

d) A dc potential of 1.414 times $(2 V + 1000)$, where V is the rms supply voltage, between the terminals of a capacitor used across the line for radio interference elimination or arc suppression.

Exception No. 1: If an ac potential results in excessive leakage through capacitors during the test specified in (a) – (c) above, the capacitors may be removed from the circuit for the ac potential. With the capacitors connected in the circuit, the battery charger shall withstand a dc potential of 1.414 times the ac rms potential between the points specified.

Exception No. 2: A capacitor complying with the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors For Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14, or with the Standard for Electromagnetic-Interference Filters, UL 1283, need not be subjected to the dielectric potential required by [29.1.1\(d\)](#).

29.1.2 To determine whether a battery charger complies with the requirements in [29.1.1](#), the battery charger is to be tested using a 500-volt-ampere or larger capacity transformer, the output voltage of which can be varied. The applied potential is to be increased from zero until the required test level is reached, and is to be held at that level for 1 minute. The increase in applied potential is to be at a substantially uniform rate as rapid as is consistent with correct indication of its value by a voltmeter.

29.2 Induced potential test

29.2.1 If a bobbin wound transformer is required to be tested as provided in [16.2.7\(b\)](#), after constant temperatures have been reached as the result of operation under the Normal Temperature Test, Section [28](#), one sample of the transformer shall withstand without breakdown an induced potential test in accordance with [29.2.2](#) and [29.2.3](#).

29.2.2 While still heated, the primary winding is to be subjected to an alternating potential of twice the rated voltage at any acceptable frequency – typically 120 hertz or higher – for 7200 electrical cycles or for 60 seconds, whichever is less. Starting at one-quarter or less of the full value, the test voltage is to be increased to the full value in not more than 15 seconds. After being held for the time specified, the voltage is to be reduced within 5 seconds to one-quarter or less of the full value, and the primary winding circuit is to be opened.

29.2.3 An oven may be used to condition the samples to the temperature attained under the conditions specified in [29.2.1](#) and [29.2.2](#) before conducting the test.

30 Water Spray Test

30.1 After being subjected to the water spray as described in [30.3](#) for 4 hours, a battery charger as mentioned in [7.8.2](#) – [7.8.8](#) or a cart-type battery charger shall:

a) For a cord-connected battery charger rated for a nominal 120-volt supply, comply with the requirement in [26.1](#) in a repeated leakage current test, except that the test is to be discontinued when the leakage current stabilizes.

b) For a battery charger other than as specified in [30.1\(a\)](#), have an insulation resistance of not less than 50,000 ohms.

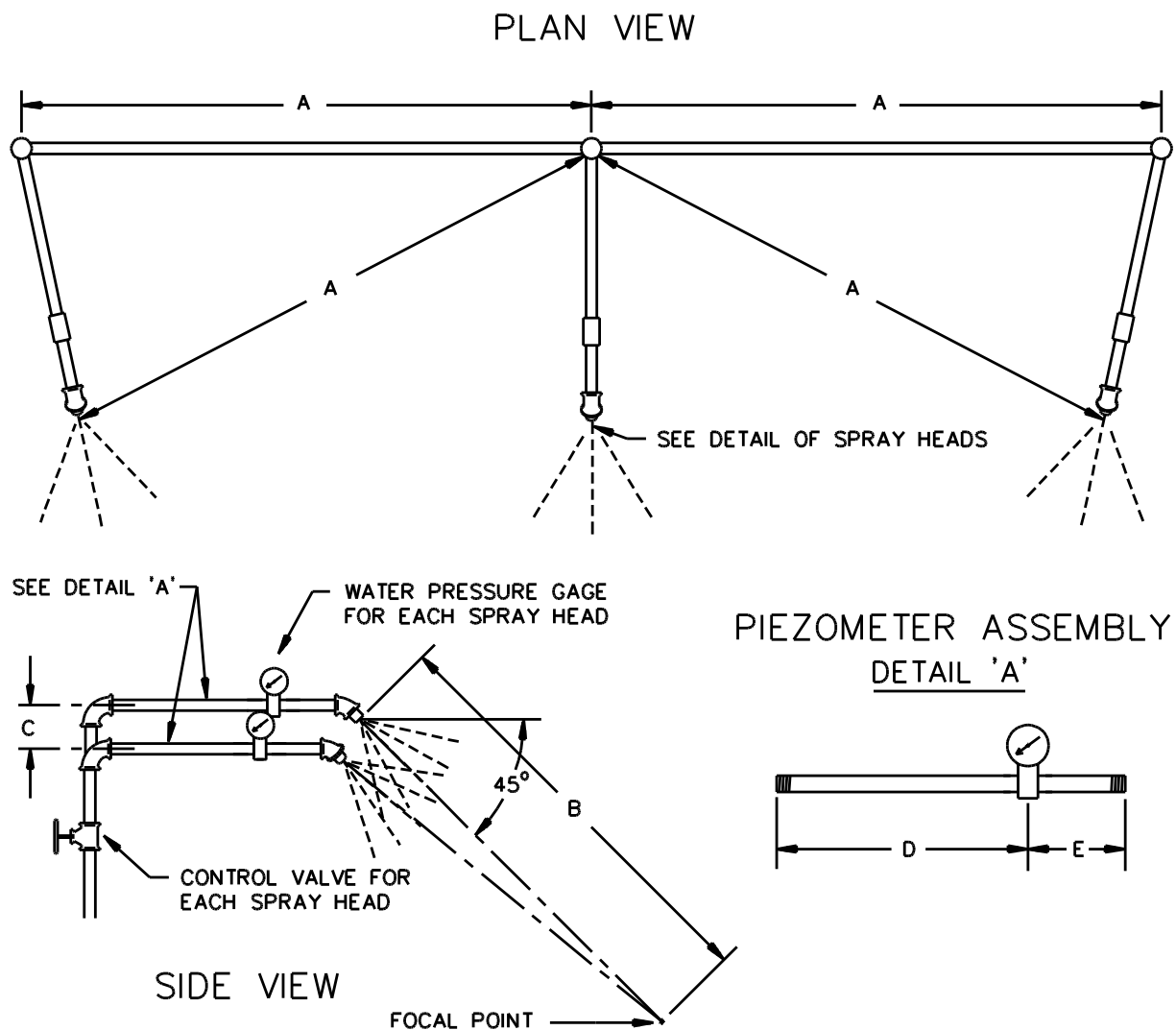
Exception: A cart-type battery charger marked in accordance with the requirements in [50.9](#) need not comply with this requirement.

30.2 After being tested in accordance with either [30.1](#) (a) or (b), a battery charger shall comply with a repeated dielectric evaluation in accordance with the Dielectric Voltage Withstand Test, Section [29](#).

30.3 Before the test described in [30.4](#) is started, the resistivity of the water is to be adjusted to 3500 ohm-centimeters ± 5 percent when measured at 25°C (77°F). At the conclusion of the test, the resistivity of the water is not to be less than 3200 ohm-centimeters or more than 3800 ohm-centimeters at 25°C.

30.4 The test apparatus is to consist of three spray heads constructed in accordance with the details shown in [Figure 30.2](#) and mounted in a water supply pipe rack as shown in [Figure 30.1](#). The water pressure is to be maintained at 5 psi (34 kPa) at each spray head. The distance between the center nozzle and the battery charger is to be approximately 5 feet (1.5 m). The battery charger is to be brought into the focal area of the three spray heads in such a position and under such conditions as are most likely to result in entrance of water into the battery charger, except that consideration is to be given to the normal mounting position. If the battery charger employs a fan or other moving part, the operation of which is likely to facilitate the entrance of water, it is to be energized and operated as intended.

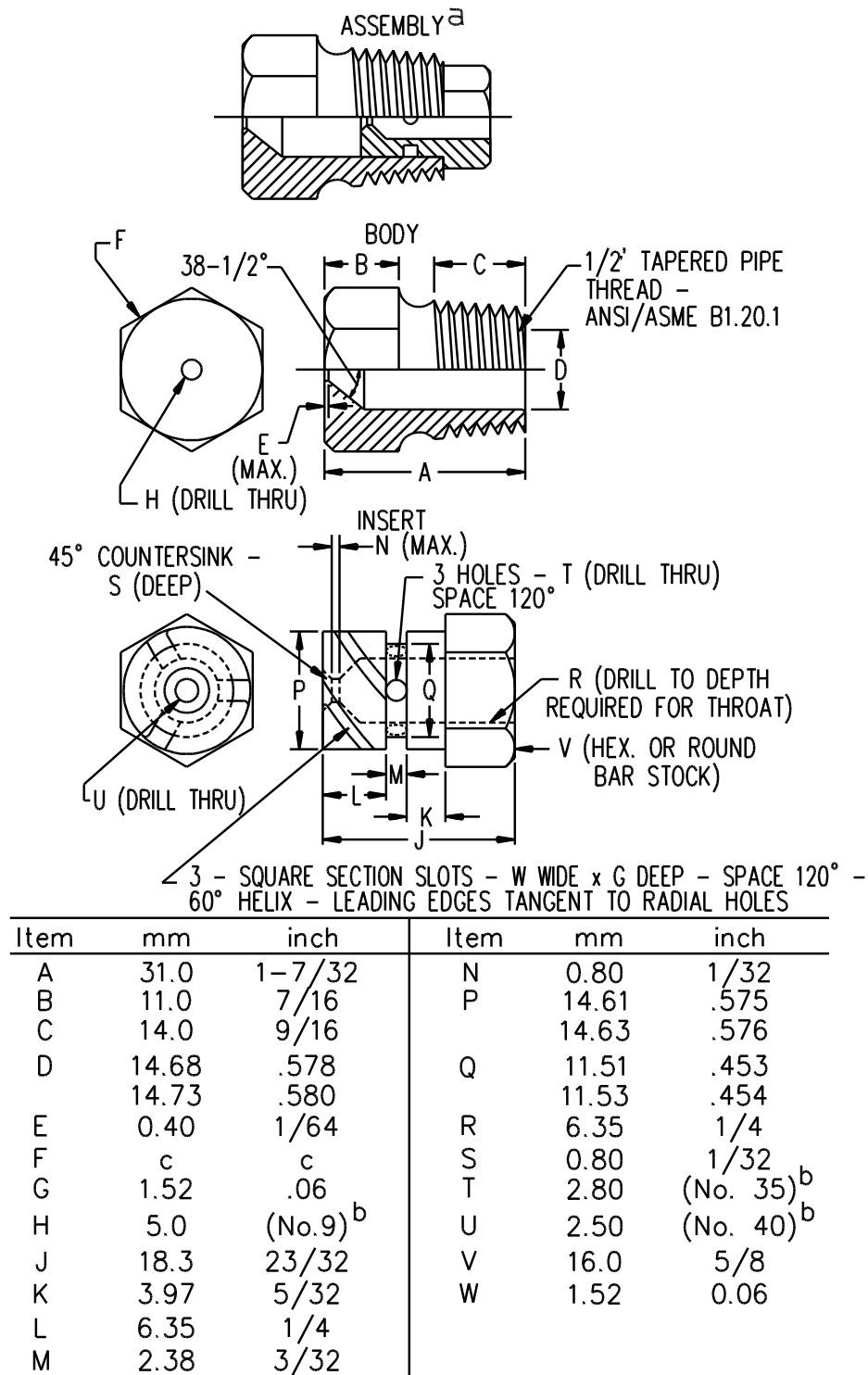
Figure 30.1
Rain test spray head piping



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

RT101F

Figure 30.2
Rain test spray head



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

^b ANSI B94.11M Drill Size

^c Optional - To serve as a wrench grip.

RT100F

31 Impact Test

31.1 General

31.1.1 A battery charger shall be tested as described in [31.2](#) and [31.3](#) (see [31.1.2](#) – [31.1.4](#)). Following the test, the battery charger shall:

- a) Not permit a probe, as illustrated in [Figure 8.1](#) and applied in accordance with [7.7.4](#), to contact an uninsulated live part that may involve a risk of electric shock or a moving part that may involve a risk of injury to persons; and
- b) Comply with the Dielectric Voltage Withstand Test, Section [29](#), with the potential applied between live parts and accessible dead metal parts.

31.1.2 The test of [31.2](#) is to be performed on the following:

- a) Units employing a polymeric enclosure, or a polymeric part forming part of the enclosure;
- b) With reference to the Exception to [7.1.3](#), enclosures of metal; or
- c) With reference to [7.5.4](#), material of a part the breakage of which may result in a risk of injury to persons, or a risk of electric shock.

The test for (a) and for polymeric parts of (c) shall be performed on samples after being conditioned for 3 hours in a cold chamber at minus 35°C (minus 31°F) for a fixed outdoor unit, and at 0°C (32°F) for all other units.

31.1.3 If an electrical instrument, such as a meter, forms part of the enclosure, the face or the back of the instrument housing, or both together, is to be impacted in accordance with [31.2](#).

Exception: This requirement does not apply to a meter complying with the requirements in the Standard for Electrical Analog Instruments – Panelboard Type, UL 1437.

31.1.4 The test of [31.3](#) is to be performed on three samples of a portable unit weighing less than 40 pounds (18 kg). The test shall be performed on samples after being stabilized to room temperature [nominal 25°C (77°F)].

31.1.5 With reference to the Exception to [7.1.3](#), a permanent distortion to the extent that spacings are reduced below the values specified in Spacings, Section [23](#), shall not result when a small section of a sheet metal enclosure having a thickness less than that specified in [Table 7.1](#) is subjected to the test described in [31.2](#).

31.2 Ball impact test

31.2.1 With reference to [31.1.2](#), the enclosure section, guard, or cover is to be subjected to an impact of 5 foot-pounds (6.78 N·m) on any surface that is exposed to a blow during intended use. The impact is to be produced by dropping a steel sphere, 2 inches (50.8 mm) in diameter and weighing approximately 1.18 pounds (0.535 kg), from a height of 51 inches (1.30 m). For surfaces other than the top of an enclosure, the steel sphere is to be suspended by a cord and allowed to swing as a pendulum dropping through a vertical distance of 51 inches.

31.3 Drop test

31.3.1 With reference to [31.1.4](#), each sample is to be dropped three times from a height of 3 feet (0.9 m) to strike a concrete surface in the positions most likely to produce adverse results.

32 Stability Test

32.1 Under conditions of normal use, a portable or stationary battery charger intended for floor or table use shall not become physically unstable to the degree that it poses a risk of injury to persons.

Exception: This requirement does not apply to a direct plug-in or cord-connected battery charger weighing 1 pound (0.5 kg) or less.

32.2 A battery charger shall not tip over but shall return to its normal at-rest position when:

- a) Tipped through an angle of 10 degrees from an at-rest position on a horizontal surface;
- b) Placed on a plane inclined at an angle of 10 degrees from the horizontal; or
- c) Subjected to an externally applied horizontal force of 20 percent of the weight of the battery charger or 50 pounds (22.7 kg), whichever is less. See [32.5](#).

32.3 A battery charger is not to be energized during the stability test. The test is to be conducted under conditions most likely to cause the battery charger to overturn. The following conditions are to be such as to result in the least stability:

- a) The position of all adjustable or movable parts such as doors, drawers, or casters;
- b) The supply and output cords placed in either the stored position or on the surface supporting the battery charger, whichever is more severe;
- c) Provision of or omission of any normal mechanical load in the battery charger such as stored parts; and
- d) Direction in which the battery charger is tipped, or the supporting surface is inclined.

32.4 With reference to the requirement in [32.2\(a\)](#), for a battery charger that is constructed so that while being tipped through an angle of 10 degrees a part or surface of the battery charger not normally in contact with the horizontal supporting surface touches the supporting surface before the charger has been tipped through an angle of 10 degrees, the tipping is to be continued until the surface or plane of the surface of the charger originally in contact with the horizontal supporting surface is at an angle of 10 degrees from the horizontal supporting surface.

32.5 The force specified in [32.2\(c\)](#) is to be applied in a horizontal direction at that point on the charger most likely to overturn the battery charger, but is not to be applied more than 5 feet (1.52 m) above floor level. The legs or points of support may be blocked to prevent the unit from sliding during the application of the force.

33 Static Load Test

33.1 When mounted as recommended by the manufacturer, a battery charger intended to be fixed to a supporting structure shall be loaded as described in [33.2](#) for 1 minute with a force equal to three times the weight of the device but not less than 20 pounds (89 N). As a result of this loading, there shall be no permanent deformation, breakage, dislocation, cracking, or other damage to the mounting means.

Exception No. 1: This test is not required for a battery charger weighing 1 pound (0.45 kg) or less.

Exception No. 2: This test is not required for a battery charger weighing 20 pounds (9.07 kg) or less and having keyhole slots in a sheet metal enclosure, or brackets welded to the enclosure, provided that the enclosure complies with the thickness requirements specified in [7.1.3](#) and [Table 7.1](#).

33.2 The force is to be applied through the approximate center of gravity of the device, is to be increased gradually to reach the required value in 5 to 10 seconds, and is to be maintained at that value for 1 minute.

34 Strain Relief Test

34.1 The strain relief means provided on a flexible cord shall withstand for 1 minute without displacement a direct pull of 35 pounds (156 N) applied to the cord, with the connections within the battery charger disconnected. The strain relief is not acceptable if, at the point of disconnection of the conductors, there is such movement of the cord as to indicate that stress on the connections would have resulted.

Exception: The strain relief means provided for the output cord on a battery charger with a low voltage limited energy output shall withstand for 1 minute a direct pull of 20 pounds (89 N). The results are not acceptable if, with the output cord connected internally, movement of the cord results in a reduction of spacings to primary or dead metal parts, damage to the transformer or enclosure, or interruption of the output circuit wiring.

34.2 A 35-pound (15.9-kg) or a 20-pound (9.1-kg) weight, as applicable, is to be suspended from the cord and supported by the battery charger so that the strain relief means is stressed from any angle the construction of the battery charger permits.

34.3 With reference to [11.4.3](#), the strain relief for a specialized vehicle connector shall withstand a straight pull of 30 lbf (133 N) if the conductors are 18 AWG or larger, and 20 lbf (89 N) if smaller than 18 AWG, applied between the connector and the cord. The connector is to be securely supported by a rigid, flat plate mounted horizontally. The plate is to have a hole just large enough for the cord to pass through. The pull is to be applied by means of a weight for 1 minute to the flexible cord, in a direction perpendicular to the plane of the cord-entry to the connector.

35 Push-Back Relief Test

35.1 To determine compliance with [11.3.14](#), a product shall be tested in accordance with [35.2](#) without occurrence of any of the conditions specified in [11.3.14](#) (a) – (d).

35.2 The supply cord or lead is to be held 1 inch (25.4 mm) from the point where the cord or lead emerges from the product and is then to be pushed back into the product. When a removable bushing which extends further than 1 inch is present, it is to be removed prior to the test. When the bushing is an integral part of the cord, the test is to be carried out by holding the bushing. The cord or lead is to be pushed back into the product in 1-inch (25.4-mm) increments until the cord buckles or the force to push the cord into the product exceed 6 pounds-force (26.7 N). The supply cord or lead within the product is to be manipulated to determine compliance with [11.3.14](#).

36 Overload of Switches and Controls Test

36.1 Unless known to be acceptable for the application (See Switches and Controllers, Section [18](#)), a switch or other control device shall perform acceptably when subjected to an overload test consisting of 50 cycles of operation making and breaking the applicable load. There shall be no electrical or mechanical breakdown of the device, undue burning or pitting of the contacts as a result of the overload or endurance test, or opening of the fuse in the grounding connections.

36.2 To determine whether a switch or other control device complies with the requirements in [36.1](#), the battery charger is to be connected to a supply circuit of rated frequency and 110 percent of maximum rated voltage. The load for the device under test is to be the same as that which it is intended to control in regular service. During the test, exposed dead metal parts of the battery charger are to be connected to ground through a 3-ampere plug fuse. The device is to be operated at a rate of not more than 10 cycles per minute, except that a faster rate of operation may be employed if agreeable to those concerned.

36.3 A switch or other device that controls a motor and has not been shown to be acceptable for the purpose, unless interlocked so that it does not break the locked rotor current of the motor, shall perform acceptably when subjected to an overload test consisting of 50 cycles of operation, making and breaking the locked-rotor current of the motor. There shall be no electrical or mechanical breakdown of the device, undue pitting or burning of the contacts, or opening of the fuse in the grounding connection.

36.4 To determine whether a switch or other control device complies with the requirement in [36.3](#), the battery charger is to be connected to a grounded supply circuit of rated frequency and maximum rated voltage – see [Table 25.1](#) – with the rotor of the motor locked in position. During the test, exposed dead metal parts of the battery charger are to be connected to ground through a 3-ampere plug fuse, and the connection is to be such that any single-pole, current-rupturing device will be located in the ungrounded conductor of the supply circuit. The device is to be operated at a rate of not more than 10 cycles per minute, except that a faster rate of operation may be employed if agreeable to those concerned.

37 Strength of Handles Test

37.1 A handle used to lift or carry a charger shall withstand a force of four times the weight of the charger without breakage of the handle, its securing means, or that portion of the enclosure to which the handle is attached.

Exception: This test is not required for a handle used for pushing or pulling a battery charger employing wheels, casters, or the like.

37.2 To determine whether a battery charger complies with the requirements in [37.1](#), a force equal to four times the weight of the charger is to be uniformly applied over a 3-inch (76-mm) width at the center of the handle, without clamping. The load is to be started at zero and is to be gradually increased so that the test value will be attained in 5 to 10 seconds and maintained at that value for 1 minute. If more than one handle is provided on a charger and the charger cannot be carried by one handle alone, the force is to be distributed between the handles. The distribution of forces is to be determined by measuring the percentage of the weight of the charger sustained by each handle with the charger in the normal carrying position. If a charger is furnished with more than one handle and can be carried by one handle only, each handle shall withstand the total force.

38 Abnormal Tests

38.1 General

38.1.1 A battery charger shall not emit flame or molten metal or cause a risk of fire or electric shock when subjected to the tests described in [38.2](#) – [38.5](#).

38.1.2 During each test:

- a) The enclosure of the battery charger is to be connected directly to ground using a conductor that includes a 3 Amp fuse;
- b) The battery charger is to rest on a softwood surface covered with white tissue paper; and
- c) A double layer of cheesecloth is to be draped loosely over the entire enclosure. The cheesecloth is to be untreated cotton cloth running 14 – 15 yards per pound (28.2 – 30.2 m/kg) and for any square inch, having a trade count of 32 x 28, which is a count of 32 threads in one direction and 28 in the other direction.

Exception No. 1: A nonmetallic enclosure without exposed dead metal parts is not required to be grounded.

Exception No. 2: For a battery charger without openings in the bottom panel, the unit is not required to be tested on a softwood surface covered with white tissue paper.

38.1.3 The supply circuit is to be sized such that protection which terminates the test be integral to the charger.

38.1.4 A protective device, such as a fuse or circuit breaker, provided as part of the battery charger is to remain in the circuit. The highest rated fuse the fuseholder will accept is to be installed.

Exception No. 1: A commercial battery charger may be tested with the fuse recommended by the manufacturer.

Exception No. 2: An internal fuse that is not referenced by markings, wiring diagrams, or the instruction manual need not be replaced.

38.1.5 The test voltage is to be adjusted to the value specified in [Table 25.1](#).

38.1.6 Any user operated control is to be adjusted to the position representing the most adverse operating condition.

38.1.7 A manually or automatically reset protector or other overload-protective device in a household battery charger shall open the output circuit within 2 minutes after initiation of the test, and within 30 seconds for subsequent cycles during the output short circuit, reverse polarity, and switch position tests.

Exception: The time required to open the output circuit may exceed the time specified provided the maximum temperature rises do not exceed the rises specified in [Table 28.2](#).

38.1.8 If a manual or automatic reset protector does not function during these tests, each test is to be continued until there is no indication of further change as a result of the test condition. If an automatically reset protector functions during the tests, the test is to be continued for 7 hours. If a manual reset protector functions during the test, it is to be operated for 10 cycles using the minimum resetting time, but not at a faster rate than 10 cycles of operation per minute. The protector should be operative upon completion of the test. The following are considered as an acceptable termination of the test:

- a) Opening or shorting of one or more capacitors, diodes, resistors, semiconductor devices, printed wiring board traces, or the like, if there is no indication of further change; or
- b) Opening of an internal fuse.

Exception No. 1: If the manually reset protector is a circuit breaker that complies with the Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, UL 489, it is to be operated for 3 cycles using the minimum resetting time but not at a rate faster than 10 cycles of operation per minute.

Exception No. 2: The protector need not be operational after the Reverse Polarity Test. See [38.3.1](#).

Exception No. 3: For the reverse polarity test, the seven hour duration does not apply. See [38.3.2](#).

38.1.9 Following each test, the dielectric voltage withstand test specified in [29.1.1\(a\)](#) is to be conducted with the potential applied between primary and output circuits. A risk of fire or electric shock is considered to exist if any of the following occur:

- a) Flame or molten metal is emitted from the enclosure of the equipment as evidenced by ignition, glowing, or charring of the cheesecloth or tissue paper;

- b) A breakdown results from the dielectric voltage withstand test; or
- c) Live parts are made accessible (see [8.1](#)).

38.1.10 A separate sample is to be used for each test unless the manufacturer requests that a single sample be subjected to more than one test.

38.2 Output short-circuit test

38.2.1 The output connections of a battery charger are to be short-circuited.

38.2.2 A polarity protection circuit that prevents output current flow until a battery is correctly connected to the output is to be made inoperative to permit the required output current flow.

38.3 Reverse polarity test

38.3.1 The external output leads are to be connected in reverse polarity to a fully charged battery.

Exception: A battery charger having output terminals or leads for fixed wiring, or leads terminating in a polarized plug or plugs is not required to be subjected to the reverse polarity test.

38.3.2 This test is to be continued for 4 hours if an automatically reset protector functions during the test. See [38.1.8](#) if other than an automatically reset protector functions during the test.

38.4 Switch position test

38.4.1 A battery charger employing a switch, such as a 6- and 12-volt switch to permit charging of batteries at different voltages, shall be connected to a supply circuit as described in [25.1](#), and to the maximum normal load described in [27.4](#), with the switch set at the minimum voltage position. Without changing the load, the switch is to be adjusted to its maximum voltage position. A discharged battery may be used for the load of this test.

38.5 Blocked fan test

38.5.1 With reference to the Exception to [15.1](#), a battery charger having a fan motor shall be operated as described in [38.1.8](#) with the rotor of the fan motor blocked. For a battery charger having more than one fan motor, the test is to be conducted with the rotor of each blower motor blocked, one at a time.

Exception: If agreeable to all concerned, all fan motors in a unit having more than one fan motor may be blocked simultaneously.

38.6 Component short and open test

38.6.1 Three tests of each combination, using untested components for each test, shall be conducted.

Exception: If analysis of the test results and circuit indicate that the result obtained is the only one likely to occur, the test need be conducted only once.

38.6.2 Unreliable components in the input power circuit, whose failure may result in an increased risk of fire and electric shock, shall be subjected to short or open circuit of any two terminals at a time, during any condition of operation. These components include electrolytic capacitors, diodes, and solid state devices or any other component not previously investigated and found suitable for the application.

Exception: An electromagnetic and radio frequency interference capacitor that complies with the dielectric voltage withstand test in [29.1.1\(d\)](#), a resistor, a transformer, an inductor, and an optical isolator, need not be subjected to this test.

38.7 Intermediate abnormal test

38.7.1 A battery charger tested in accordance with [28.1.4](#) shall be subjected to a continuous load test immediately following the temperature test. Rated output current of the battery charger is to be continuously maintained by an adjustable resistor connected in parallel with the battery.

38.8 Relay and solenoid burnout

38.8.1 An electromagnetic relay or a solenoid having an open coil construction is to be tested by blocking the armature or the plunger in the de-energized position.

38.9 Transformer burnout test

38.9.1 A resistive load that will cause the primary to draw three times the normal alternating current – see [27.1](#) and [Table 25.1](#) – is to be connected directly to the transformer secondary winding with the charger connected to a supply circuit at the maximum test voltage. See [Table 25.1](#). For a transformer having a center tap secondary, a single load is to be connected across the legs of the winding that result in the greatest potential.

Exception: A transformer employed in a switch mode circuit may be subjected to the transformer overload test described in [38.10.1](#) in lieu of the transformer burnout test. See [5.12](#).

38.9.2 A ferroresonant transformer is to be tested as described in [38.9.1](#), except that a resistive load that will draw the maximum power input – see Power Input Test, Section [27](#) – is to be connected directly to the transformer secondary winding, with the battery charger connected to a supply circuit at 106 percent of the maximum test voltage specified in [Table 25.1](#).

38.10 Transformer overload test

38.10.1 The external output connections of a switch mode battery charger are to be connected to a resistive load that will draw maximum obtainable current without causing shutdown due to operation of circuitry or overcurrent protective devices provided as part of the product.

38.11 Printed wiring board abnormal operation test

38.11.1 To comply with Exception No. 1 to [23.2](#), a printed wiring board is to be tested as described in [38.11.2](#) – [38.11.5](#).

38.11.2 During this test, if a printed wiring board trace opens, the gap is to be electrically shorted and the test continued until ultimate results occur. This procedure applies to each occurrence. If the circuit is interrupted by the opening of a component other than described in [38.11.3](#), the test is to be repeated two more times using new components as necessary.

38.11.3 Operation of an overcurrent protective device other than the branch circuit overcurrent protective device is acceptable.

38.11.4 A sample of the battery charger employing a printed wiring board is to be connected to its nominal rated supply circuit as specified for General Test requirements, Section [25](#). A foil trace is to be