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TECHNICAL BULLETIN

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On-site analysis - blessing or burden?

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The concept of on-site analysis (OSA) - a company setting up a small laboratory on its premises where it performs its own oil analysis instead of contracting it out to a specialised external oil analysis laboratory - has been around for many years. The sort of organisations that have opted for OSA are usually large operations in out of the way places such as mines where transporting oil samples is difficult and time-consuming, or where security considerations create problems such as on diamond mines.

On-site minilabs have been around for many years.

More recently, on-site minilabs have been marketed as an alternative to the employment of external oil analysis specialists for more general use.

This technical bulletin begins with a brief overview of the advantages of both the OSA and the specialised oil analysis laboratory, followed by an in-depth review of some of the critical issues to be considered when comparing the two.

Advantages of OSA

- Turnaround time is quick because the laboratory is close to hand. Oil analysis can be carried out and a report and recommendation generated in hours as opposed to days if it were sent to an outside specialist laboratory.

- Tests can be tailored to the particular environment and operation.

- On-site laboratory staff have intimate knowledge of the operation and operating conditions, which can be vital in making an accurate diagnosis of the test results.

- The laboratory has immediate access to the equipment and the personnel who maintain it which can provide invaluable information for making an accurate and detailed diagnosis.

- Complete equipment history files are available close to hand providing more detailed data than that held by an external laboratory.

OSA is only as good as the person who interprets the results.

Advantages of an external specialist facility

- The specialist laboratory is able to keep abreast of the rapid technological advances in oil analysis internationally, and upgrade equipment and tests when needed because oil analysis is its core business.

- It offers depth of experience in many diverse fields.

  Wearcheck staff for example have 75 years of combined experience in interpreting laboratory data in the fields of aeronautics, compressors, on-road transport, marine, light vehicle, earthmoving, mining and maintenance planning as well as the chemistry involved in the lubricants themselves. This depth and spread of experience cannot be achieved in an on-site minilab.

- An external laboratory has a far greater data base of samples than an OSA which has low volumes and a limited data base.

  In Wearcheck's case, the laboratory analyses over 240 000 samples per annum (an ever-increasing number) which provides a wealth of information on norms and trends throughout all types of industry and equipment and enables the lab to see problems evolving more quickly. An on-site lab might see two of one kind of sample in a month while Wearcheck will see many from all over the sub-continent, so what may appear to be a localised problem to the on-site lab could in fact be a problem that is country or continent wide.

Qualities required for an OSA laboratory manager

A mini-lab, if it is to be run effectively, requires a multi-talented manager with the following attributes: a scientific background, engineering knowledge of the equipment being sampled, as well as a knowledge of maintenance planning strategies and how to integrate all of this into the existing maintenance system. The person must also have a genuine interest in oil analysis and its implications for the company.

It is a recognised fact that OSA is only as good as the person who interprets the results. Well qualified technicians, scientists or engineers can be employed to run the laboratory but the interpretation of oil analysis data is highly specialized and a good diagnostician only becomes one with years of experience. Without the engineering background or wide experience to interpret the laboratory data, the diagnosis will be of poor quality.

As these laboratories are often situated in out of the way places, the person running the minilab must be able to carry out basic maintenance on the laboratory equipment and keep it in running order, otherwise there will be

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laboratory down-time with disastrous consequences.

To cover all these bases is not an easy task to accomplish. Finding a suitable person to run an on-site laboratory is further complicated by the fact that the position offers very few opportunities for promotion - it is a dead-end job and this results in high staff turn-over. Companies often try to run OSA as one-man shows which means that during sickness or annual leave there is usually no one to run the laboratory.

The key to effective oil analysis is: good sample, good analysis, good interpretation. If any of these steps is inadequate then the results must be suspect. An external oil analysis laboratory employs a number of different specialists to ensure that there are no weak links in the system.

The complexities of accurate diagnosis

Some manufacturers of OSA equipment have tried to build expert computer systems to perform diagnosis automatically, with the aim of eliminating the need for a diagnostician. Although there is no doubt that these artificial intelligence systems can diagnose basic problems, oil analysis is highly complex and cannot be reduced to a simple set of rules. The following is an example of how many variables need to be taken into consideration when looking at something as simple as dirt ingress.

Most people reading this technical bulletin will be familiar with oil analysis and the dangers involved with dirt entry. Dirt, grit, sand and airborne dust are highly abrasive to mechanical equipment if they get into the oil. Most readers will also be familiar with the fact that dirt is measured (spectroscopic-ally) by the amount of silicon in the oil, because most dirt contains a high level of silicon dioxide. Therefore, an increase in silicon should indicate dirt entry into the lubricated system. However, this is not as straightforward as it appears because an increase in silicon need not indicate dirt entry, and dirt entry may occur without an increase in silicon.

It should be borne in mind that a change in a particular level or variable in oil analysis should never be considered on its own - the global picture should be looked at including all parameters that can be measured. Even identical pieces of equipment in identical environments doing the same job will not behave in exactly the same way. Oil analysis results must be trended for individual components and the inter-relationships between different tests or readings must be considered in order to give a reliable diagnosis.

Figure 1 (overleaf) shows ten possible outcomes for high silicon readings when eleven parameters are considered, as well as their relation to each other. In Wearcheck's experience, this type of sample occurs on a daily basis. Figure 2 shows 12 theoretical examples of samples showing high silicon readings and the diagnosis for each.

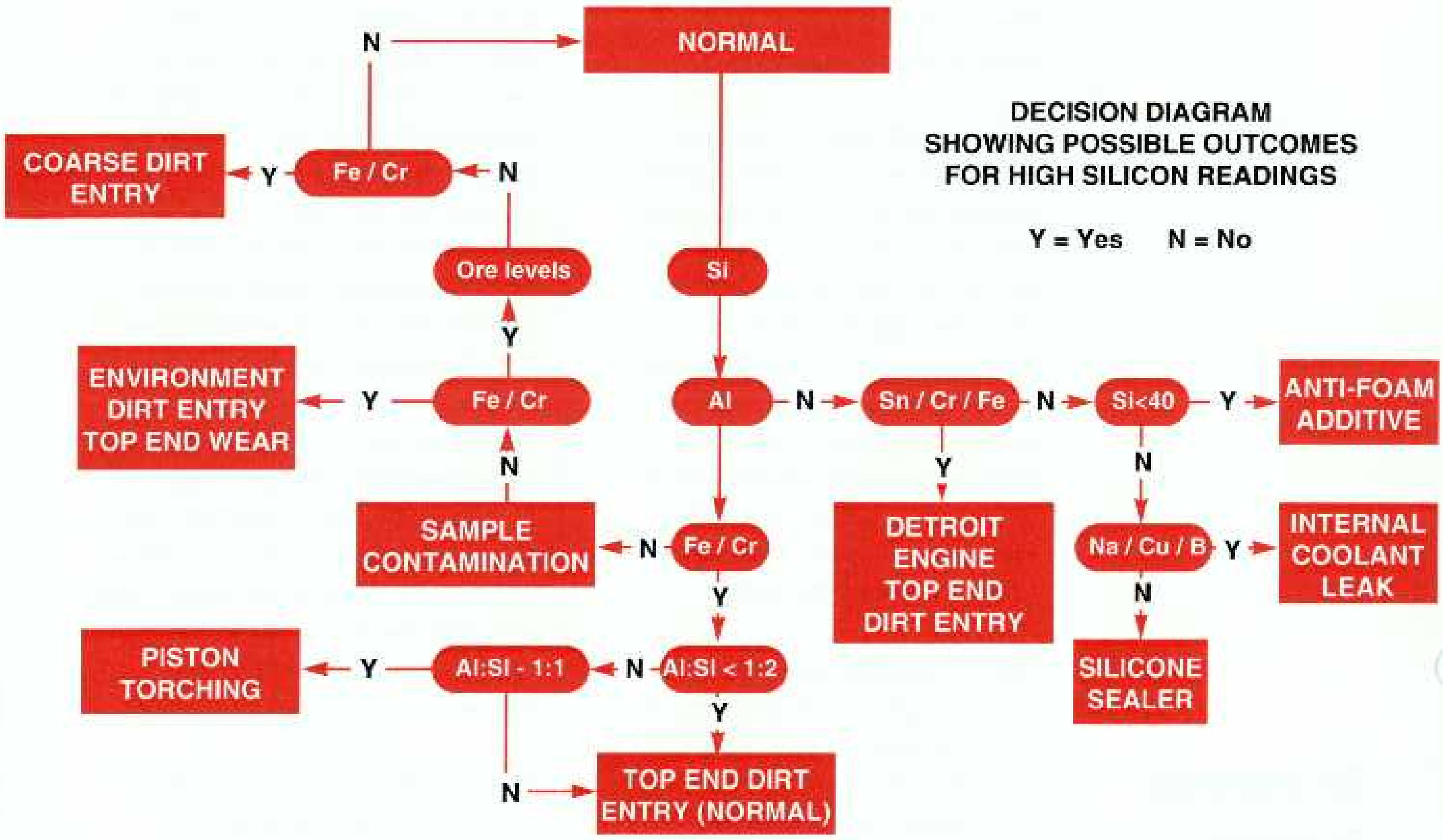

Figure 1

THEORETICAL EXAMPLES OF SAMPLES SHOWING HIGH SILICON / DIRT ENTRY

Fe	Al	Cr	Cu	Na	Si	TABLE ONE
35	8	3	15	12	15	Normal
92	29	16	20	16	69	Severe Dirt Entry
38	9	4	124	243	101	Internal Coolant Leak
35	8	3	15	12	250	Silicone Sealer Used
36	10	5	10	19	31	High Anti Foam Level
105	134	38	20	21	145	Fuel System Fault

Fe	Cr	Al	Sn	Si	TABLE TWO
35	8	3	7	15	Normal
120	25	10	35	68	Dirt Entry Detroit Engine

Fe	Cr	Al	Zr	Mn	Si	TABLE THREE
35	8	3	0	0	15	Normal
99	19	25	154	0	29	Dirt Entry Richards Bay
104	18	27	0	217	28	Dirt Entry Manganese Mine
128	73	30	0	0	31	Dirt Entry Chrome Mine

All readings in PPM

Al - Aluminium, Zr - Zirconium, Mn - Manganese, Cu - Copper, Sn - Tin, Cr - Chromium, Si - Silicon, Na - Sodium, Fe - Iron, B - Boron

Figure 2

The limitations of OSA spectrometers

The limitations of the instruments used to detect silicon are another important factor. Spectrometers are limited in the size of particle that they can detect - up to a maximum of 10 microns (1 micron is 1000th of a millimetre). In the case of coarse dirt entry, other laboratory techniques are required (such as particle counting and debris analysis) to detect its presence. An on-site spectrometer would totally miss these cases of dirt entry.

It should also be noted that the type of spectrometer usually selected for OSA has a limited number of elements that it can detect. Most can analyse up to 17 individual elements, whereas the technology that Wearcheck uses can detect 33 elements. Although an expert OSA system could correctly identify dirt entry in a lot of cases, it might not cover all eventualities and will still miss some.

WEAR AND DIRT ENTRY
RELATED TO OIL CONSUMPTION

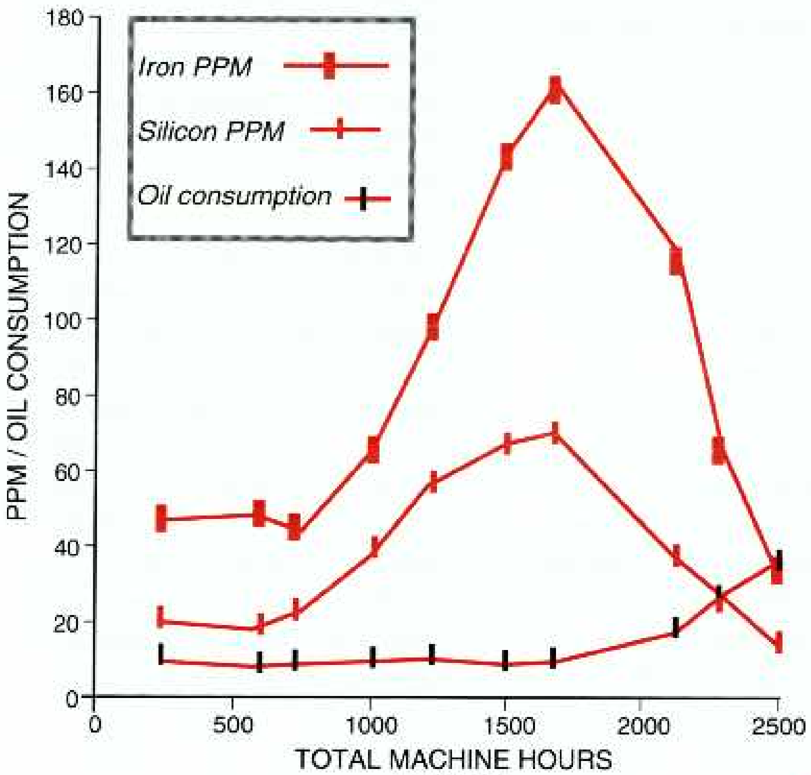

Figure 3

Interpretation of results

If the four main elements (iron, chrome, aluminium and silicon) involved in dirt entry and the three things they can do (increase, decrease and stay the same) are considered then this leads to 81 (three raised to the power of four) possible eventualities. Only four would conclusively indicate dirt entry using OSA. This assumes that any expert OSA system works on trend analysis (as Wearcheck diagnosticians do), taking into account only two subsequent samples and taking into account the degree by which readings may increase or decrease. All four of these readings increasing by 1 PPM could be misconstrued as an indication of dirt entry.

In manual diagnosis, at least three sets of data are taken into consideration and the degree of change in all readings is assessed. To carry on with this theme, if genuine dirt entry is taking place, the associated wear will eventually lead to an increase in oil consumption. The consequence of this is that the wear readings and silicon levels will decrease as the engine is being topped up with fresh oil that does not contain the dirt or generated wear metals; an engine in its death throes of top end wear will show remarkably low wear readings (see Figure 3).

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Alternatively, if the oil is left in use for extended periods of time, then all readings will naturally increase with the length of time the oil has been in use. All of these parameters are noted when a diagnostician interprets oil analysis data.

Wearcheck International as a group of independent companies processing 1,5 million samples in eight nations annually, has pooled resources to try and develop software capable of diagnosing oil analysis data, its main aim being to let the diagnostics team concentrate on more complex problems. However, over the last ten years it has had very limited success in that it is only possible to distinguish between super normal data and other data that may or may not indicate a problem. Wearcheck has never developed a minilab quite simply because the company is convinced that there is no replacement for diagnostic experience and that the expertise and experience of its diagnosticians is essential to maintain the highest levels of accuracy.

Return on investment

The financial justifications for OSA are many and varied. What follows is one simple comparison with the use of an outside specialist company.

Taking a very conservative view of the savings in mobile equipment that oil analysis can offer, one Wearcheck customer has calculated that R1 spent is R5 saved, which represents a 5:1 return on investment (ROI). Considering that this company spent R100 100 using Wearcheck's services in 1995, their calculated savings were about R500 000. This is a very conservative estimate in that it only takes into account the cost of spare parts for basic repairs. Also, only the minimal cost of repair was considered - not taking into account intangibles such as down time, lost production, the loss of company goodwill due to projects not being completed on time, or the labour to effect repairs. In real terms the ROI of oil analysis has been estimated to be as high as 10:1 if it is carried out correctly.

If a R1 million minilab is introduced into an organization which is currently spending R100 000 per annum with an outside contractor, then this cost can be directly amortised over ten years without taking into consideration inflation or the cost of the service increase. If the service provider increases the cost of its service by 10% per annum then the R1 million would be justified in seven years in today's rands (although in reality the cost of this type of equipment would probably be written off in four years).

There is no way that OSA can offer the service or expertise that a specialist laboratory can, particularly tertiary diagnosis (in-depth analysis of a customer's total data). In my experience OSA offers a ROI of between 2:1 and 3:1 on the capital investment and running costs of an on-site minilab. Taking 2,5:1 as an average, the following financial comparison can be made:

EXTERNAL ANALYSIS		ON-SITE ANALYSIS
Cost	R100 000	R143 000 * + R100 000 **
Savings	R500 000	R250 000

* amortisation ** running costs, including salary and consumables

The amortisation of R143 000 per annum is based on a company spending R1 million for an on-site laboratory as opposed to spending R100 000 per annum with an outside facility which increases its service cost by 10% per annum. The return on investment for the first year is therefore as follows:

	EXTERNAL ANALYSIS	ON-SITE ANALYSIS
Amortisation		R143 000
Running costs		R100 000
Analysis / service cost	R100 000	
Total cost	R100 000	R243 000
Savings	R500 000	R250 000
Return On Investment	R400 000	R 7 000

Specialist laboratories upgrade their systems as a matter of course.

These calculations do not include the cost of updating OSA equipment. Technology in this field advances rapidly and specialist laboratories upgrade their systems as a matter of course. Wearcheck actively evaluates new techniques as they become available through its international associations, close contact with the companies and research institutions that are developing these technologies, and by attending international conferences regularly. If a new instrument comes on the market and is deemed to be worthwhile, then that test is introduced to complement the battery of tests already carried out.

In my experience, once an on-site laboratory has been built and commissioned, the purchase of further laboratory equipment is very difficult to justify.
R1 million represents a sizeable outlay, even for a large organization for a function that is not core business, and further expenditure on OSA equipment is usually not sanctioned.

Hidden costs

There are often hidden costs in running a laboratory on site that are not factored into the economic viability of the venture, mainly because they involve departments other than the one that is responsible for the control of the laboratory. One organisation that runs its own OSA facility has very high running costs because of the need to dispose of waste solvents (laboratory chemicals) and oil in an environmentally sound manner. In Wearcheck's case for example, solvents are recycled on site and waste oil is removed free of charge by a company that turns it into furnace oil. These facilities are not readily available to organisations that are not directly involved in running industrial-sized laboratories or that are situated in isolated locations.

Internal problems

Because the laboratory cannot run

with the efficiency, accuracy or expertise of a specialist facility, the quality of service is always going to be second rate. This will result in failures not being detected and 'strip and inspects' where no problem exists. Oil analysis is not an exact science and a specialized laboratory will also get it wrong on occasion. However, because these situations occur more frequently with on-site laboratories, the credibility of the OSA service can deteriorate rapidly, causing the maintenance staff to lose confidence in oil analysis.

For oil analysis to work effectively, a top-down management commitment is required and all personnel involved must believe that it works - one weak link in the chain and the benefits of oil analysis will be greatly reduced.

Today the trend is for organisations to concentrate on their core business.

Company politics

On-site laboratories can become political within the organisations that run them. It is difficult to back down from the justification that OSA will work and then find that it is not as effective as an outside laboratory. A person who has staked his reputation on OSA will therefore tend to protect it as he moves up the hierarchy. The result is that, despite not offering the level of service that a specialist company can, the on-site minilab becomes self-perpetuating at its comparatively low level of service.

Trend to outsource

Another factor which is not directly related to the quality or efficiency of either OSA or a centralised specialist laboratory, involves current business management philosophies. Whereas 50 years ago companies tried to do everything in-house to save money, today the trend is for organisations to concentrate on their core business in the belief that contractors who are specialists in their field will offer a better, more cost-effective service because it is the contractor's core business. The thinking is that organisations should stick to their core business and leave highly specialised services to the companies that can provide the best value for money. In the case of oil analysis, when using an external specialist laboratory, although the basic cost per sample may be more, the return on each rand spent is far greater.

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