceable batteries shall inform the user in the instructions that the product has no user serviceable parts inside and the company should be contacted for service.

A13.2 FPDU that incorporates a replaceable battery shall include in the instructions accompanying the FPDU the following or equivalent wording “WARNING”:

a) "For use only with battery packs specified by the manufacturer" or an equivalent statement.

b) "When battery pack is not in use, keep it away from other metal objects, like paper clips, coins, keys, nails, screws or other small metal objects, that can make a connection from one terminal to another. Shorting the battery terminals together may cause burns or a fire" or an equivalent statement.

c) "Under abusive conditions, liquid may be ejected from the battery; avoid contact. If contact accidentally occurs, flush with water. If liquid contacts eyes, seek medical help. Liquid ejected from the battery may cause irritation or burns" or an equivalent statement.

d) "Do not mix old and new batteries" or an equivalent statement.

e) "Do not mix non rechargeable and rechargeable batteries" or an equivalent statement

A13.3 FPDU with technician replaceable batteries shall inform the user in the instructions of the following or the equivalent – "Risk of fire or explosion – only trained technicians should service or replace these batteries".

A13.4 A FPDU provided with or utilizing Lithium-ion batteries shall provide the following information:

a) The operating instructions for a product incorporating or specified for use with a lithium-ion battery shall provide appropriate information regarding battery charging, use and storage temperature limits. The operating instructions shall include the appropriate charging system and charging methods.

b) The operating instructions of a product that employs a lithium-ion battery intended for replacement and installation by the user shall provide the user with complete instructions as to how to safely replace and dispose of a used battery.

c) The instructions shall include the following "WARNING" or equivalent: "Do not incinerate."

d) The operating instructions of a product that employs a lithium-ion battery not intended for replacement by the user shall provide the user with complete instructions on safe disposal of the product.

ANNEX B (normative) – FURNITURE POWER DISTRIBUTION UNITS FOR CLUSTERED SEATING

INTRODUCTION

B1 Scope

B1.1 The requirements of this Annex cover indoor-use-only furniture power distribution units (FPDUs) for fixed mounting to stationary clustered seating in accordance with Article 518 of NFPA 70, and to stationary clustered seating in similar venues intended for fewer than 100 persons.

B1.2 An FPDU for clustered seating is supplied by one cord-and-plug connection to a permanently-installed receptacle on a branch circuit rated 250 V AC or less and 20 Amperes or less in accordance with NFPA 70.

B1.3 An FPDU for clustered seating is only intended to provide power for cord-and-plug-connected electrical utilization equipment such as a lap top, cell phone etc., to seated travelers.

B1.4 An FPDU for clustered seating consists of a primary enclosure providing cord-and-plug connection to a permanently-installed receptacle, supplementary overcurrent protection and one or more outlets. An FPDU for cluster seating may be interconnected to subordinate enclosures up to the available maximum cord-and-plug load (amperes) of the branch circuit overcurrent protective device and permanently-installed receptacle outlet. See NFPA 70, Table 210.21(B)(2) for details.

B1.5 An FPDU for clustered seating may include receptacles with integral power supply with Class 2 output connector(s).

B1.6 The requirements of this Annex also address separable interconnecting cords and separable power supply cords intended for use only with FPDUs for clustered seating and customizable in length and in connection for various seating cluster arrangements.

B1.7 An FPDU for clustered seating shall not serve as fixed wiring of a structure.

B1.8 An FPDU that is intended for mounting on top of or to any flush work surface, countertop or table of a structure or of a portable, relocatable, or stationary furnishing, including adjacent or behind work surfaces or countertops of clustered seating, is not covered by this Annex. An FPDU intended for such a purpose is covered by this Standard.

B1.9 An outlet of an FPDU for cluster seating shall not be used to power an FPDU that is mounted on top of or to any flush work surface, countertop or table of a structure or of a portable, relocatable, or stationary furnishing.

B1.10 A FPDU for clustered seating with one or receptacle outlets and that employs an electromagnetic interference filter is covered under this Annex.

B1.11 A FPDU for clustered seating with one or more receptacle outlets and that employs a surge protective device (SPD) is covered under this Annex.

B2 Glossary

B2.1 For the purposes of this Annex, the following definitions apply.

B2.2 CLUSTERED SEATING – Stationary furnishings that provide seats in a mechanically-interconnected arrangement to one another not reconfigurable by users and that are inseparable from one another except by the use of tools. The seating is not affixed to the building structure. Clustered seating does not provide facing work surfaces or countertops but may incorporate adjacent side or rear mounted work surfaces.

B2.3 POWER SUPPLY CORD –A length of flexible cord with an attachment plug at one end and individual insulated conductors intended for termination within an FPDU enclosure. It may have additional components such as an integral strain relief bushing or individual terminals.

B2.4 INTERCONNECTING CORD – A length of flexible cord terminated between two FPDU enclosures.

B2.5 PRIMARY FPDU ENCLOSURE – The FPDU enclosure intended for direct connection to the branch circuit receptacle outlet and which contains the primary supplementary overcurrent protection device and the non-detachable power supply cord. The primary FPDU enclosure may also be interconnected to subordinate FPDU enclosures.

B2.6 SUBORDINATE FPDU ENCLOSURE – The FPDU enclosure(s) for connection to the primary FPDU enclosure and not intended for direct cord connection to the branch circuit receptacle outlet.

B2.7 PRIMARY SUPPLEMENTARY OVERCURRENT PROTECTION – Any replaceable or manually-resettable type device such as a fuse or circuit breaker, intended to provide supplementary overcurrent protection, to the power circuit of the primary FPDU enclosure and to all interconnected subordinate enclosures.

B2.8 SUBORDINATE SUPPLEMENTARY OVERCURRENT PROTECTION – Any replaceable or manually-resettable type device such as a fuse or circuit breaker, intended to provide supplementary overcurrent protection, to the receptacle outlet(s) contained within each individual FPDU enclosure.

B3 General

B3.1 A FPDU for clustered seating shall comply with requirements in UL 962A except as modified by the requirements of Annex B.

B3.2 The NEMA configurations of various attachment plug and receptacle combinations referenced in this Annex are in accordance with NEMA WD6, and are included for ease of reference.

B3.3 Receptacle outlets of a FPDU for clustered seating shall comply with UL 498.

B3.4 Receptacle outlets of an FPDU for clustered seating that employ an electromagnetic interference filter shall also comply with UL 1283.

B3.5 Receptacle outlets of an FPDU for clustered seating that employ a surge protective device shall also comply with UL 1449, applicable to SPD Type 3.

B3.6 A FPDU for clustered seating that employs an integral Class 2 lead and mating Class 2 separable interface, or an integral power supply with one or more Class 2 output connector(s), or receptacles with integral power supplies with Class 2 output connectors shall also comply with Supplement SE of UL 498.

B4 Use

B4.1 The non-detachable power supply cord and interconnecting cords of an FPDU for clustered seating shall be protected from pedestrian traffic. The non-detachable power supply cord and interconnecting cords of an FPDU for cluster seating shall be located and positioned to prevent damage to the flexible cord.

B4.2 The FPDU for clustered seating may be comprised of:

a) A single FPDU enclosure with one non-detachable power supply cord for direct cord-and-plug connection to a permanently-installed branch circuit receptacle outlet, or

b) A primary FPDU enclosure with one non-detachable power supply cord for direct cord-and-plug connection to a permanently-installed branch circuit receptacle outlet and one or more subordinate

FPDU enclosures supplied by either separable or non-separable interconnecting cords of maximum lengths as specified in this Annex. The interconnection(s) may be arranged as a series, branch, star, or ring.

B4.3 The non-detachable power supply cord of a primary enclosure of a FPDU for clustered seating is not intended to be connected to any extension cord, relocatable power tap or to any other device or equipment, other than plugged-into a permanently installed branch circuit receptacle outlet.

B4.4 An FPDU for clustered seating is only intended to supply power to a travelers' cord-and-plug-connected portable utilization equipment.

B4.5 An FPDU for clustered seating shall only employ receptacle outlets of the NEMA 5-15R, 6-15R, 5-20R, or 6-20R configurations. Class 2 power supply connection(s) are permitted to employ integral output lead(s) and/or output connector(s).

B4.6 Separable Interconnecting cords of an FPDU for clustered seating shall employ only grounding-type configurations other than NEMA 5-15P, 5-15R, 6-15P, 6-15R, 5-20P, 5-20R, 5-20RA, 6-20P, 6-20R, 6-20RA, L5-15P, L5-15R, L6-15P, L6-15R, L5-20P, L5-20R, L6-20P, or L6-20R configurations.

B4.7 Separable Interconnecting cords of an FPDU for clustered seating employing configurations shown in UL 60320-1, are not permitted.

B4.8 The enclosure of an FPDU for clustered seating is intended to be permanently mounted to the seating and shall require the use of a tool for removal. The enclosure of FPDU for clustered seating shall be positioned and located so they are protected from pedestrian traffic.

B4.9 An FPDU for clustered seating is not intended to be placed directly upon the floor of a travelers' waiting space.

B4.10 An FPDU for clustered seating are intended for fixed mounting to relocatable clustered seating solely in the orientation(s) and location(s) on the furnishing indicated in the FPDU manufacturer's installation instructions.

B4.11 An FPDU for clustered seating is not intended for mounting on top of or flush with any work surface, countertop or table of a structure or of a portable, relocatable, or stationary furnishing, including adjacent or behind work surfaces or countertops of clustered seating.

CONSTRUCTION

B5 General

B5.1 The construction of a FPDU for clustered seating shall comply with all construction requirements in UL 962A Sections 7 – 26 except as modified by the construction requirements of this Annex.

B5.2 A FPDU for clustered seating shall be provided with primary supplementary overcurrent protection at the primary FPDU enclosure to protect the entire FPDU power circuit. A FPDU that has capability to interconnect its primary FPDU enclosure to one or more subordinate FPDU enclosures may also be provided with supplementary overcurrent protection to protect the receptacle(s) contained within the primary FPDU enclosure.

B5.3 A FPDU for clustered seating that has capability to interconnect its primary FPDU enclosure to one or more subordinate FPDU enclosures shall also be provided with supplementary overcurrent protection at the each additional FPDU enclosure to protect the receptacle(s) contained in each subordinate FPDU enclosure.

B5.4 Table B5.1 for FPDUs for clustered seating and associated non-detachable power-supply cord and separable and non-separable interconnecting cords supersedes Table 13.1 in UL 962A.

Table B5.1
Guide to Construction and Performance Requirements of Furniture Power Distribution for Clustered Seating

FPDU current rating (A)	Minimum Power-supply cord Size (AWG)	Power-supply cord plug rating (A)	Maximum primary supplementary OCP [a,b,c] (A)	Minimum internal wiring size (AWG)	Maximum receptacle outlet rating (A)	OCP [d,e] (A)	Minimum interconnect cord size (AWG)	Minimum rating of detachable interconnecting cord connections (A)
15	14	15	15	14	15	12	14	15
20	12	20	20	12	20	16	12	20

[a] Primary supplementary OCP shall not trip when the FPDU for clustered seating is operated at the FPDU-marked rated current.

[b] Maximum rating. A primary supplementary OCP rated less than the Maximum Primary Supplementary OCP rating and not less than rating complies with the intent of this requirement. See footnote (a) above.

[c] The primary supplementary OCP is not prohibited from being bypassed when nuisance tripping occurs during the Temperature Test. If primary supplementary OCP is bypassed during the Temperature Test at Temperature Test Load rating, then the Temperature Test needs to be repeated at FPDU rating to the primary supplementary OCP does not nuisance trip at this level. See footnote (a) above.

[d] Subordinate supplementary OCP shall not trip when the FPDU for clustered seating is operated at the receptacle-marked rated 53.7.

[e] The subordinate supplementary OCP is not prohibited from being bypassed when nuisance tripping occurs during the Temperature T If the subordinate supplementary OCP is bypassed during the Temperature Test at Temperature Test Load rating, then the Temperature Test needs to be repeated at rating to confirm that the subordinate supplementary OCP does not nuisance trip at this level. See 53.7 and footnote (d) above.

B6 Enclosure

B6.1 Nonmetallic

B6.1.1 A polymeric enclosure or the polymeric portion of an enclosure of a FPDU for clustered seating shall comply with the flammability requirements in UL 746C, for stationary equipment, and shall not be marked in accordance with 53.15.

B6.1.2 The enclosure shall comply with the strain relief, impact, crush and mold stress-relief test requirements of Sections 36, 38, 39 and 42 respectively, of this standard.

B6.1.3 A decorative feature or mounting means of a FPDU for clustered seating that is constructed of polymeric material and does not function as an enclosure of live parts shall comply with the flammability requirements for an enclosure material as identified in UL 746C, for non-attended, non-intermittent duty portable equipment.

Exception: Decorative parts are not required to be made of a material classed 5VA, 5VB, V-0, V-1, V-2, or HB, providing the part does not occupy a volume greater than 2 cubic centimeters (0.122 cubic inch), does not have any dimension greater than 3 cm (1.18 inch), and is located so it cannot propagate flame from one area to another or bridge between a possible source of ignition and other ignitable parts.

B6.1.4 A polymeric enclosure portion of a FPDU that houses solely an electrical part that is supplied from an isolated power supply of less than 42.4 volts AC or less than 60 volts DC shall comply with the flammability requirements for an enclosure material as identified in UL 746C, for non-attended, non-intermittent duty portable equipment.

B6.2 Metallic

B6.2.1 A metal enclosure of a FPDU shall have a minimum thickness in accordance with Table B6.1.

Table B6.1
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	
	inch	(mm)	inch	(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)

B6.2.2 The enclosure shall comply with the strain relief, impact, and crush test requirements of Sections 36, 38 and 39 respectively, of this standard.

B7 Enclosure Accessibility and Accessibility of Live Parts

B7.1 The electrical parts of a FPDU for clustered seating shall be located or enclosed so that persons are protected against inadvertent contact with uninsulated live parts.

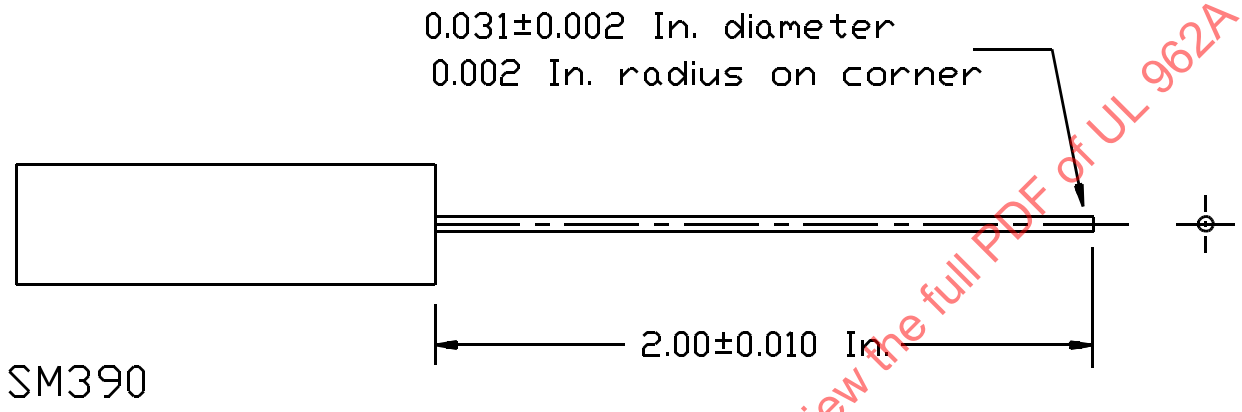
Exception: Connectors and contacts supplied by an isolated secondary circuit meeting Class 2 or Limited Power Source (LPS) power levels may be accessible to the user.

B7.2 An opening in the enclosure of a FPDU for clustered seating shall not permit contact to be made between the probe shown in Figure B7.1 to any live part contained within the enclosure or through the receptacle outlet slots. Compliance is determined by the small test probe shown in Figure B7.1 and Accessibility Tests, Section 44.

B7.3 The probe shall be applied to any depth in the enclosure opening permits and to each outlet slot openings of the receptacle with a force of 8 ounces (2.2 N) in an attempt to contact live parts. The probe shall be rotated or angled before, during, and after insertion through the opening to any position that is required to examine the enclosure or receptacle outlet slot opening. The probe shall be applied in any possible configuration; and, when necessary, manipulated in any orientation that may permit access to live parts.

Figure B7.1

Small Test Probe



MATERIAL: Tool Steel, Rockwell Hardness C58 to C60

inch	0.031 ±0.002	2.00 ±0.010
mm	0.787 ±0.051	50.8 ±0.25

B8 Mounting Means

B8.1 A FPDU for clustered seating shall be provided with a mounting means.

B8.2 The mounting means shall comply with Section 35, Mounting Hole Barrier Test, and Section B16, Adequacy of Mounting Test.

B8.3 Adhesive alone shall not be used as the securing means to mount an FPDU enclosure for clustered seating.

B8.4 A FPDU for clustered seating shall be mounted on or under seating, or on, under, or inside an adjacent side or rear mounted work surface, and shall comply with the Spill Test, Section B17, when mounted in all enclosure mounting orientations and location types specified in the manufacturer's installation instructions.

B9 Power-Supply and Interconnecting Cords

B9.1 General

B9.1.1 The power-supply and interconnecting cords of FPDUs for clustered seating shall have a voltage rating not less than the rated voltage of the FPDU and the minimum conductor size of the power-supply cord and interconnecting cords shall be as indicated in Table B5.1.

B9.1.2 The power-supply and interconnecting cords of FPDUs for clustered seating shall be of the grounding type and shall employ one of the following flexible cord Types: SJ, SJT, SJE, SJO, SJTO, SJEO or equivalent. FPDUs for clustered seating shall not employ Type SPT-3 flexible cord.

B9.1.3 A FPDU for clustered seating shall employ a non-detachable power-supply cord and either a detachable or non-detachable interconnecting cords. The minimum ampere rating of the attachment plug of a detachable interconnecting cord and interconnecting flanged outlet on an enclosure of a FPDU for clustered seating shall be as indicated in Table B5.1. The minimum ampere rating of the cord connector of a detachable interconnecting cord and interconnecting inlet on an enclosure of a FPDU for clustered seating shall be as indicated in Table B5.1.

B9.1.4 Using the longest linear path of flexible cord from the non-detachable power-supply cord plug to the farthest subordinate enclosure of the FPDU as identified by the manufacturer, the maximum cumulative length of the power-supply cord and interconnecting cords – as measured from the outside surface of the farthest subordinate enclosure of the FPDU to the plane of the face of the attachment plug – shall not exceed 50 ft (15.2 m).

B9.2 Power-supply cord

B9.2.1 The length of a non-detachable power-supply cord of a FPDU for clustered seating – as measured from the outside surface of the primary enclosure of the FPDU to the plane of the face of the attachment plug – shall not exceed 25 ft (7.6 m) nor be less than 1.5 ft (0.46 m).

B9.2.2 The attachment plug of the non-detachable power-supply cord shall be either molded-on or assembled-on to the flexible cord. The attachment plug shall be of a grounding-type, rated either 15- or 20-amperes, 125- or 250-volts and of the NEMA WD6 configuration 5-15P, L5-15P, 6-15P, L6-15P, 5-20P, L5-20P, 6 20P, or L6-20P only.

B9.2.3 The attachment plug of the non-detachable power-supply cord shall comply with the requirements in UL 498 or UL 817. A molded-on or assembled-on attachment plug may be of the hospital grade type complying with either UL 817 or UL 498 Supplement SC respectively, except the FPDU shall be marked in accordance with UL 962A, 53.19.

B9.3 Interconnecting cords

B9.3.1 The requirements of UL 962A, 13.1.8 do not apply. See B9.1.4 for the length of an interconnecting cord.

B9.4 Interconnection plugs and cord connectors

B9.4.1 The attachment plug and cord connector of a detachable interconnecting cord of a FPDU for clustered seating shall be either molded-on or assembled-on to the flexible cord and comply with either UL 817 or, for an assembled-on attachment plug, UL 498.

B9.4.2 The attachment plug and cord connector of a detachable interconnecting cord of a FPDU for clustered seating shall be of a grounding-type and of a configuration other than NEMA 5-15P, 5-15R, 6-15P, 6-15R, 5-20P, 5-20R, 5-20RA, 6-20P, 6-20R, or 6-20RA, L5-15P, L5-15R, L6-15P, L6-15R, L5-20P, L5-20R, L6-20P, or L6-20R. Configurations shown in UL 60320-1, are not permitted.

Exception: A non-standard attachment plug and connector configuration is not prohibited from being employed in a detachable interconnecting cord of a FPDU for clustered seating, provided the attachment plug and connector also complies with the requirements of B9.4.1 and B9.4.3.

B9.4.3 The attachment plug and cord connector of a detachable interconnecting cord of a FPDU for clustered seating shall be rated not less than the attachment plug of the non-detachable power-supply cord and be capable of current rupture under its full rated load rating.

B9.5 Interconnection inlet and outlet

B9.5.1 The interconnecting inlet and outlet shall be permanently attached to the enclosure of a FPDU for clustered seating.

B9.5.2 The interconnecting inlet and outlet shall comply with UL 498.

B9.5.3 The interconnecting inlet and outlet shall not be rated less than the attachment plug of the power-supply cord and be capable of current rupture under its full rated load rating.

B9.5.4 The interconnecting inlet and outlet shall be of the grounding-type and of a configuration other than NEMA 5-15P, 5-15R, 6-15P, 6-15R, 5-20P, 5-20R, 5-20RA, 6-20P, 6-20R, or 6-20RA, L5-15P, L5-15R, L6-15P, L6-15R, L5-20P, L5-20R, L6-20P, or L6-20R. Configurations shown in UL 60320-1, are not permitted.

Exception: A non-standard interconnecting inlet and outlet configuration is not prohibited from being used, provided the outlet and inlet complies with the requirements of B9.5.2, B9.5.3 and B9.5.5.

B9.5.5 The interconnecting inlet and outlet shall employ a latch, locking collar or the alike to prevent unintentional separation. Compliance is checked by Section B18, Latching Test.

B9.6 Bushings

B9.6.1 At a point where a flexible cord passes through an opening in an enclosure there shall be a bushing or the equivalent that shall be secured in place and shall have a smooth, well-rounded surface against which the cord may bear. If the enclosure is metal, an insulating bushing shall be provided. The heat- and moisture-resistant properties of the bushing material shall be such that the bushing is acceptable for the particular application.

B10 Supplementary Overcurrent Protection

B10.1 General

B10.1.1 A FPDU for clustered seating shall comply with Supplementary Protection, Section 16.

B10.2 Primary supplementary overcurrent protection

B10.2.1 The primary enclosure of the FPDU for clustered seating shall be provided with supplementary overcurrent protection to a maximum rating indicated in Table B5.1. The primary supplementary overcurrent protection shall provide protection to the power circuit of the primary enclosure of the FPDU for clustered seating and to the power circuit of all interconnected subordinate enclosures.

B10.2.2 The supplementary protection device of the primary enclosure of the FPDU for clustered seating shall not open during the Temperature Test, Section B14.

Exception: The OCP is not prohibited from being bypassed when nuisance tripping occurs during the Temperature Test. If the OCP is bypassed during the Temperature Test at Temperature Test Load rating, then the Temperature Test needs to be repeated at FPDU rating to confirm that the OCP does not

nuisance trip at this level. OCP shall not trip when the FPDU is operated at the FPDU-marked rated current.

B10.3 Subordinate supplementary overcurrent protection

B10.3.1 The subordinate enclosures of the FPDU for clustered seating shall be provided with subordinate supplementary overcurrent protection to a maximum rating indicated in Table B5.1.

B10.3.2 The subordinate enclosures of the FPDU for clustered seating shall provide supplementary overcurrent protection to the receptacle outlets. The supplementary overcurrent protective device shall not exceed the ampere rating of the attachment plug of the power-supply cord or the receptacle outlets, whichever is less.

B10.3.3 The electrical rating of the supplementary overcurrent protective device shall be marked on the enclosure. See UL 962A, 53.7 for details.

B10.3.4 The subordinate supplementary protection device of the primary enclosure of the FPDU for clustered seating shall not open during the Temperature Test, Section B14, when that enclosure of the FPDU for clustered seating is operated at the subordinate OCP rating marked in accordance with UL 962A, 53.7.

B11 Internal Wiring

B11.1 Internal Wiring shall comply with UL 83; UL 44; UL 758; or UL 62.

B11.2 The minimum conductor size of the internal wiring of a FPDU for clustered seating shall be as indicated in Table B5.1. The internal wiring of a FPDU shall be rated for the voltage, temperature, and other conditions of use.

B12 Receptacles for Connection to Utilization Equipment

B12.1 All receptacle outlets employed in a FPDU for clustered seating shall comply with flush receptacle requirements contained in UL 498.

B12.2 All receptacle outlets employed in a FPDU for clustered seating shall be of the tamper-resistant type and shall comply with the tamper resistant receptacle requirements contained in UL 498.

B12.3 The receptacle outlets employed in a FPDU for clustered seating shall be of a grounding-type, rated either 15- or 20-amperes, 125- or 250-volts, and of the NEMA WD6 configurations 5-15R, 6-15R, 5-20R, 5-20RA, 6-20R, or 6-20RA only.

B12.4 The receptacle outlets shall have a current rating of either 15 or 20 A and a voltage rating of 125 or 250 V. The receptacle outlet(s) shall have a voltage and current rating equal to that of the attachment plug on the power-supply cord. All of the receptacle outlets of a FPDU for clustered seating, both on the primary enclosure and on any subordinate enclosure, shall have the same current and voltage rating.

Exception: A 15 A receptacle is not prohibited from being used with a FPDU with a 20 A attachment plug, provided that all of the receptacle outlets of a FPDU for clustered seating are so rated.

B12.5 The grounding contact of the receptacle outlet shall comply with the requirements of the Grounding Contact Test in UL 498 applicable to flush receptacles having a 5-15R, 5-20R, 5-20RA, 6-15R, 6 20R, or 6-20RA configuration.

B12.6 Receptacle outlets of a FPDU may employ hospital grade receptacles complying with UL 498, Supplement SC but the FPDU shall be marked in accordance with UL 962A, 53.19.

B12.7 The receptacle outlets, shall comply with the Spill Test, Section B17, when mounted in all enclosure mounting orientations and location types specified in the manufacturer's installation instructions.

Exception: When the FPDU for clustered seating is provided with a portable GFCI Class A that complies with UL 943 and the GFCI is located at the attachment plug or within 12 in (305 mm) of the attachment plug, compliance with the spill test is not required.

B12.8 The primary enclosure and any subordinate enclosures of a FPDU for clustered seating may each be provided with maximum of six receptacle outlets.

PERFORMANCE

B13 General

B13.1 A FPDU for clustered seating shall comply with the performance requirements in UL 962A, Sections 27 – 51, except as modified by this Annex.

B14 Temperature Test

B14.1 A FPDU for clustered seating shall be subjected to the temperature test described in B14.2 – B14.5 and UL 962A, 29.6 – 29.14.

B14.2 A supplementary overcurrent protective device shall not open the circuit during the temperature test specified in B14.4 or B14.5. If the supplementary overcurrent protective devices open during the test, the supplementary overcurrent protective devices shall be bypassed and the Temperature Test shall be repeated at FPDU rating to confirm that the supplementary overcurrent protective device does not trip at this level. Supplementary overcurrent protective devices shall not trip when the FPDU is operated at the FPDU-marked rated current.

B14.3 The temperature of a FPDU for clustered seating, tested under the conditions of Table B5.1 shall not adversely affect any materials employed, or exceed the temperatures indicated in Table 29.1.

B14.4 For a FPDU for clustered seating shall be loaded to the FPDU's rated current specified in the Table B5.1 by connecting a resistive load by means of a solid-blade attachment plug to the last receptacle outlet of the FPDU enclosure farthest from the FPDU power-supply cord and any other receptacle that attains higher temperatures as determined by their proximity to heat-producing components.

B14.5 For a FPDU for clustered seating providing Subordinate Supplementary Overcurrent Protection, each FPDU enclosure shall be loaded to its receptacles' current rating marked in accordance with 53.7 until the FPDU is loaded to the FPDU's full rated current specified in the Table B5.1. Loading is achieved by connecting resistive loads by means of solid-blade attachment plugs to the last receptacle of the FPDU enclosure farthest from the FPDU power-supply cord and receptacle of any other FPDU enclosure that attains higher temperatures as determined by their proximity to heat-producing components.

B15 Fault Current Test

B15.1 General

B15.1.1 When required by UL 962A, 22.3, three samples of previously untested FPDUs are to be subjected to the Fault Current Test as described in UL 962A, 33.1.2, 33.1.3, and 33.2.1. The FPDU shall comply with the requirements in UL 962A, 33.1.3. Each FPDU shall be tested once.

B16 Adequacy of Mounting Test

B16.1 Static mechanical load test

B16.1.1 To determine compliance with UL 962A, 40.2 and 40.3, a sample of the FPDU for clustered seating is to be mounted in the most severe mounting configuration and orientation on any secure surface in each of the mounting configurations and orientations specified in accordance with manufacturer's installation instructions.

B16.2 Abrupt pull test

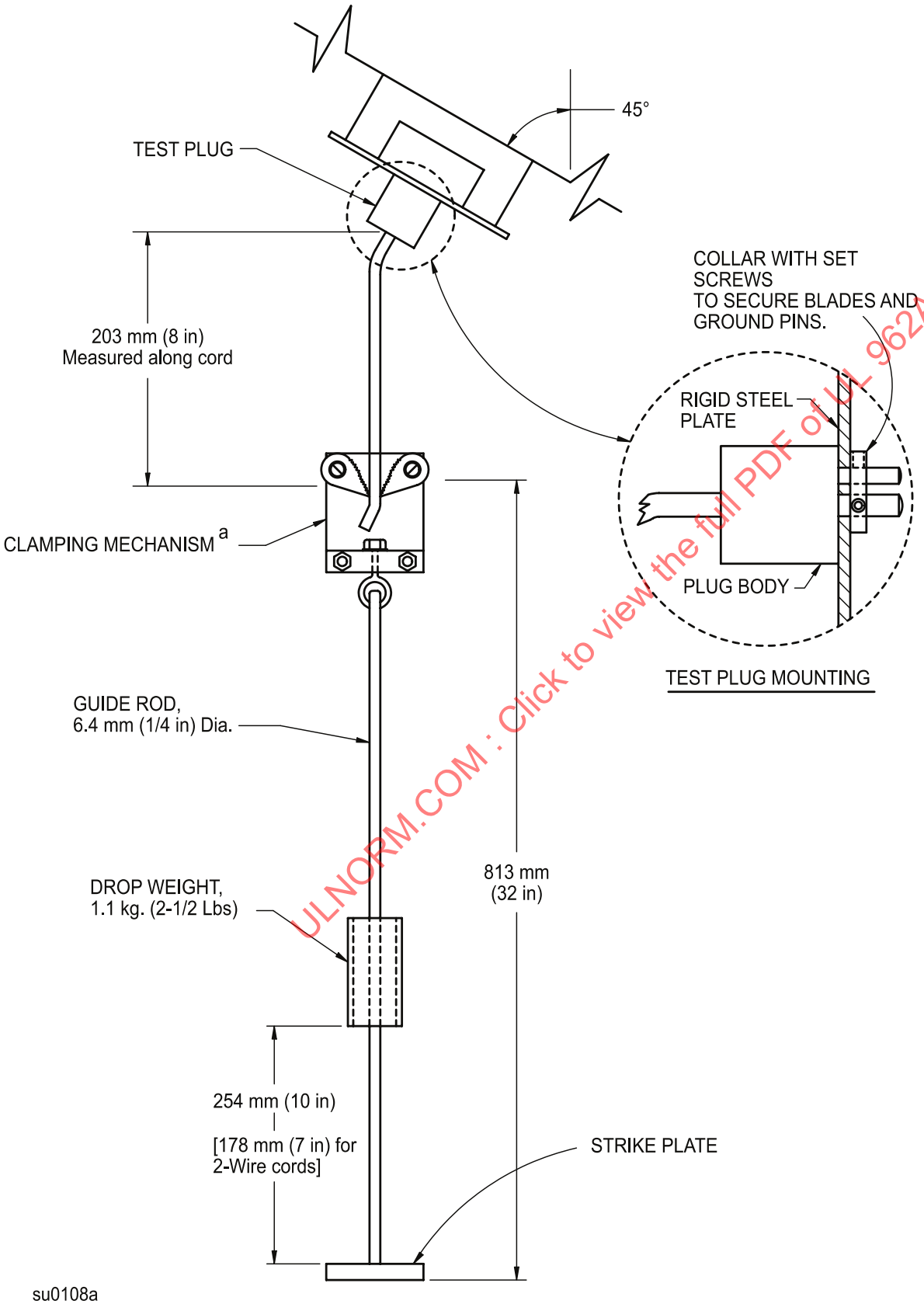
B16.2.1 The FPDU enclosure shall not crack, break, or shatter when tested as described in B16.2.2 – B16.2.5. Damage to any FPDU enclosure cover that is self-closing or tends to close itself and is to exclude liquid spillage ingress is not considered in this examination.

B16.2.2 Where primary and subordinate enclosures of a FPDU for clustered seating differ in design form, the enclosures shall be tested by separate samples.

B16.2.3 Six previously untested FPDU enclosures shall be tested. The receptacle outlet shall be replaced in the FPDU enclosure by a steel plate capable of retaining the test plug shown in Figure B16.1. The test plug shall be securely attached using the collar and set screws as shown in the inset detail of Figure B16.1. The FPDU enclosure shall be mounted in accordance with the manufacturer's installation instructions to a secure surface positioned so that the cord and/or plug are pointing downward at an angle of 45° to the vertical as shown in Figure B16.1.

Figure B16.1

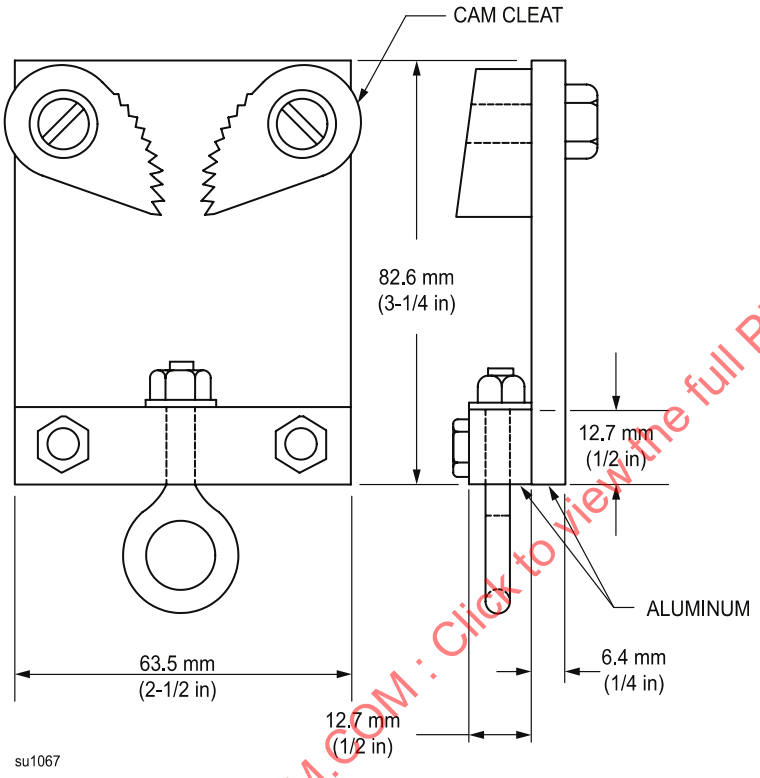
Abrupt Pull Test Apparatus



B16.2.4 The strike-plate/weight assembly shall be suspended from the cord, using a clamping mechanism similar to that depicted in Figure B16.2. A FPDU enclosure cover that is self-closing or tends to close itself is to be allowed to fall to its natural resting position. The distance, measured along the cord, from the center of the gripping area of the clamping mechanism to the point where the flexible cord exits the plug shall be approximately 0.2 m (8 in). The distance between the point of the striker-plate assembly's connection to the flexible cord (center of gripping area) to the bottom of the striker plate shall be not more than 0.8 m (32 in). The combined weight of the striker-plate assembly and holding clamp, exclusive of the 1.1 kg (2-1/2 lb) drop weight, shall be 907 ±85 g (2 lb ±3 oz).

Figure B16.2

Clamping Mechanism



B16.2.5 The representative assemblies being tested shall be subjected to an impact by raising and releasing a 1.1-kg (2-1/2-lb) weight, allowing it to fall freely for a distance of 0.25 m (10 in) to impact the strike plate. This procedure shall be repeated until:

a) The FPDU enclosure breaks away from the mounting surface,

b) Breakage of the FPDU enclosure or any other damage that could increase the risk of fire or electric shock, or

c) 25 impacts are completed.

B17 Spill Test

B17.1 A FPDU for clustered seating shall be subjected to the test described in this section and, after the testing, shall be subjected to the Dielectric Voltage-Withstand Test, UL 962A, Section 30.

Exception: When the FPDU for clustered seating is provided with a portable GFCI Class A that complies with UL 943 and the GFCI is located at the attachment plug or within 12 in (305 mm) of the attachment plug, compliance with the spill test is not required.

B17.2 Class 2 output connectors of receptacles with integral power supplies with Class 2 output connector(s) shall be blocked from liquid ingress during this test. Openings to the FPDU enclosure interior portion containing solely Class 2 load circuits shall be blocked from liquid ingress during this test. There shall be no additional blockage of openings to FPDU enclosure interior portions that contain any circuit(s) providing power to Class 2 power supplies.

B17.3 The FPDU for clustered seating shall be mounted as instructed by the manufacturer. Any cover is to be opened to the position that allows the greatest egress of liquid. A cover that is self-closing or tends to close itself is to be allowed to fall to its natural resting position. If more than one receptacle is enclosed by such a self-closing cover, then a single power-supply cord is to be mated with one of the receptacles and the cord is to exit through the wiring channel from behind the cover as instructed.

B17.4 A 3-in (76.2-mm) diameter container, 4 inches (101.6 mm) in height, is to be filled with 8 fl oz (0.24 L) of saline solution, consisting of 8 g of table salt per liter of distilled water, and placed on a supporting surface immediately adjacent to the receptacle outlets of the FPDU enclosure. The container is then to be tipped over and an effort is to be made to direct the spill toward the area of the assembly that allows the greatest ingress of liquid. The Dielectric Voltage-Withstand Test, UL 962A, Section 30 is to be conducted 1 min after the container is tipped over.

B18 Latching Test

B18.1 The latch mechanism of an interconnection plug and outlet or an interconnection cord connector and inlet shall not open or experience breakage of either the enclosure or latching means when interconnection is subjected to the Latching Test specified in B18.2 and B18.3.

B18.2 Three mated pairs of an interconnection plug and outlet or an interconnection cord connector and inlet are to be tested. The latching mechanism shall be operated to latch the mated halves together. The latching mechanism shall then be operated to release the mated halves and shall be physically separated. This sequence shall be repeated for a total of 10 cycles.

B18.3 Following the 10th cycle, the latching mechanism is to be operated to lock the mated halves together in place. A static pull of 30 lbf (133 N) is to be applied to the interconnection plug or interconnection cord connector for 1 minute in a direction perpendicular to the plane of the mated half.

B18.4 Each device is then to be subjected to a 50 – 60 Hz essentially sinusoidal potential equal to twice the rated voltage plus 1000 V applied between live parts of opposite polarity and between live parts and grounding or dead metal parts. An insulated body is to be wrapped in foil. The test voltage is to be increased at a uniform rate and as rapidly as is consistent with its value being correctly indicated by a voltmeter, and maintained at the test potential for 1 minute.

MARKINGS

B19 Details

B19.1 In addition to the markings describe in UL 962A, Section 53, a FPDU for clustered seating shall be marked with the word "CAUTION:" and the following or equivalent: "To Reduce the Risk of Electric Shock or Fire – Use Only with Same manufacturers' FPDU for Clustered Seating Modules Only".

B19.2 The word CAUTION shall be a minimum of 9/64 in (3.6 mm) high and the remaining words shall be a minimum of 1/16 in (1.6 mm) high.

INSTRUCTIONS

B20 Details

B20.1 The instructions of a FPDU for clustered seating shall comply with instructions requirements in UL 962A Section 54 except as modified by the instructions requirements of B20.2 and B20.3.

B20.2 The instructions of a FPDU for clustered seating shall include instructions on the outer surface of the smallest unit package or on a stuffer sheet or tag (or its equivalent) for intended FPDU enclosure mounting orientation(s) and mounting location(s) on the clustered seating.

B20.3 The instructions of a FPDU for clustered seating shall include instructions on the outer surface of the smallest unit package or on a stuffer sheet or tag (or its equivalent) that the power supply cord and interconnecting cords shall be protected from pedestrian traffic and that the FPDU enclosures and interconnecting cords shall not to located on floor surfaces.

B20.4 The instructions of a FPDU for clustered seating shall include instructions on the outer surface of the smallest unit package or on a stuffer sheet or tag (or its equivalent) as to the subordinate interconnection arrangement.

B20.5 The instructions of a FPDU for clustered seating shall include instructions to not place FPDU directly on the floor of a travelers' waiting space.