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Designation: ~~B913 – 05 (Reapproved 2015)~~ B913 – 21

Standard Test Method for Evaluation of Crimped Electrical Connections to 16-Gauge and Smaller Diameter Stranded and Solid Conductors[1]

This standard is issued under the fixed designation B913; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method establishes the requirements for a standardized method of evaluating the quality of crimped-type electrical connections to solid or stranded conductors. This test method applies to 16-gauge and smaller diameter copper wire, coated or uncoated.

1.2 This test method is applicable to connection systems intended for indoor use, or for use in environmentally protected enclosures. Additional testing may be required to assure satisfactory performance in applications where high humidity or corrosive environment, or both, may be present.

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1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to become familiar with all hazards including those identified in the appropriate Safety Data Sheet (SDS) for this product/material as provided by the manufacturer, to establish appropriate ~~safety~~ safety, health, and ~~health~~environmental practices, and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B8 Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

B258 Specification for Standard Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors

B542 Terminology Relating to Electrical Contacts and Their Use

3. Terminology

3.1 *Definitions*—Many terms related to electrical contacts used in this test method are defined in Terminology B542.

3.2 *Definitions of Terms Specific to This Standard:*

[1] This test method is under the jurisdiction of ASTM Committee B02 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.11 on Electrical Contact Test Methods.

Current edition approved ~~Oct. 1, 2015~~April 1, 2021. Published ~~October 2015~~April 2021. Originally approved in 2000. Last previous edition approved in ~~2010~~2015 as B913 – 05 ~~(2010).~~(2015). DOI: ~~10.1520/B0913-05R15.~~10.1520/B0913-21.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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3.2.1 *crimp, v*—to establish an electrical and mechanical attachment between the two members by mechanically deforming one contact member around another. In most cases, one member is a wire or group of wires, the other is a hollow cylinder or partial cylinder that is deformed around the wires.

3.2.2 *crimp barrel, crimp tab, n*—the portion of the crimp terminal that is deformed in the crimping operation.

3.2.3 *crimped connection, n*—a mechanical and electrical connection between a conductor and a component. The connection is made by compressing (crimping) the ~~component (crimp barrel)~~ crimp barrel or tab(s) of the component ~~about~~around the conductor using a tool specifically designed for the purpose

3.2.4 *crimp terminal, n*—an electrical component designed to be electrically and mechanically attached to a wire by deforming a portion of the component in a crimping operation to form an attachment to the wire. The other end of the terminal usually has a ring, fork, spade, tab, or related configuration designed to attach to another connection such as a screw or terminal block.

4. Summary of Test Method

4.1 A test lot of test specimens of the crimp terminal crimped to a short length of wire is prepared. The wire is pulled from a group of the specimens in a tensile pull and the force compared to set requirements based on wire diameter. A separate group of specimens is subjected to an electrical test where resistance stability of the specimen is evaluated during deflection of the wire at the exit of the crimped connection. The group is then aged for 33 days at 118°C and periodically retested in the electrical test. The electrical test results are compared to a standard value based on wire diameter. A test lot passes the evaluation if it passes both the mechanical pull test and the electrical test. In Method B, additional pull tests are performed on subgroups of parts during and after the aging test to provide information on progressive degradation in performance.

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5. Significance and Use

5.1 This test method establishes the requirements for a standardized method of evaluating the performance of crimped-type electrical connections having solid or stranded conductors.

5.2 In order to achieve a successful crimped connection, the crimping tool must deform the material of the crimp barrel or barrel tab(s) around the conductor. As a consequence, the conductor surfaces are placed under compression by the crimp terminal and areas of contact are established between the conductor and the crimp barrel. These areas provide the desired electrical connection. A reliable crimped connection is one that is capable of maintaining the contact between the conductor and crimp barrel so that a stable electrical connection is maintained when it is exposed to the conditions it was designed to endure during its useful life.

5.3 Evaluation testing is designed to ensure that a particular design crimped connection system consisting of conductor and component and associated tooling is capable of achieving a reliable electrical and mechanical connection. After the evaluation is completed, if any change in the system parts is made, the system should be reevaluated using the same procedures.

5.4 After completion of the evaluation test, the tensile pull strength results may be used to develop acceptance requirements to be used in inspection of subsequent production lots of crimped connections. An example of such an acceptance requirement is shown in Appendix X1.

5.5 The aging test, 33 days exposure at 118°C, has been used in the telecommunications industry to simulate 40 years of service at a moderately elevated temperature of 50°C, an environment that components experience within large banks of telephone equipment. This environment is similar to that seen in a wide range of electronic systems operating indoors containing active components that dissipate power. The test is designed to reproduce the stress relaxation of copper alloys in such service and has been used extensively in evaluating wire wrap connections. It also accelerates other thermally activated processes such as oxidation although their acceleration factors may be different from that of copper stress relaxation.

5.6 The aging test accelerates stress relaxation processes and other thermally activated processes but does not address some other possible hazards such as corrosion. Additional testing may be appropriate if the intended service environment presents such hazards.

6. Interferences

6.1 The wire strain relief included in some crimp terminals may mask the performance of the crimped connection to the wire. The strain relief shall be disabled prior to testing the specimens in this test method.

7. Apparatus

7.1 *Tensile Test Stand, Load cell and grips, or Holding Fixtures,* adequate to measure the force required to pull the crimp terminal off the wire at the speed specified in this test method.

7.2 *Oscilloscope,* with adequate preamplifiers to measure dynamic change of 100 ± 10 µV. An oscilloscope with a recording device is preferred as it can provide a permanent record of the results.

7.3 *Fixture with Two Clamps,* to securely hold the crimp terminal and end of the wire while making an electrical connection to each, and allow for manual deflection of the wire at the exit of the crimp terminal through 15° in all directions. A fixture with two vise-like clamps mounted about 80 mm apart on an insulating base has proved suitable. Spring clips often used with 16 to 24-gauge wire are not adequate; a higher force clamp is needed.

7.4 *dc Power Supply,* capable of providing 100-mA ~~milliamps~~ current through the sample with noise or ripple less than 10 µV on the measured sample

7.5 *Oven,* capable of maintaining a temperature of 118 ± 2°C and with a working volume adequate to contain the crimp test specimens and allow air circulation around them. The oven shall use air from the indoor environment as the air source, no other humidity control is required.

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8. Test Specimen

8.1 Prepare the following quantities of test specimens of the crimped connection made with the wire and crimp component to be evaluated. For Test Method A, prepare 64 specimens, for Test Method B, prepare 94 test specimens. For crimped connections that will be manufactured with adjustable crimp dies, prepare 64 (Test Method A) or 94 (Test Method B) test specimens each made with the smallest and largest die setting to which the dies will be set in the manufacture of the actual connections. The wire length beyond the crimp barrel shall be 200 mm, minimum. In each test method, the 64 or 94 specimens provide four extra specimens beyond those actually required for testing, the remaining four can be used in test set up or retained as examples of the manufactured test specimens since the testing is destructive. Specifications B8 and B258 define wire gauge (diameter) and wire stranding.

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8.2 Document the following items at the time that the specimens are prepared:

8.2.1 Gauge of wire,

8.2.2 Wire conductor stranding,

8.2.3 Wire coating or plating,

8.2.4 Wire manufacturer,

8.2.5 Wire manufacturer's part number for the wire used,

8.2.6 Type of wire insulation,

8.2.7 Terminal supplier name,

8.2.8 Terminal supplier's part number for the terminal,

8.2.9 Crimping tool supplier name,

8.2.10 Crimping tool supplier part number, and

8.2.11 Crimping tool die setting (if applicable).

8.3 The test specimens shall meet the following requirements:

8.3.1 All strands of the conductor(s) shall be in the crimp barrel and there shall be no evidence of missing, broken, damaged, or loose strands of the conductor(s).

8.3.2 Conductors shall not be pre-soldered or solder-dipped prior to crimping.

8.3.3 Wire is to be stripped immediately before crimping for a distance that is proper to full insertion into the crimp barrel. Strip the other end of the wire for 25 mm to allow for connection to electrical measuring devices.

8.3.4 The crimp indent shall be in the intended position and orientation on the barrel in accordance with the design intent of the manufacturer's die set and crimp barrel.

8.3.5 There shall be no cracking or rupture in any portion of the barrel, tabs, and so forth.

8.3.6 The crimp barrel shall show no evidence of re-crimping (double crimping) in the same location. Barrels may be crimped in more than one location in accordance with the ~~manufacture's~~manufacturer's design.

8.3.7 When a terminal is equipped with an insulation grip or support, the wire insulation shall be in its intended position within the grip or support after crimping. The grip or support shall, as designed, mechanically secure or support the wire insulation.

8.3.8 On pre-insulated terminals or splices, the insulated sleeve shall remain in its proper position on the crimp barrel after crimping and shall not show evidence of cracking or spalling.

8.3.9 When sleeving is used to insulate uninsulated crimped barrels, the sleeving shall be a snug fit and shall cause no evidence of damage to the wire insulation.

8.3.10 The conductor must be fully seated in the barrel and may extend beyond the barrel but not into the tongue area or plug end of terminal lugs to the extent that it will interfere with proper connection of the terminal to another part in the manner intended.

8.3.11 If more than one conductor is crimped in a single crimp terminal, the wires must not be twisted together before crimping.

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9. Procedure

9.1 *Test Method A:*

9.1.1 *Visual Test of Samples*—Visually inspect all test specimens to determine if they meet the applicable requirements of the Test Specimens section of this test method.

9.1.2 *Tensile Pull Strength Test*—Perform the tensile (pull) strength tests on 30 test specimens in the as-received condition. For multiple wire crimped connections, test (pull) the smallest diameter wire in the crimp terminal. Prior to applying the pull test, inactivate any stress relief or crimp, viz. insulation grip, in the absence of other prior agreement, so that it does not influence the test results. Place the barrel/conductor assembly in a standard tensile testing device and apply an axial load to pull the wire conductor out of the barrel or rupture the conductor. The travel speed of the pull testing head shall be held to a standard speed of 25 ± 5 mm/min. Record the maximum pull applied and failure mode, for example, pull out, wire break, and so forth.

9.1.3 *Dynamic Voltage Drop Tests:*

9.1.3.1 Subject 30 remaining specimens to the dynamic voltage drop tests. Before making voltage drop tests, incapacitate any insulation strain relief, and so forth, unless otherwise agreed upon.

9.1.3.2 Clamp the crimp terminal and the other end of the wire in the measurement fixture in such a way that the wire position incorporates enough slack that the movement described later in this section can be performed. In clamping the crimp terminal, avoid applying clamping force to the crimp barrel. Secure electrical connections shall be established and a 100-mA current passed through the wire and crimp barrel. Set the oscilloscope to a sweep rate of 100 ms/cm and a sensitivity such that 100 µV provides