Using the PI System for Proactive Asset Management

Caterpillar's Solution

Presented by **David Krenek**
Market Professional

CATERPILLAR®

Topics

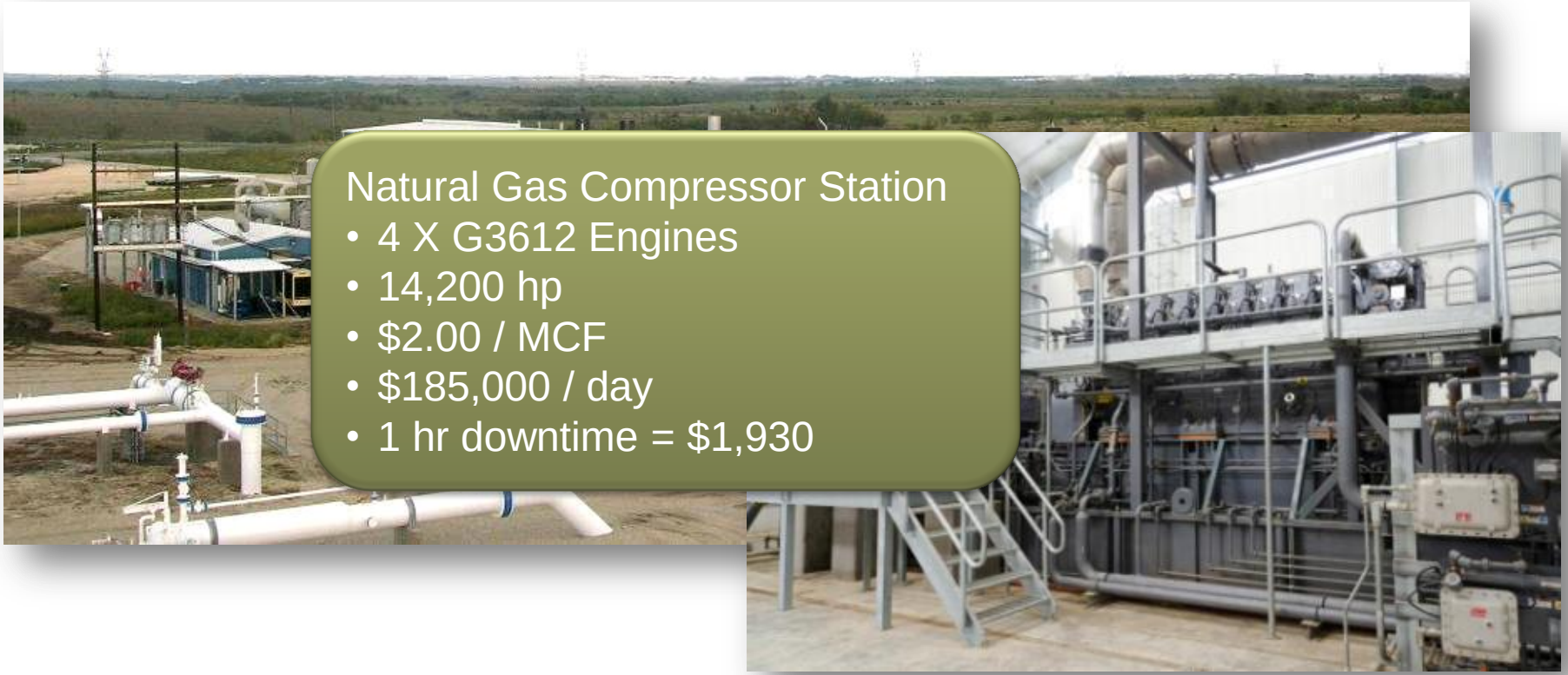
- Proactive Asset Management Background
- Caterpillar Solution
- Examples of Technology in Use
- Benefits

Proactive Asset Management (aka Condition Monitoring)

Failure	Unhealthy	Healthy
		
$$$$	$$	$
No Flexibility	Some Flexibility	Most Flexibility

Condition Monitoring

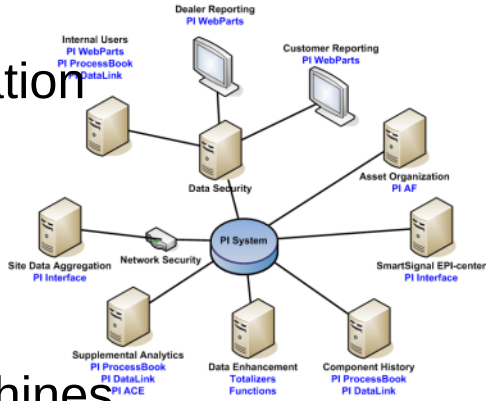
Power for Natural Gas Compression



Natural Gas Compressor Station
- 4 X G3612 Engines
- 14,200 hp
- $2.00 / MCF
- $185,000 / day
- 1 hr downtime = $1,930

Why the Pi System

- Proof of Concept Identified Gaps
  - Aggregate Data from Various Industrial Controls
  - Visualization to Facilitate Root Cause Determination
  - Data Archiving for “cradle-to-grave” Analysis
  - Additional Analytics
  - Platform for Information Distribution
- Core Competency
  - Manufacturing Highly Durable and Reliable Machines
  - Not Data Management Software
- Time and Cost to Market
- Common Platform to Customers Using the PI System



Key Processes

Aggregating Data

Data Types
- Analog
- Derived
- States
- Faults

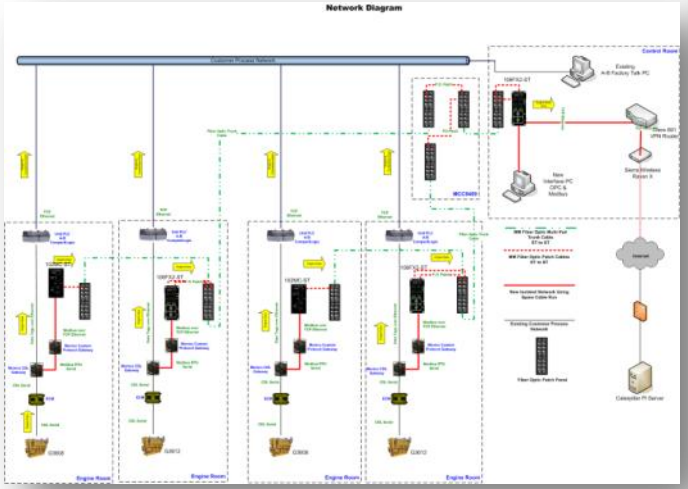
- Once per Second
- PI Interfaces
- Cat & non-Cat Products

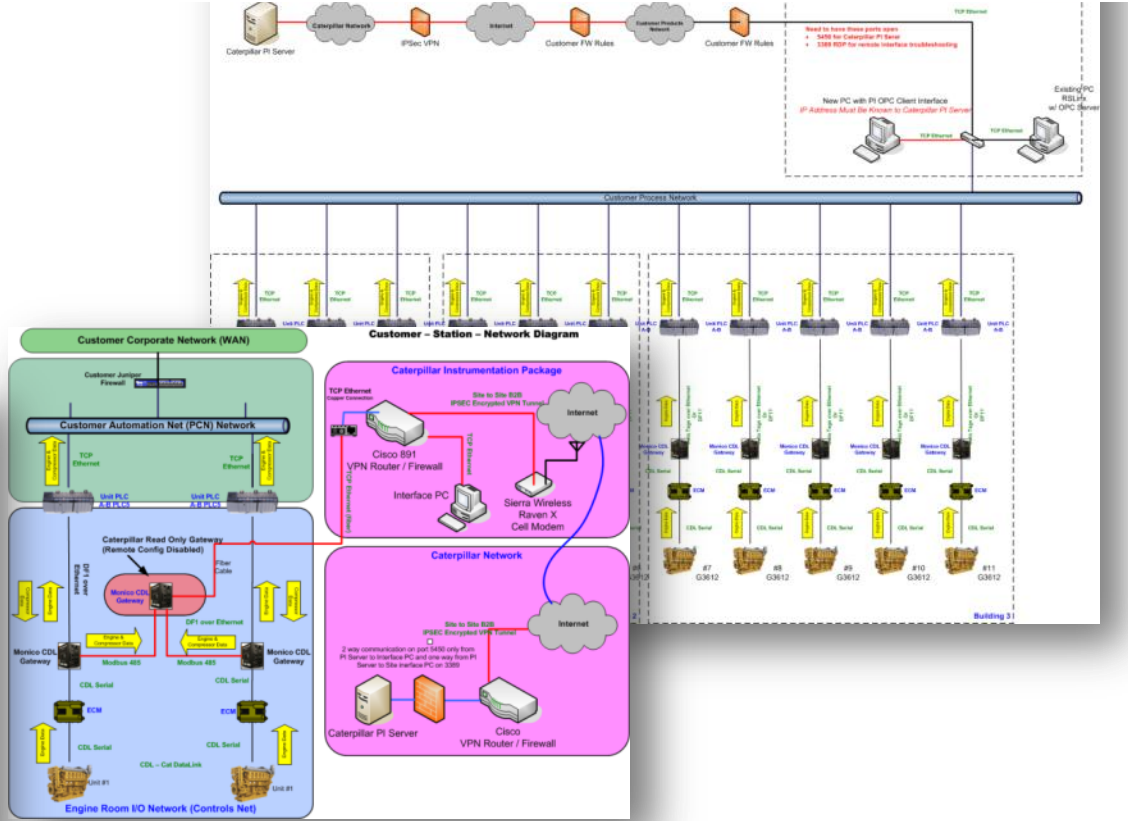
Key Processes

Transmitting Data

Connectivity Flexibility

- Cell
- DSL
- Customer Network
- PI-to-PI Interface
- Other Historian to PI System





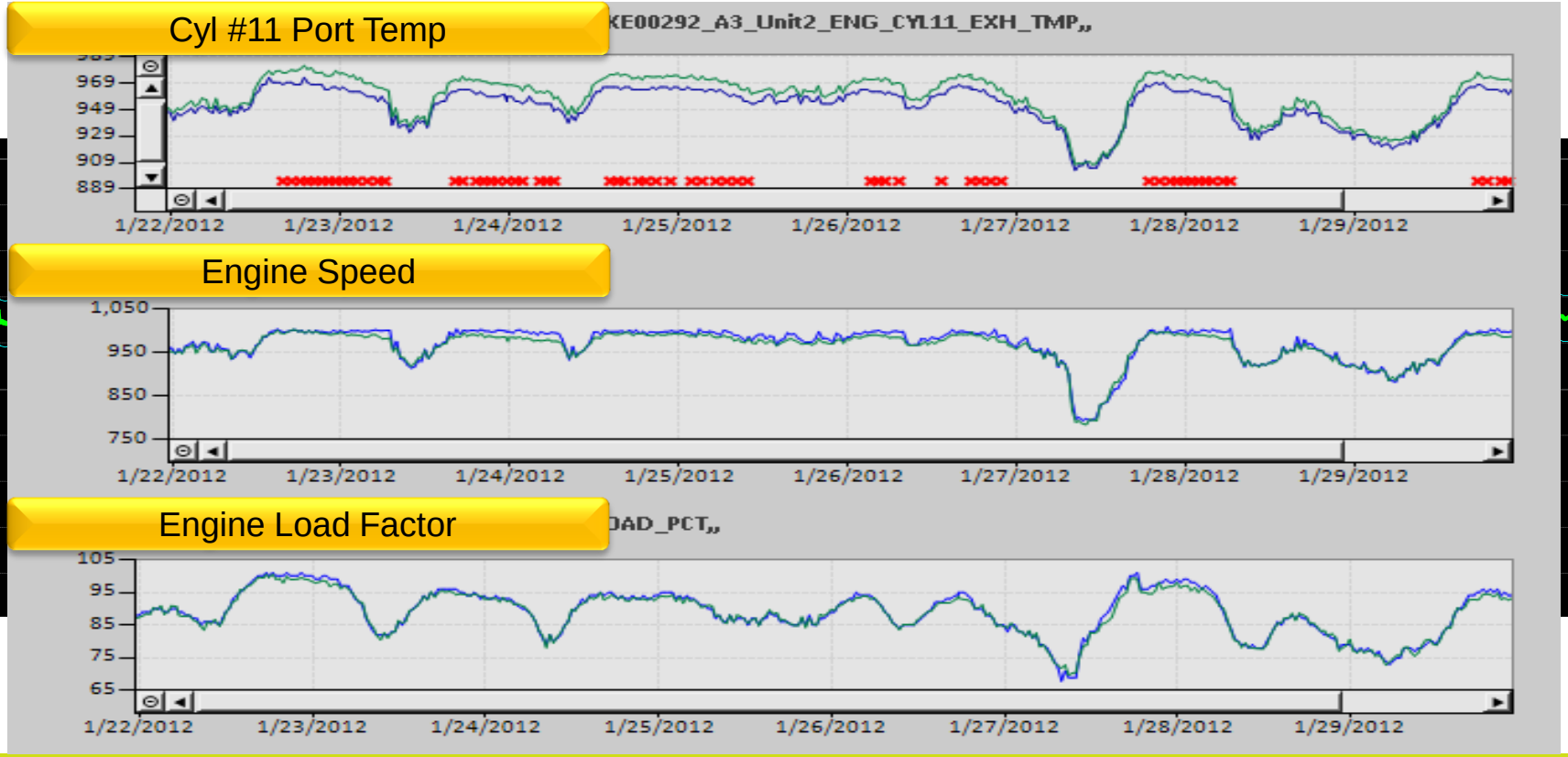
Key Processes

Key Processes

GE SmartSignal EpiCenter

- Non-parametric, multivariate data analysis

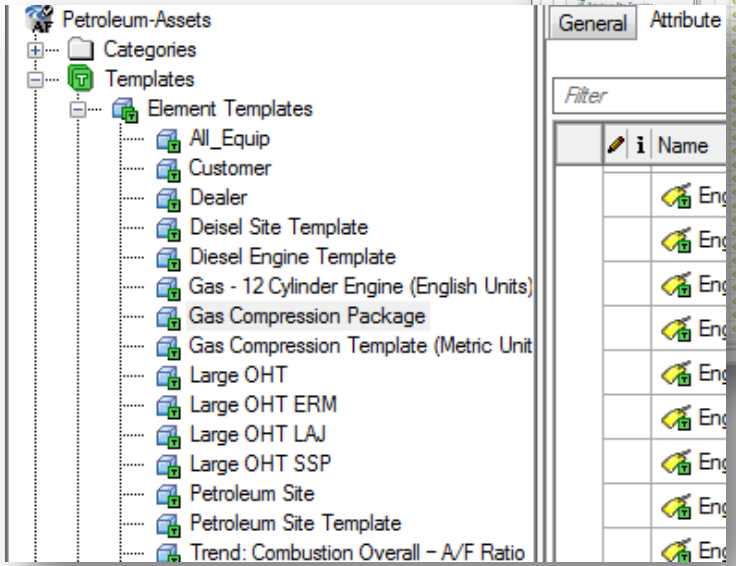
Dynamic Setpoint

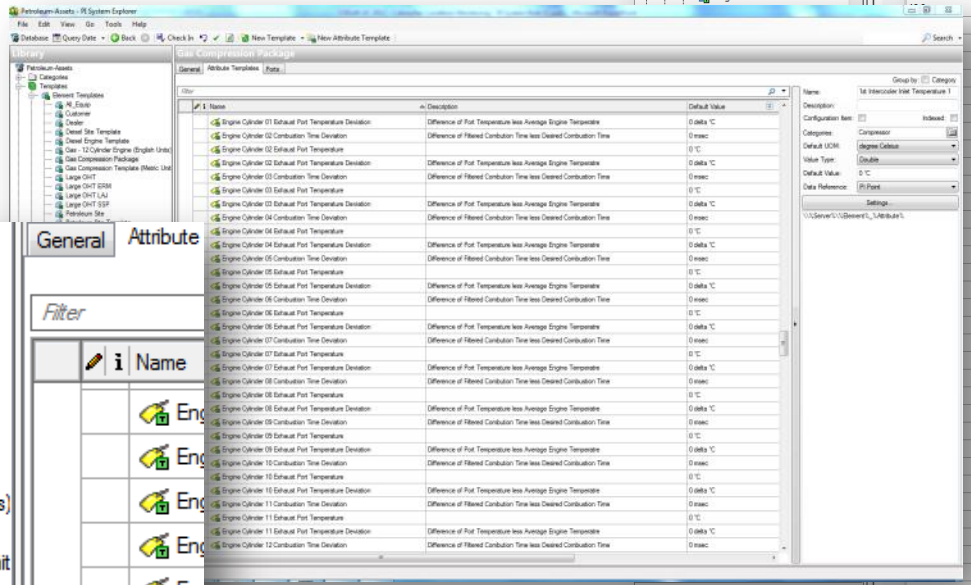


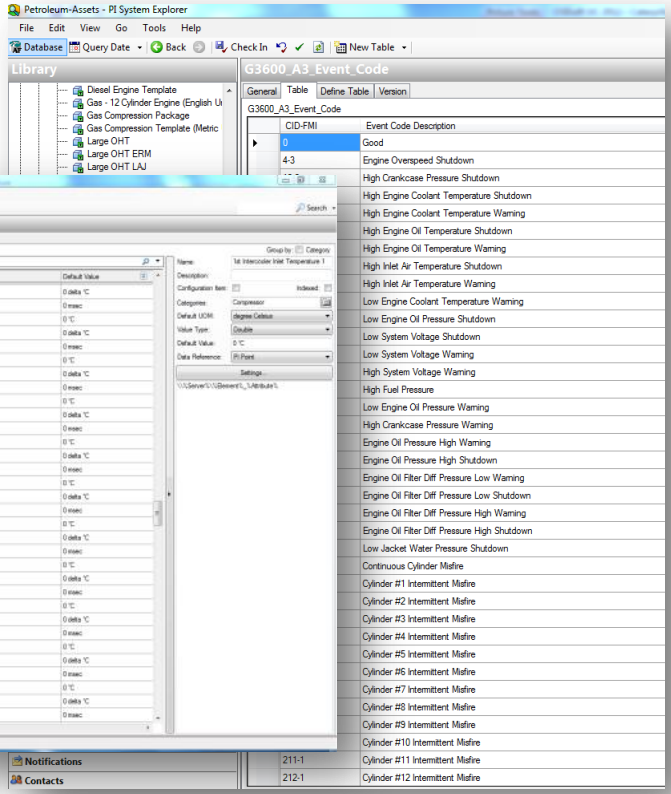
Key Processes

PI AF

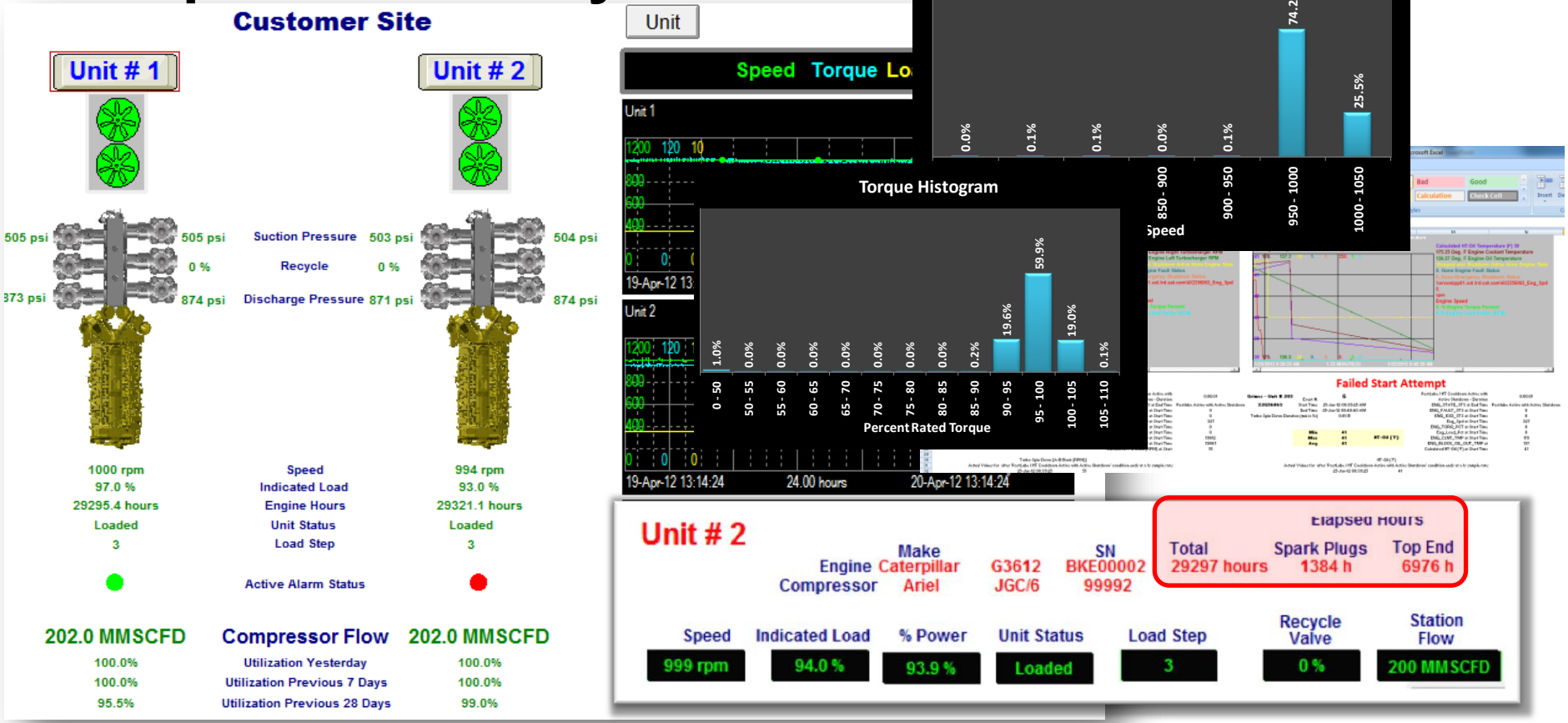
- Security
  - Network
  - Data
- Scalability



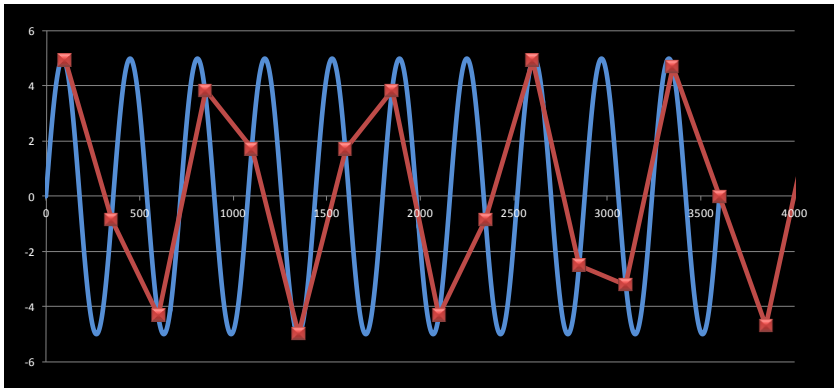


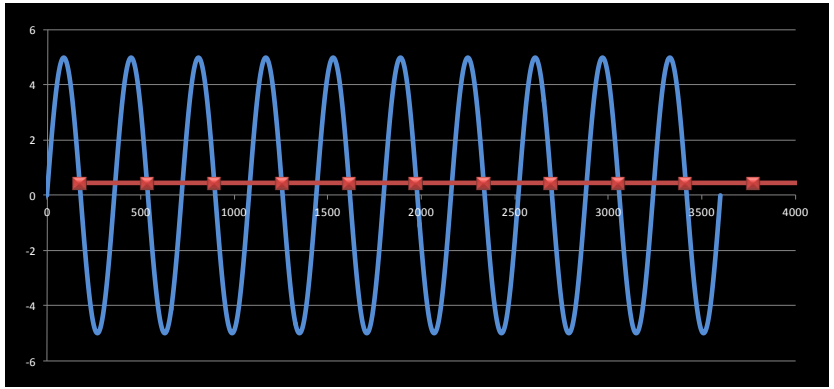


Component History & KPI's

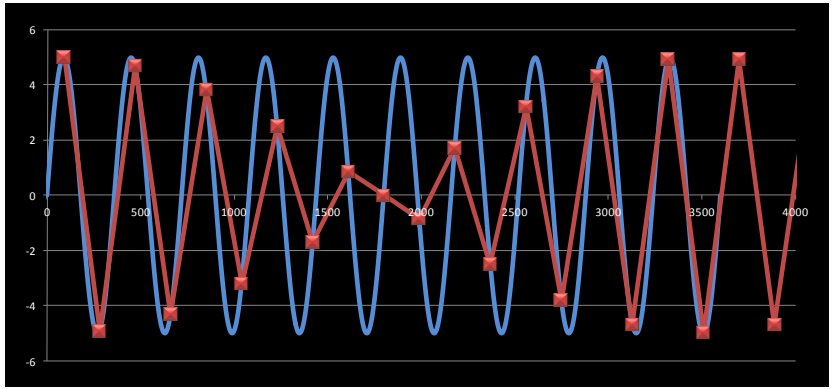


The Value of High Fidelity Data





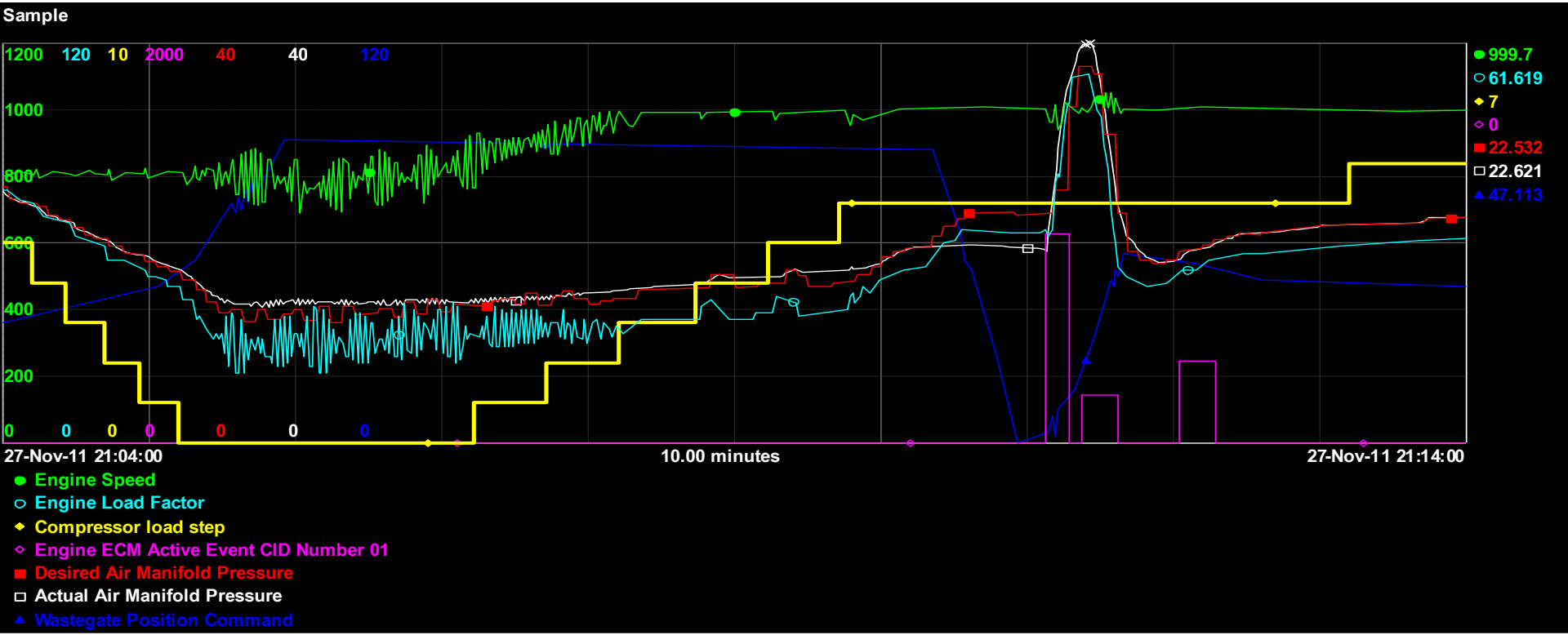
Are these trends from different processes?



Maybe

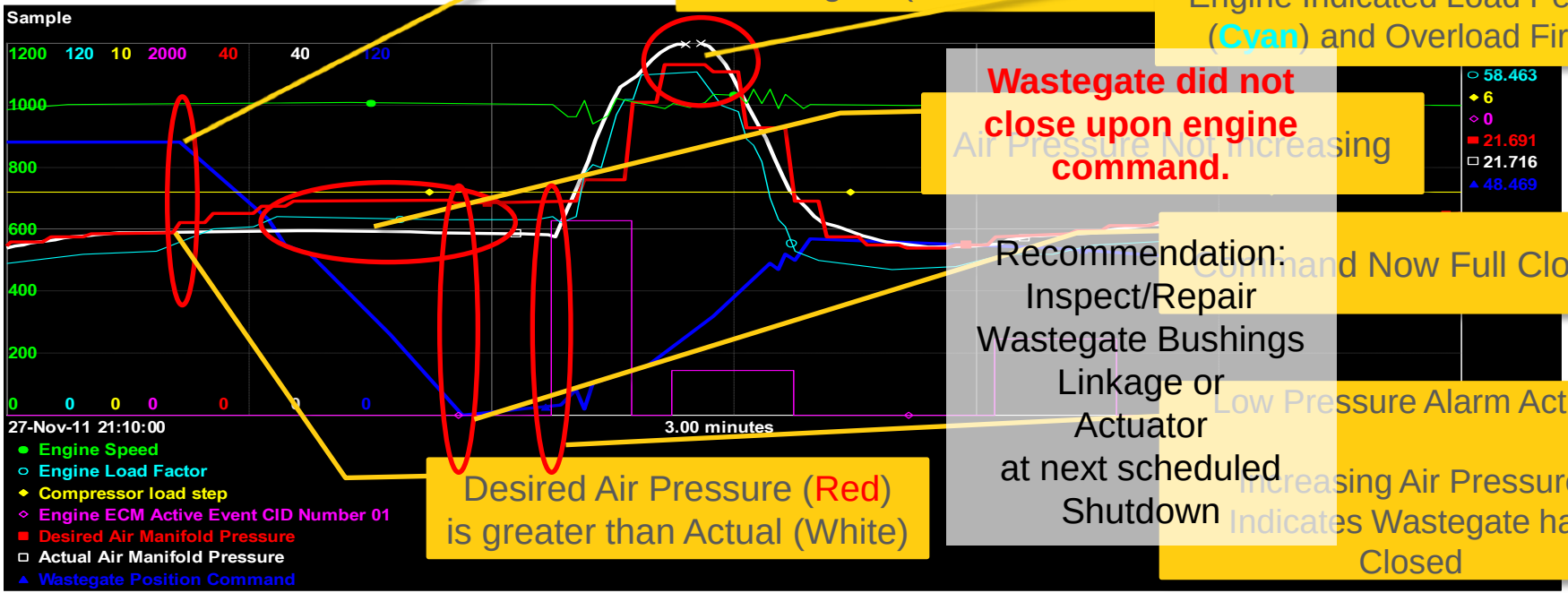
Maybe Not!

High Fidelity Data



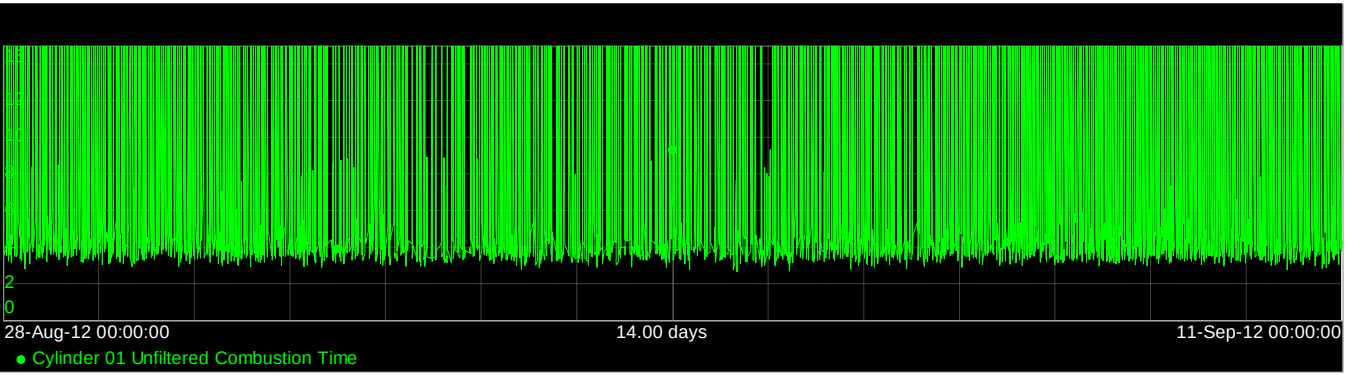
High Fidelity Data

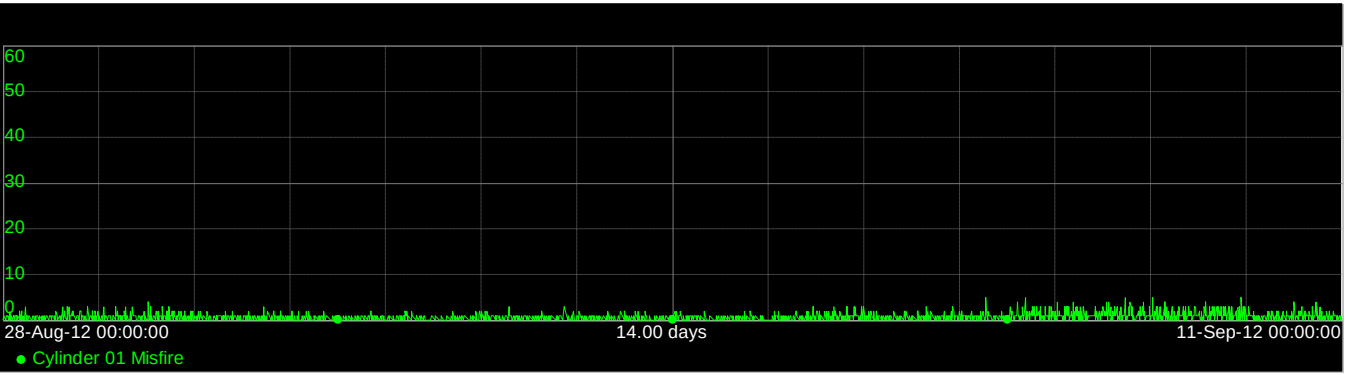
- **Event begins and ends in 3 minutes!**



Data Enhancement

Combustion Time vs. Misfire





- 12 Cylinder Engine
- 1 sec sample rate
- 1,036,800 points/day

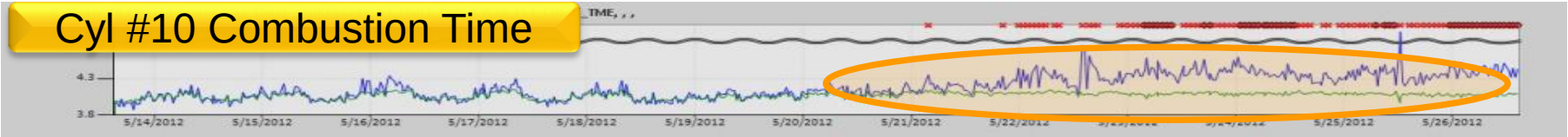
Combustion Time

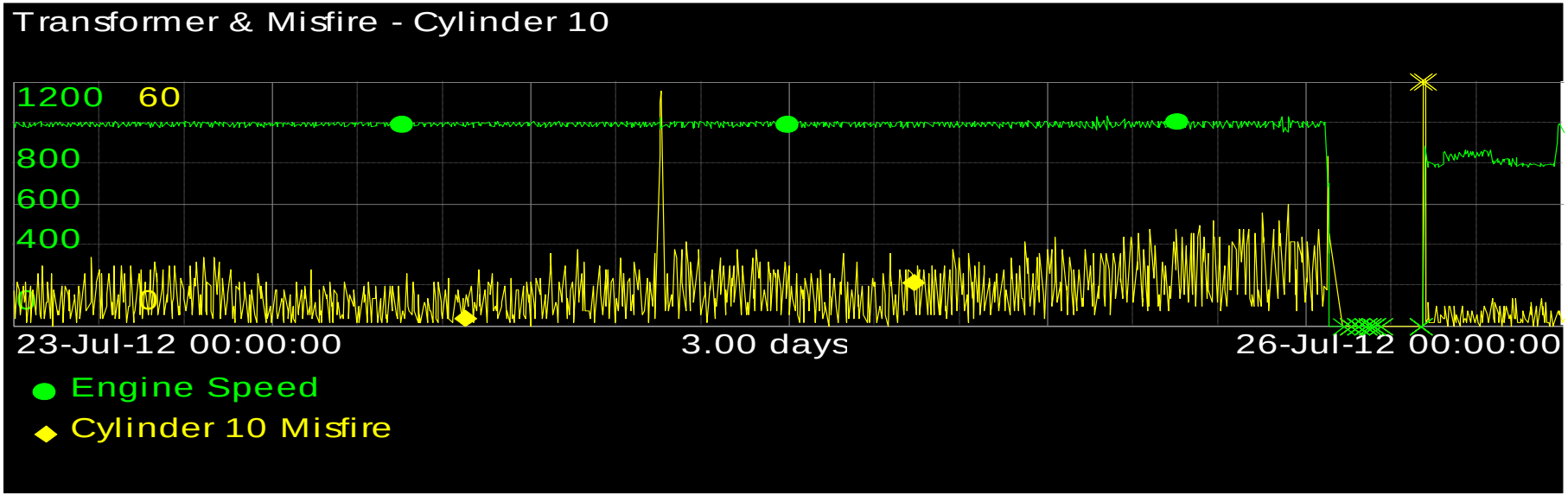
- Poor Visualization

Misfire Rate

- Insightful
- 12,000 points/day

Pre-Chamber Check Valve

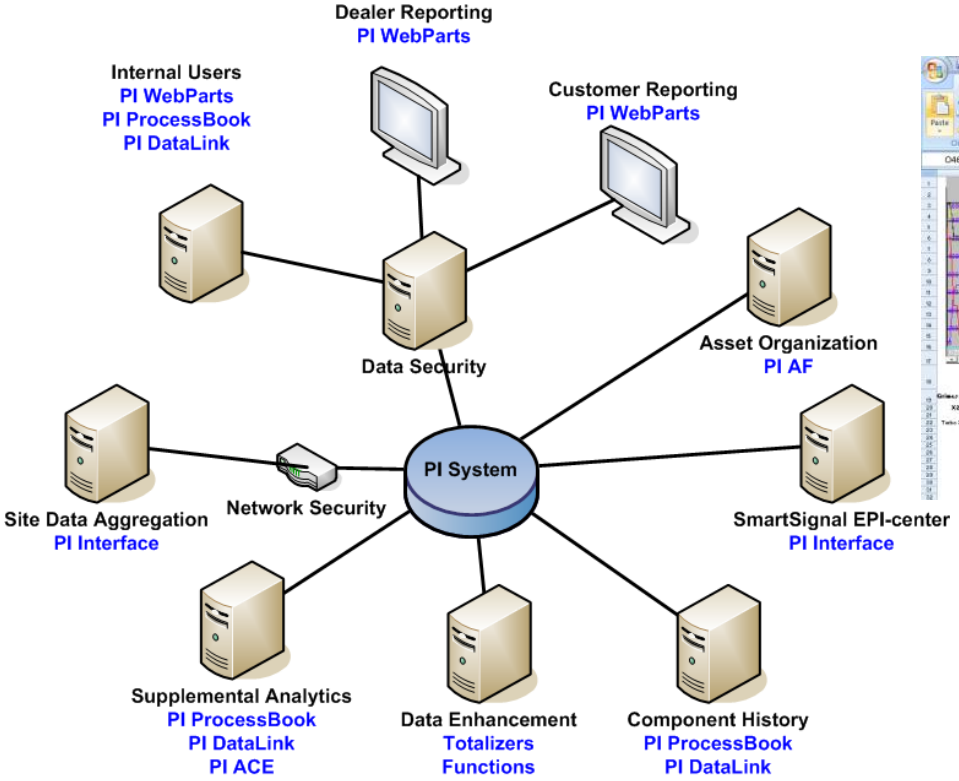


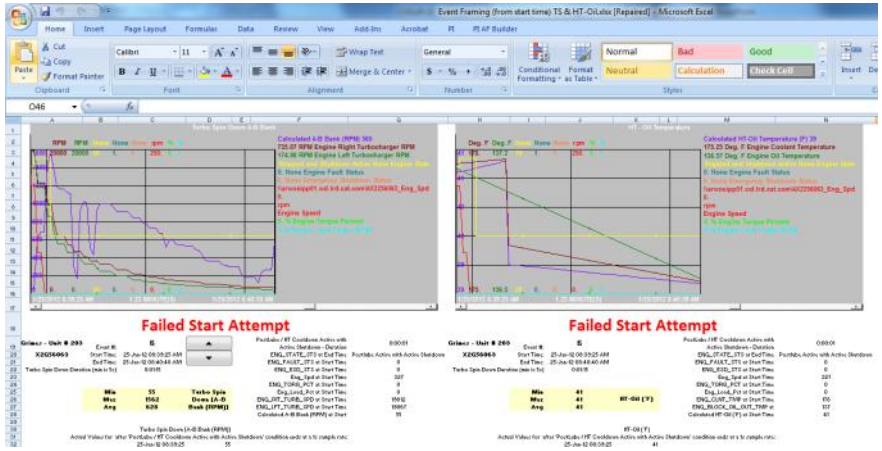


Benefits

- Case Study
  - 2 X G3612 Engine Driven Compressors
  - Pipeline Transmission
  - Manned 5 days / week – 8 hours day
  - 14 months of service
  - 99.5% Reliability
  - 488 Hours Meantime Between Outage
  - 2 Callouts in Past 6 Months

Current Implementation





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Further Reading

- “Utilizing Equipment Data for Proactive Asset Management”
- Atmos Energy & Caterpillar
- 2012 Gas Machinery Conference

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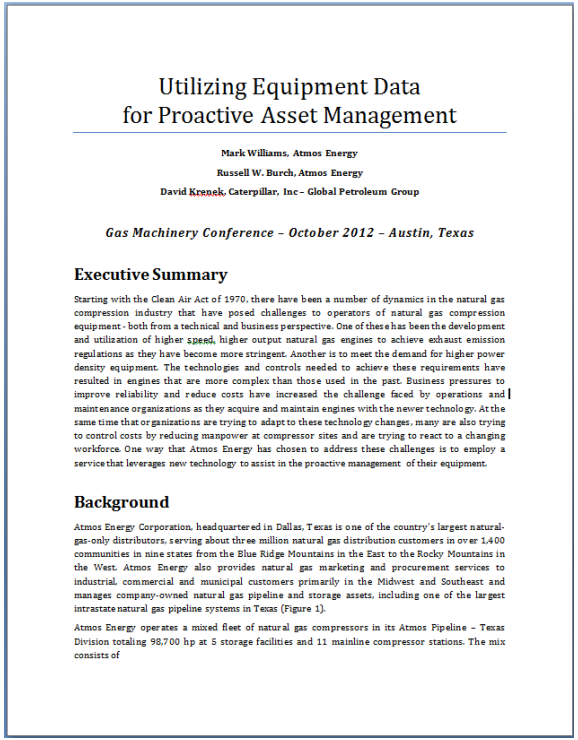


Utilizing Equipment Data
for Proactive Asset Management

Mark Williams, Atmos Energy
Russell W. Burch, Atmos Energy
David Krenek, Caterpillar, Inc – Global Petroleum Group

Gas Machinery Conference – October 2012 – Austin, Texas

Executive Summary

Starting with the Clean Air Act of 1970, there have been a number of dynamics in the natural gas compression industry that have posed challenges to operators of natural gas compression equipment - both from a technical and business perspective. One of these has been the development and utilization of higher speed, higher output natural gas engines to achieve exhaust emission regulations as they have become more stringent. Another is to meet the demand for higher power density equipment. The technologies and controls needed to achieve these requirements have resulted in engines that are more complex than those used in the past. Business pressures to improve reliability and reduce costs have increased the challenge faced by operations and maintenance organizations as they acquire and maintain engines with the newer technology. At the same time that organizations are trying to adapt to these technology changes, many are also trying to control costs by reducing manpower at compressor sites and are trying to react to a changing workforce. One way that Atmos Energy has chosen to address these challenges is to employ a service that leverages new technology to assist in the proactive management of their equipment.

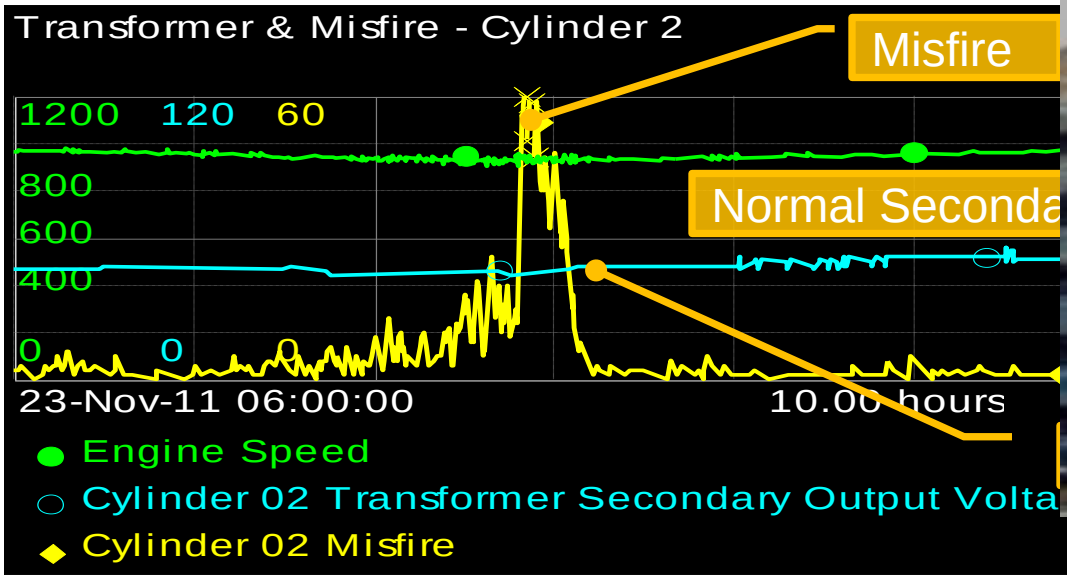
Background

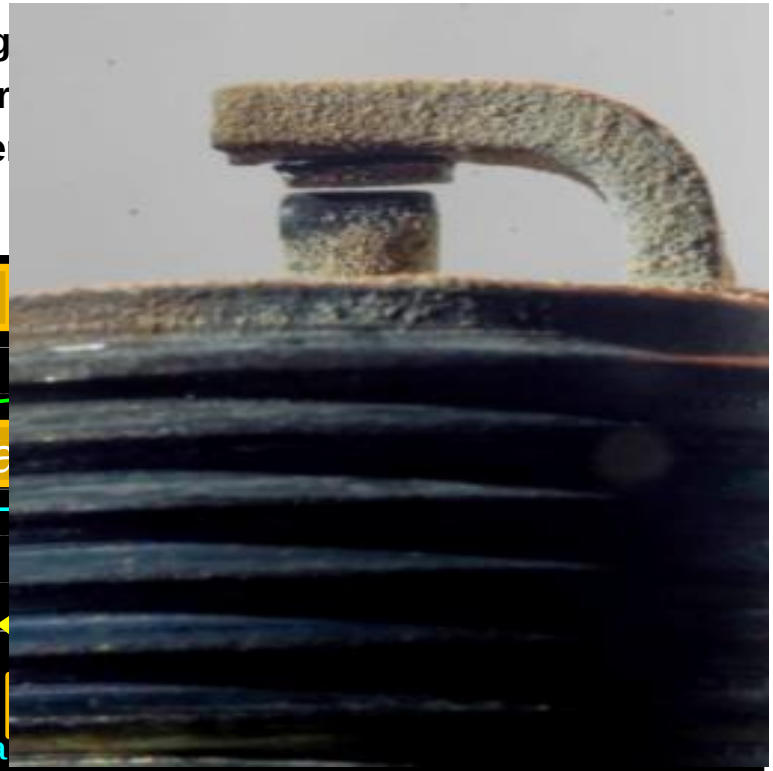
Atmos Energy Corporation, headquartered in Dallas, Texas is one of the country's largest natural-gas-only distributors, serving about three million natural gas distribution customers in over 1,400 communities in nine states from the Blue Ridge Mountains in the East to the Rocky Mountains in the West. Atmos Energy also provides natural gas marketing and procurement services to industrial, commercial and municipal customers primarily in the Midwest and Southeast and manages company-owned natural gas pipeline and storage assets, including one of the largest intrastate natural gas pipeline systems in Texas (Figure 1).

Atmos Energy operates a mixed fleet of natural gas compressors in its Atmos Pipeline – Texas Division totaling 98,700 hp at 5 storage facilities and 11 mainline compressor stations. The mix consists of

Spark Plug Failure

- Analytics alerted that Secondary Transformer Voltag
- Drill down into data identified short periods of misfir
- To reduce risk of callout during 4-day weekend, Ope
  of day before weekend





Engine Lube Oil Filter

Station – 292	ABKE00292 (Engine)	Sensor	Condition	MED	New Item
		Engine Oil Filter DP	*High*		

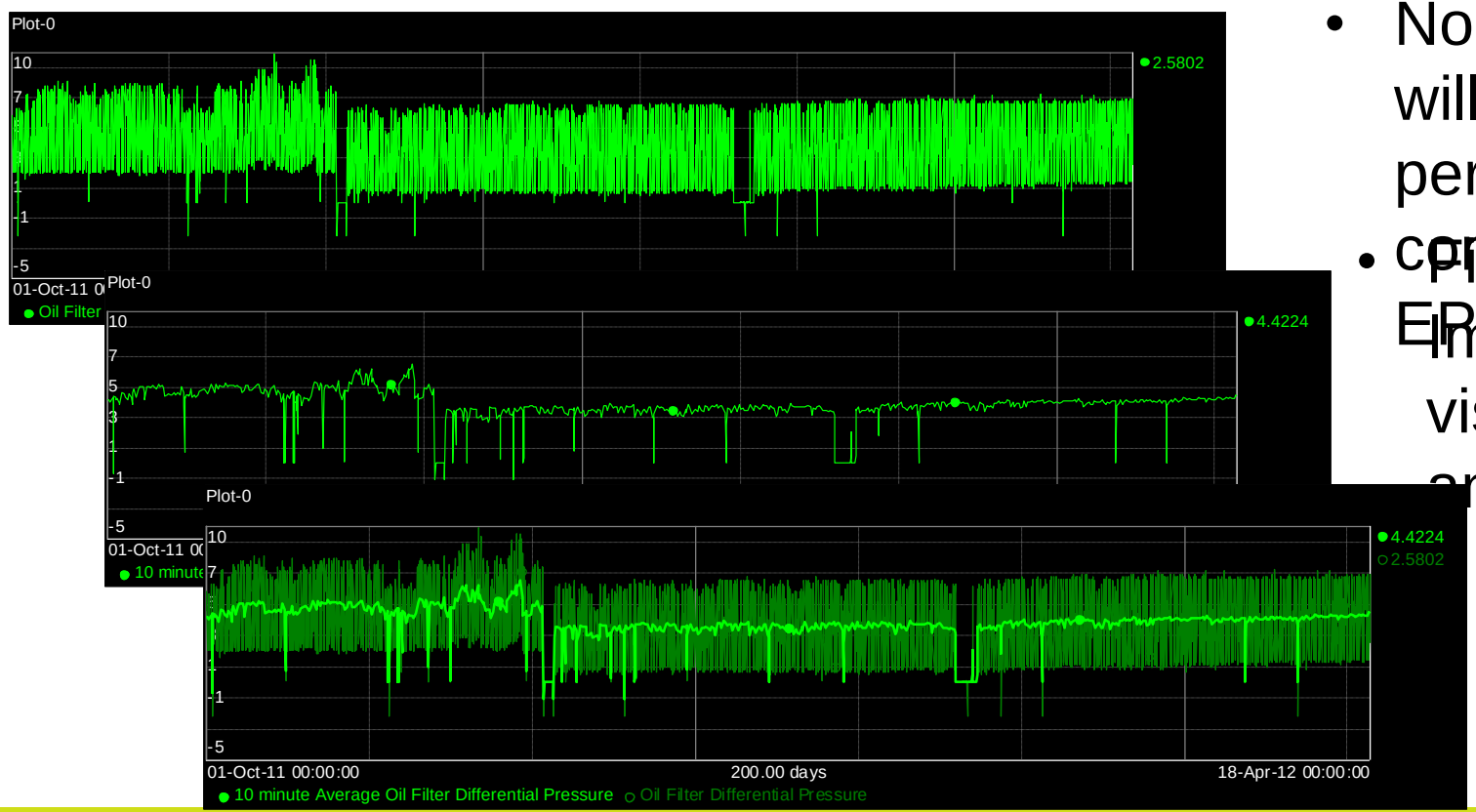
Oil Filte

Oil Pr

Oil Temp

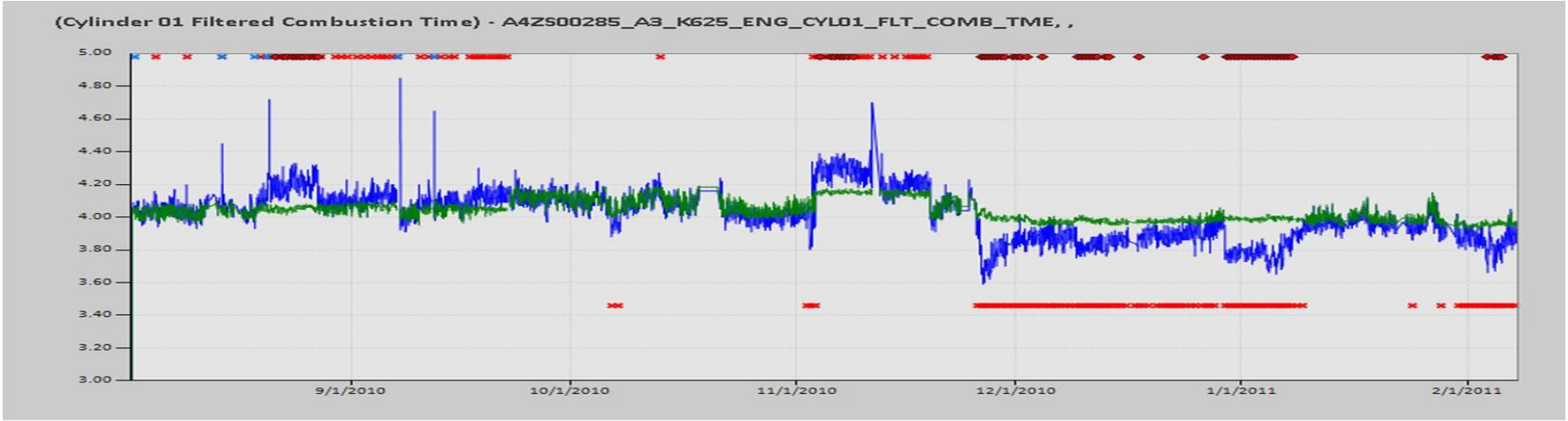
Oil-Coolant ΔT

Data Enhancement



- Noisy Signal will delay persistence condition for EPI center
- Filtered Signal improves visualization and analysis

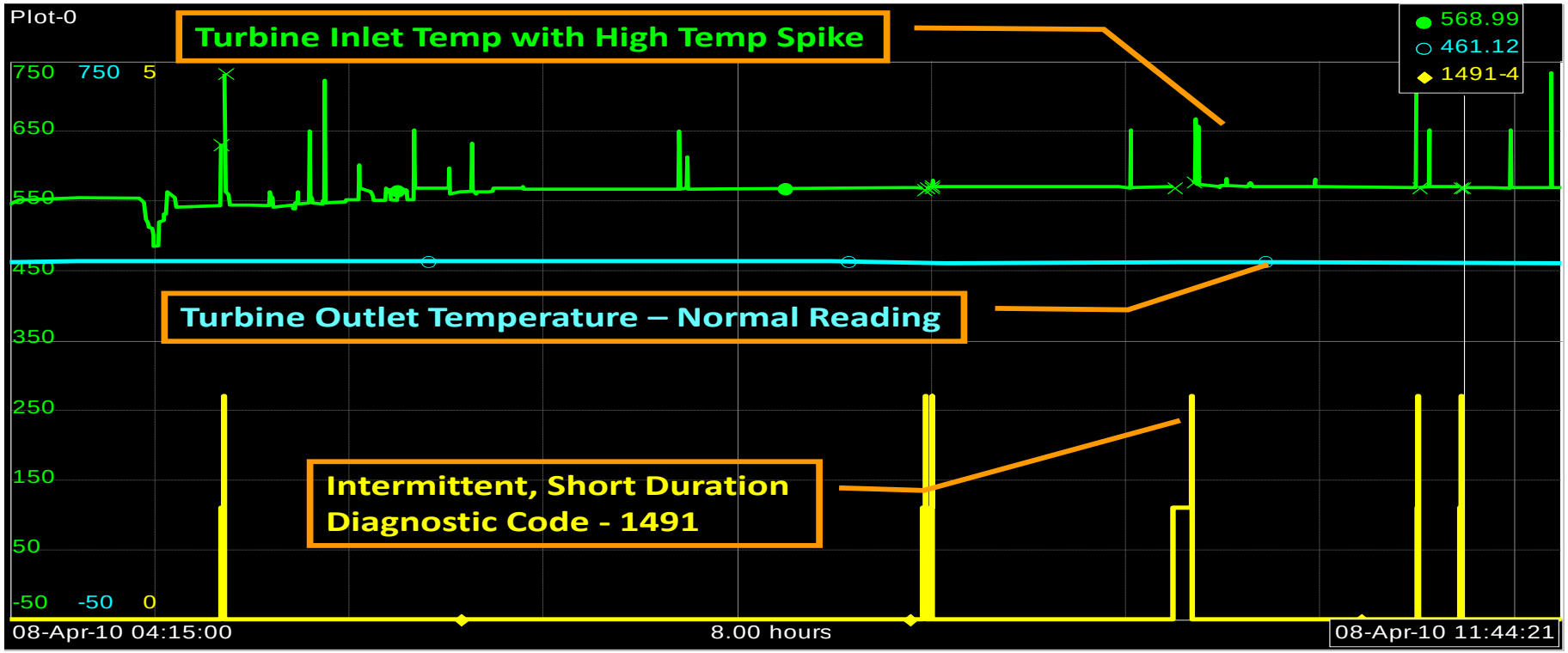
Pre-Chamber Port Erosion



6 months

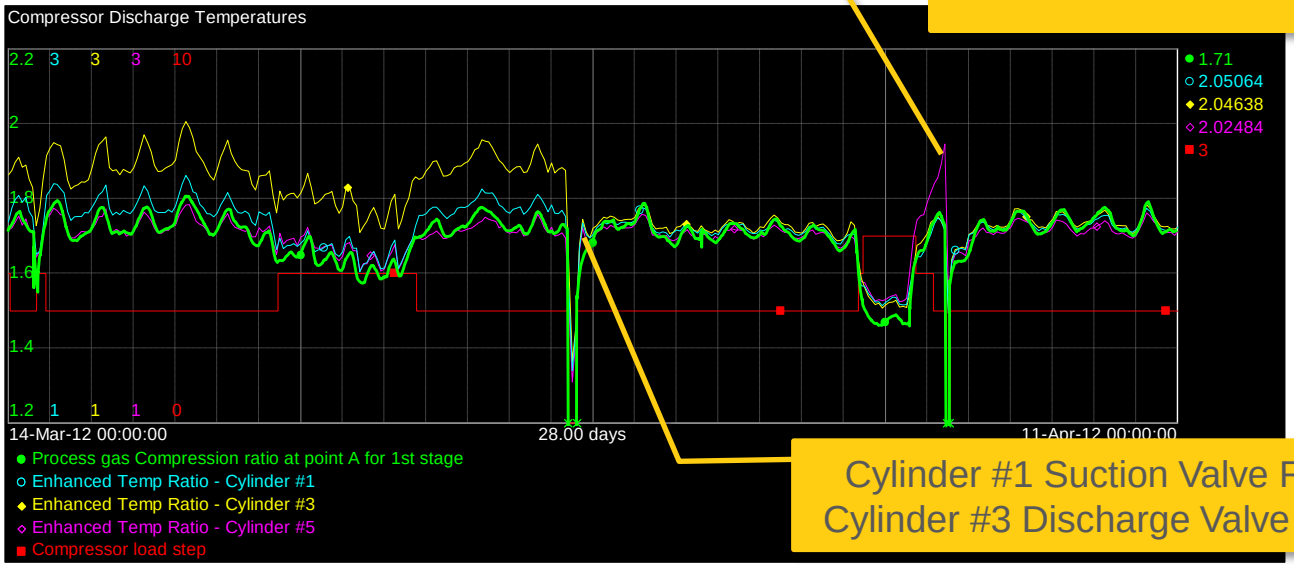
Blue is measured
Green is estimated

Sensor Failure



Signal Processing

- Temperature ratio is a function of Pressure Ratio
- Using Temperature Ratio Function Reduces Model Maintenance and Improves Visualization.



Cylinder #5 DischargeValve Repaired

Cylinder #1 Suction Valve Repaired
Cylinder #3 Discharge Valve Repaired