DETERMINING CONDITION BASED ASSET MANAGEMENT STRATEGIES

PART 4 - DECISION MAKING

PART 4 OF A 4 PART SERIES

The development of a simple condition monitoring selection tool has helped industry engineers justify and decide on the type of monitoring techniques they need for any transformer in their network. Every transformer is a little different and this tools uses those differences to provide a criticality factor that is then used to determine the type of condition monitoring techniques needed. It then goes on to suggest product types that may suit that need.

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In previous articles, it was mentioned that collecting volumes of asset condition and performance data is meaningless unless it is turned into information that can assist in the decision-making process. It almost goes without saying that good asset decisions cannot be made without good supporting information. There is a distinction here between data and information. It is the gathering of asset data that when analysed and turned into information allows the asset manager to make the decision.

The data can help in deciding what is critical in the network and reduce the risk of missing a likely failure due to an emerging problem. When the correct information is available the rate at which failures are missed is significantly reduced. It can even help to reduce the rate at which false alarms are triggered or where a failure is indicated but there is no defect present. This is a clear cost benefit to the business as the reduction in the cost of these failures will allow budget funds to be directed to other high priority projects within the network. The issue is how does an asset engineer decide what is the best data to collect on their asset. Being able to invest limited budgets on the larger and more expensive assets where it is assumed there is a greater "Bang for Buck" may not be the best way. Understanding how the asset history, network usage and impact can help decide the best use of funds.

In the CIGRE Brochure 227, Life Management Techniques for Power Transformers the authors deal with reasons why condition monitoring devices are fitted to a transformer. The one clear theme that comes through is that without any indicators and a lack of basic maintenance the risk of failure increases rapidly. It is stated that the basic failure modes normally stem from reductions in dielectric and mechanical strength properties of the transformer. Figure 1 below is taken from Brochure 227 and shows that "failure occurs when the withstand strength of the transformer with respect to one of these key properties is exceeded by operational stresses".

Ideally, every asset in the network should be monitored and assessed in detail to correctly estimate when and how a failure might occur, so that intervention, as seen in Figure 1, can occur before actual failure. If sufficient condition monitoring information is obtained, an asset could either undergo maintenance or be replaced depending on the cost and likelihood of failure. Although an outage is likely to be needed it can be planned so customers get sufficient notice and the outage time is greatly reduced.

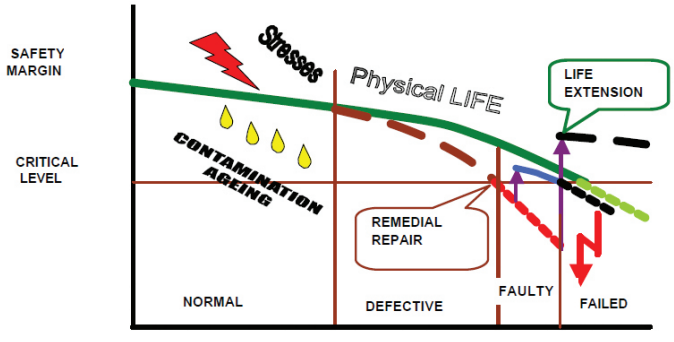

Figure 1 *Condition of a Transformer during its Life Cycle*

BENEFITS OF THE CONDITION MONITORING SPREADSHEET

The condition monitoring selection tool is a spreadsheet designed to be an easy-to-use and useful tool for asset management. The purpose of the spreadsheet tool is to do nothing more than to assist in the decision-making process for condition monitoring techniques that could be used on any network transformer. It has a basic enhancement that allows the user to further add to the list of devices on the market that provide some or all of the required techniques. This allows the engineer to quickly see and build a range of products that can provide the services needed. It does not look at the product cost or additional supporting data acquisition or analysis tools needed to support a product.

The CIGRE Brochure 343 discusses different condition monitoring techniques and their advantages along with monitoring system outputs. It provides a Table which summarises the recommended condition monitoring techniques for various parts of a power transformer. That table and comments within the CIGRE document have been used as a basis for developing this spreadsheet tool.

Having a standardised decision making process for the purchase of condition monitoring devices is extremely beneficial for the end user. Since there are so many condition monitoring techniques, it is very difficult to decide which technique should be employed in certain situations. The spreadsheet has an expandable range of techniques that have a rating and thereby recommend techniques using a standardised method across the asset fleet. When the asset manager wants to install a transformer in any given location within the network he can run the tool and use the information to justify the purchase of devices based on his predetermined standard needs for the network.

DECISION MAKING PROCESS APPLIED

There are several inputs for the spreadsheet that are used in the decision-making process. Figure 2 shows a flow diagram with inputs and outputs for the tool. The inputs are weighted and each input has a specific rating that is calculated. For a complete list of weightings and ratings see Figure 4 in Appendix A. The ratings can be reviewed by the end user so that they reflect the importance that the users place on specific criteria.

The user must fill data in each field highlighted so that a rating can be calculated for each field. These input fields are rated in terms of importance and from this and the user determined weighting, an overall importance or criticality factor for the transformer can be found.

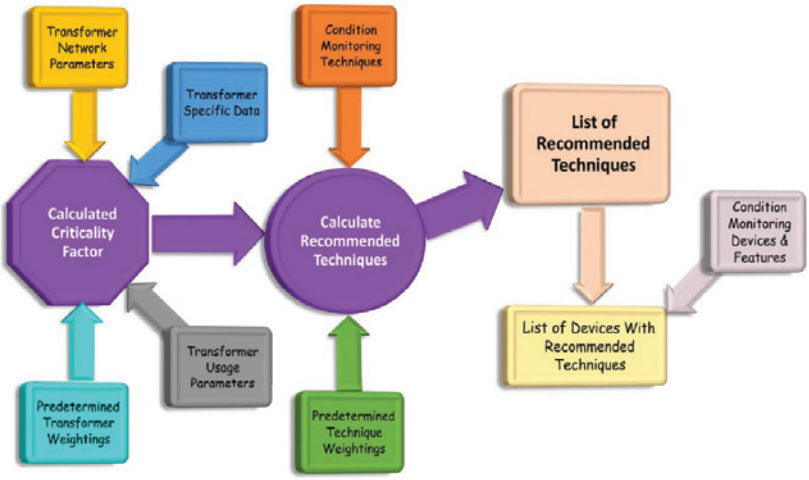

Figure 2 *Decision Making Process of* ***Transformer Condition Monitoring Selection Tool***

For example, if the user enters a rating of 20MVA for the transformer, a score of 3 is given for that input. This number is then multiplied by the weighting which may be set as 12% and then 0.36 becomes the weighted rating of that input. This is done for every input and all the weighted ratings are added to obtain the overall criticality rating for the transformer. The Criticality Factor is based on a scale of 1 to 10 with 10 being the most critical. Factors such as transformer age, overload frequency, network redundancy and location in the network are considered when assessing the overall criticality of the transformer. The "End User Importance" is very much a judgement call by the engineer as it relates to the application of the transformer. That is, the unit may be more critical with significant outage constraints than a unit that is low importance with good levels of spare capacity for the network.

Figure 3, shows the Weightings of User Inputs that contribute to the overall importance or criticality of the transformer. These weightings can be adjusted to the user's needs; however, it can have a significant influence on the value of the Criticality Factor. Sound judgement needs to be used when assessing the value of the weighting applied to each of these inputs. Once all these factors are weighted and analysed the spreadsheet automatically calculates the Criticality Factor which is then used as an input to the Condition Monitoring Technique sheet for analysis and selection. The second worksheet displays a recommendation of the features that could be installed on the transformer. The number and type of these features are directly related to the importance of the transformer, the cost of the technique, ease of fitting, and data management.

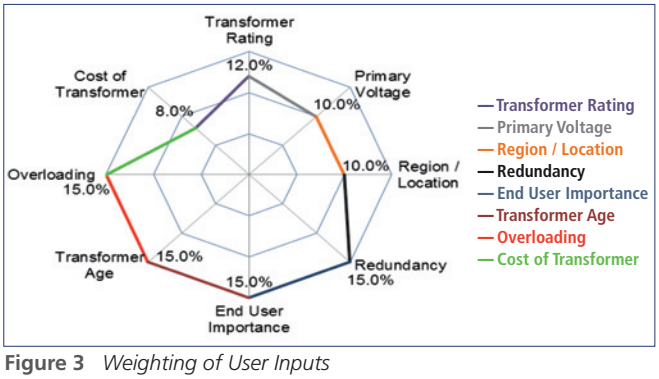

Figure 3 *Weighting of User Inputs*

The worksheet displays the features in different colours depending on the recommendation with the recommendation levels being:

Highly Recommended - Features that should be employed
Recommended - Features that should be employed if cost and need is justified
Useful - Features that are useful but not necessary to have and would not add value to the monitoring.

A worksheet titled "Features List" can be maintained by the user to add or delete features and if desired to change the ratings of the techniques. The list can have hundreds of techniques. This way the user can better target the latest features or techniques that are not only important to their company but those for which they have the capability to manage and analyse the data. By changing the ratings, the user can also have a direct impact on what techniques should be fitted to transformers in their network. It should be noted that this list also allows the user to review what products maybe on the market that provide all or some of the recommended techniques. The features list does not necessarily need to be defined for on-line or off line monitoring and can include testing techniques such as OLTC resistance, SFRA, DLA and many others as desired.

There is a worksheet which displays a list of devices that are available from suppliers. This list is far from complete and is designed to be expandable so the user can add products as they find them. Once the recommended features have been highlighted then the "Update" button at the top of this worksheet will highlight the recommended techniques so it is easy to see which products have them. The user can then easily research these products to understand if that product is suitable to their system needs. The more products added here the wider the options the end user can choose from.

INFORMATION MANAGEMENT

The condition monitoring spreadsheet outputs its recommendations according to the calculated importance or criticality of the transformer. The list of condition monitoring techniques provided as an output of this spreadsheet is a good indicator of which types of techniques are suitable for a transformer in any given network application. The spreadsheet tool does not extend to information management and many utilities struggle with managing their data. This selection tools provides a method by which to standardise the selection of condition monitoring techniques across a fleet of transformers. It does not go beyond the techniques to delve into how products deliver their data or how the utility needs to manage that data. This is an area where the engineer needs to understand what the features within the product delivers and how they can interface that data with their analysis tools

CONCLUSION

Condition monitoring is extremely important in assessing the life of any asset and this is evident with the experiences throughout the power industry. It is daunting for asset managers to decide when and how often to use a particular technique and for this reason the Condition Monitoring Selection Tool was developed.

In conclusion, this series of articles has provided some thought provoking concepts that try to challenge the way engineers approach the asset management strategies. There are numerous publications and courses available to help understand asset management. The thing to remember is there is no one way or system that is universal and all the systems available rely totally on the accuracy of the data being entered. One needs to look at the whole asset management framework and do a top down then bottom up review to ensure the corporate drivers align with the field responses and visa versa. When the two come together then the whole business will benefit.

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