



**CHAROENCHAI  
SERVICE PLUS CENTER**

# Transformer & Maintenance



**ENGLISH VERSION**



**CHAROENCHAI TRANSFORMER CO., LTD.**  
บริษัท เจริญชัยหน้อแปลงไฟฟ้า จำกัด

## Foreword



Electricity is one of the important business and industry factor. The discontinuous working of the electricity system might cause the interrupted and low-quality production as well as the high cost. Therefore, the maintenance enabling the electricity system to work constantly is very significant. The maintenance person shall be the expert and have the good knowledge in this field, so that they could maintain this system well and efficiency.

Nowadays, it is rather difficult to find the person who knows the detail of transformers and its proper maintenance. Therefore, this manual prepared by Charoenchai Transformer Co., Ltd. is valuable and beneficial for any person who is responsible for transformer maintenance and any relevant person. It also gathers general technical instruction for any general users, having no much knowledge in the transformer field.

Therefore, it is very appreciated and admirable for preparing this manual. We hope that Charoenchai Transformer Co., Ltd. will continuously contribute toward the society as ever.

**Luchai Thongnin**

Director of Council of Engineers (5<sup>th</sup> session)



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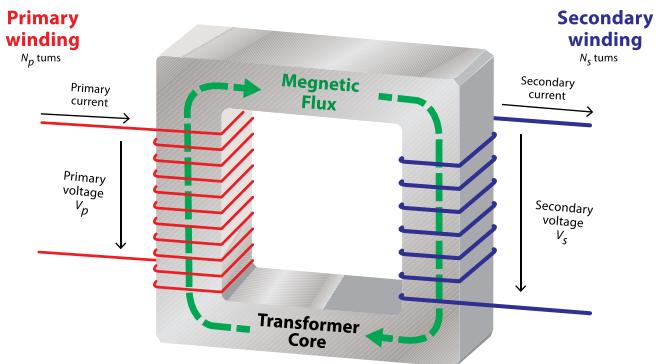
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# Introduction

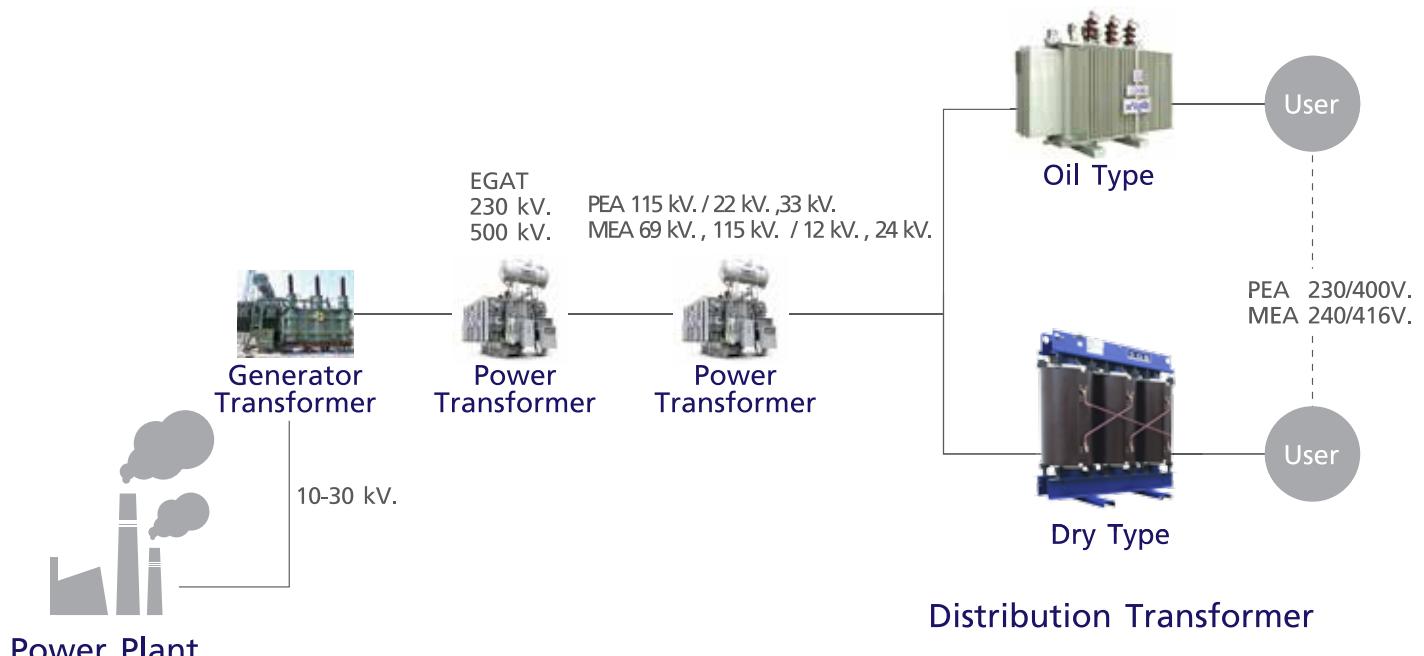




## What is a Transformer ?

Transformers are electromechanical devices that transfer energy from one circuit to another by mean of a common magnetic field with same frequency.

## How is the importance of the transformer in electricity system?



# Charoenchai Transformer



## Motivation of Life

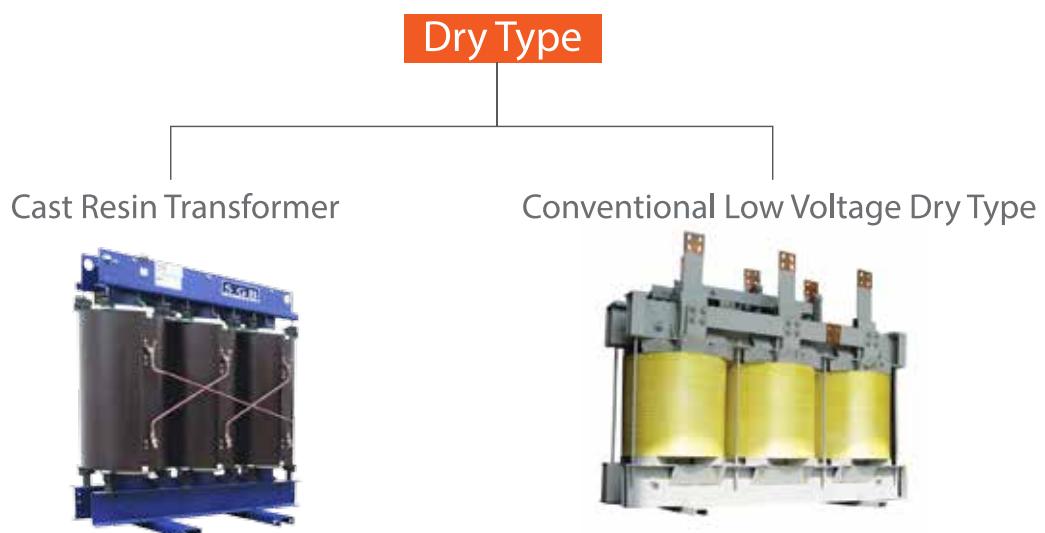
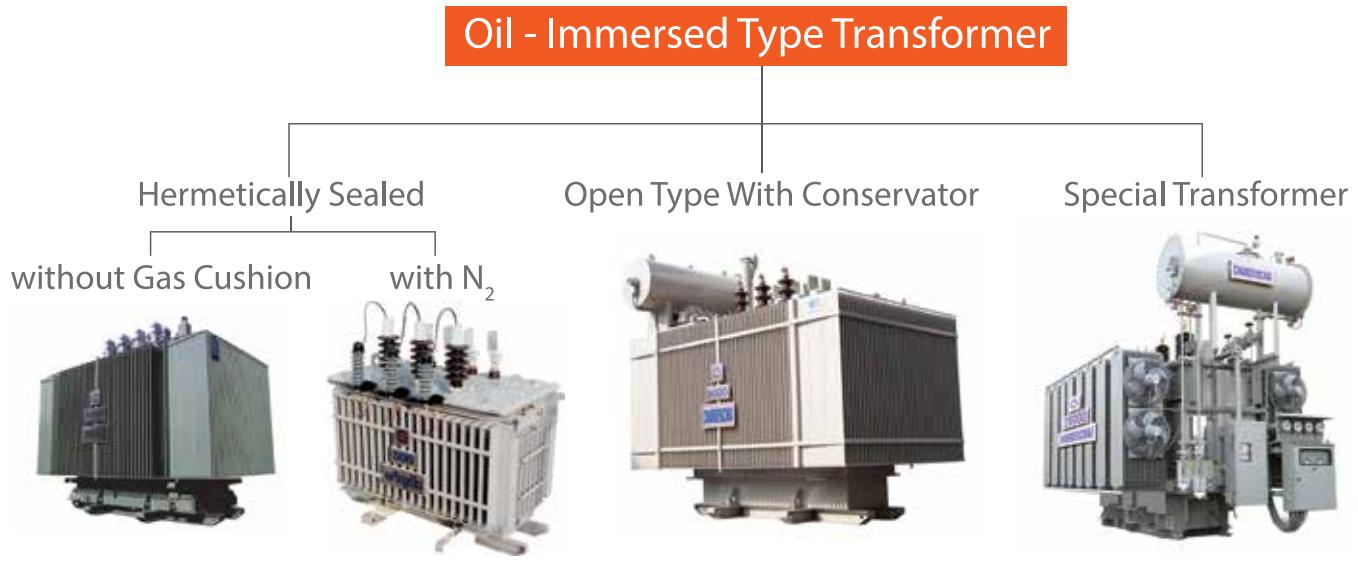
The transformer is one major part of electric power system which distributes power to human, as well as creates new technology with respect to human life in various aspects, such as industry, education, telecommunication, medicine, agriculture, business and our routine life. Therefore, we could say that the transformer is one of most important part in conveying power to manage all human life.



# Type of transformer

There are two types of transformer, dividing by insulation, as follows:

- 1) Oil - Immersed Type Transformer
- 2) Dry Type Transformer



# Oil – Immersed Type Transformer

## 1. Hermetically Sealed

### 1.1 Hermetically Sealed without Gas Cushion

Hermetically Sealed Transformer without gas cushion is one type of oil immersed transformer in which the tank is fully filled with oil. The tank is completely sealed so as to prevent moisture and oxygen from entering into the transformer. When transformer oil comes in contact with oxygen and moisture, the chemical reaction will cause oxidation reaction which leads to cause insulation failure inside the transformer and the transformer becomes less life or will be short circuited. Internal pressure will depend on the load and temperature of the transformer, the higher the load, the higher the pressure. Hermetically Sealed Transformer without gas cushion will also come together with corrugated-finned tank which has specific properties to expand and contract, without any damage, according to the changed volume due to variation of internal pressure.



### 1.2 Hermetically Sealed Transformer with $N_2$

Hermetically Sealed Transformer with  $N_2$  is one type of oil immersed transformer. The tank is completely sealed so as to prevent moisture and oxygen from entering into the transformer and also filled up above the top of oil with nitrogen gas. When transformer oil comes in contact with oxygen and moisture, the chemical reaction will cause oxidation reaction which leads to cause insulation failure inside the transformer and the transformer becomes less life or will be short circuited. Internal pressure will depend on the load and temperature of the transformer, the higher the load, the higher the pressure. Hermetically Sealed Transformer with  $N_2$  will also come together with corrugated-finned tank which has specific properties to expand and contract, without any damage, according to the changed volume due to variation of internal pressure and also the  $N_2$  will perform as a cushion at the same time.



## 2. Open Type with Conservator Tank

Open Type with Conservator Tank is one type of oil immersed transformer which is equipped with oil conservator and has air inlet and outlet to release internal pressure from the expansion of the oil volume due to the variation of internal pressure depending on the load and temperature of the transformer, the higher the load, the higher the pressure. Air inside the tank can go out and come into the tank, so called "Breathing", via the breather which is connected to the conservator. In order to prevent moisture and oxygen from entering into the transformer, which can cause oxidation reaction leading to cause insulation failure inside the transformer and the transformer becomes less life or will be short circuited, the breather shall be filled with desiccant agent call "Silica Gel" and, therefore, it is necessary to look after silica gel to be clean and fresh at all times.



### 3. Special Transformers

#### 1) Transformer for VSPP and SPP Application

Transformer for VSPP and SPP Application is one type of oil immersed transformer which is designed to have capacity (kVA) and voltage level suitable to be installed and used for SPP (Small Power Producer) and VSPP (Very Small Power Producer). This application of transformers can either be Hermetically Sealed type or Conservator Tank Type.



#### 2) AVR Transformer with On Load Tap Changer

AVR Transformer with On Load Tap Changer is one type of oil immersed transformer which is designed to be used for voltage regulating to have constant voltage of the electrical system automatically. According to voltage drop in transmission lines due to long distances from transformers to the loads, it is necessary to have an Automatic voltage Regulating transformer (AVR) to handle this problem. AVR shall be equipped with On Load Tap Changer or OLTC. For OLTC transformer, Charoenchai uncompromisingly offers Maschinenfabrik Reinhausen (MR), Germany because of its undisputable reliability.



#### 3) Transformer with On Load Tap Changer

Transformer with on Load Tap Changer is one type of oil immersed transformer which is equipped with On Load Tap Changer or OLTC. For OLTC transformer, Charoenchai uncompromisingly offers Maschinenfabrik Reinhausen (MR), Germany because of its undisputable reliability.



#### 4) Transformer for Unit Substation

Transformer for Unit Substation is less flammable oil type transformer which is designed to be installed and used inside the enclosure of Unit Substation. The enclosures of unit substations are normally installed in public area, therefore it is strictly to prevent any harm and danger that may be caused by any failure of the equipment inside the enclosure.

LAHMEYER  
Compactstation®



Noted : Charoenchai Intertrade is the sole agent and distributor of unit substation of Lahmeyer (Germany). Our unit substations have successfully passed the internal arc test according to IEC standard.

#### 5) Transformer for Coal Mine Application (Vibration Proof)

Transformer for Coal Mine Application (Vibration Proof) is designed to be used in the coal mining industry, normally underground, that shall be subject to vibration from mining operation or during transportation. Besides the transformer is designed to sustain vibration, this transformer is also flameproof by installed inside protection enclosure and this flameproof and robust transformer is recommended for use in hazardous atmosphere applications such as carboniferous mining, the oil and gas industry and the chemical industry.



#### 6) Transformer for Solar Farm Application

Transformer for Solar Farm Application is one type of oil immersed transformer which is designed to have capacity (kVA) and voltage level suitable to be installed and used for Solar Farm application, especially for its lower losses both load loss and no load loss for the optimum utilization both during energized with load or without load. This application of transformers can either be Hermetically Sealed type or Conservator Tank Type.



## 7) *Earthing Transformer*

Earthing Transformer is one type of oil immersed transformer which is designed to be used with three phase supply systems, occasionally, in case of the neutral point is not available or does not exist with a delta secondary winding of the transformer, a neutral point needs to be created. This is the purpose of the earthing transformer, which could consist of a zig-zag winding, used to achieve the required zero phase impedance stage which provides the possibility of neutral condition.



## 8) *Scott-T Transformer*

Scott-T Transformer is one type of oil immersed transformer which is specially designed to be used to derive two-phase current from a three-phase source or vice-versa. The Scott connection evenly distributes a balanced load between the phases of the source. The Scott -T transformer connection may also be used in a back to back T to T arrangement for a three - phases to 3 phases connection. This is a cost saving in the smaller kVA. transformers due to the 2 coil T connected to a secondary 2 coils T connected rather than the traditional three-coil primary to three-coil secondary transformer.



## 9) *GRIDCON® iTAP® Transformer*

GRIDCON® iTAP® Transformer is the first mass-produced solution for controllable local grid transformers and consists of the on-load tap-changer, motor-drive unit and voltage regulator.



# Dry Type Transformer

## 1. Cast Resin Transformer



Cast Resin Transformer is one type of dry type transformer which high voltage winding assembly is cast under vacuum using a class F epoxy resin. The low voltage winding is made of foil and greatly reduces the axial forces present under short circuit conditions offering superior short circuit performance. The purpose of cast resin transformer is to be used in place of oil type transformer in high-rise building, hospital and etc, where the safety is required for non flammable transformer in case of short circuit.

Noted : Charoenchai Intertrade is the sole agent and distributor of cast resin transformer of SGB Starkstrom (Germany).

## 2. Conventional Low Voltage Dry Type



Conventional Low Voltage Dry Type is one type of dry type transformer which winding assembly is using a Class H insulation which can allow maximum temperature go up to 180 Celsius. The purpose of LV dry type transformer is to be used for special machines with variation of voltage rating and used to isolate primary circuit from secondary circuit, so called Isolating Transformer, for safety purpose or reduction of interference in electrical circuit for a precision measurement of testing equipment.





## Testing

Every unit of Charoenchai Transformers shall pass the routine tests required by IEC, ANSI/IEEE and TIS.

### Routine Test

01. Measurement of winding resistance
02. Measurement of voltage ratio and check of phase displacement
03. Measurement of short-circuit impedance
04. Measurement of load loss
05. Measurement of no- load loss and current
06. Power frequency AC withstand test
07. Induced voltage test
08. Measurement of insulation resistance
09. Oil leak test
10. Oil dielectric strength test



## Type Test

01. Lightning impulse test
02. Temperature rise test
03. Determination of sound level

## Special Test

01. Short- circuit withstand test
02. Partial discharge measurement

## Transformer Oil Testing (Additional)

01. Dissolved gas analysis
02. Water content measurement



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# Transformer Maintenance

## How important is transformer maintenance?

Transformer is the heart of power supply system. Even the best of equipment will not work if the transformer is broken and unable to supply the power to them, which will definitely affect the production. Therefore, correct maintenance of the transformer is utmost important and necessary.

## Maintenance of Transformer

There are two ways commonly practice transformer maintenance:

01. Corrective Maintenance
02. Preventive Maintenance

### Corrective Maintenance

Means the traditional maintenance after the transformer broke down, which might affect the production as the transformer is unable to work. This breakdown might spread and cause significant expenses.

### Preventive Maintenance

Means the scheduled time and planned maintenance to prevent transformer from breaking down. This method will also extend the life of the transformer. In preventive maintenance, there will be constant careful planning, e.g., monthly, quarterly, annually and etc. The maintenance will be conducted either energized or shutted down. If any abnormality is detected, the maintenance will be scheduled. The objective of preventive maintenance is to detect and fix the problem before the transformer breakdown. If turning off the power is necessary, it is shall be scheduled in advance in order to control the consequence effect of turning off the power.



## Benefit of Preventive Maintenance

01. The transformer will always be ready to use;
02. Reducing the risk of electricity system malfunction and enable the scheduled power off;
03. Expanding the life of transformer; and
04. Effective work of transformer

## Transformer Check Safety

01. Transformer Check During Power Being Energize : Should not be performed during high humidity weather or after raining. The humidity in the air might endanger the worker as it will lessen the insulation. Do not get too close to the area with electricity during the check.

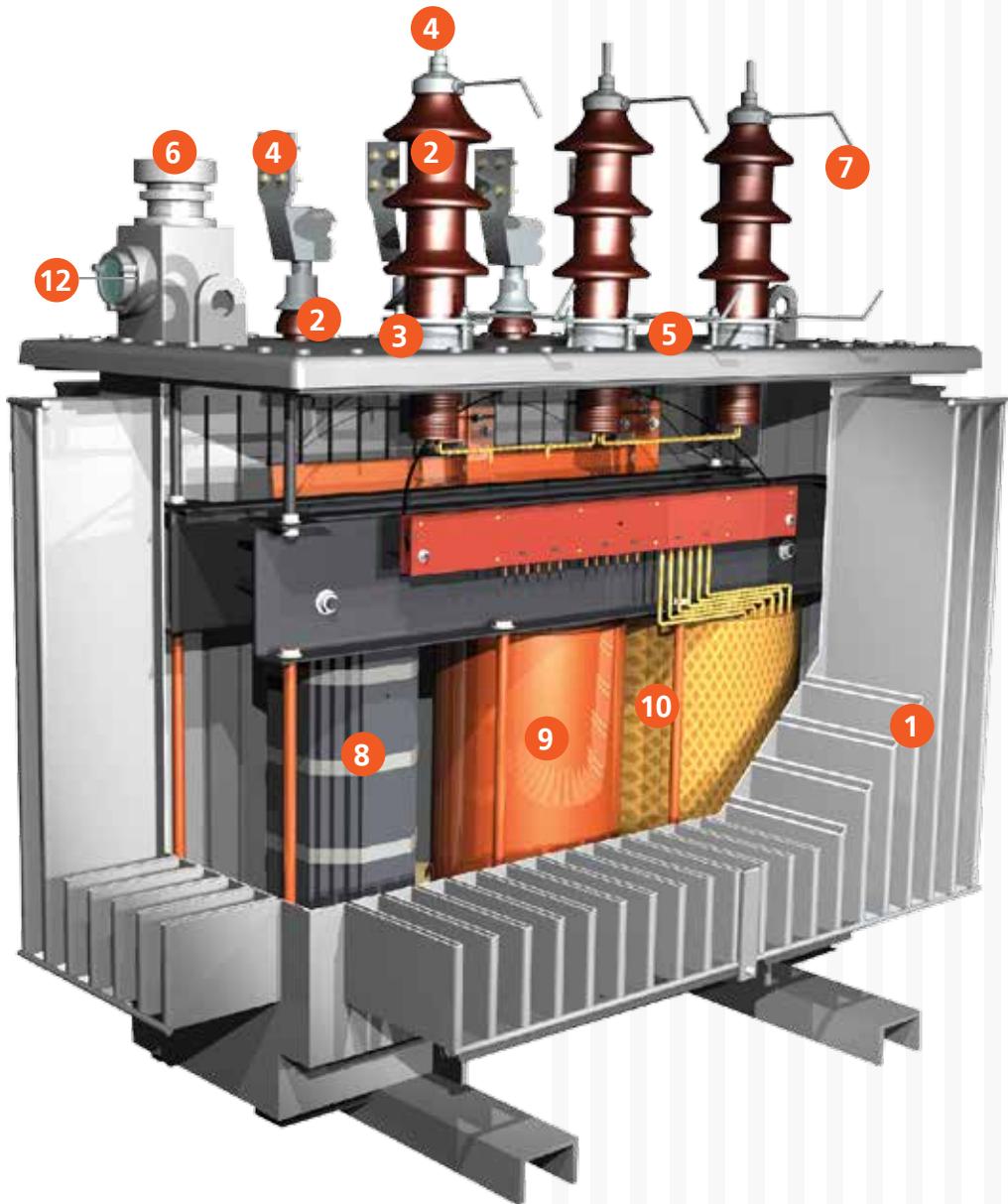
02. Transformer Check During Power Being Shutted Down: The low-voltage should be turned off first, following by the high-voltage. Always checking for electricity after turning off the power. Upon the confirmation that there is no electricity, always discharge all the charge that may remain in the transformer every time. Grounding is required during all courses of operational.

03. Always wearing all safety equipment, e.g., proper insulated glove, safety helmet, insulated boots. This will reduce the risks that might occur.

04. The person checking must know about the danger from electricity and how to prevent them.



# Important Component of Transformer



## 1. Tank and Fin

**Tank** : Covering all important components of transformer, e.g., iron core, winding and oil.

**Fin** : A component of Tank for heat dissipation during operation.

## 2. HV and LV Bushing

Insulation between the high voltage or low voltage terminal and Tank.



## 3. Transformer Gasket

A material is used to prevent leakage of oil.



## 4. HV and LV Terminal

A connection point to the power supply.



## 5. Tap Changer

For increase or decrease the voltage of the transformer in order to stabilize the voltage for user. There are both Off-Load Tap Changer and On-Load Tap Changer (OLTC)



## 6. Pressure-Relief Device

Releasing the over-pressure in the Tank to prevent damage to Tank and Fin, Without Contact or With Contact.



## 7. Arcing Horn

Preventing damage to transformer from the surge, especially from lightning.

## 8. Transformer Core

The iron core of transformer as the passage of the magnetic flux between high voltage and low voltage winding.

## 9. HV Winding

High voltage winding.

## 10. LV Winding

Low voltage winding.

## 11. Dial Type Thermometer

Showing the temperature of transformer oil, Without Contact or With Contact.



## 12. Oil Level Indicator

Indicating the level of oil in Tank, Without Contact or With Contact.



## 13. Dehydrating Breather with Silica Gel

Preventing humidity from entering the Tank. To be installed with the transformer reserved oil tank (conservator tank).



## 14. Conservator Tank

Supporting the expansion and contraction of the oil in main tank during transformer operation.



## 15. Buchholz Relay

Detecting abnormality in gas accumulation and oil flow rate. To be installed with the transformer reserved oil tank (conservator tank), Without Contact or With Contact.



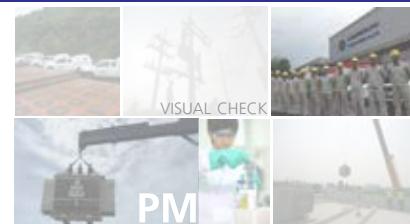
## 16. Transformer Oil

Acting as insulation between conductor and ground. Transformer oil also acts as heat dissipation by extracting the heat from winding to Fin.



# Preventive Maintenance

There are two methods for Preventive Maintenance.



## 1. Visual Check or Inspection Check

**External checking , which can be perform by yourself under ISP 01. - ISP 15.**

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- ISP 01. Tank and Fin Check
- ISP 02. HV Bushing Check
- ISP 03. LV Bushing Check
- ISP 04. HV Bushing Gasket Check
- ISP 05. LV Bushing Gasket Check
- ISP 06. Cover Gasket Check
- ISP 07. Tap Changer Gasket Check
- ISP 08. HV Terminal Check
- ISP 09. LV Terminal Check
- ISP 10. Pressure-Relief Device Check
- ISP 11. Oil Level Indicator Check
- ISP 12. Dehydrating Breather with Silica Gel Check (Only existing model)
- ISP 13. Thermometer Check
- ISP 14. Buchholz Relay Check
- ISP 15. Transformer Installing Location Check

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## 2. Measurement or Testing

**This is a detailed check in addition to Visual Check / Inspection Check**

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- TST 01. Measurement of Insulation Resistance
- TST 02. Oil Dielectric Strength Test
- TST 03. Water Content Measurement
- TST 04. Dissolved Gas Analysis

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**CSP** = Charoenchai Service Plus Center



is a transformer service center of Charoenchai, which available for nationwide services.

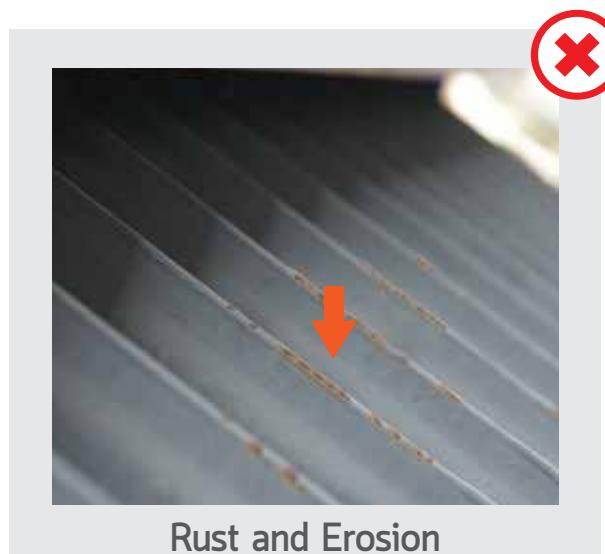
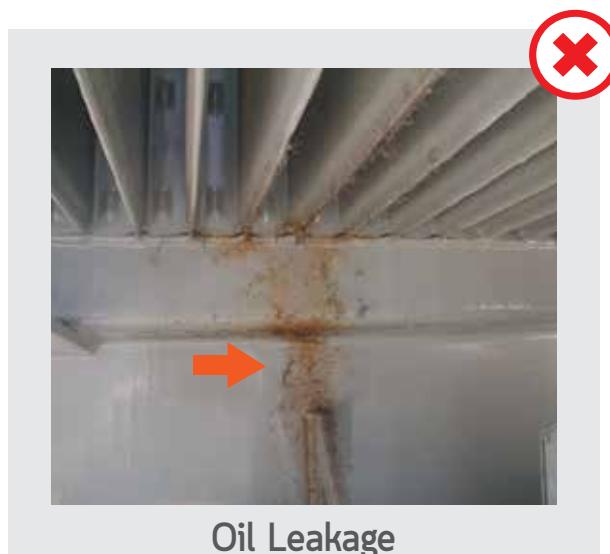
## ISP01. Tank and Fin Check

### Check and Inspection:

- » Check the leakage of oil and slick at the weld;
- » Check for rust or corrosion of the Tank;
- » Check for stains and dust.

### Suggestion and Precaution:

- » If oil leakage is found, contact **CSP** for repairing;
- » If any stains and dust is found at the Tank and Fin, cleaning is required as it will reduce the efficiency of heat extraction;
- » Re-painting is required for any rusty part to prevent oil leakage from the erosion of the Tank.



## ISP02. HV Bushing Check

### 🔧 Check and Inspection:

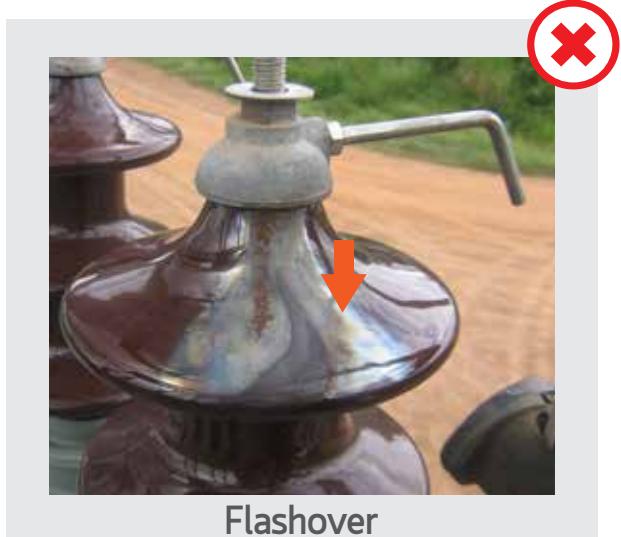
- » Check the surface of the bushing. The surface must be glossy without dust;
- » Check for any chip, crack or flashover on the surface of bushing.

### ⚠ Suggestion and Precaution:

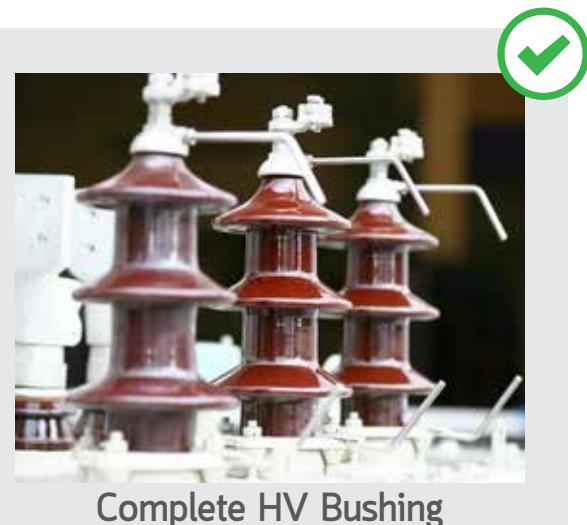
- » Cleaning is required if any stains are found on the bushing;
- » If the bushing is chipped, cracked or flashover, contact **CSP** for replacing the bushing;
- » At least once a year, cleaning by clean towel is advised



Chipped HV Bushing



Flashover



Complete HV Bushing

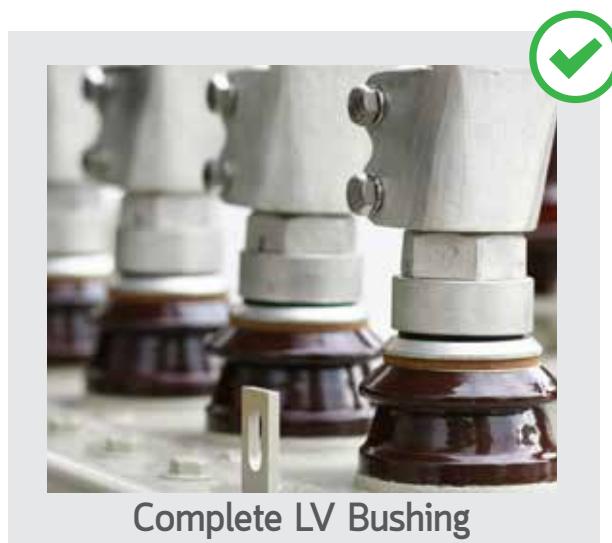
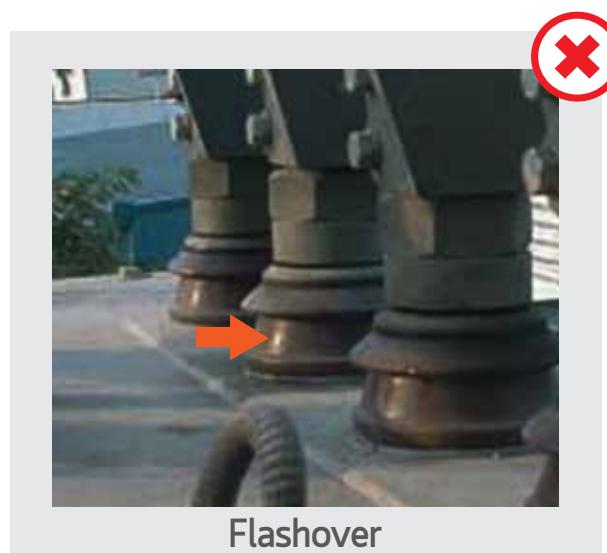
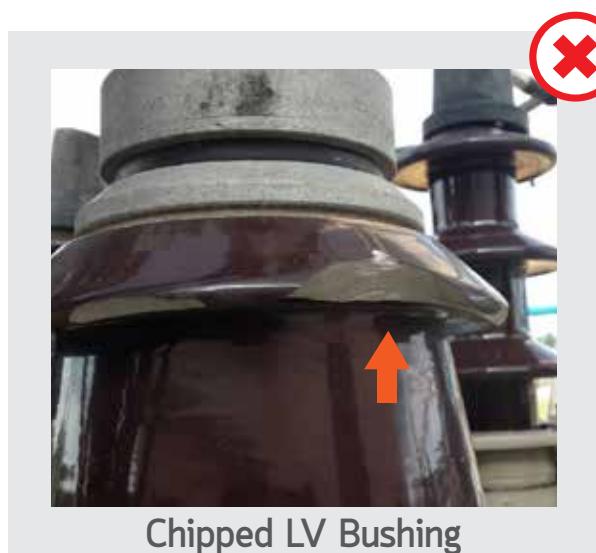
## ISP03. LV Bushing Check

### Check and Inspection:

- » Check the surface of the bushing, the surface must be glossy without dust;
- » Check for any chip, crack or flashover on the surface of bushing

### Suggestion and Precaution:

- » Cleaning is required if any stains are found on the bushing;
- » If the bushing is chipped, cracked or flashover, contact **CSP** for replacing the bushing;
- » At least once a year, cleaning by clean towel is advised.



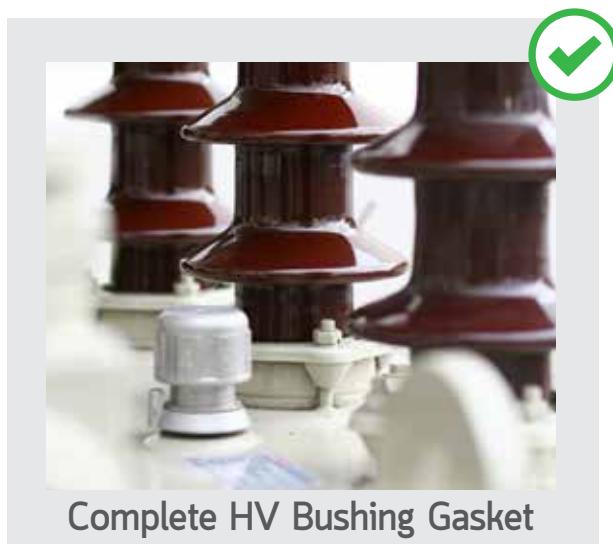
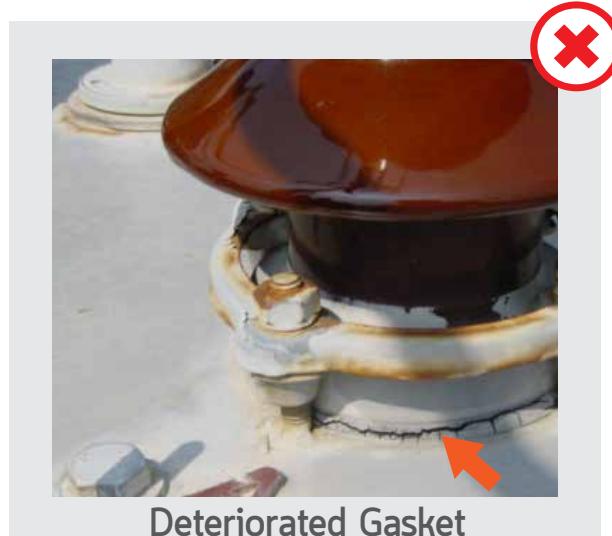
## ISP04. HV Bushing Gasket Check

### Check and Inspection:

- » Check for any oil leakage at the gasket;
- » Check for gasket deterioration.

### Suggestion and Precaution:

- » Replacing is required if any leakage is found;
- » Replacing is required if deterioration is found, e.g., cracked or disintegrate;
- » Should not pull the line too tight as it might damage the bushing or gasket.



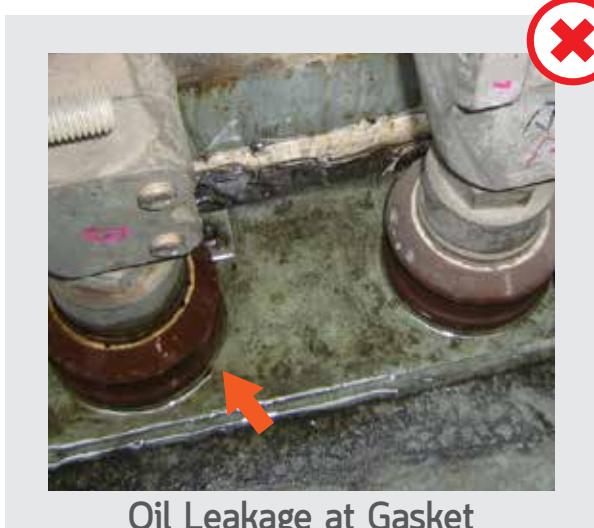
## ISP05. LV Bushing Gasket Check

### 🔧 Check and Inspection:

- » Check for any oil leakage at the gasket;
- » Check for gasket deterioration.

### ⚠ Suggestion and Precaution:

- » Replacing is required if any leakage is found;
- » Replacing is required if deterioration is found, e.g., cracked or disintegrate;
- » Should not pull the line too tight as it might damage the bushing or gasket.



Oil Leakage at Gasket



Deteriorated Gasket



Complete LV Bushing Gasket



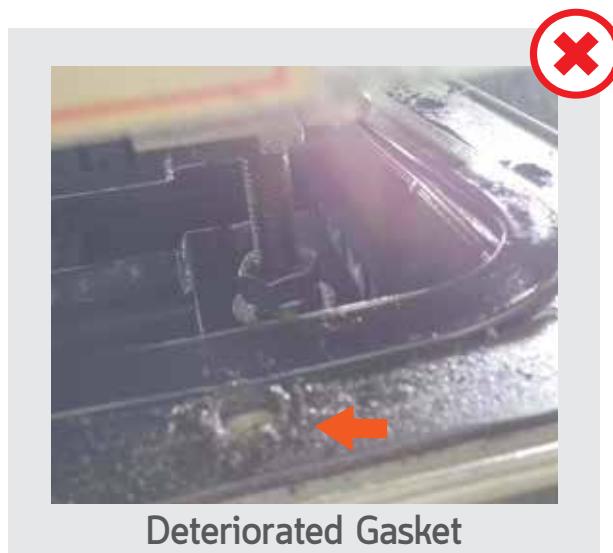
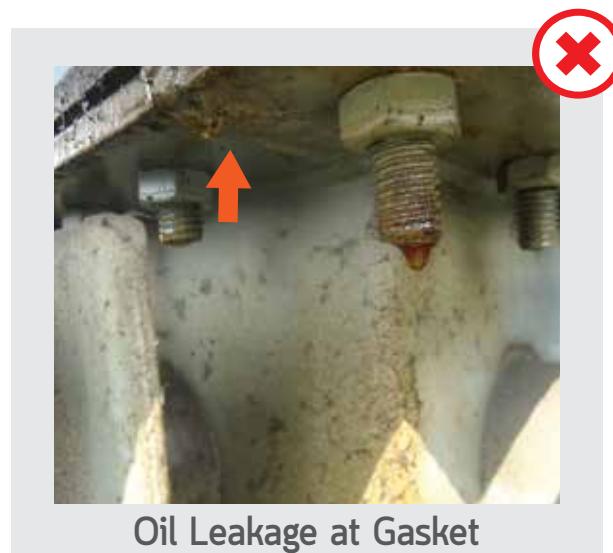
## ISP06. Cover Gasket Check

### Check and Inspection:

- » Check for any oil leakage at the gasket;
- » Check for gasket deterioration.

### Suggestion and Precaution:

- » Replacing is required if any leakage is found;
- » Replacing is required if deterioration is found, e.g., cracked or disintegrate.



## ISP07. Tap Changer Gasket Check

### Check and Inspection:

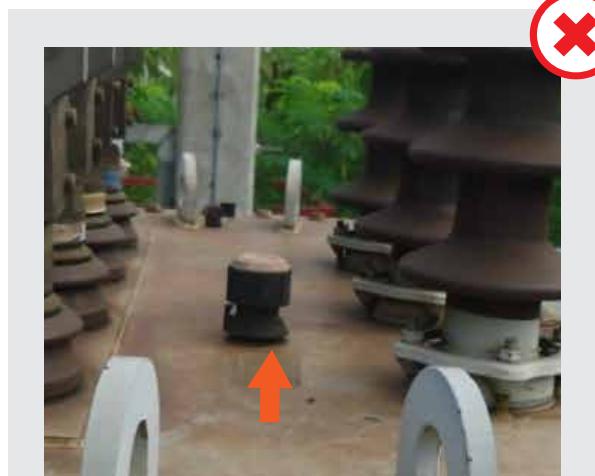
- » Check for any oil leakage at the gasket;
- » Check for gasket deterioration.

### Suggestion and Precaution:

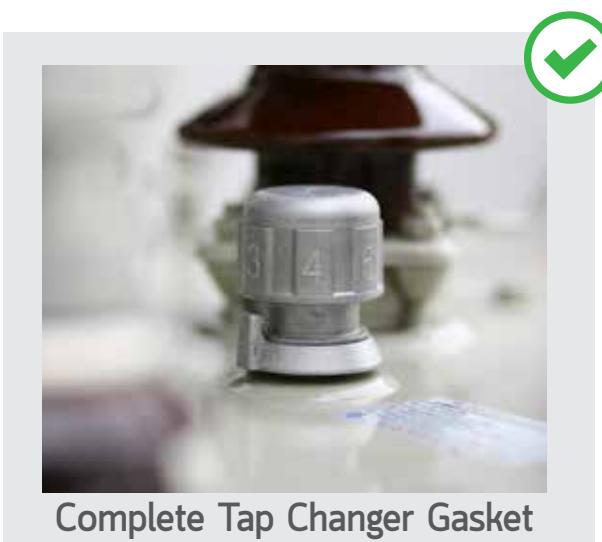
- » Replacing is required if any leakage is found;
- » Replacing is required if deterioration is found,  
e.g., cracked or disintegrate;
- » Should not pull the line too tight as it might damage  
the bushing or gasket.



Oil Leakage at Gasket



Deteriorated Gasket



Complete Tap Changer Gasket



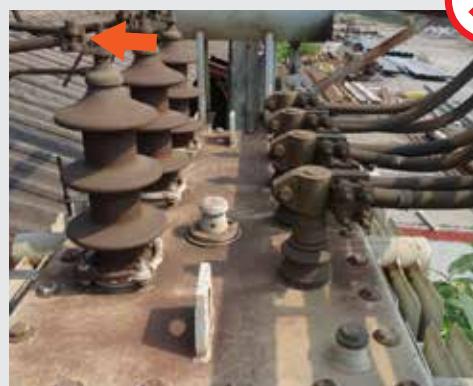
## ISP08. HV Terminal Check

### 🔧 Check and Inspection:

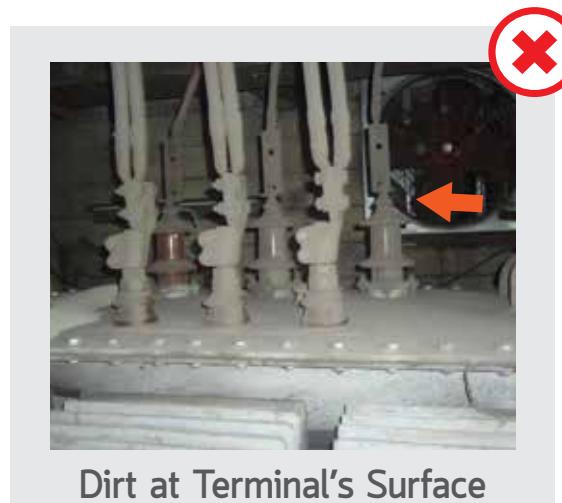
- » Check the firmness of the connecting point by visual inspection to observe the burns at connecting point or insulator, or by using thermoscan;
- » Check for stains at terminal's surface;
- » Check for rust at bolt and nut.

### ⚠ Suggestion and Precaution:

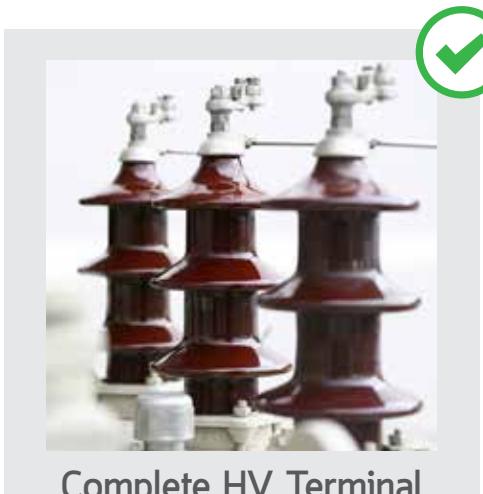
- » Replacing is required if there is burns, causing the terminal to unable to continue working;
- » Cleaning off any dirt from the terminal's surface is required;
- » Rusty bolt and nut must be replaced;
- » Compression should be performed by torque in accordance with the manufacturer's instruction.



Rust found at bolts and nuts at Terminal



Dirt at Terminal's Surface



Complete HV Terminal

## ISP09. LV Terminal Check

### 🔧 Check and Inspection:

- » Check the firmness of the connecting point by visual inspection to observe the burns at connecting point or insulator, or by using thermoscan;
- » Check for stains at terminal's surface;
- » Check for rust at bolt and nut.

### ⚠ Suggestion and Precaution:

- » Replacing is required if there is burns, causing the terminal to unable to continue working;
- » Cleaning off any dirt from the terminal's surface is required;
- » Rusty bolt and nut must be replaced;
- » Compression should be performed by torque in accordance with the manufacturer's instruction.



Rust at LV Terminal

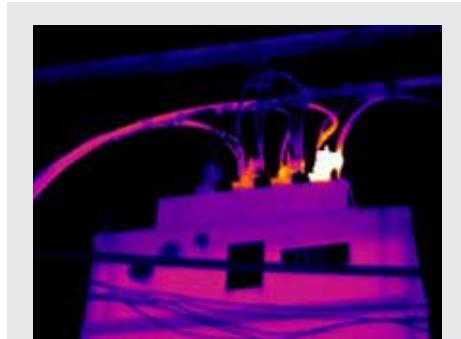


Photo of heat at LV Terminal



Complete LV Terminal



บริษัท เจริญชัยหม้อแปลงไฟฟ้า จำกัด  
CHAROENCHAI TRANSFORMER CO.,LTD.

#### BOLT TIGHTENING TORQUE TABLE

Item	Bolt Size	Material	Torque ( $\pm 10\%$ )		
			N-m	kg-cm	Lbs-inch
H.V.Terminal	M12	Brass	13	133	115
L.V.Terminal	M12	Stainless Steel	40	408	354
	M16	Stainless Steel	90	918	797



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## ISP10. Pressure-Relief Device Check

### 🔧 Check and Inspection:

- » Check for oil leakage;
- » Check the Contact by using Multimeter (for model with contact)

### ⚠ Suggestion and Precaution:

- » Fixing is required if any oil leakage is found;
- » Replacing is required if the bad Contact is found;
- » Do not refill the oil by opening the Pressure-Relief Device without shutting down the transformer.



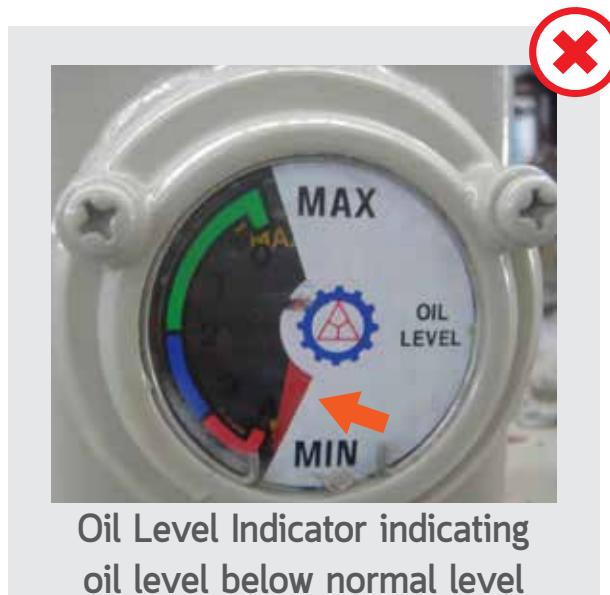
## ISP 11. Oil Level Indicator Check

### Check and Inspection:

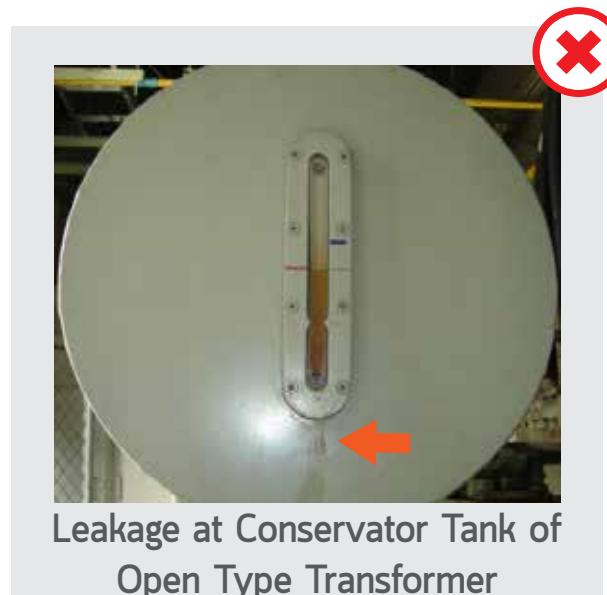
- » Check for oil leakage;
- » Check for fracture or crack at the dial window;
- » Check the Contact by using Multimeter (for model with contact)

### Suggestion and Precaution:

- » Fixing is required if any oil leakage is found;
- » Replacing is required if any fracture or crack is found at the dial;
- » Replacing is required if the bad Contact is found;
- » Contact CSP if the level of oil is lower than the red level indicator.



Oil Level Indicator indicating oil level below normal level



Leakage at Conservator Tank of Open Type Transformer



Oil Level Indicator indicating normal oil level



## ISP 12. Dehydrating Breather with Silica Gel Check

### (Only existing model)

#### **Check and Inspection:**

- » Check for fracture or crack at the dial;
- » Check for deterioration of rubber seal;
- » Check the color of silica gel (normal color is blue);
- » Check the condition and level of oil by using dust bowl.

#### **Suggestion and Precaution:**

- » Replacing is required if fracture or crack is found;
- » Replacing of rubber seal is required if any deterioration is found, e.g., cracking;
- » Changing of dehydrating agents if color changing is found, e.g. change to pink or white;
- » Changing of oil is required if any contamination is found. The oil level should not be lower than the bottom line but not over the top line of the dust bowl.

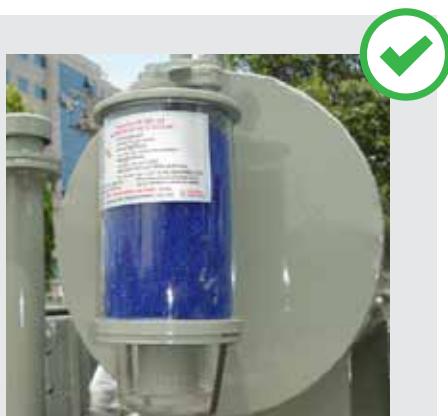
**Remark:** The color of some silica gel might be different such as orange color.



Contamination



Silica Gel Color Change



Color of unadulterated Silica Gel and Oil in a normal condition

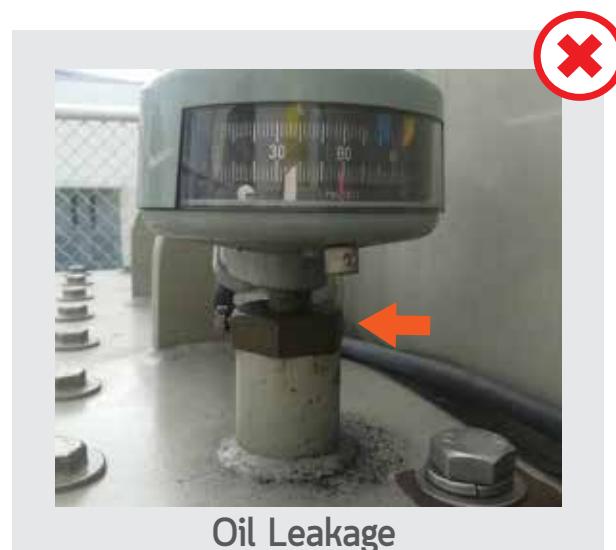
## ISP13. Thermometer Check

### Check and Inspection:

- » Check for oil leakage;
- » Check for fracture or crack at the dial;
- » Check the Contact by using Multimeter (for model with contact).

### Suggestion and Precaution:

- » Fixing is required if any oil leakage is found;
- » Replacing is required If any fracture or crack is found at the dial;
- » Replacing is required If the bad Contact is found;
- » You should not adjust the temperature by yourself as it might cause damage to the transformer. Please contact **CSP** if you wish to reset the setting.



TOP OIL TEMP. = TOP OIL TEMP. RISE + AMBIENT TEMP.			
100°C	=	60°C	+ 40°C
<input type="checkbox"/> ឧបអ្នមិប៉ែងឈុំ	ALARM	80°C - 90°C	
<input type="checkbox"/> ឧបអ្នមិកំកែយសុំសុំ	TRIP	90°C - 100°C	



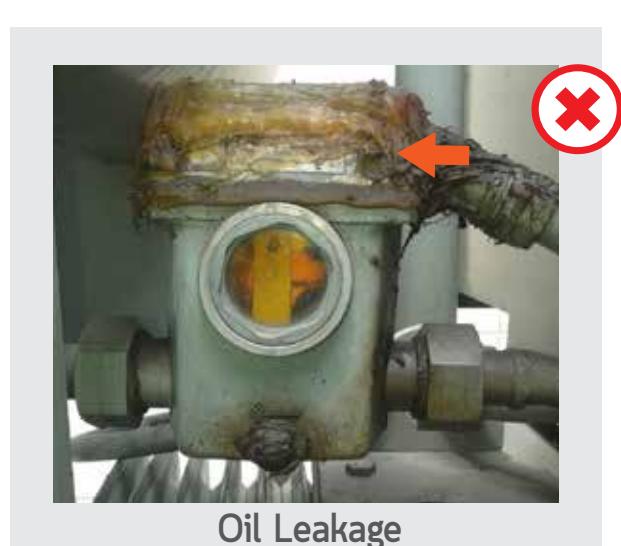
## ISP14. Buchholz Relay Check

### Check and Inspection:

- » Check for oil leakage;
- » Check for fracture or crack at the dial;
- » Check the Contact by using Multimeter (for model with contact).

### Suggestion and Precaution:

- » Fixing is required if any oil leakage is found;
- » Replacing is required If any fracture or crack is found at the dial;
- » Replacing is required If the bad Contact is found;
- » Contact **CSP** immediately if the Buchholz Relay is Alarmed or Tripped.



## ISP15. Transformer Installing Location Check

### Check and Inspection:

#### Transformer Framework

- » Check the pole and beam condition for any crack;
- » Check for any leaning;
- » Check for climbing plants and branches. Climbing plants and branches must not be near the Transformer framework or covering the part with electricity.

#### Transformer Yard

- » Check the condition of the floor, e.g. check for any weeds or flooding;
- » Check for any deterioration or damage of the fence and door;
- » Check the grounding and condition of ground line of the fence and metal parts.

#### Transformer Room

- » Check the condition of the room. The room must be clear of any irrelevant objects or fuels;
- » Check the condition of the transformer sump and pipe.
- » Check the ventilation. The vent must be clear of any blockage or obstruction;
- » Check the light system. All the bulbs must be illuminate;
- » Check the grounding and condition of ground line of the fence and metal parts;
- » Check the fire extinguishing system. All chemical must be in normal level.



#### Suggestion and Precaution:

- » Constant cleaning of the area around the transformer is advised, e.g, cutting tree branches so that it will not lean against HV or LV Terminal and causing short circuit;
- » Cable Box should be installed with every transformer to prevent power outage from bird or reptile contacting the terminal at bushing.



Weeds covering area around Transformer



Transformer Room



Transformer Yard



Transformer Framework

## TST 01. Measurement of Insulation Resistance

### 🔧 Testing:

- » Measuring insulation resistance between HV to LV
- » Measuring insulation resistance between HV to Ground
- » Measuring insulation resistance between LV to Ground

for 1 minute;  
for 1 minute;  
for 1 minute.

### ⚠ Suggestion and Precaution:

01. Insulation resistance must be as follow:

kV.	Ambient Temperature ( °C )					
	20	25	30	35	40	50
Insulation Resistance (M ohm)						
22-33	1000	750	500	375	250	125
11-12	800	600	400	300	200	100
Not over 3.5	400	300	200	150	100	50

**Note :**  
Mega Ohm - Meter  
2500 VDC.

02. If the measured insulation resistance level is below the above table, the transformer must be overhaul at the factory.

## TST 02. Oil Dielectric Strength Test

This is a common test for testing the deterioration of transformer oil.

### 🔧 Testing:

Test the oil sample with oil dielectric strength testing device.

### ⚠ Suggestion and Precaution:

01. The oil dielectric strength level must be as follow:

Test Method	Electrodes	Gap (mm.)	Oil Dielectric Strength (kV)	Result
ASTM D877-02		2.54	> 30	Good
			27 - 29	Fair
			21 - 26	Recondition
			< 20	Poor
IEC 60156		2.5	> 40	Good
			36 - 40	Fair
			30 - 35	Recondition
			< 30	Poor

02. The oil must be filtered by **CSP** if the test result is at Recondition level;
03. The oil must be changed by **CSP** if the test result is at Poor level.

## TST 03. Water Content Measurement

This is an additional testing to TST 02. for further assurance.

### ⌚ Testing:

Test the oil sample with water content measurement device.

### ⚠ Suggestion and Precaution:

01. The oil level must be as follow:

Test Method	Oil Level (ppm)	Result
ASTM D1533-88	< 35	Good
	> 35	Poor
IEC 60814	< 10	Good
	10 - 25	Fair
	> 25	Poor

02. The oil must be changed if the measurement result is at Poor level;
03. Special Requirement of customer by Charoenchai Laboratory.

## TST 04. Dissolved Gas Analysis

This is an additional testing to TST 02. for further assurance.

### ⌚ Testing:

Test the oil sample with dissolved gas measurement device.

### ⚠ Suggestion and Precaution:

01. Analyze and find the cause in any gas abnormality by Charoenchai Laboratory;
02. Special Requirement of customer by Charoenchai Laboratory.

Typical Gasses Generated by Transformer Faults	
Name	Symbol
Hydrogen	$H_2$
Oxygen	$O_2$
Nitrogen	$N_2$
Methane	$CH_4$
Carbon Monoxide	CO
Ethane	$C_2H_6$
Carbon Dioxide	$CO_2$
Ethylene	$C_2H_4$
Acetylene	$C_2H_2$



## PREVENTIVE MAINTENANCE LISTS

Code	Item List	Check and Inspection	Suggestion and Precaution
ISP01	Tank and Fin Check	<ul style="list-style-type: none"> <li>Check the leakage of oil and slick at the weld;</li> <li>Check for rust or corrosion of the Tank;</li> <li>Check for stains and dust.</li> </ul>	<ul style="list-style-type: none"> <li>If oil leakage is found, contact CSP for repairing;</li> <li>If any stains and dust are found at the Tank and Fin, cleaning is required as it will reduce the efficiency of heat extraction;</li> <li>Re-painting is required for any rusty part to prevent oil leakage from the erosion of the Tank.</li> </ul>
ISP02	HV Bushing Check	<ul style="list-style-type: none"> <li>Check the surface of the bushing.</li> </ul>	<ul style="list-style-type: none"> <li>Cleaning is required if any stains are found on the bushing;</li> </ul>
ISP03	LV Bushing Check	<ul style="list-style-type: none"> <li>The surface must be glossy without dust;</li> <li>Check for any chip, crack or flashover on the surface of bushing.</li> </ul>	<ul style="list-style-type: none"> <li>If the bushing was chipped, cracked or flashover, contact CSP for replacing the bushing;</li> <li>At least once a year cleaning by clean towel is advised.</li> </ul>
ISP04	HV Bushing Gasket Check	<ul style="list-style-type: none"> <li>Check for any oil leakage at the gasket;</li> </ul>	<ul style="list-style-type: none"> <li>Replacing is required if any leakage is found;</li> </ul>
ISP05	LV Bushing Gasket Check	<ul style="list-style-type: none"> <li>Check for gasket deterioration.</li> </ul>	<ul style="list-style-type: none"> <li>Replacing is required if deterioration is found, e.g., cracked or disintegrate;</li> <li>Should not pull the line too tight as it might damage the bushing or gasket.</li> </ul>
ISP06	Cover Gasket Check	<ul style="list-style-type: none"> <li>Check for any oil leakage at the gasket;</li> </ul>	<ul style="list-style-type: none"> <li>Replacing is required if any leakage is found;</li> </ul>
ISP07	Tap Changer Gasket Check	<ul style="list-style-type: none"> <li>Check for gasket deterioration.</li> </ul>	<ul style="list-style-type: none"> <li>Replacing is required if deterioration is found, e.g., cracked or disintegrate.</li> </ul>
ISP08	HV Terminal Check	<ul style="list-style-type: none"> <li>Check the firmness of the connecting point by observing the burns at connecting point or insulator, or by using without contact thermometer;</li> </ul>	<ul style="list-style-type: none"> <li>Replacing is required if there are burns, causing the terminal to unable to continue working;</li> <li>Cleaning off any dirt from the terminal's surface is required;</li> <li>Rusty bolt and nut must be replaced;</li> </ul>
ISP09	LV Terminal Check	<ul style="list-style-type: none"> <li>Check for stains at terminal's surface;</li> <li>Check for rust at bolt and nut.</li> </ul>	<ul style="list-style-type: none"> <li>Compression should be performed by torque in accordance with the manufacturer's instruction.</li> </ul>
ISP10	Pressure-Relief Device Check	<ul style="list-style-type: none"> <li>Check for oil leakage;</li> <li>Check the Contact by using Multimeter (for model with contact).</li> </ul>	<ul style="list-style-type: none"> <li>Fixing is required if any oil leakage is found;</li> <li>Replacing is required if the Contact is malfunction;</li> <li>Do not refill the oil by opening the Pressure-Relief Device without extinguishing the fire.</li> </ul>
ISP11	Oil Level Indicator Check	<ul style="list-style-type: none"> <li>Check for oil leakage;</li> <li>Check the Contact by using Multimeter (for model with contact).</li> </ul>	<ul style="list-style-type: none"> <li>Fixing is required if any oil leakage is found;</li> <li>Replacing is required if fracture or crack is found at the dial;</li> <li>Replacing is required if the Contact is malfunction;</li> <li>Contact CSP if the level of oil is lower than the red level indicator.</li> </ul>
ISP12	Dehydrating Breather with Silica Gel Check (Only existing model)	<ul style="list-style-type: none"> <li>Check for fracture or crack at the dial;</li> <li>Check for deterioration of rubber seal;</li> <li>Check the color of dehydrating agents (normal color is blue);</li> <li>Check the condition and level of oil by using dust bowl.</li> </ul>	<ul style="list-style-type: none"> <li>Replacing is required if fracture or crack is found;</li> <li>Replacing of rubber seal is required if any deterioration is found, e.g., cracking;</li> <li>Changing of dehydrating agents if color changing is found, e.g., change to pink or white;</li> <li>hanging of oil is required if any adulterant is found. The oil level should not be lower than the bottom line but not over the top line of the dust bowl.</li> </ul>
ISP13	Thermometer Check	<ul style="list-style-type: none"> <li>Check for oil leakage;</li> <li>Check for fracture or crack at the dial;</li> <li>Check the Contact by using Multimeter (for model with contact).</li> </ul>	<ul style="list-style-type: none"> <li>Fixing is required if any oil leakage is found;</li> <li>Replacing is required if any fracture or crack is found at the dial;</li> <li>Replacing is required if the Contact is malfunction;</li> <li>You should not adjust the temperature by yourself as it might cause damage to the transformer. Please contact CSP if you wish to reset the setting.</li> </ul>

## PREVENTIVE MAINTENANCE LISTS (2)

Code	Item List	Check and Inspection	Suggestion and Precaution
ISP14	Buchholz Relay Check	<ul style="list-style-type: none"> <li>● Check for oil leakage;</li> <li>● Check for fracture or crack at the dial;</li> <li>● Check the Contact by Using Multimeter (for model with contact).</li> </ul>	<ul style="list-style-type: none"> <li>● Fixing is required if any oil leakage is found;</li> <li>● Replacing is required if any fracture or crack is found at the dial;</li> <li>● Replacing is required if the Contact is malfunction;</li> <li>● Contact CSP immediately if Buchholz Relay call for Alarm or Trip.</li> </ul>
ISP15	Transformer Installing Location Check	<p><b>Transformer Framework</b></p> <ul style="list-style-type: none"> <li>● Check the pole and beam condition for any crack;</li> <li>● Check for any leaning;</li> <li>● Check for climbing plants and branches.Climbing plants and branches must not be near the Transformer framework or covering the part with electricity.</li> </ul>	<ul style="list-style-type: none"> <li>● Constant cleaning of the area around the transformer is advised, e.g., cutting tree branches so that it will not lean against HV or LV Terminal and causing short circuit;</li> <li>● Cable Box should be installed with every transformer to prevent power outage from bird or reptile contacting the terminal at bushing.</li> </ul>
		<p><b>Transformer Yard</b></p> <ul style="list-style-type: none"> <li>● Check the condition of the floor, e.g. check for any weeds or flooding;</li> <li>● Check for any deterioration or damage of the fence and door;</li> <li>● Check the grounding and condition of ground line of the fence and metal parts.</li> </ul>	
		<p><b>Transformer Room</b></p> <ul style="list-style-type: none"> <li>● Check the condition of the room.</li> </ul> <p>The room must be clear of any irrelevant objects or fuel;</p> <ul style="list-style-type: none"> <li>● Check the condition of clarifier and drain.</li> </ul> <p>The water must be clear of any contamination;</p> <ul style="list-style-type: none"> <li>● Check the ventilation. The vent must be clear of any blockage or obstruction;</li> <li>● Check the light system. All the bulbs must be illuminate;</li> <li>● Check the grounding and condition of ground line of the fence and metal parts;</li> <li>● Check the fire extinguishing system.</li> </ul> <p>All chemical must be in normal level.</p>	<ul style="list-style-type: none"> <li>● If the measured insulation resistance level is below the table, the transformer must be overhauled at the factory.</li> </ul>
TST01	Measurement of Insulation Resistance		<ul style="list-style-type: none"> <li>● Measuring insulation resistance between HV to LV for 1 minute;</li> <li>● Measuring insulation resistance between HV to Ground for 1 minute;</li> <li>● Measuring insulation resistance between LV to Ground for 1 minute.</li> </ul>
TST02	Oil Dielectric Strength Test		<ul style="list-style-type: none"> <li>● Test the oil sample with oil dielectric strength testing device.</li> </ul>
TST03	Water Content Measurement		<ul style="list-style-type: none"> <li>● Test the oil sample with water content measurement device.</li> </ul>
TST04	Dissolved Gas Analysis		<ul style="list-style-type: none"> <li>● Test the oil sample with dissolved gas measurement device.</li> </ul>
			<ul style="list-style-type: none"> <li>● Analyze and find the cause in any gas abnormality by Charoenchai Laboratory.</li> <li>● Special Requirement of customer by Charoenchai Laboratory.</li> </ul>
			<ul style="list-style-type: none"> <li>● Special Requirement of customer by Charoenchai Laboratory.</li> </ul>



CHAROENCHAI INTERTRADE CO., LTD.

PREVENTIVE MAINTENANCE ANNUAL PLAN

<b>User</b>	: User should perform ISP 01 – ISP 15 check once a week.
<b>Charoenchai Intertrade</b>	: Charoenchai Intertrade Co., Ltd. will perform all listed check once a year for 2 years.



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