UL 826

STANDARD FOR SAFETY

Household Electric Clocks

UL Standard for Safety for Household Electric Clocks, UL 826

Eleventh Edition, Dated November 29, 2007

Summary of Topics

This revision of UL 826 was issued to incorporate editorial updates. No changes in requirements are involved.

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Standard for Household Electric Clocks

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INTRODUCTION

1 Scope

1.1 These requirements cover electrically operated household clocks having an input rating of not more than 30 watts and 250 volts to be used in ordinary indoor locations in accordance with the National Electrical Code, NFPA 70.

1.2 These requirements do not cover clocks intended primarily for industrial or commercial installations, clocks that form part of a master clock system, outdoor clocks, time stamps, job card recorders, timers, and similar time-indicating and -recording appliances, nor do they cover illuminated clocks intended for use as portable electric lamps or for other illuminating purposes.

1.3 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 or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the 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 does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components used in the products covered by this standard.

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

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

b) Is superseded by a requirement in this standard.

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

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

2.2 Units of measurement

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

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

2.3 Undated references

2.3.1 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.

3 Glossary

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

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

3.3 PRINTED WIRING ASSEMBLY – A printed wiring board on which mechanical and electrical parts are mounted.

3.4 PRINTED WIRING BOARD – The finished combination of a pattern of conductive paths on, in, or both on and in (multilayer) a sheet of insulating material.

3.5 SAFETY CIRCUIT – Any primary or secondary circuit that is relied upon to reduce the risk of damage or injury to persons (for example, an interlock circuit).

3.6 SECONDARY CIRCUIT – A circuit supplied from a secondary winding of an isolating transformer.

CONSTRUCTION

4 Frame and Enclosure

4.1 General

4.1.1 A clock shall be formed and assembled so that it will have the strength and rigidity to resist the abuses to which it is likely to be subjected, without increasing the risk of fire, electric shock, or injury to persons because of total or partial collapse with resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

4.1.2 An edge, projection, or corner of an enclosure, opening, frame, guard, handle, knob, or the like shall be smooth and well-rounded and shall not be made in such a way that it causes any type of injury during intended use or user maintenance.

4.1.3 An enclosure shall be constructed of material of the thickness indicated in Table 4.1.

Exception No. 1: A flush plate for outlet box mounting shall comply with 4.3.3.

Exception No. 2: Sheet metal to which a wiring system is to be connected in the field shall comply with 8.1.2.

Exception No. 3: An enclosure of metal (other than white metal) thinner than specified in Table 4.1 may be used if it withstands the Enclosure Abuse (Drop) Test, Section 23.

Exception No. 4: A polymeric material may be used if it complies with 4.1.4 of this standard or with the enclosure requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

Exception No. 5: An enclosure that complies with 4.1.4 is not required to comply with Table 4.1.

Table 4.1
Minimum thickness of enclosure material

Material	With bare current carrying parts in enclosure				Without bare current carrying parts in enclosure	
	Without support		With support[a]		With or without support[a]	
	inch	(mm)	inch	(mm)	inch	(mm)
Cast metal	1/8	3.2	3/32	2.4	1/16	1.6
Die-cast metal (not white metal)	5/64	2.0	1/16	1.6	1/32	0.8
White metal, nonferrous[b]	–	–	–	–	1/32	0.8
Malleable iron	3/32	2.4	3/64	1.2	1/32	0.8
Sheet steel, uncoated	0.026	0.66	0.015	0.38	0.015	0.38
Sheet steel, galvanized	0.029	0.74	0.015	0.38	0.015	0.38
Sheet metal, nonferrous	0.036	0.91	0.015	0.38	0.015	0.38
Phenolic composition	0.060	1.52	0.060	1.52	0.060	1.52
Wood	1/8	3.2	1/8	3.2	1/8	3.2
Molded wood pulp and pressed board[c]	1/16	1.6	1/16	1.6	1/16	1.6
Glass	1/4	6.4	1/4	6.4	1/16	1.6

[a] Support consideration includes curved, ribbed, or otherwise reinforced, or whether the shape or size of the surface is such that equivalent mechanical strength is provided.

[b] Shall not be used for enclosure of bare current carrying parts.

[c] When used as a bottom cover, dial, back cover, front panel, or similar component.

4.1.4 An enclosure of nonmetallic or polymeric material for a cord-connected clock not having any uninsulated live part inside, or having coil terminals that are not exposed to contact as the only uninsulated live part inside, may be used if the clock complies with the Enclosure Abuse (Drop) Test, Section 23, and all of the following conditions:

a) The enclosure does not support any uninsulated live part.

b) Any lampholder is of the candelabra or intermediate base type unless the space available for the lamp limits the lamp envelope to the 25-watt size.

c) Under any operating condition (including stalled rotor, continuous running of the buzzer alarm, or both), the temperature at any point on the enclosure is not higher than 65°C (149°F).

d) Strain relief for the power supply cord in accordance with 7.3.1 – 7.3.5 is provided on the mechanism assembly housed in the enclosure rather than by the enclosure itself, unless each of the following four conditions has been met:

1) The clock weighs 10 pounds (4.54 kg) or less.

2) Means for strain relief is afforded by means other than a knot in the cord bearing against a side wall of the enclosure (a molded integral post or an equivalent means is considered to be a means for strain relief).

3) The strain relief is undamaged by a continuous pull of 15 pounds-force (66.7 N) on the cord while the clock is in an oven for 7 hours at 87 ±1°C (188.6 ±1.8°F).

4) With the sample at room ambient temperature, the strain relief is undamaged by a succession of three 3-foot (0.91-m) drops of the clock arrested by the power supply cord secured at its line end.

e) The enclosure is at least 0.094 inch (2.39 mm) thick.

Exception: An enclosure not having any dimension larger than 10 inches (254 mm) may have a wall thickness:

a) Not less than 0.080 inch (2.03 mm) if coil terminals are the only live parts enclosed;

b) Not less than 0.060 inch (1.52 mm) if there is no uninsulated live part exposed; or

c) Not less than 0.050 inch (1.27 mm) if there is no live part exposed, the enclosure material is rated V-2 or better, and the face is additionally supported, such as by gears of the movement.

f) The complete interior or clock mechanism is mounted as a unit in or on the enclosure.

g) The thermoplastic material has a flammability rating of HB or better. For the purpose of these requirements, cellulose acetate, polyvinyl chloride, acrylic, cellulose acetate butyrate, or polystyrene may be used.

4.1.5 An electrical part of a clock shall be located or enclosed so as to reduce the risk of unintentional contact with an uninsulated live part.

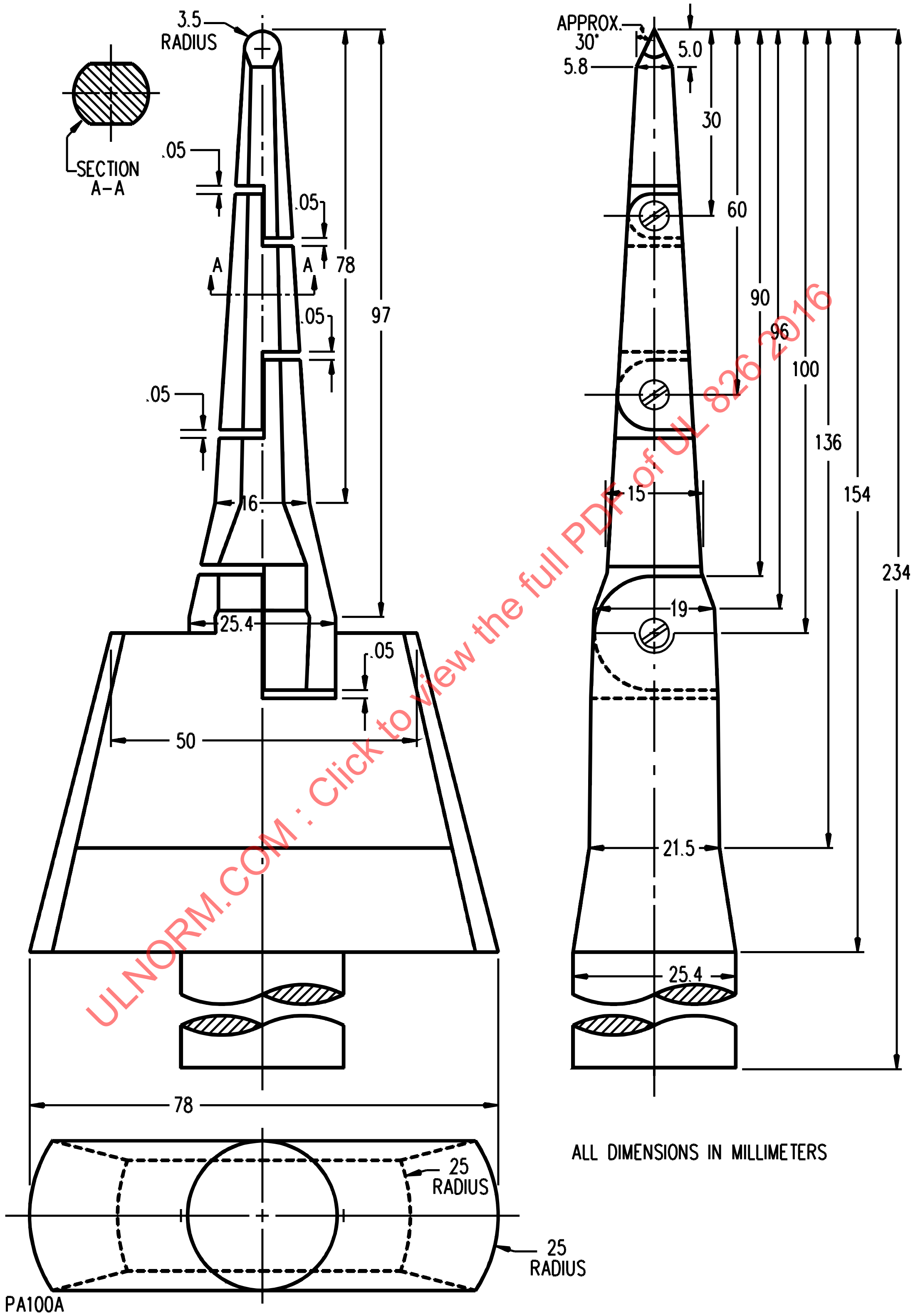
4.2 Accessibility of live parts

4.2.1 A part of the outer enclosure that may be removed by the user without the use of tools (for example, to permit attachment of accessories or to provide access to means for making operating adjustments) is not to be assumed to reduce the risk of electric shock.

4.2.2 Any functional opening likely to be exposed in a clock assembly shall be located so as to preclude contact of bare current carrying parts through it. If an opening is located in the top of the clock enclosure, it shall be constructed so that any metal object that is likely to fall through the opening shall not contact an uninsulated live part.

4.2.3 An opening in the enclosure of a clock that will not permit entrance of a 1-inch (25.4-mm) diameter rod may be used if the probe illustrated in Figure 4.1 cannot be made to touch any part that involves a risk of electric shock to earth ground.

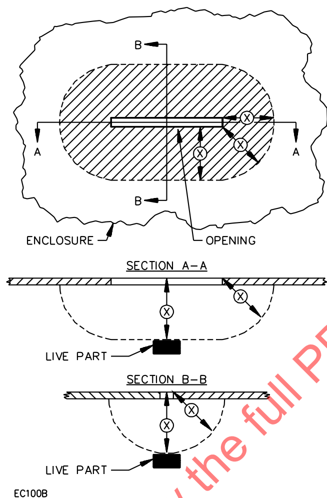
Figure 4.1
Articulate probe with web stop



4.2.4 With regard to the application of the requirement specified in 4.2.3, the probe may be articulated into any configuration and rotated or angled to any position before, during, or after insertion into the opening; and the penetration may be to any depth allowed by the opening size, including minimal depth combined with maximal articulation.

4.2.5 An opening in an enclosure that will permit entrance of a 1-inch (25.4-mm) diameter rod may be used under the conditions described in Figure 4.2.

Figure 4.2
Opening in enclosure



NOTE – The opening is considered to be in compliance if, within the enclosure, there is no uninsulated live part or enamel-insulated wire less than X inches from the perimeter of the opening nor is there an insulated live part or enamel-insulated wire within the volume generated by projecting the perimeter X inches normal to its plane. X equals five times the diameter of the largest diameter rod that can be inserted through the opening, but not less than 5 inches (127 mm).

4.2.6 In addition to compliance with 4.1.3 – 4.2.5, a dial, a crystal over a dial, a window, or a similar part depended upon to complete an enclosure shall comply with the following requirements:

a) The parts shall be of the same material and thickness required for other essential portions of the assembly and shall be secured in place.

b) If the degree of security required in (a) above is achieved by means of clips or loops that are spring-loaded over thermoplastic posts or by means of heat deformation posts, particular attention shall be given to ensuring that the posts will not shear-off under reasonable external pressure. If the degree of security required in (a) above is obtained by means of lugs or tabs on a thermoplastic dial or by means of similar parts that snap into place, the dial shall not be removable by slight pressure of the fingers or by a slight blow. A dial, a crystal over a dial, or a window that snaps into place shall not be used for enclosing bare current carrying parts that are considered to present a risk of electric shock or fire.

Exception: The degree of security required in (a) above may be obtained by a means other than those mentioned in (b) above, if the portion of the assembly that remains (for example, the mounting plate for the motor) after each dial, crystal over a dial, window, or similar part has been removed complies with each of the following requirements:

a) The material used to construct the remaining portion of the enclosure and the thickness of the material used for that portion of the assembly shall be a material that has been determined to be equivalent to that of the enclosure.

b) The remaining portion shall not contain any opening through which the probe shown in Figure 4.1 can be inserted.

4.2.7 The enclosure of a wall clock shall be provided with a means for support and shall be tested in accordance with the Enclosure Abuse (Drop) Test, Section 23.

4.2.8 A counter-supported clock with a metal or polymeric enclosure shall be subjected to the Impact Test, Section 26.

4.3 Mounting means

4.3.1 The mounting means provided on a wall clock shall be subjected to the Mounting Means Test, Section 24.

4.3.2 Mounting holes shall be located or guarded to prevent nails or similar hangers from coming in contact with any live part whether insulated or not.

4.3.3 A flush plate for outlet box mounting, provided with a clock or as an integral part thereof, shall be minimum 0.030-inch (0.76-mm) thick ferrous metal; minimum 0.040-inch (1.02-mm) thick nonferrous metal; or minimum 0.100-inch (2.54-mm) thick insulating material that is resistant to combustion.

4.4 Servicing

4.4.1 If the clock contains a replaceable fuse or incandescent lamp that directly affects the time function, the clock shall be constructed so that persons servicing these parts may not unintentionally contact an uninsulated live part or disturb internal wiring.

5 Corrosion Resistance

5.1 Iron and steel parts shall be made resistant to corrosion by film-coating, galvanizing, plating, or other means that have been determined to be equivalent if corrosive action on such unprotected parts would be likely to result in a risk of fire, electric shock, or injury to persons.

Exception No. 1: When the oxidation of iron and steel is not likely to be accelerated due to the exposure of the metal to air and moisture or other oxidizing influence (thickness of metal and the temperature are also factors), surfaces of sheet steel and cast iron parts within an enclosure may not be required to be made corrosion resistant.

Exception No. 2: Bearings, laminations, or minor parts of iron or steel (such as washers, screws, and the like) are not required to be made corrosion resistant.

6 Mechanical Assembly

6.1 A clock shall be assembled so that it will not be adversely affected by the vibration of routine operation.

6.2 A wiring device (such as a switch, lampholder, receptacle, or the like) shall be secured from turning.

Exception: A lampholder of a type in which the lamp cannot be replaced, such as a neon pilot or indicator light in which the lamp is sealed in by a nonremovable jewel, is not required to be secured from turning if rotation cannot reduce spacings below the minimum required values.

6.3 Friction between surfaces shall not be used as the sole means for securing the device from turning as specified in 6.2. For example, a lock washer, applied as intended, may be used as a means to secure a small stem-mounted switch, or other device having a single-hole mounting means, from turning.

7 Supply Connections – Cord-Connected Clocks

7.1 Cords and plugs

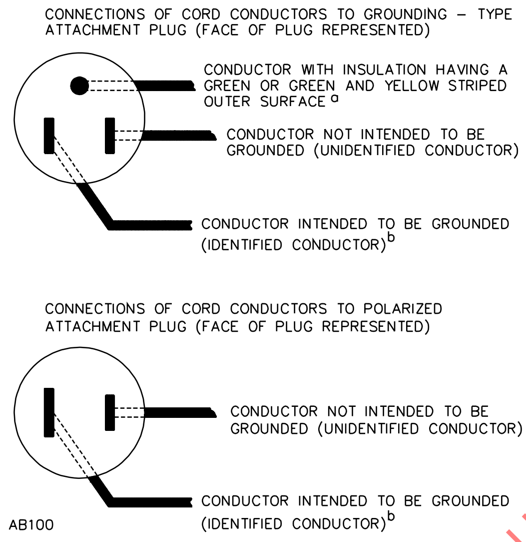
7.1.1 A clock that is intended to be connected to the power supply circuit by means of flexible cord shall be provided with at least 5 feet (1.5 m) of flexible cord and an attachment plug for connection to the supply circuit.

7.1.2 The flexible cord and attachment plug shall have a voltage and current rating not less than the rating of the clock.

7.1.3 A cord-connected clock that is provided with a manually operated, line-connected, single-pole switch for on-off operation; an Edison-base lampholder; or a 15- or 20-ampere receptacle shall be provided with a 3-wire grounding-type attachment plug or a 2-wire polarized attachment plug. The cord and the attachment plug connections shall comply with the requirements in 7.1.4 and 7.1.5.

7.1.4 The attachment plug connections of a cord-connected clock provided with a 3-wire grounding-type attachment plug or a 2-wire polarized attachment plug shall comply with Figure 7.1, and the polarity identification of the flexible cord shall comply with Table 7.1.

Figure 7.1
Connection to attachment plug



[a] In the above illustration, the blade to which the green conductor is connected may have a U-shaped or a circular cross section.

[b] Signifies a conductor identified in accordance with Table 7.1.

7.1.5 The circuit conductors in the flexible cord shall be connected to the plug and to the wiring in the appliance so that the following devices used in the primary circuit are connected to the ungrounded side of the line:

a) The center contact of an Edison-base lampholder.

b) A fuseholder.

c) Any other single-pole, overcurrent-protective device other than an automatic control without a marked off position.

d) A manually-operated, line-connected, single-pole switch.

7.1.6 The flexible cord may be permanently attached to the clock or may be in the form of a detachable power supply cord.

7.1.7 The flexible cord for a wall, table, shelf, or counter clock shall be Type SP-1 or SPT-1; or shall be of a type that has been determined acceptable for the particular application.

Exception: The supply cord for a clock rated for not more than 125 volts may use 20 AWG (0.52 mm^2) clock cord or Type XT flexible cord having parallel conductors if all the following conditions are met:

a) The clock consists of a synchronous motor or an electronic circuit with an isolating transformer.

b) The cord is permanently attached to the clock; that is, the cord cannot be easily detached by means of a cord connector or the like.

c) The cord is no longer than 8 feet (2.4 m) when measured between the clock and the face of the attachment plug.

Table 7.1
Polarity identification of flexible cords

Method of identification	Combinations considered to be in compliance		
	Wire intended to be grounded[a]		All other wires[a]
Color of braids on individual conductors	A	Solid white or gray – without tracer	Solid color other than white or gray – without tracer
	B	Color other than white or gray, with tracer in braid	Solid color other than white or gray – without tracer
Color of insulation on individual conductors	C[b]	Solid white or gray	Solid color other than white or gray
	C1[c]	Light blue	Solid color other than light blue, white, or gray
Color of separators	D[d]	White or gray	Color other than white or gray
Other means	E[e]	Tin or other white metal on all strands of the conductor	No tin or other white metal on the strands of the conductor
	F[d]	A stripe, ridge, or groove on the exterior surface of the cord	Not applicable

[a] A wire finished to show a green color with or without one or more yellow stripes or tracers is to be used only as an equipment grounding conductor. See 7.2.1 and Figure 7.1.

[b] Only for cords except Types SP-1, SP-2, and SPT-1 having no braid on any individual conductor.

[c] For jacketed cord.

[d] Only for Types SP-1, SP-2, SPT-1, and SPT-2 cords.

[e] Only for Types SPT-1 and SPT-2 cords.

7.1.8 The flexible cord for a floor-supported clock shall be Type SP-2 or SPT-2 or shall be of a type that has been determined to be acceptable for the particular application.

7.2 Grounding

7.2.1 An equipment grounding conductor of a flexible cord shall be:

a) Finished to show a green color with or without one or more yellow stripes.

b) Conductively connected to:

1) All exposed dead metal parts that are likely to become energized and

2) All dead metal parts within the enclosure that are exposed to contact during any user servicing and that are likely to become energized.

The grounding conductor shall be connected by means of a screw or other means not likely to be removed during any servicing operation not involving the power supply cord. Solder alone shall not be used for securing this conductor.

c) Connected to the fixed grounding member of an attachment plug of the grounding type.

7.3 Strain relief

7.3.1 Strain relief shall be provided to prevent mechanical stress on the flexible cord from being transmitted to terminals, splices, or interior wiring; and the strain relief shall be tested in accordance with the Strain Relief Test, Section 25.

7.3.2 A metal strain relief clamp or band may be used with Type SP-2 or lighter general use, rubber-insulated cord only if auxiliary insulation is provided over the cord for mechanical protection.

7.3.3 Unless intended for the purpose, a clamp of any material (metal or otherwise) shall not be used on Types XT, SPT-1, and SPT-2 cords.

Exception: A clamp may be used if the cord is protected by varnished cloth tubing or the equivalent under the clamp.

7.3.4 A clamp may be used with types of thermoplastic insulated cord heavier than Type SPT-1 or SPT-2. In such cases, the auxiliary insulation is not required unless it is determined that the construction of the clamp may damage cord insulation.

7.3.5 If a knot in the flexible cord serves as strain relief, any part the knot can touch shall be free of projections, sharp edges, burrs, fins, and the like that could abrade the cord.

7.4 Bushings

7.4.1 At each point in which a flexible cord passes through an opening in a wall, barrier, or enclosing case, there shall be a bushing or the equivalent, secured in place, that has a smooth, well-rounded surface against which the cord may bear. An insulating bushing shall be provided if:

a) Type SP-1, SP-2, SPT-2, or other cord lighter than Type SJ is used;

b) The wall or barrier is of metal; and

c) The construction is such that the cord may be subjected to strain or motion.

Exception: A slot in the edge or rim of a metal enclosure of a clock intended for wall mounting is not required to be bushed if the size and location of the opening are such that the cord passing through it is not likely to bear on a metal edge or if the cord is bushed in compliance with 7.4.1.

7.4.2 If the cord hole is in wood, porcelain, phenolic composition, or other nonconductive material, a smooth, well-rounded surface shall be considered to be equivalent to a bushing.

7.4.3 Ceramic materials and some molded compositions may be used for insulating bushings, but separate bushings of wood or hot molded shellac-and-tar composition shall not be used.

7.4.4 Vulcanized fiber may be used if the bushing is not less than 1/16 inch (1.6 mm) thick [with a minus tolerance of 1/64 inch (0.4 mm) for manufacturing variations] and if the bushing is formed and secured in place so that it will not be adversely affected by conditions of ordinary moisture.

7.4.5 At any point in a clock, a bushing of the same material as, and integrally molded with, the supply cord may be used on a Type SP-1 or heavier cord if the built-up section is not less than 1/16 inch (1.6 mm) thick at the point in which the cord passes through the enclosure.

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

8 Supply Connections – Permanently Connected Clocks

8.1 General

8.1.1 A clock intended for permanent connection to the branch circuit supply shall have provision for the connection of an appropriate wiring method.

8.1.2 Sheet metal to which a wiring system is to be connected in the field shall have a thickness not less than 0.032 inch (0.81 mm) if uncoated steel and not less than 0.045 inch (1.14 mm) if nonferrous.

8.1.3 The location of a terminal box or compartment in which power supply connections to a permanently connected clock are to be made shall be such that these connections may be readily inspected after the clock is installed as intended.

8.1.4 A terminal compartment intended for connection of a supply raceway shall be prevented from turning.

8.1.5 Wiring space or other compartments in a clock intended to be wired in the field shall be free of any sharp edge, burr, fin, moving part, or the like that may damage the conductor insulation.

8.2 Grounding

8.2.1 In a clock intended for permanent connection to the power supply by a metal enclosed wiring system (such as rigid metal conduit or armored cable), all exposed dead metal parts and all dead metal parts inside the enclosure that are exposed to contact during any servicing operation (including maintenance and repair), and that are likely to become energized, shall be conductively connected to the point at which the cable armor, conduit, and the like is attached to the clock.

8.2.2 In a clock intended for permanent connection to the power supply:

a) An equipment grounding conductor terminal or lead shall be provided; and

b) All exposed dead metal parts and all dead metal parts inside the enclosure that are exposed to contact during any servicing operation (including maintenance and repair), and that are likely to become energized, shall be conductively connected to such terminal or lead.

8.3 Terminals

8.3.1 Terminal parts to which connections are made shall provide reliable connections under hard usage. The parts to which wiring connections are made may consist of clamps or binding screws with terminal plates having upturned lugs or the equivalent to hold the wires in position. If a wire-binding screw is used at a wiring terminal, the screw shall not be smaller than No. 8 (4.2 mm major diameter).

Exception: A No. 6 (3.5 mm major diameter) screw may be used for a terminal to which 14 AWG (2.1 mm^2) wire would usually be connected.

8.3.2 A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.050 inch (1.27 mm) thick and shall not have fewer than two full threads in the metal.

Exception: A plate less than 0.050 inch (1.27 mm) thick but not less than 0.030 inch (0.76 mm) thick may be used if the tapped threads provide equivalent mechanical strength.

8.3.3 A terminal plate formed from stock having the minimum thickness indicated in 8.3.2 may have the metal extruded at the tapped hole to provide two full threads for the wire-binding screw.

8.3.4 Upturned lugs or a cupped washer shall be capable of retaining at least a 14 AWG (2.1 mm^2) conductor under the washer or the head of the screw.

8.3.5 A wire-binding screw shall thread into metal.

8.3.6 A wiring terminal shall be prevented from turning.

8.3.7 A permanently connected appliance rated 125 or 125/250 volts (3-wire) or less shall have one terminal or lead intended for connection of the grounded conductor of the power supply circuit.

8.3.8 The terminal or lead intended for grounded conductor connection shall be the one that is connected to the screw shell of a lampholder. No switch, overcurrent protective device, or limit control of the single pole type shall be connected in the grounded conductor.

Exception: A single pole automatic control without a marked off position may be connected in the grounded conductor.

8.3.9 A terminal intended for the connection of a grounded supply conductor shall be of or plated with metal that is white in color. It shall be readily distinguishable from the other terminals, or proper identification of that terminal shall be clearly shown in some other manner such as in an attached wiring diagram.

8.3.10 A terminal screw or the equivalent intended for the connection of an equipment grounding conductor shall be marked with the word ″ground″ or another abbreviation that has been determined to be acceptable, or the screw shall have a green colored head that is hexagon shaped, slotted, or both.

8.3.11 Field wiring terminals may be used for copper supply conductors or for either aluminum or copper supply conductors in accordance with the marking specified in 30.5.

8.4 Leads

8.4.1 Leads provided for splice connection to branch-circuit wiring shall be minimum 6 inches (152 mm) long, shall not be smaller than 18 AWG (0.82 mm^2), and any rubber or thermoplastic insulation shall not be less than 1/32 inch (0.8 mm) thick.

8.4.2 A lead intended for the connection of a grounded power-supply conductor shall be finished to show a white or gray color and shall be readily distinguishable from the other leads. An insulated grounding conductor shall be green with or without one or more yellow stripes. No other lead shall have such identification.

8.4.3 The internal connection of each wire lead provided for splice connection to supply wiring shall be capable of withstanding a pull of 20 pounds-force (89.0 N) for 1 minute without damage.

9 Live Parts

9.1 Metal used for current carrying parts shall be silver, copper, a copper alloy, or of material that has been determined to be equivalent.

9.2 An uninsulated live part shall be secured to the surface on which it is mounted, and supporting insulating material shall be secured in place, so that the part will be prevented from turning or shifting in position if spacings are reduced below the minimum values.

9.3 Friction between surfaces shall not be used as the sole means of preventing shifting or turning of live parts. A correctly applied lock washer may be used.

10 Insulating Material

10.1 Uninsulated live parts shall be mounted on porcelain, material of phenolic composition, or material that has been determined to have equivalent properties.

10.2 Ordinary vulcanized fiber may be used for insulating bushings, washers, separators, and barriers, but not as the sole support for uninsulated live parts if shrinkage, current leakage, or warpage may introduce a risk of fire, electric shock, or injury to persons. In general, thermoplastic materials are not to be used for the sole support of uninsulated live parts. However, thermoplastic materials may be used for this purpose if it has been determined that they have mechanical strength and rigidity, resistance to heat, resistance to flame propagation, and dielectric and other properties required for the application.

10.3 Molded parts shall have the mechanical strength and rigidity to withstand the stresses of actual service.

11 Internal Wiring

11.1 The internal wiring of a clock shall consist of insulated conductors having the temperature ratings, mechanical strength, and ampacity needed for the service.

11.2 Wire having thermoplastic insulation 1/64 inch (0.4 mm) thick or having insulation that has been determined to be equivalent may be used without supplementary insulation.

Exception: Supplementary insulation shall be provided if insulation is subject to flow because the wire is formed over the edge of metal or through a hole punched in sheet metal.

11.3 Supplementary insulating tubing having a wall not less than 1/64 inch (0.4 mm) thick may be used for protection against the condition indicated in 11.2.

11.4 Lamp or other accessory leads smaller than 24 AWG (0.21 mm^2) shall be protected against mechanical damage or shall be of a type capable of withstanding the vibration, impact, and handling to which it is likely to be subjected.

11.5 Wire insulated with 1/64-inch (0.4-mm) thick thermoplastic, or wire which has been determined to be equivalent, may be used within the enclosure. Internal wiring to decorative lampholders and the like may extend from the clock enclosure if the conductor is Type XT, SP-1, or SPT-1 cord; rated for the voltage involved; and routed in close conformity to the clock structure.

11.6 Wireways shall be smooth and entirely free from sharp edges, burrs, fins, moving parts, and the like that may abrade the wires; or the wires within such an enclosure, compartment, raceway, or similar area shall be located or protected to reduce the risk of contact with any sharp edge, burr, fin, moving part, or the like. Holes in sheet metal walls through which insulated wires pass shall be provided with a bushing if the wall is 0.042 inch (1.07 mm) thick or less. Holes in walls thicker than 0.042 inch (1.07 mm) shall have smooth, well-rounded edges.

11.7 A joint or connection shall be mechanically secure and shall provide positive electrical contact without strain on connections and terminals.

11.8 If stranded internal wiring is connected to a wire-binding screw or stud terminal, it shall be connected so that no loose strands result. The connection shall be made by:

a) The use of a pressure terminal connector, soldering lug, or crimped eyelet;

b) Soldering all strands of the wire together;

c) Tightly twisting all strands together; or

d) Means that have been determined to be equivalent.

11.9 A splice shall be provided with insulation equivalent to that of the wires involved if required spacing between the splice and uninsulated metal parts is not maintained.

11.10 An insulated or uninsulated aluminum conductor used as internal wiring (such as for interconnection between live parts) shall be terminated at each end by a method intended for the combination of the metals involved at the connection point.

11.11 If a wire-binding screw construction or a pressure wire connector is used as a terminating device, it shall be investigated and determined to be acceptable for use with aluminum under the conditions involved (for example, temperature and heat cycling).

12 Coil Windings

12.1 The insulation of a coil winding shall be of a composition that will resist the absorption of moisture.

12.2 Magnetic wire coated with an insulating material is not required to be given additional treatment to prevent moisture absorption.

13 Spacings

13.1 The spacings in the primary circuit of a clock shall not be less than indicated in Table 13.1. These values apply to the spacings between any uninsulated live part and:

a) An uninsulated live part of opposite polarity (either grounded or ungrounded);

b) The walls and cover of a metal enclosure, including attached metal pieces and fittings for conduit or armored cable;

c) An uninsulated grounded dead metal part other than the enclosure; and

d) An exposed dead metal part that is isolated (insulated).

Exception: The requirements in Table 13.1 do not apply to the inherent spacings of a component of a clock, such as a snap switch. Spacings of a component are considered to be in compliance based on the requirements for the component.

Table 13.1
Spacings

Application	Minimum spacing through air and over surface					
	0 – 50 volts,		51 – 150 volts,		151 – 250 volts,	
	inch	(mm)	inch	(mm)	inch	(mm)
At installation-wiring terminals	1/8	3.2[a]	1/4	6.4[a,b]	1/4	6.4[a]
At other uninsulated live parts	3/64	1.2	1/16	1.6	3/32	2.4

[a] Measured with 14 AWG (2.1 mm^2) wire connected to each terminal as in actual service.

[b] The spacing through air at installation-wiring terminals may be less than 1/4 inch (6.4 mm) but not less than 1/8 inch (3.2 mm) if the terminals are recessed in insulating material or have insulating barriers that confine loose strands of conductors so that it is unlikely that the terminals may be grounded or short-circuited.

13.2 Spacings are not specified for a secondary circuit supplied by a transformer if:

a) The secondary circuit complies with Secondary Circuits, Section 14;

b) The transformer complies with the test requirements in the Transformer Abnormal Operation Test, Section 20; and the secondary circuit complies with the test requirements in the Secondary Circuit Component Failure, Abnormal Operation Test, Section 21; or

c) The transformer complies with Class 2 requirements in the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1 and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

13.3 Primary circuit spacings between bare current carrying parts of a low potential (0 – 50 volts) circuit and a circuit operating at more than 50 volts shall not be less than those required for the circuit of the higher potential.

13.4 An insulating barrier or liner used to provide spacings shall not be less than 1/32 inch (0.8 mm) thick.

Exception: An insulating barrier or liner used in conjunction with not less than half the required spacing through air may be less than 1/32 inch (0.8 mm) but not less than 1/64 inch (0.4 mm) thick if it is:

a) Resistant to moisture;

b) Resistant to mechanical damage (if exposed or otherwise likely to be subjected to such damage);

c) Secured in place; and

d) Located so that it is not adversely affected by operation of the equipment in service, particularly with regard to arcing.

13.5 A coil winding shall provide either insulation in accordance with Table 13.2 or through air spacing in accordance with Table 13.1.

Table 13.2
Coil insulation

Location	Insulation thickness	
	inch	(mm)
Between coil turns and grounded metal or metal exposed to contact	1/32	0.8
Between coil winding and splice	1/64[a]	0.4[a]
Between adjacent coil-wire and lead-wire splices (opposite polarity)	0.020	0.51

[a] The thickness of insulation within the coil may be less if the coil withstands a 60-hertz essentially sinusoidal test potential of 1000 volts applied for 1 minute between coil-end leads after breaking the inner-layer coil lead where it enters the inner layer. Three samples are to be tested.

13.6 Insulating material having a thickness less than that specified in 13.3 and 13.4 may be used if it has been investigated and determined to be acceptable for the application.

13.7 The surface of a coil that is exposed to contact by the user, including contact made during an adjustment, shall be protected by insulation not less than 1/32 inch (0.8 mm) thick.

14 Secondary Circuits

14.1 General

14.1.1 A circuit supplied by a single source consisting of an isolating transformer, or a power supply that includes an isolating transformer, is not required to be investigated if:

a) It is in compliance with the Transformer Abnormal Operation Test, Section 20;

b) The open-circuit potential is not more than 42.4 volts peak; and

c) The energy available to the circuit is limited so that the current under any condition of load, including short circuit, is not more than 8 amperes measured after 1 minute of operation.

14.1.2 With reference to the voltage limit specified in 14.1.1, measurement is to be made with the appliance, the power supply, or the transformer primary connected to the voltage specified in 17.2 and with all loading circuits disconnected from the transformer or the power supply under test. Measurement may be made at the output terminals of the transformer or power supply. If a tapped transformer winding is used to supply a full-wave rectifier, voltage measurement is to be made from each end of the winding to the tap.

14.1.3 The circuits in which the current is limited in accordance with 14.1.4 or 14.1.5 are not required to be investigated if:

a) The power supply mentioned in 14.1.1 is not limited to available short-circuit current by construction of the transformer; and

b) The circuit includes either a fixed impedance, a fuse, a nonadjustable manual-reset circuit protective device, or a regulating network.

14.1.4 A fuse or circuit protective device used to limit the current in accordance with 14.1.3 shall be rated or set not higher than the values specified in Table 14.1.

Table 14.1
Rating for fuse or circuit protector

Open-circuit volts (peak)	Amperes
0 – 21.1	5.0
21.3 – 42.4	3.2

14.1.5 A fixed impedance or regulating network used to limit the current in accordance with 14.1.3 shall be of such value or construction that the current under any condition of load, including short circuit, does not exceed 8 amperes measured after 1 minute of operation.

14.1.6 If a regulating network is used to limit the voltage or current in accordance with 14.1.1 and 14.1.3, and if its performance may be adversely affected by failure (either by short circuit or open circuit) of any single component in the network, such failure shall not cause the voltage and current limits specified in 14.1.1 to be exceeded.

14.1.7 In a circuit of the type described in 14.1.3, the secondary winding of the transformer, the fuse or circuit protective device, or the regulating network and all wiring up to the point at which the current and voltage are limited shall be evaluated under the applicable requirements of this standard.

14.2 Connections to frame

14.2.1 A secondary circuit may be connected to the frame of the unit.

14.2.2 If the frame is used as a current carrying part of a secondary circuit, a hinge or other movable part shall not be relied upon as a current carrying means.

14.3 Separation of circuits

14.3.1 The wiring in the secondary circuits covered in 14.1.1 and 14.1.3 shall be secured from the wiring of other circuits or shall be provided with insulation that has been determined to be acceptable for use at the highest of the voltages in the other circuits.

PERFORMANCE

15 Leakage Current Test

15.1 The leakage current of a clock is to be tested in accordance with 15.3 – 15.8. The results are considered to be in compliance if the current is not more than 0.5 milliampere.

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

15.3 All exposed conductive surfaces are to be tested for leakage currents. The leakage currents from these surfaces are to be measured to the grounded supply conductor individually as well as collectively in which simultaneously accessible and from one surface to another where simultaneously accessible. Parts are considered to be exposed surfaces unless guarded by an enclosure as described in 4.1.5 and 4.2.1. Surfaces are considered to be simultaneously accessible if they may be contacted by one or both hands of a person at the same time. These measurements do not apply to terminals operating at voltages considered to present a risk of injury to persons.

15.4 If a conductive surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured using a metal foil with dimensions of 10 by 20 centimeters in contact with the surface. Where the surface is less than 10 by 20 centimeters, the metal foil is to be the same size as the surface. The metal foil is not to remain in place long enough to affect the temperature of the clock.

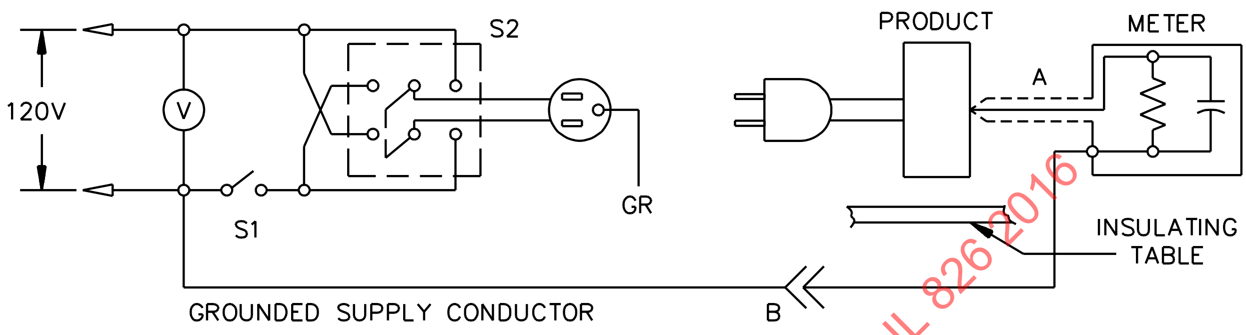
15.5 The measurement circuit for leakage current is to be as shown in Figure 15.1. The ideal measurement instrument is defined in (a) – (c). The meter actually used for a measurement need only indicate the same numerical value for a particular measurement as would the ideal instrument. The meter used need not have all the attributes of the ideal instrument.

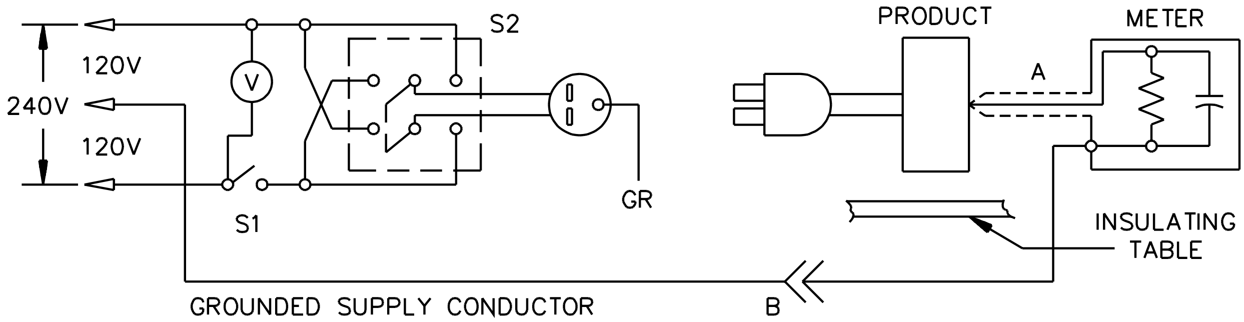
a) The meter is to have an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15 microfarad.

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

c) Over a frequency range of 0 – 100 kilohertz, the measurement circuitry is to have a frequency response (ratio of indicated to actual value of current) equal to the ratio of the impedance of a 1500 ohm resistor shunted by a 0.15 microfarad capacitor to 1500 ohms. At an indication of 0.5 milliampere, the measurement is to have an error of not more than 5 percent.

Figure 15.1
Leakage current measurement circuits





LC200

A – Probe with shielded lead.

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

15.6 Unless the meter is being used to measure leakage from one part of the clock to another, the meter is to be connected between the accessible parts and the grounded supply conductor.

15.7 A sample of the clock is to be tested for leakage current starting with the as-received condition, that condition being without prior energization other than as may occur as part of the production-line testing. Any grounding conductor is to be open at the receptacle or test terminals. The supply voltage is to be adjusted to 120 or 240 volts depending on the rating. The test sequence, with reference to the measurement circuit, is to be as follows:

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

b) Switch S1 is then to be closed, energizing the clock, and within a period of 5 seconds the leakage current is to be measured using both positions of switch S2 with the clock-switching devices in all their intended positions.

c) Leakage current is to be monitored until thermal stabilization. Both positions of switch S2 are to be used in determining this measurement. Thermal stabilization is obtained by operation as in the normal temperature test.

15.8 A sample is to be subjected to the complete leakage current test program as covered by 15.7 without interruption for other tests. With the concurrence of those concerned, the leakage current tests may be interrupted for the purpose of conducting other nondestructive tests.

16 Leakage Current Test Following Humidity Conditioning

16.1 An appliance shall comply with the requirements for leakage current in 15.1 following exposure for 48 hours to air having a relative humidity of 88 ±2 percent at a temperature of 32.0 ±2.0°C (89.6 ±3.6°F).

16.2 To determine compliance with the requirement in 16.1, a sample of the appliance that has been preheated to a temperature just above 34.0°C (93.2°F) is to be contained in a chamber under the time, humidity, and temperature conditions specified. Following the conditioning, the sample is to be tested unenergized as described in 15.7(a). The sample is then to be energized and tested as described in 15.7 (b) and (c). The test is to be discontinued when the leakage current stabilizes or decreases.

17 Current Input Test

17.1 The current input to a clock shall not exceed the marked rating of the clock by more than 10 percent when the clock is operated while connected to a supply circuit of its rated voltage and rated frequency.

Exception: A clock rated at 20 watts or less may have an input of not more than 25 percent above its marked rating.

17.2 Rated voltage is considered to be:

a) 120 volts if the marked rating is within the range of 110 – 120 volts or

b) 240 volts if the marked rating is within the range of 220 – 240 volts.

If the rating is given in terms of a range of voltages, maximum rated voltage is considered to be the highest value of the range – 120 volts or 240 volts, minimum.

18 Temperature Test

18.1 A clock is to be tested under the conditions described in 18.2. Results are considered to be in compliance if the clock does not:

a) Attain a temperature at any point that constitutes a risk of fire or damages any materials it uses nor

b) Show temperature rises at specific points greater than those indicated in Table 18.1.

Table 18.1
Maximum temperature rises

Materials and components	°C	(°F)
1. Varnished cloth insulation	60	108
2. Fuses	65	117
3. Fiber used as electrical insulation	65	117
4. Wood and other similar material	65	117
5. Any point on or within a terminal box of a stationary appliance	65	117
6. A surface upon which a cord-connected or permanently-wired appliance might be mounted in service, and surfaces that might be adjacent to the appliance when it is so mounted	65	117
7. Class 105 (A) insulation systems on coil windings of an a-c motor having a frame diameter[a] of more than 7 inches (178 mm), of a d-c motor, and of a universal motor:		
A. In an open motor:		
Thermocouple method	65	117
Resistance method	75	135
B. In a totally enclosed motor:		
Thermocouple method	70	126
Resistance method	80	144
8. Class 105 (A) insulation systems on coil windings of an a-c motor having a frame diameter[a] of 7 inches or less, not including a universal motor:		
A. In an open motor:		
Thermocouple or resistance method	75	135
B. In a totally enclosed motor:		
Thermocouple or resistance method	80	144
9. Class 130 (B) insulation systems on coil windings of an a-c motor having a frame diameter[a] of more than 7 inches, of a d-c motor, and of a universal motor:		
A. In an open motor:		
Thermocouple method	85	153
Resistance method	95	171
B. In a totally enclosed motor:		
Thermocouple method	90	162
Resistance method	100	180
10. Class 130 (B) insulation systems on coil windings of an a-c motor having a frame diameter[a] of 7 inches or less, not including a universal motor:		
A. In an open motor:		
Thermocouple or resistance method	95	171
B. In a totally enclosed motor:		
Thermocouple or resistance method	100	180
11. Class 105 insulation systems on windings of relays, solenoids, magnets, and the like:		
Thermocouple method	65	117
Resistance method	85	153
12. Class 130 insulation systems on coil windings:		
Thermocouple method	85	153
Resistance method	95	171
13. Class 130 insulation systems on windings of relays, solenoids, magnets, and the like:		
Thermocouple method	85	153

Table 18.1 Continued on Next Page

Table 18.1 Continued

Materials and components	°C	(°F)
Resistance method	105	189
14. Phenolic composition used as electrical insulation or as a part whose failure would result in a risk of fire, electric shock, or injury to persons	125[b]	225[b]
15. Rubber- or thermoplastic-insulated wires and cords	35[b]	63[b]
16. On the surface of a capacitor casing:		
Electrolytic	40[c]	72[c]
Other types	65[c]	117[c]

[a] This is the diameter, measured in the plane of the laminations, of the circle circumscribing the stator frame excluding lugs, boxes, and the like used solely for motor mounting, assembly, or connection.

[b] The limitations on phenolic composition and on rubber and thermoplastic insulation do not apply to compounds that have been investigated and determined to have heat resistant properties.

[c] A capacitor operating at a temperature higher than 65°C (149°F) may be evaluated on the basis of its marked temperature rating or, if not marked with a temperature rating, may be investigated to determine its suitability at the higher temperature.

18.2 To determine whether a clock complies with the requirements in 18.1, it is to be mounted in its intended use position on a softwood surface and connected to a supply circuit of rated voltage and frequency with the rotor of the clock motor stalled. These conditions are to be maintained until constant temperatures have been reached.

18.3 All values in Table 18.1 are based on an assumed ambient (room) temperature of 25°C (77°F), but a test may be conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F). Each observed temperature is to be corrected by the addition of the difference between 25°C (77°F) and the actual ambient temperature if the test is conducted at an ambient temperature less than 25°C (77°F), and each observed temperature is to be corrected by the subtraction of the difference between 25°C (77°F) and the actual ambient temperature if the test is conducted at an ambient temperature more than 25°C (77°F). If the test is conducted at an ambient temperature of other than 25°C (77°F), and if a corrected temperature exceeds the limit specified in Table 18.1, the test may be repeated at an ambient temperature closer to 25°C (77°F).

18.4 Temperatures are to be measured by using thermocouples consisting of wires not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.05 mm^2). When thermocouples are used in determining temperatures in electrical equipment, it is standard practice to use thermocouples consisting of 30 AWG iron and constantan wire and a potentiometer type instrument. Such equipment is to be used whenever referee temperature measurements by thermocouples are necessary.

Exception: A coil temperature may be determined by the change-of-resistance method as described in 18.8 and 18.9 if the coil is inaccessible for mounting thermocouples.

18.5 A temperature is considered to be constant when three successive readings, taken at intervals of 10 percent of the previously elapsed duration of the test (but not less than 5-minute intervals), indicate no change. The thermocouples and related instruments are to be accurate. The thermocouple wire is to conform with the requirements specified in the “Tolerances on Initial Values of EMF versus Temperature” tables in the Standard Specification and Temperature-Electromotive Force (EMF) Tables for Standardized Thermocouples, ANSI/ASTM E230.

18.6 A thermocouple junction and adjacent thermocouple lead wire are to be secured in positive thermal contact with the surface being measured. In most cases, positive thermal contact will result from securely taping or cementing the thermocouple in place but, if a metal surface is involved, brazing or soldering the thermocouple to the metal may be required.

18.7 The thermocouple method consists of the determination of temperature by the application of thermocouples to the hottest accessible parts.

18.8 The temperature rise of a winding by the change of resistance method is to be calculated from the following formula (windings are to be at room temperature at the start of the test):

$$\Delta t = \frac{R}{r}(k + t_1) - (k + t_2)$$

in which:

Δt is the temperature rise;

R is the resistance of the coil at the end of the test;

r is the resistance of the coil at the beginning of the test;

k is 234.5 for copper and 225.0 for electrical conductor grade (EC) aluminum (values of the constant for other grades shall be determined);

t_1 is the room temperature in °C at the beginning of the test; and

t_2 is the room temperature in °C at the end of the test.

18.9 If it is necessary to de-energize the winding before measuring R, the value of R at shutdown may be determined by taking several resistance measurements at short intervals, beginning as quickly as possible after the instant of shutdown. A curve of the resistance values and the time may be plotted and extrapolated to give the value of R at shutdown.

19 Dielectric Voltage-Withstand Test

19.1 General

19.1.1 A clock is to be tested by means of a 500-volt-ampere or larger transformer, the output voltage of which may be varied and is essentially sinusoidal. The applied potential is to be increased from zero until the required test level is reached, with the rate of increase as rapid as is consistent with correct indication of the test potential on a voltmeter. After the required test potential has been reached, it is to be maintained for 1 minute.

19.2 Primary circuits

19.2.1 While at its maximum normal operating temperature, a clock shall be subjected for 1 minute to the application of a 60-hertz essentially sinusoidal potential of 1000 volts for the following conditions:

a) Between primary circuit live parts and dead metal parts,

b) Between circuits that are at different potentials and are not electrically connected (this includes the primary and secondary circuits of isolating transformers), and

c) Between primary circuit terminals of opposite polarity on capacitors that are across the line.

The results are considered to be in compliance if there is no dielectric breakdown.

19.3 Secondary circuits

19.3.1 A secondary circuit of a clock is to be subjected to the application of a test potential:

a) Between a primary and the secondary circuit;

b) Between the secondary circuit and grounded metal with all the chassis-connected components disconnected at the chassis; and

c) Between the secondary circuit and a secondary circuit supplied from separate transformer windings with common connections disconnected.

The clock is to be at its maximum normal operating temperature during the test. The test potential, applied for 1 minute, is to be as indicated in Table 19.1. Results are considered to be in compliance if there is no dielectric breakdown.

Table 19.1
Magnitude of test potential

Maximum voltage in the circuit[a]	Test potential
30 or less (42.4 peak)	No test
More than 30 (42.4 peak) but not more than 250 (353.5 peak)	10 times maximum voltage in the circuit (maximum of 1000 volts rms)

[a] Where peak voltage is greater than 120 percent of 1.414 times the rms voltage, the circuit is to be tested as if the voltage were peak voltage divided by 1.414.

20 Transformer Abnormal Operation Test

20.1 General

20.1.1 A transformer is to be subjected to the 15-day abnormal operation tests described in 20.2.1 – 20.2.13. The abnormal tests may be conducted with a protective device having a rating specified by the manufacturer connected in either the primary or secondary circuit, or in both. A protective device that is relied upon to open the circuit as a result of an abnormal test is to be one that has been investigated and determined to be acceptable for the purpose.

Exception: A transformer that complies with requirements in the Standard for Transformer and Motor Transformers for Use in Audio-, Radio-, and Television-Type Appliances, UL 1411, is not required to be subjected to the abnormal operation tests.

20.1.2 For the purpose of these requirements, each secondary winding tap other than a center tap and each primary winding tap constructed to supply power to a load is to be considered the equivalent of a secondary winding.

20.2 15-day abnormal operation

20.2.1 If an abnormal operation test continues for the full 15 days without a winding or a protective device opening, the remaining tests are not required to be conducted for the sequence of tests described in 20.2.3. For example, if the test described in 20.2.3(a) continues for 15 days, the tests described in 20.2.3 (b) and (c) are not required to be conducted.

20.2.2 A transformer is to be operated for the full 15 days with the secondary winding or windings loaded to rated current.

20.2.3 Loading the secondary winding shall not result in a risk of fire or electric shock under any of the following conditions:

a) Short-circuiting the secondary winding.

b) Loading the secondary winding, in turn, to a current equal to the rated current plus 75, 50, 25, 20, 15, 10, and 5 percent of the difference between the short-circuit current and the rated current.

c) Loading the secondary winding to rated current.

20.2.4 To determine whether a transformer complies with the requirement in 20.2.3, three separate samples are to be subjected to each condition described in 20.2.3 (a) – (c). The rotor of a motor-transformer is to be free running (no load) during the tests. For a transformer that uses more than one secondary winding, each of the secondary windings is to be loaded for each condition specified in 20.2.3 with the other windings loaded to rated current. The test conditions are to be as described in 20.2.7 – 20.2.13.

20.2.5 To determine the short-circuit current value for conducting the tests described in 20.2.3(b), the transformer is to be at room temperature at the beginning of the measurement, and the short-circuit current is to be measured approximately 1 minute after the application of voltage to the primary winding. An external protective device, if provided by the manufacturer, is to be short-circuited during the measurement of the short-circuit current. If the 30-ampere line fuse or transformer winding opens within 1 minute after the application of the primary voltage, the short-circuit current is considered to be that value recorded just before the line fuse or winding opens. The short-circuit current of any one winding is to be measured with the other secondary windings open-circuited.

20.2.6 For the loading conditions, a variable resistor is to be connected across the secondary winding. The tests described in 20.2.3 (a) – (c) are to be continued for 15 days unless a winding of the transformer or a protective device opens in a shorter time. In conducting the tests described in 20.2.3 (b) and (c), the variable resistance load is to be adjusted to the required value as quickly as possible and readjusted, if necessary, 1 minute after application of voltage to the primary winding.

20.2.7 If the secondary-winding short-circuit test described in 20.2.3(a) causes one of the windings to open before 15 days, then any of the tests described in 20.2.3 (b) and (c) that continues for the full 15 days is to have a variable load resistor reduced to zero impedance at the end of the 15 days. This is to cause the transformer to burn out if this condition can occur as a result of a secondary-winding short circuit.

20.2.8 For a transformer that is provided with a built-in protective device or that is being tested in conjunction with an external protective device, the tests described in 20.2.3 (a) and (b) are to be concluded if the protective device opens the circuit. If the protective device is of the automatic recycling type, the test is to be continued for the full 15 days.

20.2.9 If a protective device opens the circuit or a winding on one sample opens during the 15-day abnormal operation tests while the samples are unattended, the variable resistor load on the other two samples is to be increased, by reducing the resistance, until the protective device opens the circuit or the winding opens, so that samples may be subjected to the dielectric voltage-withstand test described in 20.2.3 while in a heated condition.

20.2.10 Samples for the 15-day abnormal operation tests are to be prepared as follows:

a) The transformer is to be placed on a white tissue-paper-covered softwood surface.

b) Exposed dead metal parts and one end of each secondary winding are to be connected to ground through a 1-ampere non-time-delay fuse unless such a connection might create a condition that is not likely under single-fault conditions.

Exception: The fuse need not be used for a transformer intended for use in a clock in which the transformer core and secondary windings are electrically isolated from all accessible metal parts.

c) A single layer of cheesecloth is to be draped loosely over the transformer or its individual enclosure.

d) The transformer is to be connected to rated voltage fused at 30 amperes.

e) All secondary windings are to be loaded to rated current before the abnormal condition is introduced; and the loads, other than that connected to the winding to be overloaded, are not to be readjusted thereafter.

20.2.11 Each 15-day abnormal operation test is to be continued for the full 15 days or until evidence of a risk of fire develops or the circuit under test burns open.

20.2.12 The results of the test are considered to be in compliance if there is no glowing or flaming of the cheesecloth or tissue paper, the 1-ampere fuse remains intact, and there is no dielectric breakdown when the test described in 20.2.13 is conducted.

20.2.13 While still in a heated condition from the tests described in 20.2.3, a transformer shall withstand the dielectric voltage-withstand test described in 19.1.1. The dielectric voltage-withstand test potential is to be applied to the transformer approximately 1 minute after completion of the abnormal operation test.

21 Secondary Circuit Component Failure, Abnormal Operation Test

21.1 The secondary circuit of a clock investigated to the requirements in 13.2(b) may be used if there is no evidence of a risk of fire or electric shock when subjected to the tests described in 21.2 – 21.6.

21.2 During the test, the clock is to be connected to a supply circuit fused at 30 amperes and placed on a white tissue-paper-covered softwood surface.

21.3 Each component in a secondary circuit in which there is less than 1000 ohms of series impedance between the component and the transformer is to be caused to fail, one at a time, in a manner likely to occur (shorted or opened capacitor, resistor, diode, and the like) during abnormal operation.

21.4 The clock is to be reassembled and a single layer of cheesecloth is to be draped loosely over the entire appliance.

21.5 Exposed dead metal parts are to be connected to earth ground through a 1-ampere non-time-delay fuse. The supply circuit connection is to be such that the maximum potential exists between the protective device of the appliance, if any, and the chassis.

21.6 The abnormal condition is to be maintained for 7 hours or until there is evidence of a risk of fire, the circuit under test burns open, or it becomes obvious that no further change is likely to take place.

22 Stability Test of Floor-Standing Clocks

22.1 A floor clock shall be subjected to a tip-over stability test as described in 22.2.

Exception: A clock provided with a hanger, hook, or other device for securing to a wall or other object, and with user instructions, is not required to be tested.

22.2 The clock is to be placed in its intended upright position at the center of a plane that is inclined 8 degrees from horizontal. Legs or other means of support may be blocked to prevent slippage. The results are considered to be in compliance if the clock does not tip over.

23 Enclosure Abuse (Drop) Test

23.1 To determine compliance with Exception No. 3 to 4.1.3, each of three samples of a clock shall be dropped three times from a height of 3 feet (0.91 m) onto a hardwood surface. Each drop is to be conducted in such a manner that the sample will impact on the hardwood in a different position.

23.2 The hardwood surface is to consist of one layer of nominal 1-inch (25.4-mm) tongue-and-groove oak flooring mounted on two layers of 3/4-inch (19.1-mm) thick plywood. This assembly is to rest on a concrete floor.

23.3 The results are considered to be in compliance if, as a result of the series of drops, each of the three samples has:

a) No reduction of spacings below the minimum values specified in Spacings, Section 13;

b) No accessibility of any live part in accordance with 4.2.1 – 4.2.5; and

c) Results that are considered to be in compliance in a repetition of the Dielectric Voltage-Withstand Test, Section 19.

24 Mounting Means Test

24.1 A force three times the weight of the clock, but not less than 5 pounds-force (22.2 N) total, is to be applied to the clock when mounted in accordance with the manufacturer’s instructions. The results are considered to be in compliance if the clock and the mounting system remain in place with no evidence of damage.

24.2 The clock is to be mounted to a vertical surface using the intended mounting means and in accordance with any instructions provided with the clock. In the absence of mounting instructions, a nail or screw is to be driven into the mounting surface. The additional force is to be applied vertically downward through the center of gravity of the clock in a gradual manner to avoid impact and is to be maintained for 1 minute.