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CEPRI

TEST REPORT

CEPRI-EETC02-2017-0090

Client: Shanghai Chardon Electric Ltd .

Object: Separable Connectors 26kV/72kV Coupling
(Rear)T-Body Surge Arrester

Type: 26-RDTA72-10

Test Category: Type Test

POWER INDUSTRY QUALITY INSPECTION AND TEST
CENTER FOR ELECTRIC EQUIPMENT

Catalogue

Test Report	Power Industry Quality Inspection and Test Center for Electric Equipment		CEPRI-EETC02-2017-0090 Total 17 Page 2
Client	Shanghai Chardon electric Ltd .	Manufacturer	Shanghai Chardon electric Ltd .
Object	Separable Connectors 26kV/72kV Coupling (Rear)T-Body Surge Arrester	Type	26-RDTA72-10 (Φ42mm×24mm)
Sampling procedure	By the client delivery	Serial No.	3 arresters (001~003) 6 thermally prorated sections (201~206) 9 resistors (301~309) 3 housings(401~403)
Test Category	Type Test	Date	2018.01.24~2018.04.12
Requirements	GB/T 11032-2010 Metal-oxide surge arresters without gaps for a.c. systems		
Conclusion	The Separable connectors 26kV/72kV coupling(rear)T-body surge arrester without gaps for 20kV a.c. systems of26-RDTA72-10 have successfully passed the type test specified in GB/T 11032-2010.		
Note	Note 1: In the event of any difference in meanings of the text, the Chinese report shall take precedence over the English version. Note 2: Since the date of issuance, the routine test which concerns about the related content must be done every three years in order to extend the validity of this report.		

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Checked by: 左中秋 **Verified by:** 熊易

Approved by: 王保山 **Date of issue:** 2018.06.06

Test Results

No.	Item		Requirements	Results	Evaluation
1	D.C. reference voltage test		37.0kV≤$U_{1mA\,DC}$≤39.0kV	37.6kV~37.7kV	Passed
2	Leakage current test at 0.75 times D.C. reference voltage		I_L(0.75$U_{1mA\,DC}$) ≤50μA	2μA~3μA	Passed
3	Continuous operating current test		I_x≤400 μA I_R≤100 μA	I_x=126μA~131μA I_R=20μA~27μA	Passed
4	A.C. reference voltage test		$U_{1mA\,AC}$≥26.0kV	30.8kV~31.7kV	Passed
5	Partial discharge test		1.05U_c 下， PD ≤10 pC	PD=1.0pC~2.0pC	Passed
6	Seal leak rate test		Put the samples into the boiling water with 0.1%NaCl for42 h: change rate of $U_{1mA\,DC}$≤5% change of leakage current I_L≤20μA partial discharge PD≤10 pC	$\Delta U_{1mA\,DC}$= -0.27%~0% ΔI_L =+3μA~+4μA PD =1.0pC~3.0pC	Passed
7	Bending moment		Bending load ≥390.76N for 60s~90s,and meet the evaluation requirements.	400N， 60s	Passed
8	Insulation withstand tests on the arrester housing		Power-frequency voltage: Dry≥54kV, for 1min. Lightning impulse voltage : 125kV$_p$, the positive and negative 15 times respectively.	Power-frequency voltage (dry) 54.19 kV~54.41kV, 1min. Lightning impulse voltage128.9kV$_p$~134.8kV$_p$, the positive and negative 15 times respectively.	Passed
9	Residual voltage test	Lightning impulse current	≤72.0kV$_p$	69.21kV$_p$	Passed
		Steep impulse current	≤65.0kV$_p$	53.51kV$_p$	
		Switching impulse current	≤85.0kV$_p$	77.40kV$_p$	
10	Long duration current impulse withstand test		2000μs、350A、18times	2008μs、350A~370A	Passed
11	Operating duty test		115℃, 1000h	P_{2ct} < 1.1 P_{3ct} and P_{2ct}<P_{1ct}	Passed
			4/10μs 、 100kA high-current impulse , 2 times	95.6kA~100.3kA	
12	Power-frequency voltage versus time characteristics test		Supply the Power-frequency voltage versus time characteristics for the range of voltage from 1.10U_R* to 0.85U_R*, the range of time from 10s to 24h: for 1.10 U_R*, the time is10s;for 0.85 U_R*, the time is 24h.	1.10U_R* 10s 1.00U_R* 2h 0.85U_R* 24h	Passed

Content:

1~2 D.C. reference voltage test and leakage current at 0.75 times D.C. reference voltage test

Environment temperature: 21.5℃ humidity: 53%

Samples	D.C. reference voltage $U_{1mA,DC}$ kV		0.75times D.C. reference voltage kV		Leakage current μA	
	Measured value	Specified value	Measured value	Specified value	Measured value	Specified value
001	37.7	$37.0 \leqslant U_{1mADC} \leqslant 39.0$	28.3	$0.75U_{1mADC} \pm 1\%$	2	$\leqslant 50$
002	37.6		28.2		2	
003	37.6		28.2		3	

Note: The standard only provides the D.C. reference voltage lower limit. The upper limit declared by the manufacturer is used to determine the proportion of the arrester protection level.

Fulfilled the requirements.

3~4 Power-frequency reference voltage test and Continuous current test

Environment temperature: 21.5℃ humidity: 53%

Samples	The power-frequency reference voltage U_{1mAAC} kV (Peak value / $\sqrt{2}$)		I_R μA_p		I_X $\mu A_{r.m.s}$	
	Measured value	Specified value	Measured value	Specified value	Measured value	Specified value
001	31.4	$\geqslant 26.0$	20	$\leqslant 100$	126	$\leqslant 400$
002	30.8		22		131	
003	31.7		27		129	

Note1: The client claims the power frequency reference current is 1mA.

Note2: The standard specifies the continuous current through the arrester shall not exceed the manufacturer's declared value.

Fulfilled the requirements.

5 Partial discharge test

Samples	U_r	U_r duration time	$1.05U_r$	$1.05U_r$ duration time	partial discharge
	$kV_{r.m.s}$	s	$kV_{r.m.s}$	s	pC
001	26	10	21.8	60	1.0
002	26	10	21.8	60	2.0
003	26	10	21.8	60	2.0
specified value	26	2~10	21.6	60	≤10

Fulfilled the requirements.

6 Seal leak rate test

Samples	Boiling time	Cooling time	DC reference voltage			leakage current at $0.75U_{1mA,DC}$			Partial discharge		Surface check after test
			Before	After	change rate	Before	After	change rate	Before	After	
	h		kV		%	μA			pC		
001	42	5	37.7	37.7	0	2	5	+3	1.0	1.0	No visible mechanical damage
002	42	5	37.6	37.5	-0.27	2	5	+3	2.0	3.0	No visible mechanical damage
003	42	5	37.6	37.6	0	3	7	+4	2.0	2.0	No visible mechanical damage
specified value	42	≤8	≥37.0		≤5	≤50		≤20	≤10		Should not have visible mechanical damage

Note 1: NaCl concentration in water for 1 kg/m^3.

Fulfilled the requirements.

7 Bending moment

7.1 The test of bending moment

F_1=147N S=0.031m^2 F_2=18.61N

The test load MPSL=2.5×(F_1+F_2/2) =390.76N

Sample	Actual loading	Time	Max deflection	Residual deflection	Housing height	deflection rate	force / deflection curve	Sample check
	N	s	mm	mm	mm	%	-	-
001	400	60	10.7	3.4	349	0.97	no mutation	No mechanical damage
specified value	390.76	60~90	/	/	/	≤5	Should not have mutation	Should not have mechanical damage

7.2 The parameters comparison before and after test

Sample	$U_{1mA,DC}$			leakage current			Partial discharge	
	kV			μA			pC	
	Before	After	change rate %	Before	After	change rate	Before	After
001	37.7	37.7	0	2	5	+3	1.0	1.0
specified value	≥37		≤5	≤50		≤20	≤10	

Fulfilled the requirements.

8 Housing insulation withstand test

8.1 Power frequency voltage withstand test

t_d=24.5℃ t_w=19.5℃ Atmospheric pressure: 100.2kPa
Applicable altitude:≤1000m

Sam les	Specified value	Atmospheric correction factor	Altitude correction factor	Applied voltage	Correction value	Duration	Test result
	kV	K_t	K_a	kV(Peak value / $\sqrt{2}$)	kV(Peak value / $\sqrt{2}$)	s	
401	54(dry)	1.000	1.000	54	54.41	60	No flashover
402	54(dry)	1.000	1.000	54	54.19	60	No flashover
403	54(dry)	1.000	1.000	54	54.23	60	No flashover

Fulfilled the requirements.

8.2 Lightning impulse voltage withstand test

t_d=23.5℃ t_w=20.5℃ Atmospheric pressure: 100.2kPa
Applicable altitude:≤1000m

Samples	Specified value		Atmospheric correction factor	Altitude correction factor	Applied voltage	Correction value	With stand times	Test result
	kV		K_t	K_a	kV_p	kV_p		
401~403	(+)	125	1.000	1 000	127.6~134.8	127.6~134.8	15	No breakdown, no flashover
	(-)	125	1.000	1.000	128.9~134.7	128.9~134.7	15	No breakdown, no flashover

Fulfilled the requirements, test waveform is shown in figure C.1.

9 Residual voltage test

9.1 Lightning impulse current residual voltage test

Samples			301	302	303
resistor	$U_{1mA.DC}$	kV	5.39	5.33	5.43
	8/20μs, 5kA	kV_p	8.78	8.61	8.74
	8/20μs, 10kA	kV_p	9.56	9.40	9.51
	8/20μs, 20kA	kV_p	10.55	10.39	10.58
	U_{10kA}/U_{1mADC}	-	1.77	1.76	1.75
Complete arrester	$U_{1mA.DC}$	kV	$37.0 \leqslant U_{1mADC} \leqslant 39.0$		
	Scale coefficient	-	7.24	7.32	7.18
	Lightning impulse protection level	kV_p	69.21		
	Specified value	kV_p	≤72.0		

Note 1: Shunt R_s=0.025Ω, divider K_d=206.1

Note 2: According to the determined residual pressure, draw the residual voltage and current curve, in the curve corresponding to the nominal discharge current read residual voltage, defined as the lightning protection lightning protection level.

9.2 Switching impulse current residual voltage test

Samples			301	302	303
resistor	Residual voltage at 500A	kV_p	7.50	7.31	7.47
Complete arrester	Scale coefficient	-	7.24	7.32	7.18
	Test value	kV_p	54.30	53.51	53.63
	Specified value	kV_p	≤65.0		

Note 1: Shunt Rs=0.025Ω, divider Kd =206.1

9.3 Steep impulse current residual voltage test

Samples			301	302	303
resistor	10 kA U_{res1}	kV_p	10.69	10.53	10.66
	10 kA U_{res2}	kV_p	0.25		
	U_{res2}/U_{res1}	%	2.34	2.37	2.35
	U_{res1}-U_{res2}	kV_p	10.44	10.28	10.41
Complete arrester	Scale coefficient	-	7.24	7.32	7.18
	Residual voltage for the arrester	kV_p	75.59	75.25	74.74
	Inductance per unit length	μH/m	1		
	Height without resistors	m	0.349–(0.024×7)=0.181		
	Inductive voltage correction	kV_p	1×0.181×10=1.81		
	Residual voltage for the arrester after correction	kV_p	77.40	77.06	76.55
	Specified value	kV_p	≤85.0		

Note1: Shunt Rs=0.025Ω,divider Kd =61.8.

Note 2: If Ures2/ Ures1 is less than 2%,there is no need to correct Inductive effect

Fulfilled the requirements. Test waveform is shown in figure C.2 ~ figure C.4.

10 Rectangular current impulse withstand test

Temperature of the environment: 15.5℃ humidity: 70%

Samples			304	305	306	Specified value
8/20μs I_n residual voltage before test		kV_p	9.43	9.41	9.48	/
Virtual duration of the peak of a rectangular impulse $T_{0.9}$		μs	2008			2000μs (100%~120%)
Virutal total duration of a rectangular impulse $T_{0.1}$		μs	2644			≤1.5$T_{0.9}$
Actual current value	The 1st impulse	A	350	362	354	350A(90%~110%)
	The 2nd impulse	A	352	360	350	350A (100%~110%)
	The 3rd impulse	A	354	360	350	
	The 4th impulse	A	360	366	356	
	The 5th impulse	A	358	366	354	
	The 6th impulse	A	358	364	354	
	The 7th impulse	A	358	366	354	
	The 8th impulse	A	356	366	356	
	The 9th impulse	A	354	364	352	
	The 10th impulse	A	364	370	356	
	The 11th impulse	A	360	366	356	
	The 12th impulse	A	360	364	354	
	The 13th impulse	A	358	368	354	
	The 14th impulse	A	358	368	354	
	The 15th impulse	A	358	368	354	
	The 16th impulse	A	358	368	356	
	The 17th impulse	A	360	364	352	
	The 18th impulse	A	358	364	354	
8/20μs I_n residual voltage after test		kV_p	9.58	9.45	9.41	/
Change rate		%	+1.59	+0.43	-0.74	≤5
Test results			No breakdown, no flashover, No damage.			No breakdown, no flashover, no damage.

Note: shunt R_s=0.01V/A.

Fulfilled the requirements. Test waveform is shown in figure C.5

11 Operating duty test

11.1 Accelerated ageing test

Items	Unit	Samples		
		307	308	309
U_{1mADC}	kV	5.44	5.43	5.42
applying power frequency	$kV_{r.m.s.}$	3.27	3.26	3.26
chargeability	%	85.0	84.9	85.0
Power loss at 2 hours /P_{1ct}	W	1.350	1.427	1.146
Power loss at 1008 hours / P_{2ct}	W	1.020	1.054	1.016
Minimum power loss P_{3ct}	W	1.020	1.054	0.983
P_{2ct} / $1.1P_{3ct}$	-	0.91	0.91	0.94
P_{2ct} / P_{1ct}	-	0.76	0.74	0.89

Note1: Because $P_{2ct} < 1.1P_{3ct}$ and $P_{2ct} < P_{1ct}$, the samples of thermally prorated sections which made of new resistors without aging and apply voltage would be U_r and U_c in operating duty test.

Note 2: Resistor temperature: T15±4℃.

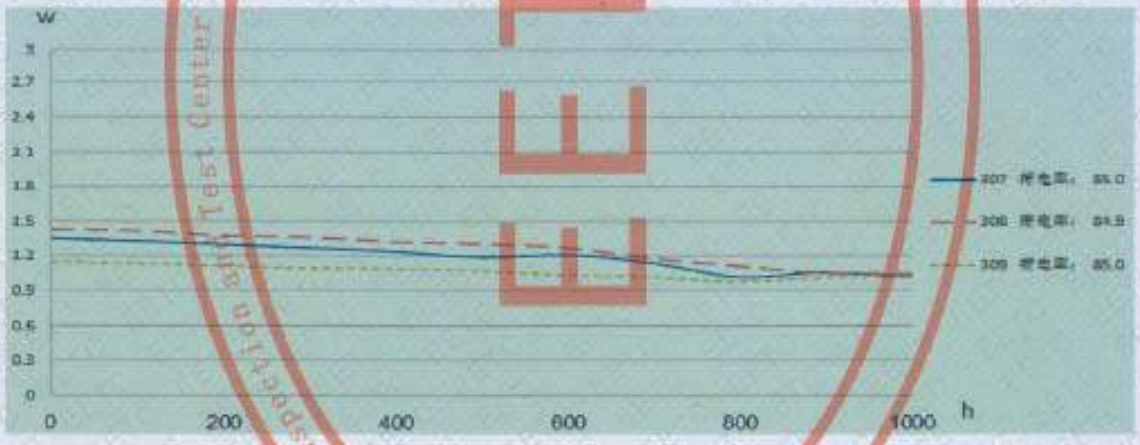

Figure1 Accelerated ageing test curve

11.2 Sample parameters for operating duty test

Samples		201	202	203
DC reference voltage U_{1mADC}	kV	5.42	5.41	5.41
Rated voltage U_r	$kV_{r.m.s.}$	3.84	3.83	3.83
Continuous operating voltage U_c	$kV_{r.m.s.}$	3.07	3.07	3.07
Aging ratio K_{ct}	-	1.00	1.00	1.00
Rated voltage U_r^*	$kV_{r.m.s.}$	3.84	3.83	3.83
Continuous operating voltage U_c^*	$kV_{r.m.s.}$	3.07	3.07	3.07
1.20 times U_c^*	$kV_{r.m.s.}$	3.68	3.68	3.68

11.3 Operating duty test

Temperature of the environment:23.0℃ humidity: 85%

Samples			201	202	203	Req.
8/20μs U_{10kA} before		kV_p	9.48	9.50	9.46	/
Condition - ing test	Applying 1.20 U_c*	$kV_{r.m.s}$	3.68	3.68	3.68	Applying 1.20U_c*
	Trigger Angle	°	54.0			Before the peak power frequency voltage 60°±15°
	The 1st group	kA	9.91~10.09	9.89~10.03	9.94~10.07	Apply 20 times 8/20 nominal discharge current, each group of five times, a total of four groups
	The 2nd group		9.89~10.11	9.91~10.05	9.95~10.12	
	The 3rd group		9.92~10.12	9.92~10.12	9.94~10.09	
	The 4th group		9.95~10.07	9.95~10.07	9.91~10.12	
high current impulse	The 1st time	kA	95.6	98.9	100.2	Apply 2 times 100 kA high current, cooled to ambient temperature between two impulse
	The 2nd time	kA	97.8	99.7	100.3	
Applied voltage after 2nd impulse	Time	ms	89	87	86	≤100
	U_r*	$kV_{r.m.s}$	3.84	3.83	3.83	peak /$\sqrt{2}$
	Duration	s	10	10	10	10
	U_c*	$kV_{r.m.s}$	3.07	3.07	3.07	-
	Duration	min	30	30	30	30
Power loss within 30 min	0min	W	3.47	3.39	3.41	In the last 15 min power loss should reduce Steadily
	5min		2.39	2.25	2.28	
	10min		1.56	1.43	1.41	
	15min		1.06	1.03	1.09	
	20min		0.92	0.89	0.91	
	25min		0.83	0.76	0.84	
	30min		0.79	0.71	0.77	
8/20μs U_{10kA} after		kV_p	9.51	9.55	9.49	-
8/20μs U_{10kA} change rate		%	+0.32	+0.53	+0.32	≤5
Visual inspection		-	No puncture, flashover, cracking or other significant damage			No puncture, flashover, cracking or other significant damage

Fulfilled the requirements. Test waveform is shown in figure C.6~C.8.

12 Power frequency voltage-versus-time characteristic test

12.1 Sample parameters for power frequency voltage-versus-time characteristic test

Samples		204	205	206
DC reference voltage U_{1mADC}	kV	5.39	5.41	5.41
Rated voltage U_r	$kV_{r.m.s.}$	3.81	3.83	3.83
Continuous operating voltage U_c	$kV_{r.m.s.}$	3.05	3.07	3.07
Aging ratio K_{ct}	-	1.00	1.00	1.00
Rated voltage U_r^*	$kV_{r.m.s.}$	3.81	3.83	3.83
Continuous operating voltage U_c^*	$kV_{r.m.s.}$	3.05	3.07	3.07

12.2 Power frequency voltage-versus-time characteristic test

Temperature of the environment: 23.0℃ humidity: 85%

Samples			204	205	206	Req.
8/20μs U_{10kA} before		kV	9.41	9.48	9.41	/
High-current impulse		kA	98.9	100.1	100.5	preheated samples to 60℃±3℃
Applied voltage after high-current impulse	Time	ms	89	89	87	≤100
	U_r^*	$kV_{r.m.s.}$	3.24	3.83	4.21	peak /√2
	Times of U_r^*	-	0.85	1.00	1.10	-
	Duration	-	24 h	2 h	10 s	-
	U_c^*	$kV_{r.m.s.}$	3.05	3.07	3.07	-
	Duration	min	30	30	30	30
Power loss within 30 min	0min	W	2.79	3.57	3.96	In the last 15 min power loss should reduce Steadily
	5min		2.13	2.85	3.17	
	10min		1.67	2.21	2.62	
	15min		1.19	1.73	2.07	
	20min		1.03	1.25	1.79	
	25min		0.88	1.04	1.55	
	30min		0.79	0.89	1.32	
8/20μs U_{10kA} after		kV_P	9.43	9.53	9.46	-
8/20μs U_{10kA} change rate		%	+0.21	+0.53	+0.53	≤5
Visual inspection		-	No puncture, flashover, cracking or other significant damage			No puncture, flashover, cracking or other significant damage

Fulfilled the requirements.

Appendix A: Object Parameters

Rated voltage U_r: 26kV Continuous operating voltage U_c: 20.8$kV_{r.m.s}$

Nominal discharge current I_n: 10kA Lightning impulse residual voltage: U_{res}: ≤72kV_P

Sample description:

①3 Arresters, number EETC02-170227-0090-001~EETC02-170227-0090-003, short for 001~003 in report; ②6 thermally prorated sections, number EETC02-170227-0090-201~EETC02-170227-0090-206, short for 201~206 in report; ③9 resistors, number EETC02-170227-0090-301~EETC02-170227-0090-309, short for 301~309 in report; ④3 housings, number EETC02-170227-0090-401~EETC02-170227-0090-403, short for 401~403 in report.

Appendix B: Main test device

NO.	Device name	Device NO.	Measurement	Uncertainty /Accuracy	Calibration institution	Expiration date
1	Long duration (rectangular)current impulse generator	EETC02-0002	2ms 1 kA, 20kV	Urel=0.0056 k=2 Urel=0.0064 k=2	National center for high voltage measurement	2018-06-04
2	impulse current generator	EETC02-0003	8/20 μs 100 kA, 20kV 4/10 μs 150 kA, 20kV 30/80 μs 50 kA, 20kV	Urel=0.0056 k=2 Urel=0.0064 k=2	National center for high voltage measurement	2018-06-04
3	Steep impulse wave current generator	EETC02-0004	1/5μs 20kA, 20kV	Urel=0.0056 k=2 Urel=0.0064 k=2	National center for high voltage measurement	2018-06-04
4	impulse current generator	EETC02-0005	8/20 μs 50 kA, 20kV 30/80 μs 10 kA, 20kV	Urel=0.0056 k=2 Urel=0.0064 k=2	National center for high voltage measurement	2018-06-04
5	800kV impulse voltage generator	EETC02-0007	0~800 kV	Urel=0.018 k=2	National center for high voltage measurement	2018-08-09
6	400kV DC high voltage generator	EETC02-0008	0~400 kV	Urel=0.012 k=2	National center for high voltage measurement	2018-06-06
7	300kV AC High Voltage generator	EETC02-0011	0~300 kV	/	/	/
	Digital high-voltage table	EETC02-0077	0~300 kV	1%	National center for high voltage measurement	2018-09-23
8	JFD-251 PD tester	EETC02-0043	/	0.5pC	National center for high voltage measurement	2018-06-06

Appendix C: Waveforms

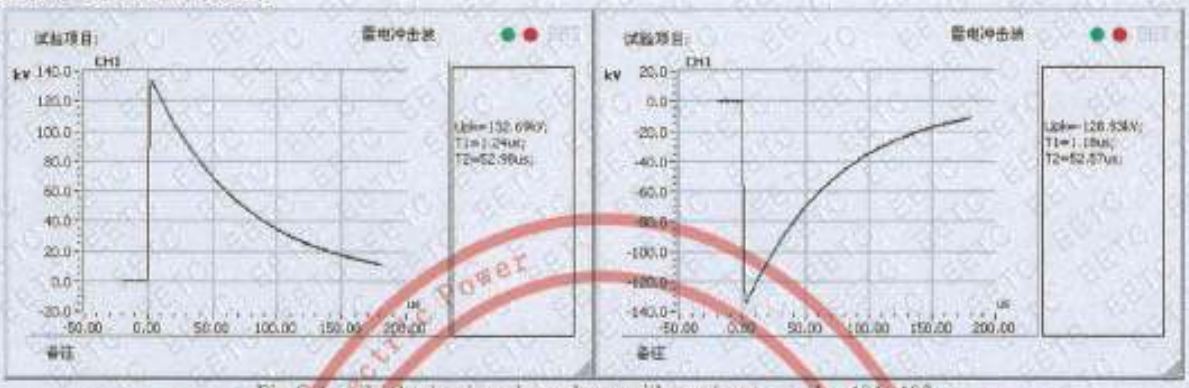

Fig.C.1 Lightning impulse voltage withstand test samples 401~403

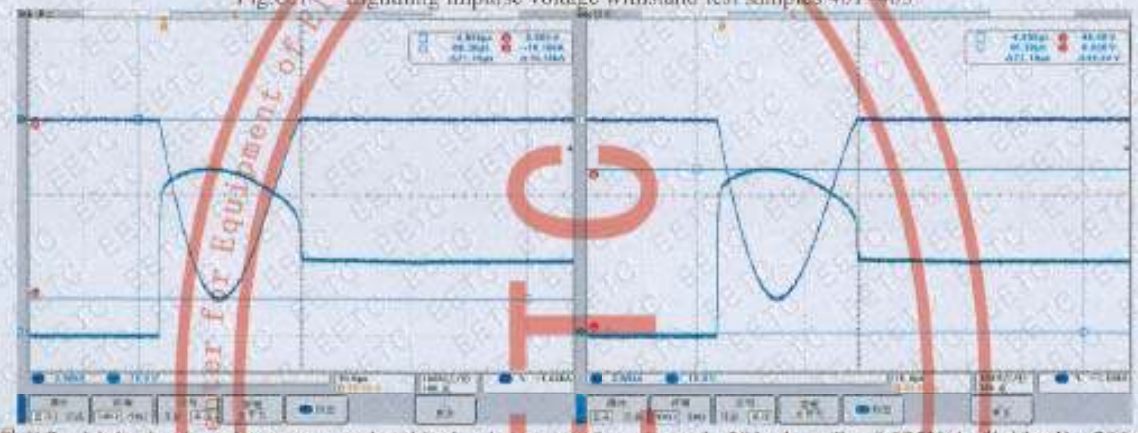

图 C.2 Lightning impulse current and residual voltage waveform (sample 301, shunt Rs=0.025V/A, divider K_d=206.1)

图 C.3 Switching impulse current and residual voltage waveform (sample 302, shunt Rs=0.025V/A, divider K_d=206.1)

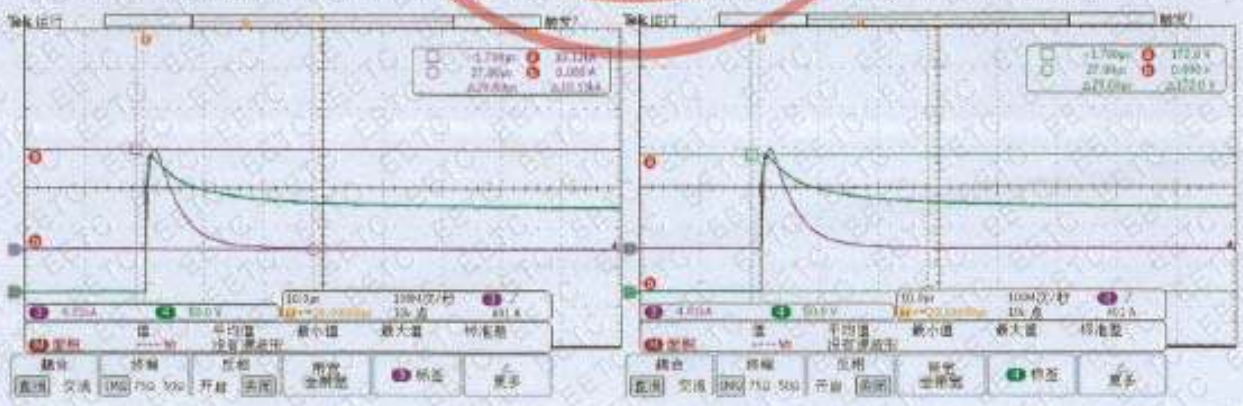

图 C.4 Steep impulse current and residual voltage waveform (sample 302, shunt Rs=0.025V/A, divider K_d=61.8)

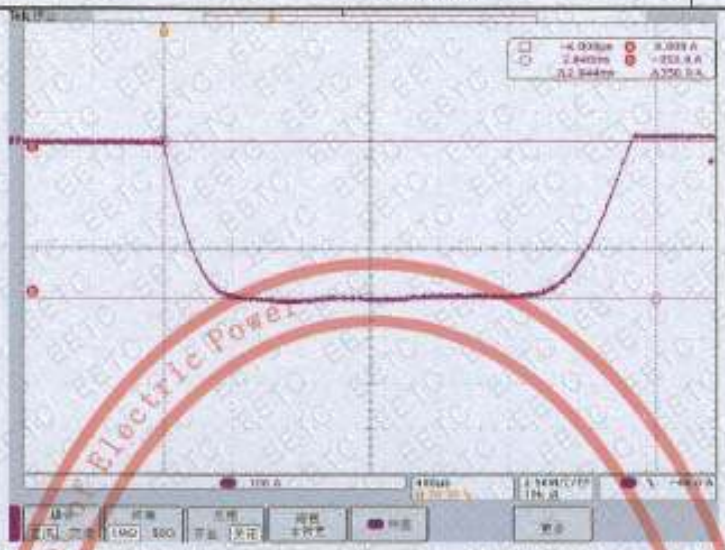

图 C.5 Rectangular impulse current waveform (sample 304, NO.1, shunt Rs=0.01V/A)

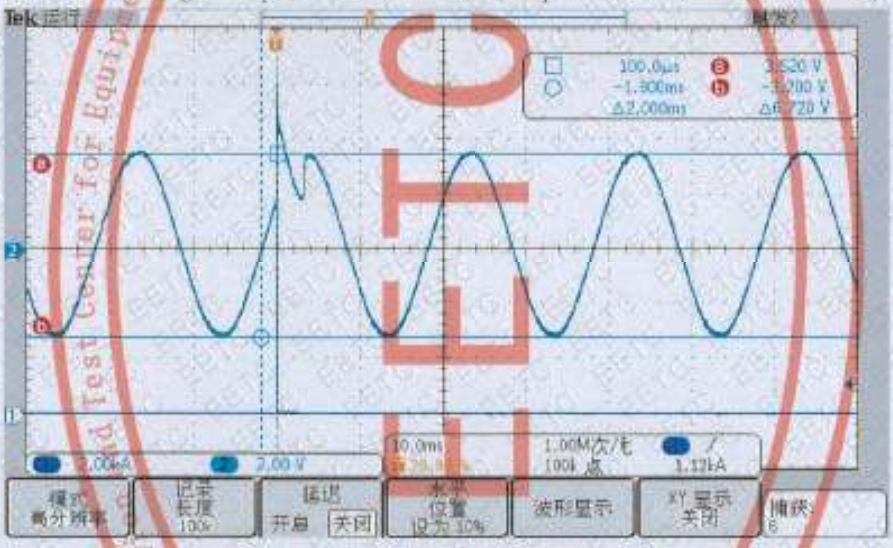

图 C.6 Preliminary test waveform (sample 201, transformer ratio K_d=1540)

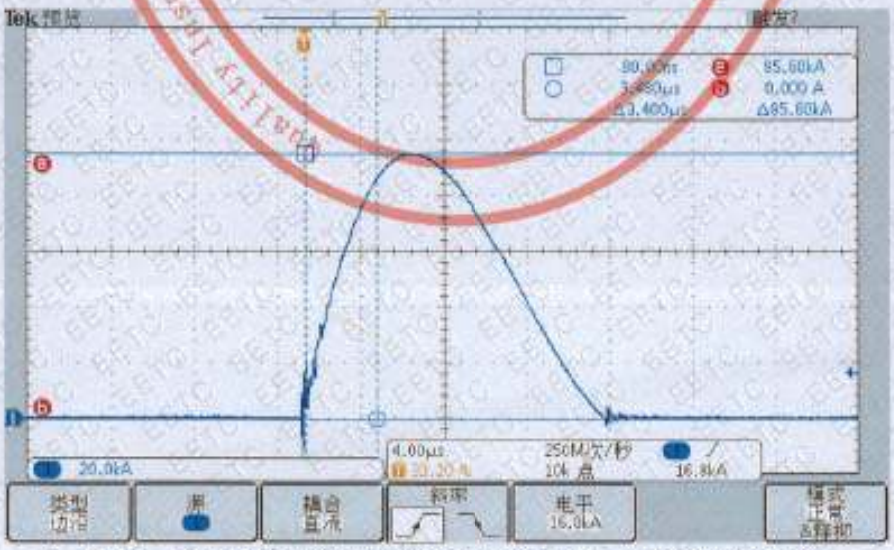

图 C.7 High impulse current waveform (sample 201, shunt Rs=0.001V/A)

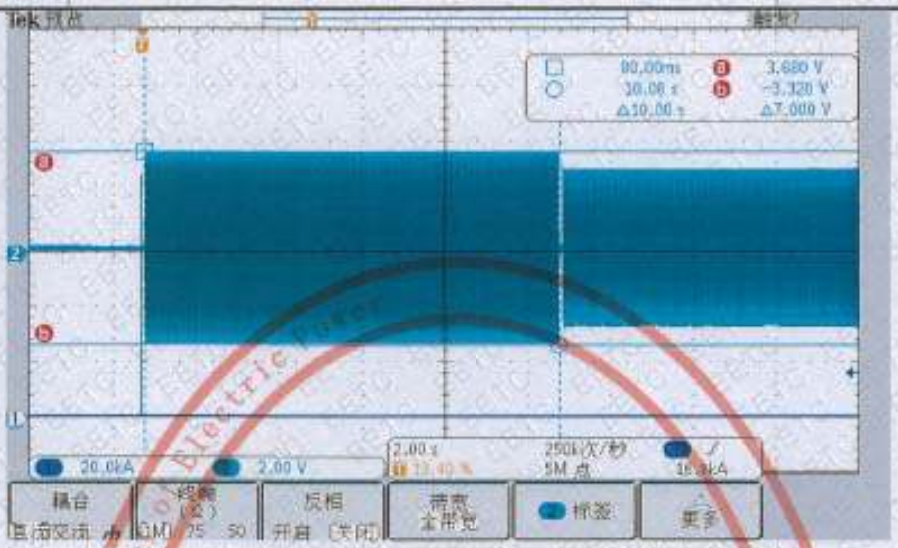

图 C.8 Operating duty test waveform (sample 201, divider K=1540)

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Appendix D: Visual and dimensional check

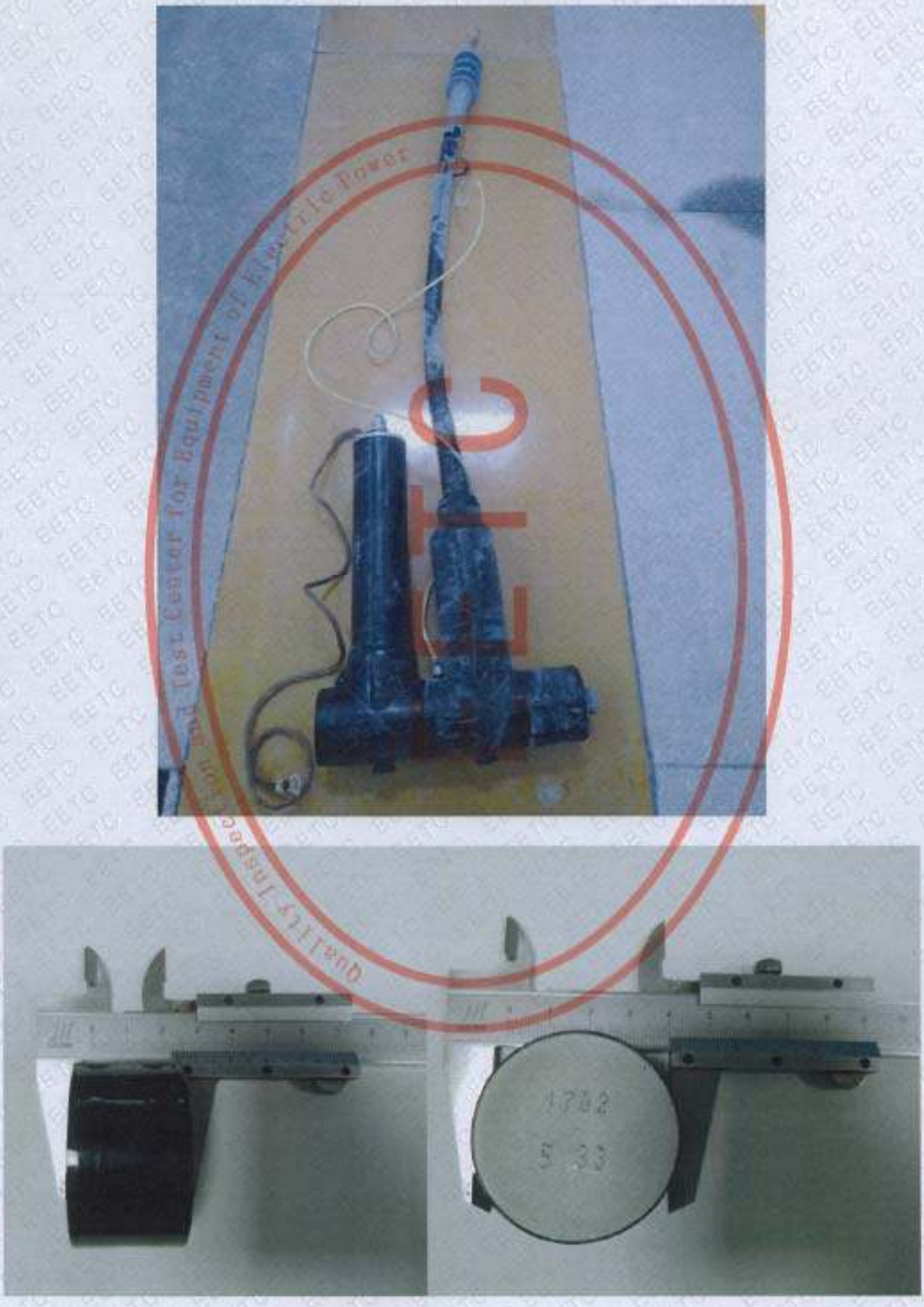

Fig.D1 26-RDTA72-10 arrester and resister

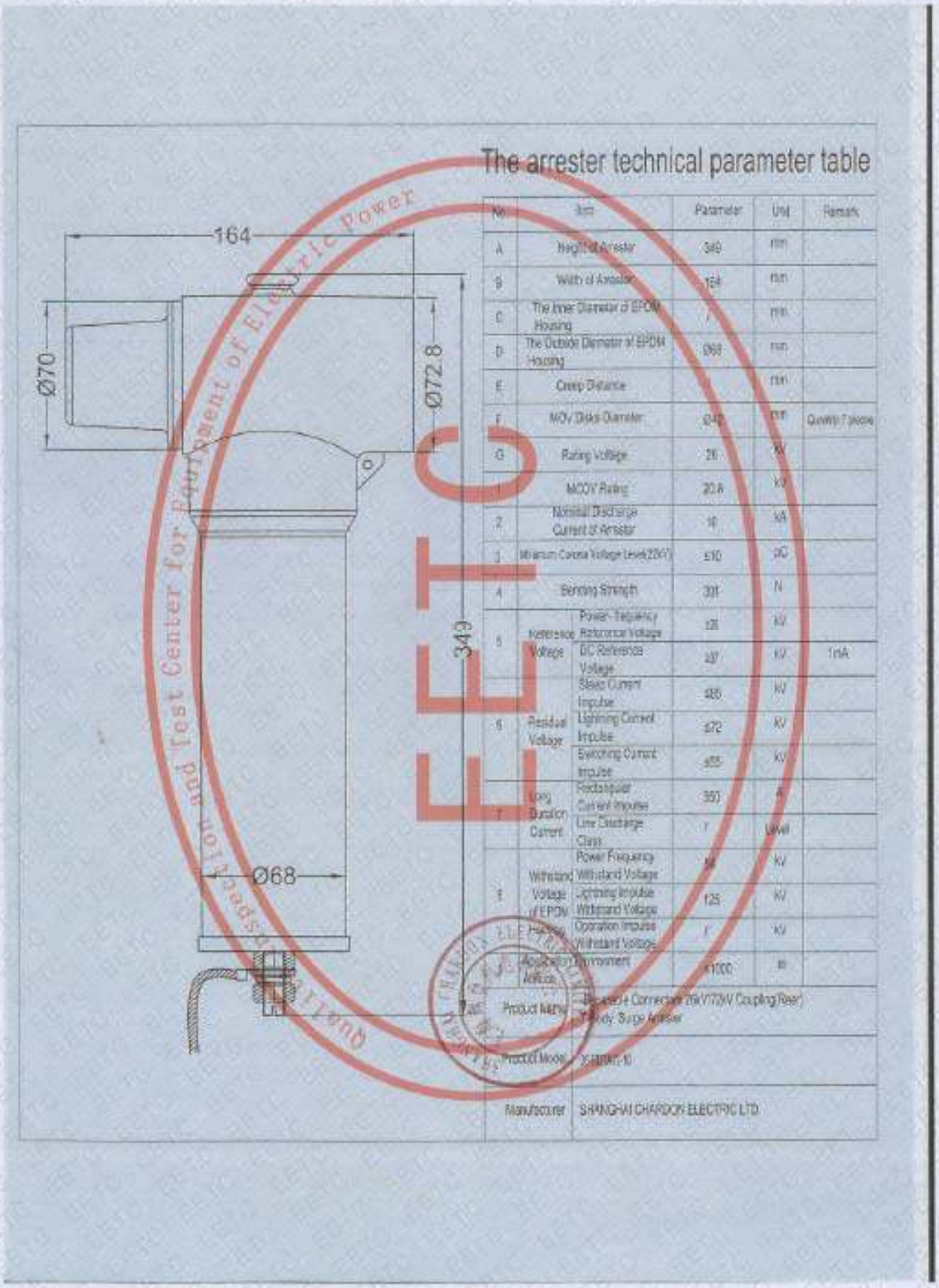

Fig D2 : Dimensional drawing of 26-RDTA72-10