



China Electric Power Research Institute
Quality Inspection and Test Center for Electric
Equipment of Power Industry



EETC2014DC202J



2013000711D



校 准
CNAS L0699



Test Report



Address: NO. 143, Luoyu Road, Hongshan District, Wuhan,
Hubei Province.

Postcode: 430074

Tel: 400-656-5689

Fax: 86-27-5983-2255

Website: <http://www.china-qitc.com.cn>

<http://www.epri.sgcc.com.cn>

China Electric Power Research Institute
Quality Inspection and Test Center for Electric Equipment
of Power Industry

Test Report

EETC2014DC201J

1. CLIENT

Fujian Ruisen Chemical Co., Ltd.

2. SAMPLE

Name: Enhanced anti-pollution coating

Item Type: RTV-II

Sample Collected: Sent by client

Manufacturer: Fujian Ruisen Chemical Co., Ltd.

3. CHECK STANDARD

DL/T 627-2012 Room temperature vulcanized silicon rubber enhanced anti-pollution coating for insulators technical requirements of manufacturer

4. CHECK CLASSIFICATION

Type test

5. CHECK DATE

2014-06-16 ~2014-11-25

6. CHECK CONCLUSION

The type test specified in standards such as DL/T627-2012 was performed on silicon rubber insulated material which was provided by Fujian Ruisen Chemical Co., Ltd..All the results of tests met the requirements.

CHECKER: 张河 武文华

VERIFIER: 袁田

EXAMINER: 华 乾

APPROVED: 王

DATE: 2014.12.19

7. TEST ITEMS and RESULTS

No.	Test Item	Specified	Test Result	Evaluation
1	Visual examination	No obvious mechanical impurity, floc or sediments	No obvious mechanical impurity, floc or sediments	Pass
2	Vulcanization time test	Surface dry time: No more than 45 min in room temperature	Surface dry time:41~42 min	Pass
		Curing time: No more than 72h in room temperature	Curing time:66h	Pass
3	Hydrophobicity test	Hydrophobicity: $\theta_{av} \geq 100^\circ \theta_{min} \geq 90^\circ$ HC: HC1~HC2 Loss of hydrophobicity: $\theta_{av} \geq 90^\circ \theta_{min} \geq 85^\circ$ HC: HC3~HC4 Migration of hydrophobicity: $\theta_{av} \geq 110^\circ \theta_{min} \geq 100^\circ$ HC: HC2~HC3 Recovery time: $\leq 24h$	Hydrophobicity: $\theta_{av}: 113.8.0^\circ \theta_{min}: 110.7^\circ$ HC: HC1 Loss of hydrophobicity: $\theta_{av}: 102.4^\circ \theta_{min}: 100.6^\circ$ HC: HC2~H3 Migration of hydrophobicity: $\theta_{av}: 122.4^\circ \theta_{min}: 119.4^\circ$ HC: HC1~HC2 Recovery time: 23h	Pass
4	Volume resistance test ($\Omega \cdot m$)	Volume resistance: $\geq 1.0 \times 10^{12} \Omega \cdot m$	Volume resistance: $6.05 \times 10^{12} \Omega \cdot m$	Pass
5	Relative dielectric constant and dielectric loss angle tangent test	$\epsilon_r: \leq 4.0$ $\tan \delta: \leq 0.4\%$	$\epsilon_r: 3.55$ $\tan \delta: 0.35\%$	Pass
6	Dielectric strength test	$\geq 18.0 \text{ kV/mm}$	22.5kV/mm	Pass
7	Tracking and erosion Test	$\geq \text{TMA4.5}$ Max erosion depth: $\leq 2.5\text{mm}$	TMA4.5 Max erosion depth: 0.62mm~1.18mm	Pass
8	Adhesion test	No less than class 2	Class 1	Pass
9	Abrasion resistance test	$\leq 0.2g$	0.1662g	Pass
10	Corrosion test	Chemical resistance :No loss, wrinkling, blistering, discoloration happen by acid, alkali, salt, reagents corrosion.	Chemical resistance :No loss, wrinkling, blistering, discoloration happen by acid, alkali, salt, reagents corrosion.	Pass
		Oil resistance: No loss, wrinkling, blistering, discoloration happen by transformer oil corrosion.	Oil resistance: No loss, wrinkling, blistering, discoloration happen by transformer oil corrosion.	

11	Artificial pollution flashover voltage test	U1/U2:≥2.0	Sample with coating: U1=84.8kV Sample without coating: U2=41.8kV U1/U2=2.03	Pass
12	Flammability test	FV-0 class	FV-0 class	Pass
13	Solid content examination	Solid content:≥50%	Solid content:50.84%	Pass
14	Shear strength test	≥3.0Mpa	3.106Mpa	Pass
15	Tear strength test	Tear strength: ≥ 9.0kN/m	Tear strength:10.20kN/m	Pass
16	Tensile strength and elongation at break test	Tensile strength: ≥4.0MPa Elongation at break: ≥250%	Tensile strength:4.24MPa Elongation at break:260%	Pass
17	Viscosity test	Viscosity≥80s	Viscosity:110s	Pass
18	Self-cleaning test	Self-cleaning ≥class 2	Self-cleaning: Class 2	Pass
19	Steep Front Impulse Withstand voltage test	Um≥(2.80~3.08)p.u 1p.u.=100kV	Positive:282.7kV~306.4kV Negative: 284.2kV~308.1kV No puncture	Pass

Annex A. Main Inspection Equipments

No.	Name/type	No.	Inspection Scale	Accuracy	Valid Date
1	Portable rubber plastic thickness meter WHS-10A	XL/YQ-084	10mm	0.02mm	09-22-2016
2	Electronic balance FA2004	XL/YQ-083	200g	Class 1	09-28-2016
3	Mercury thermometer	XL/YQ-007	100℃	1℃	12-23-2016
4	Wet and dry bulb thermometer	XL/YQ-010	-10℃ ~50℃	0.5℃	09-01-2016
5	Aneroid barometer DYM3	XL/YQ-009	80kPa~ 106.7kPa	0.1kPa	05-07-2016
6	Stopwatch Js-506	XL/YQ-033	1h	0.01s	12-09-2017
7	Vernier caliper	XL/YQ-032	200mm	0.02mm	09-29-2016
8	Optical contact angle measurement	XL/YQ-119	/	0.1°	01-27-2016
9	Dielectric loss angle tangent meter	XL/YQ-165	/	2%	12-29-2016
10	Tracking and Erosion Test device	XL/YQ-138	/	Class 1.5	08-20-2016
11	Electronic universal testing machines GP-DS2000M	XL/YQ-112	5000N	Class 1	02-17-2016
12	Digital high voltage meter JSGB-200	XL/YQ-018	200kV	1%	07-25-2016
13	Power frequency voltage measuring system	XL/YQ-154	250kV	1%	07-15-2016
14	Steep wave resistance divider	XL/YQ-106	600kV	3%	09-12-2016

Annex B. Test Item**1 Visual examination**

No obvious mechanical impurity, floc and sediments is checked out in the sample by visual examination.

2 Vulcanization time test**2.1 Determination of skin over time**

Air condition : $t_d=26.0^{\circ}\text{C}$ $t_w=22.0^{\circ}\text{C}$ RH=64%

Table 1 Skin over time test results

Sample No.	Sample and Plane Angle($^{\circ}$)	Micro Glass Bead Diameter (μm)	Micro Glass Bean and Sample Distance (mm)	Skin Over Time(min)
1	20	250	100	41
2	20	250	100	42
3	20	250	100	42

2.2 Determination of curing time

Air condition : $t_d=26.0^{\circ}\text{C}$ $t_w=22.5^{\circ}\text{C}$ RH=69%

Table 2 Curing time test results

Sample No.	Coating Thickness(mm)	Curing Time(h)
4	0.39	66
5	0.41	66
6	0.43	66

3 Hydrophobicity test

Specimen: 7#~16#

Table 3 Hydrophobicity test results

Hydrophobicity			Loss of Hydrophobicity			Migration of Hydrophobicity			Recovery time
θ_{av}	θ_{min}	HC	θ_{av}	θ_{min}	HC	θ_{av}	θ_{min}	HC	
113.8 $^{\circ}$	110.7 $^{\circ}$	1	102.4 $^{\circ}$	100.6 $^{\circ}$	2~3	122.4 $^{\circ}$	119.4 $^{\circ}$	1~2	23h

4 Volume resistance test

Air condition : $t_d=24.5^{\circ}\text{C}$ RH=55%

Sample dimension: Diameter $\times$ Thickness= $\phi 100\text{mm} \times (1.9\sim 2.0)\text{mm}$

Table 4 Volume resistance test results

Sample No.	Body resistance ($\Omega \cdot \text{m}$)	Median
17	5.74×10^{12}	6.05×10^{12}
18	6.05×10^{12}	
19	7.13×10^{12}	

5 Relative dielectric constant and dielectric loss angle tangent test

Air condition : $t_d=25.0^{\circ}\text{C}$ RH=63%

Sample dimension: Diameter $\times$ Thickness= $\phi 100\text{mm} \times 1.0\text{mm}$

Table 5 Relative dielectric constant and dielectric loss angle tangent test results

Sample No.	Relative dielectric constant ϵ_r	Dielectric loss angle tangent $\tan \delta$ (%)
20	3.74	0.37
21	3.09	0.32
22	3.83	0.36
Average	3.55	0.35

6 Dielectric Strength Test

Air condition : $t_d=24.0^{\circ}\text{C}$ RH=81%

Test method: Dip the sample into clean transformer oil, using step-up method to test dielectric strength.

Sample Dimension: $\phi 100.0\text{mm}$

Table 6 Dielectric strength test results

Sample No.	Sample Thickness (mm)	Dielectric voltage (kV)	Dielectric Strength (kV/mm)	Median (kV/mm)
23	0.98	22.4	22.8	22.5
24	0.92	20.8	22.6	
25	0.96	21.5	22.3	
26	0.93	21.0	22.5	
27	0.96	21.4	22.2	

7 Tracking and erosion test

Sample Dimension: Length $\times$ Width $\times$ Thickness= $120.0\text{mm} \times 50.0\text{mm} \times 6.0\text{mm}$

Table 7 Tracking and erosion test results

Sample No.	Polluted liquid		Voltage(kV)	Time(h)	Max. depth (mm)
	Velocity(ml/min)	Resistance($\Omega \cdot \text{cm}$)			
28	0.6	394	4.5	6	0.92
29					0.84
30					1.10
31					0.62
32					1.18

8 Adhesion test

The test employs drawing circle method

Table 8 Adhesion test results

Sample No.	33	34	35
Class	Class 1	Class 1	Class 1

9 Abrasion resistance test

Table 9 Abrasion resistance test results

Sample No.	The weight before abrasion(g)	The weight after abrasion(g)	The loss of weight(g)	Average(g)
36	66.2703	66.0982	0.1721	0.1662
37	65.7115	65.5512	0.1603	

10 Corrosion test

10.1 Chemical reagents test

a. Saline test

No loss, wrinkling, blistering, discoloration happen on the samples No.38#~No.40# which have been dropped in 3% NaCl saline reagents and heated to $25\pm 1^{\circ}\text{C}$ for 24h.

b. Acid test

No loss, wrinkling, blistering, discoloration happen on the samples No.30#~No.32# which have been dropped in 3% sulfuric acid reagents and heated to $25\pm 1^{\circ}\text{C}$ for 24h.

c. Alkaline test

No loss, wrinkling, blistering, discoloration happen on the samples No.44#~No.46# which have been dropped in 3% NaOH reagents and heated to $25\pm 1^{\circ}\text{C}$ for 24h.

10.2 Oil test

No loss, wrinkling, blistering happen on the samples No.47#~No.49# which have been dropped in transformer oil and heated to 100°C for 24h.

11 Power frequency flashover voltage test under wet condition

The test is conducted on 9 LXP-160 insulator (No.50#~ No.58#). coated by RTV-II, comparing with uncoated insulators.

Test condition: $t_d = 24.0^{\circ}\text{C}$ $t_w = 32^{\circ}\text{C}$

ESDD: $0.1\text{mg}/\text{cm}^2$ NSDD: $0.5\text{mg}/\text{cm}$

Table 10 Power frequency flashover voltage test results

Category	Specimen String No.	Flashover voltage(5 times)	Flashover voltage average	Results
Samples with coating U ₁	1	86.4 84.6 84.2	84.8	U ₁ /U ₂ =2.03
	2	86.9 83.4 82.9		
	3	85.1 84.3 85.2		
Samples without coating U ₂	4	41.3 42.6 41.2	41.8	
	5	41.9 41.2 40.8		
	6	43.6 42.3 41.7		

12 Flammability test

Table 11 Flammability test results

unit: s

Item	FV-0 Specified	Class Results				
		59	60	61	62	63
Flame burning time for single sample firstly	≤10	3	2	3	3	4
Flame burning time for single sample secondly	≤10	3	5	4	4	7
Total flame burning time of 5 samples	≤50	38				
Sum of second flame burning time and burning time without flame for single sample	≤30	5	6	5	6	9
Phenomenon of burning extend to metal metal fitting	no	no	no	no	no	no
Phenomenon of pldget burning	no	no	no	no	no	no

13 Solid content test

Table 12 Solid content test results

Sample No.	m ₀ (g)	m ₁ (g)	m ₂ (g)	Temperature (°C)	Heating time(min)	Solid Content(%)	Average(%)
64	24.1287	27.1365	25.6513	180	30	50.62	50.84
65	23.7045	26.7134	25.2406	180	30	51.05	

Notes: Solid content=[(m₂-m₀)÷(m₁-m₀)]×100% m₀-empty vessel weight, m₁-vessel and sample weight, m₂-vessel and residues weight.

14 Shear strength test

Table 13 Shear strength test results

Specimen	Length	Width	Area	Broken load	Shear strength	Average	Broken form
66	12.4	24.8	307.5	951.6	3.094	3.106	R
67	12.4	24.8	307.5	947.8	3.082		G
68	12.5	24.9	311.3	991.2	3.185		R
69	12.4	24.9	308.8	943.5	3.056		R
70	12.5	24.8	310.0	964.7	3.112		G

Notes: R means vulcanized silicone rubber broken. G means coating and glass adhesion panel broken

15 Tear strength test

Table 14 Tear strength test results (Square specimen)

Specimen No.	Tear load (N)	Specimen thickness	Tear strength(kN/m)	Average value(kN/m)
71	22.3	2.0	11.15	10.20
72	18.7	2.0	9.35	
73	19.1	2.0	9.55	
74	20.4	2.0	10.20	
75	21.6	2.0	10.80	

16 Tensile strength and elongation at break test

Table 15 Tensile strength and elongation at break test results (Dumb-bell specimen type I)

Specimen No.	76	77	78	79	80	Average
Specimen dimension (mm)	6×2.0	6×2.0	6×2.0	6×2.0	6×2.0	/
Tensile load(N)	49.3	52.4	51.9	52.0	49.1	/
Tensile strength (Mpa)	4.07	4.32	4.24	4.25	4.05	4.24
Elongation at break(%)	264	260	252	264	256	260

17 Viscosity test

Employ Tu-4 viscometer to test the viscosity of the coating.

Sample temperature: T=23.0℃

Table 16 Viscosity test results

Sample No.	81	82	Average
Steam stops read the stopwatch	107	113	110

18 Self-cleaning test**18.1 Test method**

1)The test is conducted on 3 coated with RTV-ii Width10cm×Length8cmglass panel, under the condition of $t=25^{\circ}\text{C}\pm 2^{\circ}\text{C}$, RH=40%~70%,Curing time $\geq 96\text{h}$;

2) Horizontally lay the sample on the testing pad()put 10cm long sides in a horizontal direction, 8cm long side placed vertically, place a barrier strip at the edge of 0.5cm from the sample, the barrier strip in close contact with the coated surface;

3) Get 0.3g glass beads, carefully pour over the sample surface barrier strips, 5cm length, width of 0.5cm;

4)The sample with barrier strip and glass beads transferred by the horizontal tilt angle of 45° position where the barrier strip to ensure the glass beads remain in the original position without rolling along the inclined coating surface;

5) Quickly take away the barrier strip from coated surfaces, glass beads are rolling along coated ramps along the specimen slide;

6)Collect and weigh the weight of the slipped glass beads in the collector (unit g);

7)Self-cleaning coefficient η : $x = \frac{m}{0.3} \times 100\%$

18.2 Test results

Table 17 Self-cleaning test results

Sample No.	83	84	85
Falling micro glass bean weight m(g)	0.2308	0.2263	0.2289
Self-cleaning coefficient η (%)	76.91	75.46	76.33
Self-cleaning coefficient average(%)	76.23		
Self-cleaning class	Class 2		

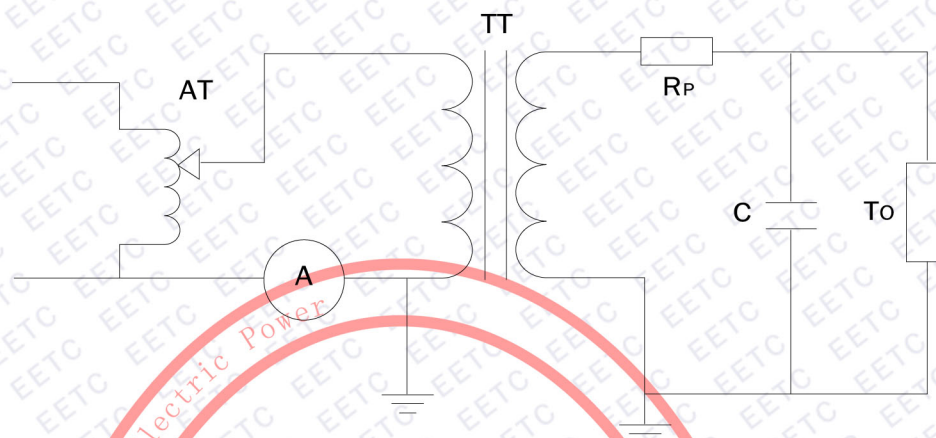
19 Impulse voltage test

Table 18 Impulse voltage test results

Sample No.	Positive		Negative		Positive		Negative	
	Number of Impulse	Breakdown Or flashover	Number of Impulse	Breakdown Or flashover	Number of Impulse	Breakdown Or flashover	Number of Impulse	Breakdown Or flashover
86	5	flashover	5	flashover	5	flashover	5	flashover
87	5	flashover	5	flashover	5	flashover	5	flashover
88	5	flashover	5	flashover	5	flashover	5	flashover
89	5	flashover	5	flashover	5	flashover	5	flashover
90	5	flashover	5	flashover	5	flashover	5	flashover
91	5	flashover	5	flashover	5	flashover	5	flashover
92	5	flashover	5	flashover	5	flashover	5	flashover
93	5	flashover	5	flashover	5	flashover	5	flashover
94	5	flashover	5	flashover	5	flashover	5	flashover
95	5	flashover	5	flashover	5	flashover	5	flashover
amplitude de	Standard Value	Um=(2.08~3.08)p.u. 1p.u.=100kV						
	Measured Value	Positive:282.7~306.4				Negative:284.2~308.1		
Notes	1) Every sample imparts positive impulse 5 times,5 times negative impulse. and repeat the action, every two action spacing interval within 1min~2min 2) 86#~95#samples are LXP-120 glass insulator coated with RTV-II							

Annex C. Test electrical wiring diagram

Frequency voltage test electrical wiring diagram

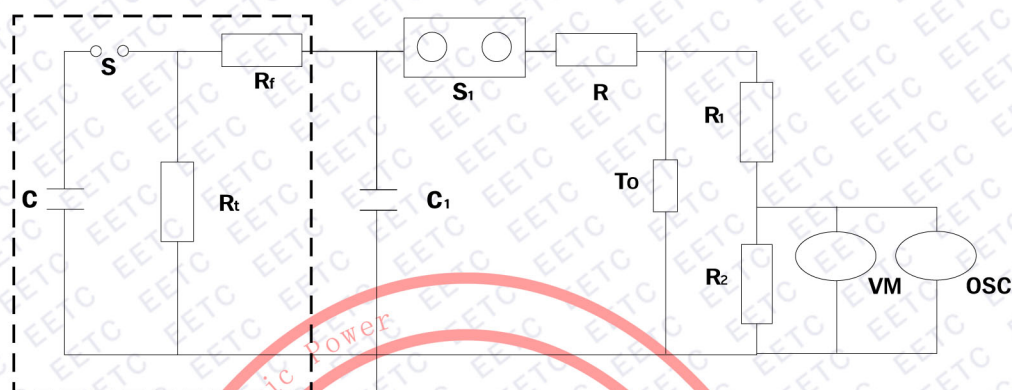


- AT ----- Voltage Regulator
 TT ----- Test transformer
 Rp ----- Protection of resistors
 A ----- Ammeter
 C ----- Capacitive voltage divider
 To ----- Sample

Test Equipment Specifications

U(kV)	Rp(k Ω)
250	20

Steep wave impulse voltage test electrical wiring diagram



C-----Impulse generator main capacitor

R_f ----Wave head resistance

R_t ----Wave tail resistance

S----- Fireball impact point gap

C_1 ----Sharpening capacitance

S_1 ----- ϕ 250 sharpening ball gap

R-----Steepness adjust the resistance

T_o ----Sample

R ----High voltage arm resistance

R_2 ----Low-voltage arm resistance

VM---Digital measuring instrument

OSC--Digital oscilloscopes

The main parameters of the test equipment

U(kV)	C(μ F)	R_f (k Ω)	R_t (t μ F)	C_1 (μ F)	R(k Ω)	R_1 (k Ω)	R_2 (Ω)
600	0.0406	2.8	80	0.00094	250	2.127	4.687