

INDUSTRY: **REFINING**_

SMARTSIGNAL MEETS REFINERY AVAILABILITY
AND SAFETY CHALLENGES



BREAKDOWNS, LEAKS, SPILLS, AND FIRES — A RECORD NUMBER OF FAILURES AND SAFETY PROBLEMS — HAVE PLAGUED REFINERIES AND HAVE CAUSED A RECORD NUMBER OF UNPLANNED SHUTDOWNS, AT RECORD COST AND LOSS OF REVENUE.

SMARTSIGNAL® PROVIDES THE EQUIPMENT-PERFORMANCE INTELLIGENCE NEEDED TO MITIGATE OR ELIMINATE MANY CAUSES OF FAILURE THAT IMPAIR AVAILABILITY, PROFITS, AND EHS OUTCOMES. SMARTSIGNAL'S CUSTOMERS HAVE ACHIEVED AVAILABILITY INCREASES OF AS MANY AS 12 PERCENTAGE POINTS WHILE DECREASING THEIR COSTS AND IMPROVING THEIR EHS OUTCOMES. THIS PAPER ILLUSTRATES HOW SMARTSIGNAL PREDICTS, DIAGNOSES, AND PRIORITIZES REFINERY EQUIPMENT AND PROCESS PROBLEMS AND HELPS AVOID MINOR AND MAJOR CATASTROPHES AND THEIR CONSEQUENCES.

INDUSTRY CHALLENGES

The industry faces massive challenges from increasing demand, volatile prices, and environmental regulations. These challenges tax refining capacity to the limit and result in two major problems:

Availability: North American refiners are running approximately 5% below normal. Half of North American refineries have reported disruptions to operations in the first half of 2007 alone—an all-time record. They've stressed their equipment and deferred maintenance, and now they're paying the price. They're experiencing more unplanned shutdowns, at higher costs, for longer durations.

"Since refining has become such a wonderful business, refiners have delayed maintenance," according to Adam Robinson, energy research analyst at Lehman Brothers. "But when they do go down, they stay down for longer, and they discover all sorts of problems."

Safety: Alarms are going off about the safety of refining operations, particularly after a recent refinery accident which killed 15 workers. According to the U.S. Federal Chemical Safety Board chairwoman, "There is a lack of investments in modern equipment. The overwhelming preponderance is that if you have inadequate engineering and equipment, poor process safety management, and poor staffing, you're set up for a catastrophe." Mr. Robinson said: "You have a system that is taxed to the limit. This is what happens when spare capacity is eroded."

Some refineries have been trying to prevent process, equipment, and safety problems by using traditional condition-monitoring tools. But, obviously, major and expensive problems still persist. That's because traditional tools:

- _ require a great deal of expertise to deploy, maintain, and use,
- _ analyze only a part of the problem,
- _ provide too many false alarms,
- _ are difficult to calibrate to changing ambient conditions and loads, and
- _ miss the unique characteristics of each individual piece of equipment.

THE SMARTSIGNAL SOLUTION

SmartSignal's advanced asset analytic solution solves the above issues and works on all critical rotating and non-rotating refinery equipment to help keep refineries up and running and safe. Exhibit A illustrates the types of refinery equipment that are analyzed by SmartSignal and the faults that are detected.

SPECIFICALLY, SMARTSIGNAL:

- _ predicts impending refinery equipment and process failures,
- _ diagnoses the causes of the failures, and
- _ prioritizes the severity of the failures.

SmartSignal analyzes all critical equipment 24/7 and provides plant personnel with notifications of issues. SmartSignal works on an exception basis and directs plant O&M personnel to only the equipment they need to review. SmartSignal focuses the plant's efforts on problems only, reducing workload and maximizing results.

Across all ambient conditions and loads, SmartSignal understands each piece of equipment's unique operating characteristics. SmartSignal works on all equipment, all OEM's, with all sensors. SmartSignal can take readings at any time, including different time slices for different pieces of equipment. And, importantly, SmartSignal works seamlessly on top of our data infrastructure partner, OSI PI™.

SmartSignal overcomes the deficiencies of traditional condition-monitoring tools. It addresses the top three concerns of the people SmartSignal serves.

SmartSignal provides:

- _ operational relevance: high-quality, actionable intelligence,
- _ speed-to-value: quick implementation within a matter of weeks, and payback within a matter of months, and
- _ ease of use: SmartSignal deploys, tunes, and maintains the software and notifies plant personnel of impending problems.

BENEFITS

SmartSignal provides the intelligence to eliminate the failures that trouble refinery operations' most critical pieces of equipment. SmartSignal allows O&M personnel to shift unplanned maintenance

"SmartSignal Services™ have worked well for us. We have merged the SmartSignal information into our business process. When we get a notification from SmartSignal, we KNOW it is worth looking into. We generate work orders based on the information SmartSignal provides."

_ REFINERY MANAGER



to planned and to lengthen maintenance intervals. This translates into:

- _ increased equipment availability and efficiency,
- _ improved profits and return on capital employed, and
- _ improved EHS outcomes.

EXAMPLES OF SMARTSIGNAL'S SUCCESS

What would it mean to your availability, safety record, and profits if you could eliminate problems with your critical equipment? Here are some problems that we've identified for our refining clients:

- _ hot gas expander turbine catalyst fouling,
- _ coker cutting water pump thrust bearing failure,
- _ vacuum bottoms pump seal failure,
- _ solvent deasphalting unit extractor heavy oil carryover,
- _ gas oil pump loss of suction due to tower damage, and
- _ recycle compressor organic chloride fouling.

In fact, one of our refinery clients eliminated a problem that would have shut down half its production for over one week. The bottom line was millions of dollars of profits saved and a potential EHS incident avoided.

ROAD FORWARD

SmartSignal can work with your team to evaluate how our advanced asset analytics can improve your performance. Through a straightforward process that requires little of your time, SmartSignal can enable your team to ascertain what SmartSignal can do for your refinery operation. There are three phases to the process:

- 1. Discovery Analysis:** The goal of the Discovery Analysis is to allow your team to find out more about SmartSignal and for the SmartSignal team to find out more about your refinery, assets, and business processes. Based on the outcome of this analysis, a decision to proceed or not to proceed to the next phase is made.
- 2. Value Analysis:** The goal of the Value Analysis is to develop an initial value premise for your company's asset base.

SmartSignal employs a methodology that identifies the major asset opportunities and then quantifies expected value based on annual savings and revenue improvement.

- 3. Test Drive:** The goal of the Test Drive is to allow your team to experience SmartSignal before making a decision to invest in it. SmartSignal has implemented over 60 Test Drives, and the feedback from our customers is that a Test Drive is a highly efficient and effective way for a team to conduct a detailed assessment before making a "go/no go" decision.

Exhibit A: Refinery Equipment and Faults	Efficiency Loss	Seal Failure	Bearing Failure	Rotating Element Failure	Valve Failure	Tube Failure	Fouling	Combustion Problems	Overheating	Carry Over	Flooding
Reciprocating Compressors	X	X	X		X		X				
Axial Compressors	X		X	X			X				
Centrifugal Compressors	X	X	X	X			X				
Centrifugal Pumps	X	X	X								
Electric Motors	X		X	X					X		
Expander Turbines	X		X	X			X				
Steam Turbines	X		X	X			X				
Gas Turbines	X		X				X				
Heat Transfer Equipment	X						X	X	X		
Control Valves						X	X				
Fired Heaters	X				X	X	X	X			
Boilers	X					X	X	X	X	X	
Catalytic Processes	X					X	X		X	X	X
Gas-Liquid Contact									X	X	X
Liquid-Liquid Contact	X								X	X	X

SmartSignal eliminates more failures on more equipment than do traditional methods.

"During an 18-month test of SmartSignal, the predictive analytic program was 100% reliable in forecasting an issue. When SmartSignal said we had a problem, we had a problem."

_FORTUNE 500 EXECUTIVE

"The value case for end users of remote monitoring is compelling, and sometimes unbelievable."

_INDUSTRY RESEARCH ANALYST

"SmartSignal monitors for us 46 units, 320 assets, and 930 models every five minutes."

_MAJOR POWER COMPANY

"SmartSignal has the most sophisticated software available for fault detection. There is no question that the technology is effective."

_FORTUNE 500 INDUSTRY EXECUTIVE



ABOUT SMARTSIGNAL

SmartSignal maximizes worldwide industry equipment performance, availability, and reliability by predicting, diagnosing, and prioritizing equipment and process issues before they become costly failures. Drawing on 45 patents, SmartSignal turbocharges basic similarity-based modeling and delivers specific, relevant, and actionable intelligence that makes people more proactive and productive. SmartSignal serves customers in power generation, oil and gas, mining, refining, aviation, pulp & paper, and other process

industries worldwide. Over the years, SmartSignal and its clients have won over twenty awards for excellence, including the *Wall Street Journal* Technology Innovation Award.

901 WARRENVILLE ROAD, SUITE 300
LISLE, ILLINOIS 60532

P: 630_829_4000

W: SMARTSIGNAL.COM



©2008 All rights reserved. SmartSignal is a registered trademark of SmartSignal Corporation in the United States and/or in other countries. All other company names and products mentioned herein may be the property of their respective companies.

IND_08_0001