دستورالعمل نصب و برده برداری بوشینگهای ترانسفورماتور

OTF 245 kV و 420 kV

ساخت نیروترانس تحت لیسانس HSP آلمان

Instruction Manual for Transformer Bushings

OTF 245 kV, 420 kV

Made by NirouTrans, under License of HSP-Germany
Mounting, Operating and Maintenance Instructions

For each bushing type these instructions are valid only together with the respective bushing specification, which contains all technical details and the dimension drawing. It is an integral part of these operating and maintenance instructions.
SAFETY INSTRUCTIONS:
Mounting, operation and maintenance works For OTF type of Transformer Bushing, involve following safety risks:
- Perilous electrical voltages
- High voltage
- Moving machines
- Large weight
- Handling of moving masses
- Injuries caused by slipping, stumbling or falling

Especially rules and instructions for these topics have to be obeyed when handling such equipment. Disregarding of these instructions can induce:
- Severe injuries to persons
- Death
- Damages of products and material
- Following industrial injury and/or consequential damages.

In addition to these rules national and international safety rules have to be obeyed.
In these instructions we have marked risks of injuries of persons and material with following signs near the texts and mounting steps:

⚠️ Personal Injuries or Fatal Damages
⚠️ Industrial Injury and/or Consequential Damages

---

Rعایت موارد ایمنی:
در طی مراحل نصب و راه اندازی و نیز بهره برداری بوشینگهای ترانسفورماتور از نوع OTF
خطرات بالقوه ذیل وجود دارد:
- خطر برق گرفتنگی
- خطر کار با برق فشار قوی
- خطرات ناشی از گریختن تجهیزات با این ابعاد
- وزن زیاد و کنترل حرکات تجهیزات با وزن زیاد
- آسیب‌های ناشی از سرکوره‌گذاری با سقوط تجهیز

کلیه قواعد، نکات، دستورالعمل‌ها و استانداردهای ایمنی مرتبط با موارد فوق می‌باشد در طی مراحل مختلف کار با چنین تجهیزاتی مانند قرار گیرد. عدم توجه به چنین دستورالعمل‌ها و قوانین، می‌تواند باعث وقوع هر یک از موارد ذیل و یا وقوع آنها با طور هم‌زمان گردد:
- آسیب دیدگی شدید افراد
- تلفات جانی
- خسارت به تجهیزات و قطعات

تلفات جانی: خرای تجهیزات صنعتی و یا خسارت‌های اساسی

علاوه بر رعایت موارد مذکور در این دستورالعمل، قوانین محلی کار ایمنی و قوانین بین‌المللی مرتبط با ایمنی نیز می‌باشد رعایت گردد. در متن این دستورالعمل و پخش‌های مربوط به مراحل نصب بوشینگ، خطرات احتمالی در دو دسته آسیب دیدگی افراد و خسارت به تجهیزات بشرح ذیل علامت‌گذاری شده است:

خطر خسارت به تجهیزات و خسارت‌های اساسی صنعتی

---

Instruction Manual for OTF Bushings 245, 420 KV made by NirouTrans, Doc. No: P711712 by A.Rajabi
1- Introduction:

This type of Bushing classified as: Oil impregnated paper (OIP), capacitive grading, outdoor - transformer - bushing. In a power transformer, bushing is one of the necessary parts. Depending on the configuration, some bushings are used in each power transformer. It is shown in fig.1, 2.

The bushing comprised an aluminum head, an insulator in porcelain, a flange in aluminum and a lower insulator in epoxy resin. The flange equipped with a test tap. The main parts of an OTF bushing are shown in fig.3.

In this service manual the correct methods of transportation, handling, storage, installation and maintenance for such equipment are explained as follows. The consideration of the mentioned instructions is necessary for long life operation of the bushing.
Connecting terminal
Clamping armature
Head (expansion volume)
Oil level indicator
Porcelain housing
Flange with test tap
Transformer ventilation
Threaded bores for lifting eyes
Cast resin housing
Shield electrode (optional)

Fig. 3 / شکل ۳

Fig. 4 / شکل ۴
The Governing Standard for Bushing as an HV equipment is IEC60137. It is applied for all in Production Procedure, Tests, Technical Spec., Operating Conditions and so on. Requiring compliance with the other standards, please contact NirouTrans company.

1-1 Bushing Technical Description

As shown in fig.4 the main insulation of the OIP transformer bushing type OTF is an insulating body (10). It is made of a special paper impregnated with oil wound onto a central tube (8) and with inserted grading layers of aluminum foil to make uniform voltage distribution along the insulating body and the bushing.

The central tube is a double tube with oil channels to provide circulation of the insulating oil. By this design the temperature developing as a result of the current losses in the current conductor are led out. The insulating body is mounted in an insulating housing (9), as porcelain Insulator. The head (7) and the flange armature (11) are cemented onto the porcelain by special cement and unseparably fixed.

On the transformer side of the bushing the cover (15) made of epoxy resin is fixed by screws to the flange and in addition at its lower end with armatures (16) of the central tube. This cover is a self-supporting, oil-tight end for the oil filling of the bushing and against the transformer oil. The whole bushing housing is sealed by means of O-Rings made of hot-oil resistant material and located in chambers.

The flange of the bushing is equipped with a test tap (13), grounding screws, air release bores, lifting eyes (12) and the transformer ventilation or Air outlet (14).

The bushing head serves as expansion volume for changes of the oil volume caused by temperature changes and has a nitrogen gas cushion (5). In the lower half there is an oil level indicator (6) for visual checks of the oil level. The head is closed by a cover (4) which has a collar socket for the central tube end on the inner side and on the outer side a flange socket for the connection of...
the Draw-Lead or conductor bolt sealing and fastening. In this flange socket there is the ventilation screw for the ventilation of the central tube (3). The bottom of the bushing head is sealed against the central tube.

The Draw-Lead or the detachable conductor bolt (1) is fixed by a clamping piece (2). In the separating area to the head cover it has bolt sealings in defined chambers. In addition the clamping piece has a pin connection of the bolt. It serves as torsion protection and secures the bolt against falling into the transformer during mounting works. The pin is secured against falling out by an additional splint. Draw-Lead and detachable conductor bolts have a threaded bore with hexagon. Screw on the front side to allow pulling them through the central tube by a draw wire or rod.

Depending upon the status of dispatch on the transformer side end of the bushing there is a detachable, insulating shield electrode with bayonet lock (17) Fig. 4.

2- Packing, Inspection and Receipt

As shown in Fig.5, Fig.6 the bushing is Packed and transported in a ventilated wooden crate. The whole bushing is covered with plastic foil. In this packing the bushing can be stored in dry rooms covered by a roof for 12 months. Long term storage, e.g. for spare bushings, can be done with a metal protection tank with oil filling on the transformer side only. Also see chapter 10 for more detail.

As Fastener, Self-Tapping Screw (Fig.7) is used to make strong connection for wooden members of Crate. In Fig.8 the screw with item No.4 used for Top Side of Crate, item No.6 for Top support and item No.8 for Flange Support, with the following advantages:

- Easy way to Unscrew
- Easy way to Fastening
- Nondestructive for Wooden Members through Unscrew and Re-screw
- Strong Joint in Crate Sides and Supports

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.
Receiving the crate, before unpacking, the packing case should be visually inspected. Any possible damage should be noted.

We recommend that the original packing should not be damaged or destroyed. It can be re-used after final testing of the transformer for dispatch to the site of installation or any other necessary transportation of bushing.

Fig.5 / شکل 5

Fig.6 / شکل 6

Fig.7 / شکل 7

Instruction Manual for OTF Bushings 245, 420 KV made by NirouTrans, Doc. No: P711712 by A.Rajabi
2-1 The Packing of Bushing in Detail

The packing arrangement shown in fig.8 with the following description:

1- Oil Sight Glass
2- Test Tap
3- Top Side
4- Self-Tapping Screws for Top Side
5- Top support
6- Self-Tapping Screws for Top support
7- Flange Support
8- Self-Tapping Screw for Flange
9- Bottom support for Porcelain Insulator
10- Attention Mark

Fig. 8 / ۸شکل

Correct Way

روش درست / ۹شکل

Fig. 9 / ۹شکل

چیدمان اجزا جعبه حمل بوشینگ مطابق شکل8 بوده و توضیح هریک به شرح ذیل می‌باشد:
1- درجه دید روشن
2- تست تب
3- درب جعبه حمل
4- پیچهای خودکار درب جعبه حمل
5- سایورت چوبی روی بوشینگ
6- پیچهای خودکار نگه‌دارنده سایورت چوبی
7- سایورت چوبی نگهدارنده فلنج
8- پیچهای خودکار نگه‌دارنده سایورت فلنج
9- سایورت چوبی زیر مقره سرامیکی
10- برچسب اخطار
3- Unpacking and Handling the Bushing

To open the Packing and remove the bushing from its crate, by using a Socket wrench or Nut-runner (Fig.9) with proper sizes of SW10 and SW16, Unscrew the Self-tapping Screws of the Top side of the Crate mentioned as item No. 4 in fig.8, then go on for item No.s 6 and 8 to take out the supports and release the Flange.

- **Important:** It is not allowed using wrecking bar or levering the Top Side of the Crate or the wooden Supports to open the packing.

It breaks the wooden parts and destroys the Crate edges (Fig.10 and Fig.11), so the packing loses its rigidity and cannot protect the inside Bushing through further transportation.

---

After removing the Top Side of the Crate and releasing the wooden supports, the Bushing shall be visually inspected. Examine all the parts of each bushing, and particularly check the porcelain insulator visually. Any possible trace of oil should be carefully noted, especially the sealing area around expansion tank and around the aluminum flange (Fig.3, Fig.4).

---

**Not allowed / Niest**

Fig.10 / 11

**Brandon Bushing**

Bray خارج نموذن بوشینگ از درون جعبه حمل ابتدا میبایست پیچهای خودکار جعبه حمل را بوسیله آگارهکس مناسب بنی سایز ۱۰ و ۱۶ باز نمود (شکل ۹). این آگارهکس میتواند از نوع دستی شارژی و یا با دست یابند. همانطور که در شکل ۸ مشاهده میگردیم پس از بارزاندن پیچ که خودکار شماره۴، درب پیچ جعبه حامل آزاد شده و بهمین ترتیب با باز نمودن پیچهای ۶ و ۸ ساپورتهای چوبی و فلنج بوشینگ آزاد میشود.

 مهم: برای بارزاندن درب پیچ جعبه حامل پیچهگی و یا جنبانمودن ساپورتهای چوبی نگهدازید.

بیشینگ، استفاده از دیلم و اهم نموندن ناهی اتصال مجاز نیست.

این عمل باعث آسیب دیدن و خرد شدن قطعات چوبی میشود (شکل‌های ۱۰ و ۱۱)، درتیجه جعبه حامل بوشینگ استحکام خود را از دست داده و قادر به محافظت از بوشینگ، در طی مراحل حمل و نقل بعید نخواهد بود.
If damages have been caused during transport, immediately after taking picture, contact insurance agent then inform NirouTrans Company and finally write the facts report in detail.

Unpacking the Crate, the Self-Tapping Screws, the Wooden Supports and the other belongings shall be retained for repacking of the bushing and the next Transportations.

### 3-1 Handling

❗️ It must be lifted with appropriate lifting gears on the head or on the porcelain housing and on the flange only. The bushing can be removed from the crate with hemp ropes or transport straps as long as the bushing remains in horizontal position. During all manipulation in horizontal position of the bushing, take care that the oil level indicator is on the upper side and prevent it from turning around its axis. Fig.5 and Fig.6 have shown a bushing handling just in horizontal position. It is not a solution for erection.

❗️ **Note:** During horizontal Transportation or Repacking of OTF bushings, the Attention Mark on the Bushing Head shall be noticed. Referring by Item No. 10 in Fig.8, It is a warning for oil level indicator being faced up.

The bushing must not be put on the floor with its transformer side end. Even in case of upholstering there is the danger that in case of impact, cracks develop in the cast resin Part, which may not be visible but jeopardize following operation of the bushing. With unprotected transformer side end the bushing can be handed outside during dry weather for a short period of time. Leaving the bushing outside in rainy weather for a longer time is not permitted. The material is hygroscopic and absorbs moisture on the surface, which has a negative influence in operating behavior on the transformer.

**3-1 حمل و انتقال بوشینگ**

نوشتگی در مقروه وجود داشته و هیچ نوع اثری از نشتی روغن روی بدنه بوشینگ و اطراف آن مشاهده نگردید. در این مورد توجه به ناحیه اتصال مقروه و تکنیک اتصال فلنج آلومینیومی به مقروه سرامیکی و مقروه رزینی (شکل‌های ۴و۵) بسیار حائز اهمیت می‌باشد. درصورت مشاهده هر یک از موارد فوق، مردان را بصورت مکثوه همراه با عکس‌برداری از نقطه خسارت دیده، با جزئیات مستند نموده و ضمن نمایه‌بردن شرکت به شرکت طرف فرآیند، موارد را به اطلاع شرکت نیروترانس برسانید.

از لحاظ استحمام جمع‌آوری جمع حمل و پس از خارج نمودن بوشینگ، از بی‌چه‌های کودکان، سایپورتهای چوبی و دیگر اجزا جمع حمل نگهداری نموده تا به هنگام بسته بندی مجدد و ارسال بوشینگ از آنها استفاده گردد.

بشوینگ را می‌پیامده با بکارگیری ابزارهای مناسب حمل که بر روی سر بوشینگ، مقروه سرامیکی و یا فلنج آن نصب می‌شود بلند نمود، برای خارج نمودن بوشینگ از درون جمع حمل می‌توان از طناب کنفی یا تسهیل کننده استفاده نموده به شرط آنکه در تمامی این مراحل بوشینگ در حالت تهیه (بایگانی و دریچه دید روغن به سمت بالا قرار گیرد و از چرخه آن حول محور طولی جلوگیری به عمل آید. چگونگی انتقال بوشینگ از مكانی به محل دیگر در حالت تهیه در شکل‌های ۵و ۶ نمایش داده شده است. این نحوه حمل برای عملیات نمودن بوشینگ برای نصب مناسب نمی‌باشد.

توجه: در تمامی مراحل حمل افقتی بوشینگ و یا بسته بندی مجدد آن، توجه به برجسب اختراق روز نوشتنگ ضرورت دارد. همانطور که در شکل‌های ۸با شماره ۱۰ نشان داده شده این برجسب، هشداری است برای لزوم قرار دادن دریچه دید روغن به سمت بالا.

Instruction Manual for OTF Bushings 245, 420 KV made by NirouTrans, Doc. No: P711712 by A.Rajabi
Contact NirouTrans if you find bushings with clear signs of moisture influence.

As shown in Fig.3 and Fig.4, the transformer side end of the bushing is made of an epoxy resin. As explained when stored for a longer period of time, they have to be especially protected against moisture and solar radiation (ultraviolet rays). The plastic cover used for the dispatch of the bushings, guarantee protections only for a limited period of time (transport packing).

When epoxy resin part subjected to UV-irradiation, the surface is destroyed.

This can be easily noticed by a light grey coloring. A surface structure damaged like this, develops micro-cracks, which leads to an increased absorption of moisture. In case bushings show such damages inform NirouTrans.

3-2 Lifting and Erection

To lift the bushing for erection, 2 Lifting Eyes (Fig.12) shall be fasten on the tapped holes of the flange (as shown in Fig.13) and the lifting gears for the head of the Bushing (Fig.14) or a proper one for porcelain insulator shall be used. How to Lift and erect the Bushing shown in Fig.15, Fig.16.

Note: Before fastening the Lifting Eyes (Fig.12) into the tapped holes of the cast aluminum Flange (Fig.13), the holes threads shall be carefully checked. Before fastening the Lifting Eyes, check the threads of the tapped holes neither deformed, nor partly removed. Prevent cross-threading during tightening the Lifting Eyes on the Flange. After all be sure about firm fitting and not stripped-threads.

3-2-1 Lifting Eye

Two type of Lifting Eyes (Fig.12) used for OTF Bushing described as

As shown in Fig.3 and Fig.4, the transformer side end of the bushing is made of an epoxy resin. As explained when stored for a longer period of time, they have to be especially protected against moisture and solar radiation (ultraviolet rays). The plastic cover used for the dispatch of the bushings, guarantee protections only for a limited period of time (transport packing).

When epoxy resin part subjected to UV-irradiation, the surface is destroyed.

This can be easily noticed by a light grey coloring. A surface structure damaged like this, develops micro-cracks, which leads to an increased absorption of moisture. In case bushings show such damages inform NirouTrans.

3-2 Lifting and Erection

To lift the bushing for erection, 2 Lifting Eyes (Fig.12) shall be fasten on the tapped holes of the flange (as shown in Fig.13) and the lifting gears for the head of the Bushing (Fig.14) or a proper one for porcelain insulator shall be used. How to Lift and erect the Bushing shown in Fig.15, Fig.16.

Note: Before fastening the Lifting Eyes (Fig.12) into the tapped holes of the cast aluminum Flange (Fig.13), the holes threads shall be carefully checked. Before fastening the Lifting Eyes, check the threads of the tapped holes neither deformed, nor partly removed. Prevent cross-threading during tightening the Lifting Eyes on the Flange. After all be sure about firm fitting and not stripped-threads.

3-2-1 Lifting Eye

Two type of Lifting Eyes (Fig.12) used for OTF Bushing described as
follows:

- Lifting Eye: M10, 0.63 ton for 245 KV Bushing with a weight of ~400 kg
- Lifting Eye: M12, 1.0 ton for 420 KV Bushing with a weight of ~750 kg

After Erection and Installation of the Bushing on the Transformer, like the other lifting gears the Lifting Eyes taken out from the bushing flange, and kept as a tool for another case.

![Fig.12 / شکل 12](image)

![Fig.13 / شکل 13](image)
3-2-2 Lifting Gear

As an example for a possible design see Fig. 14. The hoop made of bent flat iron is designed for each head diameter with appropriate tolerance (+5...+10mm). Diametrically opposite of each other, there are two large ring nuts welded onto the hoop. Their size has to allow the ropes with their loops to pass. Three retaining brackets positioned regularly around the circumference of the hoop prevent slipping from the head in direction of the flange. When lifting the bushing the largest force occurs when the bushing is in horizontal position and has to be taken by three retaining brackets (Fig. 16). If the hoop has to be fixed very low a pocket for the exposed oil level indicator of the bushing has to be provided.

The diameter of the bushing head can be taken from the corresponding bushing specification. In general they are as follows:

- Ø 320 mm for OTF 420 kV Bushing
- Ø 235 mm for OTF 245 kV Bushing

There is another kind of lifting gear fastened on the upper part of porcelain insulator exactly below the Expansion Tank as shown in Fig. 17 and Fig. 18. This lifting gear consists of two half-Rings with a lining of Elastic layer. Using

Fig. 14 / شکل 14

There are two kinds of bushings used for high voltage bushings. The bushing head is typically made of steel and the bushing body is made of porcelain or composite material. The bushing is designed to withstand the mechanical and electrical stresses during operation. The bushing head has a diameter that is specified in the corresponding bushing specification. In general they are as follows:

- Ø 320 mm for OTF 420 kV Bushing
- Ø 235 mm for OTF 245 kV Bushing

A lifting gear is used to lift and suspend the bushing during installation and maintenance. The lifting gear consists of a hoop made of bent flat iron and retaining brackets. The hoop is designed for each head diameter with appropriate tolerance (+5...+10mm). Diametrically opposite of each other, there are two large ring nuts welded onto the hoop. The size of the hoop has to allow the ropes with their loops to pass. Three retaining brackets are positioned regularly around the circumference of the hoop to prevent slipping from the head in the direction of the flange. When lifting the bushing the largest force occurs when the bushing is in a horizontal position and has to be taken by three retaining brackets (Fig. 16). If the hoop has to be fixed very low, a pocket for the exposed oil level indicator of the bushing has to be provided.

The diameter of the bushing head can be taken from the corresponding bushing specification. In general they are as follows:

- Ø 320 mm for OTF 420 kV Bushing
- Ø 235 mm for OTF 245 kV Bushing

There is another kind of lifting gear fastened on the upper part of porcelain insulator exactly below the Expansion Tank as shown in Fig. 17 and Fig. 18. This lifting gear consists of two half-Rings with a lining of Elastic layer. Using
some bolts and nuts to fasten the half-Rings on the Top part of insulator firmly. The inner Elastic lining prevents the insulator from direct contact with metal surface.

**Note:** Using the second kind of Lifting Gear and the method above mentioned is safer for the operators with less experience in this regard.

As shown in Fig.15, Fig.16 the pull ropes or loops used on the porcelain side of the bushing are also led to the flange of the bushing through the role holes of the lifting gear. The bushing is lifted with two lifting devices which allow any inclined position required for mounting of the bushing. The more the bushing turns into vertical position, the more the lifting device on the bushing head bears the full load.
During all manipulation in horizontal position of the bushings OTF, take care that the oil level indicator is on the upper side! It is necessary to prevent the bushing from turning around its axis. The head of bushing shall be in an upper level as compared to the other parts during all procedure.

4- Preparation for Mounting

After removal from the packing, the bushing has to be put down on bearing blocks at the flange and at the head. The plastic foil is removed. To avoid scratching on the surface of resin insulator, Do not use sharp-cut devices for opening the foil at the transformer side end.
There are two sets of Fastening Screws on the Clamping Piece (Fig. 20). As described in Fig. 19, first lose them (No. 1 in Fig. 19) then completely remove the Fastening Screws and its washers.
After that pull out the Clamping Piece (No.7 in Fig.19) together with Cu-Conductor (or draw-lead) a little bit (Fig.22). In this situation shown in Fig.22, O-Rings (No.4 in Fig.19) and Washer (No.3 in Fig.19) become visible.
After that as shown in Fig.23, take out the Split Pin (No.2 in Fig.19). Then remove the pin (No.5 in Fig.19) from its place (Fig.24).

As shown in Fig.25 for the next step, loose the Clamp Screw (No.6 in Fig.19) and take out the Clamp (No.7 in Fig.19). Then Pull off O-rings and Large washer (Fig.26).

After all, push Cu-Conductor (or draw-lead, No.8 in Fig.19) out of the bushing in direction of the bushing flange (Fig.27).
بوشینگهای نیروترانس مدل OTF, بصورت معمول با هادی مسی تحویل می‌گردند. اگر بوشینگ باجی هادی مسی (شافته مسی) مجهز به سرکابل مسی (شکل 28) باشد، از قبیل سوراخی در انتهای آن ایجاد شده است. در این شرایط می‌بایست کابل مسی خروجی از ترانسفورماتور را بیرون این سوراخ قرار داده، محل اتصال را لحیم یا جوش نمود.

Fig.28 / شکل 28

The OTF Bushing of NirouTrans delivered with Cu-Conductor in general. If the Bushing delivered with the Draw-Lead (Fig.28), it has the bore already. Thus connect the Draw-Lead with the transformer side cable by soft or hard soldering.

It is advantageous to push out the Cu-conductor when the bushing is in horizontal position by means of a threaded rod which is fixed to the threaded bore on the front side of the Cu-conductor (Fig.29, Fig.30).

The Cu-Conductor has some spacers made from a kind of fiber-glass insulating material (Fig.30), which ensure uniform distance to the wall of the metallic central tube of the Bushing, thus having the same function as the insulation of the cable of transformer in case of a Draw-Lead.

⚠️ Do not touch the screws and/or connections of Bushing not mentioned in this procedure. It is strictly forbidden to open the Screws unless referred in this Instruction Manual.
5- Mounting of Cu-Conductor

⚠️ In some cases the Cu-Conductor is connected into the transformer, through a mounting hole. It is shown in No.3 of Fig.31.

This kind of hand hole is especially convenient for mounting the OTF-420KV Bushings equipped with single-piece Cu-Conductor.

Attention: In case of necessity for mounting a screen electrode or External Shield on the end of the OTF Bushing, It Shall be approved by Transformer supplier and also NirouTrans as Bushing Manufacturer.
The Oil Side Shield or Screen Electrode shown in Fig.32, 33. If the bushing equipped with a Screen Electrode or Oil Side Shield in the mounting place, it is moved away to make the connecting place accessible. Meanwhile the Cu-Conductor remains on the bushing in the initial position.

Routine models of OTF-245 KV Bushings have a split Cu-Conductor contains bottom Part, upper Part and fasteners. The Bottom part of Cu-Conductor remains in the transformer. The upper Part is located right below the flange turret (No.s 1, 2 of Fig.31). During Mounting, the upper Part of Cu-conductor is lowered with the help of a pulling rod which is screwed into the threaded bore M12 of the conductor on its Top (Fig.34), until the Jointing parts becomes accessible (No.1 in Fig.31). The bushing is placed above the installation hole in such a way that the screw connection can be made. If the bushing has a shield electrode or Oil Side shield, it is pushed down. After that
the bushing is lowered into the transformer turret. At the same time the Cu-conductor is pushed upwards until it has reached its final position on the head.

The bushing head is assembled in reverse order as described for the disassembly in Chapter 4 and shown in Fig.19 to Fig.27. The O-Rings have to be cleaned before mounting and coated with a thin layer of silicone grease. The screws are fixed with the torques corresponding to their size (Table1).

<table>
<thead>
<tr>
<th>screw</th>
<th>torque (Nm)</th>
<th>torque (kpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 4</td>
<td>1.1</td>
<td>0.11</td>
</tr>
<tr>
<td>M 5</td>
<td>2.2</td>
<td>0.22</td>
</tr>
<tr>
<td>M 6</td>
<td>4.0</td>
<td>0.40</td>
</tr>
<tr>
<td>M 8</td>
<td>10.0</td>
<td>1.0</td>
</tr>
<tr>
<td>M10</td>
<td>19.0</td>
<td>1.9</td>
</tr>
<tr>
<td>M 12</td>
<td>33.0</td>
<td>3.3</td>
</tr>
<tr>
<td>M 14</td>
<td>52.0</td>
<td>5.2</td>
</tr>
<tr>
<td>M 16</td>
<td>80.0</td>
<td>8.0</td>
</tr>
<tr>
<td>M 18</td>
<td>110.0</td>
<td>11.0</td>
</tr>
<tr>
<td>M 20</td>
<td>160.0</td>
<td>16.0</td>
</tr>
<tr>
<td>M 22</td>
<td>210.0</td>
<td>21.0</td>
</tr>
<tr>
<td>M 24</td>
<td>255.0</td>
<td>25.5</td>
</tr>
<tr>
<td>M 27</td>
<td>370.0</td>
<td>37.0</td>
</tr>
<tr>
<td>M 30</td>
<td>510.0</td>
<td>51.0</td>
</tr>
</tbody>
</table>

The values mentioned in the Table1 are orientation values and refer to screw connections with screws made of noncorrosive steel. Valid only in case of flange connections with O-Ring Sealing and metallic contact of the surfaces.
6- Mounting of Draw Lead

When the bushing is mounted on the transformer the draw lead with the soldered cable is pulled through the bushing with the help of a pulling wire (Fig.35) or rod corresponding to the path when the bushing is lowered to the transformer until the draw lead comes out of the bushing head. To prevent the Draw Lead from sliding the pin (No.1 in Fig.19) can be inserted. After that the bushing is mounted on the transformer. The bushing head is assembled in reverse order as described for the disassembly in Chapter 4 and shown in Fig.19 to Fig.27. The O-Rings have to be cleaned before mounting and coated with a thin layer of silicone grease. The screws are fixed with the torques corresponding to their size (Table1).

The values mentioned in the Table1 are orientation values and refer to screw connections with screws made of noncorrosive steel. Valid only in case of flange connections with O-Ring Sealing and metallic contact of the surfaces.

Note: The example shown may be different from the actual installation situation!
7- Mounting of Oil Side Shield

Based on customer request, it is possible to design and manufacture the bushing equipped with external type of Shield Electrode. As shown in Fig.32, Fig.33 the Oil Side Shield has its own configuration and specific installation location at the Bottom of the bushing. There are some mounting mechanisms of Oil end Shield in Fig.33. Considering customer requirement, Fastener-base or spring-base design for making mounting mechanism.

At the oil end of the Bushing OTF-245KV, inside the resin part, there is an H-Shape embedded electrode as internal Shield. Therefore additional electrode or external shield may be omitted and distance to ground inside the transformer is reduced.

8- Installation of Bushing on Transformer

The bushing is installed on the transformer as described under section 5 and 6 with reference to the handling of the Cu-Conductor or the draw lead. If available, follow the instructions from the transformer manual too. This also applies for the sealing and the fastening of the fixing screws.

8-1 Grounding of the Bushing Flange

The bushing flange is equipped with grounding screws. By means of grounding bands or cables, the flange has to be connected to the transformer tank. In this way apart from International standards like IEC, national standards and local rules are often obeyed.

8-2 Purging Trapped Air

8-2-1 Purging Air from Bottom Flange of Bushing

To remove the trapped air of Transformer in the area underneath the bushing flange, the air release screw at the flange (Fig.36) has to be opened.
استانداردهای بین المللی مانند IEC، قوانین محلی و استانداردهای ملی مربوط به نیز رعایت می‌گردند.

2-8 هواگیری

2-8-1 هواگیری از طریق فلنگ بوشینگ

به منظور خارج نمودن هوای درون ترانس گردد انتخاب زیر فلنگ بوشینگ محبوس شده است. پیچ هواگیری برونی فلنگ بوشینگ تعبیه شده است (شکل ۲۶). در این راستا لازم است پیچ هواگیری مذکور را شل نمود تا هواهای اضافی خارج گردد. برای انجام هواگیری لازم نیست پیچ مذکور را بطور کامل از چاپگاه و پیچ به گونه‌ای است که با شل نمودن آن هوا را از اطراف آن خارج می‌گردد.

2-8-2 هواگیری لوله میانی بوشینگ

در طی عملیات هواگیری، هوای درون لوله میانی بوشینگ نیز می‌باشد. این موضوع از این جهت خاتمه از است که هواهای محبوس در این قسمت با فشار دما حین کارکرد ترانس افزایش حجم ییده و ممکن است در شرایطی خاص از انتهای بوشینگ بیرون ترانس وارد گردد. همانطور که در شکل ۳۶ نشان داده شده است، در قسمت فوقانی بوشینگ نیز پیچ هواگیری دیگری تعبیه شده است. برای انجام عملیات هواگیری پیچ مذکور را شل نموده و اجازه میدهیم هوا را از اطراف آن خارج گردد. در این خصوص احتیاج به پیچ آوردن کامل پیچ نمی‌باشد.

2-8-3 چک‌نهایی بوشینگ پیش از برقرار نمودن

به منظور چک‌نهایی بوشینگ پس از نصب بروی ترانس‌فوماتور جدول ۲ برتیب زیر تهیه شده است که می‌باشد مبادل انجام موارد لازم به بازپرسی قرار گیرد.
8-2-2 Purging Air from central tube of Bushing

The Air inside the central tube of the bushing has to be removed as well. Otherwise the trapped air will expand during temperature rise and in worst case enter into Transformer from the bottom part of the bushing. As shown in Fig.36, another air release screw is located in the bushing head. The screw has to be opened but not necessary to completely removed. In this way the trapped air released.

8-3 Checking before putting into Service

See adjacent checklist (Table2). A leakage check of the mounted bushing can be carried out to a limited extend only, because the transformer oil level is at the height of the bushing flange, but in case of vertically installed bushings, it does not reach up to the bushing head. The double sealing at the conductor bolt provide a reliable sealing, though.

8-4 Oil Level Indicator

The OTF bushings in routine types equipped with a prismatic oil sight glass on the head. The inside surface of glass has some grooves to shape a partly prismatic area. Incident light entering the glass is refracted at the rear surface in contact with the media. In the region that is contact with the gas, most of the light is reflected from the surface of one groove to the next and back towards the operator, appearing silvery white. In the region that is in contact with oil, most of the light is refracted into the liquid causing this region to appear almost black to the operator.

In OTF type Bushings, the oil level indicator is located at such a low level at the bushing head that the oil sight glass is below the oil level during all operating conditions of the bushing. Therefore the oil sight glass is always black and uniform (Fig.37) as explained above. Only when the oil level is lower and total reflection starts, the grinding lines display (Fig.38) and allow good control even at the larger distance.
### جدول ۲

<table>
<thead>
<tr>
<th>چک لیست، پیش از برقدار شدن بوشینگ</th>
<th>موارد لازم به پایگاه بهینه</th>
</tr>
</thead>
<tbody>
<tr>
<td>✗ All fastening screws at the flange Fixed.</td>
<td>✗ تمامی پیچ‌های فلنج در محل نصب بر روی ترانس محکم بسته شده‌اند.</td>
</tr>
<tr>
<td>✗ Grounding connection of the flange.</td>
<td>✗ اتصال به زمین از طریق فلنج بوشینگ برق‌دار است.</td>
</tr>
<tr>
<td>✗ Cap of test tap tightly fixed.</td>
<td>✗ درویش نیز خاکی محکم بسته شده است.</td>
</tr>
<tr>
<td>✗ Purging Air from central tube of Bushing.</td>
<td>✗ هواگیری لوله میانی بوشینگ انجام شده است.</td>
</tr>
<tr>
<td>✗ Purging Air from Bushing flange.</td>
<td>✗ هواگیری از طریق فلنج بوشینگ انجام شده است.</td>
</tr>
<tr>
<td>✗ Visual check of porcelain insulator for possible damages.</td>
<td>✗ بازرسی جسمی مقره سرامیکی بوشینگ از جهت عدم احتمال اصابت شده است.</td>
</tr>
<tr>
<td>✗ Pin Placed in its location at the bushing head.</td>
<td>✗ در قسمت سر بوشینگ، پین داخل های مسی در جای خود قرار دارد.</td>
</tr>
<tr>
<td>✗ Split Pin placed in its location at the bushing head.</td>
<td>✗ در قسمت سر بوشینگ، اپلی بر روی کلیم در جای خود قرار دارد.</td>
</tr>
<tr>
<td>✗ Clamp screws of the connecting bolt at the bushing head fixed.</td>
<td>✗ در قسمت سر بوشینگ، پیچ های کلیم محکم بسته شده‌اند.</td>
</tr>
<tr>
<td>✗ Oil level in the Oil level indicator is ok.</td>
<td>✗ دریچه دیو روغن سالم روغن بوشینگ را برای دستی نشان میدهد.</td>
</tr>
<tr>
<td>✗ HV Cable and Clamp fastened on the top connecting terminal of Bushing in correct way without any loose connection.</td>
<td>✗ اتصال کابل فشار فوق و کلیم بر روی ترمینال فوقانی بوشینگ محکم و بدرستی بسته شده است.</td>
</tr>
</tbody>
</table>

### دیجیتال

<table>
<thead>
<tr>
<th>فهرست چک‌لیست قبل از برقراری کار</th>
<th>وظایف لازم به پایگاه مناسب</th>
</tr>
</thead>
<tbody>
<tr>
<td>✗ تمامی پیچ‌های فلنج در محل نصب بر روی ترانس محکم بسته شده‌اند.</td>
<td>✗ اتصال به زمین از طریق فلنج بوشینگ برق‌دار است.</td>
</tr>
<tr>
<td>✗ درویش نیز خاکی محکم بسته شده است.</td>
<td>✗ هواگیری لوله میانی بوشینگ انجام شده است.</td>
</tr>
<tr>
<td>✗ هواگیری از طریق فلنج بوشینگ انجام شده است.</td>
<td>✗ بازرسی جسمی مقره سرامیکی بوشینگ از جهت عدم احتمال اصابت شده است.</td>
</tr>
<tr>
<td>✗ در قسمت سر بوشینگ، پین داخل های مسی در جای خود قرار دارد.</td>
<td>✗ در قسمت سر بوشینگ، اپلی بر روی کلیم در جای خود قرار دارد.</td>
</tr>
<tr>
<td>✗ در قسمت سر بوشینگ، پیچ های کلیم محکم بسته شده‌اند.</td>
<td>✗ دریچه دیو روغن سالم روغن بوشینگ را برای دستی نشان میدهد.</td>
</tr>
<tr>
<td>✗ اتصال کابل فشار فوق و کلیم بر روی ترمینال فوقانی بوشینگ محکم و بدرستی بسته شده است.</td>
<td></td>
</tr>
</tbody>
</table>

### جدول ۲

<table>
<thead>
<tr>
<th>فهرست چک‌لیست قبل از برقراری کار</th>
<th>وظایف لازم به پایگاه مناسب</th>
</tr>
</thead>
<tbody>
<tr>
<td>✗ تمامی پیچ‌های فلنج در محل نصب بر روی ترانس محکم بسته شده‌اند.</td>
<td>✗ اتصال به زمین از طریق فلنج بوشینگ برق‌دار است.</td>
</tr>
<tr>
<td>✗ درویش نیز خاکی محکم بسته شده است.</td>
<td>✗ هواگیری لوله میانی بوشینگ انجام شده است.</td>
</tr>
<tr>
<td>✗ هواگیری از طریق فلنج بوشینگ انجام شده است.</td>
<td>✗ بازرسی جسمی مقره سرامیکی بوشینگ از جهت عدم احتمال اصابت شده است.</td>
</tr>
<tr>
<td>✗ در قسمت سر بوشینگ، پین داخل های مسی در جای خود قرار دارد.</td>
<td>✗ در قسمت سر بوشینگ، اپلی بر روی کلیم در جای خود قرار دارد.</td>
</tr>
<tr>
<td>✗ در قسمت سر بوشینگ، پیچ های کلیم محکم بسته شده‌اند.</td>
<td>✗ دریچه دیو روغن سالم روغن بوشینگ را برای دستی نشان میدهد.</td>
</tr>
<tr>
<td>✗ اتصال کابل فشار فوق و کلیم بر روی ترمینال فوقانی بوشینگ محکم و بدرستی بسته شده است.</td>
<td></td>
</tr>
</tbody>
</table>

### تذکر مهم: توصیه می‌شود که پس از نصب بوشینگ بر روی ترانسفورماتور، حداقل ۴۸ ساعت از برقدار نمودن آن خودداری شود.
As an option magnetic oil level indicators are available on customer request. These indicators are equipped with a floater to show the oil level as shown in fig.39. The indicator follows the movement of the floater by a magnet. In this way, the operator can see the oil level in a position of Low, High or something between. *As a recommendation, the Sight glass is more reliable for checking the Oil Level of bushing.*

---

**8-4-1 Oil Checks**

Irregularities in the oil level indication should be clarified. We recommend

---

Formula for OTF Bushings 245, 420 KV made by NirouTrans, Doc. No: P711712 by A. Rajabi
to visually check the indicator regularly in reference with section 8-4 and Fig.37 to Fig.39.

Any possible trace of oil shall be carefully noted. Especially the sealing area around insulator flanges in top or bottom shall be visually checked for any oil leakage and also accumulation of dirt in results.

If there is no oil in the oil level indictor but no traces of oil can be found on the bushing, oil may have got into the transformer volume as a result of a leakage.

⚠️ As explained above if the oil level indicator doesn't show an acceptable condition, immediately contact After Sale Service of NirouTrans co.

8-5 Test Tap

Through the Design of the test tap in OTF bushings the last grading layer of the capacitive grading is led out insulated. As shown in fig.40 the removable cap (1) has a contact spring (2) in which the connecting pin (3) of the small bushing (4) provides a reliable grounding in closed condition. The cap has an O-ring sealing (5) to protect inside of the test tap, free from humidity.

During normal operating condition this connection is always grounded. For measurements of the bushing to determine capacitance and dissipation factor when the transformer is de-energized the lead of measuring device is connected to the pin.

⚠️ The test tap is not self-grounding! Therefore during operation the cap has always to be closed! Operation with open test tap leads to destruction of the small bushing (4) in the test tap, influencing inside active part of the bushing with following damage!

طراحی تپ خانزی در بوشینگ‌های OTF به گونه‌ای است که آن‌ها در ناحیه قسمت سر بوشینگ از جهت بررسی نشی و یا جمع شدن گرد و غبار که از نتایج نشی روغن می‌باشد مانندشان قرار گیرد.

درصورتی که خاکی پارزی بوشینگ، مشاهده نمودید سطح روغن از حد مجاز یا اثر اما هنگ نظر نشی از نشی روغن بوشینگ روبرو شرایط ممکن است روغن بوشینگ از پایین بودن ترانس نشی کرده باشد که این موضوع نیز نشانی از وجود اشکال مهمی در بوشینگ می‌باشد.

با توضیحات فوق اگر دریچه دید روغن، مقدار روغن را در شرایط مناسب نشان ندهد، بلافاصله با یکی از خدمات پس از فروش شرکت نیرو‌سازان تماس حاصل نمایید.

5-8 تپ خانزی

طراحی تپ خانزی در بوشینگ‌های OTF به گونه‌ای است که آن‌ها در ناحیه قسمت سر بوشینگ از جهت بررسی نشی و یا جمع شدن گرد و غبار که از نتایج نشی روغن می‌باشد مانندشان قرار گیرد.

درصورتی که خاکی پارزی بوشینگ، مشاهده نمودید سطح روغن از حد مجاز یا اثر اما هنگ نظر نشی از نشی روغن بوشینگ روبرو شرایط ممکن است روغن بوشینگ از پایین بودن ترانس نشی کرده باشد که این موضوع نیز نشانی از وجود اشکال مهمی در بوشینگ می‌باشد.

با توضیحات فوق اگر دریچه دید روغن، مقدار روغن را در شرایط مناسب نشان ندهد، بلافاصله با یکی از خدمات پس از فروش شرکت نیرو‌سازان تماس حاصل نمایید.

The test tap is not self-grounding! Therefore during operation the cap has always to be closed! Operation with open test tap leads to destruction of the small bushing (4) in the test tap, influencing inside active part of the bushing with following damage!

The test tap is not self-grounding! Therefore during operation the cap has always to be closed! Operation with open test tap leads to destruction of the small bushing (4) in the test tap, influencing inside active part of the bushing with following damage!
8-6 Cleaning and Washing

8-6-1 Cleaning un-energized Bushing

The Products may be used for washing un-energized Bushings, are industrial or similar cleaning materials and/or water. Ancillary materials which are required are: Lint-free dusters and fluffy brushes. For final cleaning use absorbent paper and/or a blower if necessary. The insulator and the metal parts must be cleaned with the cleaning materials specified. Make a final visual check to ensure that no trace of the cleaning materials remains.

8-6-2 Washing Energized Bushing

During washing energized Bushing, the safety guidelines and procedures shall be observed. In order to prevent a Flashover from occurring, the same considerations for washing the Live-line HV insulator shall be followed. In general some of the main Items are:

- Use non-conductive rubber gloves and goggles to protect your hands and eyes.
- Use a non-conductive tool for cleaning.
- Do not touch any metal or conductive object while cleaning.
- Keep a secure distance from the energized Bushing.
- Do not touch any part of the Bushing while cleaning.
- Do not use water while cleaning.

4.11 Brushing and Washing Bushing

The Products may be used for brushing and washing Bushings, are industrial or similar cleaning materials and/or water. Ancillary materials which are required are: Lint-free dusters and fluffy brushes. For final cleaning use absorbent paper and/or a blower if necessary. The insulator and the metal parts must be cleaned with the cleaning materials specified. Make a final visual check to ensure that no trace of the cleaning materials remains.

4.12 Washing Energized Bushing

During washing energized Bushing, the safety guidelines and procedures shall be observed. In order to prevent a Flashover from occurring, the same considerations for washing the Live-line HV insulator shall be followed. In general some of the main Items are:

- Use non-conductive rubber gloves and goggles to protect your hands and eyes.
- Use a non-conductive tool for cleaning.
- Do not touch any metal or conductive object while cleaning.
- Keep a secure distance from the energized Bushing.
- Do not touch any part of the Bushing while cleaning.
- Do not use water while cleaning.
• Grounding of Washing Equipment includes the chassis, wash guns …
• Wearing proper safety Clothing includes harnesses, boots, hats, glasses…
• Keeping Safe Washing Distances
• Considering Direction of Wind and Wind Velocity
• Checking electrical Conductivity of Water before washing begins
• Following Cleaning technics and Procedure includes: following Sequence of washing for a set of bushings installed on a Transformer, specifying Starting Point of washing in each Ceramic Insulator…

Attention: Taking any Solution for Insulator Contamination of energized Bushing, Washing Procedure shall be completely carried out in accordance with Related Standards, local regulations and authorized Technical provisions.

9- Maintenance

Under normal conditions, The Bushings Made by NirouTrans are maintenance free. Nevertheless checks and maintenance are useful for safe and failure-free operation of the bushing.

9-1 Visual Inspection

We recommend to visually check the Bushing regularly. Oil level indicator shall show acceptable condition as explained in section 8-4-1. Any trace of oil shall be carefully noticed, especially in sealing areas. No damage shall be seen in the sheds of porcelain insulator. If any unacceptable condition observed immediately contact After Sale Service of NirouTrans.
9-2 Removing Pollution from Insulator

Considering environmental condition, Bushing may suffer from some kinds of pollutions like: industrial, marine (salt), desert and dust pollution.

The Bushings with contaminated insulator surfaces shall be washed periodically as mentioned in section 8-6.

Periodic hand wiping or washing may be required on de-energized installed bushings as explained in section 8-6-1.

For Energized Bushing, washing procedure shall be carried out according to section 8-6-2.

9-3 ThermoVision Control

In order to take the energized-bushing under thermo-control, It is recommended to use thermovision camera and investigate the temperature distribution of the bushing (Fig.41). Following items have to be taken into consideration for the bushing which is under load:

- As a rule at the contact point, i.e. the contact area between Connecting Terminal of Bushing and Clamp of HV Conductor, an increase of temperature up to 40 K can be detected. It is not unusual. Higher temperatures or excess temperatures during low load should lead to check of the contacts especially for loose connection.

- Due to the oil circulation inside the bushing and aluminum material of the head parts of bushing, the temperature at the top is slightly higher. It is not unusual.

- Irregularities, Hot Spots or any Jump in Temperature Distribution along the outdoor part of bushing have to be investigated more closely. If necessary Contact NirouTrans.

- براي مقابله با اين وضعيت و رفع آلودگي از روی سطوح مقره، مطالب بخش 8-6 بوسينگ ميايست بصورت دوره اي شسته شود. بوسينگهاي نصب شده اي که ب ي برق شده اند مطالب آنچه در بخش 8-6-1 توضيح داده شد ميايست تميز شده یا شسته شوند. روند شست و شو برای بوسينگهاي برقدار نيز مطالب توضيحات بخش 8-6-2 مي باشد.

- عكس‌بدراري حرارتی

در راستاي پايش عمکرکد صحیح بوسینگ برقداری که زیر بار قرار دارد، استفاده از دوربین‌های حرارتی و انجام کنترل دماي قابل توصیه می‌باشد. در طی این عملیات، عکس‌بدراری حرارتی از بوسینگ انجام شده و دماي سطح بوسینگ تعیین می‌شود (شکل 41). مقدار افزایش دماي مذکور نسبت به دمای محیط اندازه گیري شده (T) به عنوان مبداً می‌باشد.

- بوسینگ یک قانون، در ناحیه اتصال کلبه فشار قوي هم ترمینال فوقانی بوسینگ، مقدار افزایش دما (ΔT) تا حد 40 ⁰C غیرعادي نمی‌باشد. درصورت مشاهده مقدار بالاتر و یا مقادیر نزيدگي به اين مبدا در باره‌هاي کم، ميايست صحت اتصال مدارک بررسی گردد.

- در قسمت سر بوسینگ، به علت وجود قطعات آلومينيومي و گردش روغن داخلي بوسینگ، افزایش جزيئي دما نسبت به مبداً ذکر شده (ΔT) قابل پذيرش مي‌باشد. در صورتی که در عكس حرارتی بوسینگ هرگز از موارد تابگی و پیشگيري در طرف دماي، پرس دمايي دماي بالا بصورت نظارت اين و مواردي از اين دست روست گرديد، لازم است موضوع به شکل دقیقي بررسی گردد. درصورت لزوم با شركت نیروترانس تماس حاصل نمایيد.
9-4 On-Site Electrical Measurements

Electrical Measurements on site (Fig.42) are restricted to the determination of the bushing Capacitance and the Dissipation factor (tanδ) due to the environment conditions and the capacity of the measuring equipment.

We recommend electrical measurements of the bushing after the first 5 years of operation, then depending upon the measuring results every 3 years.

The devices required for the measurement are usually equipped specifically for the measurement of bushings. The measurement methods and device operating (Fig.43) are described in comprehensive manuals and instructions provided by the device manufacturer.
As explained in sec. 8-5, For On-Site electrical measurements of bushing, when the transformer is de-energized the lead of measuring device is connected to the pin of Test Tap. Measuring voltage is up to 20 kV AC.

If during electrical measurements, questionable values are detected, as a rule an oil analysis is useful to get information about the condition of the bushing. In any case when such results are achieved the bushing manufacturer has to be contacted.

In case of so-called “not grounded” measurements the test voltage is applied to the conductor of the bushings and the measuring signal is taken at the test tap of the bushing.

For bushings of type OTF with oil impregnated paper as main insulation there are limit values for the deviation of the capacitance and the dielectric dissipation factor with relation to the “new value”.

- **Dielectric dissipation factor, Tan(δ):**

For tan delta, Normal values are up to 0.4%. The influence of the temperature can be neglected in range from 20°C to 70°C. Contact NirouTrans for values between 0.4% and 0.55%. Values greater than 0.55% might be a sign for an internal problem.
- Capacitance (C):

Considering Limits for measured values, the result shall be discussed.

The grading of the C-deviations is caused by the different number of grading layers. These deviations become very small in case of higher voltage levels, therefore the evaluation of the measuring results is difficult, even more as measuring tolerances are important.

- For OTF Bushings in Voltage Level of 245 KV, C – Deviation up to 2.3% is acceptable.
- For OTF Bushings in Voltage Level of 420 KV, C – Deviation up to 1.5% is acceptable.

Through measurement procedure of Bushing Capacitance (C), influence of ambient temperature and operating Load shall be taken into consideration. In range from 20°C to 90°C of operating temperature of OTF Bushings, a linear correlation of +0.05% to +1.6% is respectively acceptable.

When the deviation of capacitance is significantly larger than 3% and the tan delta results are above the limits we recommend to carry out a DGA-analysis and discuss the results with NirouTrans.

9-5 After-sales services

In the event of incorrect function of a Bushing, inform NirouTrans co. to get after sales services. In writing the report, state the full identification of the bushing (type, serial number, year of manufacture…) and describe the precise nature of the fault and if possible by taking pictures.

(C – Deviation) OTF مقدار مجاز تغییر ظرفیت خانی

• برای بوشینگهای 245 کیلوولت مقدار مجاز تغییر ظرفیت خانی

تا حد 2.3% مجاز می‌باشد.

• برای بوشینگهای 420 کیلوولت مقدار مجاز تغییر ظرفیت خانی

تا حد 1.5% مجاز می‌باشد.

در طی اجرای عملیات ثانویه نیروی دیگر، تأثیر دمای محیط و بار الکتریکی را می‌پیماید. درنظر گرفته، برای بوشینگهای OTF در دمای کارکرد 20°C تا 90°C یک تصحیح خطی بتریب +0.05% تا +1.6% قابل اضافه نمودن می‌باشد.

در هر صورت اگر تغییرات ظرفیت خانی بطور قابل ملاحظه ای بیشتر از 3% و ضریب تلفات عایقی بوشینگ (tanδ) بالاتر از حد مجاز بود، توصیه می‌گردد تا تحلیل غازهای محلول در روغن (DGA) را انجام داده و با شرکت نیروی دیگر تماس حاصل نمایید.

5-9 خدمات پس از فروش

به منظور استفاده از خدمات پس از فروش در واقع ناشی از کارکرد نامناسب بوشینگ، شرکت نیروی دیگر را مطلع سازد. در تهیه گزارش، تمامی مشخصات بوشینگ (نوع، شماره سریال، سال ساخت و ...) و همچنین شرح واقعه را به صورت صریح و دقیق و در صورت امکان بکمک عکسبرداری نگارش کنید. در صورت وجود هرگونه ابهام در هریک از مراحل پیدا شده با شرکت نیروی دیگر تماس حاصل نمایید.
10- Storage

In its original packing, OTF Bushing can be stored in dry rooms protected from rain, precipitations and direct sunlight up to 12 months.

Long-term Storage, e.g. as Spare Bushing, is possible only with a Protection Tanks on the transformer side of bushing. The material of the transformer side end of the bushing is epoxy resin that is hygroscopic and can absorb humidity, especially during long storage term. To prevent humidity penetration into the epoxy resin part, the transformer side end of bushing is covered by a protection tank filled with oil.

As shown in Fig.42, the Protection Tank is made of spray galvanized steel and is screwed to the bushing Flange with a Gasket or O-Ring for secure sealing. The tank has a screw through which insulating oil is refilled. The oil volume has to be 7% less than the total Tank volume for oil volumetric expansion in case of temperature changes. This type of long-term storage has the advantage that controls are restricted to visual checks for oil leakages.

Fig.42

Figure 42: Protection tanks

In its original packing, OTF Bushing can be stored in dry rooms protected from rain, precipitations and direct sunlight up to 12 months.

Long-term Storage, e.g. as Spare Bushing, is possible only with a Protection Tanks on the transformer side of bushing. The material of the transformer side end of the bushing is epoxy resin that is hygroscopic and can absorb humidity, especially during long storage term. To prevent humidity penetration into the epoxy resin part, the transformer side end of bushing is covered by a protection tank filled with oil.

As shown in Fig.42, the Protection Tank is made of spray galvanized steel and is screwed to the bushing Flange with a Gasket or O-Ring for secure sealing. The tank has a screw through which insulating oil is refilled. The oil volume has to be 7% less than the total Tank volume for oil volumetric expansion in case of temperature changes. This type of long-term storage has the advantage that controls are restricted to visual checks for oil leakages.

Fig.42

Figure 42: Protection tanks

In its original packing, OTF Bushing can be stored in dry rooms protected from rain, precipitations and direct sunlight up to 12 months.

Long-term Storage, e.g. as Spare Bushing, is possible only with a Protection Tanks on the transformer side of bushing. The material of the transformer side end of the bushing is epoxy resin that is hygroscopic and can absorb humidity, especially during long storage term. To prevent humidity penetration into the epoxy resin part, the transformer side end of bushing is covered by a protection tank filled with oil.

As shown in Fig.42, the Protection Tank is made of spray galvanized steel and is screwed to the bushing Flange with a Gasket or O-Ring for secure sealing. The tank has a screw through which insulating oil is refilled. The oil volume has to be 7% less than the total Tank volume for oil volumetric expansion in case of temperature changes. This type of long-term storage has the advantage that controls are restricted to visual checks for oil leakages.

Fig.42

Figure 42: Protection tanks

In its original packing, OTF Bushing can be stored in dry rooms protected from rain, precipitations and direct sunlight up to 12 months.

Long-term Storage, e.g. as Spare Bushing, is possible only with a Protection Tanks on the transformer side of bushing. The material of the transformer side end of the bushing is epoxy resin that is hygroscopic and can absorb humidity, especially during long storage term. To prevent humidity penetration into the epoxy resin part, the transformer side end of bushing is covered by a protection tank filled with oil.

As shown in Fig.42, the Protection Tank is made of spray galvanized steel and is screwed to the bushing Flange with a Gasket or O-Ring for secure sealing. The tank has a screw through which insulating oil is refilled. The oil volume has to be 7% less than the total Tank volume for oil volumetric expansion in case of temperature changes. This type of long-term storage has the advantage that controls are restricted to visual checks for oil leakages.

Fig.42

Figure 42: Protection tanks
In case of long-term storage of OTF Bushings, a thick support of approx. 300-500 mm shall be placed under the Crate on the head side of Bushing to achieve a slightly inclined position. In spite of being a Mechanism inside the bushing head to prevent the gas cushion from moving toward the Active Part of bushing in horizontal position, for long-term storage it is advantageous to locate the gas cushion statically higher than the oil volume inside the bushing.

11- Re-Packing of Bushing

We recommend that the original packing should not be damaged or destroyed. It can be used for repacking of OTF bushing in case of further transportation, e.g. after final testing of the transformer for dispatch to the site of installation or any other necessary transportation of OTF Bushing.

For repacking of OTF Bushing, consider section 2-1 and Fig.8 with the following procedure:

1- At first, the wooden crate should be visually inspected. Any possible damage should be carefully noted and completely repaired.
   Be sure that there is a foam layer on each bottom support of crate (No.9 of Fig.8). It acts as a shock-absorber for bushing during transportation.
2- Cover the resin end of Bushing by a plastic foil to protect it from precipitations, rains and direct sunlight.
3- Repacking of OTF Bushing, in horizontal position, keep the oil level indicator faced up and prevent it from turning around its axis. In this regard read again section 3, especially part 3-1 for safe procedure.
4- As shown in Fig.5 and Fig.6, Place the bushing in its crate gently.
5- Press the wooden supports (No.5 of Fig.8) on the bushing and at the same time for a strong joint; fasten the Self-tapping Screws (No.6 of Fig.8) into the side of the Crate by using a Socket wrench or Nut-runner with proper sizes of SW10 and/or SW16 as shown in Fig.9.
6. By fastening the self-tapping Screws, mount the flange support (No.7 of Fig.8) on its location and fix it to the Flange by another self-tapping Screw (No.8 of Fig.8) to prevent the bushing from turning around its axis.

7. Check that the instruction Manual is inside the crate and there is the attention Mark (No.10 of Fig.8) on the bushing head.

8. Put the Top side (No.3 of Fig.8) on its location and mount it by fastening the self-tapping Screws.

12. Environmental Aspects and Safety

The Insulating Oil used in OTF Bushing is NYTRO 10XN made by Nynas, Sweden. It is Mineral Naphthenic oil, free from PCB and other strongly harmful substances, and poses a low impact to the environment.

If you touch the oil, immediately wash it with cold water and soap and in case of eye contact, rinse with plenty of water.

12.1. Destruction

After draining the oils, they can be burnt in an appropriate plant.

The disposal should be carried out in accordance with local legal provisions, laws and regulations.

The porcelain can be deposited after it has been crushed. The metals in OTF Bushings can be recycled. To do that the oil-saturated paper insulation should be burnt.

The aluminum in condenser type insulation, with its combination of oil and paper, can be recycled after the insulation has been burnt; there is no emission of any harmful substances during this process.

Environmental Aspects and Safety

The Insulating Oil used in OTF Bushing is NYTRO 10XN made by Nynas, Sweden. It is Mineral Naphthenic oil, free from PCB and other strongly harmful substances, and poses a low impact to the environment.

If you touch the oil, immediately wash it with cold water and soap and in case of eye contact, rinse with plenty of water.

12.1. Destruction

After draining the oils, they can be burnt in an appropriate plant.

The disposal should be carried out in accordance with local legal provisions, laws and regulations.

The porcelain can be deposited after it has been crushed. The metals in OTF Bushings can be recycled. To do that the oil-saturated paper insulation should be burnt.

The aluminum in condenser type insulation, with its combination of oil and paper, can be recycled after the insulation has been burnt; there is no emission of any harmful substances during this process.

Environmental Aspects and Safety

The Insulating Oil used in OTF Bushing is NYTRO 10XN made by Nynas, Sweden. It is Mineral Naphthenic oil, free from PCB and other strongly harmful substances, and poses a low impact to the environment.

If you touch the oil, immediately wash it with cold water and soap and in case of eye contact, rinse with plenty of water.

12.1. Destruction

After draining the oils, they can be burnt in an appropriate plant.

The disposal should be carried out in accordance with local legal provisions, laws and regulations.

The porcelain can be deposited after it has been crushed. The metals in OTF Bushings can be recycled. To do that the oil-saturated paper insulation should be burnt.

The aluminum in condenser type insulation, with its combination of oil and paper, can be recycled after the insulation has been burnt; there is no emission of any harmful substances during this process.

Environmental Aspects and Safety

The Insulating Oil used in OTF Bushing is NYTRO 10XN made by Nynas, Sweden. It is Mineral Naphthenic oil, free from PCB and other strongly harmful substances, and poses a low impact to the environment.

If you touch the oil, immediately wash it with cold water and soap and in case of eye contact, rinse with plenty of water.

12.1. Destruction

After draining the oils, they can be burnt in an appropriate plant.

The disposal should be carried out in accordance with local legal provisions, laws and regulations.

The porcelain can be deposited after it has been crushed. The metals in OTF Bushings can be recycled. To do that the oil-saturated paper insulation should be burnt.

The aluminum in condenser type insulation, with its combination of oil and paper, can be recycled after the insulation has been burnt; there is no emission of any harmful substances during this process.

Environmental Aspects and Safety

The Insulating Oil used in OTF Bushing is NYTRO 10XN made by Nynas, Sweden. It is Mineral Naphthenic oil, free from PCB and other strongly harmful substances, and poses a low impact to the environment.

If you touch the oil, immediately wash it with cold water and soap and in case of eye contact, rinse with plenty of water.

12.1. Destruction

After draining the oils, they can be burnt in an appropriate plant.

The disposal should be carried out in accordance with local legal provisions, laws and regulations.

The porcelain can be deposited after it has been crushed. The metals in OTF Bushings can be recycled. To do that the oil-saturated paper insulation should be burnt.

The aluminum in condenser type insulation, with its combination of oil and paper, can be recycled after the insulation has been burnt; there is no emission of any harmful substances during this process.
استفاده در مقرره رزیه، را نیز می‌توان به راحتی سوزاند. این دو فرآیند با استی مطابق با قوانین و دستورالعمل‌های محلی باشد. مقره‌ی چینی را می‌توان پس از خرد کردن، دفن کرد.

تمامی فلزات بکار رفته در محصول قابل بازیافت هستند.

فولی آلومینیومی بکار رفته در لاشه خازنی اولین نیز پس از سوزاندن کاغذ اشباع شده با روغن، قابل بازیافت خواهد بود. در این فرآیند هیچ گونه ماده سیم و یا مضری تولید نمی‌شود.
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>فهرست مطالب</th>
<th>صفحه</th>
</tr>
</thead>
</table>

| عنوان | |
|-------|