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Asset Condition Management

Regional oil analysis initiative
moves reliability information from
spreadsheets to the Cloud

Reliability Processes Upgraded Worldwide

Around-the-clock operation of heavy equipment in harsh, gritty conditions is the nature of the coal mining and production business. Equipment failure is not an option for an industry that services customers around the world. Some of the components cost hundreds of thousands of dollars each and production downtime losses can be immeasurable.

Reliability has long been in focus at one surface operation in the U.S. that produces tens of millions of tons of coal each year. Condition monitoring of equipment began there 15 years ago to provide early detection of deterioration and avoid costly failures. By 2013, nondestructive testing (NDT) procedures, including oil analysis, vibration monitoring, ultrasonic testing, thermography and walk around visual inspections, were in use.

Early that year, the company took steps to further improve reliability and reduce costs. By 2015, the company's various cost initiatives saved \$525 million and reduced capital investments to \$194.4 million. The journey that began with oil analysis – the company's largest condition monitoring expenditure – is now being expanded and rolled out globally.

Oil is the low-hanging fruit

The established oil analysis program monitored mining equipment, such as earth moving draglines, electric mining shovels, ultra class haul trucks, track dozers and motor graders. Certain systems within the coal processing plants were also monitored. Approximately 4,000 individual oil sample points were taken as often as every two or four weeks.

Though it was helpful in managing machine health and meeting component replacement



Figure 1: Equipment failure is not an option in surface mining operations

targets, the existing oil analysis program lacked efficiency and visibility. Information was tracked using methods ranging from a computerized maintenance management system (CMMS) to spreadsheets, technician notes and stand-alone software programs.

The spreadsheet tracking of high sample volumes was particularly prone to errors. There were incidents of inaccurate sample labeling and tracking, lost samples, inconsistent return times and overdue oil sample condition assessments. Greater automation, control, accountability and “whole picture” analytics were desired.

Following a region-wide process review in 2013, the decision was made to standardize and consolidate on a cloud-based reliability information management system for oil sample analysis management, including direct communication with the oil lab.

The Web-based approach that was selected provides a more efficient and accurate oil sample identification and tracking process. Oil sample scheduling is managed within the reliability in-

formation management system and the cloud-based, interactive results are transferred directly from the oil lab and made available to tribologists at each mine.

From a web browser, the coal company's analysts are able to:

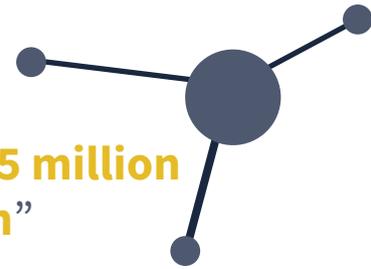
- Review the full details in an interactive sample report;
- Apply customized alarm sets that are different from the lab's alarms;
- Create trend charts for data parameters;
- See the lab's analysis comments and add new comments or questions;
- Create a condition entry for the asset location to escalate problem visibility.

Big picture reliability comes into focus

Details of problems from flagged oil samples and the recommended maintenance actions are posted to a browser-based status condition sta-

OIOGRAPHY									
Control Panel									
Site Filter: <input type="text"/>									
Samples Awaiting Review Most Recent Tasks Samples At Lab Sample Points & Scheduling									
Actions	Location Desc	Equipment Desc	Tests Completed	Status	Value Alarms	Lab Sample Code	Company	Site	Tango
	818-PD		Dec 01, 2015	Critical		1855590		- Mobile Equipment	
	522-HYD		Dec 01, 2015	Critical		1855162		- Mobile Equipment	
	View Oil Report		Dec 01, 2015	Critical		1855560		- Mobile Equipment	
	353-FDRR	RIGHT/REAR	Dec 01, 2015	Critical		1855179		- Mobile Equipment	
	353-FRONT DIFF	FRONT	Dec 01, 2015	Critical		1855172		- Mobile Equipment	
	353-REAR DIFF	REAR	Dec 01, 2015	Critical		1855177		- Mobile Equipment	
	838-PD		Dec 01, 2015	Critical		1855356		- Mobile Equipment	
	376-FDL	LEFT/REAR	Dec 01, 2015	Critical		1855165		- Mobile Equipment	
	604-HYD		Dec 01, 2015	Warning		1855561		- Mobile Equipment	
	818-FWR	RIGHT	Dec 01, 2015	Warning		1855563		- Mobile Equipment	
	939-HYD		Dec 01, 2015	Warning		1855159		- Mobile Equipment	

Figure 2: Critical oil samples are sorted to the top of the list for action by the company's oil analysts (Courtesy of 24/7 Systems)



“By 2015, the company’s various cost initiatives **saved \$525 million** and reduced capital **investments to \$194.4 million**”

TREN

Integrated Condition Status Report

Filter:

		Severity	Function	Asset	Component	Technology	Days Awaiting Checkoff	Work Order Numbers	Created By	Latest Status Comments	Latest Case Recommendation
1		4	160 - 936HP TRACK DOZER	POWER TRAIN / DRIVE SYSTEM	ENGINE SINGLE	• Oil - Lab	169	• 103206972 • 103239491 • 103878143 • 103882524			•monitor sample at normal interval By: Nov 23, 2015
2		4	171 - DOZER TRACK	POWER TRAIN / DRIVE SYSTEM	ENGINE SINGLE	• Oil - Lab	198	• 103750399 • 103793095 • 103882524 • 104179922			•oil was changed resample at next interval By: 09, 2015
3		4	474 - CAT LOADER 994H	HYDRAULIC	STEERING PUMP SINGLE	• Oil - Lab	131				•system in process of complete clean out By: (Oilography), Jul 24, 2015
4		4	474 - CAT LOADER 994H	POWER TRAIN / DRIVE SYSTEM	PARK BRAKE SINGLE	• Oil - Lab	131				•system in process of complete clean out By: (Oilography), Jul 24, 2015
5		4	492 - MOTOR GRADER	HYDRAULIC	HYDRAULIC SYSTEM	• Oil - Lab	169	• 104081070 • 104129999			•change oil at next pm

Figure 3: All condition-based problems are integrated via an interactive browser dashboard (Courtesy of 24/7 Systems)

Condition Case Details User: TF7, Date: Dec 03, 2015, Time: 11:58:55

Location: FIELD >> 101 - 87 CU YD DRAGLINE >> DRAG TRANSMISSION RIGHT REAR >> DRAG 1ST INT GEAR P01 [Locate in Tree](#)

Equipment: Plant Tag 10007406 **Diagram(s):** [Lifespan Chart](#)

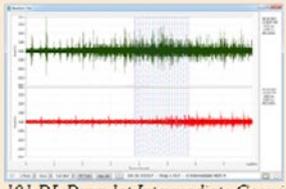
Entry	Severity	Technology	Faults
Aug 18, 2015 4 By: Steve Marshall Case: 369	4	Vibration - Route	• Gear -worn/spalled teeth
<p>Recommendations: 8/18/15) The Amplitude has more than doubled since last inspection. The gearing and mounting bearings should be inspected as soon as possible.</p> <p>Comments: 8/18/15) Vibration Amplitude has increased significantly since last inspection. 2-19-15) Not much change from last inspection. 11-12-14) Slight change since last inspection. Indication is a possible chipped gear tooth seeing indication at 1 times running speed. 8-19-14) Increasing amplitude in waveform ~9g Acc. spiking to 12g Acc.</p> <p>Linked Documents</p> <p>101 DL Drag 1st Intermediate Gear.jpg (Measurement Data)</p> <p>Work Order Request Assign CMMS</p> <p>Work Order Number Assign CMMS</p> <p>Details Report View</p> <p>Status Comment </p>  <p>101 DL Drag 1st Intermediate Gear.jpg</p> <p><input type="button" value="Checkoff"/></p>			
<p>Additional History </p> <p>Mar 05 2 Vibration - Route</p> <p>• Gear -worn/spalled teeth</p>			

Figure 4: Condition case details are captured in the reliability information management system (Courtesy of 24/7 Systems)

tus dashboard. The dashboard, easily visible to a wide audience of authorized users, lists all known problems of an asset by severity, the number of days the problems have been open and the work order numbers.

The coal company soon recognized that its other condition monitoring technologies could also integrate with this dashboard. This would eliminate the many hours spent gathering reliability information and metrics from numerous stand-alone databases and assembling and communicating it in spreadsheets. Moreover, it would provide a complete and readily accessible picture of asset health.

“Upgrades and system improvements are an ongoing effort”

The company chose to centralize all condition problems found via oil analysis, vibration analysis, ultrasound analysis, thermography and walk around inspections on the dashboard, which is part of its reliability information management software. This gives technicians and managers a single platform from which to track and manage all known conditions that can impact the reliable performance of equipment.

Partnership approach

To best meet its improvement objectives, the coal company worked jointly with the reliability software provider to map out key processes and adapt oil sample analysis management and reliability information management solutions to its business needs.

A jointly developed interface imports current meter hours twice daily from the company's CMMS and a budgeted life percentage calculation was developed. This allows the integrated condition status report to show the status of individual components and where they are in terms of their lifecycle relative to the targeted replacement interval.

An automated task system for oil sample selection and labeling was also developed. Previously, the machine run hours, component service hours and lube hours on sample labels were assigned manually and prone to errors. When the company's oil techs didn't adapt well to the new electronic system for generating labels, the responsibility was shifted to water spider personnel (staff who keep production materials in stock at point of use so production personnel can focus on asset tasks that create products or provide services).

Another early challenge was gaining support from the oil lab. The lab had to review its internal processes for managing oil analysis data and upgrade its systems to support electronic data trans-

Figure 5: The oil analysis program monitors mining equipment, such as earth moving draglines

mission. Ultimately, the new system helped to improve the coal company's relationship with the lab. It streamlined some of the oil lab's work and actually reduced or eliminated its need for manual data entry, which, in turn, reduced the potential for errors.

For this company, the improved interaction between technicians, analysts and lab personnel is increasing the accuracy and control of the mine's reliability program. Maintenance personnel can more effectively manage machine component health and have greater insight into the highest priority work, the expected useful life of the assets and complete machine health histories.

Global program rollout

Due to the western region's success, efforts are underway to standardize all NDT and reliability procedures across all operations in the company's global platform, which vary in size and scope. This involves:

- Using both Web-based oil sample analysis management and reliability information management software as the single source for machine health reporting and analytics, while using the CMMS for scheduling and costing;
- Formalizing the methodology used to determine which NDT process or processes to employ based on the equipment type;
- Standardizing the associated NDT strategy and frequency in order to maximize problem detection and apply the appropriate corrective action;
- Standardizing the tracking of value, cost savings and avoidance, route adherence, condition assessment procedures, and asset health and component condition reporting.

Upgrades and system improvements are an ongoing effort and the coal company continues to work closely with the software provider on this. For example, they are currently developing



a CMMS notifications link within the reliability software's condition status dashboard. They also plan to develop a senior assets review using the budgeted life status percentage to assist in risk-based assessments by the maintenance director, reliability manager and planners.

Meanwhile, the company continually adds more reliability processes, such as additional vibration and thermography routes, expanding the number of systems and components that are tracked and monitored. The company is also using mobile devices to capture field measurements and inspection data where problems found by inspection personnel can be integrated on the condition status dashboard.

Future plans include implementing a full system interface with the reliability information management software and the CMMS, and using more of the mobility, repair tracking and root cause failure analysis (RCFA) case management features available within the software.

By moving the entire organization from spreadsheets to a common reliability platform in the Cloud, the company is setting the stage for continuous improvements in asset performance, uptime and operational efficiency.



Steve Marshall is the Preventative Maintenance Coordinator at Xanterra, Inc. in Wyoming. He has more than 30 years of experience in the mining industry. As an accredited Six Sigma Black Belt, he has led several successful lean system improvement projects and reliability improvement initiatives at various companies, including Peabody Energy and BHP Billiton. www.xanterra.com



Forrest Pardue is President of 24/7 Systems. He has worked in the field of vibration analysis and production maintenance for the last 25 years. In 1997, he co-founded 24/7 Systems, a company focused on the development of reliability information management software and services, to facilitate the measurement, management and improvement of plant machinery reliability. He earned a BSEE from North Carolina State and an MBA from Lynchburg College. www.TF7.com

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