ANSI C29.17-2002

American National Standard

For Insulators—
Composite-Line Post Type

Secretariat:

National Electrical Manufacturers Association

Approved February 12, 2002

American National Standards Institute, Inc.

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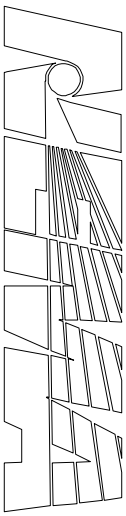

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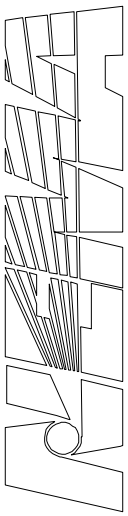

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Foreword (This Foreword is not part of American National Standard C29.17-2002.)

This first edition of this standard was based on a NEMA proposed standards publication for composite line post insulators used on overhead transmission lines. It was developed at the request of American National Standards Committee on Insulators for Electric Power Lines, ASC C-29.

This standard was processed and approved for submittal to ANSI by ASC C-29. Committee approval of the standard does not necessarily imply that all committee members voted for approval. At the time it approved this standard, the ASC C-29 Committee had the following members:

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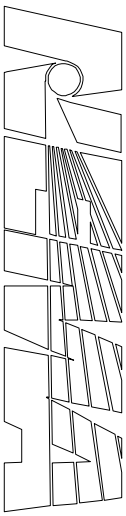

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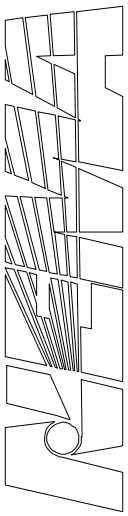


AMERICAN NATIONAL STANDARD **ANSI C29.17-2002**

For Insulators—
Composite-Line Post Type

1 Scope

This standard describes the qualification test procedures for composite line post insulators that are made of a fiberglass-reinforced resin matrix core, elastomeric weathersheds and metal end fittings. The insulators are intended for use on overhead lines in electric power systems, 70kV and above. Mechanical and electrical performance levels specified in this standard are applicable to new insulators.

2 Normative standards

2.1 Reference to American National Standards

When the following standards referred to in this document are superseded by a revision approved by the governing body, that revision shall apply.

American National Standard Test Methods for Electrical Power Insulators, ANSI C29.1-1996

American National Standard for Composite Suspension Insulators for Overhead Transmission Lines – Tests, ANSI C29.11-1996

2.2 References to other standards

IEEE Standard Techniques for High-Voltage Testing, IEEE Std. 4-1995

IEEE Dictionary of Electrical and Electronic Terms, IEEE Std. 100-1984

ASTM Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware, ASTM A153-1995

ASTM Test Method for Rubber Property – Durometer Hardness, ASTM D2240-95

ASTM Practice for Operating Light – Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials, ASTM G26-95

ASTM Practice for Operating Xenon Arc-Type Light-Exposure Apparatus With and Without Water for Exposure of Plastics, ASTM D2565-92a

ASTM Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensations Type) for Exposure of Nonmetallic Materials, ASTM G53-95

IEC Methods of test for the determination of the flammability of solid electrical insulating materials when exposed to an igniting source, IEC 60707

ISO 3452 Crack Detection

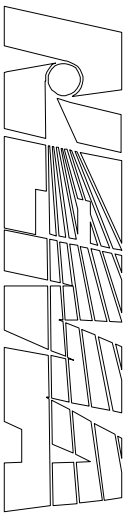
3 Definitions

See Section 3 of American National Standard for Composite Suspension Insulators for Overhead Transmission Lines – Tests, ANSI C29.11 and Section 2 of American National Standard Test Methods for Electrical Power Insulators, ANSI C29.1 for the definition of common terms used in the standards. The following definitions are specific to this standard.

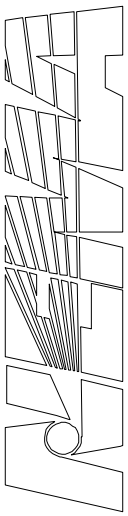
3.1 Composite line post insulator

This insulator design consists of a resin impregnated fiberglass core, an elastomeric housing, and is equipped with metallic end fitting attachment devices. Mechanical loading of this insulator design is primarily applied in a cantilever mode, although tensile, compression, and longitudinal loading may be applicable for specific installations to support electrical line conductors.

3.2 Cantilever breaking load (CBL) of a composite line post insulator



The maximum load that is reached when tested in accordance with clause 9.4 of this specification.



NOTE – Damage to the core is likely to occur at loads lower than the insulator failing load.

3.3 Specified cantilever load (SCL)

The specified cantilever load rating of the insulator is defined by the manufacturer. It shall be below the CBL as demonstrated when tested under the conditions defined in clause 9.4 of this specification.

3.4 Specified tensile load (STL)

The tensile load which can be withstood by the insulator when tested in accordance with the test protocol described in clause 9.5. This value is considered to be equivalent to a one minute withstand. This value is specified by the manufacturer.

4 Dimensions

General dimensions and characteristics of the insulator design type of class 250 will be in accordance with Chart I. Unless otherwise agreed, a design tolerance specification, as follows, may be applied on dimensions that are not defined.

+/- (0.04 x + 0.05) inches, when x is < 12 inches

+/- (0.025 x + 0.23) inches, when x is > 12 inches
(maximum limited to 2 inches)

The shape and spacing of weathersheds are not a part of this standard.

5 Marking

Each insulator shall bear symbols identifying the name or trademark of the manufacturer, a manufacturing date code or year of manufacture, and the Specified Cantilever Load (SCL) in pounds or thousands of pounds (K). The marking may also include the manufacturer's historical working load rating, identified as the RCL, or the MDCL to comply with IEC ratings. The markings shall be legible and durable.

NOTE – The manufacturer's recommended working cantilever load may be included in the marking. It can be listed as the MDCL, or the Reference Cantilever Load (RCL) and may be as much as 50% of the SCL.

6 Classification of Tests

6.1 Prototype tests

The purpose of these procedures is to verify the suitability of the product design, materials, and method of manufacture. The prototype tests are described in Section 7. When a composite post insulator design has met the prototype tests, the results will be considered valid for the entire class of insulators shown in Chart I, or equivalent design, as defined by the manufacturer. The following characteristics shall define the design:

a. The core and housing are of the same materials composition and method of manufacture as the tested insulator.

b. The end fittings are of the same design and material, and use the same method of attachment to the core as the tested insulator.

c. The housing or core sheath is of the same or greater thickness.

d. The maximum cantilever bending moment stress in the rod at SCL is the same or less than that for the tested insulator.

e. The depth and design of the connection zone of the ground end fitting (most highly stressed) are the same as that for the tested insulator.

The prototype test report will include a drawing of the insulator tested, with applicable dimensions. These dimensions will at a minimum include those defined for the applicable class, or as modified by the test apparatus limitations. The prototype test will be performed only once for the same class of insulator.

To allow for manufacturing variations, the weathershed diameter, thickness, and shape may vary up to 15% before prototype tests must be repeated. In addition, the housing thickness and covering of the metal end fittings may vary up to 15% before prototype tests must be repeated. Prototype testing of the insulator is not required for a greater thickness of the weathershed and housing, or increased rod dimensions that exceed the 15% variation limitation.

When changes in the design occur, which exceed the classification limits, prototype testing shall be repeated in accordance with the schedule, as shown in Table 1.

Table 1 – Prototype testing

If the following design criteria changes…	7.1	7.2	7.3	7.3.2	7.4	7.5
Shed Material	√		√	√		√
Shed Design	√		√			
Housing Material	√		√	√		√
Housing Design	√		√			
Core Diameter		√				
Core Material	√	√			√	
Attachment Method	√	√				
End Fitting Material		√				
End Fitting Design	√					

NOTE – Prototype testing is not required for design changes that increase the thickness of the weathershed and/or housing.

Test descriptions:

7.1 Tests on Interfaces and Connection of End Fittings.
7.2 Assembled core load tests.
7.3 Housing tracking and erosion tests.
7.3.2 Aging or weathering test.
7.4 Core Material Tests
7.5 Flammability test.

6.2 Design tests

These tests verify those characteristics of a composite insulator which depend on its size and shape. Their requirements are given in Section 8. The design tests will be performed only once for the same class of insulator.

6.3 Sample tests

These tests verify the conformance of the post insulators to the manufacturing requirements given in Section 9. The samples are selected from production lots.

6.4 Routine tests

These tests are for the purpose of verifying the final quality acceptance of the manufactured insulators. These tests are performed according to the requirements of section 10.

7 Prototype tests

Prototype testing is done in five parts as described in Sections 7.1, 7.2, 7.3, 7.4, and 7.5. The test specimens will pass the tests in each part in sequence. Prototype tests are to be performed only once for each class of insulator, as defined in Section 6.1. The results will be recorded in a test report. The test report will constitute the evidence of successful completion of the prototype tests.

7.1 Tests on interfaces and connection of end fittings

7.1.1 Test specimens

Four insulators, representative of the production process and design, shall be selected. One of these shall be reserved as a reference for the power frequency voltage test in 7.1.3.3. The insulator length (metal-to-metal) will be at least 15 times the core diameter. If shorter insulators are tested, the results are valid only for insulators up to the length tested.

The insulators shall be subjected to the routine mechanical test, per section 10.

7.1.2 Pre-stressing

The following tests (7.1.2.1, 7.1.2.2) shall be carried out on three test insulators in the sequence indicated below.

7.1.2.1 Thermal-mechanical test

The three insulators will be loaded in cantilever and subjected to the temperature cycle described in Figure 2. The load shall be selected so as to produce the same bending moment at the base of the insulator as is exerted by 50% of the SCL in normal application.

Each 24 hour cycle has a minimum of 8 hours at both +50°C and –35°C +/- 5K. The 24 hour cycle shall be run twice, with the direction of the load reversed after the first cycle.

The test may be interrupted for the load direction reversal and for maintenance of the test equipment for a total duration of 2 hours.

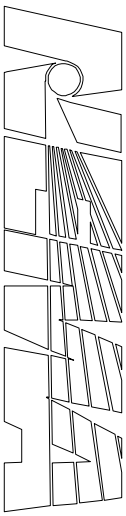
7.1.2.2 Water immersion test

The three test insulators will be immersed in boiling water for 42 continuous hours (de-ionized water with 0.1% NaCl or tap water adjusted to a conductivity of 1650 μS/cm +/- 50 μS/cm at 20°C - 25°C). After the 42 hour boiling period, the insulators will remain in the vessel until the water cools to approximately 50°C. This temperature will be maintained until the verification tests are started.

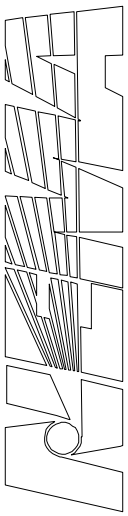
7.1.3 Verification tests

The following verification tests (7.1.3.1, 7.1.3.2, 7.1.3.3) shall be completed within 48 hours following the removal of the insulators from the water.

7.1.3.1 Visual examination



The housings shall be inspected visually. No cracks or crazing of the elastomeric shed or housing are permitted.



7.1.3.2 Steep-front impulse test

The three test specimens will be fitted with a sharp edged electrode, consisting of a clip made of copper strip approximately 20mm wide and less than 1mm in thickness. The electrode will lie firmly on the housing or sheath between the weathersheds, forming two sections of 500 mm or smaller axial length. If the test specimens have an insulating length that is less than or equal to 500mm, the voltage will be applied between the end fittings (no clip is necessary).

An impulse voltage with a steepness of of at least 1000 kV/μs will be applied to each test section. Each section will be stressed with 25 impulses of positive polarity and 25 impulses of negative polarity. Each impulse shall cause an external flashover of the test section. No punctures of any part of the insulator shall occur.

The electrodes used to form the test sections will be removed prior to the power frequency voltage test.

7.1.3.3 Power frequency voltage test

The dry power frequency flashover voltage will be determined by averaging five flashover voltages on each insulator per ANSI/IEEE 4. The flashover voltage will be reached within 1 minute by increasing the voltage linearly from zero. The flashover voltage of the reference insulator will be determined using the same procedure.

The average flashover voltage for each test insulator will be at least 90% of the flashover voltage of the reference insulator.

The three test insulators and the reference insulator will be allowed to reach thermal equilibrium with the surrounding atmosphere. All four insulators will then be subjected to 80% of the reference insulator flashover voltage for 30 minutes. No puncture of any part of the insulator shall occur, and the temperature of the shank (measured immediately after the test) will not be more than 20°C above the ambient temperature.

7.2 Assembled core load tests

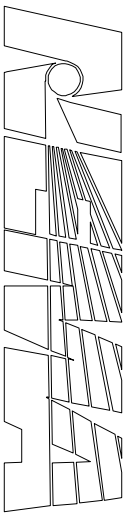
7.2.1 Core time-load test

7.2.1.1 Test specimens

Three insulators manufactured on the production line using the standard end fittings shall be selected. The section length (pole face to line attachment) shall be between 15 and 24 times the diameter of the core, or the longest length to be manufactured, whichever is less.

7.2.1.2 Core time load test

Each insulator shall be gradually loaded to 40% of the SCL or the manufacturer's RCL (whichever is greater) at a temperature of 20°C ± 10 K. The load shall be applied to the insulator at the conductor position, approximately perpendicular to the intended orientation of the conductor and approximately perpendicular to the core of the insulator. The load shall be maintained for at least 96 hours.



7.2.1.3 Evaluation

7.2.1.3.1 Visual examination

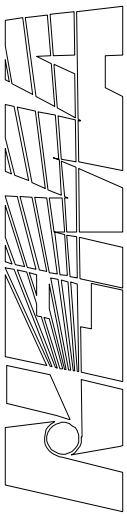
After removal of the load, visually inspect the base end fitting for cracks or permanent deformation. All threaded connections must be intact and usable.

7.2.1.3.2 Dissection and dye penetration

Cut each insulator 90° to the axis of the core and about 50 mm from the base end fitting, then cut the base end fitting longitudinally into two halves in the plane of the previously applied cantilever load. The cut surfaces shall be smoothed by means of fine abrasive cloth (grain size 180).

The cut halves shall be visually inspected for cracks and delamination. The presence of cracks or delamination in the fiberglass rod shall constitute failure.

A dye penetration test shall be performed on the cut surfaces in accordance with ISO 3452 to reveal cracks. The presence of cracks or delamination in the fiberglass rod shall constitute failure.



7.2.2 Tensile load test

7.2.2.1 Test specimens

Three insulators manufactured on the production line using the standard end fittings shall be selected.

7.2.2.2 Tensile test

A tensile load shall be applied to each insulator in line with the axis of the core of the insulator. The load shall be increased rapidly but smoothly from zero to approximately 75% of the STL and shall then be gradually increased in a time between 30 s and 90 s until the STL is reached. If the STL is reached in less than 90s, the load shall be maintained for the remainder of the 90 s. At the conclusion of the 90s, the load shall be removed.

7.2.2.3 Evaluation

The test shall be regarded as passed if there is no evidence of:

- pull out of the core from the end fitting.
- breakage of the end fitting.

7.3 Housing tracking and erosion tests

7.3.1 Test specimen

Two insulators or test specimens will be tested, in accordance with ANSI C29.11. The specimen length will be chosen such that the leakage distance falls between 200 and 700 mm and includes at least two weathersheds.

If the same elastomeric materials and manufacturing method have been previously qualified, per ANSI C29.11, this qualification section will not be repeated.

7.3.1.1 Test chamber

The test is to be performed in a test apparatus as defined in ANSI C29.11.

7.3.1.2 Test conditions

The test is to be performed for a duration of 1000 hours as described in ANSI C29.11.

7.3.1.3 Evaluation

No tracking is allowed. No weathershed punctures are allowed. Erosion is not allowed to reach the core.

7.3.2 Aging or weathering test

The manufacturer shall test and provide information on the elastomeric materials of the insulator, as defined in ASTM D2565, ASTM G52 or G53, that shows no indication of cracking or crazing after one thousand hours.

7.4 Core material tests

7.4.1 Dye penetration test

Ten samples will be prepared and tested in accordance with ANSI C29.11. There will be no dye solution penetration through the sample after fifteen minutes of exposure.

7.4.2 Water diffusion test

Six samples will be prepared in accordance with ANSI C29.11. The electrodes will be modified to provide total coverage of the cross sectional area, which insures puncture of the rod sample. The test arrangement is shown in Figure 1. No puncture or surface flashover is allowed. The current during the test shall not exceed 1-mA, rms.

7.5 Flammability test

The manufacturer shall test and provide information on the elastomeric materials of the insulator as defined in IEC 61109, section 5.5.1. The material is to be rated as category FVO, per IEC 60707, as required by IEC 61109.

8 Design tests

Design tests are to be performed on full insulators, as determined by the manufacturer, to establish an accurate representation for the electrical capabilities of each insulator class, as described in Chart 1.

8.1 Low frequency wet flashover test

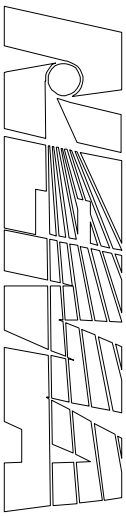
This test is to be performed on one insulator in accordance with ANSI C29.1.

8.2 Low frequency dry flashover test

This test is to be performed on one insulator in accordance with ANSI C29.11.

8.3 Lightning critical-impulse tests, positive and negative

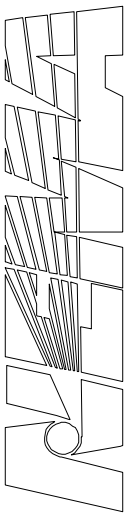
These tests are to be performed on one insulator in accordance with ANSI C29.11.



8.4 Radio-influence voltage and visible corona test

One insulator is to be tested in accordance with ANSI C29.1. The purchaser for their application can request this test by agreement with the manufacturer. The test shall be performed at 1.15 times the nominal line-to-ground operating voltage. RIV levels shall be less than 100 micro-volts.

If a light amplification device or other corona detection device is used, there shall be no visible corona on the test specimen at the hardware to housing interface.



9 Sample tests

9.1 Sample selection

The insulator(s) shall be selected from the lot at random. The purchaser has the right to make the selection. The insulator(s) shall be subjected to the applicable sample tests.

For lots of more than 200 insulators, the following table of samples shall apply.

Tests	Number of Samples
Verification of dimensions	3
Galvanizing test	3
Cantilever load test	1
Specified Tensile Load Test	1

For lots smaller than 200 insulators, the number of samples tested shall be by agreement between the user and manufacturer.

In the event of a failure of the sample to satisfy a test, the retest procedure of 9.6 shall be applied.

9.2 Verification of dimensions

The insulators in the sample shall be checked for dimensions against the dimensions on the manufacturer's drawing. If tolerances are not given on the drawing, the tolerances given in clause 4 shall apply.

9.3 Galvanizing test

For ferrous end fittings and bases, the specified size of sample shall be tested in accordance with section 6 of ANSI C29.1. Five to ten measurements shall be uniformly and randomly distributed over the entire surface. Both the average thickness value for each individual specimen and the average of the entire sample shall equal or exceed the following:

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

9.4 Verification of cantilever strength test

9.4.1 Test setup

For clauses 9.4.2 and 9.4.3, the sample insulator shall be subjected to a cantilever load in the normal vertical loading direction, or approximately perpendicular to the core of the insulator if the insulator is to be mounted vertically. The load shall be applied at the conductor mounting position, approximately perpendicular to the typical direction of the conductor.

9.4.2 Cantilever strength verification

The sample insulator shall be loaded at an approximately constant rate of less than 40% of the S.C.L. of the insulator per minute. The position of the end fitting to which the load is being applied shall be monitored. A load of at least 40% of the S.C.L. shall be held for one minute. During the 1 minute hold, the position of the top end fitting shall be monitored. Where L represents the unloaded section length of the insulator in inches, a position shift exceeding $(0.008*L)^2$ inches shall constitute failure of the test. At the conclusion of the 1 minute hold, the load shall be removed.

9.4.3 Cantilever breaking load (C.B.L.) test

By agreement between the customer and manufacturer, the C.B.L. test may be performed. The load shall be applied at an approximately constant rate of less than 40% of the S.C.L. of the insulator per minute. The direction of loading shall be free to pivot in a plane defined by the axis of the insulator and the anchoring point of the loading device. The failing load (Cantilever Breaking Load) shall be the maximum load attainable under these loading conditions.

The test is passed if the C.B.L. is greater than or equal to the S.C.L.

9.5 Specified tensile load test

One sample insulator, either randomly selected from or representing the lot, shall be subjected to a tensile loading test to demonstrate that the lot is capable of meeting the S.T.L. If the sample is representative of the lot it shall have the same rod diameter and end fitting configuration as the lot, but need not include weathersheds or housings and may use a rod length different from that of the lot, so long as the core rod length is at least 10 times diameter of the core. If a detachable base is used, it should be removed and attachment made to the end fitting which is crimped to the core rod. Attachment to the line end fitting shall be made in the attachment zone and shall represent a typical means of service loading, but need not include actual service hardware. Attachment means shall be at the manufacturer's discretion.

The tensile load shall be applied rapidly, but smoothly, from zero to 75% of the S.T.L. and then gradually be increased to the S.T.L. in a time between 30 and 90 seconds. If 100% of the S.T.L. is reached in less than 90 seconds, the load shall be sustained at the S.T.L. for the remainder of the 90 seconds. The load shall then be increased until the insulator fails. The failure load shall be recorded.

9.6 Retest procedure for sample tests

If only one insulator or metal part fails to comply with the requirements of a sample test, a new sample equal to twice the quantity originally submitted to that test shall be subjected to retesting. The retesting shall comprise the test in which failure occurred, preceded by those tests that may be considered as having influenced the results of the original test.

If two or more insulators or metal parts fail to comply with any of the sample tests or if any failure occurs during the retesting, the complete lot is considered as not complying with the standard and shall be withdrawn for examination by the manufacturer.

Provided the cause of the failure can be clearly identified, the manufacturer may sort the lot to eliminate all the insulators with this defect. The sorted lot may then be resubmitted for testing. The number then selected shall be three times the first quantity chosen for tests. If any insulator fails during this retesting, the complete lot is considered as not complying with this standard and shall be withdrawn by the manufacturer.

10 Routine Tests

Routine tests are to be performed on every insulator produced.

10.1 Tensile load test

Every insulator shall be subjected, at ambient temperature, to a tensile load of at least 50% of the S.T.L. for at least 10 seconds. No partial or complete pull out of the core from the end fitting shall occur.

10.2 Visual examination

The mounting of the metallic parts will be in conformance with the manufacturer's design drawing. Individual superficial defects in the elastomer housing and weathersheds shall not exceed 25 square millimeters and the maximum depth of such defects shall not exceed 1 mm.

Chart 1 – Class 250
design parameters for horizontal line posts
with mounting base and drop eye fitting

Design Type	Section Length		Minimum CIFO Values		Min 60 Hz Flashover Values		SCL (LBF)
	Min. Inches	Max. Inches	Positive (kV)	Negative (kV)	Dry (kV)	Wet (kV)	Min. [1]
250 - 41	41 (1041)	47 (1192)	480	495	290	260	3800
250 – 47	47 (1194)	54 (1372)	550	560	340	310	3300
250 – 54	54 (1372)	60 (1524)	650	680	410	365	2850
250 – 60	60 (1524)	66 (1676)	760	780	470	405	2650
250 – 66	66 (1676)	75 (1905)	850	885	525	465	2300
250 – 75	75 (1905)	85 (2159)	920	1010	590	520	2000
250 – 85	85 (2159)	95 (2413)	1100	1180	715	605	1750
250 – 95	95 (2413)	105 (2667)	1275	1360	795	675	1600
250 - 105	105 (2667)	115 (2921)	1445	1500	880	745	1300

NOTES —
[1] The SCL values shown represent manufacturers' ratings for line posts manufactured with nominal 2.5 inch diameter rod.
[2] Leakage distance should be at least 16 mm/kV (line to line)
[3] Metric values in parentheses ().

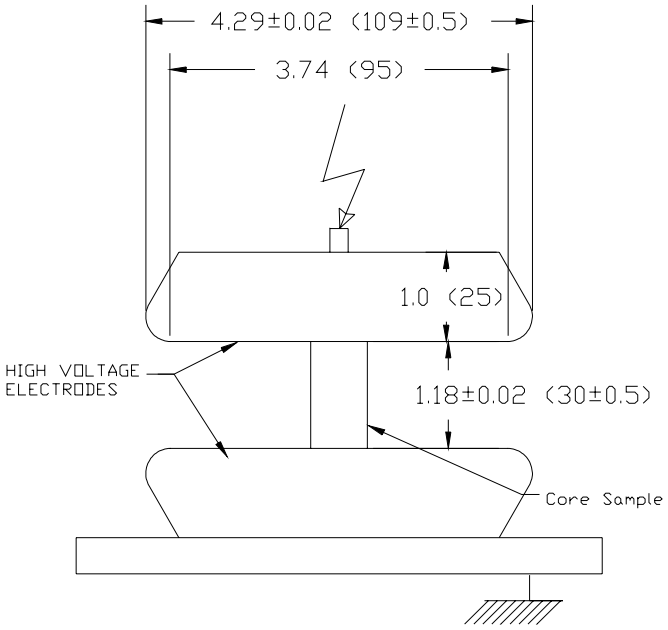


Figure 1 – Electrodes for the voltage test

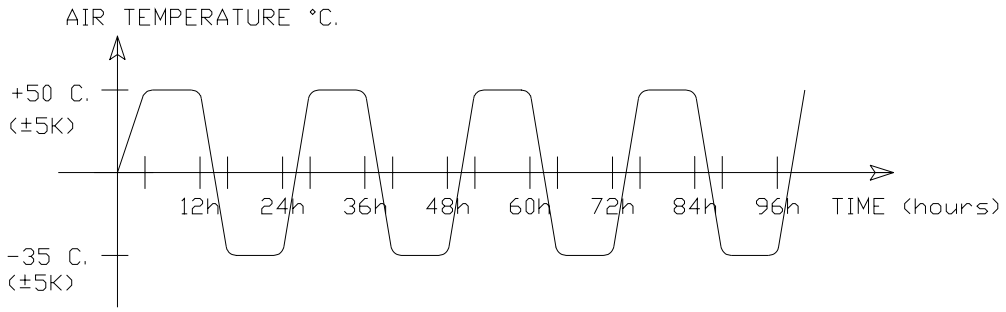


Figure 2 – Temperature cycling profile

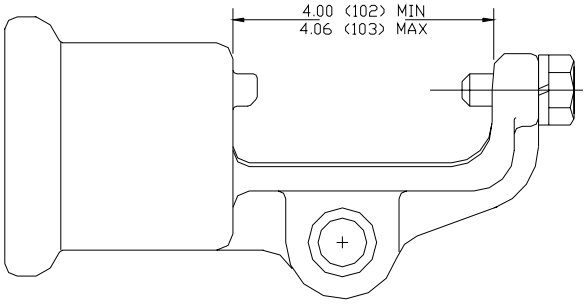


Figure 3 – Typical horizontal clamptop end fitting
(To be used with a trunnion clamp. Reference ANSI C29.7 for dimensional details.)

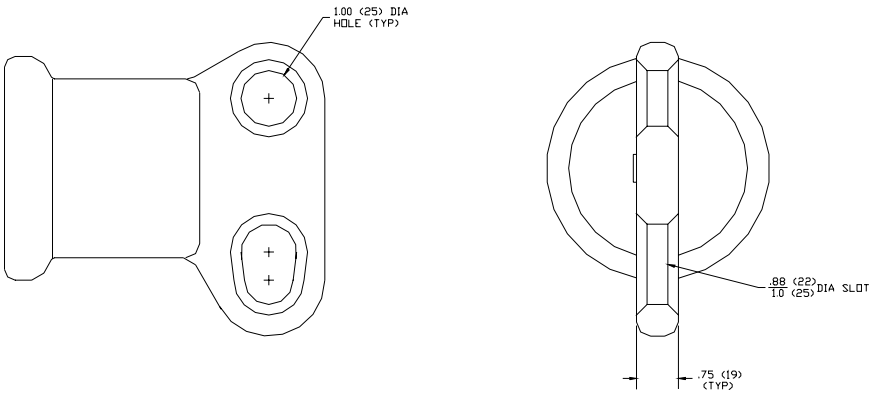


Figure 4 – Typical blade style end fitting

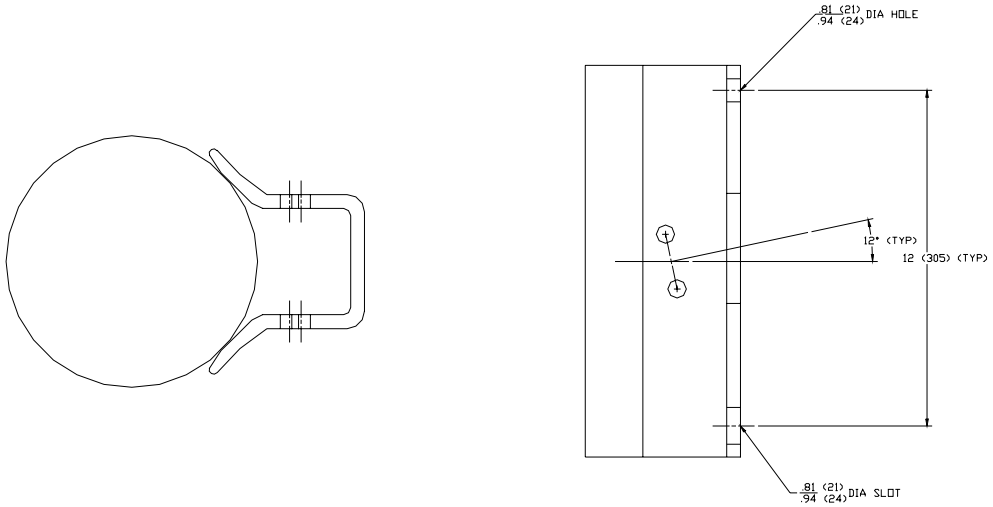


Figure 5 – Typical detachable gain base for use with round poles

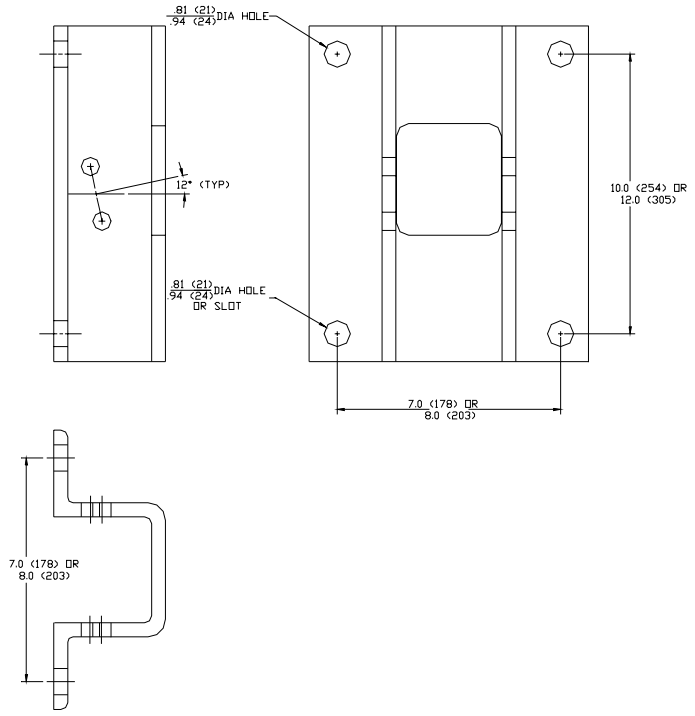


Figure 6 – Typical detachable flat base