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# Standard Test Methods and Specifications for Electrically Insulating Plastic Guard Equipment for Protection of Workers[1]

This standard is issued under the fixed designation F712; 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 These test methods cover three electrical tests on plastic guards and assembled guard systems. They are:

1.1.1 *Method A*—Withstand voltage proof test,

1.1.2 *Method B*—Flashover voltage, and

1.1.3 *Method C*—Leakage current.

1.1.4 This specification covers plastic guard equipment and guard systems used by workers for temporary insulation on electric power circuits.

1.1.5 Plastic guard equipment covered by this specification is rated for momentary, or brush contact only. Maximum-use voltages are covered in Table 1 and Table 2.

1.2 These test methods cover, but are not limited to, the following typical guards:

1.2.1 *Conductor Guards and Connecting Covers as follows:*

1.2.1.1 Line guards,

1.2.1.2 Line guard connectors,

1.2.1.3 Insulator covers,

1.2.1.4 Dead-end covers,

1.2.1.5 Bus guards, and

1.2.1.6 Bus "T" guards.

1.2.2 *Structure and Apparatus Covers as follows:*

1.2.2.1 Pole guards,

1.2.2.2 Ridge pin covers,

1.2.2.3 Switch blade covers,

1.2.2.4 Arm guards,

1.2.2.5 Cutout covers,

1.2.2.6 Structural barriers, and

1.2.2.7 Cross arm guard.

1.3 It is common practice for the user of this equipment to prepare instructions for the correct use and maintenance.

1.4 The use and maintenance of this equipment is beyond the scope of these test methods.

1.5 *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 establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.6 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

D149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

D256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

D570 Test Method for Water Absorption of Plastics

2.2 *IEEE Standard:*[3]

IEEE 978 Guide for In-Service Maintenance and Electrical Testing for Live-Line Tools

2.3 *ANSI Standard:*[4]

C39.5 Safety Requirements for Electrical and Electronic Measuring and Controlling Instrumentation

2.4 *UL Standard:*[5]

94 Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

## 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *insulating plastic guards*—devices for temporary installation on structures or energized electric power circuits for electrical protection of personnel or equipment, or both.

[1] These test methods are under the jurisdiction of ASTM Committee F18 on Electrical Protective Equipment for Workers and are the direct responsibility of Subcommittee F18.25 on Insulating Cover-Up Equipment.

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[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 Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., P.O. Box 1331, Piscataway, NJ 08854-1331, http://www.ieee.org.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org..

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

**TABLE 1 Withstand Voltage Proof Test[A]**

| Class | Rating, kV | Max Use 60 Hz | Proof Test Withstand Voltage (in-service testing) | | | Criteria |
|---|---|---|---|---|---|---|
| | 0-0[A] | 0-Ground | 0-Ground kV | | Duration, min | |
| | | | 60 Hz | DC | | |
| 2 | 14.6 | 8.4 | 13.0 | 18 | 1 | No flashover other than momentary as a result of too-close spacing of electrode |
| 3 | 26.4 | 15.3 | 24.0 | 34 | 1 | |
| 4 | 36.6 | 21.1 | 32.0 | 45 | 1 | |
| 5 | 48.3 | 27.0 | 42.0 | 60 | 0.5 | |
| 6 | 72.5 | 41.8 | 64.0 | 91 | 0.25 | |

[A] Cover-up materials are tested at values greater than the maximum use phase to ground values. The maximum use phase to phase values relate to guarded phase to guarded phase. The units are not rated for bare phase to guarded phase potentials.

**TABLE 2 Minimum Flashover Test[A]**

| | Rating, kV | Max Use 60 Hz | Min Flashover Voltage Test ϕ-Ground kV | | Criteria |
|---|---|---|---|---|---|
| | 0-0[A] | 0-Ground | 60 Hz | DC | |
| 2 | 14.6 | 8.4 | 14.0 | 20 | No flashover other than momentary as a result of too-close spacing of electrode |
| 3 | 26.4 | 15.3 | 25.0 | 35 | |
| 4 | 36.6 | 21.1 | 34.0 | 48 | |
| 5 | 48.3 | 27.0 | 43.0 | 61 | |
| 6 | 72.5 | 41.8 | 67.0 | 95 | |

[A] Cover-up materials are tested at values greater than the maximum use phase to ground values. The maximum use phase to phase values relate to guarded phase to guarded phase. The units are not rated for bare phase to guarded phase potentials.

3.1.2 *self extinguishing*—relates to a property of a plastic material compounded so as to cease combustion on removal of the source that caused ignition.

## 4. Significance and Use

4.1 All three tests may be used for product design qualification.

4.2 This specification covers the minimum electrical, chemical, and physical properties designated by the manufacturer and the detailed procedures by which such properties are to be determined. The purchaser has the option to perform or have performed any of these tests and may reject equipment that fails to meet the standard criteria. Claims concerning failure to meet the specification are subject to verification by the manufacturer.

4.3 Plastic guard equipment is used for protection against accidental brush contact by the worker. A margin of safety shall be provided between the maximum voltage at which they are used and the proof-test voltage at which they are tested. This relationship is shown in Table 1 and Table 2. The equipment is designed only for phase-to-ground or covered phase-to-covered-phase exposure.

NOTE 1—Rubber insulating equipment is realistically limited to Class 4 material in the design specification standards. Plastic guard equipment has been designed to go beyond these voltages and provide a satisfactory degree of worker protection. Major differences exist in use criteria between the rubber and the plastic guard equipment. Each glove, sleeve, or other article of rubber insulating equipment has a given safety factor for the phase to phase voltage on which it may be used and the class or proof voltage at which it is tested. Plastic guard equipment, however, is designed to provide a satisfactory safety factor only when used in a phase-to-ground exposure. If exposure is phase-to-phase, then a satisfactory safety factor is only provided if the exposure is covered-phase-to-covered-phase.

4.4 Work practices vary from user to user, dependent upon many factors. These may include, but are not limited to, operating system voltages, construction design, work procedure techniques, weather conditions, etc. Therefore, except for the restrictions set forth in this specification because of design limitations, the use and maintenance of this equipment is beyond the scope of this specification.

4.5 It is common practice and the responsibility of the user of this type of protective equipment to prepare complete instructions and regulations to govern in detail the correct and safe use of such equipment.

## 5. Apparatus

5.1 *Voltage Source and Test Techniques*—See Test Method D149. The test equipment shall have adequate power and provide relatively stepless variable test voltage that can be raised at a rate of approximately 1000 V/s ac or 3000 V/s dc.

5.2 *Energized Inner Electrodes* , in accordance with Table 3 and Table 4. The length should be sufficient to extend past the ends of the guard or guard assemblies where appropriate.

5.3 *Outer Ground Electrode*—A conductive material with size and location as indicated in Table 3.

5.4 *Shielded Cable*—To reduce the "room influence" when conducting ac leakage tests, the cable from the pickup electrode to the current-measuring device should be a shielded cable with the cable shield grounded.

## 6. Sampling

6.1 Design tests of each product model shall be conducted to verify that the requirements of Table 1 and Table 2 are met.

6.2 *Design Tests*—Samples shall consist of sufficient specimens of each product used in a specific guard system to form one of each assembly intended for field use.

6.2.1 The design tests will be used to qualify a specific product model and normally will not be repeated during production.

6.2.2 *Acceptance Tests*— A test sample shall consist of one or more specimens dependent on the percentage of the lot being tested.

6.2.3 A lot is represented either by all the guards produced in one production run or in one shipment.

6.2.4 Lots of new or unused guards shall have test specimens selected at random.

## 7. Classification

7.1 Guards are furnished in three types of materials specified in Section 9 and explained as follows:

7.1.1 Type I guards are constructed of plastic material having mechanical impact properties suitable for cold weather service.

7.1.2 Type II guards have self-extinguishing plastic construction.

**TABLE 3 Typical Electrodes for Testing Plastic Guard Equipment**

| Type of Guards | Energized Inner Electrode for All Tests [A] | Outer Ground Electrode [A] | |
|---|---|---|---|
| | | Proof Test | Flashover and Leakage Tests |
| Line guards and line guard connectors | Round metal tube or bar. | Complete electode [B] shall be spaced back from openings through which the energized electrode protrudes during the test only as necessary to avoid flashover. Therefore, the entire area of each cover shall be tested as nearly as practical. | 4 by 6-in. flexible conductive pad placed alternately on all exterior surfaces and across conductor opening of guard and assembled guard system joints spaced back from openings through which the energized electrode protrudes during the test only as necessary to avoid flashover at outer ends. |
| Insulator covers and deadened covers | Maximum conductor, hardware and insulator assembly for which rated or similar mock-up including mandrel [C] of conductive material approximate. [D] | | |
| Pole guards, ridge pin and switch blade covers | [E] Round metal tube, fabricated mandrel [C] or cluster small metal tubes. [D] | | |
| Arm guards | Round or rectangular metal tube or fabricated mandrel. [C] [D] | | |
| Cutout covers | Largest cutout with bare leads covered with equal rated line hose. Or similar mock-up including mandrel [C] of conductive material. [D] | | |
| Structural barrier | Rectangular metal sheets approximately 3 mm (0.06 in.) thick, having smoothly rounded edges and corners, have been found to be satisfactory for this purpose. Also satisfactory are wet felt or sponge-top electodes. | | |

[A] Moistened electrodes may be secured with rubber straps or blanket pins. Pressure-sensitive tape is helpful in securing dry metal foil electrodes.
[B] Suitable materials include: metal foil or screen; tap water-moistened sponge sheeting, or blanket made of wool, or similar material including synthetics.
[C] Thin metal sheet or screen wire secured on wood frames make suitable electrodes. Carved synthetic sponge moistened with tap water is suitable for small forms.
[D] The dimensions of the mandrel are to approximate the maximum size of equipment to which the guard system is to be applied.
[E] Metal canisters made for storing rubber blankets make suitable electrodes for pole guard tests.

**TABLE 4 Inner Electrode Sizes**

| Class [A] | Rating—Max Use | | Inner Electrode Diameter, in. (mm) | |
|---|---|---|---|---|
| | kV | 60 Hz | Min | Max |
| | ϕ – ϕ | ϕ – Gr. | | |
| 2 | 14.6 | 8.4 | 0.25 (6.4) | 0.75 (19.1) |
| 3 | 26.4 | 15.3 | 0.25 (6.4) | 0.75 (19.1) |
| 4 | 36.6 | 21.1 | 0.25 (6.4) | 0.75 (19.1) |
| 5 | 48.3 | 27.0 | 0.50 (12.7) | 1.50 (38.1) |
| 6 | 72.5 | 41.8 | 0.75 (19.1) | 2.00 (50.8) |

[A] Cover-up materials are tested at values greater than the maximum use phase to ground values. The maximum use phase to phase values relate to guarded phase to guarded phase. The units are not rated for bare phase to guarded phase potentials.

7.1.3 Type III guards are constructed of self-extinguishing plastic material having mechanical impact properties suitable for cold weather service.

7.2 Guards are furnished in three grades in accordance with provisions for installation as follows:

7.2.1 Grade 1 guards have hot stick handles attached for installation.

7.2.2 Grade 2 guards are equipped with eyes for installation with removable hot sticks.

7.2.3 Grade 3 guards are intended for applications where the usual installation is by hand. These guards are equipped with rope loops, or their equivalent, so their removal may be accomplished with hot sticks.

7.2.3.1 *Example*—Pole guards installed on a pole prior to raising it close to overhead line conductors. After the pole is raised the guard is opened with hot sticks and allowed to slide down the pole where it can be safely removed by hand.

7.3 Guards are made in five classes in accordance with the voltage ratings in Annex A1.

## 8. Ordering Information

8.1 Orders for guards under this specification shall include the designation ASTM Specification F712 and should include the following information.

8.1.1 Quantity,

8.1.2 Name-description of guard or cover,

8.1.3 Type, see 7.1.1 through 7.1.3,

8.1.4 Grade, see 7.2.1 through7.2.3,

8.1.5 Class, see Table 1, Table 2, or Table 4,

8.1.6 Size, if applicable, see Section 11.

NOTE 2—A typical ordering description is as follows: 100 Line Guards, ASTM Specification F712, Type I, Grade 1, Class 3A, 4.5-ft long.

NOTE 3—It is expected that manufacturers will publish catalog data conforming to this specification that will combine the requirements of 8.1.2 and 8.1.6 in a single product number. With that system, a typical order description is: 100 (Smith Manufacturing Co., Product No. XXXX) Line Guards, ASTM Specification F712.

## 9. Materials

9.1 Principal construction of insulating body shells shall be in accordance with the material requirements as follows:

9.1.1 *Type I Guards*—Minimum 1.5 ft·lbf/in. (80.06 J/m of notch) notched izod impact strength at −20°F(−29°C); maximum water absorption 0.1 % by weight; minimum 380 V/mL (0.025 mm) dielectric strength.

9.1.2 *Type II Guards*—Minimum 1.0 ft·lbf/in. (53.4 J/m) notched izod impact strength at −20°F (−29°C); maximum water absorption 0.5 % by weight; minimum 320 V/mL (0.025 mm) dielectric strength; 94 V-O flame retardancy.

9.1.3 *Type III Guards*—Minimum 3.0 ft·lbf/in. (160.1 J/m of notch) notched izod impact strength at −20°F(−29°C); maximum water absorption 0.09 % by weight; minimum 300 V/mL (0.025 mm) dielectric strength; 94 V-O flame retardancy.

9.1.4 Material ratings for Notched Izod Impact Strength shall be in accordance with Test Methods D256, Method A.

9.1.5 Material ratings for water absorption shall be in accordance with Test Method D570.

9.1.6 Material ratings for dielectric strength shall be in accordance with Test Method D149.

9.1.7 Material ratings for flame retardancy shall be in accordance with UL Standard 94.

9.2 Handles of Grade 1 Guards shall be reinforced plastic and shall be capable of withstanding 100 kV at 60 Hz for each 1 ft (300 mm) of length for 5 min without heating or tracking. (See 5.6.2 of IEEE 978.)

9.3 Ropes and cords shall be nonconductive.

## 10. Electrical Requirements

10.1 Electrical properties shall meet the requirements shown in Table 1 and Table 2.

## 11. Dimensions

11.1 Some, but not all, guards are made in specific sizes in accordance with the requirements of their applications.

11.1.1 *Example*—Pole guards made in lengths 1 through 6 ft (300 through 1.8 m) and for poles 6, 9, or 12-in. diameter (150, 225 or 300 mm, respectively).

## 12. Installation of Assembled Guard System

12.1 The guard or assembled guard system is installed on a conductive electrode (Table 3) to be energized at various voltages in accordance with the rating of the guard and the type of test being conducted. The ground electrode shall be a conductive flexible cover or pad as specified in Table 3.

12.1.1 *Method A, Withstand Voltage Proof Test*—The withstand voltage is determined by energizing, at test voltage, the electrode (Table 3) for a predetermined period of time.

12.1.2 *Method B, Flashover Voltage Test*—The flashover voltage is established by energizing the electrode (Table 3) to the point of flashover.

12.1.3 *Method C, Leakage Current Test*—The leakage current (13.10) is the current between the ground electrode (Table 3) and the energized electrode with the specimen energized at test voltage specified for the Withstand Voltage Proof Test (Table 1).

## 13. Procedure

13.1 **Warning**—The test apparatus shall be designed to afford the operators full protection in the performance of their duties. A reliable means of de-energizing and grounding the high-voltage circuit shall be provided. It is particularly important to incorporate a positive means of grounding the high-voltage section of d-c test apparatus due to the likely presence of high-voltage capacitance charges at the conclusion of the test (see ANSI C39.5).

13.2 Contaminated specimens shall be cleaned in accordance with the manufacturers' recommendations.

13.3 When testing multiple or identical specimens, or both, identify each specimen tested.

13.4 Refer to Table 3 and Table 4 to determine the electrodes appropriate for the guard and type of test to be run.

13.5 Connect a safety ground to the de-energized bus. Set up the inner electrode of size and type indicated in Table 3 and Table 4 and install a specimen on it.

13.6 Install the outer electrode as indicated in Table 3 and connect to ground.

13.7 Remove the safety ground and apply voltage at a rate of approximately 1000 V/s ac or 3000 V/s dc.

13.8 At the termination of the test period decrease the voltage approximately 1000 V/s ac or 3000 V/s dc until 50 % of test value is reached at which point the power supply may be de-energized.

13.9 Connect a safety ground, remove the outer electrode, and examine the specimen.

13.10 Maximum leakage tests require additional procedures as follows:

13.10.1 The proof test specimen may be elevated at least momentarily to a higher voltage than specified for the leakage test before connecting a current-measuring device.

13.10.2 Series connect the micro-ammeter at the grounded end of the lead from the outer electrode.

13.10.3 Record the test room interference current, μA(1), with the power supply and lead energized at the test voltage. The lead from the power supply should not be connected to the inner electrode during this measurement.

13.10.4 Connect the inner electrode to the test bus, apply the voltage, and record the gross μA(2).

13.10.5 Subtract μA(1) from μA(2) to determine the net μA(3), which is the test value.

13.11 Unless instructions to the contrary are included with the test order, guards that fail shall be indelibly marked REJECTED.

13.12 When included in the test order, guards that pass shall be marked PASSED. Marking shall include the ASTM designation number (see 1.1) and whether Methods A, B, or C were used.

13.13 The marking shall be non-conducting and non-injurious to the insulation system.

## 14. Workmanship, Finish, and Appearance

14.1 Guards shall be free of splits, punctures, gouges, or other structural defects that might affect insulating properties.

14.2 Minor surface imperfections that do not affect insulation properties required by Table 1 and Table 2 are not cause for rejection.

## 15. Inspection

15.1 Inspection shall include:

15.1.1 Size specified on order, if applicable,

15.1.2 Workmanship as indicated in Section 14, and

15.1.3 Markings in accordance with Section 18.

## 16. Acceptance, Rejection, and Rehearing

16.1 Inspection shall be in accordance with Section 15. Individual guards that do not conform may be rejected.

16.2 Testing may be required by a user prior to acceptance or being placed in service. When required, the Withstand Voltage Proof Test, in accordance with Table 1, may be used on all or part of a lot of guards.

16.3 Material that fails to conform to the requirements of this specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer or supplier may make claim for a rehearing.

## 17. Certification

17.1 When specified in purchase order or contract, a producer's or supplier's certification shall be furnished to the purchaser stating that the guards were manufactured, sampled, tested, and inspected in accordance with this specification and have been found to meet its requirements. When specified in the purchase order or contract, a report of design tests shall be furnished.

## 18. Marking

18.1 Guards shall be marked with the name or logo of the manufacturer, identity number, and lot code to indicate month and year of manufacture, for example, "__ kV Guarded Phase to Guarded Phase" and "__ kV Phase to Ground."

18.2 A packing list shall be provided with each shipment indicating manufacturer's product numbers and quantities of each different guard.

## 19. Packaging

19.1 Each shipment shall be packaged to provide protection of contents normally appropriate for selected mode of transportation.

## 20. Report

20.1 The report, if required, shall include:

20.1.1 Type of test as indicated in 1.1,

20.1.2 Identification and description of the test specimens ratings and conditions,

20.1.3 Size, material, and locations of the test electrodes with voltage used, results for each location, and whether the ASTM specifications are met,

20.1.4 In maximum leakage test reports, three values in accordance with 13.10.3 through 13.10.5 or μA(3) net leakage at each electrode location and μA(1) correction factor that was applied,

20.1.5 Organization test facility and address, test date, and person or persons conducting the test and writing the report, and

20.1.6 Atmospheric data of room temperature, barometric pressure, and dry- and wet-bulb temperatures at the test site during these tests.

## 21. Precision and Bias

21.1 No statement is made about either the precision or the bias of the test methods in this standard for measuring the dielectric strength since the results merely state whether there is conformance to the criteria for success specified in the procedure.

21.2 Each testing agency has the responsibility of judging the acceptability of its own results. The precision of the results is a function of the procedures, facilities utilized, as well as compliance to the recommended industry state-of-the-art practices. Reproducible analysis determinations by different users can be achieved only with identical facilities and trained conscientious personnel.

21.3 The test equipment shall be of such a quality that the applied voltage shall be within ±5 % of the specified test voltage.

21.4 The current-measuring device shall be of such a quality that the current measured shall be accurate to within ±3 % of full scale.

## 22. Keywords

22.1 electrical protective equipment; electrically insulating plastic guard equipment; plastic guard equipment