THE MONTH END REPORT – A WEALTH OF VALUABLE AND USEFUL INFORMATION

by John Evans B.Sc.

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The month end or management report contains a wealth of very valuable and useful information. It comprises a statistical distillation of the previous month's samples and compares these data to the previous twelve months. Analyses include a variety of parameters that will give the customer a good idea of how effective their oil analysis programme is and where the problem areas lie in terms of what the problems are, what components are affected and how severe the problems are.

Most oil analysis companies do not provide this detailed service and those that do usually charge for it. Wearcheck has been generating month end reports, free of charge, for more than thirty years. Before we look at the data contained in the month end report we first need to look at the actual oil analysis report which is what generates the month end one.

The sample report

Oil analysis reports contain a huge amount of data but the format is designed such that people at different levels in an organisation can easily access the data that is relevant to them.

The report consists of two sides in its standard printed format. The front contains basic information and the diagnosis with a banner in the top right hand corner indicating the severity of the report and the severity of the previous four samples. The back of the report contains all the raw data that was used by the WearCheck diagnosticians to generate the diagnosis.

Planners are probably interested in the raw data which can be entered into spreadsheets and manipulated to search for trends and hidden patterns. The numeric data can also be analysed statistically. Graphical representation of the data can often make obscure details very obvious. Some of this data manipulation and graphic display can be handled by various proprietary WearCheck software packages.

The foreman needs to read the diagnosis but the raw data on the back of the report may only be of passing interest. At this juncture it is important that those who need to read the diagnosis do precisely that. It is surprising how often a component is stripped when a borderline, and often trivial, situation is indicated. The customer then complains that he has dismantled an engine and cannot find anything wrong whilst the report has merely given precautionary checks for oil pressure or operating temperature

or whatever. The report is considered holistically but the end product is actually the diagnosis and nothing more.

The maintenance manager may only look at the severity banner to get a handle on how many of his samples require action and which ones need to be prioritised. Senior management probably never see a report at all. It would be an advantage if all reports were studied by all relevant people but it has to be appreciated that time is money and, in today's lean and mean business environment, the engineering manager simply will not have time to do this.

With every oil analysis report there are two fundamental parameters that are assigned to every report – the severity and the problem category. The severity has already been touched upon above so let us look at this parameter in more detail.

Sample severity

For oil analysis to be at its most effective, samples must be taken at regular intervals. There are two main reasons for this: firstly, regular samples ensure that if anything does start to go wrong then it will be detected early and corrective action can be taken promptly. Secondly, no two machines ever behave in quite the same manner so it is vital to have a sample history for trending purposes. The current set of results needs to be compared to how the machine has been behaving in the past.

What do the severity terms actually mean in the context of an oil sample report? The diagnoses of oil samples follow a very simple logic path. Customer supplied information is checked and errors or missing information commented on, wear and contamination levels are assessed, the cause of any abnormality is determined, corrective action is recommended and the condition of the oil is commented on. This thought process is applied to all samples. One further thing needs to be assessed and that is, if there are any abnormalities, how serious are they? This assessment will naturally answer the question, how quickly should I attend to this problem?

All reports have a severity rating. The ratings are, in increasing severity: normal, borderline, urgent and critical. The actual names are arbitrary but it does give an indication as to how serious a problem might be. It is important to note that even with a critical sample a recommendation for a strip down is given in less than 1/10th of one per cent of all samples. Unless there is a very obvious and very severe problem, a first actionable report on a component will never have more than a few, very basic checks that any workshop can carry out quickly and simply. The purpose of these checks is to determine whether the problem actually exists or not.

As a general rule of thumb, borderline problems are indicated when there appears to be a deviation in trend or when a defined parameter has just been exceeded. In effect, the report is saying the readings are not following their normal pattern but there is no firm evidence that a problem exists. The recommended action will be quick and simple to carry out and its primary function will be to determine if any further action needs to take place. Borderline samples can be attended to at the next regular service. In these situations, doing nothing more than taking a check sample may be a perfectly acceptable reaction to a borderline report.

If a check sample still shows the presence of a problem or that it has got worse, then some action will definitely need to be taken. Any repeat problems, no matter what the severity, should be treated seriously. So, should borderline samples even be commented on? Yes, it is far better to attend to minor problems before they become major ones.

Urgent samples indicate that there is a very strong likelihood that a problem exists. Again, the report will only recommend some confirmatory check to be carried out. With urgent samples these checks will usually be greater in number and may require more time and effort to carry them out in order to supply more information about the condition of the component. Urgent samples should be attended to as soon as it is convenient to do so.

Critical samples definitely indicate that a problem exists and that it is quite severe in nature. These problems, ideally, should be attended to immediately. It is important to note that, even at this point, it would be extremely unusual for a strip down to be recommended.

The important things to remember are that oil analysis is not an exact science and the vast majority of reports are either normal or precautionary (borderline); in fact, less than 10% of all samples are urgent or critical. As a very general benchmark, from a base of 50 000 samples which include all industries and types of equipment, 75% are normal, 16% are borderline, 6% are urgent and 3% are critical. Interestingly, the 75/16/6/3 ratio is not a million miles away from mean plus one sigma, two sigma, three sigma ratio for a normal distribution.

The other things to remember are: read the report carefully and do not over-react.

Problem categories

It is one thing to know the severity of an oil analysis report but it is also helpful if there is one word or phrase that describes the nature of the problem.

Each report will have one or more problem categories, the chart below lists these categories and what changes in readings indicate such a fault:

PROBLEM CATEGORY	GENERAL EFFECT ON LABORATORY READINGS
NORMAL	No abnormalities.
WEAR	General increase in wear readings and the PQ. The most common element is iron and typically: chromium, nickel, molybdenum, copper, aluminium and lead.
MPE (Microscopic Particle Examination)	This indicates visible debris in the samples and increased PQ. Other wear elements may also increase as per the wear category.
SILICON	Indicates dirt entry in non-engine components. Silicon will increase, usually associated with an increase in aluminium, other wear elements may increase.
AIR CLEANER	Dirt entry in engine samples. Silicon will increase. Aluminium, chromium and iron increases are normally associated.
FUEL	Fuel will increase. Viscosity will decrease. TBN, additive levels and wear readings may decrease depending on severity.
COMBUSTION	Soot will increase and so will viscosity. Sulphate, nitrate, oxidation and general wear levels may increase.
INTERNAL COOLANT LEAK	Increase in sodium, secondary elements: boron, silicon and chromium. Associated elements: copper, tin and lead. Oxidation and viscosity may increase. TBN may decrease. Free water may be detected.
COOLING SYSTEM (overheating)	Engine samples only. Increase in oxidation and viscosity, decrease in TBN, general wear readings may increase.
COOLING SYSTEM (overcooling)	Engine samples only. Increase in oxidation and sulphate. Decrease in TBN. Viscosity and wear readings usually remain constant. Overheating and overcooling are often very difficult to distinguish.
OVERHEATING	Non-engine samples. Increase in viscosity and TAN. Wear readings may increase. Oil usually discolours.
WATER	Free water detected.
OIL CONSUMPTION	Oil consumption increases and wear and contaminant levels decrease.
OIL U/S	Oil deemed to be unsuitable for further use due to contamination and/or degradation not covered by the usual problem categories.
SUSPECT	Readings that do not correlate with data supplied by the customer. Poor sampling technique.
MISCELLANEOUS	Any problem not covered by the above categories.
SAMPLE LEAKED	Insufficient sample to carry out a full range of tests due to oil leakage.
SAMPLE DETAILS	Incorrect or missing details, impairing the accurate diagnosis of results.
COARSE DIRT	Dirt that is visible to the naked eye, sand, grit, airborne dust, usually as a result of poor sampling technique.
SAMPLING TECHNIQUE	Where unexpected or abnormal results may be as a result of a poorly taken sample.

It is these two parameters, associated with every single report, that generate the month end report statistics. Now, let us look at the actual month end report and the data it contains.

The month end report

The management report is a statistical analysis of what has happened to the oil analysis programme in the last month and is compared to the same statistics for the last year. This still requires time and study but if the oil analysis programme is being well managed then it should be no more than a few pages, with most of the data in graphic or tabular form. If the report is large then this indicates serious problems that need urgent attention. Time must be set aside to study the report and solutions to these problems must be found.
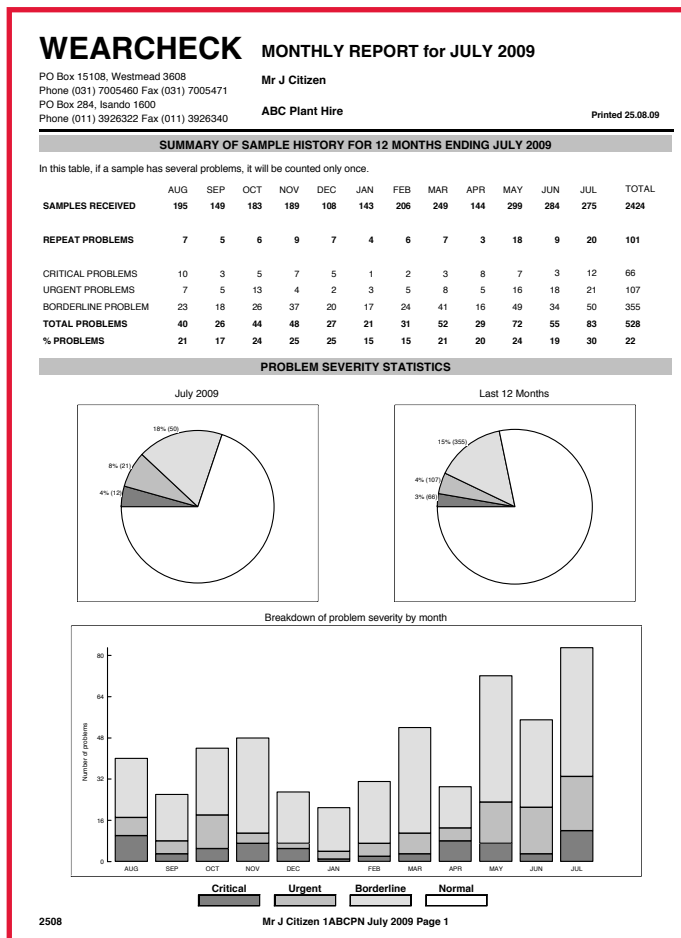
The front page gives a tabular breakdown of total samples received for the previous 12 months, showing the number of critical, urgent, borderline and total problems. Most importantly, the number of repeat problems is displayed. Below this are two pie charts that detail the percentage and severity of problems for the current month and the previous year.

This gives an indication of whether things are getting better or worse, whilst the presence of repeat problems shows that troubleshooting is probably not as effective as it should be.
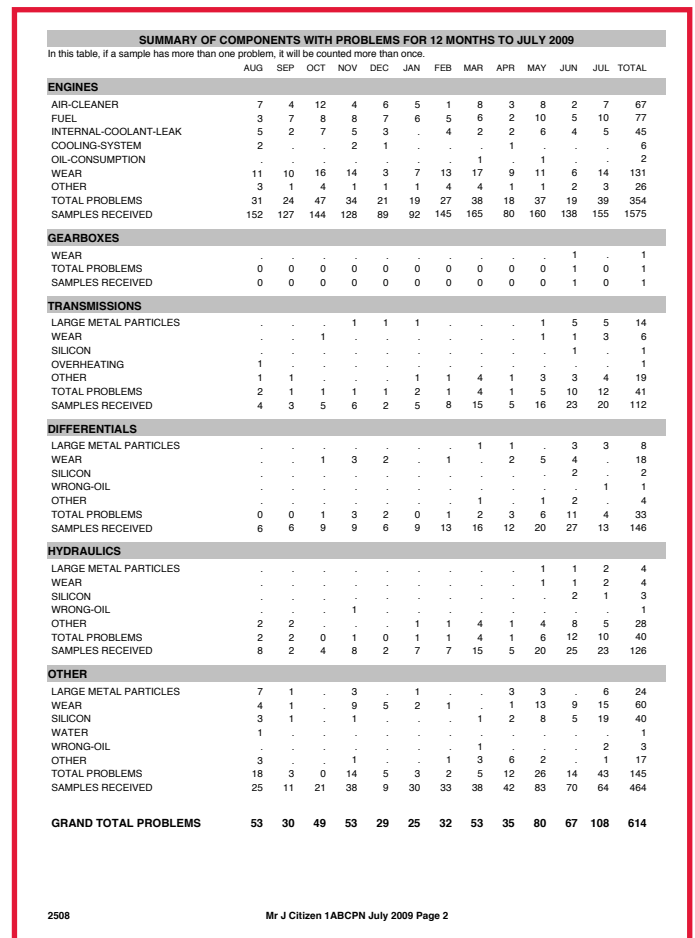
Below that is a bar chart detailing the same information but with actual numbers rather than percentages. This one page gives a complete overview of the effectiveness of the oil analysis programme.

This analysis purely deals with the severity rating attached to the sample. The second page of the report details the number of problems per problem category per component type. For example, how many engine samples showed fuel dilution or how many gearboxes were contaminated with dirt.

This information indicates the types of problems being experienced as opposed to the front page which deals with the severity of those problems. It is important to note here that these two sets of data may not appear to correlate. This is because there is not necessarily a one-to-one relationship. Critical fuel dilution and urgent dirt entry on an engine are two problems but only one sample.

WEARCHECK — MONTHLY REPORT for JULY 2009

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SUMMARY OF SAMPLE HISTORY FOR 12 MONTHS ENDING JULY 2009

In this table, if a sample has several problems, it will be counted only once.

	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	TOTAL
SAMPLES RECEIVED	195	149	183	189	108	143	206	249	144	299	284	275	2424
REPEAT PROBLEMS	7	5	6	9	7	4	6	7	3	18	9	20	101
CRITICAL PROBLEMS	10	3	5	7	5	1	2	3	8	7	3	12	66
URGENT PROBLEMS	7	5	13	4	2	3	5	8	5	16	18	21	107
BORDERLINE PROBLEM	23	18	26	37	20	17	24	41	16	49	34	50	355
TOTAL PROBLEMS	40	26	44	48	27	21	31	52	29	72	55	83	528
% PROBLEMS	21	17	24	25	25	15	15	21	20	24	19	30	22

PROBLEM SEVERITY STATISTICS

July 2009 — 18% (50), 8% (21), 4% (12)

Last 12 Months — 15% (355), 4% (107), 3% (66)

Breakdown of problem severity by month

Critical   Urgent   Borderline   Normal

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Front page of a month end report

SUMMARY OF COMPONENTS WITH PROBLEMS FOR 12 MONTHS TO JULY 2009

In this table, if a sample has more than one problem, it will be counted more than once.

	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	TOTAL
ENGINES													
AIR-CLEANER	7	4	12	4	6	5	1	8	3	8	2	7	67
FUEL	3	7	8	8	7	6	5	6	2	10	5	10	77
INTERNAL-COOLANT-LEAK	5	2	7	5	3	.	4	2	2	6	4	5	45
COOLING-SYSTEM	2	.	.	2	1	.	.	.	1	.	.	.	6
OIL-CONSUMPTION	.	.	.	.	.	.	.	1	.	1	.	.	2
WEAR	11	10	16	14	3	7	13	17	9	11	6	14	131
OTHER	3	1	4	1	1	1	4	4	1	1	2	3	26
TOTAL PROBLEMS	31	24	47	34	21	19	27	38	18	37	19	39	354
SAMPLES RECEIVED	152	127	144	128	89	92	145	165	80	160	138	155	1575
GEARBOXES													
WEAR	.	.	.	.	.	.	.	.	.	.	1	.	1
TOTAL PROBLEMS	0	0	0	0	0	0	0	0	0	0	1	0	1
SAMPLES RECEIVED	0	0	0	0	0	0	0	0	0	0	1	0	1
TRANSMISSIONS													
LARGE METAL PARTICLES	.	.	.	1	1	1	.	.	.	1	5	5	14
WEAR	.	.	1	.	.	.	.	.	.	1	1	3	6
SILICON	.	.	.	.	.	.	.	.	.	.	1	.	1
OVERHEATING	1	.	.	.	.	.	.	.	.	.	.	.	1
OTHER	1	1	.	.	.	1	1	4	1	3	3	4	19
TOTAL PROBLEMS	2	1	1	1	1	2	1	4	1	5	10	12	41
SAMPLES RECEIVED	4	3	5	6	2	5	8	15	5	16	23	20	112
DIFFERENTIALS													
LARGE METAL PARTICLES	.	.	.	.	.	.	.	1	1	.	3	3	8
WEAR	.	.	1	3	2	.	1	.	2	5	4	.	18
SILICON	.	.	.	.	.	.	.	.	.	.	2	.	2
WRONG-OIL	.	.	.	.	.	.	.	.	.	.	.	1	1
OTHER	.	.	.	.	.	.	.	1	.	1	2	.	4
TOTAL PROBLEMS	0	0	1	3	2	0	1	2	3	6	11	4	33
SAMPLES RECEIVED	6	6	9	9	6	9	13	16	12	20	27	13	146
HYDRAULICS													
LARGE METAL PARTICLES	.	.	.	.	.	.	.	.	.	1	1	2	4
WEAR	.	.	.	.	.	.	.	.	.	1	1	2	4
SILICON	.	.	.	.	.	.	.	.	.	.	2	1	3
WRONG-OIL	.	.	.	1	.	.	.	.	.	.	.	.	1
OTHER	2	2	.	.	.	1	1	4	1	4	8	5	28
TOTAL PROBLEMS	2	2	0	1	0	1	1	4	1	6	12	10	40
SAMPLES RECEIVED	8	2	4	8	2	7	7	15	5	20	25	23	126
OTHER													
LARGE METAL PARTICLES	7	1	.	3	.	1	.	.	3	3	.	6	24
WEAR	4	1	.	9	5	2	1	.	1	13	9	15	60
SILICON	3	1	.	1	.	.	.	1	2	8	5	19	40
WATER	1	.	.	.	.	.	.	.	.	.	.	.	1
WRONG-OIL	.	.	.	.	.	.	.	1	.	.	.	2	3
OTHER	3	.	.	1	.	.	1	3	6	2	.	1	17
TOTAL PROBLEMS	18	3	0	14	5	3	2	5	12	26	14	43	145
SAMPLES RECEIVED	25	11	21	38	9	30	33	38	42	83	70	64	464
GRAND TOTAL PROBLEMS	53	30	49	53	29	25	32	53	35	80	67	108	614

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Second page of a month end report

The information detailed on this page can be quite helpful with Root Cause Failure Analysis (RCFA). If the report shows that the majority of the problems are due to overheating then this is the problem that needs to be tackled first. It may be that there is common cause for this across the fleet or plant. This could become a micro-metric for programme efficiency; are the number of and severity of particular problems getting better? We will deal with micro-metrics and KPIs (Key Performance Indicators) later.

The top of page three of the report details the number of times feedback has been requested on a sample and the number of times that feedback has been returned. Feedback is critical for an effective oil analysis programme; Wearcheck and oil analysis is all about relationships. The customer obviously knows his own equipment, operation and environment better than we do and we cannot camp on site with everyone we do business with. If a certain wear profile becomes evident then the most likely cause and correction will be in the diagnosis. This does not mean, however, that it is the correct solution.

Feedback indicates to the diagnostic department whether troubleshooting has been effective. If the obvious solution is not the correct one and the problem continues to exist then other solutions will be suggested. Similarly, if a problem has been found and corrected but evidence of that problem still persists then this is more likely due to residual contamination which will result in a far less serious diagnosis.

The other important thing to note with feedback is that it needs to be relevant. There is no point in returning every feedback card with the comment 'No fault found' or 'No action taken'. This will score you 100% for returned feedback and make you look good in the eyes of the boss but is as much use as a chocolate teapot.

Below the feedback statistics is a bar chart giving a breakdown of the time it takes to get the samples to the laboratory. The shorter the better, nothing is achieved if a component fails whilst the sample is rolling around in the back of the foreman's bakkie. Likewise, samples are processed timeously at the laboratory with 90% of all samples being diagnosed within 24 hours of receipt and 99% within 48 hours, barring exceptional circumstances. This bar chart gives an overview of how quickly samples are arriving at the laboratory and if the time lag is unacceptable then corrective action can be taken. This parameter is displayed every month so this makes another programme metric that can be measured, monitored and improved.

These are all the relevant programme statistics that senior management need to look at although more information is contained within the report. Samples with wrong or inadequate information are listed. These are problems that need to be addressed, as lack of or incorrect information is the single biggest reason for oil analysis programmes not being as effective as they could be. All relevant samples are listed along with fleet or plant number, component, problem category

The number of days is the time from when a sample is taken to when it reaches the laboratory. Working days exclude weekends and public holidays.
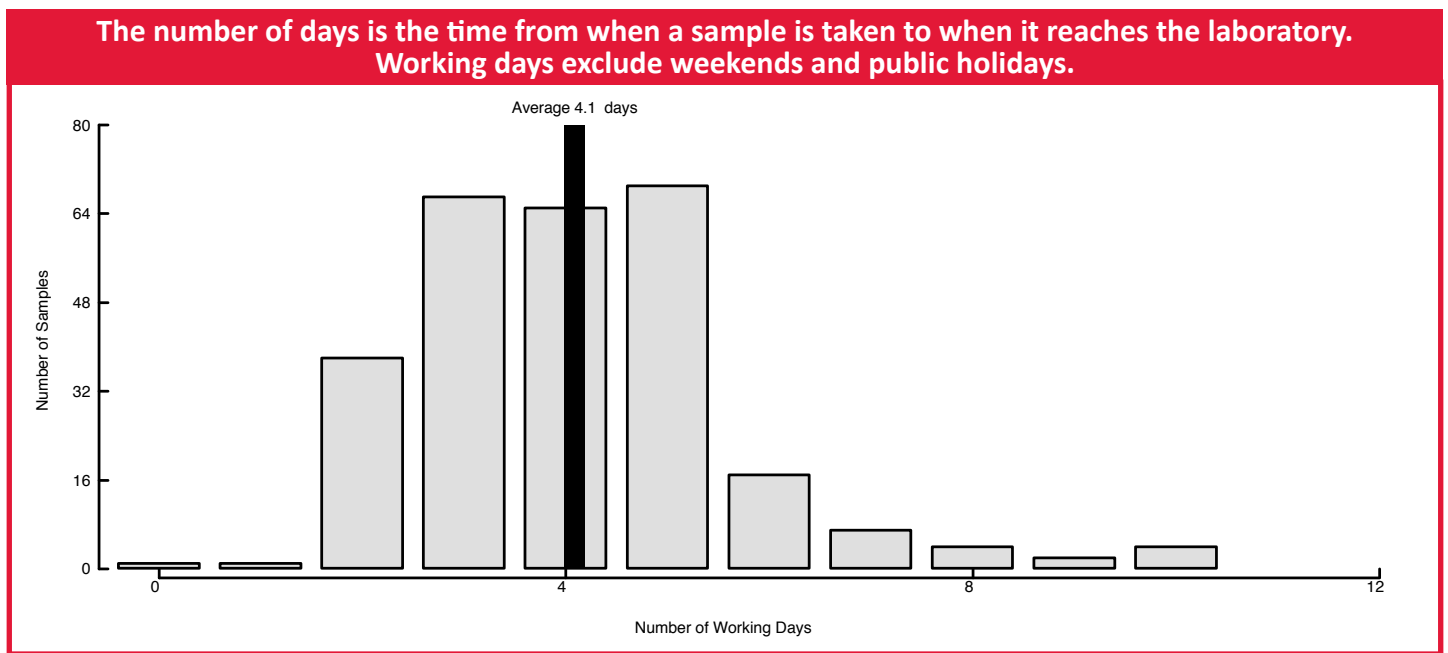
Days taken for sample to reach the laboratory

(usually 'Sample Details'), the diagnosis, date sampled and date received by the laboratory.

The following page/s show the repeat problem samples. These are the samples that require the most urgent action as it shows that troubleshooting is either not effective, not being carried out, or that serious problems exist that need immediate attention. All repeat problems need to be treated very seriously and in a prompt manner. This report section details: fleet or plant number, component, problem category, the diagnosis, the latest feedback, previous feedback and the severity banner.

The next section of the report gives details on the actionable samples received in the previous month with fleet or plant number, component, problem category and any feedback that may have been received with dates sampled, received by the laboratory and action taken. This gives a good indication as to how promptly problems are being attended to.

The next section displays feedback received in the month before that with all the data associated with the last section along with samples where no feedback has been received. Note that feedback statistics will always be a month in arrears as an actionable sample sent out on the last day of the month could never be actioned in that month

In the words of management guru, Peter Drucker, 'If you can't measure it, you can't manage it'. Similar quotes have been attributed to other consultants. Not only is there a wealth of information in the month end report, there are many key performance indicators that are already calculated and ready for use. If you are concerned about running a world class oil analysis programme then parameters need to be measured, targets set and progress monitored. All the information is available in the month end report. Perhaps the most important of the KPIs to look at are the percentage of urgent and critical samples and the number of repeat problems. If you just measure and monitor these two values then you will have a good grip on the efficiency of your oil analysis programme.

Other parameters that can also be monitored are the percentage of samples without feedback, the number of samples with sample detail problems, the average time taken to get the sample to the lab and how long it takes for a report to be actioned. In the last case you may like to set targets for different problem severities: borderline, by the next service; urgent within one week; critical, within one day. It is vitally important that targets be set and progress monitored. This progress needs to be displayed for all to see and targets achieved need to be rewarded; this will ensure buy-in from all involved.

There is a wealth of information in the monthly management report - use it!

John Evans is diagnostic manager for WearCheck.

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