DETERMINING CONDITION BASED ASSET MANAGEMENT STRATEGIES

PART 1 - INTRODUCTION

When considering the effectiveness of any asset condition monitoring, two key factors need to be considered:

1. *The rate at which failures are missed. That is, failures that occurred and the system data and trends did not detect it.*
2. *The rate at which false alarms are triggered. This is when a failure is indicated but there is no defect actually present.*

Kerry Williams of K-BIK Power Pty Ltd

In today's networks many utilities have some level of condition monitoring. It may be as simple as visual inspections, regular testing, sampling or it could be more mature with a great deal of on-line and off-line data being captured. No matter what the level there are some underlying facts that often get over looked.

RESULT IN SIGNIFICANT COSTS

The successful transmission and distribution of electrical energy is crucial in our everyday lives and underpins virtually everything we do in the world. Customers expect their electricity to be safely distributed and highly reliable. Outages only cause relatively minor inconveniences for household users, but can result in significant costs to businesses or causing disruptions to thousands of people. These outages usually occur as a result of equipment failures within the transmission or distribution network. Substation equipment such as transformers are the major part of any network, and failures often result in long unplanned outages. Ideally, every item of plant in the network should be assessed in detail to correctly estimate when and how a failure might occur. If this information is obtained, the equipment could either undergo maintenance or be replaced depending on the cost and likelihood of the failure. Although an outage might be needed when doing this, it can be planned, loads transferred without disruption or providing customers with sufficient notice of the outage. Furthermore, the outage time and associated cost of failures can be greatly reduced.

When considering the two points in the blue box above and looking at comparing the options of continuous monitoring and discrete monitoring, you must balance the cost of monitoring against the cost of failures missed and cost of false alarms. Continuous on-line monitoring can appear to be expensive but it is less likely to miss a failure, however it does give more false alarms.

COST OF THE SAMPLING INTERVAL

For periodic monitoring you must balance the cost of the sampling interval against the cost of missed failures. This balance is not easy to achieve. The more devices and techniques used to monitor equipment means the amount of data being obtained increases and so more analysis is required. Also, it is easy to obtain volumes of data but it is more difficult to turn that data into information that can be used for decision making. To show an example, consider the following two simple methods of condition monitoring of the insulation system of a power transformer:

i DGA analysis has almost zero level of false alarms if samples are taken and tested correctly. Depending on frequency of sampling – yearly, bi-yearly, etc. - there could and almost certainly will be a number of failures missed.

ii DLA analysis. As the partial breakdown progresses, the electrical properties of the insulation change and it has higher losses. Since there are a number of factors that affect the power factor and it is a measurement of the total insulation system, it is not easy to identify the cause of a bad result nor is it good at detecting localised faults.

It should also be noted here that in most cases an oil sample may be taken whilst the transformer is still in service, however, the DLA test can only be performed with the transformer totally disconnected. Therefore, the availability and cost of the outage needs to also be considered with both method and frequency of sampling.

RISK AND CONDITION BASED MANAGEMENT METHOD

If we look at using risk as the method of deciding what condition monitoring should be done then fundamentally no calculations are needed, or is that right? The simple thing to do is just analyse the risk from a high level point of view. Different monitoring systems reduce the risk to a different extent, so why not just look at each technique and weigh up the risk of not detecting a fault against the consequence of the fault. This sounds too easy but one must consider the effectiveness of reducing the risk by looking at the cost of using the technique and the level of risk reduction. The equipment being monitored also needs to be given a risk value which considers the type of equipment, its cost, criticality to the network and network usage.

One needs to live with the fact that it may well be considered that the risk of failure of some equipment is so low that almost no monitoring is needed apart from routine maintenance.

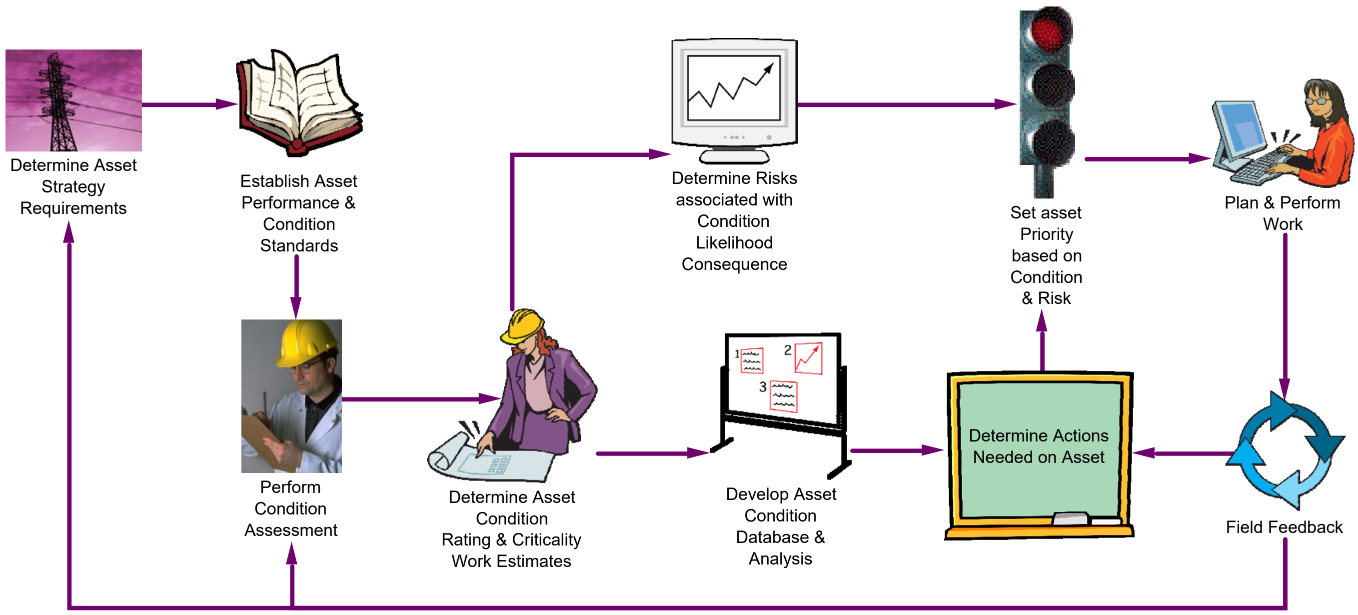

Figure 1 *A Typical Asset Management Process Using Condition Monitoring and Risk Evaluations*

A number of aspects need to be considered with the risk method:

- Issue of risk of failure of the plant. Irrespective of cost, this must be reduced to a level that can be considered tolerable.
- Cost, should a method be able to satisfy the failure risk problem, then which is it the lowest cost?
- The risk of injury or death to personnel. This cannot be ignored and depending on the equipment type, can have a substantial impact on the cost.
- Risks associated with loss of supply and corporate reputation. In some instances, these risks can drive the cost high in an effort to ensure a utility provides reliable supply to high profile customers.

It is here that we note that most modern asset management practices are tending toward condition based maintenance but have an underlying level of risk that is used in the assessing an item of plant to be monitored or not. If it is assessed as low risk and not to be monitored with have a very different impact on the maintenance strategy than plant assessed as high risk but still in very good condition. That is, an item of plant can be performing extremely well without any issues, yet its risk profile has it rated very high on criticality to the network. So again just using only a condition based assessment would not recognise the importance of such assets. Hence, the two, condition and risk must be considered collectively and weighted accordingly.

What about not monitoring: How can you do condition based maintenance if you are not monitoring the condition? The answer is simple, you can't. There needs to be some level of monitoring to be able to effectively assess the condition of the asset albeit every few years. Again, the monitoring can take many forms and cover many techniques and deliver all the data to assess. At the end of the day, all of this presents us with a problem: How to select the most suitable monitoring method for any asset fleet and then select the optimum sampling period.

RIGHT TECHNIQUE FOR A PROCESS

Before any method of monitoring can be selected or considered as the right technique for a process needs to be followed that determines the fundamental reasons for monitoring. The diagram in Figure 1 gives a simplistic view of the process. It starts with determining the asset strategy requirements. What is it and why do condition monitoring or asset management and what is it that needs to achieved. Most utilities and companies have an asset management strategy and this can be leveraged even if it is not up to date. The next step is to establish the asset performance and condition standards. All organisations need to have a level of asset performance that is acceptable to them. To continually achieve that performance, the condition criteria need to be set as minimum standards of acceptability. Without these there is no organisational or industry benchmark from which to assess the asset. This step is probably to most important of all as it sets not only the performance criteria and what you want to measure but also needs to determine the information needed from the data to make a decision. Once you have the strategy and the standards of performance you can then implement them by performing the condition assessment and gathering all the data you decided was needed. Once gathered, the data needs to be used to actually determine the asset condition. To do this, the condition data gathered needs to be added to the asset rating, criticality (risk), work needed to bring the asset to performance levels required and finally the cost estimates for achieving the desired performance.

At this juncture there is a need to split the risk from the condition, so that those criteria previously mentioned in risk (safety, reputation, criticality etc.) can be reviewed separately from the asset condition. The asset condition needs to have specialist analysis and can be review as a health index or other score based assessment of its condition. From there one needs to determine the actions needed to address the condition, this may well be "do nothing" or "total replacement", either way a decision must be made.

CONCLUSION

By using that determination and reviewing it with the risk profile the assets in any network can be prioritised based on the condition and risk. Once those priorities have been determined, it is only then that proper planning to perform the work necessary within a budget can be undertaken.

The above may seem a very simple and normal approach to condition based asset management strategies, however, I would challenge you to look closely at your organisations methods and methodically step through the process. Quite often many areas work very well, but just as often many areas fall short of the desired outcomes. I will delve into a few of these areas in the next article in this short series. td

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