UL 510

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Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape

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UL Standard for Safety for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape, UL 510

Eighth Edition, Dated February 10, 2005

Revisions: This Standard contains revisions through and including August 12, 2005.

Summary of Topics

These revisions to UL 510 include a revision to clarify the use of unconditioned samples for Physical Properties, Dielectric, and Adhesion-Strength tests; removal of reference to Method A of ASTM D1000; revision to clarify the method for conducting the Deformation Test; change ″Weather Resistant″ marking to ″Sunlight Resistant″ marking; and other miscellaneous revisions.

Text that has been changed in any manner is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The following table lists the future effective dates with corresponding reference.

Future Effective Dates	References
August 12, 2006	Section 7 title, paragraphs 7.1, 14.1, 24.2, and 24.3

The new requirements are substantially in accordance with UL's Proposal(s) on this subject dated June 10, 2005.

As indicated on the title page (page1), this UL Standard for Safety has been adopted by the Department of Defense.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: http://ulstandardsinfonet.ul.com/ulforeword.html

The master for this Standard at UL's Northbrook Office is the official document insofar as it relates to a UL service and the compliance of a product with respect to the requirements for that product and service, or if there are questions regarding the accuracy of this Standard.

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if

the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing, Recognition, and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

This Standard consists of pages dated as shown in the following checklist:

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FEBRUARY 10, 2005

UL 510

Standard for Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape

The first, second, third, fourth, fifth, and sixth editions were titled Electrical Insulating Tape.

First Edition – March, 1954
Second Edition – February, 1971
Third Edition – June, 1971
Fourth Edition – August, 1976
Fifth Edition – January, 1982
Sixth Edition – October, 1986
Seventh Edition – June, 1994

Eighth Edition

February 10, 2005

The Department of Defense (DoD) has adopted UL 510 on October 10, 1979. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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

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 set of revised requirements.

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No Text on This Page

CONTENTS

INTRODUCTION

1 Scope

1.1 This Standard covers thermoplastic and rubber tapes for use as electrical insulation at not more than 600 V and at 80°C (176°F) and lower temperatures on joints and splices in wires and cables in accordance with the National Electrical Code ANSI/NFPA 70. It is intended that rubber tape on a joint or splice be mechanically protected by a covering such as friction tape. Thermoplastic tape is acceptable without the additional mechanical protection.

1.2 The characteristic constituent of the thermoplastic tape covered in this Standard is either PVC (polyvinyl chloride or a copolymer of vinyl chloride and vinyl acetate), or PE (thermoplastic polyethylene). For the characteristic constituent(s) of rubber tape, see 18.1.

2 Components

2.1 Except as indicated in 2.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components used in the products covered by this standard.

2.2 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.

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

2.4 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.

3 Units of Measurement

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

4 Undated References

4.1 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.

ALL TAPES

5 General

5.1 The requirements in Sections 5 – 7 and 24 apply to all of the tapes covered in this Standard and are supplemented by requirements in Sections 8 – 17 covering thermoplastic tape and in Sections 18 – 23 covering rubber tape.

5.2 Lengths of tape for use as specimens in any of the tests specified in this Standard are to be taken from sample rolls of finished tape fitted snugly onto a horizontal rod or tube that is free to turn in its supports without wobbling or other extraneous motion whenever the tape is unrolled. The tape is to be in thermal equilibrium with the surrounding air at a temperature of 23.0 ±5.0°C (73.4 ±9°F) whenever being unrolled. The tape is always to be unrolled at an even rate of approximately 2 in/s (50 mm/s) – that is, rather slowly. The first three layers of tape are to be discarded. Each length of tape intended as a specimen or from which a specimen is prepared is to be protected from dust and is to be placed adhesive side up on a smooth, clean surface or is to be suspended in air for 1 hour under the conditions specified in 5.3 after removal from a roll and before being used in a test.

5.3 Unless otherwise specified, all testing shall be conducted in still air at a temperature of 23.0 ±5.0°C (73.4 ±9°F) and a relative humidity of 50 ±10 percent.

6 Flame Test

6.1 Insulating tape marked ″flame retardant ″ in accordance with 24.2 shall not flame longer than 60 seconds following any of five 15 seconds applications of the test flame, the period between applications being:

a) 15 seconds if the specimen flaming ceases within 15 seconds; or

b) The duration of the specimen flaming if the specimen flaming persists longer than 15 seconds.

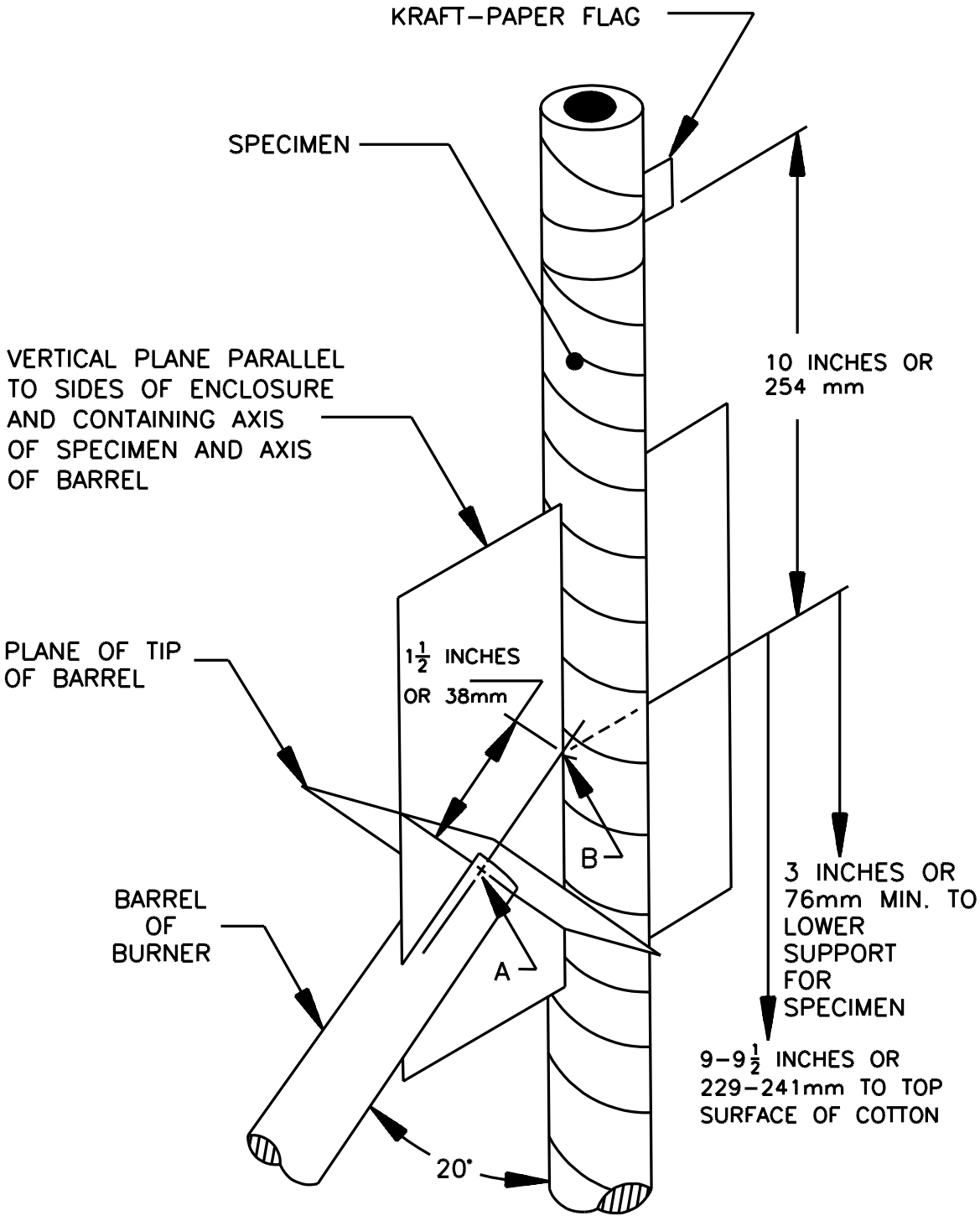
The tape shall not ignite combustible materials in its vicinity or damage more than 25 percent of the indicator flag during, between, or after the five applications of the test flame. The test is to be conducted as described in 6.2 – 6.10.

6.2 The test specimen is to be prepared as follows. A straight clean steel rod 18 in (460 mm) long and 1/8 in (3.2 mm) in diameter is to be supported in a winding jig. The winding jig is to support the rod at each end and have a crank for rotating the rod so that the tape can be wound thereon. The winding jig is to be attached to a rigid support in such a manner that it can be rotated, tilting the major axis of the rod to the horizontal. A 3-ft (900-mm) length of 3/4 in (19 mm) tape is to be cut from a roll. The tape sample is to be secured, by overlapping the first turn of tape, to the rod held in a horizontal position. A weight exerting 4.4 lbf, 19.6 N, or 2.0 kgf is then to be attached to the free end of the 3 ft (900 mm) sample to provide tension. After 1 minute under tension, the rod is to be slowly rotated, and the fixture tilted so that the tape wraps with an overlap equal to one half the width of the tape. After wrapping is completed, the lower end of the tape is to be secured and the remaining length of tape is to be cut off. A second wrapping is to be similarly applied with the direction of advance of the turns of the tape reversed from that of the

first wrapping. Finally, a third wrapping of tape is to be similarly applied with the direction of advance opposite to that of the second wrapping. Thus, six thicknesses of tape are to result at each point along the wrapped mandrel.

6.3 The test is to be conducted in a 3-sided metal enclosure in an exhaust hood or cabinet. The metal enclosure is to be 12 in (305 mm) wide, 14 in (355 mm) deep, 24 in (610 mm) high, and the top and front are to be open. The test specimen detailed in 6.2 is to be secured with its longitudinal axis vertical in the center of the enclosure. A flat horizontal layer of absorbent 100 percent cotton 1/4 to 1 in (6 to 25 mm) thick is to cover the floor of the enclosure. The upper surface of the cotton is to be 9 to 9-1/2 in (229 to 241 mm) below point B, which is the point at which the tip of the blue inner cone of the test flame touches the specimen. This is shown in Figure 6.1.

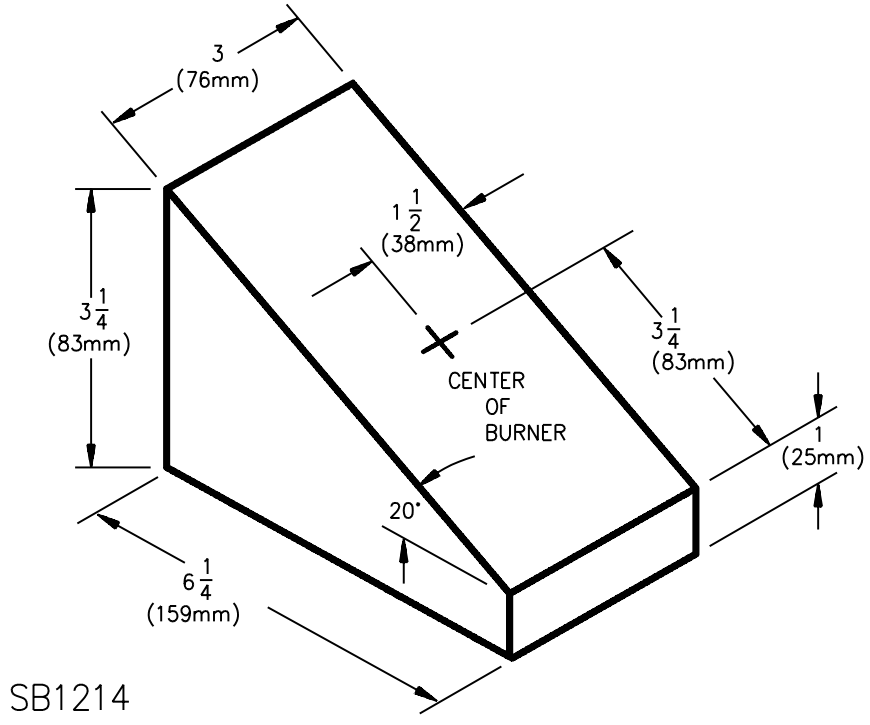
Figure 6.1
Essential dimensions for flame test
Proportions exaggerated for clarity of detail



6.4 A Tirrill gas burner (such a burner differs from a Bunsen burner in that the air flow as well as the flow of gas is adjustable) with or without a gas pilot light attached is to supply the flame. The barrel of the burner is to extend 4 in (102 mm) above the air inlets and its inside diameter is to be 3/8 in (9.5 mm). While the barrel is vertical and the burner is well away from the specimen, the overall height of the flame is to be adjusted to approximately 4 to 5 in (100 to 125 mm). The blue inner cone is to be 1-1/2 in (38 mm) high and the temperature at its tip is to be 816°C (1500°F) or higher as measured using a chromel-alumel (nickel-chromium and nickel-manganese aluminum) thermocouple. Without disturbing the adjustments for the height of the flame, the valve supplying gas to the burner flame and the separate valve supplying gas to any pilot flame are to be closed.

6.5 A wedge (acceptable dimensions are shown in Figure 6.2) to which the base of the burner can be secured is to be provided for tilting the barrel 20 degrees from the vertical while the longitudinal axis of the barrel remains in a vertical plane. The burner is to be secured to the wedge and the assembly is to be placed on an adjustable support jig. A layer of absorbent 100 percent cotton 1/4 to 1 in (6 to 25 mm) thick is to be placed on the wedge and around the base of the burner. The jig is to be adjusted toward one side or the other of the enclosure to place the longitudinal axis of the barrel in the vertical plane that contains the longitudinal axis of the specimen. The plane is to be parallel to the sides of the enclosure. The jig is also to be adjusted toward the rear or front of the enclosure to position the point A, which is the intersection of the longitudinal axis of the barrel with the plane of the tip of the barrel, 1-1/2 in (38 mm) from the point B at which the extended longitudinal axis of the barrel meets the outer surface of the specimen. Point B is the point at which the tip of the blue inner cone is to touch the center of the front of the specimen.

Figure 6.2
Acceptable dimensions of wedge in inches (millimeters)



6.6 In the absence of a gas pilot light on the burner, the support for the burner and wedge is to be arranged to enable the burner to be quickly removed from and precisely returned to the position described in 6.5 without disturbing the layer of cotton on the floor of the enclosure or the cotton on the wedge and around the base of the burner.

6.7 A strip of unreinforced 60-lb (94-g/m^2) kraft paper that is 1/2 in (13 mm) wide, approximately 5 mils (0.1 mm) thick, and is gummed on one side is to be used to make an indicator flag. The gumming is to be moistened but not more than necessary to facilitate adhesion. With the gum toward the specimen, the strip is to be wrapped around the specimen once with its lower edge 10 in (254 mm) above point B, the point at which the blue inner cone is to touch the specimen. The ends of the strip are to be pasted together evenly and trimmed to provide a flag that projects 3/4 in (19 mm) from the specimen toward the rear of the enclosure with the flag parallel to the sides of the enclosure (see Figure 6.1). The lower clamp or other support for the specimen is to be adjusted vertically to keep it from being any closer than 3 in (76 mm) to point B.

6.7 revised August 12, 2005

6.8 If the burner has a gas pilot light, the valve supplying gas to the pilot is to be opened and the pilot lit. If the burner does not have a gas pilot light, the burner is to be supported as indicated in 6.6 in a position away from the specimen and then lit. This operation and the remainder of the test are to be conducted under a forced-draft exhaust hood or cabinet operating to provide removal of smoke and fumes, but not having drafts that affect the flame.

6.9 If the burner has a gas pilot light, the valve supplying gas to the burner is to be opened to apply the flame to the specimen automatically. This valve is to be held open for 15 seconds, closed for 15 seconds (longer if flaming of the specimen persists – see the last two sentences of this paragraph), opened for 15 seconds, and so on for a total of five 15 seconds applications of the gas flame to the specimen with 15 seconds (longer if flaming of the specimen persists – see the last two sentences of this paragraph) between applications. If the burner does not have a gas pilot light, the burner is to be moved into position to apply the gas flame to the specimen, kept there for 15 seconds, removed for 15 seconds (longer if the flaming of the specimen persists– see the last two sentences of this paragraph), and so on for a total of five 15 seconds applications of the gas flame to the specimen with 15 seconds (longer if flaming of the specimen persists – see the last two sentences of this paragraph) between applications. The gas flame is to be reapplied to the specimen 15 seconds after the previous application if flaming of the specimen ceases of its own accord within 15 seconds of the previous application. If flaming of the specimen persists longer than 15 seconds after the previous application of the gas flame, the gas flame is not to be reapplied until flaming of the specimen ceases of its own accord. In the latter case, the gas flame is to be reapplied as soon as flaming of the specimen ceases.

6.10 The results of this test judged by the three following criteria using the 3/4 in (19 mm) specimen width are to be considered representative of the performance of all sizes (widths) of the tape. If any specimen:

a) Shows more than 25 percent of the indicator flag burned away or charred (soot that can be removed with a cloth or the fingers and brown scorching are to be ignored) after any of the five applications of flame, the tape is to be judged capable of conveying flame along its length.

b) Emits flaming or glowing particles or flaming drops at any time that ignite the cotton on the burner, wedge, or floor of the enclosure (flameless charring of the cotton is to be ignored), the tape is to be judged capable of conveying flame to combustible materials in its vicinity.

c) Continues to flame longer than 60 seconds after any application of the gas flame, the tape is to be judged capable of conveying flame to combustible materials in its vicinity.

7 Sunlight Resistance Test

7.1 Insulating tape marked ″sunlight resistant″ in accordance with 24.2 shall retain at least 65 percent of its original average tensile strength and elongation after being conditioned for 100 hours.

Revised 7.1 effective August 12, 2006

7.2 The original tensile strength and elongation are to be determined using the apparatus described in 21.5 and the methods applicable to the particular type of tape. A second set of tape specimens (at least five specimens) is to be vertically mounted in the specimen drum of the artificial weathering apparatus described in 7.3. After 100 hours of exposure, the specimens are to be removed from the drum and tested for tensile strength and elongation using the apparatus described in 21.5 and the methods applicable to the particular type of tape. The 2 in (50 mm) bench marks are to be added to the specimen after the 100 hours of conditioning.

7.3 The specimens are to be exposed to ultraviolet light from a radiation source such as two carbon arcs formed between vertical electrodes, 1/2 in (13 mm) in diameter, located at the center of a rotatable vertical metal cylinder 31 in (787 mm) in diameter and 17-3/4 in (451 mm) high. Each arc is to be enclosed by a clear globe of heat-resistant optical glass (9200-PX Pyrex glass or its equal) that is opaque at wavelengths shorter than 2750 angstrom units (275 nm) and whose transmission improves to 91 percent at 3700 angstrom units (370 nm).

7.4 The specimens are to be mounted vertically without tension on the inside of the cylinder, with the backing facing the arcs, and the adhesive uncovered. The cylinder is to be rotated about the arcs at one revolution per minute. A system of nozzles is to be provided so that each specimen is sprayed, in turn, with water as the cylinder revolves. With the cylinder revolving continuously and the arcs operating continuously, the spray is to be operated for 3 minutes ON and 17 minutes OFF. This cycle is to be repeated six times without interruption resulting in operation with each specimen being subjected to radiation from the arcs for a total of 102 minutes and to the water spray with radiation from the arcs for a total of 18 minutes. This sequence is to be repeated resulting, in turn, in a total elapased operating time of 100 hours. The equilibrium black-panel temperature within the cylinder while the apparatus is in operation is to be 63 ±5°C (145 ±9°F).

THERMOPLASTIC TAPE

8 Thickness

8.1 The average thickness of a thermoplastic insulating tape (inclusive of the adhesive compound), as determined by the method described in 8.2, shall not be less than 0.006 in (0.15 mm).

8.2 The average thickness of the tape is to be determined by means of a dead-weight dial micrometer having a presser foot 0.250 ±0.010 in (6.4 ±0.2 mm) in diameter and exerting a total of 6.0 ±0.1 oz-f or 1.67 ±0.02 N or 156 ±17 g-f on the specimens, the load being applied by means of a weight. Five readings are to be taken at different points on the tape and the average is to be taken as the thickness of the tape.

9 Physical Properties Tests

9.1 The physical properties of a thermoplastic insulating tape shall be such that, when five unconditioned specimens are tested for breaking strength and elongation in accordance with the Standard Test Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications, ASTM D 1000, the average performance is in accordance with Table 9.1.

9.1 revised August 12, 2005

Table 9.1
Physical properties of thermoplastic tape

Condition of specimens at time of measurement	Minimum acceptable ultimate elongation [2 in (50 mm) bench marks]		Minimum acceptable tensile strength	
	PVC tape	PE tape	PVC tape	PE tape
Unaged	100 percent [2 in (50 mm)]	60 percent [1.2 in (30 mm)]	2000 lbf/in^2 or 13.8 MN/m^2 or 1379 N/cm^2 or 1.41 kgf/mm^2	1500 lbf/in^2 or 10.3 MN/m^2 or 1030 N/cm^2 or 1.05 kgf/mm^2

10 Dielectric Breakdown Test

10.1 The average unconditioned dielectric strength of five specimens of finished PVC or PE tape shall not be less than 1000 volts per mil (39.37 kilovolts per millimeter) of the tape thickness (backing plus adhesive) when tested in accordance with the short-time method described in the Standard Test Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications, ASTM D 1000.

10.1 revised August 12, 2005

11 Test for Adhesion Strength

11.1 An unconditioned thermoplastic insulating tape shall have a minimum average adhesion strength of 16 oz-f/in or 0.175 N/mm or 18 g-f/mm when applied to steel and to the tape backing as determined by the adhesion-strength tests and procedures outlined in the Standard Test Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications, ASTM D 1000.

11.1 revised August 12, 2005

12 Moisture Absorption Test

12.1 A thermoplastic insulating tape shall retain at least 90 percent of its original average dielectric strength after conditioning for 96 hours in air at 23.0 ±1.0°C (73.4 ±1.8°F) and 96 ±2 percent relative humidity.

12.2 The average dielectric strength both before and after conditioning is to be determined as described in 10.1. Conditioned specimens are to be removed from the humidity chamber one at a time. Each specimen is to be placed between layers of dry cotton toweling, which is to be pressed gently over its entire surface. Each specimen is then to be tested immediately to minimize misleading results because of further drying of the sample. The average dielectric strength is to be determined for tape taken from at least two rolls.

13 Exposure to Heat Test

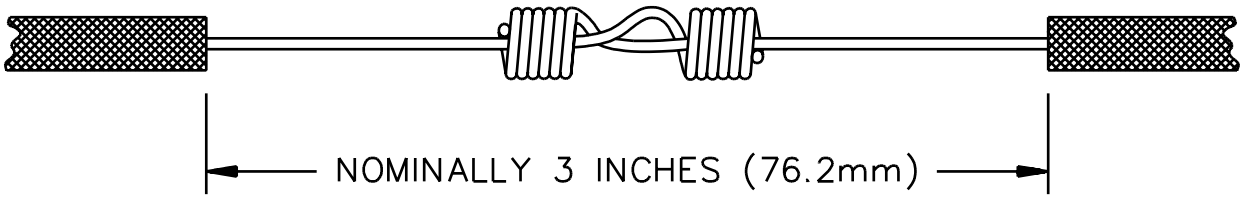
13.1 A PVC insulating tape shall not crack when flexed, or otherwise be adversely affected such as flagging (which is lifting of the terminating end of the wrapping), after being conditioned in a full-draft circulating-air oven at a temperature of 113.0 ±1.0°C (235.4 ±1.8°F) for 168 hours. A PE tape shall not crack when flexed, or otherwise be adversely affected such as flagging (which is lifting of the terminating end of the wrapping), after being conditioned in a full-draft circulating-air oven at a temperature of 87.0 ±1.0°C (188.6 ±1.8°F) for 60 days (1440 hours). In addition, after removal of either tape from the conductor, the conductor is not to show any corrosive effects from the tape.

13.2 The oven mentioned in this section shall comply with the Standard Specification for Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation, ASTM D 5423.

13.3 To determine whether a tape complies with 13.1, four tape-insulated splices made with Type T, TW, THW, THWN, THHN, RH, RHW, RHH, or XHHW wire as described in 13.4 are to be wrapped with the tape as indicated in 13.5 and conditioned, flexed, and examined as indicated in 13.6 and 13.7. The conductor is to be 12 AWG solid uncoated copper.

13.4 For each splice, two 12-in (300-mm) lengths of insulated conductor are to be used, and a 2-in (50-mm) length of insulation is to be stripped from one end of each conductor. The two bared conductors are to be connected together by means of an in-line (Western Union) splice (see Figure 13.1). The spliced ends of the conductor are to be crimped with pliers to remove sharp projections.

Figure 13.1
Western union splice



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13.5 While supporting a weight that exerts 2-1/2 lbf or 11.1 N or 1.13 kgf, a strip of tape is to be held vertically with the upper end of the tape held against the insulated wire just adjacent to the splice. Initially, the major axis of the splice is to be located approximately horizontally, and the tape is to be caused to wrap around the wire and splice by rotating the splice around its major axis. The major axis of the splice is then to be tilted from the horizontal so that each turn of the tape overlaps the preceding turn by half of the width of the tape. After the bared conductors and approximately one tape width of the wire insulation have been completely wrapped in this manner, a second wrapping is to be similarly applied, with the direction of advance of the turns of the tape reversed from that of the first wrapping. Finally, a third wrapping of tape is to be similarly applied with the direction of advance opposite to that of the second wrapping. Thus, six thicknesses of tape are to result at each point along the splice.

13.6 The insulated splices are then to be placed in a full-draft circulating-air oven that is operating at 113.0 ±1.0°C (235.4 ±1.8°F) for PVC tape and at 87.0 ±1.0°C (188.6 ±1.8°F) for PE tape. For the PVC tape, after 24 hours, two of the splices are to be removed from the oven, cooled in still air at a room temperature of 24.0 ±8.0°C (75.2 ±14.4°F) for 16 to 96 hours, and subjected to flexing as described in 13.7. If the PVC tape cracks when flexed, or if flagging occurs, or if the tape is otherwise affected adversely by the flexing after 24 hours of conditioning or, if upon removing the tape, the conductor shows signs of corrosion or other adverse effects from the tape, the test is to be terminated and the 168 hours samples are to be removed from the oven and discarded. If the PVC tape does not crack when flexed, or does not flag after 24 hours of conditioning and, if upon removing the tape, the conductor does not show signs of corrosive or other adverse effects from the tape, the two remaining PVC samples are to stay in the oven for a total of 168 hours and are then to be removed from the oven, flexed, and examined. The PE tape is to be tested as indicated for the PVC tape, but only after the 60 days (1440 hours) of conditioning.

13.7 The flexing is to be performed by holding the wire of the assembly approximately 1 in (25 mm) to the left of the splice firmly against a mandrel consisting of a solid steel rod that is 1/2 in (13 mm) in diameter and is rigidly supported at one end with its longitudinal axis horizontal. The end of the assembly, which includes the splice, is then to be wrapped tightly around the mandrel in a clockwise direction until approximately 1 in (25 mm) of the wire to the right of the splice is wrapped around the mandrel. The direction of wrap is then to be reversed and continued in the counterclockwise direction until approximately 1 in (25 mm) of the wire to the right of the splice is wrapped around the mandrel. Five clockwise operations and five counterclockwise operations followed by a clockwise unwrap are to complete the flexing procedure. Each operation is to be conducted at a uniform rate such that the flexing procedure is completed in 15 to 25 seconds. After flexing, the tape is to be examined for cracking or other damage. In addition, upon examination, the conductor is to show no corrosion or other adverse effects from the tape after removal of the tape from the splices.

14 Exposure to Cold Test

14.1 A thermoplastic insulating tape marked ″cold and sunlight resistant″ in accordance with 24.3 shall not show any cracks, transfer of adhesive, or loss of tack in the adhesive to make the tape unfit for insulating splices, after having been subjected to a temperature of minus 10.0 ±2.0°C (plus 14.0 ±3.6°F) for 2 hours.

Revised 14.1 effective August 12, 2006

14.2 To determine whether a thermoplastic tape complies with the requirements in 14.1, two rolls of tape are to be maintained at a temperature of minus 10.0 ±2.0°C (plus 14.0 ±3.6°F) for 2 hours. At the end of 2 hours, and while still being maintained at minus 10.0 ±2.0°C (plus 14.0 ±3.6°F), the tape from each roll is to be wrapped around a steel mandrel 1/8 in (3 mm) in diameter for a distance of 5 in (127 mm) using the method and apparatus mentioned in 6.2. In wrapping the tape, the advance of each turn is to equal half of the tape width. An additional length of tape taken from each roll is to be used to insulate a Western Union splice (see 13.4) while the wire and tape are at minus 10.0 ±2.0°C (plus 14.0 ±3.6°F), using a tension of 2-1/2 lbf or 11.1 N or 1.13 kgf as described in 13.5. The tape is not to crack during the operations and is to have adhesive strength that results in a splice of good workmanship. The conductor is not to be affected adversely when examined after removal of the tape from the splices.

14.2 revised August 12, 2005

15 Deformation Test

15.1 The thickness of the insulation on a splice covered with PE tape shall not decrease more than 40 percent when conditioned, under pressure, in a full-draft circulating-air oven operating at a temperature of 100.0 ±1.0°C (212.0 ±1.8°F) as described in 15.2, and the corresponding decrease in thickness shall not be more than 65 percent for PVC tape.

15.2 A bare 12 AWG solid copper conductor is to be wrapped with successive layers of tape, with each layer of tape directly over the one below, until a thickness of tape equal to approximately 1/32 in (0.8 mm) is in place over the conductor. The thickness of the insulation (tape) is to be measured by means of a dead-weight dial micrometer having no added weight and a presser foot 0.375 ±0.010 in (9.5 ±0.2 mm) in diameter.

15.2 revised August 12, 2005

15.3 The apparatus for the determination of percentage deformation shall consist of:

a) an oven capable of maintaining the required air temperature and having the characteristics required by ASTM D 5374; and

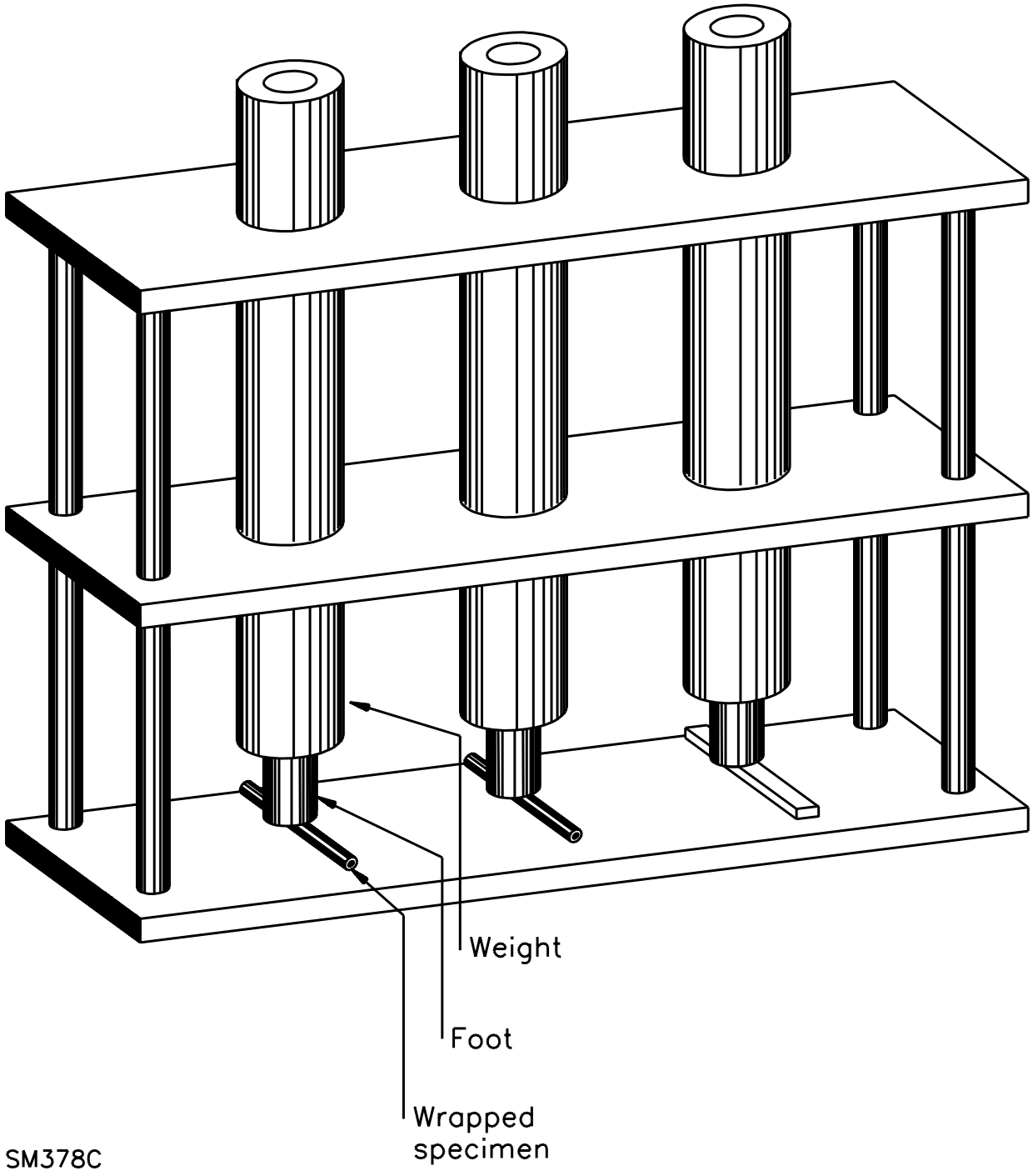
b) the necessary weights needed to exert a total force of 500 g-f (4.90 N) mounted in a metal frame so as to have free vertical movement, as illustrated in Figure 15.1.

The weight shall be provided with a 0.375 ±0.010 in (9.5 ±0.2 mm) diameter flat presser foot, slightly rounded at the edges, and intended to bear upon the specimen under test.

15.3 added August 12, 2005

Figure 15.1
Weights and specimens in supporting frame for deformation test
(See 15.3 and 15.4)

Figure 15.1 added August 12, 2005



15.4 The specimen is to be placed in the oven for 1 hour of preliminary heating at a temperature of 100.0 ±1.0°C (212.0 ±1.8°F) along with the weights and supporting frame. At the end of 1 hour, the specimen is to be placed under the foot of one of the weights for an additional hour. At the end of the second hour, the sample is carefully removed from under the weight and the thickness is remeasured within 15 seconds in the same manner as specified in 15.2, and the percent decrease in the thickness of the insulation (tape) is to be calculated using the following formula.

$$D = [(T_1 - T_2) / (T_1 - C)] X 100$$

in which:

D is the percent decrease in thickness;

T_1 is the overall sample diameter before aging;

T_2 is the overall sample diameter after oven aging; and

C is the conductor diameter.

15.4 added August 12, 2005

16 Storage Test

16.1 A thermoplastic insulating tape shall retain its adhesive qualities so that it can be used to insulate splices when an unused roll of tape is conditioned in a full-draft circulating-air oven operating at a temperature of 40.0 ±1.0°C (104.0 ±1.8°F) for 60 days or, at the manufacturer's option, a temperature of 65.0 ±1.0°C (149.0 ±1.8°F) for 240 hours (10 days).

16.2 To determine whether a thermoplastic tape complies with the requirements in 16.1, an unused roll of tape, in its original container, is to be laid flat in a full-draft circulating-air oven operating at the temperature and for the time indicated in 16.1, after which the tape is to comply with the requirements in 11.1 for adhesion strength.

17 Test for Indirect Measurement of Conductor Corrosion

17.1 PVC tape shall exhibit an average resistance of 1.0 teraohm (1,000,000 megohms) or more for a 1-in (25-mm) width of tape when five specimens are tested in accordance with the Standard Test Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications, ASTM D 1000, using copper electrodes. The conditioning temperature of specimens with the copper electrodes shall be 23.0 ±5.0°C (73.4 ±9°F).

RUBBER TAPE

18 Compound

18.1 A rubber insulating tape shall consist of a compound of unvulcanized or partially unvulcanized natural or synthetic rubber, or a blend thereof, that shall contain not more than 0.5 percent of free sulphur by weight of the original compound when tested in accordance with the Standard Test Methods for Rubber Products – Chemical Analysis, ASTM D 297.

19 Thickness

19.1 Rubber tape shall be at least 0.018 in (0.46 mm) thick.

19.2 The thickness of the tape is to be determined by means of a dead-weight dial micrometer having a presser foot 0.250 ±0.010 in (6.4 ±0.2 mm) in diameter and exerting a total of 3.0 ±0.1 oz-f or 0.84 ±0.02 N or 85 ±3 g-f on a specimen, the load being applied by means of a weight. Five readings are to be taken at different points on the tape and the smallest of these is to be taken as the minimum thickness of the tape.

20 Separator

20.1 Material, position, and coverage

20.1.1 A separator of parchment paper, glazed sheeting, polyester film, or similar material shall be interposed between adjacent layers of a roll of tape and shall cover the outside of the tape.

20.2 Sticking and unraveling tendency

20.2.1 When a roll of tape is originally unwound, the separator shall not show undue tendency to stick or to unravel.

21 Physical Properties Tests

21.1 The physical properties of a rubber insulating tape shall be such that, when three unaged samples are tested with the apparatus and according to the methods descried in 21.2 – 21.8, the tensile strength at the breaking point is not less than 250 lbf/in^2 or 1.7 MN/m^2 or 171 N/cm^2 or 176 g-f/mm^2 and the ultimate elongation (the increase in separation exhibited at the moment of rupture by bench marks that originally were 2 in (50 mm) apart) is not less than 300 percent (6 in or 150 mm).

21.2 Two strips of the tape, each 8 inches (203 mm) long, are to be placed together with their adhesive sides in contact and are to be rolled to eliminate any entrapped air. A dumbbell-shaped specimen is to be cut from the plied strips, using a die (die A) in the Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension, ASTM D 412, having a constricted portion 0.500, plus 0.002, minus 0.000 in (12.00, plus 0.05, minus 0.00 mm) wide and 2.32 ±0.08 in (59 ±2 mm) long.

21.3 The specimens to be tested are to be marked by means of a marker consisting of a stamp with parallel blades capable of making fine lines with ink on a specimen without damage to the tape. The lines (bench marks) are to be 2 in (50 mm) apart and applied on the constricted portion of the specimen and at right angles to the longitudinal axis of the specimen. Measurement of elongation is to be made with reference to the center of each mark – that is, halfway between the edges.

21.4 The ultimate-elongation and tensile-strength tests are to be conducted at a temperature of 23.0 ±5.0°C (73.4 ±9°F), using the test specimens that have been maintained at this room temperature for at least 30 minutes prior to the test.

21.5 The ultimate-elongation and tensile-strength tests are to be conducted simultaneously on a power-driven machine provided with a device that indicates the actual maximum load applied to the specimen. If a machine of the spring-balance type is used, provision is to be made so that the spring does not recoil. The machine is to be adjusted to make the speed of the power-actuated grip 20 ±1 in/min (500 ±25 mm/min). The applied tension as indicated by a dial or scale is to be accurate to 2 percent or less of the value read.

21.6 The specimen is to be clamped in position with both 2 in (50 mm) bench marks outside of and between the grips. The movable grip is to be adjusted to make the specimen taut but not under tension. The temperature of the ambient air is to be observed and recorded.

21.7 The grips are to be separated at the rate indicated in 21.5 until the specimen ruptures. During separation, the distance between the bench marks is to be observed continuously so that the distance is observed at the instant of rupture and is recorded with accuracy of at least 0.1 in (2 mm). The elongation is to be taken as the increase in distance between the bench marks, which originally were 2 in (50 mm) apart.

21.8 After rupture of the specimen, the maximum load in pounds force, mega-newtons, newtons, or grams-force is to be noted from the dial or scale and recorded together with the original width and thickness of the specimen for use in calculating the tensile strength.

22 Storage Test

22.1 A rubber insulating tape shall retain its adhesive qualities so that it can be used to insulate splices when an unused roll of tape is conditioned in a full-draft circulating-air oven at a temperature of 40.0 ±1.0°C (104.0 ±1.8°F) for 60 days (1440 hours).

22.2 To determine whether a rubber tape complies with the requirements in 22.1, an unused roll of tape, in its original container, is to be laid flat in a full-draft circulating-air oven operating at a temperature of 40.0 ±1.0°C (104.0 ±1.8°F) for 60 days (1440 hours). After this conditioning, the tape is not to become unduly attached to the separator and is to meet the fusion test in the Standard Specification for Low-Voltage Rubber Insulating Tape, ANSI/ASTM D 119.

23 Dielectric Breakdown Test

23.1 The average dielectric strength of five specimens of finished tape shall not be less than 350 volts per mil (13,800 volts per millimeter) of the tape thickness.

23.2 Three 6-in (150-mm) lengths of the finished tape are to be used in constructing each of the five specimens. With its adhesive side up, one piece of the tape is to be laid flat on a smooth, horizontal surface. A second piece is to be laid onto one long edge of the first with its adhesive side down, with its length parallel to the length of the first piece, and with an overlap of 1/8 in (3 mm). The third piece is to be laid similarly onto the remaining long edge of the first. Both joints are to be rolled to provide intimate contact.

23.3 The average thickness of the center strip of each specimen is to be determined as indicated in 8.2.

23.4 The two metal electrodes between which the specimens are to be tested individually are each to have flat faces for contacting the tape. Each electrode is to be 0.250 in (6.4 mm) wide and 4.25 in (108 mm) long with all of its edges square except at the ends, each of which is to be rounded to a cylinder with a radius of approximately 0.125 in (3.2 mm) and with an axis that is perpendicular to the longitudinal axis of the electrode and parallel to the contact face of the electrode. The dimensions of the contact face of each electrode are to be 0.250 in by 4.00 in (6.4 mm by 101 mm) to provide a contact area of 1 in^2 (646 mm^2).

23.5 The specimens, the electrodes, and the surrounding air are to be in thermal equilibrium with one another at a temperature of 23.0 ±5.0°C (73.4 ±9°F) throughout the test.

23.6 The center strip of one of the specimens is to be placed between the electrodes with the electrodes exerting a 1 lbf or 4.45 N or 454 g-f on the tape. A 48 to 62 Hz essentially sinusoidal rms potential is to be applied to the electrodes at the rate of 500 V/s, starting near zero and continuing until the tape breaks down. The potential is to be obtained from a transformer whose output is continuously variable by power-driven means and is continuously monitored by a voltmeter that is connected in the output circuit and directly and accurately indicates the potential being applied to a specimen. The breakdown voltage is to be divided by the average thickness of the tape (backing plus adhesive).

23.7 The procedures in 23.6 are to be repeated for the remaining four specimens. The tape is not acceptable if the average of the dielectric strengths determined for the five specimens is less than indicated in 23.1.

MARKINGS

24 General

24.1 Insulating tape, the wrapper or carton containing a single roll of tape, or the central paper core on which the tape is wrapped shall be marked with:

a) The manufacturer's name or trademark. A private labeler may also be identified;

b) The catalog or type number or other designation;

c) If the organization that is responsible for the tape produces tape at more than one factory, the marking shall include a distinctive marking – which may be in code – by means of which the tape can be identified as the product of a particular factory; and

d) The words ″For use at not more than 600 V and at not more than 80°C (176°F),″ or an equivalent statement.

24.2 Insulating tape, the wrapper or carton containing a single roll of tape, or the central paper core may be marked:

a) May be marked ″Flame retardant″ if the tape complies with the requirements in 6.1;

b) May be marked ″Sunlight resistant″ if the tape complies with the requirements in 7.1; or

c) May be marked ″Flame retardant and sunlight resistant″ if the tape complies with the requirements in 6.1 and 7.1.

Revised 24.2 effective August 12, 2006

24.3 Thermoplastic insulating tape, the wrapper or carton containing a single roll of tape, or the central paper core may be marked ″cold and sunlight resistant ″ if the tape complies with the requirements in 7.1 and 14.1. The markings may be combined with those mentioned in 24.2.

Revised 24.3 effective August 12, 2006

APPENDIX A

Standards for Components

Standards under which components of the products covered by this standard are evaluated include the following:

Title of Standard − UL Standard Designation

Polymeric Materials – Short Term Property Evaluations – UL 746A

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Superseded requirements for
the Standard for
Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape

UL 510, Eighth Edition

The requirements shown are the current requirements that have been superseded by requirements in revisions issued for this Standard. To retain the current requirements, do not discard the following requirements until the future effective dates are reached.

7 Weatherability Test

7.1 Insulating tape marked ″weather resistant″ in accordance with 24.2 shall retain at least 65 percent of its original average tensile strength and elongation after being conditioned for 100 hours.

14.1 A thermoplastic insulating tape marked ″cold and weather resistant ″ in accordance with 24.3 shall not show any cracks, transfer of adhesive, or loss of tack in the adhesive to make the tape unfit for insulating splices, after having been subjected to a temperature of minus 10.0 ±2.0°C (plus 14.0 ±3.6°F) for 2 hours.

24.2 Insulating tape, the wrapper or carton containing a single roll of tape, or the central paper core may be marked:

a) May be marked ″Flame retardant″ if the tape complies with the requirements in 6.1;

b) May be marked ″Weather resistant″ if the tape complies with the requirements in 7.1; or

c) May be marked ″Flame retardant and weather resistant″ if the tape complies with the requirements in 6.1 and 7.1.

24.3 Thermoplastic insulating tape, the wrapper or carton containing a single roll of tape, or the central paper core may be marked ″cold and weather resistant ″ if the tape complies with the requirements in 7.1 and 14.1. The markings may be combined with those mentioned in 24.2.

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