Insight: Transformer Risk Analysis

Large Power Transformers and Their Importance to the Electrical Grid

Recognizing the Risk

The electrical grid is made up of many different types of components ranging from small protective relays to large generators. Large Power Transformers (LPTs) are one of these components and one of the most critical for the transmission system. The loss of a LPT can have a significant negative impact that could result in local or widespread power outages. Replacement of a failed LPT can be a prolonged effort due to the time involved in the manufacturing process and transportation. LPTs are usually specifically designed for each location and, if a spare is not readily available, a new unit will need to be manufactured.

Failures of LPTs can be caused by many different factors both natural and manufactured. Internal faults are caused by deteriorating insulation, improper connections, or inadequate design. These conditions can sometimes be identified prior to failure with testing and monitoring. External events such as a close lightning strike could also cause a transformer failure with no warning.

Transformer owners should develop an adequate backup transformer replacement plan. This should include having spare inventory for specific transformers or relocating another transformer from a location in the system that may already have sufficient redundancy. Another option is the early retirement of LPTs and the use of these as spares.

The rewind or replacement of a failed LPT can take 1-2 years or longer depending on the global constraints. LPTs are also one of the most expensive pieces of equipment in an electrical substation. Considering these two reasons alone it is in the utilities' best interest to perform the appropriate monitoring and testing.

Risk is affected by the criticality and health of the transformer. As a LPT owner, the criticality and health of each LPT should be studied to determine the individual risk.

Parameters to consider when determining the criticality of a transformer may include, but is not limited to:

- Critical for utility customer loads or for industrial and commercial facility loads.
- Spares availability
- Redundant parallel transformer
- Failure probability

LPT health can be determined with monitoring and testing which will help identify potential concerns prior to a catastrophic event. An adequate LPT maintenance program should include at a minimum:

- Dissolved Gas Analysis
- Furan Testing
- Oil Quality
- Offline Electrical Testing
- Visual Inspections
- Infrared Inspections
- Online Monitoring.

Once the Criticality and Health of each LPT are quantified, the risk can be determined.

Recommendations

Perform a risk analysis by determining the criticality and health of each individual LPT. With this information, the utility will be able to focus on higher-risk units to make sure resources are allocated appropriately.

Develop a replacement plan for each LPT to verify if a spare is available or if a new unit will have to be purchased and installed. Having a plan in place will help in the event of a failure. Replacement of a LPT is a complex undertaking and having a plan in place prior will streamline the process.

Fire protection systems and containment should be considered. This includes deluge systems, firewalls, and containment basins.

Resources / Standards

AIG Insight: Transformer Monitoring and Testing

For more information, contact your local AIG Risk Engineer.