



Underwriters Laboratories Inc.®

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

January 10, 1996

Revision pages for

Standard for

Limit Controls

UL 353, Fifth Edition

Attached to this transmittal notice is a revision of the Fifth edition of UL 353.

A CHANGE ON A PAGE DATED JANUARY 10, 1996 IS INDICATED BY A SMALL PRINT NOTE FOLLOWING THE AFFECTED ITEM, PRECEDED AND FOLLOWED BY AN ASTERISK.

THIS REVISION IS CONSIDERED NON-SUBSTANTIVE AND IS BEING ISSUED TO ELIMINATE THE OXYGEN BOMB TEST. THE OXYGEN BOMB TEST IS NO LONGER APPROPRIATE IN MOST CASES DUE TO THE ADDITION OF ANTIOXIDANTS TO RUBBER AND POLYMERIC COMPOUNDS. THEREFORE, UL IS ELIMINATING THE OXYGEN BOMB TEST AND REPLACING IT WITH AN AIR OVEN AGING TEST WHICH IS USED FOR THERMOPLASTIC COMPOUNDS. THE REQUIREMENTS ARE NOW IN EFFECT.

Attention is directed to the note on the title page of this standard outlining the procedure to be followed to retain the approved text of ANSI/UL 353-1995.

Attention is directed to the note on the title page of this standard outlining the procedure to be followed to retain the Department of Defense approved text of UL 353.

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

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UL 353
Standard for
Limit Controls

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Fifth Edition

September 23, 1994

Approval as an American National Standard (ANSI) covers the numbered paragraphs on pages dated September 23, 1994. These pages should not be discarded when revised or additional pages are issued if it is desired to retain the ANSI approved text.

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The Department of Defense (DoD) has adopted UL 353 on January 27, 1992. 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 published set of revision pages.

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22.2 If the function or calibration of a control is affected by its being placed out of level, the control shall be provided with a leveling indicator such as a bubble, pendulum, or a horizontal or vertical line. Such a control, when attached as intended, shall resist without moving, a torque of 100 pound-inches (11.3 N·m).

22.3 If a control requires a mounting bracket to conform to these requirements, the bracket shall be furnished with the control. The bracket shall be marked with a part number and reference to the bracket and its part number, and use shall be indicated on the control. Such reference may be placed on the inside of the control cover.

23 Operating Mechanism

23.1 If screws and nuts serve to attach operating parts to movable members, they shall be upset or otherwise locked.

23.2 The operating mechanism of a manually operated switch shall not subject parts to damage.

23.3 Operating parts shall be separated by barriers or by their physical location from conductors to be connected to the control to avoid obstruction of such parts by stowed wiring. See also 9.3.1.

24 Adjustment and Stops

24.1 The set point shall be indicated on the control in a recognizable and legible manner. Units of measurement such as inches or millimeters, degrees F or C, pounds per square inch, etc. shall be employed. A set point for liquid level may be indicated by a horizontal line.

24.2 If a control is nonadjustable following factory calibration, it may be marked with a single set point.

24.3 If a control is adjustable in the field, stops or equivalent means shall be provided for limiting the adjustments to values within the rated set point range of the control. The set points over the range of allowable field adjustment shall be indicated thereon at increments of not more than 25 percent of the range.

24.4 An adjustable stop employed for limiting a set point shall not be used for other adjustments. It shall be secured by a means provided solely for that purpose and in a manner such that the maximum or safe setting cannot be increased except by the use of special tools or by deliberate bending or removal of some part. Nuts, screws, etc., used for this purpose shall be provided with integral lock washers or the equivalent. Parts used for support of the adjustment means shall have strength sufficient to resist accidental bending.

24.5 If a set point may be altered by resetting or removing the stop or if a control includes on it directions for altering the set point, a statement shall be on the dial, scale, or stop, or directly adjacent thereto or on the outside (not inside) of the cover. This statement shall be to the effect that the setting is a safety stop and is not to be altered to permit a higher or less safe operating point, for example "SAFETY STOP - DO NOT ALTER."

25 Reset Mechanism

25.1 A control shall not reset or be resettable manually or otherwise so that operation of the controlled appliance can be resumed until after a safe operating condition is restored. (For example, pressure or temperature returned to value at or below control set point.)

25.2 A control which is intended to be reset manually shall not reset automatically as a result of changes in environmental temperature at temperatures above minus 35°C (minus 31°F).

25.3 A manually operated reset device shall be trip-free; that is, the automatic tripping shall be independent of the manipulation or position of the reset button, handle, lever, etc.

25.4 A manually operated reset device of a control may provide one or another of the following kinds of reset function.

a) A control to be designated "Manual Reset 1" or "M1" permits the control to automatically reset to the "closed" position after safe operation conditions have been restored, if the reset means is held in the "reset" position. The operating tolerances specified in 29.1.5 – 29.1.11 shall not be exceeded if the reset means is held in the "reset" or "ON" position.

b) A control to be designated "Manual Reset 2" or "M2" shall not permit the control to function as an automatic-reset device if the reset means is held in the "reset" or "ON" position.

25.5 A control with a manual reset shall be resettable exterior to the control enclosure.

25.6 A manually operated reset mechanism shall not subject the operating mechanism or means of support to undue strain.

PERFORMANCE

26 General Tests

26.1 Except as otherwise indicated, representative commercial samples of a control shall be subjected to the required tests. Tests shall be conducted at rated frequency and at the voltage indicated in Table 27.1.

26.2 An alternating-current control having no frequency rating is to be tested on a circuit having a frequency of 60 cycles, except that a circuit having a lower frequency may be employed if agreeable to those concerned.

26.3 Where reference is made to ac voltages and currents of 60-hertz they are intended to indicate rms values, unless otherwise specified.

26.4 A control which must be mounted in a definite position in order to function properly is to be tested in that position provided directions for mounting in the correct position are given on the control or on an instruction sheet supplied with the control. See 22.2.

26.5 A part made of an elastomer shall not crack or show visible evidence of deterioration following air oven aging for 70 hours at 100°C (212°F).

26.5 revised January 10, 1996

26.6 For a control that is rated for use in a prevailing ambient temperature greater than 25°C (77°F), the Temperature Test, Section 28, overvoltage and undervoltage tests on the electromagnet (29.5.1 – 29.5.3), Overload Test, Section 30, and the Endurance Test, Section 31, are to be conducted at the rated ambient temperature. However, the overload and endurance tests under electrical load may be conducted at room ambient in accordance with note (d) of Table 28.1.

26.7 For a control that is rated for use in an ambient temperature less than 25°C (77°F), the electromagnet undervoltage test and any other tests that may be affected by the cold ambient are to be conducted at the rated low ambient. This test shall be in addition to the test conducted at the room ambient or at the rated elevated ambient temperature.



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Revision pages for

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Limit Controls

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A CHANGE ON A PAGE DATED DECEMBER 12, 1995 IS INDICATED BY A SMALL PRINT NOTE FOLLOWING THE AFFECTED ITEM, PRECEDED AND FOLLOWED BY AN ASTERISK.

THIS REVISION IS CONSIDERED NON-SUBSTANTIVE AND IS BEING ISSUED TO CHANGE THE SPECIFIC GRAVITY OF THE AQUEOUS AMMONIA TO A VALUE WHICH PRODUCES VALUES MORE CONSISTENT WITH MERCUROUS NITRATE TEST RESULTS. THIS REVISION ALSO CORRECTS SOME TYPOGRAPHICAL ERRORS. THE REQUIREMENTS ARE NOW IN EFFECT.

Attention is directed to the note on the title page of this standard outlining the procedure to be followed to retain the approved text of ANSI/UL 353-1995.

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FOREWORD

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

12.21 The resistance between the point of connection of the equipment grounding means, at or within the device, and any other point in the grounding circuit shall be not more than 0.1 ohm.

12.22 Compliance with the requirements of 12.21 may be determined by a Wheatstone Bridge, except that if unacceptable results are recorded, an alternating current of at least 20 amperes from a power supply of not more than 12 volts is to be passed from the point of connection of the equipment grounding means to the metal part in the grounding circuit, and the resulting drop in potential is to be measured between the two points. The resistance in ohms is to be determined by dividing the drop in potential in volts by the current in amperes passing between the two points. The grounding conductor of a power-supply cord is not included in this measurement.

12.22 revised December 12, 1995

13 Protection of Users and Service Personnel

13.1 These requirements apply to live parts in other than low-voltage circuits.

13.2 Live parts shall be located and enclosures and covers arranged so that persons are not likely to be exposed to electric shock while removing or replacing a cover. This requirement is also applicable to controls which are mounted on or form a cover for a junction box or wiring enclosure.

13.3 Live parts which are recessed at least 1/8 inch (3.2 mm) from any point of contact during the process of removal and replacement of a cover, are considered as not presenting a risk of electric shock if it is demonstrated by trial removal and replacement of the cover that the live parts cannot be contacted during the removal and replacement process. Projections or guards may be incorporated for the purpose of providing the equivalent of the 1/8 inch (3.2 mm) recess.

13.4 Unless the cover construction conforms with requirements for hinged covers in 6.3.5 and 6.3.8, and unless all live parts are protected as specified in 13.6, a handle, knob, or other operating means provided for manual manipulation shall be arranged so that such manipulation may be done exterior to the control enclosure. The position of such operating means shall be marked, if necessary, as a guide for proper operation.

13.5 Devices which involve manual operations which might be done only at the time of installation, during servicing procedures, or seasonally, need not comply with 13.4 provided that the construction complies with the requirements in 13.6, 13.7, 13.14, 13.16, 13.18 and 13.19.

13.6 An uninsulated live part shall be located, guarded, or enclosed so as to reduce the likelihood of contact by persons with nearby live or hazardous moving parts while relamping, changing fuses, adjusting controls, lubricating motors, or during other normal operations.

13.7 If the marking or operating instructions refer to a hole or opening in the enclosure through which a tool is to be inserted for adjustment or similar activity, the construction shall be such that uninsulated live parts cannot be contacted through the hole or opening by a 1/16 inch (1.6 mm) diameter rod of any length.

13.8 Controls which are to be adjusted only at the time of installation, servicing, or seasonally, are to be evaluated with respect to the foregoing requirement.

13.9 A live heat sink for a solid state component, a live relay frame, and the like, shall comply with 13.6, 13.14 and 13.18, but regardless of its location shall either be guarded to prevent contact by persons or the equipment shall be marked in accordance with 46.3, except as permitted in 13.12.

13.10 With respect to 13.9, it is to be noted that the size, shape, material, and color give a heat sink or relay-frame the appearance of a dead-metal part. Other types of live parts which can be mistaken for dead are to be evaluated similarly.

13.11 Guards, baffles, and internal covers which do not require tools for removal will be removed when determining whether a part is exposed to contact by the user. A part which can be contacted by a 3/4 inch (19.1 mm) diameter rod of any length or by probe shown in Figure 6.1, when inserted through openings in permanently attached guards or baffles, is considered exposed for the purposes of protecting persons.

13.12 A part on the back side of a component mounting panel or a part located so as to require major disassembly by using tools is not considered to be exposed to the user, and such parts are not considered exposed to the serviceman unless it is likely that servicing will be done while energized after the disassembly has been made.

13.13 Parts of controls which are subject to contact during normal operation, adjustments, and user servicing shall be free of sharp corners and edges.

13.14 An uninsulated live part or a hazardous moving part shall be located, guarded, or enclosed so as to prevent accidental contact by service personnel adjusting or resetting controls, etc., or performing mechanical (refrigeration, plumbing, or pneumatic temperature-control systems, lubricating motors, etc.), service functions which may have to be performed with the equipment energized.

13.15 Mechanical service functions which may have to be performed with the equipment energized include: Operation of valves or connection to fittings which may be necessary during charging or pneumatic-system adjustment, adjusting water control, or expansion valves; adjusting the setting of temperature or pressure controls with or without marked dial settings; resetting control trip mechanism; operating manual switches; adjusting air-flow dampers. A factory-set and sealed control, having the set point sealed as described in 21.2 and 21.3 and not having marking or instructions for adjustment, is not considered to be adjustable.

13.16 Adjustable or resettable electrical control or manual switching devices may be located or oriented with respect to uninsulated live parts so that manipulation of the mechanism for adjustment, resetting, or operation can be accomplished in the normal direction of access if uninsulated live parts are:

- a) Not located in front (in the direction of access) of the mechanism; and
- b) Are not located near any side or behind the mechanism, unless guarded.

13.17 In determining compliance with the preceding, bare live parts in 30-volt or less limited-energy circuits in accordance with 2.6(b) and (d) are not to be considered.

13.18 An electrical component which may require examination, adjustment, servicing, or maintenance while energized shall be located and mounted with respect to other components and with respect to grounded metal parts so that it is accessible for electrical service functions without subjecting the serviceman to the likelihood of electric shock or to accidents from adjacent hazardous moving parts. Access to the components in the control assembly is not to be impeded in the direction of access by other components or by wiring.

13.19 Accessibility and protection from the likelihood of electric shock and accidents may be obtained by mounting the control components in an assembly so that unimpeded access is provided to each component through an access cover or panel in the outer cabinet (if provided) and the cover of the control assembly enclosure.

38.2 Upon completion of the test specified in 38.1, the hydraulic pressure is to be increased until rupture occurs. The rupture shall occur at the bellows, diaphragm, or other part within the switch body or control enclosure; and, for a control intended for use with cooking or food handling appliances, rupture shall occur in the portion of the control that will be located outside of the food-containing space when the control is installed as intended. See 38.4 and 38.5.

38.3 In addition to the requirements in 38.1 and 38.2, a part of a control that is intended for use with cooking or other food handling appliances and that contains mercury or sodium-potassium shall:

- a) Not leak or rupture when heated to 120 percent of the maximum temperature in °F to which the control is likely to be exposed in intended operation, and
- b) Comply with the requirements in 38.4 when the bellows or diaphragm is deliberately punctured with a sharp pointed metal rod.

38.4 With reference to the requirements in 38.2 and 38.3, it shall not be possible for mercury escaping due to rupture by overpressure or puncture of a bellows or diaphragm to enter an oven or food handling compartment, or contact food handling hardware, when installed in the intended manner, and it shall be contained in the switch body or control enclosure or the switch body or control enclosure shall have provision for expelling the mercury outside the oven or compartment.

38.5 Sodium-potassium escaping due to the rupture by overpressure or puncture of a bellows or diaphragm shall be contained in the switch body or control enclosure and no risk of fire shall result from the overpressure or puncture.

39 10-Day Moist Ammonia Air Stress Cracking Test

39.1 After being subjected to the conditions in 39.2 – 39.4, a brass part containing more than 15 percent zinc shall show no evidence of cracking when examined using 25x magnification.

39.1 revised December 12, 1995

39.2 Each test sample is to be subjected to the physical stresses normally imposed on or within a part as the result of assembly with other components. Such stresses are to be applied to the sample prior to and be effective during the test. Samples with threads, intended to be used for installing the product in the field, are to have the threads engaged and tightened to the torque specified in Table 39.1. Teflon tape or pipe compound are not to be used on the threads.

39.2 revised December 12, 1995

Table 39.1
Torque requirements for threaded connections

Nominal thread size, inches	Torque pound-inches (N·m)	
1	1200	(135.6)
1-1/4	1450	(163.8)
1-1/2	1550	(175.1)
2	1650	(186.4)
2-1/2	1750	(197.7)
3	1800	(203.4)

Table 39.1 added December 12, 1995

39.3 Three samples are to be degreased and then continuously exposed in a set position for ten days to a moist ammonia-air mixture maintained in a glass chamber approximately 12 by 12 by 12 inches (305 by 305 by 305 mm) having a glass cover.

39.4 Approximately 600 ml of aqueous ammonia having a specific gravity of 0.94 is to be maintained at the bottom of the glass chamber below the samples. The samples are to be positioned 1-1/2 inches (38.1 mm) above the aqueous ammonia solution and supported by an inert tray. The moist ammonia air mixture in the chamber is to be maintained at atmospheric pressure and at a temperature of 93°F (34°C).

39.4 revised December 12, 1995

40 Push-In Terminals Test

40.1 Pullout test

40.1.1 A push-in (screwless) terminal shall withstand without pullout or breakage of the conductor, or of any strand of the conductor, the application of a straight pull, applied for 1 minute as further described in 40.1.2.

40.1.2 Six samples of the proper size, either solid or stranded or both (six each), are to be connected to the terminals in accordance with the manufacturer's instructions. Each sample is to be subjected to a pull on the wire with the pull gradually increasing until it reaches 20 pounds (89 N) for a high-voltage terminal and 5 pounds (22 N) for a low-voltage nonsafety terminal.

40.2 Temperature test

40.2.1 A push-in (screwless) terminal, when tested as outlined in 40.2.2 – 40.2.5, shall be capable of performing with a temperature rise which shall not exceed 30°C (54°F) based on an ambient temperature of 25°C (77°F).

40.2.2 For high-voltage terminals, a separate set of six previously unused samples is to be assembled with solid copper wire, using No. 14 AWG (2.1 mm²) for a 15 ampere rating and No. 12 AWG (3.3 mm²) for a 20 ampere rating, except that connections to a through connection in a 15-ampere device are to be wired with No. 12 AWG (3.3 mm²) conductors. For a low-voltage nonsafety terminal, the size and type of conductors used are to be in accordance with the manufacturer's instructions.

40.2.3 The high-voltage terminals are to be subjected to a conditioning consisting of nine insertions and withdrawals of a conductor of the size and type to be used for the test. A tenth insertion of a newly-stripped, previously unused length of wire is to be made and left in place for the test. A low-voltage nonsafety terminal is not to be subjected to this conditioning.

40.2.4 With the samples connected as described in 40.2.2 and 40.2.3, a current is to be passed through the assemblies at the rate of 15 amperes for those connected with No. 14 AWG (2.1 mm²) conductors, 20 amperes for those connected with No. 12 AWG (3.3 mm²) conductors, and maximum rated current for a low-voltage nonsafety terminal.

40.2.5 The above assemblies are to be continued under test for 30 days without interruption.

41 Volume Change Test

41.1 An elastomeric part in contact with one of the fluids specified in Table 41.1 shall not exhibit an averaged volume change greater than:

- a) 40 percent by swelling for reference fuel C and 25 percent for other test liquids; or
- b) 1 percent by shrinkage when subjected to a volume change test using the test liquid corresponding to the fluid in the table described in the Standard Test Method for Rubber Property — Effect of Liquids, ANSI/ASTM D471-75 with variations as noted in 41.2. The Weight Loss Test, Section 42, is to be conducted at the same time as the volume change test.

Table 41.1
Test liquids for synthetic rubber materials

Fluid in contact with part	Test liquid
LP-Gas	n-Hexane
Manufactured and Natural Fuel Gases	No. 3 Swelling Oil (ASTM D471-79(1991))
Fuel Oils and Kerosene	No. 3 Swelling Oil (ASTM D471-79(1991))
Gasoline	A and C Reference Fuels (ASTM D471-79(1991))

41.2 The tests are to be conducted at a temperature of $23 \pm 2^\circ\text{C}$ ($73 \pm 4.0^\circ\text{F}$). Three specimens are to be used for each test. For the volume change test, each specimen is to be placed on a small diameter wire hook. The volume is then to be determined by weighing the specimen first in air (M_1), to the nearest milligram, and then in water (M_2). The specimens are to be wiped dry and placed in the test liquid. After 70 hours, the specimens are to be:

- a) Removed from the liquid one at a time;
- b) Immediately wiped dry; and
- c) Within 30 seconds after removal from the test liquid, weighed in air while on the same hook (M_3).

The weight in water (M_4) is to be determined immediately thereafter. Before obtaining the weights in water (M_2 and M_4), each specimen is to be dipped in ethyl alcohol and then dipped in water, to eliminate surface air bubbles. The change in volume is to be calculated as follows, with the results reported as the average of the three specimens tested:

$$\text{Volume Change (percent)} = \frac{(M_3 - M_4) - (M_1 - M_2)}{(M_1 - M_2)} \times 100$$

41.2 revised December 12, 1995

42 Weight Loss Test

42.1 An elastomeric part in contact with LP-Gas, manufactured and natural fuel gases, or gasoline shall not exhibit an averaged weight loss (extraction) greater than 10 percent following immersion for 70 hours in the corresponding test liquid specified in Table 41.1. Weight loss tests are not conducted with No. 3 swelling oil or Reference Fuel A. The weight loss test is to be as described in the Standard Test Method for Rubber Property — Effect of Liquids, ANSI/ASTM D471-1975, with variations as noted in 42.2.

42.2 The test is to be conducted at the same time and using the same specimens as for the Volume Change Test, Section 41. For the weight loss test, each specimen is to be weighed on a balance pan, in air (M_i), to the nearest milligram, prior to immersion in the test liquid. After 70 hours of immersion, and after the weight determinations needed for the Volume Change Test, Section 41, the specimens are to be conditioned in air at a temperature of $23 \pm 2^\circ\text{C}$ ($73 \pm 4^\circ\text{F}$) for a period of 70 hours. The specimens are then to be weighed in air (M_f), on a balance pan. The weight loss is to be calculated as follows, and the results reported as the average of the three specimens tested:

$$\text{Weight Loss (percent)} = \frac{M_i - M_f}{M_f} \times 100$$

42.2 revised December 12, 1995

MANUFACTURING AND PRODUCTION TESTS

43 General

43.1 In order to ensure compliance with these requirements in production, the manufacturer shall provide regular production control, inspection, and tests. The program shall include at least the following:

- a) Calibration and adjustment of set point under prescribed conditions and following a prescribed method.
- b) Leakage Tests of parts and assemblies subject to fluid pressure.
- c) Checking to determine that electromagnetic parts function at a supply voltage 85 percent of rated voltage for ac controls and 80 percent for dc rated controls.
- d) Dielectric Voltage-Withstand Tests.
- e) Leakage and calibration tests on fluid containing temperature sensing element assemblies. See 4.7.

RATING

44 Rating

44.1 A control shall be rated in volts; and also in horsepower and/or amperes, volt-amperes, or watts; and the rating shall indicate whether the control is for direct or alternating current. The rating of a control shall include the current in amperes if the wattage rating is not a close indication of the volt-ampere input. A control for pilot duty shall be marked "PILOT DUTY" and shall be rated in volts and in volt-amperes (using the sealed value), or it may be rated in amperes if both the sealed and inrush ampere values are used. The rating of an ac control shall include the number of phases and, if necessary, the frequency; except that a control obviously intended for single-phase use only need not include the phase rating.



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Standard for

Limit Controls

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Fifth Edition

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Approval as an American National Standard (ANSI) covers the numbered paragraphs on pages dated September 23, 1994. These pages should not be discarded when revised or additional pages are issued if it is desired to retain the ANSI approved text.

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

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The Department of Defense (DoD) has adopted UL 353 on January 27, 1992. 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 published set of revision pages.

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19 Alternate Spacings – Clearances and Creepage Distances

19.1 As an alternative to the measurement method specified in Section 18, the minimum acceptable clearances (through air spacings) and creepage distances (over surface spacings) may be evaluated using the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, as specified in 19.2 – 19.4. The spacing requirements of UL 840 shall not be used for through air and over surface spacings between the field-wiring terminals and between the uninsulated live parts and a metal enclosure.

19.1 revised September 28, 1995

19.2 When applying the requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, for unencapsulated assemblies and uncoated printed wiring boards, pollution degree 3 shall be considered applicable. Pollution degree 1 requirements are applicable to encapsulated assemblies and to coated printed wiring boards complying with the printed wiring board coating performance test requirements. The pollution degrees are as defined for Creepage Distances in UL 840.

19.3 For Clearance B (controlled overvoltage) requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, the applicable overvoltage category for line voltage circuits is Category III. Category I is applicable to low-voltage circuits if short circuit between the parts involved may result in operation of the controlled equipment that increases the risk of fire or electric shock. Any overvoltage protection device to achieve these categories shall be provided as an integral part of the control.

19.4 Where measurement of clearances and creepage distances is involved to establish the minimum spacings, the methods specified for Measurement of Clearance and Creepage Distances in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, shall be used.

20 Separation of Circuits

20.1 General

20.1.1 Unless provided with insulation recognized for the highest voltage involved, insulated conductors of different circuits (internal wiring) shall be separated by barriers or shall be segregated; and shall, in any case, be so separated or segregated from uninsulated live parts connected to different circuits or opposite polarity parts of the same circuit.

20.1.2 Segregation of insulated conductors as required in 20.1.1 may be accomplished by clamping, routing, or equivalent means which ensures permanent separation from insulated or uninsulated live parts of a different circuit.

20.1.3 Field-installed conductors of any circuit shall be segregated or separated by barriers from:

- a) Field-installed and factory-installed conductors connected to any other circuit, unless the conductors of both circuits are insulated for the maximum voltage of either circuit.
- b) Uninsulated live parts of any other circuit of the control.
- c) Any uninsulated live parts whose short-circuiting may permit unsafe operation of the controlled appliance, except that a construction in which field-installed conductors may make contact with wiring terminals is acceptable, provided that Type T, RF-2, or equivalent conductors are or will be installed when wired in accordance with the National Electrical Code ANSI/NFPA 70.

20.1.4 Segregation of field-installed conductors from other field-installed conductors and from uninsulated live parts of the control connected to different circuits may be accomplished by arranging the location of the openings in the enclosure for the various conductors (with respect to the terminals or other uninsulated live parts) so that there is no liability of the intermingling of the conductors or parts of different circuit. If the number of openings in the enclosure does not exceed the minimum required for the proper wiring of the control, and if each opening is located opposite a set of terminals, it is to be assumed, for the purpose of determining compliance with 20.1.3 that the conductors entering each opening will be connected to the terminals opposite the opening. If more than the minimum number of openings are provided, the possibility of conductors entering at points other than opposite the terminals to which they are intended to be connected and contacting insulated conductors or uninsulated current-carrying parts connected to a different circuit is to be investigated. To determine if a device complies with the requirement of 20.1.3, it is to be wired as it would be in service; and in doing so, a reasonable amount of slack is to be left in each conductor, within the enclosure, and no more than average care is to be exercised in stowing this slack into the wiring compartment.

20.2 Barriers

20.2.1 If a barrier is used to provide separation between the wiring of different circuits or between operating parts and field-installed conductors, it shall be of metal or of insulating material and be held in place.

20.2.2 A metal barrier shall have a thickness at least as great as that required by Table 6.1 based on the size of the barrier. A barrier of insulating material shall be not less than 0.028 inch (0.71 mm) in thickness and shall be of greater thickness if its deformation may be readily accomplished so as to defeat its purpose. Any clearance at the edges of a barrier shall be not more than 1/16 inch (1.6 mm) wide.

20.2.3 Openings in a barrier for the passage of conductors shall be not larger than 1/4 inch (6.4 mm) in diameter and shall not exceed in number, on the basis of one opening per conductor, the number of wires which will need to pass through the barrier. The closure for any other opening shall present a smooth surface wherever an insulated wire may be in contact with it; and the area of any such opening, with the closure removed, shall not be larger than required for the passage of the necessary wires. See also 11.8.

21 Calibration Means

21.1 Means provided for factory calibration of controls shall be factory secured to prevent accidental shifting after calibration.

21.2 The means for calibration, if accessible or apparent, shall be modified, guarded, or sealed as by soldering to effectively prevent manipulation by hand or ordinary tools subsequent to the factory calibration.

21.3 A calibration means considered to be not accessible or apparent is one not showing, one not exposed to manipulation by conventional tools, or one not readily displaced. The complete concealment of conventional tool engaging means in a screw such as a slot, recessed head, etc., by the use of solder, brazing material, or cement, is considered adequate for purpose of preventing manipulation so long as the calibration means cannot be changed readily by gripping with conventional tools and engagement of manipulation is prevented at all other locations.

22 Mounting

22.1 Provision shall be made for securely mounting a control in position. Bolts, screws, or other parts used for mounting a control shall be independent of those used for securing parts of the control to its frame, base, or panel. A mounting bracket or similar part shall not depend solely on friction to maintain a control in position if the control may malfunction when moved from its normal position.

Table 29.1
Temperature-operated controls

Type of control	Rated maximum operating temperature, degrees	Maximum variations in operating temperature ^a			
		Initial variation from rated operating temperature		After endurance test variation from initial operating temperature	
		In percent	In degrees	In percent	In degrees
Water Heater Limit	Any	—	5°F (2.8°C)	5	10°F (5.5°C)
Water Heater Regulating	Above 170°F (76.7°C)	—	7°F (3.9°C)	5	10°F (5.5°C)
Fan and Boiler or Warm Air Limit	Any	5	15°F (8.3°C)	5	—

^a Where both the percent and degree variations are indicated, the greater value may be used for the maximum variation.

29.1.11 For a liquid level limit control which includes means for delaying the control action, the rated time delay shall be maintained in accordance with the following:

- a) If the time-delay is provided by mechanical means, the observed time-delay shall not vary from the rated time-delay by more than 10 percent. After being subjected to the Endurance Test, the time-delay shall not vary from the time-delay initially determined by more than 5 percent.
- b) If the time-delay is provided by electrical means (electrically heated bimetal, electronic circuit, etc.), the observed time-delay shall not exceed the rated time-delay by more than 10 percent when the control is tested under the conditions of rated voltage and frequency (see Table 27.1) and normal ambient temperature. When tested in ambients ranging from 32°F (0°C) to 150°F (66°C) and with input voltage ranging from 85 to 110 percent of rated voltage, the maximum observed time-delay under a combination of any voltage and ambient temperature between these limits shall not be more than 150 percent of the time-delay observed at rated voltage and ambient temperature. After being subjected to the Endurance Test, the time-delay shall not vary from the time-delay initially determined by more than 5 percent.

29.1.12 Unless otherwise specified by the manufacturer, the normal ambient temperature for the purpose of tests indicated in 29.1.11 is assumed to be room temperature maintained between the limits of 70°F (21°C) and 77°F (25°C).

29.1.13 A temperature or pressure-operated control is to be cycled at least:

- a) Twice immediately before determining its operating temperature or pressure in accordance with 29.2 – 29.4; and
- b) Twice before and after the appropriate endurance (cycling tests), see Endurance Test, Section 31.

29.1.14 The cycling specified in 29.1.13 is to be accomplished by starting at room temperature for temperature-operated controls and at atmospheric pressure for pressure-operated controls. If the control has an adjustable setting, the set-point is to be adjusted to the maximum temperature or pressure setting unless the control is a vacuum-operated pressure type, in which case it is to be adjusted to the minimum setting. The temperature (for temperature-operated controls) is to be increased in accordance with 29.2.1 or 29.3.2 or the pressure (for pressure-operated controls) is to be increased or decreased in accordance with 29.4.1 until the control operates. The temperature or pressure then is to be decreased (or increased) to the reset temperature or pressure and the cycle then is to be repeated.

29.1.15 The operating temperature or pressure of controls is to be determined in accordance with 29.2.1 – 29.4.1, as appropriate. Two trials are to be made at each setting. If the operating temperatures or pressures of the two trials are not within 1 percent of each other, a third trial is to be made and averaged with the first two trials. This average is to be considered as the operating temperature or pressure of the set-point.

29.2 Test of immersion-type temperature-operated control

29.2.1 A temperature-operated control having a sensing element intended to be immersed in a liquid, or in a well to be immersed in a liquid, is to be tested with the element or well immersed as intended in a liquid bath which is agitated to maintain uniform temperatures. A control for air or gas may be tested using either a forced air circulating warm-air oven of the type described in 28.2.2, or the liquid bath if appropriate to the design of the control. The control is to be mounted with only the sensing element or the entire control immersed in the test medium, whichever is appropriate. In all cases equilibrium conditions of temperature prior to the start of the test are to be established at a level approximately 20°F (11.1°C) below the anticipated set point value. The temperature of the test medium is then to be increased at a rate not in excess of 1°F (0.6°C) per minute until the control functions. The temperature of the test medium at the instant the control functions is to be considered the set point.

29.2.1 revised September 28, 1995

29.3 Test of surface-mounted temperature-operated control for hot-water heating systems

29.3.1 A surface-type temperature-operated control for hot-water heating systems is to be mounted as described in the manufacturer's instructions. The appropriate test apparatus described for the Temperature Test of such controls, 28.3.2 – 28.3.5, is to be used except if the control is intended for hot-water heating systems limited to 250°F (121°C) maximum, the control is to be applied to the outside surface of a vertical section of nominal 1 inch (ANSI B36.10M) black iron pipe.

29.3.2 The circulating system is to be arranged to raise the temperature of the water in the system at the maximum rate of 1°F (0.6°C) per minute from a temperature 20°F (11.1°C) below the indicated set point of the control to a temperature sufficient to cause the control to function. The temperature of the water measured at the elevation of the control at the instant the control functions is to be considered the set point.

29.4 Test of pressure-operated control

29.4.1 A pressure-operated control is to be connected to a source of aerostatic or hydrostatic pressure whichever is consistent with its intended use. The source of pressure is to be capable of being accurately controlled and measured. During the test, pressures near the set point are to be increased or decreased at a maximum rate of 1/2 pound per square inch gauge (3.5 kPa) per minute.

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September 23, 1994

Standard for

Limit Control

UL 353, Fifth Edition

Accompanying this transmittal notice is a copy of the Fifth edition of UL 353.

A CHANGE IS INDICATED BY A SMALL PRINT NOTE FOLLOWING THE AFFECTED ITEM.

THIS EDITION OF THE STANDARD IS NOW IN EFFECT EXCEPT FOR PARAGRAPHS 6.1.1, 6.4.2, 6.4.3, AND FIGURE 6.1, WHICH BECOME EFFECTIVE NOVEMBER 3, 1995 AS INDICATED IN THE SMALL PRINT NOTE FOLLOWING THE AFFECTED ITEMS.

THE CURRENT REQUIREMENTS IN EFFECT FOR THE REQUIREMENTS HAVING FUTURE EFFECTIVE DATES ARE LOCATED IN THE BACK OF THE STANDARD.

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

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



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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction differing from those detailed in the requirements of this Standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.