On load tap changer in Service – Maintenance aspects

by Jürgen Thomas Schwarz, Reinhausen South Africa

Abstract

Whenever you have to make a decision on buying a new asset for the substation, you choose a technically mature and sophisticated technology off the market. Uncompromising quality and maximum reliability is guaranteed.

You should not consider less, when it comes to the maintenance aspects for these equipment.

Why Maintenance?

Definition of maintenance!

Maintenance is the combination of all technical, administrative and managerial actions during the life cycle of an item intended to retain it in or restore it to a state in which it can perform the required function.

Several maintenance strategies!

Before you can choose the right strategy, you should have thought thoroughly about the different options available and about the subsequent commercial and technical consequences (Fig. 1) for your asset.

• Risk or event - based maintenance
  A typical maintenance strategy is the risk or event - based maintenance. In such cases maintenance is carried out only after a fault has already occurred and has been detected. This maintenance strategy includes:

  • Maintenance performance only after a failure
  • Availability of the facility depends on the reliability of the device
  • No influence on failure time
  • Risk of unplanned outages
  • Risk of consequential damage
  • Lowest total costs for maintenance, (but without consideration for consequential costs, which are difficult to estimate)

  This approach is recommended, if the consequences of a failure is minor or if it has no effect on the production process. If the equipment is of high priority or if it is an operational equipment this strategy is not suggested.

• Time - based maintenance

  The most common maintenance strategy for operational equipment is the time - based maintenance. In this case maintenance is carried out at predetermined intervals or according to specified criteria and is intended to reduce the probability of failure. This is a safe method and it is recommended for transformers and conventional on load tap-changers. This maintenance strategy includes:

  • Maintenance in fixed time or operation cycles
  • Replacement after a stipulated service life
  • High availability
  • Cost intensive
### Condition – based maintenance

The condition-based maintenance is an advanced and up-to-date maintenance strategy and is an alternative to time-based maintenance. It is based on performance and/or parameter monitoring and the subsequent actions. In contrast to time-based maintenance it allows extending maintenance intervals to the limit and thus exploit equipment reserves. This maintenance strategy includes:

- Maintenance depends on the technical condition
- Safe maintenance strategy
- Exploiting reserves
- Planned shutdown of equipment for maintenance
- Life cycle cost optimisation
- Knowledge of equipment condition

![Cost implication depending on maintenance strategy.](image)

### Maintenance-free equipment

Last but not least the maintenance free equipment should be mentioned as it is of great advantage for the equipment user and offers the following benefits:

- No maintenance necessary
- No maintenance costs
- No costs for logistic and planning
- No shutdown required
- Best life cycle cost consideration
- Best solution for the environment

Regardless of which maintenance strategy is decided on, it is of vital importance, to know and understand the surrounding process in order to make the right decision.
Maintenance for On Load Tap Changers (OLTC)

- Time/operation based maintenance

**Maintenance yes - but when is the right time?**
The two maintenance criteria of OLTC’s are:

(a) the number of tap change operations
(b) the time interval,

whichever is reached first. These criteria differ in terms of type and application. The maintenance criteria for OLTC’s equipped with a motor drive can mostly be found on the information plate inside the housing door. For some types it might be necessary to find the related data in the user manual. If further information are necessary, the OEM should be contacted.

By conveying the serial number and the number of operation (Fig. 2) of the OLTC under investigation to the OEM, the service history and the recommendation for upcoming services can be given. This is inevitable information in order to prevent unexpected occurrences during the service.

![Fig. 2: Important information of the asset.](image)

**The maintenance intervals of common technology**

The target of an asset owner is to optimising the maintenance of the equipment. Optimised maintenance means minimum life cycle costs at maximum system availability. To meet this challenge, it is necessary to use time-tested, innovative methods as well as new technology if possible.

Based on the decades of experience of the OEM, it is recommend to follow specific maintenance intervals for common tap-changer technology, which can be found in the related user manuals.

In simple terms, these maintenance intervals take into account the following factors:

- The wear and tear of the mechanical components such as the energy accumulator springs, the number of tap-change operations, being the decisive factor.
- Carbon formation in the insulation oil caused by arcing, the number of tap-change operations being as significant a factor as the occurring load currents.
- Contact wear, respectively the difference of wear between the main switching contacts and the transition contacts.
- The dielectric strength of the insulation oil inside the OLTC compartment.
• **Necessary steps for OLTC maintenance**

After all, it is still necessary to have maintenance!
Thus the major steps of maintenance are outlined in the following and must not be considered as complete:

- Disassembly and reassembly of the diverter switch insert
- Cleaning and inspection of the mechanics
- Visual check of the insulation distances of the diverter switch insert and oil compartment
- Parts replacement
- Exchange of the switching oil
  - (fresh oil with a breakdown voltage > 50 kV/2.5 mm, in accordance with IEC 60156)
- Determination of the degree of contact wear
- Measuring of the transition resistors
- Inspection of motor drive, drive shaft assembly, and protective relay
- Function check

It is mostly recommended to have service technicians which are aware of their responsibility and know that their diligent work often decides the fate of high-value material assets. It is also compulsory that these technicians are updated on a regular basis on the latest improvements.

Technology advances. That’s why ongoing updated measures are implemented on tap changers. By installing new components during maintenance interventions, the equipment will be up to date on the spot (Fig. 3).

![Fig. 3: Tap changer before and after maintenance.](image)

• **Condition based maintenance - The OLTC with a memory:**

To meet the special requirements of OILTAP on-load tap-changers (switching in oil), innovative electronical devices for Equipment Monitoring (Fig 4) can be easily installed in the OLTC’s motor drive. It registers load current, tap position, and oil filter data, if applicable. The device uses complex background algorithms based on our years of experience in the field of OLTCs to determine such factors as e.g. contact wear. It clearly shows service recommendations and predicts the next maintenance of your oil tap OLTC. The information thus obtained is the perfect basis for optimized service intervention scheduling and allows you a significant extension of the maintenance intervals.

It is also a perfect retrofit solution for any application, which also can be combined with the function of a voltage regulator.
• **Maintenance free Equipment – for up to 300 000 switching operation - Vacuum Technology**

Since the year 2000 there is the first high-speed resistor vacuum type OLTC (Fig. ) for in-tank installation commercially available. It represents the first step of the implementation of the vacuum switching technology in the worldwide applied in-tank OLTCs for oil filled power transformers.

With a maximum maintenance interval of up to 300 000 switching operation and no time based limitation till the first service, the equipment is practically maintenance free for almost all network applications.

As a result the life-cycle-costs of the asset can be significantly reduced and at the same time uninterrupted availability of the transformer is achieved.

**Fig. 4: Tap changer monitoring device.**

**Fig. 5: VRC Diverter with vacuum switching elements.**
Conclusion

Power transformers equipped with OLTCs are main components of electrical Networks. Therefore, the operational reliability of these transformers and their OLTCs is of high importance and has to be kept at a high level during their entire live span.

With realistic operational / maintenance strategies implementation, an assessment for maximum practicable operating efficiency can be achieved for the existing transformer population. This can be supported by using electronic device which are extending maintenance intervals to the limit and thus exploit equipment reserves. The benefits of maintenance free products are obvious as they are beneficiary considering the costs and transformer availability and limiting the risk of human failure after service has been omitted.

Given the conservative nature of the utility industry, it is not surprising that many utilities have not changed their maintenance approach in many years. However, as utilities are forced to find ways to run their systems harder with less manpower, change will become a necessity for survival.