



Designation: F2321 – 14 (Reapproved 2020)

Standard Specification for Flexible and Rigid Insulated Temporary By-Pass Jumpers¹

This standard is issued under the fixed designation F2321; 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 manufacture and testing of flexible insulated temporary By-Pass jumpers (By-Pass jumpers) used on energized power lines and equipment.

1.2 It is common practice for the user of this protective equipment to prepare complete instructions and safety regulations to govern in detail the correct and safe use of such equipment. Also see 4.2.

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

1.4 These specifications for a system of By-Pass jumpers is covered in four parts as follows:

Title	Sections
Clamps for By-Pass Jumpers	5 – 17
Ferrules for By-Pass Jumpers	18 – 31
Cable for By-Pass Jumpers	32 – 40
By-Pass Jumpers (complete assembly with clamps, ferrules, and cable)	41 – 55

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 The values stated in SI units are to be regarded as the standard. See [IEEE/ASTM SI 10](#).

1.7 The following precautionary caveat pertains only to the test method portions, Sections 13, 26, 48, and 55 of this specification. *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.*

1.8 *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 Recom-*

mendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 ASTM Standards:²

[B33](#) Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes

[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

[D2768](#) Specification for General-Purpose Ethylene-Propylene Rubber Jacket for Wire and Cable (Withdrawn 2007)³

[D2770](#) Specification for Ozone-Resisting Ethylene-Propylene Rubber Integral Insulation and Jacket for Wire and Cable (Withdrawn 2007)³

[D2802](#) Specification for Ozone-Resistant Ethylene-Alkene Polymer Insulation for Wire and Cable

[D2865](#) Practice for Calibration of Standards and Equipment for Electrical Insulating Materials Testing

[E8](#) Test Methods for Tension Testing of Metallic Materials [Metric] E0008_E0008M

[F819](#) Terminology Relating to Electrical Protective Equipment for Workers

[IEEE/ASTM SI 10](#) American National Standard for Metric Practice

2.2 ANSI Standards:⁴

[ANSI C39.5](#) Safety Requirements for Electrical and Electronic Measuring and Controlling Instruments

[ANSI C84.1](#) Voltage Ratings for Electric Power Systems and Equipment (60 Hz)

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.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

¹ This specification is under the jurisdiction of ASTM Committee F18 on Electrical Protective Equipment for Workers and is the direct responsibility of Subcommittee F18.45 on Mechanical Apparatus.

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ANSI C119.4 American National Standard for Electrical Connectors

2.3 NEMA Standard:⁵

WC 8 Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (formerly ICEA S-68-516)

3. Terminology

3.1 Definitions:

3.1.1 *flexible and rigid insulated temporary By-Pass jumpers*—devices designed and used to keep electric supply circuits effectively continuous (electrically bridged) for short periods of time at work locations when conductors or equipment may otherwise be opened or made electrically discontinuous during work operations.

3.1.1.1 *Discussion*—The devices are normally installed, used, and removed as part of a protective insulating system composed of insulating covers and/or observances of required minimum safe approach distances for workers.

3.1.2 *voltage, normal design*—a nominal value consistent with the latest revision of ANSI C84.1, assigned to the circuit or system for the purpose of conveniently designating its voltage class.

3.1.3 *voltage, maximum use*—the ac voltage (rms) classification of the protective equipment that designates the maximum nominal design voltage of the energized system that may be safely worked. The nominal design voltage is equal to phase-to-phase voltage on multiphase circuits.

3.1.3.1 *Discussion*—If there is no multiphase exposure in a system area, and the voltage exposure is limited to phase (polarity on dc systems) to ground potential, the phase (polarity on dc systems) to ground potential shall be considered to be the nominal design voltage.

3.1.3.2 *Discussion*—If electrical equipment and devices are insulated or isolated, or both, such that the multiphase exposure on a grounded wye circuit is removed, then the nominal design voltage may be considered as the phase-to-ground voltage on that circuit.

NOTE 1—The work practices and methods associated with removing multiphase exposures at any given work site are not addressed in this specification.

3.2 For definitions of other terms, refer to Terminology F819.

4. Significance and Use

4.1 These specifications cover the minimum electrical and physical properties designated by the manufacturer and the detailed procedures by which such properties are to be determined. The purchaser may at his option perform or have performed any of these tests in order to verify the manufacturer's designation. Claims for failure to meet the specification are subject to verification by the manufacturer.

4.2 By-Pass jumpers are devices designed and used to keep electrical circuits effectively continuous (electrically bridged)

⁵ Available from National Electrical Manufacturers Association (NEMA), 1300 N. 17th St., Suite 1847, Rosslyn, VA 22209.

for short periods of time at work locations when conductors or equipment may otherwise be opened or made discontinuous during work operations. By-Pass jumpers are insulated to temporarily protect personnel from brush or accidental contact only; therefore, when authorizing their use, a margin of safety should be provided between the maximum voltage used on, and the proof-test voltage at which they are tested. The relationship between proof-test voltage and the maximum voltage at which By-Pass jumpers are used is shown in Table 1. **Warning**—Portions of these devices (clamps and ferrules) are not insulated and offer no protection from accidental contact.

CLAMPS FOR BY-PASS JUMPERS

5. Scope

5.1 This specification covers clamps used in the assembly of By-Pass jumpers.

6. Classification

6.1 Clamps are furnished in, but not limited to, two styles according to their function and method of installation.

6.1.1 *Style I*—Clamps equipped with insulated handles for installation on energized conductors with rubber gloves. See Fig. 1.

6.1.1.1 Insulated handles may be either clear or opaque.

6.1.1.2 Insulating materials used in this specification include thermo-set plastic, elastomers, elastomer compounds, thermoplastic polymers or any combination, regardless of origin.

6.1.2 *Style II*—Clamps equipped with provisions for installation on energized conductors with live line tools. See Fig. 2 and Fig. 3.

6.1.2.1 Clamps are furnished according to mechanical strength and current rating. See Table 2.

6.2 Clamps are furnished in two classes according to the characteristics of the main contact jaws.

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

6.2.2 *Class B*—Clamp jaws with serrations, crosshatching or other means intended to abrade or bite through corrosion products on the surface of the conductor being clamped.

7. Sizes

7.1 Clamp size is the combination of the main contact and cable size ranges as listed by the manufacturers.

8. Ordering Information

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

TABLE 1 Proof Test/Use Voltage Relationship

Voltage Rating	Maximum Use Voltage (rms) V	AC Proof Test Voltage (rms) V	DC Proof Test Voltage (avg) V
15 kV	15 000	20 000	50 000
25 kV	25 000	30 000	60 000
35 kV	35 000	40 000	70 000
69 kV	69 000	74 000	



FIG. 1 Style I Clamp



FIG. 3 Style II Duck Bill Shape Clamp



FIG. 2 Style II "C" Shape Clamp

TABLE 2 Clamp Torque Strength, min—Style II Clamps

Cable Size (AWG)	Continuous Current A, rms, 60 Hz	Yield ^A N-m (lbf in.)	Ultimate N-m (lbf in.)
#2	200A	32 (280)	37 (330)
1/0	250A	32 (280)	37 (330)
2/0	300A	32 (280)	37 (330)
4/0	400A	37 (330)	45 (400)

^A Yield shall mean no permanent deformation such that the clamp cannot be reused throughout its entire range of application.

TABLE 3 Material Properties

	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 %

- 8.1.1 Quantity,
- 8.1.2 Name (By-Pass Jumper Clamp),
- 8.1.3 Main contact size ranges, conductor descriptions, and type of materials which are to be clamped,
- 8.1.4 Cable size, material, and description by which clamps are to be assembled,
- 8.1.5 Style (see 6.1),
- 8.1.6 Class (see 6.2), and
- 8.1.7 Clamps for By-Pass jumpers, at the customer's request, shall meet ANSI C119.4.

9. Materials

9.1 Current carrying parts of copper base or aluminum base alloy shall meet the material properties shown in Table 3 and in accordance with Test Methods E8.

10. Electrical and Mechanical Properties

10.1 Materials used shall meet the requirements of 9.1.

10.2 Electrical and mechanical properties shall conform to the requirements prescribed in Tables 1-3 and with the following:

NOTE 2—Style II clamps are uninsulated and do not require conformance with the electrical requirements of Table 1.

10.2.1 Clamps shall accept hand assembly of all cables fitted with compatible ferrules as rated per Table 2.

10.2.2 Main contacts shall accept and clamp all conductors according to the manufacturer's recommendation.

10.2.3 Style II clamps shall have the following properties:

10.2.3.1 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 live line tool. Clamps with an ultimate torque strength exceeding 45 N-m (400 lbf in.) are exempt from this provision.

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



FIG. 1 Style I Clamp



FIG. 3 Style II Duck Bill Shape Clamp



FIG. 2 Style II "C" Shape Clamp

TABLE 2 Clamp Torque Strength, min—Style II Clamps

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Elongation, min	6 %	3 %

- 8.1.1 Quantity,
- 8.1.2 Name (By-Pass Jumper Clamp),
- 8.1.3 Main contact size ranges, conductor descriptions, and type of materials which are to be clamped,
- 8.1.4 Cable size, material, and description by which clamps are to be assembled,
- 8.1.5 Style (see 6.1),
- 8.1.6 Class (see 6.2), and
- 8.1.7 Clamps for By-Pass jumpers, at the customer's request, shall meet ANSI C119.4.

9. Materials

9.1 Current carrying parts of copper base or aluminum base alloy shall meet the material properties shown in Table 3 and in accordance with Test Methods E8.

10. Electrical and Mechanical Properties

10.1 Materials used shall meet the requirements of 9.1.

10.2 Electrical and mechanical properties shall conform to the requirements prescribed in Tables 1-3 and with the following:

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10.2.1 Clamps shall accept hand assembly of all cables fitted with compatible ferrules as rated per Table 2.

10.2.2 Main contacts shall accept and clamp all conductors according to the manufacturer's recommendation.

10.2.3 Style II clamps shall have the following properties:

10.2.3.1 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 live line tool. Clamps with an ultimate torque strength exceeding 45 N-m (400 lbf in.) are exempt from this provision.

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

18.2 Two styles of ferrules are available and are designated as shrouded or unshrouded.

19. Classification

19.1 Ferrules are furnished in four types as follows:

19.1.1 *Type I*—Compression ferrule is cylindrical and made for installation on cable stranding by compression.

19.1.2 *Type III*—Plain stud-shrouded compression ferrule has a stepped bore that accepts entire cable and jacket. (See Fig. 4.)

19.1.3 *Type IV*—Threaded stud shrouded compression ferrule has a stepped bore that accepts entire cable over jacket and has male threads at forward end. (See Fig. 5.)

19.1.4 *Type VI*—Threaded stud compression ferrule has male threads at forward end. (See Fig. 6.)

20. Size

20.1 Ferrule size is the combination of cable capacity, stud description, and size after installation of cable.

21. Ordering Information

21.1 Orders for ferrules under this specification should include this ASTM designation and the following information:

- 21.1.1 Quantity,
- 21.1.2 Name (By-Pass Jumper Cable Ferrules),
- 21.1.3 Description, and material of clamp in which ferrule is to be installed,
- 21.1.4 Cable description to include conductor size, material and outside diameter of insulation on which ferrule is to be installed, and
- 21.1.5 Type (see 19.1).

22. Materials

22.1 Current carrying parts of copper base or aluminum base ferrules shall meet the following requirements:

- 22.1.1 *Copper Base Alloy*—Copper content 60 % minimum.
- 22.1.2 *Aluminum Base Alloy*—Aluminum content 90 % minimum.

23. Electrical and Physical Properties

23.1 Closed end ferrules utilizing the compression method of cable installation may have a 3 mm (0.125 in.) minimum

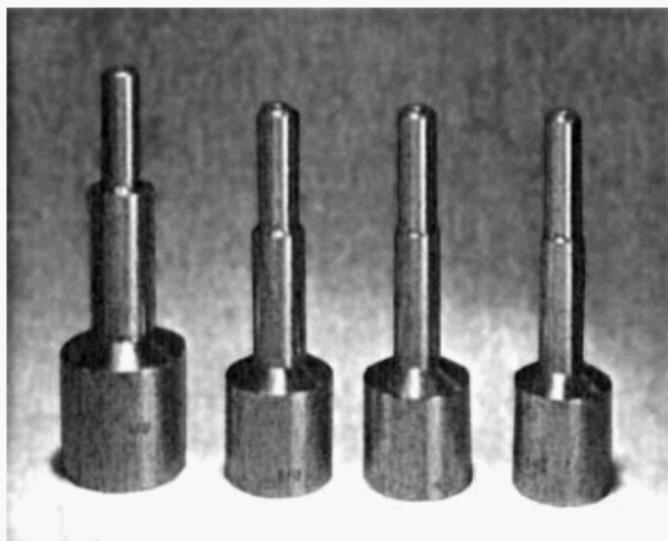


FIG. 4 Type III Plain Stud-Shrouded Compression Ferrule



FIG. 5 Type IV Threaded Stud-Shrouded Compression Ferrule



FIG. 6 Type VI Threaded Stud Compression Ferrule

diameter inspection vent hole through one side at the bottom of the (cable) bore. This applies to Types III, IV, and VI.

23.2 Ferrules shall accept cables for which they are rated without alteration of strands, and can be assembled by hand with compatible clamps.

24. Workmanship, Finish and Appearance

24.1 Components shall be free of structural defects that affect installation, assembly or performance.

24.2 Minor surface irregularities that do not affect strength or performance are not cause for rejection.

25. Sampling

25.1 A product model represents a manufacturer’s design specification according to which the production lot is manufactured.

25.2 A production lot shall consist of all ferrules of one product model produced at one time.

25.3 A test sample shall consist of two specimens selected at random from a production lot for each different test specified. When a failure occurs in one specimen from the first sample, a second sample shall be selected from the same lot and tested. If the second sample (two specimens) passes, the lot shall be acceptable. If one specimen from the second sample fails, the lot shall be rejected.

26. Design Tests

26.1 Design tests shall be made on test samples of each product model to verify that the requirements of the specification are met.

26.2 Continuous Current Rating:

26.2.1 Test the ferrules at the continuous current rating. The temperature shall be measured at the warmest spot on the clamp and on the metal strand at the midpoint of an attached cable, which is a minimum of 1.5 m (5 ft) in length. The maximum temperature of the ferrule shall be lower than the midpoint temperature of the maximum size copper cable for which the ferrule is rated.

27. Inspection

27.1 Visual and gauging inspection shall verify workmanship, finish, and appearance in accordance with Section 24.

28. Acceptance, Rejection, and Rehearing

28.1 At the option of the purchaser, a production lot may be subjected to the following:

28.1.1 Gauging inspection in accordance with Section 27. Individual ferrules that do not conform may be rejected.

28.1.2 A test sample may be tested for continuous current, in accordance with Table 4.

28.1.3 Failure of two specimens from two test samples, which have been properly installed according to the manufacturer's specifications, shall be cause for rejection of the production lot from which the samples were taken.

28.1.4 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.

29. Certification

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

30. Product Marking

30.1 Ferrules shall be marked with the manufacturer's identity code.

TABLE 4 By-Pass Jumper Cable Design and Ratings

Conductor Size (AWG)	Stranding, (min)	Current Rating A, rms, 60 Hz	Insulation, min. (mils)			Jacketing, min (mils)
			15 kV	25 kV	35 kV	
#2	133	200	175	^A	^A	65
1/0	259	250	175	260	345	65
2/0	259	300	175	260	345	65
4/0	359	400	175	260	345	65

^A Conductor size #2 unavailable for the 25 kV and 35 kV ratings.

31. Packaging

31.1 Each shipment shall be packaged to provide protection of the contents appropriate for the mode of transportation.

CABLE FOR BY-PASS JUMPERS

32. Scope

32.1 This specification covers the material, construction, and testing of the cable used in the manufacture of By-Pass jumpers.

33. Classification

33.1 By-Pass jumper cables have flexible stranded copper conductors, insulated with ethylene-propylene rubber (EPR). A heavy duty polyethylene jacket can be applied directly over the insulation for additional mechanical protection. Cables covered under this specification are designated as Jacketed and Non-Jacketed.

33.2 Flexible portions of By-Pass jumpers should remain suitably flexible for application and removal in temperatures down to -29°C (-20°F).

33.3 *Type I*—Insulated cable without a protective jacket.

33.4 *Type II*—Insulated cable with a protective jacket.

33.5 *Voltage Ratings*—There are three voltage ratings for By-Pass jumpers, 15kV, 25kV, and 35kV. (See Table 1.)

34. Size

34.1 Cable conductor sizes shall be stated in American Wires Gage numbers (AWG) #2, 1/0, 2/0, and 4/0.

35. Ordering Information

35.1 Orders for cables under this specification shall include this ASTM designation and the following information:

35.1.1 Quantity,

35.1.2 Unit of measure, (meters or feet),

35.1.3 Conductor size (see 34.1),

35.1.4 Type (see 33.3 and 33.4), and

35.1.5 Voltage Ratings (see 33.5).

36. Materials

36.1 Copper Conductor:

36.1.1 Rope-Lay-Stranded Copper Conductors Having Bunch Stranded or Concentric Stranded Members—Specifications B172, or B173 or tinned, round, soft or annealed copper wire—Specification B33.

36.2 Conductor Shielding:

36.2.1 Conductor shield (stress control layer)—conductor—NEMA WC 8, Part 2, paragraph 2.7.

36.3 Insulation:

36.3.1 Insulation shall be Ethylene-Propylene-rubber (EPR)—NEMA WC 8, Part 3 at test voltage for 100 % insulation level.

36.3.2 Ethylene-Propylene-rubber shall meet the specifications of Specification D2768, Specification D2770, or Specification D2802.

36.3.3 The minimum insulation thickness for the cable used in By-Pass jumpers is listed in Table 4.

36.3.4 For jacketed cable, the jacket shall be extruded directly over the insulation and shall be Neoprene or Chlorosulfonated Polyethylene—NEMA WC 8, Part 4 or thermosetting rated 90°C.

37. Workmanship, Finish, and Appearance

37.1 Cable shall be free of structural defects that affect installation, assembly, or performance.

37.2 Minor surface irregularities that do not affect strength or performance are not cause for rejection.

38. Design and Current Ratings

38.1 The design and current ratings for the cable used in By-Pass jumpers are listed in Table 4.

39. Certification

39.1 When specified in the purchase order or contract, a producer or supplier's certification shall be furnished to the purchaser that the cable was manufactured and tested in accordance with NEMA WC 8, if applicable.

40. Cable Marking and Packaging

40.1 Cable shall be clearly marked at 4-ft intervals with the AWG conductor size and voltage rating.

40.2 In the placing of individual orders, package size shall be agreed upon by the manufacturer and the purchaser. The cable shall be protected against damage from ordinary handling and shipping.

ASSEMBLED BY-PASS JUMPERS

41. Scope

41.1 This specification covers the complete assembly of By-Pass jumpers for temporary use of electrical systems.

41.2 The use and maintenance of this equipment are beyond the scope of this specification.

42. Classification

42.1 Assembled By-Pass jumpers are furnished in three styles according to their function and method of application.

42.1.1 *Style I*—Assembled By-Pass jumpers designed and manufactured to be installed with rubber gloves (see Fig. 7).

42.1.2 *Style II*—Assembled Flexible By-Pass jumper designed and manufactured to be installed with live line tools (see Fig. 8).

42.1.3 *Style III*—Assembled Rigid By-Pass jumper designed and manufactured to be installed with live line tools (see Fig. 9).

42.2 Assembled By-Pass jumpers are furnished in four voltage ratings according to the electrical characteristics, as indicated in Table 5.

42.3 Assembled By-Pass jumpers are furnished in two types according to the characteristics of the cable:

42.3.1 *Type I*—Insulated cable without a protective jacket.

42.3.2 *Type II*—Insulated cable with a protective jacket.



FIG. 7 Style I—Assembled Flexible By-Pass Jumper, Designed and Manufactured to be Installed with Rubber Gloves

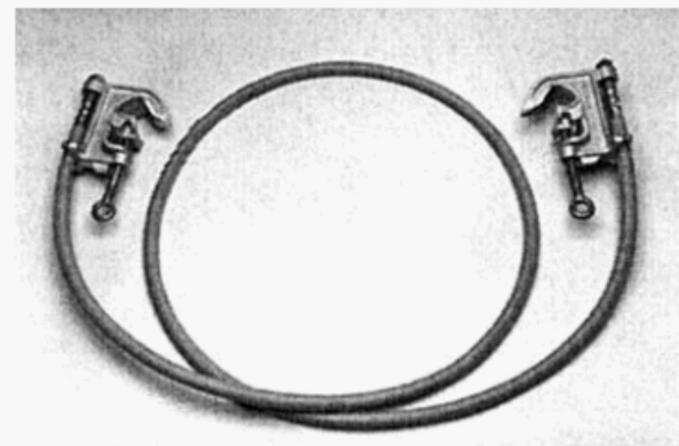


FIG. 8 Style II—Assembled Flexible By-Pass Jumper Designed and Manufactured to be Installed with Live Line Tools

42.4 Assembled By-Pass jumpers are furnished in two classes according to the characteristics of the clamp main contact jaws:

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

42.4.2 *Class B*—Clamp jaws with serrations, crosshatching or other means intended to abrade or bite through corrosion products on the surface of the conductor being clamped.

43. Ordering Information

43.1 Ordering assembled By-Pass jumpers under this specification shall include this ASTM designation and the following information:

43.1.1 Style (see 42.1),

43.1.2 Voltage Ratings (see 42.2),

43.1.3 Type (see 42.3), and

43.1.4 Class (see 42.4).

44. Materials

44.1 Clamps, cables, and ferrules shall meet the requirements prescribed in these specifications.

45. Electrical and Mechanical Properties

45.1 Electrical and mechanical properties shall conform to the requirements prescribed in Table 1, Table 2, Table 3, Table 4 and Table 5 as appropriate.

45.2 If agreed between the purchaser and supplier that a proof test on By-Pass jumpers is to be conducted, the proof test shall be performed in accordance with Section 55. The test



FIG. 9 Style II—Assembled Rigid By-Pass Jumper Designed and Manufactured to be Installed with Live Line Tools

TABLE 5 Assembled By-Pass Jumper Ratings

Voltage Rating	Maximum Use Voltage (rms) V	AC Proof Test Voltage (rms) V	DC Proof Test Voltage (avg) V	Current Rating A (rms) 60Hz			
				#2	1/0	2/0	4/0
15 kV	15 000	20 000	50 kV	200	250	300	400
25 kV	25 000	30 000	60 kV	200	250	300	400
35 kV	35 000	40 000	70 kV	200	250	300	400
69 kV	69 000	74 000		200	250	300	400

voltage shall be applied continuously for 1 min. The quantity from each lot to be tested shall be agreed upon by the purchaser and supplier.

45.3 Sample By-Pass jumpers shall not break down at voltages below those specified in Table 1 when tested in accordance with Section 55.

46. Workmanship, Finish, and Appearance

46.1 All components of the assembled By-Pass jumper shall be free of structural porosity, fins, sharp edges, splits, cracks, and other defects that affect their handling and performance.

46.2 All components of the assembled By-Pass jumper shall be formed, machined, and assembled with sufficient accuracy for smooth operation by hand. Clamps shall be free of excessive looseness to the extent detrimental to repeated applications at recommended installing torque.

46.3 Clamps, cables, and ferrules shall be assembled tightly and securely.

46.4 Non-harmful physical irregularities that do not affect strength or performance of the assembled By-Pass jumpers are not cause for rejection.

47. Sampling

47.1 A complete assembled By-Pass jumper product model represents a manufacturer’s design specification standard according to which the product model is manufactured.

47.2 A production lot shall consist of all assembled By-Pass jumpers of one product model produced at one time.

47.3 A test sample consists of two specimens of assembled By-Pass jumpers selected at random from a production lot for the specified test. When a failure occurs in one specimen from the first sample, a second sample shall be selected from the same lot and tested. If the second sample (two specimens) passes, the lot shall be accepted. If one specimen from the second sample fails, the lot shall be rejected.

48. Design Tests

48.1 Test samples of each component product model shall have been made by the manufacturer or supplier to verify conformance with the performance requirements of these specifications.

49. By-Pass Jumper Ratings

49.1 The rating of the assembled By-Pass jumper is governed by the ratings of the individual components.

50. Inspection and Production Testing

50.1 Inspection and production tests shall include the following:

50.1.1 All assembled By-Pass jumpers shall be inspected and tested to verify workmanship, finish, appearance, secure assembly, and integrity of the product in accordance with Section 46.

50.1.2 Verification that the clamps, ferrules, cable sizes, and lengths are as specified by the purchaser.

51. Acceptance, Rejection and Rehearing

51.1 At the option of the purchaser a production lot may be subject to the following:

51.1.1 Inspection in accordance with Section 50, for operation, safe use, workmanship, and appearance. Individual components or permanent assemblies that do not conform may be rejected.

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

51.1.3 If electrical testing or mechanical testing, or both, is required by a user, prior to acceptance, it shall be done in accordance with this specification for the assembled By-Pass jumpers.

52. Certification

52.1 When specified in the purchase order or contract, a manufacturer’s or supplier’s certification shall be furnished to the purchaser that the assembled By-Pass jumpers were manufactured, sampled, tested, or inspected in accordance with this specification and have been found to meet the requirements. When specified in the purchase order or contract, a report of design tests shall be furnished.

53. Packaging and Product Marking

53.1 Assembled By-Pass jumpers shall be marked with the name or logo of the manufacturer, and identity number.

53.2 A packaging list indicating manufacturer’s product numbers and quantities of each different assembled By-Pass jumper ordered shall be provided.

53.3 Each shipment shall be packaged to provide protection of the contents appropriate for the mode of transportation.

TEST METHODS

54. Sequence of Testing

54.1 The following order of procedure is suggested for testing By-Pass-jumpers:

54.1.1 Inspection of the surface in accordance with Section 50,

54.1.2 Electrical proof tests in accordance with 55.4 or 55.5.

55. Electrical Tests

55.1 All electrical tests shall be performed at room temperature.

55.1.1 *Styles I and II*—A water tank of sufficient size and depth to allow immersion of the Flexible By-Pass jumper in the water with both ends tied together electrically (see Fig. 10). The water in the tank forms one electrode and shall be connected to one terminal of the voltage source. The other electrode shall be a high-voltage cable with one end connected to the By-Pass jumper cable ends and the other terminal of the voltage source. Immerse the By-Pass jumper into the tank of water maintaining the required clearances from the By-Pass jumper ends to the water surface as indicated in Table 6.

55.1.2 *Styles III*—For Rigid By-Pass jumpers with a voltage rating the same as the cable, securely wrap aluminum foil around the Rigid By-Pass jumper maintaining the clearances per Table 6, (see Fig. 11). Connect a ground lead from the aluminum foil to the ground source of the voltage supply for

TABLE 6 Flashover Clearances - By-Pass Jumper End to Ground

Voltage Rating	AC Proof Test ^A		DC Proof Test ^A	
	in.	mm	in.	mm
15 kV	5	127	6	152
25 kV	7	178	8	203
35 kV	10	254	12	305
69 kV	12	305		

^AThese nominal clearances are intended to avoid flashover and may be increased by no more than 51 mm (2 in.) when required by a change in atmospheric conditions from the standard of 100 kPa (1 atm) barometric pressure and average humidity conditions. These clearances may be decreased if atmospheric conditions permit.

one electrode. The high voltage source shall be connected to either clamp end or both clamp ends of the Rigid By-Pass jumper to create the other electrode. If only one clamp end is attached to the high voltage source, the other end must be supported by an insulated device.

55.1.2.1 For Rigid By-Pass jumpers with a designated area of higher voltage rating than the cable rating (see Fig. 12), the aluminum foil shall be reduced to within the protected area of the Rigid By-Pass jumper as indicated by red bands and label as affixed by the manufacturer.

NOTE 3—Both ac and dc voltage proof-test methods are included in this section. If the purchaser requires a proof test, it is intended that one method be selected for the electrical tests. The method selected and the quantity from each lot to be tested shall be agreed upon by the purchaser and supplier.

55.2 It is recommended that the test apparatus be designed to afford the operator full protection in performances of his duties. 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 dc test apparatus due to the likely presence of high-voltage capacitance charges at the conclusion of the test. See ANSI C39.5.

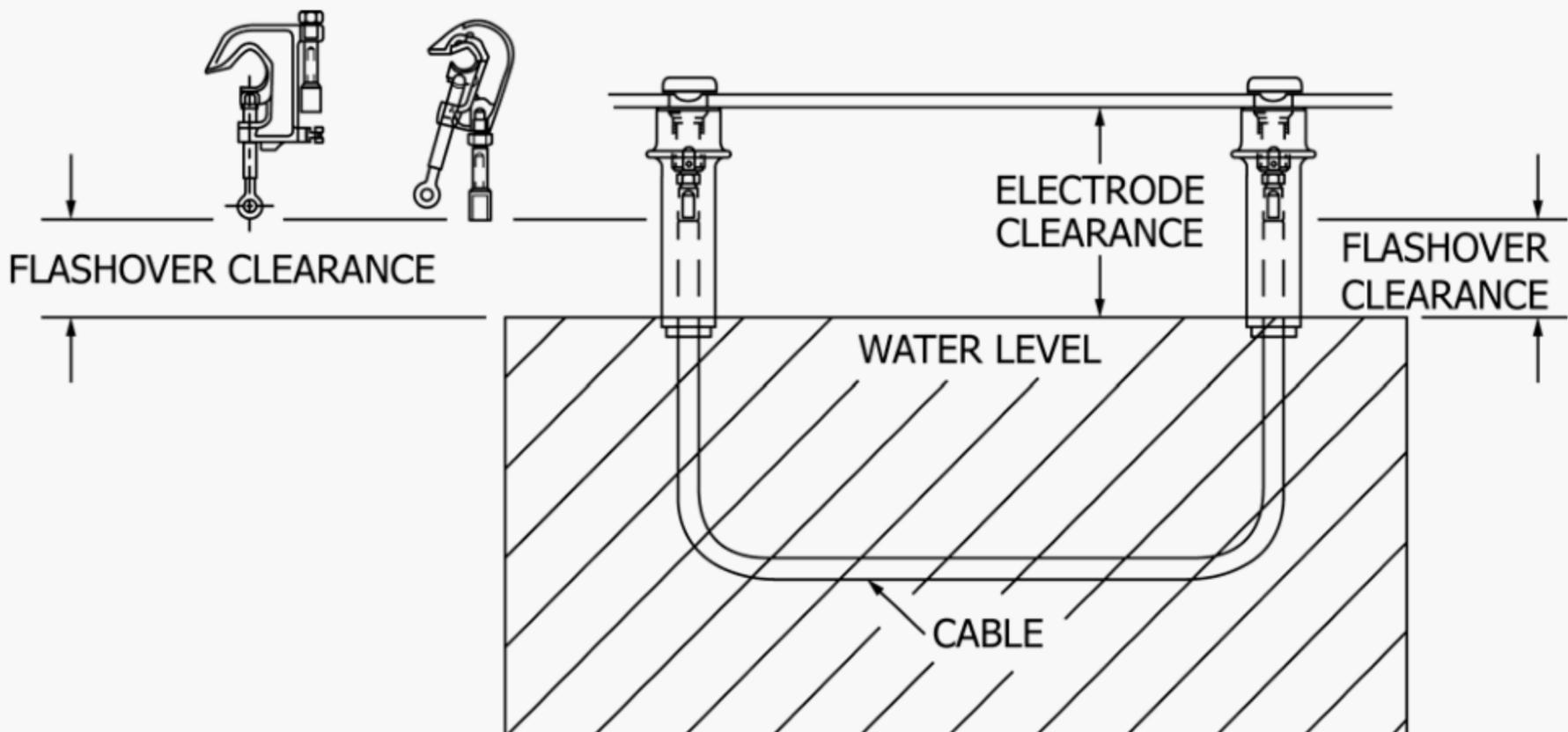


FIG. 10 Typical Test Arrangement for Flexible By-Pass Jumpers

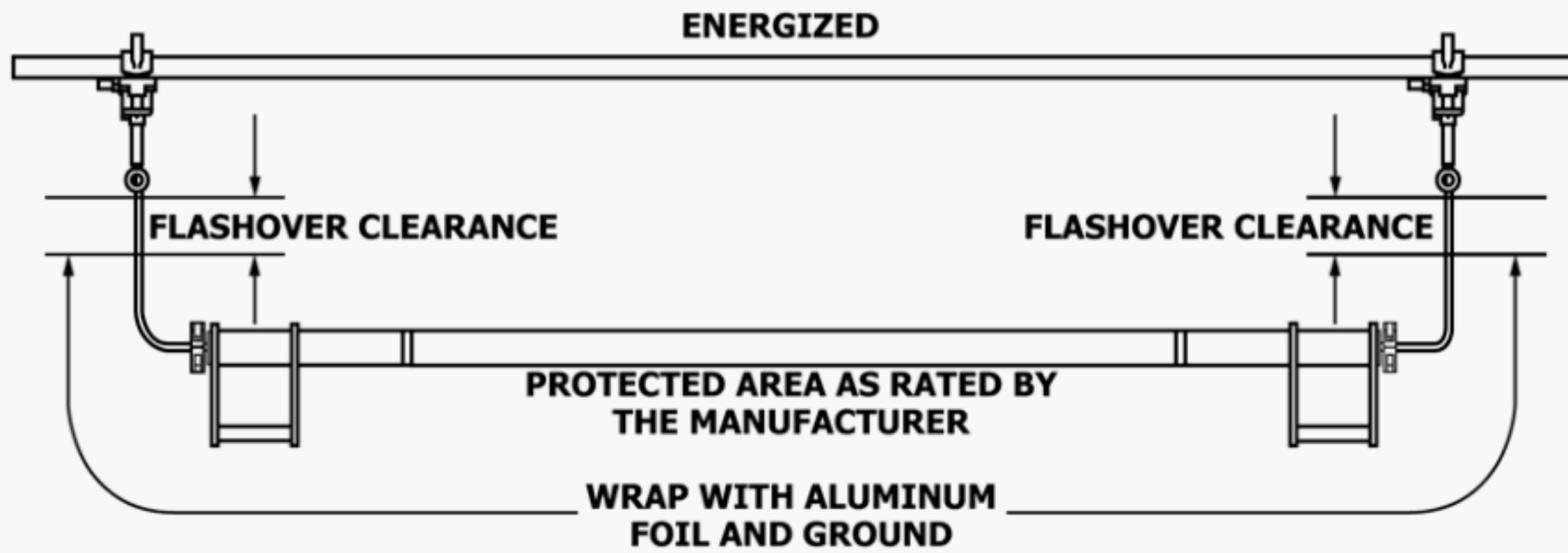


FIG. 11 Typical Test Arrangement for Rigid By-Pass Jumpers with Voltage Rating same as Cable

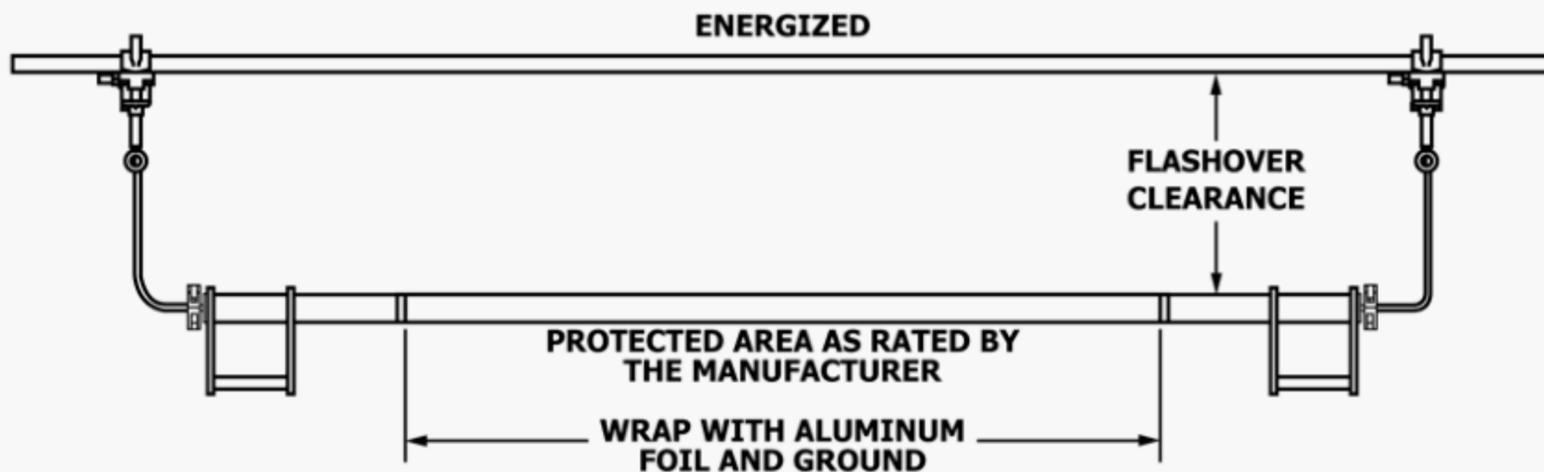


FIG. 12 Typical Test Arrangement for Rigid By-Pass Jumpers with Designated Area of Higher Voltage Rating than Cable

55.2.1 To eliminate damaging ozone and possible flashover along the By-Pass jumper, there should be a sufficient flow of air into and around the By-Pass jumper and an exhaust system to adequately remove ozone from the test machine. Consistent ozone cutting and checking during the test procedure should be cause to ascertain the adequacy of the exhaust system.

55.2.2 The equipment shall be inspected at least annually to ensure that the general condition of the equipment is acceptable and to verify the characteristics and accuracy of the test voltages. To ensure the continued accuracy of the test voltage, as indicated by the test equipment voltmeter, the test equipment shall be calibrated at least annually in accordance with the latest revision of Practice [D2865](#).

55.3 Test Equipment:

55.3.1 The test equipment used in the proof test shall be capable of supplying and essentially stepless and continuously variable voltage to the test specimen. Motor-driven regulating equipment is convenient and tends to provide uniform rate-of-rise to the test voltage. The test apparatus or each position, or both, should be protected by an automatic circuit-breaking device designed to open promptly on the current produced by breakdown of a specimen under test. This circuit breaking device should be designed to protect the test equipment under any conditions of short circuit. The equipment shall be inspected at least annually to ensure that the general condition of the equipment is acceptable and to verify the characteristics and accuracy of the test voltages.

55.3.1.1 By-Pass jumper failure indicators or accessory circuits shall be designed to give positive indication of failure and shall require resetting by the operator before tests can be continued.

55.4 AC Tests:

55.4.1 Voltage Supply and Regulation:

55.4.1.1 The desired test voltage may be obtained most readily from a step-up transformer energized from a variable low-voltage source. The transformer and its control equipment shall be of such size and design that, with the test specimen in the circuit, the crest factor (ratio of maximum to mean effective) of the test voltage shall differ by not more than 5 % from that of a sinusoidal wave over the upper half of the range of the test voltage.

55.4.1.2 The correct rms value of the sinusoidal voltage wave-form applied to the By-Pass jumper may be measured by one of the following methods: (1) a voltmeter used in conjunction with a calibrated instrument transformer connected directly across the high-voltage circuit, (2) a calibrated electrostatic voltmeter connected directly across the high-voltage circuit, (3) a voltmeter connected to a tertiary coil in the test transformer, provided it has been demonstrated that the assigned ratio of transformation does not change with load, or (4) an ac meter connected in series with appropriate high-voltage type resistors directly across the high-voltage circuit. The accuracy of the adopted voltage-measuring circuit shall be within ± 3 % of full scale.

NOTE 4—A voltmeter connected to the low-voltage side of the testing transformer may be used only if the ratio of transformation has been properly determined and is known not to change appreciably with load. A calibrated sphere gap may be used to check the accuracy of the voltage as indicated by the voltmeter.

55.4.1.3 The crest factor may be checked by the use of a peak-reading voltmeter connected directly across the high-voltage circuit; or, if an electrostatic voltmeter or a voltmeter in conjunction with an instrument potential transformer is connected across the high-voltage circuit, a standard sphere gap may be sparked over and the corresponding voltage compared with the reading of the rms voltmeter.

55.4.2 AC Proof Tests:

55.4.2.1 When a proof test is conducted, it shall be conducted in accordance with the requirements of 45.2. The proof-test voltage shall be applied initially at a low value and increased at a constant rate-of-rise of approximately 1000 V/s until the prescribed test voltage level is reached, or failure occurs. The test period starts at the instant that the prescribed testing voltage is reached. The applied voltage should be reduced to at least half value, unless an electrical failure has occurred, at the end of the test period before opening the test circuit.

55.5 DC Tests:

55.5.1 Voltage Supply and Regulation:

55.5.1.1 The dc test voltage shall be obtained from a dc source capable of supplying the required voltage. The peak to peak ac ripple component of the dc proof-test voltage shall not exceed 2% of the average voltage value under no-load conditions.

55.5.1.2 Measure the dc proof-test voltage by a method that provides the average value of the voltage applied to the

By-Pass jumper. It is recommended that the voltage be measured by the use of a dc meter connected in series with appropriate high-voltage type resistors across the high-voltage circuit. An electrostatic voltmeter of proper range may be used in place of the dc meter-resistor combination. The accuracy of the voltage-measuring circuit shall be within $\pm 2\%$ of full scale.

55.5.2 DC Proof Test:

55.5.2.1 When a proof test is conducted, it shall be conducted in accordance with the requirements of 45.2. The dc proof-test voltage shall be applied in the same manner as for ac proof tests except with a rate-of-rise of approximately 3000 V/s.

56. Rejection Criteria

56.1 Any By-Pass jumper cable assembly that fails to comply with the electrical test requirements as indicated in Section 55 shall be rejected.

56.2 Any By-Pass jumper cable assembly that upon inspection is found to have harmful physical irregularities as in Section 50 shall be rejected.

57. Precision and Bias

57.1 The precision of this test method has not been determined. No statement can be made as to the bias of this test method.

58. Keywords

58.1 By-Pass jumpers; lineman; lineman protective equipment

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