ANSI
C29.9-1983 (R1996)

American National Standard

for Wet-Process Porcelain Insulators – Apparatus, Post-Type

Secretariat:

National Electrical Manufacturers Association
1300 North 17th Street, Suite 1847
Rosslyn, VA 22209

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Foreword

(This Foreword is not a part of American National Standard C29.9-1983.)

The first edition of this standard was based essentially on the EEI-NEMA (Edison Electric Institute-National Electrical Manufacturers Association) Standards for Wet-Process Porcelain Insulators (Apparatus, Post-Type), EEI TDJ-59, NEMA 147-1956. It was developed by the American National Standards Committee on Insulators for Electric Power Lines, C29.

This standard has been revised three times by the C29 Committee. This third revision (1) makes numerous editorial changes deemed to improve clarity; (2) removes porcelain color as a requirement; (3) changes the test description for ferrous metal parts galvanizing; (4) moves packing requirements to an appendix; (5) requires electrical tests to be made on completely assembled insulators; (6) revises the mechanical proof test requirements; (7) increases routine tension test values to 50 percent of rating; and (8) adds optional routine cantilever and bending movement tests.

Suggestions for improvement of this standard will be welcome. They should be sent to the National Electrical Manufacturers Association, 2101 L Street, NW, Washington, D.C. 20037.

This standard was processed and approved for submittal to ANSI by American National Standards Committee on Insulators for Electric Power Lines, C29. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the C29 Committee had the following members:

O. Compton, Chairman
C. H. White, Secretary

Organization Represented	*Name of Representative*
Association of American Railroads (AAR)	(Representation Vacant)
Electric Light and Power Group	J. B. Fitch
	A. S. Jagtiani
	W. C. Lauth
	R. F. Lehman
	J. Weber
	E. F. Marchbank (Alt)
	J. P. Markey (Alt)
Institute of Electrical and Electronics Engineers	O. Compton
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National Electrical Manufacturers Association	A. C. Baker
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American National Standard for Wet-Process Porcelain Insulators Apparatus, Post-Type

1. Scope

This standard covers outdoor high-voltage post-type apparatus insulators made of wet-process porcelain and used in the transmission and distribution of electrical energy.

2. Definitions

2.1 See Section 2 of American National Standard Test Methods for Electrical Power Insulators, ANSI C29.1-1982, for definitions of terms.

2.2 In this standard the word "insulator" shall refer to a unit or to a stack of two or more units.

2.3 The technical reference numbers appearing in tables are a widely used and recognized identification series for apparatus insulator units or stacks.

3. General

3.1 Insulators shall conform to all respects to the requirements hereinafter stated. The text and tables supplement each other and shall be considered as part of this standard.

3.2 Some insulators are tapered and may contain units that have certain characteristics whose strengths exceed those given in the tables. Each unit shall comply with the manufacturer's strength requirements.

3.3 Manufacturers' drawings, if furnished, shall show the outline of the insulators, together with all pertinent dimensions. Any variations in these dimensions due to manufacturing tolerances shall be indicated.

4. Material

4.1 Insulators shall be made of good commercial grade wet-process porcelain.

4.2 The entire porcelain surface of the insulators that will be exposed after assembly shall be glazed. The entire porcelain surface shall be relatively free from imperfections. Color is not a part of this standard. If gray is required, it shall be in accordance with American National Standard Gray Finishes for Industrial Apparatus and Equipment, ANSI Z55.1-1967 (R1973), and conform to Munsell notation 5BG 7.0/0.4 with the following tolerances:

(1) Hue: ± 12 (3G to 7B)
(2) Color: ± 0.5
(3) Chroma: −0.2 to + 0.6

4.3 Metal parts shall be made of a good commercial grade of malleable iron, ductile iron, or steel. Ferrous parts other than stainless steel shall be galvanized in accordance with Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware, ASTM A153-80.[1]

5. Dimensions and Characteristics

5.1 Dimensions and characteristics of the insulators shall be in accordance with Tables 1 and 2 and Figure 1.

5.2 Shell diameters given for the insulators listed in Table 1 shall not be exceeded by more than three percent to ensure physical clearances in assembled apparatus.

5.3 Minimum dimensions are limited by other specified characteristics.

[1] Copies are available from ASTM, 1916 Race Street, Philadelphia, PA 19103.

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6. Marking

Each insulator unit shall bear symbols identifying the manufacturer and giving the year of manufacture. The marking shall be legible and durable.

7. Samples, Inspection, and Tests

7.1 **General.** Tests described in 7.2 shall be required only on insulators of new designs. Tests described in 7.3 shall be required on each lot of insulators. Tests described in 7.4 shall be made on each insulator. Electrical tests described in 7.2 shall be conducted on completely assembled insulators.

7.2 **Design Tests**

7.2.1 **Low-Frequency Wet Withstand.** Three insulators shall be selected at random and tested in accordance with 4.5 of ANSI C29.1-1982. Failure of any insulator to meet the rated wet withstand value, as given in the applicable table, shall constitute failure to meet the requirements of this standard.

7.2.2 **Critical-Impulse Flashover, Positive.** Three insulators shall be selected at random and tested in accordance with 4.7 of ANSI C29.1-1982. Failure of the average critical-impulse flashover value of the three insulators to equal or exceed 92 percent of the rated critical-impulse flashover value, as given in the applicable table, shall constitute failure to meet the requirements of this standard.

7.2.3 **Impulse Withstand.** Three insulators shall be selected at random and tested in accordance with 4.8 of ANSI C29.1-1982. Failure of any insulator to meet the rated impulse-withstand value, as given in the applicable table, shall constitute failure to meet the requirements of this standard.

7.2.4 **Radio-Influence Voltage (RIV).** Three insulators shall be selected at random and tested in accordance with 4.9 of ANSI C29.1-1982. If one or more insulators fail to meet the requirements given in the applicable table, three additional insulators shall be selected at random and tested. Failure of one or more of these additional insulators shall constitute failure to meet the requirements of this standard.

7.2.5 **Thermal Shock.** Three insulators shall be selected at random and tested for ten complete cycles in accordance with 5.5 of ANSI C29.1-1982. For multiunit insulators, three of each type of unit in the stack shall be tested. The temperature of the hot-water bath shall be approximately 150°F (66°C) and the temperature of the cold-water bath shall be approximately 39°F (4°C). At the end of the tenth cycle, the test specimens shall be checked for electrical soundness. If one insulator fails, three additional insulators shall be selected at random and tested. Failure of more than one insulator from the first sample, or from the first and second samples combined, shall constitute failure to meet the requirements of this standard.

7.2.6 **Compression Strength.** Three insulators shall be selected at random and tested in accordance with 5.1.4.4 of ANSI C29.1-1982. For multiunit insulators, three of each type of unit in the stack shall be tested. Failure of the average strength of the three insulators or units to meet the strength requirements given in the tables or to meet the specified higher strength requirement, where applicable, or failure of any one insulator or unit to equal 85 percent of that strength requirement shall constitute failure to meet the requirements of this standard.

7.2.7 **Torsional Strength.** Three insulators shall be selected at random and tested in accordance with 5.1.4.2 of ANSI C29.1-1982. For multiunit insulators, three of each type of unit in the stack shall be tested. Failure of the average strength of the three insulators or units to meet the strength requirements given in the tables or to meet the specified higher strength requirement, where applicable, or failure of any one insulator or unit to equal 85 percent of that strength requirement shall constitute failure to meet the requirements of this standard.

7.3 **Quality Conformance Tests**[2]

7.3.1 **Visual and Dimensional Tests.** Conformity with 4.2 may be determined by visual inspection. All insulators not conforming to 4.2 fail to meet the requirements of this standard.

Three insulators shall be selected at random from the lot and their dimensions checked against the dimensions of the manufacturer's drawing. Failure of more than one of these insulators to conform to the dimensions on the drawing shall constitute failure of the lot to meet the requirements of this standard.

7.3.2 **Porosity.** Test specimens shall be selected from insulators destroyed in other tests and tested in accordance with 5.4 of ANSI C29.1-1982. Penetration of the dye into the body of the dielectric shall constitute failure of the lot to meet the requirements of this standard.

7.3.3 **Galvanizing Test.** Five pieces representative of each type of galvanized hardware used with the insulators shall be selected at random and tested in ac-

[2] Substantial experience indicates that a total of one-half percent of the number of insulators in the lot is sufficient to establish characteristics demonstrable by destructive tests.

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cordance with Section 6 of ANSI C29.1-1982. Five to ten measurements shall be uniformly and randomly distributed over the entire surface. The average thickness value for each individual specimen and the average of the entire sample shall equal or exceed the following:

Hardware	*Average of Entire Sample*	*Average of Individual Specimen*
Hardware (except nuts/bolts)	3.4 mil	3.1 mil
Nuts/bolts	2.1 mil	1.7 mil

If the average of one specimen, or if the average of the entire sample, fails to comply with the above, ten additional pieces of the same type of hardware shall be selected at random and tested. Failure of the retest sample to comply with the minimum thickness criteria shall constitute failure of the lot to meet the requirements of this standard.

7.3.4 **Cantilever Strength.** Three insulators shall be selected at random and tested in accordance with 5.1.4.1 of ANSI C29.1-1982. For multiunit insulators, three of each type of unit in the stack shall be tested. The units may be tested in a stack or individually. Failure of the average strength of the three insulators or units to meet the strength requirements given in the tables or to meet the specified higher strength requirement, where applicable, or failure of any one insulator or unit to equal 85 percent of that strength requirement shall constitute failure to meet the requirements of this standard.

7.3.5 **Tensile Strength.** Three insulators shall be selected at random and tested in accordance with 5.1.4.3 of ANSI C29.1-1982. For multiunit insulators, three of each type of unit in the stack shall be tested. Failure of the average strength of the three insulators or units to meet the strength requirements given in the tables or to meet the specified higher strength requirement, where applicable, or failure of any one insulator or unit to equal 85 percent of that strength requirement shall constitute failure to meet the requirements of this standard.

7.4 Routine Tests

7.4.1 **Flashover.** Each hollow-core insulator unit shall be subjected to a routine flashover test before assembly in accordance with 7.1 of ANSI C29.1-1982. For this test, an electrode shall be placed on each side of, and adjacent to, the porcelain barrier. All units that puncture fail to meet the requirements of this standard.

7.4.2 **Mechanical Proof**

7.4.2.1 Each insulator of the type given in Table 1 shall be subjected to one of the following tests.

(1) A tension test in accordance with 5.1.4.3 of ANSI C29.1-1982. The load applied shall be not less than 50 percent of the tension strength shown in the table.

(2) A cantilever test in accordance with 5.1.4.1 of ANSI C29.1-1982. The load applied shall be not less than 40 percent of the cantilever strength shown in the table. The test shall be performed in each of the four quadrants.

Successful completion of either the tension test or cantilever test shall constitute demonstration of conformance with the requirements of this standard.

7.4.2.2 Each insulator of the type given in Table 2 shall be subjected to one of the following tests.

(1) A tension test in accordance with 5.1.4.3 of ANSI C29.1-1982. The load applied shall be not less than 50 percent of the tensile strength shown in the table.

(2) A cantilever test in accordance with 5.1.4.1 of ANSI C29.1-1982. The load applied shall be not less than 40 percent of the cantilever strength shown in table. The test shall be performed in each of the four quadrants.

(3) A bending moment test in which the bending moment simultaneously loads each end of the unit in proportion to the unit rating. The test shall be repeated in each of the four quadrants. The proof test moment shall be not less than 40 percent of the bending moment rating of the unit.

Successful completion of either the tension test or the cantilever test or the bending moment test shall constitute demonstration of conformance with the requirements of this standard. A unit rated higher than the stack in which it is contained shall be tested at 50 percent of the tension rating of the unit or at 40 percent of the cantilever or bending moment rating of the unit, as applicable.

8. Referenced American National Standards

When the following American National Standards referred to in this document are superseded by a revision approved by the American National Standards Institute, Inc, the revision shall apply:

American National Standard Test Methods for Electrical Power Insulators, ANSI C29.1-1982

American National Standard Gray Finishes for Industrial Apparatus and Equipment, ANSI Z55.1-1967 (R1973)

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Table 1
Dimensions and Characteristics of Post-Type Apparatus Insulators
350 Kilovolts Basic Impulse Insulation Level (BIL) and Below

Technical Reference Number	BIL Rating	Height of Insulator		Shell Dia	Max Cap Dia	Bolt Circle*	Cantilever Strength – Upright, Underhung	Tensile Strength	Compression Strength	Torsional Strength	RIV Data		Leakage Distance	Critical Impulse Flashover, Positive	Low-Frequency Wet Withstand	Impulse Withstand	Technical Reference Number
		Overall	Tolerance								Low-Frequency Test Voltage	Max RIV					
	kV	inches	inches	inches	inches	inches	pounds	pounds	pounds	inch-pounds	kV	microvolts @ 1000 kHz	inches	kV	kV	kV	
202	95	7-1/2	± 1/32	7	5	3	2000	7 000	10 000	6 000	5	50	10-1/2	105	30	95	202
205	110	10	± 1/32	7	5	3	2000	8 500	10 000	7 000	10	50	15-1/2	125	45	110	205
208	150	14	± 1/32	7	6	3	2000	10 000	10 000	8 000	15	100	24	170	60	150	208
210	200	18	± 1/32	7-1/2	6	3	2000	12 000	15 000	10 000	22	100	37	225	80	200	210
214	250	22	± 1/32	8	7-5/8	3	2000	14 000	15 000	12 000	30	200	43	280	100	250	214
216	350	30	± 1/32	9-1/8	8	3	1500	16 000	25 000	15 000	44	200	72	390	145	350	216
222	95	10	± 1/32	7-1/2	6-1/2	5	4000	15 000	20 000	12 000	5	50	10-1/2	105	30	95	222
225	110	12	± 1/32	8	6-3/4	5	4000	20 000	20 000	14 000	10	50	15-1/2	125	45	110	225
227	150	15	± 1/32	9	8	5	4000	20 000	20 000	16 000	15	100	24	170	60	150	227
231	200	20	± 1/32	10	8-1/4	5	4000	25 000	30 000	20 000	22	100	37	225	80	200	231
267	250	24	± 1/32	10	9-3/8	5	4000	25 000	60 000	20 000	30	200	43	280	100	250	267
278	350	30	± 1/32	11	9-3/4	5	3000	25 000	60 000	40 000	44	200	72	390	145	350	278

*The following bolt circles, when tapped, shall be:

3-inch bolt circle – 4 tapped holes,1/2 inch – 13 unified form special
Pitch Diameter 0.4715–0.4650
Length of engagement, 0.50 (tap after hot dip galvanizing)

5-inch bolt circle – 4 tapped holes, 5/8 inch – 11 unified form special
Pitch Diameter 0.5882–0.5810
Length of engagement, 0.625 (tap after hot dip galvanizing)

NOTE: Metric Conversions –

1 inch = 25.4 mm, rounded off to the nearest whole number for dimensions greater than or equal to 1 inch. For dimensions less than 1 inch, round off to the nearest tenth.

1 pound = 4.448 newtons, rounded off to the nearest whole number.

Inch-pound = 0.113 newton-meters, rounded off to the nearest whole number.

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Table 2
Dimensions and Characteristics of Post-Type Apparatus Insulators above 350 Kilovolts Basic Impulse Insulation Level (BIL)

Technical Reference Number	BIL Rating	Height of Insulator		Max Cap Dia		Bolt Circle*		Cantilever Strength, Upright	Tensile Strength	Compression Strength	Torsional Strength	RIV Data		Leakage Distance	Critical Impulse Flashover, Positive	Low-Frequency Wet Withstand	Impulse Withstand	Technical Reference Number
		Overall	Tolerance	Top	Base	Top	Base					Low-Frequency Test Voltage	Max RIV					
	kV	inches	inches	inches	inches	inches		pounds	pounds	pounds	inch-pounds	kV	microvolts @ 1000 kHz	inches	kV	kV	kV	
286	550	45	± 1/16	10-1/2	10-1/2	5	5	1700	20 000	60 000	40 000	73	200	99	610	230	550	286
287	550	45	± 1/16	12	12	5	5	2600	25 000	75 000	90 000	73	200	99	610	230	550	287
288	650	54	± 1/16	10-1/2	10-1/2	5	5	1400	20 000	60 000	40 000	88	200	116	710	275	650	288
289	650	54	± 1/16	12	12	5	5	2200	25 000	75 000	90 000	88	200	116	710	275	650	289
291	750	62	± 3/32	10-1/2	10-1/2	5	5	1200	20 000	60 000	40 000	103	500	132	810	315	750	291
295	750	62	± 3/32	12	12	5	5	1850	25 000	75 000	90 000	103	500	132	810	315	750	295
304	900	80	± 1/8	10-1/2	10-1/2	5	5	950	20 000	60 000	40 000	146	500	165	1010	385	900	304
308	900	80	± 1/8	12	12	5	5	1450	25 000	75 000	90 000	146	500	165	1010	385	900	308
312	1050	92	± 1/8	10-1/2	10-1/2	5	5	800	20 000	60 000	40 000	146	500	198	1210	455	1050	312
316	1050	92	± 1/8	12	12	5	5	1250	25 000	75 000	90 000	146	500	198	1210	455	1050	316
362	1050	92	± 1/8	10-7/8	10-7/8	7	7	2300	40 000	100 000	120 000	146	500	198	1210	455	1050	362
324	1300	106	± 5/32	10-1/2	10-1/2	5	5	1000	25 000	75 000	90 000	220	1000	231	1410	525	1300	324
367	1300	106	± 5/32	10-1/2	14	5	7	1450	20 000	60 000	40 000	220	1000	231	1410	525	1300	367
368	1300	106	± 5/32	10-7/8	10-7/8	7	7	2000	40 000	100 000	120 000	220	1000	231	1410	525	1300	367
369	1300	106	± 5/32	10-1/2	14	5	7	2050	20 000	60 000	40 000	220	1000	231	1410	525	1300	369
330	1470	122	± 3/16	10-1/2	10-1/2	5	5	900	25 000	75 000	90 000	220	1000	264	1610	590	1470	330
371	1470	122	± 3/16	10-1/2	14	5	7	1170	20 000	60 000	40 000	220	1000	264	1610	590	1470	371
372	1470	122	± 3/16	10-7/8	10-7/8	7	7	1750	40 000	100 000	120 000	210	1000	264	1610	590	1470	372
373	1470	122	± 3/16	10-1/2	14	5	7	1750	20 000	60 000	40 000	220	1000	264	1610	590	1470	373
379	1550	128	± 3/16	10-1/2	14	5	7	1700	20 000	60 000	40 000	318	2000	280	1710	620	1550	379
391	1800	152	± 7/32	10-1/2	14	5	7	1400	20 000	60 000	40 000	318	2000	330	2000	710	1800	391

*The following bolt circles, when tapped, shall be:

5-inch bolt circle – 4 tapped holes, 5/8 inch – 11 unified form special
Pitch Diameter 0.5882–0.5810
Length of engagement, 0.625 (tap after hot dip galvanizing)

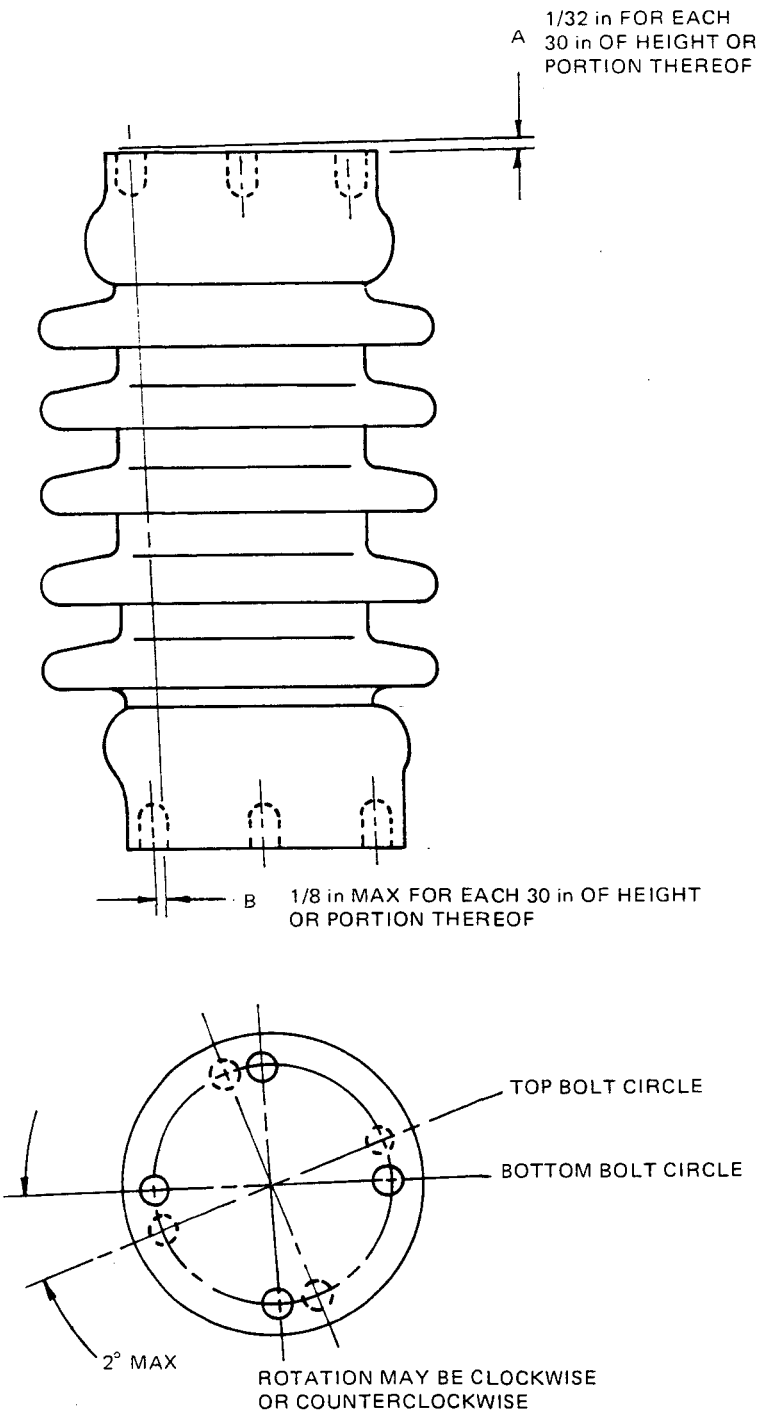
7-inch bolt circle – 4 tapped holes, 3/4 inch – 10 unified form special
Pitch Diameter 0.7077–0.7000
Length of engagement, 0.75 (tap after hot dip galvanizing)

NOTE: Metric Conversions –

1 inch = 25.4 mm, rounded off to the nearest whole number for dimensions greater than or equal to 1 inch. For dimensions less than 1 inch, round off to the nearest tenth.

1 pound = 4.448 newtons, rounded off to the nearest whole number.

Inch-pound = 0.113 newton-meters, rounded off to the nearest whole number.



NOTES:
(1) All dimensions are measured at bolt circle.
(2) Tolerance applies to individual units.

Figure 1
Tolerances

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Appendixes

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Appendix A

Packing

Packaging of insulators should be such as to afford reasonable and proper protection to the insulators in shipping and handling.

Each box or container should be marked with: the number of pieces contained therein; the catalog number, or class number, or description of the contents; and the manufacturer's name.

Appendix B

Additional Electrical Design Tests

In the following additional electrical design tests are required, the procedure given in this Appendix may prove to be useful.

B1. Low-Frequency Dry Flashover

Three insulators should be selected at random and tested in accordance with 4.2 of ANSI C29.1-1982. The average dry-flashover value of the three insulators should be equal to or exceed 95 percent of the rated dry-flashover value of the insulator.

B2. Low-Frequency Wet Flashover

Three insulators should be selected at random and tested in accordance with 4.3 of ANSI C29.1-1982. The average wet-flashover value of the three insulators should be equal to or exceed 90 percent of the rated wet-flashover value of the insulators.

B3. Critical Impulse Flashover – Negative

Three insulators should be selected at random and tested in accordance with 4.7 of ANSI C29.1-1982. The average critical impulse flashover, negative, value of the three insulators should be equal to or exceed 92 percent of the rated critical impulse flashover, negative, value of the insulators.

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American National Standards

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