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## TRANSFORMER TRANSPORTATION AND HANDLING: BEGINNING OF FUTURE RELIABILITY

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Transportation of power transformer from manufacturing plant is a challenging processes as it may caused severe damage when they are subjected to rigorous transport conditions such as troubled sea and rough road during transportation. This article will raise an awareness of the transportation procedure and mitigation actions whenever the conditions of handling and transportation indicate a potential damage to the transformer.

### INTRODUCTION

The safe and careful handling during transportation and handling of transformer is crucial since sudden impacts or shocks can lead to damage of this critical components. Therefore, it is essential to give considerable time and effort for planning and preparation of detail procedure on transportation of the transformer to ensure minimal risk to transformer, people as well as environmental.

The other aspects that equally important to the asset owners are unloading and placement of transformer once it reached at site. This include physical inspection of transformer, site assessment, checking of shock logger and verification test to confirm the mechanical integrity of the transformer.



Road transportation of power transformer

### MODE OF TRANSFORMER TRANSPORTATION

The general mode of power transformer transportation and its configuration depends upon on transformer weight and it's dimension. Other considerations are the environmental risk as larger transformers can contain tens of thousands of litres of fluid and any spills or leaks in transit can result in clean-up operation as well as presenting a hazard to other road users. In general, there are 3 modes of transformer transportation.

#### Fully assembled and full of fluid



Transportation of fully assembled power transformer

If transport weight and dimensional limits allow, smaller transformers are transported with all or most of the required oil in the main tank and fully assembled. During transportation, the majority of insulation parts are normally covered by oil and in many cases a vacuum process prior commissioning is not required. Exposed parts such as bushings, oil temperature gauges and cooling radiator must be

protected from transport damage. An emergency plan must be prepared to avoid the risk of oil spilling during transportation.

### Partially assembled and either partially full or empty fluid

Depending on the rating and physical layout, some transformer design need to be transported partially assembled and either partially full or empty fluid. The most common items to be removed are the bushings, the conservator and the cooler assemblies and associated pipework. Special care need to be taken to prevent damage and moisture ingress during handling, transport, trans-shipping and storage. Removed items must be carefully identified and packed by comprehensive packing lists.



Transportation of partially assembled power

When the transformers are transported with fluid is either partially or fully removed, the remaining space must be pressurised with dry gas or dry air to protect the transformer active part and other items, such as leads and current transformers from moisture ingress. Dry nitrogen has been the traditional gas of choice but due to safety issues, it is now more common to use zero grade dry air, which presents no health risk to workers.

The pressure in the dry air bottles can be up to 200 bar. A reducing regulating valve is used to provide a positive pressure of about 350 mbar nominal in the transformer tank. A pressure relieve valve on top of the transformer is carefully adjusted to slightly above the filling pressure. The dew point should be less than - 40°C prior to transport and the transformer should be checked for any leaks.

### Completely disassembled and empty of fluid

In this approach, all components and accessories are dismantled and the transformer tank are pressurised with zero grade dry air.

## TRANSFORMER TRANSPORTATION

Once mode of transportation is confirmed, the transformer is ready to be delivered for installation at site. Prior to this, it is important to determine the route selection and audit of delivery site for a safe transportation and unloading of the transformer.

## Route selection and permits

Relevant traffic and road authorities need to be consulted when select the route and the time of day for road transport. The load limits, bridges and height limits associated with overhead structures and tunnels need to be considered in this stage. In addition, a special trailer configuration may require to meet specific challenges.

## Audit of delivery site

Pre-delivery audit of the site is very important to determine the access condition and decide on the method of unloading. Later, the unloading plan and method statement need to be developed and approved by relevant authorities prior to the date and time of transformer delivery. Among the factors that need to be considered:

- mode of entry (forward or reverse)
- the need for traffic management and/or road closures
- space available for set up of unloading equipment such as cranes or skating equipment
- load rating and condition of road surfaces at the delivery point
- proximity of overhead structures, bus-bars and lines and whether they will be energised or disconnected
- structures under the road way such as cable pits, tunnels and chambers

## Unloading



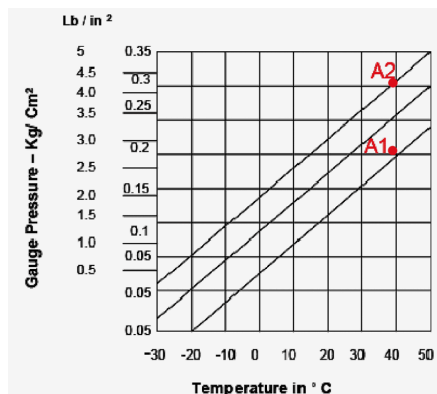
Transformer installation at site

On arrival, the transformer needs to be inspected for any physical damage during transportation. The transport provider and manufacturer need to be consulted if sign of damage or shifting has been observed. The buyer is usually responsible for ensuring that a plinth of appropriate rating has been prepared for the transformer and the location points are clearly defined. The transformer's centre of gravity and lifting or jacking locations must be clearly identified and the transformer protected from mechanical damage by slings, chains and other equipment. The transformer can then be unloaded and located in accordance with the pre-approved unloading plan. Wherever possible, the preferred method of unloading is by the use of cranes which are generally favoured for reasons of time duration and safety. The use of cranes, however, may be prohibited due to site restrictions, such as surface suitability, available space and overhead lines and structures, or the availability of suitably rated cranes at the destination site. In this case, other methods are used, such as jack and skate methodology which employs the use of lifting jacks, rails and hydraulic rams.

## INSPECTION AFTER TRANSFORMER TRANSPORTATION

After receipt of the transformer at site, following points need to be checked before erection and commissioning works.

### Checking of Gas Pressure and Dew Point



Variation of gas pressure with temperature

The gas pressure should be checked to ensure that it is still positive. If not, then the source of the loss must be located and repaired and gas re-applied. It will also be necessary to check for moisture ingress through dew point testing and/or some other suitable diagnostic tool such as polarisation/depolarisation current and frequency domain spectroscopy. High moisture content may necessitate special processing at site or the return of the transformer to the manufacturer for re-drying. The moisture should ideally be no more than the ex-works level, which should be at 0.5 %.

### Checking of Shock Logger

After unloading and positioning have been completed, the shock logger is removed and comprehensively analysed to determine if any shock events have been recorded. The following table from IEEE C57.93, gives values that, if recorded, should result in discussions with the manufacturer as to the possibility of internal damage and the need for further investigation or diagnostic testing. Frequency Response Analysis (FRA) may useful for confirmation of transformer’s mechanical integrity.

Type of Impact	Level for Discussion
Longitudinal	3g
Vertical	2g
Transverse	2g

Acceleration value that should initiate discussion

### Inspection of accessories

Unpacking and inspection of accessories need to be carried out with precautions so that the tools used for opening do not cause damage to the contents. Fragile instruments like oil level gauge, and temperature indicators are to be inspected for breakage or other damages. Any missing or damage components should be reported to manufacturer, so that the same can be investigated or shortage made up as per contract. If erection work cannot start immediately, then accessories should be repacked and packing list should be retained. All packings should be kept above ground by suitable supports so as to allow free air flow underneath.

## Next Issue

**Sound in Transformer:  
How It Happens and How to  
Avoid It**



**Its Coming Back !**

### **TNB Labs MasterClass Training 'Life Management of Power Transformer'**

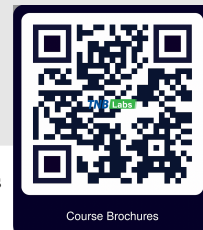
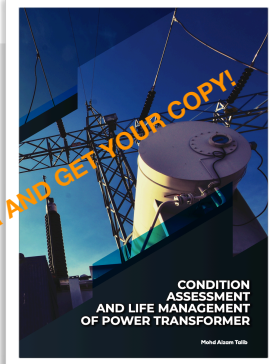
**7-10 August 2023, Le Meridien Hotel, Putrajaya**

This 4 days training will helps the participants to understand the principle design and construction of transformer, operation and maintenance, diagnostic testing, condition and life assessment of transformer as well as failure prediction.

Other than classroom theory and case studies, the participants will experienced hands-on session and lab tour of TNB Labs facility@TNB Research Centre. The participants will also receive one copy of technical book entitle "Condition Assessment and Life Management of Power Transformer".

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