陕西电子

电 力 变 压 器

安 装 使 用 说 明 书

(66～220kV 级)

Instruction Manual for Installation

and Operation of Oil Immersed Power Transformer

(66kV～220kV Power Transformer)

本企业已通过 ISO9001 质量体系

ISO14001 环境体系

ISO45001 职业健康安全体系认证

Acquired ISO9001 Certificate

AndISO14001Certificate And ISO45001Certificate

陕西汉中变压器有限责任公司

SHAANXI HANZHONG TRANSFORMER CO., LTD.

1 概论

1 General

1.1 适用范围

1.1 Application

本说明书适用于 66～220KV 级油浸式电力变压器。

This instruction is applicable for 66Kv-220kV oil-immersed power transformer.

本说明书包括：变压器铁路、公路、船舶的运输要求，现场验收、贮存注意事项，器身检查、现场安装工作流程，有关交接试验的注意事项、投入运行的条件及日常运行、维护等方面说明。

This instruction includes requirements of transportation (by railway, road, ship), site acceptance and storage, active-parts inspection and site installation, on-site acceptance tests(SAT), operation condition and daily maintenance, trouble-shooting explanation, etc.

在使用本说明书时，应结合变压器具体结构，参照有关组件的使用说明书，严格按各说明书的技术要求进行施工、如有疑问请与制造公司联系以便得到及时妥善的处理。

Installation must be strictly as per this instruction as well as the transformer structure and refer to the instruction of accessories. Any issues or confusion, please contact the manufacturer for proper resolution.

1.2 变压器在运输、贮存、安装及投入运行等过程中，须以本安装使用说明书作为指导，以免发生变压器质量问题，并请做好有关记录。

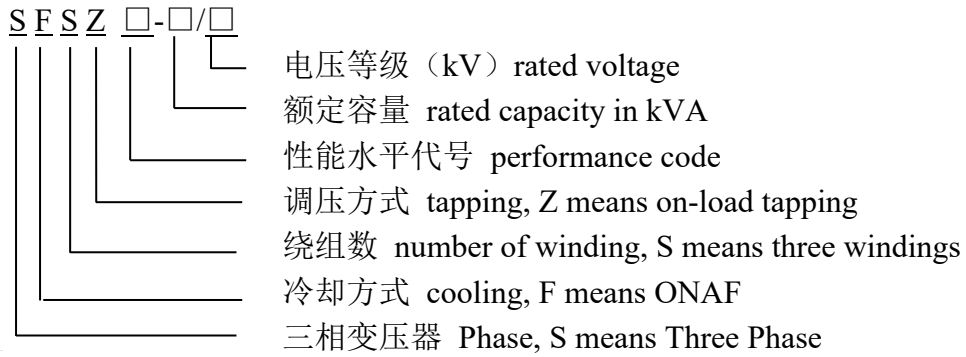
This manual shall be as a user’s guidance to avoid any quality problems occurred. Transformer lifting, transportation, acceptance, storage, installation, as well as operating should be recorded.

1.3安装与使用部门应按照工厂所提供的各类出厂技术文件、本安装使用说明书、产品专用安装说明书、各组部件的安装使用说明书进行施工。若有疑问或不清楚之处，须直接与工厂联系，以便妥善解决。

The owner/user who shall install/operate transformer should follow the requirements and all documents submitted by factory. Any issues or confusion, please contact the manufacturer for proper resolution.

1.4产品型号说明

Explanation of the transformer designation type



1.5 变压器结构简介

1.5 transformer structure

1.5.1铁芯

1.5.1 core

铁芯材料选用优质高导磁冷轧取向硅钢片、叠铁芯、腹板式夹件结构；铁芯下部四角采用强力定位，上部用定位方通与箱盖无间隙配合。

The core is made of high-quality, high-permeability, cold-rolled, grain-oriented silicon steel sheets. The core laminations are assembled, and the core structure includes yokes and clamping. The lower part of the core is firmly positioned, while the upper part uses a precise fitting mechanism with the tank cover to ensure a seamless fit.

1.4.3线圈

Coil

线圈材料采用优质无氧扁铜线，低压线圈采用连续式或螺旋式结构，高压线圈采用连续式或纠结连续式结构，首末段加强绝缘，线圈采用不浸漆工艺，其中高压线圈采用立绕式，再经真空干燥处理。

The coil made of high-quality oxygen-free flat copper wire. Low-voltage coils are designed in a continuous or helical structure, while high-voltage coils employ a continuous or interlocking continuous structure. The first and last segments of the coil are reinforced with insulation. The coils are manufactured by the non-immersion varnish process, with high-voltage coils wound in a layer winding configuration and subsequently subjected to vacuum drying treatment.

14.4器身

active part

先分相组装，再整体套装，从而保证同相线圈形成一个有机整体。

The assembly process involves first grouping the phases and then assemble all winding together as a whole active part.

1.5.4引线 leads

高压引线，有载调压式采用优质有载调压分接开关，无励磁调压采用三只单相或“1+2”相二只无励磁调压分接开关。

For high-voltage lead connections with on-load tap changing, high-quality load-tap changers are used. For off-circuit tap changing, either three single-phase or a "1+2" phase arrangement of two single-phase no-load tap changers is mouted.

1.5.5油箱 tank

变压器采用钟罩式油箱和可拆卸式片式散热器。（注：应特殊用户要求可采用分体式结构）

The transformer is equipped with a bell-type oil tank and detachable fin-type radiators. (Note: A split-type structure tank can be used upon special customer request.)

2 运输及起吊

2. Transportation and lifting

2.1 运输要求

2.1 Transportation requirements

2.1.1 充油运输的变压器应先充入合格的变压器绝缘油，油面离油箱顶约 100mm 高度空间充以干燥氮气，检查有无渗漏现象，箱顶装设的压力表应保持正压力即可。

Two methods shall be used for transporting transformer main body. 1. Transformer delivered with qualified oil. The oil shall be approximately 100mm below tank cover and filled with dry nitrogen. Check the tank and valves, no leakage is allowed. A pressure gauge shall be installed on the top of tank and pressure in the tank should be remained positive.

2.1.2 充氮运输的变压器，应充入纯度大于 99.9%，露点不高于-40℃的纯氮气，并应在油箱上装置充氮设备和压力表，保持油箱内的初始正压力在（0.02～0.03）MPa 之间（有载分接开关和本体用 U 形管连结，同时充氮）。主体运到现场后，主体内的氮气压力应保持正压。

As for the transformer shipped with nitrogen, the maximum dew point shall be -40℃, the gas purity should be 99.9% and pressure should be 0.02 MPa to 0.03 Mpa during shipping(The main tank shall be connected with OLTC tank with a U type pipe and filled with nitrogen as well). The tank should be tightly sealed without leakage and will be in positive pressure when transformer arrives at site.

2.1.3 充氮运输的变压器，在运输途中应做好充氮记录。

Transformer shipped with nitrogen shall be recorded during transportation.

2.1.4 运输装车、固定应按照相关运输部门规定执行。

Relevant regulations regarding transportation as well as fixation shall be followed.

2.1.5 必要时，应装置冲击记录仪。

If necessary, transformer should be equipped with impact recorder.

2.2 主体运输

Transportation of main body

2.2.1 整个运输过程中（包括铁路、公路、船舶运输）变压器主体倾斜度：长轴方向应不大于 15°，短轴方向应不大于 10°。

During transportation (railway, highway, vessels), the maximum tilt angle allowed for transformer main body is 15° for long axis and 10° for short axis.

2.2.2 变压器本体严禁溜放，运输加速度应限制在：纵向加速度不大于 3g，横向和垂直加速度不大于 3g。；当任一方向的冲击加速度为（1-3）g 时，认为运输过程发生过碰撞；如果任意方向的冲击加速度超过 3g（正负方向同等看待），则需要对变压器进行专门检查和试验，以便对能否正常安装和投运做出明确结论。

The transformer body must be placed with care. The maximum acceleration during transportation: longitudinal acceleration≤ 3g, lateral and vertical acceleration ≤ 3g. When the impact acceleration in any direction is 1-3g, it is considered that a collision has occurred during transportation. If the impact acceleration in any direction exceeds 3g (positive and negative directions should be treated equally), inspection and testing of the transformer should be carried out in order to confirm if the transformer can be installed and put into operation normally.

2.2.3 完全铺平的公路，最大时速应不大于 40km/h；没有完全铺平的公路是最大时速应不大于 20 km/h；未铺彻的公路最大时速应不大于 10km/h。

The maximum speed shall be 40km/h on fully paved roads and 20km/h for incomplete paved road, 10 km/h for unpaved roads.

2.3 主体起吊

2.3 Lifting of Main Body

2.3.1 起吊设备、吊具及装卸地点地基,应能承受变压器起吊重量（即运输重量）。

2.3.1 The lifting equipment/device and the loading position must be able to withstand the weight of the transformer (the maximum transportation weight).

2.3.2 主体起吊时，应将绳索挂在起吊标识位置。

2.3.2 Lifting ropes should be placed at marked lifting position.

2.3.3 吊索与垂直夹角应不大于 30°。

2.3.3 The maximum angle between the lifting rope and the vertical line should be 30°.

2.4 主体牵引

2.4 Traction of main body

2.4.1 主体牵引着力点应牵挂在下节油箱下部的专用牵引孔上。如果没有牵引孔，应牵挂在油箱两侧主体吊拌上，不允许牵挂在联管等不能受力的组、部件上。

2.4.1 Traction forcing point should be put at special pulling plate welded at lower part of tank. If no pulling plate, the traction forcing point should be placed at both sides' lifting lugs on main body. It is prohibited to force at connection pipe or

accessories.

2.4.2 在轨道上使用小车或滚杠牵引速度不应超过 100m/h。

The maximum traction speed on rail with wheel or rollers shall be100m/h.

2.4.3 在斜坡上装卸主体，斜坡度应不大于 10°，斜坡长度应不少于 10m，并有防滑措施。

If load or unload the main body on slope, the maximum obliquity should be 10° and the minimum slope length should be 10m. Protection measures against skid must be taken.

2.4.4 使用千斤顶时，千斤顶应同时顶在千斤顶支板下，升起和降落时，应保持同时动作、速度相等，应防止千斤顶打滑。

All the jacks should be placed under jack pads, hoisting and lowering with simultaneous action and same speed. Protection measures against jack skid must also be taken.

2.5 责任

2.5 Responsibility

用户或代表检查冲击记录仪的记录，一般控制冲击加速度 3g 以下，并妥善保管冲击记录仪和冲击记录。如果发现变压器限位块、绑扎钢丝、油箱及附件有损伤，怀疑变压器受到了冲击，请履行以下条款：

The consignee and the shipper shall check the three-dimensional shocking recorder for the transformers transported with a three-dimensional shocking recorder. The maximum transportation direction and lateral acceleration should be 3g. Please keep the shocking record and three-dimensional shocking recorder properly. If any damage is found to the transformer's position limiting block, securing wire, tank, accessories due to an impact, please do as follows:

（1）不要打开变压器

（2）通知运输部门，要求立即检查；

（3）通知制造厂；

（4）不要卸车；

（5）对可见的损伤部位拍照或录像。

(1) Do not open the transformer tank.

(2) Inform the transportation department to inspect the damaged position immediately.

(3) Inform the factory.

(4) Do not unload the transformer.

(5) Take photographs/videos of visible damage areas.

3 验收和保管贮存

3. Inspection, Acceptance and Storage

3.1 到货验收

3.1 Inspection, Acceptance

3.1.1 应按订货合同验证铭牌、附件、备件。

3.1.1 Check nameplate, accessories, and spare parts according to the contract.

3.1.2 应检测变压器主体在运输过程中与运输车的相对位移量，安装冲击记录仪运输的变压器应检查冲击记录仪记录情况，并作好记录；再进行外观检查，查看是否有碰撞损坏现象。若发现问题，应立即与承运人和运输部门联系，共同查明原因，以便妥善处理，并将有关情况通知制造公司，作好记录。

Check for any displacement between the transformer and the vehicle, the steel ropes used for fixation are intact without breakage. The consignee and the shipper shall check the three-dimensional shocking recorder for the transformers transported with a three-dimensional shocking recorder. Check for any cracks in the welds of the bottom limitation device and make a record. Inspect the transformer for any damage, deformation, cracks, etc. If any abnormality is found in the transformer or if there are abnormal records in the three-dimensional shocking recorder, the consignee should promptly negotiate with the carrier, stop unloading the good and notify the manufacturer immediately.

3.1.3 带油运输的变压器检查有无渗漏油及油面高度，并做记录；充氮运输的变压器应检查氮气压力是否保持正压力，并作好记录。

For transformers transported with oil, check the transformer and no oil leakage permitted. For transformers transported with gas, the gas pressure should be maintained in positive, all checking results should be recorded.

3.1.4 应检查附件包装箱有无破损、丢失现象。若有问题，应作好记录，并与制造公司联系， 核对损坏、丢失情况，以便妥善处理。

Detailed records should be made for any damages/shortages/non-conformance term during inspection and acceptance. The consignee and the manufacturer shall check the package quantity as per the delivery list. If there is any problem, please contact the manufacturer immediately for an appropriate resolution.

3.1.5 应按产品发货清单一览表，核对货箱数及附件数，再检查有无破损、丢失等现象。若有问题应立即与制造厂联系，以便妥善处理。

Check the accessories packing according to the "Product Packing List, Packing Inventory, and delivery pictures" and make a record. Verify the types of the accessories/components in every case. Check for any damages or missing items and make a record of it. In case of any issues, please contact the carrier and the manufacturer promptly.

3.2 附件开箱检查验收

Checking and Acceptance of Accessories

3.2.1 货到现场，需安装时，应提前与制造公司联系，告知开箱时间，与制造公司共同进行开箱检查验收。如果提前开箱效验，需提前通知我公司售后部门。

The consignee should inform the manufacturer the unpacking inspection time in advance and open the packages and inspect the accessories in the present of

manufacturer's representative.

3.2.2 应按各装箱单，核对箱内零件、部件、组件是否与装箱单符合，检查有无损坏现象，并作好记录。

The consignee and the manufacturer shall check the package quantity as per the delivery list and make a record. Verify the types of the accessories/components in every case.

3.2.3 应核对出厂文件及技术资料、合格证书是否齐全。

Check USER'S MANUAL, TECHNICAL DOCUMENTS, DRAWINGS CERTIFICATES OF TRANSFORMER AND ACCESSORIES.

3.3 保管及贮存

On-site Storage and Handling

3.3.1 经开箱检查，核对无缺陷验收后，应详细记录签收。

After the unpacking inspection, the acceptance document for signing should be completed.

3.3.2 经开箱检查的零件、部件、组件应按其性能特点进行保管，必须有防雨水、雪、腐蚀性气体直接侵入的措施。

Different accessories and parts should be stored separately according to their specific characteristic, the warehouse shall be weatherproof and no corrosive gases.

3.3.3 仪器仪表及带有电气元件的组件（如电动操作机构，控制柜等），应放置在通风干燥的地方，并有防潮措施。

Instruments, meters and electric parts should be put at dry and ventilating place, and moisture-proof.

3.3.4 带油运输的变压器到达现场，当需要存放且存放期超过两个月时，应在第一个月内装上储油柜（包括有载调压开关储油柜），注入合格的绝缘油至储油柜相应温度的油面高度，并在储油柜上装置吸湿器。或在未装储油柜的情况下，变压器上部抽真空后，充以 0.01～0.03MPa、纯度不低于 99.99%，露点低于-40℃的氮气。

For transformers transported with oil that will not be installed in two months from the date of arrival at site, please install the conservators both the main tank and the OLTC within the first month of arrival. Enough qualified oil shall be filled in the tank up to the oil level as per corresponding temperature. A dehydrating breather shall be installed. Oil replenishment must be done through the butterfly valve on the tank cover or the valve on the conservator to prevent air from entering the tank. If the conservator shall not be installed, the upper non-oil-filled space in the tank should be evacuated and filled with dry pure nitrogen (dew point below -40°C, pressure 0.01 MPa to 0.03 Mpa, purity: 99.99%).

3.3.5 充氮运输的变压器一个月不进行安装，应排出氮气，注入合格的绝缘油，安装好储油柜和吸湿器。在排氮注油过程中，应注意工作人员安全，远离变压器，以防窒息。当不能及时注油时，应继续充与原气体相同的气体保

管，但必须有压力监视装置。压力应保持为 0.01～0.03MPa，气体的露点应低于-40℃。

If transformer is transported with nitrogen, and after its arrival it will be put in storage for more than 1 month, then the transformer should be exhausted the nitrogen and filled with qualified insulation oil, installed the conservator and dehumidifier. Exhausting nitrogen and filling transformer oil, operators must be far away from the transformer, avoid being asphyxiated. If transformer is not filled with oil in time, it should be stored by filling the same gas with 0.01~0.03Mpa pressure and dew point lower than -40℃.

3.3.6 电容式套管存放期超过六个月时，应把套管端头抬高与水平夹角不小于15°或从包装箱内取出垂直存放。

Condenser type bushing which being stored for more than 6 months shall raise its terminal at an angle more than 15° from horizontal, or they should be stored vertically after removing to package. Seal both terminals of the bushing by plastic.

3.3.7 设备在保管期间，应经常检查。充油保管的应经常检查有无渗油，油位是否正常，外表有无锈蚀，并每 5 个月检查一次油的绝缘强度；充气保管的应检查气体压力，并做好记录。

Regular inspections such as checking of leakage/rust/oil level should be carried out. Oil samples test such as measurement of breakdown voltage, water content, dielectric loss should be performed every five months. Check the nitrogen pressure of the main tank regularly and make records.

3.4 绝缘油的管理

Acceptance and Storage of Transformer Oil

3.4.1 绝缘油过滤注入油罐时，应防止混入杂质、潮气、雨水和空气污染，严禁在雨天进行倒罐过滤油。

It is strictly prohibited to filter oil and transfer oil during rainy, snowy, foggy days. When filtering and injecting transformer oil into the oil tank, precautions must be taken to prevent the entry of impurities and moisture, and to avoid contamination by air.

3.4.2 装油容器应严格清洗干净，并检查容器密封情况；

Transformer oil should be preserved by sealed and clean dedicated tanks /containers.

3.4.3 注入变压器内的绝缘油，应达到表 1 指标。

1 Requirement of transformer oil before filling oil inside of transformer

表 1

电压等级，kV Rated Voltage	击穿耐压，kV Breakdown Voltage kV/2.5mm	介质损耗因数 90℃时 Measurement of tanδ（90℃）	微水含量 Water content in oil 10^{-6}

66	＞40	＜0.010	＜20
110	＞50	＜0.010	＜15
220	＞50	＜0.010	＜15

3.4.4 一般情况应尽量使用制造厂提供的绝缘油；如需补充其他来源的绝缘油应符合混油规定，并经有关单位试验，确定混油的相容性，否则严禁混合使用。

Check the brand and specification of transformer oil as per the contract. It should not be mixed or stored in same transformer with different type/brand/grade insulating oils. If different oil must be filled in same transformer, mixed oil tests should be carried out and the oil should be compatible.

3.4.5 变压器油的存储应使用密封清洁的专用油罐或容器，不同牌号的变压器油应分别贮存与保管，并做好标识。

Different types /grades/brand transformer oil should be stored and handled separately in special containers and labelled properly.

3.4.6 使用存放超过 90 天的变压器油在使用前需进行试验，达到变压器油的标准 GB/T7595《运行中变压器油质量标准》后方可注入产品中。

Transformer oil that has been stored for more than 90 days shall be tested before oil filling and can be filled into the transformer only the test results meet GB/T7595 "Quality Standards for Transformer Oil in Operation".

3.4.7 严禁在雨、雪、雾天进行倒罐滤油。变压器油过滤注入油罐时，须防止混入杂质，进入潮气，被空气污染。

It is strictly prohibited to filter oil and transfer oil during rainy, snowy, foggy days. When filtering and injecting transformer oil into the oil tank, precautions must be taken to prevent impurities and moisture, and to avoid contamination by air.

3 整体复装

Final Assembly at Site

4.1 基于变压器设计制造水平的提升，变压器内部稳定性提高。为使产品保持良好的绝缘水平， 变压器到达现场后，一般情况下不需要进行吊芯检查，可通过观察孔或升高座进行器身位置检查,直接进行复装。而对于运输安装过程中发生了大的冲击、碰撞、或运行中出现故障等特殊情况下产生问题需全面检查及排除故障，应按附录 B 器身检查进行后，再进行复装。

We are improving transformer design and workmanship; the active part stability has been increased. In order to unsure good insulation, open tank and lifting core for inspection is not required on site. The tank position can be checked through observation holes(manhole) or by raising the base, and the transformer can be installed at site directly. For special cases where accident occur due to impacts/collisions during transport and installation, or faults during operation, the transformer and active part shall be inspected and tested as per Annex B before

reassembly.

4.2 整体复装的注意事项

Cautions for Overall Reassembly

对吊罩检查的变压器复装前，应对器身要进行下列各项测量：

All the following checking and tests shall be carried out before reassembling a transformer which being checked by opening tank and checking active parts:

- 铁心与夹件之间的绝缘电阻（测量完毕，夹件必须接地）；
  Insulation resistance between the core and clamps (after finishing measurement, the clamps must be grounded).
- 心柱和边柱的屏蔽接地检查（指装有屏蔽产品，屏蔽必须接地）；
  Check grounding between the core and frame (for transformers with shielding, the shield must be grounded).
- 夹件对铁心及油箱间的绝缘电阻（测量完毕，铁心与油箱必须接地）；
  Insulation resistance between clamps and tank (after finishing measurement, the core and tank must be grounded).

4.2.1 应严格清理所有附件及密封制品，并擦洗干净，以及擦净箱沿密封槽内的变压器油。安装部门自行配制的油管路，也须严格进行清理，管路系统内不允许存在焊渣和异物等，并作好安全记录。自行配制的油管路，不允许在管道内加装金属网，以免金属网冲入油箱内，危害变压器的安全运行。

All accessories and sealing products should be thoroughly cleaned, no oil in the tank sealing groove. Any oil pipeline systems prepared by the installation department should also be thoroughly cleaned, and no welding slag or foreign objects should be inside the pipeline. Metal mesh is not allowed to be installed inside self-prepared oil pipelines to prevent metal mesh from entering the oil tank, which could endanger the safe operation of the transformer.

4.2.2 检查各法兰口是否清洁及密封衬垫是否完全光洁、完好。

All flange openings should be clean, and the sealing gaskets should be completely clean and intact.

4.2.3 紧螺栓时应均匀对称拧紧。

Tighten the bolts evenly and symmetrically.

4.2.4 密封垫压紧后不应偏心。

After tightening the sealing gaskets, they should be in the central part.

4.2.5 吊装时，注意不应磕碰，绳索必须绑扎牢固。

During transformer lifting, impacts are not allowed, lifting ropes must be securely fastened.

4.2.6 开关顶盖及防爆盖严禁踩踏。

No man shall step on ON-LOAD TAP CHANGER covers and explosion-proof covers.

4.2.7 引线不应绞、扭或随意弯折。

The leads/wires should not be pulled violently, do not twisted/bent.

42.8 注意钢结构件上的标示应对号入座。

Markings on steel structural components should be matched.

4.2.9 没有使用的电流互感器二次侧应短接。

Check the wiring of the current transformers, and the current transformers without loads shall be properly short-circuited and grounded. CT operation by open circuit is strictly prohibited.

4.2.10 在变压器上安装时，不应将其它无关物品带上变压器，以免掉入油箱内。将所有的标准件及工具装在准备好的容器内。

No components/tools/bolts/nuts shall fall into the transformer tank, and all standard parts and tools should be placed in prepared containers.

4.3 组装前的准备工作

Preparation for overall installation

4.3.1 参照油纸电容式变压器套管使用说明书，测量套管性能指标。

For OIP bushings, measurement shall be carried out as per user's manual.

4.3.2 参照温度控制器使用说明书，整定温度限值。指针式温控器在调试时，禁止用任何拨动指针的方式调试，可在容器内盛热水，将温度探头浸入热水中，观察指针动作和触动接点导通，以达到调试目的。

Refer to the user manual (temperature controller) for setting temperature limits. For analog temperature controllers, adjusting the pointer in any way is not allowed. You can fill the container with hot water and immerse the temperature probe into the hot water to observe the movement of the pointer and the activation of the contact points for calibration.

4.3.3 参照气体继电器使用说明书，整定信号，动作整定值。

Check the gas relay for signal calibration and set the operation as per user's manual.

4.3.4 参照压力释放阀使用说明书，检查动作接点和复位情况。

Refer to the pressure relief valve user manual to inspect the contact operation as well as reset.

4.3.5 参照油位表使用说明书，检查油位表的动作灵活性。

Check the oil level gauge's operation as per user's manual.

4.3.6 参照储油柜的安装使用说明书，组装储油柜。

Install the conservator as per user's manual.

4.4 整体复装

Final Assembly

经过吊芯检查的回装，应保证其与油箱连结部位的绝缘。

All the assembly after checking by opening tank and lifting active part, the insulation of the tank and tank connection shall be good.

4.4.1 安装储油柜应参照储油柜安装使用说明书，安装油位表及联管和胶囊、吸湿器。储油柜与主体的安装，参照出厂文件中储油柜装配图进行联接装配。

Check the pressure of the rubber diaphragm bag, clean the internal and external surfaces of the conservator thoroughly, the diaphragm should be intact without any

damage. For the pipe-type oil level gauge, the oil level indicated by the oil pipe shall match the real oil level in the conservator. For the pointer-type oil level indicator, the float will move freely to avoid false oil level. The signal contact position of the oil level gauge should be correct and in good insulation.

4.4.2 压力释放阀的安装，请参照压力释放阀使用说明书装配。压力释放阀若带导油罩，应将导油罩的导油喷口装向箱壁外侧。

The pressure release device should be installed in the correct direction; the valve cover and the internal part of the turret should be clean, good sealing, accurate movement of electrical contacts, and good insulation, all the assembly should be as per the user's instruction.

注意：投运时，压力释放阀下面蝶阀应处于开启状态，有压板压力释放阀，压板应打开。

Note: The butterfly valve under the pressure relief valve should be open, open the pressure plate of the pressure release valve if appliable.

4.4.3 气体继电器及导气盒的安装参照气体继电器使用说明书与导气盒使用说明书。无励磁调压变压器只有一个气体继电器，应装在储油柜与油箱之间的联管上。有载调压变压器在有载调压开关与开关储油柜间还有一个φ25 的气体继电器。气体继电器安装时，箭头应指向储油柜，还应检查导气盒铜管是否畅通。在送电前，应检测气体继电器是否动作可靠，整定值按用户要求提前整定好。

Installation of gas relay and gas collection box should be as per the user's instructions. For off-load tap changer (OFTC) transformers, one gas relay is fitted on the tank, which should be installed on the interconnecting pipe between the conservator tank and the main tank. For on-load tap changer (OLTC) transformers, t a φ25 gas relay between the OLTC and the OLTC oil conservator. The arrow on the gas relay should point towards the conservator tank. The copper pipe of the GAS COLLECTION BOX should be checked for blockage. Before commissioning, the gas relay should operate reliably. The setting value should be preset according to user requirements.

4.4.4 套管安装，请参照套管使用说明书 。引线根部和接线柱根部不应硬拉、扭曲、打折。（66～110）kV 级以上引线根部锥度绝缘，应进入均压球内。从视察窗中观察，并加以调整，套管均压球以下 150mm 内引线应伸直，不允许弯折的地方。 均压球应拧紧，且均压球内应清理干净，套管及套管升高座按标记（钢号）对号入座。

Bushing installation should as per requirement of instructions. The lead and binding post should not be pulled, twisted or bent. For (66~110)kV wires and above, the tapered insulation at lead ends should extend into the equalizing sphere. Observe through inspection window and adjust so leads are straight within 150mm below equalizing sphere without bends. The equalizing sphere should be tightened and cleaned inside. Bushing and bushing turret should be

matched per marked steel grades.

4.4.5 散热器的安装，请参照散热器使用说明书。风冷却变压器，采用宽片式或扁管式散热器，应防止散热器碰撞、变形，在规定位置上吊装散热器，防止相互碰撞，不可采用强行矫正，带应力安装，以免拉伤散热器造成渗漏油。

Preparations shall be as per user's manual before installation.

Fin-type radiators and coolers should be thoroughly flushed and sealed, free from rust/ rainwater/oil stains. Otherwise, the interior of the equipment should be cleaned with qualified insulating oil by an oil filtration equipment before installation, all remaining oil should be drained out.

4.4.6 风机的安装，请参照风机使用说明书。

注意：一般风机安装时风机铭牌向外侧安装。

The fan motor and blades should be securely fixed and shall rotate flexibly without any obstruction, no excessive vibration, no overheating occurs during test. The blades should be free from distortion/deformation, and do not contact with the air duct. The rotation direction should be as per the indication of on fans. Wires for power supply shall be properly insulated and oil resistance. Valves in the pipeline should operate flexibly, with correct opening and closing positions. The valve and flange connections should be well-sealed.

4.4.7 控制线路的安装，应按出厂文件中控制线路安装图，注意请提前在油箱箱体上安装线盒和布线，以免安装散热器后无法安装控制线。若产品带套管型电流互感器，应将测量控制回路联线接好。

注意：变压器在运行中，套管型电流互感器的二次出头不得开路，不接表计时,应将短接。

The installation of control wiring system should as per the secondary wiring diagram provided by the factory. Please ensure that the marshalling kiosk and wiring are installed on the transformer tank in advance to prevent difficulties in installing control wires after the radiators are installed. The bushing-type current transformers, the connections for measuring and controlling circuits should be properly linked.

Note: During transformer operation, the secondary terminals of bushing-type current transformers must not open circuit; they should be short-circuited.

4.4.8 有载分接开关的安装，应按其安装使用说明书，连接开关主体，安装水平、垂直传动轴，安装电动机构并进行档位和正反圈数校正，应保证电动机构、本体和远方指示三位一致；无励磁分接开关的操动杆和传动机构安装应保证三相分接位置一致。

Confirm that all operating lever is correctly positioned. All the positions indicated for all three phases should be consistent. The tap changer can be operated only after passing the inspection. The transmission mechanism, electric motor, transmission gears, and transmission rods in the operating

mechanism should be firmly fixed, correctly connected, and operate flexibly.

4.4.9 温控器安装，请参照温控器安装使用说明书，装温包时，温度计座内应注入距顶面 50mm 高的变压器油，温度整定值应提前按用户要求值整定好，并将远方和现场温度指示校准一致。

- The temperature measuring device should meet the requirements of the user's instruction. The thermometer should be calibrated, and the signal contacts should function correctly with good conductivity. The temperature indicator pocket on the top cover should be filled with transformer oil, the oil level shall be 50mm under the top cover and sealed without any oil leakage. The spare temperature indicator sockets should be sealed, no water shall enter. The temperature indicator should be adjusted according to the user's requirements, the remote display and local temperature display shall be same value.

4.4.10 装好所有联管及其零部件。

All the other pipes and components shall be connected.

注意：变压器设计时，已在整体及联管放坡，变压器在安装时地基不需整体放坡（除非另有说明）

All the transformer pipes are slope settling designed (unless otherwise indicated).

5. 真空注油 Vacuum Oil Filling

5.1 真空注油 Vacuum Oil Filling

充氮运输的变压器现场应采用真空注油工艺。 用不吊芯方法进行器身检查的变压器，也应按此项规定进行真空注油。真空注油的环境温度应≥5℃，油温应大于器身温度 15℃，以免空气中的水分凝结在器身和箱壁上。

For transformers transported with nitrogen, the transformer should be filled oil by vacuum on site. Transformers not being inspected by lifting active part should be filled oil by vacuum as well. Ambient temperature for vacuum oil filling should be ≥5° C, oil temperature ≥15° C active part temperature, moisture condensation on tank and walls are not allowed.

5.1.1 当日能完成器身检查和整体复装的变压器应在整体复装完成后，立即进行抽真空及真空注油。

If active-part checking and re-assembly can be finished within one day, transformer should be evacuate and filled with oil immediately after re-assembly.

5.1.2 当日不能完成器身检查和整体复装的变压器应及时注入合格的变压器油，应待次日放出油后继续进行器身检查和整体复装，完成后进行抽真空及真空注油。

Transformer shall be filled qualified oil in time if active part checking shall not be finished within one day, evacuate transformer and fill the oil as soon as inspection and re-assembly are finished completely.

5.1.3 带有载调压开关的变压器，应随变压器同时放出有载调压开关内绝缘油，

并用连通管在专设位置上连通开关油室和变压器油箱，以便开关油室同时进入真空，并同时接好有载调压开关油管，以便同本体同时真空注油。若开关不同本体一起注油，则真空注油前应将开关中加满油。

For transformer with OLTC (On-load tap-changer), the oil in the oil compartment of tap-changer also must be drained at the same time. Use a “U” type pipe to connect the tap-changer’s oil compartment with transformer tank so that the oil compartment can be evacuated at the same time. Oil-filling pipe of tap-changer also should be connected, so tap-changer can be filled with oil together. If the tap-changer isn’t filled with oil together with transformer tank, then it must be filled with oil before filling the tank.

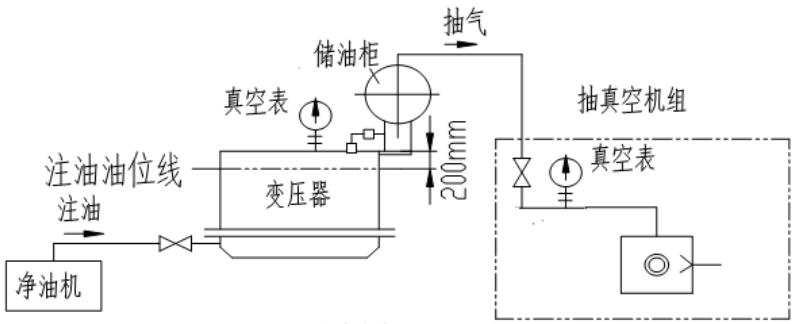
请注意：注油时应在油箱上安装压力真空表，以监视油箱内的真空度情况。

Notice: please install a vacuum meter to supervise the vacuum in the tank during oil-filling.

5.1.4. 操作过程：method

a 在变压器上安装好真空表。将变压器底部阀门用一根胶管连接到真空净油机进油阀门，滤油机进油管连接油罐。再用另一根胶管在变压器储油柜顶部连接到真空机组抽气阀，见示意图。

Install a vacuum gauge on the transformer. Connect a hose from bottom valve of transformer to the oil inlet valve of the vacuum oil purification unit. Connect the oil inlet pipe of the oil filtration unit to the oil tank. Use another hose to connect from the conservator tank top to the vacuum pump unit suction valve, as shown in the schematic diagram.



示意图

b 先打开箱盖上的阀门排空氮气，再起动真空机组的真空泵，运转正常后打开储油柜与真空机组连接阀门，对变压器本体抽真空。

open the valve on the tank cover to vent the nitrogen gas, then start the vacuum pump. After operation, open the valve connected the conservator and the vacuum unit to vacuum the transformer main tank.

c 根据电压等级变压器抽真空规定的真空度及抽真空时间见表 2

See Table 2 for required vacuum degree and duration for transformer vacuuming

d 抽到要求的真空度后，维持前真空度处理时间，然后打开净油机排油口阀门，在真空状态下注油，油温控制在 50±5℃，注油过程中，要继续抽真空，并控制注油过程中的真空度，同时减缓注油速度。

After the vacuum value meet the requirements, maintain the vacuum for the specified duration, then open the oil outlet valve of the purification unit to fill oil under vacuum. The oil temperature should be 50±5°C. Continue vacuuming the transformer during oil filling and monitoring vacuum while slowing oil filling rate.

Table 2 duration of vacuum

电压等级 Voltage kV	真空度 Vacuum Pa	持续真空时间 Duration h	注油保持真空度 Max. pressure, Pa
66～110	≤200	4	300
220	≤200	4	300

e 当油位距油箱箱顶 200-300 时停止注油。并在要求的真空度下维持后真空时间，对油脱气，如在注油后直接进行热油循环，可不进行 2h 的真空脱气。

Stop filling oil as soon as oil level is 200-300mm under tank cover. Maintain the vacuum at the specified value. If performing hot oil circulation after oil filling, the 2h vacuum degassing may be omitted.

f 后真空结束后，解除变压器油箱上部真空，此时变压器油应浸没所有的绝缘件。

Release vacuum from tank top. All insulation components should be submerged in transformer oil.

g 变压器抽真空脱气后，当变压器箱体内油位下降较大，可通过净油机适当补进一部分油至规定油位。

If oil level drops substantially after transformer vacuuming, re-fill oil by an oil purification equipment.

h 静放浸油，常压静放浸油时间见表 3

The transformer shall put for still settling and oil will cool down. The duration is indicated in Table 3

Table 3 duration

电压等级/kV **Rated Voltage**	66～110	220
静放时间/h **Duration**	10～12	12～16

i 静放结束后，才能进行电气性能试验。

All the electric tests shall be performed after still duration finished.

5.2 带油运输的变压器现场补充注油及静放

supplementary oil-filling and placing still for transformer transported with oil

本体带油运输，且现场不吊罩检查也不具备真空注油条件的变压器，待附件安装完成后进行补油处理。**注入变压器的油必须符合 3.4.3 表 1 的规定，试验合**

格后方可注入。

For transformers transported with oil and will not be lifted the active part for inspection, and vacuum oil filling was not possible, oil filling should be performed after accessory installation. The oil must meet the requirements in Table 1 of section 3.4.3 and be tested qualified before filling.

5.2.1 补充油必须从箱盖上或储油柜的碟阀进油，以避免空气进入器身。装置补充注油管路（因补注油须从油箱上部进行，以免造成油箱内经真空处理好的绝缘油混入气泡）。

Oil filling must be through the drainage valve on conservator/tank cover to prevent air from entering the tank. Set up oil filling pipes (oil filling should be from tank top to avoid bubble occurring in the oil).

5.2.2 安装气体继电器时同时打开储油柜、净油器及其它应投入运行的蝶阀、闸阀，并检查阀门处于开启状态后定位。

After installing gas relay, please open butterfly valves and gate valve of conservator and oil-filter or other valves which should be open during transformer operation. And lock them after the valves are open.

5.2.2 拆除有载分接开关油室与变压器油箱连通的连通管，并密封好此处法兰，同时安装好开关储油柜。

Remove pipes between on-load tap-changer and transformer tank, and seal the flange, install the conservator of tap-changer.

5.2.3 打开注油阀门补充注油，同时按油面上升高度逐步打开升高座、导气管、冷却器集油盒的放气塞、散热器等最高位置放气塞进行排气，出油后即旋紧放气塞。

Open oil-filling valve to fill supplementary oil and open the air-release plug of ascending flange, air conduit, oil-collecting box of cooler or radiator according to the rising of oil level, screw the plug immediately when oil overflows.

5.2.4 注油至储油柜相应温度的油位高度（储油柜排气，参照储油柜使用说明书），同时经有载分接开关储油柜注油到相应温度的油位高度。

Fill oil to the oil level in conservator as per the ambient temperature (conservator air releasing refers to its instruction). The conservator of on-load tap-changer should be also filled with oil to the level corresponding to the temperature.

5.2.5 整体密封性试验，一般采用油静压法，压力应不大于 0.03MPa。将注满油的变压器静放 24h，检查油箱各处有无渗漏油现象。若有渗漏，要及时处理，直至无渗漏为止，密封试验结束。

Oil leakage test is usually by oil static-pressure method with maximum pressure 0.03MPa. Still the oil-filled transformer for 24h to check tank sealing. If any, it should be treated soon till no leakage.

5.2.6 总的静放时间，从补充注油结束算起，应不小于 72h。在这期间，应多次放气。

The total duration of still placing should be more than 72h from complement of supplementary oil-filling. Release air repeatedly during static settlement.

5.3 全真空储油柜产品的注油

Oil-filling of full-vacuum-type conservator

对于全真空储油柜产品，在安装现场条件具备的前提下，应对变压器总体（包括储油柜、散热器等附件）进行抽全真空（但应防止胶囊破损），并一次性注油至储油柜相应温度的油位高度，具体操作、整体密封性试验要求如上述。

For the full-vacuum type conservator, if possible, the transformer (including conservator, radiators and other accessories) has to be vacuum-pumped (the air bag in the conservator should be protected from damage), and fill oil corresponding to the temperature, the detailed operation and the requirement of sealing test of transformer is stated above.

6 交接试验与试运行 Acceptance test and Commission

6.1 交接试验前的检查 Check before acceptance test

6.1.1 检查分接开关位置，无励磁分接开关的分接位置三相是否一致。带有载分接开关的，检查电动机构与开关刻度盘及远方指示数据是否一致。

1.1.1 Check the positions of the tap changer on all phases, the tap position indication shall be accurate. All the tap indication in motor drive mechanism and remote tap position indication is the same.

6.1.2 变压器外部空间绝缘距离，应不小于表 4 规定。

Minimum External Insulation Clearance of the transformer should be as per table 4.

Table 4

Rated voltage kV	Maximum operating voltage Um/kV	Separate Source Withstand Voltage (AV)/kV		Rated lightning impulse withstanding voltage (LI)/kV	Minimum Air Clearance mm		
		Phase-earth	Phase-phase		Phase-earth	Phase-phase	To other winding terminal
66	72.5	140	140	325	630	630	630
110	126	200	200	480	950	950	950
220	252	360	360	850	1600	1800	1600

注：表中为海拔高不大于 1000m 数据。当海拔高度超过 1000m 而小于 2500m 时，每超过 100m 按表中数据增加 1%计算。

Note: The data in the table is based on the maximum altitude 1000m. It will

increase 1% per 100m as altitude is over 1000m but below 2500m.

6.1.3 检查储油柜油面高度有无假油位、是否与环境温度相符合。如果储油柜油面低于正常油面，可以从储油柜下的注油管加油，加油时，应先把注油管的活门上的放气塞打开，等放气塞流油后再进行加油。

Check the oil level in the conservator. If the oil level is below normal level, fill oil from the oil-filling pipe under conservator. Firstly, open the air-relief plug on oil-filling valve until the oil-relief plug has oil flowing out, and then fill oil.

6.1.4 检查接地系统是否可靠正确。

Check the grounding system.

6.1.5 检查铁心接地，应保证一点接地，不能形成回路。

There should be a single-point grounding, the core, upper and lower clamps should not be a loop after being connected.

6.1.6 检查油箱是否可靠接地。

Check the proper grounding of the tank. The tank should be reliable grounded by the grounding bolts on the tank if applicable.

6.1.7 投入运行的组件阀门（事故放油阀、真空注油阀除外），是否呈开启位置。气体继电器、升高座等装置应再次排气。

Turn on the valves(except emergency oil-draining valve, vacuum oil-filling valve), check cooler's operation, the control circuit shall be correct. The gas relay should be installed in the correct direction, oil shall be filled properly, and the gas is fully discharged.

6.1.8 温控器的检测，按使用说明书将温度控制限值整定到用户需求值。

Check the measurement circuits temperature gauge. Verify that the wiring of protection/control/signal circuits is correct, ensure the proper and reliable operation of circuit breakers for each protective equipment.

6.1.9 对二次线路的检测，将高、低油温节点短路，或将过负荷电流继电器节点短路，通电后风机正常运转。

7 Check and test the circuits of the gas relay, pressure relief valve, oil level gauge, temperature gauge, and bushing-type CT. Verify that the wiring of protection/control/signal circuits is correct, ensure the proper and reliable operation of circuit breakers for each protective equipment. The overload contacts of current relay are shorted the blower fans should operate or stop normally.

6.1.10 检查油位表、压力释放阀、气体继电器、温控器等各报警、跳闸回路是否畅通

Check the alarm and trip circuit of oil level indicator, pressure-relief valve, gas relay, temperature controller are expedite.

6.2 交接试验

Pre-commissioning tests(SAT)

在外表检查和交接试验前的检测项目均符合要求时，方可进行下述试验。

All the visual inspection and pre-commissioning tests should meet the requirements, and the following tests can be performed.

6.2.1 空载试验和空载冲击合闸试验（冷却器不投入运行）。

No-load test and no-load switching-on impulse test (coolers shall not be in operation).

① 变压器应由电源侧接入电压,因为电源侧装有保护装置,以便保证在非正常情况时切断电源。

Voltage input in the transformer should be connected from the power supply side for where the protective system is mounted.

② 将变压器的气体继电器的信号接点，改接至变压器电源的跳闸回路。

Change the signal contacts of the gas relay to be connected to the trip circuit of the transformer power supply.

③ 将过电流保护时限整定为瞬时动作。

Set the overcurrent protection to instantaneous action.

④ 变压器接好加压线后，电压应由零徐徐上升至额定电压保持 1 小时，在此期间变压器应无任何异常现象。

The transformer shall be connected to the boost line and the voltage be increased gradually and maintain it for 1 hour, no abnormal phenomena will occur on transformer.

⑤ 紧接着④试验后继续徐徐升压到 1.1 倍额定电压后，保持 10min 应无异常现象，再徐徐降压。现场如不具备徐徐升压的条件，可改为空载一小时试运行，当顶层油温低于 42K，可不开动散热器风扇或不投入冷却器。

After measuring the transformer, please continue to increase 110% rated voltage and maintain it for 10 minutes without any abnormal phenomena, and then reduce the voltage. If it is impossible for increasing voltage on-site, one hour of no-load commission should be performed. The radiator/fans/cooling equipment shall be turned off if the top oil temperature is below 42K.

⑥ 对于有载调压变压器，有载分接开关在额定电压下电动操作两周，最后调整到额定分接位置。

For the transformer with on-load tap changers, please operate the OLTC at the rated voltage for two circulations, the tapping should be at the rated voltage.

⑦ 空载冲击合闸试验。

No-load switching-on impulse test

a. 气体继电器信号触头调整到报警回路,跳闸触头接到继电器保护跳闸回路,过电流保护调整到保护整定值。

The signal contacts of the gas relay should be in the alarming, and the trip contacts should be in protective tripping. Adjust the overcurrent protection to the set value.

b. 所有引出中性点(包括 110kV 侧)必须大电流接地。

All the neutral points of the transformer shall be connected (including 220kV and 110kV sides), a large-current ground connection is necessary.

C. 在额定电压下，对变压器进行 3～5 次冲击合闸试验，监视激磁涌流冲击作用下的继电保护装置的动作情况。

3-5 times of switching-on impulse tests at the rated voltage of the system on the transformer shall be performed and monitor the operation of the protection devices.

6.2.2 耐压及局部放电试验

Transformer voltage withstand test and measurement of partial discharge

① 具备条件时,可进行耐压试验,试验电压值可按相应标准或技术协议。

Transformer voltage withstand tests shall be carried out according to the requirement of the IEC standard or the technical agreements if applicable.

② 具备条件时，可进行局部放电试验，试验方法和施加电压可按相应标准或技术协议。

Measurement of Partial Discharge shall be carried out according to the requirement of the IEC standard or the technical agreements if applicable.

6.2.3 按国家标准或技术协议进行其它试验项目，系统调试时对变压器进行的其他高压试验应另行协商。

Other test should be carried out according to IEC standards or technical agreements. The high-voltage tests on the transformer during system commissioning should be negotiated and agreed.

6.2.4 试验结束后拆除变压器的临时接地线。

Remove the temporary grounding wires from the transformer after the tests.

6.3 试运行前的检查

Checking before Commissioning

6.3.1 无励磁分接开关应在无激磁状态下连续调换分接档位，以消除油膜对接触电阻的影响，然后将档位对准，此时开关动静触头间的接触直流电阻小于 500μΩ。各分接开关要处于同一档位，且与线路电压相符合。

The off-circuit tap-changer should continuously be changed at non-excitation to eliminate the impact of the oil film on the contact resistance, adjust the tapping position. The maximum contact DC resistance between the moving and static contacts of the switch is 500 μΩ. Each tap changer must be in the same gear and consistent with the line voltage.

6.3.2 套管中法兰引出的小瓷套，在变压器运行时，应可靠接地。

Check the core earthing. The core must be reliably grounded If the core (clamp) is grounded via a grounding bushing.

6.3.3 检查变压器带电侧中性点是否已可靠接地（冲击时应直接接地）。

Check the grounding of the accessories/components, all the grounding should be correct and reliable, such as the neutral of the transformer.

6.3.4 检查各保护装置，断路器整定值和动作灵敏度是否良好。

Check the protection devices, the settings and actions of all breakers.

6.3.5 检查继电器保护，如气体继电器、温控器、压力释放阀及套管式电流互感器测量回路、保护回路与控制回路接线是否正确，必要时进行短路联动试验。

Check the measurement circuits of the gas relay, pressure relief valve, oil level gauge, temperature gauge, and bushing-type CT. Verify that the wiring of protection/control/signal circuits is correct, ensure the proper and reliable operation of circuit breakers for each protective equipment.

6.3.6 检查套管式电流互感器二次侧不带负荷的是否已短接，不允许开路运行。

Check the wiring of the current transformers, and the current transformers without loads shall be properly short-circuited and grounded. CT operation by open circuit is strictly prohibited.

6.3.7 检查储油柜吸湿器是否畅通。

The connection pipes between dehydrating breather and conservator should be sealed well; all pipes should be unobstructed.

6.3.8 重复检查接地系统是否接地可靠。

Repeated checking of the grounding system.

6.3.9 查对保护装置整定值，系统电压不稳定时，应适当调整保护系统整定值，以便有效的保护变压器。

Check the pre-set value of protecting device, when the system voltage is not stable, adjust the pre-set value of protecting system suitably in order to protect the transformer effectively.

6.3.10 在上述检查及试验项目符合要求时,方可进行空载试验和空载冲击合闸试验。

Only the above checking and tests conforming with the requirements, can the transformer be switched on and commissioned without loading.

6.4 投入试运行 Commissioning

试运行首先将冷却系统开启，待冷却系统运转正常后再投入试运行。

Turn on the radiators/fans/oil pumps, once the cooling system work normally, the transformer shall be put into daily operation.

6.4.1 空载试运行，变压器应由电源侧接入电压后，如有条件由零点徐徐上升至额定电压，也可用电压冲击合闸。

The transformer shall be put into no-load trial operation and the voltage be increased gradually; this is applicable for no-load voltage switch-on test as well.

6.4.2 变压器空载冲击合闸，应注意下列事项:

Precautions for No-load test and no-load switching-on impulse test

a) 空载冲击合闸前，变压器应静放 24h 以上，装配放气塞的升高座和套管要定时放气；

Before no-load switch-on commissioning, transformer should be placed in still for more than 24 hours, the ascending flange and bushing should be air released regularly from the air relief plug.

b) 空载冲击合闸前，过流保护动作时限应整定为零，气体继电器信号回路暂接入分闸回路上；

Before no-load switching-on commissioning, actuating time limit of over current protection should be preset to zero; signal contacts of gas relay should be connected into trip circuit temporarily.

c) 电源三相开关不同步时差应小于 10ms,合闸应有避雷器保护，变压器中性点应可靠接地（应直接接地）；

The out-off-step time difference of three-phase tap changer connected at power supply side should be less than 10ms, when the transformer is switched on it must be protected by lightning arrester, the neutral of transformer should be earthed reliably (earthed directly).

空载冲击合闸电压不能超过变压器的档位指示电压的 5%，合闸次数最多应为 5 次，第一次受电后持续时间应不小于 10min,每次合闸间隔时间应不小于 5min；

5 times of switching-on impulse tests at the rated voltage of the system on the transformer shall be performed at most. The maximum voltage of no-load switching-on should be 105% of the voltage corresponding to the tap position. The minimum duration of the first energization should be 10 minutes, and the minimum duration of other energizations should be 5 minutes.

d) 试验结束后，应将气体继电器信号接点接报警回路，分闸接点接分闸回路，并调整过流保护限值。

After finishing test, connect the signal contacts of gas relay into the alarm circuit, tripping contacts be connected to the trip circuit, and adjust the limit of overcurrent protection

6.4.3 带负载试运行 Loaded commissioning

6.4.3.1 空载试运行 24h 无异常后，可转入带负载试运行，应逐步分级地从 25%、50%、75%到 100%增加负载。

Once the transformer has completed no-load commissioning for 24 hours successfully, the transformer shall be put into on-load operation. Its load will be increased from 25% to 50%, 75%, up to 100% gradually.

6.4.3.2 在带一定负载连续试运行 24h 后，变压器主体及附件均正常，变压器便转入正常运行。

After commissioning with certain load continuously for 24 hours, the main body and accessories of transformer are all normal, then the transformer will be put normal operation.

7 运行维护 Inspection and Maintenance

7.1 正常运行 Normal operation

7.1.1 经试运行无异常现象发生，则认为变压器已正式投入运行。

If NO abnormal phenomenon occured in commissioning, it means the transformer has been put into normal operation.

7.1.2 在正常运行阶段，应经常查看油面温度，油位变化，储油柜有无冒油或油位下降现象。如果检查出气体继电器内有可燃性气体时，应立即查明原因，是否由密封不好或其它原因所致。

During the daily operation, check the top oil temperature and oil level regularly. If the oil in conservator overflows or the oil level descend. If it is found that there is the flammable gas in the gas relay, should find out its reason.

7.1.3 查看、视听变压器运行声音是否正常，有无爆裂等杂音和冷却系统运转是否正常，散热器、冷却器、辅助冷却器、备用冷却器是否均能按规定整定值自动投入和切除。对风冷变压器，当达到额定电流的 2/3 或油面温度达到 65℃时，应投入吹风装置，当负载电流低于 1/2 额定电流或油面温度低于 50℃时切除风扇。对强油风冷变压器应按负载情况自动投入或切除相当数量的冷却器（见 7.4 条）。

Check, watch and listen if the sound of transformer is normal and has the noise of implosion, and the cooling system is normal. Check if the radiators or coolers and auxiliary and spare cooler can run and stop automatically according to the regulated preset value. For forced-air-cooled transformer, when the transformer reaches 2/3 rated current or top oil temperature reaches 65℃, blast devices should be started when load current is less than 1/2 rated current or top oil temperature is less than 50℃, fans should be stopped. For forced-oil & forced-air-cooled transformer, a corresponding number of cooler should be automatically put into running or stopped according to loading situation.

7.2 维护 Inspection and Maintenance

7.2.1 投入运行的变压器每六个月应对变压器油样进行监测，如发现油中溶解气体指标超标，或其他性能指标超过限定值时，应进行油色谱跟踪，当超标 2 倍时，应停止运行，查明原因。

Taking and testing oil sample every six months, if the gas dissolved in the oil is over regulation or other performance index is over limit value, analysis the oil chromatogram, when the value is over two times standard, stop operating and find out the reason.

7.2.2 油浸式风冷变压器风扇停止工作时，顶层油温不超过 65℃时，允许带额定负载运行。强迫油循环的变压器，如果冷却系统故障停电，切除全部冷却器时，在额定负载下允许运行 20min，若油面温度未达到 75℃，则允许上升到 75℃，但最长运行时间不应超过 1h。

The oil immersed ONAF cooling transformer when fans stop working and if the top oil temperature is no more than 65℃, the transformer is allowed to operate with rated load. For OFAF or ODAF cooling transformer, if power

supply of the cooling system is failure and all coolers are cut off, the transformer should be run for 20minutes at most with rated load; if the top oil temperature lower than 75℃, then the oil temperature can rise to 75℃, the maximum operation time should be 1 hour.

7.2.3 变压器铁心的接地套管在运行状态下，应有效接地。测量铁心接地电流不应超过 0.1A，注意避免铁心多点接地和瞬间开路。

Earthing bushing of transformer core should be earthed effectively when transformer is in operation. The maximum core earthing current measured should be 0.1A. The core SHALL NOT BE earthed at multiple point and being instant open-circuit.

7.2.4 有载分接开关，应每三个月取一次油样试验，必要时应过滤油室中变压器油或更换变压器油。记录有载分接开关操作次数，当有载调压开关在某时期动作频繁时，应缩短取油样试验的周期。

Maintenance of OLTC refers to instruction of OLTC. Oil samples should be taken for testing every three months. If possible, the transformer oil in the oil chamber should be filtered or replaced. The operations number of the on-load tap changer should be recorded. If the on-load tap changer operates frequently during a certain period, please take sample oil and carry out oil test.

7.2.5 检查净油器、吸湿器吸潮剂，受潮率达 60%时应更换。

Check silica gel in oil purifier and breather, change them if the ratio of damping reaches 60%

7.2.6 定期检查风扇电机运转是否正常，如果有扫堂现象应立即退出运行，进行检查或更换。

Check fans regularly if the fan-motor appears the phenomenon hitting housing, quit operation and check or change it.

1.1.2 7.2.7 定期测量绝缘油电气强度、介质损耗因数 tan δ、含水量、酸值与原始记录比较。

Measure the dielectric strength of insulation oil regularly, dielectric loss factor(tan), moisture content, acid value, and compare them with the original record.

7.2.8 测量介质损耗因数应注意：电网系统内消弧线圈对测量结果有严重影响，测量时，应停止使用消弧线圈。当系统内干扰很强无法测出介质损耗因数（tan δ）时，应采取措施消除干扰，再进行测量。

Measuring the dielectric loss factor, the arc-suppression coil in network system has interferences to the measured result. When the dielectric loss factor is being measured, the arc-suppression coil should be stopped. If the system is effected by heavy interference that there is no way to measure the dielectric loss factor, take

measures to eliminate the interference and try again

7.2.9 检查继电器保护（气体继电器，释压器等）和差动保护接点回路，接线是否牢固、接线端子电缆有无发热老化现象。

Check the circuit of relay protection (gas relay, pressure relief valve) and differential protection, the wiring connections should be firm and the connecting cables should not be heating or aging.

7.2.10 定期检查，装配螺栓是否松动，密封衬垫有无老化及渗漏情况，日常维护时如发生以上问题时，应立即修复或通知制造厂协助修复，并作好记录。

The bolts/nut/washer should not be loose and sealing gasket should not be aged. If the above problems come about in daily maintenance, repair it immediately or inform the manufacturer to help to repair and record it in detail.

7.2 变压器故障分析和排除

Analysis and elimination of transformer faults

7.3.1 如果气体继电器报警，应迅速查明原因，收集气体进行分析。

If gas relay alarms, find out the reason as soon as possible, collect the gas to analyze.

7.3.2 绝缘油如果出现不合格现象，应立即采取处理措施。

If insulation oil is unqualified, take measures to process oil immediately.

7.3.3 变压器运行发生下列情况时，应立即停止运行，进行器身检查:

a) 变压器油温升超出允许值时；
b) 因大量漏油，油面急剧下降不能处理时；
c) 在正常冷却，正常负荷下，油面不正常上升时；
d) 变压器内部声音不正常，不均匀，有爆裂声音时；
e) 储油柜、开关防爆膜破裂喷油时；
f) 压力释放阀动作喷油时；
g) 油的颜色变化严重，油内出现碳化时；
h) 套管严重损坏，有放电时；
i) 色谱分析，有可燃性气体，总烃增长率过快时。

If transformer is in operation, any of the following situations appears must stop transformer operation immediately and check the active part.

a) When oil temperature rise exceeds allowable value;
b) When oil level descends too rapidly because of the large quantities of oil leakage;
c) When oil level rises abnormally under normal cooling and loading;
d) When the sound in transformer isn't normal or uneven, well-proportioned and bursting noise;
e) When oil sprays from on-load tap-changer because of breakage of bursting disc;

f) When pressure relief valve is actuated and oil sprays occurs;

g) When great change in oil color and the oil is carbonized;

h) When bushing is broken seriously and discharges;

i) When there are flammable gases occurs in chromatographing and the growth rate of the total hydrocarbon is too fast.

7.3 强油冷却系统的运行及维护

The operation and maintenance of the forced-oil-cooling system

7.4.1 强油循环系统应具备有两路独立电源供电，一路出现故障，另一路自动投入继续供电。当两路电源全部停止供电时，冷却系统处于自冷状态，此时若变压器带额定负载，允许运 20min；若负载不满，油面温度不超过 75℃时，允许继续运行，但运行时间不应超过 1h.

Forced oil circulating system should have two separate power suppliers, when one power fails, the other power shall continue to supply electricity. If failure occurs on both powers, the cooling system will work under self-cooling condition with rated load, the maximum operation duration shall be 20 min. Anyway maximum duration will be 1 hour if the transformer is not fully loaded, meanwhile, the maximum top oil temperature should be 75℃.

7.4.2 若风扇停止运行，油泵照常运行，变压器按油温控制。

If the fans do not work while the oil pump operates normally, the transformer should be controlled according to oil temperature.

7.4.3 冷却系统的起、停，用户按当地的环境温度设定油面温度的限制。

Control of starting or stopping of cooling system, user should set up the top oil temperature limitation according to the local environment temperature.

7.4.4 当变压器负荷较低时，应根据负荷情况启动冷却器的台数，其具体计算如下：

When loading of the transformer is low, certain number of coolers will be started according to loading condition, the physical calculation is as following:

$$S_n = \sqrt{P_K' / P_K} \times S_H \quad (kVA)$$

式中：S_n——变压器开启 n 组冷却器所能带的负载。

S_H——变压器额定容量(kVA)。

P_K——变压器 75℃时的负载损耗(kW)。

P_K' ——变压器开启 n 组冷却器允许负载损耗(kW)。

$$P_K' = nP - P_0$$

式中：n——开启的冷却器组数。

P_0——变压器在额定频率下的空载损耗(kW)。

P——变压器负载运行时每组冷却器的负荷(kW)。

$$P = (P_0 + P_K)/(N-1)$$

式中：N——实装冷却器的数量。

$$S_n = \sqrt{P_k' / P_k} \times S_H \qquad \text{(kVA)}$$

Where Sn—Permissible loading of transformer under operation of n coolers;

S_H-- Rated power of the transformer, kVA;

P_k--Load losses at 75℃, kW;

P_k'—Allowable load los under operation of n coolers;

P_k'=nP-P0

Where n—number of operated coolers;

P0—no-load loss at rated frequency;

P—Dissipation power of every cooler when transformer is loaded fully;

P=(P0+ Pk) / (N-1)

N—Number of coolers installed

7.5 螺栓紧固外加（最大）力矩应按表 5 规定

The extra (Max.) moment on bolts should follow the values in table 5.

Table-5

螺 栓 **Bolts**	M10	M12	M16	M20	M24	M30	M36	M42
力矩(Nm) Moments	35	45	75	120	200	260	300	480

7.6 产品自进厂验收合格、使用、维修至报废全过程应遵守以下环保要求：

Environmental Requirements for the Lifecycle from Product Acceptance, Operation, Maintenance to Disposal:

7.6.1.变压器在使用过程中定期进行维护保养，确保产品正常运行，噪声达标排放；

Transformers should keep regular maintenance during daily operation to ensure the qualified noise.

7.6.2.在产品使用维护过程中产生的废油及相关废弃物，应按相关环保要求进行收集和暂存后，交由有资质的处理机构处置。

Waste oil and waste materials during transformer operation and maintenance should be collected and stored in special containers accordance with relevant environmental requirements and handed over to qualified organizations.

7.6.3.产品达到使用寿命，需要报废的，对废弃变压器油及产生的相关废弃物，应联系有资质的处理机构回收处理，自己不得擅自处置。

When the transformer/accessories close to its lifetime and should be scrapped, waste oil as well as waster material should be recovered and disposed of by

qualified organizations. Careless disposal is not allowed.

8 变压器附图
Transformer Drawings

附图一 铭牌图 I Nameplate Drawings
附图二 总装外形图 II Outline Arrangement Drawing
附图三 运输图 III Transportation Drawing
附图四 端子箱图 IV Marshalling Kiosk Drawing
附图五 冷却控制箱图（自冷无） V. Secondary Wiring Drawing For Forced Cooling Transformer

9 附录

附录 A 规范性附录
变压器信号温度计与绕组温度计的设定值
根据变压器设计时的规定条件，变压器的信号温度计与绕组温度计的设定如下：

a) 信号温度计控制器

风扇启动温度	65℃
风扇停止温度	50℃
报警温度	95℃

b) 绕组温度计控制器

风扇启动温度	80℃
风扇停止温度	70℃
报警温度	105℃
跳闸温度	120℃

注：变压器线圈的平均温升比油温升大约高 10～15℃.

Attachment A

The preset value of transformer oil temperature indicator and winding temperature indicator: (for reference)

a) Transformer oil temperature indicator

Fan starting temperature:	65℃
Fan stop temperature:	50℃
Alarming temperature:	95℃

b) Transformer winding temperature indicator

Fan starting temperature: 80℃

Fan stop temperature: 70℃

Alarming temperature: 105℃

Tripping temperature: 120℃

附录 B 器身检查

1 器身检查的要求

1.1 基于变压器设计制造水平的提升，变压器内部稳定性提高。为使产品保持良好 的绝缘水平， 变压器到达现场后，一般情况下不需要进行吊芯检查，可通过观察孔或升高座进行器身位置检查。

We are improving transformer design and workmanship; the active part stability has been increased. In order to unsure good insulation, open tank and lifting core for inspection is not required after the transformer arrives on site. The tank position can be checked through observation holes or by raising the base, and the transformer can be installed at site directly..

1.2 而对于运输安装过程中发生了大的冲击、碰撞的特殊情况下产生问题需全面检查及排除故障，应进行吊芯检查。

For special cases where accident occurs due to impacts/collisions during transport and installation, or faults during operation, the transformer and active part shall be lifted for inspection.

1.2 对于船舶运输的变压器若冲撞记录仪读数正常，则无需吊芯检查。应采用不吊芯方法检查；不吊芯检查是打开人孔或视察窗孔进入油箱内进行器身检查。

For the transformer have been effectively monitored during long-distance transportation without emergency/severe vibration/ significant jolts/collision occurred, it is unnecessary to inspect the active part by lifting. However, the on-site engineer must go through the manholes and inspect the active part.

1.4 器身检查的条件

1.4.1 在室外进行检查时，应搭建临时防护帐篷或有防尘措施，不应在阴雨、下雪、风沙天气中进行。

A temporary dust cover must be fitted outside of the manhole before opening the manhole to check the transformer. Internal inspection and wiring shall be carried out in rainy/snowy/windy weather.

1.4.2 器身检查时，环境温度不应低于 5℃.如低于 5℃时，应采用热风机或其它方法给环境加热.器身温度应高于环境温度，有条件时加热器身温度比环境温度高 10℃。

Inspections should be carried out on sunny days without sandstorms, the

ambient temperature ＞5℃. If ambient temperature ＜5℃, the environment should be heated by hot air blower. The temperature of the transformer should be 10℃ higher than the ambient temperature.

1.4.3 阴天进箱检查时，应连续给油箱内注入加热的干燥空气。

Dry air should be continuously input to the tank in cloudy days for checking inside of transformer tank.

1.4.4 器身在空气中暴露时间，从开始放油或排出氮气开始计时，应按下述执行：

a）相对湿度不大于 65%时，不超过 16h；

b）相对湿度不大于 75%时，不超过 12h；

c）相对湿度大于 75%时，器身应进行相应的干燥处理。

a) The exposure duration shall start from the beginning of oil draining or opening any cover /plug and will be terminated by vacuuming. The maximum allowable duration should be as follows based on the ambient relative humidity:

maximum 16 hours: relative humidity between 65%,

maximum 12 hours: relative humidity between 75%.

The relative humidity is greater than 75%, the active part should be dried.

2 器身检查前的准备工作 Preparation before checking active part

2.1 应按总油重(包括添加油重)，过滤好足够的绝缘油。

It is essential to prepare sufficient insulating oil as per the total oil quantity, including the added oi.

2.2 充氮运输的变压器，应把氮气排除干净后，进行器身检查，排氮时应注意人身安全，以免造成窒息，可以采用充油置换法。

When transformers filled with nitrogen, the nitrogen gas should be completely removed before conducting the active part inspection. During nitrogen purging, no worker is allowed to enter the tank before the nitrogen gas has been fully discharged and oil replacement is recommended.

2.3 带油运输的变压器排油时，通过真空滤油机将油排入准备好的干净油桶、油罐，排油时应将箱盖上的注油蝶阀打开，才能顺利排油。当油箱内残油高于 200mm 时，人不能进入油箱检查。人进入油箱后，入孔处需设专人监护和内外联系。对于桶式油箱变压器，需要吊芯检查时，油应抽至箱盖下 200mm～300mm 。

Open the oil filling butterfly valve on the tank cover, and a vacuum oil filtration equipment shall be used for draining the oil into the clean oil barrels/containers. When the oil level in the tank is higher than 200mm, workers are not allowed to enter the tank for inspection. Dust prevention measures should be implemented at the manhole during checking active part, a worker should be stationed to contact with the worker inside of the tank. After inspection, the worker should confirm that there are no debris in the tank,

check the tools according to the record, and close the manhole cover properly. For barrel-type tank transformers, the oil level should be kept in 200mm to 300mm below the tank cover during active part inspection.

2.4 对于钟罩式油箱，起吊上节油箱前，应先拆除无励磁调压开关的操动杆，并记好相应位置（相位及分接位置），以便复装，有载调压开关的拆卸应按有载开关安装使用说明书，拆除钟罩式油箱上开关头部法兰与开关主体的连接，将开关主体置放于器身支撑架上，拆卸时要记好相应位置的标记；还要拆开器身上部与油箱顶部的连接。

For bell-type tank transformers, remove the operating lever of the off-circuit tap changer and mark its position (phase and tapping position) for reassembly before lifting the upper oil tank. Remove/install the OLTC as per the installation and usage instructions. Disconnect the connection between the switch terminal flange on the bell-type tank and the switch, then put the switch on the transformer support frame, mark the positions. Meanwhile, disconnect the connection between the upper part of the transformer active part and the tank cover.

2.5 准备好起吊设备、抽真空装置、滤油机、安全灯、工具、备用材料和试验设备等，器身检查时，对于工具及工作人员随身携带物品，应做好记录，并在操作时，时常进行清点；进入油箱的工具、衣物、鞋等应清理干净，保证无异物掉入油箱内。

Prepare the lifting equipment, vacuum evacuation device, oil filtrating machine, safety lights, tools, spare materials, and testing equipment. During the active part inspection, keep records of the tools and items carried by the workers during the operation. Clean all tools, clothing, shoes, etc., no foreign objects fall into the tank.

2.6 安装或指导安装人员应具备必要的上岗资格，相关量具应在监测的有效期内；安装人员身上的物品，只要与变压器安装无关的非金属物与金属物，在安装时不应带入变压器现场。

Workers who shall install/supervising the transformer must possess the qualification certificates, all the measuring instruments should be in within the expiration date. Non-metallic and metallic items unrelated to transformer installation should not be brought into the installation area.

3 吊芯 lifting active part

3.1 起吊时，安排人员应观察四周，防止吊车及上节油箱挂上电线或其它障碍物（最好选择合适的环境）。

The place for lifting tank cover/active parts should be clean, and dust prevention/ emergency rain/snow protection measures should be prepared. Ladders and objects with sharp edges used for inspection should not be leaned against leads/wirings/insulating components/wire clamps. Climbing on wire supports and leads is not allowed.

3.2 对于钟罩式油箱，拆除箱沿螺栓起吊，用准备好的定位棒插入箱沿四角螺孔，吊车试吊，调整吊车或绳索，使上节油箱箱沿与下节油箱箱沿平行，开始起吊，起吊高度按电力变压器图样吊高示意图的规定。起吊时应防止上节油箱碰上引线或引线支架。

3.3 Remove the upper positioning components and remove the connection between the tap changer and the tank. The tap changer shall be on the rated tapping before lifting the tap. Remove and lift tap changer (if available) shall be as per the specific requirements indicated in the user's manual. After lifting the upper tank by hoisting sling, the active parts inspection shall be carried out. When lifting the upper tank, the lifting burden should be evenly distributed,

注意：吊车起吊吨位，必须大于起吊物 2 倍以上！

REMARK: The capacity of the crane must be at least 2 times of the lifting object !

4 器身检查 checking of active part

4.1 器身检查应注意事项

PRECAUTIONS FOR CHECKING

a) 引线、导线夹及绝缘件上不应搭、挂、靠任何物品，不应在引线及支架上攀登;

Ladders and objects with sharp edges used for inspection should not be leaned against leads/wirings/insulating components/wire clamps. Climbing on wire supports and leads is not allowed.

b) 器身上不应放置任何物品;

Do not placed any objects on the active parts.

c) 线圈引出线不应有任何弯折（对于有折伤的应进行修复），须保持原安装位置;

The wires lead out from the coils should not be bent (any bent wires should be repaired) and must remain in the original installation positions.

注意：严禁在油箱内更换灯泡和检查、修理工具。

REMARK: Changing light bulbs and inspecting or repairing tools inside the tank is strictly prohibited.

4.2 器身检查的内容

Inspection for the active parts

4.2.1 检查铁心线圈有无移位、变形及铁心夹紧螺栓、拉板是否松动；检查所有紧固件在运输中有无松动，检查器身压钉是否处于压紧状态，锁紧螺母是否处于锁紧状态。

No deformation occurred on the cores, and the insulation between core yoke and clamps should be good. The core should not have multiple grounding connections. The core restraining plate and yoke restraining strap should be securely fastened, and the insulation should be good. The pressure nails of the windings should be securely fastened, and the anti-loose nuts should be

tightened.

- 4.2.2 用开关扳手或开关手轮转动开关，检查触头接触是否良好，是否干净清洁，无励磁分接开关位置是否正确，三相均应在额定位置。检查开关引线连接是否可靠。有载开关的切换开关油室应密封良好，拧紧油室底部的放油塞。

  For the off-circuit tap changer, the connections between the tap terminals and windings should be securely tightened. The rotating contacts should stay correctly positioned at each position, consistent with the indicator. The operating rod, tap cam, small shaft, and pins should be intact and undamaged. The rotating disk should move smoothly and in good sealing. For on-load tap changer, the selector switch and change-over switch should in good contact. The tapping leads should be connected correctly and securely, and the change-over switch should be well sealed.

4.2.3 使用摇表检查铁心、夹件及旁轭屏蔽板接地情况是否良好。测量铁心是否一点接地，如果发现有多点接地应立即排除。测量绝缘电阻良好，应无击穿和闪络现象，且铁心绝缘电阻不应小于 200 兆欧。拉板结构铁心，可直接由铁心接地线与夹件测量铁心与夹件（地）之间的绝缘电阻。非拉板结构的铁心，应将铁心接地片拆开，方可测量铁心与夹件（地）之间的绝缘电阻。对于铁心铁轭是用低磁钢拉带紧固，应将钢拉带与夹件间的连线拆开，测量钢拉带与夹件、钢拉带与铁心之间的绝缘电阻。

Use a megohmmeter to check the grounding of the iron core, clamps, and adjacent yoke shield plates. Measure if the iron core is single-grounded; if multiple grounding points are found, they should be eliminated immediately. Measure good insulation resistance with no breakdown or flashover, and the insulation resistance of the iron core should not be less than 200 megohms. For plate structure iron cores, the insulation resistance between the iron core and the clamp (ground) can be directly measured by the iron core grounding wire. For non-plate structure iron cores, the iron core grounding plate should be disassembled to measure the insulation resistance between the iron core and the clamp (ground). For iron cores where the iron yoke is fastened with low-magnetic steel strips, the connection between the steel strips and the clamps should be disconnected to measure the insulation resistance between the steel strips and the clamps, and between the steel strips and the iron core.

4.2.4 检查引线有无损伤、变形，绝缘包扎是否松散、损伤。

The insulation of the out-let wires should be securely wrapped without any damage/twisting.

4.2.5 检查油箱内壁及箱壁屏蔽装置，有无毛刺、尖角、杂物、污物等与变压器无关的异物，并擦洗干净。

All foreign matter inside the tank (including non-metallic foreign matter) should be thoroughly removed. Once no visible impurities remain, the tank can be flushed with qualified transformer oil, and the tank bottom should be

cleaned.

4.2.6 检查、拆除油箱内运输用的临时紧固装置。

remove all debris and temporary from the transformer,

4.2.7 在器身检查前放完油后，应先装上由于运输超限拆下的下节油箱上所有阀门，封闭好真空注油时需封闭的所有阀门，以便下一步的真空注油和组件复装工作。

After draining the oil from the body before inspection, first install all the valves removed due to transportation oversize on the lower section of the oil tank, close all the valves that need to be closed for vacuum filling, for the next step of vacuum filling and component reassembly work.

P 陕西汉中变压器有限责任公司

地址:陕西省汉中市经济技术开发区北区

电话：0916-2227206

售后服务热线/传真: 0916-2318507

网址: www.sxhztranformer.com

邮箱: sales2@sxhztransformer.com.com

Shaanxi Hanzhong Transformer co.,ltd.

Add: Chencang Road South, North Economic Development Area, Hanzhong, Shaanxi Province, P. R. China

Tel: 86 916 2227206

After-sale Service: 86 916 2318507

Website: www.sxhztranformer.com

Email: sales2@sxhztransformer.com.com