

# Conoco Phillips Ferndale Condition Monitoring Success

## From Chaos to Calm with Azima DLI Methodology

### Background

The Conoco Phillips Ferndale Washington Refinery was constructed in 1954. Ferndale is an integrated single train fuels refinery with the following operating units: FCC, HF Alkylation, Reformer and the typical array of supporting units. The refinery's capacity is 110,000 Bbl's per day and it has about 1,000 pieces of equipment. The rotating equipment group has full responsibility for the condition, effectiveness and mechanical integrity of the machinery. The staff consists of three rotating equipment reliability engineers, one part time vibration monitoring technician and a maintenance superintendent.



### Challenge

Dating back to 1991, the Conoco Philips Ferndale plant had no formal vibration monitoring program and employed a reactive approach to maintenance. The team was so busy responding to problems that required immediate attention that there was no time to make any long term improvements. Operations had such little confidence in the plant's pumps and motors that it was a common expectation that even spared equipment had to be repaired and returned to service the same day. This created a lot of machinist overtime as the team routinely spent their weekends overseeing machine failures.

It became apparent that something had to change. The plant needed a way to get away from reactive maintenance (run to failure) and move toward a more strategic, proactive approach to addressing machine reliability and uptime.

During the plant's investigation of machine condition assessment technologies, they evaluated oil analysis and thermography solutions and concluded that for their machinery and the types of failures they had experienced, vibration monitoring offered the highest potential return on invested money and time. The team also recognized the necessity of regular, repetitive data collection to establish a representative history and statistical baseline data from which deviations could be accurately recognized.

*"In my opinion, vibration monitoring is the cornerstone to identifying machinery problems. How else can you stand next to a running piece of equipment and determine without shutting it down, that it suffers from impeller unbalance, misaligned shafts, or is at the early stages of bearing damage," said Ryan R. Barnes, maintenance superintendent of rotating equipment services at Conoco Phillips, Ferndale Washington Refinery.*

The team began the search for a vibration monitoring system, one that emphasized accurate and repeatable data collection and easy analysis. Conoco Phillips Ferndale considered several approaches to data collection. One was to use Ferndale operators or machinists to collect the vibration data and then have reliability engineers or contractors do the analysis. The other was to outsource the entire condition monitoring program. The team decided to hire a committed, on-site data collector to be involved with the entire program, from data collection to working with an outside vendor that would handle primary analysis. This way the data collector wouldn't be pulled away for pump repairs or to perform operator rounds. Also, because the plant has such a small staff, it was critical that the vibration monitoring system purchased be fast, accurate and repeatable, and most importantly, easily diagnose potential problems.

### **The Vibration Condition Monitoring Program**

After reviewing available vibration monitoring solutions, Conoco Phillips Ferndale selected the Azima DLI vibration data collector with ExpertALERT software. The solution incorporated a number of features which would help the team be successful including:

Rapid data collection:

- Triaxial simultaneous data acquisition allows vibration data to be collected in three directions in less than 20 seconds per test location (for a typical 3,600 rpm machine). This includes both low (0-10 orders) and high (0-100 orders) frequency ranges.
- Bar Code Scanner allows effortless point identification. No searching through a list of pumps or test point locations, i.e. inboard or outboard bearing. Data collectors can simply point and shoot the bar code label glued next to the pump base or foundation and the data collector begins recording immediately. The labels can even withstand years of harsh conditions in outdoor refinery environments.

Accurate and repeatable Results:

- Test location attachment pads with a screw-mounted connection to the transducer is the most accurate means of collecting repeatable vibration data, especially in the higher frequencies. The bronze pads have an alignment notch to orientate the triaxial transducer and a 10x32 threaded captive screw for fast connection.

Easy to diagnose problems:

- All vibration monitoring programs utilize some sort of data screening technique, either enveloping or mask alarms. Azima DLI uses an expert analysis program called ExpertALERT. This software uses statistical analysis to compare accumulated average baseline signature against the test data. By comparing the tested machines spectral peaks to this baseline, exceedences are processed through a complex set of rules for the machine and a diagnosis is rendered. From a couple hundred pumps and motors collected in one day, 20 to 30 percent of these machines will generate a significant diagnostic report that requires follow up manual analysis.

## Lessons Learned

- For the Ferndale plant, it was imperative to have a single person, with appropriate training and certification, who owned, and was responsible for the predictive monitoring program with real interest, enthusiasm and accountability.
- In addition to collecting and analyzing data, the program owner must have enough time to analyze the few machine problems that arise, and track the statistics and metrics needed to refine the program and recommend plant improvements.
- Principal contributors to Ferndale's success, and certainly the ability to conduct a highly successful vibration monitoring program with a single individual, are the tri-axial accelerometer that allows fast data collection and high resolution data to support the automated diagnostics that are an integral part of the Azima DLI program.
- The Azima DLI diagnostics are highly accurate and only require minimal manual intervention. Unlike even the most conscientious and diligent human expert, computers don't get bored or lose interest scanning vast quantities of complex data looking for minute changes. When the system reports a bearing is failing, you can bet that bearing is failing with a good idea of how long it has remaining to live.
- Achieving success with any monitoring program requires a significant investment in time and resources to gain understanding of a machines internal configuration. In operation the program can be continually refined and upgraded with screening and diagnostic tasks improved.

## Results

- Over the past 16 years, unplanned machine failures have diminished to near zero.
- The plants pump MTBF (Mean Time Between Failure) rate increased from 22 months to 52 months in a 10 year period after implementing the Azima DLI condition monitoring system.
- The annual maintenance costs for all pump repairs have dropped from \$1,300,000/yr in 1994 to \$600,000/yr in 2004.
- Virtually every maintenance task at the plant is planned.
- Equipment failures are few and far between.
- Machinist overtime has been nearly eliminated.

## Conclusion

Since 1991, the Conoco Phillips Ferndale plant has come a very long way. What was once a run-to-failure plant where machine breakdowns were common and machinist overtime was inevitable, is now a plant with a 91 percent on-stream availability with a staff of just five machinists. Implementing Azima DLI Watchman

vibration data collector with ExpertALERT software was the crucial turning point for the Ferndale plant. Using Azima DLI, the staff is now able to perform preventative maintenance and predict machine failures well before they happen which has led to machine failures dropping to near zero.

*“People often ask us how we’re able to average 91 percent on-stream availability year after year with such a small staff. I tell them we’re able to be so efficient because we use data collectors and software from Azima DLI,” said Ryan R. Barnes, maintenance superintendent of rotating equipment services at Conoco Phillips, Ferndale Washington Refinery.*

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