

37.3 A molding, cover, shelf, top cap, or similar part not forming an electrical enclosure, that is formed of polymeric material shall be classed HB or higher in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

*Exception: This requirement does not apply to the following:*

*a) External accessories that are not permanently attached to the mount, such as a screwdriver, container of lubricating oil, and similar accessories.*

*b) Small parts that satisfy all of the following:*

*1) The maximum volume does not exceed 0.122 inch<sup>3</sup> (2 cm<sup>3</sup>), and*

*2) The maximum dimension does not exceed 1.18 inches (3 cm).*

*c) Polymeric material 0.010 inch (0.254 mm) thick or less.*

37.4 A polymeric mounting system shall comply with [12.6](#) for an electrical enclosure and with this Section for the construction not comprised of the electrical enclosure.

37.5 Fabric materials that have an individual or a mechanically contiguous surface area of 10 square feet (0.93 m<sup>2</sup>) or more shall comply with Standard Test Methods of Fire Tests for Flame Propagation of Textiles and Films, NFPA 701.

37.6 Molded foam structure or other structures are to be made of a material that complies with the Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes, UL 1975, with a maximum allowable rate of heat release of 150 kilowatts; providing the part occupies a volume greater than 2 cubic centimeters (0.122 cubic inch), has any dimension greater than 3 cm (1.18 inch), and is located so it can propagate flame from one area to another or bridge between a possible source of ignition and other ignitable parts. The mount shall comply with the requirements when fully assembled as intended.

## **38 Adhesives Used to Secure Parts**

38.1 An adhesive that is relied upon to reduce a risk of fire, electric shock, or injury to persons shall comply with the requirements for adhesives in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

38.2 The requirement in [38.1](#) also applies to an adhesive used to secure a conductive part, including a nameplate, that may, if loosened or dislodged:

a) Energize an accessible dead metal part;

b) Make a live part accessible;

c) Reduce spacings below the minimum acceptable values; or

d) Short-circuit live parts.

38.3 Whether the conditions mentioned in [38.2](#) (a) – (d) can occur is to be considered with respect to both:

a) A part inside the device; and

b) A part on the outside of the device that may affect equipment in which the device is to be installed.

## 39 Fasteners

39.1 A User Adjustable Fastener such as a bolt, pin, or screw, that when loosened for adjustment can be loosened to the point that its partial or full removal could result in an injury to persons, shall be provided with a secondary securement means such as a lock nut, cotter pin or similar feature that would require the user to deliberately defeat it.

39.2 Motor operated mounting systems shall be provided with fasteners that are not subject to loosening from vibration or movement of the articulating components. Lock nuts, locking adhesives, cotter pins and retaining rings are some but not all of the features that are to be used to prevent articulating joints from unintentionally becoming disassembled.

## 40 Lubrication

40.1 Motor operated mounting systems shall be provided with lubricated articulated joints or be constructed with materials that have self-lubricating properties. (Example: Teflon).

40.2 If a motor operated mounting system requires periodic lubrication, the type of lubricant, the frequency of lubrication and the points to be lubricated shall be specified in the User-maintenance instructions, see [81.1](#).

## 41 Corrosion Protection

41.1 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, or similar type of coating;
- e) Epoxy powder coating;
- f) Air-dry paint; or
- g) Other coating providing equivalent corrosion protection.

41.2 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.

## 42 Wireways and Tubing

42.1 A mounting system shall be constructed so that when wires are pulled through, or the unit otherwise wired, the covering or insulation on the conductors is not damaged against any surface they are able to contact.

42.2 Wireways shall be free from burrs and fins.

42.3 Tubing that is used as a wireway shall be free from kinks and cracks.

42.4 Screw threads of sheet metal screws and self-tapping screws shall not be exposed for a distance of more than 3/16 inch (4.8 mm) in a wireway unless the wires are held away from or prevented from contacting the screw threads.

### 43 Strain Relief

43.1 Strain relief shall be provided so that mechanical stress on a flexible cord will not be transmitted to terminals, splices, or interior wiring. To determine compliance, the supply cord is to be tested in accordance with Section [61](#), Strain Relief Test, and Section [62](#), Push Back Relief Test.

43.2 A knot shall not be employed to provide strain relief.

43.3 Means shall be provided to prevent the supply cord or lead from being pushed into the enclosure of a mounting system through the cord-entry hole when such displacement results in:

- a) Subjecting the supply cord or lead to mechanical damage;
- b) Exposing the supply cord or lead to a temperature higher than that for which it is rated;
- c) Reducing spacings below the minimum required values; or
- d) Damaging internal connections or components.

To determine compliance, the supply cord or lead shall be tested in accordance with the Push-Back Relief Test, Section [62](#).

### 44 Bushings

44.1 At the point where a flexible cord passes through an opening in a wall, barrier, or enclosing case, there shall be a bushing or the equivalent that shall be substantial, secured in place as intended, and shall have a smooth, rounded surface against which the cord may bear. The heat-resistant properties of a nonmetallic bushing material shall comply with the requirements of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. If the bushing is necessary to meet enclosure requirements of Section [12](#), Electrical Enclosures, it shall additionally meet the enclosure requirements of UL 746C.

44.2 When the material through which the cord 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.

44.3 Ceramic materials and some molded compositions are generally capable of being used for insulating bushings. Separate bushings of wood or hot-molded shellac-and-tar compositions are prohibited.

44.4 Vulcanized fiber may be employed when the bushing is not less than 3/64 inch (1.2 mm) thick and is formed and secured in place so that it is not adversely affected by conditions of ordinary moisture and temperature.

44.5 A separate soft-rubber, neoprene, or polyvinyl chloride bushing is capable of being employed:

- a) Anywhere in an mounting system when it is used in conjunction with a type of cord for which an insulating bushing is not required and the edges of a hole in which such a bushing is used is free from burrs, fins, and other conditions that can damage the bushing; or
- b) In the frame of a motor or in the enclosure of a capacitor attached to a motor when:

- 1) The bushing is not less than 3/64 inch (1.2 mm) thick; and
- 2) The bushing is located so that it will not be exposed to oil, grease, oil vapor, or other substances that can have a deleterious effect on the compound employed.

## 45 Thermal Insulation

45.1 Thermal insulation shall be:

- a) Located and mounted or supported so that it will not be adversely affected by any intended operation of the mounting system;
- b) Noncombustible or be classed V-0, 5VA, or 5VB minimum, in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94;
- c) Non electrically conductive; and
- d) Meet spacings from uninsulated live parts of a mounting system.

## 46 Glass Panels

46.1 Glass shall not be less than 0.115 inch (2.92 mm) thick if the length or width of the glass is not greater than 12 inches (305 mm). Glass having a length or width greater than 12 inches (305 mm) shall not be less than 1/8 inches (3.2 mm) thick and the glass shall be a non-shattering or tempered type that, when broken, complies with the requirements in the Standard Performance Specifications and Methods of Test for Safety Glazing Material Used in Buildings, ANSI Z97.1.

## 47 Counter Balance Mechanisms

47.1 Any device that stores energy (example: spring, pressurized cylinder) to counter balance the normal load applied to the mounting system shall be fully enclosed or otherwise guarded or restrained to reduce the likelihood of injury in the event of device failure.

47.2 The enclosure shall have sufficient strength and rigidity to contain the counter balance device upon breakage of the energy storing device.

## 48 Sharp Edges

48.1 Sharp edges, corners, projections, or other similar parts shall not be accessible during user assembly or normal use. An accessible edge, corner, projection, or other similar part shall be smooth and well rounded to reduce the risk of a cut-type injury when contacted during user assembly or normal use. Compliance shall be determined by the Sharp Edge Test, Section [69](#).

## 49 Securement of Products for Use with the Mounting System

49.1 Shelves and platforms of a mounting system shall be provided with a means to restrict an apparatus from sliding off the surface. Friction shall not be the sole means of restricting an apparatus from sliding off a supporting surface. Fasteners that are required to be inserted into the end-use mounting system shall be evaluated for the ability to support the loads encountered under all angles of adjustment.

*Exception: Fixed horizontal shelves and platforms need not comply with this requirement.*

49.2 A mounting system having shelves, platforms, and mounting brackets that are intended to support an apparatus and having provision for fixed tilt or adjustable tilt shall be provided with a mechanical means of securing the apparatus to the mount.

49.3 An articulating mounting system shall be provided with a mechanical means of securing the apparatus to the mount.

49.4 Gravity and adhesives alone shall not be relied upon to secure products to articulating mounts or adjustable tilt mounts. A mechanical fastening means is required.

## **50 Mounting System Ventilation**

50.1 If the mounting system is provided with an enclosure including doors, covers or panels that may be closed restricting ventilation to the audio/video equipment, information technology equipment, and similar products while performing their intended function, a minimum of 2 sq cms per Watt of effective ventilation opening shall be provided per the maximum recommended wattage for the components the mounting system is intended to support. Approximately one half of the area is to be located near the base of the bottom edge of the mounting system and the remaining open area is to be located near the top of the mounting system.

50.2 Mounts that incorporate both enclosed and unenclosed apparatus supports shall be provided with a minimum of 2 sq cms per Watt of effective ventilation opening per the maximum recommended wattage for the components the mounting system is intended to enclose or partially enclose.

50.3 Any internal dividers such as shelving, shall allow the flow of convection air through the mounting system.

50.4 Ventilation openings may not originate or exit into confined spaces of a building structure, walls, floors, ceilings and the like.

50.5 A reduction in the area of ventilation openings may be provided when powered ventilation is integral to the mounting system and any of the following are provided:

- a) A trouble signal indicator visible to the user is activated when the air flow drops below 75 percent of the design air flow; or
- b) Power to any receptacle provided as part of the mounting system deenergizes when air flow drops below 75 percent of the design air flow.

50.6 A mounting system or apparatus that recesses into an enclosure or within the building structure when not in use shall be provided with an interlock to deenergize the power to the apparatus when in the recessed position. Designs intended to be operated within an enclosure and complying with [50.1](#) – [50.5](#) are not required to have an interlock.

## **51 Articulating Motor Operated Mounting Systems**

### **51.1 Mechanical enclosures and guards**

51.1.1 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 mounting system, 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.

51.1.2 Determination as to whether a guard, a release, an interlock, or similar device is required for mounts intended for wall or shelf mounting shall be judged with consideration to the mount and/or apparatus being located at any height between one foot from the floor and one foot below a ceiling. Installation instructions indicating a specific mounting height shall not be considered in determining that a guard is not required.

51.1.3 An entrapment guard or enclosure is not required for a ceiling-mount or apparatus that when lowered, its lowest point is 8 ft (2.44 m) or more above the floor. The device shall be marked as specified in [74.3](#) and the instructions shall contain the Warning and information specified in [79.2](#) and [79.3](#).

51.1.4 A moving part, 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 probe illustrated in [Figure 13.2](#) unless the mounting system is provided with a safety circuit and complies with Section [31](#), Safety Circuits.

51.1.5 Mounting systems that present a risk of injury as described in [51.1.1](#) shall be provided with either an active safety circuit or passive guard to prevent injury.

51.1.6 Safety systems that are electrical in nature shall be designed such that any failure of the system will result in the mounting system not producing a risk of injury due to the safety system failure. Also see Section [31](#), Safety Circuits.

51.1.7 A mechanical safety system, such as a guard, shall comply with [51.1.10](#) – [51.1.12](#).

51.1.8 During the investigation of a mounting system to determine compliance with [51.1.4](#), a part of the enclosure that is removable without the use of a tool (such as an accessory, the cover over an opening for an operating adjustment, or similar components) is to be opened or removed.

51.1.9 Among the factors to be evaluated with respect to both intended operation of the mounting system 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;
- c) The risk of unintentional contact;
- d) The speed of the moving part;
- 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; and
- f) An exposed motorized moving part such as the edge of a shelf, the edge of a video display and the like, shall not exert a force greater than 40 pounds between the moving part and any object that can be inserted between the moving part and a fixed structure such as but not limited to a wall, ceiling, floor or any portion of the device. All degrees of rotation and movement shall be considered in the evaluation.

51.1.10 Guards shall:

- a) Require the use of tools for their removal;
- b) Have sufficient strength and rigidity;

- c) Be complete;
- d) 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
- e) Be self-restoring.

51.1.11 An 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.

51.1.12 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 mounting system.

## 52 User/Installer Assembly

52.1 A mounting system and its accessories intended to be user or installer assembled shall comply with the following:

- a) The assembly shall be accomplished by the user or installer with ordinary tools including those provided with the mounting system;
- b) An assembly or part intended to be cut to length, drilled or fitted by the installer may be provided if means are furnished for joining any altered part to a companion part or assembly. The field altered part shall comply with the following:
  - 1) Mounting holes for connection to the building structure shall be factory produced.
  - 2) Electrical enclosures shall not be subjected to field cutting or drilling.
  - 3) An assembly where insulated conductors or cords are routed or pass through after the cutting or drilling operation is performed shall be provided with a method of preventing contact of the insulated conductor or cord with a field cut edge or drilled hole. A field installed bushing is acceptable if provided with the assembly. The bushing shall comply with Section [44](#) and not require a special tool to install unless provided with the assembly.
  - 4) When drilling is specified the size of the drill bit and the instructions shall clearly describe the location or locations to be drilled.
  - 5) Cut and drilled edges shall not be exposed to the user after the operation has been performed unless they comply with Section [48](#).
  - 6) The field cut or drilled mounting system when altered as specified in the instructions shall comply with the requirements of this Standard.
- c) All parts such as screws, bolts, and similar parts that are required to complete the assembly of the mounting system shall be provided;
- d) Installation and assembly instructions shall be provided as detailed in Instructions, General, Section [78](#); and
- e) The manufacturer shall provide fasteners and mounting hardware for each of the mounting surfaces. The fasteners and mounting hardware need not be provided if the installation instructions supplied by the manufacturer give complete details of the hardware to be used (At a minimum, screws or bolts are to be identified by the size or diameter, length, thread size, material hardness

[when harder than grade 2 (class 4.6)], and quantity; concrete or masonry anchors are to identify the manufacturer's name, size, and model number).

## 53 Knockouts

### 53.1 Clearance

53.1.1 Openings in an enclosure for the connection of a wiring system that in some cases will not be used shall be closed by a knockout, cover, or plug. The closure shall be formed of metal not less than 1.35 mm (0.053 in) thick or of a non-metallic material acceptable for the purpose. The closure shall be such that it may be readily removed, but will not drop out in ordinary handling.

### 53.2 Flat surfaces surrounding knockouts

53.2.1 Flat surfaces surrounding a knockout on both the inside and outside of an enclosure shall extend beyond the edge of the knockout in all directions for at least the distance given in [Table 53.1](#) and shall comply with [71.1](#). Projections or indentations in the flat surface are prohibited. The flat surface areas of adjacent knockouts that partially or wholly overlap meet the intent of this requirement.

**Table 53.1**  
**Knockout Dimensions**

Conduit trade size	Knockout diameter mm (inches)					
	Minimum		Nominal		Maximum	
	mm	(inch)	mm	(inch)	mm	(inch)
1/2	21.82	(0.859)	22.23	(0.875)	23.01	(0.906)
3/4	27.79	(1.094)	28.17	(1.109)	28.98	(1.141)
1	34.52	(1.359)	34.93	(1.375)	35.71	(1.406)
1-1/4	43.66	(1.719)	44.04	(1.734)	44.86	(1.766)
1-1/2	49.73	(1.958)	50.39	(1.984)	51.21	(2.016)
2	61.80	(2.433)	62.71	(2.469)	63.50	(2.500)
2-1/2	74.12	(2.918)	75.41	(2.969)	76.20	(3.000)
3	90.50	(3.563)	91.29	(3.294)	93	(3.661)
3-1/2	103.20	(4.063)	104.78	(4.125)	106	(4.173)
4	115.90	(4.563)	117.88	(4.641)	119	(4.685)
5	142.88	(5.625)	145.26	(5.719)	147	(5.787)
6	170.18	(6.700)	173.05	(6.813)	175	(6.890)

### 53.3 Diameters

53.3.1 A knockout shall have a diameter that accommodates the corresponding trade sizes of conduit specified in [Table 53.1](#). The diameter of the knockout shall be measured at points other than where a tab remains after the knockout has been removed.

### 53.4 Strength of knockouts

53.4.1 A knockout shall comply with [70.1](#). The diameter of the knockout shall be measured at points other than where a tab remains after the knockout has been removed.



## PERFORMANCE

### GENERAL

#### 54 General

54.1 A mounting system shall be assembled and mounted in accordance with the manufacturer's installation instructions.

54.2 When conducting tests, a mounting system shall comply with the following:

a) Accessory shelves, platforms, brackets, arms and compartments intended to be attached or suspended from the mounting system, shall be assembled and secured to the mount;

*Exception: This requirement does not apply if it is determined that the absence of an accessory is considered to present a risk of injury not present when the accessory is installed.*

b) The fasteners and anchors provided or recommended by the manufacturer to be used to secure the apparatus to the mounting system and the mounting system to the building structure shall be used;

c) Tests shall be performed on each of the surfaces to which the manufacturer recommends the mount to be secured in the installation instructions;

d) As specified in each test procedure, each shelf, platform, bracket, and compartment shall be loaded in accordance with [Table 54.1](#); and

e) Mounting systems that are adaptable to more than one size or more than one configuration and determined to present different risks than represented by the maximum size apparatus intended to be supported shall be investigated for use with all sizes necessary to determine compliance with all sections of these requirements.

**Table 54.1**  
**Supporting Surface Loading Parameters**

Surface type	Load
Shelf, platform, or bracket intended to support a CRT television/monitor or similar apparatus	Weight specified in <a href="#">Table 54.2</a> or manufacturer specified load, whichever is greater
Shelf, platform, or bracket intended to support a loudspeaker or similar apparatus	Manufacturer specified load
Shelf, platform, or bracket intended to support a VCR, DVD, DVR player, satellite receiver, cable box or similar apparatus	Manufacturer specified load or 25 lbs. (11.34 kg), whichever is greater
Flat Panel Displays such as Plasma Display, Liquid Crystal Display (LCD), and Light Emitting Diode Display (LED)	Manufacturer specified load
Apparatus other than mentioned above	Manufacturer specified load or 25 lbs. (11.34 kg), whichever is greater
Dedicated storage area – Tapes, CDs, DVDs	Manufacturer specified load
Shelf, platform, or bracket intended to support a video projector	Manufacturer specified load

54.3 When conducting the Cycling Test for Articulating Mounts, Section [66](#), and the Mounting Securement Test, Section [67](#), the following shall apply:

- a) Material used to simulate the load is to consist of cast or cold-rolled steel plates or bars or other equivalent dead-load or load cells and such applied in a manner duplicating dead loads. In stacking the plates or bars, they are to be overlapped or criss-crossed in such a manner that the weight is evenly distributed over the supporting surface so as to act as a rigid unit that limits the bowing or flexure of the supporting surface or bracket to a minimum;
- b) For shelves, platforms, and constructions that require the load to be suspended, the weights are to be suspended from the center of the platform, bracket, or shelf to which the apparatus is to be mounted. Care is to be taken so that the securement of the load does not distort the mounting surface. If necessary, a rigid plate made of wood or metal can be used to evenly distribute the force of the load over the supporting surface or bracket. The weight of the rigid plate is to be considered as part of the load weight;
- c) The mounting system is to be suitably supported to inhibit premature loading and stress on the mounting means and to minimize the risk of injury due to shifting weights or premature collapse of the mount while stacking the weights. The support is to be kept in place until all of the required weights are in place. The support is to be gradually removed until the weights are freely suspended. The mounting system shall support the freely suspended test load for the required time period;
- d) For mounts intended to support CRT type displays, the mount shall be loaded with the test fixture as described in [Figure 54.1](#);
- e) For direct-mount-type products such as flat-panel displays, a suitable test plate(s) that complies with the Video Electronics Standards Association FDMI™ (VESA) Flat Display Mounting Interface Standard, representative of the end product, is to be used as the test load. The load shall be mounted by drilling through the plates(s) and using nuts or tapping the plate to use the fasteners supplied by or recommended by the manufacturer. The test load is to be secured to the mounting system as the display is recommended to be positioned by the manufacturer. If other mounting or securing hardware is specified to support the display, these shall be used as specified by the mount manufacturer. The test plate is to be considered part of the load weight;
- f) The force is to be applied in the direction that would represent the normal pull of gravity. For flat panel displays, the force is to be applied to the center of the suitable test plate. See [Figure 54.2](#);
- g) The minimum load weight to be used for CRT televisions and monitors shall be determined by the maximum diagonal screen size recommended by the manufacturer. See [Table 54.2](#);
- h) If there is a range of apparatus specified or multiple apparatus specified, the mount is to be loaded in any combination that results in the maximum stress on the mounting system components; and
- i) An adjustable mount shall be tested in the most severe position. This may require adjusting the mount to various positions to determine the worst case position. An articulating mount shall be adjusted to each extreme position of movement while loaded.

**Table 54.2**  
**Simulated Cathode Ray Tube (CRT) Television Load Parameters**

<b>Maximum screen diagonal, inches (cm)</b>	<b>Weight, lbs (kg)</b>
Up to 16 (40.64)	35 (15.88)
17 – 19 (43.18 – 48.26)	60 (27.22)
20 – 21 (50.80 – 53.34)	70 (31.82)
22 – 26 (55.88 – 66.04)	85 (38.56)
27 – 28 (68.58 – 71.12)	105 (47.63)
29 – 35 (73.66 – 88.90)	180 (81.65)
36 – 40 (91.44 – 101.60)	240 (108.86)