Designation: F855 – 20

Standard Specifications for Temporary Protective Grounds to Be Used on De-energized Electric Power Lines and Equipment [1]

This standard is issued under the fixed designation F855; 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 specifications cover the equipment making up the temporary grounding system used on de-energized electric power lines, electric supply stations, and equipment.

1.2 It is common practice for the users of protective grounding equipment to prepare complete instructions and regulations to govern in detail the correct use and maintenance of such equipment.

1.3 The uses and maintenance of this equipment are beyond the scope of these specifications.

1.4 These specifications for a system of protective grounding utilizing copper cables are covered in four parts, as follows:

	Sections
Clamps for Temporary Protective Grounds	4 – 16
Ferrules for Temporary Protective Grounds	17 – 30
Cables for Temporary Protective Grounds	31 – 39
Protective Grounds (Complete Assembly With Clamps, Ferrules, and Cable)	40 – 52

1.5 Each of the four parts is an entity of itself, but is listed as a part of the system for completeness and clarification.

1.6 Currents presented in Table 1 are based upon cable melting times, as determined from equations by I. M. Onderdonk and are to used in situations involving an asymmetry value less than 20 % ($X/R \leq 1.8$). See Appendix X1.

1.6.1 Currents presented in Table 2 are based upon the values from EPRI Project RP2446 Computer Program RTGC "A Desktop Computer Program for Calculating Rating of Temporary Grounding Cables" and are to be used in situations involving an asymmetry value greater than 20 % ($X/R \geqq 1.8$), see Appendix X2.

NOTE 1—Table 1 represents the clamp and assembly ratings that existed prior to this revision. Table 2 represents new ratings now required for high *X/R* situations.

1.6.2 See Appendix X1 and Appendix X2 for a discussion of these topics.

1.7 The values stated in Newton-Meter units are to be regarded as the standard. The values in parentheses are the inch-pound units.

1.8 The following precautionary caveat pertains to the test method portions, Sections 12 and 25 of these specifications: *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.9 *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]

B172 Specification for Rope-Lay-Stranded Copper Conductors Having Bunch-Stranded Members, for Electrical Conductors

B173 Specification for Rope-Lay-Stranded Copper Conductors Having Concentric-Stranded Members, for Electrical Conductors

D470 Test Methods for Crosslinked Insulations and Jackets for Wire and Cable

D753 Specification for General Purpose Polychloroprene Jacket for Wire and Cable (Withdrawn 1984)[3]

D2219 Specification for Poly(Vinyl Chloride) Insulation for Wire and Cable, 60°C Operation

D2633 Test Methods for Thermoplastic Insulations and Jackets for Wire and Cable

D2768 Specification for General-Purpose Ethylene-Propylene Rubber Jacket for Wire and Cable (Withdrawn 2007)[3]

[1] These specifications are under the jurisdiction of ASTM Committee F18 on Electrical Protective Equipment for Workers and are the direct responsibility of Subcommittee F18.45 on Mechanical Apparatus.

Current edition approved Sept. 15, 2020. Published October 2020. Originally approved in 1983. Last previous edition approved in 2019 as F855 – 19a. DOI: 10.1520/F0855-20.

[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] The last approved version of this historical standard is referenced on www.astm.org.

TABLE 1 Protective Ground Cable, Ferrule, Clamp and Assembly Ratings for Symmetrical Current

Grade	Grounding Clamp Torque Strength, min				Short Circuit Properties[A]							Continuous Current Rating, A RMS, 60 Hz
	Yield[B]		Ultimate		Withstand Rating, Symmetrical kA RMS, 60 Hz			Ultimate Rating Capacity[CD], Symmetrical kA RMS, 60 Hz				
	lbf·in.	n·m	lbf·in.	n·m	15 cycles (250 ms)	30 cycles (500 ms)	Copper Cable Size	15 cycles (250 ms)	30 cycles (500 ms)	60 cycles (1 s)	Maximum Copper Test Cable Size	
1	280	32	330	37	14	10	#2	18	13	9	2/0	200
2	280	32	330	37	21	15	1/0	29	21	14	4/0	250
3	280	32	330	37	27	20	2/0	37	26	18	4/0	300
4	330	37	400	45	34	25	3/0	47	33	23	250 kcmil	350
5	330	37	400	45	43	30	4/0	59	42	29	250 kcmil	400
6	330	37	400	45	54	39	250 kcmil or 2 2/0	70	49	35	350 kcmil	450
7	330	37	400	45	74	54	350 kcmil or 2 4/0	98	69	48	550 kcmil	550

[A] Withstand and ultimate short circuit properties are based on performance with surges not exceeding 20 % asymmetry factor (see 9.1 and 12.3.4.2).
[B] Yield shall mean no permanent deformation such that the clamp cannot be reused throughout its entire range of application.
[C] Ultimate rating represents a symmetrical current which the assembly or individual components shall carry for the specified time.
[D] Ultimate values are based upon application of Onderdonk's equation to 98 % of nominal circular mil area allowed by Specifications B172 and B173.

NOTE 1—TPG testing is done on complete assemblies. Assembly ratings assume the grade of lowest graded component (see 43.1.6).

D2770 Specification for Ozone-Resisting Ethylene-Propylene Rubber Integral Insulation and Jacket for Wire and Cable (Withdrawn 2007)[3]
E8/E8M Test Methods for Tension Testing of Metallic Materials

2.2 *ANSI/IEEE Standard:*[4]
C 37.09 Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Basis

2.3 *ICEA/NEMA Standard:*[5]
ICEA S-19-81/NEMA WC 3-80 (R 1986) Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

2.4 *IEC Standard:*[6]
IEC 61230 Ed. 2, 2008, Portable Equipment for Earthing or Earthing and Short-Circuiting

2.5 *IEEE Standard:*[7]
IEEE 386 Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V
IEEE 1048 Guide for Protective Grounding of Power Lines
IEEE 1246 Guide for Temporary Protective Grounding Systems Used in Substations

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *continuous current rating*—designated RMS current which can be carried continuously under specified conditions.

3.1.2 *protective ground assembly*—a temporary electrical connection between a source of potential energization and the earth, rated for the maximum anticipated fault current or continuous induced current, or both.

3.1.2.1 *Discussion*—Throughout this specification, kc mil = 1000 circular mils.

3.1.3 *protective grounding equipment*—devices installed temporarily on de-energized electric power circuits for the purposes of potential equalization and to conduct a short circuit current for a specified duration (time).

3.1.4 *time to failure*—failure time of the cable is the time between the initiation of current flow and the instant at which arcing begins.

3.1.5 *ultimate capacity*—this represents a current which it is calculated the component is capable of conducting for the specified time. It is expected that component damage may result. The component shall not be reused, except in test situations.

3.1.6 *withstand rating*—this represents a near symmetrical current which shall be conducted without any component being damaged sufficiently to prevent being operable and reusable. The protective ground shall be capable of passing a second test at this current after being cooled to ambient temperature.

CLAMPS FOR TEMPORARY PROTECTIVE GROUNDS

4. Scope

4.1 This specification covers clamps used with ferrules and elastomer or thermoplastic covered flexible cable in the manufacture of protective grounds installed temporarily for protective grounding of de-energized circuits.

[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 The Insulated Cable Engineers Association, Inc. (ICEA), P.O. Box 2694, Alpharetta, GA 30023, http://www.icea.net.
[6] Available from International Electrotechnical Commission (IEC), 3 rue de Varembé, Case postale 131, CH-1211, Geneva 20, Switzerland, http://www.iec.ch.
[7] 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.

TABLE 2 Ultimate Assembly Rating for High *X/R* Ratio Applications

Grade Size	Rating Rated Current (kA)	High Asymmetrical Test Requirements *X/R* = 30 Cycle Current Peak Values (kA) Rating X 2.69															Test Duration (cycles)	I^2t (Mega amps^2-s)
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th		
1H	15	41	37	34	32	30	28	27	26	25	25	24	24	23	23	23	15	74
2H	25	68	62	57	53	50	47	45	43	42	41	40	39	38	38	38	15	208
3H	31	84	76	70	65	61	58	56	53	52	50	49	48	47	47	46	15	312
4H	39	105	96	88	82	77	73	70	67	65	63	62	61	60	59	58	15	501
5H	47	127	116	106	99	93	88	84	81	78	76	74	73	72	71	70	15	728
6H	55	148	135	124	116	109	103	98	94	91	89	87	85	84	83	82	15	997
7H	68	183	167	154	143	134	127	121	117	113	110	107	105	104	102	101	15	1523

NOTE 1—The above current values are based on electromechanical test values.
NOTE 2—Assemblies that have been subjected to these shall not be re-used.
NOTE 3—For use with currents exceeding 20 % asymmetry factor.
NOTE 4—See X2.7.2 for additional information.
NOTE 5—Alternate testing circuits are available for laboratories that cannot achieve the above requirements. See Appendix X2 for details.

5. Classification

5.1 Clamps are furnished in, but not limited to, three types according to their function and method of installation, as follows:

5.1.1 *Type I*—Clamps for installation on de-energized conductors equipped with eyes for installation with removable hot sticks.

5.1.2 *Type II*—Clamps for installation on de-energized conductors having permanently mounted hot sticks.

5.1.3 *Type III*—Clamps for installation on permanently grounded conductors or metal structures with tee handles, and eyes or square or hexagon head screw(s), or both.

5.1.4 Other types of special clamps, such as those for cluster grounds or for underground equipment grounding, may be made, tested, and certified by the manufacturer as meeting the requirements of this specification.

5.1.5 Separable insulated connectors used in manufacturing underground equipment grounding assemblies shall meet the requirements of IEEE 386.

5.2 Clamps are furnished in grades according to mechanical strengths, short circuit capabilities, and duration of faults, as indicated in Table 1 or Table 2. For Table 1 grade designations, clamp ratings must include maximum use current and indication whether testing was done at Ultimate or Withstand Ratings. The maximum use current listed shall not exceed the test current used in their electrical short circuit design tests (per 12.3.4).

5.3 Clamps are furnished in two classes according to the characteristics of the main contact jaws:

5.3.1 *Class A*—Clamp jaws with smooth contact surfaces.

5.3.2 *Class B*—Clamp jaws with serrations, or cross hatching, or other means intended to abrade or bite through corrosion products on the surfaces of the conductor being clamped.

6. Sizes

6.1 Clamp size is the combination of the main contact and cable size ranges as listed by the manufacturers. It should be noted that the main contact may connect to a cable or bus bar or be used at the "ground end" to connect to a variety of conductive grounded objects.

7. Ordering Information

7.1 Orders for clamps under this specification shall include this ASTM designation and the following information:

7.1.1 Quantity,

7.1.2 Name (grounding clamp),

7.1.3 Main contact size ranges, conductor descriptions, and materials which are to be clamped by main contact,

7.1.4 Cable size, material, and description by which clamps are to be assembled,

7.1.5 Type (see 5.1),

7.1.6 Grade (see 5.2 and Table 1 or Table 2),

7.1.7 Class (see 5.3),

7.1.8 Asymmetrical current or other supplementary requirements, if applicable. (See Supplementary Requirements S1 to S10 for styles and designs.)

NOTE 2—A typical ordering description is as follows: 100 Grounding Clamps, Main contact range #2 to 350 kcmil for 2/0 Copper flexible grounding cable, ASTM F855, Type 1, Grade 3, Class A, Design C, Style 7.

NOTE 3—It is expected that manufacturers will publish catalog data conforming to this specification that will combine the requirements of 7.1.1 – 7.1.8 in a single product number. With that system, a typical order description is: 100 (Smith Manufacturing Co. Product No. XXXX) grounding clamps ASTM F855, Grade 2-max use 21kA, Ultimate Rating.

8. Materials

8.1 Current carrying parts made of copper base or aluminum base alloy shall have the following material properties in accordance with Test Methods E8/E8M:

	Copper Base Alloy	Aluminum Base Alloy
Tensile strength, min	207 MPa (30 000 psi)	207 MPa (30 000 psi)
Yield strength, min	90 MPa (13 000 psi)	138 MPa (20 000 psi)
Elongation, min	6 %	3 %

8.2 Type II clamps shall be equipped with an insulating handle (hot stick) appropriate for the nominal voltage of the circuit to be grounded.

9. Electrical and Mechanical Properties

9.1 Electrical and mechanical properties shall conform to the requirements prescribed in Table 1 or Table 2, as appropriate, and the following paragraphs. See Appendix X1 for a discussion and derivation of the current levels in Table 1. See Appendix X2 for a discussion of the effects of asymmetrical current and the derivation of the currents in Table 2.

9.1.1 Types I and II stick installed clamps shall be designed such that a failure does not increase the risk of injury to the user or have excess mechanical strength to prevent failure, defined as follows:

9.1.1.1 In the event the clamp is over-torqued during installation, normal fracture shall be such that the attached cable remains under control by being retained with the stick.

9.1.1.2 Clamps with an ultimate torque strength exceeding 45 N·m (400 lbf·in.) are exempt from the provisions of 9.1.1.1.

9.1.2 Resistance from the main contact to the attached cable contact shall be less than that for an equal length of maximum size cable(s) for which the clamp is rated.

9.1.3 Main contacts shall accept and clamp all conductors or structural members in accordance with the manufacturer's rating.

9.1.4 Clamp shall accept hand assembly of all cables fitted with compatible ferrules as rated per Table 3.

9.1.5 Cable termination shall include a cable support or shall be made to accept a cable supporting ferrule. This support shall secure the entire cable over the jacket and is provided in addition to the electrical connection to the strand.

9.1.6 Type I clamps shall be operable with clamp sticks and shall fit securely inside a nominal 13 mm (½ in.) wide slot in the head of the stick.

10. Workmanship, Finish, and Appearance

10.1 Components shall be free of structural porosity, fins, sharp edges, splits, cracks, and other defects that affect handling or performance.

10.2 All parts shall be formed, machined, and assembled with sufficient accuracy for smooth operation by hand, and