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Electrical Analog Instruments – Panel Board Types

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Summary of Topics

This new edition of UL 1437 is being issued through UL's electronic publishing system to ensure format uniformity between the PDF and HTML versions of the document. While numbering and figure placement, where appropriate, may have been updated, no substantive changes have been incorporated in the document.

As indicated on the title page (page1), this UL Standard for Safety has been adopted by the Department of Defense.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: http://ulstandardsinfonet.ul.com/ulforeword.html

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

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

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Standard for Electrical Analog Instruments – Panel Board Types

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Fourth Edition

December 12, 2006

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

The Department of Defense (DoD) has adopted UL 1437 on October 3, 1994. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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 set of revised requirements. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at http://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover electrical and electrically operated indicating and recording instruments of the analog type that are powered only from the measured parameter and are intended for ordinary use in panel boards and the like.

1.2 These requirements cover direct-acting or indirect-acting instruments and accessories that may contain electronic devices.

1.3 These requirements cover instruments indicating quantities of electrical analogs including all of the following:

a) Ammeters.

b) Voltmeters.

c) Wattmeters.

d) Varmeters (reactive volt-ampere meters).

e) Frequency meters.

f) Power-factor meters.

g) Synchroscopes.

1.4 These requirements cover instruments constructed for special purposes such as, ultrasensitive d-c microammeters, high-resistance voltmeters, thermo-milliammeters, thermal voltmeters of the vacuum-couple type, and instruments with special and unusual ranges.

1.5 These requirements cover analog instruments that may be categorized according to use or principle of operation as follows:

a) Use:

1) Panel Type, including edgewise.

2) Switchboard type, including edgewise.

b) Principle of operation:

1) Electrodynamics.

2) Permanent-magnet moving coil.

3) Moving iron.

4) Thermocouple.

5) Rectifier.

1.6 These requirements also cover auxiliary equipment and accessories designed to be used with measuring instruments as indicated in 1.1 – 1.5.

1.7 These requirements do not cover:

a) Indicating instruments provided with arrangements for curve drawing, contact making, and the like that derive the power for the functioning of these arrangements from an external source other than the measured parameter.

b) Instruments that use active devices such as transistors, electron tubes, and the like for amplifying the electrical quantity measured, that require a power source other than the quantity measured for operation. An example of this is a battery-powered ohmmeter. This equipment is covered by the requirements for electrical and electronic measuring and testing equipment, UL 1244.

1.8 Instruments covered by these requirements are intended for use indoors or in sheltered (from the elements) locations, as follows:

a) Temperature – 5 – 40°C or 41 – 104°F; instruments may occasionally be used for temporary or short periods at minus 10 – plus 5°C or 14 – 41°F.

b) Altitude – Up to 2200 meters (7218 feet).

c) Relative Humidity – Up to 80 percent.

1.9 These requirements do not cover certain other properties of the instruments such as effectiveness, accuracy, or reliability.

1.10 Throughout this Standard the term ″instrument″ applies to analog indicating and recording instruments and their accessories as described in 1.1 – 1.6.

1.11 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.

2 Glossary

2.1 For the purpose of this Standard, the following definitions apply.

2.2 ACCESSIBLE PART – A part that can be contacted by a person either directly or by means of a probe – see Figures 8.1 and 8.2 – when the instrument is in use.

2.3 CIRCUIT-TO-GROUND VOLTAGE – The rated value of voltage with respect to earth ground.

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

2.5 CREEPAGE DISTANCE – The shortest distance measured over the surface of insulation between conductive parts, excluding gaps of less than 1.0 mm (0.039 inch).

2.6 ELECTRONIC DEVICE – A part or an assembly of parts in which electrons flow through a vacuum, gas, or semiconductor.

2.7 GROUND – A conductive connection, whether intentional or unintentional, between an electrical circuit or instrument and the earth, or to some conducting body that serves in place of the earth.

2.8 MEASURING (CONTROL, TEST) TERMINAL – The external terminal or connector of the instrument to which connection is made to serve the instrument's function.

2.9 RATING – An electric value assigned to a component or instrument in determining its application.

3 Components

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

3.2 A component need not comply with a specific requirement that:

a) Involves a feature or characteristic not needed in the application of the component in the product covered by this Standard, or

b) Is superseded by a requirement in this Standard.

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

3.4 Specific components are recognized as being incomplete in construction features or restricted in performance capabilites. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions for which they have been recognized.

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.

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 General

6.1.1 The instrument shall be constructed to provide, either in normal use or under fault conditions:

a) Protection against the risk of electric shock, personal injury, and fire, and

b) Protection of components and wiring from displacement or damage.

6.1.2 The materials and components referred to in 6.1.1 and elsewhere in this Standard are those involving risk of fire, electric shock, or personal injury and are so considered unless specifically indicated otherwise.

6.2 Component construction requirements

6.2.1 Each component shall be fastened and secured if breaking or loosening of any electrical connection can result in risk of fire, electric shock, or personal injury. Internal wiring shall be routed and protected in such a manner that its insulation is not damaged or degraded.

7 Enclosure and Insulating Materials

7.1 General

7.1.1 The enclosure shall have the strength and rigidity necessary to resist the abuses to which it may be subjected during normal use and operator servicing without a reduction of spacings, loosening or displacement of parts or other defects that may result in inability of the instrument to comply with the requirements in this Standard.

7.2 Enclosure materials

7.2.1 Each polymeric enclosure material shall be classified with regard to flammability rating, resistance to hot–wire ignition, and resistance to high-current-arc ignition according to Table 7.1.

Table 7.1
Material requirements[a]

Application	Properties		
	Flammability classification[b,e]	Resistance to ignition from	
		Hot wire[c,e]	High-ampere arc,[d,e]
In contact with parts conductively connected to a line-connected circuit			
(A) Enclosures and insulating materials	94HB	30 sec	60 arcs
	94V-2	30 sec	30 arcs
	94V-1	15 sec	30 arcs
	94V-0	10 sec	15 arcs
(B) Printed-wiring boards	94V-1, 94V-0	–	–
(C) Connectors	94V-2, 94V-1, 94V-0	–	–
In contact with unlimited power circuits[g], other than line-connected circuits			
(D) Enclosures and insulating materials[f]	94HB, 94V-2, 94V-1, 94V-0	15 sec	30 arcs
(E) Printed-wiring boards[f]	94V-1, 94V-0	–	–
(F) Connectors[f]	94V-2, 94V-1, 94V-0	–	–
In contact with high-voltage circuits in which the potential exceeds 2500 V_{peak} and the maximum power exceeds 15 watts			
(G) Enclosures and insulating materials[f]	94V-2, 94V-1, 94V-0	–	–
(H) Printed-wiring boards[f]	94V-1, 94V-0	–	–
(I) Connectors[f]	94V-2, 94V-1, 94V-0	–	–
(J) Enclosure materials (required parts) used in applications other than those covered in lines (A), (D), and (G)[f]	94HB	15 sec	30 arcs
	94V-2, 94V-1, 94V-0	–	–
(K) Insulating materials, printed-wiring boards and connectors used in applications other than those covered in lines (B), (C), (E), (H), and (I)	–	–	–

[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 (1/8-inch) thick bar specimens can be accepted in lesser thicknesses in the end product. For other parts, a material classified using 1.6-mm (1/16-inch) thick bar specimens can be accepted in lesser thicknesses in the end product.

[c] Hot-Wire Resistance to Ignition – Hot-wire 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 samples are to be used for this test. For enclosures, a material classified using 3.2-mm (1/8-inch) thick bar specimens can be accepted in lesser thicknesses in the end product. For other parts, a material classified using 1.6-mm (1/16-inch) thick bar specimens can 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.

Table 7.1 Continued on Next Page

Table 7.1 Continued

Application	Properties		
	Flammability classification[b,e]	Resistance to ignition from	
		Hot wire[c,e]	High-ampere arc,[d,e]

[d] High-Ampere Arc-Resistance to Ignition – High-Ampere arc-ignition performance is expressed as the number of arc-rupture exposures (standardized as to electrode type and shape and electrical circuits) that are necessary to ignite a material when they are applied at a standard rate on the surface of the material. Bar samples are to be used for this test. For enclosures, a material classified using 3.2-mm (1/8-inch) thick bar specimens can be accepted in lesser thicknesses in the end product. For other parts, a material classified using 1.6-mm (1/16-inch) thick bar specimens can 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.

[e] For an assembly, samples for the test parameters according to Table 7.1 can consist of the assembly and can be tested as finished parts, or test samples can be cut from finished products. In the case of small parts that might be consumed before the test is completed, large samples of the same material can be tested provided that they represent the same or lesser thicknesses than the part in question. None of the larger samples is to be entirely consumed. Samples that consist of an assembly or a section thereof that are not flat stock samples are to be positioned in what is considered to be the worst-case position in the application.

[f] The requirements that materials used in applications covered by Table 7.1 (D) – (J) possess certain flammability and ignition ratings do not apply to small parts. For the purpose of these requirements, a small part is one that complies with all of the following criteria:

a) The maximum dimension of the part does not exceed 30 mm (1.18 inches).

b) The volume of the part does not exceed 8000 mm^3 (0.488 cubic inch).

c) The part is located where it cannot act as a bridge between a source of arcing or ignition and other ignitible parts.

[g] An unlimited-power circuit is one which is not limited in accordance with 15.1.1(a).

7.2.2 The construction of the enclosure shall prevent molten metal, burning insulation, flaming particles, and the like from falling upon combustible materials, including the surface upon which the instrument rests or is otherwise supported.

7.2.3 When operated at end-scale conditions (maximum normal load), the temperature rises of instrument parts shall not exceed the values indicated in Table 18.1. For an instrument having special operating conditions, such as short-term or intermittent use, this requirement applies as far as compatible with such operating conditions.

7.2.4 When operated at end-scale conditions (maximum normal load) at elevated temperatures (see the High-Ambient Temperature Evaluation, Section 19) the instrument shall be resistant to the external forces described in Sections 24 – 28.

7.3 Insulating materials

7.3.1 Materials in contact with unlimited circuitry (see Subdivision of Circuits Into Groups, Section 15) shall be classified with regard to flammability rating, resistance to hot-wire ignition, and resistance to high-current-arc ignition according to Table 7.1.

7.3.2 The instrument when operated at end-scale conditions (maximum normal load) at an elevated temperature (see the High-Ambient Temperature Evaluation, Section 19) shall retain its dielectric voltage–withstand capabilities and spacings.

8 Accessibility of Live Parts

8.1 General

8.1.1 Parts that are intended to be accessible after installation, including accessible parts of terminals, shall not involve the risk of electric shock.

8.1.2 Coatings, film, and fibrous materials consisting only of enamel, lacquer, oxides, anodic films, nonimpregnated paper, untreated fiber, and wood shall not be regarded as providing protection from the risk of electric shock. Such insulations that are accessible shall be removed or disregarded during the determination of accessibility of live parts.

Exception: Exception: Materials such as untreated paper, fiber, or wood may be used as a mechanical barrier if warpage or displacement does not prevent its effectiveness.

8.2 Determination of accessibility

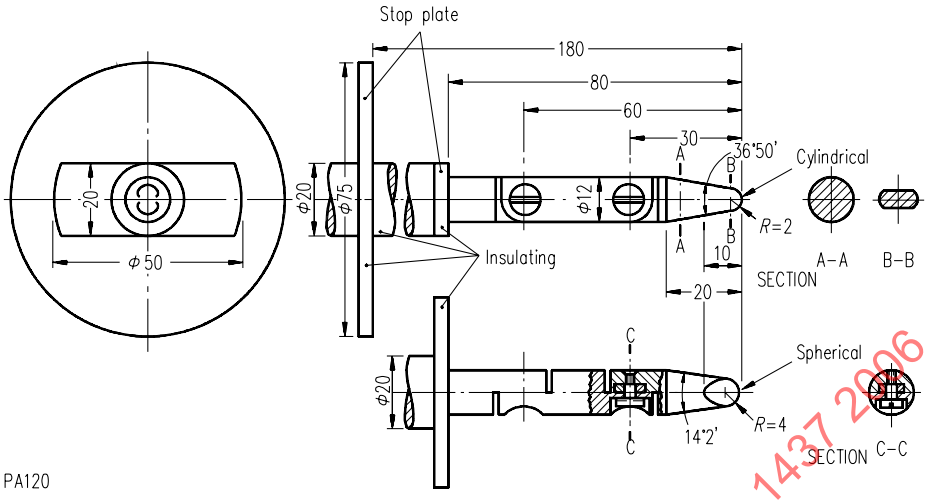
8.2.1 A part is accessible if one or both of the following conditions exist:

a) The International Electrotechnical Commission (IEC) articulate accessibility probe with stop plate (Figure 8.1) applied in every possible position through openings in the exterior surfaces, including the bottom, touches the part.

b) The IEC rigid accessibility probe (Figure 8.2), applied with a maximum force of 30 N (6.75 lbf), in every possible position through openings in all exterior surfaces, including the bottom, touches the part.

8.2.2 For an instrument that is insulation-encased, conductive foil shall be wrapped about the accessible surfaces of the instrument. Where the enclosure is partially insulation-encased, conductive foil shall be wrapped only about the insulating portion.

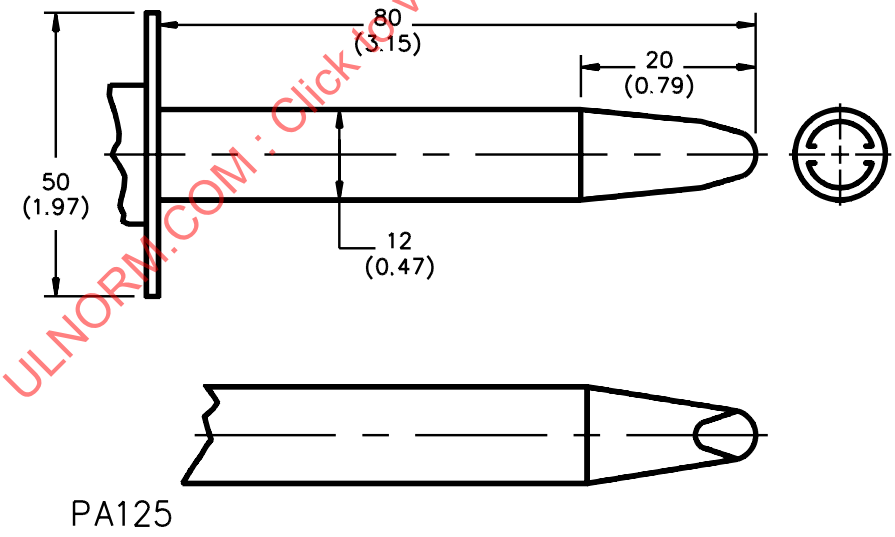
Figure 8.1
International Electrotechnical Commission (IEC) Articulate accessibility probe with stop plate



All dimensions in millimeters

mm	2	4	10	20	30	50	60	75	80	180
inch	5/64	5/32	25/64	25/32	1-3/16	1-31/32	2-23/64	2-61/64	3-5/32	7-3/32

Figure 8.2
International Electrotechnical Commission (IEC) Rigid accessibility probe



All dimensions in mm (inches)

NOTE: For missing dimensions refer to Figure 8.1

8.3 Determination of electric shock

8.3.1 A part is considered to involve the risk of electric shock if:

a) The potential between the part and ground, or any other simultaneously accessible part, exceeds one or more of the following:

1) 30 V rms (42.4 V peak).

2) 60 V dc.

3) 24.8 V dc interrupted at a rate of 10 – 200 Hz.

and either:

b) The available current from the part exceeds the limits for leakage current in 17.1.4; or

c) The potential between the part and ground, or any other simultaneously accessible part, involves one of the following:

1) 42.4 V peak but not more than 450 V peak and the capacitance between the parts exceeds 0.1 µF.

2) 450 V peak but not more than 15 kV peak and the product of capacitance (in µF) and potential (in V) exceeds 45 µC.

3) 15 kV peak and one half of the product of capacitance (in µF) and the square of the potential (in V) exceed 350 mJ.

8.4 Instrument connection

8.4.1 To determine if an accessible part can result in the risk of electric shock in accordance with 8.3.1, the following steps are to be followed:

a) The instrument is to be connected to an input source adjusted for the end scale of the instrument and circuit-to-ground rating.

b) The potential between accessible parts is to be measured.

c) The leakage current between accessible parts is to be measured as indicated in the Leakage Current Test, Section 17.

d) The capacitance between accessible parts is to be measured.

8.5 Operator servicing

8.5.1 Each part of an instrument that becomes accessible upon removing any cover or opening any door that is intended to be removed or opened by the operator for the purposes of operator servicing shall not involve the risk of electric shock as indicated in 8.3.1.

8.6 Operating shafts

8.6.1 Any operating shaft that is accessible after removing a knob, handle, or the like shall not involve the risk of electric shock.

Exception: An insulating knob, handle, and the like that is captive to and encloses the shaft, and the means for removing such insulating knob, handle, and the like that are not exterior to the instrument need not comply with this requirement.

8.7 Adjustment openings

8.7.1 Each part of an instrument that is accessible to a tool introduced into the instrument through an adjustment opening shall not involve the risk of electric shock. See 8.3.1.

8.7.2 To determine if a part is accessible, the tool specified or supplied with the instrument or a test pin that is 3 mm (7/64 inch) in diameter – whichever results in more unfavorable conditions– is to be inserted through the adjustment opening to a depth of 3 times the depth of the adjustment device and at all possible angles. The construction is acceptable if the tool or test pin does not contact the part being evaluated.

9 Connection Devices

9.1 Terminals

9.1.1 Each terminal shall be anchored, fitted, or mounted so that the terminal cannot work loose when connections are made.

9.2 Insulation

9.2.1 Each conductor and its basic insulation shall be arranged so that inadvertent loosening of wire, screws, and the like cannot reduce the spacings below those outlined in 12.1.1 or cause any accessible part to render an electric shock.

9.3 Protective ground terminals

9.3.1 A protective ground terminal shall comply with all of the following requirements:

a) The terminal shall be at least of equivalent size to the other terminals and shall accommodate a conductor of the same size.

b) The terminal shall be protected against corrosion by galvanizing, plating, or equivalent means if corrosion can result in such damage to the part as to result in risk of fire, electric shock, or personal injury.

c) The terminal shall be used solely for such purpose.

d) The terminal shall be adjacent to the measuring or testing terminals.

e) The terminal shall not be interrupted by a switching device or a fuse in the instrument or accessory.

9.4 Screw connections

9.4.1 A screw connection that during the life of the instrument is to be loosened and tightened readily – such as a terminal screw or a screw for fixing a lever, knob, or the like – shall screw into a metal nut or metal insert.

9.4.2 To determine if a screw-type terminal is securely anchored, the Torque Test for Terminals, Section 22, shall be conducted.

10 Internal Wiring

10.1 Where loosening of a circuit connection, including a splice, can result in the risk of electric shock or fire, the connection shall be made mechanically secure.

10.2 Each wire shall be protected from or routed away from sharp edges, screw threads, burrs, moving parts, and the like. A hole through which wires are routed shall have smooth, well-rounded surfaces, or shall have a bushing.

10.3 Each clamp or guide that is used for routing of wires shall have smooth well-rounded edges. Pressure exerted by such a clamp or guide shall not cause cold-flow or otherwise deform the insulation.

11 Separation of Circuits

11.1 General

11.1.1 The insulation of a wire in contact with another wire or an uninsulated live part shall be rated for the highest voltage to which the wire insulation is stressed.

11.1.2 Contact between wires or a wire and a live part may be prevented by one or more of the following means:

a) The spacings in 12.1.1.

b) An insulating barrier.

c) A grounded shield.

11.2 Printed-wiring boards

11.2.1 A printed-wiring board shall comply with the Standard for Printed-Wiring Boards, UL 796, and be classified with regard to flammability rating as outlined in Table 7.1.

12 Spacings

12.1 Circuits

12.1.1 The spacings between an uninsulated part of a circuit and:

a) Another uninsulated part of any circuit,

b) Ground, and

c) An accessible conductive part

shall comply with Table 12.1.

12.2 Fasteners

12.2.1 A screw that may be replaced by a longer screw, resulting in reduction in creepage or clearance distance below those indicated in Table 12.1, shall be captive.

Table 12.1
Protective spacings

Maximum circuit voltage[b] (volts)		Distance[a] – millimeters (inch)	
Sinusoldal a-c (rms)	**d-c, a-c peak or mixed voltage**	**Through air (clearance)[c]**	**Over surface (creepage)[d]**
not over 24	not over 35	1.0 (0.040) [0.5 (0.20)]	Same
over 24, not over 60	over 35, not over 85	2.0 (0.080) [1.0 (0.040)]	Same
over 60, not over 130	over 85, not over 184	2.5 (0.100) [1.5 (0.060)]	Same
over 130, not over 250	over 184, not over 354	3.0 (0.120) [2.0 (0.080)]	Same
over 250, not over 450	over 354, not over 630	3.5 (0.140)	4.5 (0.180)
over 450, not over 650	over 630, not over 920	4.0 (0.160)	6.0 (0.240)
over 650, not over 1000	over 920, not over 1400	5.5 (0.220)	9.0 (0.360)
over 1000, not over 1500	over 1400, not over 2100	10.0 (0.400)	12.0 (0.480)
over 1500, not over 2000	over 2100, not over 2800	12.0 (0.480)	14.0 (0.560)
over 2000, not over 2500	over 2800, not over 3600	14.0 (0.560)	15.5 (0.620)

[a] The smaller values in the brackets [ ] apply to miniature components (for example, printed circuits and micromodules) and are accepted only where the spacings are rigidly maintained by constructional means and cannot be reduced during assembly of the component or part into the equipment.

[b] Opposite polarity spacings are based on voltages measured according to 15.2.1. Spacings between live parts and exposed conductive surfaces (or foil wrapped around exposed insulating material) are based on the maximum rated voltage to ground.

[c] See definition in 2.4.

[d] See definition in 2.5.

13 Grounding

13.1 Each accessible conductive part that may become live because of a fault, or because a reduction in spacings may occur as a result of handling, shall be connected to the means provided for connection to a protective ground.

13.2 An isolated metal nameplate or handle, isolated metal trim of the enclosure, or an isolated screw or other similar hardware that is fastened into a polymeric or other nonconductive enclosure is not considered to be a conductive part involving the risk of electric shock.

14 Component Parts and Accessories

14.1 Resistors and inductors

14.1.1 If short circuiting of an inductor or a resistor as described in Testing Under Fault Conditions, Section 23, results in noncompliance with the requirements in that Section, it shall be rated for at least twice the power dissipation measured under normal test conditions.

14.2 Component short-circuit

14.2.1 An electrolytic capacitor or electronic device with any terminal connected to an unlimited circuit (see 15.1.1) shall be tested as described in Testing Under Fault Conditions, Section 23.

14.3 Overcurrent protective and thermal-limiting devices

14.3.1 Each overcurrent–protective device and thermal–limiting device employed in an instrument shall be rated for the load it controls.

14.3.2 Each overcurrent-protective device and thermal-limiting device employed in an instrument shall not operate under normal operating conditions.

14.4 Accessories

14.4.1 An accessory (or accessories) shall not increase the operating voltage beyond the rated circuit-to-ground voltage of the instrument when connected according to any instructional information that is provided with the instrument.

14.4.2 An accessory (or accessories) used with a wattmeter, varmeter, power-factor indicator and the like shall not increase the voltage between the current and voltage circuits in excess of the rated circuit-to-ground voltage.

15 Subdivision of Circuits Into Groups

15.1 General

15.1.1 To determine those circuit locations where tests are to be conducted as described in Accessibility of Live Parts, Section 8, and Testing Under Fault Conditions, Section 23, and to determine the requirements for materials in contact with current-carrying parts as described in 7.2.3, the circuits of the instrument are to be divided into two groups, limited and unlimited, as follows:

a) Limited Circuit – A limited circuit is one in which both the voltage and current are limited.

1) Limited Voltage – The open-circuit voltage complies with one of the following:

i) Not more than 30 V rms (42.4 V peak).

ii) Not more than 60 V dc.

iii) Not more than 24.8 V dc interrupted at a 10 – 200 Hz rate.

2) Limited Current – The available current under any load condition, including short circuit, is not more than 8 A, measured after 1 minute of operation.

b) Unlimited Circuit – An unlimited circuit is one in which either the voltage or the current is not limited.

15.2 Open-circuit voltage measurement

15.2.1 The measurement of the open–circuit voltage is to be made with the instrument connected to an input source adjusted to produce end-scale value. All loading circuits are to be disconnected from the circuit undergoing evaluation.

15.3 Available-current measurement

15.3.1 The measurement of the available current is to be made with the instrument connected to an input source adjusted to produce end-scale value. All loading circuits are to remain connected.

15.4 Current-limiting means

15.4.1 A circuit in which the current is limited by any of the following:

a) A fixed impedance,

b) A fuse or thermal cutoff,

c) A nonadjustable manual-reset circuit protective device, or

d) A regulating network

is considered to be a limited circuit as defined in 15.1.1 if the open-circuit voltage is also limited.

15.5 Overload-protector rating

15.5.1 The rating of a fuse or circuit protective device that is used to limit the current in accordance with 15.4.1 shall not be greater than $I_{limited}$ where:

$$I_{limited} = \frac{200}{(2.0)(U)}$$

in which:

U is the open-circuit voltage measured as described in 15.2.1 and

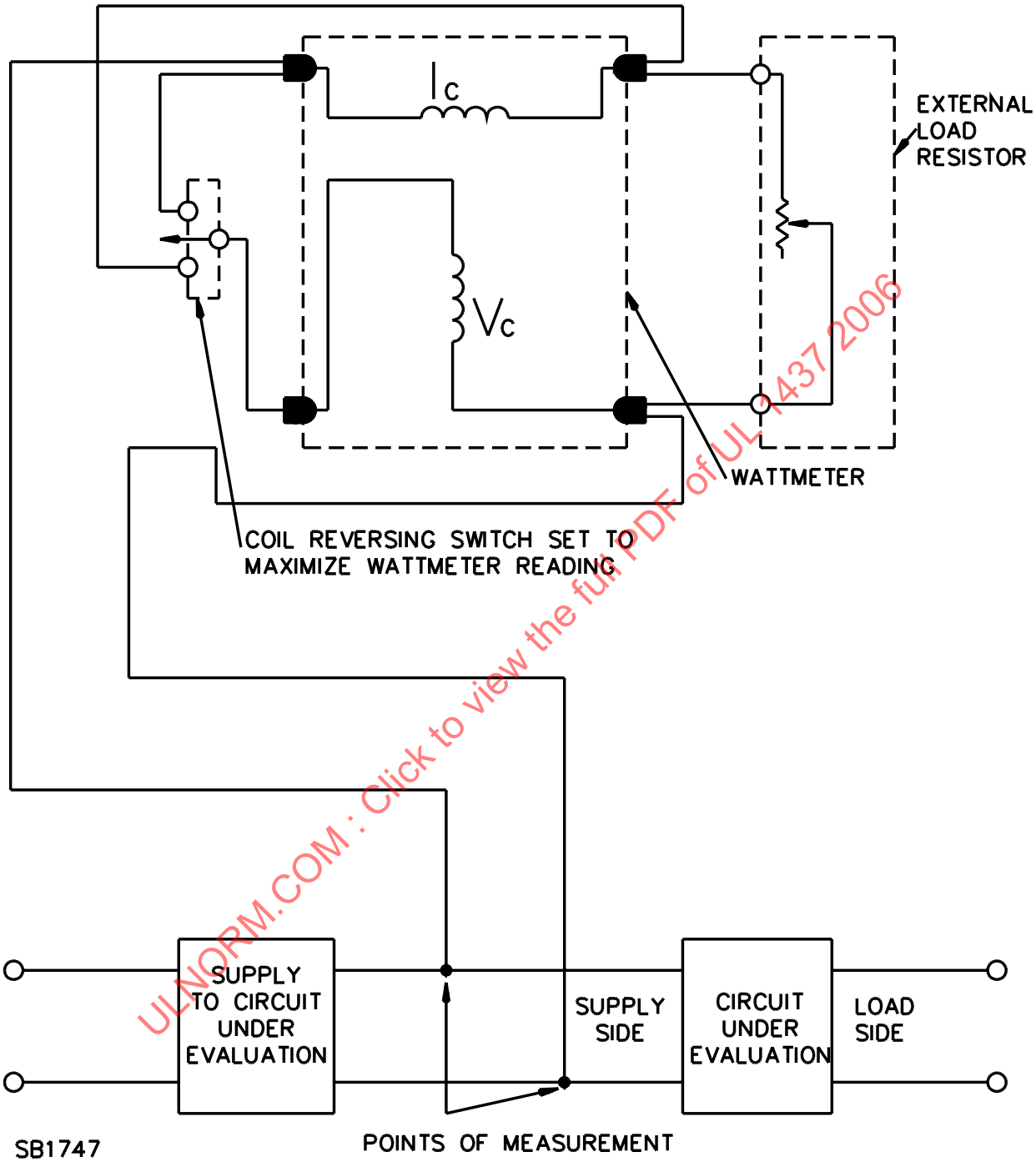
200 represents the maximum watts (see 15.5.2) and

$I_{limited}$ is the maximum rating that, because of the characteristics of the overload protector, may or may not actually limit the capability of the circuit being evaluated to 200 W or less.

To determine if the overload rating is acceptable, the test described in 15.5.2 shall be conducted.

15.5.2 A variable external resistor and a wattmeter are to be connected to the circuit under evaluation as shown in Figure 15.1, and a shorting switch is to be connected across the overload protector in the closed position. The external resistor is to be adjusted for maximum resistance before being connected into the circuit. The resistor is then to be adjusted so that the power it dissipates is exactly 200 watts as indicated by the wattmeter reading. The switch across the overload protector is then to be opened and the time required for the overload protector to open is to be recorded. If the overload protective device opens the supply to the circuit under evaluation in 5 seconds or less, the rating of the protective device is acceptable.

Figure 15.1
Connection of wattmeter



15.6 Fixed-impedance rating

15.6.1 A fixed impedance that is used to limit the current shall be such that the current under any load condition, including short circuit, is not more than 8 A, measured after 1 minute of operation.

15.7 Regulating-network rating

15.7.1 A regulating network that is used to limit the current, voltage, or both shall not be such that the current, voltage, or both exceeds those values specified for limited circuits when subjected to a test that simulates malfunction of any single unreliable component in the network.

PERFORMANCE

16 General

16.1 General

16.1.1 Tests shall be carried out on one and the same piece of equipment except where identical multiple samples are specified. Where it is necessary to perform destructive tests, additional samples of identical components or instruments are to be used.

16.1.2 Each test specified shall be carried out on an instrument representing the condition as shipped from the factory.

16.2 Voltmeter sensitivity

16.2.1 For voltage measurements of circuits, the voltmeter sensitivity shall not be less than 20,000 ohms per volt dc or 5,000 ohms per volt ac for potentials of 500 V or less and 10 megohms input impedance for potentials of more than 500 V. A voltmeter that has a higher input impedance shall be used wherever it is warranted by the impedance of the circuit under test unless otherwise indicated.

16.3 Cheesecloth indicators

16.3.1 Cheesecloth specified in this Standard shall be untreated cotton cloth running 26 – 28 m^2/kg (14 – 15 yd^2/lb) and having what is known to the trade as a count of 32 by 28. Tests involving cheesecloth shall be made in a closed room with no forced air circulation.

16.4 Reference test conditions (reference conditions for test purposes)

16.4.1 Unless otherwise specified, all of the following conditions shall prevail in the test location:

a) Temperature within the range of 15 – 35°C (59 – 95°F).

b) Relative humidity less than 80 percent.

c) Air pressure within the range of 86 – 106 kPa (12.5 – 15.4 psi).

d) Environment free of hoarfrost, dew, percolating water, rain, and the like.

16.4.2 Each test shall be carried out under the most unfavorable combination of:

a) Position – The instrument shall be in any position of normal use and mounted according to instructional information provided with the instrument. Normal ventilation shall not be impeded by artificial means.

b) Measuring Circuits – A measuring circuit shall be energized by any voltage between zero and the rated input voltage and at any rated frequency. Each input and output shall be connected to any potential between zero and the rated circuit-to-ground voltage.

c) Ground Terminals – Each protective ground terminal shall be connected to ground. The measuring circuit ground terminal shall be connected to ground when specified by the manufacturer unless otherwise specified in the test paragraphs.

d) Operating Controls – Each accessible control shall be set to any position. Each remote-control (operating) device shall be connected and disconnected.

e) Normal Use – Normal use of a measuring instrument includes the connection of the measuring circuits to an external supply adjusted to deliver a signal of any value within rated measuring ranges.

f) Accessories – Each noninterchangeable accessory shall be connected according to instructional information provided with the instrument or accessory. Each interchangeable accessory or accessory of limited interchangeability shall be subjected to separate tests related to its own characteristics.

16.5 Protective devices

16.5.1 A component or circuit intended for protective, limiting, or regulating purposes or the like that operates as a result of testing according to this Standard and is relied upon for compliance with the requirements in this Standard shall comply with the applicable component requirements. Examples of such components are fuses, thermostats, regulators, circuit breakers, fusible resistors, limiting controls, and regulating controls.

16.6 Voltage and current

16.6.1 Values of applied voltage and current are root-mean-square (rms) values, unless otherwise stated.

17 Leakage Current Test

17.1 General

17.1.1 Each accessible part of the instrument is to be tested for leakage current between it and all other accessible parts, and between the part and ground.

17.1.2 The leakage-current measurements are to be conducted on a previously untested sample (without prior energization, except as may occur as production-line testing) and on a sample that has been subjected to Humidity Conditioning, Section 21.

17.1.3 Leakage-current measurements are to include all currents present, including capacitively coupled currents.

17.1.4 When the instrument under test is connected as described in 17.3.1, the leakage current shall not cause an indication on the specified measuring instrument of more than:

a) 0.5 mA d-c.

b) 0.5 mA a-c for frequencies up to 100 Hz.

c) 0.5 mA a-c at 100 Hz linearly increasing to 3.5 mA peak at 700 Hz.

d) 3.5 mA a-c for frequencies between 700 Hz and 100 kHz.

17.2 Specified measuring instrument

17.2.1 The specified measuring instrument is one that complies with all of the following specifications:

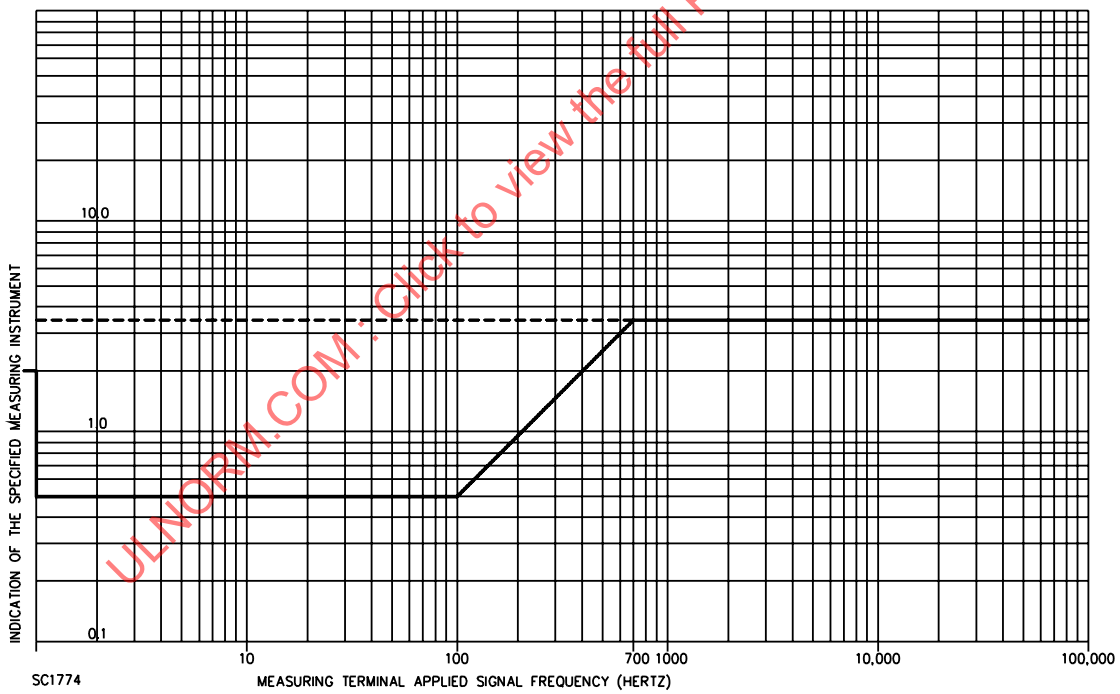
a) The instrument has an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15 µF.

b) For direct currents, the instrument is to indicate the average direct current.

c) For alternating currents, the instrument is to indicate 1.11 times the average of the full-wave rectified composite waveform of current in milliamperes through the resistor; and the instrument has the frequency response (ratio of indicated to actual value of current) over a frequency range of 10 Hz to 100 kHz that is equal to the ratio of the impedance of a 1500-ohm resistor shunted by a 0.15-µF capacitor to 1500 ohms.

d) The instrument is to have an error of not more than 5 percent for d–c measurements of 0.5 mA and 5 percent for a-c measurements at the limits indicated in Figure 17.1.

Figure 17.1
Indication of the specified measuring instrument resulting from measuring terminal incidental current plotted as a function of signal frequency applied to the equipment measuring terminals

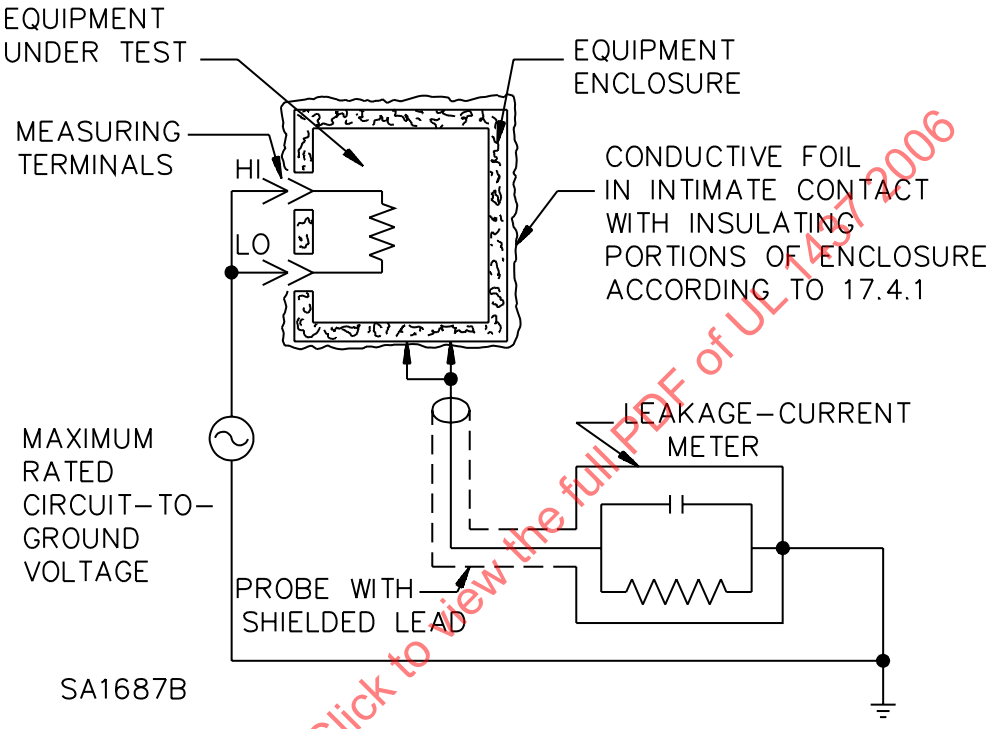


17.2.2 The actual measuring instrument used need not have all the attributes of the specified measuring instrument if equivalent readings can be obtained.

17.3 Instrument connection

17.3.1 For the purpose of measuring leakage current, the instrument shall be at reference test conditions and each measuring terminal shall be connected to its maximum rated circuit-to-ground voltage. See Figure 17.2.

Figure 17.2
Leakage-current measurement circuit for self-powered equipment



17.4 Enclosure of insulating material

17.4.1 If the instrument is wholly or partially insulation-encased, accessible parts shall be evaluated using one of the following constructions:

a) A 200 by 200 mm (8 by 8 inch) piece of conductive foil shall be wrapped anywhere about accessible parts of the instrument.

b) Two 100 by 200 mm (4 by 8 inch) pieces of conductive foil shall be wrapped about the instrument at any two locations of accessible parts.

c) A conductive surface shall be employed upon which any accessible part of the instrument may rest.

18 Normal Temperature Test

18.1 General

18.1.1 When operated under conditions of maximum normal load, the temperature rises in Table 18.1 shall not be exceeded.

Table 18.1
Maximum temperature rise[a] under reference test conditions

Parts of the instrument	Temperature rise °Celsius (°Fahrenheit)	
1. Accessible parts:		
a) Surfaces of enclosures	35 (63)	
b) Small areas and easily discernible heat sinks not likely to be touched in normal use	65 (117)	
2. Operating devices and handles:		
a) Metallic	20 (36)	
b) Nonmetallic	30 (54)	
3. Enclosure interior surfaces:		
a) Wood	65 (117)	
b) Insulating material	b	
4. Insulating materials:		
a) Polymeric	b	
b) Varnished cloth	60 (108)	
c) Fiber	65 (117)	
d) Wood and similar material	65 (117)	
5. Insulating systems:	Method	
	Resistance	Thermocouple
Class 130 windings of:		
a) Transformers	95 (171)	85 (153)
b) Relays, electromagnets, solenoids, etc.	105 (189)	85 (153)
c) Vibrator coils	95 (171)	95 (171)
6. Capacitors[c]:		
a) Electrolytic	40 (72)	
b) Other types	65 (117)	
7. Fuses	65 (117)	
8. Semiconductor devices[c]	75 (135)	
9. Softening point of any sealing compound	d	
10. Selenium rectifiers[c]	50 (90)	
11. Terminal box	65 (117)	
12. Surface on which equipment might be mounted in service, and surfaces that might be adjacent to the unit when it is so mounted	65 (117)	
13. Wire and cords[c]	35 (63)	

[a] The normal temperature test shall be conducted at a room temperature of 15 – 35°C (59 – 95°) and the observed temperatures corrected to a room temperature of 25°C (77°F).

[b] Polymeric material shall be acceptable for the application when judged with respect to temperature.

[c] Does not apply if investigated and accepted for a higher temperature.

[d] The maximum sealing compound temperature, when corrected to 25°C (77°F) ambient temperature, is 15°C (27°F) less than the softening point of the compound as determined by the Test for Softening Point by Ring-and-Ball Apparatus, ASTM E 28-67(1982).

18.1.2 For an instrument that has limited operating conditions, such as short-term or intermittent use, 18.1.1 applies as far as compatible with such operating conditions.

18.2 Instrument mounting

18.2.1 The instrument is to be mounted or supported as indicated by the instructions provided. In the absence of instructions, the instrument is to be positioned in the manner that results in the greatest heating.

18.3 Instrument connections

18.3.1 Electrical connections to the instrument under test shall be made as indicated by the instructions provided. In the absence of instructions, wiring connections shall be made using copper conductors sized according to the intended load.

18.4 Doors and covers

18.4.1 Doors or covers that may be closed during operation of the instrument shall be closed during the test.

Exception: Exception: The actual conditions of normal operation of the instrument shall be considered. For example, doors or covers that must be opened after each cycle of operation shall be opened as required.

18.5 Thermocouples

18.5.1 Thermocouples, if used, shall be Nos. 28 – 32 AWG iron and constantan, or according to the Standard for Temperature Measurement Thermocouples, ANSI MC96.1-1982.

18.5.2 A thermocouple junction and lead wire shall be held in thermal contact with the material being measured. Taping or cementing the thermocouple is acceptable. However, if a metal surface is involved, brazing or soldering may be required.

18.6 Temperature limits

18.6.1 Compliance with the temperature limits shall be checked by measuring the temperature rise under reference test conditions (see 16.4.1) after thermal equilibrium has been attained.

18.6.2 Thermal equilibrium is attained when there is no temperature change on the part being measured when three successive readings taken at 5-min intervals indicate no change.

19 High-Ambient Temperature Evaluation

19.1 Instrument conditioning

19.1.1 The instrument shall be conditioned for 4 hours at 40.0 ±2.0°C (104.0 ±3.6°F).

19.2 Insulating materials

19.2.1 The instrument, when operated at end-scale value at the temperature specified in 19.1.1, shall retain its dielectric voltage-withstand capabilities according to 20.1.1, and spacings according to 12.1.1.

19.3 Polymeric enclosures

19.3.1 The instrument, when operated at the end-scale value at the elevated temperature specified in 19.1.1, shall be resistant to external forces as described in Sections 24 – 28.

20 Insulation Voltage Test (Dielectric Voltage-Withstand Test)

20.1 General

20.1.1 Insulation and spacings between conductors shall sustain a test voltage according to Table 20.1 without breakdown. This test shall be performed on an instrument in the previously untested condition (see 17.1.2) as well as on an instrument that has been subjected to Humidity Conditioning, Section 21, and High-Ambient Temperature Evaluation, Section 19.

Table 20.1
Test voltage for dielectric voltage-withstand tests

Voltage between conductors (U)[a]			Test voltage[b]		
d-c	a-c_{rms}	a-c_{peak} or mixed a-c_{peak} + d-c	d-c[d]	a-c_{rms} [c]	a-cpeak [c]
0 to 42.4	0 to 30	0 to 42.4	707	500	707
–	above 30	–	$2.828U_{rms}$ + 1414	$2U_{rms}$ + 1000	$2.828U_{rms}$ + 1414
–	–	above 42.4	$2U_{peak}$ + 1414	$1.414U_{peak}$ + 1000	2Upeak1414
above 42.4	–	–	$2U_{d-c}$ + 1414	$1.414U_{d-c}$ + 1000	$2U_{d-c}$ + 1414

[a] For opposite polarity, U is the voltage measured as described in 15.2.1. For a test between live parts and exposed conductive parts, protective ground terminal, and/or foil wrapped around exposed insulting material, U is the maximum rated voltage to ground.

[b] The test voltage specified as d-c, a-c_{rms} and a-c_{peak} are considered equivalent for dielectric voltage-withstand test purposes.

[c] The test-voltage waveform shall be an essentially sinusoidal voltage with a frequency of 45 – 65 Hz.

[d] The d-c test voltage shall have not more than 3-percent ripple.

20.1.2 To determine that an instrument complies with the requirement in 20.1.1 the instrument is to be tested by means of a 500 VA or larger transformer, the output voltage of which is essentially sinusoidal and can be varied. Starting at zero, the test potential is to be increased until the required test value is reached, and is to be maintained at that value for 1 min. The increase in the test potential is to be at a substantially uniform rate and as rapid as consistent with its value being correctly indicated by the voltmeter.

20.1.3 If wiring that is not marked with a voltage rating or has a voltage rating that may not be acceptable for the application is used inside an instrument, the wiring shall comply with the test described in 20.1.1. The test potential shall be based on the voltage measured between conductors under reference test conditions.

20.1.4 The test potential is to be applied between measuring or testing circuits and each of the following parts:

a) The protective grounding terminal.

b) The instrument enclosure, or conductive foil wrapped about the accessible portions of the equipment.

c) Accessible conductive parts.

20.2 Indication of breakdown

20.2.1 Breakdown is often indicated by an abrupt decrease or nonlinear advance of voltage as the voltage is increased. Similarly, a breakdown is often indicated by an abrupt increase in current. Corona and similar phenomena are to be disregarded.

21 Humidity Conditioning

21.1 General

21.1.1 The instrument insulations that involve risk of electric shock shall not break down when tested as described in the Insulation Voltage Test (Dielectric Voltage-Withstand Test), Section 20, nor have leakage currents exceeding the limits specified in the Leakage Current Test, Section 17, following humidity conditioning.

21.1.2 The instrument shall not be exposed to moisture condensation when subjected to humidity conditioning.

21.2 Preconditioning

21.2.1 To comply with 21.1.2 the instrument shall be temperature preconditioned by storing in a chamber operating at a temperature of 40.0 – 44.0°C (104.0 – 111.2°F) and a humidity of 50 percent or less. The instrument shall remain in the chamber until the instrument temperature has stabilized but not less than 4 hours.

21.3 Conditioning

21.3.1 Parts of an instrument that become accessible upon removing covers or opening doors that are intended to be removed or opened by the operator for purposes of operator servicing shall be removed or opened during conditioning.

21.3.2 Immediately following the temperature preconditioning described in 21.2.1, the instrument shall be conditioned in a chamber operating at 38.0 – 40.0°C (100.4 – 104.0°F) and 90 – 95 percent humidity. The instrument shall remain in the chamber for 48 hours.

21.3.3 The instrument shall be inoperative during the humidity conditioning.

21.3.4 Before conducting the Leakage Current Test, Section 17, and the Insulation Voltage Test (Dielectric Voltage-Withstand Test), Section 20, the instrument shall have been removed from the humidity chamber and, if the instrument is encased in insulation, conductive foil shall be wrapped about the accessible portions of the instrument. Where the enclosure is partially encased in insulation, conductive foil shall be wrapped only about the insulating portion.

22 Torque Test for Terminals

22.1 General

22.1.1 To determine compliance with 9.1.1 and 9.4.2 a torque test as described in 22.2.1 – 22.2.4 shall be conducted.

22.2 Direction and application of torque

22.2.1 The torque shall be applied clockwise and then counterclockwise in a plane perpendicular to the axis of the terminal. The force necessary to produce the specified torque shall be applied in a plane perpendicular to the axis of the terminal so as to cause a clockwise and then counterclockwise torque along the axis of the terminal.

22.2.2 The torque shall be applied gradually to the terminal, held at the specified value, and then monitored for a period of not less than 5 seconds, but not more than 15 seconds. Five samples are to be tested with an average holding time of not less than 8 seconds.

22.2.3 When testing nonwire, rigid-type terminals of other than the screw-thread type, the applied torque is dependent on the equivalent diameter of the external portion of the terminal assembly. The equivalent diameter is defined as equal to twice the distance from the central axis of the terminal to the point on the circumference where mating torque is applied. The torque shall be applied according to the equivalent diameter shown in Table 22.1.

Table 22.1
Value of torque to be applied when testing nonwire, rigid-type teminals of other than the screw-thread type

Equivalent diameter inch (millimeter)	Torque	
	pound-inches	(Newton-meters)
1/16 (1.6) and less	0	0
>1/16 to 1/8 (1.6 to 3.2), inclusive	8	(0.91)
>1/8 to 3/16 (3.2 to 4.8), inclusive	18	(2.04)
>3/16 to 5/16 (4.8 to 7.9), inclusive	40	(4.52)
>5/16 to 1/2 (7.9 to 12.7), inclusive	80	(9.04)
>1/2 (12.7)	120 minimum	(13.56 minimum)

22.2.4 When testing screw-thread terminals, the torque shall be applied to the center line of the terminal assembly according to the terminal size shown in Table 22.2.

Table 22.2
Value of torque to be applied when testing screw-thread terminals

Screw-thread terminal size	Torque	
	pound-inches	(Newton-meters)
No. 4	3.0	(0.34)
No. 6	5.0	(0.57)
No. 8	11.0	(1.24)
No. 10	15.0	(1.70)
No. 12	24.0	(2.71)
1/4 inch (6.35 mm)	32.0	(3.62)

23 Testing Under Fault Conditions

23.1 General

23.1.1 When the equipment is operated under fault conditions as described in 23.5.1.1 – 23.6.1:

a) Accessible parts shall not involve an electric shock. See Accessibility of Live Parts, Section 8.

b) The temperature limits described in Table 23.1 shall not be exceeded.

c) Any other condition shall not occur so as to result in risk of electric shock, fire, or personal injury.

Table 23.1
Maximum temperature rises under fault conditions

Parts of the instrument	Maximum temperature rise	
	°Celsius	(°Fahrenheit)
1. External parts:		
a) Outer surface of enclosures	35	(63)
b) Metallic knobs, handles, and the like	20	(36)
c) Nonmetallic knobs, handles, and the like	30	(54)
2. Inside surface of enclosure of:		
a) Wood	90	(162)
b) Insulating material	see[a]	see[a]

[a] The maximum temperature rises on the inside of enclosures of insulating materials shall not exceed the rating of the material.

23.1.2 Compliance with the requirements in this Section is determined as described in 23.2.1 and 23.3.1.

23.1.3 From an examination of the instrument and its circuit diagram, the fault conditions can be determined that may result in the likelihood of electric shock, fire and personal injury. Unlimited circuits as covered in Subdivision of Circuits Into Groups, Section 15, are to be examined to identify those parts to which faults are to be applied.

23.1.4 During fault conditions:

a) The instrument shall be operated until further change due to the fault is unlikely. In most cases, continuous operation for seven hours is sufficient to determine that further change due to the fault is unlikely.

b) Multiple simultaneous faults shall not be applied.

c) The instrument shall be connected to a source adjusted to produce end-scale values.

d) The instrument shall:

1) Have accessible conductive parts of the enclosure connected to the ground terminal through a 1-A non-time-delay fuse.

2) Be wrapped in a single layer of cheesecloth and placed on a white tissue paper covered softwood surface.

e) Each fuse or other overcurrent protective device marked as described in 31.3.1 shall be in the circuit under test.

f) Any part of the instrument that is intended to be removed or opened by the operator for the purposes of operator servicing shall be removed or opened.

23.2 Fire

23.2.1 There shall not be:

a) Emission of flame or molten metal that causes the cheesecloth or tissue paper to burn, char, or glow; or

b) Flame inside the enclosure that continues for longer than 30 seconds.

23.3 Electric shock

23.3.1 The instrument is considered to be unacceptable with respect to risk of electric shock if any of the following occurs:

a) The fuse connected in series with the protective grounding means opens.

b) Insulation breaks down when subjected to the Insulation Voltage Test (Dielectric Voltage-Withstand Test), Section 20.

c) Parts that are intended to be accessible after installation do not comply with the accessibility requirements in Accessibility of Live Parts, Section 8.

d) Spacings are reduced below those indicated in Spacings, Section 12.

e) Leakage current exceeds those values indicated in the Leakage Current Test, Section 17.

23.4 Protective devices and circuit components

23.4.1 The opening of the instrument protective device, or any other circuit component, before any condition indicated in 23.1.1 occurs is an acceptable termination of a fault condition.

23.4.2 A fault condition terminated as indicated in 23.4.1 shall be repeated two more times and shall not cause the temperature rises after 2 min to exceed the temperature rises indicated in Table 23.1.

23.5 Fault conditions

23.5.1 Component short-circuit test

23.5.1.1 An electrolytic capacitor, inductor, or electronic device with any terminal connected to an unlimited circuit (see Subdivision of Circuits Into Groups, Section 15) shall be short-circuited terminal-to-terminal, one at a time; or open-circuited, one terminal at a time.

23.5.2 Temperature-control-device disabling test

23.5.2.1 An automatic temperature-regulating or -limiting control, and a thermal-protective device shall be disabled.

Exception: Components covered by Components, Section 3, and employing the marking described in 31.4.1 and 31.4.2 need not comply with this requirement.

23.5.3 Continuous-operation test

23.5.3.1 An electromagnetic device – such as a motor, relay and the like – that is intended for short-term or intermittent operation shall be operated continuously if continuous operation can inadvertently occur.

Exception: An electromagnetic device in equipment rated for short-term or intermittent operation or an electromagnetic device rated for continuous operation need not comply with this requirement.

23.5.4 Transformer short-circuit and overload tests

23.5.4.1 General

23.5.4.1.1 A transformer connected to an unlimited circuit (see Subdivision of Circuits Into Groups, Section 15) shall be subjected to short-circuit and overload tests.

23.5.4.1.2 Any secondary winding not under test may be connected or not as may occur in the equipment unless one condition produces more unfavorable results.

23.5.4.2 Short circuit

23.5.4.2.1 Each secondary winding shall be separately short-circuited.

Exception: A transformer that has inherent temperature-limiting (impedance) protection need not comply with this requirement. In such a transformer, the temperature rise according to the resistance method during the short-circuit test should not exceed 135°C (243°F) for Class 105(A) insulation systems or 160°C (288°F) for Class 130(B) insulation systems.

23.5.4.3 Transformer with automatic-reset protector

23.5.4.3.1 A transformer with an automatic-reset protector is to be short-circuited for 360 hours with no damage to the protector.

23.5.4.4 Transformer with manual-reset protector

23.5.4.4.1 A transformer with a manual-reset protector is to be short-circuited for 50 cycles, with the protector being reclosed as quickly as possible after it has opened, with no damage to the protector.

23.5.4.5 Overload

23.5.4.5.1 Each secondary winding shall be separately overloaded as follows:

a) If overcurrent protection is provided, the load shall be adjusted to 110 percent of the rating of the overcurrent protective device.

b) If overcurrent protection is provided in both primary and secondary windings, the load shall be adjusted to 110 percent of the rating of the primary or secondary overcurrent protective device, whichever occurs first.

c) If overcurrent protection is not provided, the load shall be adjusted to the maximum VA output.

23.5.4.5.2 The load may be a variable resistor connected across the secondary winding. The load is to be rapidly adjusted and readjusted, if necessary, 1 min after energizing.

23.6 Multi-function and over-range test

23.6.1 Each range and function switch shall be operated and set for any combination of conditions. Each terminal shall be connected to any end-scale value or, for a multiple-terminal instrument, any combination of end-scale values.

24 Polymeric Enclosure – Stress-Relief Distortion

24.1 General

24.1.1 An enclosure of polymeric material shall withstand the thermal conditioning described in 24.2.1 without resulting in any unacceptable condition that is described in 24.3.1.