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TEST REPORT

CEPRI-EETC02-2022-0242(E)

Client: ZGHD ELECTRIC CO.,LTD

Object: 24kV Shielded rear connected metal oxide
lightning arrester

Type: GHD-24BLQ-34/85

Test Category: Type Test

**POWER INDUSTRY QUALITY INSPECTION AND TEST
CENTER FOR ELECTRIC EQUIPMENT**



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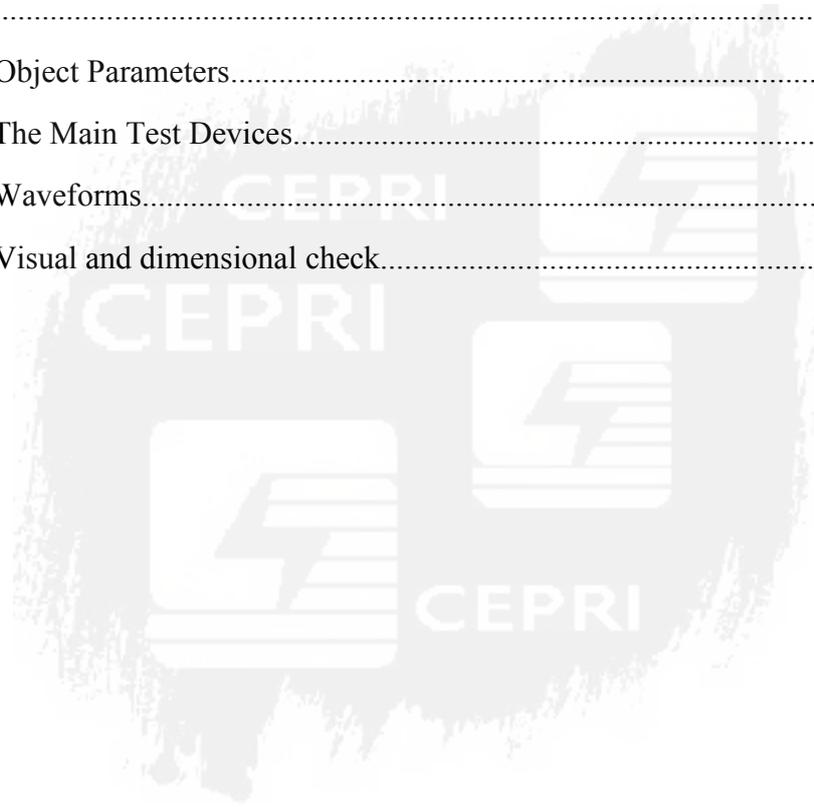
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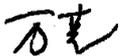
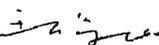
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Catalogue

1.Catalogue.....	1
2.Signature Page.....	2
3.Test Results.....	3
4.Content.....	4
5.Appendix A Object Parameters.....	15
6.Appendix B The Main Test Devices.....	15
7.Appendix C Waveforms.....	16
8.Appendix D Visual and dimensional check.....	19



Test Report	Power Industry Quality Inspection and Test Center for Electric Equipment		CEPRI-EETC02-2022-0242(E) Total 21 Page 2
Client	ZGHD ELECTRIC CO.,LTD 	Manufacturer	ZGHD ELECTRIC CO.,LTD
Object	24kV Shielded rear connected metal oxide lightning arrester	Type	GHD-24BLQ-34/85 (Φ32mm×30mm)
Sampling procedure	By the client delivery	Serial No.	1 arrester (001) 1 dielectrically prorated sections(101) 10 thermally prorated sections (201~210) 16 resistors (301~316) 1 housing(401)
Test Category	Type Test	Date	2022.12.22~2023.02.13
Requirements	GB/T 11032-2020 Metal-oxide surge arresters without gaps for a.c. systems 		
Conclusion	The 24kV Shielded rear connected metal oxide lightning arrester GHD-24BLQ-34/85 have successfully passed the type test specified in GB/T 11032-2020.		
Note	Note :See appendix A for sample instruction.		
Tested by: 万克		梁菊霞	
Checked by: 王陆璐		Verified by: 左中秋	
Approved by: 王保山			
		Date of issue: 2023-03-22	



Test Results

No.	Item	Requirements	Results	Evaluation	
1	D.C. reference voltage test	$48.0\text{kV} \leq U_{1\text{mADC}} \leq 49.3\text{kV}$	48.9kV	Pass	
2	Leakage current test at 0.75 times D.C. reference voltage	$I_L(0.75U_{1\text{mADC}}) \leq 50\mu\text{A}$	4 μA	Pass	
3	Continuous operating current test	$I_x \leq 1000\mu\text{A}$ $I_R \leq 300\mu\text{A}$	$I_x = 218\mu\text{A}$ $I_R = 67\mu\text{A}$	Pass	
4	A.C. reference voltage test	$U_{1\text{mAAC}} \geq 34.0\text{kV}_p / \sqrt{2}$	$36.42\text{kV}_p / \sqrt{2}$	Pass	
5	Partial discharge test	$1.05U_c$ 下, $PD \leq 10\text{pC}$	$PD = 1.6\text{pC}$	Pass	
6	Insulation withstand tests on the arrester housing	Power-frequency voltage: Dry $\geq 50\text{kV}_{\text{rms}}$, for 1min. Lightning impulse voltage : 125.0kV_p , the positive and negative 15 times respectively.	Power-frequency voltage dry: $50.1\text{kV}_{\text{rms}}$, 1min. Lightning impulse voltage: $125.5\text{kV}_p \sim 126.8\text{kV}_p$ the positive and negative 15 times respectively.	Pass	
7	Residual voltage test	Lightning impulse	$\leq 85.0\text{kV}_p$	84.28kV_p	Pass
		Switching impulse	$\leq 75.0\text{kV}_p$	66.11kV_p	
		Steep current	$\leq 95.0\text{kV}_p$	89.87kV_p	
8	Repetitive charge transfer withstand test	10 samples should withstand 20 times 2ms long-duration current impulse and the charge value should not less than $0.2C$.	$0.221C \sim 0.240C$	Pass	
9	Test to verify long term stability under continuous operating voltage	The accelerated ageing test of resistors should be carried out according to the specified procedure.	$P_{\text{max}} \leq 1.3P_{\text{min}}$, $P_{\text{all.max}} \leq 1.1P_{\text{start}}$; the samples fulfilled the requirements.	Pass	
10	Heat dissipation behavior verification test	The test section is for all instants during the cooling period have a temperature higher than the complete arrester.	Fulfilled the requirements. See fig 2.	Pass	



No.	Item	Requirements	Results	Evaluation												
11	Operating duty test	Long-duration current impulse 2 times. Rated thermal energy injection $Q_{th} \geq 0.7 C$ The residual voltage shall not have changed by more than 5%.	$Q_{th} \geq 0.718C$ The residual voltage changed ratio is from +0.98%~+1.16%	Pass												
12	Power-frequency voltage-versus-time characteristics	$Q_{th} \geq 0.7C$ Supply the Power frequency voltage-versus-time characteristics for the range of voltage from $1.20U_r^*$ to $1.00U_r^*$, the range of time from 0.1s to 1200s for with prior duty, $1.20U_r^*$ to $1.00U_r^*$, the range of time from 1.1s to 1200s for without prior duty.	$Q_{th} \geq 0.722C$ With prior duty test <table border="1"> <tr> <td>$1.20U_r^*$</td> <td>0.1s</td> </tr> <tr> <td>$1.15 U_r^*$</td> <td>1.1s</td> </tr> <tr> <td>$1.10 U_r^*$</td> <td>10.1s</td> </tr> <tr> <td>$1.00 U_r^*$</td> <td>1200s</td> </tr> </table> Without prior duty test <table border="1"> <tr> <td>$1.20 U_r^*$</td> <td>1.1s</td> </tr> <tr> <td>$1.00 U_r^*$</td> <td>1200s</td> </tr> </table>	$1.20U_r^*$	0.1s	$1.15 U_r^*$	1.1s	$1.10 U_r^*$	10.1s	$1.00 U_r^*$	1200s	$1.20 U_r^*$	1.1s	$1.00 U_r^*$	1200s	Pass
$1.20U_r^*$	0.1s															
$1.15 U_r^*$	1.1s															
$1.10 U_r^*$	10.1s															
$1.00 U_r^*$	1200s															
$1.20 U_r^*$	1.1s															
$1.00 U_r^*$	1200s															
13	Test to verify the dielectric withstand of the internal components of an arrester	1 time 65kA-4/10 μ s	64.8kA, no puncture, flashover, cracking or other significant damage.	Pass												

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Test Report	Power Industry Quality Inspection and Test Center for Electric Equipment	CEPRI-EETC02-2022-0242(E) Total 21 Page 5
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Content:

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

Environment temperature:9.5℃ humidity:34%

Samples	D.C. reference voltage U_{1mADC} kV		0.75times D.C. reference voltage kV		Leakage current μA	
	Measured value	Specified value	Measured value	Specified value	Measured value	Specified value
001	48.9	$48.0 \leq U_{1mADC} \leq 49.3$	36.7	$0.75U_{1mADC} \pm 1\%$	4	≤ 50

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:9.5℃ humidity:34%

Samples	The power-frequency reference voltage U_{1mAAC} $kV_p/\sqrt{2}$		I_R μA_p		I_X μA_{rms}	
	Measured value	Specified value	Measured value	Specified value	Measured value	Specified value
001	36.42	≥ 34.0	67	≤ 300	218	≤ 1000

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	$1.05U_c$	$1.05U_c$ duration time	Partial discharge
	kV_{rms}	s	kV_{rms}	s	pC
001	34.0	10	28.6	60	1.6
specified value	34.0	2~10	28.6	60	≤ 10

Fulfilled the requirements.



6 Insulation withstand tests on the arrester housing

6.1 Power frequency voltage withstand test

t=8.5°C RH=57% Atmospheric pressure: 102.5kPa

Samples	Specified value	Applied voltage	Duration	Test result
	kV _{rms}	kV _{rms}	s	
401	50.0(dry)	50.1	60	No flashover

Fulfilled the requirements.

6.2 Lightning impulse voltage withstand test

t=8.5°C RH=57% Atmospheric pressure: 102.5kPa

Samples	Specified value		Applied voltage	Withstand times	Test result
		kV	kV _p		
401	(+)	125.0	125.5~126.5	15	no flashover
	(-)	125.0	125.5~126.8	15	no flashover

Fulfilled the requirements.

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Test Report	Power Industry Quality Inspection and Test Center for Electric Equipment	CEPRI-EETC02-2022-0242(E) Total 21 Page 7
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7 Residual voltage test

7.1 Lightning impulse current residual voltage test

Samples			301	302	303
Resistor	U_{1mADC}	kV	6.54	6.54	6.54
	8/20 μ s, 2.5kA	kV _p	10.63	10.62	10.65
	8/20 μ s, 5kA	kV _p	11.17	11.16	11.18
	8/20 μ s, 10kA	kV _p	12.51	12.49	12.55
	U_{5kA}/U_{1mADC}	-	1.71	1.71	1.71
Complete arrester	U_{1mADC}	kV	48.0 $\leq U_{1mADC} \leq 49.3$		
	Scale coefficient	-	7.54	7.54	7.54
	8/20 μ s, 2.5kA	kV _p	80.13	80.06	80.28
	8/20 μ s, 5kA	kV _p	84.20	84.13	84.28
	8/20 μ s, 10kA	kV _p	94.30	94.15	94.60
	Lightning impulse protection level	kV _p	84.28		
	Specified value	kV _p	≤ 85.0		

Note 1: Shunt 0.025 V/A, divider $K_d=206.8$

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.

7.2 Switching impulse current residual voltage test

Samples			301	302	303
Resistor	Residual voltage at 250A	kV _p	8.77	8.75	8.77
Complete arrester	Test value	kV _p	66.11	65.96	66.11
	Switching impulse current residual voltage	kV _p	66.11		
	Specified value	kV _p	≤ 75.0		

Note: Shunt 0.025 V/A, divider $K_d=206.8$

7.3 Steep current impulse residual voltage test

Samples			301	302	303
Resistor	5 kA U_{res1}	kV _p	12.20	12.19	12.19
	5 kA U_{res2}	kV _p	0.29		
	U_{res2}/U_{res1}	%	2.4	2.4	2.4
	$U_{res1}-U_{res2}$	kV _p	11.90	11.90	11.90
Complete arrester	Scale coefficient	-	7.54	7.54	7.54
	Residual voltage for the arrester	kV _p	89.78	89.70	89.70
	Inductance per unit length	μ H/m	0.3		
	Height without resistors	m	0.301-(0.03 \times 8)=0.061		
	Inductive voltage correction	kV _p	0.3 \times 0.061 \times 5=0.09		
	After correction	kV _p	89.87	89.87	89.87
	Residual voltage for the arrester after correction	kV _p	89.87		
Specified value	kV _p	≤ 95.0			

Note1: Shunt 0.0267V/A, divider $K_d=59.8$ 。

Note 2: If U_{res2}/U_{res1} is less than 2%, there is no need to correct Inductive effect.

Fulfilled the requirements. Test waveform is shown in appendix C fig C.1~ fig C.3.



Test Report	Power Industry Quality Inspection and Test Center for Electric Equipment	CEPRI-EETC02-2022-0242(E) Total 21 Page 8
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8 Repetitive charge transfer withstand

Samples: 10 resistors (304~313)

Requirements of standards: The samples should withstand more than 0.2C by 8/20us current impulse for 20 times, and after test, have no breakdown or flashover or breakage, the change of residual voltage within $\pm 5\%$, the change of reference voltage within $\pm 5\%$, also should withstand capability to one 8/20us current impulse of at least 0.5 kA/cm² peak current density or 2 times I_n , whichever is lower.

Test data: Fulfilled the requirements, the test waveforms were shown in appendix C fig C.4.

Samples		304	305	306	307	308	309	310	311	312	313
Before test	U_{1mAAC} , kV	4.78	4.75	4.76	4.78	4.78	4.75	4.75	4.76	4.76	4.77
	$8/20\mu s U_{5kAp}$, kV	11.17	11.12	11.15	11.18	11.17	11.11	11.11	11.13	11.15	11.17
Q_{rs} , C		Q_{rs} (Claimed repetitive charge transfer rating) $\times 1.1=0.22$									
1 st	Q_{rs} , C	0.231	0.233	0.224	0.226	0.237	0.227	0.233	0.225	0.222	0.227
2 nd	Q_{rs} , C	0.223	0.226	0.233	0.222	0.233	0.231	0.240	0.232	0.222	0.235
3 rd	Q_{rs} , C	0.226	0.222	0.235	0.237	0.224	0.226	0.236	0.231	0.222	0.225
4 th	Q_{rs} , C	0.238	0.224	0.239	0.238	0.230	0.239	0.236	0.231	0.227	0.237
5 th	Q_{rs} , C	0.236	0.236	0.225	0.224	0.223	0.226	0.229	0.238	0.224	0.227
6 th	Q_{rs} , C	0.231	0.226	0.226	0.239	0.237	0.227	0.227	0.227	0.230	0.228
7 th	Q_{rs} , C	0.231	0.235	0.222	0.222	0.235	0.227	0.226	0.226	0.225	0.223
8 th	Q_{rs} , C	0.235	0.239	0.234	0.222	0.225	0.228	0.227	0.231	0.236	0.231
9 th	Q_{rs} , C	0.222	0.231	0.228	0.223	0.229	0.230	0.235	0.238	0.234	0.235
10 th	Q_{rs} , C	0.235	0.240	0.222	0.238	0.231	0.234	0.226	0.221	0.237	0.235
11 th	Q_{rs} , C	0.230	0.236	0.229	0.224	0.224	0.226	0.234	0.233	0.223	0.230
12 th	Q_{rs} , C	0.221	0.239	0.236	0.235	0.239	0.224	0.224	0.237	0.228	0.222
13 th	Q_{rs} , C	0.227	0.225	0.230	0.223	0.232	0.228	0.221	0.222	0.222	0.224
14 th	Q_{rs} , C	0.226	0.234	0.225	0.232	0.227	0.223	0.227	0.222	0.228	0.238
15 th	Q_{rs} , C	0.226	0.232	0.239	0.233	0.233	0.237	0.235	0.237	0.225	0.227
16 th	Q_{rs} , C	0.235	0.236	0.233	0.238	0.232	0.222	0.237	0.235	0.222	0.238
17 th	Q_{rs} , C	0.235	0.239	0.238	0.235	0.235	0.225	0.226	0.237	0.227	0.224
18 th	Q_{rs} , C	0.234	0.233	0.228	0.228	0.233	0.239	0.230	0.221	0.222	0.235
19 th	Q_{rs} , C	0.240	0.234	0.224	0.222	0.226	0.235	0.223	0.232	0.239	0.238
20 th	Q_{rs} , C	0.229	0.226	0.233	0.235	0.240	0.234	0.233	0.234	0.225	0.228



Test evaluation	One 8/20 current impulse, kA	4.02 kA $(0.5\text{kA}/\text{cm}^2=0.5 \times 3.14 \times (3.2/2)^2=4.02\text{kA}$ which is lower than 2 times I_n)									
	U_{1mAAC} , kV	4.05	4.03	4.06	4.05	4.05	4.07	4.03	4.05	4.07	4.05
	Change rate, %	4.93	4.92	4.93	4.92	4.91	4.93	4.91	4.93	4.91	4.93
	$8/20\mu\text{s}$ U_{5kAP} , kV	+3.14	+3.58	+3.57	+2.93	+2.72	+3.79	+3.37	+3.57	+3.15	+3.35
	Change rate, %	11.39	11.38	11.36	11.41	11.42	11.36	11.35	11.38	11.41	11.45
	Visual inspection	+1.97	+2.34	+1.88	+2.06	+2.24	+2.25	+2.16	+2.25	+2.33	+2.51
		All the samples have no puncture, flashover or cracking.									

Note: Shunt 0.00192V/A.

9. Test to verify long term stability under continuous operating voltage

Samples: 3 dielectrically prorated sections(314~316)

Requirements of standards: 3 resistors should pass the accelerated ageing test.

Test data: Fulfilled the requirements, the accelerated ageing curves were shown in fig 1.

Samples	314	315	316
U_{1mADC} , kV	6.52	6.52	6.52
U_c , kV _{rms}	3.93	3.93	3.93
Charge rate,%	85.2	85.2	85.1
Power losses P_{start} , 3h, W	0.734	0.710	0.715
Power losses P_{100h} , W	0.695	0.669	0.673
Power losses P_{200h} , W	0.638	0.629	0.627
Power losses P_{300h} , W	0.650	0.642	0.643
Power losses P_{400h} , W	0.618	0.634	0.657
Power losses P_{500h} , W	0.592	0.621	0.634
Power losses P_{600h} , W	0.611	0.613	0.618
Power losses P_{700h} , W	0.620	0.625	0.637
Power losses P_{800h} , W	0.602	0.617	0.635
Power losses P_{900h} , W	0.615	0.627	0.621
Power losses P_{end} , 1000+8h,W	0.632	0.620	0.625
P_{min} , W	0.592	0.613	0.618
Any increase of power losses from P_{min} during the remaining test period, P_{max}	0.632	0.627	0.637
$P_{all,max}$, W	0.734	0.710	0.715
$P_{max} / 1.3P_{min}$	0.821	0.787	0.793
$P_{all,max} / 1.1 P_{start}$	0.910	0.909	0.909

Note: (1) Because $P_{max} \leq 1.3P_{min}$, $P_{all,max} \leq 1.1P_{start}$, the samples fulfilled the requirements.
(2) The temperature of blocks: 115 ± 4 °C.



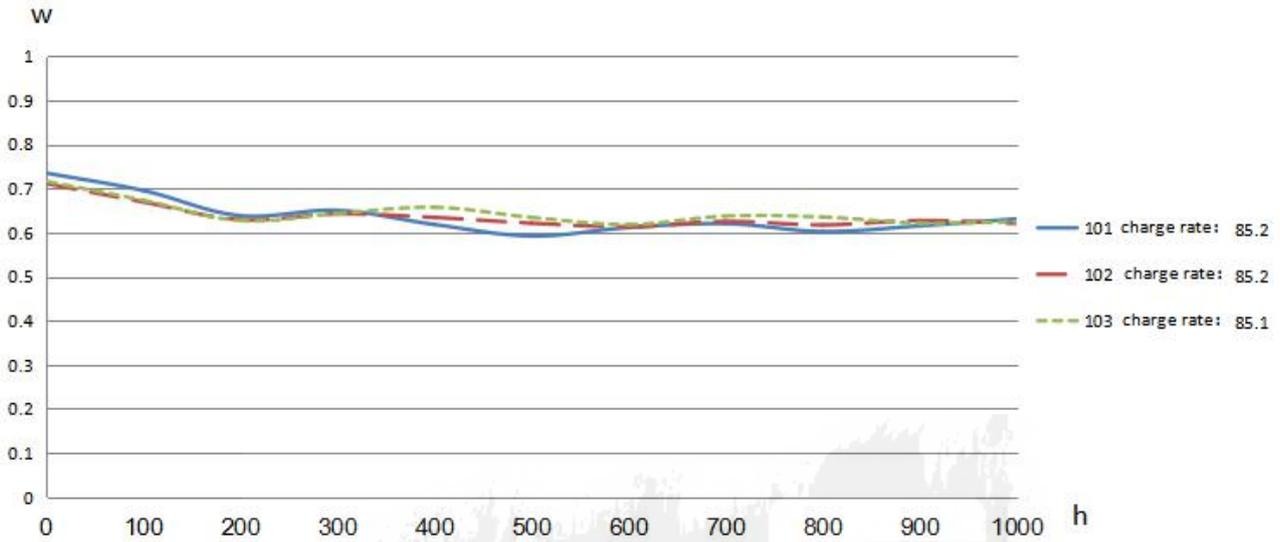


Fig 1 Accelerated ageing test curve

10 Heat dissipation behavior verification of test sample

Samples: 1 thermally prorated section (210) 1 arrester (001)

Requirements of standards: the MO resistors in the sample shall be heated to 140°C by the application of power-frequency voltage. When the temperature is reached, the voltage source shall be disconnected and the cooling time curve shall be determined. At any time, the measured cooling curve of section falls shall above the measured

cooling curve of the arrester.

Test data: Fulfilled the requirements, the test waveform was shown in fig 2.

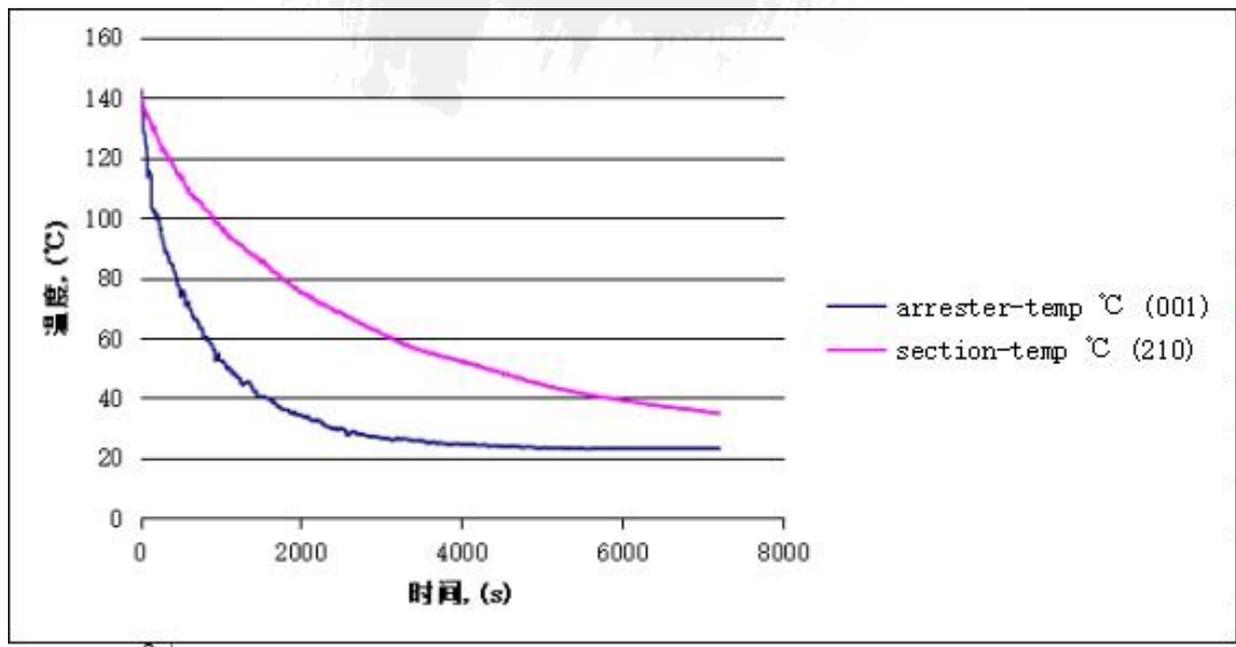


Fig 2 The cooling curve for the section and arrester

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Test Report	Power Industry Quality Inspection and Test Center for Electric Equipment		CEPRI-EETC02-2022-0242(E) Total 21 Page 11			
11 Operating duty test						
Samples: 3 thermally prorated sections (201~203)						
Requirements of standards: 3 thermally prorated sections should pass the high current impulse operating duty test.						
Test data: Fulfilled the requirements, the test waveforms were shown in appendix C fig C.5~ fig C.6.						
Samples		201	202	203		
U _{1mADC} , kV		6.54	6.54	6.54		
U _{sr} , kV _{rms}		4.63	4.63	4.63		
U _{sc} , kV _{rms}		3.71	3.71	3.71		
8/20μs, U _{5kA} , before, kV		11.17	11.18	11.17		
Conditioning test	1 st high current impulse, kA		65.6	65.2	64.9	
	2 nd high current impulse, kA		65.2	64.8	65.5	
preheated samples		preheated samples to 85.0°C±3°C				
Rated thermal energy injection, Q _{th}	Lightning current impulse	1 st Q _{th} , C	0.358	0.363	0.362	
		2 nd Q _{th} , C	0.369	0.372	0.356	
	Q _{th} rating (2 times), C		0.727	0.735	0.718	
Applied voltage after the 3 rd impulse	Time	Req.	as short as possible (within 100ms)			
		Actual	86	86	86	
	Applied voltage and duration	U [*] _{sr} , kV _{rms}		4.63	4.63	4.63
		Duration, s		10	10	10
		U [*] _{sc} , kV _{rms}		3.71	3.71	3.71
Duration, min		30	30	30		
Power loss, W	1 s		4.87	4.56	4.66	
	5 min		2.65	2.51	2.53	
	10 min		1.83	1.75	1.81	
	15 min		1.51	1.48	1.50	
	20 min		1.22	1.20	1.20	
	25 min		1.06	1.05	1.06	
	30 min		0.98	0.98	0.99	
Samples cooled to		cooled to ambient 20°C±15°C				
8/20μs, U _{5kA} , after, kV		11.29	11.31	11.30		
Variability of the residual voltage, %		+1.07	+1.16	+0.98		
Visual inspection		No puncture, flashover, cracking or other significant damage				



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Test Report		Power Industry Quality Inspection and Test Center for Electric Equipment		CEPRI-EETC02-2022-0242(E) Total 21 Page 12		
12 Power-frequency voltage-versus-time test						
12.1 Power-frequency voltage-versus-time test data (with prior duty)						
Samples		204	205	206	207	
U _{1mADC} , kV		6.53	6.54	6.54	6.55	
U _{sr} , kV _{rms}		4.63	4.63	4.63	4.64	
U _{sc} , kV _{rms}		3.70	3.71	3.71	3.71	
8/20μs, U _{5kA} , before, kV		11.15	11.17	11.18	11.20	
preheated samples		preheated samples to 85°C±3°C				
2ms long-duration current impulse	1 st impulse	Q _{th} , C	0.362	0.358	0.363	0.368
	2 nd impulse	Q _{th} , C	0.373	0.366	0.359	0.371
	Q _{th} rating (2 times), C		0.735	0.724	0.722	0.739
Applied voltage after the 3 rd impulse	Time	Req.	as short as possible (within 100ms)			
		Actual	86	86	88	88
	Applied voltage and duration	U _{sr} [*] , kV _{rms}	5.55	5.33	5.10	4.64
		TOV scale	1.20	1.15	1.10	1.00
		Duration, s	0.1	1.10	10.1	1200
		U _{sc} [*] , kV _{rms}	3.70	3.71	3.71	3.71
		Duration, min	30	30	30	30
Power loss, W	1 s	8.17	5.59	5.02	4.22	
	5 min	5.22	3.02	2.85	2.28	
	10 min	3.29	2.17	1.92	1.42	
	15 min	2.35	1.56	1.59	1.03	
	20 min	1.63	1.19	1.36	0.89	
	25 min	1.25	1.06	1.15	0.85	
	30 min	1.18	1.01	1.08	0.82	
Samples cooled to		cooled to ambient 20°C±15°C				
8/20μs, U _{5kA} , after, kV		11.33	11.30	11.32	11.28	
Variability of the residual voltage, %		+1.61	+1.16	+1.25	+0.71	
Visual inspection		No puncture, flashover, cracking or other significant damage				
Fulfilled the requirements, the test waveforms were shown in appendix C fig C.7~C.9.						



Test Report	Power Industry Quality Inspection and Test Center for Electric Equipment	CEPRI-EETC02-2022-0242(E) Total 21 Page 13
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12.2 Power-frequency voltage-versus-time test data (without prior duty)

Samples		208	209	
U _{1mADC} , kV		6.54	6.55	
U _{sr} , kV _{rms}		4.63	4.64	
U _{sc} , kV _{rms}		3.71	3.71	
8/20μs, U _{5kA} ,before, kV		11.21	11.20	
preheated samples		preheated samples to 85.0°C±3°C		
Applied voltage	Applied voltage and duration	U _{sr} [*] , kV _{rms}	5.56	4.64
		TOV scale	1.20	1.00
		Duration, s	1.1	1200
		U _{sc} [*] , kV _{rms}	3.71	3.71
		Duration, min	30	30
Power loss, W	1 s	3.25	2.83	
	5 min	2.16	1.56	
	10 min	1.41	1.18	
	15 min	1.03	0.95	
	20 min	0.88	0.89	
	25 min	0.85	0.85	
	30 min	0.85	0.84	
Samples cooled to		cooled to ambient 20°C±15°C		
8/20μs, U _{5kA} ,after, kV		11.27	11.28	
Variability of the residual voltage, %		+0.54	+0.71	
Visual inspection		No puncture, flashover, cracking or other significant damage		

Fulfilled the requirements, the test waveforms were shown in appendix C fig C.10.

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Test Report	Power Industry Quality Inspection and Test Center for Electric Equipment	CEPRI-EETC02-2022-0242(E) Total 21 Page 14
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13 Test to verify the dielectric withstand of the internal components of an arrester

Samples: 1 dielectrically prorated section (104)

Requirements of standards: preheat the sample to 60°C, consists of one application of a 65kA high-current impulse.

There should be no evidence of a dielectric breakdown. The test waveforms were shown in appendix C fig C.11.

Sample	101		
U_{1mAAC} , kV	4.76		
8/20 μ s, U_{5kA} ,before, kV	11.13		
preheated samples	preheated samples to 60°C±3°C		
high-current impulse, kA	64.8		
Samples cooled to	cooled to ambient 20°C±15°C		
8/20 μ s, U_{5kA} ,after, kV	11.21		
Variability of the residual voltage, %	+0.72		
Visual inspection	The block can not remove from the section	8/20 μ s current impulse, 2 times	4.02 kA ($0.5kA/cm^2=0.5 \times 3.14 \times (3.2/2)^2=4.02kA$ which is lower than 2 times I_n)
		1 st impulse, kA _p	4.05
		2 nd impulse, kA _p	4.03
		Curve check	No puncture, flashover, cracking or other significant damage

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Appendix A: Object ParametersRated voltage U_r : 34kVContinuous operating voltage U_c : 27.2kV_{rms}Nominal discharge current I_n : 5kALightning impulse residual voltage: U_{res} : $\leq 85kV_p$

High-current impulse: 65kA

Claimed repetitive charge transfer rating: 0.2C

Sample instruction:

- 1) 1 arrester, number EETC02-22/11/10-0242-001, short for 001 in report;
- 2) 10 thermally prorated sections, number EETC02-22/11/10-0242-201~EETC02-22/11/10-0242-210 short for 201~210 in report;
- 3) 16 resistors, number EETC02-22/11/10-0242-301~EETC02-22/11/10-0242-316, short for 301~316 in report;
- 4) 1 housing, number EETC02-22/11/10-0242-401, short for 401 in report.;
- 5) 1 dielectrically prorated sections, number EETC02-22/11/10-0242-101, short for 101 in report.

Appendix B: Main test device

NO.	Device name	Device NO.	Measurement	Uncertainty /Accuracy	Calibration institution	Expiration date
1	impulse current generator	EETC02-0003	8/20 μ s 40 kA 4/10 μ s 130 kA	$U_{rel}=0.015$ k=2 $U_{rel}=0.021$ k=2	National center for high voltage measurement	2023-06-23
2	impulse current generator	EETC02-0005	8/20 μ s 40 kA , 30kV 30/80 μ s 2 kA , 30kV	$U_{rel}=0.015$ k=2 $U_{rel}=0.018$ k=2	National center for high voltage measurement	2023-06-29
3	1/5 μ s impulse current generator	EETC02-0004	1/5 μ s 20kA , 20kV	$U_{rel}=0.015$ k=2 $U_{rel}=0.018$ k=2	National center for high voltage measurement	2023-06-29
4	800kV impulse voltage generator	EETC02-0007	0~800 kV	$U_{rel}=0.019$ k=2 $U_{rel}=0.016$ k=2	National center for high voltage measurement	2023-05-27
5	400kV DC high voltage generator	EETC02-0008	0~400 kV	$U_{rel}=0.012$ k=2	National center for high voltage measurement	2022-08-18
6	Operating duty test system-voltage	EETC02-0009	0~10kV	$U_{rel}=0.004$ k=2	Beijing Aerospace measurement and testing technology institute	2023-01-06
7	Partial discharge test system	EETC02-0043	/	$U_{rel}=0.013$ k=2	China Inspection Southwest Measurement Co.,LTD	2023-08-24
8	MOA-II D.C. reference voltage detector	EETC02-0048	DC 0~9 kV	$U_{rel}=0.008$ k=2	National center for high voltage measurement	2023-04-18
9	Temperature measuring system	EETC02-0053	0-150 $^{\circ}$ C	$U_{rel}=0.2^{\circ}$ C k=2	Hubei province meteorological metrological verification station	2022-12-05



Appendix C: Waveforms

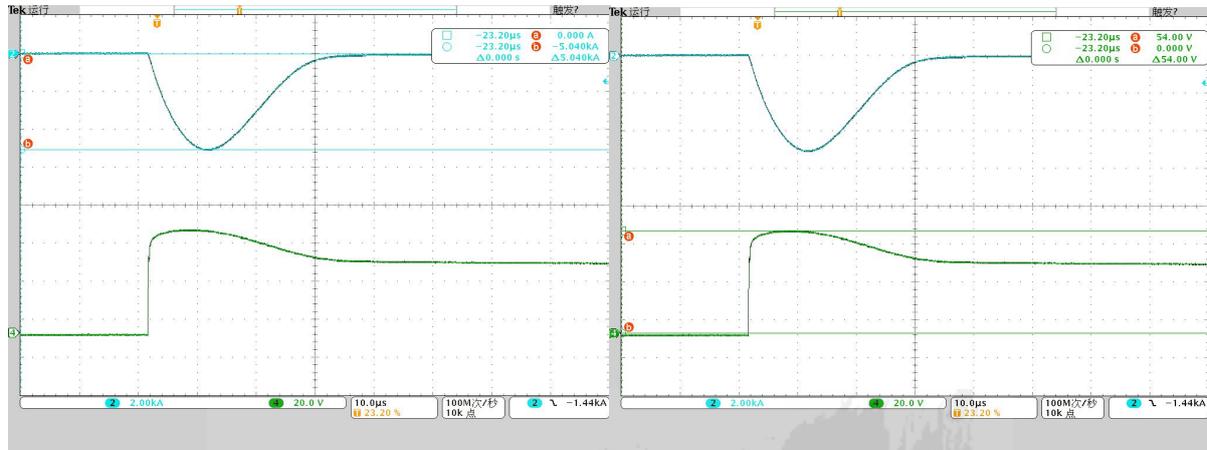


Fig C.1 Lightning impulse current and residual voltage waveform (sample 301, shunt 0.025V/A, divider $K_d=206.8$)

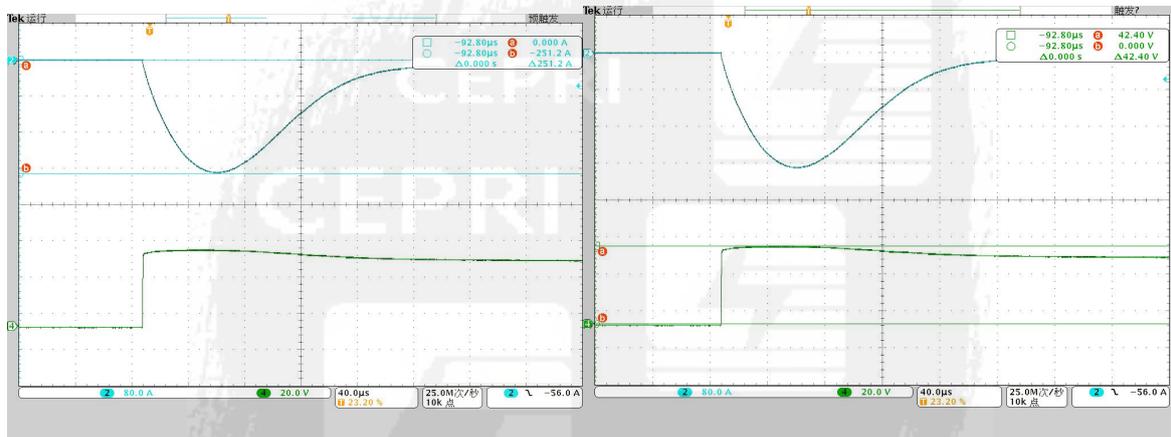


Fig C.2 Switching impulse current and residual voltage waveform (sample 301, shunt 0.025V/A, divider $K_d=206.8$)

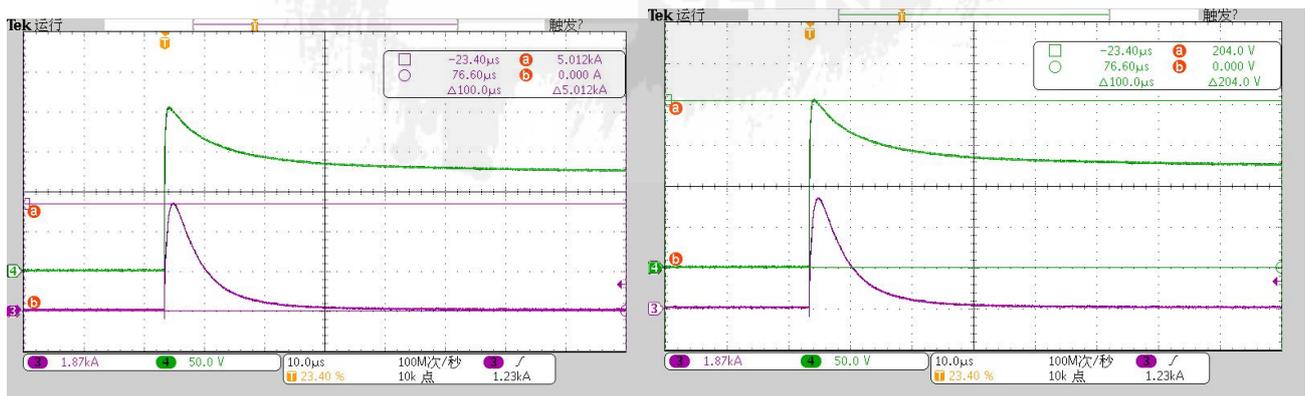


Fig C.3 Step impulse current and residual voltage waveform (sample 301, shunt 0.0267V/A, divider $K_d=59.8$)



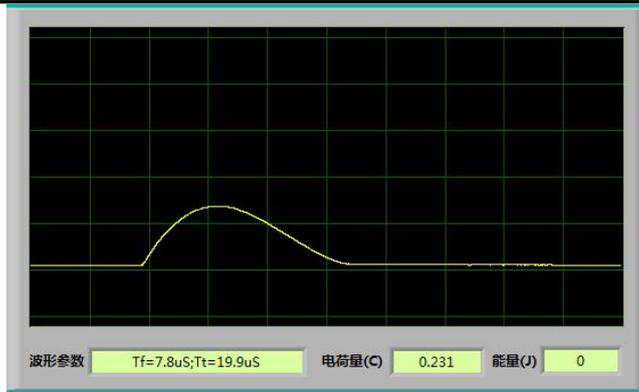


Fig C.4 The 1st time of sample 304, Repetitive charge transfer withstand, 0.00192V/A

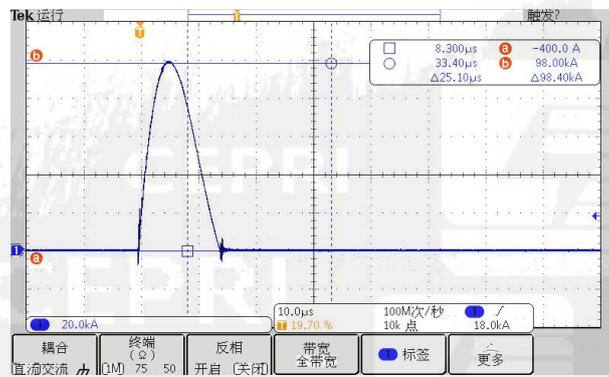


Fig C.5 Waveform of 201 conditioning test (first impulse)

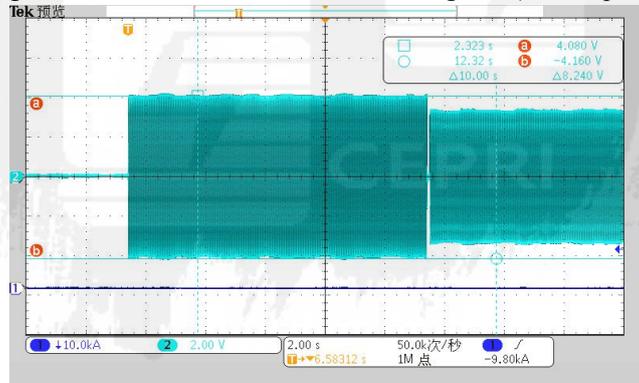


Fig C.6 Operating duty waveform, sample 201, $K_d=1590$

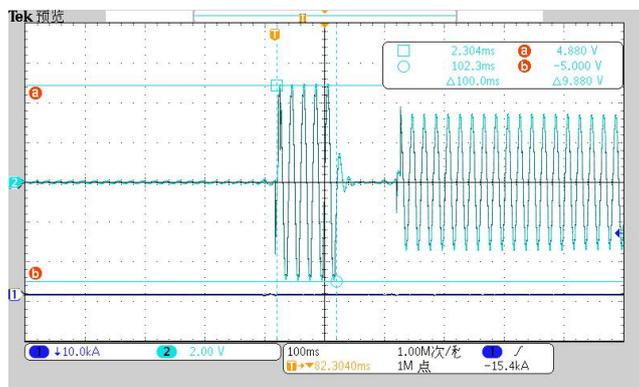


Fig C.7 Power-frequency voltage-versus-time test waveform, sample 204, $K_d=1590$



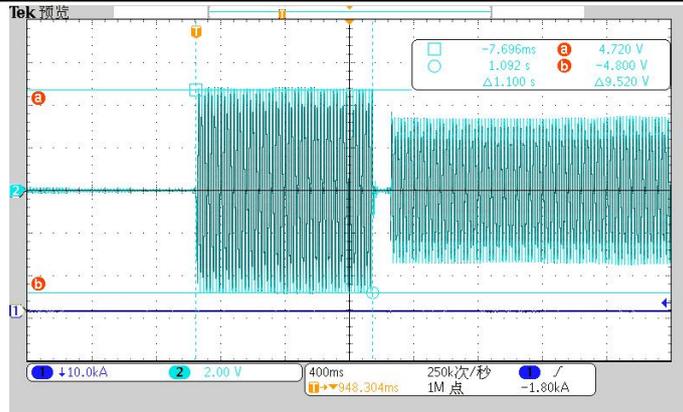


Fig C.8 Power-frequency voltage-versus-time test waveform, sample 205, $K_d=1590$

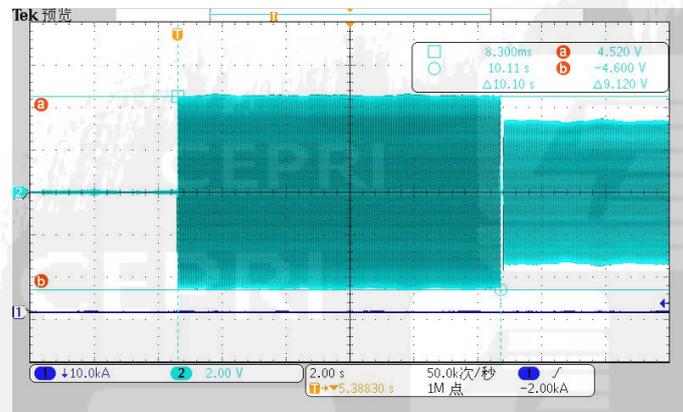


Fig C.9 Power-frequency voltage-versus-time test waveform, sample 206, $K_d=1590$

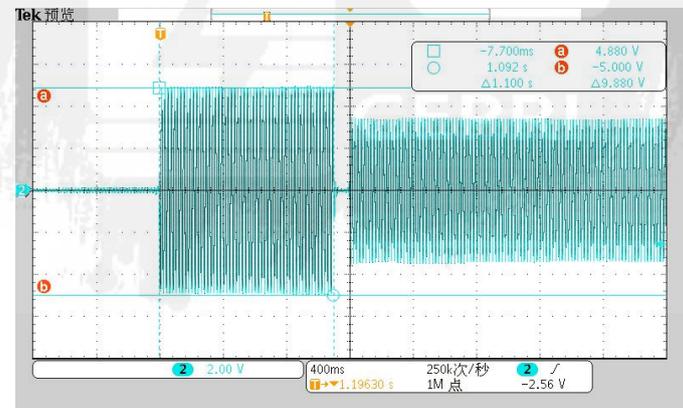


Fig C.10 Power-frequency voltage-versus-time test waveform, sample 208, $K_d=1590$

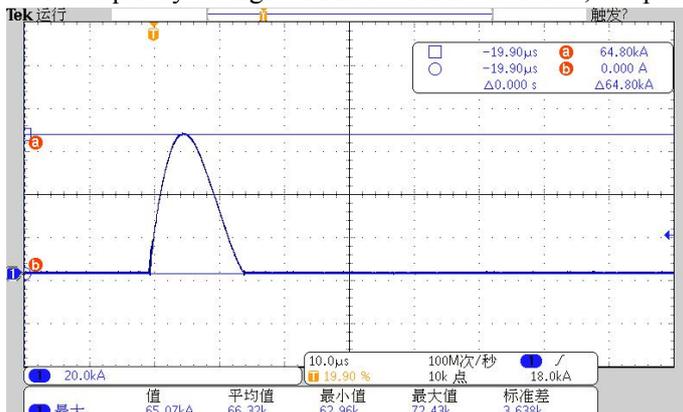


Fig C.11 Test to verify the dielectric withstand of the internal components of an arrester , sample 101



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Appendix D: Visual and dimensional check



Fig D1: GHD-24BLQ-34/85 type arrester and resistor



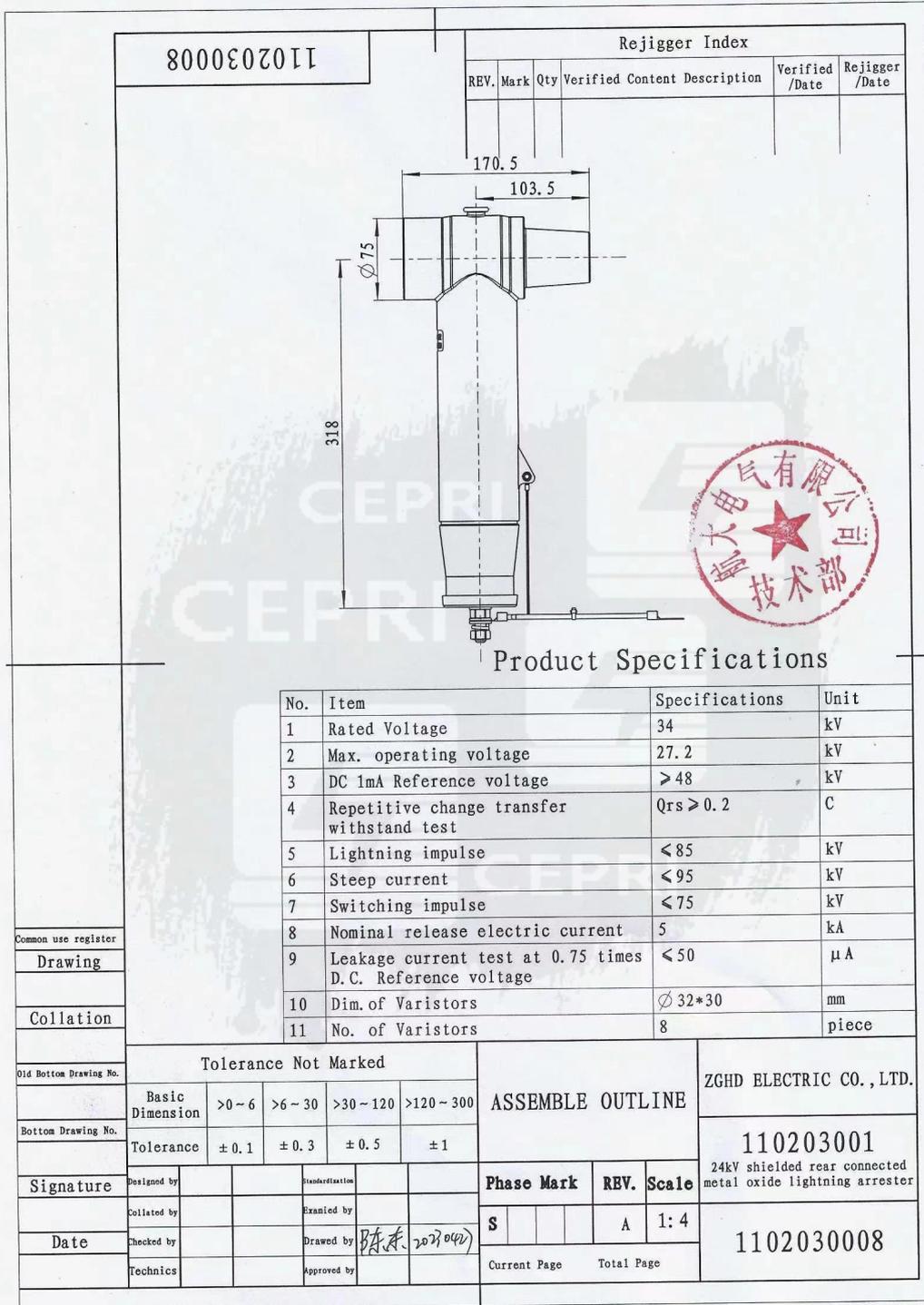


Fig D2 : Dimensional drawing of GHD-24BLQ-34/85



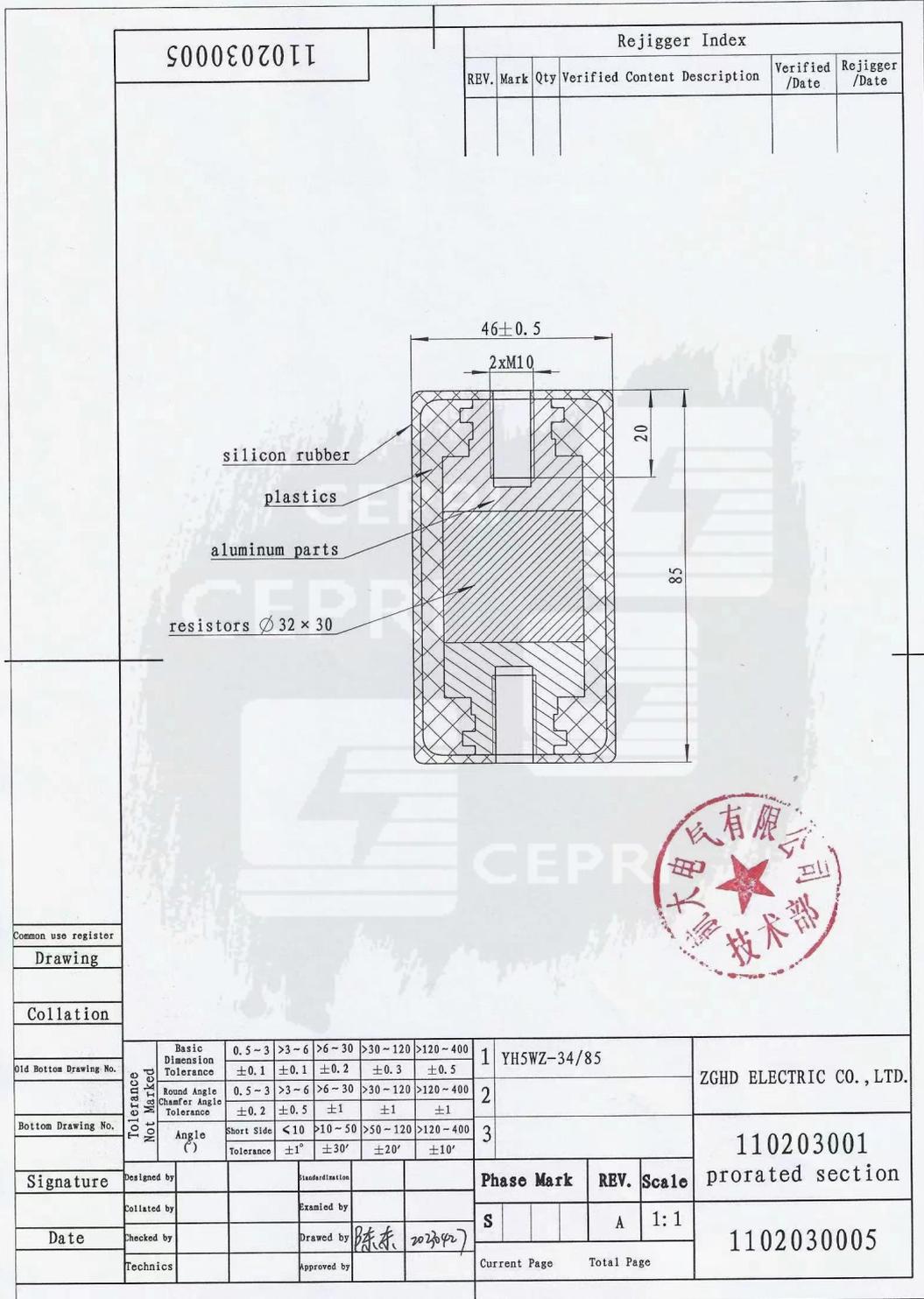


Fig D3 Dimensional drawing of dielectrically prorated section

