CMA 20150001196Z
CAL (2015)国认监认字(059)号
ilac-MRA
CNAS
中国认可
国际互认
检测
TESTING
CNAS L0223

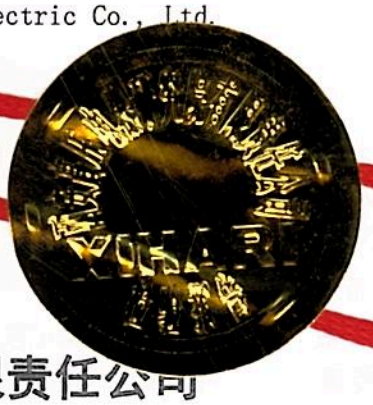
XIHARI

No. 170064J

检 验 报 告

Test Report

试 品 型 号: TYPE	BRFDLW-72.5/630-4	
试 品 名 称: DESIGNATION	复合油纸绝缘电容型变压器套管 Composite Oiled Paper Insulation Transformer Bushing for Capacitance	
委 托 单 位: CLIENT	江苏神马电力股份有限公司如皋分公司 Jiangsu Shemar (Rugao) Electric Co., Ltd.	
制 造 单 位: MANUFACTUER	江苏神马电力股份有限公司如皋分公司 Jiangsu Shemar (Rugao) Electric Co., Ltd.	
检 验 类 别: TEST CLASSIFICATION	型式试验 Type tests	



西安高压电器研究院有限责任公司
XI'AN HIGH VOLTAGE APPARATUS RESEARCH INSTITUTE CO., LTD.
国家绝缘子避雷器质量监督检验中心
NATIONAL QUALITY SUPERVISION & INSPECTION CENTER
FOR INSULATOR & SURGE ARRESTER

注意事项
REMARK

1、检验报告无“检验报告专用章”及封印无效。The test report will be invalid without the “Special stamp for test repot” or the seal.

2、仅下述情况不需要本实验室的书面许可：完整的复制本报告；或同时复制结论页及概述页。While without the laboratory permission in writing form, it’s only allowed to completely copy this report;or copy these pages--the test conclusion pages and summary pages in the same time.

3、检验报告无编写、校核、批准人签字无效。The test report will be invalid without the original signature of edit by, checked by and approval by.

4、检验报告涂改无效。The test report will be invalid with alter of any character or data.

5、对检验报告若有异议，应于收到报告之日起二十五天内向本实验室提出。Any dissensions to this test report should be formally submitted to the laboratory within 25 days from the receiving date.

6、本检验报告仅适用于被试品，任何采用相同设计的同型号产品与被试品的一致性由制造单位负责。This test report is only for the testedobject. It’s manufacturer’s duty to keep the uniformity of any products of the same type using the same design and the test object.

7、本检验报告的产品和相关内容可能涉及专利,本实验室不承担识别这些专利以及由此引起的任何责任。Tested object, report and relevant contents may relate to patent. The laboratory is not responsible for identifying these patents and any others.

8、本检验报告封面、目录、概述及检验结论页面为防伪页。The page ‘cover’, ‘contents’, ‘summary’and ‘test conclusion’contain the anti-fake label.

地址：西安高压电器研究院有限责任公司陕西省西安市西二环北段 18 号
Address: Xi’an High Voltage Apparatus Research Institute Co.,Ltd. No.18 North Section of Xi’erhuan, Shaanxi, China
邮政编码 Zip：710077
电话 Tel.：(029)84225675 (029)84221456
传真 Fax.：(029)84225680
电子邮箱 E-mail: lab@xihari.com

XIHARI	检验报告 Test Report	No. 170064J Page 1 of 55

目录
Contents

XIHARI	检验报告 Test Report	No. 170064J Page 2 of 55

概述
Summary

试品型号及名称 Test object		BRFDLW-72.5/630-4 复合油纸绝缘电容型变压器套管 BRFDLW-72.5/630-4 Composite Oiled Paper Insulation Transformer Bushing for Capacitance
委托单位 Client	名称 Name	江苏神马电力股份有限公司如皋分公司 Jiangsu Shemar (Rugao) Electric Co., Ltd.
	联系方式 Connection	江苏省如皋市神马电力工业园（226500） 电话：0513-80575246 传真：0513-80579581 Rucheng Town, Rugao, Nantong,Jiangsu Province, P. R. China Postal code: 226500 Tel:+86 513 80575246 Fax: +86 513 80579581
制造单位 Manufacturer		江苏神马电力股份有限公司如皋分公司 Jiangsu Shemar (Rugao) Electric Co., Ltd.
出厂日期 Manufacture date		/
产品编号 Serial No.		1#

制造单位规定的试品主要技术参数 Rated value assigned by the client	额定电压/Rated voltage kV	72.5	
	额定电流/Nominal current A	630	
	雷电冲击干耐受电压/Dry lightning impulse withstand voltage kV	325	
	工频耐受电压（干/湿）/Power-frequency withstand Voltage (Dry/Wet) kV	155/155	
	额定频率/Rated frequency Hz	50	
	长度/Length mm	1990	
	爬电距离/Creepage distance mm	2250	
	悬臂弯曲负荷/Bending load N	3000	

委托单位提供的技术资料 The tested object is guaranteed by the manufacturer	0SM.116.132.1 72.5kV 复合油纸绝缘电容型变压器套管试验大纲 72.5kV Composite Oiled Paper Insulation Transformer Bushing for Capacitance Testing Schedule.
	0SM.132.321.1 72.5kV 复合油纸绝缘电容型变压器套管产品图样 72.5kV Composite Oiled Paper Insulation Transformer Bushing for Capacitance Drawing.
委托单位声明 Note	
委试方代表 Representation of client	朱兴祥 Zhu Xingxiang
试品到达日期 Reception date	/
试验日期 Date of tests	起 From 2017-03-01 止 To 2017-03-08
试验地址 Test address	/

检验结论
Test Conclusion

委托单位:	江苏神马电力股份有限公司如皋分公司
Client:	Jiangsu Shemar (Rugao) Electric Co., Ltd.
试品型号及名称:	BRFDLW-72.5/630-4 复合油纸绝缘电容型变压器套管
Test object:	BRFDLW-72.5/630-4 Composite Oiled Paper Insulation Transformer Bushing for Capacitance
制造单位:	江苏神马电力股份有限公司如皋分公司
Manufacturer:	Jiangsu Shemar (Rugao) Electric Co., Ltd.
检验类别:	型式试验
Test classification:	Type Tests

实施的检验项目/Tests have been performed :

逐个试验/Routine Test	介质损耗因数和电容量测量 Measurement of dielectric dissipation factor and capacitance 工频干耐受电压试验 Dry power-frequency voltage withstand test 局部放电量测量 Measurement of partial discharge quantity 抽头绝缘试验 Tests of tap insulation 充液体、充混合物以及液体绝缘套管的密封试验 Tightness test on liquid-filled, compound-filled and liquid-insulated bushings 法兰和其他紧固件上的密封试验 Tightness test at the flange or other fixing device 外观检查和尺寸检查 Visual inspection and dimensional check
型式试验/Type test:	介质损耗因数和电容量测量 Measurement of dielectric dissipation factor and capacitance 局部放电量测量 Measurement of partial discharge quantity 工频湿耐受电压试验 Wet power-frequency voltage withstand test 雷电冲击干耐受电压试验 Dry lightning impulse voltage withstand test 温升试验 Temperature rise test 热短时电流耐受试验 Verification of thermal short-time current withstand 悬臂负荷耐受试验 Cantilever load withstand test 充液体、充混合物以及液体绝缘套管的密封试验 Tightness test on liquid-filled, compound-filled and liquid-insulated bushings 尺寸检查 Dimensional check 局部放电量测量 Measurement of partial discharge quantity 介质损耗因数和电容量测量 Measurement of dielectric dissipation factor and capacitance

检验结论
Test Conclusion

检验依据/Applied standards:

GB/T 4109-2008 交流电压高于1000V的绝缘套管
Insulated bushings for alternating voltage above 1000V (IEC 60137 Ed.6.0,MOD)

检验结论/Conclusion:

按照检验依据规定的逐个试验、型式试验各项全检，其结果均符合检验依据和技术资料的规定；型式试验合格。

All the items of routine test and type tests as specified by the standard were tested, the results met the requirements of the standards and technical specifications.

The results of the type tests met the requirements of the standards and technical specifications .

编写Edited by: 日期Date: 2017-05-23

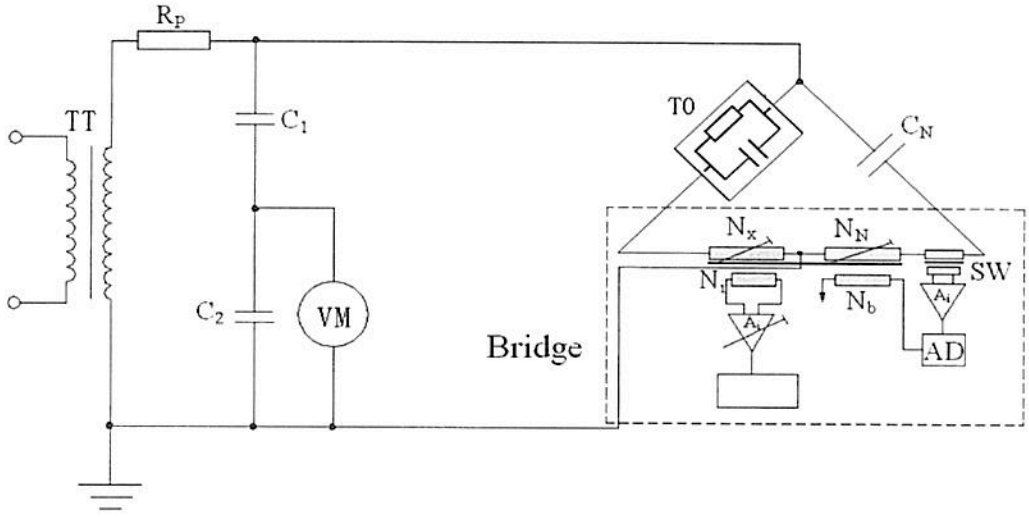
校核Checked by: 日期Date: 2017-05-25

批准Approved by: 日期Date: 2017-05-25

介质损耗因数和电容量测量(逐个)
Measurement of Dielectric Dissipation Factor and Capacitance (Routine Test)

介质损耗因数和电容量测量线路图

(Circuit diagram of measurement of dielectric dissipation factor and capacitance)



TT---工频试验变压器(PF transformer)

R_p---保护电阻(Protection resistance)

C_1---高压臂电容(H.V arm capacitance)

C_2---低压臂电容(L.V arm capacitance)

C_N---标准电容器(Standard capacitor)

TO---试品(Test object)

VM---数字测量仪(Voltmeter)

Bridge---测量电桥(Bridge)

试验所用设备主要参数

(Main parameters of testing equipment)

U/S(kV/kVA)	f_{TT}(Hz)	R_p(kΩ)	C_1(pF)	C_2(μF)
550/2200	50	2	500	2.12
扩展不确定度(Expanded uncertainty): U=2.4pC，(k=2)。				

介质损耗因数和电容量测量(逐个)
Measurement of Dielectric Dissipation Factor and Capacitance (Routine Test)

试验日期/Date: 2017-03-01

t= 9.0℃， RH= 62%， P= 102.0kPa

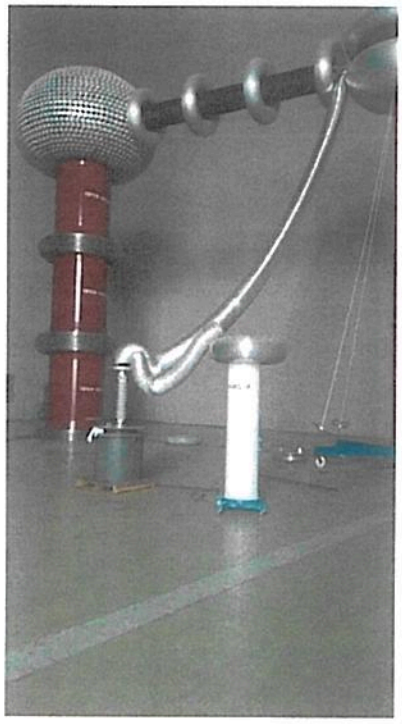
试验分别在44.0kV、72.5kV下进行介质损耗因数和电容量测量。要求在44.0kV、72.5kV电压下tanδ最大值为0.4%，测量电压从44.0kV提高至72.5kV时，tanδ最大允许增值为0.1%，电容量规定值：250pF～270pF。

The dielectric dissipation factor and capacitance are measured on 44.0kV and 72.5kV. The allowed tanδ is 0.4% on all test voltages. When the test voltage raises from 44.0kV to 72.5kV, the increase of tanδ must be less tan 0.1%. Cx :250pF～270pF.

标准电容C_N=50.12pF。
Standard capacitor C_N=50.12pF.

样品编号 Specimen No.	测量电压 Voltage applied kV		Cx pF	tanδ %	△tanδ %
	应施电压 Expected voltage	实施电压 Measured voltage			
1	44.0	44.5	268.2	0.338	/
	72.5	72.6	268.2	0.337	0.001

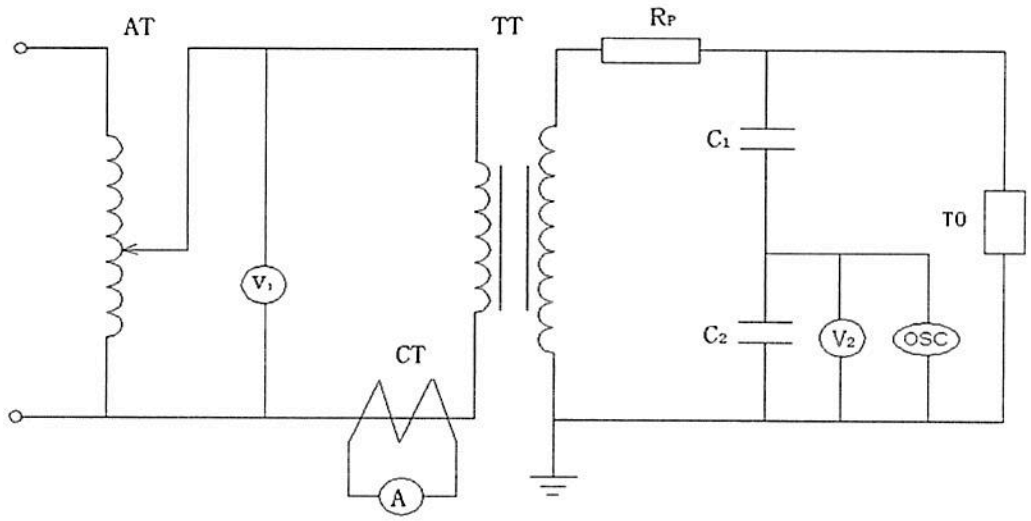
符合检验依据规定，合格。
The result met test standard and the technical specifications.



DLCZP170064J-001

工频干耐受电压试验（逐个）
Dry Power-frequency Voltage Withstand Test (Routine Test)

工频试验原理接线图
(Diagram of power frequency voltage circuit)



AT——调压器(Regulator)

R_p——保护电阻(Protection resistance)

CT——电流互感器(Current transformer)

TT——工频试验变压器(PF transformer)

TO——试品(Test object)

A——电流表(Current meter)

C_1——高压臂电容(H.V arm capacitance)

C_2——低压臂电容(L.V arm capacitance)

V_2——数字电压表(Voltmeter)

OSC——数字示波器(Oscilloscope)

试验所用设备主要参数

(Main parameters of testing equipment)

U/S(kV/kVA)	f_{TT}(Hz)	R_p(kΩ)	C_1(pF)	C_2(μF)
2250/2250	50	30	300	3.0
扩展不确定度(Expanded uncertainty): U<2%，(k=2)。				

XIHARI	检验报告 Test Report	No. 170064J Page 8 of 55

工频干耐受电压试验（逐个）
Dry Power-frequency Voltage Withstand Test (Routine Test)

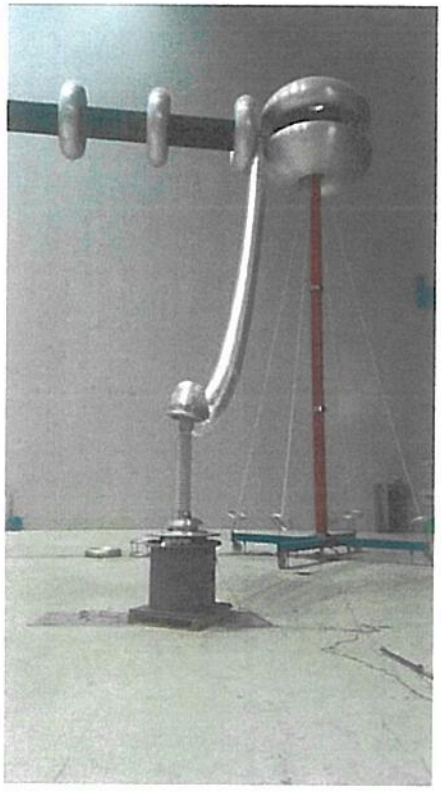
试验日期/Date: 2017-03-01

t=9.0℃， RH= 62%， P= 102.0kPa

规定值/Specifications: 155kV. 电压校正系数/Correction coefficient K_t= 1.000

样品编号 No.	应该施加电压值 Expected voltage value kV	实际施加电压值 Measured voltage kV	耐受时间 Duration s	样品状况 Result
1	155	155.3	60	未闪络 No flashover
规定值 Specifications	/	/	60	不应闪络 No flashover

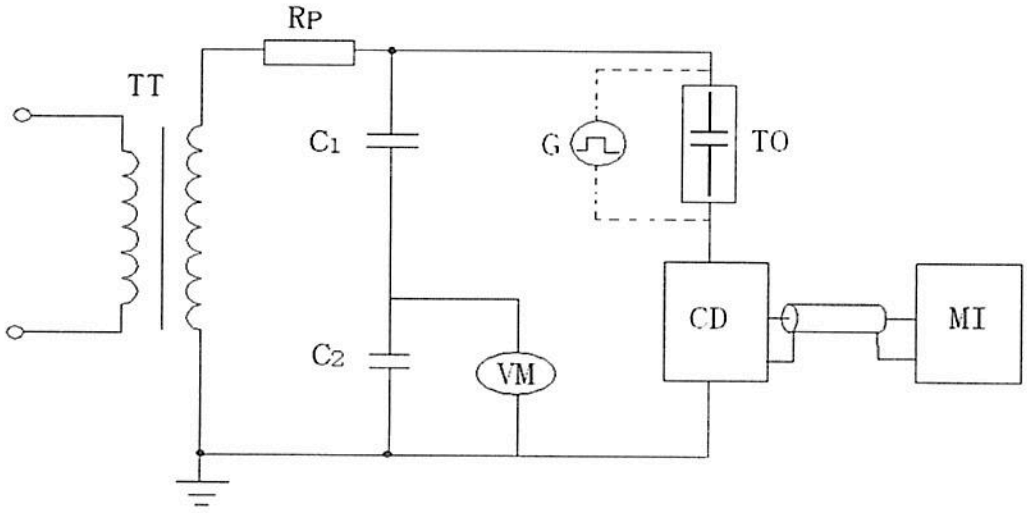
符合检验依据规定，合格。
The result met test standard and the technical specifications.



PFVZP170064J-001

局部放电测量(逐个)
Partial Discharge Measurement (Routine Test)

局部放电量测量线路图（AC）
(Circuit diagram of partial discharge measurement, AC)



TT---工频试验变压器(PF transformer)

R_p---保护电阻(Protection resistance)

C_1---高压臂电容(H.V arm capacitor)

C_2---低压臂电容(L.V arm capacitor)

CD---耦合装置(Coupling device)

TO---试品(Test object)

VM---数字电压表(Voltmeter)

G---方波校准器(Step voltage generator)

MI---局放测量仪(Measuring instrument)

试验所用设备主要参数

(Main parameters of testing equipment)

U/S(kV/kVA)	f_{TT}(Hz)	R_p(kΩ)	C_1(pF)	C_2(μF)
550/2200	50	2	500	2.12
扩展不确定度(Expanded uncertainty): U=2.4pC，(k=2)。				

局部放电测量(逐个)
Partial Discharge Measurement (Routine Test)

试验日期/Date: 2017-03-01

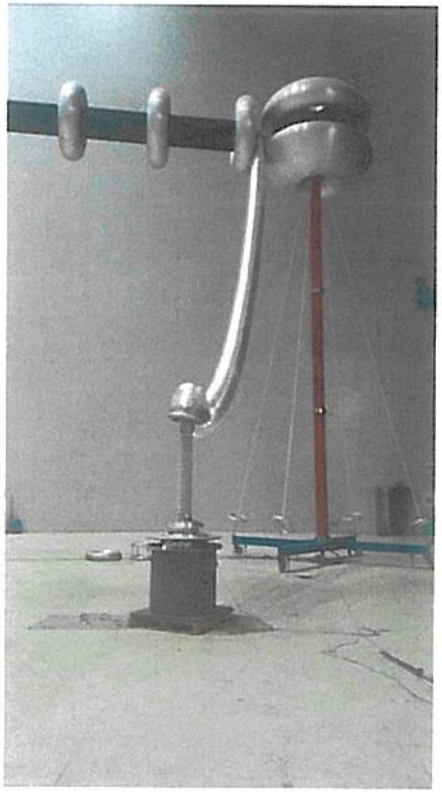
t= 9.0℃， RH= 62%， P= 102.0kPa

试验前采用5pC校准源对回路进行校准，背景噪音为≤2.5pC。
Step voltage generator: 5pC. Background noise ≤2.5pC.

预加电压为155kV，持续1min，在72.5kV、63.0kV和46.0kV的测量电压下进行局部放电测量，要求的局部放电量72.5kV、63.0kV和46.0kV下最大值为5pC。
The applied voltage is 155kV for 1 min. Partial discharge is measured on 72.5kV, 63.0kV and 46.0kV. and allowed partial discharge is 5pC max..

样品编号 Specimen No.	实施电压 Voltage applied kV	持续时间 Duration min	局部放电量 Partial discharge pC
1	73.1	5	≤3.6
	63.2	5	≤3.6
	46.3	5	≤3.6

符合检验依据规定，合格。
The result met test standard and the technical specifications.

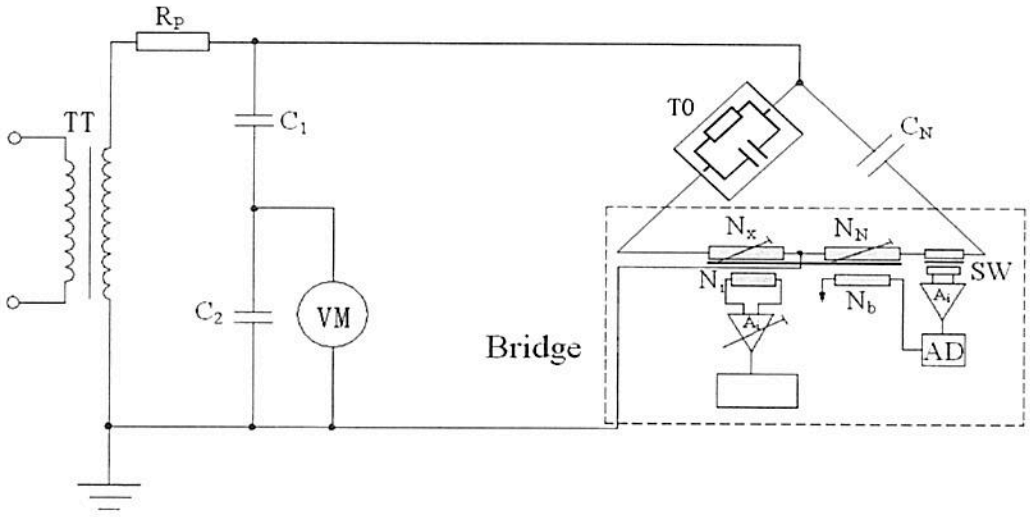


PDZP170064J-001

介质损耗因数和电容量测量(逐个)
Measurement of Dielectric Dissipation Factor and Capacitance (Routine Test)

介质损耗因数和电容量测量线路图

(Circuit diagram of measurement of dielectric dissipation factor and capacitance)



TT---工频试验变压器(PF transformer)

R_p---保护电阻(Protection resistance)

C_1---高压臂电容(H.V arm capacitance)

C_2---低压臂电容(L.V arm capacitance)

C_N---标准电容器(Standard capacitor)

TO---试品(Test object)

VM---数字测量仪(Voltmeter)

Bridge---测量电桥(Bridge)

试验所用设备主要参数

(Main parameters of testing equipment)

U/S(kV/kVA)	f_{TT}(Hz)	R_p(kΩ)	C_1(pF)	C_2(μF)
550/2200	50	2	500	2.12
扩展不确定度(Expanded uncertainty): U=2.4pC，(k=2)。				

XIHARI	检 验 报 告 Test Report	No. 170064J Page 12 of 55

介质损耗因数和电容量测量(逐个)
Measurement of Dielectric Dissipation Factor and Capacitance (Routine Test)

试验日期/Date: 2017-03-02

t= 9.0℃， RH= 40%， P= 102.6kPa

试验分别在44.0kV、72.5kV下进行介质损耗因数和电容量测量。要求在44.0kV、72.5kV电压下tanδ最大值为0.4%，测量电压从44.0kV提高至72.5kV时，tanδ最大允许增值为0.1%，电容量规定值：250pF～270pF。

The dielectric dissipation factor and capacitance are measured on 44.0kV and 72.5kV. The allowed tanδ is 0.4% on all test voltages. When the test voltage raises from 44.0kV to 72.5kV, the increase of tanδ must be less tan 0.1%. Cx :250pF～270pF.

标准电容C_N=50.12pF。
Standard capacitor C_N=50.12pF.

样品编号 Specimen No.	测量电压 Voltage applied kV		Cx pF	tanδ %	△tanδ %
	应施电压 Expected voltage	实施电压 Measured voltage			
1	44.0	44.5	268.7	0.332	/
	72.5	72.6	268.9	0.332	0

符合检验依据规定，合格。
The result met test standard and the technical specifications.

DLCZP170064J-002

抽头绝缘试验(逐个)
Tests of Tap Insulation (Routine Test)

试验日期/Date: 2017-03-02

1 对地耐压试验/The ground pressure test

P=102.6kPa t=9.0℃ RH=40%

样品编号 Specimen No.	实施电压 Voltage applied kV	持续时间 Duration min	样品状况 Result
1	3	1	未闪络、未击穿 No flashover, No puncture
规定值 Specifications	3	1	未闪络、未击穿 No flashover or puncture

符合检验依据规定，合格。
The result meets test standard and the technical specifications.

2 介质损耗因数和电容量测量/Measurement of dielectric dissipation factor and capacitance

2.1 试验要求/The test requirement

试验在1kV电压下进行介质损耗因数和电容量测量，要求tanδ最大值为5%，电容量≤5000pF，对地绝缘≥1000MΩ。
Measure the dielectril loss factor and capacitance under the test voltage of 1kV. tanδ≤5%. Cx≤5000pF. grounding insulation ≥1000MΩ.

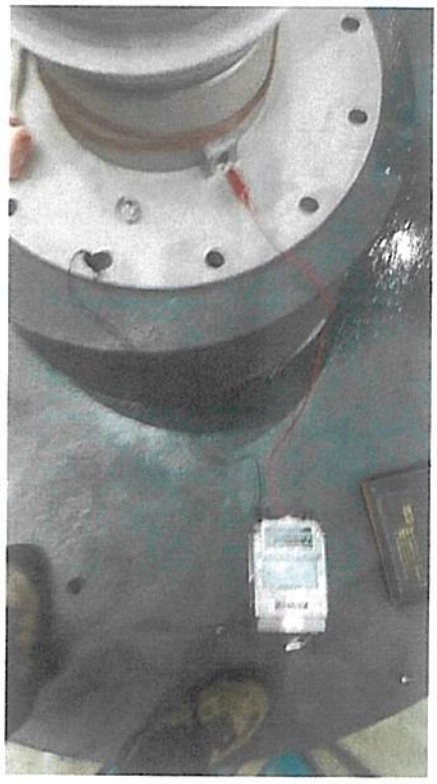
2.2 试验结果/The test result

样品编号 Specimen No.	实施电压 Voltage applied kV	Cx pF	tanδ %
1	1	153.3	0.583
规定值 Specifications	1	≤5000	≤5

符合检验依据规定，合格。
The result meets test standard and the technical specifications.

抽头绝缘试验(逐个)
Tests of Tap Insulation (Routine Test)

TTIZP170064J-001



TTIZP170064J-002

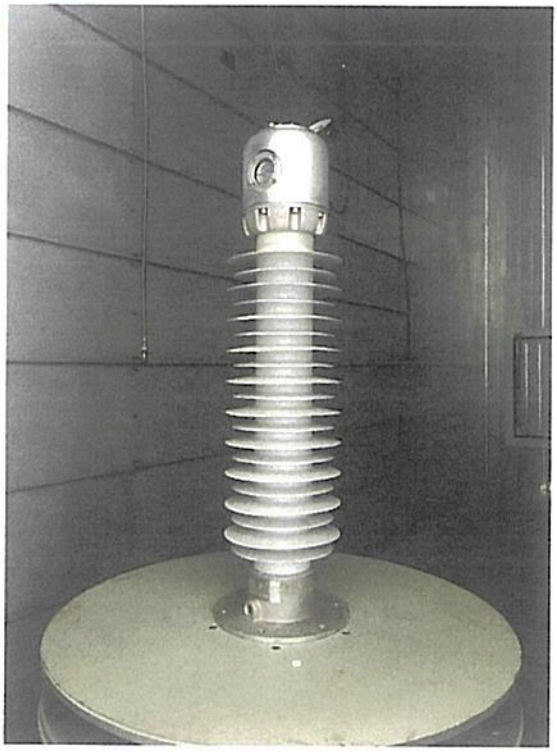
充液体、充混合物以及液体绝缘套管的密封试验（逐个）
Tightness Test on Liquid-filled, Compound-filled and Liquid-insulated Bushings (Routine Test)

试验日期/Date： 2017-03-04

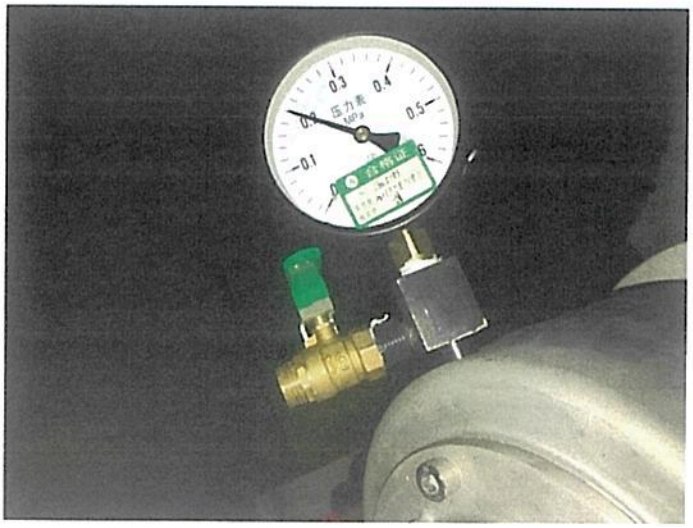
样品编号 Specimen No.	施加压力值 The pressure value MPa	持续时间 Duration h	试验温度 Test temperature ℃	样品状况 Result
1	0.20	12	60	无泄漏、未损坏 No leakage, no damage
规定值 Specifications	0.20	12	60	不应泄漏或损坏 No leakage or damage

符合检验依据规定，合格。

The result met test standard and the technical specifications.



试验整体



密封表压

法兰和其他固定装置的密封试验（逐个）
Tightness Test at the Flange or Other Fixing Device (Routine Test)

试验日期/Date： 2017-03-05

样品编号 No.	施加压力值 The pressure value MPa	持续时间 Duration min	样品状况 Result
1	0.25	15	无泄漏、未损坏 No leakage, no damage
规定值 Specifications	0.25	15	不应泄漏或损坏 No leakage or damage

符合检验依据规定，合格。

The result met test standard and the technical specifications.

试验整体

密封表压

外观检查和尺寸检查（逐个）
Visual Inspection and Dimensional Check (Routine Test)

试验日期/Date: 2017-03-02

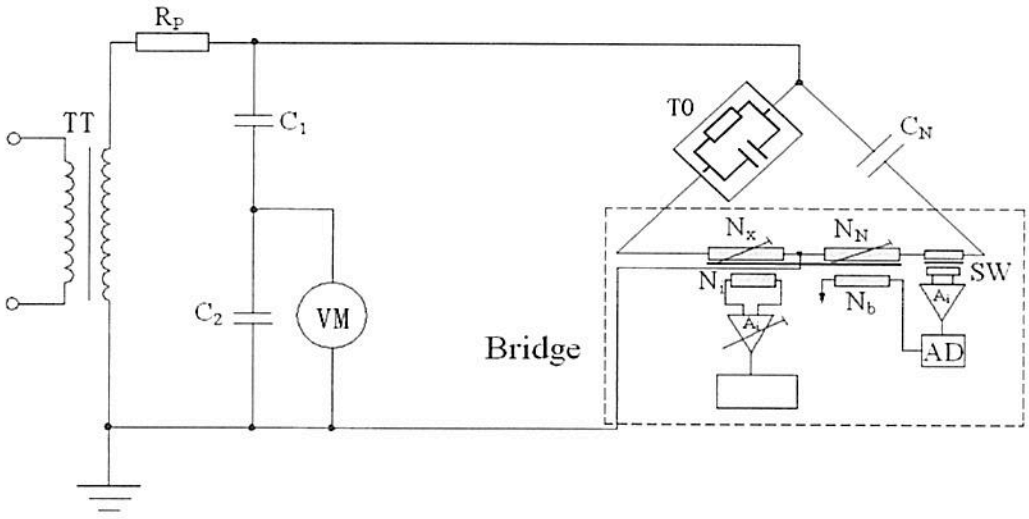
试品外观表面无缺陷，套管尺寸符合相关图纸，套管整体长度为1892mm，满足（1892±10）mm；油中端长度为890mm，满足（890±5）mm；爬电距离为3113mm，满足＞2250mm。符合检验依据规定，合格。

The outside surface has no vice, the dimension of bushing conforms to the drawing. the total length is 1892mm, met the requirement of （1892±10）mm. the length of oil side is 890mm, met the requirement of （890±5）mm. creepage distance is 3113mm. met the requirement of more than 2250mm.The result met test standard and the technical specifications.

介质损耗因数和电容量测量(型式)
Measurement of Dielectric Dissipation Factor and Capacitance (Type Test)

介质损耗因数和电容量测量线路图

（Circuit diagram of measurement of dielectric dissipation factor and capacitance）



TT---工频试验变压器(PF transformer)

R_p---保护电阻(Protection resistance)

C_1---高压臂电容(H.V arm capacitance)

C_2---低压臂电容(L.V arm capacitance)

C_N---标准电容器(Standard capacitor)

TO---试品(Test object)

VM---数字测量仪(Voltmeter)

Bridge---测量电桥(Bridge)

试验所用设备主要参数

(Main parameters of testing equipment)

U/S(kV/kVA)	f_{TT}(Hz)	R_p(kΩ)	C_1(pF)	C_2(μF)
550/2200	50	2	500	2.12
扩展不确定度(Expanded uncertainty)：U=2.4pC，(k=2)。				

介质损耗因数和电容量测量(型式)
Measurement of Dielectric Dissipation Factor and Capacitance (Type Test)

试验日期/Date: 2017-03-06

t= 11.0℃， RH= 41%， P= 101.8kPa

试验分别在44.0kV、72.5kV下进行介质损耗因数和电容量测量。要求在44.0kV、72.5kV电压下tanδ最大值为0.4%，测量电压从44.0kV提高至72.5kV时，tanδ最大允许增值为0.1%，电容量规定值：250pF～270pF。

The dielectric dissipation factor and capacitance are measured on 44.0kV and 72.5kV. The allowed tanδ is 0.4% on all test voltages. When the test voltage raises from 44.0kV to 72.5kV, the increase of tanδ must be less tan 0.1%. Cx :250pF～270pF.

标准电容C_N=50.12pF。
Standard capacitor C_N=50.12pF.

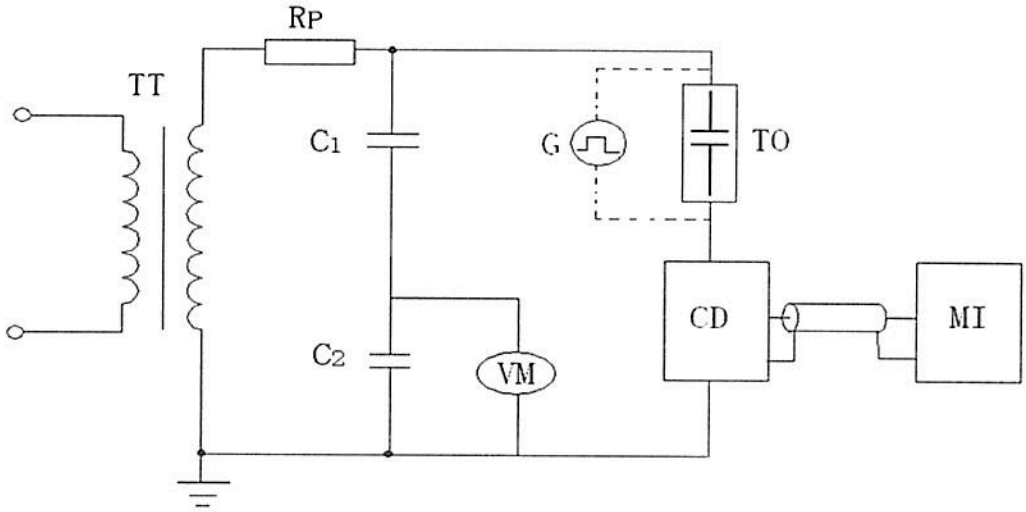
样品编号 Specimen No.	测量电压 Voltage applied kV		Cx pF	tanδ %	△tanδ %
	应施电压 Expected voltage	实施电压 Measured voltage			
1	44.0	44.2	268.6	0.331	/
	72.5	72.8	268.8	0.333	0

符合检验依据规定，合格。
The result met test standard and the technical specifications.

DLCZP170064J-003

局部放电测量(型式)
Partial Discharge Measurement (Type Test)

局部放电量测量线路图（AC）
(Circuit diagram of partial discharge measurement, AC)



TT---工频试验变压器(PF transformer)

R_p---保护电阻(Protection resistance)

C_1---高压臂电容(H.V arm capacitor)

C_2---低压臂电容(L.V arm capacitor)

CD---耦合装置(Coupling device)

TO---试品(Test object)

VM---数字电压表(Voltmeter)

G---方波校准器(Step voltage generator)

MI---局放测量仪(Measuring instrument)

试验所用设备主要参数

(Main parameters of testing equipment)

U/S(kV/kVA)	f_{TT}(Hz)	R_p(kΩ)	C_1(pF)	C_2(μF)
550/2200	50	2	500	2.12
扩展不确定度(Expanded uncertainty): U=2.4pC，(k=2)。				

局部放电测量(型式)
Partial Discharge Measurement (Type Test)

试验日期/Date: 2017-03-06

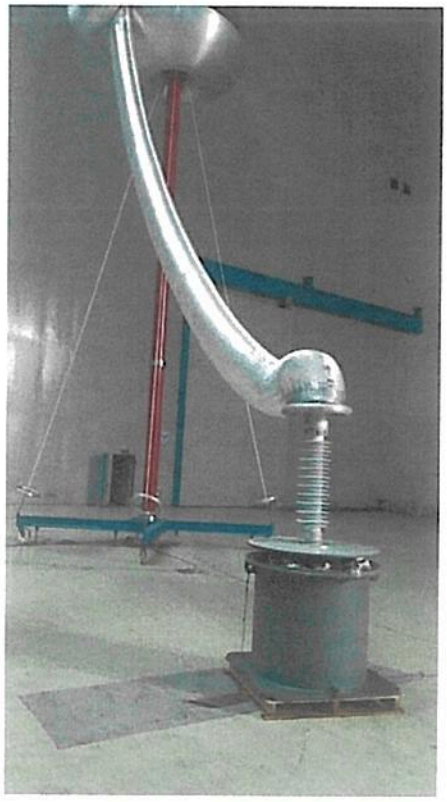
t= 8.5℃， RH= 64%， P= 101.9kPa

试验前采用5pC校准源对回路进行校准，背景噪音为≤2.5pC。
Step voltage generator: 5pC. Background noise ≤2.5pC.

预加电压为155kV，持续1min，在72.5kV、63.0kV和46.0kV的测量电压下进行局部放电测量，要求的局部放电量72.5kV、63.0kV和46.0kV下最大值为5pC。
The applied voltage is 155kV for 1 min. Partial discharge is measured on 72.5kV, 63.0kV and 46.0kV. and allowed partial discharge is 5pC max..

样品编号 Specimen No.	实施电压 Voltage applied kV	持续时间 Duration min	局部放电量 Partial discharge pC
1	73.3	5	≤3.7
	63.5	5	≤3.6
	46.1	5	≤3.6

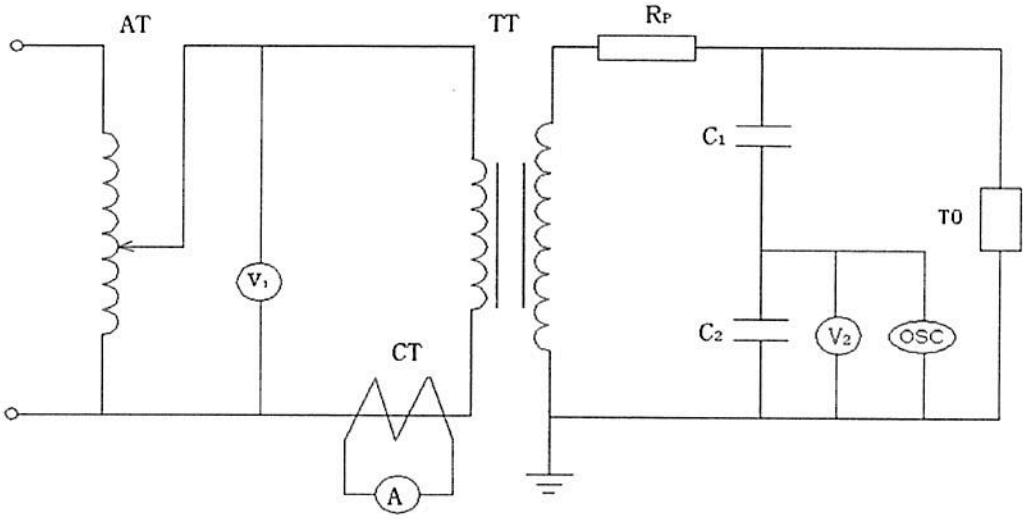
符合检验依据规定，合格。
The result met test standard and the technical specifications.



PDZP170064J-002

工频湿耐受电压试验（型式）
Wet Power-frequency Voltage Withstand Test (Type Test)

工频试验原理接线图
(Diagram of power frequency voltage circuit)



AT——调压器(Regulator)

R_p——保护电阻(Protection resistance)

CT——电流互感器(Current transformer)

TT——工频试验变压器(PF transformer)

TO——试品(Test object)

A——电流表(Current meter)

C_1——高压臂电容(H.V arm capacitance)

C_2——低压臂电容(L.V arm capacitance)

V_2——数字电压表(Voltmeter)

OSC——数字示波器(Oscilloscope)

试验所用设备主要参数

(Main parameters of testing equipment)

U/S(kV/kVA)	f_{TT}(Hz)	R_p(kΩ)	C_1(pF)	C_2(μF)
2250/2250	50	30	300	3.0
扩展不确定度(Expanded uncertainty): U<2%，(k=2)。				

工频湿耐受电压试验（型式）
Wet Power-frequency Voltage Withstand Test (Type Test)

试验日期/Date: 2017-03-06

t=8.5℃， RH= 64%， P= 101.9kPa

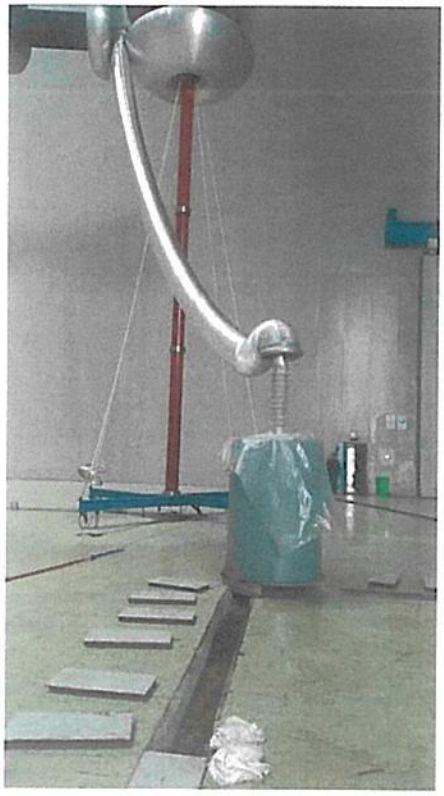
雨水温度t_{water}=9.4℃， 实测雨水电导率/Conductivity of water σ= 105.1μS/cm

降雨量/Precipitation rate: 水平分量为/Horizontal component is 1.2mm/min， 垂直分量为/vertical component is 1.2mm/min。

规定值/Specifications: 155kV. 电压校正系数/Correction coefficient K_t= 1.016

样品编号 No.	应该施加电压值 Expected voltage value kV	实际施加电压值 Measured voltage kV	耐受时间 Duration s	样品状况 Result
1	155	157.7	60	未闪络 No flashover
规定值 Specifications	/	/	60	不应闪络 No flashover

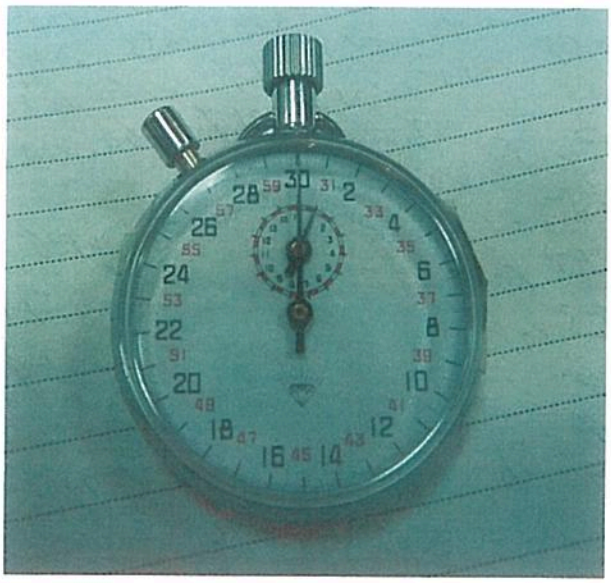
符合检验依据规定，合格。
The result met test standard and the technical specifications.



PFVZP170064J-002

工频湿耐受电压试验（型式）
Wet Power-frequency Voltage Withstand Test (Type Test)

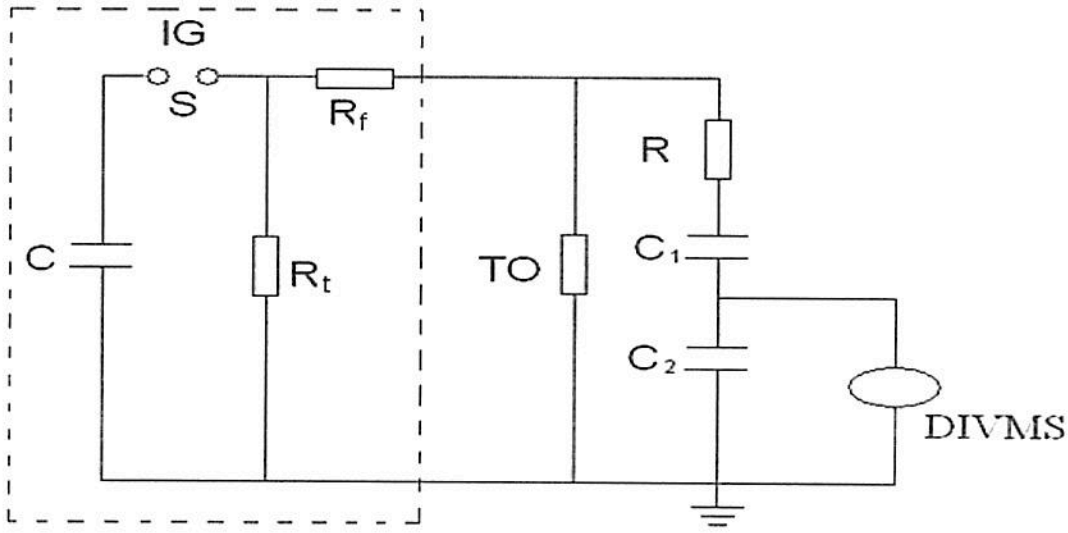
PFVZP170064J-002



PFVZP170064J-003

雷电冲击干耐受电压试验（型式）
Dry Lightning Impulse Voltage Withstand Test (Type Test)

冲击试验原理接线图
(Diagram of impulse voltage circuit)



C——冲击发生器主电容(IG capacitance)

R_f——波头电阻(front resistance)

R_t——波尾电阻(Tail resistance)

R——阻尼电阻(Damping resistance)

S——冲击点火球隙(Sphere gap)

C_1——高压臂电容(H.V arm capacitance)

C_2——低压臂电容(L.V arm capacitance)

TO——试品(Test object)

DIVMS——数字冲击电压测量系统(Impulse voltage measuring systems)

试验所用设备主要参数

(Main parameters of testing equipment)

U(kV)	C(μF)	R_f(Ω)	R_t(Ω)	C_1(pF)	C_2(μF)
2400	0.09	490	715	300	0.9
扩展不确定度(Expanded uncertainty): U<2%，(k=2)。					

雷电冲击干耐受电压试验（型式）
Dry Lightning Impulse Voltage Withstand Test (Type Test)

试验日期/Date: 2017-03-06

t= 8.5℃， RH= 64%， P= 101.9kPa

规定值/Specifications: 325kV. 电压校正系数/Correction coefficient K_t= 0.987

实际试验时取K_t=1.000
Choosing K_t=1.000 during test

样品编号 Specimen No.	极性及波形 Polarity and wave	实际施加电压值 Voltage applied kV	加压次数 Times	样品状况 Result
1	正极性全波 Positive polarity full wave	326.2 ~ 335.3	15	未闪络、未击穿 No flashover, No puncture
规定值 Specifications	正极性全波 Positive polarity full wave	325	15	空气端闪络次数≤2 不应击穿 Flashover less than 2 shots No puncture
1	负极性全波 Negative polarity full wave	325.3	1	未闪络、未击穿 No flashover, No puncture
规定值 Specifications	负极性全波 Negative polarity full wave	325	1	不应闪络或击穿 No flashover or No puncture
1	负极性截波 Negative polarity chopped wave	367.2 ~ 368.5	5	未闪络、未击穿 No flashover, No puncture
规定值 Specifications	负极性截波 Negative polarity chopped wave	375	5	不应闪络或击穿 No flashover or No puncture
1	负极性全波 Negative polarity full wave	325.3 ~ 335.6	14	未闪络、未击穿 No flashover, No puncture
规定值 Specifications	负极性全波 Negative polarity full wave	325	14	不应闪络或击穿 No flashover or No puncture

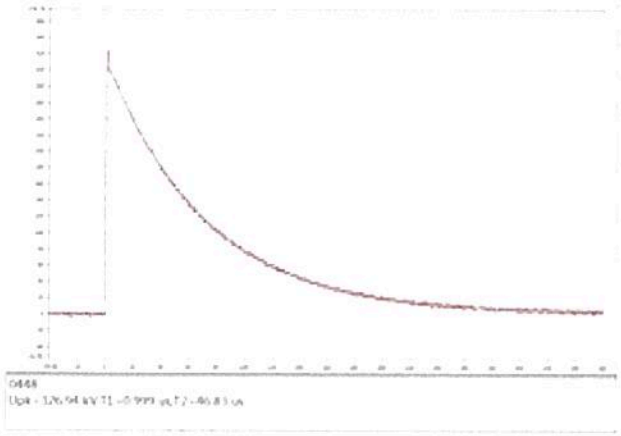
符合检验依据规定，合格。
The result met test standard and the technical specifications.

雷电冲击干耐受电压试验（型式）
Dry Lightning Impulse Voltage Withstand Test (Type Test)

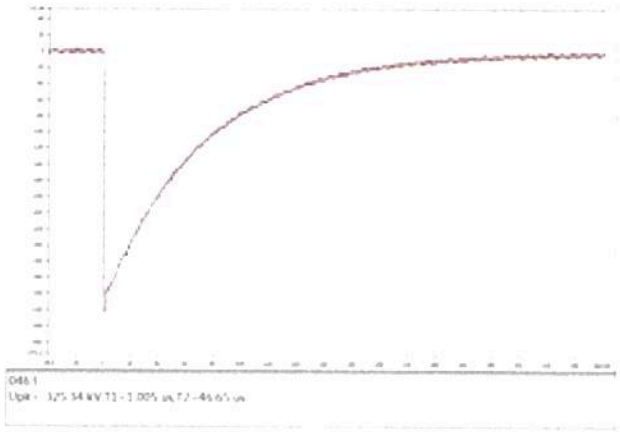
IPVZP170064J-001

雷电冲击干耐受电压试验（型式）
Dry Lightning Impulse Voltage Withstand Test (Type Test)

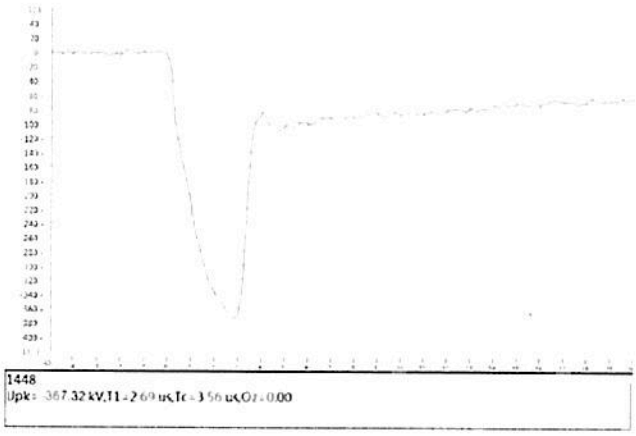
典型示波图/Typical oscillogram



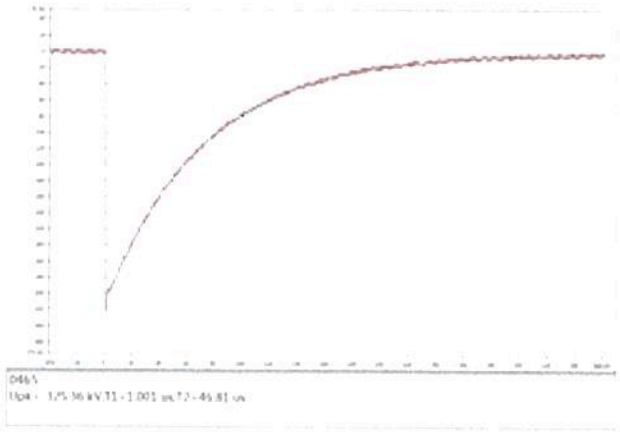
IPVBT170064J-001



IPVBT170064J-002



IPVBT170064J-003



IPVBT170064J-004

温升试验（型式）
Temperature Rise Test (Type Test)

试验日期/Date: 2017-03-07

实测温升数据
Measured data of temperature-rise tests

测量部位编号 No.	测量部位名称 Measuring position	实测温升 Temperature rise K	允许温升值 Specifications K
1	铜排一米处/One meter from the copper line	15.0	/
2	接线端子/The connecting terminal	18.8	≤75
3	固定连接/The fixed connection	19.3	≤75
4	固定连接/The fixed connection	19.0	≤75
5	接线帽/The wiring cap	18.1	/
6	油枕/The oil pillow	13.9	/
7	法兰/The flange	13.1	/
8	硅橡胶件/The silicon rubber	3.8	/
9	法兰件/The flange	27.0	/
10	螺母/The screw nut	46.3	≤70
11	底板/The bottom board	48.2	≤75
12	固定连接/The fixed connection	53.1	≤75
13	接线端子/The connecting terminal	53.4	≤75
14	铜排一米处/One meter from the copper line	50.1	/
15	变压器油/The transformer oil	61.2	58～62

环境温度为12.5℃，施加电流1000A。

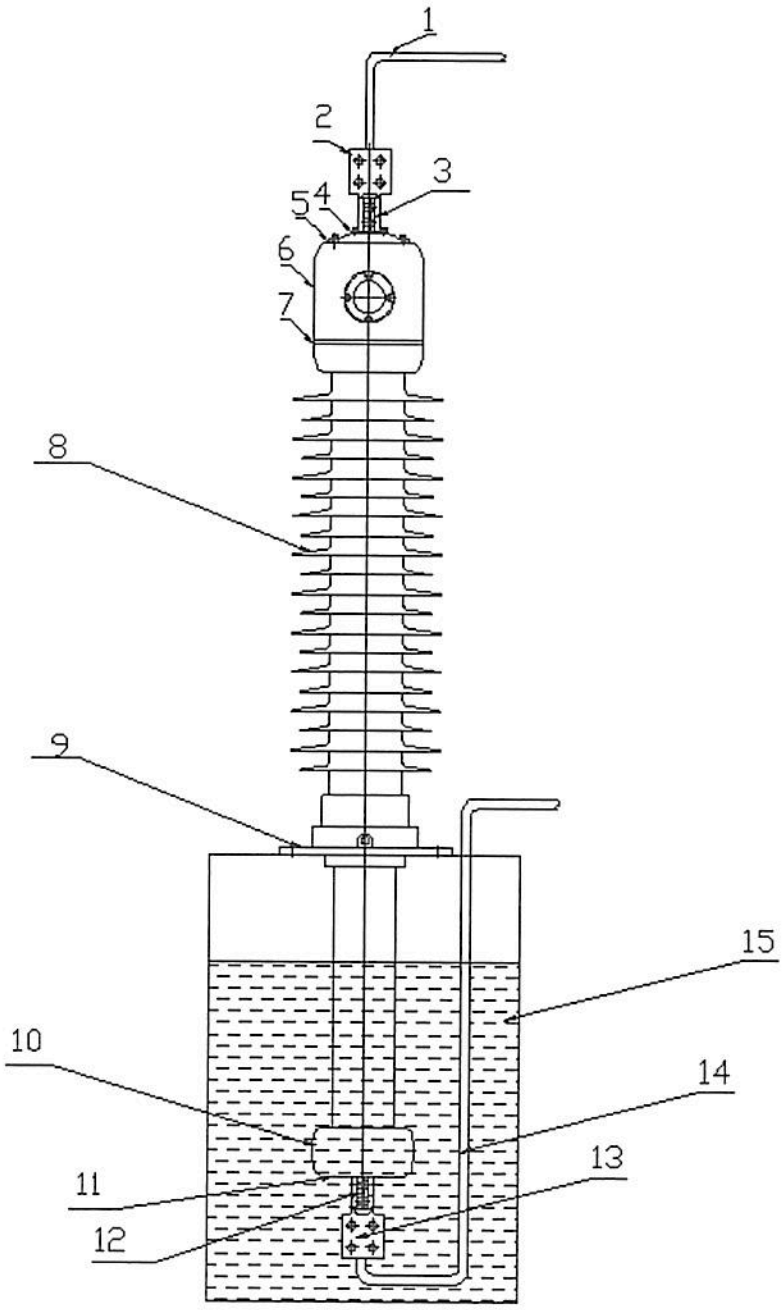
Ambient air temperature: 12.5℃. The current is 1000A.

测量部位编号及热电偶测量部位见示意图。

Measuring position Numbers and measuring position of the thermo cell see diagram.

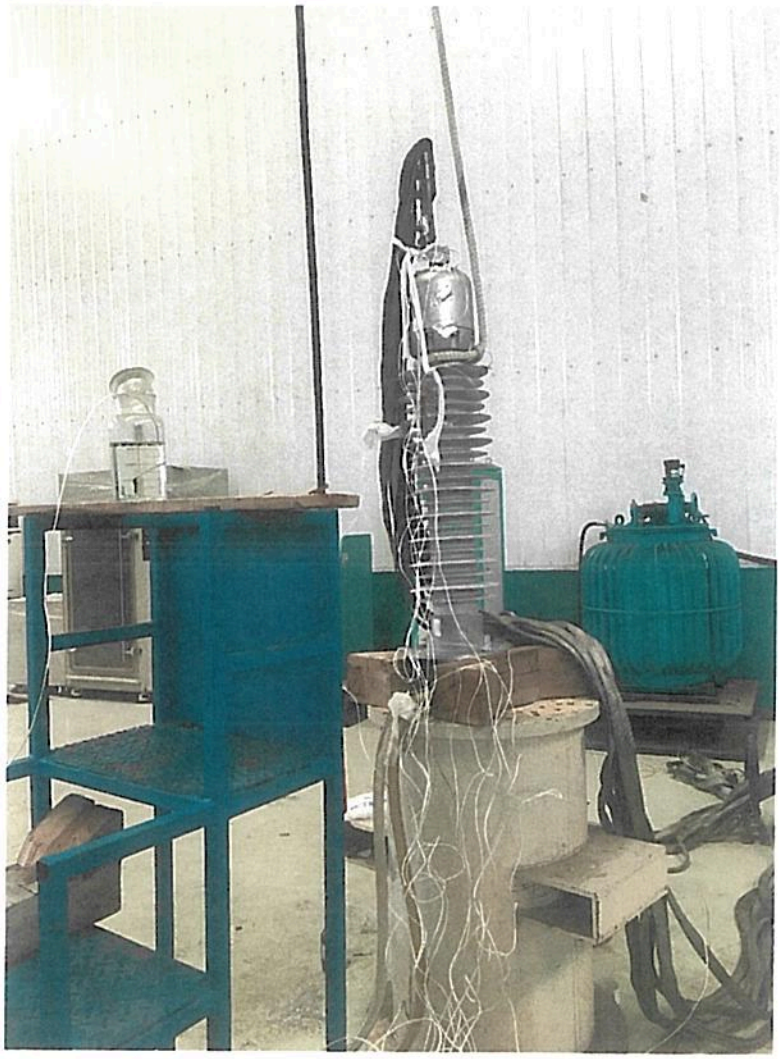
温升试验（型式）
Temperature Rise Test (Type Test)

测量点示意图/Measuring position diagram



温升测量点示意图
（Measuring position diagram of the temperature-rise test）

温升试验（型式）
Temperature Rise Test (Type Test)



温升试验整体 Photograph 1

热短时电流耐受试验（型式）
Verification of Thermal Short-time Current Withstand (Type Test)

根据GB/T4109-2008第8.8条的规定，套管耐受I_{th}的能力用下式计算证明，如果导体的最终温度θ_f不超过180℃，则认为套管能耐受I_{th}标准值。热短时电流耐受试验可以免做。

According to GB/T4109-2008, the ability of the bushing to withstand value I_{th} can be demonstrated by the following calculation, if θ_f does not exceed 180℃ the bushing shall be considered to be able to withstand value of I_{th}.

$$\theta_f=\theta_0+\alpha\times I_{th}^2\times t_{th}/(S_t\times S_e)$$

式中/Where: θ_f—导体的最终温度/the final temperature of the conductor, ℃

θ_0—在环境温度40℃下载I_r连续运行时的导体温度/the temperature of the conductor under continuous operation with Ir at an ambient temperature of 40℃, ℃;

α— 铜为/for copper is 0.8 $(K/s)/(kA/cm^2)^2$;

I_{th}—标准规定的热短时电流/the standard value of current as specified, kA;

t_{th}—标准规定的热短时电流的持续时间/the rate duration as specified, s;

S_t—与I_r相适应的总截面积/the total cross-section in square centimeters corresponding to I_r, cm^2;

S_e—用于计算集肤效应的等效截面积/the equivalent cross-section in square centimeters taking account of skin effect, cm^2。

$S_t=12.56cm^2$;

$S_e=10.27cm^2$;

θ_0（max）=64 ℃;

I_{th}=25kA;

t_{th}=2s;

$\theta_f=64+0.8\times25^2\times2\div(12.56\times10.27)=71.8$(℃);

因为$\theta_f<180$℃，所以热短时电流耐受试验免做。

The thermal short-time current withstand test can be omitted.

注：以上计算过程均由客户提供。

Note: the above calculation is provided by customer.

XIHARI	检 验 报 告 Test Report	No. 170064J Page 33 of 55

悬臂负荷耐受试验（型式）
Cantilever Load Withstand Test (Type Test)

试验日期/Date: 2017-03-08

试验时套管内部充0.20MPa（表压）的SF_6气体、套管中心导管内充0.20MPa（表压）的SF_6气体。
The pressure of SF_6 is 0.20MPa.

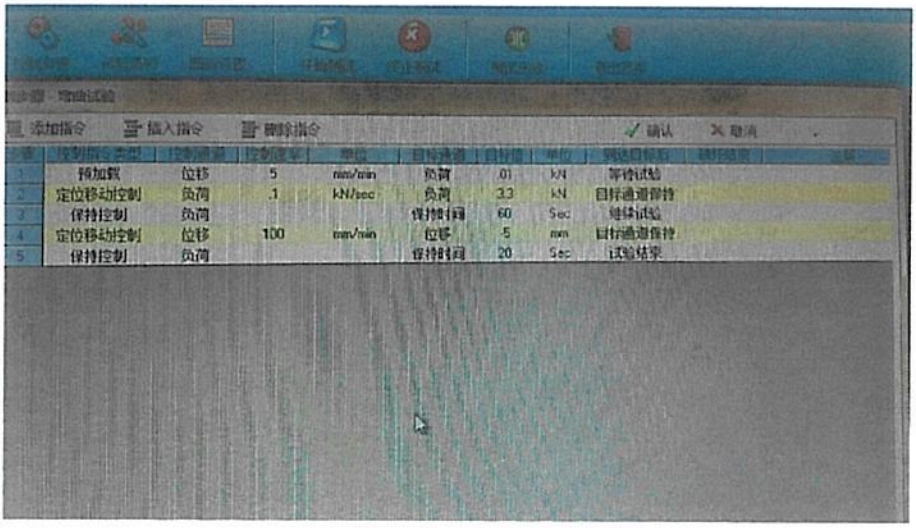
由于产品处于水平放置，考虑产品自身重量的影响，故负载由原先3000N 调整为3300N。

样品编号 No.	施加负荷 Load applied N	持续时间 Duration s	样品状况 Result
1	3300	60	未损坏 No damage
规定值 Specifications	3300	60	不应损坏 No damage

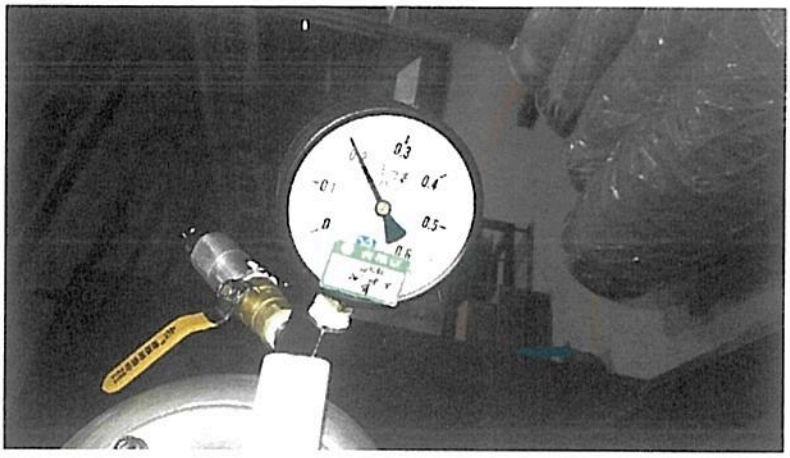
符合检验依据规定，合格。
The result met test standard and the technical specifications.

套管试验整体

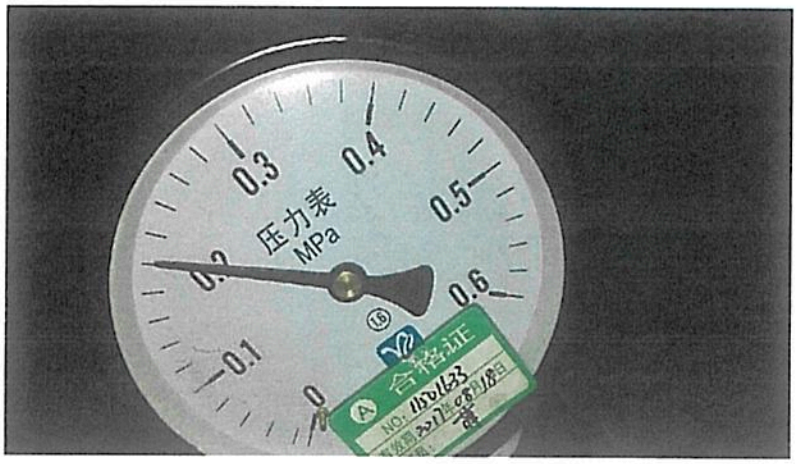
悬臂负荷耐受试验（型式）
Cantilever Load Withstand Test (Type Test)



力值



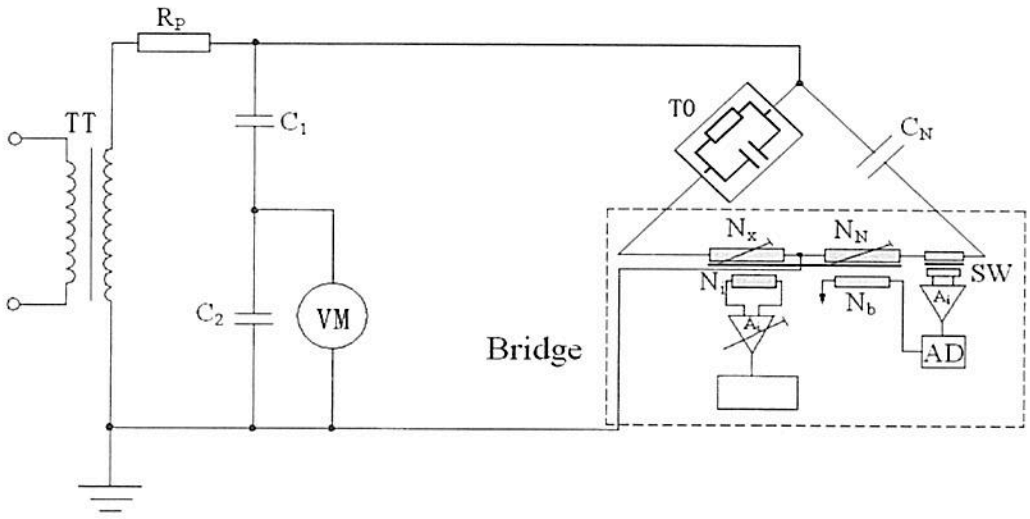
表压



表压

介质损耗因数和电容量测量(悬臂负荷耐受试验后)
Measurement of Dielectric Dissipation Factor and Capacitance (After Cantilever Load Withstand Test)

介质损耗因数和电容量测量线路图
(Circuit diagram of measurement of dielectric dissipation factor and capacitance)



TT---工频试验变压器(PF transformer)

R_p---保护电阻(Protection resistance)

C_1---高压臂电容(H.V arm capacitance)

C_2---低压臂电容(L.V arm capacitance)

C_N---标准电容器(Standard capacitor)

TO---试品(Test object)

VM---数字测量仪(Voltmeter)

Bridge---测量电桥(Bridge)

试验所用设备主要参数

(Main parameters of testing equipment)

U/S(kV/kVA)	f_{TT}(Hz)	R_p(kΩ)	C_1(pF)	C_2(μF)
550/2200	50	2	500	2.12
扩展不确定度(Expanded uncertainty): U=2.4pC，(k=2)。				

XIHARI	检 验 报 告 Test Report	No. 170064J Page 36 of 55

介质损耗因数和电容量测量(悬臂负荷耐受试验后)
Measurement of Dielectric Dissipation Factor and Capacitance (After Cantilever Load Withstand Test)

试验日期/Date: 2017-03-06

t= 9.0℃， RH= 40%， P= 102.6kPa

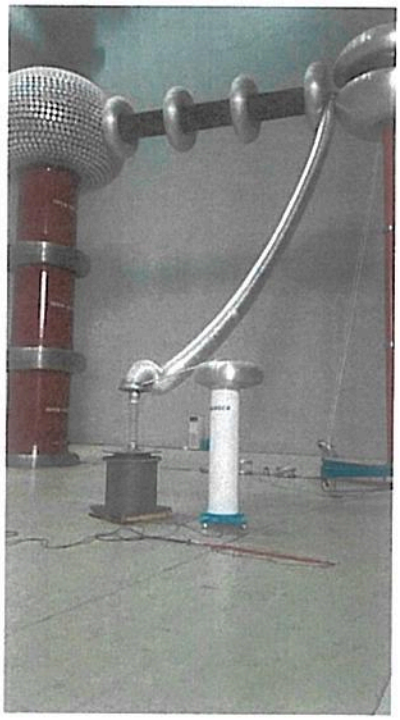
试验分别在44.0kV、72.5kV下进行介质损耗因数和电容量测量。要求在44.0kV、72.5kV电压下tanδ最大值为0.4%，测量电压从44.0kV提高至72.5kV时，tanδ最大允许增值为0.1%，电容量规定值：250pF～270pF。

The dielectric dissipation factor and capacitance are measured on 44.0kV and 72.5kV. The allowed tanδ is 0.4% on all test voltages. When the test voltage raises from 44.0kV to 72.5kV, the increase of tanδ must be less tan 0.1%. Cx :250pF～270pF.

标准电容C_N=50.12pF。
Standard capacitor C_N=50.12pF.

样品编号 Specimen No.	测量电压 Voltage applied kV		Cx pF	tanδ %	△tanδ %
	应施电压 Expected voltage	实施电压 Measured voltage			
1	44.0	44.6	263.6	0.334	/
	72.5	72.3	268.6	0.332	0.002

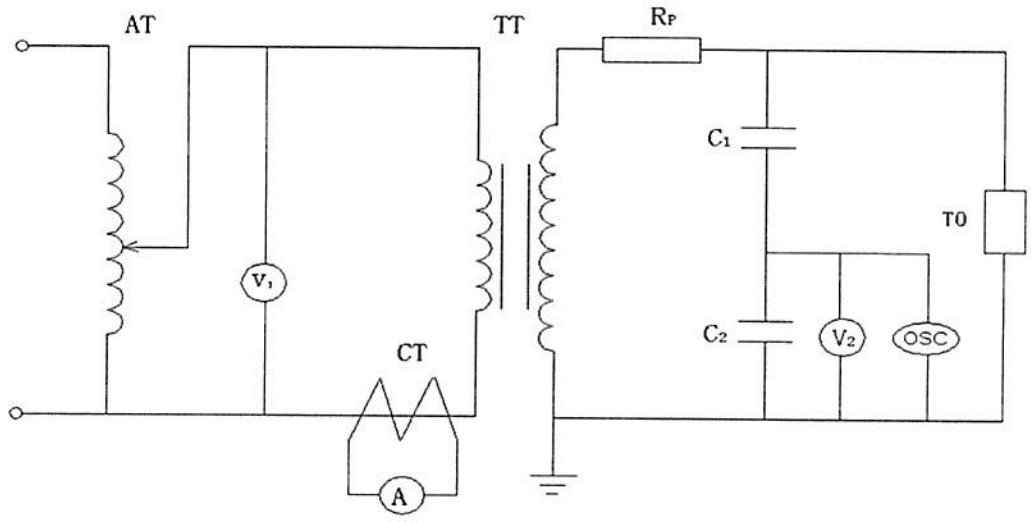
符合检验依据规定，合格。
The result met test standard and the technical specifications.



DLCZP170064J-004

工频干耐受电压试验(悬臂负荷耐受试验后)
Dry Power-frequency Voltage Withstand Test (After Cantilever Load Withstand Test)

工频试验原理接线图
(Diagram of power frequency voltage circuit)



AT——调压器(Regulator)

R_p——保护电阻(Protection resistance)

CT——电流互感器(Current transformer)

TT——工频试验变压器(PF transformer)

TO——试品(Test object)

A——电流表(Current meter)

C_1——高压臂电容(H.V arm capacitance)

C_2——低压臂电容(L.V arm capacitance)

V_2——数字电压表(Voltmeter)

OSC——数字示波器(Oscilloscope)

试验所用设备主要参数

(Main parameters of testing equipment)

U/S(kV/kVA)	f_{TT}(Hz)	R_p(kΩ)	C_1(pF)	C_2(μF)
2250/2250	50	30	300	3.0
扩展不确定度(Expanded uncertainty): U<2%，(k=2)。				

XIHARI	检验报告 Test Report	No. 170064J Page 38 of 55

工频干耐受电压试验(悬臂负荷耐受试验后)
Dry Power-frequency Voltage Withstand Test (After Cantilever Load Withstand Test)

试验日期/Date: 2017-03-07

t=8.0℃， RH= 66%， P= 102.1kPa

规定值/Specifications: 155kV. 电压校正系数/Correction coefficient K_t= 1.000

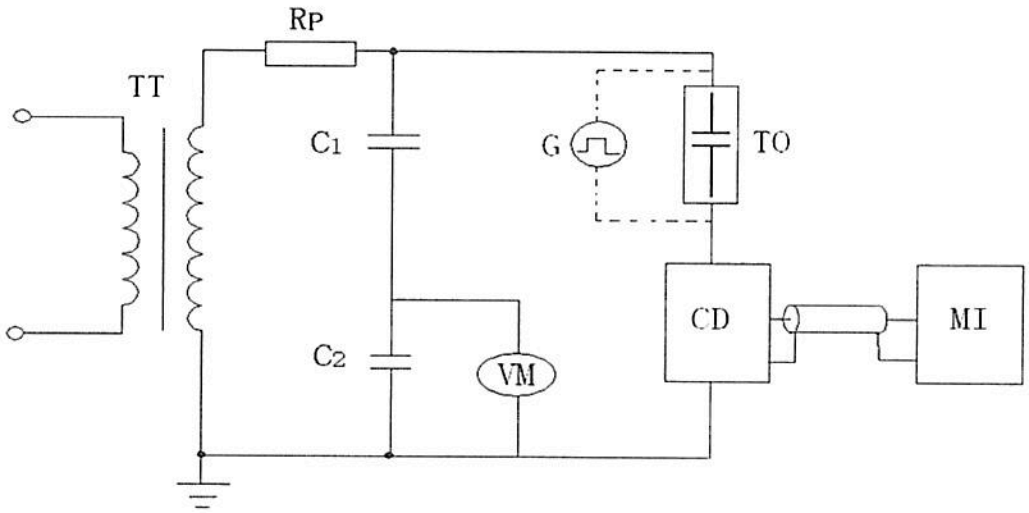
样品编号 No.	应该施加电压值 Expected voltage value kV	实际施加电压值 Measured voltage kV	耐受时间 Duration s	样品状况 Result
1	155	156.0	60	未闪络 No flashover
规定值 Specifications	/	/	60	不应闪络 No flashover

符合检验依据规定，合格。
The result met test standard and the technical specifications.

PFVZP170064J-003

局部放电测量(悬臂负荷耐受试验后)
Partial Discharge Measurement (After Cantilever Load Withstand Test)

局部放电量测量线路图（AC）
(Circuit diagram of partial discharge measurement, AC)



TT---工频试验变压器(PF transformer)

R_p---保护电阻(Protect resistor)

C_1---高压臂电容(H.V arm capacitor)

C_2---低压臂电容(L.V arm capacitor)

CD---耦合装置(Coupling device)

TO---试品(Test object)

VM---数字电压表(Voltmeter)

G---方波校准器(Step voltage generator)

MI---局放测量仪(Measuring instrument)

试验所用设备主要参数

(Main parameters of testing equipment)

U/S(kV/kVA)	f_{TT}(Hz)	R_p(kΩ)	C_1(pF)	C_2(μF)
550/2200	50	2	500	2.12
扩展不确定度(Expanded uncertainty): U=2.4pC，(k=2)。				

局部放电测量(悬臂负荷耐受试验后)
Partial Discharge Measurement (After Cantilever Load Withstand Test)

试验日期/Date: 2017-03-07

t= 8.0℃， RH= 66%， P= 102.1kPa

试验前采用5pC校准源对回路进行校准，背景噪音为≤2.5pC。
Step voltage generator: 5pC. Background noise ≤2.5pC.

预加电压为155kV，持续1min，在72.5kV、63.0kV和46.0kV的测量电压下进行局部放电测量，要求的局部放电量72.5kV、63.0kV和46.0kV下最大值为5pC。
The applied voltage is 155kV for 1 min. Partial discharge is measured on 72.5kV, 63.0kV and 46.0kV. and allowed partial discharge is 5pC max..

样品编号 Specimen No.	实施电压 Voltage applied kV	持续时间 Duration min	局部放电量 Partial discharge pC
1	72.3	5	≤3.8
	63.2	5	≤3.6
	46.4	5	≤3.6

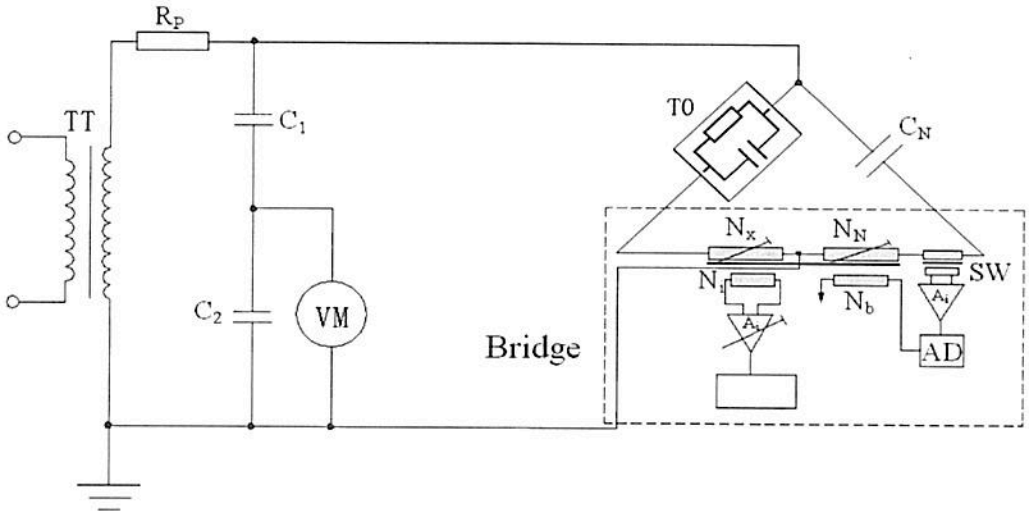
符合检验依据规定，合格。
The result met test standard and the technical specifications.

PDZP170064J-003

介质损耗因数和电容量测量(悬臂负荷耐受试验后)
Measurement of Dielectric Dissipation Factor and Capacitance (After Cantilever Load Withstand Test)

介质损耗因数和电容量测量线路图

(Circuit diagram of measurement of dielectric dissipation factor and capacitance)



TT---工频试验变压器(PF transformer)

R_p---保护电阻(Protection resistance)

C_1---高压臂电容(H.V arm capacitance)

C_2---低压臂电容(L.V arm capacitance)

C_N---标准电容器(Standard capacitor)

TO---试品(Test object)

VM---数字测量仪(Voltmeter)

Bridge---测量电桥(Bridge)

试验所用设备主要参数

(Main parameters of testing equipment)

U/S(kV/kVA)	f_{TT}(Hz)	R_p(kΩ)	C_1(pF)	C_2(μF)
550/2200	50	2	500	2.12
扩展不确定度(Expanded uncertainty): U=2.4pC，(k=2)。				

介质损耗因数和电容量测量(悬臂负荷耐受试验后)
Measurement of Dielectric Dissipation Factor and Capacitance (After Cantilever Load Withstand Test)

试验日期/Date: 2017-03-07

t= 8.0℃， RH= 66%， P= 102.1kPa

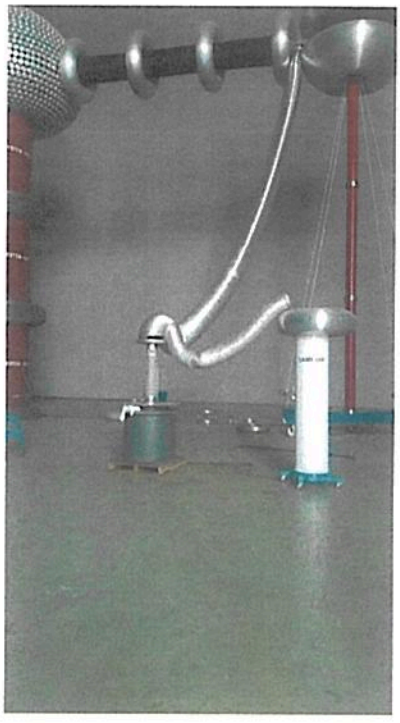
试验分别在44.0kV、72.5kV下进行介质损耗因数和电容量测量。要求在44.0kV、72.5kV电压下tanδ最大值为0.4%，测量电压从44.0kV提高至72.5kV时，tanδ最大允许增值为0.1%，电容量规定值：250pF～270pF。

The dielectric dissipation factor and capacitance are measured on 44.0kV and 72.5kV. The allowed tanδ is 0.4% on all test voltages. When the test voltage raises from 44.0kV to 72.5kV, the increase of tanδ must be less tan 0.1%. Cx :250pF～270pF.

标准电容C_N=50.12pF。
Standard capacitor C_N=50.12pF.

样品编号 Specimen No.	测量电压 Voltage applied kV		Cx pF	tanδ %	△tanδ %
	应施电压 Expected voltage	实施电压 Measured voltage			
1	44.0	44.7	268.5	0.335	/
	72.5	72.8	268.5	0.337	0.002

符合检验依据规定，合格。
The result met test standard and the technical specifications.



DLCZP170064J-005

抽头绝缘试验(悬臂负荷耐受试验后)
Tests of Tap Insulation (After Cantilever Load Withstand Test)

试验日期/Date: 2017-03-07

1 对地耐压试验/The ground pressure test

P=102.1kPa t=8.0℃ RH=66%

样品编号 Specimen No.	实施电压 Voltage applied kV	持续时间 Duration min	样品状况 Result
1	3	1	未闪络、未击穿 No flashover、No puncture
规定值 Specifications	3	1	未闪络、未击穿 No flashover or puncture

符合检验依据规定，合格。
The result meets test standard and the technical specifications.

2 介质损耗因数和电容量测量/Measurement of dielectric dissipation factor and capacitance

2.1 试验要求/The test requirement

试验在1kV电压下进行介质损耗因数和电容量测量，要求tanδ最大值为5%，电容量≤5000pF，对地绝缘≥1000MΩ。
Measure the dielectril loss factor and capacitance under the test voltage of 1kV. tanδ≤5%. Cx≤5000pF. grounding insulation ≥1000MΩ.

2.2 试验结果/The test result

样品编号 Specimen No.	实施电压 Voltage applied kV	Cx pF	tanδ %
1	1	153.3	0.583
规定值 Specifications	1	≤5000	≤5

符合检验依据规定，合格。
The result meets test standard and the technical specifications.

抽头绝缘试验(悬臂负荷耐受试验后)
Tests of Tap Insulation (After Cantilever Load Withstand Test)

TTIZP170064J-004

TTIZP170064J-005

XIHARI	检 验 报 告 Test Report	No. 170064J Page 45 of 55

充液体、充混合物以及液体绝缘套管的密封试验(悬臂负荷耐受试验后)
Tightness Test on Liquid-filled, Compound-filled and Liquid-insulated Bushings (After Cantilever Load Withstand Test)

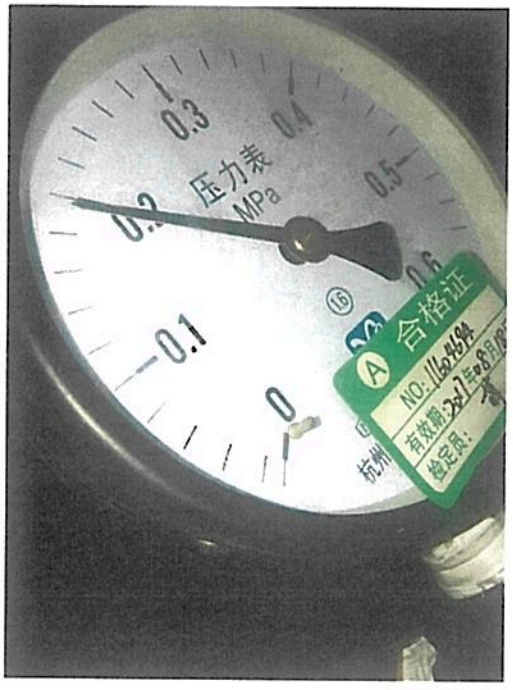
试验日期/Date： 2017-03-08

样品编号 Specimen No.	施加压力值 The pressure value MPa	持续时间 Duration h	试验温度 Test temperature ℃	样品状况 Result
1	0.20	12	75	无泄漏、未损坏 No leakage, no damage
规定值 Specifications	0.20	12	75	不应泄漏或损坏 No leakage or damage

符合检验依据规定，合格。

The result met test standard and the technical specifications.

试验整体



密封表压

XIHARI	检 验 报 告 Test Report	No. 170064J Page 46 of 55

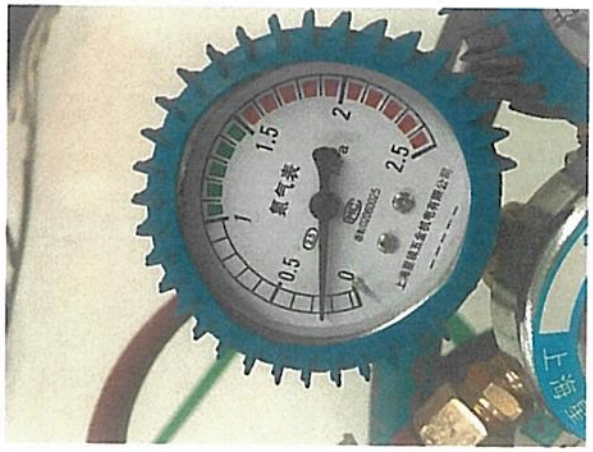
法兰和其他固定装置的密封试验(悬臂负荷耐受试验后)
Tightness Test at the Flange or Other Fixing Device (After Cantilever Load Withstand Test)

试验日期/Date： 2017-03-08

样品编号 No.	施加压力值 The pressure value MPa	持续时间 Duration min	样品状况 Result
1	0.25	15	无泄漏、未损坏 No leakage, no damage
规定值 Specifications	0.25	15	不应泄漏或损坏 No leakage or damage

符合检验依据规定，合格。
The result met test standard and the technical specifications.

试验整体



密封表压

外观检查和尺寸检查（悬臂负荷耐受试验后）
Visual Inspection and Dimensional Check (After Cantilever Load Withstand Test)

试验日期/Date: 2017-03-07

试品外观表面无缺陷，套管尺寸符合相关图纸，套管整体长度为1892mm，满足（1892±10）mm；油中端长度为890mm，满足（890±5）mm；爬电距离为3113mm，满足＞2250mm。符合检验依据规定，合格。

The outside surface has no vice, the dimension of bushing conforms to the drawing. the total length is 1892mm, met the requirement of （1892±10）mm. the length of oil side is 890mm, met the requirement of （890±5）mm. creepage distance is 3113mm. met the requirement of more than 2250mm.The result met test standard and the technical specifications.

充液体、充混合物以及液体绝缘套管的密封试验(型式)
Tightness Test on Liquid-filled, Compound-filled and Liquid-insulated Bushings (Type Test)

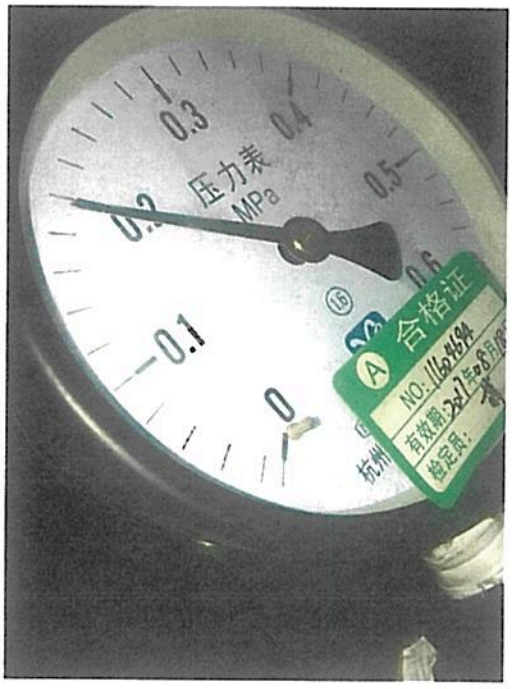
试验日期/Date： 2017-03-08

样品编号 Specimen No.	施加压力值 The pressure value MPa	持续时间 Duration h	试验温度 Test temperature ℃	样品状况 Result
1	0.20	12	75	无泄漏、未损坏 No leakage, no damage
规定值 Specifications	0.20	12	75	不应泄漏或损坏 No leakage or damage

符合检验依据规定，合格。

The result met test standard and the technical specifications.

试验整体



密封表压

尺寸检查（型式）
Dimensional Check (Type Test)

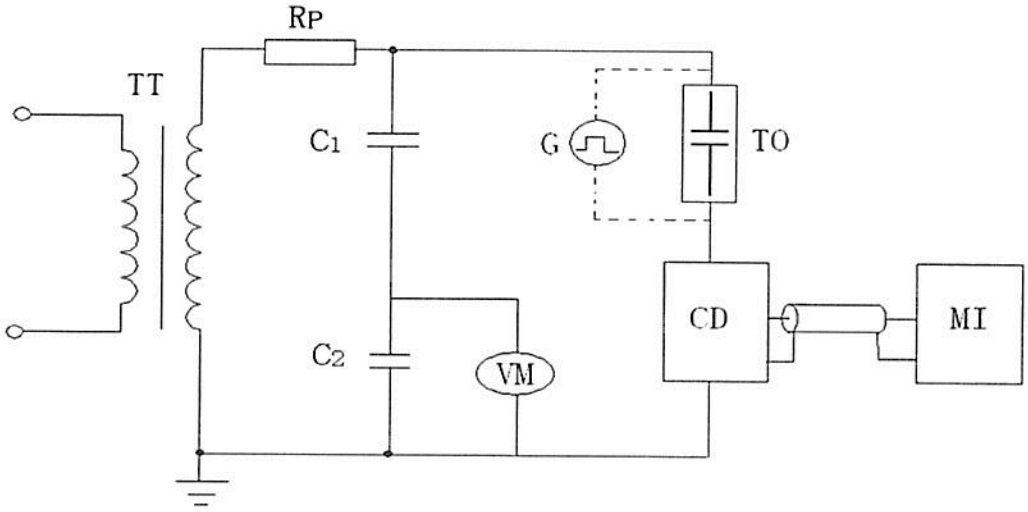
试验日期/Date: 2017-03-06

试品外观表面无缺陷，套管尺寸符合相关图纸，套管整体长度为1892mm，满足（1892±10）mm；油中端长度为890mm，满足（890±5）mm；爬电距离为3113mm，满足＞2250mm。符合检验依据规定，合格。

The outside surface has no vice, the dimension of bushing conforms to the drawing. the total length is 1892mm, met the requirement of （1892±10）mm. the length of oil side is 890mm, met the requirement of （890±5）mm. creepage distance is 3113mm. met the requirement of more than 2250mm.The result met test standard and the technical specifications.

局部放电测量(型式)
Partial Discharge Measurement (Type Test)

局部放电量测量线路图（AC）
(Circuit diagram of partial discharge measurement, AC)



TT---工频试验变压器(PF transformer)

R_p---保护电阻(Protection resistance)

C_1---高压臂电容(H.V arm capacitor)

C_2---低压臂电容(L.V arm capacitor)

CD---耦合装置(Coupling device)

TO---试品(Test object)

VM---数字电压表(Voltmeter)

G---方波校准器(Step voltage generator)

MI---局放测量仪(Measuring instrument)

试验所用设备主要参数

(Main parameters of testing equipment)

U/S(kV/kVA)	f_{TT}(Hz)	R_p(kΩ)	C_1(pF)	C_2(μF)
550/2200	50	2	500	2.12
扩展不确定度(Expanded uncertainty)：U=2.4pC，(k=2)。				

局部放电测量(型式)
Partial Discharge Measurement (Type Test)

试验日期/Date: 2017-03-07

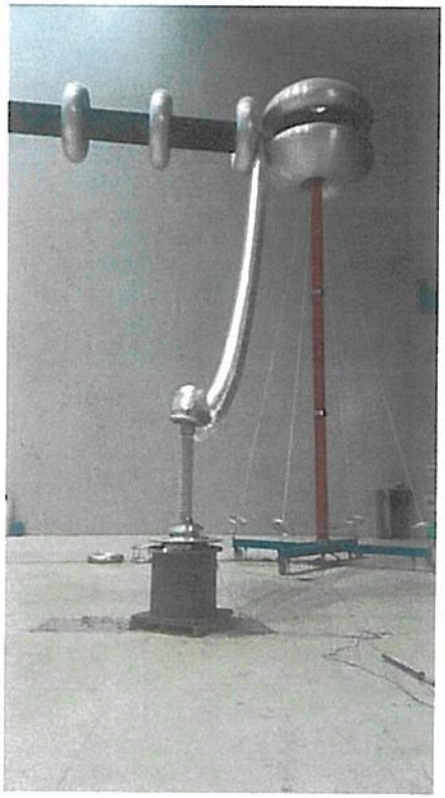
t= 8.0℃， RH= 66%， P= 102.1kPa

试验前采用5pC校准源对回路进行校准，背景噪音为≤2.5pC。
Step voltage generator: 5pC. Background noise ≤2.5pC.

预加电压为155kV，持续1min，在72.5kV、63.0kV和46.0kV的测量电压下进行局部放电测量，要求的局部放电量72.5kV、63.0kV和46.0kV下最大值为5pC。
The applied voltage is 155kV for 1 min. Partial discharge is measured on 72.5kV, 63.0kV and 46.0kV. and allowed partial discharge is 5pC max..

样品编号 Specimen No.	实施电压 Voltage applied kV	持续时间 Duration min	局部放电量 Partial discharge pC
1	72.7	5	≤3.9
	63.6	5	≤3.7
	44.2	5	≤3.7

符合检验依据规定，合格。
The result met test standard and the technical specifications.



PDZP170064J-004

介质损耗因数和电容量测量(型式)
Measurement of Dielectric Dissipation Factor and Capacitance (Type Test)

试验日期/Date: 2017-03-07

t= 8.5℃， RH= 64%， P= 101.9kPa

试验分别在44.0kV、72.5kV下进行介质损耗因数和电容量测量。要求在44.0kV、72.5kV电压下tanδ最大值为0.4%，测量电压从44.0kV提高至72.5kV时，tanδ最大允许增值为0.1%，电容量规定值：250pF～270pF。

The dielectric dissipation factor and capacitance are measured on 44.0kV and 72.5kV. The allowed tanδ is 0.4% on all test voltages. When the test voltage raises from 44.0kV to 72.5kV, the increase of tanδ must be less tan 0.1%. Cx :250pF～270pF.

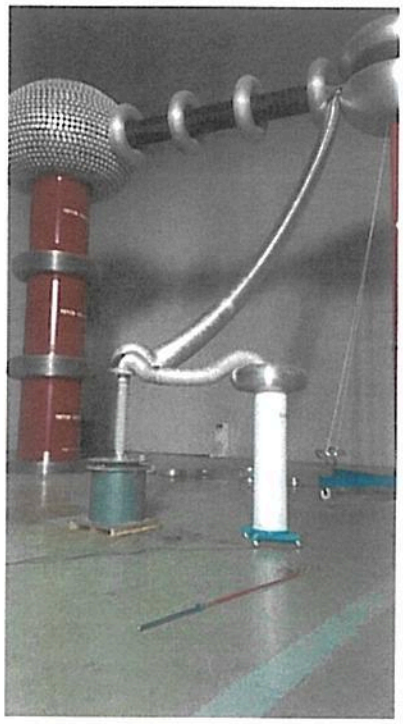
标准电容C_N=50.12pF。

Standard capacitor C_N=50.12pF.

样品编号 Specimen No.	测量电压 Voltage applied kV		Cx pF	tanδ %	△tanδ %
	应施电压 Expected voltage	实施电压 Measured voltage			
1	44.0	44.8	268.7	0.335	/
	72.5	72.7	268.7	0.333	0.002

符合检验依据规定，合格。

The result met test standard and the technical specifications.



DLCZP170064J-006

附录
Appendix

1 确认的试品图纸/Drawing

0SM.132.321.1

2 试品照片/ Photographs

(/)

附录
Appendix

1 确认的试品图纸/Drawing