UL 2999

STANDARD FOR SAFETY

Individual Commercial Office Furnishings

UL Standard for Safety for Individual Commercial Office Furnishings, UL 2999

First Edition, Dated May 22, 2020

Summary of Topics

This revision of ANSI/UL 2999 dated May 2, 2024 includes the addition of UL 62133-2 to 3.2.1.4 and revisions to Table 34.1 and Table 35.1.

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

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated March 29, 2024.

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UL 2999

Standard for Individual Commercial Office Furnishings

First Edition

May 22, 2020

This ANSI/UL Standard for Safety consists of the First Edition including revisions through May 2, 2024.

The most recent designation of ANSI/UL 2999 as an American National Standard (ANSI) occurred on May 2, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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ANNEX A Standards for Components

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INTRODUCTION

1 Scope

1.1 These requirements cover individual commercial office furnishings. The products are used in accordance with the National Electrical Code, NFPA 70. They are intended for dry locations only. These furnishings include both electrified and non-electrified and may include, but not limited to:

a) Motor-operated tables and desks;

b) Tables and desks (non-motor-operated);

c) Storage Cabinets;

d) Seating;

e) Bench Systems; and

f) Motorized adjustable carts and stands for audio/video equipment.

1.2 These requirements cover products rated 600 V ac or less.

1.3 Furnishings intended for the small office or homes shall be evaluated to the Standard for Household and Commercial Furnishing, UL 962.

1.4 Office furnishing panel systems are covered by the Standard for Office Furnishings, UL 1286.

1.5 A non-motorized furnishing only intended to support audio/video equipment shall be evaluated in accordance with one of the following:

a) If the audio/video support system is an entertainment center, cart, or a stand and it is intended for support or attachment of audio/video equipment, the Standard for Household, Commercial, and Institutional-Use Carts, Stands and Entertainment Centers for Use with Audio and/or Video Equipment, UL 1678;

b) If the audio/video support system is intended to be mounted to walls or ceilings as the primary support means and not supported by the floor, the Standard for Wall- and Ceiling-Mounts and Accessories, UL 2442;

c) If a cart, stand or support surface is supplied with the audio or video equipment by the manufacturer of the audio or video equipment, the requirements contained in the Standard for Audio, Video, and Similar Electronic Apparatus – Safety Requirements, UL 60065, the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, or the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1; applies as applicable to the product;

d) Information Technology and Communications Equipment Cabinets, Enclosure and Rack Systems are investigated to the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1 or the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1.

1.6 Prefabricated rooms, booths, and pods shall be evaluated to the Standard for Household and Commercial Furnishing, UL 962.

2 Glossary

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

2.2 ACCESSIBLE PART – A part located so that it is able to be contacted by a person, either directly or by means of the probe illustrated in Figure 13.1.

2.3 ACCESSORY – An optional part that electrically and/or mechanically interfaces with the basic furnishing and is intended to be attached to the furnishing by the user or installer. Subassemblies field assembled to form the basic furnishing are not accessories.

2.4 APPLIANCE CONNECTOR – The mating part of the appliance coupler integral with, or intended to be attached to, the power supply cord.

2.5 APPLIANCE COUPLER – A means of enabling the connection and disconnection at will, of a cord to an appliance or other equipment. It consists of two parts: an appliance connector and an appliance inlet.

2.6 APPLIANCE INLET – The mating part of the appliance coupler integrated or incorporated in the appliance or equipment or intended to be fixed to it.

2.7 APPURTENANCE – Accessory objects on a furnishing such as a door, drawer, or a sliding work surface.

2.8 ATTENDED – When an individual is physically present where the furnishing is, is able to see the complete furnishing, and the area around the furnishing.

2.9 BATTERY – General term for:

a) Any single cell; or

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

May be ready for use or may be an installed component. The term "battery(ies)" shall refer to single or multi-cell batteries.

2.10 BATTERY PACK – A battery which is ready for use, contained in a supplemental rigid enclosure, with or without protective devices.

2.11 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.

2.12 BATTERY, SECONDARY – A battery that is intended to be discharged and recharged many times.

2.13 BATTERY, TECHNICIAN-REPLACEABLE – A battery intended for use in a product 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.

2.14 BATTERY, VENTED – A lead acid storage battery the electrodes of which are made of lead and the electrolyte consists of a solution of sulfuric acid in which the products of electrolysis and evaporation are allowed to escape freely to the atmosphere. These batteries have commonly been referred to as flooded or wet.

2.15 BELLOWS – A telescoping guard that hinders someone from contacting a hazardous part.

2.16 BENCHING SYSTEM – A series of primary surfaces interconnected longitudinally to a length greater than 72 inches by an integrated/shared support structure to extend the span of the overall surface.

2.17 BONDED (BONDING) – The permanent joining of metallic parts to form an electrically conductive path that provides electrical continuity and the capacity to conduct any current likely to be imposed without a risk of electric shock, fire, or injury to persons.

2.18 BRANCH CIRCUIT – The circuit conductors between the final over current device protecting the circuit and the outlet(s).

2.19 BRANCH CIRCUIT, MULTIWIRE – A branch circuit that consists of two or more ungrounded conductors that have a voltage between them, and a grounded conductor that has equal voltage between it and each ungrounded conductor of the circuit and that is connected to the neutral or grounded conductor of the system.

2.20 CARTON – A carton is a box or envelope of cardboard, pasteboard, shrink film, or similar material (but not newspaper, wrapping paper, tissue paper, or similar paper products) in which a product or parts of a product are packaged for shipment.

2.21 CELL, COMPONENT – The basic functional electrochemical unit containing an assembly of electrodes, electrolyte, container, terminals, and usually separators, that is a source of electrical energy by direct conversion of chemical energy. May be ready for use or may be provided as component of battery pack.

2.22 CHANNEL – A passage intended for the routing and holding of communication wiring, low-voltage wiring, and wiring having functional insulation plus a layer of supplementary insulation. A channel is not required to provide mechanical protection and is not evaluated as an enclosure.

2.23 CLASS 2 CIRCUIT – A circuit having power and voltage limitations as defined in the Article 725 of National Electrical Code, NFPA 70 Such a circuit shall comply with:

a) The Standard for Low Voltage Transformers – Part 3: Class 2 and 3 Transformers, UL 5085-3; or

b) The Standard for Class 2 Power Units, UL 1310.

2.24 COMMERCIAL – A place in which business is transacted, such as an office building, factory, warehouse, retailer, or similar location, and which is not a residence. It also includes institutions.

2.25 CONNECTOR, UNIT-TO-UNIT MECHANICAL – An assembly that is used to connect two or more adjacent units for the purpose of providing mechanical support between the units.

2.26 CONTROL, AUTOMATIC ACTION – A control in which at least one aspect is non-manual.

2.27 2.27 CONTROL, AUXILIARY – A device or assembly of devices that provides a functional utility, is not relied upon as an operational or protective control, and therefore is not relied upon for safety. For example, an efficiency control not relied upon to reduce the risk of electric shock, fire, or injury to persons during normal or abnormal operation of the end product is considered an auxiliary control.

2.28 CONTROL CIRCUIT – A system of components that may include programmable logic devices other than a thermal protector or a motor current protector that has the ability to detect the condition of a furnishing's operation or that controls a furniture function.

2.29 CONTROL, MANUAL – A device that requires direct human interaction to activate or rest the control.

2.30 CONTROL, OPERATING – A device or assembly of devices, the operation of which starts or regulates the end product during normal operation. For example, a thermostat, a thermal cutout/limiter or another layer of protection, the failure of which would reduce the risk of electric shock, fire, or injury to persons, is considered an operating control.

2.31 CONTROL, PROTECTIVE (limiting) – A device or assembly of devices, the operation of which is intended to reduce the risk of electric shock, fire or injury to persons during normal and reasonably anticipated abnormal operation of the appliance. For example, a thermal cutout/limiter, or any other control/circuit relied upon for normal and abnormal conditions, is considered a protective control.

2.32 CONTROL, TYPE 1 ACTION – The actuation of an automatic control for which the manufacturing deviation and the drift (tolerance before and after certain conditions) of its operating value, operating time, or operating sequence has not been declared and tested in accordance with the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

2.33 CONTROL, TYPE 2 ACTION – The actuation of an automatic control for which the manufacturing deviation and the drift (tolerance before and after certain conditions) of its operating value, operating time, or operating sequence have been declared and tested in accordance with the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

2.34 CORD CONNECTOR (convenience outlet) – A female contact device that is wired or molded on flexible cord and intended to be installed as part of an office furnishing wiring system to supply current to utilization equipment.

2.35 CRITICAL COMPONENTS – Any component that if changed may have an effect on the performance of the furnishing or that is restricted by the construction requirements

2.36 DAISY CHAIN – A series of cord connected products with receptacles that are plugged into another product with receptacles, which is then plugged into a building outlet. One example would be a Furniture Power Distribution Unit (FPDU) plugged into another FPDU.

2.37 DEAD METAL PART – Any metal part that is not intended to carry current.

2.38 DECORATIVE PART – A part that does not serve any function, such as mechanical support or for electrical protection. It is just there for aesthetics.

2.39 DIRECT AND INDIRECT CONTACT OF LIVE PARTS – A non-metallic part is considered in direct contact of a live part when it is touching the live part or within 1/32 inch (0.8 mm) of the live part. Indirect contact is when a non-metallic part is supporting another non-metallic material that is in direct contact with a live part.

2.40 ELECTRICAL CONNECTING ASSEMBLY TYPES – Electrical systems intended for office furnishing systems. Specific types include:

a) BASE FEED – An electrical assembly that contains supply conductors used to provide electrical power from a branch-circuit electrical supply located in the floor, column or wall of the building structure to the base of the office furnishing starter unit.

b PASS-THROUGH UNIT – An electrical assembly without any means for connection of utilization equipment and used to pass electrical power through a unit.

c) TOP FEED – An electrical assembly that contains the electrical supply conductors used to provide electrical power from a branch-circuit electrical supply located in the ceiling or wall of the building structure to the office furnishing starter unit.

d) UNIT-TO-UNIT – An electrical assembly that is used to electrically interconnect two adjacent mechanically connected units.

e) SYSTEMS JUMPER – An electrical connection assembly that is used for the interconnection of office furnishing electrical systems and manufactured wiring systems.

f) SYSTEM-TO-SYSTEM ADAPTER – An electrical connection assembly that is used for the interconnection of one type or configuration of office furnishing electrical system to a different type or configuration of office furnishing electrical system.

2.41 ENCLOSURE – A container that holds the electrical components and serves as an electrical and mechanical enclosure.

2.42 ENCLOSURE, ELECTRICAL – That part of the product that:

a) Renders inaccessible all or any parts of the equipment that may otherwise present a risk of electric shock; and/or

b) Retards propagation of flame initiated by electrical disturbances occurring within.

2.43 ENCLOSURE, MECHANICAL – A part of the equipment intended to reduce the risk of injury due to mechanical and other physical hazards.

2.44 ENTRAPMENT ENVIRONMENTS:

a) USAGE AREA I – An area where children or people with cognitive disabilities are anticipated to be present and likely not constantly supervised. Examples include residences, hotel rooms, retail stores, theaters, restaurants, and classrooms.

b) USAGE AREA II – An area where children or people with cognitive disabilities are anticipated to be present, but the furnishings are locked out and only operated by a trained person. Examples include medical exam rooms, customer service areas, and retail sales areas, such as carpet dispensers.

c) USAGE AREA III – An area where it is anticipated adults with normal cognitive abilities are present, trained to use the furnishings present, and children or people with cognitive disabilities are rarely present or if present are closely supervised, such as in a commercial office.

2.45 FIELD-WIRING TERMINAL – A terminal to which a conductor is intended to be connected in the field.

2.46 FUNCTIONAL LOAD – A level of loading intended to be typical of hard use.

2.47 FURNISHING SUPPORT SYSTEM – A system of components intended to secure a furnishing to the building or other structure.

2.48 FURNISHING TYPES:

a) FIXED FURNISHING – Intended to be permanently connected electrically to a source of supply and the building.

b) PORTABLE FURNISHING – A small furnishing that meets all of the following:

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

2) Connected electrically to an electrical source of supply with a power supply cord and plug; and

3) Likely to be frequently relocated, without the use of tools or equipment, due to its small size and weight. A product with a mass exceeding 40 lbs (18 kg) is not generally considered to be portable.

c) STATIONARY FURNISHING –

1) Connected electrically to an electrical source of supply with a power supply cord and plug; and

2) Unlikely to be frequently relocated due to size, weight or configuration or intended to be fastened in place requiring tools for removal.

2.49 FURNITURE POWER DISTRIBUTION UNIT – An outlet assembly that complies with the Standard for Furniture Power Distribution Units, UL 962A.

2.50 GROUND – A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth or to some conducting body that serves in place of the earth.

2.51 GROUNDED – Connected to earth or to some conductive body that serves in place of earth.

2.52 GROUNDED CONDUCTOR – A system or circuit conductor that is intentionally grounded.

2.53 GROUNDING CONDUCTOR EQUIPMENT – The conductive path(s) that provides a ground-fault current path and connects normally non-current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both.

2.54 INDIVIDUAL OFFICE FURNISHING – A furnishing used for conducting business in an office that is intended to stand alone or be mechanically and electrically connected to another individual office furnishing.

2.55 INSULATION, BASIC – Insulation applied to live parts to provide basic protection against electric shock.

2.56 INSULATION, SUPPLEMENTARY – A separate layer of insulation that is provided in addition to the basic insulation to reduce the risk of electric shock in the event of breakdown of the basic insulation.

2.57 ISOLATED SECONDARY CIRCUIT – A circuit derived from an isolated secondary winding of a transformer and that has no direct connection back to the line-connected circuit (other than through grounding means). A secondary circuit that has a direct connection back to the line-connected circuit is determined to be part of the line-connected circuit.

2.58 LED – Light Emitting Diode

2.59 LEAKAGE CURRENT – All currents, including capacitively coupled currents, that flow through a person upon contact between accessible conductive surfaces of a product and ground or other accessible surfaces of the product.

2.60 LIMITED POWER SOURCE (LPS) – A limited power source is as defined in the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, and shall comply with the requirements of UL 60950-1.

2.61 LINE OF SIGHT – The ability to see the furnishing so that the user can observe the furnishing is moving to make sure that it will not harm anyone in the area.

2.62 LINE-VOLTAGE CIRCUIT – A circuit involving a potential of not more than 600 V and having circuit characteristics in excess of those of a low-voltage circuit.

2.63 LIVE PART – Any part where current is flowing.

2.64 LOADING:

a) FULLY LOADED – Where the furnishing has the complete test load on the product.

b) PARTIALLY LOADED – The furnishing is partially loaded. It may have a load anywhere greater than zero (unloaded) or less than the complete test load (Fully Loaded).

c) UNLOADED – Where the furnishing has no load being held by the product.

2.65 LOCATION, DRY – A location not normally subject to dampness, but may include a location subject to temporary dampness, as in the case of a building under construction, provided ventilation is adequate to prevent an accumulation of moisture.

2.66 LOCKED-ROTOR – The armature or rotor is prevented from rotating.

2.67 LOW-VOLTAGE CIRCUIT – A circuit involving a potential of not more than 30 volts alternating current (42.4 peak) open circuit supplied by a primary battery, by a Class 2 transformer, or by a combination of a transformer and a fixed impedance that as a unit, complies with all performance requirements for a Class 2 transformer. A circuit derived from a line-voltage circuit by connecting a resistance in series with the supply circuit as a means of limiting the voltage and current, is not considered to be a low voltage circuit.

2.68 MATTRESS – A pad used for sleeping.

2.69 MIU – Measurement Indication Unit. In the past, leakage current values have been given in milliamperes (mA), however the term Measurement Indication Unit (MIU) is being adopted in conformance with the latest edition of the American National Standard for Leakage Current for Appliances, ANSI C101-1992. The term MIU refers to the numerical indication of a defined measurement instrument. The MIU unit is related to the level of physiological effect produced by body current, independent of frequency. The MIU coincides numerically with milliamperes only at low frequencies. At high frequencies, the milliamperes flowing through the instrument can significantly deviate. Therefore, the term MIU has been selected instead of milliamperes for measurement of leakage current.

2.70 MODULAR WIRING SYSTEMS FOR OFFICE FURNITURE – See Electrical Connecting Assemblies, 2.34.

2.71 NORMAL USE – The intended function applied by the user or operator utilizing the installation and operation instructions for the furnishing.

2.72 OFFICE FURNISHING PANEL SYSTEM – Consists of panels, study carrels, work stations and pedestal-style systems that are mechanically interconnected to form an office furnishing system to be installed in accordance with Article 605 of the National Electrical Code, NFPA 70. They may be provided with an electrical distribution system, including switches and receptacles. They may contain channels for routing communication cable within the system components separate from power-circuit raceways. The systems may include filing cabinets, desks, work surfaces, shelves, storage units, etc., that have a

particular electrical or mechanical function unique to an office furnishing system. These types of furnishing systems are covered by the Standard for Office Furnishings, UL 1286.

2.73 PANEL – A flat or curved surface that controls and/or defines space; provides privacy and a means for hanging components.

2.74 PORTABLE LUMINAIRE – A portable luminaire is a cord and plug connected luminaire that provides illumination for a room or specific area and is able to be moved to a new location with or without the use of readily available tools.

2.75 PROOF LOAD – A level of loading or force in excess of hard use.

2.76 PUBLIC OCCUPANCIES – Include but are not limited to health care facilities, old age convalescent and care homes, college dormitories, residence halls, jails, prisons, nursing care homes, public auditoriums, hotels and motels.

2.77 RACEWAY – An enclosure (See 2.35) that is intended specifically for mechanical, fire, and electrical protection for the internal system wiring.

2.78 RECEPTACLE, CONVENIENCE (convenience outlet) – A female contact device intended to be installed as part of an office furnishing to supply current to utilization equipment, which is used to plug in electrical products that are not provided with the furnishing, but connected by users in the field, and unused when the furnishing is shipped and generally easily accessible to the user for this purpose.

2.79 RELOCATABLE POWER TAP (RPT) – An outlet assembly that complies with the Standard for Relocatable Power Taps, UL 1363 and is considered for temporary use.

2.80 REMOTELY CONTROLLED – The ability to control a furnishing that is out of sight of the operator.

2.81 RFID – Radio-frequency identification.

2.82 RISK OF ELECTRIC SHOCK – A risk of shock is considered to exist at parts accessible to the user or operator in a normally dry location during the intended use or servicing if the voltage exceeds 42.4 Vac peak (the peak voltage of a 30-Vac sine wave), 60 Vdc and in a normally wet location if the voltage exceeds 21.2 Vac peak (the peak voltage of a 15-Vac sine wave), 30 Vdc and the available current exceeds the leakage current levels specified in Leakage Current Test, Section 61.

2.83 RISK OF FIRE – A risk of fire is considered to exist at a component part or assembly if an investigation shows that the supply for such part or assembly is capable of delivering a power of more than 15 W into an external resistor connected between the points in question and any return to the power supply.

2.84 SAFETY CIRCUIT – A control circuit designed to guard against or mitigate risk of fire, shock or personal injury.

2.85 SAFETY EXTRA LOW VOLTAGE (SELV) CIRCUIT – An isolated secondary circuit that under normal operating conditions and single fault conditions provides a voltage that is 30 V rms (42.4 V peak) or 60 V DC or less. The current may exceed Class 2 limitations. These circuits are derived from a source evaluated to the SELV requirements in the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1 for the application of these requirements.

2.86 SCREEN – Non-load-carrying space divider that is less than ceiling height and does not carry power.

2.87 SECURITY LOCKOUT DEVICE – A device that prevents unauthorized users from operating the equipment, such as a lock and key, or a keypad with a code.

2.88 SMART DEVICE – A device that has the ability to run software such as a smart phone.

2.89 STARTER UNIT – The piece of furnishings that is connected to the external supply source and that potentially has provision for electrical connection of additional portions of a furnishing system. The starter unit is located as the first unit in the system.

2.90 SUB-ASSEMBLY – An individual component or a group of components that when all of the sub-assemblies are combined form the completed furnishing. Sub-Assemblies are normally used when the sub-assemblies are shipped from different manufacturing locations and are assembled in the field by the user or installer.

2.91 SUSPENDED FURNISHING – A furnishing that is suspended from a ceiling or wall and is not supported by the floor.

2.92 TABLE/DESK ELECTRICAL SYSTEM – A cord and plug electrical system with receptacles that is provided with overcurrent protection and designed to limit the total number of receptacles that can be daisy chained.

2.93 TIP OVER – The condition where the unrestricted unit will not return to its normal upright position.

2.94 UPHOLSTERED FURNISHING OR FURNITURE – Furnishings / Furniture that is provided with coverings, padding, webbing and/or springs, to be used as a seat or other supporting means for a person.

2.95 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.

2.96 VIDEO MOUNTING SYSTEM TYPES:

a) ADJUSTABLE MOUNT – A mounting system designed with components that may be adjusted once, infrequently or requires a tool be used for adjustment and is intended to support the video display in a fixed position after assembly and installation.

b) ARTICULATING MOUNT – A mounting system intended to allow active movement, adjustment, and repositioning, after installation.

c) MONITOR ARM – A device identified to support a computer video display that is in turn supported by or secured to a desk or table.

d) WORK SURFACE – A horizontal surface used to perform tasks and/or for storage space.

2.97 WORKING PRESSURE – The maximum system pressure measured during normal operating conditions. When more than one pressurized system is provided the furnishing is capable of having multiple working pressures.

3 Components

3.1 General

3.1.1 Except as indicated in 3.1.2, a component of products covered by this standard shall comply with the requirements for that component. See Annex A for a list of standards covering components used in the products covered by this standard, but it is not all inclusive.

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

a Involves a feature or characteristic not required in the application of the component in the product covered by this standard; or

b) Is superseded by a requirement in this standard.

3.1.3 A component shall be used in accordance with its rating established for the intended conditions of use. Intended use also includes how the component will be used. For instance, a portable power supply shall not be used on a stationary or fixed furnishing unless it can still be considered portable, which means that it can be easily disconnected from the power source and removed.

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

3.1.5 Equipment in a Class 2 / LPS circuits shall comply with the safety requirements of a standard applicable to the equipment type. Examples of equipment and applicable Standards include:

a) Information, communication or audio/video product:

1) Standard for Audio, Video, and Similar Electronic Apparatus-Safety Requirements, UL 60065;

2) Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1;

3) Standard for Safety for Audio/video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1.

b) Wireless charging pad:

1) Standard for Induction Power Transmitters and Receivers for Use with Low Energy Products, UL 2738.

c) Luminaire:

1) Standard for Low Voltage Lighting Systems, UL 2108.

2) Standard for Portable Electric Luminaires, UL 153.

3.2 Batteries

3.2.1 General

3.2.1.1 Furnishings 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.

3.2.1.2 The process of installing or removing a battery from a furnishing or a remote control shall not cause the furnishing to operate in a manner that may cause personal injury.

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

3.2.1.4 Batteries of a type other than specified in 3.2.1.1 shall comply with the requirements of the Standard for Household and Commercial Batteries, UL 2054, or the Standard for Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes – Safety Requirements for Portable Sealed Secondary Cells, and for Batteries Made from Them, for Use in Portable Applications – Part 2: Lithium Systems, UL 62133-2, and if of the lead acid storage battery type, shall additionally comply with the Pressure Release Test, Flame Arrester Vent Cap Tests in the Standard for Valve Regulated or Vented Batteries with Aqueous Electrolytes, UL 1989.

3.2.1.5 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.

3.2.1.6 A battery shall be protected by an enclosure in accordance with 11.6 – 11.8.

3.2.2 Battery chargers and circuits

3.2.2.1 A battery charging circuit integral to the furnishing, a battery charger supplied with the furnishing, or available as an accessory to the furnishing operating at a Class 2 or LPS power output level shall comply with the applicable requirements. See 2.23 and 2.63, respectively.

3.2.2.2 A battery charging circuit integral to the furnishing, a battery charger supplied with the furnishing, or available as an accessory to the furnishing operating at above a Class 2 or LPS power output level shall comply with the requirements in the Standard for Power Units Other Than Class 2, UL 1012 or the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, or the Standard for Audio/Visual, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1.

3.2.3 Non-replaceable batteries

3.2.3.1 A furnishing provided with a battery or batteries that are not intended to be replaced by the user shall be located within the furnishing enclosure such that it is inaccessible to the user.

3.2.4 Technician-replaceable batteries

3.2.4.1 A furnishing containing a battery or batteries that are only to be replaced by trained technicians shall be marked in accordance with 88.4 and shall include a statement in the instructions in accordance with 95.6.

3.2.5 Battery compartments

3.2.5.1 A battery compartment with replaceable batteries shall have no accessible contact with batteries, internal wiring or circuits in excess of Class 2 power and isolation. Accessibility is determined by the requirements in Section 13, Accessibility of Uninsulated Live Parts and Film-Coated Wire.

Exception: A battery compartment that allows access to batteries, internal wiring, circuits and components other than a Class 2 circuit shall:

a) If cord and plug connected – be provided with a caution marking (see 88.1), to disconnect all sources of power before opening the compartment. A circuit shall discharge any accessible electrical components in the battery compartment within 2 seconds; other than the battery; or

b) For a permanently connected furnishing – be provided with an interlock device that de-energizes and discharges any accessible electrical components within 2 seconds in the battery compartment; other than the battery; or

c) For a permanently connected furnishing – be provided with a disconnect switch that can be locked in the off position. When placed in the off position any accessible electrical components in the battery compartment shall be discharged within 2 seconds; other than the battery. Adjacent to the disconnect switch a caution marking (see 88.2) to disconnect all sources of power before opening the compartment.

3.2.5.2 A battery compartment provided with replaceable batteries shall comply with the requirements in 11.4, Mechanical Enclosure And Guards – Mechanical Considerations.

3.2.5.3 A furnishing 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.

3.2.5.4 The battery tray capacity shall be at least equal to the volume of electrolyte of all the cells of the battery.

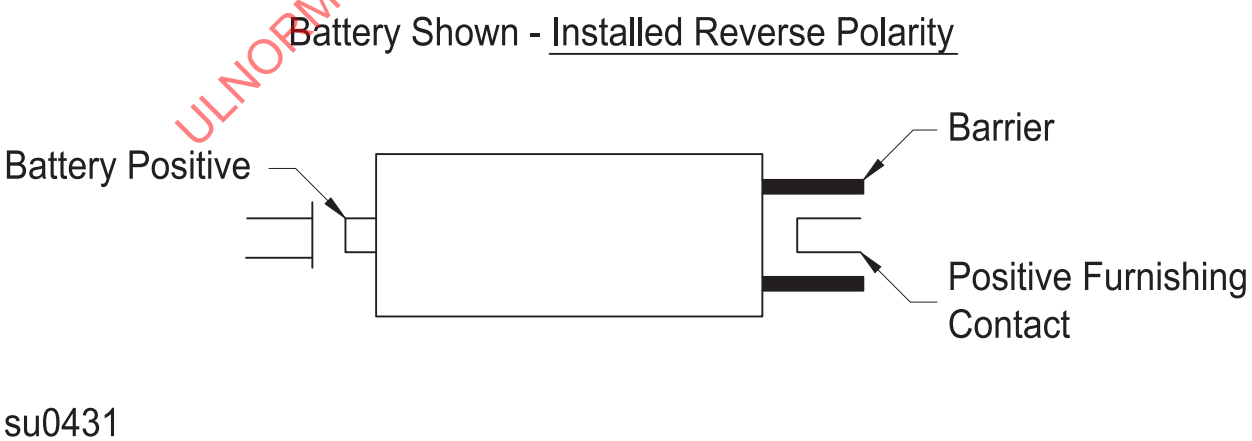
3.2.5.5 An enclosure or part of an enclosure that also serves as a compartment for a rechargeable vented battery shall be provided with ventilated openings to permit dispersion of gases from the battery.

3.2.5.6 A diagram indicating battery polarity installation shall be present 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 service person.

3.2.5.7 A battery holder or compartment where more than one AAAA, AAA, AA, C or D cells batteries or other battery configurations can be inadvertently installed in reverse polarity shall be provided with a means that prevents the negative battery terminal from making contact with the intended positive contact in the furnishing battery compartment. For example, a non-conductive barrier. See Figure 3.1.

Figure 3.1

Battery shown – Installed reverse polarity



3.2.6 Battery circuits

3.2.6.1 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.

3.2.6.2 One of the following methods shall be used to determine compliance with 3.2.6.1:

a) Suitable overcurrent protective devices rated for the available current shall be installed in the circuit; or

b) Compliance with the requirements as outlined in Section 75, Abnormal – Tests.

3.2.7 Battery charging

3.2.7.1 A furnishing 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 furnishing.

3.2.7.2 The output characteristics of a battery charging circuit shall be compatible with its rechargeable battery. The instructions shall include reference to this as specified in 95.7.

3.3 Capacitors

3.3.1 A capacitor provided as a part of a capacitor motor and a capacitor connected across-the-line, such as a capacitor for radio-interference elimination or power-factor correction, shall be housed within an enclosure or container that protects the plates against mechanical damage and that reduces the risk of the emission of flame or molten material resulting from malfunction or breakdown of the capacitor. The container shall be of metal providing strength and protection not less than that of uncoated steel having a thickness of 0.020 inch (0.51 mm).

Exception: The individual container of a capacitor is able to be of sheet metal less than 0.020 inch (0.51 mm) thick or is able to be of material other than metal when the capacitor is mounted in an enclosure that houses other parts of the furnishing. The enclosure must be rated for use in enclosing live parts.

3.3.2 When the malfunction or breakdown of a capacitor results in a risk of fire, electric shock, or injury to persons, thermal or overcurrent protection shall be provided in the furnishing to reduce the risk of such a condition.

3.3.3 A capacitor connected from one side of the line to the frame or enclosure of a furnishing shall have a capacitance rating of not more than 0.10 microfarad.

3.3.4 A furnishing that is intended to be controlled by or operated in conjunction with a capacitor or a combination capacitor-and-transformer unit shall be supplied with such capacitor or unit.

3.3.5 Under both normal and abnormal conditions of use, a capacitor employing a dielectric medium more combustible than askarel shall not result in a risk of electric shock or fire and shall be protected against expulsion of the dielectric medium. A capacitor complying with the requirements for protected oil-filled capacitors in the Standard for Capacitors, UL 810, meets the intent of this requirement.

3.4 Connectors

3.4.1 A connector shall comply with one of the following:

a) The Standard for Attachment Plugs and Receptacles, UL 498;

b) The Standard for Insulated Multi-Pole Splicing Wire Connectors, UL 2459;

c) The Standard for Component Connectors for Use in Data, Signal, Control and Power Applications, UL 1977, provided the connector meets voltage and current requirements for the intended load and the material RTI is suitable for the maximum temperature on the connector developed in the Temperature Test. UL 1977 connectors shall meet minimum flammability class rating of HB, V-2, V-1,V-0, VTM-2, VTM-1, or VTM-0 and be suitable for direct contact of live parts (See Section 19, Materials in Direct and Indirect Contact of Live Parts);

d) A connector located in a SELV circuit that during the Section 64, Temperature Test does not exceed 50°C, shall be manufactured from a polymeric material with a minimum electrical RTI of 70° C, and complies with Materials in Direct and Indirect Contact of Live Parts, Section 19 for materials in direct contact of live parts; or

e) Any connector may be used located in a Class 2 or LPS circuit that during the Temperature Test, Section 64, does not exceed 50°C.

3.4.2 A furnishing with multiple Class 2 / LPS supply or load connections where interconnection could cumulatively exceed Class 2 / LPS limits shall be provided with polarized connectors that prohibit such interconnection.

3.4.3 Coaxial cable connectors shall not be used for connections.

3.4.4 Connectors that are part of an Office Furnishing Electrical Connecting Assemblies shall comply with the Standard for Office Furnishings, UL 1286.

3.4.5 Connectors that are part of a Table/Desk Electrical System shall comply with the Standard for Household and Commercial Furnishings, UL 962, or the requirements in 3.4.6.

3.4.6 Electrical mating connectors shall:

a) Be reliably keyed by a physical, mechanical or electronic means to maintain correct polarity between power-feed and interconnected parts;

b) Be rated 15 amps minimum;

c) Comply with the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. Connectors totally enclosed in a metal raceway shall be classed HB and connectors not so enclosed shall be classed V-2 or less flammable in accordance with the Standard for Test for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94;

d) Have the grounding-terminal conductors connect before or at the same time as mating supply conductors connect when two or more connectors are being mated as intended. During disconnection of mating connectors, the supply conductors shall disconnect before or at the same time the grounding conductor disconnects;

e) Not subject mating parts to tension during normal use of the product;

f) Be latched or otherwise secured together to provide electrical continuity between mating parts. Connectors that are not provided with a mechanical latch shall be subjected to the minimum separation force portion of the Mating Connector Tests, Section 69; and

g) Be subjected to Section 67, Electrical Distribution Systems;

h) Shall maintain polarity throughout the system.

j) Standard IEC or NEMA style attachment plugs (for example NEMA 5-15 or IEC-C13) shall not be used.

k) Electronically keyed systems shall comply with 3.5, Controls.

3.5 Controls

3.5.1 General

3.5.1.1 Controls shall not introduce a risk of electric shock, fire, or personal injury.

3.5.1.2 An electronic auxiliary or operating control (e.g. a non-protective control), the failure of which would not increase the risk of electric shock, fire, or personal injury, need only be subjected to the applicable requirements of this end product standard.

3.5.2 Auxiliary controls

3.5.2.1 Auxiliary controls shall be evaluated using the applicable requirements of this end product standard unless otherwise specified in this end product standard.

3.5.3 Operating controls

3.5.3.1 Operating (regulating) controls shall be evaluated using the applicable component standard requirements specified in 3.5.5 – 3.5.10 and the parameters in 3.5.3.3 – 3.5.3.4, unless otherwise specified in this end product standard.

3.5.3.2 Operating controls that rely upon software for the normal operation of the end product where deviation or drift of the operating parameters of the control may result in an increased risk of electric shock, fire, or injury to persons, shall comply with:

a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991; and the Standard for Software in Programmable Components, UL 1998;

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1; or

c) The Standard for Safety of Household and Similar Electrical Appliances, Part 1: General Requirements, UL 60335-1, if motorized.

3.5.3.3 The following test parameters shall be among the items considered when judging the acceptability of an operating control investigated using the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1:

a) Control action Types 1 or 2;

b) Unless otherwise specified this standard, manual and automatic controls shall be tested for 6,000 cycles with under maximum normal load conditions, and 50 cycles under overload conditions;

c) Installation class 2 in accordance with the Standard For Electromagnetic Compatibility (EMC) – Part 4-5: Testing And Measurement Techniques – Surge Immunity Test, IEC 61000-4-5;

d) For the applicable Overvoltage Category, see Table 3.1;

e) For the applicable Material Group, see Table 3.2; and

f) For the applicable Pollution Degree, see Table 3.3.

Table 3.1
Overvoltage categories

Furnishing type	Overvoltage category
Intended for fixed wiring connection	III
Portable and stationary cord-connected	II
Control located in low-voltage circuit	I
NOTE – Applicable to low-voltage circuits if a short circuit between the parts involved may result in operation of the controlled equipment that would increase the risk of fire or electric shock.	

Table 3.2
Material group

CTI PLC value of insulating materials	Material group
CTI ≥ 600 (PLC = 0)	I
400 ≤ CTI < 600 (PLC = 1)	II
175 ≤ CTI < 400 (PLC = 2 or 3)	IIIa
100 ≤ CTI < 175 (PLC = 4)	IIIb
NOTE – PLC stands for Performance Level Category, and CTI stands for Comparative Tracking Index as specified in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.	

Table 3.3
Pollution degrees

Furnishing control microenvironment	Pollution degree
No pollution or only dry, nonconductive pollution. The pollution has no influence. Typically hermetically sealed or encapsulated control without contaminating influences, or printed wiring boards with a protective coating can achieve this degree.	1
Normally, only nonconductive pollution. However, a temporary conductivity caused by condensation may be expected. Typically indoor appliances for use in household or commercial clean environments achieve this degree.	2
Conductive pollution, or dry, nonconductive pollution that becomes conductive due to condensation that is expected. Typically controls located near and may be adversely affected by motors with graphite or graphite composite brushes, or outdoor use appliances achieve this degree.	3

3.5.3.4 The following test parameters shall be among the items considered when judging the acceptability of an operating control investigated using other than the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1:

a) Control action Types 1 or 2;

b) Unless otherwise specified in this standard, manual and automatic controls shall be tested for 6,000 cycles with under maximum normal load conditions, and 50 cycles under overload conditions;

c) For the applicable Overvoltage Category, see Table 3.1;

d) For the applicable Material Group, see Table 3.2; and

e) For the applicable Pollution Degree, see Table 3.3.

3.5.4 Protective controls

3.5.4.1 Protective (limiting) controls shall be evaluated using the applicable component standard requirements specified in 3.5.5 – 3.5.10, and as applicable, the parameters in 3.5.4.5 – 3.5.4.7.

3.5.4.2 Solid-state protective controls that do not rely upon software as a protective component shall comply with:

a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991;

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, except Controls Using Software;

c) The Standard for Safety of Household and Similar Electrical Appliances, Part 1: General Requirements, UL 60335-1, if motorized.

3.5.4.3 Solid-state protective controls that rely upon software as a protective component shall comply with:

a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, and the Standard for Software in Programmable Components, UL 1998; or

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

3.5.4.4 An electronic control that performs a protective function shall comply with the applicable requirements in this Section (Controls) while tested using the parameters in 3.5.4.5 – 3.5.4.7. Examples of protective controls are: a control used to sense abnormal temperatures of components within the appliance; an interlock function to de-energize a motor; temperature protection of the motor due to locked rotor, running overload, loss of phase; or other function intended to reduce the risk of electric shock, fire, or injury to persons.

3.5.4.5 The following test parameters and conditions shall be as specified when determining the acceptability of an electronic protective control investigated using the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1:

a) Failure-Mode and Effect Analysis (FMEA) or equivalent Risk Analysis method;

b) Power Supply Voltage Dips, Variation and Interruptions within a temperature range of 10°C (18°F) and the maximum ambient temperature determined by conducting the Temperature Test, Section 64;

c) Surge Immunity Test – installation class 3 shall be used;

d) Electrical Fast Transient/Burst Test, a test level 3 shall be used;

e) Electrostatic Discharge Test;

f) Radio-Frequency Electromagnetic Field Immunity:

1) Immunity to conducted disturbances – When applicable, test level 3 shall be used; and

2) Immunity to radiated electromagnetic fields; field strength of 3 V/m shall be used;

g) Thermal Cycling Test shall be conducted at ambient temperatures of 10.0 ±2°C (50.0 ±3°F) and the maximum ambient temperature determined by conducting the Temperature Test, Section 64. The test shall be conducted for 14 days;

h) Overload shall be conducted based on the maximum declared ambient temperature (T_{max}) or as determined by conducting the Temperature Test, Section 64; and

i) If software is relied upon as part of the protective electronic control, it shall be evaluated as software class B.

3.5.4.6 The test parameters and conditions used in the investigation of the circuit covered by 3.5.3.4 shall be as specified in the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, using the following test parameters:

a) Supervised safety circuits as defined by UL 991 may not rely on a trouble signal or indicator to prevent the risk of injury;

b) A field strength of 3 V/m is to be used for the Radiated EMI Test;

c) Composite Operational and Thermal Cycling Tests in accordance with UL 991 is not required on indoor furnishings;

d) The Humidity Class is to be based on the appliance's intended end use and is to be used for the Humidity Test;

e) A vibration level of 5 g is to be used for the Vibration Test;

f) When a computational investigation is conducted, lp shall not be greater than 6 failures/106 hours for the entire system. For external secondary entrapment protection devices that are sold separately, lp shall not be greater than 0 failures/106 hours. For internal secondary entrapment protection devices whether or not they are sold separately, lp shall not be greater than 0 failures/106 hours. The Operational Test is to be conducted for 16 days;

g) The Endurance Test is to be conducted concurrently with the Operational Test. The control shall perform its intended function while being conditioned for 14 days in an ambient air temperature of 60°C (140°F), or 10°C (18°F) greater than the operating temperature of the control, whichever is higher. During the test, the control is to be operated in a manner representing normal use;

h) For the Electrical Fast Transient Burst Test, test level 2 is to be used;

i) Conduct a failure-mode and effect analysis (FMEA);

j) If software or firmware is relied upon as part of the protective electronic control, it shall be evaluated as software class 1 in accordance with the Standard for Software in Programmable Components, UL 1998.

3.5.4.7 Unless otherwise specified in this standard, protective controls shall be evaluated for 100,000 cycles for Type 2 devices and 6,000 cycles for Type 1 devices with rated current.

3.5.5 Electromechanical and electronic controls

3.5.5.1 A control, other than as specified in 3.5.6 – 3.5.10, shall comply with:

a) The Standard for Solid-State Controls for Appliances, UL 244A;

b) The Standard for Temperature-Indicating and -Regulating Equipment, UL 873; or

c) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

3.5.6 Motor controls

3.5.6.1 A control used to start, stop, regulate or control the speed of a motor shall comply with:

a) The Standard for Solid-State Controls for Appliances, UL 244A;

b) The Standard for Temperature-Indicating and -Regulating Equipment, UL 873;

c) The Standard for Industrial Control Equipment, UL 508;

d) The Standard for Power Conversion Equipment, UL 508C;

e) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1;

f) The Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1; or

g) The Standard for Safety of Household and Similar Electrical Appliances, Part 1: General Requirements, UL 60335-1.

3.5.6.2 A component that only supplies power to a motor is not considered a controller, but a power supply.

3.5.6.3 The failure of a motor controller shall not introduce an electrical shock, fire or causality hazard as follows:

a) When a controller is designed to load switch (manage current to multiple loads) the reliability of the switching or load sharing shall be investigated so that under a fault condition an electrical shock, fire or causality hazard is not created.

b) When multiple motors apply a force to a portion of the furnishing the load on each motor shall be determined. Load management (switching) if provided by a controller shall be determined to be suitable for the loads or if it is determined the load management is not reliable then consideration shall be given to each motor applying its force to the furnishing portion singly or in combination whichever is determined to be worst case.

Exception: The above conditions do not apply where electronic drive circuits are determined to be reliable by single component faults as determined by evaluation with Controls, 3.5.

3.5.7 Pressure controls

3.5.7.1 A pressure control shall comply with one of the following:

a) The Standard for Solid-State Controls for Appliances, UL 244A;

b) The Standard for Industrial Control Equipment, UL 508; or

c) The Standard for Automatic Electrical Controls – Part: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls – Part 2-6: Particular Requirements for Automatic Electrical Pressure Sensing Controls Including Mechanical Requirements, UL 60730-2-6.

3.5.8 Remote controls

3.5.8.1 Remote controls or applications on smart devices shall not be provided on any furnishing whose operation could cause personal injury (see 11.3, Personal Injury, Entrapment, Pinch Points, and Shear

Considerations) while in motion when using the remote or application unless they can only be used in line of sight.

3.5.8.2 Remote controls or applications on smart devices shall comply with the control requirements in this standard based on their application.

3.5.9 Temperature controls

3.5.9.1 A temperature control shall comply with:

a) The Standard for Solid-State Controls for Appliances, UL 244A;

b) The Standard for Temperature-Indicating and -Regulating Equipment, UL 873;

c) The Standard for Industrial Control Equipment, UL 508; or

d) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9.

3.5.9.2 A temperature sensing positive temperature coefficient (PTC) or a negative temperature coefficient (NTC) thermistor that performs the same function as an operating or protective control shall comply with:

a) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9; or

b) The Standard for Thermistor-Type Devices, UL 1434.

3.5.9.3 A thermal cutoff shall comply with the Standard for Thermal-Links – Requirements and Application Guide, UL 60691.

3.5.9.4 A temperature sensing positive temperature coefficient (PTC) or a negative temperature coefficient (NTC) thermistor, that performs the same function as an operating or protective control, shall be tested using the following number of cycles when testing a sensing device in accordance with the endurance test:

a) For a device employed as an operating device – 6,000 cycles;

b) For a device employed as a protective device – 100,000 cycles; and

c) For a device employed as a combination operating and protective device – 100,000 cycles.

3.5.10 Timer controls

3.5.10.1 A timer control shall comply with:

a) The Standard for Solid-State Controls for Appliances, UL 244A; or

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Timers and Time Switches, UL 60730-2-7.

3.6 Electrical distribution systems

3.6.1 Electrical Distribution Systems that are intended for use in Office Furnishing Systems may be used and shall comply with the Standard for Office Furnishings, UL 1286, and be used in accordance with its instructions.

3.6.2 Electrical Distribution Systems that are intended for use in cord and plug connected power table/desk electrical system may be used and shall comply with the Standard for Household and Commercial Furnishings, UL 962 and be used in accordance with its instructions.

3.6.3 The Standard for Manufactured Wiring Systems, UL 183, may be used provided they meet the following criteria when installed:

a) Mechanically Protected, installed where not subjected to sharp blows or other mechanical abuse, which would cause crushing;

b) Not subjected to tension;

c) The conduit is not relied upon for providing grounding continuity. A separate grounding lead must be provided;

d) Splices and connection points, such as at switches or receptacles must be visible for field inspection by local authorities. Removal of drawers, covers or similar features is allowed for inspection, but no tools should be needed; and Shall not be used in a furnishing where flexible conduit will be subjected to repeatedly flexing after the initial installation.

3.6.4 Means shall be provided to mount the receptacles or raceway of a system to the work surface. The means provided shall have strength and rigidity to reduce the risk of distortion which facilitates installation in a manner other than intended.

3.7 Motors – Construction and overload protection

3.7.1 A motor shall comply with the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1, and shall be provided with overload protection by one of the following methods:

a) The Standard for Impedance Protected Motors, UL 1004-2;

b) The Standard for Thermally Protected Motors, UL 1004-3;

c) The use of a fuse;

d) A protective control evaluated in combination with the specific motor involved; or

e) The use of a circuit that disconnects power or reduces power from the motor in a sufficiently short time to prevent a fire hazard as determined by 3.5, Controls. Methods (c), (d), and (e) shall comply with the Running Overload Motor Test, 74.2, and Locked Rotor Test, 74.3.

3.7.2 The construction of Class 2, LPS, and SELV motors do not need to comply with the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1 provided they use a Class A Insulation System as defined in UL 1004-1 and comply with the requirements in this standard. Motors in a Class 2, LPS, or SELV circuit do not need to comply with the overload protection in 3.7.1(d), if the alternate method in 74.3.3 and 74.3.4 is performed.

3.7.3 When a requirement in this standard refers to the horsepower rating of a motor and the motor is not rated in horsepower, use is to be made of the applicable table of the National Electrical Code, NFPA 70, which gives the relationships between horsepower and full-load currents for motors. For a universal motor,

the table applying to a single-phase, alternating-current motor is to be used when the furnishing is marked for use on alternating current only; otherwise the table applying to direct-current motors is to be used.

3.7.4 The functioning of a motor-protective device provided as part of a furnishing, whether such a device is required or not, shall not result in an increase in the risk of fire, electric shock, or injury to persons.

3.7.5 Overload devices, including types used for running overload protection, other than those that are inherent in a motor, shall be located in each ungrounded current carrying conductor of a single-phase supply system and in each current carrying ungrounded conductor of a 3-phase supply system.

3.7.6 With reference to 3.7.1, an overload-protective device conforming with the National Electrical Code, NFPA 70, is identified as an overload device that is responsive to motor current and is rated or set as specified in column A of Table 3.4. When the rating of the motor-running overload protection determined to comply with the foregoing does not correspond to a standard size or rating of a fuse, nonadjustable circuit breaker, thermal cutout, thermal relay, or heating element of a thermal-trip motor switch, the next higher size, rating, or setting is able to be used, and is not able to be more than that specified in column B of Table 3.4. For a multispeed motor, each winding connection is to be evaluated separately.

Table 3.4
Maximum rating or setting of overload-protective device

Type of motor	Ampere rating of device as a percentage of motor full-load current rating	
	A	B
Motor with marked service factor of 1.15 or more	125	140
Motor with marked temperature rise of 40°C (72°F) or less	125	140
Any other motor	115	130

3.7.7 Motor-overload protection in which contacts control a relay coil in a motor starter shall comply with the requirements in 3.7.1.

3.8 Printed-wiring (circuit) boards

3.8.1 A printed-wiring board shall comply with the requirements in the Standard for Printed-Wiring Boards, UL 796, be suitable for direct contact, and shall be classed V-0, V-1, or V-2 in accordance with the requirements in the Standard for Test for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

Exception No. 1: A printed-wiring board containing only circuitry not exceeding Class 2 limits shall be rated minimum HB in accordance with the requirements in the Standard for Test for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

Exception No. 2: A printed-wiring board comprised of non-combustible materials is not required to comply with the Standard for Test for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

3.8.2 A furnishing that has a receptacle grounding path through traces on a printed wiring board shall comply with the Printed-Wiring Board (PWB) Ground Path Test, Section 72 and the Printed Circuit Board (PWB) Conductor Overcurrent Test, Section 73.

3.8.3 A trace on a PWB providing a current path to an external load operating inexcess of Class 2 power levels shall comply with the Printed Circuit Board (PWB) Conductor Overcurrent Test, Section 73.

3.9 Receptacles

3.9.1 A 15- or 20-ampere, nominal 120 volt receptacle in a furnishing shall be of the grounding type. The grounding contact of the receptacle shall be bonded in accordance with 14.3, Grounding and Bonding – Bonding.

3.9.2 A non-locking type 125-volt, 15 and 20 ampere receptacle (NEMA 5-15R or 5-20R) used in furnishings intended for use in business offices, corridors, waiting rooms and the like in clinics, medical and dental offices and outpatient facilities (Article 406.12, Item 5) shall be a Tamper-Resistant type and marked as specified in 87.2.11.

Exception No. 1: This requirement does not apply when receptacles are located more than 5-1/2 feet (1.7 m) above the floor.

Exception No. 2: This requirement does not apply when receptacles are part of a luminaire or appliance.

3.9.3 A non-locking type 125-volt, 15 and 20 ampere receptacle (NEMA 5-15R or 5-20R) receptacles that are controlled by an automatic control device, or that incorporate control features that remove power from the receptacle for the purpose of energy management or building automation, shall be marked as specified in 87.2.10.

3.9.4 A receptacle shall:

a) Be flush with or project beyond a nonconductive surrounding surface; or

b) Project at least 0.015 inch (0.38 mm) beyond a conductive surrounding surface.

3.9.5 Receptacles shall comply with the Spill Test, Section 77.

Exception No. 1: This requirement does not apply to a receptacle that is oriented in a position so its face is in a vertical plane ±5 degrees.

Exception No. 2: This requirement does not apply to a receptacle that is covered or otherwise protected from spillage when not in use.

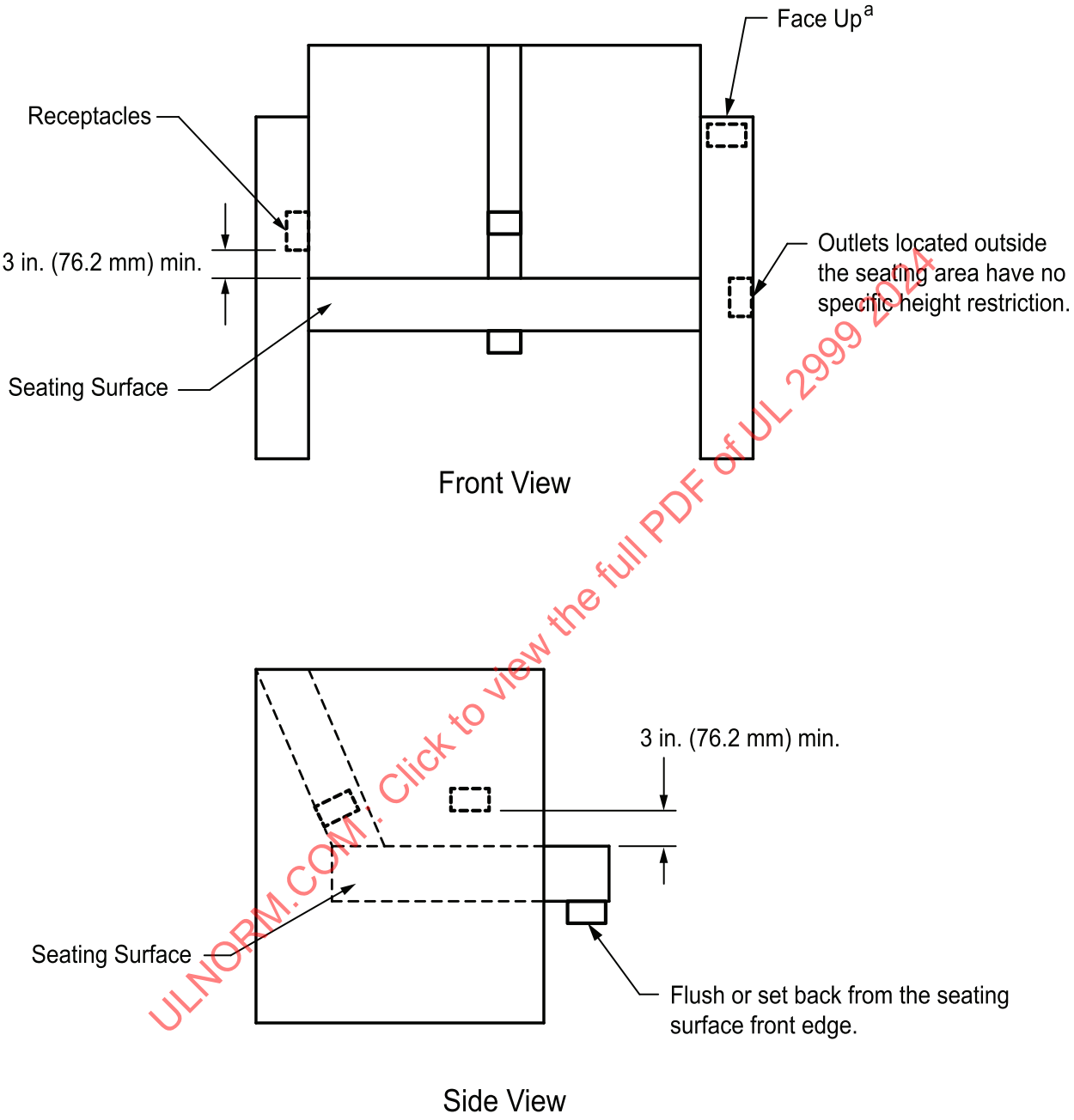
Exception No. 3: This requirement does not apply to a receptacle that is located at least 3 inches (76 mm) above the work surface, measured from the lower edge of the receptacle, when the work surface is adjusted to its highest position.

Exception No. 4: This requirement does not apply to a receptacle that is located adjacent to a seating surface and the receptacle is oriented in a position so its face is in a vertical plane ±5 degrees and located at least 3 inches (76 mm) above the uncompressed seating surface.

3.9.6 A furnishing intended to be permanently wired and provided with a receptacle installed within 6 feet (1.8 m) of a sink shall either be protected by an installed Class A type GFCI receptacle protecting all receptacles mounted within 6 feet (1.8 m) of the sink or shall specify in the installation instructions to connect the receptacle circuit to a branch circuit protected with a Class A GFCI device. See 94.14.

Figure 3.2

Receptacle locations for seating surfaces



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3.9.7 A receptacle shall not be provided in any storage area that is intended to store or hold liquids.

3.9.8 A receptacle shall not be mounted in an area that holds liquid containers, such that, if the container breaks the liquid would directly enter a receptacle or if the furnishing is able to retain the liquid the liquid would flood the receptacle.

3.9.9 For a cord and plug connected furnishing provided with one or more convenience receptacles overcurrent protection (OCP) shall be provided in accordance with Table 3.5, excluding OCP for electrical power systems, which shall comply with Section 20, Overcurrent Protection for Cord and Plug Table/Desk Electrical Distribution Systems. For a furnishing that has a convenience receptacle and additional equipment that consumes energy, such as lighting or a fan, OCP shall be provided, such that the total rating of the product is not exceeded. For example, a product rated 12 amps and provided with a light that draws 2 amps, either the overall device shall be protected with a 12 amp OCP or the receptacle shall be provided with a 10 amp OCP.

Table 3.5
Guide to construction requirements for convenience receptacles in furnishings

Furniture rating[d] (Amps)	Minimum power supply cord (AWG)	Number of receptacles	Supplementary OCP required?	Supplementary OCP rating[a] (Amps)	Temperature test load (Amps)	Minimum internal wiring size (AWG)
13 – 16	12	<6	NO	20[c]	20	12
13 – 16	12	<6	YES	20	20	12
12	14	<4	NO	15[c]	15	14
12	14	≥4	YES[c]	15	15	14
<12	14	<4	NO	15[b]	15	14
<12	14	≥4	YES	15	15	14

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

[b] When provided with an OCP.

[c] An OCP is not required for a 12 Amp rated furnishing with four receptacles as long as:

1) Internal wiring is 12 AWG;

2) The power-supply cord is 12 AWG;

3) All other components are evaluated for use at 20 A; and

4) The Temperature Test, Section 64 load is 20 A.

[d] If the product only has receptacles with no other load, the rating may be 20 amps for 12 AWG and 15 amps for 14 AWG.

3.9.10 Required overcurrent protection shall either be a supplementary overcurrent protector or a replaceable fuse.

3.9.11 A user replaceable fuse shall not allow the user to contact an electrically energized part during the replacement of the fuse.

3.9.12 A fuseholder shall be of the lock out type and prevent insertion of a fuse larger (higher current) than that specified.

3.9.13 A convenience receptacle shall be visible to the user.

Exception: The receptacle may be hidden if:

a) It can be made visible by opening a hinged door or the like; and

b) The supply cord to a furnishing will not be subject to abrasion because of the location of the receptacle.

3.9.14 Receptacle circuits shall not be provided with a dimmer.

3.9.15 For cord-connected Electrical Distribution Systems, the total number of grounding type receptacles shall not exceed eight under any configuration. Up to three (simplex) receptacles provided within a single enclosure, and that are within 1 foot (0.3 m) of each other, one duplex receptacle, or one triplex receptacle shall be treated as one receptacle. The interconnection means shall be designed to maintain polarity and to prevent more than eight receptacles.

3.10 Switching devices

3.10.1 General

3.10.1.1 These requirements apply to controls that perform any electrical switching function, either automatically or manually controlled, such as switches, relays, contactors, thermostats, thermal cutoffs, and circuit breakers.

Exception: They do not apply to a switching device in secondary circuits when:

a) The circuit in which the switching device is located is not a safety circuit; or

b) The switching device does not have a marked "off" position and is not used as part of the circuit to disconnect power when a switch with a marked "off" position is turned to the "off" position.

3.10.1.2 All manually operated or adjustable switching devices shall be of the indicating type. The indicating means shall be incorporated on the device or knob, on an attached plate, or on the panel on which the device is mounted.

3.10.1.3 With reference to 3.10.1.2, a switching device that has only "on" and "off" positions is not prohibited from being provided with the international symbols "I" and "O" to signify "on" and "off" when the significance of these symbols is explained in the instructions packaged with the furnishing.

3.10.1.4 When a switching device with a marked "off" position is mounted such that movement of the operating handle is vertical, the lower position shall be the "off" position.

Exception: This requirement does not apply to a switching device having two or more positions in addition to the "off" position, such as a double-throw switch.

3.10.1.5 A switching device shall be judged with respect to the temperature limitations of the materials employed.

3.10.1.6 A manually-operated motor-control switch shall be provided in a cord-connected motor-operated furnishing that employs a motor rated more than 1/3 horsepower (250 W output).

3.10.2 Switch electrical ratings

3.10.2.1 A switching device shall have a current and voltage rating not less than that of the load that it controls when the furnishing is operated as specified in the Normal Temperature Test, Section 64.

3.10.2.2 The current rating of a switching device that controls a solenoid, a magnet, a transformer, an electric-discharge-lamp (such as fluorescent and HID) ballast, or any inductive load other than a motor shall be at least twice the rated full-load current of the component that it controls, unless the switch has been found acceptable for the control of an inductive load at least equal to the rated full-load current of the component.

3.10.2.3 A switching device that controls a motor load shall have a motor rating (full-load/locked rotor amps or horsepower) at least equivalent to the load.

3.10.2.4 A switching device that controls a screw shell-type lampholder or another tungsten-filament load shall:

a) Have a tungsten-filament lamp rating at least equivalent to the rating of the anticipated load, but not less than 25 W;

b) Have a current rating equivalent to at least six times the rating of the anticipated load, but not less than 150 W, for alternating-current circuits; or

c) Have a current rating equivalent to at least ten times the rating of the anticipated load, but not less than 250 W, for direct-current circuits.

Exception: This requirement does not apply to pilot or indicating lamps, or to lampholders for pilot or indicating lamps.

3.10.2.5 A switching device controlling any combination of a tungsten-filament load, a motor or other inductive load, and a resistive load, shall have a current rating at least equal to the sum of any ratings required by 3.10.2.1 – 3.10.2.4, as applicable, and the rated current of the resistive load.

3.10.2.6 A switching device provided as part of a furnishing intended to be connected to a power-supply circuit involving a potential to ground of more than 150 volts shall be acceptable for the maximum potential to ground of the circuit.

3.10.3 Specific applications

3.10.3.1 A switching device in a fixed or stationary furnishing that controls a heating element and has a marked "off" position shall open all ungrounded conductors of the heating-element circuit or cause the conductors to be opened.

3.10.3.2 An automatically reset protective device shall not be employed when automatic resetting results in injury to a person.

4 Units of Measurement

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

4.2 Values of voltage and current are rms values, unless otherwise stated.

4.3 Where the measurement is not a minimum, maximum, or provided with its own tolerance number, the following tolerances shall be acceptable:

Measurement	Range	Tolerance(±)
Linear Dimension	Up to 3/64 inch (1 mm)	0.002 inch (0.05 mm)
	3/64 to 1 inch (1 – 25 mm)	0.004 (0.1 mm)

Measurement	Range	Tolerance(±)
	> 1 inch (25 mm)	0.5%
Angles	ALL	0.2%

Note that instead of the words minimum or maximum, the limits may be expressed by other phrases such as not less than, not more than, shall not exceed, etc.

5 Undated References

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.

6 Environmental Considerations

6.1 All furnishings are considered intended for dry locations only. The furnishings shall not be provided with any information such as markings, instructions, or illustrations that implies or depicts damp or wet use.

7 Assembly

7.1 A furnishing shall be completely wired with all splices and electrical connections before the furnishing leaves the factory. The furnishing itself is not prohibited from being shipped unassembled.

Exception: Electrical connections made by connectors instead of splices are not required to be wired before the furnishing leaves the factory.

7.2 Furnishings shipped unassembled where all individual pieces are shipped from the same manufacturing location shall be shipped from the factory in a carton or as an unpackaged complete assembly. Unassembled parts, when required elsewhere in the standard to accompany the furnishing, shall be included. Glassware is not required to be actually mounted in a frame or holder; it is able to be separately wrapped to protect it from breakage during shipment.

7.3 Furnishings shipped unassembled where the individual pieces, (sub-assemblies) are shipped from more than one manufacturing location and shipped to the field for assembly shall be constructed so that each sub-assembly is capable of being incorporated into the final assembly without requiring alteration by the installer. This excludes items that are part of the assembly instructions, such as attaching a work surface top with screws. Subassemblies that must bear a definite relationship to each other for the intended operation of the product shall be arranged and constructed to permit them to be incorporated into the complete assembly only in the correct relationship with each other, without requiring alteration or realignment. See Section 93, Markings for Sub-Assemblies and Section 99, Instructions for Sub-Assemblies.

7.4 When wires pass through a joint between sections of a furnishing that are separable for packing purposes, the joint shall be such that rotation of one section with respect to the other during the assembly of the sections is limited to not more than 360 degrees. Friction alone does not meet the intent of the requirement to prevent rotation.

Exception: When all of the following conditions exist, rotation between sections of a furnishing is not limited to 360 degrees:

a) The internal diameter of the tubing through which the wires pass is 1/2 inch (12.7 mm) or more;

b) The rotation during assembly is limited to not more than one revolution for each 3 inches (76 mm) of unobstructed tubing length through which the wires pass, when such rotation does not place any stress on the conductors; and

c) The conductors do not involve splices unless the splices are:

1) Inaccessible during assembly in accordance with Figure 13.1; and

2) Secured and provided with strain relief that has been shown to be reliable and not easily defeated by the user, such as being able to be removed or rotated.

7.5 When a splice or an electrical connection is located in a section of a furnishing that is separable for packing purposes, as noted in 7.1, the unit shall be provided with strain relief to reduce the risk of stress being transmitted to the splice or electrical connection during unpackaging and assembly of the furnishing. The strain relief shall be reliable and not easily defeated by the user. See the Strain Relief For Internal Conductors And Connectors Test, 66.2.

7.6 When wires pass through a joint between sections of a furnishing that are separable for packing purposes the joint or section shall comply with 10.2.6, Protection of Cord and Wiring, while unassembled.

7.7 When in any position of adjustment, a spring-loaded or adjustable section of a furnishing shall not transmit stress to a splice or wiring within any section of the unit either during assembly or when completely assembled. For example, the stem of an adjustable height floor-furnishing unit shall raise and lower without binding or crimping the wiring of the unit.

7.8 A part that must be removed to assemble a furnishing in the intended manner to the supply circuit is not required to be fastened, but the construction shall be such, and the hardware shall be provided, to allow field assembly.

7.9 Any furnishing that is not completely assembled shall be provided with assembly instructions, which may be provided via a website. See 94.1.

8 Accessories

8.1 A furnishing having provision for the use of an accessory shall be constructed so that the use of the accessory does not introduce a risk of fire, electric shock, or injury to persons.

8.2 A furnishing shall comply with the requirements in this Standard with or without the accessory installed.

8.3 Installation of an accessory by the user shall be restricted to an arrangement by which the electrical connections are accomplished by means of mating connectors, attachment plugs and receptacles, or attachment plugs and cord connectors that maintain correct polarity.

8.4 Installation of an accessory shall not require, splicing, cutting of wiring, or the soldering of connections by the installer.

Exception: Accessories, such as a power in-feed, that are intended to be connected and installed by a trained individual, such as an electrician, may be cut and spliced to connect to the building wiring system.

8.5 Strain-relief means shall be provided for the wiring of an accessory where stress may be transmitted to the connections during or after installation.

8.6 The mounting method and location of an accessory shall be specified in the installation instructions for the furnishing. See Section 97, Accessory Instructions.

8.7 Instructions shall be provided with the accessory covering the model number or series of furnishing the accessory is intended for use with. See Section 97, Accessory Instructions.

8.8 The instructions shall be sufficiently detailed and accurate so that installation is feasible, and that the furnishing complies with the requirements of this standard with the accessory installed. See 29.2, General Conditions – Trial Installation.

8.9 An accessory may be shipped with or separately from the basic furnishing.

8.10 A part that is required for the furnishing to perform its basic function is not considered an accessory and shall be supplied with the basic furnishing.

CONSTRUCTION

9 General

9.1 Each electrical device and insulated conductor shall have ratings (voltage, current, wattage, temperature, etc.) at least equal to the parameters that are applied to it during intended use.

9.2 Means shall be provided to reduce the risk of contact between the surface of a cabinet and a cabinet light other than at the intended mounting means so that the temperature of the mounting surface or the surface where the light falls does not exceed its temperature limit. The means provided shall have strength and rigidity to reduce the risk of distortion which facilitates installation in a manner other than intended.

9.3 When wires pass through a joint between sections of a furnishing the construction shall comply with the requirements in 7.4.

9.4 A furnishing shall be formed and assembled so that it has the strength, stability, and rigidity required to resist the abuses during normal use and maintenance to which it is subjected without increasing the risk of fire, electric shock, or injury to persons.

9.5 A furnishing shall be smooth and rounded and shall not be so sharp as to constitute a risk of injury to persons during intended use and maintenance of a product, when investigated in accordance with the Standard for Tests for Sharpness of Edges on Equipment, UL 1439.

9.6 A Furnishing or part of a furnishing is considered to be subjected to physical abuse if a 2-in (51-mm) diameter sphere is able to contact the part.

Exception: If the location of the part makes it unlikely that the part will be accidently contacted it is not considered to be subjected to mechanical abuse such as directly underneath a fixed work surface.

9.7 When conductors are stranded, the connection means shall be such that loose strands are minimized.

9.8 All connections shall be electrically and mechanically secure.

9.9 Fixed Furnishings shall be provided with a means to be mounted to the building structure. Stationary Furnishings may be provided with a means to be mounted to the building structure. Portable Furnishings may be provided with a temporary (no tools are needed to remove the furnishing) means to be mounted to the building structure.

10 Power-Supply Connections

10.1 Permanently connected furnishing

10.1.1 A permanently connected furnishing shall be provided with field-wiring terminals or leads for the connection of conductors having an ampacity rated as intended for the furnishing, and in accordance with the National Electrical Code, NFPA 70. A furnishing shall be provided with a splice compartment, junction box or length of raceway to make connections.

10.1.2 A lead that is intended to be connected in the field to a power-supply circuit conductor shall not be smaller than 18 AWG (0.82 mm^2), and shall be sized based on the rated current of the furnishing.

10.1.3 A terminal or splice compartment shall be complete and shall enclose all field-wiring terminals and splices to be made in the field.

10.1.4 Each terminal or splice compartment in which power-supply connections are to be made in the field shall be located so that the connections are able to be readily accessible for inspection after installation of the furnishing.

10.1.5 The compartment specified in 10.1.4 shall be located so that, when making conduit connections, internal wiring and electrical components are not exposed to mechanical abuse or strain.

10.1.6 A terminal compartment intended for connection of a supply electrical enclosure shall be attached so as to be prevented from turning with respect to the supporting surface.

10.1.7 A wiring terminal shall be prevented from turning or shifting in position.

10.1.8 A wire-binding screw at a wiring terminal shall not be smaller than No. 10 (4.8 mm diameter). If a pre-tapped hole is not provided, a thread-forming screw shall be used.

Exception: A No. 8 (4.2 mm diameter) screw is able to be used at a terminal intended only for connection of a 14 AWG (2.1 mm^2) or smaller conductor.

10.1.9 A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.050 inch (1.27 mm) thick.

Exception: A plate not less than 0.030 inch (0.76 mm) thick is able to be used when the tapped threads comply with Section 56, Tightening Torque Test.

10.1.10 A wire-binding screw shall be provided with an upturned lug, cupped washer, or equivalent means that retains a supply conductor of the size intended.

10.1.11 A terminal (for example, a plate and screw) intended for the connection of the grounded supply conductor shall be formed of or plated with metal that is substantially white in color and shall be readily distinguishable from other terminals or shall be clearly identified in some other manner, such as on an attached wiring diagram.

10.1.12 A lead intended for the connection of the grounded power-supply conductor shall be finished to show a white or gray color, and shall be readily distinguishable from other leads.

10.1.13 The free length of a lead located inside an outlet box or field-wiring compartment and intended for field connection to a branch circuit shall not be less than 6 inches (152 mm).

10.1.14 When a terminal block is provided, it shall be suitable for field wiring.

10.1.15 An opening for conduit shall have dimensions as indicated in Table 10.1.

Table 10.1
Dimensions associated with openings for conduit

Nominal trade size of conduit	Unthreaded opening diameter[a]		Throat minimum		Diameter maximum		Minimum diameter of flat surface	
inches	inch	(mm)	inch	(mm)	inch	(mm)	inch	(mm)
1/2	0.875	(22.2)	0.56	(14.2)	0.62	(15.7)	1.15	(29.2)
3/4	1.109	(28.2)	0.74	(18.8)	0.82	(20.8)	1.45	(36.8)
1	1.375	(34.9)	0.94	(23.9)	1.05	(26.7)	1.80	(45.7)
1-1/4	1.734	(44.0)	1.24	(31.5)	1.38	(35.1)	2.31	(58.7)

[a] A plus tolerance of 0.031 inch (0.79 mm) and a minimum tolerance of 0.015 inch (0.38 mm) applies to the knockout diameter. Knockout diameters are measured other than at points where a tab remains after removal of knockout.

10.1.16 The minimum unobstructed diameter of the flat surface surrounding the back of an opening for unthreaded conduit shall be as indicated in Table 10.1.

10.1.17 When threads for the connection of threaded conduit are tapped all the way through a hole, there shall be no fewer than 3-1/2 or more than 5 threads. The construction of the hole shall be such that a conduit bushing is able to be properly attached and the minimum unobstructed diameter surrounding the back of the hole shall be as indicated in Table 10.1.

10.1.18 When threads for the connection of threaded conduit are not tapped all the way through a hole, there shall be no fewer than five full threads. The unthreaded parts of the hole and the back edge shall be smooth and well-rounded for protection of the conductors. The unthreaded throat diameter of the hole shall have an internal diameter as noted in Table 10.1.

10.1.19 The minimum usable volume of a field wiring compartment shall be as specified in Table 10.2.

Table 10.2
Minimum usable volume of terminal compartment

Size of conductors		Volume for each conductor that originates outside the compartment and terminates or is spliced within the compartment, and each conductor that passes through the compartment without splice or termination, including a grounding conductor.	
AWG	(mm^2)	cm^3	(cubic inches)
18	(0.8)	24.6	(1.50)
16	(1.3)	28.7	(1.75)
14	(2.8)	32.77	(2.00)
12	(3.3)	36.87	(2.25)
10	(5.3)	40.97	(2.50)
8	(5.5)	49.2	(3.0)
6	(6.5)	81.9	(5.0)

10.1.20 Conduit shall only be used as permitted by NFPA 70. For example, flexible metal conduit shall not be used where it is subject to physical abuse and flexed after installation.

10.2 Cord-connected furnishing

10.2.1 Cord Requirement

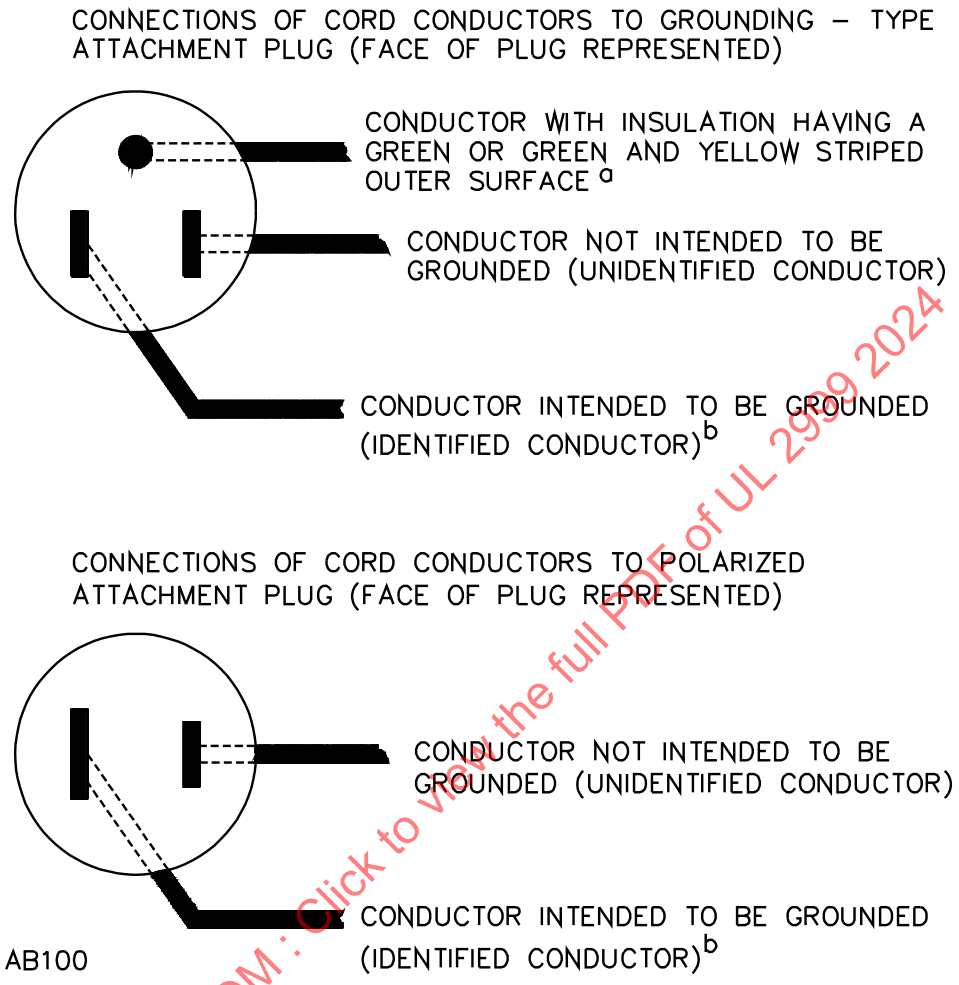
10.2.1.1 A furnishing intended to be connected to the power-supply source by means of a flexible cord and plug shall be provided with a flexible cord and an attachment plug for connection to the supply source. Furnishings supplied with more than one power supply cord shall comply with 10.2.2, Multiple Power Supply Cords.

10.2.1.2 When a 3-wire grounding-type or a 2-wire polarized attachment plug is provided, the circuit conductors in the flexible cord shall be connected to the plug and to the wiring in the product so that any of the following devices used in the primary circuit shall be connected in an ungrounded current carrying conductor: the center contact of the Edison-Base lampholder, a single pole switch, an automatic control with a marked off position, a single fuseholder, and any other single-pole overcurrent protective device.

10.2.1.3 When a 3-wire grounding-type attachment plug or a 2-wire polarized attachment plug is provided, the attachment plug connection shall comply with Figure 10.1 and the polarity identification of the flexible cord shall comply with Table 10.3. See Section 101, Operating Instructions.

Figure 10.1

Connections to attachment plugs



[a] In the above illustration, the blade to which the green conductor is connected is able to have a U-shape instead of a circular cross section.

[b] Signifies a conductor identified in accordance with Table 10.3. The grounded (identified) conductor is the neutral supply conductor.

Table 10.3
Polarity identification of flexible cords

Method of identification	Usable combinations	
	Wire intended to be grounded[a,b]	All other wires[a]
Color of braid on individual conductors	Solid white or gray – without tracer	Solid color other than white or gray – without tracer
	Color other than white or gray, with tracer in braid	Solid color other than white or gray – without tracer
Color of insulation on individual conductors	Solid white or gray[c]	Solid color other than white or gray
Other means	Light blue[d]	Solid color other than light blue, white, or gray
		No tin or other white metal on the strands of the conductor

[a] A wire finished to show a green color with or without one or more yellow stripes or tracers is to be used only as an equipment-grounding conductor. See 14.2.1 and Figure 10.1.

[b] The grounded conductor is the neutral supply conductor.

[c] Only for cords – other than Types SPE-2 and SPT-2 – having no braid on any individual conductor.

[d] For jacketed cords.

10.2.1.4 A furnishing required to be grounded shall be provided with a grounding-type attachment plug.

10.2.1.5 If the cord includes an equipment grounding conductor, the grounding conductor shall be connected to all exposed or accessible unenergized metal parts that may become energized of the furnishing by a mechanical means in accordance with Grounding and Bonding, Section 14 and to the grounding pin of a grounding attachment plug. See Figure 10.1.

10.2.1.6 The power-supply cord shall be rated for use at a voltage not less than the rated voltage of the product. The power-supply cord shall be sized in accordance with Table 10.4. A furnishing provided with a 20 Amp rated receptacle shall be provided with a minimum 12 AWG (3.3 mm^2) conductor cord or when provided with a 15 Amp receptacle with a minimum 14 AWG (2.1 mm^2) conductor cord.

Table 10.4
Power supply cord ampacity

Cord size AWG (mm^2)	Furniture maximum rating (Amperes) per cord	
	3 current-carrying conductors	2 current-carrying conductors
6 (13.3)	45	55
8 (8.4)	35	40
10 (5.3)	25	30
12 (3.3)	20	25
14 (2.1)	15	18
16 (1.3)	10	13
18 (0.82)	7	10

10.2.1.7 The flexible cord shall be of a type indicated:

a) Cords acceptable where temperatures of more than 121°C (250°F) are attained on any surface the cord can contact:

HSJ, HSJO, HSJOW

b) Cords acceptable where 121°C (250°F) or lower temperatures are attained on any surface the cord can contact:

SJ (Hard Usage), SJT, SJE, SJEO, S (Extra Hard Usage), SO, SOW, SOO, SOOW, STO, STOW, STOO, STOOW, SEO, SEOW, or equivalent Hard Usage (SJ) or Extra Hard Usage (S) cords.

10.2.1.8 A power supply with a supply cord input shall comply with 10.2.1. – 10.2.1.7.

10.2.1.9 When a furnishing employs a power supply with a supply cord input and output conductors the combined length of the supply cord and the output conductors shall be in compliance with Table 10.6 requirements. For example, if the input cord is 2 feet (609.6 mm) and the output wiring is 3 feet (914.4 mm), the total length of cord is considered to be 5 feet (1524 mm).

10.2.1.10 The length of a power supply cord shall be within the limits specified in Table 10.6.

Table 10.6
Length of power supply cord

Cord exit point (Based on the construction or the use instructions)	Minimum acceptable length		Maximum acceptable length	
	Feet	(mm)	Feet	(mm)
Cord exit point lower than 3 feet from the floor	5.0	(1524)	25	(7620)
Cord exit point greater than 3 feet from the floor	9.0	(2743)	25	(7620)

10.2.1.11 When the intended means of mounting or other features or constructions of a furnishing warrants other than the required length of power-supply cord, a shorter cord is able to be provided. Instructions shall be provided in accordance with 94.11.

10.2.1.12 The current rating of the attachment plug of a furnishing shall not be less than 125 percent of the maximum current input of the furnishing or the marked rating when no electrical load is provided as part of the furnishing.

Exception: Furnishings that only incorporate electrical distribution systems and are provided with a cord and plug.

10.2.1.13 Means shall be provided to support the cord to reduce risk of contact with a cabinet light at a location other than the cord exit.

Exception: If the temperature rating of the cord is equal to or above the maximum temperature measured during the Temperature Test, Section 64.

10.2.1.14 The furnishing shall be constructed so that neither the cord nor plug is damaged when the furnishing is placed against a wall. Examples of constructions include, but are not limited to wood blocks to hold the furnishing out from the wall and right angle (flat) cord/plugs.

10.2.1.15 Power supply cords and interconnecting cords that constitute a risk of injury, which includes shock and fire, from damage shall be protected from moving parts of a furnishing.

10.2.1.16 Cords subject to flexing shall be subjected to the Conductor Cycling Endurance Test, Section 68 unless:

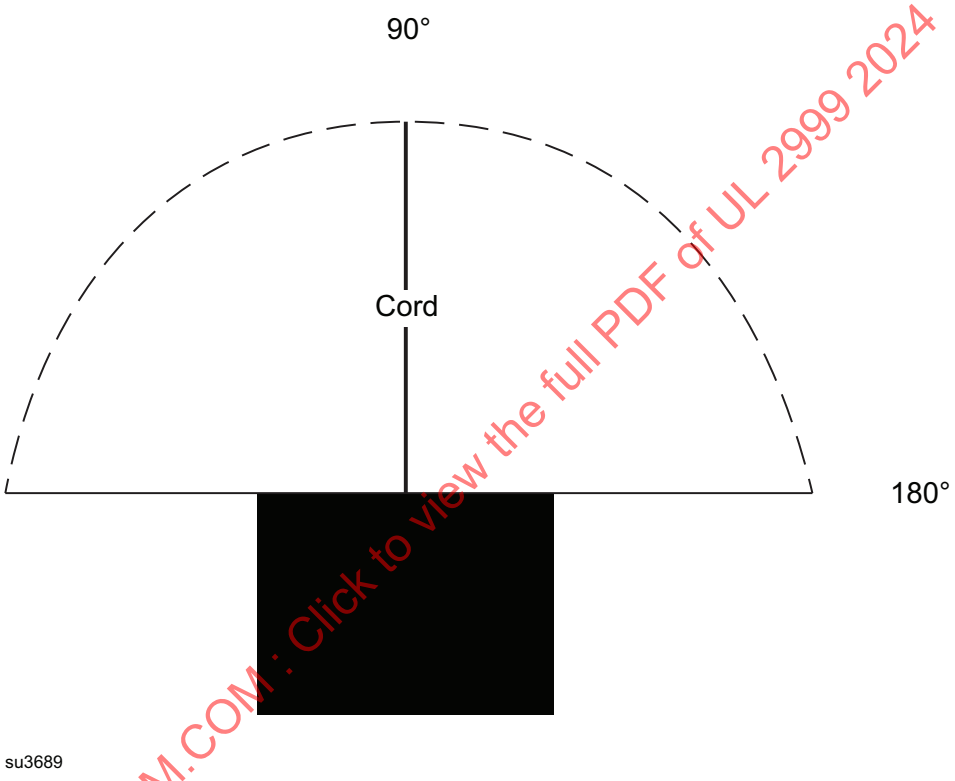
a) The cord is not flexed more than 90 degrees as specified in Figure 10.2;

b) The cord is provided with a strain relief at each end of the cord where it enters an enclosure; and

c) The cord is not subject to a twisting motion along its longitudinal axis.

Figure 10.2

Cord Flexing



10.2.1.17 Cord and plugs shall not be used where recessed in the furnishing unless it complies with the requirements in 17.3, Cord Used For Internal Wiring.

10.2.2 Multiple power supply cords

10.2.2.1 Cord connected furnishings shall not be provided with more than one power supply cord unless all of the following conditions are met:

a) Not more than two cords are provided;

b) Each flexible cord is of the type, size, and rating required for the type of product and the load supplied;

c) Each attachment plug cap's rating is:

1) Not less than that of the furnishing and not less than the maximum current input of the furnishing when tested in accordance with the Input Test, Section 63;

2) The current rating of the attachment plug of a furnishing rated more than 15 amperes shall not be less than 125 percent of the maximum current input of the furnishing when tested in accordance with the Input Test, Section 63, and not less than 125 percent of the rated current of the furnishing;

d) The total current input in accordance with the Input Test, Section 63, (including current through all cords) is not more than 80 percent of the branch circuit supply for the single branch circuit to which it is connected (based on the plug configuration);

Exception No. 1: The current is not required to be less than 80 percent of the single branch circuit when the plugs are supplied by separate branch circuits, evidenced by any of the following:

i) The attachment plugs are not the same configuration or rating and the instructions contain the information in 100.6 (a) and (b);

ii) The rating of either or both plugs is greater than 20 Amps; or

iii) The product is marked in accordance with 87.2.7, and the instructions contain the information in 100.6 (a) and (c).

Exception No. 2: The current is not required to be less than 80 percent of the branch circuit rating when:

i) Both attachment plugs are rated 15 Amps or less; and

ii) The total current input is equal to or less than the attachment plug rating.

e) With reference to 10.2.2.1, Exception No. 1 (d) (i), where detachable power supply cords are used, both the attachment plugs and the inlets shall have different configurations.

f) The product is provided with a single accessible control or switch with a marked "off" position that disconnects all ungrounded conductors of the product;

Exception No. 3: The furnishing is not required to have a single disconnect when multiple disconnect means are provided in accordance with any of the following:

i) There is a control or switch for each of the two power supply cords, and the controls or switches are grouped and identified;

ii) Both power supply cords are of the detachable type, the only supplied loads are receptacles, and the cord attachment points are grouped and identified;

iii) The product is provided with a mechanical or electrical interlock system that results in all ungrounded conductors of the supply being disconnected in the event that either cord is disconnected; or

iv) A marking is provided and located adjacent to each switch in accordance with 87.2.8.

g) The furnishing is rated in accordance with 86.3;

h) The product contains the markings in 87.2.7; and

i) The furnishing is provided with instructions as indicated in 100.6.

10.2.2.2 A cord and plug connected electrical distribution system shall only be provided with one cord.

10.2.3 Detachable power supply cords

10.2.3.1 Shall comply with the following:

a) Shall either be provided with an NEMA WD-6 configuration mating attachment cord connector body and inlet; or

b) Be provided with a Standard for Appliance Couplers for Household and Similar General Purposes – Part 1: General Requirements, UL 60320-1 configuration mating appliance attachment cord connector body and inlet.

10.2.3.2 The power supply cord ampacity shall be rated for the maximum current rating of the appliance inlet configuration provided.

10.2.3.3 Adjacent to the inlet shall be marked the maximum voltage and current rating of the furnishing and a WARNING statement as specified in 87.2.16.

10.2.4 Secondary connections

10.2.4.1 A furnishing powered by a direct plug-in power supply with a Class 2 or LPS output shall comply with the output cord conductor requirements specified for the power supply.

10.2.4.2 When a furnishing employs a direct plug-in power supply the length of the output conductors shall be in compliance with Table 10.6 requirements.

10.2.4.3 A furnishing powered by a remote power supply shall be provided with a means of connection for each circuit in accordance with Section 10, Power Supply Connections.

Exception No. 1: A Class 2/LPS furnishing is permitted to provide a means of connection suitable for power limited cable such as CL2, CL3, CAT6 [for a Power Over Ethernet (POE)], or equivalent.

Exception No. 2: A Class 2/LPS furnishing unit may be used with an exposed bare conductor system provided that all low voltage current-carrying parts that extend through or are located behind a wall, ceiling surface, or other enclosed area after installation shall be enclosed in material that complies with 11.6, Electrical Enclosures – General, 11.7, Metallic Electrical Enclosures, and 11.8, Electrical Enclosures of Polymeric Materials.

10.2.4.4 An exposed bare conductor power unit shall be provided with an output connection means which provides an electrically and mechanically secure connection for the low voltage exposed bare conductors.

10.2.4.5 For a Class 2 furnishing employing an interconnecting wiring system that is included as part of the system, the wiring method is permitted to be other than specified in 10.2, provided the wiring complies with Section 17, Internal Wiring. Flexible cord shall not be used for a supply connection means that is intended to be:

a) Concealed or extended through a wall, floor, ceiling, or similar building structure such as a kitchen cabinet;

b) Located above a suspended ceiling or dropped ceiling;

c) Not visible for its entire length; or

d) Subject to strain or physical damage.

10.2.5 Strain relief

10.2.5.1 A strain-relief means shall be provided so that mechanical stress placed on a flexible cord or flexible conduit is not transmitted to terminals, splices, or internal wiring. When a clamp is employed with a cord, auxiliary insulation is required when the clamp is able to damage the cord insulation.

10.2.5.2 Insulating bushings serving as strain relief shall comply with the Standard for Insulating Bushings, UL 635. Tests specified in this Standard (e.g. Strain Relief Test) may still need to be performed to confirm the combination of the insulating bushing and the supporting parts are suitable in combination.

10.2.5.3 If wood, pressed board, or other fibrous material is used to secure the strain-relief assembly, the fibrous material shall be secured to the furnishing by a positive means.

10.2.5.4 Means shall be provided to reduce the likelihood of an attached supply cord or lead from being pushed into the enclosure of a furnishing through the cord-entry hole if damage to cord could result from contact with internal mechanical and electrical components or systems.

10.2.5.5 To determine compliance with 10.2.5.1, a strain relief means is to be subjected to the applicable tests specified in Section 66, Strain Relief Tests.

10.2.5.6 A metal strain relief clamp or band shall not be used unless it has been evaluated to the Standard for Conduit, Tubing, and Cable Fittings, UL 514B for the size of, number of and type of cord or conductor.

10.2.6 Protection of cord and wiring

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

10.2.6.2 The cord shall be provided with mechanical means that prevent the cord being pushed inside the enclosure and contacting:

a) A lamp or heated surface;

b) A sharp edge;

c) A moving part; or

d) Other hazards, such as displacing components in circuitry exceeding Class 2 or LPS.

10.2.6.3 An insulating bushing shall be provided where the flexible cord or wiring enters a pendant lampholder or the base or stem of a furnishing, and at the ends of metal tubing where the cord or wiring are pulled during the adjustment of the unit.

Exception No. 1: A smooth, metal bushing is able to be used when Type SPT-2, SJ, SV, or heavier cord is used.

Exception No. 2: An insulating bushing is not required with Integral Type SPT-2 cord when:

a) The metal through which the cord passes is not less than 0.042 inch (1.07 mm) thick and the surface is smooth, or the edge of the metal is rolled not less than 120 degrees; or

b) The cord at the point where it passes through the hole is provided with additional insulation that is:

1) Not less than 1/32 inch (0.8 mm) thick;

2) Molded to the cord; and

3) Of thermoplastic for Type SPT-2 cord.

10.2.6.4 Cord or wiring that passes through tubing or contacts the edge of a sheet-metal wall 0.042 inch (1.07 mm) or less thick shall be reliably held away from the edges of the metal or shall be protected by a non-rubber bushing or a grommet or by rolling the edge of the metal not less than 120 degrees.

10.2.6.5 When cords or wires pass through or contact the edges of sheet metal thicker than 0.042 inch (1.07 mm), the metal shall be treated by reaming or the equivalent to remove burrs, fins, or sharp edges that are able to damage insulation.

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

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

10.2.6.8 A hard-fiber bushing or grommet form is able to be employed when the bushing is not less than 3/64 inch (1.2 mm) thick. A rubber bushing is not suitable for use.

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

10.2.6.10 Polymeric sleeving shall not be used for reducing the risk of cutting or abrasion of wiring. Fiberglass sleeving not less than 0.010 inch (0.25 mm) thick is capable of being used.

10.2.6.11 A bushing shall be securely held in place.

10.2.6.12 When a power supply cord is routed internally or externally along a furnishing or a cord is utilized for the interconnection of electrical components provided with the furnishing the cord shall be protected from damage by any of the following means:

a) Recessing the cord in a channel or a complete enclosure;

b) Providing projections extending out from the furnishing at least equivalent to the depth of the diameter of the cord; or

c) Providing a removable protective cover.

11 Enclosures and Guards

11.1 General

11.1.1 Among the factors taken into consideration in determining the acceptability of an enclosure are its:

a) Physical strength;

b) Resistance to impact;

c) Moisture absorptive properties;

d) Combustibility;

e) Resistance to corrosion; and

f) Resistance to distortion at temperatures to which the enclosure may be subjected under conditions of normal or abnormal use.

For a nonmetallic enclosure, all of these factors are to be considered with respect to thermal aging.

11.2 Channels and raceways used for mechanical support

11.2.1 Channels and raceways shall be located underneath the furnishings and not run in the open between furnishing work stations unless they are above 28 inches and they are evaluated in accordance with 11.2.3.

11.2.2 Channels and raceways used to support a work surface or storage shall comply with the testing requirements in Section 32, Structural Test Requirements – General Loading; Section 34, Desks and Tables; Table 34.1; Section 35, Storage Furnishings; and Table 35.1, as applicable.

11.2.3 Channels and raceways intended for seating or that may be used for seating shall comply with the testing requirements in Sections 32, Structural Test Requirements – General Loading; Section 33, Seating; Table 33.1; Table 33.2; Section 37, General Stability Test Criteria; Section 38, Furnishing Stability Configuration Test Requirements; Section 40, Seating; Table 40.1 and Table 40.2, as applicable.

11.3 Personal injury, entrapment, pinch points, and shear considerations

11.3.1 When the operation and maintenance of a furnishing by the user or bystanders involves the risk of injury to persons, protection shall be provided to reduce the risk. All moving parts shall be made inaccessible by guards or bellows, or, if accessible, not present any risk of injury.

11.3.2 When investigating a furnishing with respect to the requirement in 11.3.1, conditions of foreseeable misuse shall be evaluated.

11.3.3 Among the factors which need to be considered simultaneously, to be evaluated with respect to both intended operation of the furnishing and any foreseeable misuse in investigating an exposed moving part are:

a) The degree of exposure required to perform the intended function;

b) The sharpness of the moving part. Moving parts shall have accessible edges rounded to a radius of 0.8 mm (0.03 inches) and accessible corners to 1.6 mm (0.06 inches);

c) The risk of unintentional contact by the user or someone in the area. A furnishing that when installed or placed in its intended location and its highest point of travel is 84 inches (2,130 mm) above the floor is not considered a risk of unintentional contact. Installation and operation instructions shall warn against placing a fixed structure at a point less than 85 inches (2159 mm) above the movable component of the furnishing;

Exception: A furnishing, when installed or placed in its intended location and its highest point of travel is 84 inches (2,130 mm) above the floor, is not considered a risk of unintentional contact. Installation and operation instructions shall warn against placing a fixed structure at a point less than 85 inches (2159 mm) above the movable component of the furnishing.

d) The speed of the moving part. Usage Area III: Moving parts that may cause entrapment traveling less than 1 inch / second (2.54 cm/second) are not considered an entrapment hazard provided the requirements for commercial operator attended products in 23.2, Usage Area III are followed. If two parts are in motion, the combined speed of the parts shall be considered. The speed for rotating parts shall be measured at the fastest moving point. Space around accessible pinch points should not be constrained such that a user is unable to retract a body part with sufficient speed from the space to avoid injury;

e) The risk that a part of the body is endangered or that clothing is able to be entangled by the moving part, resulting in a risk of injury to persons;

f) The force involved when loaded with the rated load; and

g) A force of 2 lbs (9 Newtons) or greater is required for the person to become dislodged.

11.3.4 When considering entrapment or pinch points, consideration should be given to the body part(s) that may become trapped. See Table 11.1 for dimension requirements for spacing to prevent entrapment.

Table 11.1
Entrapment space requirements

Body Part	Child Inches (cm)		Adult Inches (cm)	
	Less Than	Equal to or More Than	Less Than	Equal to or More Than
Arm	0.16 (0.41)	5.0 (12.7)	0.16 (0.41)	5.0 (12.7)
Body	None	20.0 (50.8)	None	20.0 (50.8)
Finger	0.16 (0.41)	1.0 (2.5)	0.32 (0.8)	1.0 (2.5)
Foot	1.0 (2.5)	4.72 (12.7)	1.4 (3.5)	5.0 (12.7)
Hand	0.16 (0.41)	4.0 (10.2)	0.16 (0.41)	4.0 (10.2)
Head	2.4 (6.1)	12.0 (30.5)	4.8 (12.0)	12.0 (30.5)
Leg	0.16 (0.41)	7.0 (17.8)	0.16 (0.41)	7.0 (17.8)
Toes	0.16 (0.41)	2.0 (5.1)	0.16 (0.41)	2.0 (5.1)

11.3.5 When considering entrapment or pinch points, consideration should be given to the ability to reach the potential entrapment area. See Table 11.2. Potential areas that are beyond the dimensions given are not considered a hazard to the user or person near the furnishing.

Table 11.2
Entrapment reach requirements

Body Part	Inches (cm)	Comment
Height	84 (213)	Measured from the floor
Arm	59 (150)	Measured from hip & presumes individual may move upper body
Leg	43 (110)	Measured from crotch

11.4 Mechanical enclosures and guards – Mechanical considerations

11.4.1 A functional attachment that is made available or specified for use with a furnishing shall be included in the investigation of the furnishing. Unless the instructions specify the use of two or more attachments at the same time, only one attachment at a time is to be investigated with the furnishing.

11.4.2 Bellows shall:

a) Require the use of tools for their removal;

b) Be removable for servicing;

c) Have sufficient strength and rigidity to avoid the articulate probe with web stop (Figure 13.1) from being inserted to a depth that causes entrapment or damages the guard, when pressed with a force of 10 lbs (44.5 N); and

d) Be complete so that there are no opens that would allow an appendage to enter, such as an arm for leg. See Table 11.1.

11.4.3 Whether a guard, a release, an interlock, or similar device is required and whether such a device is adequate shall be determined from an investigation of the complete furnishing, its operating characteristics, its intended installation location, the intended user group (youth, adult, persons with diminished capacity, elderly), trained or untrained users and the potential risk of injury to persons. The investigation shall include evaluation of the results of breakdown or malfunction of any one component, and not more than one component at a time, unless one event contributes to another. When the investigation shows that breakdown or malfunction of a particular component results in a risk of injury to persons, that component shall be investigated for reliability.

11.4.4 A moving part, lifting or reclining mechanism, the rotor of a motor, a pulley, belt, gear, fan, or other part that constitutes a risk of injury shall be enclosed or provided with means to reduce the risk of injury. Such a part shall not be able to be contacted by the user or someone in the area. Compliance shall be determined by the probe illustrated in Figure 13.1 unless the furnishing is provided with a safety system and complies with 11.4.5. A force greater than 40 lbs (178 N) between a moving part and any object that can be entrapped by the moving part is considered a hazard. The furnishing shall be subjected to the Force Measurement and Operator Attended Test, Section 53, if there is a possibility that the force may be less than 40 lb. When using the probe to determine if a potential entrapment area can be reached, there are several items to be considered:

a) If the entrapment area beyond the distances specified in Table 11.2;

b) That children may go into places that an adult would not, such as crawling on the floor; and

c) The probe should be adjusted in any position that it can be manipulated along with the probe user's arm.

Exception: Instead of the 40 lbs (178 N) force, the maximum dynamic force shall not exceed 90.0 lbs (400 N) during the first 0.75 seconds. The static force shall not exceed 34.0 lbs (150 N) from 0.75 to 5.00 seconds and shall not exceed 5.6 lbs (25 N) after 5.00 seconds. See Section 53, Force Measurement and Operator Attended Tests.

11.4.5 Furnishings that present a risk of injury as specified in 11.4.4 shall be provided with either an active safety circuit or passive guard to prevent injury.

11.4.6 A mechanical safety system, such as a guard, shall comply with 11.4.8.

11.4.7 During the investigation of a furnishing to determine compliance with 11.4.5, a part of the mechanical enclosure that is removable without the use of a tool shall be removed.

Exception: A part that is removable without the use of a tool is not required to be opened or removed when the furnishing is marked in accordance with 87.2.6.

11.4.8 Guards shall:

a) Require the use of tools for their removal;

b) Be removable for servicing;

c) Have sufficient strength and rigidity;

d) Be complete;

e) Not present a risk of injury to persons such as a pinch point, during additional handling because of required service, such as cleaning, unjamming, or similar service; and

f) Be self-restoring.

11.4.9 A mechanical enclosure or guard over a rotating part shall retain a part that, because of breakage or other reasons, becomes loose or separates from a rotating part, and shall retain a foreign object that is able to be struck and propelled by the rotating part.

11.4.10 When breakage or deterioration of material adjacent to a moving part results in an increased risk of injury, the material shall have such properties as to withstand the loads it is subjected to during use of the furnishing.

11.4.11 A furnishing that does not incorporate a shade shall comply with Section 76, Lamp Drape Test and shall be marked with the maximum wattage lamp intended for use with the furnishing.

11.4.12 When unintentional operation of a switching device results in a risk of injury to persons, the actuator of the switch shall be located or guarded so that such unintentional operation does not occur. A switch that is located or guarded so that it cannot be turned on by moving a 2 inch (51 mm) diameter sphere at any angle to the switch or actuator complies with this requirement.

11.5 Mechanical connectors

11.5.1 Whether a release, a mechanical connector (joining two furnishings), or similar device is adequate shall be determined from an investigation of the complete furnishing, its operating characteristics, and the potential risk of injury to persons. The investigation shall include evaluation of the results of breakdown or malfunction of any one component, and not more than one component at a time, unless one event contributes to another. When the investigation shows that breakdown or malfunction of a particular component results in a risk of injury to persons, that component shall be investigated for reliability.

11.5.2 A mechanical connector shall be constructed to withstand the strain to which it is subjected during normal use.

11.5.3 When two or more furnishings are capable of being used in combination, a mechanical means of securement between tables shall be provided.

11.5.4 All non-metallic mechanical connectors shall comply with 59.1, Mechanical Connector Test (Non-Metallic). All flexible connectors shall comply with 59.2, Flexing (metallic or non-metallic).

11.6 Electrical enclosures – General

11.6.1 A part such as a splice, tap, wire, transformer, capacitor, ballast, current-carrying part, or device with an exposed live part shall be contained in an electrical enclosure constructed of metal, glass, ceramic, porcelain, or polymeric material. Such parts shall be contained in the enclosure during normal maintenance and use.

Exception No. 1: A current-carrying part of a wiring device (such as the screw shell and center contact of a lampholder, the lampholder contacts, starter holder contacts, or similar components of a fluorescent luminaire) that are normally fitted with a functional component (a lamp, a starter, or similar component) during use of the furnishing is not required to be additionally enclosed.

Exception No. 2: A component, such as a ballast, that has an integral outer housing that has been evaluated as an enclosure is not required to be additionally enclosed.

Exception No. 3: A power-supply cord is not required to be contained within the furnishing other than at the connection point to internal components.

Exception No. 4: Components in a Class 2 or LPS circuit do not need to be in an enclosure, but if one is provided it shall comply with 11.6, Electrical Enclosures – General, 11.7, Metallic Electrical Enclosures, and 11.8, Electrical enclosures of polymeric material.

11.7 Metallic electrical enclosures

11.7.1 A furnishing shall be formed and assembled so that it will have the strength and rigidity necessary to resist the abuses to which it is likely to be subjected, without increasing the 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.

11.7.2 For unreinforced, flat surfaces in general, cast metal shall not be less than 1/8 inch (3.2 mm) thick, except that malleable iron may be not less than 3/32 inch (2.4 mm) and die cast metal may be not less than 5/64 inch (2.0 mm) thick. Corresponding thicknesses of not less than 3/32 inch (2.4 mm), 1/16 inch (1.6 mm), and 3/64 inch (1.2 mm), respectively, may be acceptable if the surface under consideration is curved, ribbed, or otherwise reinforced, or if the shape or size, or both, of the surface is such that the necessary mechanical strength is provided.

11.7.3 Sheet metal shall comply with Table 11.3.

Table 11.3
Thicknesses of sheet-metal electrical enclosure

	Minimum thickness, inch (mm)					
Material	**Knockouts and other points of connection for a wiring system**		**Sheet-metal electrical enclosure[a]**		**Recessed sheet-metal electrical enclosure[a]**	
Uncoated sheet steel	0.036	(0.91)	0.025	(0.64)	0.023	(0.58)
Sheet aluminum	0.050	(1.27)	0.035	(0.89)	0.029	(0.74)

[a] Thinner thicknesses may be used if they comply with the Crushing and Impact testing in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

11.8 Electrical enclosures of polymeric material

11.8.1 A polymeric material enclosure of electrical parts shall comply with the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C as applicable to polymeric enclosures including tests.

Exception No. 1: Components in a SELV circuit shall comply with UL 746C but only the HWI needs to be evaluated under the electrical properties.

Exception No. 2: Components in a Class 2 or LPS circuit do not need to be in an enclosure, but if one is provided it shall comply with UL 746C, except the Flame Rating and Electrical Properties shall be in accordance with Table 11.4.

Table 11.4
Non-metallic material requirements for Class 2, LPS, and 15 watt circuits

Furnishing type	Energy source		
	Minimum flammability ratings for enclosure material[a]		Electrical properties
	15 watts or less[b]	Class 2 or LPS	Class 2 / LPS
Portable	HB	HB	HWI only
Stationary	HB	V-1	HWI only
Fixed	HB	V-1	HWI only

[a] Complies with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, 12 mm flame test for HB, 20 mm flame test for V-0, V-1, V-2 materials, and 127 mm flame test for 5V materials.

[b] 15 watts as measured under any condition of loading including open circuit and short circuit.

11.8.2 A polymeric material used for electrical insulation or an enclosure shall be fabricated in accordance with the Standard for Polymeric Materials – Fabricated Parts, UL 746D.

Exception: A polymeric material that is fabricated in the same location where final assembly takes place and where no blending or compounding operations are involved is not required to comply with this requirement.

11.9 Barriers

11.9.1 The enclosure of a furnishing shall reduce the risk of molten metal, burning insulation, flaming particles, or similar materials falling on combustible materials, including the surface upon which the furnishing is supported.

11.9.2 The requirement in 11.9.1 necessitates that a switch, a relay, a solenoid, or similar device be individually and completely enclosed, except for terminals, unless it is shown that malfunction of the component does not result in a risk of fire, or there are no openings in the bottom of the furnishing enclosure. It also necessitates the use of a barrier:

a) Under an electrical component unless:

1) The structural parts of the furnishing provide the equivalent of such a barrier;

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

i) Open main winding;

ii) Open starting winding;

iii) Starting switch short-circuited;

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

v) A component fault condition.

3) A motor complying with the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1; and

i) The Standard for Impedance Protected Motors, UL 1004-2; or

ii) The Standard for Thermally Protected Motors, UL 1004-3.

as applicable for the over temperature protection incorporated with the motor construction.

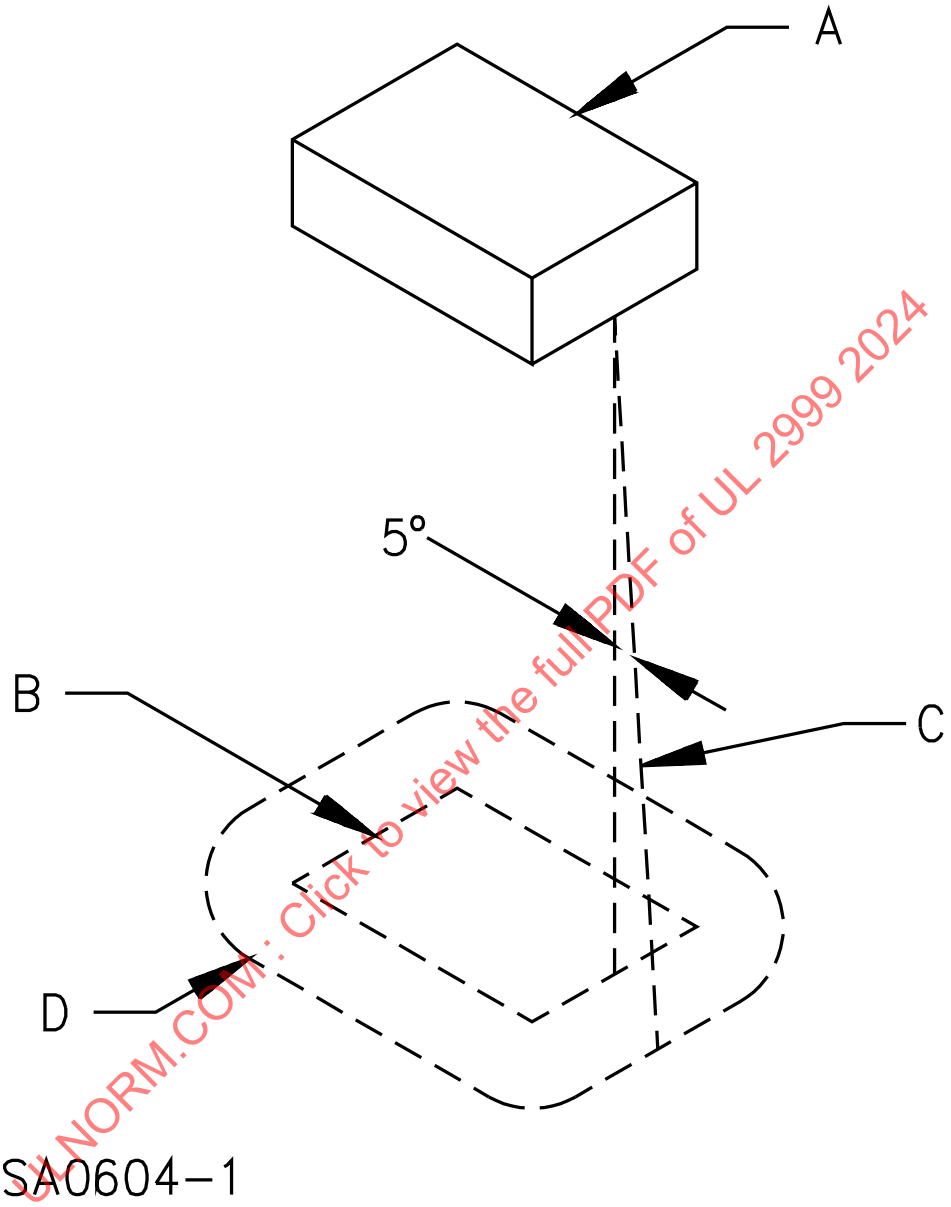
b) Under wiring, unless rated VW-1.

11.9.3 The barrier specified in 11.9.2 shall be of noncombustible material or shall comply with the Internal Barriers Section in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C and shall have a comparative tracking index (CTI) of 3 for commercial applications.

11.9.4 The barrier specified in 11.9.2 shall be horizontal, shall be located as illustrated in Figure 11.1, and shall not have an area less than that specified in Figure 11.1. Openings for drainage, ventilation, or similar condition, are not prohibited from being employed in the barrier, when such openings do not allow molten metal, burning insulation, or similar materials to fall on combustible material.

Figure 11.1

Location and extend of barrier



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

B – Projection of outline of component on horizontal plane.

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

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

11.10 Openings

11.10.1 General purpose open holes, such as ventilating open holes, shall be located more than 13 mm (0.5 in) from the mounting surface of a furnishing and shall comply with the following:

a) The area of each open hole shall not exceed 10 cm^2 (1.5 in^2).

b) The total area of holes shall be not more than 15 percent of the total area of the surface in which the hole or holes are located.

c) The open holes shall not be located in the mounting surface, in a canopy, or directly below electrical parts, as specified in Figure 11.1, that are required to be enclosed, unless the parts:

1) Are protected by a barrier in accordance with 11.9, Barriers;

2) Have demonstrated compliance with the applicable normal and abnormal test requirements; or

3) Are constructed so as not to present a risk of fire under any foreseeable conditions.

11.11 Doors or covers

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

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

11.12 Mounting means

11.12.1 An opening provided for mounting shall be located or guarded so that a nail, hook, or similar part does not reduce spacings, displace a part that creates a risk of fire or electric shock, and does not contact one of the following:

a) An uninsulated live part;

b) Magnet wire;

c) Internal wiring; or

d) Any other part that creates a risk of fire or electric shock.

11.12.2 A furnishing intended to be mounted shall employ a mechanical means of mounting that does not rely on friction.

11.12.3 An adhesive used as the sole means of support to secure a furnishing or part of a furnishing which if displaced could cause a risk of injury shall be investigated to determine that it reliably secures the product. General – Adhesives, Function Analysis, and Program of Investigation, in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, shall be used when performing the investigation. The maximum force as defined in UL 746C shall be four times the weight of the part or loaded furnishing under investigation as received and two times the weight of the part or furnishing after the adhesive has been subjected to the environmental conditioning.

11.13 Polymeric devices for uses other than direct or indirect contact of a live part

11.13.1 A polymeric device which provides mechanical support or electrical insulation or separation whose deterioration would reduce spacings between uninsulated live parts or could result in a risk of injury created due to softening or melting of the support means shall comply with mechanical RTI temperature limits (with and without impact) for the material in the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B.

11.14 Glass components

11.14.1 Edges of glass accessible during normal use or maintenance shall be seamed, swiped, fire-polished, or similarly treated to eliminate sharpness. The Standard for Tests for Sharpness of Edges on Equipment, UL 1439 shall be used to determine compliance.

11.14.2 Glass components less than or equal to 1 foot^2 (0.09 m^2) or that are irregular shaped and fit within a 1 foot^3 (0.03 m^3) box do not have minimum thickness, securement or impact resistance requirements.

11.14.3 Glass components larger than specified in 11.14.2 but less than 9 feet^2 (0.84 m^2) shall have a minimum thickness of 1/8 inch or 3.0 mm and shall meet the requirements of the Standard for Safety glazing materials used in buildings – safety performance specifications and methods of test, ANSI Z97.1, Class A, the Standard for Glass in Building – Thermally Toughened Soda Lime Silicate Safety Glass, EN 12150, or have a minimum thickness of 1/8 inch or 3.0 mm and perform according to the requirements specified in 48.1, Tests on Glass Components – Impact Test.

11.14.4 Glass components larger than or equal to 9 feet^2 (0.84 m^2) shall have a minimum thickness of 1/8 inch or 3.0 mm and meet Standard for Safety glazing materials used in buildings – safety performance specifications and methods of test, ANSI Z97.1, Class A or the Standard for Glass in Building – Thermally Toughened Soda Lime Silicate Safety Glass, EN 12150 requirements.

11.14.5 Glass components larger than 1 foot^2 (0.09 m^2) shall be subjected to 48.2, Tests on Glass Components – Glass Retention Test.

12 Protection Against Corrosion

12.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, powder coating, or other equivalent means, when corrosion of such parts results in a risk of fire, electric shock, or injury to persons.

Exception: This requirement does not apply to bearings, laminations, or minor parts of iron or steel, such as washers, screws, or similar parts.

12.2 Copper, aluminum, and alloys of copper and aluminum, stainless steel, and similar materials having inherent resistance to atmospheric corrosion may be used without additional corrosion protection.

12.3 All exposed, exterior and interior, surfaces of ferrous metal parts shall be protected by one of the following:

a) A coating of nonferrous metal applied by the hot dip process method;

b) A plating of nonferrous metal applied either by electro-deposition or by chemical means;

c) A coating of vitreous enamel;

d) Baked paint, powder coating or similar type of coating; or

e) Air-dry paint.

12.4 When deterioration of a liquid container provided as a part of a furnishing results in a risk of fire or electric shock, the container shall be of a material that is resistant to corrosion by the liquid with which it is intended to be used.

13 Accessibility of Uninsulated Live Parts and Film-Coated Wire

13.1 To reduce the risk of unintentional contact that results in a risk of electric shock from an uninsulated live part or film-coated wire, an opening in an enclosure shall comply with either:

a) For an opening that has a minor dimension (see 13.6) less than 1 inch (25.4 mm), such a part or wire shall not be contacted by the probe illustrated in Figure 13.1.

b) For an opening that has a minor dimension of 1 inch (25.4 mm) or more, such a part or wire shall be spaced from the opening as specified in Table 13.1.

Exception No. 1: A motor is not required to comply with these requirements when it complies with the requirements in 13.2.

Exception No. 2: Does not apply to circuits in Class 2, LPS, or SELV circuits.

Exception No. 3: A contact opening in a connector employed for quick assembly of power between two tables, or the like is acceptable if a flat-faced, 1/4 diameter probe (see Figure 13.4) cannot be made to contact an uninsulated live part when the probe is inserted through the contact opening, or the mating plug is partially inserted into the connector.

Figure 13.1

Articulate probe with web stop

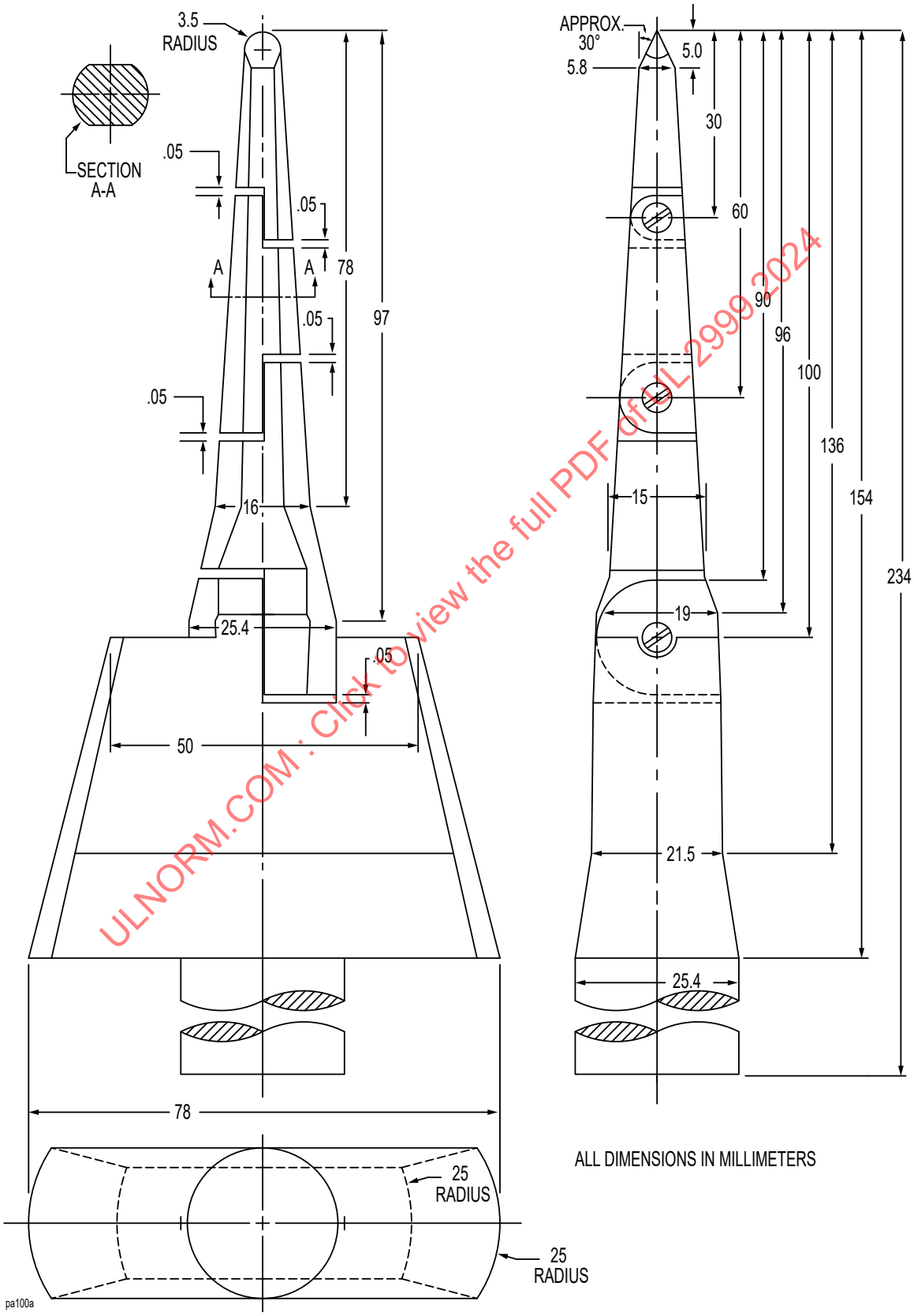


Table 13.1
Minimum required distance from an opening to a part involving a risk of electric shock

Minimum dimension[a] of opening		Minimum distance from opening to part	
inches	(mm)[b]	inches	(mm)[b]
3/4[c]	(19.1)	4-1/2	(114)
1[c]	(25.1)	6-1/2	(165)
1-1/4	(31.8)	7-1/2	(191)
1-1/2	(38.1)	12-1/2	(318)
1-7/8	(47.6)	15-1/2	(394)
2-1/8	(54.0)	17-1/2	(445)
d	d	30	(762)

[a] See 13.6.

[b] Between 3/4 and 2-1/8 inches (19.1 and 54.0 mm), interpolation is to be used to determine a value between values specified in the table.

[c] Any dimension less than 1 inch (25.4 mm) applies to a motor only.

[d] More than 2-1/8 inches (54.0 mm), and not more than 6 inches (152 mm).

13.2 With respect to a part or wire as specified in 13.1, in an integral enclosure of a motor as specified in the Exception to 13.1:

a) An opening that has a minor dimension (see 13.6) less than 3/4 inch (19.1 mm) is able to be used when:

1) Film-coated wire is not able to be contacted by the probe illustrated in Figure 13.3;

2) In a directly accessible motor (see 13.7), an uninsulated live part is not able to be contacted by the probe illustrated in Figure 13.3; and

3) In an indirectly accessible motor (see 100.6), an uninsulated live part is not able to be contacted by the probe illustrated in Figure 13.2.

b) An opening that has a minor dimension of 3/4 inch (19.1 mm) or more is able to be used when a part or wire is spaced from the opening as specified in Table 13.1.

Figure 13.2

Straight probe

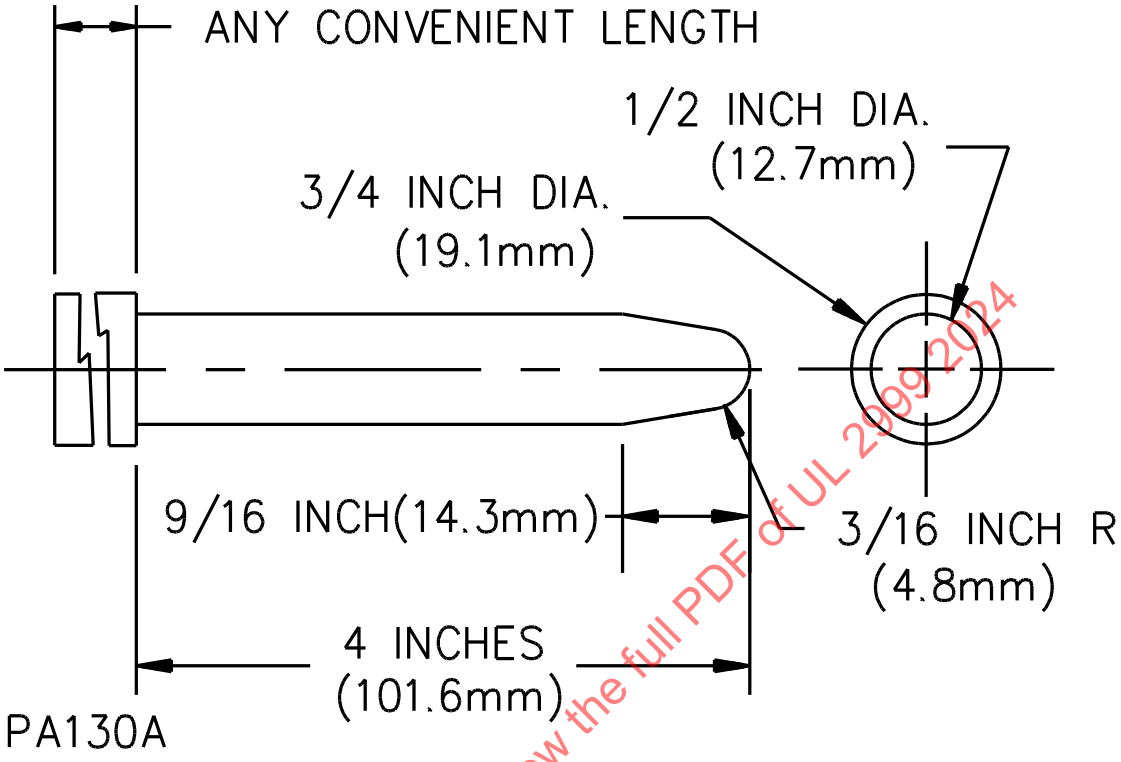


Figure 13.3

Straight probe

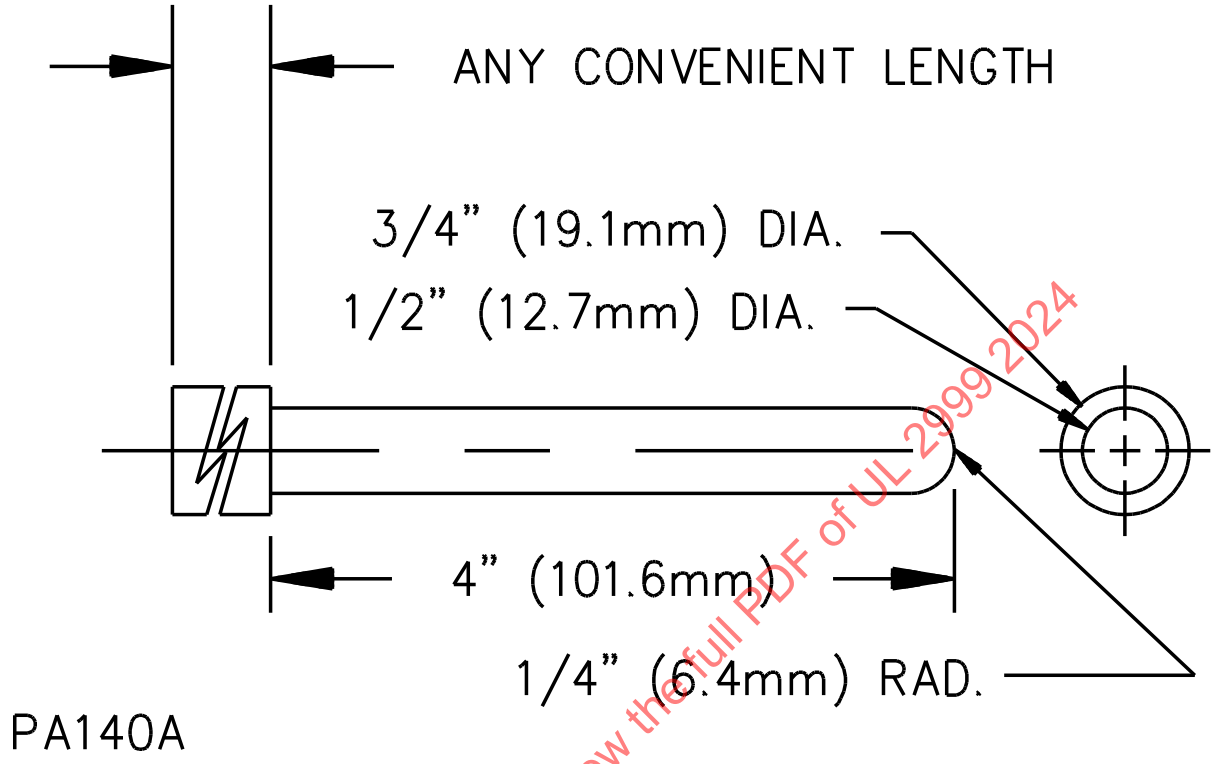
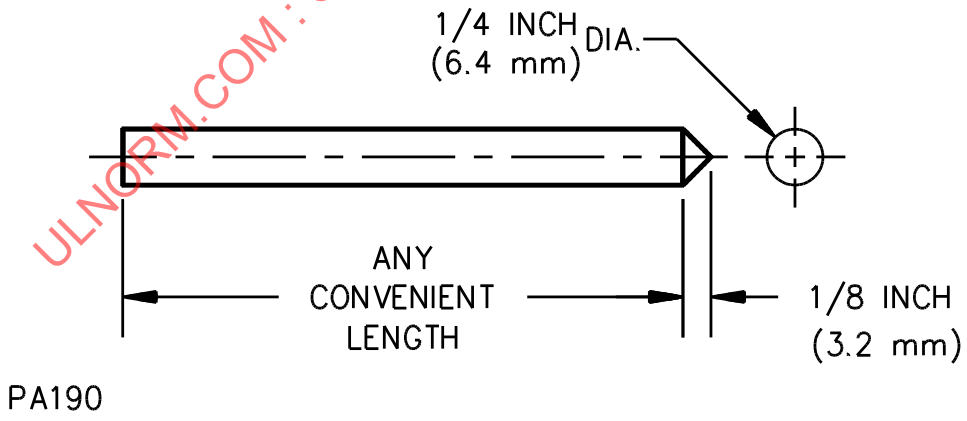


Figure 13.4

Accessibility probe



13.3 The probes specified in 13.1 and 13.2 and illustrated in Figure 13.1 – Figure 13.4 shall be applied to any depth that the opening allows, and shall be rotated or angled before, during, and after insertion through the opening to any position required to examine the enclosure. The probe illustrated in Figure 13.1 shall be applied in any configuration allowed by the construction; and, when required, the configuration shall be changed after insertion through the opening.

13.4 The probes specified in 13.2 and 13.4 shall be used as measuring instruments to investigate the accessibility provided by an opening, and not as instruments to investigate the strength of a material: they shall be applied with the minimum force required to determine accessibility.

13.5 With reference to the requirements in 13.1 and 13.2, the minor dimension of an opening is the diameter of the largest cylindrical probe having a hemispherical tip that is able to be inserted through the opening.

13.6 With reference to the requirements in 13.2, an indirectly accessible motor is a motor that is accessible only by opening or removing a part of the outer enclosure (such as a guard or panel) that is able to be opened or removed without using a tool, or that is located at such a height or is otherwise guarded or enclosed so that it is not contacted during normal use of the furnishing. A directly accessible motor is one that is able to be contacted without opening or removing any part or that is located so as to be accessible to contact during normal use of the furnishing.

13.7 During the examination of a furnishing to determine compliance with 13.1 or 13.2, a part of the enclosure that is able to be opened or removed by the user without a tool (such as an accessory, the cover over an opening for an operating adjustment, or similar components) is to be opened or removed.

13.8 With reference to the requirements in 13.1 and 13.2, an insulated brush cap is not required to be additionally enclosed.

14 Grounding and Bonding

Note: Does not apply to circuits in Class 2, LPS, or SELV circuits.

14.1 Grounding

14.1.1 A product shall have provision for grounding all exposed non-current carrying conductive parts that may become energized and any receptacles. There shall also be provision for grounding all internal, uninsulated non-current carrying parts that can become energized and that can be contacted during servicing by the user or service personnel. A part shall be considered capable of becoming energized if failure of electrical spacing or insulation or both can result in conductive connection to a current carrying part.

Exception: A furnishing provided with a means of double insulation in accordance with the applicable requirements in the Standard for Double Insulation Systems for Use in Electrical Equipment, UL 1097 or the Reference Standard for Double Insulation Systems for Use in Electronic Equipment, UL 2097, shall not be provided with grounding. A furnishing that complies with the requirements for double insulation shall also be marked with the double insulation symbol. See 87.2.5.

14.1.2 When a grounding means is provided, whether required or not, it shall be in accordance with 14.1.4. When the furnishing is cord connected, the grounding means shall also comply with the requirements in 14.1.7. All exposed unenergized metal parts and all un-energized metal parts within the enclosure that are exposed to contact during user servicing and are able to become energized during or after a fault condition shall be reliably connected to the means for grounding.

14.1.3 The following are able to be used as a means for grounding:

a) In a furnishing intended to be permanently connected, an equipment-grounding terminal or lead. See 14.1.8 and 14.1.9; or

b) In a cord-connected furnishing, an equipment-grounding conductor in the power-supply cord.

14.1.4 The grounding conductor shall be secured to the frame or enclosure of the furnishing by means of a screw, other than sheet metal, that is not removed during any servicing operation not involving the power-supply cord, or by other equivalent means. Servicing includes repair of the furnishing by a qualified service person. The grounding connection shall penetrate nonconductive coatings, such as paint or power coating.

14.1.5 The grounding conductor of a cord-connected furnishing shall be connected to the grounding member of an attachment plug. The grounding member shall be fixed.

14.1.6 A separable connection, such as that provided by an attachment plug and a mating connector or receptacle, shall be such that the equipment-grounding connection is made before or at the same time as the connection to and broken after or at the same time as the disconnection from the supply conductors.

Exception: Interlocked plugs, receptacles, and connectors that are not energized when the equipment-grounding connection is made or broken are able to be used without the grounding connection specified above.

14.1.7 When a furnishing is intended to be grounded and is provided with means for separate connection to more than one power supply, each separate connection shall be provided with a means for grounding. The means for grounding shall be bonded together.

14.1.8 A terminal intended solely for the connection of an equipment-grounding conductor shall be capable of securing a conductor of the size required for the application.

14.1.9 A connection device that depends on solder alone shall not be provided for connecting the equipment-grounding conductor.

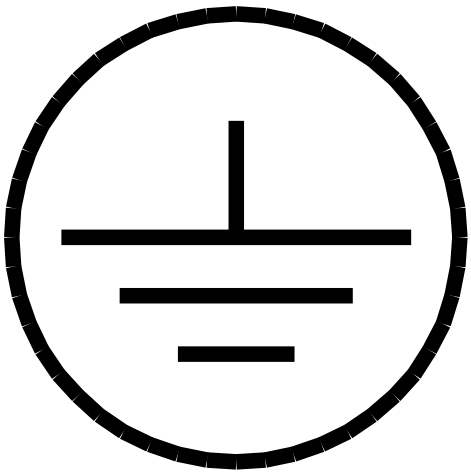
14.2 Grounding identification

14.2.1 The surface of an insulated lead intended solely for the connection of an equipment-grounding conductor shall be green with or without one or more yellow stripes, and no other lead shall be so identified.

14.2.2 A wire-binding screw intended for the connection of an equipment-grounding conductor shall have a green-colored head that is hexagonal or slotted, or both. A pressure wire connector intended for connection of such a conductor shall be plainly identified, such as by being marked with the grounding symbol in Figure 14.1, "G", "GR", "GRD", "Green", "Ground", or "Grounding", or by a marking on a wiring diagram provided on the furnishing.

Figure 14.1

Grounding symbol



14.3 Bonding

14.3.1 Accessible non energized metal or other conductive parts that may become energized and are not connected directly to the grounding conductor shall be bonded to the ground connection point.

14.3.2 A ground path for electrical current shall be provided between all parts of a metal electrical enclosure containing electrical parts or wiring. See Section 70, Grounding-Impedance Test.

14.3.3 Flexible metal conduit longer than 6 feet (1.8 m) in total length shall not be relied upon for the ground path through an individual furnishing or between furnishings that are connected during installation.

14.3.4 The grounding means through an individual furnishing and between furnishings that are connected during installation shall have an ampacity at least equivalent to that of the supply conductors.

14.3.5 A furnishing that employs quick-connect means for electrically connecting the branch-circuit power supply from furnishing to furnishing shall be constructed so that the grounding connection is made prior to all other supply connections.

14.3.6 A non-energized metal part that is able to become energized shall be bonded to the ground return path by means of a conductor not smaller than the supply wires of the furnishing.

15 Polarity and Identification

15.1 A supply cord conductor that is intended to be grounded shall be marked in accordance with Table 10.3 and shall be connected to the wide blade of a 2-wire attachment plug, or the left-hand blade of a 3-wire attachment plug when looking at the face of the plug with the grounding pin up. See Figure 10.1.

15.2 The screwshell or screwshell contact of each Edison-Base lampholder shall be connected to the grounded supply conductor.

15.3 A switch, fuse or other protective device shall not be connected to the grounded supply conductor.

Exception: When the switch, fuse or other protective device simultaneously interrupts all non-grounded conductors of the supply circuit, it is not prohibited from also being connected to the grounded supply conductor.

15.4 Any portion of a furnishing that is able to be detached, thereby breaking electrical connections – such as a detachable power supply cord, interlocking connectors, or a cord connector – shall be constructed such that it is only able to be assembled in the manner that maintains correct electrical polarity.

16 Separation of Circuits

16.1 Conductors of circuits operating at different voltage potentials shall be reliably separated from each other unless they are each provided with insulation acceptable for the highest voltage potential involved.

16.2 An insulated conductor shall be reliably retained so that it cannot contact an uninsulated energized part of a circuit operating at a different potential.

16.3 In a compartment that is intended for the field installation of conductors, and that contains provision for connection of Class 2, Class 3, Class 1, power, or lighting circuit conductors, a barrier shall be provided to separate the conductors operating at different circuit voltage potentials, or the arrangement of the compartment shall be such that a minimum spacing of 1/4 inch (6.4 mm) can be maintained between the conductors of the different circuits including the conductors to be field installed.

17 Internal Wiring

17.1 Conductors

17.1.1 A passage in a sheet metal wall through which insulated wires are routed, shall be provided with provision to avoid contact with sharp edges or burrs, screw threads, sharp fins, moving parts, drawers, or similar components that are able to abrade or otherwise damage the wire insulation in accordance with 10.2.6, Protection of Cord and Wiring.

17.1.2 A metal clamp used for routing or securing internal wiring shall be provided with smooth, rounded edges. Auxiliary non-conducting mechanical protection shall be provided under a clamp at which pressure is exerted on an insulated conductor. If cord is used for internal wiring (See 17.3, Cord Used for Internal Wiring) a metal clamp suitable for cord may be used without auxiliary non-conducting mechanical protection.

17.1.3 Internal wiring shall consist of wires of a type or types that are determined to meet the requirements for the intended use with respect to flexibility, mechanical abuse, temperature, ampacity, and voltage. Conductors of any cross-sectional-area are permitted when the conductors are in Class 2 or LPS circuits.

17.1.4 Conductors that can be flexed after installation, including during repositioning of the furnishing, shall be stranded, secured in a manner that prevents cutting of or abrasion, and mechanically spaced apart so that current-carrying parts of opposite polarity are not inadvertently shorted.

Exception: Solid conductors are able to be employed between furnishings when they form fixed angles and the raceway allows for inspection and replacement of the wiring when configurations are changed.

17.1.5 Conductors operating at different voltage potentials shall be separated from each other by one or more of the following:

a) Enclosing the different voltage conductors in a separate wiring channel;

b) Providing a partition of grounded metal or material that complies with the requirements for internal barriers in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, between the conductors of the different voltages;

c) Providing reliable physical separation of at least 1/4 inch (6.4 mm) between conductors of the different voltages; or

d) Insulation provided on all conductors rated for the highest voltage potential of any conductor.

17.1.6 Internal conductors and connectors provided for wiring between components shall be subjected to the Strain Relief Test, Section 66.

Exception: This test is not required if the conductors and connectors are provided with a suitable electrical enclosure such that they are not subject to mechanical strain.

17.1.7 Conductors of any size are permitted when the conductors are in Class 2 or isolated LPS circuits only and are physically separated from all other non-Class 2 or non-isolated LPS circuits, such as by a barrier or reliably fixed spacing of minimum 6.4 mm (0.25 in).

17.2 Splices

17.2.1 A splice or connection shall be mechanically secured and provide electrical continuity. A soldered connection shall be mechanically secured before being soldered. A splice shall not be made in an area other than a specified wiring compartment. For example, a splice shall not be located inside conduit.

17.2.2 A splice shall be provided with insulation equivalent to that of the conductors involved.

17.2.3 In determining when splice insulation consisting of fabric, thermoplastic, or other type of tubing is able to be used, factors to be evaluated include its dielectric properties, use temperature, and similar conditions. Thermoplastic tape wrapped over a sharp edge shall not be used.

17.2.4 Stranded internal wiring that is connected to a wire-binding screw shall be provided with a means to restrict loose strands of wire from contacting other uninsulated energized parts not always of the same polarity or non-energized metal parts. This is able to be accomplished by use of a pressure-type spade terminal connector with turned-in or turned-up ends, by a closed loop connector, or other equivalent means.

17.3 Cord used for internal wiring

17.3.1 Cord may be used for internal wiring when:

a) A strain relief is provided where the cord enters and/or exits the interior of the furnishing;

b) Cord may be routed within a furnishing provided that it is visible along its length and the electrical component is provided with a strain relief to prevent strain to splices: or

c) A removable cover, without the use of tools and does not require the furnishing to be picked up or other difficult actions, is provided that allows visual inspection of the cord and the electrical component is provided with a strain relief is provided to prevent strain to splices.

17.3.2 When cord is provided for internal wiring it shall comply with the requirements in 17.1, Internal Wiring – Conductors.

17.4 Conductors subject to flexing

17.4.1 Individual conductors or conductors assembled into groups that are subject to flexing in the normal use of the furnishing shall be stranded.

17.4.2 Conductors subject to flexing in the normal use of the furnishing shall comply with the Conductor Cycling Endurance Test, Section 68.

Exception: Conductors utilized in a Class 2 or LPS circuit are not required to be subjected to the conductor cycling endurance test unless the circuit is relied upon for the safe operation of the furnishing.

18 Spacings

18.1 Other than at wiring terminals, the spacing between uninsulated energized parts of opposite polarity and between an uninsulated energized part and a non-energized metal part that is exposed to contact by persons or that is able to be grounded shall not be less than the value specified in Table 18.1.

Exception No. 1: The inherent spacings of a component, such as a snap switch, are investigated on the basis of the requirements for the component.

Exception No. 2: This requirement does not apply when a spacing complies with the requirements in 18.4.

Table 18.1
Spacings at other than field-wiring terminals

Potential involved	Over surface		Through air	
Volts	inch	(mm)	inch	(mm)
0 – 50	1/16	(1.6)	1/16	(1.6)
51 – 125	1/4	(6.4)[a]	1/8	(3.2)[a]
126 – 250	1/4	(6.4)[a]	1/4	(6.4)[a]
251 – 600	1/2	(12.7)	3/8	(9.5)[a]

[a] Film-coated wire is identified as an uninsulated energized part. However, a spacing of not less than 3/32 inch (2.4 mm) over surface and through air between film-coated wire, rigidly supported and held in place on a coil, and a non-energized metal part is able to be used.

18.2 When an uninsulated energized part is not rigidly fixed in position by means other than friction between surfaces, or when a movable non energized metal part is in proximity to an uninsulated energized part, the construction shall be such that the required minimum spacing is maintained with the part in any position.

18.3 When an isolated non energized metal part is interposed between or is in close proximity to energized parts of opposite polarity, to an energized part and an exposed non energized metal part, or to an energized part and a non-energized metal part that is able to be grounded, the spacing shall not be less than 3/64 inch (1.2 mm) between the isolated non energized metal part and any one of the other parts previously specified, when the total spacing between the isolated non energized metal part and the two other parts complies with the value specified in Table 18.1.

18.4 An insulating lining or barrier of vulcanized fiber employed to maintain required spacings shall not be less than 1/32 inch (0.8 mm) thick, and shall be so located that it is not adversely affected by arcing.

Exception No. 1: Vulcanized fiber not less than 1/64 inch (0.4 mm) thick is able to be used in conjunction with an air spacing of not less than 50 percent of the spacing required for air alone.

Exception No. 2: Thinner vulcanized fiber or other insulating material is able to be used, when it complies with the Internal Barriers section of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluation, UL 746C.

18.5 All uninsulated energized parts connected to different voltage potential circuits shall be spaced from one another as though they were parts of opposite polarity, in accordance with the requirements in 18.1 and 18.8 and shall be investigated on the basis of the highest voltage involved.

18.6 The spacing between uninsulated energized parts of opposite polarity and between such parts and non-energized metal that is able to be grounded in service is not specified for parts of low-voltage circuits.

18.7 The spacing between wiring terminals of opposite polarity, and between a wiring terminal and any other uninsulated metal part not of the same polarity, shall not be less than that specified in Table 18.2.

Table 18.2
Spacings at wiring terminals

Potential involved,	Minimum spacings, inch (mm)					
	Between wiring terminals, through air, or over surface		Between terminals and other uninsulated metal parts not always of the same polarity[a]			
			Over surface		Through air	
250 or less	1/4	(6.4)	1/4	(6.4)	1/4	(6.4)
More than 250	1/2	(12.7)[b]	1/2	(12.7)[b]	3/8	(9.5)

[a] Applies to the sum of the spacings involved where an isolated dead part is interposed.

[b] A spacing of not less than 3/8 inch (9.5 mm), through air and over surface, is able to be used at wiring terminals in a wiring compartment or terminal box when the compartment or box is integral with a motor.

18.8 At terminal screws and studs to which connections are made in the field by means of wire connectors, eyelets, or similar devices, spacings shall not be less than those specified in Table 18.1 when these devices are positioned at the minimum spacing.

18.9 As an alternative to the spacing requirements of Table 18.1, the spacing requirements in the Standard for Insulation Coordination, Including Clearances and Creepage Distances for Electrical Equipment, UL 840, and are able to be used. The spacing requirements of UL 840 shall not be used for field wiring terminals and spacings to a non-energized metal enclosure.

18.10 It is anticipated that the level of pollution for indoor use equipment is pollution degree 2. Hermetically sealed or encapsulated enclosures, or coated printed wiring boards in compliance with the Printed Wiring Board Coating Performance Test of the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840 are identified as pollution degree 1.

18.11 It is anticipated the equipment is rated overvoltage category II as defined in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840.

18.12 In order to apply Clearance B (controlled overvoltage) clearances, control of overvoltage shall be achieved by providing an overvoltage device or system as an integral part of the product.

18.13 All printed wiring boards are identified as having a minimum comparative tracking index (CTI) of 100 without further investigation, for evaluation to the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840.

19 Materials in Direct and Indirect Contact of Live Parts

19.1 Material in direct or indirect contact with uninsulated live parts other than magnet wire shall be porcelain or another material investigated and found acceptable in accordance with the requirements covering mechanical/electrical property considerations of the Standard for Polymeric Materials – Use in

Electrical Equipment Evaluations, UL 746C. These materials shall withstand the most severe conditions likely to be met in service.

Exception No. 1: Small parts and adhesives need not be investigated if they are:

a) Not relied upon to maintain the proper functioning of the device with regard to the likelihood of electric shock, fire, and injury to persons; and/or

b) Not relied upon to maintain separation between uninsulated live parts of opposite polarity, live parts, and accessible metal parts and/or uninsulated live parts and earth ground.

Exception No. 2: Materials in Class 2, LPS, and SELV circuits shall only have an applicable temperature rating, a dielectric value as specified in Table 71.1 and the defined HWI value.

19.2 The material of any part of a base or body shall not introduce a risk of fire or shock by warping, creeping, or distorting under conditions of arcing, temperature, and mechanical stress that are likely to occur in service.

19.3 A polymeric material shall have a mechanical with impact RTI and electrical temperature RTI of at least the temperature of the part measured during the normal temperature test.

Exception: When the temperature measured during the normal temperature test is 50°C (122°F) or less, the polymeric material is not required to have an RTI rating.

19.4 Material used to support live parts or an insulating barrier shall be acceptable for continuous operation at the maximum temperature measured on the material during the Temperature Test, Section 64.

19.5 A small molded part such as a terminal block shall have mechanical strength and rigidity that withstands the stresses of actual service.

19.6 A molded part shall not exhibit softening of the material determined by handling immediately after the condition specified in 30.1, Conditioning of Polymeric Components, nor shall there be shrinkage, warpage, or other distortions as determined after cooling to room temperature that results in any of the following:

a) Reduction of spacings between uninsulated live parts of opposite polarity, uninsulated live parts and accessible dead or grounded metal, and uninsulated live parts and the enclosure below the minimum acceptable values;

b) Uninsulated live parts or internal wiring accessible to contact, or defeating the integrity of the enclosure so that acceptable mechanical protection is not afforded to internal parts of the equipment; or

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

20 Overcurrent Protection for Cord and Plug Table/Desk Electrical Distribution Systems

20.1 All cord and plug connected table/desk electrical distribution systems (See 3.6.2) shall be provided with supplementary overcurrent protection rated 15 amps maximum. The supplementary overcurrent protection shall be installed in the table provided with the power supply cord. For example, in a multi-table system, the starter table shall be provided with the supplementary overcurrent protector. It is permissible to install the overcurrent protection in the attachment plug, the power cord, or the first power unit.

20.2 The overcurrent protective device shall not open under normal loading conditions.

20.3 The overcurrent protective device shall be a supplementary protector of the automatic-trip-free, manual-reset type or a replaceable fuse. A system that is provided with fuses that are intended to be replaced in the field shall be marked in accordance with the requirements in 87.2.14.

20.4 The overcurrent protective device shall comply with the requirements in the Standard for Supplementary Protectors for Use in Electrical Equipment, UL 1077, for use with motor loads. Its short-circuit capacity shall be a minimum of 1000 A and it shall have the following calibration at 25°C (77°F): 100 percent hold, 125 percent/135 percent trip.

20.5 When a replaceable fuse is used to provide the required protection, it shall comply with the Standard for Low-Voltage Fuses – Part 14: Supplemental Fuses, UL 248-14.

20.6 A single-pole supplementary protector 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 simultaneously.

21 Interconnection Between Furnishings and Between Components in Furniture

21.1 An interconnecting cord shall be supported through individual furnishings and between mechanically continuous furnishings. The cord supports shall be such that the cord has a maximum unsupported distance of 2 feet (0.6 m), and does not hang down more than 6 inches (152 mm).

21.2 An interconnecting cord that spans two furnishings shall be supported a maximum of 3 inches (76 mm) in from each furnishing it spans.

Exception: An interconnecting cord 18 inches (45.7 cm) or less is not required to be supported provided it hangs 6 inches (152 mm) or less from the bottom of the table.

21.3 Interconnecting cords shall be provided with a means of securement on at least one end of the cord.

21.4 An interconnecting cord that has securement means on each end of the cord shall have securement means comply with the requirements for mechanical connectors. See 11.5, Enclosures and Guards – Mechanical Connectors and Section 59, Tests on Mechanical Connectors.

21.5 The securement of the cord shall be such that no strain will be transmitted to the interconnection contacts if the furnishings are pulled apart.

21.6 The total length of the system of all interconnecting cordage of a table / desk electrical system, exclusive of the supply cord, shall not exceed 40 feet (12 m) and the system shall prohibit more than 8 receptacles. The prohibition of 8 receptacles may be achieved through mechanical means or electronic. See 67.3, Receptacle Limits Test, for tests to demonstrate the 8 receptacles restriction.

21.7 A raceway shall be supported through individual tables and between mechanically continuous units.

21.8 Class 2 or LPS circuits may use one of the methods in Table 21.1 with the applicable connectors.

Table 21.1
Interconnecting conductors and cable types

Furnishing type	Energy source	
	15 watts or less (under any condition of loading)	Class 2 or LPS
Portable	A or B	B
Stationary or Fixed	A or B	B
A) The conductor or cable shall be rated for the intended temperature, power and voltage. B) Cords or cables not evaluated as a part of the component product requirement and not contained within a metal or polymeric enclosure in accordance with Table 11.2 shall be a jacketed type CL3, CL3R, CL3P, Power-limited Circuit Cable or other jacketed type cord with a minimum 0.013 inch (0.33 mm) jacket thickness or the combined conductor and jacket thickness not less than 0.013 inch (0.33 mm). Individual conductors may not be utilized outside a fire enclosure or without an overall jacket covering.		

22 Furnishings with Extendable Elements

22.1 A drawer or other pullout component shall incorporate a stop to reduce the likelihood of unintentional dislocation from the furnishing.

Exception: Drawers and pullouts with less than 15.4 lbs (7.0 kg) do not need a stop.

22.2 A furnishing that has multiple extendable elements shall be provided with a mechanism that only allows one pullout component at a time.

Exception: The furnishing does not need to be provided with a mechanism provided it complies with the following tests in any configuration permitted:

a) Loading tests:

1) Section 32, Structural Test Requirements for Furnishings – General Loading;

2) Section 34, Desks and Tables;

3) Section 35, Storage Furnishings; and

b) Stability tests:

1) Section 39, Stability Test for Portable Furnishings;

2) Section 41, Desks and Tables (Non-Motorized and Motorized With and Without Casters; and

3) Section 42, Storage Furnishings.

23 Operator Attended Commercial Products

23.1 Usage Area II

23.1.1 A commercial furnishing that requires the operator to be present to perform the intended function complies with the requirements in 11.4, Mechanical Enclosure and Guards – Mechanical Considerations, when all of the following conditions are met:

a) A furnishing that is accessible to the public when the trained operator is not present shall be provided with a security lockout device that disables operation of the furnishing to prevent nonqualified persons from operating the furnishing;

1) A trained operator is considered present when they are within sight of the furnishing and are within 20 feet (6.1 meter) of the furnishing.

2) The lockout device may be a passcode, proximity sensor that require a unique sensor to activate (such as RFID), a physical key, a two-step process (such as pressing 2 keys in the correct order, or other means that would prevent an untrained person to operate the furnishing.

3) Where multiple furnishings are located within the same space and a proximity activation device is used as the access to allow movement of the furnishing, each furnishing shall have a separate code or equivalent restriction to allow movement of only the intended furnishing within the specified proximity.

4) A lockout (electronic or mechanical) system shall automatically reset and lockout the movement of the furnishing after a maximum of 2 minutes of inactivity. Inactivity is when the operator is no longer present.

b) Any point or part of the furnishing that is considered to present an entrapment or personal injury hazard shall be visible to the operator such that they can determine the proximity of an individual to the entrapment area when positioned at the operator controls while performing the intended function;

c) A control for the operation of the exposed movable part shall be a momentary contact type that when released all moving parts of the device that constitute a hazard are stopped. The moving parts may move some distance after power is disconnected as long as no potential hazard occurs with consideration of the body part(s) that may be involved. For instance, if a finger could be involved, the entrapment area after the moving part has fully stopped shall not be less than 1 inch (2.5 cm). Non-momentary contact memory and remote controls shall not be used;

d) A switch that controls the direction of travel shall be capable of being stopped and the direction of travel reversed at any point in the operation of the furnishing;

e) A switch that is used to control a movable part that can result in personal injury shall be guarded or located to prevent unintentional movement of the part; and

f) Upon power failure the furnishing shall remain in the existing position. Upon reinstatement of power the furnishing shall not move until the operator activates the switch controlling movement. A product that complies with this section shall be provided with installation and operation instructions in accordance with Section 104, Operator Attended Commercial Products Instructions.

g) Shall have the marking specified in 90.4.

23.2 Usage Area III

23.2.1 Furnishings in Usage Area III shall comply with 23.1, Operator Attended Commercial Products – Usage Area II with the following differences:

a) A security lockout is not necessary;

b) If the speed is less than 1 inch / second (2.54 cm/second), the entrapment area does not have to be visible to the operator;

c) The switch referred to in 23.1.1(c) may be a memory type switch that allows the furnishing to adjust to a preset position when the operator is present at the control on the furnishing;

d) If the speed is less than 1 inch / second (2.54 cm/second), the switch specified in 23.1.1(e), would not need to be guarded. This requirement supersedes the requirement in 10.2.1.14; and

e) Shall have the marking specified in 90.5.

23.3 Usage Area III – Alternate for motorized tables

23.3.1 These requirements are for furnishings that are provided with safety features that prevent personal injury and may be used as an alternate evaluate means to the requirements in 23.2, Operator Attended Commercial Products – Usage Area III.

23.3.2 The viability of these safety features shall be determined by performing the Collision Mitigation Evaluation, Section 54.

23.3.3 The controls shall be evaluated for reliability by performing a FMEA in accordance with UL 991, Standard for Tests for Safety-Related Controls Employing Solid-State Devices, Sections 7 and 23, 24 or 25 and the 14 day Composite Operational and Thermal Cycling Test, Section 16.

23.3.4 The computational investigation shall be used as part of the FMEA Analysis. The computational investigation shall comply with 3.5.4.6(f).

23.3.5 For the Composite Operational and Thermal Cycling Test, the temperature range shall be 16 – 30°C (60 – 85°F) unless the manufacturer specifies temperatures outside that range. In that case, the temperatures shall be based on the manufacturer's specifications. During the test if the control stops working, because of a temperature limiting safety feature of the control, the temperatures shall be adjusted so that the product will operate throughout the 14 day test.

23.3.6 The control shall be subjected to the Follow-Up program specified in UL 991, Supplement SA.

24 Parts Subject to Pressure

24.1 Factory sealed systems

24.1.1 A component or system that is pressurized with fluids or gasses from the factory shall be subjected to the normal and abnormal test series for that furnishing without rupture of the system or resulting in a risk of fire, shock or injury to persons.

24.1.2 A component or system with a polymeric containment part such as a hose, tubing, enclosure and the like, relied upon to contain the pressure, shall be subjected to the requirements in 30.1, Conditioning of Polymeric Components, before subjecting the component or system to the normal and abnormal test series for the furnishing.

24.2 Open systems and systems with pumps

24.2.1 A system other than specified in 24.1, Factory Sealed Systems, or one that is intended to move the fluid or gas with a pump shall withstand, without rupture, a hydrostatic pressure equivalent to five times the maximum working pressure in accordance with Section 52, Hydrostatic Pressure Test.

25 Abnormal Conditions – General

25.1 When the conditions of intended operation are not representative of all conditions possible in service, a product shall not present a risk of fire, electric shock, or injury to persons when operated under such abnormal conditions and foreseeable misuse (likely using the furnishing in a manner not intended by the manufacturer).

25.2 Continuous operation, malfunction of components, shorting of output circuits, failure of cooling fans, and likely misuses of the product are conditions to be simulated.

25.3 Abnormal conditions (See Section 75, Abnormal Tests) shall be considered when evaluating furnishings.

25.4 The failure of a component in a furnishing circuit shall not result in a risk of fire, electric shock, or injury to persons.

25.5 A controller designed to manage power or signaling to single or multiple loads shall operate so that upon any single component failure the system does not result in a risk of fire, electric shock, or injury to persons.

25.6 A product that requires operations in a specific sequence shall operate so that upon any single component failure the product does not result in a risk of fire, electric shock, or injury to persons.

25.7 A product that requires limited operation time shall operate so that upon any single component failure the product does not result in a risk of fire, electric shock, or injury to persons.

26 Safety Circuits

26.1 A safety circuit shall be suitable for the application. Components that have been determined to be reliable through previous investigation are not subject to further evaluation unless review of the use, or specific use within a circuit, requires additional evaluation to determine the device or circuit will perform reliably. An electro/mechanical device intended to control the safety functionality of the furnishing such as but not limited to a relay, contactor, position switch, reed switch and similar devices shall be capable of functioning properly through 100,000 cycles of operation at rated load.

26.2 When the investigation in accordance with Section 75, Abnormal Tests, determines that a component or circuit fault results in a risk of fire, electric shock, or injury to persons or the furnishing has a safety function, then the component(s) or circuit(s) in question shall be investigated to determine that they possess the necessary reliability for the anticipated product service life. The circuit(s) shall comply with the requirements for Protective Controls, 3.5.4.

27 Furniture Flammability

27.1 Mattresses

27.1.1 All Mattresses, Mattress Sets and Mattress Foundations shall comply with the Federal Register 16 CFR Part 1633 – Standard for the Flammability (Open Flame) of Mattress Sets. The mattress shall be marked as required in 16 CFR Part 1633 and any other markings required by this standard.

27.1.2 All mattresses, mattress sets and mattress foundations shall comply with the Federal Register 16 CFR Part 1632, Standard for the Flammability of Mattresses and Mattress Pads. The mattress shall be marked as required in 16 CFR Part 1632 and any other markings required by this standard.

27.1.3 Mattresses, mattress sets and mattress foundations intended for use in public occupancies shall comply with 27.1.1, 27.1.2, and the State of California Department of Consumer Affairs Bureau of Home Furnishings and Thermal Insulation, Technical Bulletin 129, Flammability Test Procedure for a Mattress for Use in Public Buildings (October 1992). The mattress shall be marked in accordance with Technical Bulletin 129 and 87.2.25.

27.2 Upholstered seating

27.2.1 Upholstered seating furnishings shall comply with the State of California Department of Consumer Affairs Bureau of Home Furnishings and Thermal Insulation, Technical Bulletin 117-2013, Requirements, Test Procedure and Apparatus for Testing the Flame Retardance of Resilient Filling Materials Used in Upholstered Furniture (March 2013). The furnishing shall be marked in accordance with 87.2.27.

27.3 Other commercial furnishing types

27.3.1 A furnishing or combination of furnishings that are intended to be used together, such as a row of bookcases or tables ganged (mechanically connected) together within one foot (30.5 cm), with a combustible surface area greater than 10 square feet (0.93 m^2) shall comply with the Standard for Test for Surface Burning Characteristics of Building Materials, UL 723 (ASTM E84, Characteristics of Building Materials). The product literature shall be reviewed to determine the intended use. Surface area calculation shall be determined as follows:

a) Surface areas are calculated based on only one side of the surface;

b) All surfaces between vertical and 45 degrees including 45 degrees from vertical are considered vertical surfaces. All surfaces between horizontal and up to 45 degrees from horizontal are considered horizontal surfaces. The areas of the vertical and horizontal surfaces shall be added together;

c) Edges (Examples – Front edge of a shelf, vertical stile or horizontal rail of a unit) of surfaces 2 inches or less in dimension are not added into the area calculation unless they can be positioned directly adjacent to each other;

d) Removable and optional portions of the furnishing are to be included in the area determination; and

e) Merchandise or electrical equipment on the furniture or separately investigated portions of the furnishing such as a conductor, cable, luminaire, power supply, amplifier, speaker, TV, monitor etc. are not to be included in the surface calculation or test.

27.3.2 A decorative molding, cover, shelf, top cap, or a similar component that is formed of combustible material and runs at least the full width of one unit, such as the length of a table, shall have a flammability rating of HB in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

Exception: Materials that are tested in combination with a sample evaluated to 27.3.1 do not need to comply with UL 94 unless used for other purposes specified in this standard.

27.3.3 A combustible material used to form a small [less than 1 sq. inch or less than 4 oz (113.4 g)] decorative part or mechanical connector is not required to have a flammability rating of HB or better in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94. This requirement also applies to fabric and adhesive systems employed as a decorative covering on interpanel poles and posts.

27.3.4 Products tested to UL 723 shall have a maximum flame-spread rating of 200 and if the smoke developed rating is over 450 the product shall be marked as specified in 87.2.17.

28 Heating Pads – For Use in Upholstered Furnishings

28.1 A heating pad employed in a furnishing shall comply with the applicable requirements in the Standard for Electric Heating Pads, UL 130 or Medical Electrical Equipment, Part 1: General Requirements for Safety, UL 60601-1.

Exception: A heating pad that is not accessible and that complies with the requirements in the Resistance to Moisture Test, 79.1; the Thermostat Test, 79.2, and the Flexing and Twisting Test, 79.3, is acceptable.

28.2 Fabric, batting, padding, foam, and synthetic or natural leather shall not be relied upon to serve as electrical insulation.

28.3 Current-carrying metal parts within a heating pad shall be electrically insulated with a material that complies with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. The thickness (not including the envelope or padding material) of insulation applied directly to the current-carrying metal parts shall not be less than 0.028 inch (0.71 mm) unless the parts are secured in position (to prevent their motion relative to one another, the envelope, or both). If the parts are secured, 0.013 inch (0.33 mm) shall be the minimum insulation thickness.

Exception: Appliance wiring material with insulation thickness as specified above.

28.4 A furnishing heating pad shall be provided with a supplemental envelope (enclosure) that complies with the following:

a) The envelope shall be of materials acceptable for the application and shall enclose all electrical parts of the pad without any ventilation or other openings;

b) An envelope of unsupported vinyl sheeting on a furnishing pad shall not be thinner than an average thickness of 0.020 inch (0.5 mm):

1) The average thickness of a rectangular specimen measuring approximately 1 by 4 inches (25 by 102 mm) is to be determined from measurements made by means of a dead-weight dial micrometer having a flat anvil and a flat-faced cylindrical presser foot that is 0.25 ±0.01 inch (6.35 ±0.25 mm) in diameter and exerts 85 ±3 gf (0.83 ±0.03 N) on the specimen. The calibration of the dial on the micrometer is to facilitate estimation of each measurement to 0.0001 inch (0.0025 mm); and

2) The thickness of a specimen is to be measured midway across the width of the specimen at the center of its length and at points 1/2 inch (13 mm) from each end. Each measurement is to be estimated at the nearest 0.0001 inch (0.0025 mm) and recorded. The smallest of the three recorded thicknesses is to be rounded off to the nearest 0.001 inch (0.025 mm).

28.5 Foam padding in direct contact with or provided as a component of a heating pad shall comply with the requirements for HBF or better material as specified in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

PERFORMANCE

MECHANICAL TESTS

29 General Conditions

29.1 General

29.1.1 Where an angle is specified, the tolerance shall be ±2.0 degrees.

29.2 Trial installation

29.2.1 A furnishing shipped disassembled or an accessory shall be trial-installed to determine that the installation is applicable, that the instructions are detailed and accurate, and that the use of the furnishing or accessory does not introduce a risk of fire, electric shock, or injury to persons.

30 Conditioning of Products

30.1 Conditioning of polymeric components

30.1.1 A polymeric material used to support or carry a weight load shall be conditioned in accordance with 30.1.2 prior to conducting loading or mounting tests.

30.1.2 An unloaded representative furnishing support system employing polymeric parts and its accessories are to be placed in a full-draft circulating-air oven. The air temperature within the oven is to be maintained at a minimum of 70°C (158°F) or 10°C higher than the temperature obtained on the polymeric parts during the temperature test, whichever is higher, for a minimum of 7 hours. The support system and its accessories are to be allowed to cool to room temperature before conducting the Stability Test, Loading Test, Cycling Test or Mounting Securement Test.

30.2 Conditioning of components secured by adhesives

30.2.1 An adhesively secured component used to support or carry a weight load shall be conditioned as specified in 30.2.2 prior to conducting the stability, loading tests or the Adhesive Securement Test, Section 31.

30.2.2 Two representative furniture support systems employing adhesives as the sole support shall be conditioned as follows:

a) One furniture support system shall be placed in an air-circulating oven for: Seven days at 100 ±1.0°C (212 ±1.8°F); and

b) One furniture support system shall be conditioned for a minimum of seven days in an environment of 85 ±5 percent relative humidity at 32.0 ±2.0°C (89.6 ±3.6°F).

The support system and its accessories are to be allowed to cool to room temperature before conducting the required test.

31 Adhesive Securement Test

31.1 A component of a furnishing secured by an adhesive that would create a risk of fire, electrical shock or injury to persons upon adhesive failure shall comply with the test specified in 31.2. The adhesive is considered satisfactory when the adhered surfaces do not separate.

31.2 The joined components shall be subjected to the conditioning specified in 30.2, Conditioning of Components Secured by Adhesives.

31.3 The furnishing shall be installed in accordance with the installation instructions. A weight equal to 4 times the weight of the adhered component is to be attached to any point on the adhered component that subjects the adhesive to the weight load. The component shall remain affixed to the furnishing for a minimum of 1 minute.

32 Structural Test Requirements for Furnishings – General Loading

32.1 A furnishing shall be subjected to the structural loading tests, Section 33, Seating, Section 34, Desks and Tables, Section 35, Storage Furnishings, and Section 36, Bests and shall not collapse or deform to a degree that presents a risk of fire, electric shock, or injury to persons.

a) A risk of injury to persons is determined to exist when the furnishing or part of a furnishing collapses, partially collapses or is damaged to the extent that there are sharp edges or corners exposed which do not comply with the Standard for Tests for Sharpness of Edges on Equipment, UL 1439; and

b) Electrical components within the furnishing shall comply with the requirements of Accessibility of Uninsulated Live Parts and Film-Coated Wire, Section 13, and Dielectric Voltage-Withstand Test, Section 71.

32.2 For height adjustable tables, the tables shall be able to maintain the functional load at its highest height and for proof load shall not collapse or deform to a degree that presents a risk of fire, electric shock, or injury to persons.

32.3 Optionally, for tables, desks, and storage units, the company can specify the functional load. In those cases, the normal (functional) load will be the load specified by the company and the abnormal (proof) load will be 1.5 the normal load.

33 Seating

33.1 Chairs shall be subjected to the tests as outlined in Table 33.1, Table 33.2, or Table 33.3, as applicable.

Table 33.1
Office seating ANSI/BIFMA 5.1-2017

Section	Test Name
5	Backrest Strength – Static Type I & II
6	Backrest Strength – Static Type III
7	Drop – Dynamic
8	Swivel – Cyclic
9	Tilt Mechanism – Cyclic
10	Seating Durability – Cyclic
12	Arm Strength – Vertical – Static
13	Arm Strength – Horizontal – Static
14	Backrest Durability – Cyclic – Type I
15	Backrest Durability – Cyclic – Type II & III
17	Leg Strength – Front & Side Application
18	Footrest Static Load – Vertical

Table 33.1 Continued on Next Page

Table 33.1 Continued

Section	Test Name
19	Footrest Static Load – Vertical – Cyclic
20	Arm Durability – Cyclic
22	Tablet Arm Chair Static Load
23	Tablet Arm Chair Load Ease – Cyclic
24	Durability

Table 33.2
Large occupant seating ANSI/BIFMA 5.11-2015

Section	Test Name
6	Backrest Strength – Static Type I
7	Backrest Strength – Static Type II & III
8	Drop – Dynamic
9	Swivel – Cyclic
10	Tilt Mechanism – Cyclic
11	Seating Durability – Cyclic
13	Arm Strength – Vertical – Static
14	Arm Strength – Horizontal – Static
15	Backrest Durability – Cyclic – Type I
16	Backrest Durability – Cyclic – Type II & III
18	Leg Strength – Front & Side Application
19	Arm Durability – Cyclic
21	Tablet Arm Chair Static Load
22	Tablet Arm Chair Load Ease – Cyclic
23	Structural Durability – Cyclic

Table 33.3
Lounge and Public Seating – Tests ANSI/BIFMA 5.4-2012

Section	Test Name
5	Backrest Strength Test – Horizontal – Static
6	Backrest Strength Test – Vertical – Static
7	Backrest Durability Test – Horizontal – Cyclic
8	Backrest Durability Test – Vertical – Cyclic
9	Arm Strength Test – Horizontal – Static
10	Arm Strength Test – Vertical – Static
11	Arm Durability Test – Horizontal – Cyclic
12	Arm Durability Test for Multiple Seating Units – Vertical – Cyclic
13	Arm Durability Test for Single Seat Units – Angular – Cyclic
14	Seating Durability Tests – Cyclic

Table 33.3 Continued on Next Page

Table 33.3 Continued

Section	Test Name
15	Drop Test – Dynamic
16	Leg Strength Test – Front and Side Application
17	Unit Drop Test – Dynamic
19	Swivel Test – Cyclic
20	Tilt Mechanism Test – Cyclic
22	Tablet Arm Load Ease Test – Cyclic
23	Tablet Arm Load Test – Static

34 Desks and Tables

34.1 Desks and tables shall be subjected to the tests as outlined in Table 34.1.

Table 34.1
Desk / Table Products ANSI/BIFMA X5.5-2021

Section	Test Name
5.2	Concentrated Functional Load
5.3	Distributed Functional Load
5.4	Concentrated Proof Load
5.5	Distributed Proof Load
5.6	Transactional Surface Torsion Load
5.7	Extendible Element Static Load
5.8	Benching Systems – Distributed Functional Load and Stability
5.9	Benching Systems – Distributed Proof Load
7	Desk/Table Unit Drop
8	Leg Strength
9	Separation Tests for Tall Desk/Table Products
13	Interlock Strength
16	Keyboard Support and Input Device Support Adjustment
17.2 & 17.3	Vertical Hinged & Vertical Receding Doors, BiFold, and Multi-Fold Strength
5.3 & 5.4	Bottom Horizontal Hinged Strength
17.4	Vertical Receding Strength
17.5	Horizontal Receding Strength
20	Tilting Top Table – Cycle
21	Tilting Top Table – Latch Strength
22	Monitor Arm Strength
23	Monitor Arm Cycle

35 Storage Furnishings

35.1 Storage furnishings shall be subjected to the tests as outlined in Table 35.1, as applicable.

Table 35.1
Storage Units ANSI/BIFMA X5.9-2019

Section	Test Name
4.2	Concentrated Functional Load
4.3	Distributed Functional Load
4.4	Concentrated Proof Load
4.5	Distributed Proof Load
4.6	Extendible Element Static Load
5	Leg/Glide Assembly Strength
6	Racking Resistance
7.2	Drop Test – Dynamic – for Units with Seat Surfaces
7.3	Durability Test for Units with Seating Surfaces – Cyclic Impact
9.2	Horizontal Force Stability Test for Storage Units without Extendible Elements
9.3	Stability Test for Type I Units with at least one Extendible Element
9.4	Stability Test for Type I Storage Units with Multiple Extendible Elements
9.5	Stability Test for Type II Storage Units with Extendible Elements
9.6	Vertical Force Stability Test for Storage Units
9.7	Stability Test for Pedestals/Storage Units with Seat Surfaces

36 Beds

36.1 Loading

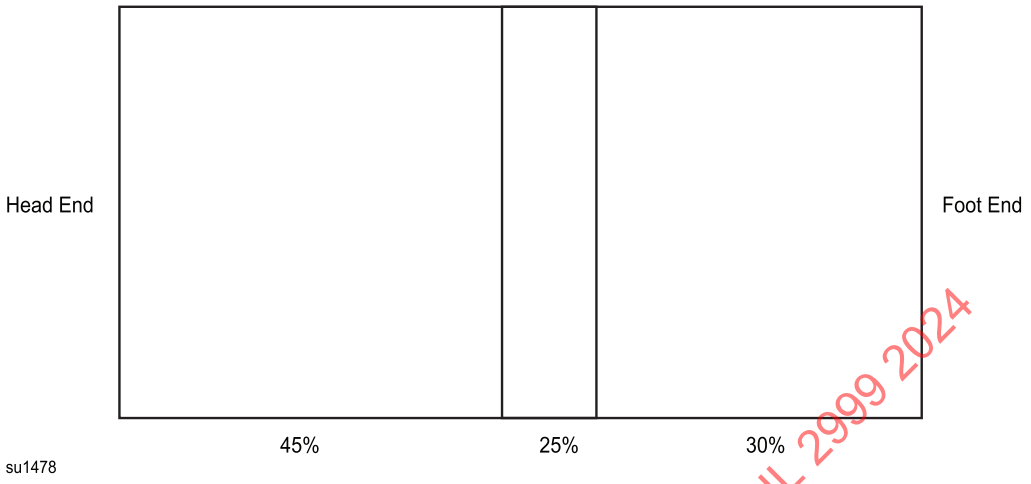
36.1.1 For a bed, the test weight is to be a minimum of 500 lbs (227 kg) per intended person. For example, a twin bed is intended for 1 person and a queen bed is intended for 2 people. The weight is to be evenly distributed over the surface. For an articulating bed the weight shall be distributed as specified in Figure 36.1. The test weight shall include the weight of a box spring, if one is intended to be used, and a mattress, if these are not provided, see Table 36.1. The weight shall be applied for a minimum of 15 minutes.

Table 36.1
Bed component weights

Bed Type	Box Spring (Lbs / Kg)	Mattress (Lbs / Kg)	Total (Lbs / Kg)
Twin	50 / 22.7	75 / 34.0	125 / 56.7
Double (Full)	60 / 27.2	100 / 45.4	160 / 72.6
Queen	75 / 34.0	150 / 68.0	225 / 102.1
King	100 / 45.4	170 / 77.1	270 / 122.5

Figure 36.1

Articulating bed weight distribution Top View



36.1.2 Following the test specified in 36.1.1 the Weight drop test 36.2.1 shall be conducted on the bed. The bed shall comply with 32.1.

36.2 Weight drop

36.2.1 For weight drop test, the test weight shall be a minimum of 300 lbs (136 kg) in a canvass bag 16 inches (41 cm) in diameter filled with ball bearings, or steel shot. The weight shall be dropped at least 6 inches (21.24 cm) above the uncompressed surface. Any seating or lying position not under test shall have a minimum weight of 300 lbs (102 kg) evenly applied over the surface. The system shall comply with 32.1.

37 General Stability Test Criteria

37.1 A furnishing when subjected to the stability requirements shall not present a risk of fire, electric shock, or injury to persons.

a) A risk of injury to persons is determined to exist when the furnishing or part of a furnishing overturns, is displaced or dislodged from its support surface or when the furnishing or support surface is damaged to the extent that there are sharp edges or corners exposed which do not comply with the Standard for Tests for Sharpness of Edges on Equipment, UL 1439.

b) Electrical components within the furnishing shall comply with the requirements in Section 13, Accessibility of Uninsulated Live Parts and Film-Coated Wire and Section 71, Dielectric Voltage-Withstand Test.

Exception: Based on visual observation that no damage has occurred to the electrical components these tests do not need to be performed.

37.2 A furnishing is to be tested on a smooth hard surface such as concrete or smooth wood. The furnishing shall be assembled or set up in accordance with the instruction manual provided with the furnishing.

38 Furnishing Stability Configuration Test Requirements

38.1 A furnishing shall be assembled in accordance with the installation or assembly instructions.

38.2 A furnishing that requires an addition of a component or material in order to perform its intended function shall be tested for stability with the component or material in place. (Examples: A container that requires dirt to be in place to plant a plant, a decorative water feature where the user needs to add water for the unit to function, a patio shade umbrella that requires a ballast material in its base to remain upright in accordance with the instructions).

38.3 If a furnishing can perform its intended function with or without the component or material in place as specified in the functional loading requirements in Section 32, Structural Test Requirements for Furnishings – General Loading; Section 33, Seating; Section 34, Desks and Tables; Section 35, Storage Furnishings; and Section 36, Beds, the furnishing shall be subjected to the stability test in any or all of the following conditions considered being most severe:

a) Unloaded;

b) Partially loaded with the functional load; and/or

c) Fully loaded with the functional load.

When testing partially loaded, the fully loaded load shall be placed as specified in the loading tests and the individual loads removed one at a time so that the furnishing is tested in the least stable position. For example, an area with a work surface would have the load only along one side at a time.

38.4 Articulated parts shall be positioned and loaded to represent worst case. This may require multiple tests to determine. (Example: A furnishing which is intended to be used with or without a video display or converts from an entertainment center to an armoire, wardrobe or shelving unit.)

38.5 The load may be secured to the furnishing for test purposes. Loads shall comply with the requirements in Section 32, Structural Test Requirements for Furnishings – General Loading; Section 33, Seating; Section 34, Desks and Tables; Section 35, Storage Furnishings; and Section 36, Beds, as applicable, functional loads.

38.6 A furnishing that is comprised of an assembly that allows for portions of the assembly to be used without being completely assembled shall comply with the stability test both assembled and with the usable portion of the assembly alone without the other attachments. (Example: A patio umbrella and table assembly where the umbrella or table can be used without the other component).

38.7 A furnishing provided with a means to level the furnishing shall be adjusted to level or as closely to level as the adjustment allows in accordance with the use instructions.

38.8 A furnishing provided with a coordinating device that only allows the opening or extending of drawers, doors or appendages in a specific combination or sequence shall be used for the conduct of the stability test if found to function as intended when attempts are made to manually defeat the device by opening and closing the operable elements of the furnishing in any combination.

38.9 Doors shall be manipulated to a point that provides the least stability for the furnishing (typically perpendicular, 90 degrees, to the front plane of the furnishing). Other positions shall be investigated if 90 degrees to the front plane of the furnishing is determined not to be the worst-case position for stability. All doors shall be manipulated singly or in combination. Positioning of doors or other appurtenances shall not be used to prevent tip over.

39 Stability Test for Portable Furnishings

39.1 A portable furnishing, other than the types listed in Section 40, Seating; Section 41, Desks and Tables (Non-Motorized and Motorized With and Without Casters); and Section 42, Storage Furnishings,

shall be constructed so that there is no risk of fire, electric shock or injury to persons when subjected to the test specified in 39.2 and 39.3. The furnishing shall not overturn.

39.2 Storage or work areas shall be loaded or unloaded with the functional load as specified in Section 32, Structural Test Requirements for Furnishings – General Loading; Section 33, Seating; Section 34, Desks and Tables; Section 35, Storage Furnishings; and Section 36, Beds, as applicable, whichever is considered worse case. Loads shall be applied in accordance with Section 32 and may be secured to the furnishing for test purposes.

39.3 The portable furnishing is to be placed in any orientation on an incline plane at an angle of 10 degrees to a level horizontal plane. Furnishings with articulating features are to be adjusted to the least stable position.

40 Seating

40.1 Chairs shall be subjected to the tests as outlined in Table 40.1.

Table 40.1
Office seating ANSI/BIFMA 5.1-2017

Section	Test Name
11.3	Rear Stability
11.4	Front Stability

Table 40.2
Office seating ANSI/BIFMA 5.11-2015

Section	Test Name
12.3	Rear Stability
12.4	Front Stability

Table 40.3
Lounge and Public Seating – Tests ANSI/BIFMA 5.4-2012

Section	Test Name
21.3	Rear Stability for Non-tilting Units
21.4	Rear Stability Test for Tilting
21.5	Front Stability

41 Desks and Tables (Non-Motorized and Motorized With and Without Casters)

41.1 Desks and tables shall be subjected to the tests as outlined in Table 41.1.

Table 41.1
Desk / Table Products ANSI/BIFMA X5.5-2014

Section	Test Name
4.2	Stability with Extendible Elements Open
4.3	Stability Under Vertical Load
4.4	Horizontal Stability Test for Desks/Tables with Casters
4.5	Stability Test for Keyboard/Laptop Tables
4.6	Force Stability Test for Tall Desk/Table Products
5.8	Benching Systems – Distributed Functional Load and Stability

42 Storage Furnishings

42.1 Storage furnishings shall be subjected to the tests as outlined in Table 42.1, as applicable.

Table 42.1
Storage units ANSI/BIFMA X5.9-2019

Section	Test Name
4.0	Stability

43 Stability Tests for Other Stationary and Fixed Furnishings

43.1 A stationary and fixed furnishing, other than the types listed in Section 40, Seating; Section 41, Desks and Tables (Non-Motorized and Motorized With and Without Casters); and Section 42, Storage Furnishings, shall be constructed so that there is no risk of fire, electric shock or injury to persons when subjected to the tests specified in 43.2. The furnishing shall not overturn.

43.2 Storage or work areas shall be loaded or unloaded with the functional load specified in Section 32, Structural Test Requirements for Furnishings – General Loading; Section 33, Seating; Section 34, Desks and Tables; Section 35, Storage Furnishings; and Section 36, Beds, as applicable, whichever is considered worse case. Loads shall be applied in accordance with Sections 32 – 36, as applicable, and may be secured to the furnishing for test purposes. The furnishing is to be placed in any orientation on the incline plane. Furnishings with articulating features are to be adjusted to the least stable position.

a) A furnishing without casters, rollers or wheels is to be placed on an incline plane at an angle of 2 degrees to a level horizontal plane. The furnishing may be loaded or adjusted before or after being placed on the incline. The glides, feet, and similar parts are to be blocked or otherwise restricted from moving along the surface. The means used to restrict movement are not to restrict tipping of the assembly.

b) A stationary furnishing with casters, rollers or wheels is to be placed on an incline plane at an angle of 10 degrees to a level horizontal plane. The casters, rollers or wheels shall be rotated to the least stable position. The furnishing may be loaded or adjusted before or after being placed on the incline. The casters, rollers or wheels are to be blocked or otherwise restricted from moving along the surface. The means used to restrict movement shall not restrict tipping of the assembly.

44 Stability Test for Furnishings Having a Support Surface or Mounting Surface for a Television (TV) or Monitor

44.1 The following tests specified in the Standard for Household, Commercial, and Institutional-Use Carts, Stands and Entertainment Centers for Use with Audio and/or Video Equipment, UL 1678, shall be performed:

Section	Test Name
16.4	Dynamic Tip Stability Test For Tall Institutional Carts And Stands
16.5	Force Stability Test

45 Stability Test for Furnishings Provided With a Step

45.1 A furnishing with an intentional step or a surface that is likely to be used as a step shall be constructed such that there is not a risk of fire, electric shock or injury to persons when subjected to the test specified in 45.2. The furnishing shall not over turn or if secured to a structure shall not separate from the structure.

45.2 The furnishing shall be configured as specified in Section 32, Structural Test Requirements for Furnishings – General Loading; Section 33, Seating; Section 34, Desks and Tables; Section 35, Storage Furnishings; and Section 36, Beds, as applicable. A fully assembled furnishing is to be subjected to a minimum of 300-lb (435-N) load applied straight down through a flat rigid structure 4 by 4 inches (102 by 102 mm) in any position along the furnishing structure element under investigation. The load is to be applied for a minimum of 1 minute.

46 Stability Test for Furnishings Provided With a Foot or Leg Rest

46.1 A furnishing with a foot or leg rest or a surface that is likely to be used as a foot or leg rest shall be constructed such that there is not a risk of fire, electric shock or injury to persons when subjected to the tests specified in 46.2. The furnishing shall not over turn or if secured to a structure shall not separate from the structure.

46.2 The furnishing shall be configured as specified in Section 32, Structural Test Requirements for Furnishings – General Loading; Section 33, Seating; Section 34, Desks and Tables; Section 35, Storage Furnishings; and Section 36, Beds, as applicable. A fully assembled furnishing is to be subjected to a minimum of 50-lb (222.4 N) load applied straight down through a flat rigid structure 4 by 4 inches (102 by 102 mm) in any position along the furnishing structure element under investigation. The load is to be applied for a minimum of 1 minute.

47 Structure Mounted or Secured Furnishing Tests

47.1 General

47.1.1 The Cycling Test for Furnishings with Articulating Components, Section 51, shall be conducted prior to conducting the furnishing securement tests.

47.1.2 These tests are not applicable for products covered by the BIFMA standards referenced in this standard.

47.2 Suspended furnishing, securement test

47.2.1 A furnishing secured to a vertical structure without additional support at the base (floor, shelf) or a furnishing suspended from a horizontal structure (ceiling, rack) shall be secured to a structure in accordance with the installation instructions using the hardware provided or specified. See 94.9. A furnishing system and its accessories shall be constructed so there is no cracking, or similar damage to the mounting bracket, securement means, supporting structure, furnishing or any combination thereof to the point where the mounting system releases from the structure, the product collapses, creates a risk of fire, electric shock, or injury to persons when tested in accordance with 47.2.2 and 47.2.3.

47.2.2 Common North American Structures, Section 50 defines typical building surfaces located in North America. The test shall be conducted using one or more surface type. The installation instructions shall specify the surfaces that were used for the test.

Sufficient detail shall be provided in the instructions to specify the structures, hardware, fasteners and mounting system that were used to support the furnishing.

Exception: None of the common structures in Section 50 are required to be tested if the installation instructions define a different type of structure. That structure shall be used to conduct this test.

47.2.3 The test load shall be a minimum of 4 times the weight of the furnishing plus the functional load specified in Section 34, Desks and Tables and Section 35, Storage Furnishings, as applicable. The total test weight is to be gradually applied and maintained for a minimum of 5 minutes. [Example: Furnishing weighs 50 lbs (22.7 kg) and has a normal load of 20 lbs (9.1 kg). The test load to be added to the furnishing is 4 times 50 lbs (22.7 kg) plus the 20 lbs (9.1 kg) equaling 220 lbs (100 kg)].

47.3 Vertically-secured base supported, securement test

47.3.1 A furnishing system intended for attachment to a vertical structure while also resting on a horizontal structure (floor, shelf) shall be secured to the structure in accordance with the installation instructions using the hardware provided or specified. See 94.9. A furnishing system and its accessories shall be constructed so there is no cracking or similar damage to the mounting bracket, securement means, supporting structure, furnishing or any combination thereof to the point where the mounting system releases from the structure, the product collapses, creates a risk of fire, electric shock, or injury to persons when tested in accordance with these requirements.

47.3.2 The furnishing shall be placed on a 2-degree plane that slopes away from the vertical support structure. The test shall be configured as follows:

a) Any adjustable leveling system shall be used to bring the furnishing parallel to the vertical structure or as close to parallel to the vertical structure as the leveling means allows.

b) All appurtenances shall be adjusted to extend to their maximum position away from the vertical structure.

c) The furnishing shall be loaded with the functional load in accordance with Section 32, Structural Test Requirements for Furnishings – General Loading; Section 33, Seating; Section 34, Desks and Tables; Section 35, Storage Furnishings; and Section 36, Beds, as applicable.

d) The furnishing shall be subjected to these forces for a minimum of 5 minutes.

47.4 Base-secured base supported, securement test

47.4.1 A furnishing system intended for attachment to a horizontal structure (example: floor or shelf) while also resting on the horizontal structure shall be secured to the structure in accordance with the

installation instructions using the hardware provided or specified. See 94.9. A furnishing system and its accessories shall be constructed so there is no cracking or similar damage to the mounting bracket, securement means, supporting structure, furnishing or any combination thereof to the point where the mounting system releases from the structure, the product collapses, creates a risk of fire, electric shock, or injury to persons when tested in accordance with these requirements.

47.4.2 The furnishing shall be placed on a 2-degree plane that slopes away from the vertical support structure. The test shall be configured as follows:

a) Any adjustable leveling system shall be used to bring the furnishing parallel to the vertical structure or as close to parallel to the vertical structure as the leveling means allows.

b) All appurtenances shall be adjusted to extend to their maximum position away from the vertical structure.

c) The furnishing shall be loaded with the functional load in accordance with Section 32, Structural Test Requirements for Furnishings – General Loading; Section 33, Seating; Section 34, Desks and Tables; Section 35, Storage Furnishings; and Section 36, Beds, as applicable.

d) The furnishing shall be subjected to these forces for a minimum of 5 minutes.

48 Tests on Glass Components

48.1 Impact test

48.1.1 In accordance with 11.14, Glass Components, a glass surface shall be subjected to the impact test specified in 48.1.2. The glass surface shall not crack or break to the extent that a piece of the glass surface is released or drops from its normal position.

48.1.2 A solid steel sphere, minimum 2 inch (51 mm) in diameter and weighing minimum 1.18 lbs (0.54 kg), is to fall through the distance required to result in an impact of minimum 5 ft-lbf (6.8 J). The sample is to be supported as normally supported by the furnishing.

48.2 Retention test

48.2.1 In accordance with 11.14, Glass Components, a glass surface shall be subjected to the retention test specified in 48.2.2. The glass shall not become dislodged or displaced from its mounting means to the point where it completely separates from its mounting means.

48.2.2 The glass surface is to be mounted in the intended manner. A sand-filled bag having a 30.0 ±0.5 inch (760 ±13 mm) circumference and a minimum weight of 20 lb (9.1 kg) is to fall as a pendulum through the distance that produces a minimum impact of 35 ft-lbf (18.4 J) on any point on the panel.

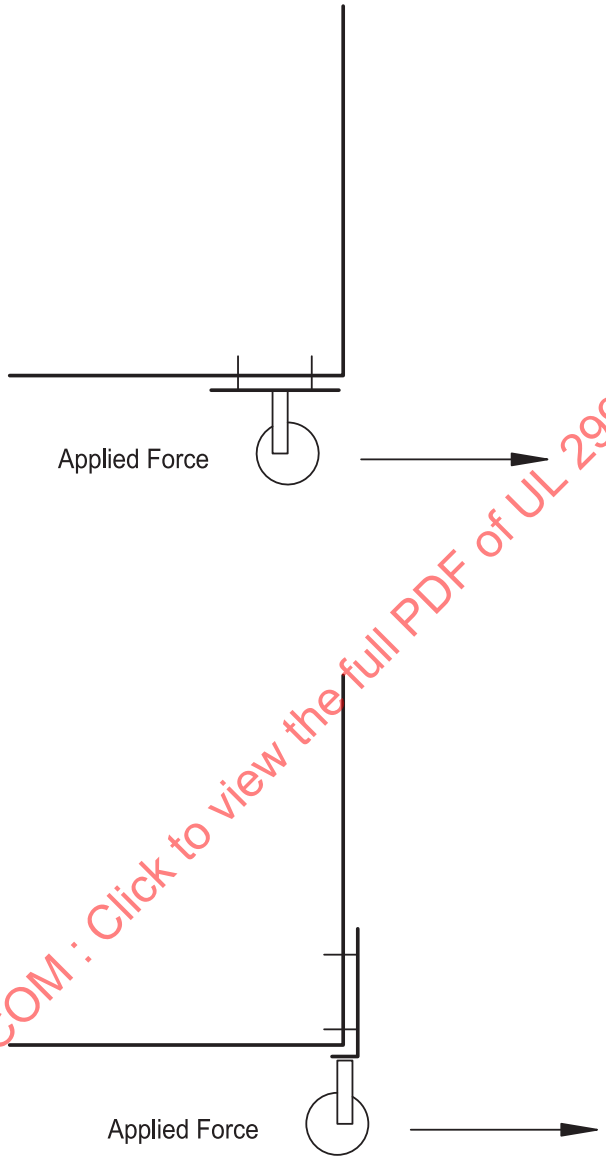
49 Wheel, Roller, or Caster Securement Test

49.1 A wheel, roller, or caster shall be capable of withstanding a pull equal to the minimum normal functional load plus the weight of the furnishing, divided by the number of wheels, rollers, or casters supporting the loaded weight of the furnishing when applied as specified in 49.2.

49.2 The force is to be applied by a weight or a steady pull for a period of minimum 1 minute as specified in Figure 49.1 in any direction that represents the worst case based on how the wheel, caster or roller is attached. The force shall be applied at the axle center of the wheel, caster or roller. The force is to be applied with the specimen at room temperature and the furniture unloaded. The wheel, roller, or caster shall not pull free from its securing means and shall remain suitable for its intended use.

Figure 49.1

Caster test



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50 Common North American Structures

50.1 General

50.1.1 This Section is provided to assist the user in selecting typical representative supporting surfaces. Tests are not required to be conducted utilizing these specific surfaces. The actual surfaces that the product is intended to be mounted to and the hardware to be used to accomplish the mounting or securement shall be tested and then specified in the installation instructions. For the purpose of these requirements “standard” materials are referenced to provide a basis of comparison of test results.

50.2 Insert type masonry anchors

50.2.1 Concrete anchors are to be installed in accordance with the anchor installation instructions. For performance tests in concrete the concrete area shall be at least two times the total intended mounting surface area that the furnishing mount will cover when installed. The concrete thickness shall be at least twice the depth of the anchor.

50.2.2 Whenever a standard concrete material is necessary it shall be mixed so that the 28-day compressive strength is from 2500 to 3000 psi (17.2 to 20.7 MPa) or equivalent.

50.2.3 Whenever standard concrete block is needed it shall comply with ASTM C90, the Standard for Concrete Masonry Units.

50.2.4 Whenever standard clay brick is needed it shall comply with ASTM C62, the Standard for Specification for Building Brick (Solid Masonry Units Made from Clay or Shale).

50.2.5 Following the installation of the test anchors in the substrate the furnishing mounting system is to be secured to the anchors in accordance with the instructions specified in Section 32, Structural Test Requirements for Furnishings – General Loading, as applicable.

50.3 Power driven masonry anchors/fasteners

50.3.1 Concrete powder-driven fasteners are to be driven into the concrete mounting samples to the full depth of the shank. Following the installation of test samples in the concrete each assembly is to be secured and subjected to the required loading as specified in Section 32, Structural Test Requirements for Furnishings – General Loading; Section 33, Seating; Section 34, Desks and Tables; Section 35, Storage Furnishings; and Section 36, Beds, as applicable.

50.3.2 Whenever standard concrete material is necessary it shall be proportioned so that the 28-day compressive strength is from 2500 to 3000 psi (17.2 to 20.7 MPa) or equivalent.

50.3.3 Samples of fasteners intended for use in steel are to be driven into steel having thickness(es) in which it is intended for use and having hardness values (Brinnell) of not less than 160 nor more than 240.

50.3.4 Each sample is to penetrate to the depth specified in the installation instructions.

50.4 Welding studs

50.4.1 Welding studs are to be attached to steel plates using the tools and methods specified in the installation instructions.

50.5 Wood studs

50.5.1 The furniture mounting system shall specify the minimum acceptable wall system to which the furniture mounting system is intended to be secured to. The minimum stud size [nominal 2-inch (50.8 mm) by 4-inch (102 mm), 2-inch (50.8 mm) by 6-inch (152 mm), etc.], the minimum and maximum stud spacing, the maximum specified wall covering thickness (Gypsum drywall, lath and plaster, etc.) shall be used for the test. Standard wood studs shall be graded in accordance with the American Softwood Lumber Standard No. PS 20 and shall be Grade No. 2.

50.5.2 For a typical 2-inch (50.8 mm) by 4-inch (102 mm) or 2-inch (50.8 mm) by 6-inch (152 mm) wood stud the fastening means used to secure the mounting system to the wood studs shall be secured to the thin edge of the stud, the 1-1/2 inch (38 mm) width.

50.6 Steel studs

50.6.1 The minimum acceptable wall system to which the mounting system is intended to mount shall be specified. The minimum stud size [2-inch (50.8 mm) by 4-inch (102 mm), 2-inch (50.8 mm) by 6-inch (152 mm), etc.], the minimum stud metal thickness or gauge, the minimum and maximum stud spacing, the stud type and structural shape conforming to the North American Specification for the Design of Cold-Formed Steel Structural Members, the maximum wall covering thickness (Gypsum drywall, lath and plaster, etc.) shall be used for the test. Gypsum wallboard shall be standard 1/2 inch (12.7 mm) or less non-fire rated secured to the studs with screws 12 inches (305 mm) on center.

50.6.2 For a typical 2-inch (50.8 mm) by 4-inch (102 mm) or 2-inch (50.8 mm) by 6-inch (152 mm) steel stud the fastening means used to secure the mounting system to the steel studs shall be secured to the thin edge of the stud, the 1-1/2 inch (38 mm) width.

51 Cycle Test for Furnishings with Articulating Components

51.1 A furnishing with an articulating feature that when loaded exceeds minimum 50 lbs (22.68 Kg) shall be constructed so there is no collapse, permanent damage, loosening of hinges or fasteners resulting in a risk of fire, electric shock, or injury to persons during or after the cycling test. The furnishing shall be installed according to the instructions provided with the furnishing. All movement tension adjustments shall be adjusted to provide the greatest resistance to movement recommended by the instructions provided.

51.2 The cycling test shall be conducted prior to conducting the furnishing securement test.

51.3 An articulating furnishing and its accessories shall be constructed so there is no undue wear to joints or reduction of spacings or damage to electrical insulation after the cycling test. Spacings shall comply with Section 18, Spacings, after cycling and the furnishing systems electrical system shall comply with Section 71, Dielectric Voltage Withstand Test, after cycling.

Exception: Electrical systems supplied by a class 2 or LPS power source and posing no risk of injury from failure to operate are not required to comply with the dielectric voltage withstand test after cycling.

51.4 A manually or motor operated articulating furnishing shall be subjected to 500 cycles of operation. Threaded fasteners and tension adjustments shall not be adjusted during the cycling test.

51.5 During the cycling test, an articulating furnishing system shall be loaded as specified for the functional loading test in Section 32, Structural Test Requirements for Furnishings – General Loading; Section 33, Seating; Section 34, Desks and Tables; Section 35, Storage Furnishings; and Section 36, Beds, as applicable.

51.6 A cycle is considered to be one extreme position to the opposite extreme position and back to the original position.

51.7 A cycle for a furnishing system with more than one axis of movement shall be cycled such that each axis is to be cycled either individually or in combination, whichever operation is allowed by the control and results in the 500 cycles being equally divided between all axes of adjustment. (Example: A manually-adjusted two-axis movement would have 250 cycles conducted on each axis). All axes may be tested at once if the testing apparatus is able to articulate each axis through its full range of motion.

52 Hydrostatic Pressure Test

52.1 When required by Section 24, Parts Subject to Pressure, three samples of each part or the system as an assembly subject to pressure are to be filled with any nonhazardous liquid, such as water, so as to exclude air, and are to be connected to a hydraulic pump. The pressure is to be raised gradually to the required test value, five times the maximum working pressure, and is to be held at that value for 1 minute, during which time the sample shall not burst. Leakage is acceptable provided the leakage does not create a risk of fire, shock or injury to persons.

53 Force Measurement and Operator Attended Tests

53.1 A motorized or otherwise powered moving part as required by 11.4, Mechanical Enclosure And Guards – Mechanical Considerations shall be subjected to the force measurement tests specified in 53.2 – 53.5. The force shall not exceed a maximum of 40 lbs (177.9 N). There shall be no collapse or permanent damage to the furnishing or mounting means (if provided) resulting in a risk of injury during or following the test.

53.2 The furnishing shall be loaded in accordance with the functional load as specified in Section 32, Structural Test Requirements for Furnishings – General Loading; Section 33, Seating; Section 34, Desks and Tables; Section 35, Storage Furnishings; and Section 36, Beds, as applicable, as applicable to the furnishing under investigation or unloaded if determined to be more severe.

53.3 A furnishing that has accessories that can be removed or added shall be subjected to the force measurement in any configuration determined to be most severe. Normally the largest size accessory is used for the investigation, but consideration may be given to smaller sizes when a more severe result may occur.

53.4 The motorized or powered moving part of the furnishing shall be operated at the maximum velocity allowed by the design of the furnishing. The force measurement shall be repeated three times and the maximum force measured shall not exceed a maximum of 40 lbs (177.9 N).

53.5 The force measurements shall be conducted in any location as required by the requirements specified in 11.3, Personal Injury, Entrapment, Pinch Points, and Shear Considerations; and 11.4, Mechanical Enclosures and Guards – Mechanical Considerations. Figure 53.1 – Figure 53.4 are provided as typical examples of entrapment locations and shall be considered when conducting the force measurements.

53.6 As an alternative to the 40 lbs (N), the force measurements shall comply with the following values:

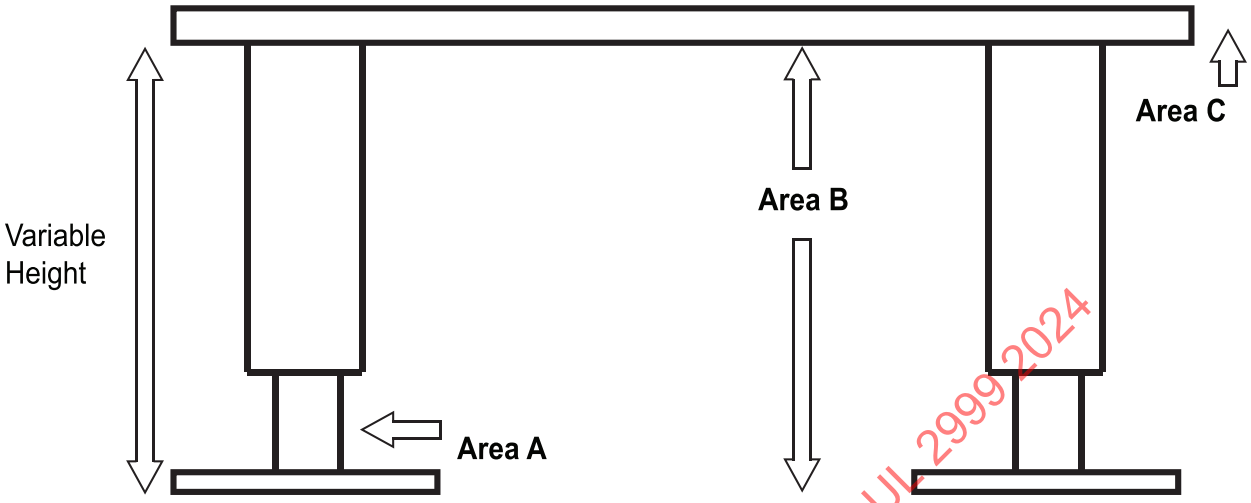
a) First 0.75 seconds shall not exceed a dynamic force of 90.0 lbs (400 N);

b) 0.75 to 5 seconds shall not exceed a static force of 34.0 lbs (150 N); and

c) After 5 seconds shall not exceed a static force of 5.6 lbs (25 N).

Figure 53.1

Examples of entrapment areas



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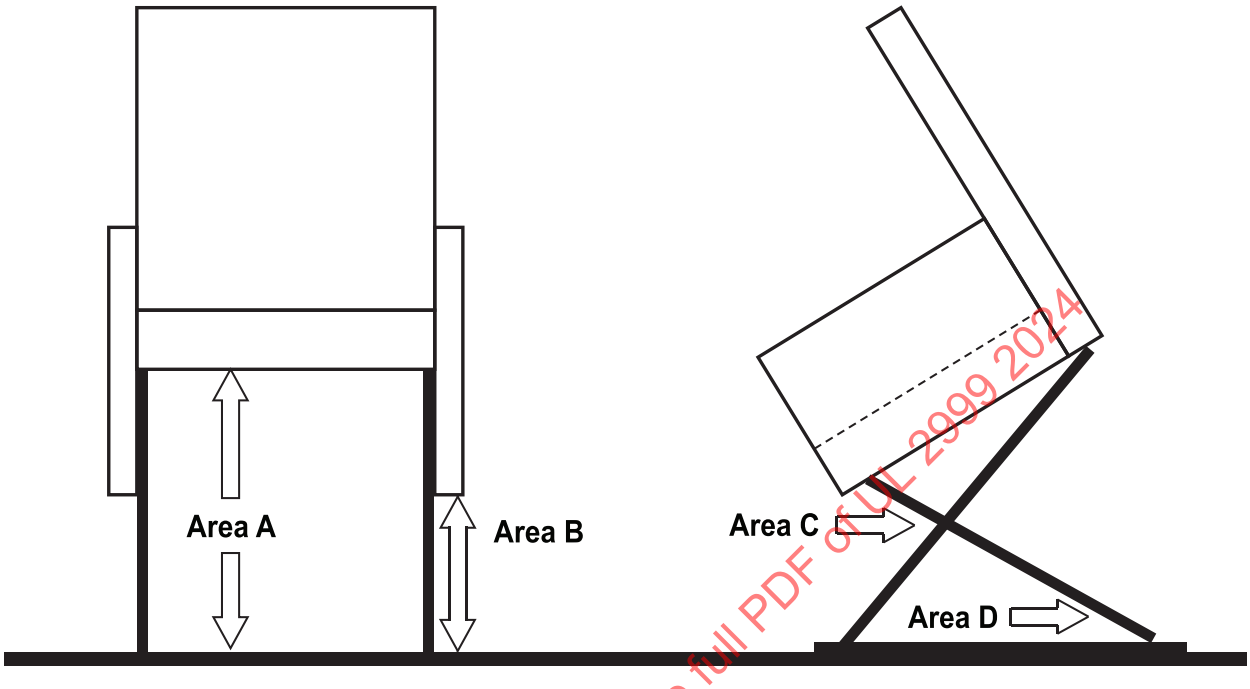
Area A – is considered to be an entrapment area because a head, hand, finger and other appendages can be pinched between the upper movable leg and lower fixed leg. Geometry and configuration can affect the entrapment concern.

Area B – is not considered to be an entrapment area because there is sufficient room between the table top and floor or between a chair seat and the table top. Instructions are also required to address entrapment.

Area C – The edge of the table could create an entrapment. Instructions address placement of the table in relation to other objects. The force limitation does not apply.

Figure 53.2

Examples of entrapment areas



su1679

Area A – is considered to be an entrapment area because infants, children and animals could be within this area. Geometry and configuration can affect the entrapment concern.

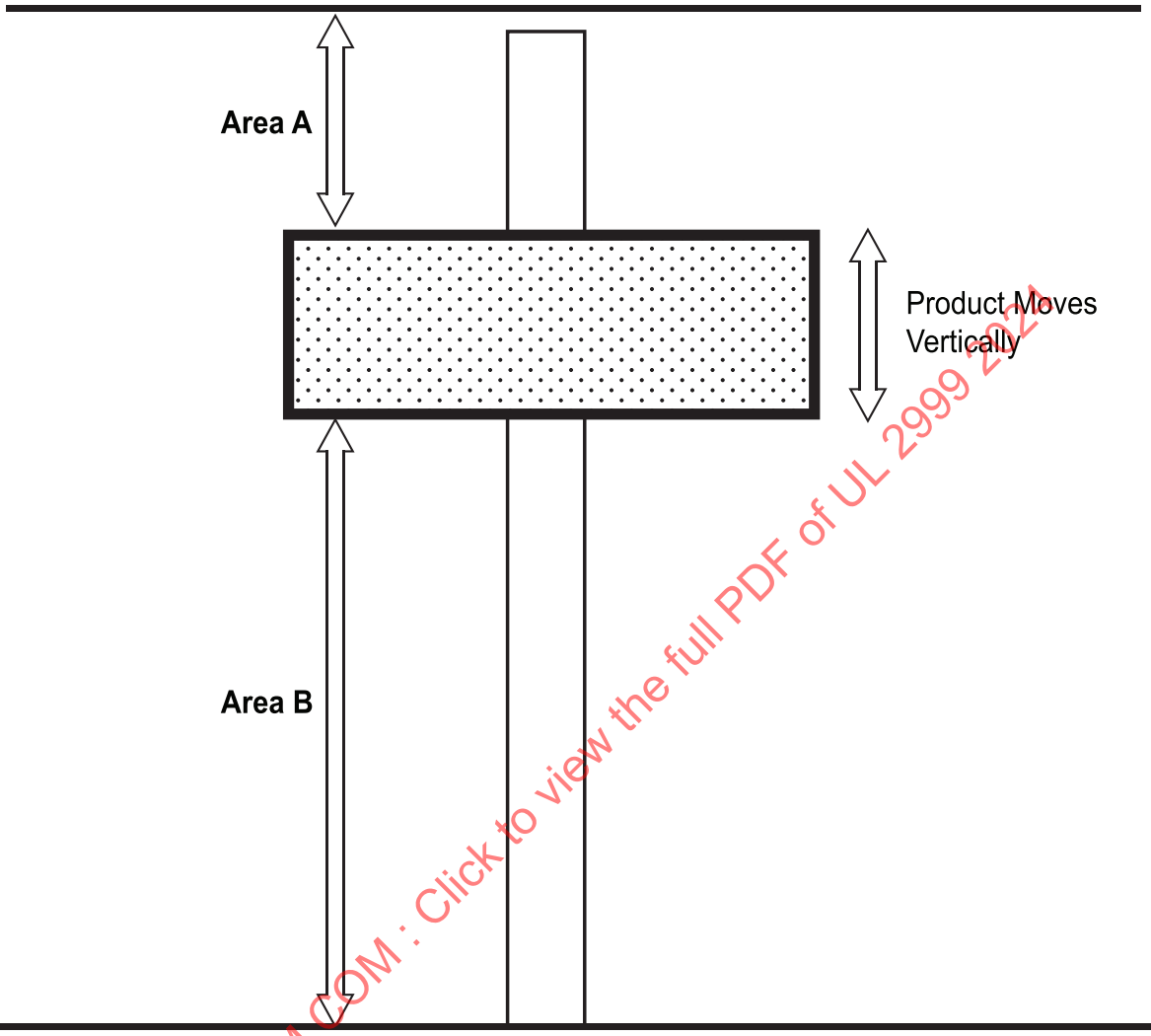
Area B – is considered to be an entrapment area because infants, children, animals and other appendages could be within this area. Geometry and configuration can affect the entrapment concern.

Area C – is considered to be an entrapment area because of the potential for a head, hand, finger or leg to become entrapped within the scissor mechanism.

Area D – is considered to be an entrapment area because of the potential for a head, hand, finger, leg and cords to become entrapped within the scissor mechanism.

Figure 53.3

Examples of entrapment areas



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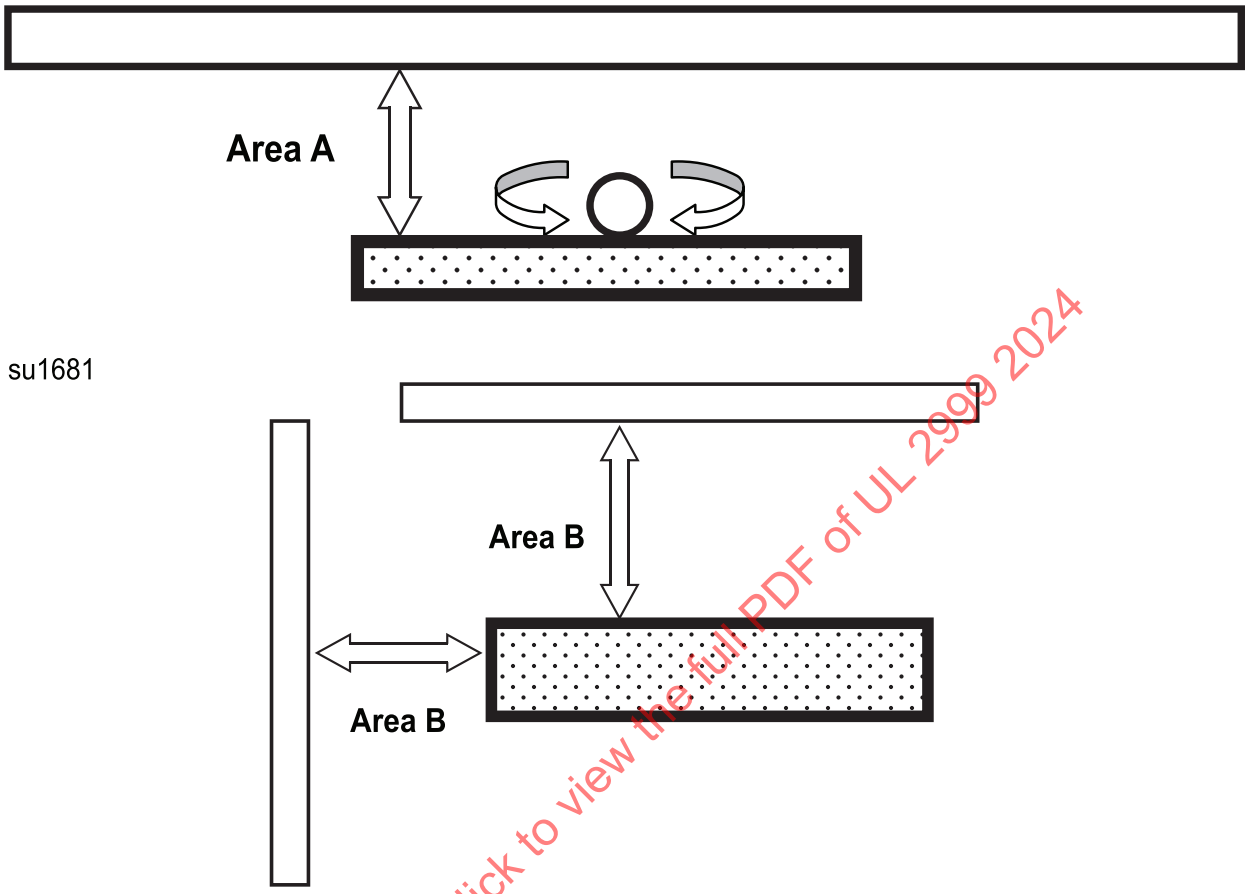
Area A – is considered to be an entrapment area when the top of the moving furnishing is located below 84 inches (2133.6 mm) from the floor. Consideration must be given to furnishings that can be moved or placed on other furnishings that have fixed objects above them such as a shelf or top of a cabinet. Use and installation instructions can be utilized to determine recommended placement.

Area B – is considered to be an entrapment area because infants, children, animals and other appendages could be within this area. Geometry and configuration can affect the entrapment concern. A furnishing that leaves 18 inches (457.2 mm) or more between the base or floor and poses no pinch concern would be considered not to be an entrapment hazard.

Figure 53.4

Examples of entrapment areas



Area A – is considered to be an entrapment area when the furnishing rotates about an axis and can entrap between the furnishing and a fixed structure. Consideration must be given to furnishings that can be moved or placed on other furnishings that have fixed structures. Examples: a wall or back of a cabinet. Use and installation instructions can be utilized to determine recommended placement.

Area B – is considered to be an entrapment area when the furnishing moves horizontally side to side or back to front in relation to a fixed structure. Consideration must be given to furnishings that can be moved or placed on other furnishings that have fixed objects behind them or to the side of them such as a wall or side or back of a cabinet. Use and installation instructions can be utilized to determine recommended placement.

53.7 A furnishing that relies on a momentary contact switch to function shall be subject to the following conditions where applicable:

The furniture is to carry the rated normal load during test and powered at rated voltage.

a) When a momentary contact switch is released the corresponding moving parts shall stop.

b) Upon power failure the furnishing shall remain in the existing position.

c) Upon reinstatement of power the furnishing shall not move until the operator activates the switch controlling movement.

d) A switch that controls the direction of travel shall be capable of being stopped and the direction of travel reversed at any point in the operation of the furnishing.

53.8 In accordance with 23.1.1(a), the lockout feature shall be engaged 10 times. After each time the lockout is engaged, the furnishing shall try to be activated. The furnishing shall not operate.

53.9 In accordance with 23.1.1(a), the lockout feature shall be disengaged 10 times and the furnishing operated each time. Two minutes after the furnishing has been operated, the furnishing shall try to be activated. The furnishing shall not operate.

53.10 In accordance with 23.2.1 (b) and (d), the furnishing shall be operated so that the maximum speed is obtained for those parts of the furnishing where speed is being measured. The speed shall be either measured by using an instrument that can measure speed or by calculating the speed by measuring the distance traveled and the time. The speed shall not exceed 1 inch / second (2.54 cm/second).

54 Collision Mitigation Evaluation

54.1 For furnishings following the alternate evaluation in 23.3, Usage Area III – Alternate for Motorized Tables, the furnishing shall be tested as specified in 54.2 – 54.4. The collision mitigation system(s) shall continue to function 100% of the time. There shall be no false positives. The test shall be conducted unloaded and with the functional load specified in Section 32, Structural Test Requirements for Furnishings – General Loading. When testing a family of products, testing may be performed on samples that represent worst case situations rather than testing each unit.

54.2 Three impact test surfaces shall be used.

a) A rigid surface, such as steel or wood. The test surface may be supported by any means that does not allow any movement.

b) A rigid surface such as steel or wood, in combination with 2 inch thick foam with a density of 25% Indentation Force Deflection (IFD) of 45 lbf. ± 5 lbf. (200 N ± 22 N) as defined in ASTM D 3574-17, Standard Methods for Flexible Cellular Materials – Slab, Bonded, and Molded Urethane Foams. The test surface may be supported by any means that does not allow any movement.

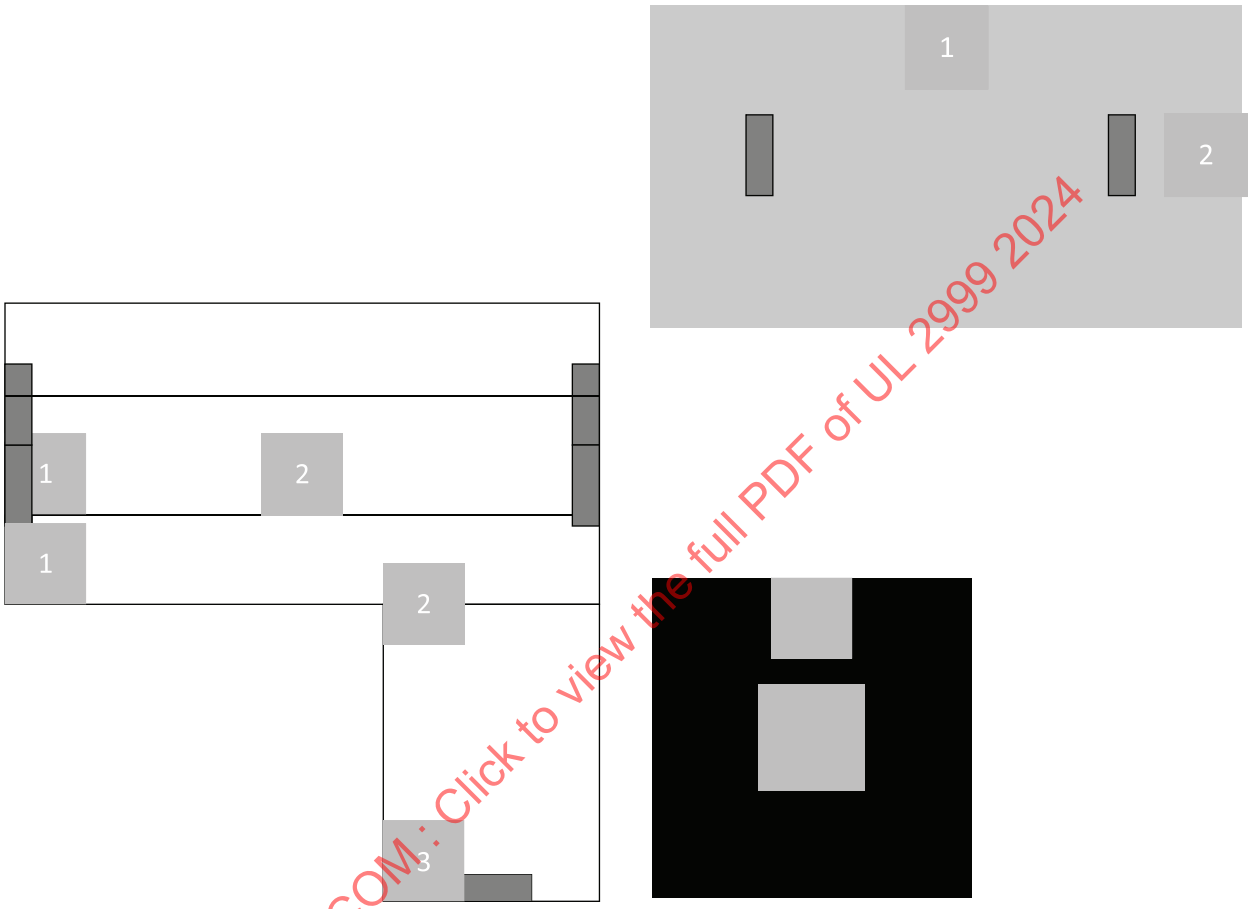
c) A flexible surface represented by 2 inch thick foam with a density of 25% Indentation Force Deflection (IFD) of 45 lbf. ± 5 lbf. (200 N ± 22 N) as defined in ASTM D 3574-17 supported by a frame that provides 35 lbs (156 N) of force resistance.

54.3 For surfaces that have at least two or more supports, the test surfaces shall be located at the positions specified in Figure 54.1. For pedestal furnishings, the test shall only be performed at any edge location.

54.4 The furnishing shall be cycled 20 times at each location. The Impact surface shall be located both below and above the impact location.

Figure 54.1

Test Locations



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55 Snap-Fit Cover Pull-Out Test

55.1 A snap-fit cover employed as part of a furnishing electrical enclosure shall be subjected to the tests specified in 55.2 or 55.3. The cover shall not crack or dislodge from the means of support on the electrical enclosure. Any distortion of the cover resulting from the tests shall not restrict the normal removal and replacement of the cover.

55.2 The electrical enclosure is to be clamped in place and oriented so that the covered face of the electrical enclosure is parallel to the horizontal and directed down. A minimum of 25 lb (11.3 kg) weight is to be attached to any point on the edge or outside surface of the cover and gradually released until it hangs freely. The weight is then to hang for a minimum of 1 minute.

55.3 For a snap-fit cover formed of polymeric material, the test specified in 55.2 is to be repeated on three additional samples of the cover after the samples have been conditioned as specified in Conditioning of Products, Section 30.

56 Tightening Torque Test

56.1 With respect to the Exception to 10.1.9, the tapped threads in a plate not less than 0.30 inch (7.6 mm) thick are able to be used when the threads do not strip after being subjected to the tightening torque specified in Table 56.1. A screw, either supplied or specified in the instructions, is to be tightened to the terminal at a torque, and with a wire in place, as specified in Table 56.1. There shall be two or more full threads in the metal. The metal is able to be extruded, when required, to provide the threads.

Table 56.1
Tightening torque for wire-binding screws

Size of terminal screw, No.	Wire sizes to be tested, AWG[a]	Tightening torque Minimum lb-inches (N·m)
8	14 (S) and 16 – 22 (ST)	16 (1.8)
10	10 – 14 (S) and 16 – 22 (ST)	20 (2.3)
[a] ST – stranded wire; S – solid wire.		

57 Portable Furnishing with Liquid Drop Test

57.1 Three samples of a portable furnishing provided with a factory filled and sealed liquid container shall be subjected to the drop test specified in 57.2 without leakage of the material within the vessel as determined by visual observation following the drop.

57.2 Three samples shall be dropped a minimum of 3 feet (91.4 cm) onto a nominal 1/2 inch (12.7 mm) thick trade size knot free softwood or softwood plywood sheet directly supported by a concrete floor.

58 Enclosure Tests for Special Use

58.1 Compression

58.1.1 A metallic electrical enclosure having a thickness less than the applicable value specified in Table 11.1 or a raceway of polymeric electrical enclosure shall be subjected to the test specified in 58.1.5. The electrical enclosure shall have strength and rigidity at least equivalent to that of a reference electrical enclosure of sheet metal complying with the thickness specifications in Table 11.1.

58.1.2 The reference electrical enclosure is to be constructed as follows:

a) The electrical enclosure is to have the same overall dimensions as the electrical enclosure to be tested.

b) All seams, joints, or splices at corners or back edges of the electrical enclosure are to be closed by overlapping flanges formed of sheet metal from which the electrical enclosure is made, metal surfaces overlapping adjacent surfaces or supporting frame, separate overlapping flanges, or continuous welding that provides a construction equivalent to an integral-flanged construction.

c) A flange joining adjacent sides, including top and bottom, of the electrical enclosure is to have at least one fastening for every 3 inches (76.2 mm), or fraction thereof, of electrical enclosure depth. One such fastening is to be located not more than 1.5 inches (38.1 mm) from the front edge of the electrical enclosure.

Exception: A electrical enclosure having integral flanges and that is not over 4 inches (102 mm) deep is able to employ a single fastening at each corner of the electrical enclosure to secure adjacent sides, including top and bottom.

d) A flange at the back of the electrical enclosure (the side opposite the cover) is to have fastenings located not more than 1.5 inches (38.1 mm) from each end and not more than 6 inches (152 mm) apart.

e) A separate flange is not to have less than two fastenings on each side of a seam.

58.1.3 With reference to 58.1.2(b), the overlap is to be at least 1/4 inch (6.4 mm) and is to extend the full length of the seam.

58.1.4 With reference to 58.1.2 (c), (d), and (e), rivets, welds, bolts, and screws having machine-screw threads are able to be used for fastenings.

58.1.5 For the test, the reference electrical enclosure is to rest on a smooth, solid, horizontal surface. A vertical force is to be applied to any point on the rear walls of the reference electrical enclosure. The force shall be applied until there is a measurable deflection. The value of force and the limit of deflection are not specified. The force is to be applied through a rod having a maximum of 1/2 by 1/2 inch (12.7 by 12.7 mm) flat steel face.

58.1.6 The actual electrical enclosure is to rest on a smooth, solid, horizontal surface. A vertical force is to be applied to any point on the rear walls of the reference electrical enclosure. The force is to be applied through a rod having a maximum of 1/2 by 1/2 inch (12.7 by 12.7 mm) flat steel face. The force value shall be the same as was measured in 58.1.5. The deflection shall be equal to or less than what was measured during the testing of the reference electrical enclosure.

58.2 Deflection test

58.2.1 An electrical enclosure cover formed of polymeric material raceway or a drawn, embossed, flanged, or similarly strengthened electrical enclosure cover made of metal having thickness less than the applicable value specified in Table 11.1 shall not deflect inward more than 1/4 inch (6.4 mm) or to a degree that damages enclosed wiring or terminations when a vertical force of a minimum of 100 lbs (445 N) is applied at any point on the cover. For the test, the electrical enclosure is to rest on its back on a smooth, solid, horizontal surface with the cover secured as intended. The force is to be applied through a rod having a minimum of 1/2 by 1/2 inch (12.7 by 12.7 mm) flat steel face. Separate samples are able to be used for additional tests.

59 Tests on Mechanical Connectors

59.1 Mechanical connector test (non-metallic)

59.1.1 Before the Flexing Test, three complete samples of a nonmetallic unit-to-unit mechanical connector shall be conditioned as specified in 30.1, Conditioning of Products – Conditioning of Polymeric Components. The connector shall not crack, shrink, melt, swell, warp, or otherwise be damaged to an extent that interferes with the intended use.

59.1.2 A connector of rubber-like material, such as neoprene, is to be placed in an air oven for a minimum of 70 hours at 100 ±2°C (212 ±3.6°F).

59.2 Flexing (metallic or non-metallic)

59.2.1 A flexible unit-to-unit mechanical connector that allows the connected units to be moved without disassembly of the product shall be tested as specified in 59.2.2 and 59.2.3. The connector shall not be damaged to an extent that it presents a risk of injury to persons or that potentially interferes with the intended use of the product. The connector shall continue to support the heaviest table at the end of the test.

59.2.2 Each of three samples of the connector is to be subjected to 50 cycles of flexing. The flexible connector is to be secured to two units, at least one of which is the heaviest unit provided. One unit is to be clamped in its normal upright position. The heaviest unit is to be pivoted along the axis of the hinge while standing on a smooth, hard surface with glides or feet, if provided, in place. Starting with the units making an angle of 180 degrees, the heaviest unit is to be moved through an angle X equal to 135 degrees unless the travel is mechanically limited to a lesser angle. The heaviest unit is then to be moved through an angle Y equal to 270 degrees in the opposite direction, unless the travel is mechanically limited to a lesser angle and then returned through an angle Z to the starting position. This is one complete cycle.

59.2.3 Following the test specified in 59.2.2, a connector formed of molded rubber or polymeric material is to be subjected to the applicable conditioning as specified in 59.2.1 or 59.2.2. The connector is then to be subjected to 50 additional cycles of flexing using the procedure specified in 59.2.2.

ELECTRICAL TESTS

60 General

60.1 During any normal electrical test, no safety device shall operate, such as safety circuits, overcurrent, or over temperature protection.

60.2 Where cheesecloth is indicated as a risk of fire indicator, the cheesecloth shall be doubled layer and be bleached, running approximately 14 – 15 yd^2/lb (28 – 30 m^2/kg), and having what is known to the trade as a "count of 32 × 28" – that is, for any inch square, 32 threads in one direction and 28 threads in the other direction (for any centimeter square 13 threads in one direction and 11 threads in the other direction).

61 Leakage Current Test

61.1 A cord-connected furnishing rated for a nominal 250-volt or less single-phase supply shall be subjected to the test in accordance with 61.2 – 61.9. Leakage current shall not be more than:

a) 0.5 MIU for a two-wire cord- and plug-connected portable furnishing; and

b) 0.5 MIU for a three-wire (including grounding conductor) cord- and plug-connected portable furnishing; and

c) 0.75 MIU for a three-wire (including grounding conductor) cord- and plug-connected stationary or fixed furnishing.

Exception No. 1: The leakage current of a furnishing incorporating a sheath type heating element is to be monitored during heat-up and cool-down and shall not exceed 2.5 MIU during the first 5 minutes of energizing the furnishing. At the end of this time, the leakage current shall be not more than the 0.5 MIU or 0.75 MIU limit, as applicable.

Exception No. 2: Furnishings provided with a single component, such as a power supply, that has already been subjected to the leakage current do not need to be tested again.

61.2 All accessible conductive parts are to be tested for leakage currents. Leakage currents from these parts are to be measured to the grounded supply conductor individually as well as collectively when simultaneously accessible, and from one part to another when simultaneously accessible. A part is determined to be accessible unless it is guarded by an enclosure that is intended for protection against the risk of electric shock as specified in Section 13, Accessibility of Uninsulated Live Parts and Film-Coated Wire. Conductive parts are determined to be simultaneously accessible when they can be readily contacted by one or both hands of a person at the same time. These measurements do not apply to terminals operating at voltages that do not involve a risk of electric shock. When all accessible conductive parts are bonded together and connected to the grounding conductor of the power-supply cord, the leakage current is to be measured between the grounding conductor of the product and the grounded supply conductor.

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

61.4 A furnishing employing water or other liquid is to be tested with a hard water solution of minimum 0.5 grams of calcium sulphate ($CaSO_4$) per liter of distilled water (0.07 ounces $CaSO_4$ per gallon of distilled water).

Exception: The composition of the water solution is not specified when it is determined by engineering evaluation that the leakage current will not be affected.

61.5 Typical measurement circuits for leakage current with the ground connection open are illustrated in Figure 61.1. The measurement instrument is specified in Figure 61.2. The meter that is used for a measurement is only required to indicate the same numerical value for a particular measurement as would the defined instrument; it is not required to have all the attributes of the defined instrument. Over the frequency range 20 Hz to 1 MHz with sinusoidal currents, the performance of the instrument is to be as follows:

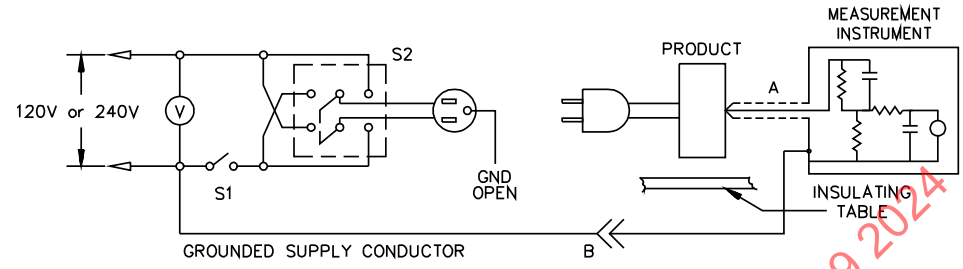
a) The measured ratio V1/I1 with sinusoidal voltages is to be as close as feasible to the ratio V1/I1 calculated with the resistance and capacitance values of the measurement instrument specified in Figure 61.2.

b) The measured ratio V3/I1 with sinusoidal voltages is to be as close as feasible to the ratio V3/I1 calculated with the resistance and capacitance values of the measurement instrument specified in Figure 61.2. V3 is to be measured by the meter M in the measuring instrument. The reading of meter M in RMS volts can be converted to MIU by dividing the reading by 500 ohms and then

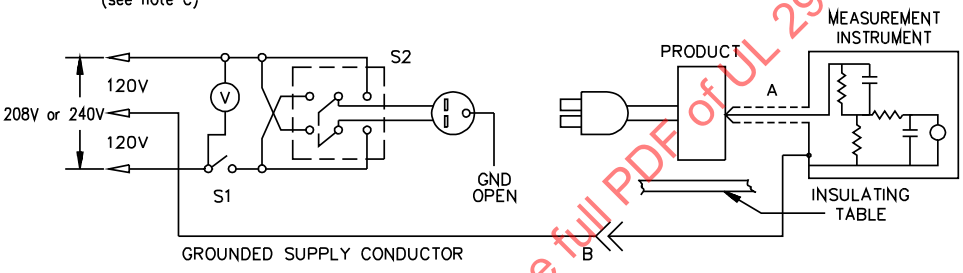
multiplying the quotient by 1,000. The mathematic equivalent is to simply multiply the RMS voltage reading by 2.

Figure 61.1

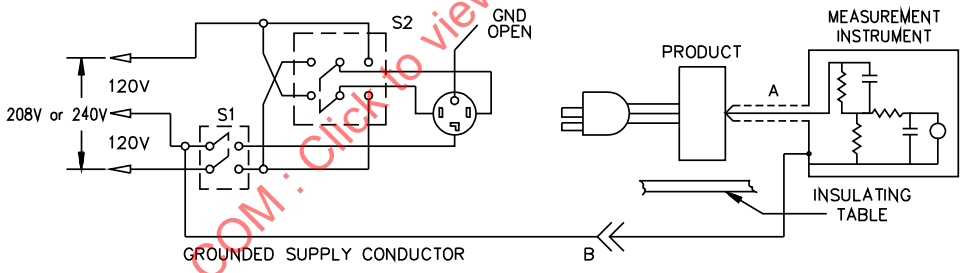
Equipment intended for connection to power supply



Equipment intended for connection to a 120–volt or an end–grounded 2–wire, 240–volt power supply (see note C)



Equipment intended for connection to a 2–wire grounded–neutral 208–volt or 240–volt power supply (see note C)



Equipment intended for connection to a 3–wire grounded–neutral 208–volt or 240–volt power supply

A – Probe with shielded lead.

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

C – Equipment intended for connection to a 2–wire 240–volt power supply is to be tested assuming that the product will be connected to an end–grounded supply (top circuit, above), unless the product is marked in accordance with paragraph 86.11 of UL 197, in which case it is to be tested for connection to a grounded–neutral supply (middle circuit, above).

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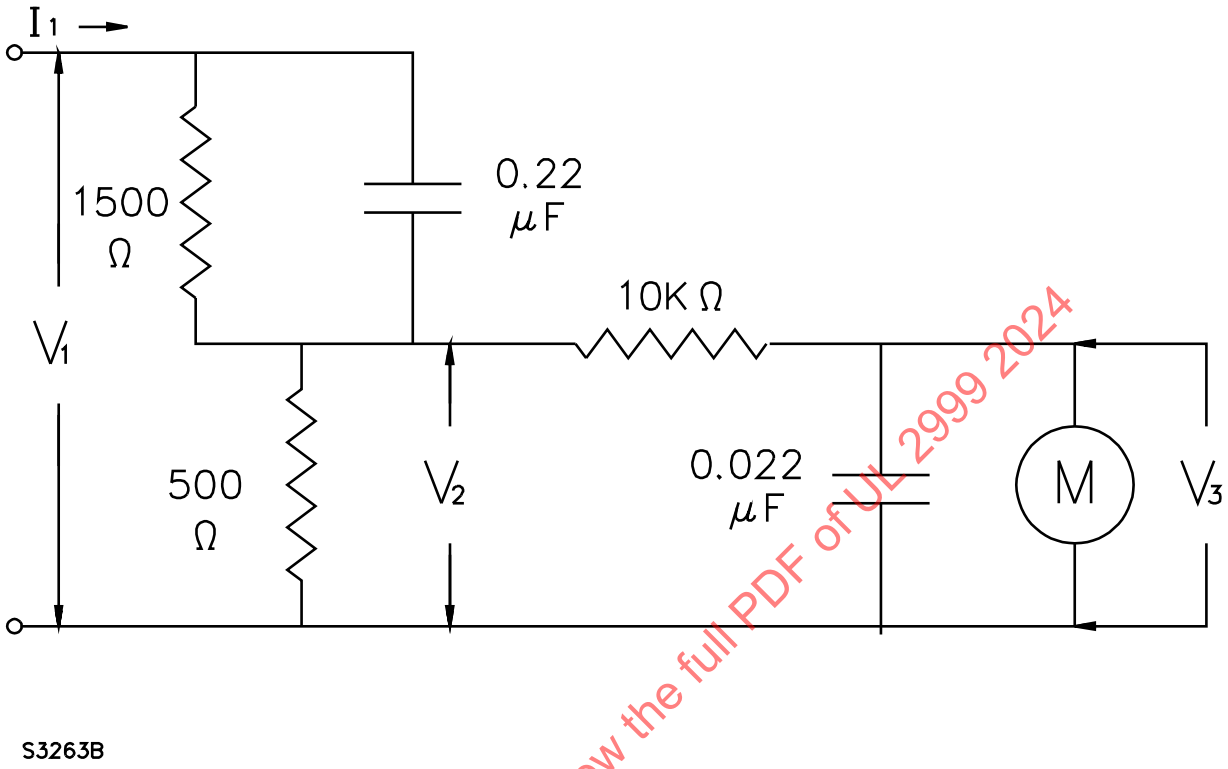
Figure 61.2

Measurement instrument for reaction (leakage) current



61.6 Unless the measurement instrument is being used to measure leakage current from one part of a furnishing to another, it is to be connected between accessible parts and the grounding and supply conductor connected to ground (the grounded or grounding conductor) that has the least extraneous voltages introduced from other equipment operated on the same supply. For products rated 120 volts or 240 volts, with one supply conductor grounded, this is likely to be the grounded supply conductor.

61.7 Prior to the test specified in 61.8, a furnishing utilizing one or more sheathed heating elements is to be conditioned for a minimum of 24 hours in a chamber having a temperature of 30 ±5°C (86 ±9°F) and a relative humidity of 50 ±5 percent, followed by conditioning for a minimum of 48 hours in a chamber having a temperature of 30 ±5°C (86 ±9°F), and a relative humidity of 90 ±5 percent. The test in 61.8 is to be conducted as soon as is practical after the conditioning, but in no case more than 24 hours after the furnishing is removed from the conditioning chamber.

Exception No. 1: The entire furnishing is not required to be conditioned if the sheathed heating elements are removed from the furnishing and conditioned as stated. The elements are to be re-installed in the furnishing before the test is conducted.

Exception No. 2: The conditioning is not required if all sheathed heating elements in the furnishing comply with the requirements of the Resistance to Moisture Test in the Standard for Sheathed Heating Elements, UL 1030.

61.8 A sample of the furnishing, conditioned as specified in 61.7, where required, is to be tested for leakage current starting with the as-received condition – the as-received condition being without prior energization, except as may occur as part of the production-line testing. The supply voltage is to be adjusted to rated voltage. The test sequence is to be as follows, with reference to the measurement circuit specified in Figure 61.1:

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

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

c) 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 as in the normal temperature test.

d) The leakage current is also to be monitored with switch S1 open while the furnishing is at operating temperature and while cooling.

61.9 A sample is to be subjected to the entire leakage current test, as specified in 61.8, without interruption for other tests.

Exception: With the concurrence of those concerned, the leakage current test is not prohibited from being interrupted to conduct other nondestructive tests.

62 Starting Current Test

62.1 A motor-operated furnishing shall start and operate normally on a circuit protected by an ordinary – not time-delay – fuse having a current rating corresponding to that of the branch-circuit power-supply to which the furnishing is to be connected. As a result of the test the fuse shall not open or an overload protector provided as part of the furnishing shall not trip.

Exception: The requirement for an ordinary fuse does not apply when:

a) The construction of the motor-operated furnishing or the nature of its usage is such that it is used continually on the same branch circuit after installation;

b) The motor-operated furnishing starts and operates as intended on a circuit protected by a time-delay fuse; or

c) The motor-operated furnishing is marked in accordance with 90.3.

62.2 The motor-operated furnishing is to be started three times at room temperature at the beginning of the test. Each start of the motor is to be made under conditions representing the beginning of intended operation and the motor is to be allowed to come to rest between successive starts.

63 Input Test

63.1 The current or wattage input to a furnishing shall not be more than 110 percent of the rated value when the furnishing is operated under the condition of maximum normal load and when connected to a supply circuit of maximum rated voltage and rated frequency. The current or wattage input to a furnishing shall not be less than 85 percent of the rated value.

Exception No. 1: When the furnishing is not provided with an installed electrical load (such as motor or luminaire), the input is determined as specified under Electrical Ratings, Section 86.

Exception No. 2: Furnishings that are not provided with any type of electrical load and only receptacles are not subjected to the Input Test.

63.2 For a furnishing having a single voltage rating, such as 115 volts, maximum rated voltage is determined to be that single value of voltage. When the rating is given in terms of a range of voltages, such as 110 – 120 volts, maximum rated voltage is determined to be the highest value of the range. If the range extends to other voltages levels, then the test shall be performed at each of the voltage levels. For example, a furnishing rated 100 – 240 Volts shall be tested at 120 V, 208 V, and 240 V.

63.3 Furnishings employing LED luminaires or other types of loads that operate from a Class 2 / LPS source of supply shall have the input to the load measured. The load current or wattage shall not exceed 110 percent of the rated value when the furnishing is operated under the condition of maximum normal load and when connected to a supply circuit of maximum rated voltage.

64 Temperature Test

64.1 General

64.1.1 An electrified furnishing shall be tested as specified in 64.1.2 – 64.1.5. Temperatures shall not exceed the applicable values specified in Table 64.1 when tested at rated load, both electrical and mechanical. If an OCP is provided, the electrical load shall be at the same current as the OCP.

Exception No. 1: When the furnishing is only provided with an outlet assembly that complies with one of the following, the temperature test is not required:

a) Standard for Relocatable Power Tap, UL 1363;

b) Standard for Furniture Power Distribution Unit, UL 962A; or

c) Outline of Investigation for Multioutlet Assembly, UL 111.

Exception No. 2: A furnishing provided with a Luminaire that complies with Components, Section 3, when installed and operated in accordance with its installation and operation instructions, has no other electrical load and no receptacle outlets is not required to be subjected to the temperature test.

Exception No. 3: When the furnishing is not provided with an installed electrical load (such as motor or Luminaire), the temperature test is not required when the electrical system consists of receptacle assemblies installed and connected to a field wiring junction box or is cord and plug connected; and complies with the requirements as specified in the National / Canadian Electric Code, NFPA 70 / C22.1-15.

64.1.2 The temperature limits specified in Table 64.1 are based on an ambient temperature of 25°C (77°F). The temperature test is able to be conducted at any ambient temperature 10 – 40°C (50 – 104°F) and corrected to an ambient of 25°C (77°F).

Table 64.1
Maximum temperature

Material and component parts	°C	(°F)
1. Capacitors:[b]		
Electrolytic[a]	65	(149)
Other types	90	(194)
2. Fuses		
A. Class G, J, L, T, and CC		

Table 64.1 Continued on Next Page

Table 64.1 Continued

Material and component parts	°C	(°F)
Tube	125	(257)
Ferrule or blade	100	(212)
B. Other[f]	90	(194)
3. Fiber employed as electrical insulation	90	(194)
4. At any point within a terminal box or wiring compartment of a permanently connected furnishing in which power-supply conductors are to be connected, including such conductors themselves, unless the furnishing is marked in accordance with 91.1.	60	(140)
5. A surface upon which a furnishing is able to be fastened in place, and surfaces that are adjacent to the furnishing when so fastened.	90	(194)
6. Surfaces that are adjacent to the cabinet light when it is mounted	90	(194)
7. Class 105(A)[c,h]		
Thermocouple method	90	(194)
Resistance method	100	(212)
8. Class 120(E)[c,h]		
Thermocouple method	100	(212)
Resistance method	110	(230)
9. Class 130(B)[c,h]		
Thermocouple method	110	(230)
Resistance method	120	(248)
10. Class 155(F)[c,h]		
Thermocouple method	135	(275)
Resistance method	145	(293)
11. Class 180(H)[c,h]		
Thermocouple method	150	(302)
Resistance method	160	(320)
12. Phenolic composition employed as electrical insulation or as part of the deterioration of which results in a risk of fire or electric shock[d]	150	(302)
13. Phenolic lampholder body[g]	150	(302)
14. Rubber- or thermoplastic-insulated wire and cord[d,e]	60	(140)
15. Sealing compound	65°C (149°F) less than melting point	
16. Varnished-cloth insulation	85	(185)
17. Wood and other combustible material	90	(194)
18. Lampholder screw shell	200	(392)
19. Current carrying parts		
A. Copper or copper alloy	200	(392)
B. Aluminum	200	(392)
C. Stainless steel, monel, nickel plated copper	250	(482)
20. Accessible parts		
A. External surfaces (other than lamps or lenses)[i]	90	(194)
B. Operating knobs, handles, and levers intended for momentary contact during adjustment only or areas that are able to be incidentally contacted.		

Table 64.1 Continued on Next Page

Table 64.1 Continued

Material and component parts	°C	(°F)
1. Wood	90	(194)
2. Plastic or rubber[j]	85	(185)
3. Glass, porcelain, or vitreous enameled material	75	(167)
4. Metal	50	(122)
C. Handles or surfaces intended to be grasped for lifting, carrying, or holding:		
1. Metallic	45	(113)
2. Nonmetallic	60	(140)
21. The maximum acceptable temperature on external surfaces of a furnishing employing a heating pad in the area subject to user contact.	70	(158)
22. Temperatures on components shall not exceed their ratings.		

[a] The temperature on insulating material integral with the enclosure of an electrolytic capacitor that is physically integral with or attached to a motor shall not be more than 90°C (194°F).

[b] A capacitor that operates at a temperature of more than 90°C (194°F) is able to be judged on the basis of its marked temperature limit.

[c] At a point on the surface of a coil where the temperature is affected by an external source of heat, the temperature rise measured by a thermocouple are not prohibited to be higher by the following amount than the maximum specified when the temperature rise of the coil, as measured by the resistance method, is not more than that specified in the table.

Item	Additional temperature rises	
	°C	(°F)
7	15	(27)
8	15	(27)
9	20	(36)
10	15	(27)
11	15	(27)

[d] The limitations on phenolic composition and on rubber and thermoplastic insulation do not apply to compounds that have been investigated and found usable at higher temperatures

[e] Rubber-insulated conductors within a Class A-insulated motor, rubber-insulated motor leads, or a rubber-insulated flexible cord entering a motor are able to be subjected to a temperature rise of more than 60°C (140°F), when a braid is employed on the conductor of other than a flexible cord. However, this does not apply to thermoplastic-insulated wires or cords.

[f] A fuse that has been investigated and found usable at a higher temperature is able to be used at that temperature.

[g] Does not apply when investigated and found to be usable at a higher temperature.

[h] A totally enclosed motor is able to have winding temperature 5°C (9°F) higher than those stated.

[i] Where lens is not also serving as a portion of the shade.

[j] Includes plastic with a metal plating not more than 0.005 inch (0.13 mm) thick; and metal with a plastic or vinyl covering not less than 0.005 inch thick.

64.1.3 A material provided for direct or indirect contact with live parts and any electrical insulating barrier shall be suitable for continuous operation at the maximum temperature measured on the material.

64.1.4 When temperature readings are to be obtained by means of thermocouples, the thermocouples shall consist of wires not larger than 24 AWG (0.21 mm^2). When thermocouples are used in the determination of temperatures in connection with the heating of electrical devices, it is common to employ thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan wire, and an instrument specifically designed for accurate determination of the attained temperature. Such equipment is to be used whenever reference temperature measurements are required.

64.1.5 To facilitate conducting the test on a totally enclosed – encapsulated – component of a furnishing, 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.

64.1.6 A polymeric material used as a decorative trim or part shall be rated for the temperatures to which it is subjected during intended use, in that it shall not melt or deform in such a way as to interfere with the intended operation of the furnishing.

64.1.7 A cabinet light is to be operated continuously at rated luminaire wattage until constant temperatures are attained. A motor-operated furnishing is to be on and operating at maximum load during the temperature test. A temperature is determined to be constant when the test has been running for at least 3 hours, and three successive readings, taken at 30-minute intervals, are within 1.8°F (1°C) of one another and are not still rising. A motor operated furnishing shall be operated as specified in 64.2.1 – 64.2.3.

64.1.8 A receptacle provided shall be loaded to its rating. Furnishings provided with a string of receptacles shall have the last receptacle loaded to the maximum load using 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.

64.1.9 A furnishing provided with overcurrent protection (OCP) rated greater than the furnishing rating, shall be subjected to additional temperature test at the OCP rating with the OCP bypassed.

64.2 Motor-operated furnishing

64.2.1 A thermal- or overload-protective device shall not open the circuit during the temperature test.

64.2.2 For a furnishing that is not intended for continuous operation, the time of operation of the furnishing is to be evaluated when conducting the temperature test.

64.2.3 For the Temperature Test, a mechanical load is to be placed on the furnishing to simulate the intended use as follows:

a) The furnishing shall be loaded in accordance with the functional loading requirements in Section 32, Structural Test Requirements for Furnishings – General Loading; Section 33, Seating; Section 34, Desks and Tables; Section 35, Storage Furnishings; and Section 36, Beds, as applicable.

b) For a furnishing that is not intended to operate continuously, the furnishing shall be cycled until maximum temperatures are obtained in accordance with one of the following:

1) When markings nor instructions state a duty cycle for a furnishing that is not intended to run continuously, the minimum duty cycle sequence shall be nine complete cycles of its complete range of motion, without pause between cycles, except that a 5-minute period is to be interposed between the third and fourth cycle and between the sixth and seventh cycles. During the 5-minute interval the motor is to be running, with the furnishing not operating, when allowed by the construction. Otherwise, the motor is to be de-energized. A temperature is determined to be maximum when the test has been running for at least 4 hours, and three successive readings, taken at 1-minute intervals, are within 1.8°F (1°C) of one another and are not still rising. When the speed of operation of the furnishing is controllable, the test is to be performed at such speed that maximum heating results. A furnishing that is capable of more than one mode of motion is to be tested in each mode for the nine complete cycles; or

2) When the markings or operation instructions specify a different cycle and endurance sequence than “1" the operation sequence shall follow the sequence specified in the

instructions. The operation instructions shall specify a duty cycle that is reasonable for the application of the product. Consideration shall be given to the specific function of the product.

65 Battery Operated Furnishings

65.1 General

65.1.1 Batteries shall not exceed the battery temperature limits and battery chargers and charging circuits shall not exceed their temperature limits. Temperatures on batteries shall be measured on the surface that will exhibit the highest temperatures. It may be necessary to measure in more than one spot.

65.1.2 Primary (Non-rechargeable) battery powered furnishings shall be tested as specified in 65.2, Battery Operated Furnishings – Method I.

65.1.3 Secondary (rechargeable) battery powered furnishings shall be tested as specified first in 65.2, Battery Operated Furnishings – Method I, then followed by 65.3, Battery Operated Furnishings – Method II.

65.2 Method I

65.2.1 A battery powered furnishing shall have new fully charged batteries installed. The furnishing if powered from an external power source in addition to the battery shall be disconnected from the external power source. The furnishing shall be operated as specified in Section 64, Temperature Test, until the furnishing will no longer perform the electrical or mechanical function(s) it is intended to perform.

65.2.2 A furnishing that requires external power in addition to installed batteries shall have new fully charged batteries installed and the furnishing shall be operated as specified in the Temperature Test, Section 64, until the temperatures stabilize or 4 hours minimum until the furnishing will no longer perform the electrical or mechanical function(s) it is intended to perform.

65.3 Method II

65.3.1 Cells or batteries discharged to the rated capacity or as specified below are to be used for this test. The batteries are to be tested in an ambient temperature of 25 ±5°C (77 ±9°F):

a) If furnishing is to be tested using a lead-acid battery or batteries each battery is to be discharged to maximum of 1.75 volts per cell – measured with the load connected.

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

65.3.2 The furnishing is to be energized and the batteries are to be allowed to fully charge with the furnishing in a non-energy consuming or movement mode unless designed to be operable while the batteries are being charged.

65.4 Discharge test

65.4.1 The furnishing shall be operated until all electrical storage products are fully charged.

65.4.2 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.

65.5 Battery installation test

65.5.1 Installing a battery in a furnishing or a remote control shall not cause the furnishing to operate in a manner that may cause personal injury.

65.5.2 A fully charged battery shall be installed in the furnishing or remote control. The furnishing shall not move in a manner that would cause personal injury. The test shall be repeated for each control setting on the furnishing. Manually operated momentary contact switches are not to be activated while inserting the battery.

66 Strain Relief Test

66.1 Cords

66.1.1 The strain-relief means provided on an attached flexible cord, when tested in accordance with 66.1.2 shall be capable of withstanding for minimum 1 minute, without displacement, a pull of a minimum of 35 lbf (156 N) applied to the cord, with the connection within the furnishing disconnected.

66.1.2 Strain relief that relies on polymeric material shall first be conditioned in accordance with 30.1, Conditioning of Polymeric Components. The cord conductors are to be severed within the furnishing. A minimum 35 lb (156 N, 15.9 Kg) force is to be applied to the cord and supported by the furnishing so that the strain-relief means is stressed from any angle that the construction of the furnishing permits. The strain relief is not in compliance if:

a) At the point of disconnection of the conductors, there is sufficient movement of the cord to indicate that stress on the connections have resulted; or

b) At the point of disconnection of the conductors, movement exceeded 0.063 inches (1.6 mm).

66.2 Strain relief for internal conductors and connectors test

66.2.1 A minimum pull force of 89 N (20 lb) shall be applied for a minimum of 1 minute to each conductor in a direction perpendicular to the plane of the entrance to the conductor connection. If the conductors are bundled into a single monolithic cable the test may be conducted on the cable assembly instead of the individual conductors. There shall be no breaking of the conductor or loosening of the conductor connections.

67 Electrical Distribution Systems

67.1 General

67.1.1 These tests are for the systems specified in 3.6.1 — 3.6.3.

67.2 Strain relief

67.2.1 Power infeed (base and top feeds)

67.2.1.1 Systems that rely on polymeric material shall first be conditioned in accordance with 30.1, Conditioning of Polymeric Components.

67.2.1.2 A fitting intended to secure the power supply cord to an electrical connector or table system raceway shall be subjected to the tests specified in 67.2.1.3 – 67.2.1.5. The fitting shall not allow the completed assembly to separate. The supporting metal or polymeric material used at a point where the

circuit supply is to be connected shall not crack, distort to an extent that interferes with the intended operations of the product, or allow stress to be placed on wire terminations.

67.2.1.3 Three samples of each raceway-fitting interface of the completed power supply cord assembly are to be used.

67.2.1.4 A decorative panel or other mechanical device that is not reliably secured in place is not prohibited from being removed for the purpose of conducting the tests.

67.2.1.5 Each of the samples is to be secured to the support (electrical connector or table system raceway) as intended in the completed cable assembly. The support device is to be clamped in position and oriented so that the opening of the support device is downward and parallel to the horizontal. Power supply cords employing a connector to mate with a raceway component on the table, and not having a separate clamp, are to be tested by inserting the connector in the mating component and then clamping the component in position. Wire connections within the electrical connector or raceway are to be disconnected if they tend to support the applied force. A minimum 35-lb (16 kg) weight is to be attached to the cable at a distance of 6 inches (152 mm) from the face of the opening of the support device, and is to be gradually applied to the power supply cord in a direction perpendicular to the face of the power supply cord fitting. The weight is to be applied for a minimum of 1 minute.

67.2.2 Unit-to-unit, system jumper, system-to-system, and pass-through-unit electrical connections

67.2.2.1 The strain-relief means between a connector and the supporting flexible cable or raceway is to be tested as specified in 67.2.2.3. The strain-relief means shall not:

a) Be displaced or damaged or cause damage to the cable or raceway.

b) Have sufficient movement of the cable to indicate that stress on the connections have resulted at the point of disconnection of the conductors; or at the point of disconnection of the conductors, movement exceeded 0.063 inches (1.6 mm).

67.2.2.2 Each of three samples of the connector and associated cable or raceway assembly is to be tested.

67.2.2.3 Wire terminations within the assembly are to be disconnected if they tend to support the applied force. A minimum 35 lb (156 N) force is to be applied in the direction that tends to cause direct pullout of the connector from the raceway. The force is to be gradually applied and maintained at the specified value for a minimum of 1 minute.

67.3 Receptacle limits test

67.3.1 In accordance with 21.6, for cord and plug electrical distribution systems, an additional unit shall be attempted to be added to the system.

67.3.2 Compliance is achieved if the system is limited to 8 receptacles or if the electronics does not permit power to be supplied to the additional receptacle or disconnects all power to the receptacle.

68 Conductor Cycling Endurance Test

68.1 In accordance with 17.4, Conductors Subject To Flexing, a furnishing in which the normal use of the furnishing results in movement of conductors or other insulated electrically energized parts shall withstand an endurance test as specified in 68.3 and 68.4. There shall be no electrical or mechanical malfunction of the furnishing and, after the endurance test, the conductors subjected to the flexing and the furnishing as a

complete assembly shall comply with the requirements in Section 71, Dielectric Voltage-Withstand Test. In addition to the general requirements specified in Section 71 shall be conducted between each individual conductor and any other conductor that was subjected to the Conductor cycling test.

Exception: Conductors utilized in a Class 2 or LPS circuit are not required to be subjected to the conductor cycling endurance test unless the circuit is relied upon for the safe operation of the furnishing.

68.2 The furnishing is to be energized during the test. The voltage supply circuit and the temperature conditions shall be in accordance with the normal temperature test.

68.3 The endurance test required by 68.1 is to consist of 6000 cycles of operation. The conductors are to be flexed while energized from one extreme position to the opposite extreme position as allowed by the design of the furnishing.

68.4 For the endurance test specified in 68.3, any mechanical arrangement is to be employed to operate the movable member at a rate of between 10 – 30 cycles per minute or at rate allowed by the furnishing construction.

69 Mating Connector Test

69.1 The test as specified in the Standard for Office Furnishings, UL 1286, Mating Connector Separation Tests shall be performed on connectors used in power table/desk electrical systems.

70 Grounding-Impedance Test

70.1 The exposed non energized metal parts that may become energized and the ground contact of a receptacle outlet of the furnishing shall be conductively connected to the ground pin of the attachment plug as determined by the grounding test in 70.2 – 70.4.

Exception: A ground path comprised of components evaluated for use as an assembly and suitable as a fault current path are not required to be tested.

70.2 Any resistance measuring device, such as an ohmmeter, is to be employed during testing.

70.3 When tested, the resistance between any point required to be grounded and the equipment grounding terminal in the case of a furnishing intended for permanent electrical connection; or the point on the furnishing where the grounding conductor of the cord is attached; shall not be more than 0.1 ohm. The resistance is to be determined by any convenient method as noted in 70.2, except that when unacceptable results are obtained, the measurement is to be taken in accordance with 70.4.

70.4 When a measurement is required by 70.3, an alternating current of at least 25 amperes from a power supply of not more than 6 volts is to be passed from the equipment grounding terminal or the point of attachment of the wiring system to the un-energized live part, and the resulting drop in potential is to be measured between these two points. The resistance in ohms is to be determined by dividing the drop in potential in volts by the current in amperes passing between the two points.

71 Dielectric Voltage-Withstand Test

71.1 The insulation and spacings of a furnishing shall withstand the test potential specified in Table 71.1 without breakdown. The test shall be performed immediately after the Temperature Test, Section 64.

Table 71.1
Minimum dielectric voltage and time

Insulation type	Rated voltage	One minute (Vac)	One minute (Vdc)	1 Second (Vac)	1 Second (Vdc)
Single	42.4 ac peak or 60 dc or less	500	700	600	850
Double		1000	1400	1200	1700
Single	Above 42.4 ac peak or 60 dc	1000 + (2 × Rated Voltage)	1.414 × (1000 + (2 × Rated Voltage))	1200 + (2.4 × Rated Voltage)	1.414 x (1200 + (2.4 × Rated Voltage))
Double		2000 + (4 × Rated Voltage)	1.414 × (2000 + (4 × Rated Voltage))	2400 + (4.8 × Rated Voltage)	1.414 × (2400 + (4.8 × Rated Voltage))

71.2 Breakdown is usually indicated by the tripping of an overload protector in the test equipment; however, an abrupt decrease or retarded advance of the voltmeter reading also indicates insulation breakdown.

71.3 A 60-hertz sinusoidal (for AC) potential is to be applied between live parts conductively connected to the supply circuit and dead metal parts. The applied potential is to be as specified in Table. The supply source is to have capacity to maintain the potential specified, except in case of breakdown. The voltage is to be increased gradually from zero until the specified test potential is reached or until breakdown occurs.

Exception: Circuits operating at a voltage of 42.4 V a.c. peak or 60 V d.c. or less the test potential shall be minimum 500 V a.c. or 700 V d.c.

71.4 The test equipment is to include a transformer having a sinusoidal output for ac tests, a means of indicating the test potential, an audible or visual indicator of electrical breakdown, and either a manually reset device to restore the equipment after electrical breakdown or an automatic feature to reject any product that does not meet the requirement.

71.5 When the output of the test-equipment transformer is less than 500 volt-amperes, the equipment is to include the voltmeter in the output circuit to directly indicate the test potential.

71.6 When the output of the test-equipment transformer is 500 volt-amperes or more, the test potential is able to be indicated by a voltmeter in the primary circuit or in a tertiary-winding circuit, a selector switch marked to indicate the test potential, or in the case of equipment having a single test-potential output, a marking shall be visible while the equipment is in use to indicate the test potential. When a marking is used without an indicating voltmeter, the equipment shall include a positive means, such as an indicator lamp, to indicate that the manually reset switch has been reset following a dielectric breakdown.

71.7 Test equipment other than that specified in 71.4 – 71.6 is able to be used with the consent of those concerned.

71.8 For an upholstered furnishing that employs a heating pad, the test potential specified in 71.3 is to be applied between interconnected current-carrying parts of each sample furnishing in the area of the heating pad and sheets of metal foil on the sides or faces of the furnishing. The furnishing, with the foil on each side or face of the heating pad surface, is to be covered with felt mats as specified in 71.9. A uniform minimum pressure of 25 lb/foot^2 (122 kg/m^2) is to be applied to the felt mats so that the metal foil is held in close contact with the heating pad covering.

71.9 The felt mats specified in 71.8 are to be 1 inch (25 mm) thick and have an area sufficient to completely cover the area of the heating pad and to extend for not less than 2 inches (51 mm) all the way around the pad area.

72 Printed-Wiring Board (PWB) Ground Path Test

72.1 Three samples of the PWB assembly with a ground path trace shall be subjected to the Ground Path Test currents as specified in Table 72.1. The enclosure of the PWB shall be mounted as intended and wrapped in cheesecloth. During and following the test, the following conditions shall not occur:

a) Emission of flame, molten metal, or glowing or flaming particles through any openings (preexisting 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 with the probe specified in Figure 13.1; and

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

Table 72.1
Minimum Ground path test currents

Grounding and bonding supply copper conductor size		Test current, A	
AWG or kcmil	(mm^2)	Time, s	Copper
14	(2.1)	4	300
12	(3.3)	4	470
10	(5.3)	4	750
8	(8.4)	4	1180
6	(13.3)	6	1530
4	(21.2)	6	2450

72.2 Following the test, the resistance of each ground conductor trace is to be determined. This is determined by measuring the voltage drop when a minimum current of 25 A, derived from a 60 Hz source with a no-load voltage not exceeding 6 V, is passed between the supply ground conductor or terminal and the load side of each outlet. The resistance shall not be more than 0.1 ohms.

73 Printed Circuit Board (PWB) Conductor Overcurrent Test

73.1 In accordance with Printed wiring boards, 3.8, three PWB circuit assemblies with supply conductor traces are to be subjected to the Printed Circuit Board Conductor Overcurrent Test. The assembly shall comply with the requirements in 73.4 and 73.5.

73.2 The furnishing or smallest electrical enclosure containing the circuit under test shall be mounted as intended and wrapped in cheesecloth.

73.3 The overload current is to be 200 percent of the current rating of the maximum size branch circuit overload device to which the furnishing is intended to be connected. The overcurrent test current is to be applied for a minimum of 2 minutes.

73.4 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 (preexisting 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 with the probe specified in Figure 13.1; and

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

73.5 After the sample has cooled to room temperature the spacing's between traces or between the traces and other grounded non-energized metal parts shall comply with the requirements in Section 18, Spacings.

74 Motor Testing

74.1 General

74.1.1 Motors that use method 3.7.1 (c), (d), or (e) for protection shall comply with the following:

A motor that only operates when the user is present and when activated by the user with a momentary contact switch is not required to be subjected to the Running Overload Motor Test, 74.2.

a) A furnishing where the motor operation is automatic or the motor can operate without the presence of the user shall comply with the Running Overload Motor Test, 74.2.

b) All motor operated furnishings shall comply with the Locked Rotor Test, 74.3, unless subjected to the locked rotor tests under one of the standards in 3.7.1.

74.1.2 Where the motor is protected by the limiting impedance of the motor windings or by the opening of an electrical component, other than over current protection, three samples of the motor under investigation shall be subjected to the test. Where the motor is protected by an overcurrent device or thermal protector only one sample will need to be tested.

74.1.3 The motor is to be thermocoupled with a minimum of 4 thermocouple on the windings or case for a totally enclosed motor. The thermocouples should be placed at both ends of the motor and at different angles.

74.2 Running overload motor test

74.2.1 The case, windings or body of the motor shall then be wrapped in cheesecloth. The risk of fire indicator (cheesecloth) is to be double-layered. There shall be no ignition (charring or discoloration is acceptable) of the cheesecloth and the maximum temperature on [the case on an enclosed motor or a winding on an open motor] shall not exceed 150°C (302°F). The Dielectric Voltage-Withstand Test shall be conducted immediately following the running overload test while still heated. The test shall be conducted in accordance with Section 71, Dielectric Voltage-Withstand Test.

74.2.2 The running overload test shall be carried out by operating the motor under normal load; and then increasing the load so that the current is increased to the point just below where the power supply or controller limits the current to the motor(s). Supply voltage shall be maintained at its original value.

74.2.3 In accordance with 25.7, if the furnishing has a control that limits the operation time, the test duration of the overload test shall be conducted based on the controller limiting the operation of the device. Single component faults within the controller circuit shall be considered.

74.3 Locked rotor test

74.3.1 A motor shall be tested in accordance with 74.3.2. There shall be no ignition (charring or discoloration is acceptable) of the cheesecloth and the maximum temperature on [the case on an enclosed motor or a winding on an open motor] shall not exceed 150°C (302°F).

74.3.2 Motors shall be connected to a source of supply that will provide rated voltage and has the current capacity to provide the locked-rotor current. The motor should not be connected to a controller unless that is the only way it will operate. If connected to a controller, any functions that may interfere with the test shall be defeated unless the controller function has been evaluated as a protective control in accordance with 3.5.4, Protective Controls. Cheesecloth shall be placed around the motor. The rotor shall be locked for 7 hours or until steady conditions are established.

74.3.3 As an alternate to 74.3.2 for totally enclosed motors that have not been evaluated to 3.7.1, the motors shall be prepared the same as in 74.3.2, except a power source shall be used to provide sufficient current without any protection circuit operating. The outside of the motor shall be drabbed with cheesecloth. If the motor is enclosed in a secondary metal enclosure, such as the leg of a table, the cheesecloth may be placed on the outside of the secondary and if the leg is open at one end the cheesecloth shall be placed inside the leg in contact with the motor. If the test is performed with motor inside a secondary metal enclosure, such as a leg, temperatures shall be measured on the outside of the enclosure if the user may contact the surface.

74.3.4 There shall be no ignition (charring or discoloration is acceptable) of the cheesecloth or any indication of a fire, such as insulation on leads discolored or melted. the maximum temperature on the secondary enclosure shall not exceed 90°C (194°F).

74.3.5 Dielectric Voltage-Withstand Test shall be conducted immediately following the locked rotor test while still heated. The test shall be conducted in accordance with Section 71, Dielectric Voltage-Withstand Test.

75 Abnormal – Tests

75.1 General

75.1.1 A product shall not present a risk of fire, electric shock, or injury to persons when operated under the abnormal conditions specified in 75.2, Continuous Operation, 75.3, Output or Furnishing Interconnection Field Wiring, 75.4, Electronic Components and 75.5, Cooling Fans and Blowers. Compliance with the tests specified in this section is met when all of the following occurs:

a) There is no ignition or charring of the cheesecloth indicator (charring is deemed to have occurred when the structural integrity of the threads has been destroyed due to temperature);

b) The fuse from the enclosure to ground does not open;

c) Immediately following these tests, the product complies with:

1) The Dielectric Voltage-Withstand Test, Section 71, within 1 minute after completion of the abnormal test; or

2) The Leakage Current Test, Section 61, when the product is provided with a power supply cord and attachment plug; or

d) Immediately following these tests, the product complies with the entrapment force limitations specified in Section 53, Force Measurement and Operator Attended Tests.

e) The product complies with the enclosure and guarding requirements in 11.4, Mechanical Enclosure And Guards – Mechanical Considerations.

75.1.2 During the tests, cheesecloth, is to be draped loosely over the furnishing or portion of the furnishing under investigation.

75.1.3 The product is to be connected to a power supply and connected in series with a non-time-delay fuse of the maximum current rating of the branch circuit. Opening of the fuse before any condition of risk of fire or electrical shock results is considered as meeting the intent of the requirements. The enclosure, when metallic or employing dead-metal parts, shall be connected to ground either through a fuse rated to correspond to the input rating of the unit or 3 amperes, whichever is less. Only one abnormal condition is to be simulated at a time.

75.1.4 Abnormal operation tests are to be conducted until ultimate results are obtained, or for 7 continuous hours. Examples of ultimate results include the following:

a) Ignition of any portion of the furnishing under investigation;

b) Electrical breakdown of an insulating system;

c) The furnishing becomes permanently inoperable by:

1) Opening of one or more capacitors, diodes, resistors, semiconductor devices, printed-wiring board traces, motor, or similar part or component, when there is no indication of further change;

2) Opening of the intended branch-circuit overcurrent protective device; or

3) Opening of a non-user accessible, non-resettable protective device.

d) The operating temperatures of the furnishing stabilize, and it is apparent that continued operation for the full 7 hours will not affect the test results.

e) Reset protector functions in accordance with 75.1.5; and

f) Any other condition that indicates continued operation will not affect the results of the test.

75.1.5 When an automatically reset protector functions during tests, the test is to be continued for a minimum of 7 hours or until ultimate results occur. When a M1 manual reset protector functions during a test, it is to be operated for 10 cycles using the minimum resetting time, at a rate not faster than 10 cycles of operation per minute. When an M2 manual reset protector functions during a test it is to be operated in the minimum time allowed by the construction of the furnishing as specified in the use instructions to restore the operation of the furnishing. The M2 protector shall be tripped for 10 cycles of operation or for a minimum of 7 hours or until ultimate results occur. The protector shall be operative upon completion of the test.

Exception: When the manual reset protector is a circuit breaker that complies with the Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, UL 489, it is to be operated for 3 cycles using the minimum resetting time at a rate not faster than 10 cycles of operation per minute.

75.1.6 A risk of fire or electric shock is determined to exist when any of the following occurs:

a) Flame or molten metal is emitted from the enclosure of the equipment as evidenced by ignition, glowing, or charring of the cheesecloth;

b) A breakdown results from the dielectric voltage-withstand test;

c) Live parts are made accessible;

d) The 3-amp non-time-delay ground fuse opens; or

e) A failure of the Leakage Current test.

75.1.7 During these tests, all fuses which are field-renewable by the user and are of an interchangeable type shall be replaced by a fuse of the same size and voltage rating using the highest available current rating for that size. Opening of the fuse before any condition of risk of fire or electrical shock results satisfies the requirement of the test.

Exception: Fuses need not be replaced when the product employs marking identifying the need for using the indicated fuse(s) located so that it is obvious as to which fuse or fuseholder(s) the marking applies and where readily visible during replacement of the fuse(s). A single marking is acceptable for a group of fuses. The marking shall comply with 87.2.14.

75.1.8 All abnormal conditions are to be continued until ultimate results are obtained, such as burnout or stabilization of temperatures.

75.2 Continuous operation

75.2.1 A user-operated control is to be adjusted to the position representing the most adverse operating condition.

75.2.2 A product that normally would only be operated for a limited time shall be capable of operating continuously in any condition of normal use possible without risk of fire, electric shock, or injury to persons.

75.3 Output or furnishing interconnection field-wiring

75.3.1 Each output circuit of the product to which field wiring is intended to be connected is to be individually opened or shorted.

75.3.2 The test condition in 75.3.1 shall be applied one at a time. The abnormal condition shall be introduced while the equipment is operating in any condition of normal use.

75.4 Electronic components

75.4.1 All circuit components located in a control or safety circuit shall be examined using the equipment circuit diagrams and component specifications to determine those faults that can occur. The failure of any component in the input and output circuits, excluding secondary ground-fault protection circuits, that results in risk of fire or electric shock, shall be subjected to short-circuits and open-circuits of transistors, rectifiers, diodes, and capacitors, faults causing continuous dissipation in resistors designed for intermittent dissipation, and internal faults in integrated circuits causing excessive dissipation. The product shall then be operated during each of the fault conditions until constant temperature or burnout occurs. Only one short-circuit or open-circuit test is to be conducted at a time.

75.4.2 The components specified in 75.4.1 includes an electrolytic capacitor, a diode, a solid-state device, or any other component not previously investigated and determined to be rated for the application.

Exception: A previously investigated component determined to be reliable such as a rated electromagnetic and radio-frequency-interference capacitor, a resistor, a transformer, an inductor, or an optical isolator, is not required to be subjected to this test.