Designation: B812 – 18

Standard Test Method for Resistance to Environmental Degradation of Electrical Pressure Connections Involving Aluminum and Intended for Residential Applications[1]

This standard is issued under the fixed designation B812; 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.

INTRODUCTION

Electrical pressure connection systems involving aluminum are those in which one or more of the components of the system in the direct electrical path or carrying any electrical current is fabricated of aluminum, including aluminum wires, aluminum bus bars, aluminum bolts, aluminum terminations, or any other aluminum current-carrying member. Included are systems which must carry current for safety purposes such as ground shields or straps attached to aluminum framing or other structural members. Pressure connection systems can be evaluated by this test method. Such systems are comprised of the wire or other structure being connected and the means of connection, any element of which is made of aluminum.

Connection systems tested are exposed sequentially to ambients of high relative humidity and temperature cycles of 75°C, such as may be encountered by some connections in actual residential applications. Periodic observation of the potential drop across the connection interfaces while carrying rated current provides a measurement of connection performance.

1. Scope

1.1 This test method covers all residential pressure connection systems. Detailed examples of application to specific types of connection systems, set-screw neutral bus connectors and twist-on wire-splicing connectors, are provided in Appendix X1 and Appendix X2.

1.2 The purpose of this test method is to evaluate the performance of residential electrical pressure connection systems under conditions of cyclic temperature change (within rating) and high humidity.

1.3 The limitations of the test method are as follows:

1.3.1 This test method shall not be considered to confirm a specific lifetime in application environments.

1.3.2 The applicability of this test method is limited to pressure connection systems rated at or below 600 V d-c or a-c RMS.

1.3.3 This test method is limited to temperature and water vapor exposure in addition to electrical current as required to measure connection resistance.

1.3.4 This test method does not evaluate degradation which may occur in residential applications due to exposure of the electrical connection system to additional environmental constituents such as (but not limited to) the following examples:

1.3.4.1 Household chemicals (liquid or gaseous) such as ammonia, bleach, or other cleaning agents.

1.3.4.2 Chemicals as may occur due to normal hobby or professional activities such as photography, painting, sculpture, or similar activities.

1.3.4.3 Environments encountered during construction or remodeling such as direct exposure to rain, uncured wet concrete, welding or soldering fluxes and other agents.

1.3.5 This test method is limited to evaluation of pressure connection systems.

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, health, and environmental practices, and determine the applicability of regulatory limitations prior to use.*

1.5 *This standard should be used to measure and describe the properties of materials, products, or assemblies in response to electrical current flow under controlled laboratory conditions and should not be used to describe or appraise the fire*

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[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.

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hazard or fire risk of materials, products, or assemblies under actual installation conditions or under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.

1.6 *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]

B542 Terminology Relating to Electrical Contacts and Their Use

2.2 *Underwriter Laboratory Standards:*

UL486B Standard for Wire Connectors For Use With Aluminum Conductors, ANSI/UL 486B [3]

UL486C Standard for Splicing Wire Connectors [3]

2.3 *NEC Document:*

ANSI/NFPA 70 National Electric Code [4]

3. Terminology

3.1 *residential applications, n*—residential applications are those involving a structure or vehicle used for permanent or temporary human habitation. Included are homes (single or multiple-unit houses and mobile or modular structures), motels, hotels, dormitories, hospitals, rest homes, and recreational vehicles. Excluded are railroad cars, boats, airplanes, nonresidential, commercial (office buildings, stores) and industrial applications (factories, warehouses).

3.2 *pressure connection system, n*—an electrical connection intended to carry current between components or conductors in contact under mechanical pressure.

3.2.1 *Discussion*—The mechanical pressure may be applied by clamping, tightening of threaded components, spring force, crimping, swaging, or other means. For the purpose of the test procedure, the connection system consists of all components normally present in the application, including both current-carrying and other metallic components, and non-metallic components (insulators, insulation, protective boots or sleeve, etc.). Also see definition of "Connection, Pressure (Solderless)," in Article 100 of reference noted in Section 2.3 (NEC).

3.3 *aluminum, n*—as the term "aluminum," the material of which conductors (wire, cable, busbars, etc.), connection components, and test board components may be made, includes aluminum metal and its alloys.

3.4 *reference conductor, n*—a continuous length of the same conductor material (wire, cable, busbar, etc.) incorporated in the connection system being tested by being mounted on the same test board assembly and connected in the same series circuit.

3.5 *reference connection system, n*—the reference connection system is the same connection system as that which is under evaluation, but which is exposed only to a dry environment at normal room temperature.

4. Summary of Test Method

4.1 The environmental exposure of the connections tested consists of weekly sequences consisting of five thermal cycles of 75°C temperature change (taking a maximum of 8 h to accomplish), followed by exposure for the balance of the week to conditions at or near 100 % relative humidity at room temperature. The text exposure cycle is repeated for a minimum of four one-week cycles. Reference connections are kept in a dry environment at room temperature for the same duration. Potential drop measurements, at rated current, are made prior to each weekly environmental exposure cycle, and a final set of measurements is taken at the end of the test.

5. Significance and Use

5.1 The principal underlying the test is the sensitivity of the electrical contact interface to temperature and humidity cycling that electrical pressure connection systems experience as a result of usage and installation environment. The temperature cycling may cause micromotion at the mating electrical contact surfaces which can expose fresh metal to the local ambient atmosphere. The humidity exposure is known to facilitate corrosion on freshly exposed metal surfaces. Thus, for those connection systems that do not maintain stable metal-to-metal contact surfaces under the condition of thermal cycling and humidity exposure, repeated sequences of these exposures lead to degradation of the contacting surface indicated by potential drop increase.

5.2 The test is of short duration relative to the expected life of connections in residential usage. Stability of connection resistance implies resistance to deterioration due to environmental conditions encountered in residential service. Increasing connection resistance as a result of the test exposure indicates deterioration of electrical contact interfaces. Assurance of long term reliability and safety of connection types that deteriorate requires further evaluation for specific specified environments and applications.

5.3 *Use*—It is recommended that this test method be used in one of two ways. First, it may be used to evaluate and report the performance of a particular connection system. For such use, it is appropriate to report the results in a summary (or tabular) format such as shown in Section 17, together with the statement "The results shown in the summary (or table) were obtained for (insert description of connection) when tested in accordance with Test Method B812. Second, it may be used as the basis for specification of acceptability of product. For this use, the minimum test time and the maximum allowable increase in potential drop must be established by the specifier. Specification of connection systems in accordance with this use

[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.

[3] Available from Underwriters Laboratories (UL), 333 Pfingsten Rd., Northbrook, IL 60062-2096, http://www.ul.com.

[4] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, http://www.nfpa.org.

of the standard test method would be of the form: "The maximum potential drop increase for any connection, when tested in accordance with Test Method B812 for a period of weeks, shall be mV relative to the reference connections." Connection systems that are most resistant to thermal-cycle/humidity deterioration, within the limitations of determination by this test method, show no increase in potential drop, relative to the reference connections, when tested for indefinite time. Connections that are less resistant to thermal-cycle/humidity conditions applied by this test will demonstrate progressive increases in potential drop with increasing time on test. Thus, the following examples of specifications are in the order of most stringent (No. 1) to least stringent (No. 3).

	Duration, weeks	Maximum Potential Drop Increase, mV
1.	52	0
2.	16	0.2
3.	4	1.0

6. Interferences

6.1 *Temperature*—Because resistance of metallic conductors is a function of temperature, provision of a standard length of conductor wire has been provided to permit correction for room temperature changes for potential drop measurements. However, degraded electrical connections among the test samples can be a source of abnormal heat during the measurements (when current is flowing), causing temperature variations from point-to-point on the test assembly. If individual connections are noted to be heating abnormally when potential drop measurements are being made (as determined by relatively high potential drop), it is desirable to minimize temperature nonuniformity by using temporary thermal isolation barriers.

6.2 *Current*—Current variation during the measurement leads to erratic results. Calibration of the required constant current source shall be maintained.

6.3 *Instruments*—Instrument stability shall be maintained by means of frequent calibration checks. Stability of reference voltage drop across a standard resistor should be maintained to within the instrument ratings by checks both before and after each group of measurements.

6.4 *Magnetic Fields*—Voltage signals resulting from stray magnetic fields intersecting the voltage probe leads or power supply leads need to be assessed prior to beginning each series of measurements. Generally, this can be done by moving the leads and observing the resultant voltage changes. Alternatively, a source of stray magnetic field such as an energized autotransformer can be moved adjacent to the measurement circuit for detection of voltage changes. If voltage instability is observed, corrective action such as shielding or removal of magnetic field sources is required.

7. Apparatus

7.1 *Materials*—Other than materials normally considered to be part of the connection system being evaluated, materials selected for use in the test system (for construction of test frames, fixturing, humidity chamber, etc.) shall be resistant to outgassing at the maximum temperature of use in the test.

7.2 *Humidity Vessel*—The humidity vessel shall be a clean sealed chamber, the bottom of which is covered with deionized water to a depth of approximately 30 mm, and a platform for samples above the water level. The vessel shall include a shield to prevent condensate dripping onto test samples. The material of the humidity vessel shall be inert with regards to humidity such that no contamination of test samples or deionized water occurs. The vessel is to be operated in a normal laboratory environment which has continuous temperature control during the period of the test.

NOTE 1—This apparatus is intended to expose samples to relative humidity at or near 100 %.

7.3 *Temperature Chamber*—The temperature chamber shall be capable of control at the defined upper temperature of the thermal cycle such that chamber temperature stability, uniformity, and control accuracy shall be within ±2°C. The lower temperature of the cycle may be achieved in the same chamber, if it is capable of cooling to the lower defined temperature. Alternatively, the thermal cycle can be achieved by transfer between the high-temperature chamber and a room-temperature environment or cold chamber, depending on the prescribed low temperature of the thermal cycle.

7.4 *Power*—A 50⁄60 Hz ac constant current supply is required, capable of continuously maintaining the specified test current within ±1 %. For safety reasons, the maximum output potential at open circuit shall be 12 V and the supply output must be isolated from the 120/240 volt alternating current (VAC) primary circuit.

7.5 *Test Board*—A mounting board or frame shall be provided for the test samples such that the board or frame be inert with regard to humidity and dimensionally stable with regard to the thermal cycle of 75°C temperature change. To the extent possible, the thermal expansion coefficient shall match that of the material being tested. (Example: frame shall be aluminum if aluminum wire or cable is a major part of the connection system being tested.) The board or frame shall provide for mechanical mounting of the test samples such that individual samples are independent of adjacent samples in regards to effects of mounting or the process of obtaining electrical measurements. As required by dimensions of the thermal or humidity chambers used, the test sample population may be divided among several test boards.

7.6 *Temperature Measurement*—Ambient and chamber temperature shall be measured by such apparatus as can detect 0.5°C temperature change within the desired range. A calibrated glass thermometer is acceptable for this purpose.

7.7 *Current Measurement*—An a-c ammeter capable of resolution of 0.5 % of the applied measurement current is required.

7.8 *Potential Drop Measurement*—A millivoltmeter capable of resolution of 0.01 mV is required for potential drop measurements.

8. Hazards

8.1 *Fire Hazards*—Degradation of electrical connections can lead to high resistance paths that are capable of significant