Observations on Specifying a Transformer Main Tank DGA Monitor

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In his recent paper: "When On-Line Monitoring Goes Wrong", my colleague Terry Krieg spoke very wisely about the wider implementation of transformer main tank monitors, making clear that not only are these devices covering some 80% of the demonstrated insurance risk of a plant, they are only going to deliver a viable and useful result if they are purchased, installed, and implemented suitably (i.e.: alarms set, plan of response in place etc). Fortunately, there is readily-available assistance to hand and LORD Consulting takes pleasure and pride in taking its unique IP in this area to clients Australasian-wide with excellent success in the overall risk minimisation.

Today there are many devices sold as 'transformer DGA monitors' but they are by no means equal and in some cases, we are sad to observe, simply unsuited to the role. It is truly a case of 'buyer beware' and here too the old adage 'you get what you pay for' very much applies to the purchase and successful deployment of these devices. Well then, what should one buy to do the job optimally? Firstly, we need to make the observation that there two generic types of monitor sold: 'Detection' and 'Diagnostic' monitors.

'DETECTION' AND 'DIAGNOSTIC' MONITORS

'Detection' monitors, firstly, are ones that are intended to detect an adverse condition in the main tank early then alarm and also to aid in trending, tracking, and qualifying the issues as they develop. Inherently, detection monitors typically look at key indicator gasses but, contrary to popular misconceptions spread by some, detection monitors are hugely valuable at managing the transformer risk and, *if of suitable quality* and observed by a lightly-trained eye, are capable of giving a very good initial indication of the nature of the fault (assessed by gas level, rate of change, and behaviour pattern). By far, these are the most popular types deployed in the Australasian and international markets.

Conversely, 'Diagnostic' monitors do all the same things that detection monitors to but also measure 5 or 9 key combustible gases typically and allow varied levels of DGA analysis and diagnostic interpretations of main tank condition via associated skilled analysis based upon Industry standard 'Analysis Rules'.

Contrary to popular belief, a good detection monitor, suitably implemented, will detect and warm of a pending event as early as a good diagnostic monitor and for about 30% of the cost, typically!

The key point to make, and this is a common observation applying to both detection and diagnostic monitors, is that accuracy of measurement is a paramount specification in selecting such devices. Accuracy is typically stated as +/- X% of reading (i.e.: the basic error) + Y ppm (the total of

these excursions around the true level of gas being the total uncertainty of reading). If total reading accuracy lies above +/-15% in real terms then two major issues arise: the first is that one cannot trend data reliably (the need to do so being a fundamental requirement of managing a main tank issue!), and secondly one cannot make a determination of main tank condition with such errors using diagnostic DGA monitors.

Looking at all brands of transformer monitor on the market, the best have reading accuracy errors of +/-5% and but many only offer +/-20% on a 'good day'. In reality the problems arising from reading error, particularly in being able to deliver plausible and useful trends of condition change in the main tank, simply compound rapidly as one rises in error…it is not a simple level-based observation.

Accuracy is also in itself not just the sole parameter of determining the quality or usefulness of a transformer monitor. One must look at three more parameters to get the fuller picture: 'repeatability', drift with time, and minimum reading level (sometimes called 'lowest detection limit' or LDL). 'Repeatability', firstly, is the measure of how consistently a device will read the same value for a recurrent exposure to the same gas level within its stated measurement range. The higher the figure the less stable the monitor is inherently. Repeatability should be stated in all specification sheets and assessed along with reliability when making a purchase decision. If the figure is not there then the buyer should suspect a less stable monitor and treat the offering with caution.

'DRIFT WITH TIME'

'Drift with time' is harder to quantify off a brochure and requires one to ask hard questions of the maker. One clue of concern in this area is a footnote on the accuracy specifications which status something like "…accuracies at the time of calibration". This implies these are as good as they even can be when set up in the factory but that from there on things can be expected to drift and the specification to worsen. Some monitors use clever techniques to conduct regular 'first principles' calibration inside the device which hold true for their whole lives but this is a rare feature seen in only the better monitors. On the multi-gas DGA front, again the more expensive and quality options address drift issues via providing an on-board calibration gas where all of the measured gasses are present in lab-certified concentrations and the monitor then does a daily calibration automatically and makes its own adjustments to return the device to the published specification, also accompanying this with a self-diagnostic warning that further reassures the customer if anything is amiss. In nearly all brands, however, the means to reassure the client of stability with time is worryingly vague, if explained at all, and one should fear the worst….there indeed may well be no provision at all to offset drift! Every measurement system drifts (an inescapable fact of physics!) and it is the challenge of all designers to mitigate that and to reassure the client that this has been a feature of the design. If that is not stated, then the customer can expect the published accuracies will worsen with time and the device then will become a liability in guiding the client when a main tank situation develops. Cleary, in the latter scenario, the entire expenditure on monitoring would then have been a wasted investment which is an outcome we as consultants in this area work hardest to avoid at the outset when working with clients in the selection and implementation planning process.

The third key parameter to assess when selecting a monitor is the 'lowest detection limit' (LDL). This is the point below which the monitor will not register a reading of gas levels. Whilst it may seem this has nothing to do with accuracy per se, it is a vital matter for the simple reason that if the monitor cannot 'see' the gas levels at all then accuracy does not even come into the discussion. Why raise this? Well, as consultants we are alarmed to see particularly 'detection' monitors coming onto the market from many 'reputable companies' which have an LDL (i.e.: only start reading at all) of 25 ppm. A good diagnostic monitor will have LDL values as low as 0.2 ppm and a good detection monitor will have LDL values for H_2 of nominally 2 ppm. Given that most modern transformers have gas levels of 2-3 ppm when new, to reach 25 ppm the transformer will have had to get to a state of perhaps 12 times worse that it ought to be before the monitor even notices it! Worse still, devices with LDL values of 25 ppm typically also combine this LDL with a poor accuracy of +/- 20% rdg. *making the unit almost unusable as a trending* device even when it finally realises a serious issue is happening. That combination, and certainly a high LDL on its own even, is simply not an acceptable specification option for an informed buyer!

'GET WHAT ONE PAYS FOR'

One final but important matter linking all these threads together pertains specifically to the 'detection' monitor. In the recent Cigre Technical Brochure 783 published in Nov 2019, it was made clear that the market was given a serious caution as to the role of accuracy and resolution (LDL) in the effectiveness of such monitors in suitably determining and warning of a developing main tank issue. Only those detection monitors with the *very best of accuracies and LDL specifications* were found to be able to successfully determine reliably the onset of thermal and arcing faults. In effect, whilst not stated per se in the document, this *effectively* condemns from contention all monitors with LDL values in the order of 25 ppm, course accuracies approaching +/-20%, and poor repeatability readings, sending instead a clear signal that one must *absolutely* focus upon selecting devices with the very best accuracy, LDL, and repeatability that can be purchased.

As mentioned above, and a fitting conclusion to this brief article, one very much does 'get what one pays for' when purchasing a transformer DGA monitor or we stumble again on the old adage: ***"The uninformed customer simply becomes a gullible client!"*** It is thus vital to do one's homework when buying a monitor if one is serious about obtaining reliable and timely warnings, plausibly- trended conditions, and (in the case of diagnostic monitors) correct diagnosis of the underlying condition.