

UL 294

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May 1, 1995

Revision pages for

Standard for

Access Control System Units

UL 294, Fourth Edition

Attached to this transmittal notice is a revision of the fourth edition of UL 294.

A CHANGE ON A PAGE DATED MAY 1, 1995 IS INDICATED BY A SMALL PRINT NOTE FOLLOWING THE AFFECTED ITEM, PRECEDED AND FOLLOWED BY AN ASTERISK.

THESE NEW AND REVISED REQUIREMENTS ARE NOW IN EFFECT.

The new and revised requirements are substantially in accordance with UL's bulletins on Subjects 291 (294, 365, 603, 609, 634, 639, 680, 752, 771, 983, 1023, 1034, 1037, 1076, 1610, 1635) dated February 24, 1994 and Subjects 294 (205A) dated November 30, 1994. These bulletins are now obsolete and may be discarded.

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 294-1993.

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

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

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UL 294

Standard for

Access Control System Units

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June 30, 1994

Approval as an American National Standard (ANSI) covers the numbered paragraphs on pages dated June 30, 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.

Approved as ANSI/UL 294-1981, May 18, 1981
Revision of ANSI/UL 294-1981, Approved as ANSI/UL 294, May 5, 1983
Approved as ANSI/UL 294-1986, May 20, 1986
Approved as ANSI/UL 294-1993, October 11, 1993

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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11.4 The power supply cord shall be provided with strain relief means so that a stress on the cord will not be transmitted to terminals, splices, or internal wiring. See the Strain Relief Test, Section 50.

11.5 If a knot in a flexible cord serves as strain relief, a surface against which the knot may bear or with which it may come in contact shall be free from projections, sharp edges, burrs, fins, and the like which may cause abrasion of the insulation on the conductors.

11.6 Clamps of any material (metal or otherwise) may be used on cords and supply leads without varnished-cloth insulating tubing or the equivalent under the clamp, unless the tubing or the equivalent is necessary to prevent the clamp from damaging the cord or supply leads.

11.7 The supply cord or supply leads shall be prevented from being pushed into the product through the cord-entry hole if such displacement is likely to:

- a) Subject the cord or supply leads to mechanical damage or exposure to a temperature higher than for which the cord or supply leads are rated,
- b) Reduce spacings (such as to a metal strain-relief clamp) below the minimum intended values, or
- c) Damage internal connections or components.

12 Permanently Connected Products

12.1 General

12.1.1 A fixed product shall have provision for connection of one of the applicable wiring systems in accordance with the National Electrical Code, ANSI/NFPA 70-1993.

12.1 revised July 1, 1994

12.1.2 A knockout provided for connection of a field-wiring system to a field-wiring compartment shall accommodate conduit of the trade size determined by applying Table 12.1.

Table 12.1
Trade size of conduit, inches (mm OD)

Wire size,		Number of wires ^a ,				
AWG	(mm ²)	2	3	4	5	6
14	(2.1)	1/2 (21.3)	1/2 (21.3)	1/2 (21.3)	1/2 (21.3)	1/2 (21.3)
12	(3.3)	1/2 (21.3)	1/2 (21.3)	1/2 (21.3)	3/4 (26.7)	3/4 (26.7)
10	(5.3)	1/2 (21.3)	1/2 (21.3)	1/2 (21.3)	3/4 (26.7)	3/4 (26.7)
8	(8.4)	3/4 (26.7)	3/4 (26.7)	1 (33.4)	1-1/4 (42.3)	1-1/4 (42.3)
6	(13.3)	3/4 (26.7)	1 (33.4)	1 (33.4)	1-1/4 (42.3)	1-1/4 (42.3)

NOTE — Trade size per Specifications for Zinc-Coated Rigid Steel Conduit, ANSI C80.1.

^a This table is based on the assumption that all conductors will be of the same size and there will be no more than six conductors in the conduit. If more than six conductors will be involved or if all of them are not of the same size, the cross-sectional area of the smallest conduit that may be used is determined by multiplying by 2.5 the total cross-sectional area of the wires, based on the cross-sectional area of Type THW wire.

12.1.3 A terminal box or compartment in which power supply connections are to be made shall be located so that the connections are accessible without removal of parts other than a service cover or panel and the cover of the outlet box or compartment in which the connections are made.

12.1.4 A terminal compartment intended for the connection of a supply raceway shall be secured against turning or shifting in position.

12.1.5 The product shall be provided with field-wiring terminals or leads for the connection of conductors having an ampacity not less than that required by the product. It is assumed that branch circuit conductors rated for not less than 60°C (140°F) will be used.

12.2 Field-wiring terminals

12.2.1 As used in these requirements, a field-wiring terminal is a terminal to which power supply (including equipment grounding) or control connections will be made in the field when the product is installed.

12.2.1.1 A field wiring terminal shall comply with:

- a) 12.2.3 – 12.2.7, or
- b) The field wiring requirements in the requirements for electrical quick-connect terminals, UL 310; or
- c) The Standard for Wire Connectors and Soldering Lugs for Use With Copper Conductors, UL 486A; or
- d) The Standard for Equipment Wiring Terminals for Use With Aluminum and/or Copper Conductors, UL 486E; or
- e) The field wiring requirements (Code 2) in the requirements for terminal blocks, UL 1059.

The current-carrying parts shall be silver, copper, a copper alloy, or a similar nonferrous conductive material. Securing screws and the like may be plated steel. Equipment provided with quick-connect terminals intended for field termination of electrical conductors to the equipment and complying with the requirements for electrical quick-connect terminals, UL 310, shall be provided with strain relief, and the installation instructions shall include instructions for effecting the strain relief and include reference to the specific connectors to be used.

12.2.1.1 added May 1, 1995

12.2.2 A field-wiring terminal shall be secured against turning or shifting in position. This may be accomplished by such means as:

- a) Two screws or rivets;
- b) Square shoulders or mortices;
- c) A dowel pin, lug, or offset; or
- d) A connecting strap or clip fitted into an adjacent part.

Friction between surfaces shall not be used for preventing movement of the terminals.

12.2.3 Nonferrous soldering lugs or solderless (pressure) wire connectors shall be used with No. 8 AWG (8.4 mm²) and larger wires. If the connectors or lugs are secured to a plate, the plate thickness shall not be less than 0.050 inch (1.3 mm). Securing screws may be of plated steel.

12.2.4 A wire binding screw intended for connection of the power-supply (line-voltage) source shall not be smaller than No. 10 (4.8 mm diameter). The screw may be of plated steel.

Exception: A No. 8 (4.2 mm diameter) screw may be used for the connection of one No. 14 AWG (2.1 mm²) and a No. 6 (3.5 mm diameter) screw may be used for the connection of a No. 16 or 18 AWG (1.3 or 0.82 mm²) conductor.

12.2.5 For connection of other than power-supply (line-voltage) circuits using No. 10 AWG (5.3 mm²) and smaller wires, a wire binding screw shall not be smaller than No. 8 (4.2 mm diameter). However, a No. 6 (3.5 mm diameter) screw may be used for the connection of a No. 14 AWG (2.1 mm²) or smaller conductor. Also, a No. 4 (2.8 mm diameter) screw may be used as a No. 19 AWG (0.65 mm²) or smaller conductor.

12.2.6 A terminal plate tapped for wire binding screws shall:

- a) Have not less than two full threads in the metal (the terminal plate metal may be extruded to provide the two full threads) and shall have upturned lugs, clamps, or the equivalent, to hold the wires in position. Other constructions may be used if they provide thread security equivalent to that of the wire binding screw.
- b) Be of a nonferrous metal not less than 0.050 inch (1.3 mm) in thickness for a No. 8 (4.2 mm diameter) or larger screw, and not less than 0.030 inch (0.076 mm) in thickness for a No. 6 (3.5 mm diameter) or smaller screw.

12.2.7 If two or more conductors are intended to be connected by wrapping under the same screw, a nonferrous intervening metal washer shall be used for each additional conductor. A separator washer is not required if two conductors are separated before being secured under a common clamping plate. If the wires protrude above terminal barriers, the nonferrous separator shall include means, such as upturned tabs or sides, to retain the wire.

12.3 Qualified application

12.3.1 Any of the following terminal configurations may be used for connection of field wiring, if they also comply with the requirements in 12.3.2:

- a) Push-In Terminals – Nonferrous (screwless) push-in terminals of the type used on some switches and receptacles. Solid conductors are pushed into slots containing spring-type contacts. The leads can be removed by means of a tool inserted to relieve the spring tension on the conductor. Push-in terminals may not be used with aluminum conductors. The marking adjacent to the terminal shall indicate that copper conductors only are to be used.
- b) Quick Connect Terminals – Nonferrous (push-type) terminals consisting of male posts permanently secured to the device and provided with compatible female connectors for connection to field wiring. A special tool for crimping of field wires is required. Mating terminals shall be shipped with the product with instructions for their installation.
- c) Solder Terminals – Conventional nonferrous solder terminals.
- d) Solderless Wrapped Terminals – Solderless wrapped nonferrous terminals that require a special tool and terminal post construction.
- e) Telephone Type Terminals – Nonferrous terminal plates employing a narrow V-shaped slot for securing of a conductor in a special post design. A special tool for wire connection is required.
- f) Other Terminals – Other terminal connections may be used if determined to be equivalent to terminals described in (a) – (e). They are subject to the same restrictions.

12.3.2 Any of the terminal configurations listed in 12.3.1 may be used for connection of field wiring if they comply with all of the following:

- a) If a special tool is required for connection, its use shall be indicated on the installation wiring diagram by name of manufacturer and model number or equivalent, along with information as to where the tool may be obtained.
- b) The range of permissible wire sizes shall be indicated on the installation wiring diagram. The minimum permissible wire size to be used shall not be less than No. 22 AWG (0.32 mm²).
- c) The wire size to be used shall have the current-carrying capacity appropriate to the circuit application.
- d) The terminal configurations shall comply with the requirements of Special Terminal Assemblies Tests, Section 53.

Exception: Terminals complying with the requirements in any of the standards specified in 12.2.1.1 (b) – (e) are not required to be subjected to the Special Terminal Assemblies Tests, Section 53.

12.3.2 revised May 1, 1995

12.4 Field wiring leads

12.4.1 If leads are provided in lieu of wiring terminals, they shall not be less than 6 inches (152 mm) long, and shall not be smaller than No. 22 AWG (0.32 mm²). See 12.4.2.

Exception No. 1: A lead may be less than 6 inches in length if it is evident that the use of a longer lead:

- a) May result in damage to the lead, lead insulation, or product;*
- b) May result in a risk of fire, electric shock, or injury to persons;*
- c) May impair the intended operation of the product; or*
- d) Is not required for the intended operation of the product.*

Exception No. 2: Solid copper leads as small as No. 26 AWG (0.13 mm²) may be used if:

- a) The current does not exceed 1 ampere for lengths up to 2 feet (61 cm) and the current does not exceed 0.4 ampere for lengths up to 10 feet (3.05 m);*
- b) There are two or more conductors and they are covered by a common jacket or the equivalent;*
- c) The assembled conductors comply with the requirement of 50.2.1 for strain relief; and*
- d) The installation instructions indicate that the lead shall not be spliced to a conductor larger than No. 18 AWG (0.82 mm²).*

12.4.2 For connection of a line voltage source, the leads shall not be smaller than No. 18 AWG (0.82 mm²).

12.4.3 Leads intended for connection to an external circuit shall be provided with a strain relief if stress on the lead may be transmitted to terminals, splices, or internal wiring. See the Strain Relief Test, Section 50.

12.5 Polarity identification

12.5.1 In a product intended to be connected to a grounded circuit, one terminal or lead shall be identified for the connection of the grounded conductor. The identified terminal or lead shall be the one which is connected to the screw shells of lampholders and to which no primary overcurrent-protective devices or other switching devices of the single-pole type are connected.

12.5.2 A terminal intended for the connection of a grounded supply conductor shall be composed of or plated with metal that is substantially white in color and shall be distinguishable from the other terminals. Otherwise, identification of the terminal shall be clearly shown in an alternative manner, such as on an attached wiring diagram. A lead intended for the connection of a grounded power-supply conductor shall be finished to show a white or natural gray color and shall be distinguishable from the other leads.

13 Grounding

13.1 A grounding means shall be provided for all equipment containing parts that require grounding. See Bonding for Grounding, Section 17.

27.4 FCC requirements

27.4.1 A product radiating or utilizing radio frequency energy shall be shown to comply with the regulations of the Federal Communications Commission (FCC) before it is submitted for test. A letter of certification from the FCC is required as evidence of compliance.

28 Normal Operation Test

28.1 A unit shall perform its intended function when installed in accordance with 28.2 – 28.4.

28.2 The unit is to be mounted in the intended manner and its terminals connected to circuits of related equipment as indicated by the installation-wiring diagram so as to represent a typical system combination.

28.3 If equipment is to be mounted in a definite position in order to function as intended, it shall be tested in that position.

28.4 Power-input supply terminals are to be connected to supply circuits of rated voltage and frequency. A product under test is to be in the intended circuit condition and ready for normal operation when it is connected to related products and circuits as specified in 28.2 and 28.3.

29 Input Measurement Test

29.1 The input of a product shall not exceed the marked current, power, or volt-ampere rating by more than 10 percent when the product is operated under all conditions of use while connected to a source of supply in accordance with the requirements in 29.2.

29.2 The test voltage for this test is to be the maximum rated voltage for the product. For a product having a single voltage rating, such as 115 volts, maximum rated voltage is to be that single voltage. If the voltage is given in terms of a range of voltages, such as 110 – 120 volts, the maximum rated voltage is the highest value of the range.

30 Output Measurement Test

30.1 The measured output voltage of an access control system unit shall be within the limits specified in Table 30.1 while the unit is connected to a source of supply in accordance with 27.3.1.

Table 30.1
Output voltage limits

No load			Full load		
85 percent rated Input	100 percent rated Input	110 percent rated Input	85 percent rated Input	100 percent rated Input	110 percent rated Input
85 to 110.5 percent of rated maximum	100 to 130 percent of rated maximum	100 to 143 percent of rated maximum	85 to 100 percent of rated maximum	100 to 110 percent of rated maximum	100 to 110 percent of rated maximum

30.2 The measured voltages at the output circuits, with the minimum and maximum (rated) loads applied in turn, shall be compatible with the rating of the product intended to be connected to the circuit.

30.3 To determine if the output capacity of an inherently limited power source complies with the requirements in Table 3.1, a variable resistive load is to be connected to the circuit. With the product connected to a rated source of supply, the load resistor is to be changed in increments from the open-circuit to the short-circuit conditions in not less than 1-1/2 nor more than 2-1/2 minutes. Voltage and current measurements are to be recorded for each increment and the maximum VA calculated. If an overcurrent protective device is provided, it may be shunted out during the test, if necessary.

31 Electrical Supervision Test

31.1 General

31.1.1 Malfunctioning of an electronic component, such as opening or shorting of a capacitor, shall either not impair the intended operation of the product or shall be indicated by a trouble or alarm signal. Otherwise, the product shall be provided with a test feature as described in 31.1.2.

31.1.2 A manual test method provided as a part of the operation of the system may be used in lieu of electrical supervision if it effectively tests the capability of critical components.

31.1.3 With reference to the requirements in 31.1.2, a critical component is one whose malfunctioning will impair the operation of the product or will create the risk of fire or electric shock.

31.1.4 Any cover, door, panel, or mounting means shall be electrically supervised if it gives access to any relays, terminals, controls, or related components that might be subject to tampering. When a cover, door, panel, or mounting is opened or removed, either an alarm or trouble signal shall activate, or the access function shall not operate.

Exception: Tamper protection need not be provided for a request-to-exit device intended to render free exit from inside the secured area if tampering with the device cannot cause the device's field of view to extend beyond the secured area.

31.1.4 revised May 1, 1995

31.1.5 If the primary electrical source of the product is to be ac, a "power on" indicator of a visible type shall be provided.

31.2 Power interruption

31.2.1 The interruption and restoration of the electrical supply shall not result in false operation of the product.

32 Standby Power

32.1 The use of a standby power supply is optional. If a standby power supply, such as a battery, is provided, it shall be of sufficient capacity to supply power to the system for 4 hours while the system is operated once every 5 minutes. If the battery capacity is such that it cannot provide power for 4 hours of operation, the product shall be prominently marked as specified in 59.12.

32.2 Instructions for the replacement of batteries shall be on the product, and the polarity shall be indicated.

33 Undervoltage Operation Test

33.1 An access control system unit shall operate as intended while energized at 85 percent of its rated voltage.

33.2 An access control system unit that uses primary or secondary batteries for principal power or standby power shall be tested for operation at 85 percent of nominal battery voltage.

52 Mechanical Strength Tests for Enclosures

52.1 Constant-force test

52.1.1 The external enclosure of a product containing high-voltage circuits or circuits that are not power limited shall withstand a force of 25 pounds (111 N) for 1 minute without:

- a) Permanent distortion to the extent that spacings are reduced below the values specified in 25.2 – 25.5,
- b) Transient distortion resulting in contact with live parts, or
- c) Creation of openings that expose uninsulated high- or low-voltage live parts.

52.1.2 The external enclosure of a product containing only low-voltage power-limited circuits is to be subjected to the test specified in 52.1.1, except that the applied force is to be 10 pounds (44 N).

52.1.3 The force specified in 52.1.1 is to be applied by means of a steel hemisphere 1/2 inch (12.7 mm) in diameter. Any openings that result from application of the force are to be judged under the requirements specified in 5.2.3 and 5.2.4.

52.2 Impact test

52.2.1 The external enclosure of a product containing high-voltage circuits or circuits that are not power-limited shall withstand an impact of 5 foot-pounds (6.78 J) without:

- a) Permanent distortion to the extent that spacings are reduced below the values specified in 25.2 – 25.5,
- b) Transient distortion resulting in contact with live parts, or
- c) Creation of openings that expose uninsulated high- or low-voltage live parts.

52.2.2 The impact is to be applied by means of a solid, smooth, steel sphere 2 inches (50.8 mm) in diameter and weighing approximately 1.18 pounds (0.54 kg). The sphere is to fall freely from rest through a vertical distance of 51 inches (1.31 m). Any openings resulting from the impact are to be evaluated under the requirements in 5.2.4 and 5.2.5.

52.2.3 The external enclosure of a product containing only low-voltage power-limited circuits is to be subjected to the test specified in 52.2.1 and 52.2.2, except that the impact is to be 2 foot-pounds (2.7 J), and the sphere is to fall freely from rest through a vertical distance of 20-13/32 inches (0.51 m).

53 Special Terminal Assemblies Tests

53.1 General

53.1.1 To determine compliance with the requirements of 12.3.1 and 12.3.2, representative samples of the terminal assembly shall comply with the requirements specified in 53.3.1 – 53.6.2.

Exception: Terminals complying with the requirements in any of the standards specified in 12.2.1.1 (b) – (e) are not required to be subjected to these tests.

53.1.1 revised May 1, 1995

53.2 Disconnection and reconnection

53.2.1 If a wire is to be disconnected for testing or routine servicing and then reconnected, each terminal is to be subjected to 20 alternate disconnections and reconnections prior to execution of the tests described in 53.3.1 – 53.6.2.

53.3 Mechanical secureness

53.3.1 A terminal connection shall withstand, without separating from the wire, the application of a straight pull of 5 pounds-force (22.2 N) applied for 1 minute to the wire in the direction that would most likely result in pullout.

53.3.2 Six terminal assemblies using the maximum wire size and six using the minimum wire size are to be subjected to this test. If a special tool is required to assemble the connection it is to be used, in accordance with the manufacturer's instructions. Each sample is to be subjected to a gradually increasing pull on the wire until the test pull of 5 pounds-force (22.2 N) is attained.

53.3.2 revised July 1, 1994

53.4 Flexing test

53.4.1 The wire attached to a terminal shall withstand five right angle bends without breaking.

53.4.2 Six terminal assemblies using the maximum wire size and six using the minimum wire size are to be subjected to this test. The terminal is to be secured against movement. With the wire in 3 pounds-force (13.3 N) tension and held at a point 3 inches (76.2 mm) from the terminal-to-wire juncture, the wire is to be bent at a right angle from its nominal position. The wires are to be assembled to the terminals using any special tool required, according to the manufacturer's instructions.

53.5 Millivolt drop test

53.5.1 The millivolt drop across a terminal connection shall not be greater than 300 millivolts when the maximum current specified by the manufacturer is flowing through the terminal connections and the circuit is connected to rated voltage. The terminal assemblies are to be connected in series. In one trial, wiring is to be made with wire of the maximum size intended for use; in the other trial, wire is to be of minimum size intended.

53.5.2 Six terminal assemblies using the maximum wire size and six assemblies using the minimum size are to be subjected to this test. The wires are to be connected to the terminals, according to the manufacturer's instructions and using any special tools required. The millivolt drop then is to be measured using a high impedance millivoltmeter.

53.6 Temperature test

53.6.1 The maximum temperature rise on a terminal junction shall not be greater than 30°C (54°F) based on an ambient temperature of 25°C (77°F).

53.6.2 Six terminal assemblies using the maximum wire size and six using the minimum size are to be subjected to this test. The wire is to be assembled to the terminals using any special tools, if required, according to the manufacturer's instructions. The maximum current to which the wire will be subjected in service is next to be passed through the series connection of the terminals. The maximum temperature rise is then to be measured by the thermocouple method after temperatures have stabilized.

64.3 The wiring assembly shall be constructed with supply conduit connections but without pipe thread compounds and located to exclude water from electrical enclosures when the product is subjected to the Rain Test, Section 66.

64.4 A wire not intended for use in wet locations, and all cords shall be routed and supported so as not to be immersed in water.

65 Components, Electrical Insulating Material

65.1 Nonabsorptive electrical insulation shall be used in the construction of electrical components. Untreated fiber is an example of a material that shall not be used. Vulcanized fiber on electrical components may be used if components are not wetted as a result of the Rain Test, Section 66.

PERFORMANCE

66 Rain Test

66.1 The section of the product exposed to weather shall withstand a rain exposure for 1 hour. After each exposure the product shall have an insulation resistance between live parts and dead metal parts of not less than 50,000 ohms. Except as specified in 66.2 and 66.3, water shall not enter enclosures above the level of the lowest electrical component (insulated wire excepted).

66.2 Motor windings may be judged on the basis of the insulation resistance and by the Dielectric Voltage-Withstand Test, Section 42, if the motor is within the product enclosure and is shielded from openings in the top of the enclosure.

66.3 Water may enter an enclosure above the lowest electrical component if the point of entrance is not in proximity to live parts and live parts are not wetted during the rain exposure.

66.4 The product is to be operated so that electrical components are energized and the product is tested under the conditions judged most likely to cause the admission of water into or onto electrical components. To accomplish this it may be necessary to operate the product under various modes of operation or to de-energize the product if this could cause more water to enter. In any case, each exposure is to last 1 hour. If more than one exposure is required, the product is to be prepared for test as indicated in 66.6 before the test is repeated.

66.5 Field-wiring connections are to be made in accordance with the wiring method specified by the manufacturer for the product. Openings intended to terminate conduit are to be sealed. Openings intended for the entry of a conductor or conductors for a low-voltage or power-limited circuit are not to be sealed unless seals are provided as part of the product. See 62.1.2 and 62.1.3.

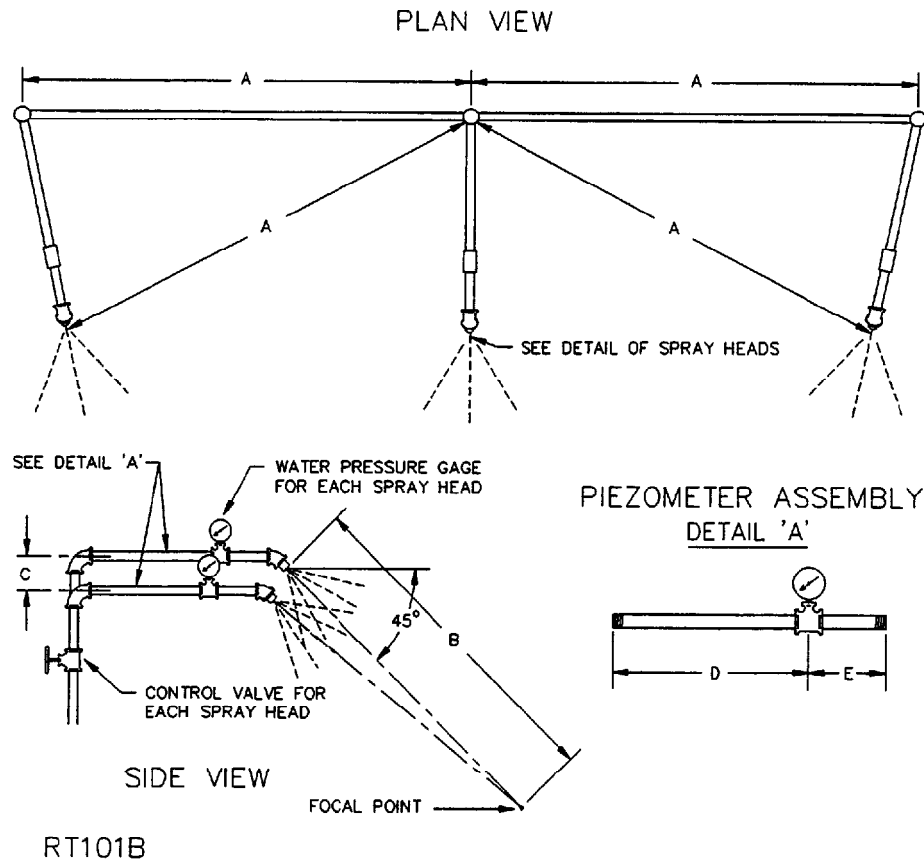
66.6 Except as indicated in 66.7, the product is to be examined to determine that all electrical parts, including motor windings, are not wetted and that there is no accumulation of water within the enclosures of electrical parts prior to rain exposure.

66.7 Drying of the product prior to the second or subsequent exposure is not required if, without such preparation, the product complies with the requirement of 66.8.

66.8 Insulation resistance is to be measured 1 minute after application of the voltage obtained by using the series-voltmeter method, or other means determined to be equivalent, and a dc circuit. After measurement of the insulation resistance, the complete unit is to be subjected to the Dielectric Voltage-Withstand Test, Section 42.

66.9 The rain test apparatus is to consist of three spray heads mounted in a water supply rack as shown in Figure 66.1. Spray heads are to be constructed in accordance with Figure 66.2. The water pressure for all tests is to be maintained at 5 psi (34.5 kPa) at each spray head. The unit is to be positioned in the focal area of the three spray heads so that the greatest quantity of water from the spray heads will enter the unit. The spray is to be directed at an angle of 45 degrees to the vertical toward the louvers or other openings closest to live parts.

Figure 66.1
Rain test apparatus



Item	inch	mm
A	28	710
B	55	1400
C	2-1/4	55
D	9	230
E	3	75

RT101B

Figure 66.1 revised May 1, 1995

**Underwriters Laboratories Inc.®**A not-for-profit organization dedicated to public safety
and committed to quality service**July 1, 1994****Revision pages for****Standard for****Access Control System Units****UL 294, Fourth Edition**

Attached to this transmittal notice is a revision of the second edition of UL 294.

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INTRODUCTION

1 Scope

1.1 These requirements apply to the construction, performance and operation of systems intended to regulate or control:

- a) Entry into an area, or
- b) Access to or the use of a device(s) by electrical, electronic or mechanical means.

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

1.2 revised July 1, 1994

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 generally used in the products covered by this standard.

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

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

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

2.1.4 Specific components are recognized as being 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 for which they have been recognized.

2.2 Units of measurement

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

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.

2.4 Terminology

2.4.1 The term "product" as used in this standard refers to all types of access control system units.

3 Glossary

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

3.2 CIRCUITS, ELECTRICAL:

a) High-Voltage – A circuit involving a potential of not more than 600 volts and having circuit characteristics in excess of those of a low-voltage power limited circuit.

b) Low-Voltage – A circuit involving a potential of not more than 30 volts alternating current (ac), 42.4 volts direct current (dc) or ac peak.

c) Power Limited – A circuit whose output is limited as described in Tables 3.1 and 3.2. The power limitation is provided by the construction of the transformer, a fixed impedance, a noninterchangeable fuse, a nonadjustable manual reset circuit protective device, or a regulating network.

3.3 CORD-CONNECTED UNIT – A unit intended for connection to the power source by means of a supply cord. Such a unit is intended to be moved for reasons of interchange or realignment of the units of a system.

3.4 LINE-VOLTAGE – The voltage (commonly 115, 208, and 230 volts) at any field-connected source of supply, nominally 50 – 60 hertz (Hz); 115, 208, or 230 volts.

Table 3.1
Power limitations for inherently limited power source
(overcurrent protection not required)

Circuit voltage V_{max}^a AC – DC, volts	Maximum nameplate ratings,		Current limitation I_{max}^b , amperes
	VA, volt-amperes	Current, amperes	
0 to 20	$5.0 \times V_{max}^a$	5.0	8.0
over 20 to 30	100	$100/V_{max}^a$	8.0
over 30 to 100	100	$100/V_{max}^a$	$150/V_{max}^a$
over 100 to 250 DC only	$0.030 \times V_{max}^a$	0.030	0.030
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^a V_{max} : Maximum output voltage regardless of load with rated input applied. 0 – 20 V-rms, 0 – 28.3 dc or ac peak; 20 – 30 V-rms, 28.3 – 42.4 V dc or ac peak.			
^b I_{max} : Maximum output current after 1 minute of operation under any noncapacitive load, including short circuit.			

7.8 Product enclosure mounting

7.8.1 An enclosure shall have means for mounting that shall be accessible without disassembly of any operating part of the product. Removal of a completely assembled panel to mount the enclosure is not considered to be disassembly of an operating part.

7.9 Polymeric materials

7.9.1 Among the factors taken into consideration when judging the acceptability of a nonmetallic enclosure are:

- a) The mechanical strength;
- b) Resistance to impact;
- c) Moisture-absorption properties;
- d) Flammability and resistance to ignition from electrical sources;
- e) Dielectric strength, insulation resistance, and resistance to arc tracking; and
- f) Resistance to distortion and creeping at temperatures to which the material may be subjected under any conditions of use.

All these factors are considered with regard to aging in accordance with the Polymeric Materials Test, Section 47, and the Mechanical Strength Tests for Enclosures, Section 52.

8 Electric Shock

8.1 Any part that is exposed only during operator servicing shall not present the risk of electric shock. See the Electric Shock Current Test, Section 38.

8.2 Each terminal provided for the connection of an external antenna shall be conductively connected to the supply circuit grounded conductor. The conductive connection shall have a maximum resistance of 5.2 megohms, a minimum wattage rating of 1/2 watt, and shall be effective with the power switch in either the on or off position.

Exception: The conductive connection need not be provided if:

- a) *Such a connection is established in the event of electrical breakdown of the antenna isolating means;*
- b) *The breakdown does not result in a risk of electric shock; and*
- c) *In a construction using an isolating power transformer, the resistance of the conductive connection between the supply circuit and chassis does not exceed 5.2 megohms.*

8.3 The maximum value of 5.2 megohms mentioned in 8.2 is to include the maximum tolerance of the resistor value used; that is, a resistor rated 4.2 megohms with 20 percent tolerance or a resistor rated 4.7 megohms with a 10 percent tolerance may be used. A component comprised of a capacitor with a built-in shunt resistor that complies with the requirements for antenna isolating capacitors may be rated a minimum of 1/4 watt.

8.4 The insertion in any socket of any vacuum tube or its glass or metal equivalent of like designation used in the product shall not result in a risk of electric shock.

9 Corrosion Protection

9.1 Iron and steel parts, other than bearings, and the like, where such protection is impracticable, shall be protected against corrosion by enameling, galvanizing, sherardizing, plating, or other means providing such protection. Bearing surfaces shall resist binding due to corrosion.

9.2 The requirement specified in 9.1 applies to all enclosures of sheet steel or cast iron, and to all springs and other parts upon which intended mechanical operation may depend.

Exception No. 1: This requirement does not apply to parts, such as washers, screws, bolts, and the like, if corrosion of the unprotected parts would not impair the operation of the unit or create a risk of fire, electric shock, or unintentional contact with moving parts that can cause injury to persons.

Exception No. 2: Parts made of stainless steel, polished or treated, if necessary, do not require additional protection against corrosion.

9.3 Metal used in cabinets and enclosures shall be used in combinations that are galvanically compatible. However, this requirement does not apply if galvanic action does not result in impaired operation of the product, risk of fire, electric shock, or unintentional contact with moving parts that can cause injury to persons.

9.4 Hinges and other attachments shall be resistant to corrosion.

FIELD WIRING CONNECTIONS

10 General

10.1 Wiring terminals or leads that are of at least the size required by the National Electrical Code, ANSI/NFPA 70-1993, shall be provided for connection of conductors.

10.1 revised July 1, 1994

11 Cord Connected Products

11.1 A portable product that is intended to be connected to high voltage or line voltage shall be provided with not less than 6 feet (1.8 m) of flexible cord and a two-prong attachment plug or three-prong grounding-type attachment plug rated for connection to the required supply circuit.

Exception: The cord may be less than 6 feet (1.8 m) in length if the use of the longer cord:

- a) May result in damage to the cord or product;*
- b) May result in a risk of fire, electric shock, or injury to persons;*
- c) May impair the intended operation of the product; or*
- d) Is not required for the intended operation of the product.*

11.2 A flexible cord may be used with a stationary product.

11.3 The flexible cord shall be of Type SJ, SJT, or other types determined to be equivalent, minimum No. 18 AWG (0.82 mm²). It shall be rated for use at the voltage and current rating of the product.

11.4 The power supply cord shall be provided with strain relief means so that a stress on the cord will not be transmitted to terminals, splices, or internal wiring. See the Strain Relief Test, Section 50.

11.5 If a knot in a flexible cord serves as strain relief, a surface against which the knot may bear or with which it may come in contact shall be free from projections, sharp edges, burrs, fins, and the like which may cause abrasion of the insulation on the conductors.

11.6 Clamps of any material (metal or otherwise) may be used on cords and supply leads without varnished-cloth insulating tubing or the equivalent under the clamp, unless the tubing or the equivalent is necessary to prevent the clamp from damaging the cord or supply leads.

11.7 The supply cord or supply leads shall be prevented from being pushed into the product through the cord-entry hole if such displacement is likely to:

- a) Subject the cord or supply leads to mechanical damage or exposure to a temperature higher than for which the cord or supply leads are rated,
- b) Reduce spacings (such as to a metal strain-relief clamp) below the minimum intended values, or
- c) Damage internal connections or components.

12 Permanently Connected Products

12.1 General

12.1.1 A fixed product shall have provision for connection of one of the applicable wiring systems in accordance with the National Electrical Code, ANSI/NFPA 70-1993.

12.1 revised July 1, 1994

12.1.2 A knockout provided for connection of a field-wiring system to a field-wiring compartment shall accommodate conduit of the trade size determined by applying Table 12.1.

Table 12.1
Trade size of conduit, inches (mm OD)

Wire size,		Number of wires ^a ,				
AWG	(mm ²)	2	3	4	5	6
14	(2.1)	1/2 (21.3)	1/2 (21.3)	1/2 (21.3)	1/2 (21.3)	1/2 (21.3)
12	(3.3)	1/2 (21.3)	1/2 (21.3)	1/2 (21.3)	3/4 (26.7)	3/4 (26.7)
10	(5.3)	1/2 (21.3)	1/2 (21.3)	1/2 (21.3)	3/4 (26.7)	3/4 (26.7)
8	(8.4)	3/4 (26.7)	3/4 (26.7)	1 (33.4)	1-1/4 (42.3)	1-1/4 (42.3)
6	(13.3)	3/4 (26.7)	1 (33.4)	1 (33.4)	1-1/4 (42.3)	1-1/4 (42.3)

NOTE — Trade size per Specifications for Zinc-Coated Rigid Steel Conduit, ANSI C80.1.

^a This table is based on the assumption that all conductors will be of the same size and there will be no more than six conductors in the conduit. If more than six conductors will be involved or if all of them are not of the same size, the cross-sectional area of the smallest conduit that may be used is determined by multiplying by 2.5 the total cross-sectional area of the wires, based on the cross-sectional area of Type THW wire.

12.1.3 A terminal box or compartment in which power supply connections are to be made shall be located so that the connections are accessible without removal of parts other than a service cover or panel and the cover of the outlet box or compartment in which the connections are made.

12.1.4 A terminal compartment intended for the connection of a supply raceway shall be secured against turning or shifting in position.

12.1.5 The product shall be provided with field-wiring terminals or leads for the connection of conductors having an ampacity not less than that required by the product. It is assumed that branch circuit conductors rated for not less than 60°C (140°F) will be used.

12.2 Field-wiring terminals

12.2.1 As used in these requirements, a field-wiring terminal is a terminal to which power supply (including equipment grounding) or control connections will be made in the field when the product is installed.

12.2.2 A field-wiring terminal shall be secured against turning or shifting in position. This may be accomplished by such means as:

- a) Two screws or rivets;
- b) Square shoulders or mortices;
- c) A dowel pin, lug, or offset; or
- d) A connecting strap or clip fitted into an adjacent part.

Friction between surfaces may not be used for preventing movement of the terminals.

12.2.3 Nonferrous soldering lugs or solderless (pressure) wire connectors shall be used with No. 8 AWG (8.4 mm²) and larger wires. If the connectors or lugs are secured to a plate, the plate thickness shall not be less than 0.050 inch (1.3 mm). Securing screws may be of plated steel.

12.2.4 A wire binding screw intended for connection of the power-supply (line-voltage) source shall not be smaller than No. 10 (4.8 mm diameter). The screw may be of plated steel.

Exception: A No. 8 (4.2 mm diameter) screw may be used for the connection of one No. 14 AWG (2.1 mm²) and a No. 6 (3.5 mm diameter) screw may be used for the connection of a No. 16 or 18 AWG (1.3 or 0.82 mm²) conductor.

12.2.5 For connection of other than power-supply (line-voltage) circuits using No. 10 AWG (5.3 mm²) and smaller wires, a wire binding screw shall not be smaller than No. 8 (4.2 mm diameter). However, a No. 6 (3.5 mm diameter) screw may be used for the connection of a No. 14 AWG (2.1 mm²) or smaller conductor. Also, a No. 4 (2.8 mm diameter) screw may be used as a No. 19 AWG (0.65 mm²) or smaller conductor.

12.2.6 A terminal plate tapped for wire binding screws shall:

- a) Have not less than two full threads in the metal (the terminal plate metal may be extruded to provide the two full threads) and shall have upturned lugs, clamps, or the equivalent, to hold the wires in position. Other constructions may be used if they provide thread security equivalent to that of the wire binding screw.

13.2 The following are considered to constitute means for grounding:

- a) In a product intended to be permanently connected by a metal enclosed wiring system, a knockout or equivalent opening in the metal enclosure of the product.
- b) In a product intended to be permanently connected by a nonmetal enclosed wiring system, such as nonmetallic-sheathed cable, an equipment grounding terminal or lead.
- c) In a cord-connected product, an equipment grounding conductor in the cord.

13.3 On a permanently-connected product, a terminal intended solely for the connection of an equipment grounding conductor shall be capable of securing a conductor sized in accordance with the National Electrical Code, ANSI/NFPA 70-1993.

13.3 revised July 1, 1994

13.4 A soldering lug, a push-in connector, a screwless connector, or a quick-connect or similar friction-fit connector shall not be used either as the grounding terminal intended for the connection of field supply connections or as the grounding wire in a supply cord.

13.5 On a permanently-connected product, a wire binding screw intended for the connection of an equipment grounding conductor shall have a green head that is hexagonal, slotted, or both. A pressure wire connector intended for connection of such a conductor shall be plainly identified such as by being marked "G," "GR," "GROUND," or "GROUNDING," or the like, or by a marking on a wiring diagram provided on the product. See also 13.7.

13.6 The wire binding screw or pressure wire connector specified in 13.5 shall be secured to the frame or enclosure of the product and shall be located so that it is unlikely to be removed during service operations, such as replacing fuses, resetting manual-reset devices, or the like.

13.7 If a pressure wire connector intended for grounding is located where it would be mistaken for a neutral conductor of a grounded supply, it shall be identified by a marking "EQUIPMENT GROUND" or by a green color identification or by both of these.

13.8 On a permanently connected product, the surface of an insulated lead intended solely for the connection of an equipment grounding conductor shall be finished in a continuous green, or a green with one or more yellow stripes. No other lead shall be so identified.

13.9 On a cord-connected product, the grounding conductor of the flexible cord shall be finished in a continuous green or in a green with one or more yellow stripes. No other conductor shall be so identified.

13.10 With reference to 13.9, the grounding conductor shall be secured to the frame or enclosure of the product by a positive means (see Bonding for Grounding, Section 17) that is not likely to be removed during any servicing operation not involving the power-supply cord. The grounding conductor shall be connected to the grounding blade of the attachment plug.

INTERNAL WIRING

14 General

14.1 Internal wiring shall have thermoplastic or rubber insulation not less than 1/64 inch (0.4 mm) thick for 0 – 300 volt applications if:

- a) Power is less than 375 volt-amperes (VA),

- b) Current is less than 5 amperes, and
- c) The wiring is not subject to flexing or mechanical abuse.

Otherwise, thermoplastic or rubber insulation not less than 1/32 inch (0.8 mm) thick and rated 600 volts shall be used. Other insulating material of lesser thickness may be used if it is determined to be equivalent.

14.2 A lead or cable assembly connected to parts mounted on a hinged cover shall be of sufficient length to permit the full opening of the cover without application of stress to the lead, cable assemblies or lead connections. The leads shall be secured or equivalently arranged to prevent abrasion of insulation and jamming between parts of the enclosure.

14.3 Insulation, such as coated fabric and extruded tubing, shall not be affected physically or electrically by the temperature or other environmental conditions to which it may be subjected in intended use.

14.4 Wireways shall be smooth and entirely free from sharp edges, burrs, fins, moving parts, and the like, that can cause abrasion of the conductor insulation. 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) or less in thickness. Holes in walls thicker than 0.042 inch shall have smooth, rounded edges.

15 Wiring Methods

15.1 All splices and connections shall be mechanically secure and bonded electrically.

15.2 Stranded conductors clamped under wire-binding screws or similar parts shall have the individual strands soldered together or equivalently arranged.

15.3 A splice shall be provided with insulation determined to be equivalent to that of the wires involved.

15.4 A printed wiring assembly shall comply with the Standard for Printed-Wiring Boards, UL 796.

15.5 A printed-wiring assembly using insulated coatings or encapsulation shall be tested for dielectric voltage withstand before and after being treated. If it is impractical to use untreated samples, finished samples shall be subjected to the Dielectric Voltage-Withstand Test, Section 42, after they are subjected to the Humidity Test, Section 36; Temperature Test, Section 43; and other applicable tests described in this standard.

15.6 At a point where a flexible cord passes through an opening in a wall, barrier, or enclosing case, there shall be a bushing or the equivalent that shall provide a smooth, rounded surface against which the cord may bear.

15.7 If the cord hole is made in phenolic-composition or other nonconducting material, or in metal not less than 0.042 inch (1.07 mm) thick, it shall have a smooth, rounded surface determined to be equivalent to that of a bushing.

15.8 Ceramic materials and some molded compositions may be used for insulating bushings.

15.9 Under intended operating conditions fiber may be used where it will not be subjected to a temperature higher than 90°C (194°F) if the bushing is not less than 3/64 inch (1.2 mm) thick and if the bushing will not be exposed to moisture.

52 Mechanical Strength Tests for Enclosures

52.1 Constant-force test

52.1.1 The external enclosure of a product containing high-voltage circuits or circuits that are not power limited shall withstand a force of 25 pounds (111 N) for 1 minute without:

- a) Permanent distortion to the extent that spacings are reduced below the values specified in 25.2 – 25.5,
- b) Transient distortion resulting in contact with live parts, or
- c) Creation of openings that expose uninsulated high- or low-voltage live parts.

52.1.2 The external enclosure of a product containing only low-voltage power-limited circuits is to be subjected to the test specified in 52.1.1, except that the applied force is to be 10 pounds (44 N).

52.1.3 The force specified in 52.1.1 is to be applied by means of a steel hemisphere 1/2 inch (12.7 mm) in diameter. Any openings that result from application of the force are to be judged under the requirements specified in 5.2.3 and 5.2.4.

52.2 Impact test

52.2.1 The external enclosure of a product containing high-voltage circuits or circuits that are not power-limited shall withstand an impact of 5 foot-pounds (6.78 J) without:

- a) Permanent distortion to the extent that spacings are reduced below the values specified in 25.2 – 25.5,
- b) Transient distortion resulting in contact with live parts, or
- c) Creation of openings that expose uninsulated high- or low-voltage live parts.

52.2.2 The impact is to be applied by means of a solid, smooth, steel sphere 2 inches (50.8 mm) in diameter and weighing approximately 1.18 pounds (0.54 kg). The sphere is to fall freely from rest through a vertical distance of 51 inches (1.31 m). Any openings resulting from the impact are to be evaluated under the requirements in 5.2.4 and 5.2.5.

52.2.3 The external enclosure of a product containing only low-voltage power-limited circuits is to be subjected to the test specified in 52.2.1 and 52.2.2, except that the impact is to be 2 foot-pounds (2.7 J), and the sphere is to fall freely from rest through a vertical distance of 20-13/32 inches (0.51 m).

53 Special Terminal Assemblies Tests

53.1 General

53.1.1 To determine compliance with the requirements of 12.3.1 and 12.3.2, representative samples of the terminal assembly shall comply with the requirements specified in 53.3.1 – 53.6.2.

53.2 Disconnection and reconnection

53.2.1 If a wire is to be disconnected for testing or routine servicing and then reconnected, each terminal is to be subjected to 20 alternate disconnections and reconnections prior to execution of the tests described in 53.3.1 – 53.6.2.

53.3 Mechanical secureness

53.3.1 A terminal connection shall withstand, without separating from the wire, the application of a straight pull of 5 pounds-force (22.2 N) applied for 1 minute to the wire in the direction that would most likely result in pullout.

53.3.2 Six terminal assemblies using the maximum wire size and six using the minimum wire size are to be subjected to this test. If a special tool is required to assemble the connection it is to be used, in accordance with the manufacturer's instructions. Each sample is to be subjected to a gradually increasing pull on the wire until the test pull of 5 pounds-force (22.2 N) is attained.

53.3.2 revised July 1, 1994

53.4 Flexing test

53.4.1 The wire attached to a terminal shall withstand five right angle bends without breaking.

53.4.2 Six terminal assemblies using the maximum wire size and six using the minimum wire size are to be subjected to this test. The terminal is to be secured against movement. With the wire in 3 pounds-force (13.3 N) tension and held at a point 3 inches (76.2 mm) from the terminal-to-wire juncture, the wire is to be bent at a right angle from its nominal position. The wires are to be assembled to the terminals using any special tool required, according to the manufacturer's instructions.

53.5 Millivolt drop test

53.5.1 The millivolt drop across a terminal connection shall not be greater than 300 millivolts when the maximum current specified by the manufacturer is flowing through the terminal connections and the circuit is connected to rated voltage. The terminal assemblies are to be connected in series. In one trial, wiring is to be made with wire of the maximum size intended for use; in the other trial, wire is to be of minimum size intended.

53.5.2 Six terminal assemblies using the maximum wire size and six assemblies using the minimum size are to be subjected to this test. The wires are to be connected to the terminals, according to the manufacturer's instructions and using any special tools required. The millivolt drop then is to be measured using a high impedance millivoltmeter.

53.6 Temperature test

53.6.1 The maximum temperature rise on a terminal junction shall not be greater than 30°C (54°F) based on an ambient temperature of 25°C (77°F).

53.6.2 Six terminal assemblies using the maximum wire size and six using the minimum size are to be subjected to this test. The wire is to be assembled to the terminals using any special tools, if required, according to the manufacturer's instructions. The maximum current to which the wire will be subjected in service is next to be passed through the series connection of the terminals. The maximum temperature rise is then to be measured by the thermocouple method after temperatures have stabilized.

54 Attack Tests

54.1 Destructive attack

54.1.1 The enclosure protecting the internal parts of a product shall resist, for 5 working minutes, attempts to gain access to the parts if:

- a) Manipulation of the parts can cause release of the locking mechanism, and
- b) The product is located in an exposed position outside of the area being controlled.

54.1.2 The time that the enclosure shall resist attack is to be reduced to 2 minutes if an alarm is activated during the attack.

54.1.3 The tools used in the attack test are to include hammers, chisels, adjustable wrenches, pry bars, punches, and screwdrivers. No hammer is to exceed 3 pounds (1.36 kg) in head weight, and no tool is to exceed 18 inches (457 mm) in length.

54.1.4 The product under test is to be securely mounted on a substantial rack in its intended position, and the attack is to be carried out by one operator.

54.1.5 The building structure in which the product under attack may be mounted shall be represented by gypsum wallboard 5/8 inch (15.9 mm) thick.

54.2 Nondestructive attack

54.2.1 The external control that regulates access to the system shall not be damaged after 5 working minutes of an attack that attempts to operate the control in an unintended manner.

54.2.2 The time that the external control shall resist attack is to be reduced to 2 minutes if an alarm is activated during the attack.

54.2.3 If the attack consists of running through a series of codes, the attack is to be repeated ten times, each time with a new code setting unknown to the attacker. One opening of the locking mechanism during this test is permissible.

55 Tests for Alarm Sounding Devices

55.1 If the alarm is connected to a remote, manned guard station, the annunciation shall be visual and audible and shall identify the control being attacked. The audible alarm may be silenced, but the visual indication shall remain until the alarm condition has been cleared.

55.2 If the alarm is local, the alarm sounding device, mounted within its intended housing and in its intended mounting position, shall provide a sound output equivalent to that of an omni-directional source with an A-weighted sound pressure level of at least 85 decibels at 10 feet (3.05 m) while connected to a source of rated voltage. See 27.3.1.

55.3 The sound power output of the alarm sounding device is to be measured in a reverberant room qualified for pure tones under Precision Methods for the Determination of Sound Power Levels of Broad-Band Noise Sources in Reverberation Rooms, ANSI S12.31-1990, or Precision Methods for the Determination of Sound Power Levels of Discrete-Frequency and Narrow-Band Noise Sources in Reverberation Rooms,

ANSI S12.32-1990. The sound power in each 1/3 octave band shall be determined using the comparison method. The A-weighting factor shall be added to each 1/3 octave band. The total power shall then be determined on the basis of actual power. The total power shall then be converted to an equivalent sound pressure level for a radius of 10 feet (3.05 m) using the following formula:

$$L_p = L_w - 20 \log_{10} R - 0.6$$

in which:

L_p is the converted sound pressure level,

L_w is the sound power level measured in the reverberation room, and

R is the radius for the converted sound pressure level (10 feet).

55.3 revised July 1, 1994

55.4 The output specified in 55.2 shall not be less than 82 decibels when the voltage is reduced to the minimum value specified in the Undervoltage Operation Test, Section 33.

55.5 When connected with its power supply, the alarm sounding device shall sound at the level specified in 55.2 for not less than 15 minutes.

56 Alarm Housing Test

56.1 The alarm housing shall resist for a period of 120 seconds attempts to silence the alarm. The 120-second attack shall be started with the alarm silent and the attack shall initiate the alarm. See 7.4.1 – 7.4.4 for construction requirements for the alarm enclosure.

MANUFACTURING AND PRODUCTION LINE TESTS

57 Production Line Dielectric Voltage-Withstand Test for High-Voltage Products

57.1 Each access control system unit rated more than 30 volts ac rms (42.4 volts dc or ac peak) shall withstand, without breakdown, as a routine production-line test, the application of an essentially sinusoidal ac potential of a frequency within the range of 40 – 70 hertz, or a dc potential, between high-voltage live parts and the enclosure, high-voltage live parts and exposed dead metal parts, and live parts of circuits operating at different potentials or frequencies. The test potential is to be:

- a) For an access control system unit rated at 250 volts ac rms or less – either 1000 volts (1414 volts, if a dc potential is used) applied for 60 seconds or 1200 volts (1697 volts, if a dc potential is used) applied for 1 second.
- b) For an access control system unit rated at more than 250 volts – either 1000 volts plus twice the rated ac rms voltage (1414 volts plus 2.828 times the rated ac rms voltage, if a dc potential is used) applied for 60 seconds or 120 volts plus 2.4 times the rated voltage (1697 volts plus 3.394 times the rated ac rms voltage, if a dc potential is used) applied for 1 second.

57.2 A printed wiring assembly or other electronic circuit component that would be damaged by the application of, or would short-circuit, the test potential, is to be removed, disconnected, or otherwise rendered inoperative before the test. A representative subassembly may be tested instead of an entire access control system unit. Rectifier diodes in the power supply may be individually shunted before the test to avoid destroying them in the case of a malfunction elsewhere in the secondary circuits.

57.3 If a product uses both high-voltage and low-voltage circuits, the test is to be conducted with the low-voltage circuits connected to the cabinet, chassis, or other dead metal parts so that the potential that is applied between the high-voltage live parts and dead metal parts will simultaneously be applied between high-voltage live parts and low-voltage circuits.

57.4 A 500 volt-ampere or larger transformer, the output voltage of which can be varied, is to be used to determine compliance with 57.1. The requirement of a 500 volt-ampere or larger transformer can be waived if the high-potential testing equipment used maintains the specified voltage at the access control system unit during the test.

57.5 The test equipment is to make a visible indication when the test potential is applied and an audible or visible indication, or both, of breakdown. In the event of breakdown, manual reset of an external switch is required, or an automatic reject of the unit under test is to result. Other arrangements may be used if determined to achieve the results contemplated.

59.10 If a separate grounding conductor is necessary as part of the installation wiring for a product, a marking shall be included on the product to indicate this fact. The marking shall make reference to the installation instructions unless complete instructions are attached to the appropriate product.

59.11 If the wires in a terminal box or compartment of a product intended for power-supply connections may attain a temperature higher than 60°C during the Temperature Test, Section 43, the unit shall be marked "For supply connections, use wires rated for at least ____ °C," or with an equivalent statement at or near the point at which the supply connections are to be made. The temperature to be used in this marking shall be as indicated in Table 59.1. The marking shall be in a position in which it will be readily visible during and after installation of the product.

Table 59.1
Temperature for marking

Temperature attained in terminal box or compartment, °C (°F)		Temperature in marking, °C
61 – 75	142 – 167	75
76 – 90	168 – 194	90

59.12 If the capacity of a standby battery is such that it cannot provide power for 4 hours of operation as specified in 32.1, the product is to be marked with the following or equivalent wording: "Battery capacity for emergency standby at least ____ hours." The blank is to be filled in with the applicable time in hours.

60 Marking Permanency Tests

60.1 Directly applied marking, or a marking plate secured by cement or adhesive, shall comply with the applicable part of the Standard for Marking and Labeling Systems, UL 969.

OUTDOOR USE EQUIPMENT

ASSEMBLY

61 General

61.1 A product or section of a product intended for installation where it may be exposed to the weather shall comply with the requirements of the preceding sections of this standard and shall, in addition, comply with the following requirements.

62 Construction

62.1 General

62.1.1 An enclosure or enclosures exposed to weather shall be constructed to prevent the wetting of live parts as specified in the requirements of this section.

62.1.2 To determine compliance with 60.1, a complete assembly, with supply conduit connections but without pipe thread compounds, is to be subjected to the Rain Test, Section 66.

62.1.3 Enclosures for electrical components shall have provision for drainage if knockouts or unthreaded openings in the enclosure are used.

62.1.4 Except as specified in 62.1.5, cabinets and enclosures shall have a thickness of not less than:

- a) 0.032 inch (0.81 mm) if of uncoated sheet steel;
- b) 0.034 inch (0.86 mm) if of zinc-coated sheet steel; and
- c) 0.045 inch (1.14 mm) if of copper, brass, or aluminum.

62.1.5 Enclosures thinner than those described in 62.1.4 that comply with the specifications of Table 7.2 or 7.3 (whichever applies) may be used if they are protected by an outer cabinet. Sheet steel cabinets and enclosures using panels consisting of more than one sheet of lesser thickness than specified in 62.1.4 may be used if the construction is determined to be equivalent in all respects, including mechanical strength and corrosion resistance, to a single sheet of steel of the thicknesses stated in 62.1.4.

62.2 Corrosion protection

62.2.1 Sheet steel cabinets and electrical enclosures exposed to the effects of weathering shall be protected against corrosion as specified in 62.2.2.

62.2.2 An outer cabinet that protects motors, wiring, or enclosed current-carrying parts, and an inside enclosure that protects current-carrying parts other than motors shall comply with the requirements specified in:

- a) 62.2.4, if the cabinet or enclosure is not less than 0.053 inch (1.35 mm) thick; or
- b) 62.2.5, if it is of lesser thickness.

An outer cabinet that is the sole enclosure of current-carrying parts shall comply with the requirements specified in 62.2.5. (Minimum metal thicknesses are specified in Table 7.2.)

62.2.3 The requirements specified in 62.2.1, 62.2.2, and 62.2.4 – 62.2.6 are not applicable to a metal part, such as a decorative grille, that is not required to comply with this standard.

62.2.4 With reference to the applicable requirements specified in 62.2.2, one of the following coatings shall be used:

- a) Hot-dipped mill-galvanized sheet steel that complies with the coating Designation G60 or A60 in Table I of the Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, ASTM Designation A525-91b, and has not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in this ASTM Designation. The weight of zinc coating may be determined by any method; however, in case of question the weight of coating shall be established in accordance with the Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles, ASTM Designation A90-81(1991). An A60 (alloyed) coating shall also comply with the requirements in 62.2.7.
- b) A zinc coating, other than that provided on hot-dipped mill-galvanized sheet steel. The thickness of the coating shall comply with the requirements specified in 69.1(a) of the Metallic Coating Thickness Test, Section 69. An annealed coating shall also comply with the requirements in 62.2.7.
- c) Protection equivalent to that afforded by G60 hot-dipped mill-galvanized coating. See 62.2.6.

62.2.4 revised July 1, 1994

62.2.5 With reference to the applicable requirement specified in 62.2.2, one of the following coatings shall be used:

- a) Hot-dipped mill-galvanized sheet steel complying with the coating Designation G90 in Table I of the Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, ASTM Designation A525-91b, and has not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in this ASTM Designation. The weight of zinc coating may be determined by any method; however, in case of question the weight of coating shall be established in accordance with the Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles, ASTM Designation A90-81(1991).
- b) A zinc coating, other than that provided on hot-dipped mill-galvanized sheet steel. The thickness of the coating shall comply with the requirements specified in 69.1(b) of the Metallic Coating Thickness Test, Section 69. An annealed coating shall also comply with the requirements in 62.2.7.
- c) A cadmium coating. The thickness of coating shall comply with the requirement of 69.2.

62.2.5 revised July 1, 1994

62.2.6 With reference to 62.2.2 and 62.2.4(c), other finishes may be used if comparative tests with galvanized sheet steel indicate they provide equivalent resistance to corrosion. Such finishes include paints, special metallic finishes and combinations of the two. The steel, which is not to be annealed, wiped or given other surface treatment as part of the test, shall comply with the requirements of either 62.2.4(a) or 62.2.5(a), whichever is applicable.

62.2.7 Where the bending and forming process damages a coating already annealed on a surface, the bent or formed area shall be painted. The coating is considered to be damaged if flaking or cracking is visible at the outside radius of a bent or formed section viewed at 25-power magnification. This requirement applies specifically to any hot-dipped, mill-galvanized A60 (alloyed) coating or to any annealed-zinc coating.

62.2.8 Extruded and rolled edges and holes shall be painted in compliance with 62.2.7. However, simple sheared or cut edges and punched holes are not considered to be formed and need not be painted. Also, no paint is required on those inside surfaces of a cabinet or enclosure that are not touched by water during the Rain Test, Section 66.

62.2.9 Nonferrous cabinets and enclosures may be used without corrosion protection.

62.2.10 Nonmetallic cabinets and enclosures shall comply with the requirements in the Mechanical Strength Tests for Enclosures, Section 52, after being subjected to the Ultraviolet Light and Water Exposure Test, Section 71.

62.2.11 If a gasket is required to seal electrical enclosures against the entrance of rain and condensate, it shall be held in place by mechanical fasteners or adhesives, except as specified in paragraph 62.2.12, and shall comply with the requirements in the Accelerated Aging Tests for Gaskets, Sealing Compounds, and Adhesives, Section 72. A gasket shall be neoprene, rubber or thermoplastic. Other materials may be used if they have properties determined to be equivalent.

62.2.12 A gasket need not be held by mechanical fasteners or adhesives if it cannot be displaced when the enclosure cover is removed or if it reengages as intended when the cover is replaced. Consideration is to be given to the manner in which the gasket is intended to be mounted in application.

63 Field-Wiring Connections

63.1 Openings provided for field-wiring connections shall be intended for connection of conduit and shall not be less than 7/8 inch (22.2 mm) in diameter. An opening shall be threaded unless it is located wholly below the lowest uninsulated live part within the enclosure, or the opening is sheltered to prevent water draining into the enclosure along the outside surface of a field-supplied wireway. Threaded holes for conduit shall be provided with a conduit end stop unless the thread is tapered.

64 Internal Wiring

64.1 The internal wiring shall be constructed and assembled so as to reduce the risk of electric shock when the product is exposed to weather.

64.2 Wiring material used to connect electrical component enclosures may be Type RW wire, or it may be appliance-wiring material specified in Group A of Table 64.1 and has equivalent moisture resistance to Type RW. The wiring shall be enclosed in rigid- or flexible-steel conduit, in electrical metallic tubing, or in moisture-resistant nonmetallic sheathed cable. Wiring material of the type specified in Group A of Table 64.1, installed in either rigid conduit or electrical metallic tubing with raintight fittings or in liquid-tight flexible metal conduit with suitable fittings, may be used. Cords of appliance wiring material as specified in Group B of Table 64.1, may also be used. Bushings, where used, are to be nonabsorptive.

Table 64.1
Typical wiring materials

Group	Type of wire, cord, or cable	Wire size,		Insulation thickness,	
		No. AWG	(mm ²)	Inch	(mm)
A	AC, ACL, ACT, RF-2, FF-2, FFH-2, TF, TFF, TFN, TFFN, SF-2, SFF-2, RH, RHH, RHW, RUH, RUW, T, THW, XHHW, MTW, THW-MTW, THWN, PF, PGF, PFF, PGFF, TW, or thermoplastic appliance wiring material, with insulation thicknesses shown at the right corresponding to wire sizes indicated	10 and smaller	5.3	2/64	0.8
		8	8.4	3/64	1.2
		6	13.3	4/64	1.6
		4	21.2	4/64	1.6
		3	26.7	4/64	1.6
		2	33.6	4/64	1.6
		1	42.4	5/64	2.0
		1/0	53.5	5/64	2.0
		2/0	67.4	5/64	2.0
		3/0	85.0	5/64	2.0
		4/0	107.2	5/64	2.0
B	SO, ST, SPT-3, SJO, SJT, or appliance wiring material having thermoplastic or neoprene insulation, with insulation thicknesses shown at the right corresponding to the wire sizes indicated.	18	0.82	4/64	1.6
		16	1.3	4/64	1.6
		14	2.1	5/64	2.0
		12	3.3	5/64	2.0
		10	5.3	5/64	2.0
		8	8.4	6/64	2.4
		6	13.3	8/64	3.2
		4	21.2	9/64	3.6
		2	33.6	10/64	4.0

69.6 Each sample is to be cleaned before testing. All grease, lacquer, paint, and other nonmetallic coatings are to be removed completely by means of a solvent. Samples are then to be thoroughly rinsed in water and dried with clean cheesecloth. Care is to be taken that the cleaned surface does not come in contact with the hands or any foreign material.

69.7 The sample is to be supported 0.7 – 1.0 inch (17.8 – 25.4 mm) below the orifice. The surface to be tested is to be inclined approximately 45 degrees from horizontal so that the drops of solution strike the point to be tested and run off.

69.8 After cleaning, the sample to be tested is to be placed under the orifice. The stopcock is to be opened and the time in seconds is to be measured with a stopwatch until the dropping solution dissolves the protective metallic coating and exposes the base metal. The end point is achieved with the first appearance of the base metal, which is made recognizable by a change in color.

69.9 Each specimen of a test lot is to be subjected to the test at three or more points on the inside surface and at an equal number of points on the outside surface where the metallic coating is expected to be the thinnest. Cut, stenciled and threaded surfaces are not to be tested as part of the inside surface. On enclosures made from precoated sheets, the external corners that are subjected to the greatest deformation may have thin coatings.

69.10 To calculate the thickness of the coating being tested, the thickness factor appropriate for the temperature at which the test was conducted is to be selected from Table 69.1 and then multiplied by the time in seconds required to expose base metal as determined in 69.8.

Table 69.1
Thickness of coatings

Temperature,		Thickness factors, 0.00001 inch (0.0003 mm) per second,	
°F	(°C)	Cadmium platings	Zinc platings
70	21.1	1.331	0.980
71	21.7	1.340	0.990
72	22.2	1.352	1.000
73	22.8	1.362	1.010
74	23.3	1.372	1.015
75	23.9	1.383	1.025
76	24.4	1.395	1.033
77	25.0	1.405	1.042
78	25.6	1.416	1.050
79	26.1	1.427	1.060
80	26.7	1.438	1.070
81	27.2	1.450	1.080
82	27.8	1.460	1.085
83	28.3	1.470	1.095
84	28.9	1.480	1.100
85	29.4	1.490	1.110
86	30.0	1.501	1.120
87	30.6	1.513	1.130
88	31.1	1.524	1.141
89	31.7	1.534	1.150
90	32.2	1.546	1.160

70 Corrosion Tests

70.1 General

70.1.1 A finish may be used on exposed surfaces if its corrosion resistance is determined to be equivalent to that of galvanized steel as determined by the tests specified in 70.1.2 – 70.4.2.

70.1.2 A set of three samples of G60 or G90 (as applicable) hot-dipped, mill-galvanized sheet steel and a set of three samples of the alternately-finished sheet steel are to be subjected to the corrosion tests and the Ultraviolet Light and Water Exposure Test, Section 71. The tests are to be conducted until equivalency or nonequivalency is established. The samples are to be of identical size. Prior to exposure to light or water, the coating of one sample from each set is to be inscribed with a narrow groove that lays bare the base metal. A separate set of six samples is to be used for each test.

70.1.3 During the test exposures, the samples are to be supported in plastic racks at a 15-degree angle from vertical.

70.2 Salt spray (fog)

70.2.1 The apparatus for salt-spray (fog) testing is to consist of:

- a) A fog chamber, the inside of which measures 48 by 30 by 36 inches (1.2 by 0.8 by 0.9 m);
- b) A salt-solution reservoir;
- c) A supply of conditioned compressed air;
- d) A dispersion tower constructed in accordance with Test Method of Salt Spray (Fog) Testing, ASTM B117-90, for producing a salt fog;
- e) Sample supports;
- f) Provision for heating the chamber; and
- g) Necessary means of control.

70.2.1 revised July 1, 1994

70.2.2 The dispersion tower for producing a salt fog is to be located in the center of the chamber and is to be supplied with humidified air at a pressure of 17 – 19 psi (117 – 131 kPa) so that the salt solution is aspirated as a fine mist or fog into the interior of the chamber.

70.2.3 Common salt (sodium chloride) is to make up 5 percent of the weight of the salt solution, and the other 95 percent is to be contributed by distilled water. The pH value of the collected solution is to lie between 6.7 and 7.2, and its specific gravity is to be between 1.0255 to 1.0440 at 25°C (77°F). The temperature of the chamber is to be maintained at 35 plus 1 or minus 2°C (95 plus 2 or minus 3°F) throughout the test.

70.2.4 Drops of solution that accumulate on the ceiling or on the cover of the chamber are to be diverted from dropping on the samples. Drops of solution that fall from samples are not to be recirculated but are to be removed by a drain located at the bottom of the chamber.

72.3 Gaskets or materials other than those mentioned in 72.1 and 72.2 shall be nonabsorptive and provide the resistance to aging and temperatures specified in 72.1 and 72.2.

72.4 Where a gasket is secured by an adhesive, the force required to peel the gasket from its mounting surface after exposure to aging and immersion conditions specified in 72.8 shall not be less than:

- a) 50 percent of the force required to peel off gaskets fixed to "as received" samples, and
- b) 2 pounds (8.82 N) for each inch (25.4 mm) of gasket width.

72.5 Thermoplastic material shall not deform, melt, or otherwise deteriorate to a degree that will impair its sealing properties when subjected to accelerated aging conditions specified in Table 72.2. Solid PVC gasket material shall have physical properties indicated in Table 72.1 before and after the accelerated aging.

72.6 Tensile strength and elongation are to be determined using the test methods and apparatus described in the Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers – Tension, ASTM D412-92.

72.6 revised July 1, 1994

72.7 A sealing compound is to be applied to the surface it is intended to seal. A representative sample of the surface with the sealing compound applied is to be subjected to accelerated aging under the conditions indicated in Table 72.2 for air-circulated oven exposure.

72.8 Where gaskets are secured by adhesives, samples of the gasket adhesive and mounting surface are to be subjected to:

- a) Accelerated aging under the conditions indicated in Table 72.2 for air-circulated oven exposure, and
- b) Immersion in distilled water for 3 days.

MARKINGS

73 Details

73.1 A nameplate on outdoor use equipment shall be of corrosion-resistant material.

73.2 A nameplate attached by adhesives shall resist defacement and removal in compliance with the Marking Permanency Tests, Section 60, when it is subjected to the temperatures and atmospheric conditions that it will encounter in use.

73.3 A unit or accessory that is intended for remote mounting and that has been investigated and determined to be acceptable for outdoor use shall be legibly marked on or near the nameplate with the words "Outdoor Use" or the equivalent.

ACCESSORY EQUIPMENT

74 General

74.1 Sections 75 – 77 are intended to cover requirements that, in addition to the provisions in the preceding sections of this standard, are applicable to accessory equipment.