

# Engineering Standards Department


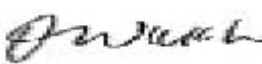
## JPS Spec. No. 3420-S-97/12-04

### PORCELAIN AND POLYMER INSULATORS

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Revision Number	Date of Revision	Revision Made	Checked By
1	August 03,2016	Remove insulators manufactured from porcelain except for Guy Strain  Added clause 5.5.1.2-5.5.1.4	
2	May 25,2021	Update 4.1 –Insulators parameters	

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The "Technical Specifications, General Requirements" Forms a part of this specification.

## 1. SCOPE

These specifications cover the requirements for Suspension and Post type insulators made from silicone materials for use on a 50 Hz system with Transmission and Distribution voltages of 138 kV, 69 kV, 24kV,13.8 kV and 12 kV.

Guy strains shall be manufactured from wet-process porcelain.

## 2. GENERAL REQUIREMENTS

### 2.1 INFORMATION

Refer to "General Requirements" Section 2 paragraph 2.1 of "Technical Specifications, General Requirements".

### 2.2 DRAWING etc. by SUPPLIER

Refer to Section 2 paragraph 2.2, "Technical Specification, General Requirements"

### 2.3 DEFINITIONS

These definitions apply primarily to polymer insulators. For additional definitions, see Section 2 of ANSI/IEEE Std. 987

2.3.1 **Core:** The axially aligned glass fibre reinforced resin rod that forms the mechanical load bearing component of the insulator.

2.3.2 **Cracking:** Rupture of the weather shed material to depths greater than 0.1 mm.

2.3.3 **Design Tests:** Tests which are required on new designs of insulators.

2.3.4 **Acceptance Tests:** Tests which are required on each lot.

2.3.5 **End Fittings:** The insulator attachment hardware that is connected to the core.

2.3.6 **Suspension Insulator:** The term as it is used in this specification means any insulator intended to carry primarily tension loads and includes tangent and deadend installations.

2.3.7 **Post Insulator:** The term as is used in this specification means any insulator intended to carry tension, torsion, bending or compression loads. It includes horizontal and vertical installation.

2.3.8 **Tracking:** Irreversible degradation of surface material from the formation of conductive carbon paths.

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- 2.3.9 **Weathershed:** The external part of the insulator that protects the core and provides the wet electrical strength and leakage distance.
- 2.3.10 **Ultimate Strength:** The ultimate strength of an insulator is the tensile load at which any part of the insulator fails to perform its function of providing mechanical support.
- 2.3.11 **Cantilever Strength:** The cantilever strength of an insulator is the cantilever load at which any part of the insulator fails to perform its function of providing mechanical support.
- 2.3.12 **Lot:** The quantity of any one type of insulator manufactured under an identical process not exceeding 3000 units.
- 2.3.13 **JPSCo: JAMAICA PUBLIC SERVICE COMPANY LIMITED.**

### **3. STANDARD AND SERVICE CONDITIONS**

#### **3.1 STANDARDS/REFERENCES**

- 3.1.1 Refer to the latest revisions to "Codes and Standards" Section 3 of "The Technical Specifications, General Requirements".
- 3.1.2 The following codes, standards, their latest issues, amendments and supplements shall be observed in the design, manufacture, performance and tests of the insulators.
- 3.1.2.1 Standards of the AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI):
1. ANSI C29.1 Test Method for Electrical Power Insulators.
  2. ANSI Z55.1 Grey Finishes for Industrial Apparatus and Equipment
  3. ANSI 987 IEEE Guide for Application of Composite Insulators
  4. ANSI C29.4 Wet-Process Porcelain Insulators - Strain Type.
  5. ANSI C29.5 Wet-Process Porcelain Insulators - Low and Medium Voltage Types.
- 3.1.2.2 Standards of the CANADIAN STANDARDS ASSOCIATION (CSA),
1. G164-M Hot Dip Galvanizing of Irregularly Shaped Articles
  2. CAN 3-Z299.3 Quality Assurance Program Category 3
- 3.1.2.3 Standards of the AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM),

1. D750 Recommended Practice for Operating Light and Weather Exposure Apparatus (Carbon ARC Type) for Artificial Weather Testing of Rubber Compounds
2. D1499 Recommended Practice for Operating Light and Water Exposure Apparatus (Carbon Arc Type) for Exposure of Plastics
3. D2240 Rubber Properties Durometer Hardness
4. D2565 Recommended Practice for Operating Xenon-Arc Light and Water Exposure Apparatus for Plastics
5. G152 Recommended Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
6. G153 Recommended Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
7. G155 Recommended Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials
8. G154 Recommended Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials
9. A153 Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
10. C151 Test Method for Autoclave Expansion of Porcelain Cement.

3.1.2.3 In the event of conflicts between reference standards/specifications and this specification the more stringent specification shall have precedence and govern. However, the bidder shall point out these conflicts in his bid at the time of tendering.

### **3.2 SERVICE CONDITIONS**

3.2.1 Polymer (Silicone) insulators are intended for use in highly contaminated areas, and are frequently located less than 50 m from the coast line, sometimes directly exposed to salt spray for the ocean.

3.2.2 Refer to "Geographic Conditions" Section 4 "The Technical Specifications, General Requirements".

### **3.3 PRODUCT QUALIFICATION**

3.3.1 Unqualified insulators to be supplied shall be qualified under this section.

3.3.2 Application for qualification shall be accompanied by the following:

3.3.2.1 Three sample insulators of the pertinent type together with two copies of the applicable drawings complete with details including the method of attaching the end fittings to the core.

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- 3.3.2.2 Three samples of the weathershed material. These shall be either of rectangular shape, having dimensions of 200 x 50 x 5 to 10 mm or cylindrical having a length of 200 mm and a diameter of 20 mm.
- 3.3.2.3 Two samples of the core material. These shall be of the same diameter as in the insulator design and have a length of 250 mm.
- 3.3.2.4 Three samples of any other material used to form part of the weathershed structure. The size of the test samples shall be the same as in par. 3.2.2.
- 3.3.2.5 Certified test results covering the design test (par. 5) requirements.
- 3.3.2.6 A copy of the manufacturer's Inspection and Test Plan as per CN/CSA 3-Z299.3, that the manufacturer intends to use during the manufacture of these insulators.
- 3.3.2.7 The colour of the weathershed shall be subject to the approval of Jamaica Public Service Co. Ltd.
- 3.4 The method of marking the end fittings shall be subject to the approval of Jamaica Public Service Co. Ltd.
- 3.5 JPSCo reserves the option to request a sample of three more insulators of the pertinent type be provided with the qualification application.
- 3.6 Insulators supplied under this specification shall be identical in all respects to the qualified product. Any change in materials, dimensions, manufacturing processes, or any other design factor, shall be brought to the attention of JPSCo for approval. Failure to do so shall result in disqualification.
- 3.7 Insulators qualified under this specification shall automatically require re-qualification after five (5) years from the date of any prior qualification.

#### 4. DETAILED REQUIREMENTS

##### 4.1 TYPE

##### 4.1.1 Guy Strain Insulator Porcelain

Material	Porcelain
Combined Mech. & Elec. Strength	89 kN(20,000 lb.)
Colour	Sky Grey
Class	ANSI 54-4
MFG. & Cat. No.	CHANCE C909-1044 or approved equal.

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#### 4.1.2 Horizontal Post Type Silicone Insulator 69 kV

Material	Polymer
Standard	IEC 61109, ANSI C29.13, CSA C411.5, IEEE 987-2001
Insulator Voltage Class	69kV
Leakage Distance	2238mm
Cantilever Strength (SCL)	21.1kN
Tensile Strength (STL)	120kN
Average Flashover Voltage	
- Low Frequency Dry	335kV
- Low Frequency Wet	295kV
Positive Critical Impulse Flashover	495kV Impulse Withstand
Colour	Sky Grey

#### 4.1.3 Silicone Suspension Insulator 69 kV

Material	Polymer
Standard	IEC 61109, ANSI C29.13, CSA C411.5, IEEE 987-2001
Insulator Voltage Class	72.5kV Max
Ends	Ball-Eye
Leakage Distance	2131mm
SML Load	90kN
Average Flashover Voltage	
- Low Frequency Dry	300kV
- Low Frequency Wet	235kV
Positive Critical Impulse Flashover	485kV
Colour	Sky Grey

#### 4.1.4 Silicone Suspension Insulator 138 kV

Material	Polymer
Standard	IEC 61109, ANSI C29.13, CSA C411.5 IEEE 987-2001
Insulator Voltage Class	138kV
Basic Impulse Level	
Leakage Distance	4458mm
Tensile Strength	134kN

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Average Flashover Voltage	
- Low Frequency Dry	555kV
- Low Frequency Wet	450kV
Positive Critical Impulse Flashover	880kV
Ends	Ball-Eye
Colour	Sky Grey

#### 4.1.5 Post Type Silicone Insulator 138 kV

Material	Polymer
Standard	IEC 61109, ANSI C29.13, CSA C411.5, IEEE 987-2001
Insulator Voltage Class	138kV
Leakage Distance	4315mm
Cantilever Strength (SCL)	10.8kN
Tensile Strength (STL)	134kN
Average Flashover Voltage	
- Low Frequency Dry	595kV
- Low Frequency Wet	490kV
Positive Critical Impulse Flashover	900kV Impulse Withstand
Colour	Sky Grey

#### 4.1.6 Silicone Post Insulator 35 kV

Material	Polymer
Standard	IEC 61109, ANSI C29.13, CSA C411.5, IEEE 987-2001
Insulator Voltage Class	35kV
Leakage Distance	860mm
Cantilever Strength (SCL)	12.5kN
Tensile Strength (STL)	45kN
Average Flashover Voltage	
- Low Frequency Dry	120kV
- Low Frequency Wet	85kV
Positive Critical Impulse Flashover	240kV
Colour	Sky Grey

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#### 4.1.7 Silicone Suspension Insulator 35 kV

Material	Polymer
Standard	IEC 61109, ANSI C29.13, CSA C411.5, IEEE 987-2001
Insulator Voltage Class	35kV Max
Ends	Tongue-Clevis
Leakage Distance	750mm
SML Load	70kN
Average Flashover Voltage	
- Low Frequency Dry	155kV
- Low Frequency Wet	145kV
Positive Critical Impulse Flashover	264kV
Colour	Sky Grey
MFG. & Cat. No	K-Line KL-35ASCTM or approved equal

#### 4.1.8 Silicone Universal Line Post 35 kV

Material	Polymer
Leakage distance	660 mm (26")
Dry Arcing distance	270 mm (10.6")
Cantilever Strength	12.5 kN (2800 lb.)
Tensile Strength	13.4 kN (3000 lb.)
Colour	Sky Grey
MFG. & Cat. No.	K-Line KL-35SK or approved equal

#### 4.1.9 Guy Strain Fibreglass Insulator

Application	Used on 138 kV and 69 kV transmission.
Tensile Strength	134 kN (30 000 lb.)
MFG. & Cat. No.	Joslyn 201-78 or approved equal.

#### 4.1.10 Guy Strain Porcelain Insulator

Application	Used on 24 kV distribution system
Class	ANSI 54-1
Tensile Strength	44.5 kN (10 000 lb.)
Colour	Sky Grey
MFG. & Cat. No.	OHIO Brass 31502 or approved equal

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#### 4.1.11 Silicone Pilot Insulator 35 kV

Leakage distance	750 mm (29.5")
Dry Arc Distance	348 mm (13.7")
Colour	Sky Grey
MFG. & Cat. No.	K-Line KL35SRSIUX or approved equal

#### 4.1.12 Silicone Pilot Insulator 69 kV

Leakage distance	1798 mm (70.8")
Dry Arc Distance	627 mm (24.7")
Colour	Sky Grey
MFG. & Cat. No.	K-Line KL69HRSIUB19 or approved equal

### 4.2 CONSTRUCTION

4.2.1 All Guy strain insulators shall be manufactured from good commercial grade wet-process porcelain.

4.2.2 Weathershed material for polymer insulators shall be one piece moulded silicone construction, rigidly attached to the fibreglass core. Independent movement and the penetration of moisture between the core and weathershed material is unacceptable.

Assembled and extruded weathersheds are not acceptable. EPDM/Silicone alloys are not acceptable.

4.2.3 End fittings for polymer insulators shall be attached such that no moisture can penetrate to the core layer at attachment points. End fittings for suspension distribution silicone insulators shall be fabricated from aluminium wherever possible.

### 4.3 ADDITIONAL REQUIREMENTS POLYMER (Silicone)

4.3.1 **General:** Polymeric Suspension and Line Post Insulators described in this specification generally consist of core, weathersheds and metal end fittings. The core shall be manufactured from resin and glass fibres and weathersheds shall be fabricated from silicone. All 138 kV insulators shall come complete with corona rings.

4.3.2 **Colour:** The preferred colour for the weathershed material of polymer insulators is light Grey no. 70 in accordance with ANSI Z55.1.

4.3.3 **Galvanizing:** All ferrous items, other than stainless steel, shall be galvanized to CSA G164-M and ASTM. The zinc coating thickness shall be not less than 600 g/m<sup>2</sup>.

4.3.4 **Dimensions:** Suspension insulator dimensions shall be with the relevant ANSI C29 standards.

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4.3.5 **End Fittings:** Polymer suspension insulators shall be terminated at the bottom end with a tongue fitting and at the top end with a clevis fitting. The clevis fitting shall be supplied with a 16 mm pin and a cotter key of copper base alloy or stainless steel. Both end fittings shall be made from aluminium wherever possible.

Line Post polymer insulators shall be terminated at the base with a base mount, having a 19 mm (3/4") 10 unified form bolt hole conforming to Fig. 13 of ANSI C29.7 and at the top end with a line end trunnion, conforming to the dimensions shown in Fig. 11 of ANSI C29.7 and the cap gage in Fig. 12 of ANSI C29.7.

4.3.6 **Workmanship:** Castings and weathersheds shall be uniform in quality. They shall be clean, sound, smooth and free from gross defects and excessive moulding flashing.

4.3.7 **Marking:** Markings shall be restricted to hardware and end fittings. Each insulator shall be permanently marked as follows:

- (i) Manufacturer's name or trademark and catalogue number
- (ii) Year of Manufacture
- (iii) Voltage Rating
- (iv) Principal Mechanical Strength

Each insulator unit shall be marked identifying the manufacturer, and indicating the year of manufacture. In addition suspension insulators shall have markings indicating rated combined mechanical and electrical strengths.

All marking shall be legible, durable and shall be in English.

#### 4.4 **Data to be Furnished by Bidder**

4.4.1 The Bidder shall attach to his proposal the form included in the "Schedule of Technical Data" As Exhibit 'B' duly completed for each type of insulator.

### 5. **TEST AND TEST PROCEDURES**

5.1 Tests on porcelain insulators shall be conducted in accordance with ANSI C29.1.

5.2 Certified test reports shall be provided for each batch of insulator supplied.

5.3 Manufacturer shall invite the Purchasers Representatives (2) at the manufacturer's expense, to witness the tests. This invitation shall be extended at least two (2) weeks before the commencement of such tests. The cost of this visit shall be shown separately. This condition may be waived at the discretion of the Purchaser.

5.4 Refer to "Test" Section 5 of "Technical Specifications General Requirements" for further test requirements.

#### 5.5 **Additional Tests and Test Procedures**

### 5.5.1 Design Tests

5.5.1.1 **Hydrolysis Resistance:** Hydrolysis resistance of the weathershed material shall be demonstrated by a boiling water test. The SHORE A hardness determined in accordance with ASTM D2240 after 100 hours of boiling shall not decrease by more than 20 percent, when measured within 12 hours after boiling. Obvious signs of degradation such as dissolving or crumbling shall constitute failure to meet the requirements of this specification. Tests the performance of the housing material and seal between rubber and fitting

5.5.1.2 **Water Diffusion Test :** Six cut samples from an insulator shall be tested where the samples shall be boiled in salt water for 100h ,then a voltage of 12kV shall be applied for one minute with a maximum current of 1mA. No punctures or surface flashovers should occur.

5.5.1.3 **Flammability Test:** The flammability test is done according to IEC standards as a means of identifying the fire resistance of insulator materials. The housing (shed and sheath) material shall be tested for ignition and self-extinguishing properties.

5.5.1.4 **Core Rod Electrical Test:** This test shall be conducted to check for any contaminants within the rod. The test unit shall apply the equivalent of 100kV/ft (328kV/m) to each rod while measuring leakage current. The test is applied along the entire length of the rod.

5.5.1.5 **Weatherometer Resistance:** Three samples of the weathershed materials shall be tested for 1000 hours by one of the following methods:

- a) Carbon Arc Methods : ASTM D750, D1499, G152 or G153.
- b) Xenon Arc Methods : ASTM G155 or D2565.
- c) Fluorescent UV Method : ASTM G154.

Cracking, when examined under X25 magnification, shall constitute failure to meet the requirements of this specification. Test without water are not permitted.

5.5.1.6 **Tracking Resistance:** Three samples of the weathershed material and each material forming part of the weathershed structure shall be tested for tracking resistance using the tracking resistance wheel in accordance with ANSI C29. The test samples shall be in accordance with par. 3.3.2. Evidence of tracking or severe erosion on any of the test samples at the end of the 1000 hours tracking exposure, shall constitute failure to meet the requirements of this specification.

5.5.1.7 **Dye Penetration:** A dye penetration test shall be performed on five 10 mm thick wafers of the weathershed material. The wafers shall be cut normal to the axis of the insulator with a diamond coated circular saw blade cooled with water. The cut surfaces shall be lapped with 180 mesh or finer abrasive and wiped clean with isopropyl alcohol. The wafers are placed with fibres vertical into a container on a layer of 3 mm diameter glass or metal balls. One percent alcohol solution of fuchsine dye (1g fuchsine in 100g methanol) is poured into the container to a level 3-5 mm above the level of the balls. Dye penetration of the wafers within 15 min. by capillarity, when viewed under black light, shall constitute failure to meet the requirements of this specification.

5.5.1.8 **Dielectric Properties:** A dielectric test shall be performed on five 30 mm thick wafers of the weathershed material. The wafers shall be cut normal to the axis of the insulator with a diamond coated circular saw blade cooled with water. The cut surfaces shall be lapped with 180 mesh or finer abrasive and wiped clean with isopropyl alcohol. The wafers shall be boiled for 100 hours

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in distilled water containing 0.1 percent by weight of NaCl. After boiling and within one to three hours of removal from the water, the wafers shall be subjected to a dielectric test between parallel plate electrodes. The test voltage shall be kept constant for one minute at 14 kV rms. Leakage current exceeding 1 mA rms. or puncture of the wafers shall constitute failure.

**5.5.1.9 Low-Frequency Dry Flashover Test:** Three insulators shall be subjected to the low-frequency dry flashover test as defined in ANSI C29.1. Failure of the average dry flashover value of the three insulators to equal or exceed 95 percent of the rated dry flashover value, as given in the Table of Requirements shall constitute failure to meet the requirements of this specification.

**5.5.1.10 Low-Frequency Wet Flashover Test:** Three insulators shall be subjected to the low-frequency wet flashover test as defined in ANSI C29.1. Failure of the average wet flashover value of the three insulators to equal or exceed 90 percent of the rated wet flashover value, as given in the Table of Requirements shall constitute failure to meet the requirements of this specification.

**5.5.1.11 Critical Impulse Flashover Test:** Three insulators shall be subjected to the critical impulse flashover test as defined in ANSI C29.1. Failure of the average positive or negative critical impulse flashover value of the three insulators to equal or exceed 92 percent of the rated critical impulse flashover value, whichever is lower, as given in the Table of Requirements shall constitute failure to meet the requirements of this specification.

**5.5.1.12 Power Arc Test:** Three suspension polymer insulators of each design of end fittings shall be tested for power arc endurance while tensioned horizontally at 13.4 kN (3000 lb.). An arc shall be initiated across the insulator by means of a shorting fuse wire. The arc shall burn 15 to 150 cycles and the current magnitude, determined by the ampere-time product ( $I \times t$ ), shall be 150 kA-cycles. Mechanical separation of any one insulator shall constitute failure to meet the requirements of this specification.

**5.5.1.13 Radio-Influence Test:** Three insulators shall be subjected to the radio-influence test as defined in ANSI C29.1. Failure of one or more insulators to meet the requirements as given in the Table of Requirements shall constitute failure to meet the requirements of this specification.

**5.5.1.14 Ultimate Strength Test:** Five polymer suspension insulators of each design of end fitting shall be subjected to the tension strength test as defined in ANSI C29.1 to demonstrate the ultimate strength. Failure of  $(X-3S)$  to be greater than or equal to 44.5 kN (10 000 lb.) shall constitute failure to meet the requirements of this specification.

Where  $X$  = average of the mechanical strength for the 5 tests.  
 $S$  = Standard deviation for the 5 tests.

**5.5.1.15 Torsion Strength Test:** Five insulators of each design of end fitting shall be subjected to the torsion strength test as defined in ANSI C29.1 to the limit specified in the Table of Requirements. Subsequent to the test, three wafers from each unit (one from the centre and one from each end) shall be tested in accordance with par. 5.5.1.4. Dye penetration within 15 min. by capillarity of any wafer shall constitute failure to meet the requirements of this specification.

**5.5.1.16 Cantilever Strength Test:** Five line post insulators shall be subjected to the cantilever strength test as defined in ANSI C29.1 in parallel to the test specimen mounting flange to demonstrate the cantilever strength of the insulator. No breaking of an insulator at a value less than 12 kN shall be permitted. A calculated value  $(X-3S)$  less than 12 kN shall constitute failure.

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Where X = average of the mechanical strength for the 5 tests.  
S = Standard deviation for the 5 tests.

## 5.5.2 Acceptance Tests and Inspections

5.5.2.1 Tension Proof Test: All polymer insulators shall be tension proof tested to 44.5 kN (10,000 lb) in accordance with the routine tests as specified in ANSI C29.1.

5.5.2.2 Three insulators from each lot shall be sectioned. Three wafers from each insulator (one from the centre and one from each end) shall be tested in accordance with par. 5.5.1.4. Dye penetration of any wafer within 15 min. by capillarity shall constitute rejection of the lot.

5.5.2.2.1 Three insulators shall be tested from each lot for:

- i) Galvanizing thickness and adhesion in accordance with par. 4.3.3
- ii) Dimensions in accordance with par. 4.3.4
- iii) End fittings in accordance with par. 4.3.5
- iv) End fitting shall be marked in accordance with par. 4.3.7

## 6 QUALITY ASSURANCE PROVISIONS

6.1 The manufacturer shall:

- i) have an implemented Quality Assurance Program conforming to CSA/ CAN3 - Z299.3 to ensure that the product quality characteristics specified will be met.
- ii) supply objective evidence with each shipment in the form of the acceptance tests results in accordance with par. 5.5.2, to confirm that items supplied meet the requirements of this specification.

## 7 PACKAGING AND PACKAGE MARKING

7.1 Polymer insulators shall be supplied in weather proof shipping containers. All packaging shall be so constructed as to ensure acceptance and safe delivery by common or other carrier to the delivery point called for in the purchasing documents. The packaging procedure used shall have received prior approval in writing from JPSCO. The gross mass of any package containing polymer insulators shall not exceed 20 kg (45 lb.).

7.2 On each shipping container, in weather proof lettering, the following minimum information shall be shown:

- (i) JPSCO specification number
- (ii) JPSCO purchase order number
- (iii) Manufacturer's name or trademark
- (iv) Manufacturer's catalogue number
- (v) Quantity

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(vi) Weights (Gross, Net and Unit)

## **8. SHIPMENT**

8.1 No shipment of Insulators shall commence without the written approval of JPSCO. Approval shall only be given after the receipt of all relevant documents, certifications, final drawings, test reports etc.

8.2 JPSCO shall be informed at least ten (10) workings days prior to shipment.

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# Signature Certificate



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