



Underwriters Laboratories Inc.®

A not-for-profit organization dedicated to public safety
and committed to quality service

November 10, 1995

Revision pages for

Standard for

Professional Video and Audio Equipment

UL 1419, First Edition

Attached to this transmittal notice is a reprinted title page for the First edition of UL 1419.

Attention is directed to the note on the title page of this standard outlining the procedure to be followed to retain the approved text of ANSI/UL 1419-1995.

Revised and/or additional pages may be issued from time to time.

With the inclusion of the accompanying material, the standard consists of pages dated as shown in the following checklist:

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UL 1419

Standard for

Professional Video and Audio Equipment

First Edition

November 11, 1992

Approval as an American National Standard (ANSI) covers the numbered paragraphs on pages dated November 11, 1992 and December 3, 1993. These pages should not be discarded when revised or additional pages are issued if it is desired to retain the ANSI approved text.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Approved as ANSI/UL 1419-1995, August 2, 1995

Revisions of this standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest published set of revision pages.

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October 4, 1994

Revision pages for

Standard for

Professional Video and Audio Equipment

UL 1419, First Edition

Attached to this transmittal notice is a revision of the First edition of UL 1419.

A CHANGE ON A PAGE DATED OCTOBER 4, 1994 IS INDICATED BY A SMALL PRINT NOTE FOLLOWING THE AFFECTED ITEM, PRECEDED AND FOLLOWED BY AN ASTERISK.

THESE NEW AND REVISED REQUIREMENTS ARE NOW IN EFFECT.

The new and revised requirements are substantially in accordance with UL's bulletin on this subject dated April 22, 1994. The bulletin is now obsolete and may be discarded.

Revised and/or additional pages may be issued from time to time.

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UL 1419

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FOREWORD

- A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.
- B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.
- C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.
- D. A product employing materials or having forms of construction differing from those detailed in the requirements of this Standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be judged to comply with the Standard.
- E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.
- F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

INTRODUCTION

1 Scope

1.1 These requirements cover power operated video and audio equipment operated and maintained by trained personnel under the conditions of controlled access.

1.2 These requirements cover such equipment as video tape recorders, audio/video editing equipment, audio/video receiving and processing equipment, signal transmission equipment, television cameras, video digitizers, video monitors, metering equipment and similar equipment.

1.3 This standard also covers auxiliary equipment and accessories which by themselves may not perform the desired function of the equipment outlined in 1.2 but are used in addition to or as a supplement to the basic equipment (remote controls, convertors, stands, etc.).

1.4 These requirements do not cover products that are intended for household or commercial use.

1.5 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this Standard, and that involves a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the acceptable level of safety as originally anticipated by the intent of this Standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this Standard cannot be judged to comply with this Standard. Where considered appropriate, revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this Standard.

1.5 revised October 4, 1994

1.6 Equipment employing circuits that are intended to connect directly to a telecommunications network shall also comply with the applicable requirements in the Standard for Telephone Equipment, UL 1459.

1.7 These requirements cover equipment rated 600 volts or less for use in accordance with the National Electrical Code, ANSI/NFPA 70.

2 Glossary

2.1 For the purpose of these requirements the following definitions apply.

2.2 **ACCESSIBLE PART** – A part so located that it can be contacted by means of a probe (see Figure 30.1).

2.3 **ADJUSTABLE CONTROL** – A control provided for making adjustments necessary to render the equipment capable of performing its intended functions.

2.4 **BRANCH CIRCUIT** – A branch circuit is that portion of the building wiring system beyond the final overcurrent device on the power distribution panel protecting the circuit to the field wiring terminals in permanently connected equipment or to the receptacle outlet for cord connected equipment.

2.5 **CART** – A stand (see Personal Injury Tests, Section 55) provided with casters, wheels, or rollers to make it mobile.

2.6 **CASTER** – Any roller or swiveled wheel attached to a cart, stand, or equipment that makes the cart, stand, or equipment mobile.

2.7 **CLEARANCE DISTANCE** – The shortest distance measured through air between conductive parts.

2.8 **CREEPAGE DISTANCE** – The shortage distance measured over the surface of insulation between conductive parts.

Table 6.1
Product evaluation options

Option	240 W Determination ^{a,b,c}	Component Tests > 240 W Circuitry ^{a,b,d}	Table 7.1 Section ^b	Paragraphs 7.3 thru 7.7	Table 7.3 Section ^b
A (Construction)					
Primary	Yes	Yes	C	Yes	No
Secondary	No	No	C	Yes	No
Enclosure	N/A	N/A	A, B	Yes	No
B (Performance)					
Primary	Yes	Yes	No	No	A
Secondary	Yes	Yes	No	No	A, C
Enclosure	N/A	N/A	No	No	A, B
^a Does not apply to components and parts of Power Supplies that comply with the requirements of UL 478 (Option A only), UL 1012, UL 1310, UL 1270, UL 1409, UL 1410, UL 813, UL 1459, or UL 1950 (D3 deviations for Option A only) for construction and performance. ^b Does not apply to primary and secondary circuits supplied by a power supply as indicated in footnote ^a with an NEC Class 2 output. ^c Refer to Section 49 for 240 W determination. ^d Refer to Sections 51 and 52 for Component Testing.					

Revised Table 6.1 effective March 15, 2000

7 Frame and Enclosure

7.1 General

7.1.1 The enclosures, guards, and barriers of the equipment shall be complete, or completion of the enclosures, guards, and barriers shall be attained when the equipment is combined during installation.

7.1.2 Required enclosures, guards, and barriers shall be capable of being removed and replaced with a minimum of effort if removal is necessary for servicing the protected parts.

7.1.3 An enclosure, guard, and barrier shall have the strength and rigidity to resist the abuses likely to be encountered during intended use without increasing the risk of fire, electric shock, electrical energy – high current levels, or injury to persons due to total or partial collapse, with resulting reduction of spacings to less than required, or the loosening, displacement, or exposure of parts, or other serious defects.

7.1.4 The strength and rigidity of the enclosure is to be judged by the Strength of Enclosure Tests, Section 54.

7.1.5 A handle or handles intended to support hand carried or hand operated equipment shall be subjected to the Handle Strength Test as described in 55.4.

7.2 Doors or covers

7.2.1 If part of an enclosure consists of a door or cover leading to an operator access area, one of the following requirements shall apply:

- a) Either the door or cover shall be interlocked to comply with the requirements in 31.1; or
- b) The door or cover, although intended to be opened by the operator, shall comply with both the following conditions:
 - 1) It shall not be removable by the operator from the enclosure;
 - 2) It shall be provided with a means to keep it closed during normal operation.

7.3 External materials – Option A (Construction)

7.3.1 Materials such as steel, aluminum, glass, and other similar materials are to be used for the enclosure, guard, or cabinet of the equipment. Glass shall be heat resistant, tempered, wired, or laminated. Other materials may be used for part or all of an enclosure, if they comply with the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluation, UL 746C. The accessibility need not be investigated as part of the enclosure flammability – 130 mm (5-inch) Flame Test as required in UL 746C. See Table 7.1.

Exception: The enclosure materials of portable equipment may be rated minimum 94V–2. See Table 7.1

7.4 Internal materials – Option A (Construction)

7.4.1 All combustible material used within a fire containment enclosure shall be rated in accordance with Table 7.1.

7.4.2 All materials located in circuits not involving a risk of fire and segregated from parts involving a risk of fire by a barrier with a minimum flammability rating of 94V–2 may be rated minimum 94HB.

Exception: All materials located in an enclosure constructed of steel or aluminum, or material with a minimum 94–5V flammability rating and containing no openings may be rated 94HB without the use of a barrier.

7.4.3 Flammability requirements do not apply to polymeric materials, printed wiring boards and wiring within an enclosure having a volume of 0.06m³ or less, consisting totally of metal and having no ventilation openings, or within a sealed unit containing an inert gas.

7.4.3 added October 4, 1994

11.1.7 Only one supply cord shall be provided to connect equipment to the branch circuit.

Exception: More than one power supply cord may be provided if one of the following is true:

- a) More than 1 voltage or kind of power is necessary (for example, 3-phase and 1-phase, regulated and unregulated, alternating current and direct current).
- b) The additional power supply cord (1) is provided as part of and (2) supplies power only for an optional component or group of components that may be installed at a later date in order to extend the function of the equipment.
- c) Redundant power supply sources are necessary.

11.1.8 If more than one power supply cord is provided on the equipment, the construction shall be such that physical disconnection of any one power supply cord shall automatically cause de-energization of all circuits within the equipment supplied by other cords.

Exception No. 1: In the case of cords that remain connected, a terminal strip, any circuit breaker, and other parts of equipment on the line side of a disconnect device may remain energized if service personnel performing service functions not involving these parts are protected by an enclosure or other means from unintentional contact with these parts.

Exception No. 2: Automatic de-energization may be omitted if the equipment is provided with the marking specified in 60.15.1.

11.2 Equipment coupler

11.2.1 An equipment coupler employed as part of a detachable power supply cord set shall be so constructed that the equipment coupler cannot readily be used to defeat a conventional interlock device.

11.2.2 The conventional interlock device referred to in 11.2.1 has nominally 2.4 mm (3/32 inch) diameter pins, spaced 7.9 mm (5/16 inch) apart, measured between pin centers.

11.3 Cord strain relief

11.3.1 A non-detachable power supply cord or non-detachable interconnecting cable that involves fire or shock energy shall be attached to the equipment so that a mechanical strain on the cord leaving the overall enclosure cannot:

- a) Be transmitted to terminals, splices, or internal wiring;
- b) Separate an interlock connector from the part of the equipment to which it is attached; or
- c) Damage an interlock such that it does not perform its intended function.

11.4 Cord and wire routing

11.4.1 A separate flexible cord or wire that is not connected in the supply circuit or that does not involve a risk of fire or electric shock shall not be routed through a bushing or opening with the power supply cord at a point of flexure.

11.5 Attachment plug

11.5.1 The attachment plug shall conform with one of the configurations covered in American National Standard, C73 Series and in the Standard for Attachment Plugs and Receptacles, UL 498.

11.5.2 If the equipment can be adapted for use on two or more different supply voltages by means of an input voltage selector, the attachment plug provided with the equipment shall be acceptable for the voltage for which the equipment is intended to be connected when it is shipped from the factory.

11.5.3 A fuseholder, an overcurrent protective device (other than an automatic control without a marked off position), the center contact of an Edison base lampholder, an interlock, and a manual on-off switch with a marked off position shall be connected to the ungrounded side of the line when used in the primary circuit.

11.5.4 Equipment may incorporate an overcurrent protective device connected in the grounded (neutral) side of the line provided that all the following conditions are met:

- a) The grounded circuit conductor shall not be depended upon to carry a current imbalance such as is likely in equipment supplied by a 3-phase, 4-wire or a single-phase, 3-wire system;
- b) Each ungrounded circuit conductor shall be provided with an overcurrent protective device having a current rating no higher than that of the overcurrent protective device in the grounded circuit conductor;
- c) The screw shell of a plug fuseholder and the accessible contact of an extractor fuseholder located in the grounded circuit conductor shall be connected toward the grounded supply line.

11.5.4 revised October 4, 1994

11.6 Bushings

11.6.1 There shall be an insulating bushing that is secured in place:

- a) Where the power supply cord emerges from the enclosure; and
- b) Where the cord might be subjected to strain or motion.

Exception No. 1: A bushing of the same material as and molded integrally with the supply cord is acceptable on a Type SPT-2 or heavier cord if the built-up section is not less than 1.6 mm (1/16 inch) thick at the point at which the cord passes through the enclosure.

Exception No. 2: An insulated metal grommet may be acceptable in place of an insulating bushing if the insulating material used is not less than 0.8 mm (1/32 inch) thick and completely fills the space between the grommet and the metal in which the grommet is mounted.

11.6.2 If the exit for the cord is in wood, wood composition or an insulating material, a surface free of fins, burrs, and the like is considered equivalent to a bushing.

11.6.3 Ceramic, porcelain, and phenolic materials and some molded compositions are acceptable for insulating bushings. Separate bushings of wood or rubber are not acceptable.

11.6.4 Fiber may be employed if the finished bushing is not less than 1.2 mm (3/64 inch) thick and is so formed and secured in place that it will not be affected adversely by ordinary moisture. Sheet fiber not less than 0.7 mm (0.028 inch) thick may be used under the same conditions.

23.1.3 The placing of a lead along a flat surface and soldering (identified as tack soldering) is not acceptable.

Exception: Tack soldering of a lead is acceptable if it can be demonstrated that a risk of fire, electric shock, or injury to persons does not exist with the lead detached.

23.1.4 A splice shall have insulation equivalent to that of the wires involved if permanence of spacing between the splice and other metal parts is not provided.

23.1.5 Threaded pressure wire connectors used for splicing internal wiring shall be so located within the overall enclosure that they will not be subject to handling by the user.

Exception: Connectors that are additionally taped to the conductors.

23.2 Wire wrapped connections

23.2.1 A solderless wire wrapped connection is acceptable if it is not subject to movement or flexure of the wires during conditions of intended operation or user servicing.

23.2.2 Wiring used for solderless wire wrapped connections shall be solid, copper wire in 0.21, 0.32, or 0.52 mm² (Nos. 24, 22, or 20 AWG). Other sizes and types of wire may be used if they provide an equivalent connection.

23.2.3 A terminal shall be of copper or brass and shall have at least two sharp edges. A terminal of other material may be subjected to an investigation.

23.3.4 The wrap shall have at least 20 points on the corners of the terminal in contact with the wire with at least 16 points closely wrapped with no overlapping. The term closely wrapped means that there are no gaps between adjacent turns greater than one-half the diameter of the wire, not including gaps on the first and last turns. See Table 23.1. A lesser number of wraps may be subjected to an investigation to determine equivalence.

Table 23.1
Typical number of wraps

Number of sharp corners on the terminal	Number of closely wrapped turns	Total number of turns
4	4	5
2	8	10

24 Spacings

24.1 The spacings between field wiring terminals of opposite polarity and the spacings between a field wiring terminal and any other uninsulated metal part (dead or live) of the opposite polarity shall be no less than indicated in Table 24.1.

24.2 In primary circuits where hand-soldering is involved, other than at field wiring terminals, the spacings between an uninsulated live part and any other uninsulated metal part (dead or live) of the opposite polarity shall be no less than indicated in Table 24.2. If an uninsulated live part is not rigidly fixed in position (by means other than friction between surfaces) or if a moveable dead metal part is located near an uninsulated live part, the construction shall be such that at least the minimum spacings shall be maintained regardless of the position of the moveable part.

24.2 revised October 4, 1994

24.3 For circuits operating at greater than 2500 V, spacings from those parts to accessible conductive parts or conductive enclosure, shall be in accordance with Figure 24.1 where peak kilovolts (V_1) = $2E + 1000$ or be in accordance with the Dielectric Voltage-Withstand Test for high voltage circuits specified in the Dielectric Voltage-Withstand Test, Section 41.

24.3 revised October 4, 1994

24.4 The spacings in all circuits of equipment where machine soldering is involved are to be investigated on the basis of the Dielectric Voltage-Withstand Test specified in Section 41, Dielectric Voltage-Withstand Test.

24.4 revised October 4, 1994

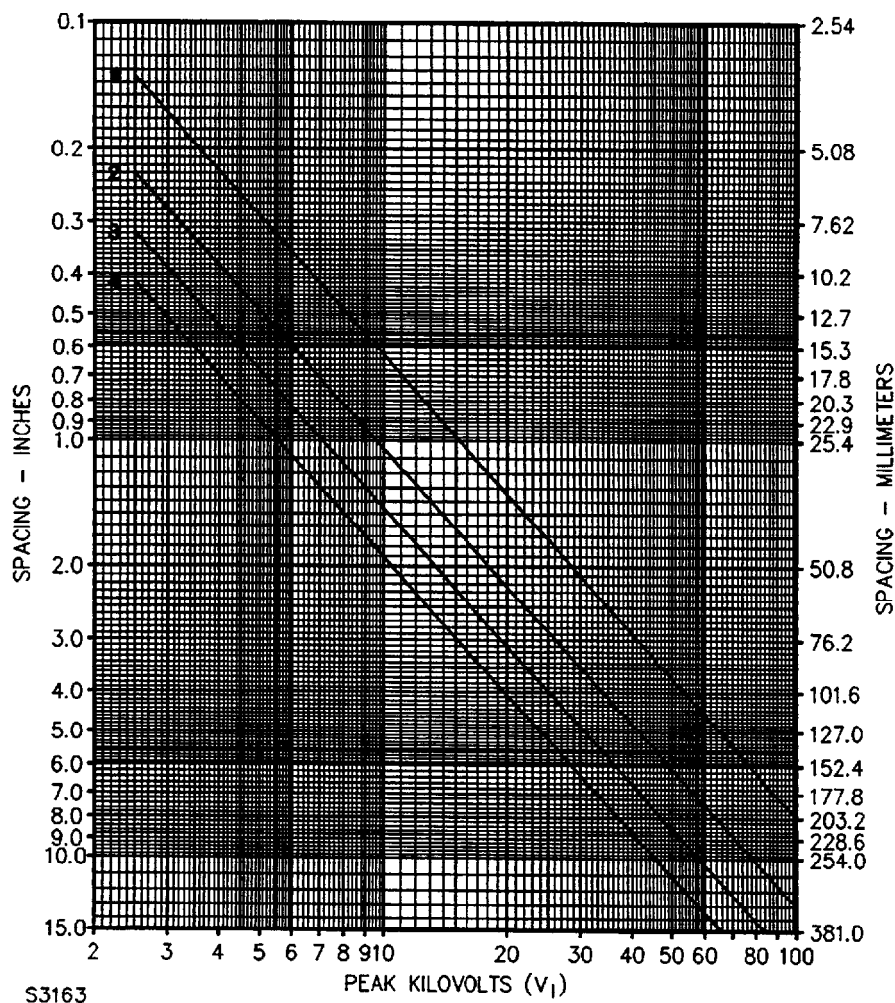
Table 24.1
Minimum spacings at field wiring terminals

Potential Involved Volts	Between Field Wiring Terminals (Through Air or Over Surface)		Between Field Wiring Terminals and Other Uninsulated Parts Not Always of the Same Polarity			
			Over Surface		Through Air	
	mm	(Inch)	mm	(Inch)	mm	(Inch)
0 – 50	3.2	1/8	3.2 ^a	1/8 ^a	3.2	1/8
51 – 250	6.4	1/4	6.4 ^a	1/4 ^a	6.4	1/4
251 – 600	12.7 ^b	1/2 ^b	12.7 ^{a,b}	1/2 ^{a,b}	9.5	3/8

^a These spacings apply to the sum of the spacings involved wherever an isolated dead metal part is interposed.

^b A spacing of not less than 9.5 mm (3/8 inch) over surface or through air may be provided at wiring terminals in a wiring compartment or terminal box that is integral with a motor.

Figure 24.1
Spacings



V_1 – Measured between parts operating at greater than 2500 V and accessible conductive parts or conductive enclosure

Curve 1 – Through air spacings.

Curve 2 – Over surface spacings – insulating materials having an arc-tracking (D-495) PLC of 0,1,2,3 or 4.

Curve 3 – Over surface spacings – insulating materials having an arc-tracking (D-495) PLC of 5.

Curve 4 – Over surface spacings – insulating materials having an arc-tracking (D-495) PLC of 6 or 7.

Figure 24.1 revised December 3, 1993

Table 24.2
Minimum primary circuit spacings where hand-soldering is involved, other than
at field-wiring terminals ^{a,b}

Potential Involved Volts	Over Surface		Through Air	
	mm	(Inches)	mm	(Inches)
51 – 125	1.6 ^c	(1/16 ^c)	1.6 ^c	(1/16 ^c)
126 – 250	2.4 ^c	(3/32 ^c)	2.4 ^c	(3/32 ^c)
251 – 600	12.7 ^d	(1/2 ^d)	9.5 ^d	(3/8 ^d)

^a Film coated wire is to be considered an uninsulated live part.

^b On printed wiring boards, their connectors and board mounted electrical components, wired on the load side of line filters or similar voltage peak reduction networks or components or both, a minimum spacing of 0.58 mm (0.023 inch) plus 0.005 mm (0.0002 inch) per volt peak shall be maintained over surface and through air between uninsulated live parts and any other uninsulated conductive part (live or dead) not of the same polarity.

^c At closed in points only, such as a screw and washer construction of an insulated stud mounted in metal, a spacing of 1.2 mm (3/64 inch) is acceptable.

^d A spacing of not less than 2.4 mm (3/32 inch) over surface and through air may be provided between a dead metal part and film coated wire that is rigidly supported and held in place on a coil.

Table 24.2 revised October 4, 1994

25 Grounding

25.1 General

25.1.1 All equipment with accessible conductive parts or parts within the enclosure that are exposed to contact during any servicing operation and are likely to become energized shall be grounded. All of these parts shall be connected to the grounding means.

Exception: This requirement does not apply to a polarized direct plug-in type ac adapter complying with the requirements in the Standard for Class 2 Power Units, UL 1310.

25.1.1 revised October 4, 1994

25.1.2 With reference to the requirement in 25.1.1 the following accessible conductive parts are not considered likely to become energized:

- a) A small metal part (such as an adhesive attached foil marking, a screw, and a handle) that is:
 - 1) On the exterior of the enclosure and separated from all electrical components by grounded metal, or
 - 2) Electrically isolated from all electrical components.
- b) A panel or cover that is isolated from all electrical components by a barrier of vulcanized fiber, varnished cloth, phenolic composition, or other moisture-resistant insulating material not less than 0.8 mm (1/32 inch) thick and secured in place.
- c) A panel or cover that does not enclose uninsulated live parts and is electrically isolated from other electrical components.
- d) Cores and assembly screws of relays, solenoids, and the like.

- e) Accessible conductive parts marked in accordance with 60.11.1.
- f) Antennas, antenna terminals, control shafts, mounting screws, and the like that are not practical to connect to the grounding means.

25.1.3 An ac receptacle that is provided on equipment shall be of a grounding type. The grounding contact of the receptacle shall be electrically connected to the grounding means of the equipment.

25.1.4 The resistance between the point of connection of the equipment grounding means, at or within the equipment, and any other point in the grounding circuit shall be no more than 0.1 ohm. Determination of the resistance is in accordance with the test in 38.1.

25.2 Cord-connected equipment

25.2.1 An equipment grounding conductor shall be:

- a) Finished to be either green or green with one or more yellow stripes;
- b) Connected to the grounding member of an attachment plug having a fixed grounding contact; and
- c) Connected, by a screw or other means (not likely to be removed during servicing not involving the power supply cord), to the frame or enclosure of the equipment. Solder alone shall not be used for securing the grounding conductor to the frame or enclosure. The screw shall be of corrosion resistant metal or shall be protected against corrosion in a manner that will not inhibit electrical conductivity between the screw and any other conductor. A lock washer or star washer shall be employed to prevent the screw from becoming loosened by vibration.

25.2.1 revised October 4, 1994

25.2.2 If a portion of the main ground is provided on the printed wiring board (PWB) trace, then compliance of the printed wiring board trace as a reliable means for main grounding shall be determined by the tests described in Ground Trace Tests-Electrical in Section 53A. The ground trace shall terminate as described in 25.2.1(c).

25.2.2 revised October 4, 1994

25.2.3 If two or more pieces of equipment are electrically or mechanically connected to one another and one of them is grounded, each piece of equipment that has a separate power supply cord shall have an equipment grounding conductor in the power supply cord. If the pieces of equipment are interconnected electrically and one of them is grounded, they shall be bonded together; for example, by means of a discrete conductor included in an interconnecting cable.

25.2.4 If equipment (1) is provided with a detachable power supply cord, and (2) has conductive parts that are connected to the grounding conductor that might be contacted during the connection or disconnection of the equipment coupler at the equipment end of the cord, the construction shall be such that the grounding connection is made first and broken last with respect to the power supply conductors.

25.3 Permanently connected equipment

25.3.1 A field wiring terminal or lead for the connection of an equipment grounding conductor shall be provided.

25.3.2 A field wiring terminal for the connection of an equipment grounding conductor shall be a screw type connector capable of securing a conductor of the proper size.

25.3.3 A wire binding screw intended for the connection of the equipment grounding conductor shall have a green colored head that is hexagonal, slotted, or both. A screw type pressure wire connector intended for connection of such a conductor shall be plainly identified by the marking "G", "GR", "GND", "Ground", "Grounding", the symbol



UL0005

or the like, or by marking on a diagram provided on the equipment. The wire binding screw or screw type wire connector shall be so located that it is unlikely to be removed during the intended servicing of the equipment, and the wire binding screw shall have upturned lugs or the equivalent to retain the conductor.

25.3.4 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 color coded.

Exception: The requirements in 25.3.4 that cover the color coding of grounding leads apply to internal wiring that is visible in a wiring compartment in the area in which field connections are to be made. They do not apply to leads or wiring of low voltage circuits that are separated or segregated from primary field wiring connections by barriers.

26 Risk of Electric Shock

26.1 Accessible live parts

26.1.1 Uninsulated parts that are accessible to the user constitute a risk of electric shock if they:

- a) Do not comply with the leakage current requirements in Section 27, Leakage Current and the open circuit voltage between these parts and earth ground or other accessible conductive parts is more than 30 Vrms, 42.4 Vpeak or 60 Vdc (or 15 Vrms, 21.2 Vpeak or 30 Vdc where wet contact is likely to occur), or
- b) Are not grounded and do not meet the criteria of the ungrounded dead metal parts requirements in Grounding, Section 25.

27 Leakage Current

27.1 For cord connected equipment, when tested in accordance with Equipment Leakage Current Test, Section 39, the leakage current at any accessible part shall not be more than:

- a) 0.75 milliamperes for hand held equipment; and
- b) 3.5 milliamperes for all other equipment, or
- c) 5.0 milliamperes for all other equipment that complies with the following:
 - 1) The cross sectional area of the internal protective conductor shall not be less than 1.0 mm² in the path of high leakage current, and
 - 2) The equipment is provided with the marking specified in 60.14.1, and
 - 3) The equipment is provided with installation instructions as specified in Installation Instructions, Section 62.

—OR—

- d) 5% of the maximum input current for equipment that complies with (1), (2), and (3) of (c) above, and is provided with an industrial (twist lock) type attachment plug and socket, or an attachment plug other than a standard type parallel blade or T-blade configuration.

Table 41.1
Dielectric voltage-withstand test – Potentials and applications

Circuit or component	Points of application ^a	Test potentials ^b
Primary circuits		
Printed wiring portions	c, d	(2E + 1000) V dc
All parts	c, d	1000 V, 60 Hz; or 1400 V dc
Power transformers	e	1000 V, 60 Hz
Other circuits		
Power transformer supplied secondary	f	(2E + 1000) V dc
Load side of rectifier of direct connected supply	d, f	(2E + 1000) V dc
High Voltage Circuits (over 2500 V dc or peak ac)	g	(1.25E + 1750) V dc or peak ac
High voltage circuits	h	(2E + 1000) V dc

^a Power dissipating component parts, electronic devices, and electrolytic capacitors located between the circuits under test shall be removed or disconnected so that the spacings and insulations, rather than such component parts, are subjected to the full dielectric voltage-withstand test potential. Switches and other controls, whether accessible or not, shall be set or adjusted so that all conductors and parts intended to be tested are connected to the circuit under test.

^b E equals the maximum peak potential in volts under normal operation between the conductor or part to be tested and earth, an accessible conductive part, or other conductive part.

^c The insulations and spacings shall be tested between primary circuit parts and the following parts all connected together:

1. The grounding terminal.
2. The enclosure, with a conductive foil wrapped around insulating portions of the enclosure.
3. Accessible conductive parts.

Care should be taken to make sure that each capacitor, winding separation, or other separation (such as a spacing between conductors) that isolates accessible conductive parts from the primary circuit shall be tested.

^d The insulations and spacings between parts of opposite polarity shall be tested.

^e The insulations and spacings between windings and parts of a transformer conductively connected to the supply circuit, and not complying with the exceptions to 50.1, shall be tested. The windings and parts to be tested shall include each of the following:

1. Primary to shield or guard (if employed).
2. Primary to core.
3. Primary to each secondary (or all secondaries connected together).

^f Other than secondary circuits in Option A (Construction) evaluations and in primary circuits where hand soldering is involved, the insulations and spacings between parts of circuits involving the risk of electric shock or fire and each of the following shall be tested:

1. The protective grounding terminal (if provided).
2. The enclosure, with a conductive foil wrapped around insulating portions of the enclosure.
3. Accessible conductive parts.
4. All other circuits.

^g Shall operate at this potential without breakdown for 1 minute.

^h The insulation and spacings between the high voltage circuit and accessible conductive parts shall be tested unless the spacings between these parts comply with Figure 24.1, where peak kilovolts (V_1) = 2E + 1000.

Table 41.1 revised October 4, 1994

41.2 A d-c test voltage shall not have more than 3 percent ripple.

41.3 The indicated test voltage shall be measured directly across the points of application of the test potential with a high resistance voltmeter.

41.4 The test voltage shall be raised gradually and smoothly to the specified value so that there are no transients that may cause the instantaneous test potential applied to exceed the peak value specified.

41.5 If the Production-Line Dielectric Voltage-Withstand Test potential, in accordance with Section 58, Tests by the Manufacturer, exceeds 1300 V, 50 or 60 Hz, or 1840 V dc, or a time duration of more than 2 seconds, the equipment shall be subjected to the continuous application of the voltage potential that the manufacturer intends to use on the production line for a duration that is 100 times the factory-test time. There shall be no breakdown of insulation or spacings in the equipment that would result in a risk of fire or electric shock.

41.6 Breakdown

41.6.1 Breakdown is often indicated by:

- a) An abrupt decrease or nonlinear advance of voltage as the test voltage is increased, or by
- b) An abrupt increase in current.

42 Abnormal Operation Test

42.1 General

42.1.1 For abnormal operation tests, the equipment shall be operated according to applicable paragraphs contained in this Section.

42.2 Supply circuit fuse rating

42.2.1 The equipment shall be connected to a supply circuit fused at 30 A.

42.3 Equipment supporting surface

42.3.1 The equipment shall be placed on a white tissue paper covered softwood surface.

42.4 Cheesecloth indicator

42.4.1 A single layer of cheesecloth shall be draped loosely over the entire piece of equipment.

42.5 Fuse indicator

42.5.1 Accessible conductive parts are to be connected to earth ground through a 1-A nontime-delay type fuse.

42.6 User-removable parts

42.6.1 Parts of the equipment that are subject to removal during user servicing may be omitted if all of the following conditions apply:

- a) The parts are not necessary for the functioning of the equipment.
- b) The parts are not exposed to view during the operation of the equipment.
- c) The parts are not captivated.

53 Multiple Voltage Equipment Test

53.1 Equipment having a user adjustable supply circuit voltage selector shall have its voltage selector set in any marked supply circuit voltage position with the equipment connected to any one of the rated supply circuits. The combinations of selector settings and supply circuit to which the equipment is intended to be connected are to be that which develop the most severe operating conditions.

53.2 To determine if the equipment complies with the test in 53.1, the test is to be conducted under the conditions described in the applicable clauses of Section 42, Abnormal Operation Test.

53A Ground Trace Tests-Electrical

Section 53A added October 4, 1994

53A.1 Ground Fault Current Test

53A.1.1 Three samples shall be subjected to the test as described in 53A.1.2 to 53A.1.6.

53A.1.2 Before and after the test, a resistance measurement should be made between the grounding terminal and the accessible dead metal part using the method described in the Ground Impedance Test, Section 38.

53A.1.3 The power source for the test circuit shall be calibrated to supply 1000 amps under short circuit conditions and have a 75-80% power factor. The test circuit shall be connected in series with a 20A circuit breaker suitable for branch circuit protection.

53A.1.4 For equipment with motor attachment cap only, the test circuit is to be connected between the ground pin of the motor attachment cap and the ground stud on the PWB or the enclosure.

53A.1.5 For equipment with power supply cord permanently attached to the unit, the test circuit is to be connected between the grounding lead of power supply cord and the ground stud on the PWB or the enclosure.

53A.1.6 The circuit connection is made by connecting the ground terminal of the power supply cord or the ground pin of the motor attachment cap using the same length and size as the power cord to one side of the power source. Then, connect the ground stud on the PWB or the enclosure to the opposite of the power source using the same length and size of wire as the power cord.

53A.1.7 The test results are considered acceptable if:

- a) Measured "before" and "after" resistance does not exceed 0.1 ohms; and,
- b) Difference between before and after test resistance does not exceed 20%; and,
- c) There shall be no evidence of separation of the trace from the PWB as a result of these tests.

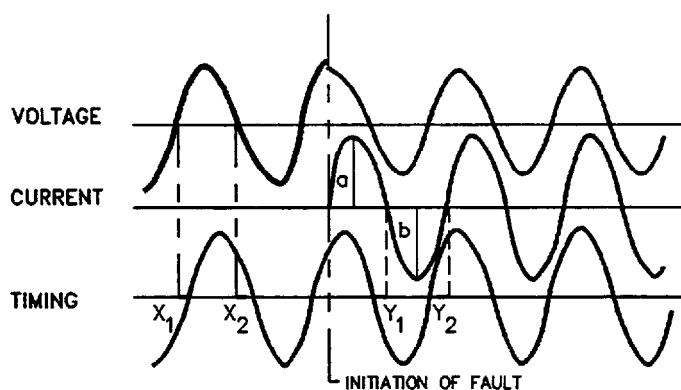
The opening of branch circuit or supplementary protection is considered acceptable termination of the test.

53A.2 Calibration of Test Circuits

53A.2.1 The available current capacity of the circuit is to be at least 1000 amperes. The frequency of the test circuit is to be 60 ± 12 hertz.

53A.2.2 The current is to be the rms value of the first complete cycle — see Figure 53A.1 — when the circuit is closed to produce an essentially symmetrical current waveform. The direct-current component is not to be added to the value obtained when measured as illustrated. In order to obtain the desired symmetrical waveform of a single-phase test circuit, controlled closing is recommended although random closing methods may be used. The power factor is to be determined by referring the open circuit voltage wave to the two adjacent zero points at the end half of the first complete current cycle by transposition through a suitable timing wave. The power factor is to be computed as an average of the values obtained by using the two current zero points.

Figure 53A.1
Determination of current
and power factor



SB0740

$$\text{rms Current} = \left(\frac{a+b}{2} \right) (\text{rms calibration of instrument element})$$

$$\text{Power Factor} = \frac{\cos[(Y_1 + X_1)(180^\circ)] + \cos[(Y_1 + Y_2)(180^\circ)]}{2}$$

Where X_1 , X_2 , Y_1 and Y_2 values are fractions of the 1/2-cycle distance in which they occur.

53A.3 Grounding Path Abnormal Overload Test

53A.3.1 Three samples shall be subjected to the test described in 53A.3.2 to 53A.3.7.

53A.3.2 Before and after the test, a resistance measurement should be made between the grounding terminal and the accessible dead metal part using the method described in Grounding Impedance Test, Section 38.

53A.3.3 The temperature of the ground trace shall be monitored using suitable instruments. The temperature shall not exceed the acceptable limits of the PWB as specified.

53A.3.4 The grounding path should be subjected to the series of overload conditions based on the relied-upon overcurrent protection ratings. The overload conditions shall be as per Table 53A:

Table 53A

Overload Condition (%)	110	135	200
Test Duration	7 hrs	2 hrs	2 min

53A.3.5 For equipment with motor attachment cap only, the test circuit is to be connected between the ground pin of the motor attachment cap and the ground stud on the PWB or the enclosure.

53A.3.6 For equipment with power supply cord permanently attached to the unit, the test circuit is to be connected between the grounding lead of power supply cord and the ground stud on the PWB or the enclosure.

53A.3.7 The circuit connection is made by connecting the ground terminal of the power supply cord or the ground pin of the motor attachment cap using the same length and size as the power cord to one side of the power source. Then, connect the ground stud on the PWB or the enclosure to the opposite side of the 1000 ampere power source using the same length and size of wire as the power cord.

53A.3.8 The test results are considered acceptable if:

- a) Measured "before" and "after" resistance does not exceed 0.1 ohms; and,
- b) Difference between before and after test resistance does not exceed 20%; and,
- c) There shall be no evidence of separation of the trace from the PWB as a result of these tests.

54.4 Impact

54.4.1 The impact force applied to a part of an enclosure is to be obtained using a solid smooth steel sphere with a radius of $25\text{ mm} \pm 0.5\text{ mm}$ (1 inch) and weighing approximately 0.54 kg (1.18 lb). The sphere is to fall freely from rest through the distance required to cause it to strike the top of the enclosure with the specified impact. For surfaces other than the top of the enclosure the sphere is to be suspended by a cord and is to fall as a pendulum through the distance required to strike the surface with the specified impact. The enclosure is to be placed so that the surface tested is vertical and in the same vertical plane as the point of support of the pendulum. Parts of the enclosure that may interfere with the cord of the pendulum are to be removed. During the test, the enclosure is to be placed against a vertical wall.

54.4.2 For the impact test, a component, such as a knob, a window, a cover, a control shaft, and the like, that is intended to be in place during normal use is to be mounted in the intended manner.

54.4.3 The external surfaces of an enclosure used (1) to reduce the likelihood of contact with live parts, or (2) to complete the enclosure of parts involving a risk of fire, shall withstand a single impact of the value specified in Table 54.3. The enclosure parts to be subjected to the impact test include the top, sides, front, back, windows, covers, knobs, buttons, control shafts, antenna terminals, jacks, and the like. The enclosure bottom need not be subjected to the impact test.

54.5 Mold stress relief test

54.5.1 The overall enclosure, employed so that parts involving the risk of electric shock are not accessible, shall withstand either of the temperature stability methods described in 54.5.2.1 without any shrinkage, warpage, or any other distortion that results in one or both of the following conditions:

- a) Interference with the operation or user servicing of the equipment.
- b) Noncompliance with the criteria specified in 54.1.1.

54.5.2 Mold stress relief test method

54.5.2.1 The Mold Stress Relief Test mentioned in 54.5.1 may, at the manufacturer's option, be conducted in either of the following ways:

- a) A sample of the equipment shall be placed in a cubical unvented test cell having a volume not less than 40 times that of the equipment and so arranged that the circulation of air within the cell simulates room conditions of actual use. The air temperature within the cell, as measured at the base of the equipment, shall be maintained at 60°C (140°F). The equipment shall be connected to a 130 V (260 V for equipment rated at a nominal 230 V) supply circuit and operated continuously for 7 hours while resting on a supporting surface having an area approximately equal to that of the equipment base and centrally located in the test cell.
- b) The equipment shall be placed in a circulating air oven for 7 hours. The oven shall be maintained at a temperature of 10°C (50°F) higher than the maximum operating temperature of the enclosure, measured at the hottest spot on the inside of the enclosure, under operating conditions, but not less than 70°C (158°F). The equipment shall not be operated during the test.

55 Personal Injury Tests

55.1 General

55.1.1 Equipment shall be subjected to the applicable tests described in 55.2.1 – 55.5.4. Equipment shall be subjected to the applicable tests alone and again while placed on any cart or stand that is provided or recommended by the equipment manufacturer.

55.2 Force stability test

55.2.1 When tested as described in 55.2.2, equipment shall not tip over when subjected to a force of 20 percent of the weight of the equipment or 11 kgf (25 lbf), whichever is less.

Exception: Tabletop equipment weighing less than 4.5 kg (10 lbs) or wall, floor, or ceiling mounted equipment.

55.2.2 The Force Stability Test is to be conducted under conditions most likely to cause tipover. The equipment is to be arranged in its intended position with all doors, drawers, casters, wheels (which are to be blocked), and other appurtenances in the position that results in the least stability. The force is to be applied in the direction or the location most likely to overturn the equipment. The force is not to be applied to extended antennas or more than 1.5 m (5 feet) above floor level.

55.3 Cart or stand loading

55.3.1 When tested as described in 55.3.2, a cart or stand shall not collapse or break so as to expose sharp edges or pinch points that result in the risk of injury to persons.

55.3.2 The equipment shall be placed on the cart or stand and a weight that exerts a force of three times the intended equipment weight or 45 kg (100 lb), whichever is greater, but not exceeding 68 kg (150 lb), shall be added to the top of the equipment. A shelf or drawer, if provided, shall be loaded with a uniform load that exerts 11 kg (25 lb). The test loads shall be applied simultaneously for 1 minute.

55.4 Handle strength

55.4.1 When tested as described in 55.4.2 – 55.4.5, a handle or support system shall not break nor shall there be any breakage of the securing means, including that portion of the enclosure to which the handle or support system is attached.

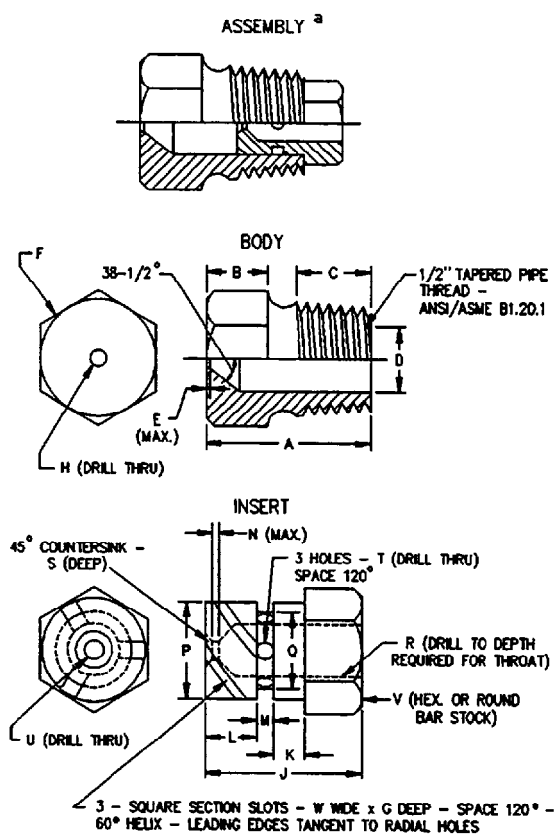
Exception: Handles provided on rack mounted equipment, used for insertion and removal from the rack, usually located on the front of the equipment.

55.4.1 revised October 4, 1994

55.4.2 When tested as described in 55.4.4, an equipment handle or support system shall withstand a force of four times the weight of the equipment.

55.4.3 A cart or stand handle or support system shall withstand a force of twice the combined weight of the cart or stand and the equipment.

Figure 56.2
Water-spray-test spray head



Item	inch	mm	Item	inch	mm
A	1-7/32	31.0	N	1/32	0.80
B	7/16	11.0	P	.575	14.61
C	9/16	14.0	Q	.576	14.63
D	.578	14.68	R	.453	11.51
	.580	14.73		.454	11.53
E	1/64	0.40	S	1/32	0.80
F	c	c	T	(No. 35) ^b	2.80
G	.06	1.52	U	(No. 40) ^b	2.50
H	(No. 9) ^b	5.0	V	5/8	16.0
J	23/32	18.3	W	0.06	1.52
K	5/32	3.97			
L	1/4	6.35			
M	3/32	2.38			

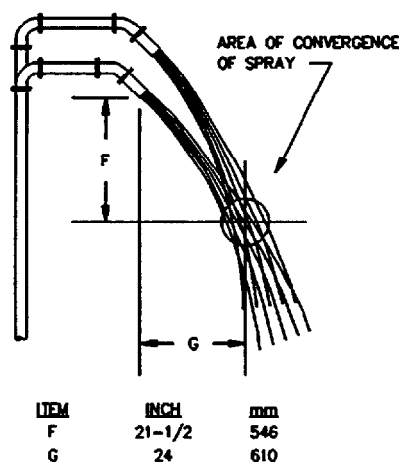
^a Nylon Rain-Test Spray Heads are available from Underwriters Laboratories Inc.

^b ANSI B94.11M Drill size

^c Optional - To serve as wrench grip.

RT100C

Figure 56.3
Convergence of water spray



SB1736

57 Audio Output Maximum Voltage Test

57.1 The audio output potential of an amplifier or similar equipment having exposed or accessible output terminals shall be 100 volts or less when tested as described in 57.2.

57.2 A variable frequency signal generator is to be connected to the input terminals, and an adjustable load resistor is to be connected across the output terminals. If the output terminals are marked to indicate the load impedance which should be connected thereto, the test impedance is to be adjusted to have a value equal to the rated output load impedance of the amplifier. If the output terminals are marked with a voltage rating, the value of the test load impedance is to be adjusted to the value calculated on the basis of the rated power output of the amplifier ($R = E^2/W$). The input signal voltage is to be adjusted to such a value that the equipment delivers rated power or maximum available undistorted sine wave power to the load, whichever is greater. After the adjustments described above are made, in accordance with the method of marking the output terminals, the output circuit is to be opened and the potential across the output terminals measured. The test is to be repeated over the range from 60 to 100 Hz (in steps of 10) by adjusting the signal generator, and throughout these tests, the supply circuit is to be adjusted in accordance with 35.5.1.

MANUFACTURING AND PRODUCTION-LINE TESTS

58 Tests by the Manufacturer

58.1 Production-line dielectric voltage-withstand test

58.1.1 Each piece of equipment shall withstand as a routine production-line test the application of a potential not less than 1200 V, 50 or 60 Hz, or 1700 V dc between parts involving the risk of electric shock and accessible conductive parts for a period of 1 (plus 1, minus 0) second, without an indication of unacceptable performance, see 58.2.1(c), or 58.3.1(c).

Exception No. 1: The test need not be made on speakers and similar components mounted in cabinets made of wood or other nonconductive material if the components are not likely to be touched or handled in the use of the equipment and if their mounting screws, or the equivalent, are not exposed on the exterior of the cabinet.

Exception No. 2: At the manufacturer's option, the ac or dc test may be conducted at a potential of 5/6 the specified voltage with the duration of application increased to 1 minute.

58.1.1 revised October 4, 1994

58.1.2 See 41.5 for the performance test Dielectric Voltage-Withstand Test which is required if the production-line dielectric voltage-withstand test potential either exceeds 1300 V, 50 or 60 Hz, or 1840 V dc, or is applied for more than 2 seconds.

58.1.3 The test shall be conducted when the equipment is complete and ready for packing, or when it is complete except for parts such as snap covers or friction-fit knobs that interfere with the performance of the test. For the test, the equipment may be in the heated or unheated condition.

58.1.4 The test equipment shall include:

- a) A means for indicating the test voltage that is being applied to the equipment being tested. This may be accomplished by sensing the voltage at the test leads, or by an equivalent means.
- b) A means for effectively indicating unacceptable performance. The indication is to be (1) auditory if it may be readily heard above the background noise level, (2) visual if it commands the attention of the operator, or (3) a device that automatically rejects an unacceptable product. If the indication of unacceptable performance is auditory or visual, the indication is to remain active and conspicuous until the test equipment is reset manually.

58.1.5 There shall not be any transient voltage applied to the equipment being tested that results in an instantaneous voltage to the equipment exceeding 120 percent of the peak value of the test voltage that the manufacturer selects for this test. This requirement applies for the entire duration of the test, including the time that the voltage is first applied to the equipment and the time that the voltage is removed from the equipment.

58.1.6 The control of the applied voltage specified in these requirements, whether manual or automatic, shall be maintained under conditions of varying line voltage. Higher test potentials may be used only if the higher dielectric stress is not likely to adversely affect the insulating systems of the equipment.

58.2 A-C production-line test

58.2.1 When adjusted for production-line testing, an ac tester shall have the following features and characteristics:

- a) The test equipment shall produce an output voltage that (1) has an essentially sinusoidal waveform, (2) has a frequency that is within the range of 40 – 70 Hz, and (3) has a peak value of the waveform that is not less than 1.3 and not more than 1.5 times the root-mean-square value.
- b) The test equipment shall produce an output voltage that is not less than the value specified, nor is the magnitude of the test voltage to be greater than 120 percent of the specified potential when the tester is used in each of the following conditions:
 - 1) If the test duration is 1 second, the output voltage is to be maintained within the specified range (1) when only a voltmeter having an input impedance of at least 2 megohms and a specimen of the equipment being tested are connected to the output terminals, and (2) when a resistance of not less than 2 megohms is connected in parallel with the voltmeter and the equipment being tested, and the value of the resistance is reduced in increments that are not greater than 25 percent of the preceding value to the point at which an indication of unacceptable performance just occurs.

2) If the test duration is 1 minute, the output voltage is to be increased from zero at a uniform rate so as to arrive at the specified potential in approximately 5 seconds. The output voltage is to be maintained within the specified range, by manual or automatic means, throughout the 1 minute duration of the test or until there is an indication of unacceptable performance.

c) When the test equipment is adjusted to produce the specified voltage, and a resistance of 120,000 ohms is connected across the output, the test equipment is to indicate an unacceptable performance within 0.5 second. A resistance of more than 120,000 ohms may be used to produce an indication of unacceptable performance if the manufacturer elects to use a tester having higher sensitivity.

58.3 D-C production-line test

58.3.1 When adjusted for production-line testing, a dc tester shall provide a means for indicating unacceptable performance. For the purpose of these requirements, unacceptable performance is defined as:

- a) An abrupt decrease or nonlinear advance of voltage as the test voltage is increased, or similarly,
- b) An abrupt increase in current.

58.4 Continuity of grounding connection

58.4.1 Electrical continuity between the grounding blade of the attachment plug and all conductive parts that are accessible (and likely to be energized) shall be maintained and verified as a routine production-line test. The continuity shall be determined by the use of an electrical indicating device, such as an ohmmeter, a low-voltage battery-and-buzzer combination, or the like. The continuity may also be determined by the voltage drop method in accordance with 38.1.

58.5 Polarization verification

Sub-section 58.5 added October 4, 1994

58.5.1 Electrical-continuity is to be verified as a routine production-line procedure between the ungrounded supply-circuit conductor of the attachment plug and parts of the product that are intended to be connected to the ungrounded supply-circuit conductor, such as a primary fuse, switch, relay or ungrounded contact of a convenience receptacle. The continuity is to be verified either visually or through the use of an electrical indicating device, such as an ohmmeter, a low-voltage battery-and-buzzer combination, or the like.

Exception: Polarization verification of 58.5.1 need not be conducted where assembly techniques exist that do not allow polarization to change.

58.5.1 added October 4, 1994

MARKINGS

59 General

59.1 The markings required in Section 60, Marking Details, shall comply with each of the following requirements:

- a) The marking shall be permanent so as to resist the deleterious effects of handling, cleaning agents (as specified by the manufacturer), or the like, expected in the operation and user servicing of the equipment, and
- b) The marking shall be such that it makes the information clear and legible under conditions of intended use and user servicing of the equipment.

60.15.2 Equipment not furnished with a detachable power supply cord as described in the exception of 11.1.1 shall be marked adjacent to the equipment coupler or at an equivalent location to inform the user to see the instruction manual for proper selection of the power supply cord. The instruction manual shall contain complete instructions concerning such selection.

Exception: The marking may be in the form of a tag, nonpermanent label, or insert that is provided on or packaged with the equipment so that the marking is visible at the time of installation.

60.16 *Deleted October 4, 1994*

60.16.1 *Deleted October 4, 1994*

60.17 Audio output

60.17.1 The audio output terminals of an amplifier having an output potential greater than 100 volts, when tested as described in 57.2, shall be marked to indicate that Class 1 wiring shall be used for the output circuit. If the output potential is 100 volts or less when the amplifier is so tested, the output terminals shall be marked to indicate that Class 2 wiring may be used.

Exception: The output terminals need not be marked for use with Class 2 wiring for portable equipment equipped with standard phone or phono jacks.

60.17.2 The audio output connections of the equipment shall be marked with the output power based on the rms voltage or current, or the average output power, and with the impedance or audio line voltage rating.

Exception: The marking is not required if (1) a loudspeaker is provided as a permanent part of the equipment and no other audio output connections are provided, or (2) the audio output power is no greater than 3 watts.



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December 3, 1993

Revision pages for

Standard for

Professional Video and Audio Equipment

UL 1419, First Edition

Attached to this transmittal notice is a revision of the First edition of UL 1419.

A CHANGE ON A PAGE DATED DECEMBER 3, 1993 IS INDICATED BY A SMALL PRINT NOTE FOLLOWING THE AFFECTED ITEM, PRECEDED AND FOLLOWED BY AN ASTERISK.

THESE NEW AND REVISED REQUIREMENTS ARE NOW IN EFFECT EXCEPT FOR PARAGRAPH 50.1 AND TABLE 6.1, WHICH BECOME EFFECTIVE MARCH 15, 2000 AS INDICATED IN THE SMALL PRINT NOTE FOLLOWING THE AFFECTED ITEM. TO RETAIN THE REQUIREMENTS IN EFFECT UNTIL MARCH 15, 2000, DO NOT DISCARD THE PREVIOUS PAGES CONTAINING THE REQUIREMENTS SPECIFIED ABOVE UNTIL THIS FUTURE EFFECTIVE DATE.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this standard unless the applicant specifically requests that the product be judged under the current requirements. However, should the applicant elect this option, it should be noted that compliance with all the requirements in this standard will be required as a condition of continued Listing, Recognition and Follow-Up Services after the effective date and understanding of this should be signified in writing.

The new and revised requirements are substantially in accordance with UL's bulletin on this subject dated May 20, 1993. The bulletin is now obsolete and may be discarded.

Revised and/or additional pages may be issued from time to time.

With the inclusion of the accompanying material, the standard consists of pages dated as shown in the following checklist:

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UL 1419

Standard for

Professional Video and Audio Equipment

First Edition

November 11, 1992

Revisions of this standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest published set of revision pages.

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(1 - 11/11/92 - 12/03/93)

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2.9 CORD-CONNECTED EQUIPMENT – Equipment intended to be connected to the branch circuit by means of a flexible cord.

2.10 FIBER – Where the term "fiber" is used in this standard to denote a material usually used as electrical insulation, vulcanized fiber is meant.

2.11 FIELD-WIRING TERMINAL – Any terminal to which a supply or other wire can be connected by an installer in the field is a field wiring terminal unless the wire is provided as part of the equipment and a connector, soldering lug, soldering loop, crimped eyelet, pressure terminal, or other means for making the connection is factory-assembled to the wire.

2.12 GROUND – Earth ground, unless otherwise specified.

2.13 HAND-HELD EQUIPMENT – Portable equipment that is held in one or both hands during normal use.

2.14 INTERLOCK – A mechanism that deenergizes parts involving a risk of electric shock or that stops moving parts before they become accessible to the user when the enclosure of the part is opened or a cover is removed.

2.15 MINOR DIMENSION OF OPENING – The minor dimension of an opening is the diameter of the largest sphere that can pass through the opening.

2.15A MULTIPLE (REDUNDANT) POWER SUPPLIES - Two or more power supplies, that are duplicates of each other, where one serves as a basic power source and the other(s) as back - up(s) should the basic power source become inoperative.

2.15A added December 3, 1993

2.16 ORDINARY TOOLS – Flat-bladed and cross-head screwdrivers, nut drivers, and pliers.

2.17 PORTABLE EQUIPMENT – Cord and plug connected equipment that weighs less than or equal to 18.2 kg (40 lb) and has no provision for permanent mounting and can be moved from one place to another without the use of carts or other assisting equipment.

2.18 POWER AMPLIFIERS – Equipment capable of sufficiently increasing the amplitude or power of a low level electric audio signal to drive a speaker. Equipment may be portable, rack mounted or permanently installed, with output terminals for connection to speaker loads, or with self contained speakers.

2.19 POWER-SUPPLY CORD – The cord provided to connect the equipment to the branch circuit.

2.20 PRIMARY CIRCUIT – Circuit that is conductively connected to the supply circuit.

2.21 PROBE – An instrument used to determine accessibility. See Figure 30.1.

2.22 RACK-MOUNTED EQUIPMENT – Equipment that is provided with means for rack mounting.

2.23 SECONDARY CIRCUIT – Circuit that is conductively connected to the secondary winding of an isolating transformer.

2.24 UNINSULATED LIVE PART – A conductive part that involves a risk of fire or electric shock.

2.25 UNLIMITED POWER CIRCUIT – A circuit involving more than 240 W as described in 29.1.

2.26 USER SERVICING – Servicing which can occur outside the enclosure in areas where uninsulated live parts are not accessible. See 32.1 for examples of user servicing.

3 Components

3.1 A component of equipment covered by this standard shall comply with the requirements for that component and shall be used in accordance with its recognized rating and other limitations of use. See Appendix A for a list of standards covering components generally used in the equipment covered by this standard. A component need not comply with a specific requirement that:

- a) Involves a feature or characteristic not needed in the application of the component in the equipment covered by this standard, or
- b) Is superseded by a requirement in this standard.

4 Units of Measurement

4.1 If a value for measurement is followed by a value in other units in parenthesis, the second value may be only approximate. The first stated value is the requirement.

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

5 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.

CONSTRUCTION

6 General

6.1 The construction of the equipment shall be such that (1) intended use and user servicing does not result in a risk of fire, electric shock, or injury to persons; (2) the materials and components are used within their electrical, mechanical, and temperature limits; and (3) the assembly protects the components and wiring from being displaced or damaged.

6.2 The materials and components referred to in 6.1 and in other requirements are those involving a risk of fire, electric shock, or injury to persons and are so considered unless specifically indicated otherwise.

6.3 The equipment shall comply with either Option A (Construction) or Option B (Performance) indicated in Table 6.1.

6.4 Systems

6.4.1 For a system that is comprised of two or more interconnected devices, each device may be evaluated to either Option A or Option B in Table 6.1.

Table 6.1
Product evaluation options

Option	240 W Determination ^{a),b),c)}	Component Tests > 240 W Circuitry ^{a),b),d)}	Table 7.1 Section ^{b)}	Paragraphs 7.3 thru 7.7	Table 7.3 Section ^{b)}
A (Construction)					
Primary	Yes	Yes	C	Yes	No
Secondary	No	No	C	Yes	No
Enclosure	N/A	N/A	A, B	Yes	No
B (Performance)					
Primary	Yes	Yes	No	No	A
Secondary	Yes	Yes	No	No	A, C
Enclosure	N/A	N/A	No	No	A, B

^a Does not apply to components and parts of Power Supplies that comply with the requirements of UL 478 (Option A only), UL 1012, UL 1310, UL 1270, UL 1409, UL 1410, UL 813, UL 1459, or UL 1950 (D3 deviations for Option A only) for construction and performance.

^b Does not apply to primary and secondary circuits supplied by a power supply as indicated in footnote ^{a)} with an NEC Class 2 output.

^c Refer to Section 49 for 240 W determination.

^d Refer to Sections 51 and 52 for Component Testing.

Revised Table 6.1 effective March 15, 2000

7 Frame and Enclosure

7.1 General

7.1.1 The enclosures, guards, and barriers of the equipment shall be complete, or completion of the enclosures, guards, and barriers shall be attained when the equipment is combined during installation.

7.1.2 Required enclosures, guards, and barriers shall be capable of being removed and replaced with a minimum of effort if removal is necessary for servicing the protected parts.

7.1.3 An enclosure, guard, and barrier shall have the strength and rigidity to resist the abuses likely to be encountered during intended use without increasing the risk of fire, electric shock, electrical energy—high current levels, or injury to persons due to total or partial collapse, with resulting reduction of spacings to less than required, or the loosening, displacement, or exposure of parts, or other serious defects.

7.1.4 The strength and rigidity of the enclosure is to be judged by the Strength of Enclosure Tests, Section 54.

7.1.5 A handle or handles intended to support hand carried or hand operated equipment shall be subjected to the Handle Strength Test as described in 55.4.

7.2 Doors or covers

7.2.1 If part of an enclosure consists of a door or cover leading to an operator access area, one of the following requirements shall apply:

- a) Either the door or cover shall be interlocked to comply with the requirements in 31.1; or
- b) The door or cover, although intended to be opened by the operator, shall comply with both the following conditions:
 - 1. It shall not be removable by the operator from the enclosure;
 - 2. It shall be provided with a means to keep it closed during normal operation.

7.3 External materials – Option A (Construction)

7.3.1 Materials such as steel, aluminum, glass, and other similar materials are to be used for the enclosure, guard, or cabinet of the equipment. Glass shall be heat resistant, tempered, wired, or laminated. Other materials may be used for part or all of an enclosure, if they comply with the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluation, UL 746C. The accessibility need not be investigated as part of the enclosure flammability – 130 mm (5-inch) Flame Test as required in UL 746C. See Table 7.1.

Exception: The enclosure materials of portable equipment may be rated minimum 94V–2. See Table 7.1

7.4 Internal materials – Option A (Construction)

7.4.1 All combustible material used within a fire containment enclosure shall be rated in accordance with Table 7.1.

7.4.2 All materials located in circuits not involving a risk of fire and segregated from parts involving a risk of fire by a barrier with a minimum flammability rating of 94V–2 may be rated minimum 94HB.

Exception: All materials located in an enclosure constructed of steel or aluminum, or material with a minimum 94–5V flammability rating and containing no openings may be rated 94HB without the use of a barrier.

Table 7.1 — Material requirements—Option A^{a)}

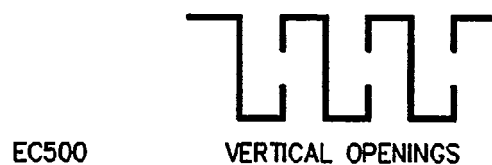
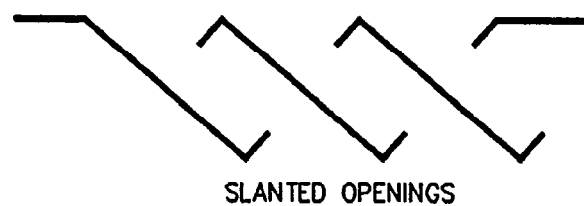
Application	Flammability ^{c),d)}	Properties of material
Section		
A. Nonportable enclosures	b	b
B. Portable enclosure	94V-2	—
C. Internal parts ^{e),g)}	94V-2	—
D. External Parts ^{e),f),g)}	94HB	—
^{a)}These requirements do not apply to the internal insulating systems of components or where component requirements exist. ^{b)}Must comply with flammability and properties of materials requirements in UL 746C except accessibility after flame test. ^{c)}The flammability classifications 94V-0, 94V-1, 94V-2, and 94HB are to be determined by the tests described in the Standard for Tests for Flammability of Plastic Material for Parts in Devices and Appliances, UL 94. For enclosures, a material classified using 3.2 mm thick bar specimens can be accepted in lesser thicknesses in the end product. For other parts, a material classified using 1.6 mm thick bar specimens can be accepted in lesser thicknesses in the end product. ^{d)}For an assembly, the test parameters according to Table 7.1 can consist of the assembly and can be tested as finished parts, or test assemblies can be cut from finished parts. In the case of small parts that might be consumed before the test is completed, large pieces of the same material can be tested provided that they represent the same or lesser thickness than the part in question. None of the larger pieces are to be entirely consumed. Test assemblies or a section thereof that are not flat stock pieces are to be positioned in what is considered to be the worst position in the application. ^{e)}The requirements that materials possess certain flammability classifications do not apply to small parts. For the purpose of these requirements, a small part is one which: 1) the maximum dimension does not exceed 60 mm, and 2) the volume does not exceed 8000 mm³, and 3) is located where it could not act as a bridge between a source of arcing or ignition and other ignitable parts. ^{f)}Those parts outside required enclosure parts. ^{g)}Internal and external parts may consist of insulating materials, printed wiring boards, connectors, and the like.		

7.5 Enclosure openings

7.5.1 Enclosure openings over parts involving a risk of fire or electric shock or over parts not involving a risk of fire or electric shock that are not separated from such parts by a barrier complying with 7.3.1 and having openings only allowing for lead passage shall comply with the requirements in 7.6.1 – 7.8.1, and Figure 7.1.

7.5.1 revised December 3, 1993

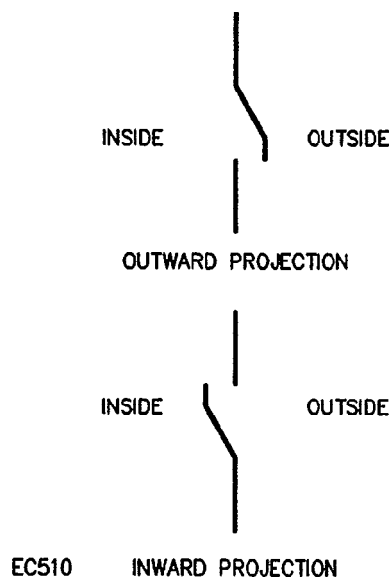
FIGURE 7.1
CROSS SECTIONS OF TOP-ENCLOSURE DESIGNS



7.6 Louvers

7.6.1 An opening in the front, back or sides of an enclosure shall be shaped and located so that a falling object cannot pass through the opening in a vertical direction. Louvers may be used if shaped to deflect an external falling object outward. See Figure 7.2.

FIGURE 7.2
LOUVERS



7.7 Enclosure bottom openings

Heading 7.7 revised December 3, 1993

7.7.1 Ventilation openings may be provided in the bottom of an enclosure under materials that are not rated 94V-1 or less flammable if the openings are constructed so that materials do not fall directly from the interior of the equipment onto the openings. Other bottom opening constructions that may be used are those that incorporate a perforated metal plate as described in Table 7.2, or a galvanized or stainless steel screen having a mesh not greater than 2 by 2 mm and a wire diameter of not less than 0.45 mm.

7.6.2 relocated as 7.7.1 December 3, 1993

Table 7.2 — Perforated metal plates

Minimum thickness		Maximum diameter of holes		Minimum spacings of holes center to center	
mm	(Inch)	mm	(Inch)	mm	(Inch)
0.66	(0.026)	1.14	(0.045)	1.70	(0.067)
0.66	(0.026)	1.19	(0.047)	2.36	(0.093)
0.81	(0.032)	1.91	(0.075)	3.18	(0.125)
0.91	(0.036)	1.60	(0.063)	2.77	(0.109)
0.91	(0.036)	1.98	(0.078)	3.18	(0.125)
1.00	(0.039)	1.60	(0.063)	2.77	(0.109)
1.00	(0.039)	2.00	(0.079)	3.00	(0.118)

7.7.2 The bottom of the enclosure under areas containing only materials rated 94V-1 or less flammable may have openings no larger than 6.4 mm (1/4 inch) square. Openings that are not square may be provided if they do not have an area greater than 40 mm² (1/16 inch²).

7.6.3 relocated as 7.7.2 December 3, 1993

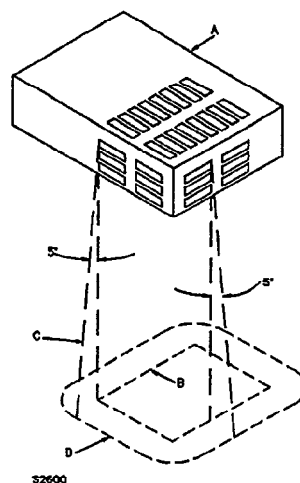
7.7.3 The bottom of an enclosure shall consist of a complete or partial bottom enclosure under a component, groups of components, or assemblies, as shown in Figure 7.3, that complies with the ventilation opening requirements in 7.7.1 and 7.7.2.

Exception No. 1: Units may have openings without limitation on their size and number in areas that contain only wires, cables, plugs, receptacles, and impedance-protected and thermally protected motors.

Exception No. 2: Equipment intended to be mounted on a concrete floor or other noncombustible surface need not be provided with a bottom enclosure if marked in accordance with 60.20.1.

7.7.3 added December 3, 1993

Figure 7.3
Enclosure bottom



- a** The entire component under which an enclosure (flat or dished with or without a lip or other raised edge) of noncombustible material is to be provided. The sketch is of an acceptably enclosed component with ventilation openings showing that the enclosure is required only for those openings through which flaming parts may be emitted. If the component or assembly does not have its own noncombustible enclosure, the area to be protected is the entire area occupied by the component or assembly.
- b** Projection of the outline of the area of A that needs a bottom enclosure vertically downward onto the horizontal plane of the lowest point on the outer edge D of the enclosure.
- c** Inclined line that traces out an area D on the horizontal plane of the enclosure. Moving around the perimeter of the area B that needs a bottom enclosure, this line projects at a 5 degree angle from the line extending vertically at every point around the perimeter of A and is oriented to trace out the largest area; except that the angle may be less than 5 degrees if the enclosure bottom contacts a vertical enclosure or side panel, or if the horizontal extension of the enclosure B to D exceeds 152 mm (6 inch).
- d** Minimum outline of the enclosure, except that the extension B to D need not exceed 152 mm (6 inch), flat or dished with or without a lip or other raised edge. The bottom may be flat or formed in any manner provided that every point of area D is at or below the lowest point on the outer edge of the enclosure.

Figure 7.3 added December 3, 1993

7.8 Top openings

Subclause 7.7 renumbered and relocated as 7.8 December 3, 1993

7.8.1 Top openings shall not have a minor dimension of more than 4.8 mm (3/16 inch) unless the configuration is such that vertical entry to uninsulated live parts cannot occur.

Exception No. 1: An opening in the top of an overall enclosure and having a dimension larger than 4.8 mm (3/16 inch) is acceptable if it is protected by a knob, handle, louver, or similar part such that a falling object cannot pass directly through the opening in a vertical direction. Refer to Figure 7.1 for examples of acceptable designs.

Exception No. 2: If a falling object can pass through the opening in a vertical direction, it is acceptable if the object can only contact parts not involving a risk of fire or electric shock and is prevented by barriers or the like from moving into areas containing such parts.

7.7.1 relocated as 7.8.1 December 3, 1993

Table 7.3 — Material requirements—Option B^{a)}

Application	Flammability Classification ^{b),d)}	Resistance to Ignition From Hot Wire ^{c),d)} PLC Min
(A) Enclosures ^{e)} or insulating materials ^{e)} , printed wiring boards and connectors ^{e)} in contact with parts conductively connected to supply, unlimited power ^{f)} or > 2500 V circuits (high voltage)	94V-2 94V-1 94V-0 94-5V	—
(B) Enclosure materials used in all other applications ^{e)}	94HB	3
(C) Insulating materials, printed wiring boards and connectors used in applications other than those covered in (A) or (B) above	—	—

^{a)}These requirements do not apply to the internal insulating systems of components or where component requirements exist.

^{b)}The flammability classifications 94V-0, 94V-1, 94V-2, and 94HB are to be determined by the tests described in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94. For enclosures, a material classified using 3.2 mm thick bar specimens may be accepted in lesser thicknesses in the end product. For the parts, a material classified using 1.6 mm thick bar specimens may be accepted in lesser thicknesses in the end product.

^{c)}Hot-Wire Resistance to Ignition performance is expressed as the number of seconds needed to ignite standard specimens that are wrapped with resistance wire that dissipates a specified level of electrical energy. Bar specimens are to be used for this test. For enclosures, a material classified using 3.2 mm thick bar specimens may be accepted in lesser thicknesses in the end product. Refer to the Standard for Polymeric Materials— Short-Term Property Evaluations, UL 746A, for details of the test.

^{d)}For an assembly, specimens for the test parameters according to Table 7.3 may consist of the assembly and may be tested as finished parts, or test specimens may be cut from finished parts. In the same case of small parts that might be consumed before the test is completed, large specimens of the same material may be tested provided that they represent the same or lesser thickness than the part in question. None of the larger specimens are to be entirely consumed. Specimens that consist of an assembly or a section thereof that are not flat stock pieces are to be positioned in what is considered to be the worst position in the application.

^{e)}The requirements that materials used in applications covered by (A) and (B) of Table 7.3, possess certain flammability and ignition ratings do not apply to small parts. For the purpose of these requirements, a small part is one which:

- 1) the maximum dimension does not exceed 60 mm, and
- 2) the volume does not exceed 8000 mm³, and
- 3) is located where it could not act as a bridge between a source of arcing or ignition and other ignitable parts

^{f)}An unlimited power circuit is one in which the maximum available power is not limited to 240 W or less in accordance with Section 29, Risk of Fire.

7.9 Material requirements — Option B (Performance)

Subclause 7.8 renumbered and relocated as 7.9 December 3, 1993

7.9.1 Polymeric materials used for an enclosure or internal parts, printed wiring boards, connectors, and the like shall be rated for flammability and ignition according to Table 7.3.

7.8.1 relocated as 7.9.1 December 3, 1993

7A Equipment Intended to be Installed in Restricted Access Areas

Section 7A added December 3, 1993

7A.1 Equipment may be provided without enclosures if it is intended solely for installation in restricted access areas such as dedicated equipment rooms, equipment closets and the like that limit access to the equipment to trained service personnel only. Such equipment shall comply with 7A.2 – 7A.8.

7A.2 The bottom of equipment intended to be installed in restricted access areas shall comply with the requirements for enclosure bottom openings in 7.7.1 – 7.7.3.

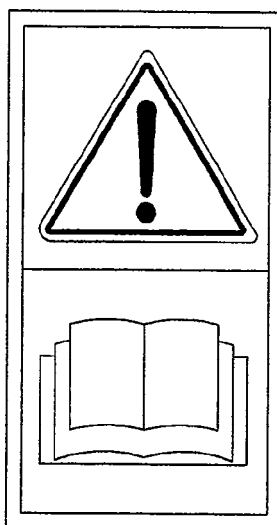
7A.3 Material utilized in the construction of the equipment, including insulating materials, and the like, shall comply with Table 7.1.

7A.4 Printed wiring boards shall have a flammability rating of 94V-O.

7A.5 All internal wiring and interconnecting cables provided with the equipment shall be rated minimum VW-1.

7A.6 The equipment shall be constructed to provide for the protection of service personnel in accordance with Section 33A.

7A.7 The equipment shall be marked "To Be Installed Only in Restricted Access Areas (Dedicated Equipment Rooms, Equipment Closets, or the like) In Accordance with Articles 110–16, 110–17, and 110–18 of the National Electrical Code, ANSI/NFPA No. 70". The reference to the National Electrical Code Articles may be omitted from the marking if the information is included in the installation or instruction manual and the equipment marking includes the symbol



SM696A

or the words "See Instruction Manual", or the equivalent.

7A.8 Air filters for use in cooling systems shall be classed "Class 1" in accordance with the requirements in the Standard for Test Performance of Air Filter Units, UL 900 or shall be constructed of materials rated