UL 1839

STANDARD FOR SAFETY

Automotive Battery Booster Cables

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UL Standard for Safety for Automotive Battery Booster Cables, UL 1839

Second Edition, Dated August 31, 2016

Summary of Topics

This revision of ANSI/UL 1839 dated December 16, 2021 includes a change in the instruction requirements to allow tag markings in lieu of marking on packaging: 14.1

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 revised requirements are substantially in accordance with Proposal(s) on this subject dated November 12, 2021.

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ANSI/UL 1839-2021

UL 1839

Standard for Automotive Battery Booster Cables

First Edition – December, 2005

Second Edition

August 31, 2016

This ANSI/UL Standard for Safety consists of the Second Edition including revisions through December 16, 2021.

The most recent designation of ANSI/UL 1839 as an American National Standard (ANSI) occurred on December 16, 2021. 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 battery booster cable sets used for providing a temporary connection of a surface vehicle battery of up to 24 volts to another similar battery to provide emergency starting power when required. These battery booster cable sets are designated as general use booster cables sets and service booster cable sets.

1.2 These requirements do not cover wiring or cabling intended for connection of electrical systems in a vehicle or for wiring or cabling used in the recharging function of electric vehicle recharging equipment.

2 Units of Measurement

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

3 Components

3.1 Except as indicated in 3.2, a component of a product covered by this standard shall comply with the requirements for that component.

3.2 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.

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

3.4 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.

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.

5 Glossary

5.1 For the purpose of these requirements the following definitions apply. The term booster cable is used to represent both general use booster cable sets and service booster cables sets.

5.1A BOOSTER CABLE SET, GENERAL USE – a cable set that consists of clamps at both ends for temporary connection to a supply battery and a depleted battery. The cable set may be provided with a middle connector.

5.1B BOOSTER CABLE SET, SERVICE – a cable set that consists of clamps at one end for temporary connection to the depleted battery but provided with terminations that are permanently connected to the supply battery. A middle connector is required to be provided for disconnection of the clamp side of the cable set when not in use.

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5.2 CLAMP – Device located at both ends of the booster cable which contains the jaw ends, connectors, and handles, which are used to make the connections to the battery.

5.3 CONDUCTORS – Wiring used in the booster cable.

5.4 CONNECTORS – Portion of the clamp that contacts the battery terminals.

5.5 INSULATION – Protective covering of the conductors, cable, and clamps.

5.6 JAW END – Portion of the clamp that opens in order to accommodate the battery terminals.

5.7 MIDDLE CONNECTOR – A connector located in the middle of the cable that is disconnected prior to the clamps being connected to the vehicle batteries and then used to complete the connection once the clamps are connected to the respective battery terminals.

5.8 TERMINATION – a connector that is affixed to the wire of a cable set and used to connect to the battery terminals of a supply battery.

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CONSTRUCTION

6 Cable and Clamps

6.1 Conductors shall be of copper per the Standard Specification for Soft or Annealed Copper Wire, ASTM B3; or the Standard Specification for Soft or Annealed Copper Wire for Electrical Purposes, ASTM B33; or copper clad aluminum per the Standard Specification for Copper-Clad Aluminum Wire, ASTM B566. The conductors shall comply with the specifications in Table 6.1 and the applicable tests for cables in Section 7.

Table 6.1
Conductor constructions

SAE wire[a] size	Metric wire[b] Size (mm^2)	Minimum conductor area for finished cable		No. strands/gage	Strand diameter	
		Cir. mil.	(mm^2)		in	(mm)
10	(6)	9343	(4.65)	19/23	0.0226	(0.574)
8	(10)	14810	(7.23)	19/21	0.0285	(0.724)
6	(16)	24538	(12.1)	37/21	0.0285	(0.724)
4	(25)	37360	(18.3)	61/22	0.0253	(0.643)
2	(35)	62450	(31.1)	127/23	0.0226	(0.574)
1	(50)	77790	(38.1)	127/22	0.0253	(0.643)
0	(50)	98980	(48.3)	127/21	0.0285	(0.724)
2/0	(70)	125100	(59.8)	127/20	0.0320	(0.813)
3/0	(95)	158600	(77.6)	259/22	0.0253	(0.643)
4/0	(120)	205500	(98.5)	427/23	0.0226	(0.574)

[a] The SAE wire size number indicates that the cross sectional area of the conductors approximates the area of the American Wire Gage for equivalent sizes.

[b] The metric wire size shown is the next larger standard metric wire size (except for the size shown for the 1/0) for the SAE wire size. Note that the mm^2 for each type is the same number as the metric wire size i.e., a metric wire size of 6 is 6 mm^2. The metric dimensions are not the direct conversion from the circular mils.

Note: Stranding other than those shown for SAE and metric wire sizes are not prohibited when they meet the minimum conductor area specifications in Table 6.1.

6.2 The conductor insulation material shall be thermoplastic or a thermoset with a minimum average insulation thickness of not less than 1.5 mm (0.06 in) for 10 – 2 AWG (6 – 35 mm^2) wire and 2.0 mm (0.08 in) for 1 – 4/0 AWG (50 – 120 mm^2) wire. A separator shall be used between uncoated conductors and insulations with a sulfur cure. Separators are optional for other constructions.

6.3 The booster cable set shall not be less than 3700 mm (12 ft) in length, measured from jaw-end to jaw-end.

6.4 The conductors of a booster cable set employing parallel conductors shall be separated at each end to allow the jaw ends of the clamps to span a minimum distance of 920 mm (3 ft).

6.5 The cable insulation shall resist mechanical abuse that is encountered during use and storage. In addition, the cables shall be capable of being flexed under wide temperature fluctuations. Cables shall be tested in accordance with Section 7.

6.6 Clamps shall be constructed using a metallic substrate with integral insulation coating or using a complete nonmetallic construction. For nonmetallic constructions, the material shall have a minimum flame rating of HB. The insulating coating or the nonmetallic material shall comply with the applicable tests as outlined in Section 8.

6.7 General use booster cables shall be provided with clamps on both ends of the booster cable assembly. Service booster cables shall be provided with clamps on one end of the cable set and terminations that allow permanent connection to a battery on the opposite end. A suitable middle connector is required for all service booster cables.

6.8 When terminations are provided, they shall be suitably rated for the conductor type and ampacity of the booster cable assembly and they shall be suitable for the wire size involved. Terminations shall be in accordance with UL 486A-486B, Wire Connectors.

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PERFORMANCE

7 Cable

7.1 Deformation test

7.1.1 Specimens of insulation from thermoplastic insulated cable are to be subjected to the load indicated in Table 7.1 while being maintained at a temperature of 121°C ±1.0°C (249.8°F ±1.8°F). Insulation thickness shall not be decreased more than 50 percent.

Table 7.1
Specimen loading

Size of conductor	Load exerted on a specimen by pressor foot[a]	
	grams-Force	N
10	500	4.90
8 – 1	750	7.36
1/0 – 4/0	1000	9.81

[a] The specified load is the weight of the spindle and the added weight to the spindle.

7.1.2 For the 10 – 4/0 AWG sizes of thermoplastic-insulated, thermoset-insulated, or other wire, the insulation thickness T_1 is to be determined from measurements made at a marked position on a 25 mm (1 in) length of the finished, insulated conductor. The diameter D_1 over the insulation is to be measured to the nearest 0.01 mm (0.001 in) by means of a dead-weight dial micrometer whose presser foot puts a load of 0.84 ±0.02 N or 85 ±2 gf on the specimen. The presser foot is to have a flat, round face whose diameter is 6.4 ±0.2 mm (0.250 ±0.010 in). The anvil of the instrument is to be round, at least 38 mm (1.5 in) in diameter, and is to be parallel to the face of the presser foot. The diameter d over the conductor, or over the separator, is to be measured by means of the same dial micrometer. The thickness T_1 is then calculated to the nearest 0.01 mm (0.001 in) from the formula:

$$T_1 = \frac{D_1 - d}{2}$$

7.1.3 The insulated conductors of a parallel cord are to be separated. The insulation thickness T_1 of an insulated conductor from a parallel or jacketed cord or from a fixture wire is to be determined as indicated in 7.1.2 from measurements made at a marked position on a 25 mm (1 in) length of insulated conductor from the finished flexible cord or fixture wire.

7.1.4 The apparatus for this test is illustrated in Figure 7.1 . The apparatus is to be of brass and is to consist of three rods that are free to move vertically in a support frame. The assembly is to be constructed for use in a heated oven. Each rod is to be straight and 19.0 ±0.2 mm (0.75 ±0.010 in) in diameter. The weight of each rod is to be 250 g (8.8 oz). The lower end of each rod is to be reduced in diameter to 9.5 ±0.2 mm (0.375 ±0.010 in) or for the final 19 mm (3/4 in) or length of the rod. The lower end of the reduced-diameter section is to be flat, round, without sharp edges, and both concentric with and perpendicular to the longitudinal axis of the rod. The lower end of the reduced section is to serve as the foot that presses on a specimen during a test. The force on the specimen is to be the sum of the force exerted by the rod (2.45 N or 250 gf) plus that of any weight to be placed on the upper end of the rod to make the total force equal the load specified in Table 7.1. Each weight is to be indent stamped with its exact weight.

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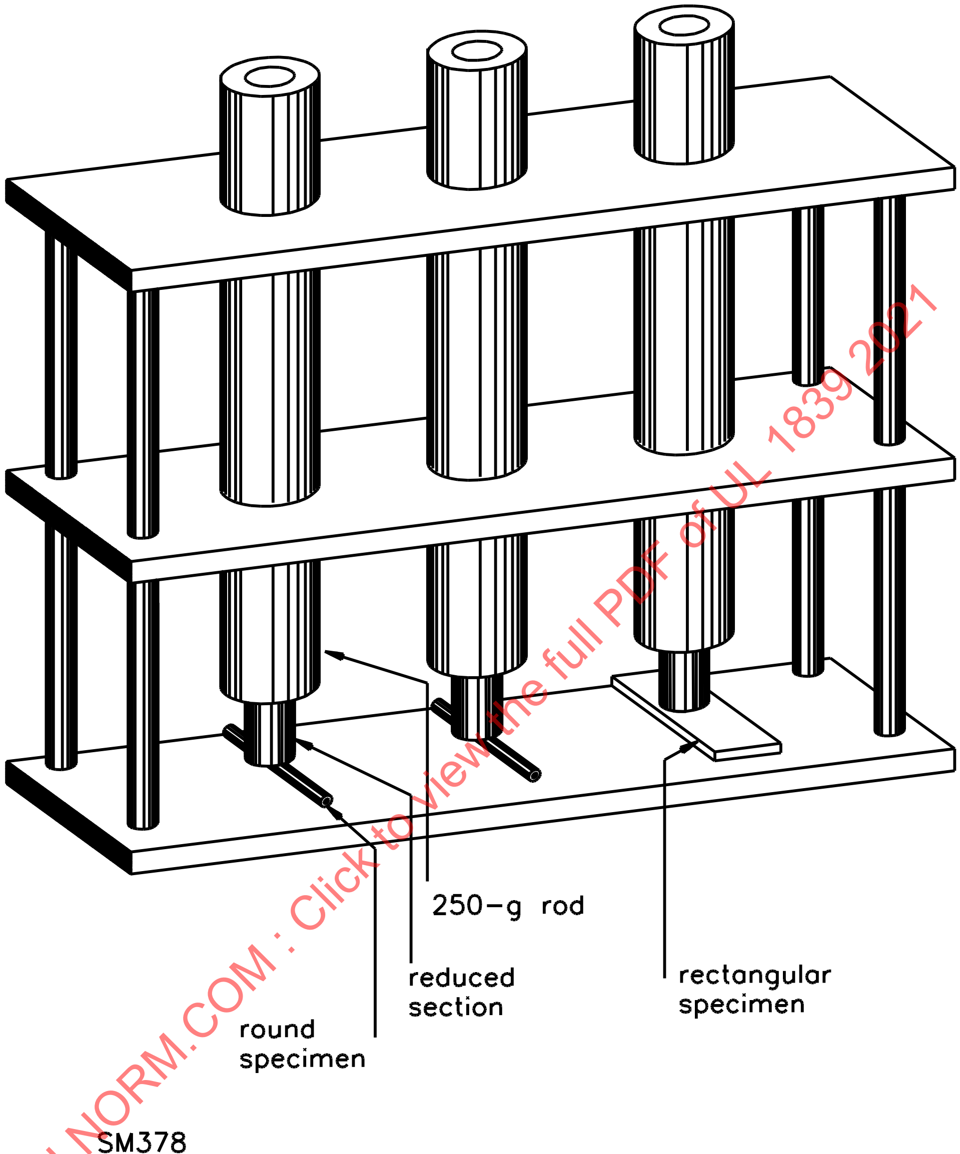
Figure 7.1

Deformation test apparatus with specimens in place



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Added weights are not shown

7.1.5 The frame is to consist of three flat, rectangular plates spaced 57 mm (2-1/4 in) apart (vertical separation) and parallel to one another in a rigid assembly. The dimensions of the plates are to be the same (plates measuring 216 by 70 by 6 mm (8-1/2 by 2-3/4 by 1/4 in) are typical). The upper surface of the lower plate is to be the surface against which each rod presses a specimen during a test. That surface is to be horizontal during a test. That surface is to be smooth (the surface is to be refinished when repeated testing indents the surface or makes it rough to the touch). Identically located holes are to be provided through the center and upper plates to serve as guides and supports for the rods, which are to be free to move vertically and not otherwise. The diameter of each hole is to be larger than the 19 mm (3/4 in) diameter or diameter portion of a rod for clearance of vertical movement of a rod in the hole. Horizontal separation between the rods is to enable weights to be in place on all three rods at the same time with a clearance between the weights. Each rod is to project a distance above the upper plate that enables a weight to be placed on the upper end of the rod without the weight touching the upper plate while the rod is resting on the lower plate (no specimen under the rod). Means integral with the frame is to keep the frame above the floor of the oven and stable during a test.

7.1.6 With the applicable weight in place on each rod that is to be used for a test, the apparatus is to be placed beside one or more test specimens in an air oven (a dead air, full draft, or internal fan oven is appropriate) that has been preheated to a temperature of 150°C ±1°C (300°F ±2°F) for specimens from wire or cord with Class 36 TPE insulation or jacket, 100°C ±1°C (212 ±2°F) for specimens of Class 30 PE insulation, 136°C ±1°C (277°F ±2°F) for specimens from Type THHN wire, and 121°C ±1.0°C (249.8°F ±1.8°F) for all other specimens. The specimens and the loaded apparatus are to remain side by side in the oven for 60 minutes of preliminary heating at full draft. At the end of the 60 minutes, one rod is to be lifted and a specimen is to be centered under it. The loaded rod is to be lowered and gently bear on the specimen at the marked location. The rod is to continue to bear on the specimen while the apparatus and the specimen remain in the oven for an additional 60 minutes. The entire surface of the foot of the rod is to be in contact with any specimen that is rectangular.

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7.1.7 At the end of the second 60 minutes, the rod is to be lifted and the specimen under it is to be removed. The specimen diameter (round specimen) or thickness (rectangular specimen) is to be measured for determination of the specimen thickness T_2 to the nearest 0.01 mm (0.001 in). The measurement is to be made at the marked position in the same was as the specimen was measured for determining T_1. In the case of a round specimen, the diameter d over the conductor or any separator is not to be remeasured – that is in the calculation of T_2 it is appropriate to use the measured value of d that was used in calculating T_1. To minimize the time the specimen has to recover before its deformed diameter or thickness is measured, measurement is to be made in a short time after the rod is lifted. Where more than 15 seconds elapses between the time at which the rod is lifted and the time of measurement, the specimen is to be discarded and the test is to be repeated with a new specimen. The percent deformation is to be calculated for the specimen from the following formula and compared with the maximum deformation stated in 7.1.1:

$$Deformation\ \ in\ \ percent = \frac{100 \times (T_1 - T_2)}{T_1}$$

7.1.8 Where the calculation for the single specimen shows a greater deformation that the maximum stated in 7.1.1, the test is to be repeated using three new specimens. At the end of the second 60 minutes, these three specimens are not to be removed from under the rods at the same time. Instead, the procedure of lifting the rod, removing the specimen, and quickly making the measurement is to be followed for each specimen in turn. Each of the three specimens is to show a deformation equal to or less than the maximum stated in 7.1.1.

7.1.9 In the event that a single round specimen containing a stranded conductor deforms more than stated in 7.1.1, it is appropriate to conduct a test using a single new specimen in which the stranded conductor has been replaced with a solid conductor of a diameter that fits snugly inside the insulation and not tightly enough to stress the tube of the insulation. A test is not to be made on an insulation into which a solid conductor has been inserted to replace the original stranded conductor without there first being non-compliance of that insulation tested with the stranded conductor in place – that is, a stranded conductor is to be replaced with a solid conductor for referee testing only. Where a single referee specimen shows a greater deformation than the maximum stated in 7.1.1, the referee testing is to be repeated as described in 7.1.8 using three new specimens in which the conductor has similarly been replaced. Each of the three new referee specimens is to comply.

7.2 Heat shock test

7.2.1 Cables employing thermoplastic insulation shall be subjected to the Heat shock test described in 7.2.2.

7.2.2 A specimen of finished wire is wound around a mandrel having a diameter as specified in Column A of Table 7.2. The specimen is wound in a U bend with the specimen in contact with the mandrel, for not less than 180 degrees, and held in place. Once wound, the specimen, and the mandrel, are then subjected to a temperature of 121°C ±1.0°C (249.8°F ±1.8°F) in an oven for 1 hour.

Table 7.2
Mandrel diameters

Size of conductor	A (Heat shock)		B (Room temperature and cold bend)	
	in	(mm)	in	(mm)
10 AWG	0.168	(4.27)	0.563	(14.30)
8	0.228	(5.79)	0.688	(17.48)
6	0.646	(16.41)	1.250	(31.75)
4	0.744	(18.90)	1.375	(34.93)
2	0.866	(22.00)	1.563	(39.70)
1	1.016	(25.81)	2.688	(68.28)
1/0	1.098	(27.89)	2.875	(73.03)
2/0	1.190	(30.23)	3.000	(76.20)
3/0	1.294	(32.87)	3.250	(82.55)
4/0	1.410	(35.81)	3.500	(88.90)

7.2.3 Insulation shall not show any cracks on the inside or outside surface after the test.

7.3 Cold bend test

7.3.1 Samples of the cable shall be subjected to the Cold bend test described in 7.3.2.

Exception: A temperature of minus 25°C ±2°C (minus 13°F ±4°F) used for a temperature rating of minus 25°C (minus 13°F) is an alternate temperature to minus 40°C (minus 40°F) when the cables are marked as specified in 12.1(d).

7.3.2 The specimens and the appropriate mandrel, as specified in Table 7.2, are cooled for a period of 4 hours at a specified temperature. After this cooling period, the specimens are wound onto the mandrel for six complete turns. The winding is to be done at a rate of about 3 seconds per turn, and successive turns are to be in contact with one another. The test is to be performed in the cold chamber where space and mounting means are available in the chamber. Where this is not practical, it is appropriate to remove a specimen and a mandrel from the test chamber and perform the test outside the chamber. In either case, the winding is to be completed within 30 seconds of the time that the cold chamber is opened.

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7.3.3 The temperature for this test shall be minus 40°C ±2°C (minus 40°F ±4°F) in order for the temperature rating to be minus 40°C (minus 40°F).

7.3.4 There shall be no evidence of cracks on the inside or outside surfaces after the test has been completed.

7.4 Crushing resistance and abrasion test

7.4.1 General

7.4.1.1 Crushing resistance and abrasion resistance tests as described in Sections 7.4.2 and 7.4.3 respectively apply to cables having thermoplastic insulation. Following the test samples shall be subjected to the Dielectric voltage-withstand test in Section 7.7.

7.4.2 Crushing resistance test

7.4.2.1 The cable is to be crushed between flat, horizontal steel plates in a compression machine whose jaws close at a rate of 10 ±1 mm/min (0.50 ±0.05 in/min). Each plate is to be 50 mm (2 in) wide.

7.4.2.2 The cable is to be tested both flat and edgewise.

7.4.2.3 The cable, the apparatus, and the surrounding air are to be in thermal equilibrium with one another at a temperature of 23°C ±5°C (73°F ± 9°F) throughout the test.

7.4.2.4 The insulated circuit conductors and the two steel plates are to be connected to low-voltage indicators (buzzers or similar devices) and to power supplies for the purpose of indicating a short circuit between circuit conductors or between any circuit conductor and the steel plates. The grounding conductor in the test length of the cable is to be out of the circuit.

7.4.2.5 The cable is to be tested in a continuous length of at least 2540 mm (100 in), with the cable being advanced to and crushed at ten points along the length. The first test is to be conducted 230 mm (9 in) from one end of the test length and the nine remaining tests are to be conducted at succeeding intervals of at least 230 mm (9 in) down the length of the cable. The average of the ten crushing trials is to be calculated and recorded.

7.4.2.6 The upper steel plate in the compression machine is to be raised several cable diameters above the lower plate, and the cable at the first test point in to be placed and held on the lower plate with the longitudinal axis of the cable horizontal, perpendicular to the longitudinal axes of the plates, and in the vertical plane that laterally bisects the plates. The upper steel plate is to be moved down until it is snug against the cable. The downward motion of the plate is then to be continued at the rate of 10 ±1 mm/min (0.50 ±0.05 in/min) increasing the force on the cable until one or more of the indicators signal that contact has occurred between the circuit conductors or between one or more of the circuit conductors and ground. The force indicated by the dial on the compression machine at the moment of contact is to be recorded.

7.4.2.7 The average of the ten crushing trials shall not be less than 1.33 kN (300 lbs) for flat crushing force and 2.67 kN (600 lbs) for edgewise crushing force.

7.4.3 Abrasion resistance test

7.4.3.1 A cable shall not wear through exposing the underlying protective sheath or conductor assembly in fewer than 70 complete cycles of abrasion against sharp steel edges. The test is to be conducted as described in 7.4.3.2 – 7.4.3.5.

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7.4.3.2 Six straight untwisted 380 mm (15 in) specimens are to be cut from a sample length of cable. They are to be laid flat and parallel to one another on a flat horizontal steel plate and are to be individually secured in place at their ends. An abrasion tool consisting of a weighted solid steel right-circular cylinder across one face of which three straight parallel teeth are machined symmetrically about a diameter (see Figure 7.2) is to be supported above (not touching) the center of each specimen with its teeth perpendicular to the longitudinal axis of the specimen. The support is to minimize the play of the tool at the ends of each stroke during the abrasion process.

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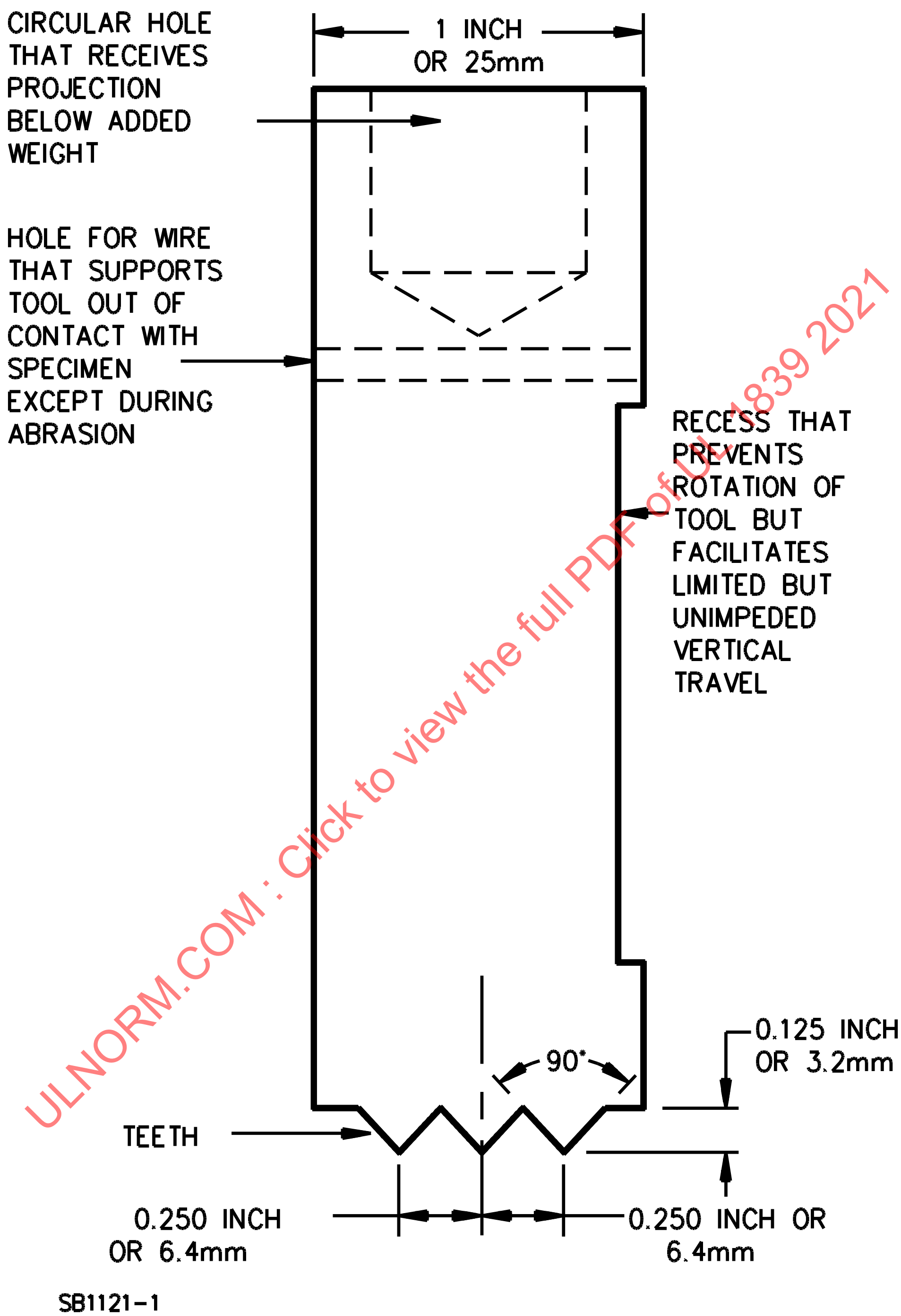
Figure 7.2

Essentials of cylindrical abrasion tool



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Die-and-tool steel alloy KW hardened after machining to Rockwell C 62. The teeth are to be sharpened to an edge having no burrs every 1600 – 2500 cycles. The hardness is to be checked after each sharpening and, if necessary, the teeth are to be rehardened. The abrasion tools are to be used and resharpened in sets. Hence, at least two sets of six are needed.

7.4.3.3 The plate on which the specimens are mounted is to be made to reciprocate horizontally in simple harmonic motion at 30 cycles per minute in the direction parallel to the longitudinal axes of the specimens. The stroke is to center on the abrasion tools, and the length of stroke is to be the 150 mm (6 in) occupying the center portion of the specimens.

7.4.3.4 The test is to be started with the plate on which the specimens are mounted at rest at either end of the stroke and the stroke counter set at zero and for the beginning of a cycle. Weight is to be added to the top of each of the abrasion tools to make the combination of each tool and its added weight exert downward 13.34 ±0.14 N or 1.36 ±0.01 kgf. The abrasion tools are to be lowered gently onto the specimens and the plate is to be started reciprocating immediately. The action is to be continued without interruption until one or more of the tools wear through the outer covering on the cable or until 70 full cycles have been completed without any tool wearing through. An operator is to be present throughout the test to observe the wear, brush away accumulations of debris during the test that might influence the abrading action of the tools in subsequent tests, and to notice and record the number of strokes at which the cable on each specimen wears through if it wears through.

7.4.3.5 The insulation on one or more of the specimens shall not be worn through in fewer than 70 complete cycles.

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7.5 Chemical exposure

7.5.1 Samples of the cable are to be subjected to:

a) A 7 day vapor exposure of a solution of dilute sulfuric acid having a specific gravity of 1.2 at 38°C (100°F). The samples shall be placed in a 38°C ±2°C (100°F ±4°F) ambient.

b) 40 hour immersion in IRM 903.

c) 40 hour immersion in ASTM Reference Fuel C.

Following these exposures, the samples shall be subjected to the Dielectric voltage-withstand test in Section 7.7.

7.6 Water absorption

7.6.1 Samples of the cable are to be subjected to the conditions described in the Standard Test Method for Water Absorption of Plastics, ASTM D570 (ISO 2896). The maximum absorption of moisture shall not exceed 1 percent.

7.6.2 Three samples are to be used for this test. Specimen forms and dimensions may vary according to the size and shape of the sample.

7.6.3 The percentage increase in weight is to be calculated from the data recorded.

7.7 Dielectric voltage-withstand test

7.7.1 Samples of the cable are to be subjected to this test after the Crushing resistance test, Section 7.4.2, Abrasion resistance test, Section 7.4.3 and Chemical exposure, Section 7.5. The cable is to be wrapped in foil and a 500 volt, 60 Hz potential applied between the conductors and the foil, and also between the two conductors. The test voltage is to be applied for 1 minute. There shall be no evidence of breakdown of insulation.

Exception: The test potential of 500 V ac specified may be replaced by a dc voltage of 707 V.

7.8 Ampacity test

7.8.1 Attach one of the cables of the battery booster cable set to the current source and ammeter.

7.8.2 Thermocouples, consisting of No. 30 iron/constantan wire are to be connected to:

a) The outer surface of the battery booster cable clamp handle;

b) The portion of the clamp between the pivot and the jaw-end; and

c) A chart recorder with 130°C (266°F) maximum reading.

7.8.3 The current is to be increased until either the voltage drop across the cables reaches 2.5 volts or the anticipated ampacity is reached.

7.8.4 After 10 seconds, record either the current (if the voltage drop is set to 2.5 V) or the voltage drop (if the current is set at the anticipated ampacity).

7.8.5 After 25 seconds, the current is to be turned off.

7.8.6 The temperatures of the clamp are to be monitored for an additional two minutes and the maximum temperatures are to be recorded. Table 7.3 specifies the maximum temperature rises.

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Table 7.3
Maximum surface temperature rises on clamp

Location	Composition of surface			
	Metallic		Nonmetallic	
Area between pivot and jaw-ends of clamp	45°C	(81°F)	70°C	(126°F)
Handle portion of clamp – area between pivot and hand ends	25°C	(45°F)	35°C	(63°F)
Note – Maximum surface temperature rise of handles is based on UL Casualty Requirements for carrying and holding handles – SAE J1494 specifies 66°C (150°F) max.				

7.8.7 Repeat the steps in 7.8.1 – 7.8.6 with the other battery booster cable in the set.

7.8.8 When more than one test is run with a cable, it is to be allowed to cool for 15 minutes before retesting.

7.8.9 The rating of the battery booster cable is not to exceed the largest of the test currents that does not produce a total voltage drop greater than 5 V across both conductors of the set or a temperature greater than that specified in Table 7.3 for that conductor.

7.9 Cold impact test

7.9.1 Samples of the cable are to be subjected to a temperature of minus 25°C ±2°C (minus 13°F ±4°F) for 4 hours. The cable is then to be impacted by a 2.27 kg (5 lb) weight dropped from a height of 610 mm (2 ft). The samples are to be checked for signs of cracking. There shall be no evidence of cracking.

7.10 Flame test

7.10.1 Samples of the cable are to be subjected to the Resistance to flame propagation test described in the Standard for Low Voltage Battery Cable, SAE J1127.

7.11 Temperature rating

7.11.1 The temperature rating of the cable insulation is to be determined by the method described in the Standard for Battery Booster Cables, SAE J1494. The rating shall be not less than 60°C (140°F) and the cable insulation shall retain at least 80 percent of its yield strength and the elongation shall be at least 50 percent of its original elongation.

8 Clamps

8.1 General

8.1.1 When making connections to a battery with a set of battery booster cables, complete insulation of the jaw and handle portion of the clamp assembly as described in 8.1.2, is required to reduce the risk of shock.

8.1.2 The handle and jaw portion of the clamp assembly shall be insulated from the connector which makes contact with the battery terminals. The connector contacts shall be recessed so that they do not contact a straight edge placed across the recessed area surrounding the contacts. The integrity of integrally coated metal clamp assemblies is to be judged as described in 8.1.3.

8.1.3 The acceptability of integrally coated metal clamps shall be determined by subjecting samples of the clamp assemblies to each of the conditions described in Sections 8.2 – 8.8. The acceptability of nonmetallic clamps shall be determined by subjecting samples of the clamp assemblies to each of the conditions described in Sections 8.2 – 8.8, with the exception of the abrasion test in Section 8.6 which is not required.

8.1.4 Metal parts, such as assembly rivets, clamp springs, and similar parts, shall be insulated from the connectors and comply with 8.1.5, or they shall be recessed so that the user cannot contact the metal part in accordance with 8.1.6.

8.1.5 When the assembly rivet, clamp spring, or similar part is insulated from the connector, the insulation shall comply with the Dielectric voltage-withstand test, Section 8.8.

8.1.6 When the assembly rivet, clamp spring, or similar part is recessed to avoid user contact, the part shall not be contacted by the tip of the probe shown in Figure 8.1 when inserted from any angle.

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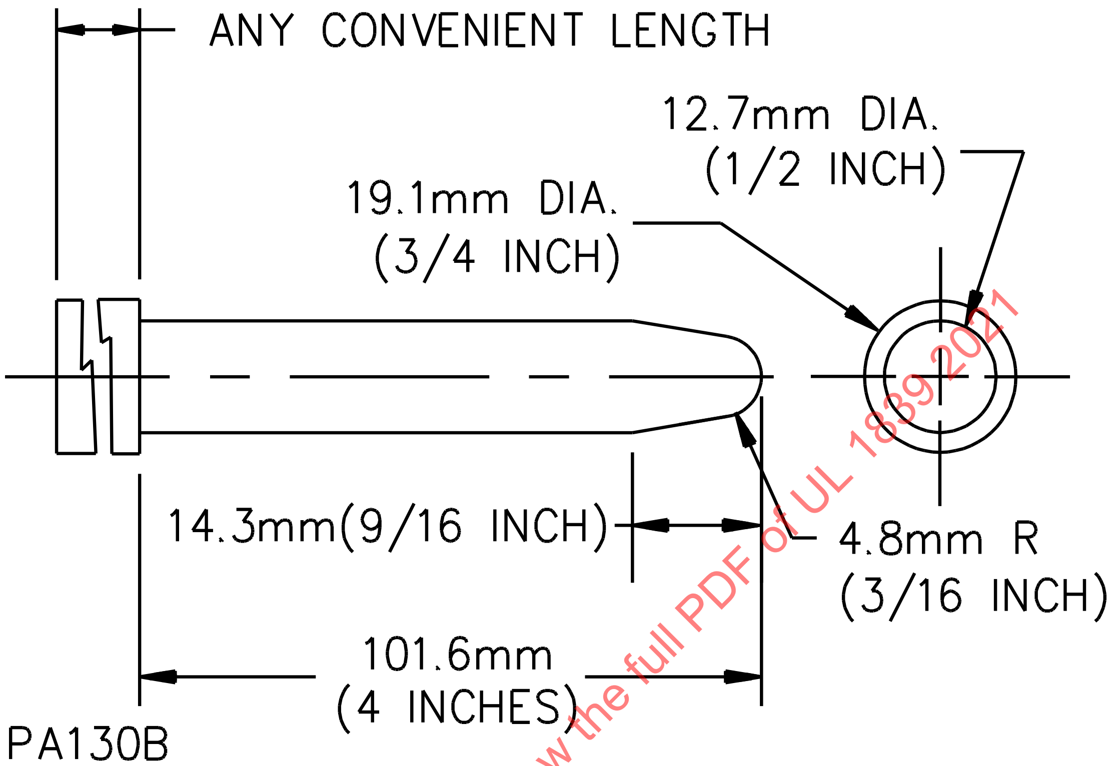
Figure 8.1

Straight probe



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8.1.7 Batteries that are provided as part of the clamp shall be suitable for the application and be of the coin or button cell type. The overall voltage shall be 12 V or less. The batteries shall be contained within a battery compartment to protect the cells. Retention of the batteries shall be in accordance with the requirements in Products Incorporating Button or Coin Cell Batteries of Lithium Technologies, UL 4200A, with the exception that the Pre-conditioning parameters are replaced with the Aging test in this document and the drop test is replaced by the drop test in this document.

8.1.8 The battery compartment indicated in 8.1.7 shall be complete with no openings and shall be formed of plastic that complies with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, and has flame rating of HB minimum.

8.2 Cold drop

8.2.1 Three samples of the insulated clamp are to be subjected to a low-temperature exposure consisting of minus 40°C ±2°C (minus 40°F ±4°F) for one hour. The samples are then dropped 1500 mm (5 ft) onto a concrete surface. The low temperature exposure shall be minus 40°C ±2°C (minus 40°F ±4°F) for a rating of minus 40°C. Following this exposure, the samples are to be subjected to the Dielectric voltage-withstand test in Section 8.8. If batteries are provided with the clamps, the batteries shall be removed for this test.

Exception: A low temperature exposure of minus 25°C ±2°C (minus 13°F ±4°F) used for a temperature rating of minus 25°C (minus 13°F) is an alternate temperature to minus 40°C (minus 40°F) when the clamps are marked as specified in 12.1(d).

8.2.2 Following exposure to this condition:

a) There shall not be significant deterioration of physical properties of the integrally coated insulation as determined by a visual examination for the presence of cracks, peeling, deformation, eroding, excessive wear, or other imperfections of the insulating material that result in exposing the surface of the metal clamp.

b) There shall not be significant deterioration of physical properties of the nonmetallic clamp material as determined by a visual examination for the presence of cracks, peeling, deformation, eroding, excessive wear, or other imperfections of the insulating material that result in exposing conductive parts. Additionally, the clamp shall continue to comply with 8.1.2.

c) When batteries are provided with the clamps, there shall be no damage or deterioration to the battery compartment that would allow the coin/button batteries to be expelled or allow access to the batteries.

8.3 Aging

8.3.1 Three samples of the insulated clamp are to be subjected to an elevated temperature exposure for seven days at 100°C ±2°C (212°F ±4°F). Following this exposure, the samples are to be subjected to the Dielectric voltage-withstand test in Section 8.8. If batteries are provided with the clamps, the batteries shall be removed for this test.

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8.3.2 Following exposure to this condition:

a) There shall not be significant deterioration of physical properties of the integrally coated insulation as determined by a visual examination for the presence of cracks, peeling, deformation, eroding, excessive wear, or other imperfections of the insulating material that result in exposing the surface of the metal clamp.

b) There shall not be significant deterioration of physical properties of the nonmetallic clamp material as determined by a visual examination for the presence of cracks, peeling, deformation, eroding, excessive wear, or other imperfections of the insulating material that result in exposing conductive parts. Additionally, the clamp shall continue to comply with 8.1.2.

c) When batteries are provided with the clamps, there shall be no damage or deterioration to the battery compartment that would allow the coin/button batteries to be expelled or allow access to the batteries.

8.4 Water absorption

8.4.1 Three samples of the clamp are to be subjected to the conditions described in the Standard Test Method for Water Absorption of Plastics, ASTM D570 (ISO 2896). The maximum absorption of moisture is not to exceed 1 percent.

8.4.2 The percentage increase in weight is to be calculated from the data recorded.

8.4.3 Following exposure to this condition:

a) There shall not be significant deterioration of physical properties of the integrally coated insulation as determined by a visual examination for the presence of cracks, peeling, deformation, eroding, excessive wear, or other imperfections of the insulating material that result in exposing the surface of the metal clamp.

b) There shall not be significant deterioration of physical properties of the nonmetallic clamp material as determined by a visual examination for the presence of cracks, peeling, deformation, eroding, excessive wear, or other imperfections of the insulating material that result in exposing conductive parts. Additionally, the clamp shall continue to comply with 8.1.2.

8.5 Acid exposure

8.5.1 Three samples of the insulated clamp are to be subjected to a seven-day vapor exposure of a solution of dilute sulfuric acid having a specific gravity of 1.2 at 38°C (100°F). The samples and solution are to be placed in a 38°C ±2°C (100°F ±4°F) ambient. Following this exposure, the samples are to be subjected to the Dielectric voltage-withstand test in Section 8.8. If batteries are provided with the clamps, the batteries shall be removed for this test.

8.5.2 Following exposure to this condition:

a) There shall not be significant deterioration of physical properties of the integrally coated insulation as determined by a visual examination for the presence of cracks, peeling, deformation, eroding, excessive wear, or other imperfections of the insulating material that result in exposing the surface of the metal clamp.

b) There shall not be significant deterioration of physical properties of the nonmetallic clamp material as determined by a visual examination for the presence of cracks, peeling, deformation, eroding, excessive wear, or other imperfections of the insulating material that result in exposing conductive parts. Additionally, the clamp shall continue to comply with 8.1.2.

c) When batteries are provided with the clamps, there shall be no damage or deterioration to the battery compartment that would allow the coin/button batteries to be expelled or allow access to the batteries.

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8.6 Abrasion test

8.6.1 Six specially prepared samples of the integrally coated insulated clamp are to be subjected to the test conditions described in 8.6.2 – 8.6.5. These samples are to be constructed using a metal substrate of the same material used for the cable clamps and coated with the same insulation as provided on the cable clamps, in the minimum thickness used. The samples of the substrate material are to be 200 mm (8 in) long by 25 mm (1 in) wide; the thickness is not specified.

8.6.2 The samples are to be laid flat and parallel to one another on a flat horizontal steel plate and are to be individually secured in place at their ends. An abrasion tool consisting of a weighted solid steel right-circular cylinder across one face of which three straight parallel teeth are machined symmetrically about a diameter (see Figure 7.2) is to be supported above (not touching) the center of each specimen with its teeth perpendicular to the longitudinal axis of the specimen. The support is to minimize the play of the tool at the ends of each stroke during the abrasion process.

8.6.3 The plate on which the specimens are mounted is to be made to reciprocate horizontally in simple harmonic motion at 30 cycles per minute in the direction parallel to the longitudinal axes of the specimens. The stroke is to center on the abrasion tools, and the length of the stroke is to be the 152 mm (6 in) occupying the center portion of the specimens.

8.6.4 The test is to be started with the plate on which the specimens are mounted at rest at either end of the stroke and the stroke counter set at zero and for the beginning of a cycle. Weight is to be added to the top of each of the abrasion tools to make the combination of each tool and its added weight exert downward 13.34 ±0.14 N or 1.36 ±0.01 kgf. The abrasion tools are to be lowered gently onto the specimens and the plate is to be started reciprocating immediately. The action is to be continued without interruption until one or more of the tools wear through the insulation on the substrate or until 70 full cycles have been completed without any tool wearing through. An operator is to be present throughout the test to observe the wear, brush away accumulations of debris during the test that might influence the abrading action of the tools in subsequent tests, and to notice and record the number of strokes at which the insulation on each specimen wears through if it wears through.

8.6.5 The insulation on one or more of the specimens shall not be worn through in fewer than 70 complete cycles. Also, there shall not be significant deterioration of physical properties of the integrally coated insulation as determined by a visual examination for the presence of cracks, peeling, deformation, eroding, excessive wear, or other imperfections of the insulating material that result in exposing the surface of the substrate.

8.7 Water exposure

8.7.1 Three samples of the clamp are to be immersed in water at 23°C ±2°C (73.4°F ±4°F) for 1 minute. Following this exposure, the samples are to be subjected to the Dielectric voltage-withstand test in Section 8.8.

8.7.2 Following exposure to this condition:

a) There shall not be significant deterioration of physical properties of the integrally coated insulation as determined by a visual examination for the presence of cracks, peeling, deformation, eroding, excessive wear, or other imperfections of the insulating material that result in exposing the surface of the metal clamp.

b) There shall not be significant deterioration of physical properties of the nonmetallic clamp material as determined by a visual examination for the presence of cracks, peeling, deformation, eroding, excessive wear, or other imperfections of the insulating material that result in exposing conductive parts. Additionally, the clamp shall continue to comply with 8.1.2.

8.8 Dielectric voltage-withstand test

8.8.1 Samples of the clamp are to be subjected to this test after the Cold drop, Section 8.2, Aging, Section 8.3, Acid exposure, Section 8.5 and Water exposure, Section 8.7. A 500 volt, 60 Hz potential is to be applied between:

a) The connector and foil wrapped around the handle of the clamp;

b) The connector and the assembly rivet; and

c) The connector and the clamp spring.

Exception No. 1: The test potential of 500 V ac specified may be replaced by a dc voltage of 707 V.

Exception No. 2: Assembly rivets or coil springs recessed against contact in accordance with 8.1.6 are not required to be tested.

8.9 Clamp retention

8.9.1 General

8.9.1.1 The clamp assembly is to be capable of providing a sound mechanical and electrical connection to the point of attachment, such as a battery terminal or a metallic ground. Compliance with this requirement shall be determined by 8.9.1.2 and 8.9.1.3.

8.9.1.2 The clamp is to be subjected to 1,000 cycles of opening the jaws to the maximum opening position, followed by releasing the handles to the at-rest position. Following completion of this test, the sample is to be subjected to the test described in 8.9.1.3.

8.9.1.3 The clamp is to be oriented parallel to a vertical plane and attached to an automotive battery terminal consisting of a 16 ±3 mm (5/8 ±1/8 in) diameter lead post. After the clamp is attached, it is to be

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twisted back and forth 45 degrees about an axis parallel to that of the terminal post. The clamp is not to become dislodged from the battery terminal when the tensile force of 44.5 N (10 lbs) is applied to the cable in any direction parallel to a horizontal plane located above the top of the battery terminal posts at a distance equal to the overall length of the clamp assembly.

8.9.1.4 The cable is to be securely connected to the clamp assembly and meet the requirements of 8.9.1.5 and 8.9.2.1.

8.9.1.5 Each end of the cable connected or joined to the clamp assembly is be able to withstand a tensile force of 445 N (100 lbs), applied along an axial direction to the interface between the cable clamp and the conductor without separating.

8.9.2 Secureness test

8.9.2.1 The connection between the cable and the clamp assembly is to be subjected to the test described in 8.9.2.3.

8.9.2.2 The sample shall be intact after being subjected to the test described in 8.9.2.3 for 30 minutes.

8.9.2.3 The setup is to be as shown in Figure 8.2. The clamp is to be fastened to a length of conductor that is at least 76 mm (3 in) longer than the height specified in Table 8.1. As shown in Figure 8.2, the free end of the conductor is to be passed through a bushing of the size specified in Table 8.1. The bushing is to be attached to an arm driven by a motor in such a manner that the center of the bushing describes a circle in a horizontal plane. The circle is to have a diameter of 76 mm (3 in), and its center is to be vertically below the center of the conductor opening in the clamp. The distance between the upper side of the bushing and the clamp is to be within 12.7 mm (1/2 in) of the distance specified in the column titled Height in Table 8.1. The bushing is to be lubricated to prevent binding, twisting, or rotation of the insulated clamp. A weight as specified in Table 8.1 is to be suspended from the free end of the conductor. The testing machine is to be operated at the rate of 9 revolutions per minute.

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