UL 497C

STANDARD FOR SAFETY

Protectors for Coaxial Communications Circuits

UL Standard for Safety for Protectors for Coaxial Communications Circuits, UL 497C

Second Edition, Dated August 3, 2001

Summary of Topics

This revision of ANSI/UL 497C dated February 7, 2022 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated December 17 2021.

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UL 497C

Standard for Protectors for Coaxial Communications Circuits

First Edition – March, 1998

Second Edition

August 3, 2001

This ANSI/UL Standard for Safety consists of the Second Edition including revisions through February 7, 2022.

The most recent designation of ANSI/UL 497C as a Reaffirmed American National Standard (ANS) occurred on February 7, 2022. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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INTRODUCTION

1 Scope

1.1 These requirements cover protectors for use on coaxial cable circuits to be used in accordance with the applicable requirements of the National Electrical Code, NFPA 70.

1.2 As covered by these requirements, a coaxial cable circuit protector consists of single or multiple air gap arresters, gas tube arresters, or solid-state arresters, with or without fuses or other current-limiting devices. A circuit protector is intended to protect equipment, wiring, and personnel at the subscriber premises against the effects of excessive potentials and currents on the coaxial line caused by lightning, contacts with power conductors, power induction, or rises in ground potential.

1.3 This standard does not cover the following:

a) Lightning protective devices for the protection of secondary distribution wiring systems and equipment.

b) Antenna discharge units for radio and television receiving appliances.

c) Lightning conductor and air terminals for connection of lightning rods for building protection.

d) Protectors for fire alarm signaling circuits that are covered by the Standard for Protectors for Data Communications and Fire-Alarm Circuits, UL 497B.

e) Equipment covered by the Standard for Secondary Protectors for Communications Circuits, UL 497A.

f) Equipment covered by the Standard for Transient Voltage Surge Suppressors, UL 1449.

g) Equipment covered by the Standard for Protectors for Paired-Conductor Communications Circuits, UL 497.

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.

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

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

b) Is superseded by a requirement in this standard.

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

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

2.2 Units of measurement

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

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

2.3 Undated references

2.3.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

3 Glossary

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

3.2 ARRESTER – An overvoltage component or assembly of components which permit current to flow through it when a designed voltage limit is reached. The arrester may consist of a spark gap, gas tube, solid-state component or the equivalent, coupled with other hardware which serves to support, position, and align the current-carrying components that make up the arrester.

3.3 CURRENT-LIMITING – This condition is achieved when the abnormal high current condition is reduced to a maximum current value equal to the normal operating current of the circuit.

3.4 CURRENT-LIMITING DEVICE – This device reacts to an abnormal high current condition to prevent overheating of the normal current path and/or circuit in series with the current-limiting device. These devices may take the form of a thermo-resistance or thermo-mechanical device.

3.5 INDOOR USE (CONTROLLED ENVIRONMENT) – Installation of equipment in an area where the atmosphere is artificially controlled. For the purpose of this standard, indoor ambient is limited to a temperature of 0 – 30°C (32 – 86°F). Limits for corrosion concentrations are defined in the test program. Rain does not occur.

3.6 MINIMUM CURRENT-LIMITING POINT – The minimum abnormal current value which causes operation of the current-limiting device that reduces the current flow to a current-limited state.

3.7 NORMAL-USE POSITION (Position of Normal Use) – A mounting or positioning of the product in an intended manner that is prescribed in the installation instructions of the manufacturer and conforms to the installation requirements of the National Electrical Code, ANSI/NFPA 70.

3.8 OUTDOOR USE (UNCONTROLLED ENVIRONMENT) – An area subjected to the natural environmental conditions which make-up the ambient and moisture extremes of this plant. For the purpose of consistency, the ambient and moisture extremes are defined in the various tests of this standard.

3.9 OUTSIDE PLANT (OSP) – That part of the communications circuit extending from the subscriber premise protector to the main distribution frame of the public utility company providing the service.

3.10 PROTECTOR – A device comprised of an overvoltage, overcurrent component, or both and is intended to prevent damage to a circuit or system when abnormally high voltage and/or current occur.

3.11 TRUE RMS – Unit of electrical measurement by a meter capable of sampling, over time, the varying magnitude of a complex waveform to produce a computed root-mean-square value equivalent to the same direct current value which produces the same heating effect.

CONSTRUCTION

4 General

4.1 A coaxial cable circuit protector shall be constructed to withstand, without damage, its intended installation and use and shall comply with the applicable performance requirements specified in Sections 10 – 33.

4.2 A fuseless coaxial protector shall consist of an assembly comprising:

a) An insulating base or grounded metallic base supporting an overvoltage arrester;

b) Provision for connecting the center conductors of a coaxial cable circuit; and

c) Provision for connecting at least one grounding conductor.

An arrester shall be connected between the coaxial center conductor and ground. The connection or connections for the grounding conductor shall be conductively connected to a ground electrode or terminal.

4.3 A fused coaxial protector shall consist of an assembly comprising:

a) An insulating base supporting an arrester;

b) Provision for mounting a center conductor fuse;

c) Provision for connecting the center conductors of a coaxial cable circuit; and

d) Provision for connecting at least one grounding conductor.

The fuse or current-limiting device shall be connected in series between each incoming center conductor of the outside plant (OSP) and the corresponding subscriber premises termination. The connection or connections for the grounding conductor or conductors shall be conductively connected to the ground electrodes or terminal of the coaxial protector. The overvoltage arrester shall be connected to the station termination end of the fuse or current-limiting device. A cover may be provided over the assembly.

4.4 A protector shall not have provision for adjustment of its components.

5 Enclosures

5.1 General

5.1.1 An enclosure for coaxial protectors shall have the strength and rigidity to resist total or partial collapse with attendant reduction of spacings, loosening or displacement of parts, or other conditions that impair the operation of the product and increase the risk of fire, electric shock, or injury to persons.

5.1.2 Enclosures for individual components, outer enclosures, and combinations of the two are considered in determining compliance with 5.1.1.

5.1.3 Protector enclosures shall have provision for mounting.

5.1.4 A protector intended for outdoor use shall be provided with a water-resistant cover or enclosure.

5.2 Sheet metal

5.2.1 The thickness of sheet metal used for an enclosure of a protector shall not be less than the applicable value specified in Table 5.1 or Table 5.2.

Exception: Sheet metal of lesser thickness is not prohibited from being used when, considering the shape, size, and function of the enclosure, it is determined to provide equivalent mechanical strength.

Table 5.1
Minimum thickness of sheet metal for electrical enclosures – carbon steel or stainless steel

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness			
Maximum width,[b]		Maximum length,[c]		Maximum width,[b]		Maximum length,[c]		Uncoated,		Metal coated,	
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	inches [MSG]	(mm)	inches [GSG]	(mm)
4.0	(10.2)	Not limited		6.25	(15.9)	Not limited		0.020	(0.51)	0.023	(0.58)
4.75	(12.1)	5.75	(14.6)	6.75	(17.1)	8.25	(21.0)	[24]	[24]		
6.0	(15.2)	Not limited		9.5	(24.1)	Not limited		0.026	(0.66)	0.029	(0.74)
7.0	(17.8)	8.75	(22.2)	10.0	(25.4)	12.5	(31.8)	[22]	[22]		
8.0	(20.3)	Not limited		12.0	(30.5)	Not limited		0.032	(0.81)	0.034	(0.86)
9.0	(22.9)	11.5	(29.2)	13.0	(33.0)	16.0	(40.6)	[20]	[20]		
12.5	(31.8)	Not limited		19.5	(49.5)	Not limited		0.042	(1.07)	0.045	(1.14)
14.0	(35.6)	18.0	(45.7)	21.0	(53.3)	25.0	(63.5)	[18]	[18]		
18.0	(45.7)	Not limited		27.0	(68.6)	Not limited		0.053	(1.35)	0.056	(1.42)
20.0	(50.8)	25.0	(63.5)	29.0	(73.7)	36.0	(91.4)	[16]	[16]		
22.0	(55.9)	Not limited		33.0	(83.8)	Not limited		0.060	(1.52)	0.063	(1.60)
25.0	(63.5)	31.0	(78.7)	35.0	(88.9)	43.0	(109.2)	[15]	[15]		
25.0	(63.5)	Not limited		39.0	(99.1)	Not limited		0.067	(1.70)	0.070	(1.78)
29.0	(73.7)	36.0	(91.4)	41.0	(104.1)	51.0	(129.5)	[14]	[14]		
33.0	(83.8)	Not limited		51.0	(129.5)	Not limited		0.080	(2.03)	0.084	(2.13)
38.0	(96.5)	47.0	(119.4)	54.0	(137.2)	66.0	(167.6)	[13]	[13]		
42.0	(106.7)	Not limited		64.0	(162.6)	Not limited		0.093	(2.36)	0.097	(2.46)
47.0	(119.4)	59.0	(149.9)	68.0	(172.7)	84.0	(213.4)	[12]	[12]		
52.0	(132.1)	Not limited		80.0	(203.2)	Not limited		0.108	(2.74)	0.111	(2.82)
60.0	(152.4)	74.0	(188.0)	84.0	(213.4)	103.0	(261.6)	[11]	[11]		
63.0	(160.0)	Not limited		97.0	(246.4)	Not limited		0.123	(3.12)	0.126	(3.20)
73.0	(185.4)	90.0	(228.6)	103.0	(261.6)	127.0	(322.6)	[10]	[10]		

NOTE – Sheet steel for an enclosure intended for outdoor use (watertight) shall be at least 0.036 inch (0.91 mm) thick when zinc-coated and at least 0.032 inch (0.81 mm) thick when uncoated.

[a] A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal that is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and that has sufficient torsional rigidity to resist the bending moments which may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure that is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes:

Table 5.1 Continued on Next Page

Table 5.1 Continued

Without supporting frame[a]		With supporting frame or equivalent reinforcing[a]		Minimum thickness	
Maximum width,[b] inches (cm)	Maximum length,[c] inches (cm)	Maximum width,[b] inches (cm)	Maximum length,[c] inches (cm)	Uncoated, inches (mm) [MSG]	Metal coated, inches (mm) [GSG]

1) A single sheet with single formed flanges (formed edges),

2) A single sheet which is corrugated or ribbed, and

3) An enclosure surface loosely attached to a frame, for example, with spring clips.

[b] The width is the smaller dimension of a rectangular sheet metal piece which is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

[c] For panels which are not supported along one side (for example, side panels of boxes) the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide.

Table 5.2
Minimum thickness of sheet metal for electrical enclosures – aluminum, copper, or brass

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness,	
Maximum width,[b] inches	(cm)	Maximum length,[c] inches	(cm)	Maximum width,[b] inches	(cm)	Maximum length,[c] inches	(cm)	inches	(mm)
3.0	(7.6)	Not limited		7.0	(17.8)	Not limited			
3.5	(8.9)	4.0	(10.2)	8.5	(21.6)	9.5	(24.1)	0.023	(0.58)
4.0	(10.2)	Not limited		10.0	(25.4)	Not limited			
5.0	(12.7)	6.0	(15.2)	10.5	(26.7)	13.5	(34.3)	0.029	(0.74)
6.0	(15.2)	Not limited		14.0	(35.6)	Not limited			
6.5	(16.5)	8.0	(20.3)	15.0	(38.1)	18.0	(45.7)	0.036	(0.91)
8.0	(20.3)	Not limited		19.0	(48.3)	Not limited			
9.5	(24.1)	11.5	(29.2)	21.0	(53.3)	25.0	(63.5)	0.045	(1.14)
12.0	(30.5)	Not limited		28.0	(71.1)	Not limited			
14.0	(35.6)	16.0	(40.6)	30.0	(76.2)	37.0	(94.0)	0.058	(1.47)
18.0	(45.7)	Not limited		42.0	(106.7)	Not limited			
20.0	(50.8)	25.0	(63.5)	45.0	(114.3)	55.0	(139.7)	0.075	(1.91)
25.0	(63.5)	Not limited		60.0	(152.4)	Not limited			
29.0	(73.7)	36.0	(91.4)	64.0	(162.6)	78.0	(198.1)	0.095	(2.41)
37.0	(94.0)	Not limited		87.0	(221.0)	Not limited			
42.0	(106.7)	53.0	(134.6)	93.0	(236.2)	114.0	(289.6)	0.122	(3.10)
52.0	(132.1)	Not limited		123.0	(312.4)	Not limited			
60.0	(152.4)	74.0	(188.0)	130.0	(330.2)	160.0	(406.4)	0.153	(3.89)

NOTE – Sheet copper, brass, or aluminum for an enclosure intended for outdoor use (watertight) shall not be less than 0.029 inch (0.74 mm) thick.

[a] A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal which is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and which has sufficient torsional rigidity to resist the bending moments which may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure which is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes:

Table 5.2 Continued on Next Page

Table 5.2 Continued

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				
Maximum width,[b]		Maximum length,[c]		Maximum width,[b]		Maximum length,[c]		Minimum thickness,
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	inches (mm)
1) A single sheet with single formed flanges (formed edges),								
2) A single sheet which is corrugated or ribbed, and								
3) An enclosure surface loosely attached to a frame, for example, with spring clips.								
[b] The width is the smaller dimension of a rectangular sheet metal piece which is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.								
[c] For panels which are not supported along one side (for example, side panels of boxes) the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide.								

5.3 Nonmetallic

5.3.1 An enclosure of nonmetallic material for a coaxial cable circuit protector shall have the mechanical strength and durability intended for the application and be formed so that it covers all uninsulated current-carrying parts. Refer to the Distortion Test, Section 21; the Flame Test, Section 22; and the Impact Test (Polymeric Enclosures), Section 23 for test requirements.

6 Protection Against Corrosion

6.1 General

6.1.1 An iron or steel part shall be protected against corrosion by enameling, galvanizing, sherardizing, plating, or other means determined to be equivalent.

Exception No. 1: This requirement does not apply to a part, such as a washer, screw, bolt, or the equivalent, when corrosion of the unprotected part does not result in a risk of fire or electric shock, or in unintentional contact with moving parts that involve a risk of injury to persons, or impair the operation of the protector.

Exception No. 2: A part made of stainless steel, polished or treated, when required, does not require additional protection against corrosion.

6.1.2 The requirement of 6.1.1 applies to all enclosures whether of sheet steel or cast iron, and to all springs and other parts upon which mechanical operation depends.

6.1.3 Bearing surfaces shall be of such materials as to resist binding due to corrosion.

6.1.4 Metals shall be used in combinations that are galvanically compatible.

6.1.5 Hinges and other attachments shall be resistant to corrosion.

6.1.6 Nonferrous cabinets and enclosures may be used without additional corrosion protection.

6.2 Outdoor use

6.2.1 A metal cover for a protector intended for outdoor use shall be provided with a finish to protect against corrosion. See Outdoor Corrosion Test, Section 33.

6.3 Grommets

6.3.1 Each wiring entrance hole shall be provided with a grommet or other similar means to prevent the entrance of water and foreign matter. The grommets shall be sized to accept the maximum number of conductors specified in 7.1 and 7.2. Grommets shall be subjected to the test requirements of the Air Oven Aging Test, Section 30, and the Ozone Exposure Test, Section 31.

7 Field-Wiring Connections

7.1 A coaxial cable circuit protector shall be provided with a threaded receptacle which accepts the mating connector of an OSP coaxial cable to which it is intended to be connected.

7.2 A coaxial cable circuit protector shall have provision for connecting at least one grounding conductor not smaller than No. 12 AWG (3.3 mm^2). A three- to six-cable protector shall have provision for connecting at least one grounding conductor not smaller than No. 10 AWG (5.3 mm^2). Protectors intended for connecting more than six coaxial circuits shall have provision for connecting at least one grounding conductor not smaller than No. 6 AWG (13.3 mm^2). All coaxial protector ground terminals shall be capable of connecting a minimum No. 14 AWG (2.1 mm^2) wire.

7.3 Either of the following two terminal configurations is capable of being used for the connection of field wiring:

a) A stud-type terminal post with securing nut – the post shall not be smaller than No. 6-32 (3.5 mm) screw size or

b) A setscrew contact where the grounding wire is inserted into a retaining hole of the grounding conductor bus bar system and secured with a setscrew.

7.4 A grounding terminal shall be prevented from turning and shall not employ a setscrew form of contact that could shear a conductor during installation. This shall be accomplished with:

a) Two screws or rivets;

b) Square shoulders or mortises;

c) A dowel pin, lug, or offset; or

d) A connecting strap or clip fitted into an adjacent part.

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

7.5 A metal terminal plate tapped for a wire-binding screw shall be extruded at the tapped hole so as to give the thickness required for at least two full threads.

8 Components

8.1 General

8.1.1 An uninsulated live part shall be secured to an insulated mounting surface so that it is prevented from turning or shifting in position, when such motion is capable of resulting in a reduction of spacings less than the required minimum values. See Spacings, Section 9.

8.1.2 A coaxial cable circuit protector assembly shall be protected against fouling by dust or other material capable of affecting intended operation.

8.1.3 A current-carrying part shall be silver, copper, copper-alloy, or any non-corrosive metal that complies with the test current requirements of this standard.

8.2 Arrester assemblies

8.2.1 An arrester assembly provided with a protector block or intended for field replacement use shall be constructed so that it is compatible with each protector base with which it is intended to be used. Refer to Installation Instructions, General, Section 35.

8.3 Electrical insulation material

8.3.1 A base for the support of a current-carrying part shall be formed of a noncombustible, moisture-resistant insulating material, such as porcelain, phenolic, cold-molded composition, or other material determined to be equivalent. A material is considered noncombustible when the material complies with the Flame Test, Section 22, or the applicable requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

8.3.2 A polymeric material used for the sole support of an uninsulated live part shall be determined to be equivalent to the materials indicated in 8.3.1.

9 Spacings

9.1 For the purpose of this standard, a coaxial cable circuit protector is considered to be a series-connected device which is connected to an OSP circuit and which is capable of using Class 3 power as defined in the National Electrical Code, ANSI/NFPA 70. The center conductor is considered to be a limited power circuit and shall comply with the creepage distance and clearance requirements noted in the requirements of this section.

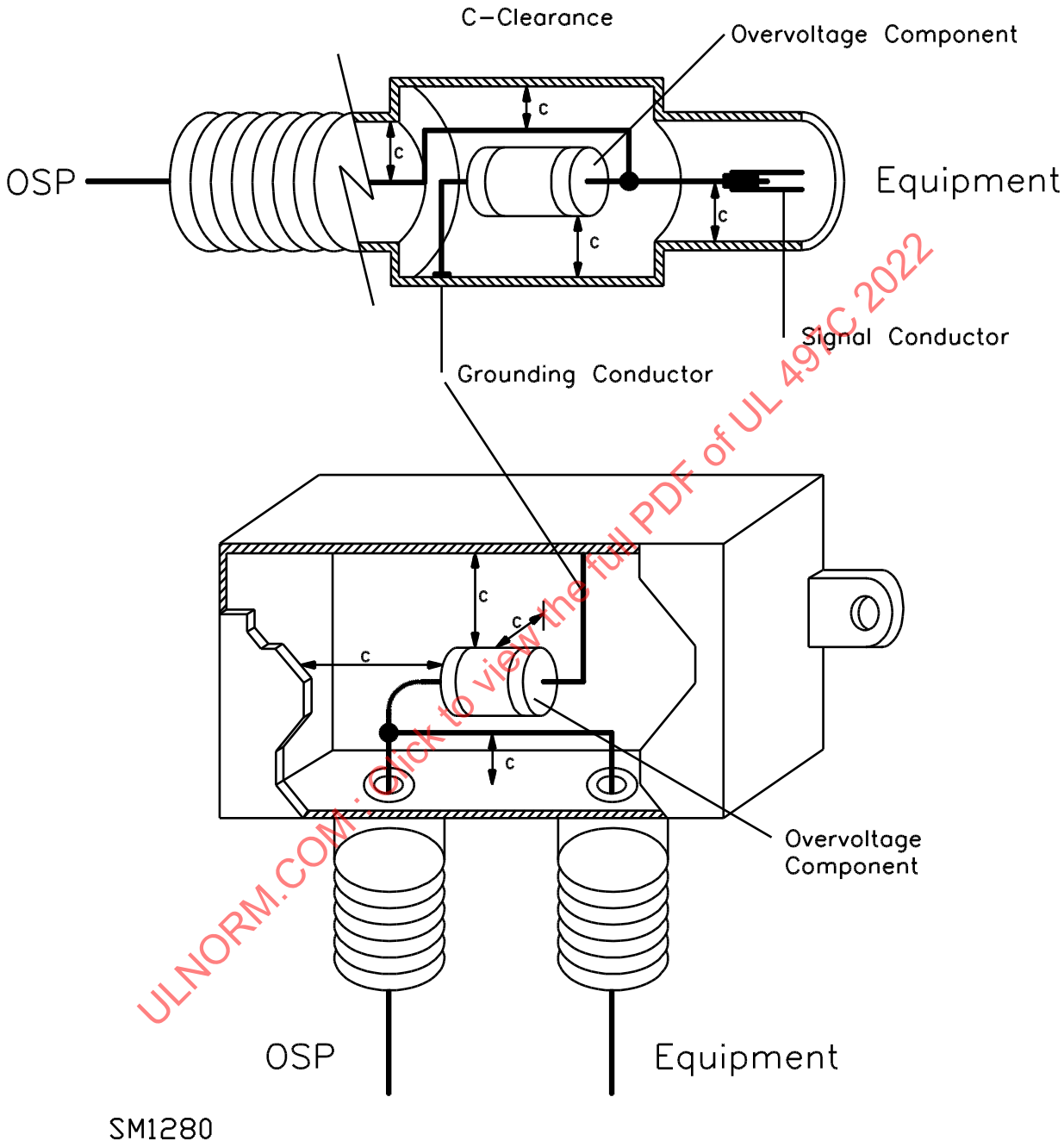
9.2 Clearances shall comply with the minimum dimensions (mm) in Table 9.1. These clearances apply to the distances between the coaxial center conductor within the protector (see Figure 9.1) and all accessible conductive parts not intended to operate as a live or current-carrying part.

Table 9.1
Minimum clearances

Class voltage	Sealed, mm	Unsealed, mm	
		Indoor use	Indoor/outdoor
<100 volts	0.45	0.6	0.7
<150 volts	0.5	0.7	0.8
NOTE – The term "sealed" refers to protectors that use a sealing compound such as epoxy to enclose the overvoltage component within the protector. The weatherability of the material shall be recognized for the intended application.			

Figure 9.1

Typical coaxial protector wire configurations



PERFORMANCE

10 General

10.1 The tests specified in this standard are intended to be used to evaluate the safety and performance of current-limiting devices, voltage-limiting devices, or the combination of both that provide protection to coaxial premise wiring. These devices are to be installed at the point of entry to the protected premise and the test program for this standard is formatted to address this type of installation.

10.2 Samples that are representative of production are to be used for the following tests unless otherwise indicated.

10.3 The flow charts specified in Figure 10.1 – Figure 10.3 provide sample requirements for typical test programs. Programs are not prohibited from being modified to accommodate hybrid systems, previously evaluated components, and changes to evaluated products.

10.4 Tests are not required when the plastic parts use material flame-rated for the intended application. For the purpose of this standard, enclosures shall employ material rated 5VA. Material used in the support of current-carrying parts shall use material rated a minimum V-2. Plastic used for indirect support shall be rated minimum HB. In addition, the part shall maintain a minimum thickness equal to or greater than the thickness specified for the flame rating.

Figure 10.1

Typical protector investigation (current-limiting device)

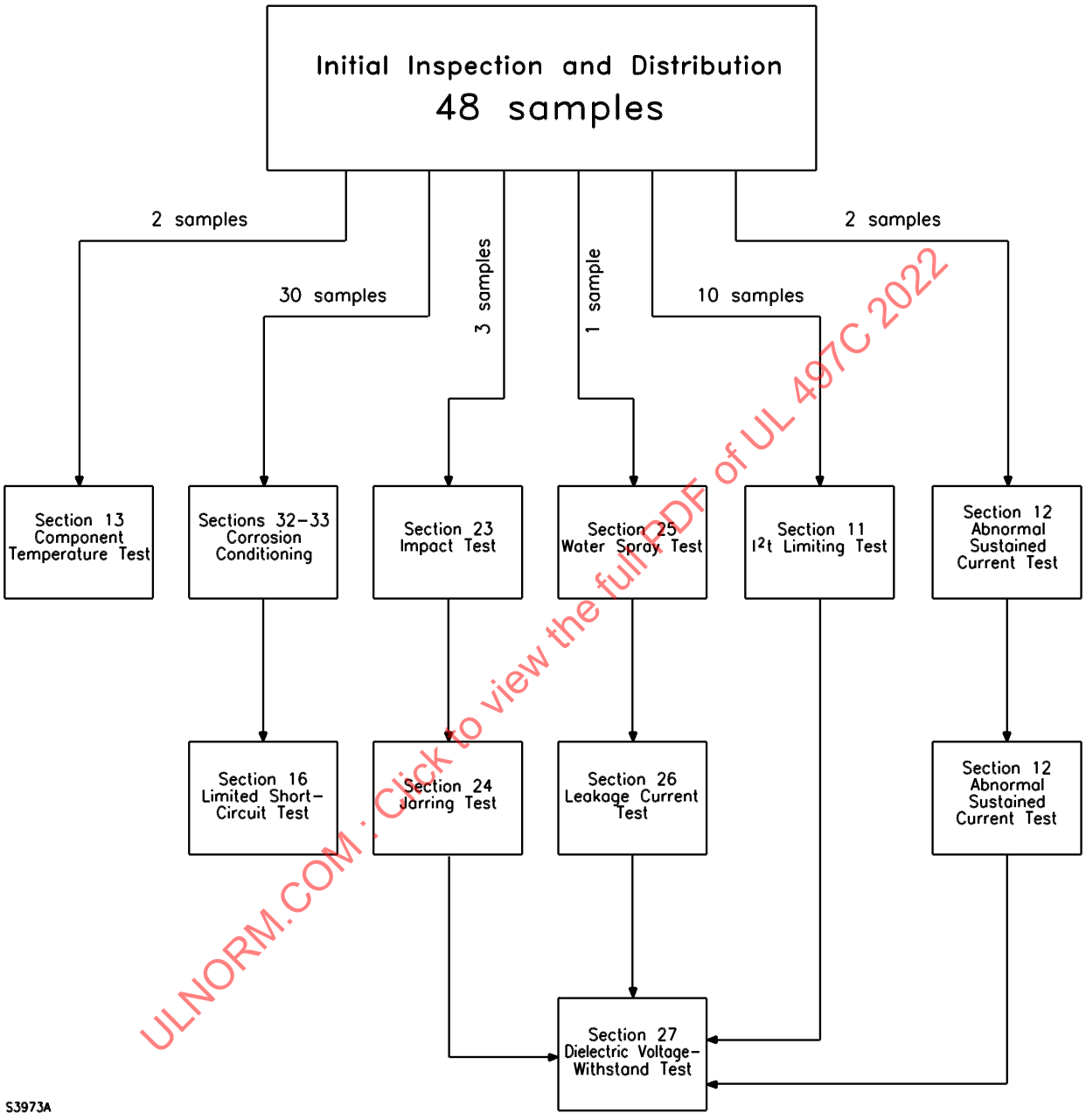


Figure 10.2

Typical protector investigation (overvoltage type)

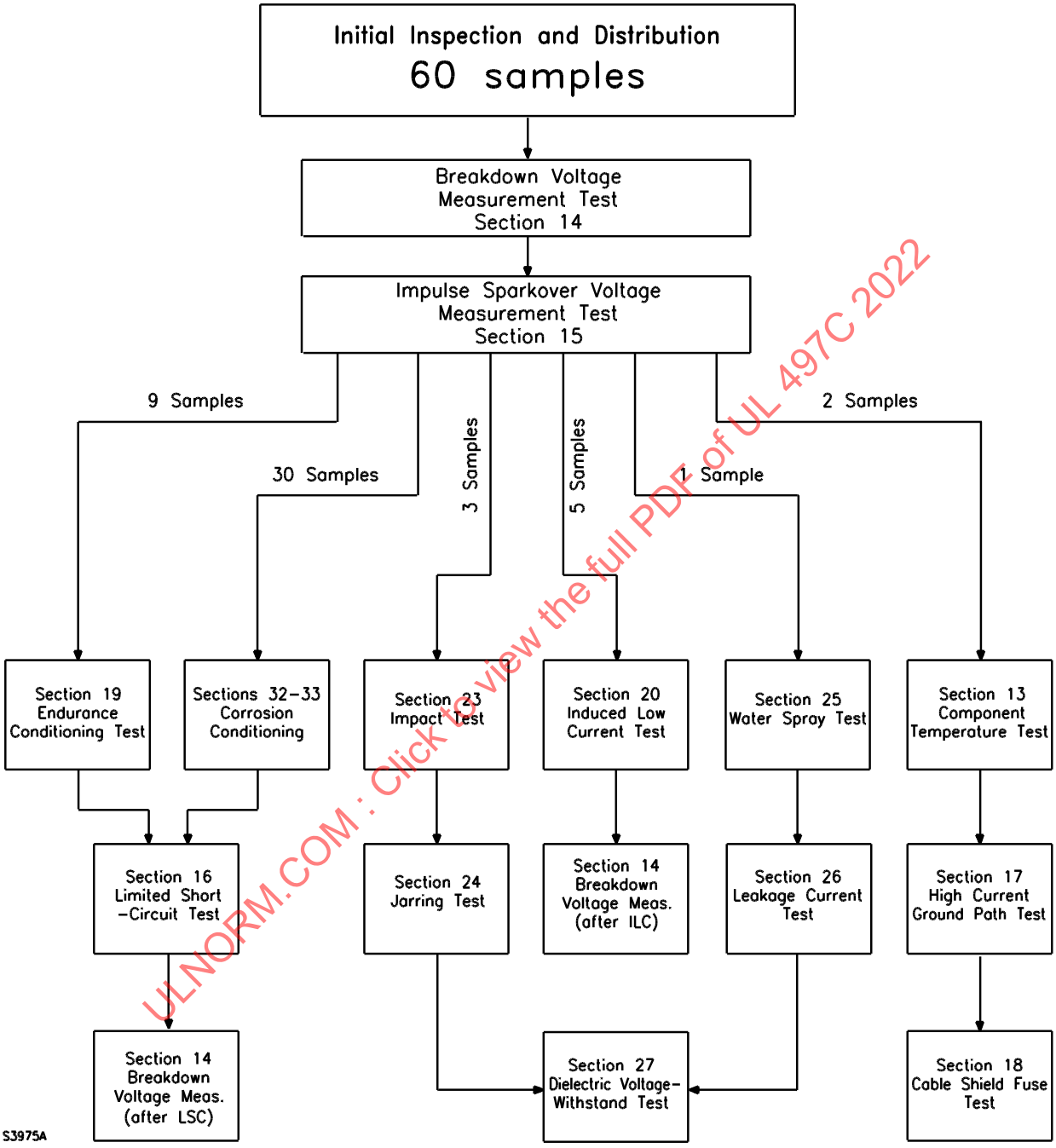
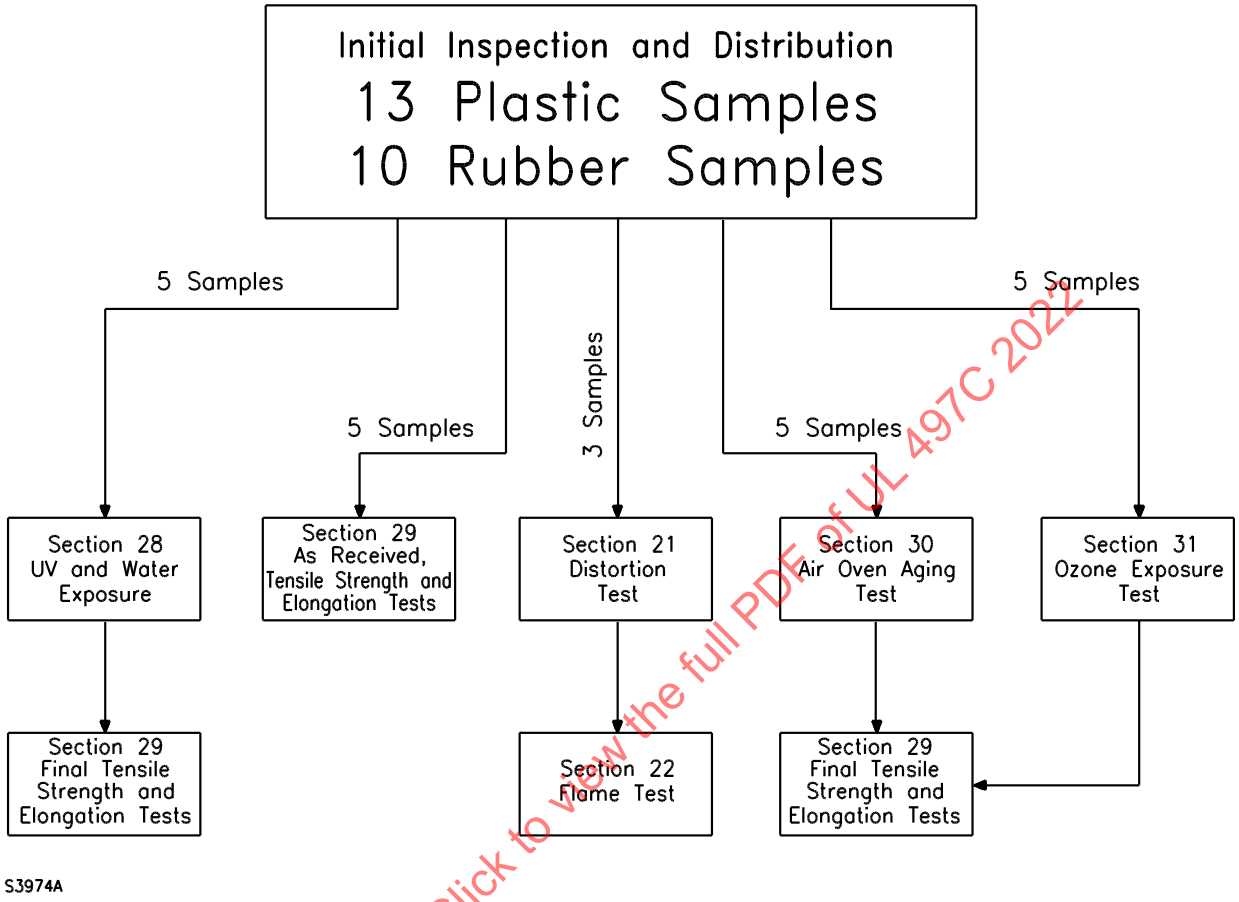


Figure 10.3

Plastic and rubber components test program



NOTE – The tensile strength test is conducted on rigid or semi-rigid plastic material. The elongation test is conducted on non-rigid plastics or rubber material.

11 I^2t Limiting Test

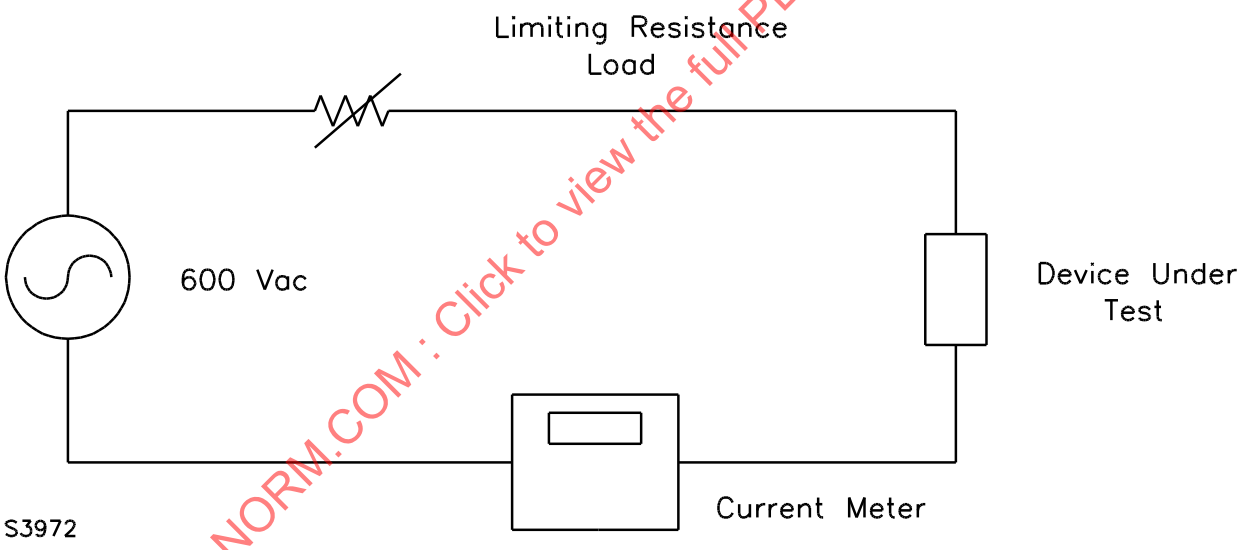
11.1 When tested as described in 11.2 – 11.3, the measured I^2t of the test samples shall be equal to or less than the rating for the device. Ten samples are to be used in this test whereas a different sample is to be subjected to only one test current at a time. Ten different current values are to be used to determine the maximum measured I^2t of the device. Each sample is to be tested only once.

11.2 Each sample is to be mounted in a position of normal use and electrically connected to the test circuit as shown in Figure 11.1. Prior to energization of power, calibration of input power is to be accomplished by temporally disconnecting the circuit from the voltage supply and adjusting the voltage output to 600 V AC. The circuit is to be reconnected to the de-energized supply and with the test sample short-circuited, the limiting resistors are to be adjusted to the required test current.

11.3 The time to extinguish the test current is to be recorded from energization of the circuit to extinguishment of the current. Each trial is to be conducted in the same manner and the time and current is to be recorded for each current condition. The value of current is to be recorded with a True RMS current meter. These values are then to be plotted for comparison as shown in the example of Figure 11.2.

Figure 11.1

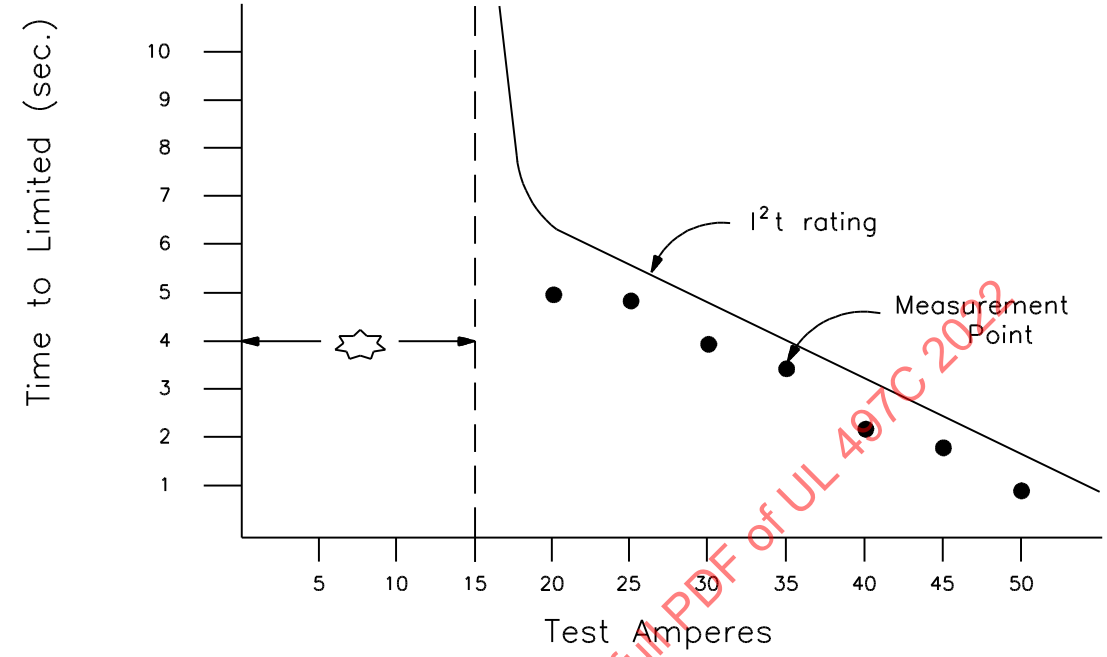
Test circuit



NOTE – Depending upon the extinguishing time, either a stopwatch or more sophisticated equipment is capable of being used. The timing device shall be able to record within 5 percent of the actual time.

Figure 11.2

Comparison plot



12 Abnormal Sustained Current Test

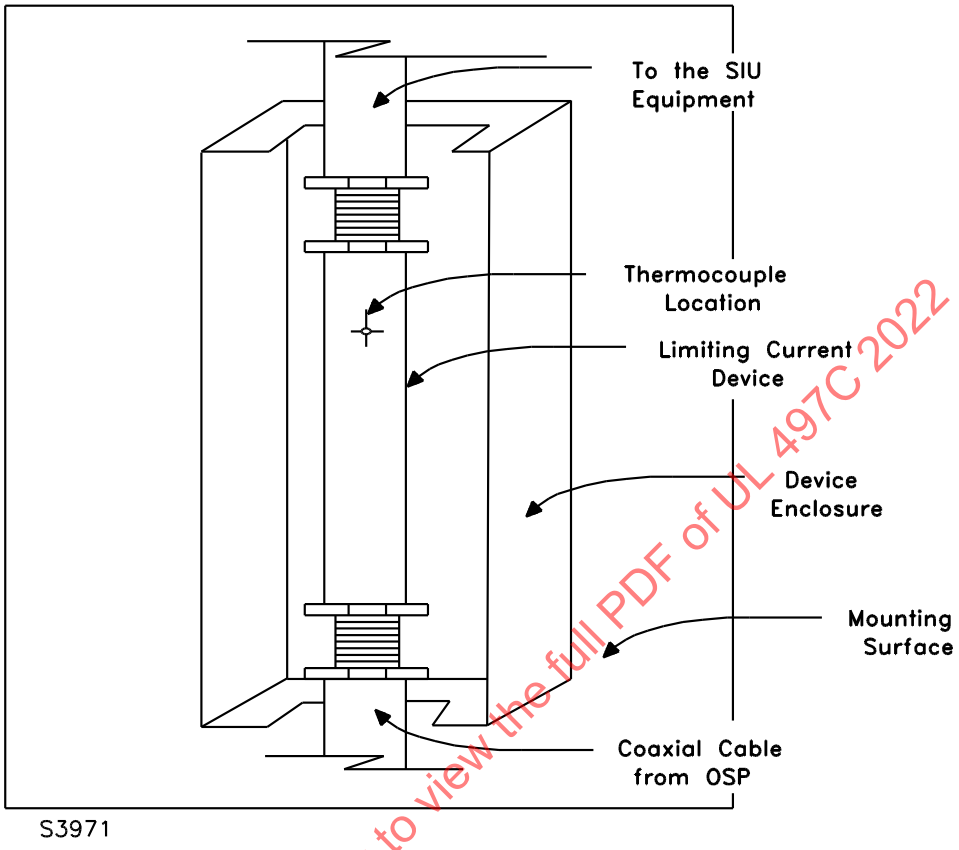
12.1 When tested as described in 12.2 and 12.3, the current-limiting device shall operate to limit or extinguish the abnormal test current before the mounting surface of the protector enclosure exceeds a 65°C rise above ambient temperature. Normal ambient temperature is 25°C. Two samples are to be subjected to this test.

12.2 Using the minimum current-limiting point as determined in the I^2t Limiting Test, Section 11, the next lowest 5-ampere increment point is to be used as the starting value for this test. Each sample is to be mounted in a position of normal use and electrically connected to the test circuit as shown in Figure 11.1. The sample is to be energized and its temperature monitored until the surface temperature of the element stabilizes. The current to the protector is then to be increased in 1 ampere increments every 5 minutes until the mounting surface of the enclosure reaches 65°C or the unit current limits.

12.3 The location of the thermo-sensing elements are shown in Figure 12.1. These elements are to be located as close as possible to the current-limiting device and the most vulnerable point to temperature change for the enclosure. One sample per trial is to be tested.

Figure 12.1

Limiting current device with enclosure



NOTE – Figure 12.1 shows a typical mounting configuration for a current-limiting device. Other configurations are capable of being used when they comply with the applicable requirements of this standard.

13 Component Temperature Test

13.1 When tested as described in 13.2 – 13.4, the current or overvoltage limiting device shall operate for normal rated current during which the surface of the protector components shall not exceed a 65°C rise above ambient temperature. Normal ambient temperature is 25°C. Two protector samples are to be subjected to this test. One sample per trial is to be tested.

13.2 The location of the thermocouple or heat-measuring device is illustrated in Figure 12.1. When more than one component is used in the protection circuit, each is to be monitored for temperature. The test circuit is the same as shown in Figure 11.1 except the source voltage is to be reduced to rated normal operating voltage. The test current is to be adjusted to the rated value using the limiting resistor shown in Figure 11.1.

13.3 Upon energization of power, the sample is to be monitored continuously until constant temperatures are obtained. Each test trial is to be conducted a minimum of one hour. The trial is concluded when three separate measurements indicate that there is no change in temperature. Each of the temperature readings is to be measured after a time increment of no less than ten percent of the first time period of one hour or greater.

13.4 The protector, overvoltage and/or overcurrent, shall be classified for use with power limitation (see Installation Instructions, General, Section 35) as defined in the National Electrical Code, ANSI/NFPA 70, for Class 3, non-inherently power sources, and shall be tested in accordance with the limitation shown in Table 13.1.

Table 13.1
Power limitations

Parameters	Classification limits		
	Low	Medium	High
Maximum volts	100	150	150
Maximum amperes	10	6.67	15
Maximum power	100	100	2250
	Test limits, amperes/volts		
Trial No. 1	10 / 10	6.67 / 22.5	15 / 10
Trial No. 2	5 / 20	5 / 30	10 / 15
Trial No. 3	2 / 50	2 / 75	5 / 30
Trial No. 4	1 / 100	1 / 50	1 / 50

14 Breakdown Voltage Measurement Test

14.1 Coaxial cable circuit protectors are to be subjected to the following tests while installed in the protector base or blocks with which they are intended to be used.

14.2 Breakdown voltage measurements are to be taken on each arrester within the protector:

a) In the as-received condition;

b) After being conditioned in accordance with the Indoor Corrosion Test, Section 32, or the Outdoor Corrosion Test, Section 33;

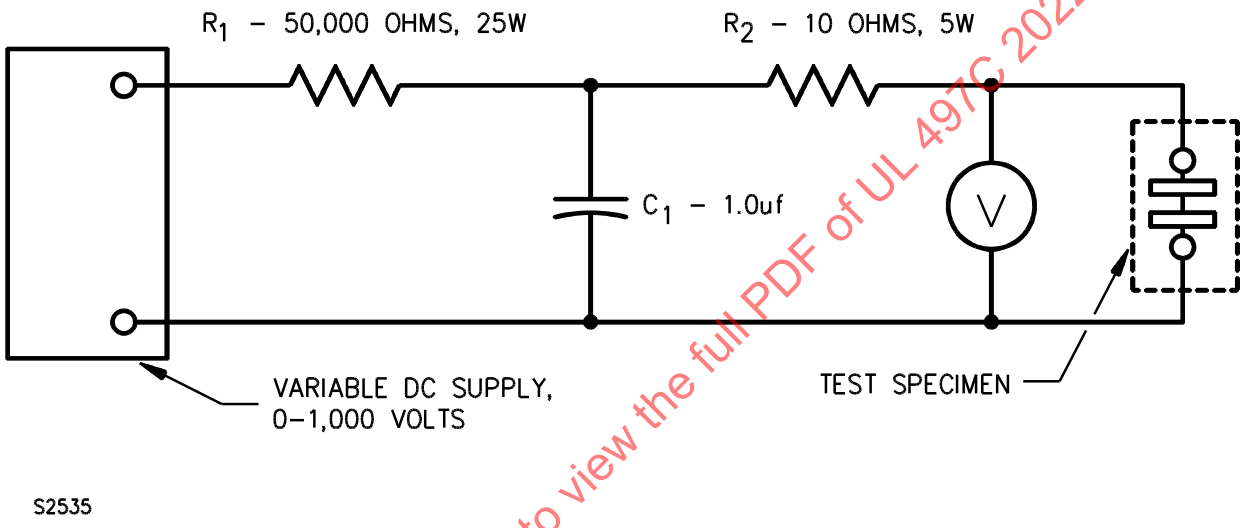
c) After the limited short-circuit conditions specified in the Limited Short-Circuit Test, Section 16; and

d) After the endurance conditioning specified in the Endurance Conditioning Test, Section 19.

14.3 Each arrester is to be connected in the as-received condition to a circuit as illustrated in Figure 14.1. The supply voltage is to be increased at a rate not greater than 2000 volts per second. The voltage across the arrester is to be monitored, and the initial breakdown voltage of each arrester is to be recorded. An arrester assembly shall breakdown within ±25 percent of the manufacturer's rating or within the upper and lower limits of a rated voltage range. An arrester assembly shall breakdown at no higher than 750 volts.

Figure 14.1

Breakdown voltage measurement test



NOTE – R_1 may be varied to change the rate of rise across C_1.

15 Impulse Sparkover Voltage Measurement Test

15.1 An arrester shall break down at less than 1000 volts when subjected separately to single impulse potentials having both positive and negative polarities. The rate of voltage rise of each impulse is to be 100 ±10 volts per microsecond:

a) From 200 – 1000 volts, inclusive, for the primary protection element; and

b) From 300 – 1500 volts, inclusive, for the back-up or secondary device of the same arrester.

The discharge current shall be sufficient to cause operation in the arc mode but shall not exceed a current limit of 10 amperes.

15.2 An arrester intended for use only as a back-up or secondary device shall break down at less than 1500 volts.

16 Limited Short-Circuit Test

16.1 Primary coaxial cable circuit protectors shall withstand the high current conditions of this test without loss of their protective functions or risk of fire and electric shock. Each test trial is to be conducted after conditioning. Different samples are to be subjected to different conditionings and different currents. Sample distribution is shown in Figure 16.1. The conditioning and current combinations are illustrated in Performance, General, Section 10.

16.2 The abnormal high current fault is to be conducted on the center conductor of the coaxial test circuit. The test circuit is connected as illustrated in Figure 16.2. Calibration of the test loads is accomplished by adjusting the voltage and current while the sample has been removed from the circuit.

16.3 The protectors are to be rated for use with a current-limiting device. This information shall be indicated in accordance with the marking and installation requirements of this standard. During this test, the protector is to be tested with the current-limiting device specified in the protector's installation instructions. The location and positioning of both the overvoltage protector and current-limiting device during this test is illustrated in Figure 16.2.

16.4 In those cases where only a current-limiting device is being evaluated, the circuit is the same as specified in Figure 11.1. During testing, each sample is to be placed in a position of intended use and all wire connections are to be made using wire gauge sizes large enough to handle the test current without fire or abnormal heat to the test fixture. The test ambient is to be 25 ±3°C.

16.5 Outdoor-use protectors are to be tested with the cover or enclosure in place as intended in service. Indoor-use protectors are to be tested with the cover or enclosure removed, unless the protector is specifically intended to be installed in service with the cover or enclosure in place. A single layer of cheesecloth is to be loosely draped over the device under test so as to touch all surface areas, but to be clear of the area where fusing is intended.

16.6 The test currents are to be 60, 120, and 350 amperes at not less than 480 V AC rms.

Figure 16.1

Limited short-circuit test

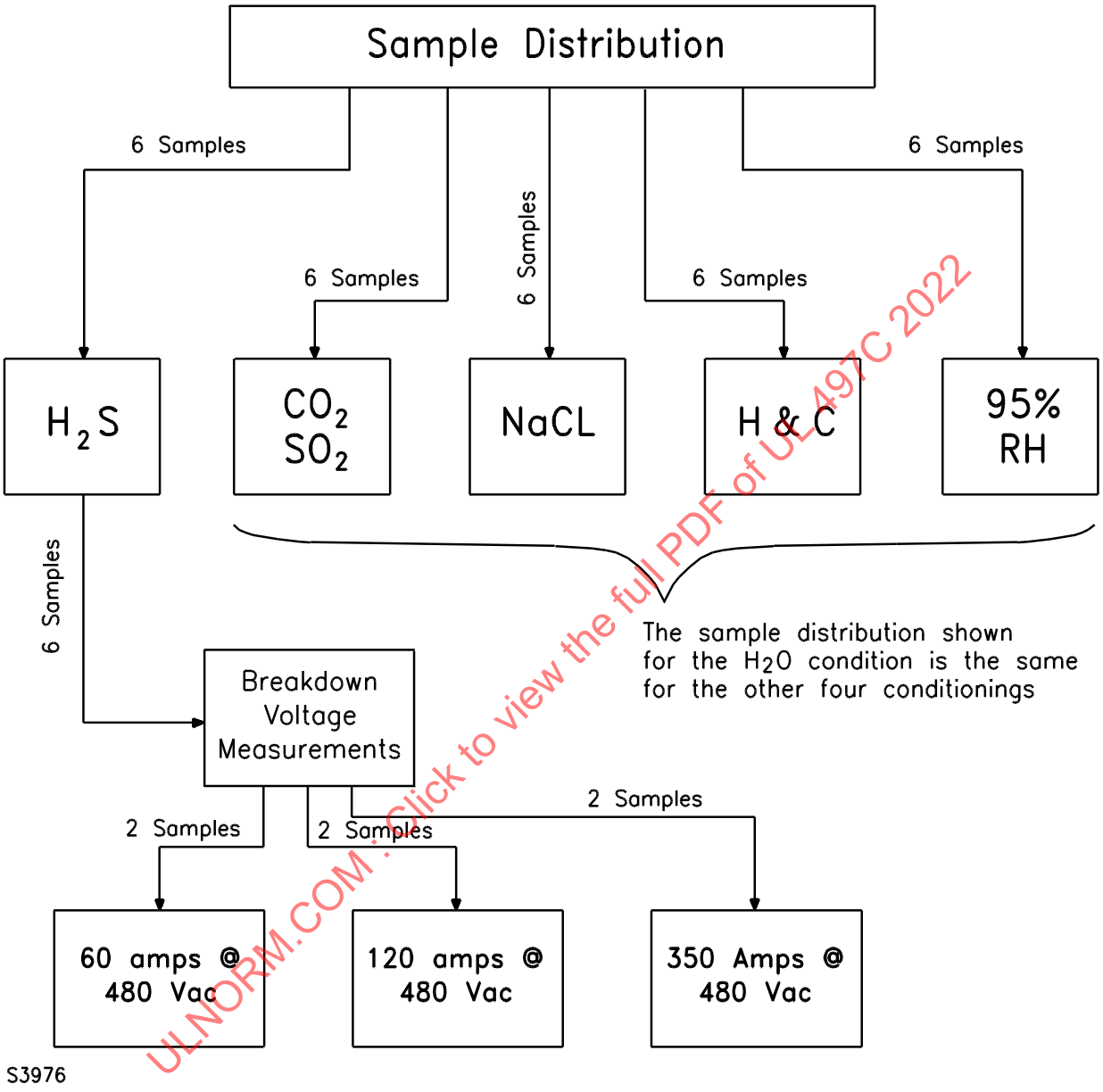
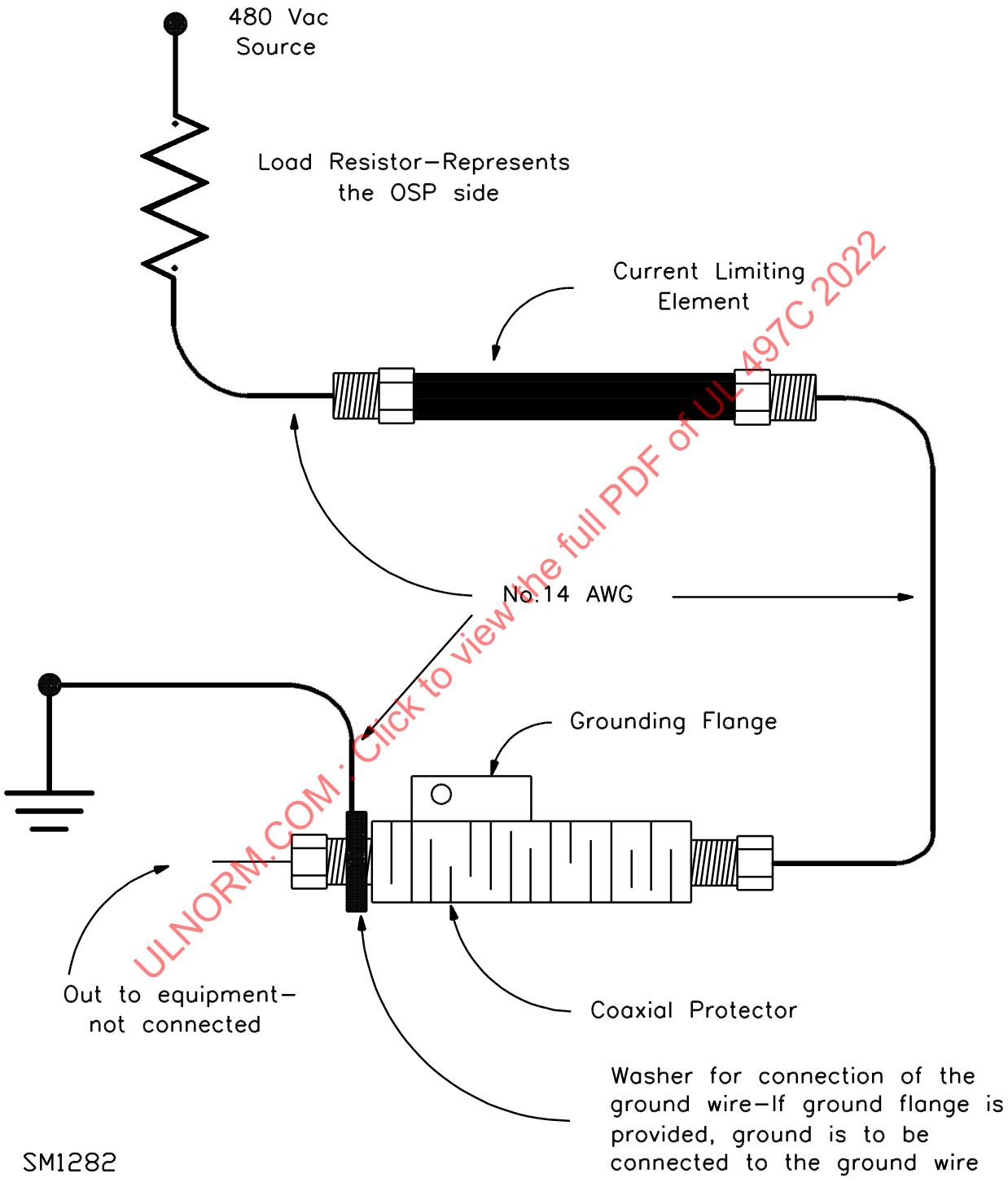


Figure 16.2

Typical test circuit for limited short-circuit test



16.7 Breakdown voltage measurements are to be taken on overvoltage protection devices while in the "as-received" condition, after conditioning and upon completion of this test. The conditionings are as follows:

a) Ten-day exposure in an atmosphere containing hydrogen sulfide in mixture with air saturated with water vapor at room temperature. The concentration is to be 1.0 percent by volume of the conditioning tank for outdoor use and 0.1 percent for indoor use.

b) Ten-day exposure in an atmosphere containing carbon dioxide and sulfur dioxide in mixture with air saturated with water vapor at room temperature. The concentration is to be 1.0 percent for each corrosion when testing for outdoor use. When conducting indoor concentrations, the sulfur dioxide is reduced to 0.5 percent concentration.

c) Ten-day exposure to salt spray, using a solution containing 20 percent by weight of sodium chloride. Test conditioning in accordance with the Standard Practice for Operating Salt Spray (Fog) Apparatus, ASTM B117, is to be used for producing a salt fog. This exposure applies to outdoor-type units only.

d) Fifty cycles of heating and cooling, each cycle consisting of 15 minutes at minus 30°F (minus 34.4°C) followed by 15 minutes at 150°F (65.6°C).

e) Twenty-four-hour exposure in a humidity chamber adjusted to 95 ±5 percent relative humidity at 86 ±3°F, with breakdown voltage measurements and limited short-circuit conducted within one hour after removal from the chamber.

16.8 After being subjected to the conditions specified in 16.7, the breakdown voltage of the device is not prohibited from being decreased to a short condition of the overvoltage device.

16.9 After the limited short-circuit, protectors are to be tested for breakdown voltage.

17 High Current Ground Path Test

17.1 A coaxial cable circuit protector shall withstand a continuous fault current, which is capable of being caused by a power contact to the outer coaxial metal shield, without the risk of ignition or charring of the cheesecloth or emission of flame or molten metal, other than from a fusible element, from the unit under test. The temperature rise of a softwood mounting surface shall not exceed 65°C (117°F) at any time during the test. Following this test, the breakdown voltage measurement is to be repeated and all arresters, within the protector, shall break down at or below the maximum rated breakdown voltage. Two samples are to be subjected to this test.

17.2 For this test, a risk of fire is indicated by the ignition or charring of the cheesecloth or emission of flame or molten metal from the unit under test.

17.3 Each coaxial protector sample is to be mounted on a vertical softwood surface. Each sample of the protector, with the ground wire connected as shown in Figure 16.2, is to be connected so that the outer coaxial shield is caused to carry a current of 80 amperes rms at 600 volts for 15 minutes with a single layer of cheesecloth covering the protector.

18 Cable Shield Fuse Test

18.1 A coaxial cable circuit protector shall withstand a high current fault of 3500 amperes, which is capable of being caused by a power contact to the outer coaxial metal shield, without the risk of ignition or charring of the cheesecloth or emission of flame or molten metal, other than from a fusible element, from the unit under test. The protector shall also maintain a ground continuity of 0.6 ohm or less.

18.2 The equipment is to be placed in a position of normal use and electrically connected in accordance with the manufacturer's installation instructions. The product under test is to be connected to a meter-length RG11 cable or cable sized for the protector it is intended to be used with.

18.3 The outer metallic shield of the cable is to be terminated to the test sample using a compatible coaxial connector, while the other end of the cable is to be clamped to the positive terminal of a 3500-ampere power source. The negative terminal of the power supply is to be connected to the ground terminal of the equipment under test.

18.4 Current calibration is to be achieved by shorting the sample with No. 6 gauge copper wire of meter length, and adjusting the test current using limiting non-inductive resistors. Prior to energization, the test sample is to be covered with cheesecloth. Two samples are to be subjected to this test.

18.5 Power is to be maintained until the test current is extinguished or constant temperatures are recorded. The sample is to be visually monitored for signs of a fire hazard indicated by the emission of flame or molten metal from the sample. The cheesecloth is also to be checked for charring or burning.

18.6 Upon completion of the 3500-ampere test trial, the threaded ground boss section to the ground terminal of the sample shall be checked for ground continuity.

19 Endurance Conditioning Test

19.1 After being subjected to endurance conditioning, an arrester shall continue to breakdown at or below its maximum rated breakdown voltage, measured in accordance with the Breakdown Voltage Measurement Test, Section 14, and shall comply with the requirements of the Limited Short-Circuit Test, Section 16. A total of 9 protectors with at least one arrester per protector is to be used in this test.

19.2 Three protector assemblies are to be subjected to conditioning with 500 cycles of a 10-ampere (short-circuit peak), 10- x 1000-µs wave with an open-circuit minimum voltage of 1000 volts. Two hundred fifty cycles are to be applied at each polarity, with a cycling time of at least 1 second.

19.3 Three additional protector assemblies are to be subjected to conditioning with 100 cycles of a 100-ampere (short-circuit peak), 10- x 1000-µs waveform with an open-circuit minimum voltage of 1000 volts. Fifty cycles are to be applied at each polarity, with a cycling time of at least 10 seconds.

19.4 The remaining three samples are to be subjected to conditioning with two cycles of a 5000-ampere (short-circuit peak), 8 x 20-µs waveform with an open-circuit minimum voltage of 1000 volts. One cycle is to be applied at each polarity with a cycling time of at least 1 minute between pulses.

20 Induced Low Current Test

20.1 There shall be no indication of a risk of fire in samples of protectors during continuous operation at low-current, high-voltage condition. The arrester is not prohibited from shorting, and shall not have an impulse sparkover voltage or DC breakdown voltage greater than its maximum rated breakdown voltage. Additionally, at no time during the test shall the temperature rise of the softwood mounting sample exceed 65°C (117°F).

20.2 Four sets of two different samples (a total of eight samples) are to be tested using the procedure described in the Limited Short-Circuit Test, Section 16. Each pair of test samples is to be tested at current levels of 0.25, 0.5, 1, and 2 amperes. The test is to be continued until constant temperatures are reached, but in no case less than 2 hours, unless the device employs a fail-shorted means that causes the temperature to drop upon operation. The maximum temperature is to be measured in this case.

21 Distortion Test

21.1 There shall be no warping of a polymeric material used as the sole support of current-carrying parts or impairment of the integrity of a cover as a water seal when representative samples of the polymeric material are aged for 7 days in a circulating-air oven maintained at 70°C (158°F). Covers subjected to this test are to be installed as intended on the protectors.

21.2 For this test, three representative samples are to be placed in the oven. After completion of the 7-day aging period, the samples are to be removed, allowed to cool to room temperature, and then examined. Samples of an outdoor enclosure are to be subjected to this test and then subjected to the Water Spray Test, Section 25.

22 Flame Test

22.1 When tested in accordance with 22.2 – 22.6, a polymeric material used as part of a protector for the sole support of current-carrying parts, or as a cover of a protector that encloses live wiring, shall not continue to burn for more than 1 minute after a fifth 5-second application of the test flame, with an interval of 5 seconds between each application of the test flame. There shall be no flaming or dripping of particles nor complete consumption of the sample during the test, and the material shall not be destroyed in the area of the test flame to the extent that there is loss of the protective function.

22.2 Three samples of the material are to be subjected to this test. Components and other parts that influence the performance are capable of being left in place. At least two of the three test samples shall perform acceptably. When a third sample does not comply with the requirements of 22.1 – 22.6, the test is to be repeated on a new sample, with the flame applied under the same conditions as for the unacceptable sample. When the new sample does not comply with the requirements, the material is not acceptable.

22.3 The following test equipment is to be used:

a) Test Chamber – The test chamber is to consist of a sheet metal cell 2- by 1- by 1-foot (610- by 305- by 305-mm), open at the top and on one long side. The chamber is to be located so that an ample supply of air is provided, but the sample is not to be subjected to drafts. The chamber is capable of being placed in a ventilating hood when the fan is turned off during the test and allowed to run only between tests to remove fumes.

b) A ring stand with an adjustable clamp for supporting the specimens.

c) Burner and Mounting Block – The test flame is to be obtained by means of a Tirrill burner having a tube with a nominal bore of 3/8 inch (9.5 mm). The tube length above the primary air inlets is 4 inches (102 mm). The burner is to be adjusted so that, while in a vertical position, the overall height of the flame is 5 inches (127 mm), and the height of the inner blue cone is 1-1/2 inches (38 mm). A mounting block is to be provided so that the burner is positioned at an angle of 20 degrees from the vertical.

d) A stopwatch or clock.

e) A circulating-air oven.

22.4 The test samples are to be conditioned for 7 days in a circulating-air oven maintained at a temperature of 70°C (158°F). Prior to the flame test, the samples are allowed to cool to room temperature.

22.5 The test samples are to be mounted as intended for service in the test chamber. The test flame is to be applied at an angle of 20 degrees from the vertical to any portion of the interior of the enclosure susceptible to ignition by proximity to live or arcing parts, arresters, or wiring.

22.6 The test flame is to be applied to a different location on each of the three samples tested.

23 Impact Test (Polymeric Enclosures)

23.1 Products intended to be fixed in place by a mechanical means shall show no signs of damage to enclosure, support base, or other mounting apparatus that results in live parts becoming accessible and shall not produce a risk of electric shock when subjected to the conditions specified in 23.2 and 23.3.

23.2 Three "as received" samples of the assembly shall be used for this test. Each test sample is to be held in a fixed position by its intended fixing means. A smooth, solid steel sphere 2 inches (50.8 mm) in diameter and having a mass of 1.18 pounds (0.54 kg) is to be allowed to fall through a vertical distance of 51-3/4 inches (1.3 m) as required to cause the sphere to strike the front cover, faceplate, or exposed portion of the sample with an impact of 6.8 N·m (5 foot-pounds).

23.3 Following the impact test described in 23.2, the samples shall comply with the Dielectric Voltage-Withstand Test, Section 27.

23.4 Products intended for outdoor use are to be subjected to the impact test while exposed to a temperature of minus 35°C (minus 31°F). Prior to impact, the samples are to be conditioned for 3 hours at an ambient temperature of minus 35°C and then subjected to impact while still exposed to the ambient or immediately upon removal from the ambient test chamber.

23.5 Following the impact test, products intended for outdoor use that experience damage such as cracking or any dimensional change shall comply with the Water Spray Test, Section 25.

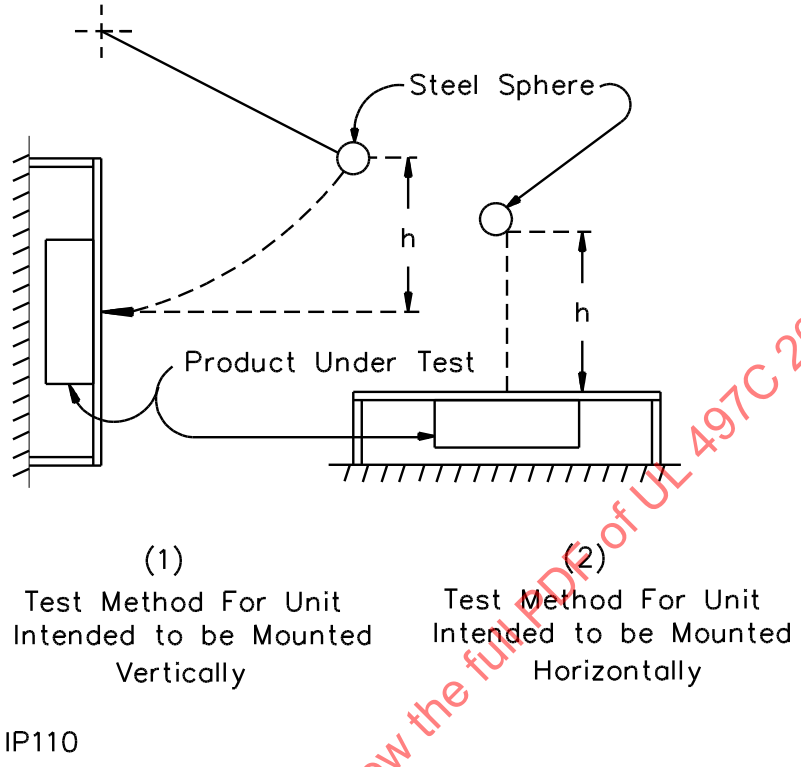
24 Jarring Test

24.1 After testing as described in 24.2, the protector shall breakdown within plus 25 percent of the manufacturer's specified breakdown voltage rating. The breakdown voltage is to be determined by the method described in the Breakdown Voltage Measurement Test, Section 14.

24.2 The protector is to be mounted as intended to the center of a 6- by 4-foot (1.8- by 1.2-m), nominal 3/4-inch (19.1-mm) thick plywood board secured in place at four corners. An impact is to be applied to the center of the reverse side of this board by means of a 1.18-pound (0.54-kg), 2-inch (50.8-mm) diameter steel sphere either swung through a pendulum arc from a height (h) of 30.5 inches (775 mm), or dropped from a height of 30.5 inches, depending upon the intended mounting of the equipment, to apply 3 foot-pounds (4.08 J) of energy. See Figure 24.1.

Figure 24.1

Jarring test



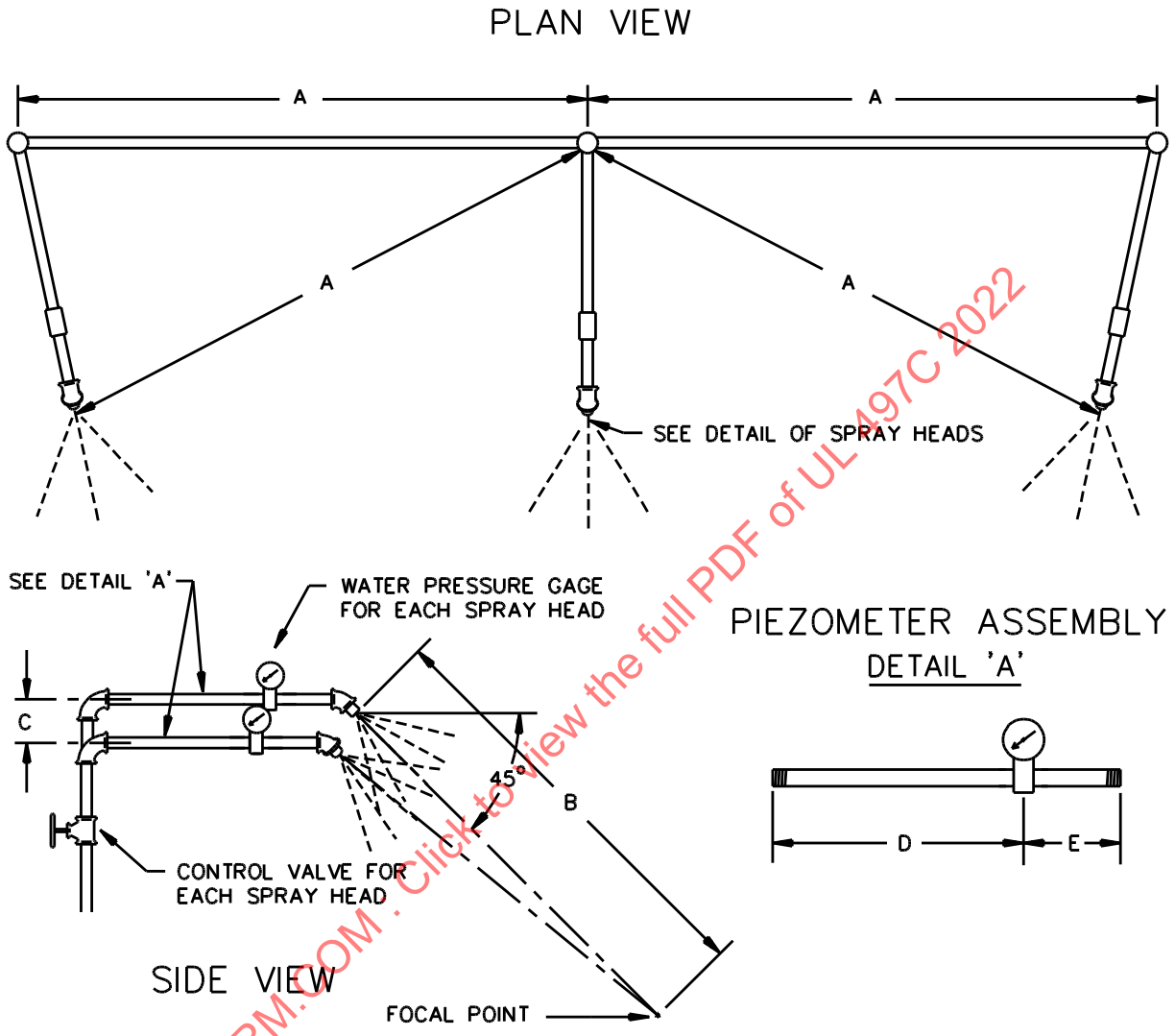
25 Water Spray Test

25.1 The current-carrying parts of a protector intended for outdoor use shall not be wet after a 1-hour spray exposure as described in 25.2.

25.2 The test apparatus is to consist of three spray heads mounted in a water supply pipe rack as illustrated in Figure 25.1. Spray heads are to be constructed in accordance with Figure 25.2. The water pressure is to be maintained at 5 psi (34.5 kPa) at each spray head. The distance between the center nozzle and the protector is to be 5 feet (1.5 m). The complete protector with cover in place is to be brought into the focal area of the three spray heads in such a position and under such conditions that the greatest quantity of water will enter the protector while mounted on a vertical surface in a position of intended use. The spray is to be directed at an angle of 45 degrees to the vertical toward the protector or openings closest to current parts. Two samples are to be subjected to this test.

Figure 25.1

Spray-head piping



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

RT101E