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TEST REPORT

SR. No. TL51040C

สำนักบริหารมาตรฐาน /	5888
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Issued By **High Voltage Division**

Date of Issue13 JUN 2008.....

Approved Signatory

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Test object description	: Pin-Post Type Porcelain Insulators, Class 56/57EA
Manufacturer	: Fine Art Ceramic Company Limited
Sample number	: สผอ.140 1251-13/3
Sample quantities	: 50 units
Date of receipt	: 8 April 2008
Specimen condition	: Normal
Client/Customer	: Thai Industrial Standards Institute, Ministry of Industry Rama VI Rd., Ratchathewi, Bangkok, 10400, Thailand
Refer to	: Letter No. 16786, dated 3 April 2008
Purpose	: Electrical, mechanical and thermal characteristics test
Date of test	: 9 April 2008 to 28 May 2008
Place of test	: High-voltage Laboratory, Faculty of Engineering Chulalongkorn University
Reference standards	: 1) TIS 1251-2537: Standard for Pin-Post Type Porcelain Insulators. 2) ANSI C. 29.1-1988: Test Methods for Electrical Power Insulators. 3) NEMA Standards Publication No. 107-1987. : Methods of Measurement of Radio Influence Voltage (RIV) of High-Voltage Apparatus.

Test items:

1. Low-Frequency Dry Flashover Test
2. Low-Frequency Wet Flashover Test
3. Critical Impulse Flashover Tests
4. Radio-Influence Voltage Test (RIV)
5. Cantilever Strength Test
6. Zn. Coating Thickness Test
7. Thermal Shock Test
8. Dimensional Test
9. Visual Inspection Test
10. Porosity Test

Distribution of samples:

Test items	Sample No.	Quantity, units
1	1 - 3	3
2	4 - 6	3
3	7 - 9	3
4	9 - 14	5
5	15 - 19	5
6	20 - 24	5
7	25 - 29	5
8	30 - 32	3
9	1 - 50	50
10	Specimens from destroyed insulator	-

Test

1. Low-Frequency Dry Flashover Test

Test procedure

The test voltage was 50-Hz alternating voltage obtained from a 200-kV 10-kVA testing transformer. The voltage measurement was made by means of a 200-kV capacitor voltage divider with an accuracy of $\pm 1\%$. The test procedure was conducted in accordance with the paragraph 9.4.1 of TIS 1251-2537.

Quantity of sample : 3 units

Date of test : 25 May 2008

Atmospheric conditions

Barometric pressure, p	750.2	mmHg.
Temperature, T	30.0	°C
Relative humidity, h	74.0	%

Correction factors

The air density correction factor (k_d) and the humidity correction factor (k_h) based on standard conditions, i.e. $b = 760$ mm.Hg., $T = 25$ °C, and absolute humidity = 15 g/m^3 , are:

$$k_d = 0.971$$

$$k_h = 0.916$$

Test results : Test results are shown in Table 1.

Table 1 The results of the low-frequency dry flashover test on Pin-Post Type Porcelain Insulators, Class 56/57-4, Sample No. สรธ.14ธ 1251-13/3.

Sample No.	Flashover voltage, kV
1	153.0
2	155.4
3	154.8
Mean value	154.4
Standard value	140
Standard requirement	Mean value ≥ 133

Note: The given flashover voltages were the average values of five consecutive applied voltages.

2. Low-Frequency Wet Flashover Test

Test procedure

The test voltage was 50-Hz alternating voltage obtained from a 200-kV 10-kVA testing transformer. The voltage measurement was made by means of a 200-kV capacitor voltage divider with an accuracy of $\pm 1\%$. The test procedure was conducted in accordance with the paragraph 9.4.2 of TIS 1251-2537.

Quantity of sample : 3 units

Date of test : 25 May 2008

Atmospheric conditions

Barometric pressure, p	750.2	mmHg.
Temperature, T	30.0	°C
Relative humidity, h	74.0	%

Correction factors

The air density correction factor (k_d) and the humidity correction factor (k_h) based on standard conditions, i.e. $b = 760$ mm.Hg., $T = 25$ °C, and absolute humidity = 15 g/m^3 , are:

$$k_d = 0.971$$

Characteristics of rain water :

Resistivity	17,800	ohm-cm
Rate of precipitation	5	mm./min.
Water pressure	2.5	bars

Test results : Test results are shown in Table 2.

Table 2 The results of the lower-frequency wet flashover test on Pin-Post Type Porcelain Insulators, Class 56/57-4, Sample No. สมอ.14๑ 1251-13/3.

Sample No.	Flashover voltage, kV
4	105.3
5	108.1
6	107.9
Mean value	107.1
Standard value	95
Standard requirement	Mean value ≥ 85.5

Note: The given flashover voltages were the average values of five consecutive applied voltages.

3. Critical Impulse Flashover Tests

Test procedure

Standard lightning impulse voltages, i.e. 1.2/50 μ s waveform, were generated by an impulse generator of 600 kV 30 kJ. The impulse waveforms were shown in figure 1. The measurement of impulse voltage was made by means of a 400-kV capacitor voltage divider and a peak voltmeter. The measuring system has an accuracy of $\pm 1.5\%$.

The test procedure was performed in accordance with the paragraph 9.4.3 of TIS 1251-2537. The critical dry impulse flashover voltage was determined by the up-down method.

Polarity	Positive	Negative	
Quantity of sample :	3	3	units
Date of test :	6 May 2008	13 May 2008	

Atmospheric conditions

Barometric pressure, p	750.1	750.4	mm.Hg.
Temperature, T	33.5	30.0	$^{\circ}$ C
Relative humidity, h	48.0	56.0	%

Correction factors

The air density correction factor (k_d) and the humidity correction factor (k_h) based on standard conditions, i.e. $b = 760$ mm.Hg., $T = 25$ $^{\circ}$ C, and absolute humidity = 15 g/m^3 , are:

k_d	0.960	0.971
k_h	0.976	0.984

Test results : Test results are shown in Table 3.

Table 3 The results of critical impulse flashover test on Pin-Post Type Porcelain Insulators, Class 56/57-4, Sample No. สบอ.14๑ 1251-13/3.

Sample No.	Flashover voltage, kV	
	Positive polarity	Negative polarity
7	252.60	338.19
8	259.36	332.49
9	253.92	327.85
Mean value	255.29	332.84
Standard value	225	300
Standard requirement	Mean ≥ 207	Mean ≥ 276

4. Radio-Influence Voltage Test (RIV)

Test procedure

The test procedure was conducted in accordance with paragraph 9.4.4 of TIS 1251-2537. The test circuit, shown in figure 2, was applied in accordance with the recommendation of NEMA Publ. No. 107-1987.

RIV was measured at a frequency of 1 MHz using an EMI/Field Intensity Meter model NM-25T of Carnel Labs. The test circuit was calibrated with external calibrating signal from the PD Calibrator type 451 of Haefely. The 50-Hz alternating voltages were applied sequentially to the specimen at different levels and the values of RIV were measured.

Quantity of sample : 5 units

Date of test : 27 May 2008

Atmospheric conditions

Barometric pressure, p	750.8	mmHg.
Temperature, T	32.0	°C
Relative humidity, h	60.0	%

Measuring frequency : 1 MHz

The circuit RIV factor and background interference

The circuit RIV factor, k_r , is 0.86 and the background interference is less than 2 μV .

Test results : The test specimens generated RIV less than 88 μV at the specified test voltage of 44 kV, as shown in Table 4.

Table 4 The results of RIV test on Pin-Post Type Porcelain Insulators, Class 56/57-4, Sample No. สบอ.14๑ 1251-13/3.

Test voltage, kV	RIV for sample No., μV				
	10	11	12	13	14
40	23.3	9.3	69.8	52.3	64.0
42	24.4	9.9	81.4	52.3	64.0
44	29.1	10.5	87.2	52.3	69.8
46	34.9	16.3	93.0	64.0	81.4
48	58.1	16.3	116.3	81.4	93.0
46	58.1	9.3	81.4	69.8	87.2
44	34.9	8.1	69.8	58.1	81.4
42	29.1	8.1	34.9	52.3	75.6
40	23.3	8.1	23.3	40.7	58.1
Standard requirement	RIV at 44 kV must be less than 100 μV				

5. Cantilever Strength Test

Test procedure

The test procedure was conducted in accordance with paragraph 9.5.1 of TIS 1251-2537. The load was applied to the insulator until it was broken.

Quantity of sample : 5 units

Date of test : 22 April 2008

Atmospheric conditions

Barometric pressure, p	760.0	mmHg.
Temperature, T	30.0	°C
Relative humidity, h	70.0	%

Test results : Test results are shown in Table 5.

Table 5 The results of cantilever strength test on Pin-Post Type Porcelain Insulators, Class 56/57-4, Sample No. สมอ.14๑ 1251-13/3.

Sample No.	Failing load of the insulators, kN
15	16.22
16	16.23
17	13.97
18	15.52
19	15.20
Mean value	15.43
Standard value	12.50
Standard requirement	1) Mean value ≥ 12.5 2) Each value ≥ 10.6

6. Zn. Coating Thickness Test

Test procedure

The test procedure was conducted in accordance with the paragraph 9.2 of TIS 1251-2537. The test equipment was a coating thickness meter model EBAN 2000(F) with an accuracy of $\pm 1\%$.

Quantity of sample : 5 units

Date of test : 23 April 2008

Atmospheric conditions

Barometric pressure, p	758.0	mmHg.
Temperature, T	31.0	°C
Relative humidity, h	67.0	%

Test results : Test results are shown in Table 6.

Table 6 The results of Zn. coating thickness test on Pin-Post Type Porcelain Insulators, Class 56/57-4, Sample No. สบอ.14อ 1251-13/3.

Part	Thickness, μm .						
	Sample No.	Position					Average of individual specimen
		1	2	3	4	5	
CAP	20	138	121	108	139	137	128.6
	21	141	126	93	100	114	114.8
	22	153	142	142	134	138	141.8
	23	178	159	123	124	146	146.0
	24	115	126	91	120	103	111.0
	Average of all samples						
PIN	20	118	114	76	144	68	104.0
	21	122	90	89	97	108	101.2
	22	112	118	116	118	112	115.2
	23	124	111	105	126	105	114.2
	24	104	99	95	98	91	97.4
	Average of all samples						
WASHER	20	57	70	58	58	66	61.8
	21	89	56	50	53	59	61.4
	22	67	89	74	91	85	81.2
	23	57	62	58	57	58	58.4
	24	66	60	58	67	65	63.2
	Average of all samples						
NUT	20	53	61	75	67	73	65.8
	21	54	58	56	68	54	58.0
	22	71	51	60	73	81	67.2
	23	143	112	113	118	129	123.0
	24	62	59	83	52	65	64.2
	Average of all samples						

Standard requirement of Average Zn Coating Thickness		
Hardware	Average Zn Coating Thickness, μm	
	Individual Specimen	Entire Sample
Iron parts (except nut and washer)	78	86
Nut and washer	43	53

7. Thermal Shock Test

Test procedure

The test procedure was conducted in accordance with paragraph 5.5 of ANSI C29.1-1982. The insulators were immersed alternately in hot and cool water. The temperature of the hot and cold water baths were approximately 66°C and 4°C, respectively. The insulators were tested for ten complete cycles. Then, they were tested for electrical soundness by being subjected to momentary flashover.

Quantity of sample : 5 units

Date of test : 11 April 2008 and 23 April 2008

Atmospheric conditions

Barometric pressure, p	753.0	mmHg.
Temperature, T	31.0	°C
Relative humidity, h	60.0	%

Test results : The test specimens showed electrical soundness, when passed the momentary flashover, after the thermal shock test.

8. Dimensional Test

Test procedure

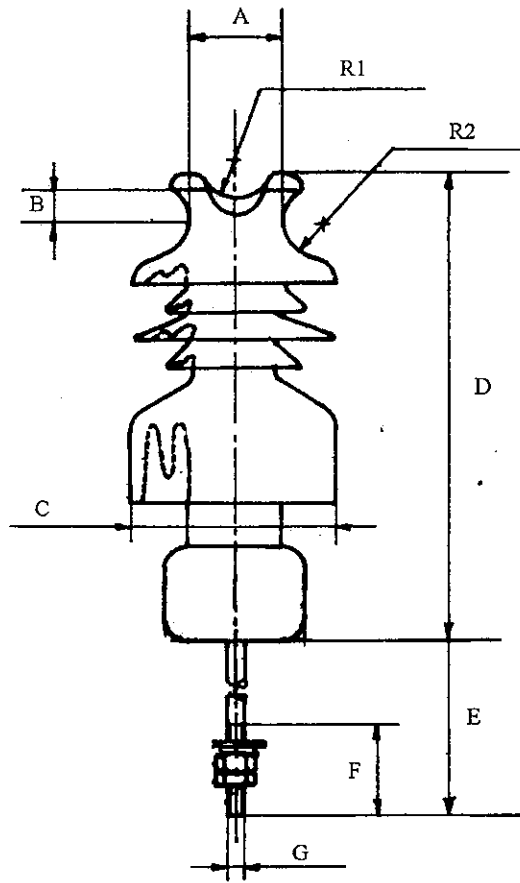
The test procedure was conducted in accordance with the paragraph 9.1.2.2 of TIS 1251-2537.

Quantity of sample : 3 units

Date of test : 28 May 2008

Test results : Test results are shown in Table 7.

Table 7 The results of dimensional test on Pin-Post Type Porcelain Insulators, Class 56/57-4, Sample No. สมอ.14๑ 1251-13/3.



Dimension in mm.

	Requirement	No.30	No.31	No.32		Requirement	No.30	No.31	No.32
A	70 - 76	72.5	72	73	F	89	90	91	90
B	14 - 22	19	20	19	G	M20	M20	M20	M20
C	∅ 190	192	192	190.5	R ₁	≥ 25	> 25	> 25	> 25
D	432	448	446	444	R ₂	≥ 25	> 25	> 25	> 25
E	178	182	181	181	Dry arcing distance		533	520	528
Leakage distance		1020	1011	1012					

9. Visual Inspection Test

Test procedure

The test procedure was conducted in accordance with the paragraph 9.1.2.1 of TIS 1251-2537.

Quantity of sample : 50 units

Date of test : 9 April 2008

Test results : No imperfection, exceeding the specified area, was observed.

10. Porosity Test

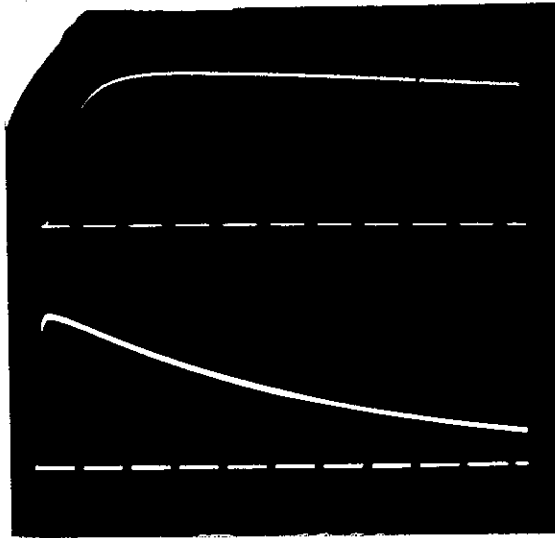
Test procedure

The test procedure was conducted in accordance with the paragraph 9.1.1.3 of TIS 1251-2537.

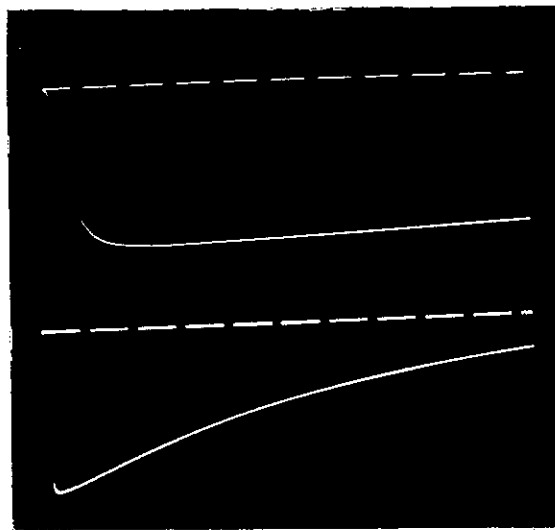
Quantity of specimens: Selected specimens from destroyed insulators in other tests.

Date of test : 17 April 2008

Test results : There was no visible penetration of dye into the porcelain on any of the fragments tested.



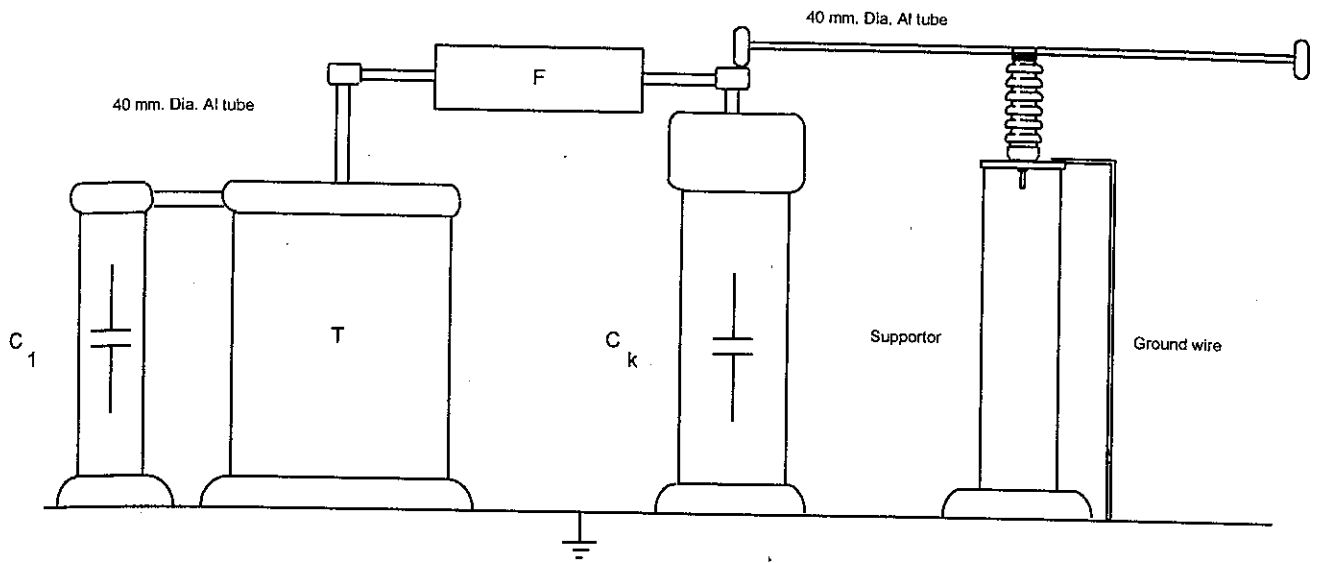
Positive polarity



Negative polarity

Time scale: Upper trace 1 $\mu\text{s}/\text{div.}$; Lower trace 10 $\mu\text{s}/\text{div.}$

Figure 1 Impulse voltage waveforms.



- T = Testing transformer: 20 kVA, 50 kV, 50 Hz.
- C₁, C₂ = Capacitor voltage divider: 100 pF 100 kV.
- F = Inductance (Filter): 3.7 mH.
- C_k = Coupling capacitor: 1000 pF 100 kV

Figure 2 RIV test circuit.

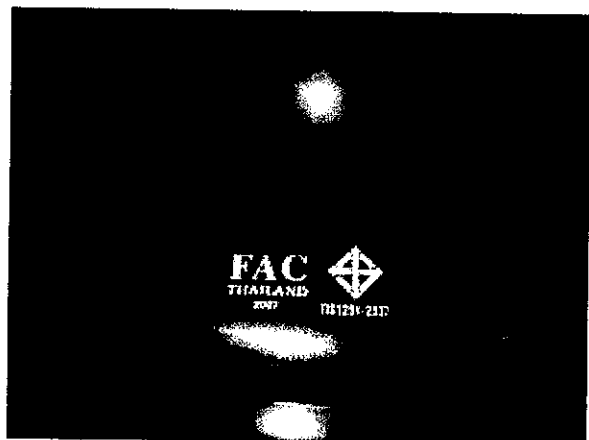


Figure 3 Pin-Post Type Porcelain Insulators, Class 56/57-4, Sample No. สบอ.14๑ 1251-13/3.