DETERMINING CONDITION BASED ASSET MANAGEMENT STRATEGIES

PART 3 - DETERMINING ASSET CONDITION RATINGS

PART 3 OF A 4 PART SERIES

Two questions that many Asset Managers ponder on a regular basis:

- *Can I fit monitoring devices on assets to maximise the in-service life and performance of that asset with a constrained budget?*
- *How can I use the available data from Health Indices and databases to make decisions on fitting a device to one asset in preference to another and show it has added value to the network?*

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If you do a web search on Asset Health Indices you will get all sorts of links to files, suppliers of software, academic papers and much more. So how does one sort through these and decide what is right for their specific needs and provide their business with a health index or condition rating that adds value to their asset management strategies and programs?

It may disappoint you to know that there is no one solution that fits all, there are no silver bullets that will defeat the demon giant data bank that holds the answers but only provides questions. There is however, a way of starting to understand what data needs to go into that demon data bank and why. It lies in the understanding and use of simple tools that help decide what data to collect from the assets in question. In other words, go back to the start of your condition monitoring program and decide what you need to monitor and why. If you have a health index then look at what it is telling you about the assets in a way that is not necessarily condition related. Look at it from the point of view of how critical that asset is to your network if it were to fail tomorrow.

DETERMINING ASSET CRITICALITY

How do you determine what is critical and what is not? Many might argue that this is simple and that they know what assets are critical to their network and some only find out when planned or unplanned outages occur. Very few organisations have a method that they can use to identify which assets are most critical in their fleet.

If we take the example of power transformers, it seems obvious that the transformer in the CBD is more critical than the one in the remote rural environment. If we have a closer look the CBD unit may in fact have an N-2 scenario whereas the rural unit may only be N. That is, the loss of 1 of 3 CBD units in the substation may have a short-term impact on the customers until load is swung to the other two transformers so the failed unit is replaced in due course. The loss of the rural unit can mean that community has lost supply for a greater length of time while load is swung to other substations, feeders are reconfigured, emergency generation is bought in and the transformer is replaced under an emergency plan. As can be seen, the rural unit may in fact have a greater system impact and so could be considered as a higher criticality unit. The answers as to which is more important lies in knowing the unit loading, area faults, the unit condition, the network configuration and the customers being supplied. As equipment ages it is vital that it is properly maintained but with ever increasing pressures on budgets to do more with less, there are often compromises which sometimes contribute to a failure.

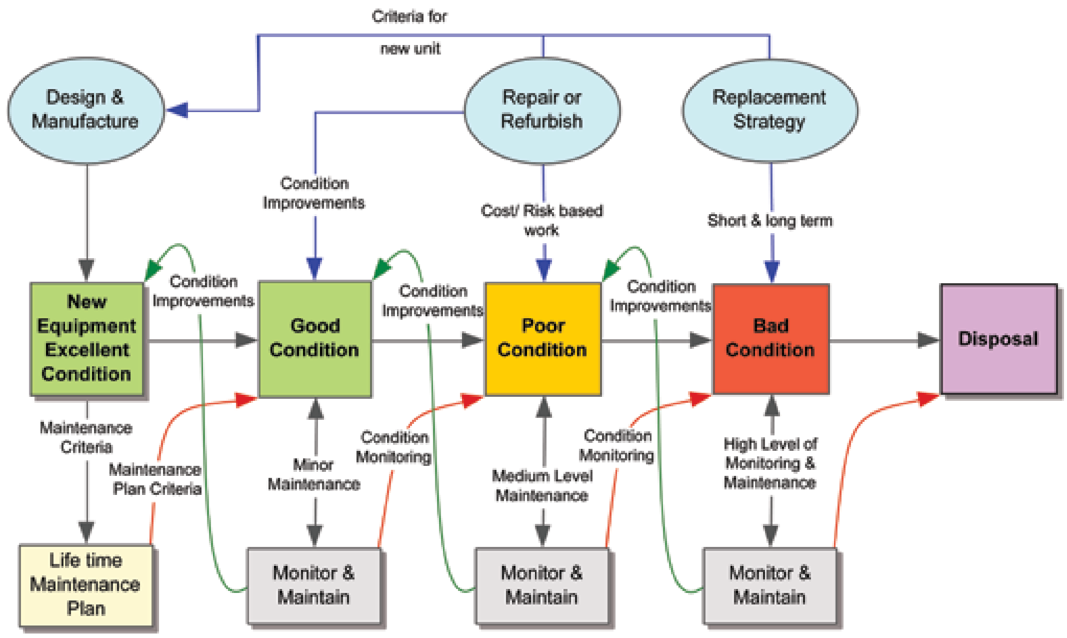

Figure 1 *A Typical Condition & Aging Model for Equipment*

AREAS OF CONCERN

Deciding on what is critical in the network and fitting appropriate monitoring equipment, helps reduce the risk of missing a failure due to reduced maintenance. It can even help detect those false alarms that cause unplanned outages. As stated back in Part 1 of this series of articles the areas of concern for asset managers are; the rate at which failures are missed because the system data and trends did not detect it and the rate at which false alarms are triggered or where a failure is indicated but there is no defect present.

Figure 1 is an asset aging model that shows the life cycle process needed for an asset that is well managed to its normal end of life. This model (and many like it) look at the assets as not failing prematurely, however in reality there is a small percentage of units each year that do fail unexpectantly. It may be lower than 0.5% per annum but they do happen and need to be managed. What this model is suggesting is that by adequately monitoring the asset and diligently applying the feedback to correctly maintain the asset those unexpected failures will reduce to a far lower level. Having said that, it can be deduced that by reducing the failure rates and doing only the necessary maintenance, the asset manager can then maximise the in-service performance life of the asset.

Figure 1 shows how the condition monitoring has a clear linkage into maintaining of the whole of life of the asset and it is clear as to the importance of having not just the condition monitoring tools and techniques but also the direct feedback and analysis of the data used for monitoring the unit. When the condition of the unit is assessed and the data gets fed back into the asset management database correctly, then the efficiencies will follow. This will not happen in a short time unless the end user has a substantial database of historical information that can be put into the process. Generally major substation assets have a life span of 40 to 60 years and so the data collected today may not seem to be important now but may well be vital in 10 or 15 years.

The blue ovals shown in Figure 1 are milestones associated with refurbishing or performing significant repairs on the asset and these serve to extend the life and further reduce the number of premature failures. There first and last in those milestones are the design review and replacement strategy which are both key steps in the overall process. Additionally, as the asset tends toward the aged or condition end of life the replacement strategy is needed prior to total failure. The key here though, is knowing when that total end of life has been reached. Ideally the asset should be replaced only minutes before total failure but in reality, that is (currently) not possible to predict and so a strategy is required.

ASSET CRITICALITY FACTORS & LIFE CYCLE

So how does an asset criticality factor help in this life cycle? The answer is not obvious but it is reasonably simple. As mentioned previously, by understanding how the assets (not just transformers) are used in your network and selecting the right condition monitoring techniques for those assets you can gather all the key data that allows for the right decision to be made. The criticality factor can assist in determining the life cycle maintenance strategy of an asset. If asset maintenance plans are formulated for the assets on their type and we use a criticality factor to assist with the maintenance strategy then every asset could, in theory, have a different maintenance plan. That is simply not practical nor economical for any size network. So, where the criticality factor comes into play is at the whole of the substation level. Here the criticality of the total substation within the network can be evaluated. Once that is assessed then individual assets can be assessed in relation to their impact on the substation. Just as mentioned in the CBD and rural transformer example above an individual asset can have a profound impact on the network but it is more important to be considered in its location within the whole substation and network than as an individual asset.

Using this type of knowledge can help set the maintenance strategy for the substation rather than the individual asset. Then working back down the levels and having assessed the asset impact, the level of attention specific assets get within the asset maintenance strategy can be determined. What is meant by this is that the asset type maintenance is not changed but additional attention may be paid to how the maintenance on an individual asset is performed by setting tighter acceptable limits. An example might be that a circuit breaker operating time may be getting slower but is still just inside the manufacturer's limits. Therefore, adjustments could be made sooner or additional monitoring may be appropriate to ensure the circuit breaker does not become the weak link in the substation chain.

As you can see, the criticality of a site then the assets are vital to understanding what needs to be monitored and why. So, what goes into a Criticality Factor and how can it be used to determine the condition monitoring needed on the asset?

Condition monitoring of 132 kV bushing

A SIMPLE TOOL FOR SELECTING CONDITION MONITORING TECHNIQUES

A few years ago, I spent some time developing a simple way of looking at major assets and what condition monitoring techniques were needed for that asset. By choosing the most obvious asset - the power transformer - a spreadsheet was developed that used a weighting system for specific system and performance criteria and could be adjusted by the end user. By selecting system parameters and the transformer details an output criticality factor was developed. That factor then allowed the user to review what condition monitoring techniques were needed for that specific transformer in its specific network application.

This type of tool allows asset managers to justify a level of monitoring across the network. By having each unit assessed on a common base the asset manager can look across the fleet and decide where to spend his budget to get the best outcome for the network. It does not mean that every transformer that has a high criticality must get the condition monitoring devices fitted first, that is a decision for the asset manager, based on the substation network criticality. It does however, give the output of what techniques should be fitted as a minimum, those that could be added if the devices have it as a standard feature or there are extra funds available and then there are those techniques that are not needed on the unit.

ADDING IN THE RISK

Having worked out all the criticality factors and how to apply them to individual assets we need to add in the risk factor. As is common knowledge, risk is the likelihood of an event times the consequence of the event to determine the impact. So how does this and the criticality factor help with maintenance strategies? By assessing the risks associated with each substation and asset, the asset manager can prioritise the application of the condition monitoring devices to the assets. If you recall the asset manager has a defined budget and needs to decide where to get the best value for the spend. By adding in the risk to the criticality it will allow the asset manager to set a clear path to ensuring the most critical and highest impact assets are monitored first and then work through the fleet with the budgets as they are delivered year upon year.

Again, this sounds easy and we know that budget constraints are what slows these programs down very quickly, however, by using the criticality and risk as organisational baselines for justifying the expenditure then there is an avenue to justify a sustainable or increased budget even if these factors change over the years. In essence, the budget, the criticality and the risk are a trio that when collectively used properly, allow asset managers to maximise the value-added monitoring they need to further maximise asset performance.

WHAT CONDITION MONITORING TO APPLY TO AN ASSET

The last piece of this part of the puzzle is to decide on what condition monitoring to fit to your asset. This is not an easy step as there are many options available and many companies only too willing to advise how their product is better than another. The real leveller here is the condition monitoring technique. By understanding the techniques one can decide what is most valuable for the need within an organisation. I do need to mention here that the asset failures also have an impact if there are clear failure patterns emerging, as these need to be monitored for early intervention.

The first thing here is to look at what you want to monitor, what it will do for the asset and why it needs to be monitored. Once you understand what added value that technique will give your asset management system the easier it will be to decide what product to choose. There is also the need to consider how the data from the device will be received, analysed and provide information to make a decision (sound familiar?). Therefore, that main frame data base or warehouse which is the source of all asset condition data comes back around to help in the decision-making process. If the device cannot give data in a format that can be handled easily by your system, then an add-on software package will be needed. Ideally add-ons should be avoided unless there is no option as these need additional managing and if not kept up to date can create a problem with the end asset condition health report. No single part of the process can be considered in isolation as they all must interface and flow or the information output will have a less than desirable network impact.

CONCLUSION

As can be seen from the above there is a very winding road to travel when deciding what to monitor, what to spend money on and how to integrate it into the organisation. The bottom line is: there is not one solution and it will depend on the organisational drivers, the asset criticality and what impact the loss of that asset has in the network. One take out of this article should be that before you buy devices, look at what you will do with that device, which asset it will be fitted to and why, along with what value adding it will bring to the organisational asset performance.

I trust you have gleaned some value from these articles and can use some aspects to look at how your organisational asset management process flows. If there are gaps, then you need to challenge yourself to develop a solution that fits the organisational drivers. Every business is different and recognise that what works for one company may not work for another. What has been provided in these articles is a way of looking at the organisational processes, data collection methods and assessing if the asset management strategy developed is actually what is needed to achieve the best asset performance. td

The Fourth and Final Article will appear in Transmission & Distribution Issue 1, 2017

In my next article, I will provide some detail on the condition monitoring selection tool and how it uses a criticality factor to select the right condition monitoring technique for the asset. I will explain how the criticality factor is developed and how the way the asset is used in a network can impact the amount of condition monitoring needed and why.