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CEPRI

TEST REPORT

CEPRI-EETC09-2020-0810(E)

Client: Dalian Hivolt Power System Co., Ltd

Object: High-voltage ceramic wall bushing

Type: CWW-40.5/4000-4

Test Category: Routine Tests /Type Tests

POWER INDUSTRY QUALITY INSPECTION AND TEST
CENTER FOR ELECTRIC EQUIPMENT

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Catalogue

Test Report	Power Industry Quality Inspection and Test Center for Electric Equipment		CEPRI-EETC09-2020-0810(E) Total 17 Page 2
Client	Dalian Hivolt Power System Co., Ltd	Manufacturer	Dalian Hivolt Power System Co., Ltd
Object	High-voltage ceramic wall bushing	Type	CWW-40.5/4000-4
Sampling procedure	By the Client	Serial No.	YJ-202002
Test Category	Routine Tests /Type Tests	Date	2020.12.01~2020.12. 08
Requirements	1.GB/T 4109-2008 Insulated bushings for alternating voltages above 1000V 2.IEC 60137:2017 Insulated bushings for alternating voltages above 1000V		
Conclusion	According to GB/T4109-2008 and IEC60137:2017, routine tests and type tests were performed on CWW-40.5/4000-4 dry high-voltage wall bushing which was provided by The Dalian Hivolt Power System Co.,Ltd. All the results were in accordance with the requirements.		
Note	In the event of any difference in meanings, the Chinese report shall take priority over the English version.		

Compiled by: 邬文亮 陈启勇

Checked by: 王焱 **Verified by:** 黄华

Approved by: 叶国雄 **Date of issue:** 2020-12-30

Test Results

No.	Item	Requirements	Results	Evaluation
		Routine Tests		
1	Visual inspection and dimensional check	The surface of bushing shall be clean, smooth and no defects. Dimensions of parts for assembling and/or interconnection shall be in accordance with the relevant drawings, checked by sampling.	Meet the requirements.	Pass
		Type Tests		
2	Dry lightning impulse voltage withstand test	Rated lightning impulse:200kV/±15 Waveform: 1.2/50μs	Lightning impulse: 199kV～202kV +15 199kV～202kV -15 No flashover or puncture occurred.	Pass
3	Dry or wet power-frequency voltage withstand test	The withstand voltage of 95kV is applied for 1min between the bushing high voltage terminal and earth. In wet condition, the withstand voltage of 80kV is applied for 1min between the bushing high voltage terminal and earth.	95kV/50Hz/1min No flashover or puncture occurred. Atmosphere correction factor K_t=0.996 80kV/50Hz/1min No flashover or puncture occurred. Atmosphere correction factor K_t=1.004	Pass
4	Temperature rise test	The bushing shall be carried out at rated current I_r±2%. The maximum value of temperature rise above the ambient temperature and the maximum temperature are shown by followed: Current carrying and non-current carrying metallic parts in contact with:75K Terminals to be connected to exterior conductors by screws or bolts:75K	Details are shown in content 4.	Pass

No.	Item	Requirements	Results	Evaluation
5	Verification of thermal short-time current withstand	The bushing shall be considered to be able to withstand the standard value of I_{th} if θ_f does not exceed 180℃.	The calculated final temperature of the conductor(θ_f): 119℃	Pass
6	Cantilever load withstand test	The bushing shall be completely assembled and installed vertically to a suitable rigid device. The load shall be applied perpendicular to the axis of the bushing at the mid-point of the air side terminal for 60s. There shall be no evidence of damage (deformation, rupture or leakage).	Test load: 3150N Duration: 1min No evidence of damage.	Pass
7	Verification of dimensions	The dimensions of the bushing under test shall be in accordance with the relevant drawings, particularly with regard to any dimensions to which special tolerances apply and to details affecting interchangeability.	Creepage distance(Outdoor/Indoor): 1290/1065mm Arcing distance(Outdoor/Indoor): 515/440mm Total length: 1240mm	Pass

Content

1. Visual inspection and dimensional check

1.1 Reference standard requirement

The surface of bushing shall be clean, smooth and no defects. Dimensions of parts for assembling and/or interconnection shall be in accordance with the relevant drawings, checked by sampling.

1.2 Data

Visual inspection	No surface defects.
Dimensional check	Dimensions of parts for assembling and/or interconnection are in accordance with the relevant drawings.

1.3 Test result

The test object passed the tests.

2. Dry lightning impulse voltage withstand test

2.1 Reference standard requirement

The test object shall be subject to 15 full lightning impulses of positive and negative polarity at 200kV (peak value).

No disruptive discharge on non-self restoring insulation shall occur and the number of disruptive discharge shall not exceed two for each series. No evidence of insulation failure shall be detected.

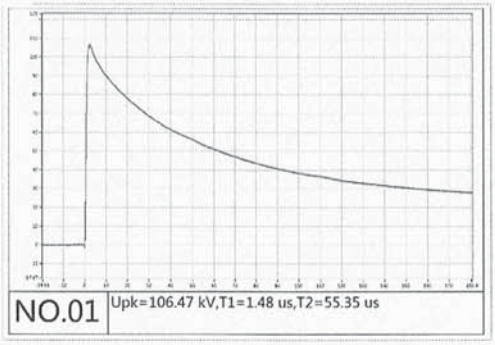
2.2 Data

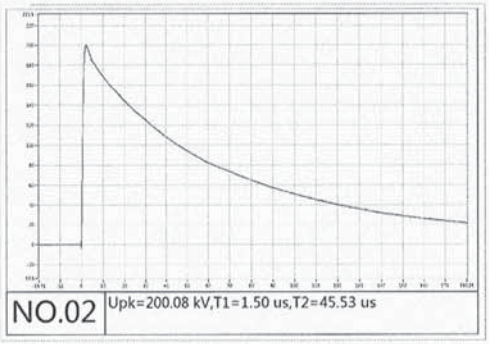
Ambient temperature: 12℃ Relative humidity: 64%

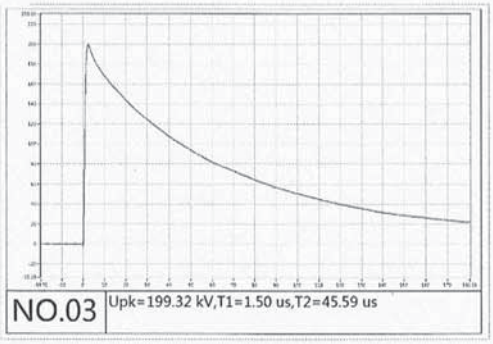
No.	Voltage polarity	Test voltage (peak)(kV)	Chopped time(μs)	Waveform No.	Result
1	Positive lightning impulse	106	/	1	Pass
2	Positive lightning impulse	200	/	2	Pass
3	Positive lightning impulse	199	/	3	Pass
4	Positive lightning impulse	201	/	4	Pass
5	Positive lightning impulse	202	/	5	Pass
6	Positive lightning impulse	200	/	6	Pass
7	Positive lightning impulse	201	/	7	Pass
8	Positive lightning impulse	200	/	8	Pass
9	Positive lightning impulse	201	/	9	Pass
10	Positive lightning impulse	201	/	10	Pass

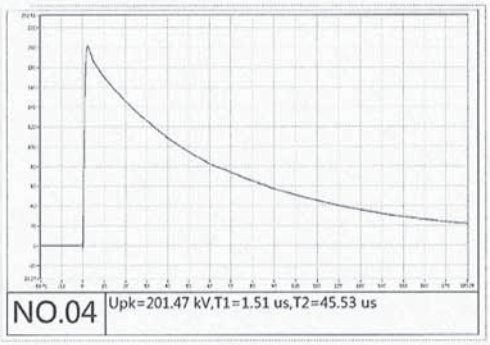
No.	Voltage polarity	Test voltage (peak)(kV)	Chopped time(μs)	Waveform No.	Result
11	Positive lightning impulse	199	/	11	Pass
12	Positive lightning impulse	200	/	12	Pass
13	Positive lightning impulse	201	/	13	Pass
14	Positive lightning impulse	200	/	14	Pass
15	Positive lightning impulse	201	/	15	Pass
16	Positive lightning impulse	200	/	16	Pass
17	Negative lightning impulse	106	/	17	Pass
18	Negative lightning impulse	199	/	18	Pass
19	Negative lightning impulse	200	/	19	Pass
20	Negative lightning impulse	201	/	20	Pass
21	Negative lightning impulse	201	/	21	Pass
22	Negative lightning impulse	201	/	22	Pass
23	Negative lightning impulse	202	/	23	Pass
24	Negative chopped impulse	201	/	24	Pass
25	Negative chopped impulse	200	/	25	Pass
26	Negative lightning impulse	201	/	26	Pass
27	Negative lightning impulse	202	/	27	Pass
28	Negative lightning impulse	201	/	28	Pass
29	Negative lightning impulse	202	/	29	Pass
30	Negative lightning impulse	201	/	30	Pass
31	Negative lightning impulse	201	/	31	Pass
32	Negative lightning impulse	201	/	32	Pass

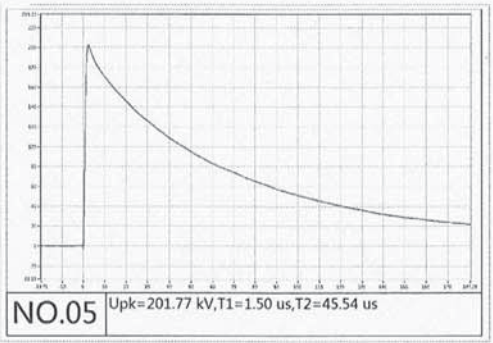
Test waveforms:

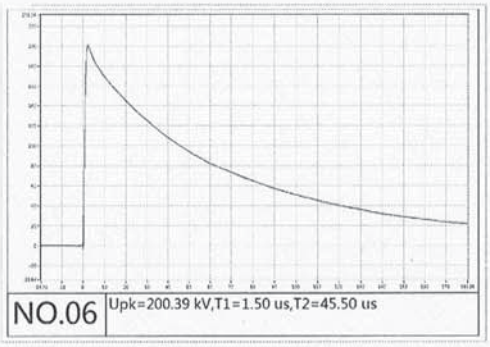


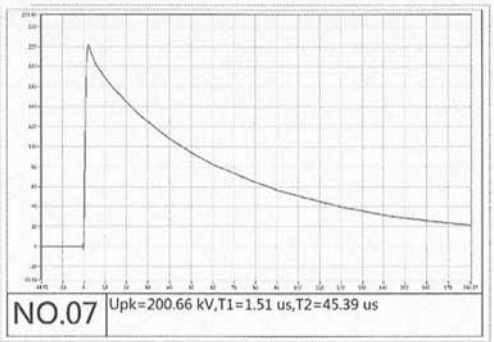


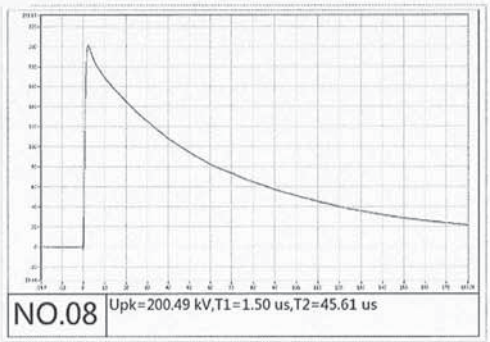


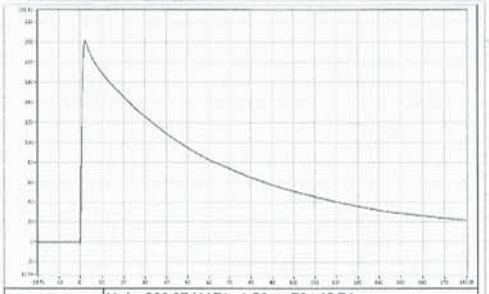




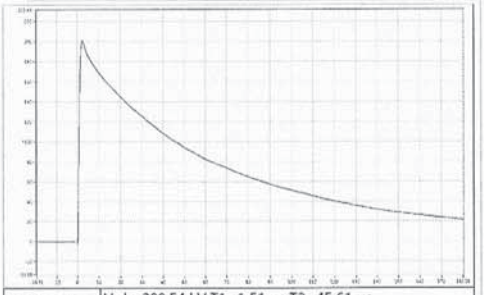




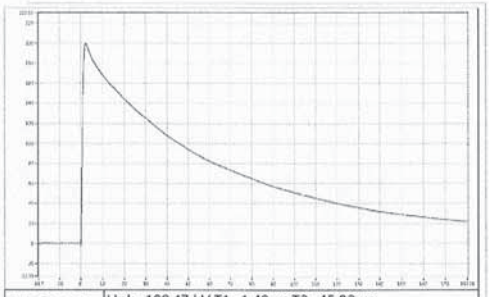




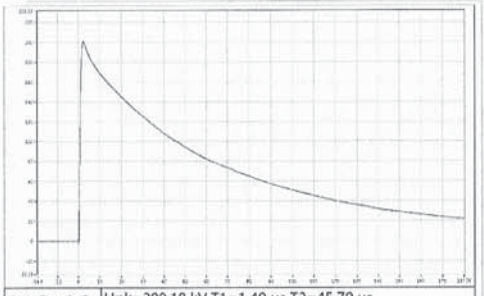
NO.09 Upk=200.97 kV,T1=1.50 us,T2=45.74 us



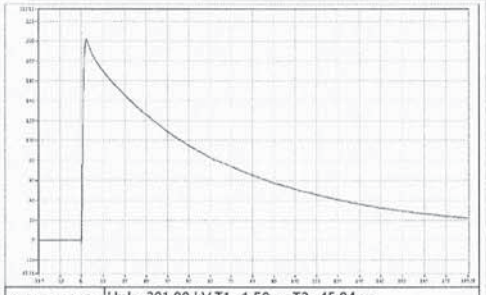
NO.10 Upk=200.54 kV,T1=1.51 us,T2=45.61 us



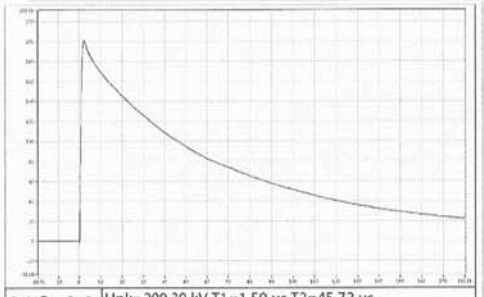
NO.11 Upk=199.47 kV,T1=1.49 us,T2=45.82 us



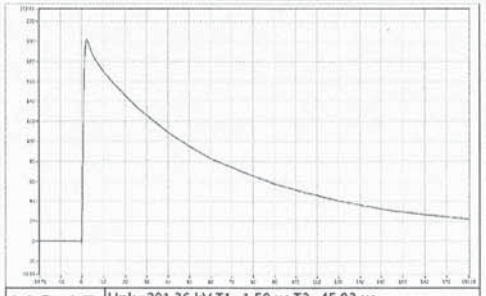
NO.12 Upk=200.18 kV,T1=1.49 us,T2=45.70 us



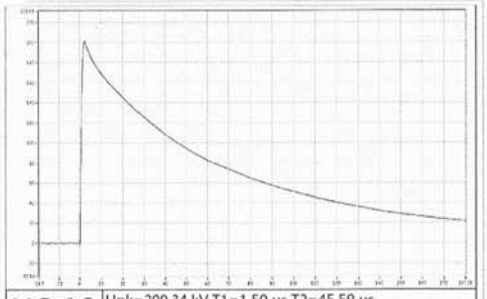
NO.13 Upk=201.00 kV,T1=1.50 us,T2=45.84 us



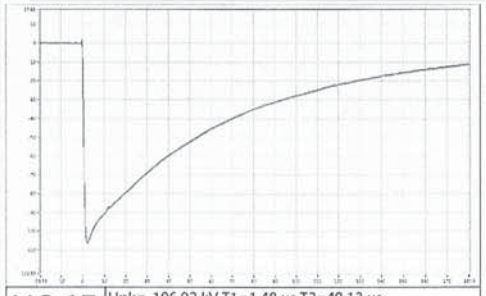
NO.14 Upk=200.30 kV,T1=1.50 us,T2=45.72 us



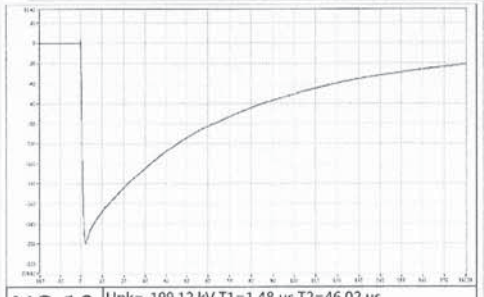
NO.15 Upk=201.36 kV,T1=1.50 us,T2=45.83 us



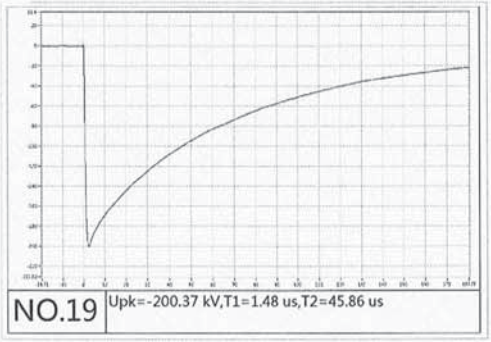
NO.16 Upk=200.34 kV,T1=1.50 us,T2=45.59 us



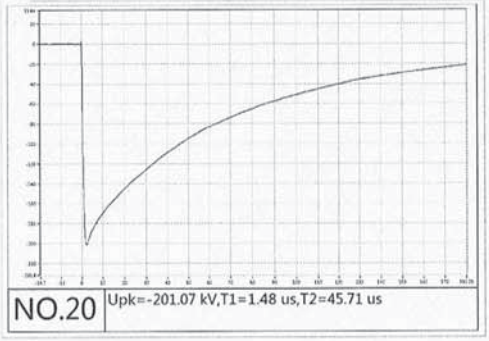
NO.17 Upk=-106.02 kV,T1=1.48 us,T2=49.13 us



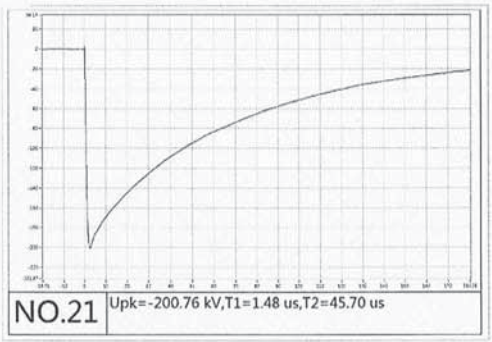
NO.18 Upk=-199.12 kV,T1=1.48 us,T2=46.02 us



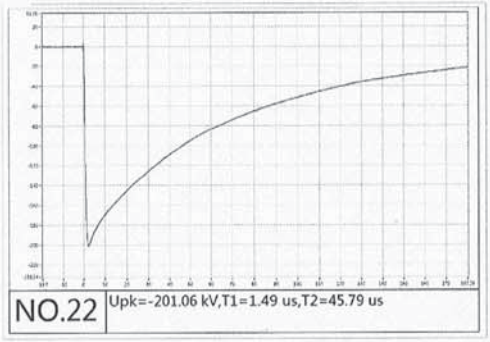
NO.19 Upk=-200.37 kV,T1=1.48 us,T2=45.86 us



NO.20 Upk=-201.07 kV,T1=1.48 us,T2=45.71 us

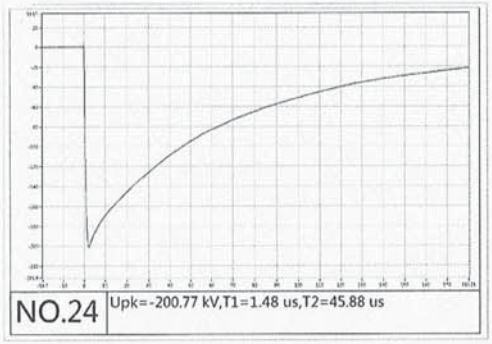


NO.21 Upk=-200.76 kV,T1=1.48 us,T2=45.70 us

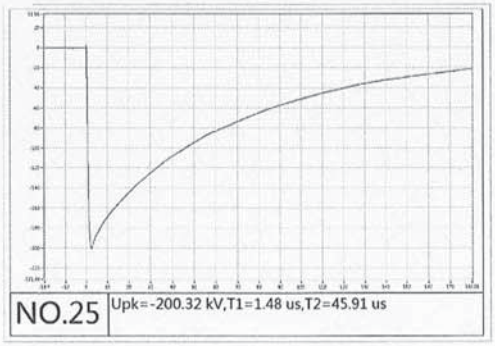


NO.22 Upk=-201.06 kV,T1=1.49 us,T2=45.79 us

NO.23 Upk=-202.37 kV,T1=1.49 us,T2=45.87 us

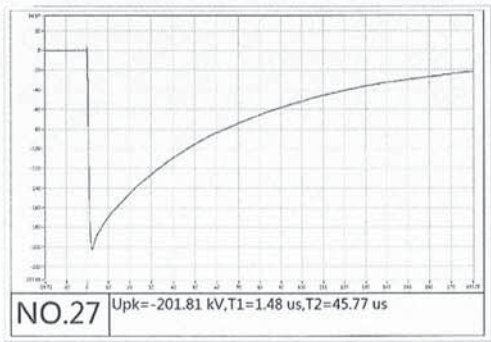


NO.24 Upk=-200.77 kV,T1=1.48 us,T2=45.88 us

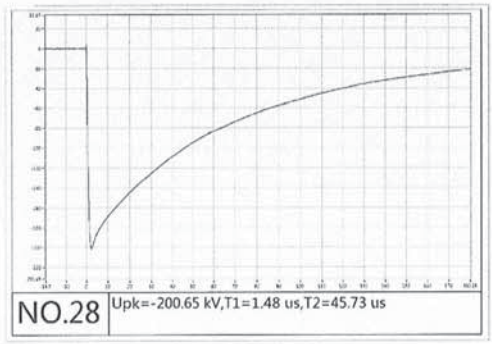


NO.25 Upk=-200.32 kV,T1=1.48 us,T2=45.91 us

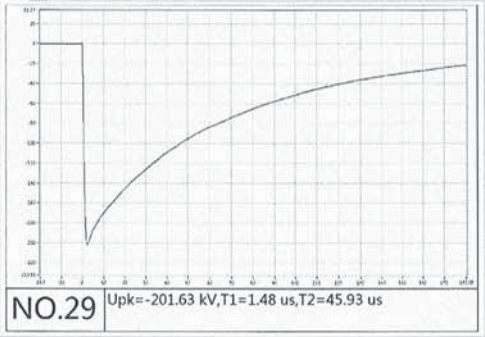
NO.26 Upk=-201.47 kV,T1=1.48 us,T2=45.85 us

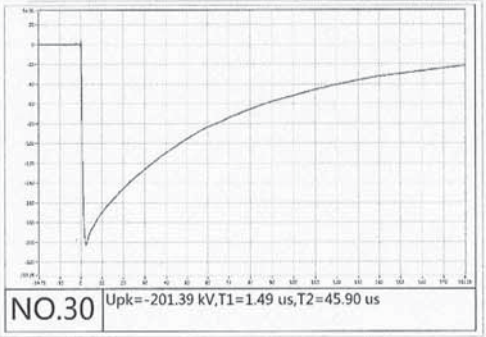


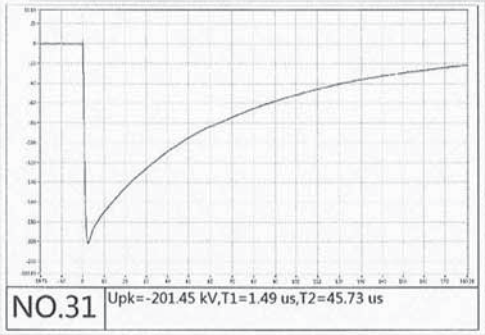
NO.27 Upk=-201.81 kV,T1=1.48 us,T2=45.77 us

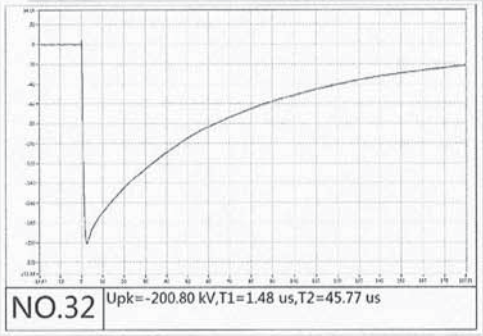


NO.28 Upk=-200.65 kV,T1=1.48 us,T2=45.73 us









3.3 Test result

The test object passed the tests.

3. Dry or wet power-frequency voltage withstand test

3.1 Reference standard requirement

The withstand voltage of 95kV is applied for 1min between the bushing high voltage terminal and earth. No flashover or puncture occurs.

In wet condition, the withstand voltage of 80kV is applied for 1min between the bushing high voltage terminal and earth. No flashover or puncture occurs.

3.2 Data

Ambient temperature: 12℃ Relative humidity:64%

Ambient air pressure: 101.7kPa Atmosphere correction factor: K_t=0.996

Modality of application	Test voltage/Frequency/Duration
Between high voltage terminal and earth	95kV/50Hz/1min

Water temperature: 17℃ Water conductivity: 97μS/cm

Vertical precipitation: 1.3mm/min Horizontal precipitation: 1.4mm/min

Ambient temperature: 12℃ Relative humidity: 64%

Ambient air pressure: 101.7kPa Atmosphere correction factor: K_t=1.004

Modality of application	Test voltage/Frequency/Duration
Between high voltage terminal and earth	80kV/50Hz/1min

3.3 Test result

The test object passed the tests.

4. Temperature rise test

4.1 Reference standard requirement

The bushing shall be carried out at rated current $I_r \pm 2\%$. The maximum value of temperature rise above the ambient temperature and the maximum temperature are shown by followed:

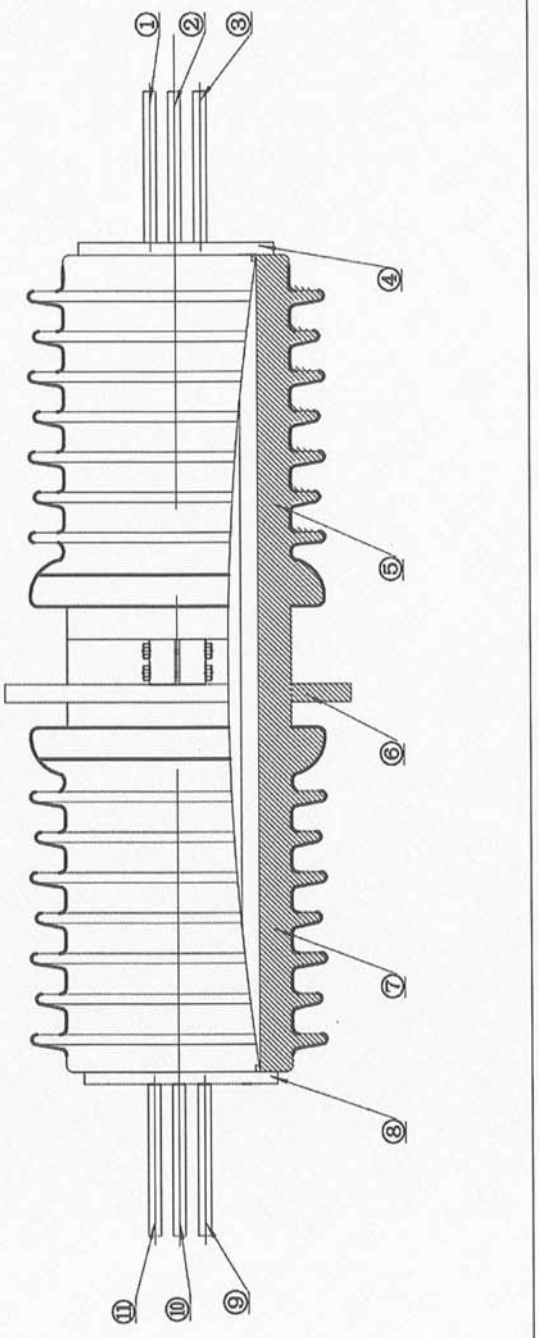
Current carrying and non-current carrying metallic parts in contact with: 75K/105℃

Terminals to be connected to exterior conductors by screws or bolts: 75K/105℃

4.2 Data

Test current: 4000A Ambient temperature: 11℃ Relative humidity: 61%

Thermo-couple No.	Location	Description of component	Temperature rise（K）/ Temperature (℃)	Temperature rise limits(K) /Temperature limits(℃)
1	Terminal（Indoor）	Terminals (copper, tinned)to be connected to exterior conductors by screws or bolts	56/67	75/105
2	Terminal（Indoor）	Terminals(copper, tinned) to be connected to exterior conductors by screws or bolts	56/67	75/105
3	Terminal（Indoor）	Terminals (copper, tinned)to be connected to exterior conductors by screws or bolts	56/67	75/105
4	Corona Ring（Indoor）	Current carrying and non-current carrying metallic parts in contact with (aluminum alloy)	33/44	75/105
5	Porcelain Insulator (Indoor)	/	12/23	/
6	Flange	Aluminum alloy	6/17	/
7	Porcelain Insulator(Outdoor)	/	12/23	/
8	Corona Ring（Outdoor）	Current carrying and non-current carrying metallic parts in contact with (aluminum alloy)	32/43	75/105
9	Terminal（Outdoor）	Terminals (copper, tinned) to be connected to exterior conductors by screws or bolts	54/65	75/105
10	Terminal（Outdoor）	Terminals (copper, tinned) to be connected to exterior conductors by screws or bolts	56/67	75/105
11	Terminal（Outdoor）	Terminals (copper, tinned) to be connected to exterior conductors by screws or bolts	57/68	75/105



No.1: Terminal (Copper/Tinning, Indoor）

No.2: Terminal (Copper/Tinning, Indoor)

No.3: Terminal (Copper/Tinning, Indoor)

No.4: Corona Ring (Aluminum alloy, Indoor)

No.5: Porcelain Insulator(Indoor)

No.6: Flange (Aluminum alloy)

No.7: Porcelain Insulator(Outdoor)

No.8: Corona Ring (Aluminum alloy, Outdoor)

No.9: Terminal (Copper/Tinning, Outdoor）

No.10: Terminal (Copper/Tinning, Outdoor)

No.11: Terminal (Copper/Tinning, Outdoor)

4.3 Test result

The test object passed the tests.

5. Verification of thermal short-time current withstand

5.1 Reference standard requirement

According to GB/T4109-2008 clause 8.8 and IEC60137:2017 clause 8.9, the ability of the bushing to withstand the standard value of I_{th} shall be demonstrated by the following calculation. The bushing shall be considered to be able to withstand the standard value of I_{th} if θ_f does not exceed 180℃.

5.2 Data

θ_0 (℃)	α	I_{th}(kA)	t_{th}(S)	S_t(cm^2)	S_e(cm^2)
111.9	0.8	100	1	37.5	30.99
$\theta_f = \theta_0 + \alpha \times I_{th}^2 \times t_{th} / (S_t \times S_e)$ =119℃					

Where: θ_0 ,S_t and S_e are provided by manufacturer;

θ_f: the final temperature of the conductor;

θ_0: the temperature of the conductor under continuous operation with I_r at an ambient temperature of 40℃;

α: 0.8 for copper , 1.8 for aluminium;

I_{th}: the standard value as specified;

t_{th}: the rated duration as specified;

S_t: the total cross-section;

S_e: the equivalent cross-section.

5.3 Test result

The test object passed the tests.

6. Cantilever load withstand test

6.1 Reference standard requirement

The bushing shall be completely assembled and installed vertically to a suitable rigid device.

The load shall be applied perpendicular to the axis of the bushing at the mid-point of the air side terminal for 60s. There shall be no evidence of damage (deformation, rupture or leakage).

6.2 Data

Ambient temperature: 11℃ Relative humidity: 76%

Location	Test load (N)	Duration (min)	Sample status
Indoor terminals	3150	1	No evidence of damage (deformation, rupture or leakage).
Outdoor terminals	3150	1	

6.3 Test result

The test object passed the tests.

7. Verification of dimensions

7.1 Reference standard requirement

The dimensions of the bushing under test shall be in accordance with the relevant drawings, particularly with regard to any dimensions to which special tolerances apply and to details affecting interchangeability.

7.2 Data

Dimension	Creepage distance	Outdoor: 1290mm ; Indoor: 1065mm
	Arcing distance	Outdoor: 515mm ; Indoor: 440mm
	Total length	1240mm
	Dimensions of parts for assembling and/or interconnection are in accordance with the relevant drawings	

7.3 Test result

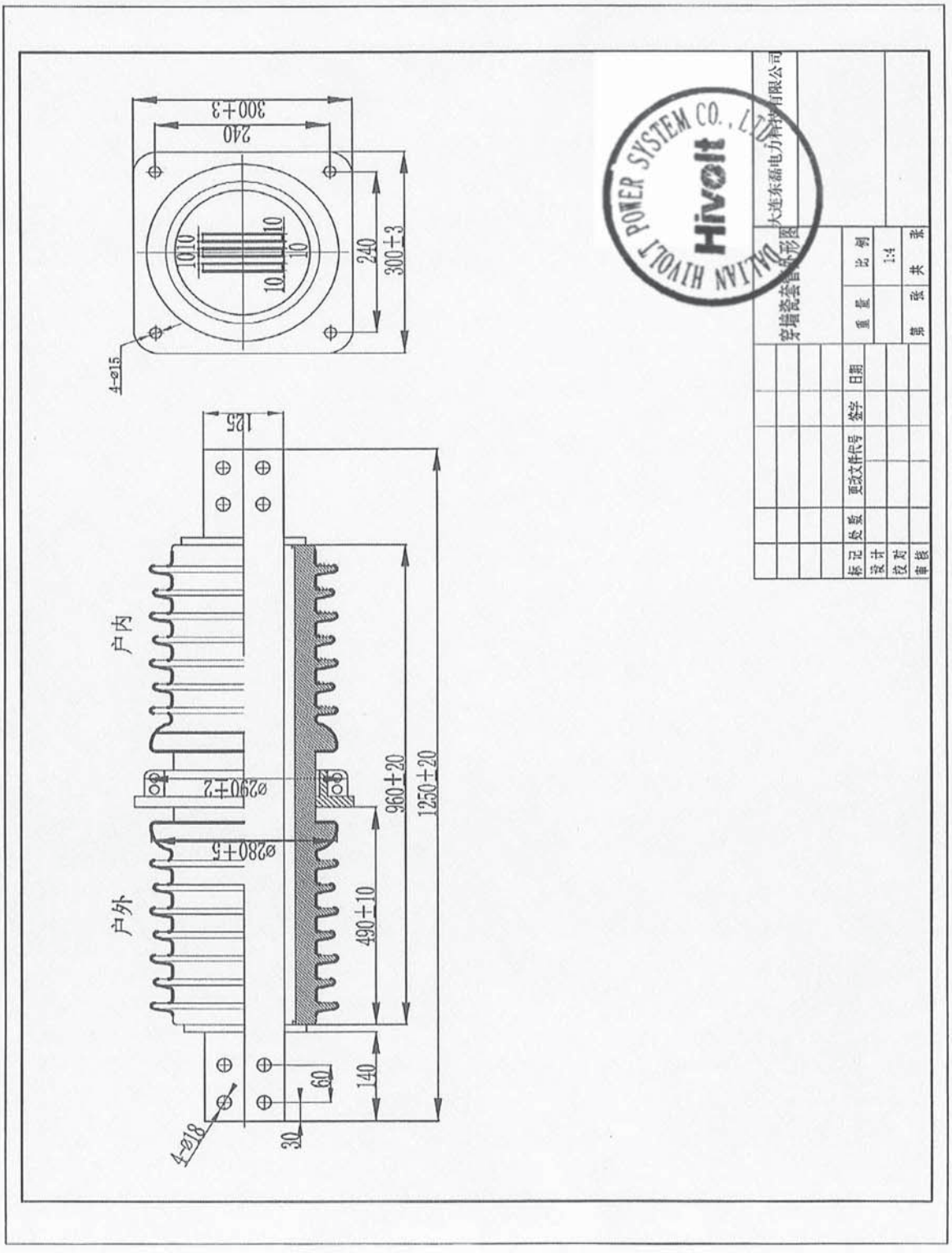
The test object passed the tests.

Appendix A Object Parameters

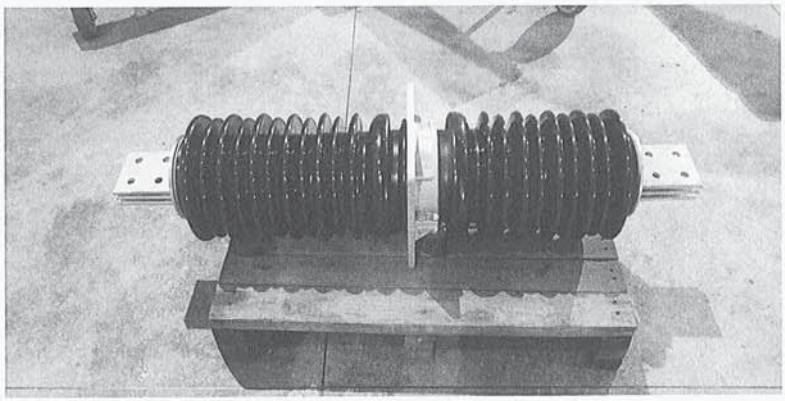
A.1 Parameters

Highest voltage for equipment(U_m)	40.5kV	Rated current(I_r)	4000A
Altitude	≤1000m	Rated frequency	50Hz
Rated insulation level	40.5/95/200 kV	Rated short-time thermal current (r.m.s.)	100kA/1s

A.2 Drawings


300±3
240
240
300±3
4-ø15
125
户内
户外
ø290±2
ø280±5
960±20
1250±20
490±10
140
60
30
4-ø18
DALIAN HIVOLT POWER SYSTEM CO., LTD
Hivolt
大连东源电力科技有限公司
穿墙套管
外形图
标记 处数 更改文件号 签字 日期
设计
校对
审核
重量 比例
1:4
第 张 共 张

A.3 Photographs of test object



A.4 Statement

A.4.1 The test object offered by the client is a new, clean high voltage ceramic wall bushing, including frame and all the other parts as in normal operation.

A.4.2 The testing laboratory has checked that the drawings and other data submitted by the client can adequately represent the essential details and parts of the equipment to be tested, but isn't responsible for the accuracy of the detailed information.

Appendix B Main Test Devices

No.	Name/ Type/ Specification	Serial No.	Measurement Range	Uncertainty / Accuracy class / Maximum Permissible Error	Calibration Institute	Valid Date
1	Power frequency voltage measurement system	#1105415 EETC09-1031	（40-800） kV	3	National Center for High Voltage Measurement	2022.04.07
2	Impulse Voltage Measuring System	#17015-1 EETC09-1030	(200-3000)kV	3	National Center for High Voltage Measurement	2022.11.12
3	Digital Conductivity Meter	#722014072713 EETC09-1043	(50-150) μS/cm	5	Guangzhou GRG Metrology& Test Co., Ltd.	2021.05.21
4	Multi-Channel Thermometer	#TPV91986 EETC09-1024	（0-100） ℃	±2℃	National Center for High Voltage Measurement	2021.04.18
5	Weight indicator	#1610099647 EETC09-1052	(50-1000)kg	5	Guangzhou GRG Metrology& Test Co., Ltd.	2021.05.20