



**INDEPENDENT POWER TRANSMISSION OPERATOR S.A.**

**TRANSMISSION NEW PROJECTS DEPARTMENT**

**DEPARTMENT OF DESIGN AND SPECIFICATION  
OF OVERHEAD TRANSMISSION LINES**

**ATHENS - GREECE**

**SPECIFICATION TR-1**

**STRING INSULATOR UNITS**

**Revision March 2015  
ATHENS - GREECE**



## **INDEPENDENT POWER TRANSMISSION OPERATOR S.A.**

### **TRANSMISSION NEW PROJECTS DEPARTMENT**

#### **DEPARTMENT OF DESIGN AND SPECIFICATION OF OVERHEAD TRANSMISSION LINES**

##### **SPECIFICATION TR-1**

This specification covers the manufacturing and testing of cap and pin type insulators, made from toughened glass.

The insulators have to pass successfully the tests mentioned in paragraph 3 and shall meet all the requirements mentioned in present specification. For all the standards referred below is valid their latest edition.

### **1. DESIGN AND FABRICATION**

- 1.1** The insulators shall be designed and fabricated to provide mechanical ruggedness and long-service life, without thereby sacrificing requirements to meet electrical and operating characteristics herein specified. The quality of the insulators during the manufacturing process will be verified by standard EN ISO 9001. Under surfaces and ribs shall be shaped for easy cleaning. Shells shall be substantially symmetrical in shape without appreciable warping.
- 1.2** The toughened glass shall be sound and free from defects and blemishes, which might adversely affect the life of the insulator. All exposed glass parts shall have a smooth surface.
- 1.3** Insulators shall be designed to avoid excessive concentration of electrical stresses, in any section or across leakage surfaces. Design features tending to adversely affect radio reception shall be avoided as far as practicable.
- 1.4** The toughened glass, shall not engage directly with hard metal. When cement is used, every precaution shall be taken to ensure that such cement is suitable and that it shall not cause fracture by expansion or loosening by contraction.
- 1.5** The metal parts, except for the cotter pins, shall be made of a good commercial grade of malleable iron or open hearth or electric furnace steel, hot-dip galvanized. Cotter pins shall be made of phosphor-bronze or stainless steel. Stainless steel used shall have good resistance against corrosion and shall be of quality 18 Cr – 8 Ni or equivalent.
- 1.6** Dimensions of ball and socket couplings of string insulator units shall be in accordance with Standard IEC 60120 (standard coupling / split – pin).

### **2. MARKING**

Each insulator unit shall bear legible and indelible symbols identifying the manufacturer, the year of manufacture and the rated combined mechanical and electrical strength, identified by the word "M-E".

### **3. TESTS**

Insulators shall be subjected to the following tests, in accordance with International Standard IEC 60383-1, except cases that different standard is referred, and the values given in Annexes A, B, C and D, depending on the required insulator.

All required tests should be preformed in proper independent laboratories accredited according to International Standard ISO/IEC 17025, except sample and routine tests which can be performed to manufacturer's laboratory, if it is certified by ISO 9001. Test reports have to be written in Greek or English language and shall be certified by laboratory where the tests have taken place.



### **3.1 TYPE TESTS:**

- 3.1.1 Dry lightning impulse withstand voltage test, as per paragraph 13.
- 3.1.2 Wet power-frequency withstand voltage test (the wet flashover voltage shall also be determined), as per paragraph 14.
- 3.1.3 Mechanical failing load test, as per paragraph 19.
- 3.1.4 Thermal-mechanical performance test, as per paragraph 20.
- 3.1.5 Steep front-of-wave flashover voltage test, according to requirements and procedures of Standard IEC 61211/2004. Tests that have taken place according to requirements and procedures of the above standard and previous edition are also acceptable.
- 3.1.6 Power arc test  

Test shall be performed according to requirements and procedures of International Standard IEC 61467, with test circuit B (Unbalanced supply circuit / Balanced return circuit) of Table 1 and Test series X of Table 2.  
Each insulator unit shall withstand this test without puncture or mechanical failure.
- 3.1.7 Radio-Influence Voltage test, as per Standard IEC 60437.
- 3.1.8 Residual-Strength test, as per Standard IEC 60797.

### **3.2 SAMPLE TESTS:**

- 3.2.1 Puncture test, as per paragraph 15.1
- 3.2.2 Steep front-of-wave flashover voltage test, according to requirements and procedures of Standard IEC 61211/2004.
- 3.2.3 Verification of dimensions, as per paragraph 17.
- 3.2.4 Mechanical failing load test, as per paragraph 19.
- 3.2.5 Verification of the axial, radial and angular displacements, as per paragraph 21.
- 3.2.6 Verification of the locking system, as per paragraph 22.
- 3.2.7 Thermal shock test, as per paragraph 24.
- 3.2.8 Galvanizing test, as per paragraph 26.

### **3.3 ROUTINE TESTS** (shall be performed in the following order):

- 3.3.1 Visual examination, as per paragraph 27.
- 3.3.2 Mechanical routine test (to a tensile load equal to 50% of the specified electromechanical failing load), as per paragraph 28.2.

## **4. INSPECTION AND TESTING**

- 4.1 The insulators shall be subjected to inspection and shall not be released for shipping without the approval of Corporation's representative. The approval for shipping shall neither relieve the Manufacturer from responsibility of furnishing material conforming to all requirements of Corporation nor invalidate any claim which Corporation may make because of defective or unsatisfactory material.



- 4.2** Manufacturer shall submit to Corporation copies of the control and test reports of the material. Corporation reserves the right to demand all the routine test reports from the manufacturer.
- 4.3** In each delivery quantity, sample tests shall be performed in accordance with the requirements of par.3.2 of present specification.
- 4.4** For type test reports that haven't been submitted or that aren't adequate according to the requirements of par.3 of present specification, IPTO SA reserves the right to request the performance of any or all type tests specified in par.3.1 of present specification on samples which shall be taken from the production of the offered items. The Corporation reserves the right to select test laboratory and witness any or all tests.
- 4.5** All Bidders shall have to state the manufacturers of the material, as well as all related sub-contractors, if any.  
They shall also have to submit along with their offer a Quality Assurance Plan (Q.A.P), for the manufacturing procedure of the stated manufacturer and all potential sub-contractors, by which it shall be evident in a detailed way the entire manufacturing procedure, the quality control equipment as well as all quality control stages, including all of the related printed material and referring to the specific international standards and regulations applied.  
During the Technical Evaluation procedure, IPTO SA shall reserve itself the right to monitor the production procedure so as to ascertain the application of the Q.A.P. and, in general, to conclude on the production procedure, in a way that shall deem the offer technically acceptable or not.

## **5. PACKING AND SHIPPING**

- 5.1** Packing and shipping of the insulators must be in such a manner that protects them from damage in transit (by sea, plane, rail way, on road) and handling.
- 5.2** Containers shall conform the all standard requirements, for the class of material being packed and shall be suitable for outdoor storing.
- 5.3** Each container shall be legibly and durable marked with the gross weight, the number of units, the purchase order number, the characteristic mark of the manufacturer and all shipping marks.
- 5.4** All insulators, together with crates and methods of packing, shall be subject to final inspection and test at Seller's works. The number of insulators in each crate is specified in ANNEXES A, B and C.

## **6. DATA TO BE SUBMITTED WITH OFFER**

In the offers must be included the following data in a clear and unique way.

- 6.1** Full description of the offered items, with a scale drawing showing in cross-section for each insulator type, all essential data, dimensions and tolerances, type of material of each part and method of casting (malleable or cast, etc.) of metal parts.
- 6.2** A reference list of at least three (3) Electrical Companies, who have buy enough quantities of the same or similar type insulators with those that are offered which have been used with excellent operation on overhead Transmission Lines, for a period of at least five (5) years followed by the corresponding certificates.  
Reference list and corresponding certificate shall include the exact type of insulator, operation voltage, exact quantity and the date of selling or installation.  
Certificates shall be original or validated copies and distinct regarding the Electrical Company that edit and guarantee the excellent operation of corresponding insulators.  
Bidders that have supplied in the last decade, IPTO SA (or PPC SA) with the requested material, have no obligation of submitting the prerequisites of this paragraph, provided that it does not change the factory of manufacture.
- 6.3** Test reports concerning the type tests specified in par.3.1 of present specification, by independent



laboratory accredited according to International Standard ISO/IEC 17025. Test reports must be complete, with drawing of the tested insulator.

- 6.4** Confirmation of the insulators data specified in ANNEXES A, B or C and to complete them in corresponding columns.
- 6.5** The following data for a string of 10 units in case of insulators of ANNEX A and 18 units in case of insulators of ANNEX B and C:
- Low-frequency flashover dry,
  - Low-frequency flashover wet,
  - Dry impulse flashover positive and negative and
  - Wet Switching Impulse flashover positive and negative.



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**ATHENS - GREECE**  
**SPECIFICATION TR-1 / ANNEX A**  
**INSULATOR DATA**

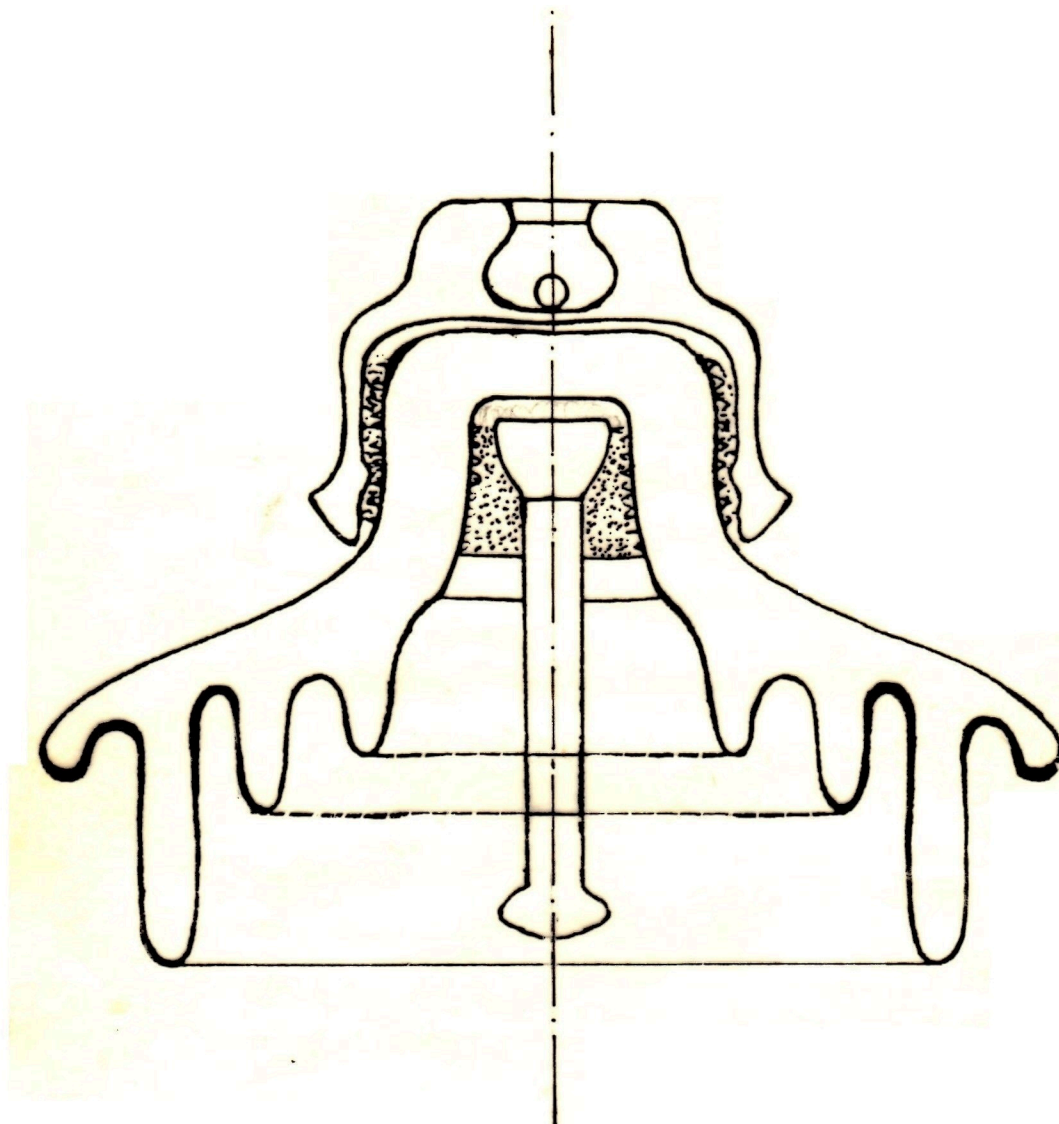
(Insulators for application on 150 kV T.L.)

DESIGNATION		Normal type	Manufacturer data	Fog type	Manufacturer data	Fog type	Manufacturer data
				Type 1		Type 2	
Maximum Diameter	mm	255		255		280	
Spacing	mm	146		127		146	
Ball and Socket size	mm	16A		16A		16A	
Minimum Leakage Distance	mm	295		390		440	
Min. Electro-Mechanical failing load / Tensile strength	kN	100		100		100	
Mechanical Impact strength	Nm	10		10		10	
Short Circuit Current of the system $I_{sys}$	kA	18		18		18	
Duration t	sec	0.5		0.5		0.5	
Power Frequency Withstand voltage Dry one minute	kV	70		70		85	
Power Frequency Withstand voltage Dry one minute (String of five items)	kV	280		244		280	
Power Frequency Withstand voltage Wet one minute	kV	40		40		50	
Power Frequency Withstand voltage Wet one minute (String of five items)	kV	195		170		195	
Dry lightning Impulse Withstand voltage	kV	105		110		125	
Dry lightning Impulse Withstand voltage (String of five items)	kV	430		395		430	
Power Frequency Puncture Voltage	kV	130		130		130	
Power Frequency test Voltage to determine RIV, rms to ground	kV	10		10		10	
Maximum RIV at 1000 kHz	$\mu V$	50		50		50	
Number of units per package		5		6		5	
Net weight per unit	kg						

**Remarks:**

1. The pin of the fog type insulators shall be equipped with a zinc sleeve fused to it without gaps. The fused area shall be more than 80% of the total area between the zinc sleeve and the pin. The zinc sleeve shall have sufficient thickness and length. The zinc shall have a minimum purity of 99.7%
2. The galvanization of the caps of the fog type insulators shall be reinforced with a thickness of 110  $\mu m$ .
3. Especially the fog type insulators, type 1, shall be designed according to drawing TMFM 1001, regarding the under ribs.
4. The value  $I_{sys}$  shall be used to perform type test of par.3.1.6 of present specification, with test circuit B of Table 1 and Test series X of Table 2, according to International Standard IEC 61467.





<b>ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV &amp; 400 kV</b> <b>FOG INSULATOR SHAPE</b> <b>ΜΟΡΦΗ ΜΟΝΩΤΗΡΑ ΟΜΙΧΛΗΣ</b>				
ΣΧΕΔΙΑΣΗ	ΜΕΛΕΤΗ	ΕΛΕΓΧΟΣ	ΕΓΚΡΙΣΗ	ΗΜΕΡΟΜΗΝΙΑ
Α.ΜΑΘΙΟΥΛΑΚΗΣ	Α. ΜΑΘΙΟΥΛΑΚΗΣ	Π. ΤΣΕΧΕΛΙΔΟΥ	Σ. ΚΑΛΑΦΑΤΗΣ	ΜΑΡΤΙΟΣ 2015
 ΑΔΜΗΕ	<b>ΔΙΕΥΘΥΝΣΗ ΝΕΩΝ ΕΡΓΩΝ Γ. Μ.</b> <b>Τομέας Σχεδιασμού &amp; Προδιαγραφών</b> <b>Εναέριων Γ.Μ.</b>			ΚΛΙΜΑΚΑ: --
				<b>ΤΣΠΕΓΜ 1001</b>



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**SPECIFICATION TR-1 / ANNEX B**  
**INSULATOR DATA**

(Insulators for application on 400 kV T.L.)

DESIGNATION		Normal type	Manufacturer data	Fog type	Manufacturer data
Maximum Diameter	mm	280		330	
Spacing	mm	170		170	
Ball and Socket size	mm	20		20	
Minimum Leakage Distance	mm	370		540	
Min.Electro-Mechanical failing load / Tensile strength	kN	160		160	
Mechanical Impact strength	Nm	10		10	
Short Circuit Current of the system $I_{sys}$	kA	31.5		31.5	
Duration t	sec	0.5		0.5	
Power Frequency Withstand voltage Dry one minute	kV	75		90	
Power Frequency Withstand voltage Dry one minute (String of five items)	kV	300		320	
Power Frequency Withstand voltage Wet one minute	kV	45		55	
Power Frequency Withstand voltage Wet one minute (String of five items)	kV	200		230	
Dry lightning Impulse Withstand voltage	kV	110		140	
Dry lightning Impulse Withstand voltage (String of five items)	kV	470		535	
Power Frequency Puncture Voltage	kV	130		130	
Power Frequency test Voltage to determine RIV, rms to ground	kV	10		10	
Maximum RIV at 1000 kHz	$\mu V$	50		50	
Number of units per package		5		6	
Net weight per unit	kg				

**Remarks:**

1. The pin of the fog type insulators shall be equipped with a zinc sleeve fused to it without gaps. The fused area shall be more than 80% of the total area between the zinc sleeve and the pin. The zinc sleeve shall have sufficient thickness and length. The zinc shall have a minimum purity of 99.7%.
2. The galvanization of the caps of the fog type insulators shall be reinforced with a thickness of 110  $\mu m$ .
3. The value  $I_{sys}$  shall be used to perform type test of par.3.1.6 of present specification, with test circuit B of Table 1 and Test series X of Table 2, according to International Standard IEC 61467.