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TEST REPORT

SR. No. TL51037B

สำนักบริหารมาตรฐาน 1
เลขรับที่ 5891
วันที่ 16 มิ.ย. 2551
เวลา 14.30 น.

Issued By **High Voltage Division**

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Test object description	: Line-Post Type Porcelain Insulators, Class 57-3.
Manufacturer	: Fine Art Ceramic Company Limited
Serial number	: สพอ.140 1077-23/2
Sample quantities	: 50 units
Date of receipt	: 10 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. 16787, dated 3 April 2008
Purpose	: Electrical, mechanical and thermal characteristics test
Date of test	: 9 April 2008 to 30 May 2008
Place of test	: High-voltage Laboratory, Faculty of Engineering Chulalongkorn University
Reference standards	: 1) TIS 1077-2535: Standard for Line-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. 1077-2535.

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 low-frequency dry flashover test on Line-Post Type Porcelain Insulators, Class 57-3, Sample No. สทอ.14๑ 1077-23/2.

Sample No.	Flashover voltage, kV
1	132.0
2	132.0
3	128.4
Mean value	130.8
Standard value	125
Standard requirement	Mean value ≥ 114

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. 1077-2535.

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 lower-frequency wet flashover test on Line-Post Type Porcelain Insulators, Class 57-3, Sample No. สร๑.14๑ 1077-23/2

Sample No.	Flashover voltage, kV
4	118.6
5	117.1
6	114.5
Mean value	116.7
Standard value	100
Standard requirement	Mean value ≥ 90

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. 1077-2535. The critical dry impulse flashover voltage was determined by the up-down method.

Polarity	Positive	Negative	units
Quantity of sample :	3	3	
Date of test :	6 May 2008	8 May 2008	
<i>Atmospheric conditions</i>			
Barometric pressure, p	750.4	751.0	mm.Hg.
Temperature, T	33.5	33.0	$^{\circ}$ C
Relative humidity, h	48.0	60.0	%

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 = 15g/m^3 , are:

k_d	0.960	0.962
k_h	0.976	0.958

Test results : Test results are shown in Table 3.

Table 3 The results of critical impulse flashover test on Line-Post Type Porcelain Insulators, Class 57-3, Sample No. สบอ.14๑ 1077-23/2.

Sample No.	Flashover voltage, kV	
	Positive polarity	Negative polarity
7	225.38	323.46
8	219.15	321.70
9	222.22	323.75
Mean value	222.25	322.97
Standard value	210	260
Standard requirement	Mean ≥ 193.2	Mean ≥ 239.2

4. Radio-Influence Voltage Test (RIV)

Test procedure

The test procedure was conducted in accordance with paragraph 9.4.4 of TIS. 1077-2535. 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 about 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	756.0	mmHg.
Temperature, T	32.0	°C
Relative humidity, h	59.0	%

Measuring frequency : 1 MHz

The circuit RIV factor and background interference

The circuit RIV factor, k_r , is 0.846 and the background interference is less than 2 μV .

Test results : The test specimens generated RIV less than 22 μV at the specified test voltage of 30 kV, as shown in Table 4.

Table 4 The test results of RIV test of Line-Post Type Porcelain Insulators, Class 57-3, Sample No. $\pi\pi\theta.14\theta$ 1077-23/2.

Test voltage, kV	RIV for sample No., μV				
	10	11	12	13	14
26	8.3	4.7	4.1	5.3	1.2
28	16.5	5.9	4.7	5.9	1.2
30	21.3	7.1	5.3	6.5	1.2
32	23.6	11.8	5.3	7.1	2.4
34	24.8	14.2	5.3	8.3	3.5
32	17.7	11.8	4.7	7.1	3.0
30	14.2	9.5	4.1	5.9	3.0
28	11.8	5.9	3.5	5.9	2.4
26	9.5	4.7	3.5	4.7	1.2
Standard requirement	RIV at 30 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. 1077-2535. Load was applied to the insulator until it was broken.

Quantity of sample : 5 units

Date of test : 21 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 Line-Post Type Porcelain Insulators, Class 57-3, Sample No. สบอ.14๑ 1077-23/2.

Sample No.	Failing load of the insulators, kN
15	12.93
16	15.31
17	15.52
18	14.22
19	14.87
Mean value	14.57
Standard value	12.5
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. 1077-2535. 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 Line-Post Type Porcelain Insulators, Class 57-3, Sample No. สบ.14๑ 1077-23/2.

Part	Thickness, μm .						Average of individual specimen
	Sample No.	Position					
		1	2	3	4	5	
CAP.	20	173	122	100	138	125	131.6
	21	105	139	179	376	127	185.2
	22	113	175	110	107	105	122.0
	23	125	95	84	165	122	118.2
	24	98	173	157	108	134	134.0
	Average of all samples						138.2
PIN	20	86	65	85	74	65	75.0
	21	81	83	77	86	129	91.2
	22	89	86	88	85	80	85.6
	23	69	89	67	59	87	74.2
	24	120	110	94	120	131	115.0
	Average of all samples						88.2
WASHER	20	81	83	87	72	75	79.6
	21	69	61	61	74	64	65.8
	22	52	52	52	56	55	53.4
	23	70	90	76	84	82	80.4
	24	88	58	73	80	72	74.2
	Average of all samples						70.7
NUT	20	61	73	73	58	81	69.2
	21	91	86	78	84	114	90.6
	22	68	99	117	77	60	84.2
	23	78	77	79	81	94	81.8
	24	96	102	77	72	79	85.2
	Average of all samples						82.2

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 : 10 April 2008 and 22 April 2008

Atmospheric conditions

Barometric pressure, p	751.3	mmHg.
Temperature, T	33.0	°C
Relative humidity, h	46.0	%

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

8. Dimensional Test

Test procedure

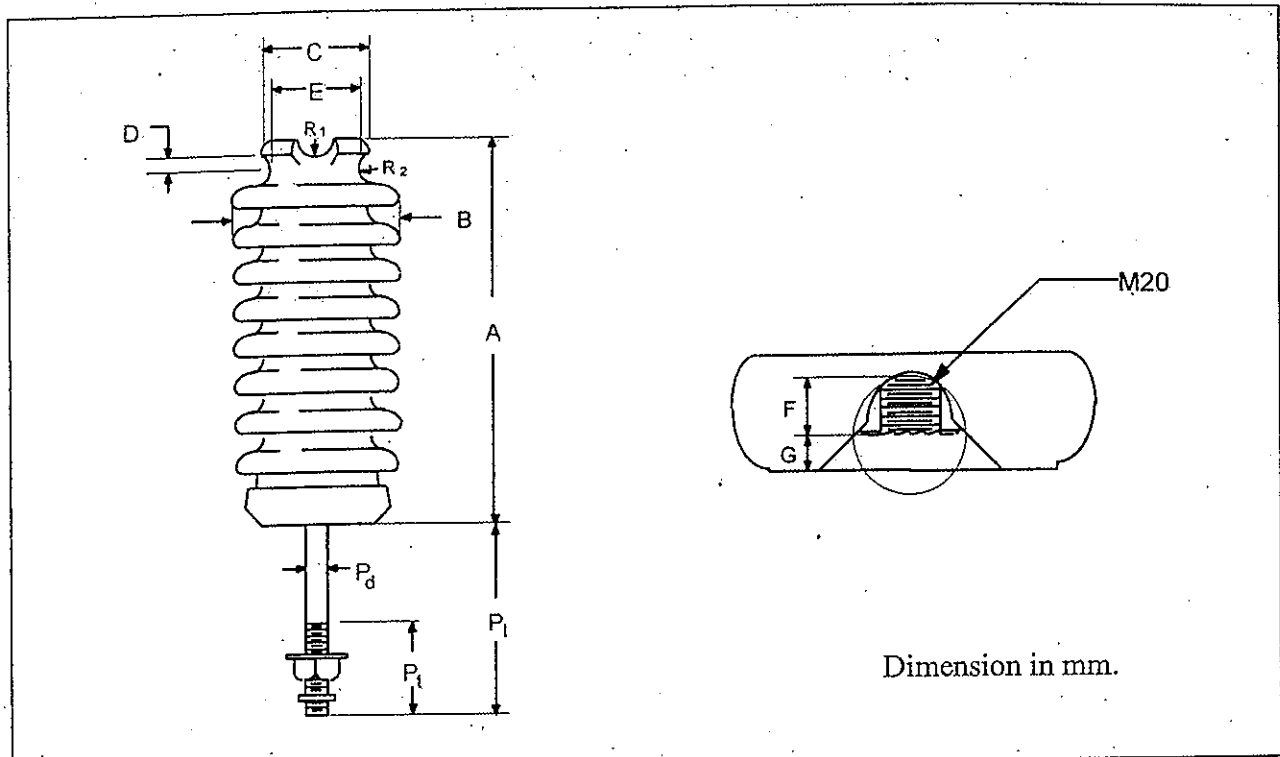
The test procedure was conducted in accordance with the paragraph 9.1.2.2 of TIS. 1077-2535.

Quantity of sample : 3 units

Date of test : 30 May 2008

Test results : Test results are shown in Table 7.

Table 7 The results of dimension test on Line-Post Type Porcelain Insulators, Class 57-3,
Sample No. สบอ.14อ 1077-23/2.



	Requirement	No.30	No.31	No.32		Requirement	No.30	No.31	No.32
A	368	387	380	385	F	≥ 22	24	23	24
B	165	161	161	160	G	8 - 12	10	10	10
C	≤ 124	100.5	100.5	89	P _d	19	19	19	19
D	14 - 22	17	18	17	P ₁	178	181	181	183
E	70 - 76	73.5	73.5	73	P _t	89	91	90	90
R _t	≥ 25	< 25	< 25	< 25	R ₂	≥ 25	> 25	> 25	> 25
Leakage distance		829	829	822	Dry arcing dist.		334	329	330

9. Visual Inspection Test

Test procedure

The test procedure was conducted in accordance with the paragraph 9.1.2.1 of TIS. 1077-2535.

Quantity of sample : 50 units

Date of test : 9 April 2008

Test results : The entire surface of each insulator was relatively smooth and free from imperfection.

10. Porosity Test

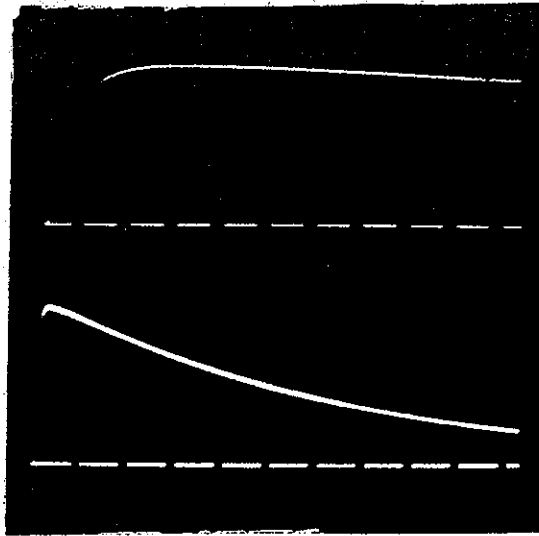
Test procedure

The test procedure was conducted in accordance with the paragraph 9.1.1.3 of TIS. 1077-2535.

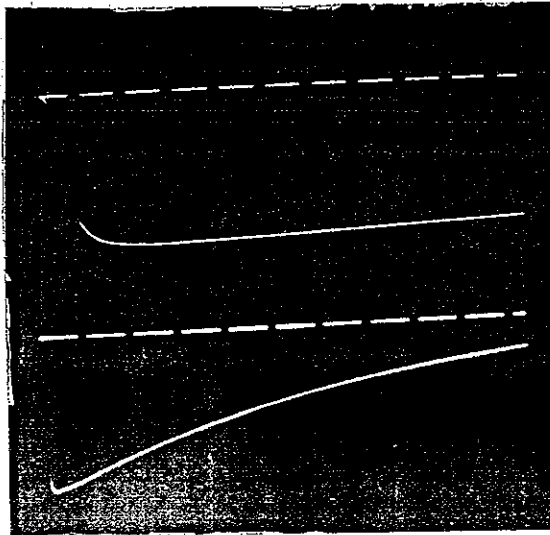
Quantity of specimens: Selected specimens from destroyed insulators in other tests.

Date of test : 17 April 2008

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



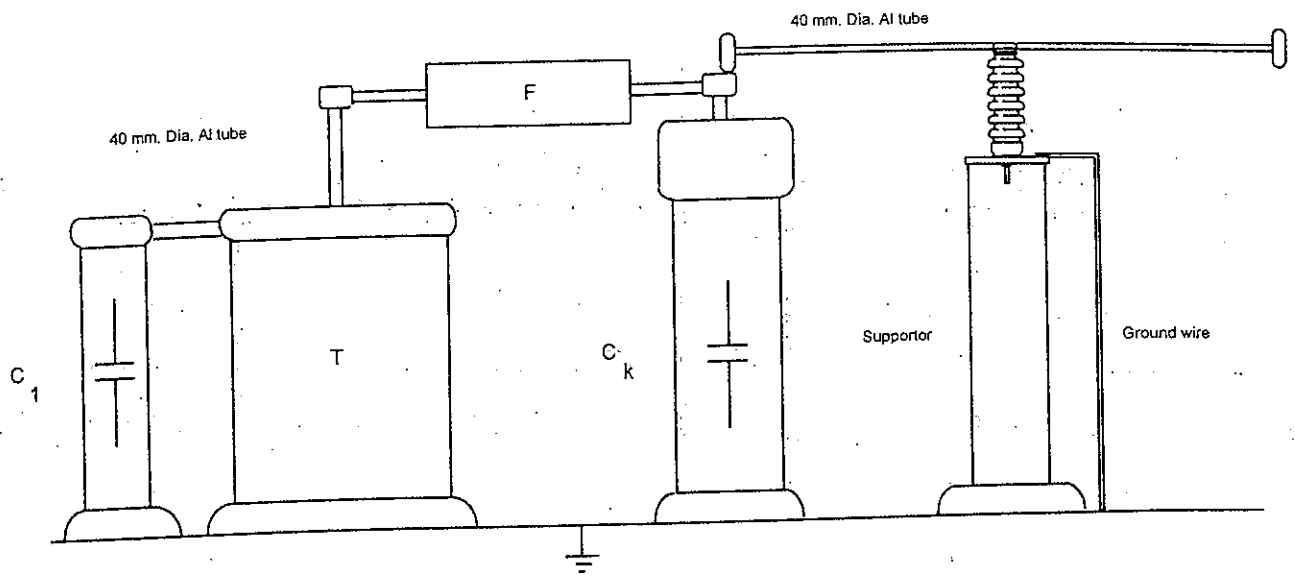
Positive polarity



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.

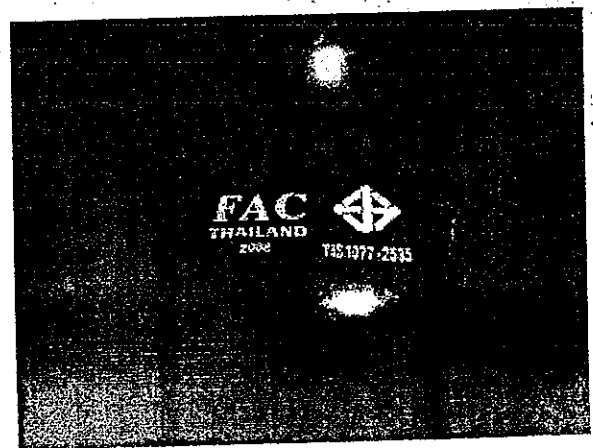
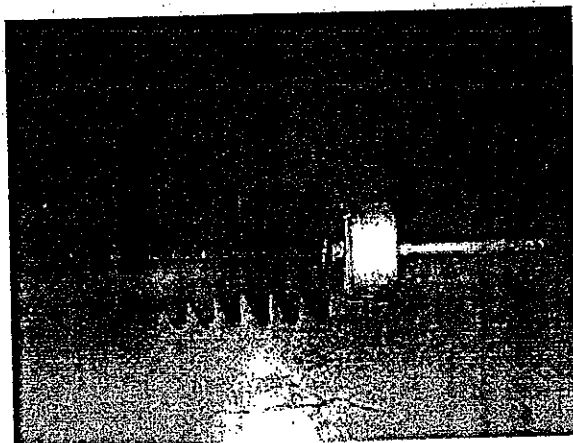


Figure 3 Line-Post Type Porcelain Insulators, Class 57-3, Sample No. สบ.14๑ 1077-23/2.