SCHEDULED OIL SAMPLING:
A Proactive Approach Towards Pollution Prevention and
Waste Minimization.

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The Waste Reduction Operations Complex (WROC) at the Idaho National Engineering Laboratory (INEL) maintains an emergency fire protection system which provides fire water during emergency conditions. The diesel engine driving this system receives regular preventative maintenance (PM) and servicing. The Waste Minimization Plan for WROC requires that all systems and processes be given a regular assessment to verify any Pollution Prevention (P2) or Waste Minimization (Waste Min.) activities. The WROC Maintenance group has implemented a proactive or best management practice (BMP) that reflects this P2/Waste Min. awareness. The diesel engine is operated for 30 minutes each week to maintain its readiness. A typical owner's manual for industrial engines require that the oil be changed every 100-hours of operation or 6-months; only 13-hours of operation occur during the 6-months before the required oil change. Thirteen hours of operation would not warrant changing the oil. The WROC proactive approach to this problem is to perform an annual Scheduled Oil Sampling (SOS). An 8-ounce sample of oil is obtained and sent to a SOS lab. The SOS lab analyzes the condition (breakdown) of the oil and, provides a detailed analysis of metal particulates (from engine wear), and checks for impurities, such as, sulphur, water, coolant, and fuel in the system. The oil is changed only when the sampling results warrant that an oil change is necessary. The actual costs of the oil, filters, and labor far exceed the costs of performing the SOS. The projected cost savings after 8 years is about $12,000 in labor, oil changing costs, and hazardous waste analysis.
Background: One of the systems in place at the INEL Waste Reduction Operations Complex (WROC) facility is an emergency diesel engine system which provides power for pumping fire water during emergency conditions. The diesel engine receives regular preventative maintenance (PM) and servicing to guarantee readiness. The Waste Minimization Plan for WROC requires that all systems and processes be given a regular assessment to verify any Pollution Prevention (P2) or Waste Minimization (Waste Min.) activities. The WROC Maintenance Engineering group has implemented a cost saving proactive and best management practice (BMP) approach relative to preventative maintenance for this diesel engine that reflects P2 and Waste Min. awareness.

Situation: The emergency diesel engine at WROC is operated for 30-minutes each week to maintain its readiness. A typical owner's manual for industrial engines requires that the engine oil be changed every 100-hours of operation or 6-months. As a result, there are only 13-hours of operation during the 6-months before the required oil change. However, after 13 hours of operation the oil has not deteriorated and does not need to be changed. Also there are costs other than that of labor, oil and filters that have to be considered. These include disposal costs and the cost to perform a hazardous waste analysis (which checks for arsenic, cadmium, chromium, and lead; total halogens, flash point, and PCBs; all at a cost of $500) required by 40 CFR 266.102(b) because the used oil will eventually be burned for energy recovery.

Proposal: Six months is not enough time for the oil to get dirty and warrant changing. A proactive approach to this situation is to have a regular oil analysis performed on the oil. Caterpillar offers a scheduled oil sampling (SOS) analysis service. This SOS is the best indicator for determining what is happening inside the engine regarding engine wear and oil analysis.
SOS and analysis is not a new procedure. In 1986, L.H. Handler ("Sampling and Analysis of Industrial Lubricants" 1986) brought out key points concerning scheduled oil changes versus scheduled oil sampling:

- The outcome of scheduled lubricant change intervals is that good lubricant is wasted or that machinery is damaged because the lubricant has been used beyond its useful life span.

- A key benefit of used oil analysis is that the user can diagnose many equipment problems before they lead to catastrophic failure.

- Another benefit is that oil analysis can determine the maximum length of time the lubricant can be used without risking damage to equipment.

The SOS accomplishes two important aspects simultaneously: minimizing wastes (used oil, and oil filters) and monitoring the diesel engine much closer to ensure a long working life.

**REASON:** The annual SOS oil analysis consists of three tests: wear analysis, chemical and physical tests, and oil condition analysis. The wear analysis uses an atomic absorption spectrophotometer to identify elements deposited in the oil as a result of engine wear (iron, chromium, copper, aluminum, and silicon). Chemical and physical tests detect if water, fuel, or antifreeze are in the oil, and whether or not the concentrations exceed established maximum concentration limits. The presence and amounts of contaminants such as soot, sulfur containing products, oxidation products, and nitration products are measured by infrared analysis.

Over the years, oil analysis companies have developed engine wear profile charts. The charts can identify which bearing or engine part is wearing according to the metallic impurities present in the oil. This produces a pedigree or profile of engine wear. If a certain impurity exceeds the stated limits on the wear profile charts, then this is an indication of excessive wear and can indicate specific engine parts that need to be replaced and when engine overhauling becomes necessary. If excessive wear is indicated, sampling and analysis will be performed semi-annually.
**ACTION:**  SOS is in place at WROC and it will be continued. This plan demonstrates the best management practice to profile maintenance requirements for the emergency diesel engine; this insures the required operational readiness and a proactive approach to P2 and Waste Min.. The analysis is performed annually and the oil will be changed only when conditions are warranted. The spectrographic analysis results will be compiled by the maintenance engineers to trend and establish engine wear patterns.

**RESULTS:**  Changing the oil every 13-hours, as was the former practice, insures that the engine oil was always clean. The negative side is that it is not known what was actually happening on the inside of the engine-- the oil was changed before the impurities could accumulate, and it is more costly in labor, supplies and disposal costs to change oil before it is time. The site buses (which also have diesel engines) typically operate for 200 hours before the oil is changed. Two hundred hours of operation for the WROC diesel engine would correspond to changing the oil every 8 years. The two following charts show a comparison between the previous 6-month oil change out costs versus the SOS costs for annual sampling and analysis and oil change out every 200 hours of operation (96 months).
TABLE 1: PREVIOUS 6-MONTH OIL CHANGE COSTS FOR WROC EMERGENCY DIESEL ENGINE

<table>
<thead>
<tr>
<th>ITEM</th>
<th>6-MONTH COSTS</th>
<th>12-MONTH COSTS</th>
<th>24-MONTH COSTS</th>
<th>48-MONTH COSTS</th>
<th>96 MONTH COSTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>OIL*</td>
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<td>$640.00</td>
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</table>

COST IN DOLLARS PER MONTH AFTER 96-MONTHS = $158.00/MONTH

* Five gallons of oil are needed per oil change.

TABLE 2: SOS OIL ANALYSIS COSTS FOR WROC EMERGENCY DIESEL ENGINE

<table>
<thead>
<tr>
<th>ITEM</th>
<th>6-MONTH COSTS</th>
<th>12-MONTH COSTS</th>
<th>24-MONTH COSTS</th>
<th>48-MONTH COSTS</th>
<th>96-MONTH COSTS</th>
</tr>
</thead>
<tbody>
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<tr>
<td>HAZ. WASTE ANALYSIS</td>
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COST IN DOLLARS PER MONTH AFTER 96-MONTHS= $17.00/MONTH

CONCLUSION: The following conclusions are drawn from this study:

1) SOS demonstrates a P2 proactive attitude.
2) SOS will allow one to produce an engine wear profile.
3) Engine overhaul will not happen before needed, and
4) Enactment of SOS is expected to produce a cost savings of over $12,000.00 in an 8 year period.

As a result it is recommended to continue the SOS practice.
References


Theisen, Joe. SOS lab manager for Western States Equipment Company. Telephone interview on 1-23-95.