Subject 486D

June 26, 2009

SUMMARY OF TOPICS

The following changes in requirements to the Standard for Sealed Wire Connector Systems, UL 486D, are being proposed:

1. Relocation of Clause 1.4

2. Test requirements for wire connectors

3. Editorial revisions

4. Clarification for test sequence requirements in Clauses 8.2.1 – 8.8.1

5. Clarification of terminology

6. Editorial clarification of tests referenced in Clause 9.3.1.2

7. Revisions to marking, labeling and packaging

8. Revision to Table 1, Required test sequences

9. Revisions to figures

10. Miscellaneous revisions to Annex B

STP BALLOTS AND ALL COMMENTS DUE: AUGUST 10, 2009

For your convenience in review, proposed additions to existing requirements are shown <u>underlined</u> and proposed deletions are shown ~~lined-out~~.

1. Relocation of Clause 1.4

RATIONALE

Proposal submitted by: Jake Killinger, Underwriters Laboratories

Clause 1.4 adds nothing to the understanding of the standard. It isn't specific as to what general requirements from Part 0 apply. Also UL 486A-486B (Wire Connector) and UL 486C (Splicing Wire Connector) standards do not contain such a statement. UL 467 (Grounding & Bonding) does contain a similar statement, but presents it as a Note under Reference Publications for CSA. As such, paragraph 1.4 will be relocated as a note under Clause 2.2.2, CSA Standards.

PROPOSAL

~~1.4 For products intended for use in Canada, general requirements are given in CAN/CSA-C22.2 No. 0.~~

2.2.2 CSA Standards

Note: For products intended for use in Canada, general requirements are given in CAN/CSA-C22.2 No. 0.

C22.1-02
Canadian Electrical Code, Part I (19th edition) (CEC)

CAN/CSA-C22.2 No. 0-M91 (R2001)
General Requirements – Canadian Electrical Code, Part II

CAN/CSA-C22.2 No. 65-03
Wire Connectors

C22.2 No. 188-04
Splicing Wire Connectors

2. Test requirements for wire connectors

RATIONALE

Proposal submitted by: Jake Killinger, Underwriters Laboratories

Clause 7.1.1 requires the wire connector or splicing wire connector to comply with current cycling, static heating sequence and mechanical sequence of the referenced documents. That would seem appropriate for uninsulated wire connector and splicing wire connector, as well as for insulated wire connector and splicing wire connector used in a sealed wire connector systems, such as a twist-on type. However, insulated types would also need to comply with all other aspects of performance as well such as Dielectric Withstand, Secureness of Insulation, etc.

It also would seem appropriate that a wire connector or splicing wire connector having insulation piercing and or spring action features comply with those requirements as well.

Also there's the cold installation aspect, which would appear to be appropriate for outdoor use products covered by sealed wire connector systems.

These should also comply with all of the performance requirements of wire connector and splicing wire connector standards.

PROPOSAL

7.1.1 A wire connector used in a sealed wire connector system shall comply with the ~~current-cycling, static-heating sequence, and mechanical sequence~~ performance tests, as appropriate, described in UL 486A-486B, CAN/CSA-C22.2 No. 65, or NMX-J-543-ANCE; or in UL 486C, CSA C22.2 No. 188, or NMX-J-548-ANCE, as applicable.

3. Editorial revisions

RATIONALE

Proposal submitted by: Jake Killinger, Underwriters Laboratories

Clause 9.1.1 reads identically to 8.1.1 and both state the sealed wire connector system is hereafter abbreviated as an assembly. No such statement appears in 7.1 although 7.1.2 also uses the term assemblies. Since this is the first such occurrence, add the statement from 8.1.1 and 9.1.1 as a note following 7.1.2 and delete 8.1.1 and 9.1.1.

Clause 8.1.3.1 should not be a sub clause of 8.1.3. The topics having nothing in common. Recommend 8.1.3.1 be relabeled as 8.1.4.

Add missing parenthesis in clause 9.1.3.

Add parenthesis and space in clause 9.1.4.

Similar to clauses 9.5.4.1 and 9.6.3.1, the reference in clause 9.7.3.1 should be to 9.2.3, not 9.2.3.1.

PROPOSAL

7.1.2 A sealed wire connector system shall be subjected to all of the tests in Table 1 and to any additional test sequences in Table 2, as applicable (see 10.3). After subjecting the assemblies to a test sequence, the insulating properties of the covers or the like shall not be adversely affected as determined by the specified tests.

Note: A sealed wire connector system test assembly is hereafter abbreviated as an assembly or assemblies.

~~8.1.1 A sealed wire connector system test assembly is hereafter abbreviated as an assembly or assemblies.~~

~~9.1.1 A sealed wire connector system test assembly is hereafter abbreviated as an assembly or assemblies.~~

~~8.1.3.1~~ 8.1.4 For a sealed wire connector system having multiple cutoff rings consisting of different sizes, the following rings shall be tested:

a) the largest and the smallest sizes, if the number of cutoff rings consists of four sizes or less;

b) the largest, smallest, and one intermediate size, if the number of cutoff rings consist of five sizes; or

c) the largest, smallest, and two intermediate sizes, if the number of cutoff rings consists of more than five sizes.

9.1.3 The preparation of the connector shall be as specified in 10.5 a) and in accordance with UL 486A-486B, CAN/CSA-C22.2 No. 65, or NMX-J-543-ANCE; or in UL 486C, CSA C22.2 No. 188, or NMX-J-548-ANCE, as applicable. Each connector shall have provision for the connection of at least two conductors.

9.1.4 The associated insulating and sealing components shall be assembled in accordance with the manufacturer's instructions. See 10.5 b).

9.7.3 Dielectric withstand

9.7.3.1 Following the hosedown test and while still immersed, the assemblies shall be subjected to a dielectric withstand test as specified in ~~9.2.3.1~~ 9.2.3.

4. Clarification for test sequence requirements in Clauses 8.2.1 – 8.8.1

RATIONALE

Proposal submitted by: Jake Killinger, Underwriters Laboratories

Clauses 8.2.1, 8.3.1, 8.4.1, 8.5.1, 8.6.1, 8.7.1 and 8.8.1 detail the number of samples that need to be prepared, but don't exactly say what to do with these, such as subjecting them to the test in X. Other THC 99 documents state to subject them to the test in clause X. See UL 467, UL 486C, and UL 486A-486B, clause 8. Recommend editorial revision to append such a phrase onto each of these clauses.

PROPOSAL

8.2 Test sequence A, general

8.2.1 Three assemblies shall be prepared with the maximum size wire and three assemblies shall be prepared with the minimum size wire, and the six assemblies shall be subjected to this test sequence.

8.3 Test sequence B, shelf aging

8.3.1 Three assemblies shall be prepared with the maximum size wire and shall be subjected to this test sequence.

8.4 Test sequence C, use aging

8.4.1 Three assemblies shall be prepared with the maximum size wire and shall be subjected to this test sequence.

8.5 Test sequence D, direct burial

8.5.1 Twelve assemblies shall be prepared with the maximum size wire and shall be subjected to this test sequence.

8.6 Test sequence E, rain

8.6.1 Three assemblies shall be prepared with the maximum size wire and three assemblies shall be prepared with the minimum size wire, and the six assemblies shall be subjected to this test sequence.

8.7 Test sequence F, hosedown

8.7.1 Three assemblies shall be prepared with the maximum size wire and three assemblies shall be prepared with the minimum size wire, and the six assemblies shall be subjected to this test sequence.

8.8 Test sequence G, submersion

8.8.1 Three assemblies shall be prepared with the maximum size wire and three assemblies shall be prepared with the minimum size wire, and the six assemblies shall be subjected to this test sequence.

5. Clarification of terminology

RATIONALE

Proposal submitted by: Jake Killinger, Underwriters Laboratories

The document should be consistent in its reference to the area of the product under test scrutiny. It is sometimes referred to as a seal and other times as the joint. Since the title of the standard uses ″Sealed″, it is proposed to replace all occurrences of joint with seal.

PROPOSAL

9.2.5.1 Following the heat-conditioning, the assemblies shall be removed from the air-circulating oven and allowed to cool to room temperature. Each ~~joint~~ seal formed by the insulation cover and the conductor insulation shall be subjected to this test. The insulated conductor shall be securely clamped at a distance (H) equal to:

a) 25 times the diameter of the insulated conductor for 4 AWG (21.2 mm^2) or smaller sizes; or

b) 15 times the diameter for sizes larger than 4 AWG (21.2 mm^2).

The distance shall be measured from the end of the clamp to the ~~joint~~ seal formed by the ~~insulating~~ insulation cover and the conductor insulation. The assembly shall be bent 90 degrees to one side and returned to the starting position, and then bent 90 degrees in the opposite direction and returned to the starting position. This cycle shall be repeated nine more times. Figure 1 illustrates a typical test assembly for a splicing-type connector. Figure 3 illustrates a typical test assembly for a terminal-type connector.

9.5.1.1 The assemblies shall be prepared so that a minimum of 76 mm (3 in) of conductor extends from the ends of the ~~insulating system~~ seal formed by the insulation cover and the conductor insulation. Six assemblies shall be oven conditioned as specified in 9.4.1.1. The other six assemblies shall be cold conditioned at minus 10 ±2 °C (14 ±4 °F) for 2 h.

9.5.2.3 The impact test shall consist of dropping a steel sphere, 51 mm (2 in) in diameter and with a mass of 0.54 kg (1.18 lb), onto the assembly from a height of 914 mm (3 ft). Three assemblies subjected to cold conditioning and three assemblies subjected to the heat conditioning shall be impacted on the weakest wall, generally the thinnest wall section. The three remaining assemblies subjected to cold conditioning and the three remaining assemblies subjected to the heat conditioning shall be impacted at the ~~joint where the conductor insulation meets the sealed wire connector system~~ seal formed by the insulation cover and the conductor insulation. See Annex A for a typical impact test apparatus.

9.7.1.1 The components shall be assembled in accordance with the manufacturer's instructions in 10.5. The assembly shall be sprayed by water from a hose having a 25 mm (1 in) inside diameter nozzle that delivers at least 246 l (65 gallons) of water per min. The water stream shall be directed at the assembly from a distance of 3.0 – 3.7 m (10 – 12 ft) and shall be moved along the ~~joints~~ seals or surface at a minimum rate of 1.6 sec/cm (4 sec/in). The duration of the water stream contact with the assembly shall be 5 min.

6. Editorial clarification of tests referenced in Clause 9.3.1.2

RATIONALE

Proposal submitted by: Jake Killinger, Underwriters Laboratories

The order of referenced clauses can be misleading since the numbers do not correlate with the order of testing as dictated by the written text. Propose adding the reference clause number in parenthesis following the written text.

PROPOSAL

9.3.1.2 After being allowed to cool to room temperature, the components shall be assembled to the maximum size wire using the assembly information in 10.5. The assemblies shall then be subjected to the flexing and twisting test (9.2.5), followed by the immersion (9.2.1) and insulation-resistance (9.2.2) tests ~~specified in 9.2.1, 9.2.2, and 9.2.5~~.

7. Revisions to marking, labeling and packaging

RATIONALE

Proposal submitted by: Jake Killinger, Underwriters Laboratories

Clause 10.6 is poorly worded, but the intent is that the special conductor types, when used for testing are to be marked along with the rest of the markings in 10.1. clause 10.2 allows for these markings to be located in a number of places, but all of these are to be in the same location and not split up between the different allowances of 10.2.

In addition, clause 10.1 c) should also allow for the wire combinations in the case of devices such as a twist on connector. See clauses 8.1.2 and 8.1.3 and the splicing wire connector standard.

Lastly, the wire ranges for sealed wire connector systems with cutoff rings would change for each cutoff ring. Propose the addition of a note to 10.1 c) that the wire range needs to be specified for each cutoff ring.

PROPOSAL

10.1 A sealed wire connector system shall be marked with the:

a) manufacturer's name or trademark;

b) catalog number;

c) wire range or wire combinations;

Note: Devices with multiple wire ranges, i.e., cutoff rings, are to clearly identify the wire range for each cutoff ring.

d) voltage rating;

e) operating temperature rating; ~~and~~

f) following wording: “For use in wet or damp locations”~~.~~; and

g) special conductor types (see 10.6).

10.6 A sealed wire connector system tested with the conductor types used for the applications specified in 1.2 (see 9.1.5) shall ~~include~~ also be marked with those conductor types in the same location as the other markings specified in 10.1.

8. Revision to Table 1, Required test sequences

RATIONALE

Proposal submitted by: Jake Killinger, Underwriters Laboratories

In Table 1, Sequence B and Sequence C, delete the parenthetical (initial) and (repeated) since it is unnecessary and misleading. For these sequences, the insulation resistance is only conducted once.

PROPOSAL

Table 1 – Required test sequences

(Clause 7.1.2)

A – General[+]	B – Shelf Aging	C – Use Aging[++]
Immersion	Heat condition before assembly	Heat conditioning
Insulation resistance (initial)	Flexing and twisting	Immersion
Dielectric withstand	Immersion	Insulation resistance ~~(repeated)~~
Heat conditioning	Insulation resistance ~~(initial)~~	
Flexing and twisting		
Immersion		
Insulation resistance (repeated)		
Cold conditioning		
Flexing and twisting		
Immersion		
Insulation resistance (repeated)		
Current cycle and water immersion		
Insulation resistance (repeated)		
Dielectric withstand		
Leakage current		
[+] Test sequence A is based on ANSI C119.1. [++] See 9.4 note.		

9. Revisions to figures

RATIONALE

Proposal submitted by: Jake Killinger, Underwriters Laboratories

Figure 1 – The point of application of the force is shown at the top of the Figure 1. This is typically the same distance h as shown below the sealed wire connector system to the clamping vise. Propose to revise the figure to include this dimension. Revise graphic to add distance h from the top of the sealed wire connector system to the point of application of the test force. There should also be additional length of conductor beyond the point of application of the test force.

Figure 2 – In Figure 2, similar to Figure 1, a horizontal line is needed from the top of the vise to the bottom of the designator line for distance H. Revise graphic to add a horizontal line similar to Figure 1.

Figure A.1 – The only required dimension as shown in Figure A.1 is the vertical height as specified in 9.5.2.3. All other dimensions are merely suggestions. Add a note to state that. Also change the required height dimension to match the values in 9.5.2.3. Change “iron sphere” to “Steel Sphere”. Change “center of junction” to “point of impact on sealed wire connector system”. Also add note.

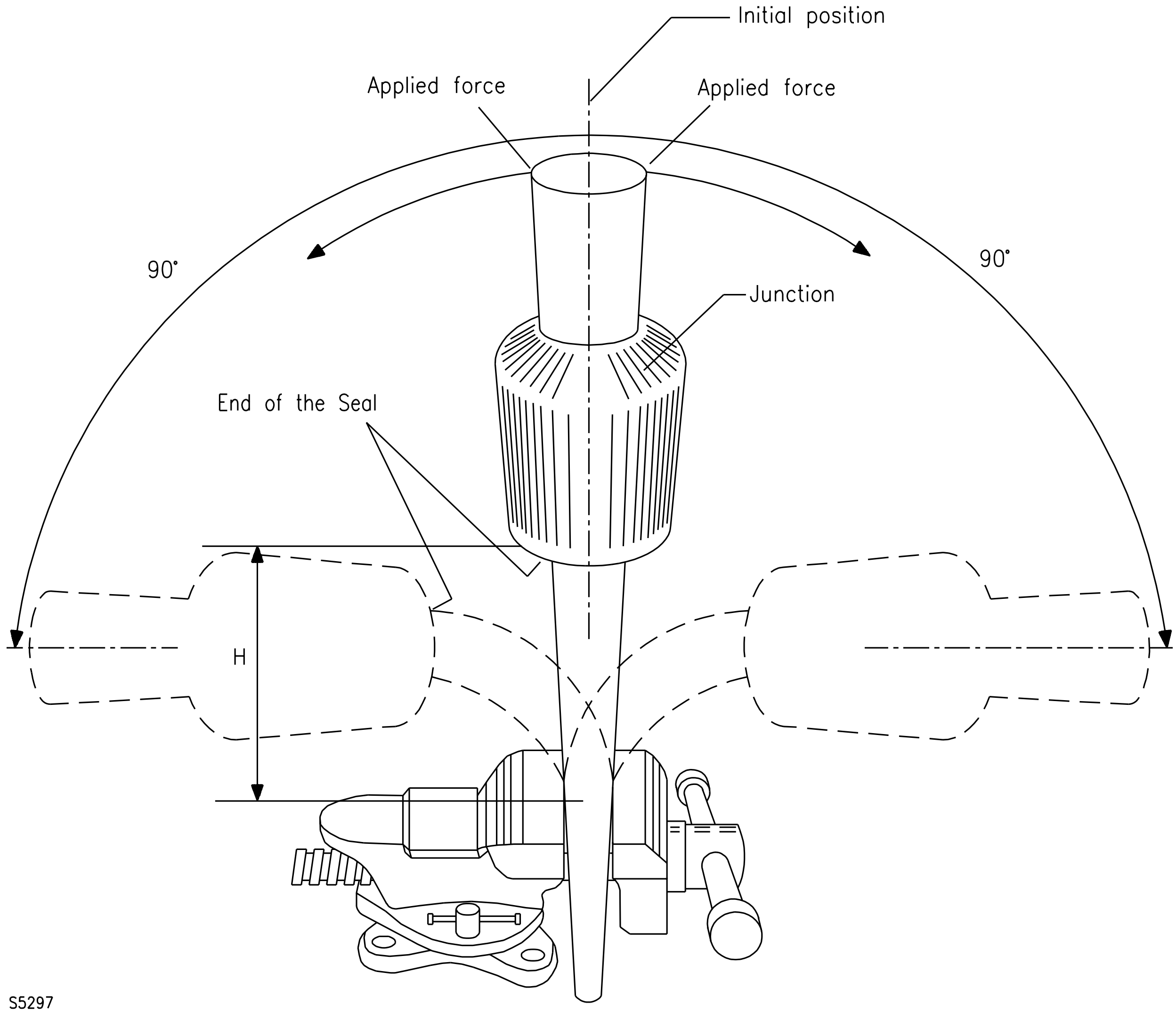
Figure A.1 (concluded) – The only required dimension as shown in Figure A.1 (concluded) is the minimum 76 mm (3 in) conductor length as it projects from the seal, see 9.5.1.1. All other dimensions are merely suggestions. Add a note to state that. Also change the required dimension to identify it as a minimum. Change the “beginning of the junction” to “End of the seal”. Also add note.

PROPOSAL

(CURRENT) Figure 1 – Flexing test for splicing-type connector

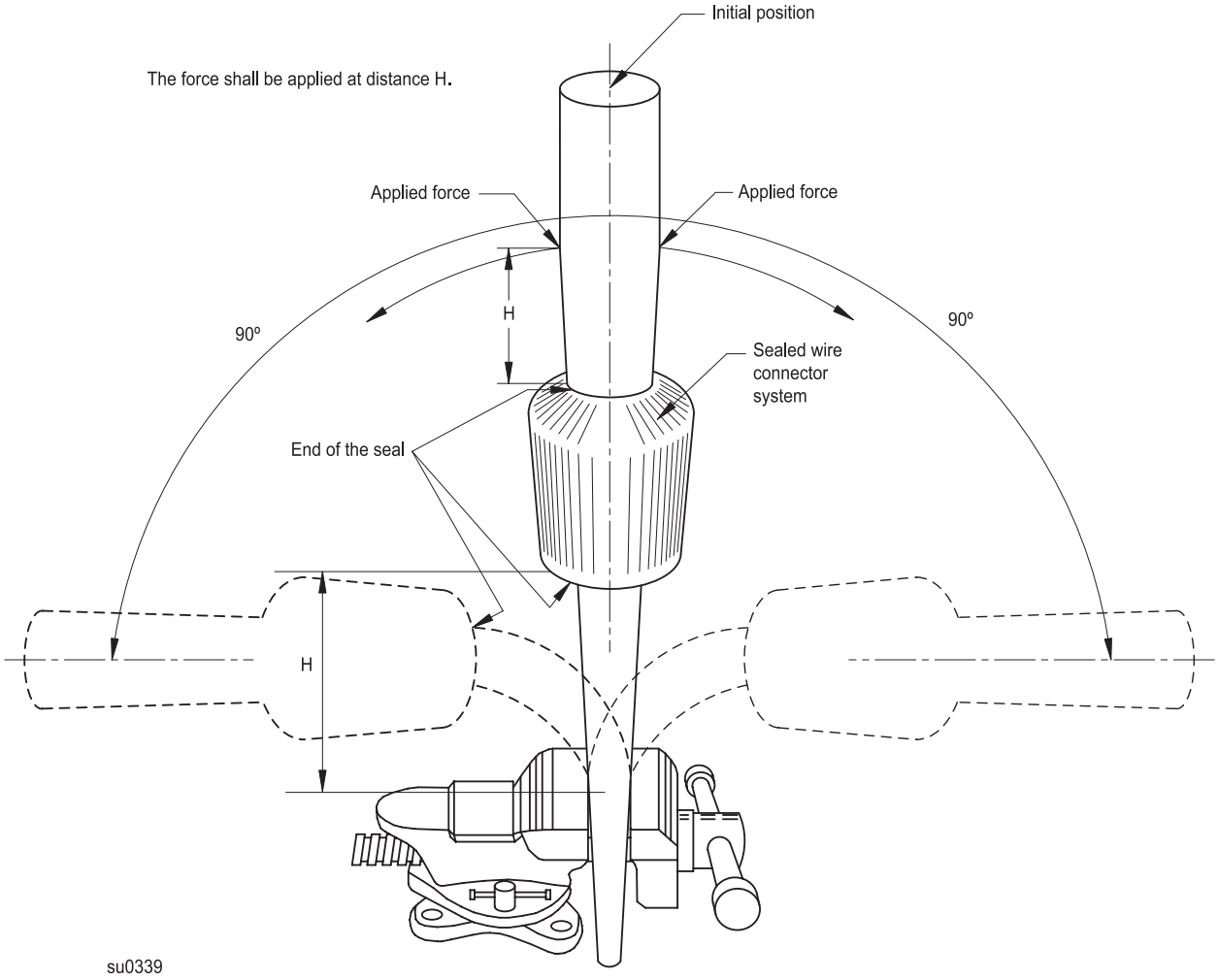
(Clause 9.2.5.1)

The force shall be applied at the top of the specimen



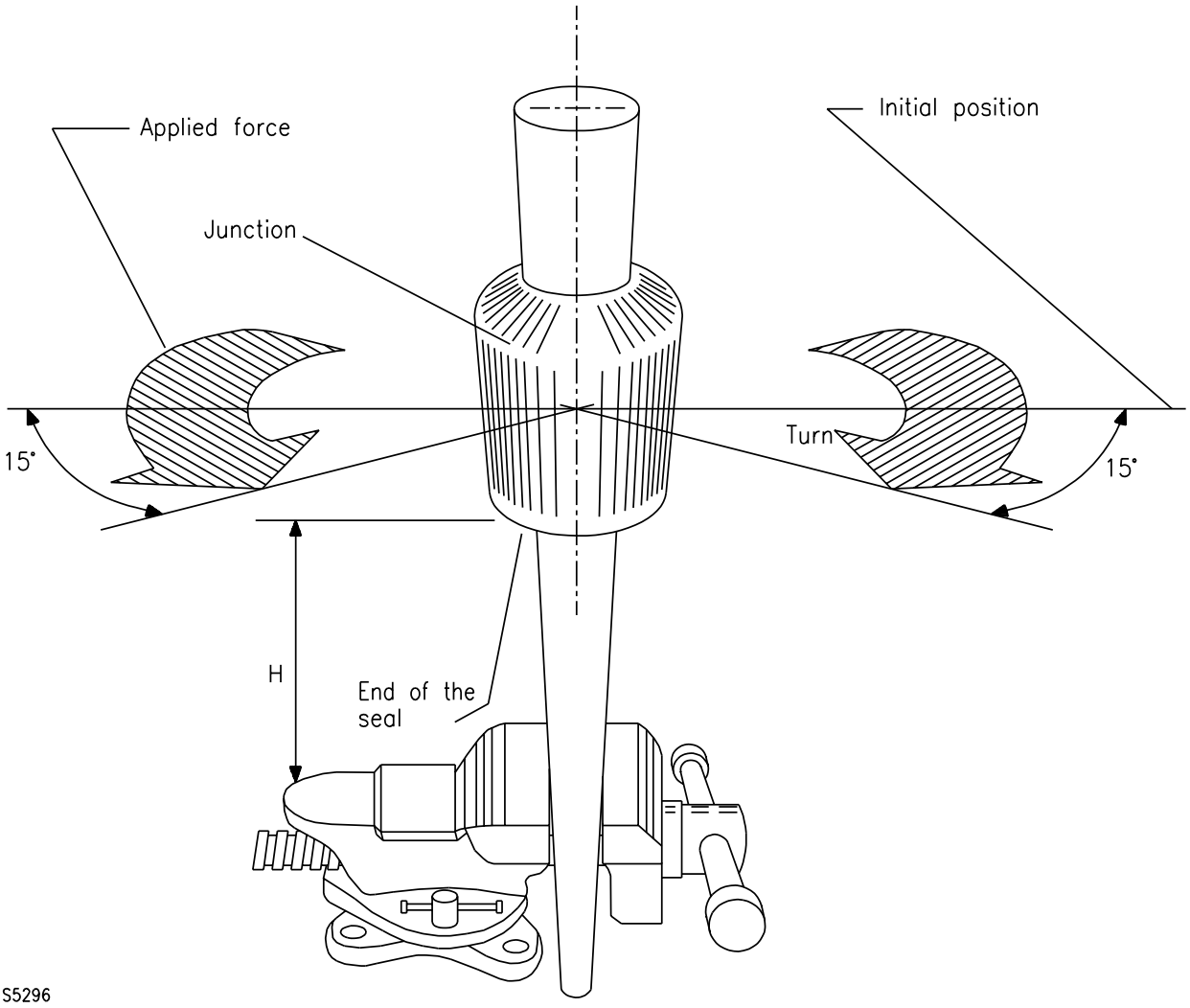
(REVISED) Figure 1 – Flexing test for splicing-type connector

(Clause 9.2.5.1)



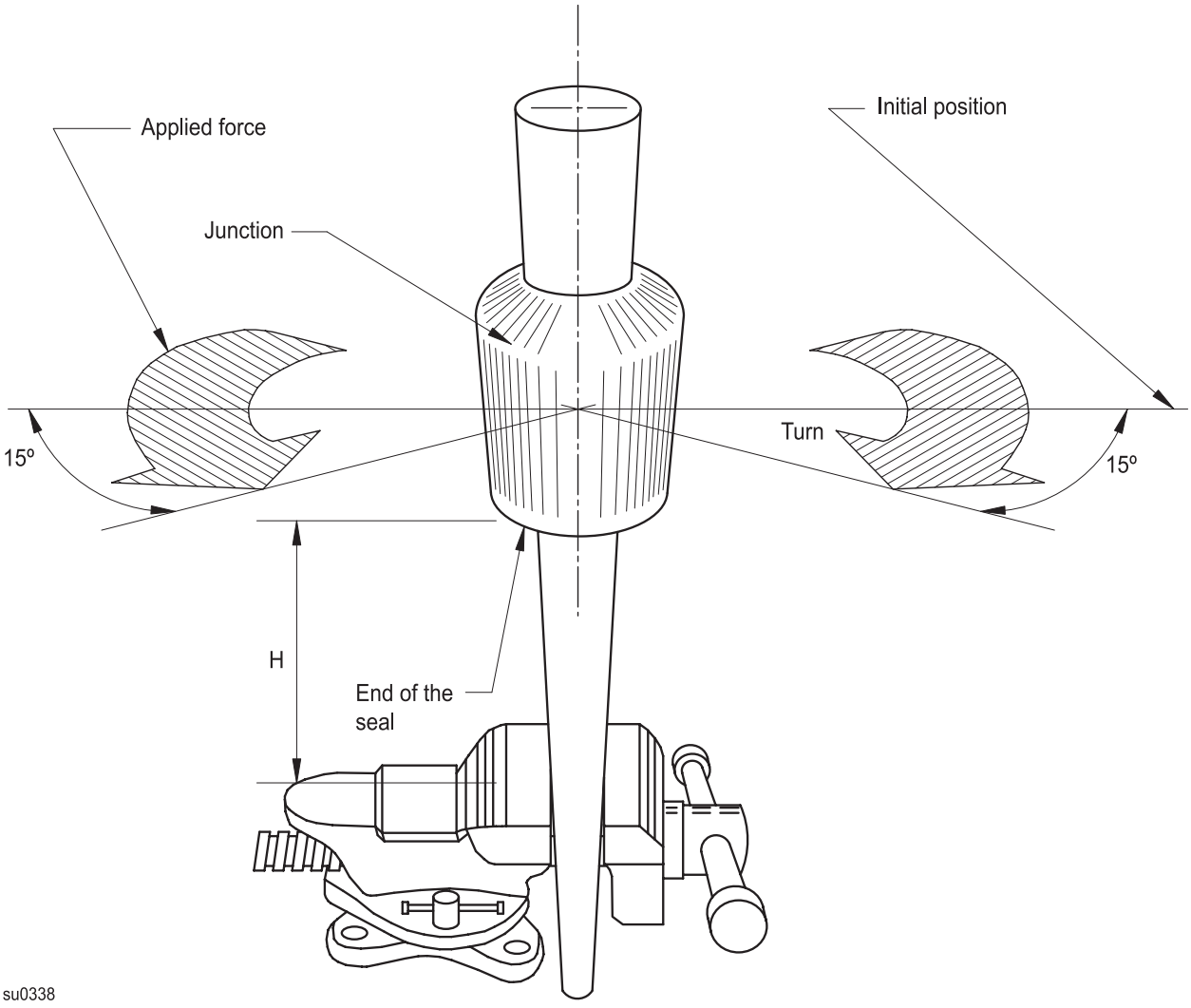
(CURRENT) Figure 2 – Twisting test for splicing-type connector

(Clause 9.2.5.2)

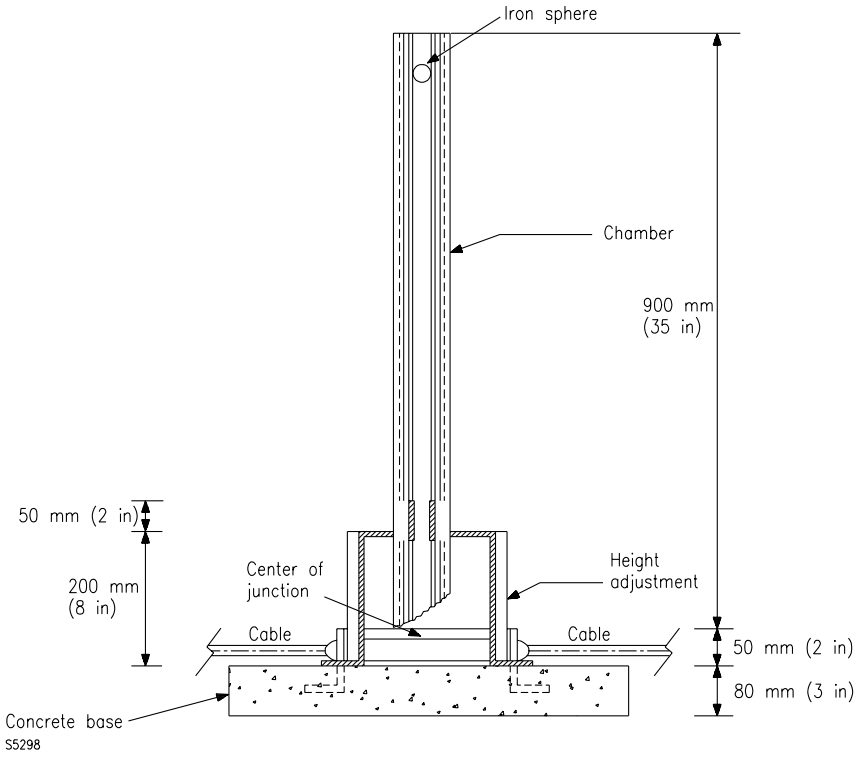


(REVISED) Figure 2 – Twisting test for splicing-type connector

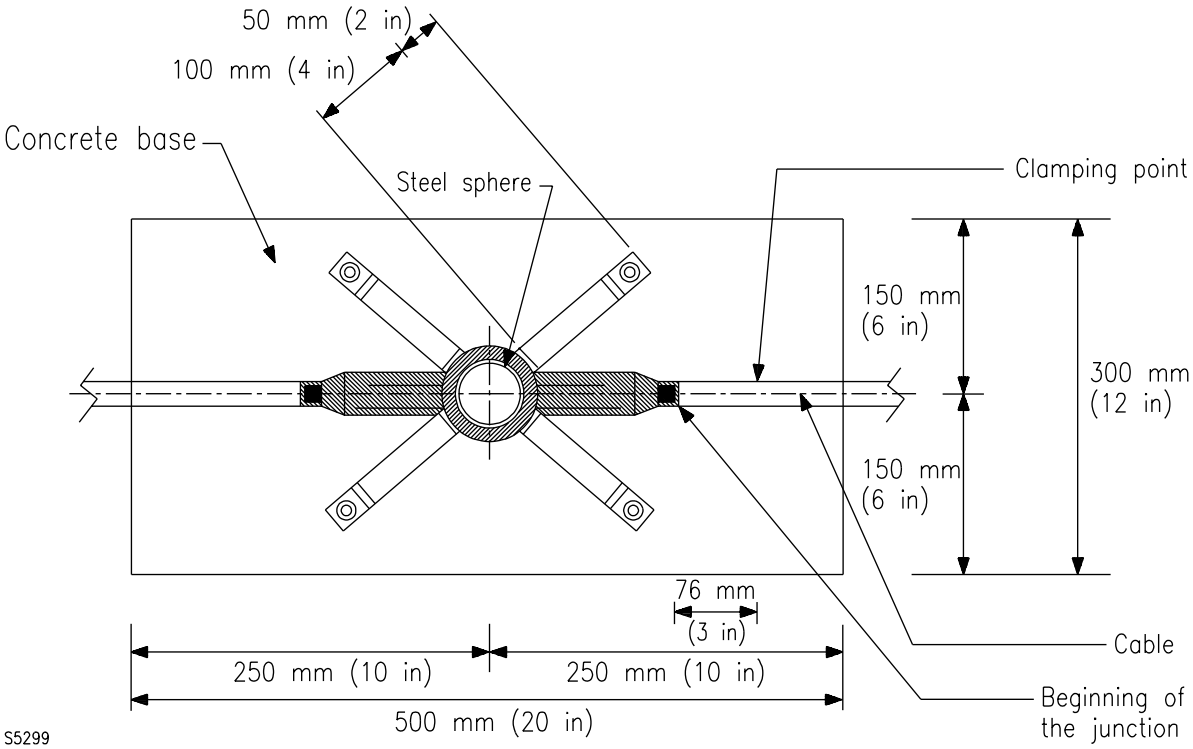
(Clause 9.2.5.2)



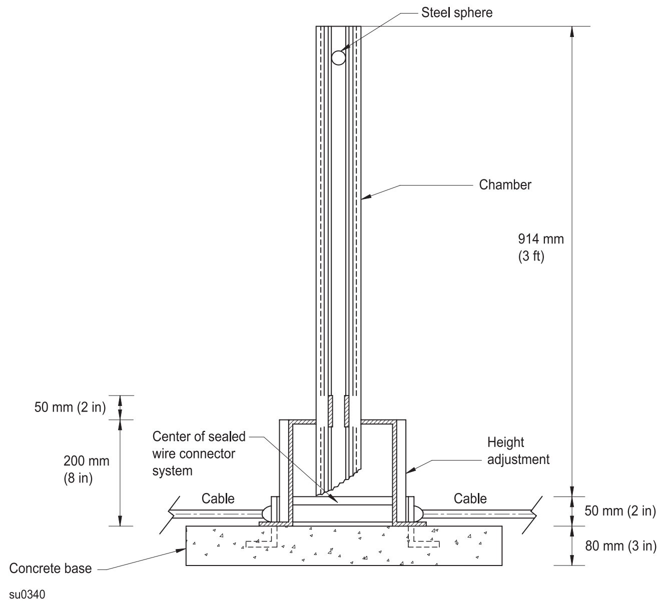
(CURRENT) Figure A.1



(CURRENT) Figure A.1 (Concluded)

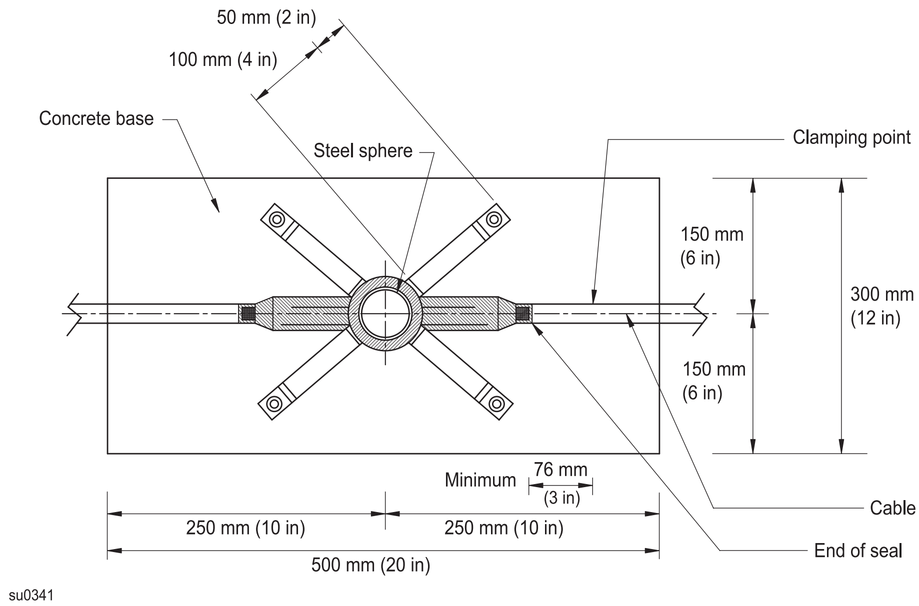


(REVISED) Figure A.1



Note: Design of the impact test apparatus may vary. Other dimensions may be used except for those required dimensions in Clause 9.5.

(REVISED) Figure A.1 (Concluded)



Note: Design of the impact test apparatus may vary. Other dimensions may be used except for those required dimensions in Clause 9.5.

10. Miscellaneous revisions to Annex B

RATIONALE

Proposal submitted by: Jake Killinger, Underwriters Laboratories

Consistency in terminology - B2.2.2 defines ‘tracking current’, but in Figs B.1 and B.2 as well as the legend for these Figs, it is identified as I Stray. These should be changed to I Tracking. Also editorially revise the text in Annex B to help in understanding and consistency in wording.

PROPOSAL

Annex B – Guarded Circuit

(Informative)

(Clause 9.2.2.1)

B.1 Description

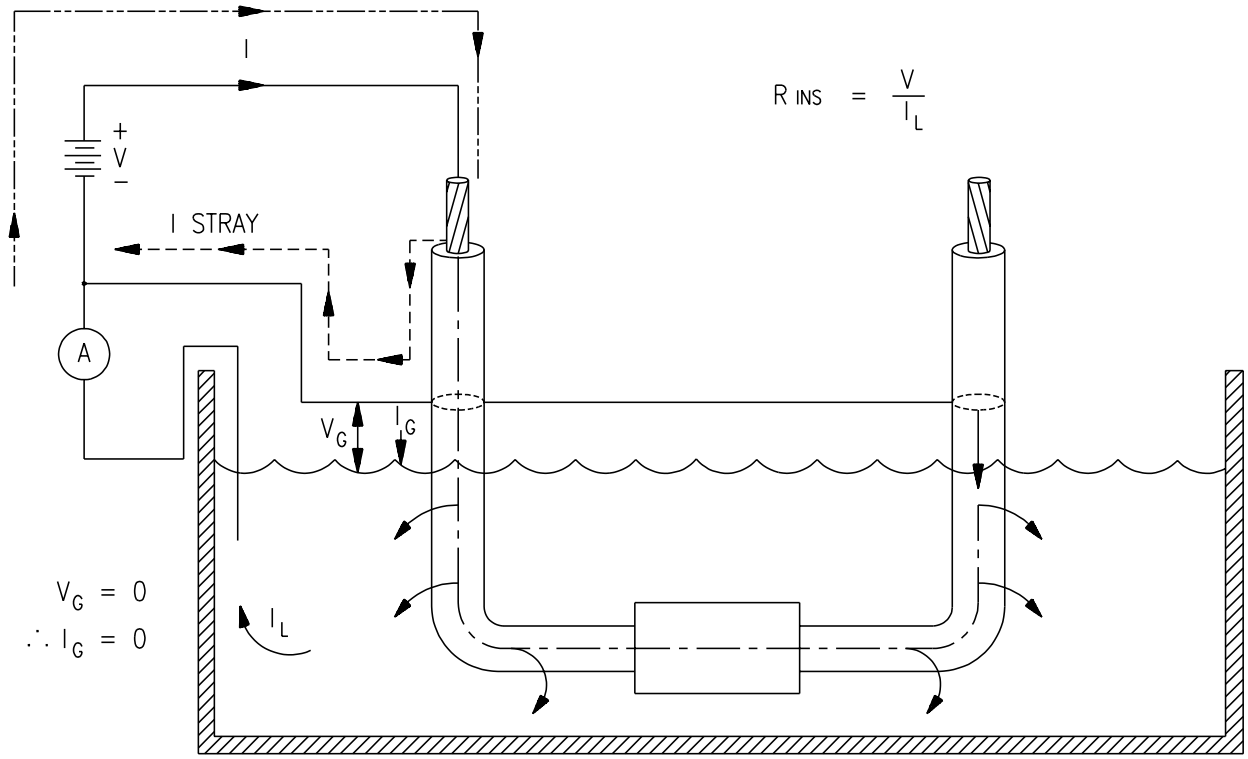
B.1.1 A guarded circuit is used to eliminate or to minimize the current flow between the insulation and conductor ends caused by tracking currents.

B.2 Setup

B.2.1 A typical test setup to measure insulation resistance is to submerge the test ~~conductor and sample~~ assembly in water with both ends of conductor exposed to open air. Next, apply ~~a~~ the d.c. test voltage between one exposed end of the test conductor and the water (which serves as ground). Resistance is calculated by dividing the known applied voltage by the measured current.

B.2.2 Applying a voltage between the conductor and water causes current to flow. The current will go two ways, from the wire through the insulation to the water and from the exposed wire along the surface of the conductor insulation to the water. The latter is called tracking current. To eliminate or minimize the tracking current from the measurement, create a guard by wrapping bare wire around the insulation near the exposed ends of the conductor keeping the exposed conductor ends along with the bare wire out of the water. These guards will capture or collect the tracking current ~~leakage~~ along the surface of the conductor insulation before it reaches the water.

(CURRENT) Figure B.1



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1) A = Ammeter

2) I = Current total; $I = I_{STRAY} + I_L$

3) I_G = Guard current

4) I_L = Leakage current

5) I_{STRAY} = Current along insulation

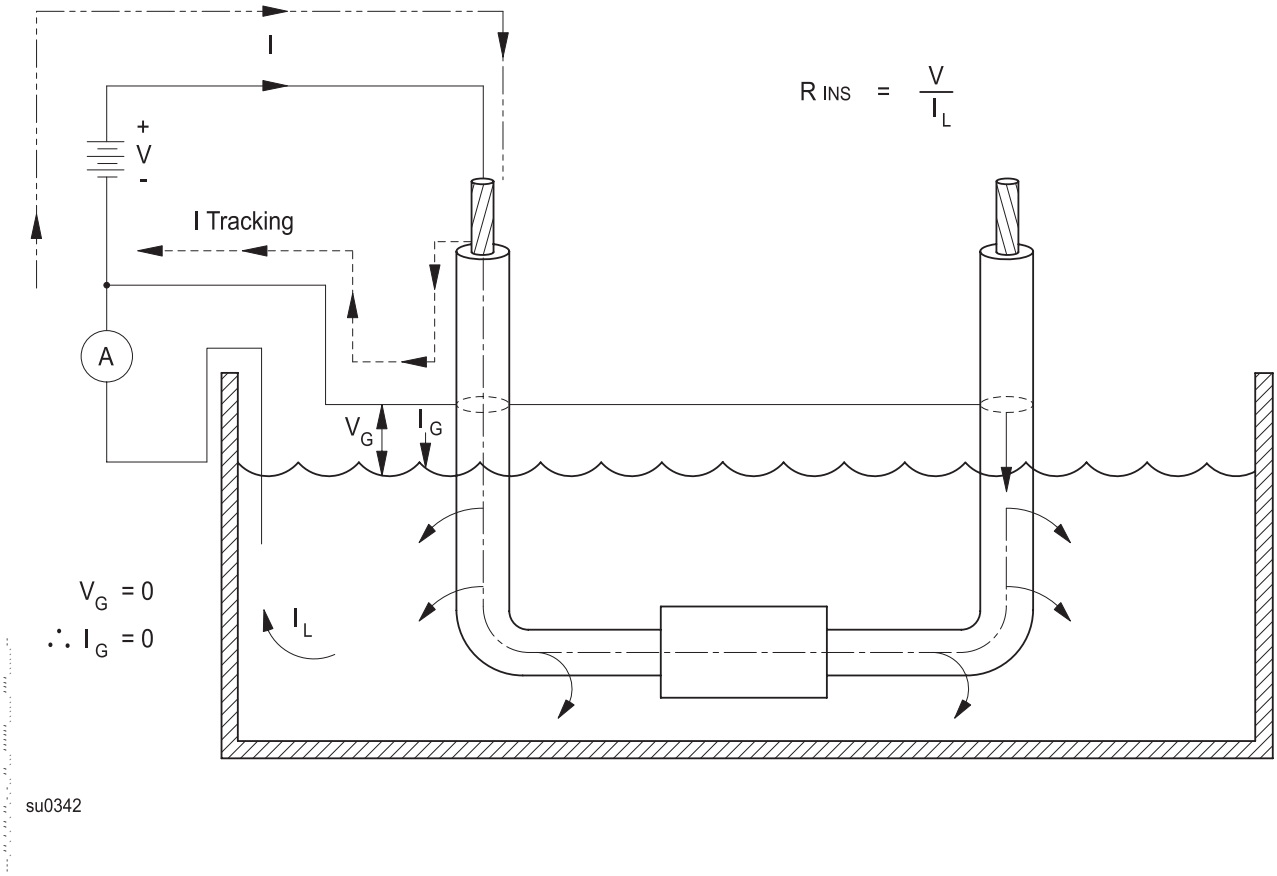
6) V = Voltage source

7) V_G = Guard voltage

8) Guard should be close to water (no potential between water and guard) and current should be measured in water circuit

9) Figure B.1, shows V_G to water is 0 V

(REVISED) Figure B.1



1) A = Ammeter

2) I = Current total; $I = I_{\text{~~STRAY~~ TRACKING}} + I_L$

3) I_G = Guard current

4) I_L = Leakage current

5) $I_{\text{~~STRAY~~ TRACKING}}$ = Current along insulation

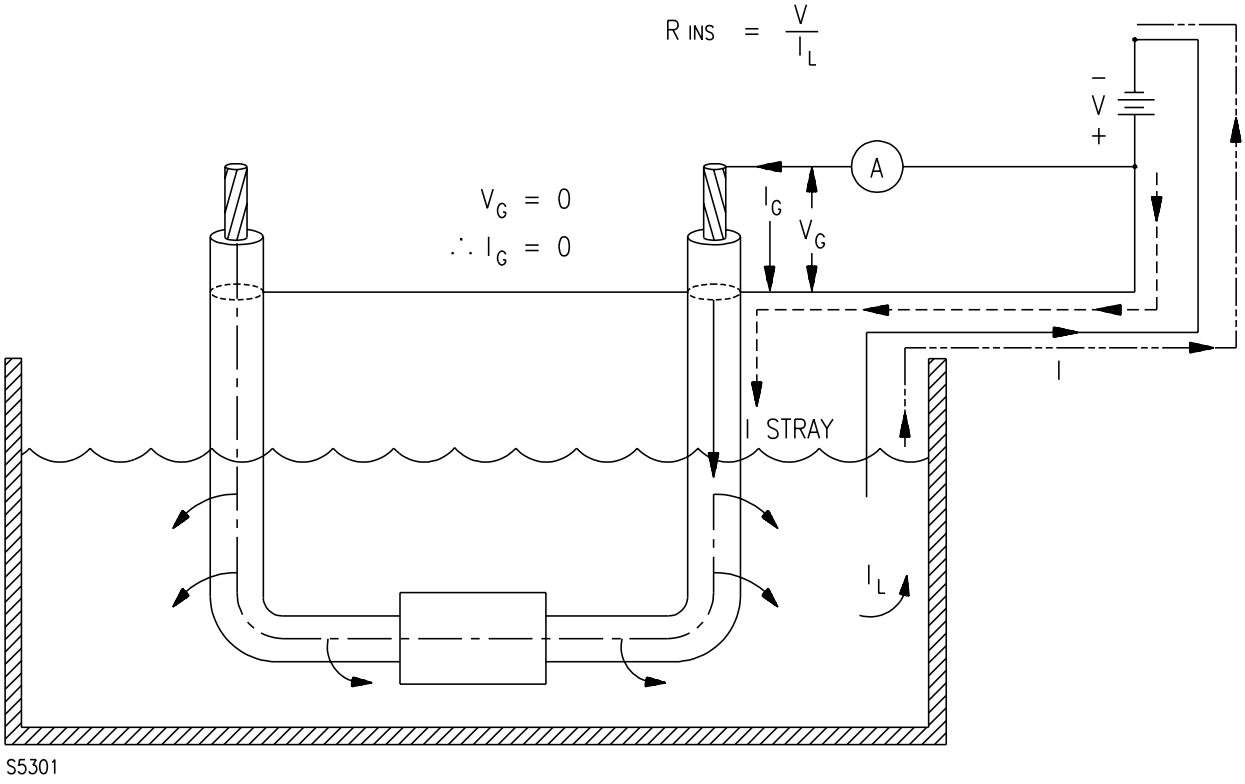
6) V = Voltage source

7) V_G = Guard voltage

8) Guard should be close to water (no potential between water and guard) and current should be measured in water circuit

9) Figure B.1, shows V_G to water is 0 V

(CURRENT) Figure B.2



1) A = Ammeter

2) I = Current total; $I = I_{STRAY} + I_L$

3) I_G = Guard current

4) I_L = Leakage current

5) I_{STRAY} = Current along insulation

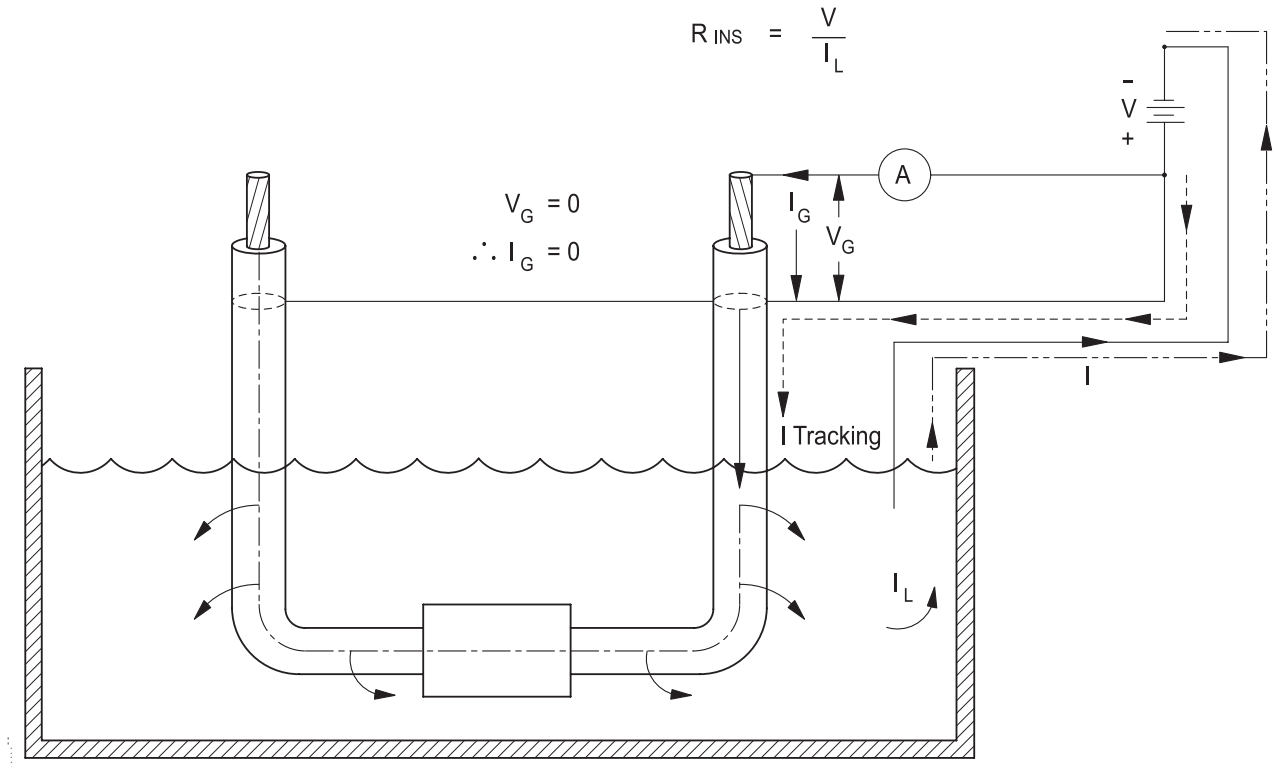
6) V = Voltage source

7) V_G = Guard voltage

8) Guard should be close to cable core (no potential between core and guard) and current should be measured in cable core circuit

9) Figure B.2 shows 0 V between core and guard

(REVISED) Figure B.2



su0343

1) A = Ammeter

2) I = Current total; $I = I_{\text{STRAY}\ \underline{\text{TRACKING}}} + I_L$

3) I_G = Guard current

4) I_L = Leakage current

5) $I_{\text{STRAY}\ \underline{\text{TRACKING}}}$ = Current along insulation

6) V = Voltage source

7) V_G = Guard voltage

8) Guard should be close to cable core (no potential between core and guard) and current should be measured in cable core circuit

9) Figure B.2 shows 0 V between core and guard

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