OCTOBER 25, 2023

A Journey Towards Compression Advanced Asset Performance Management

Talk 1: SoCalGas - A Journey Towards Compressor Predictive Analytics

Talk 2: Process Innovations: Modern AVEVA PI System Implementation with Process Innovations

Nawar Fattah, P.Eng. – Senior Rotating Equipment Engineer, SoCalGas

Joseph Rose – Project Manager, SoCalGas

Caleb Sargent – VP Operations, Process Innovations

A JOURNEY TOWARDS COMPRESSOR PREDICTIVE ANALYTICS

AVEVA WORLD 2023

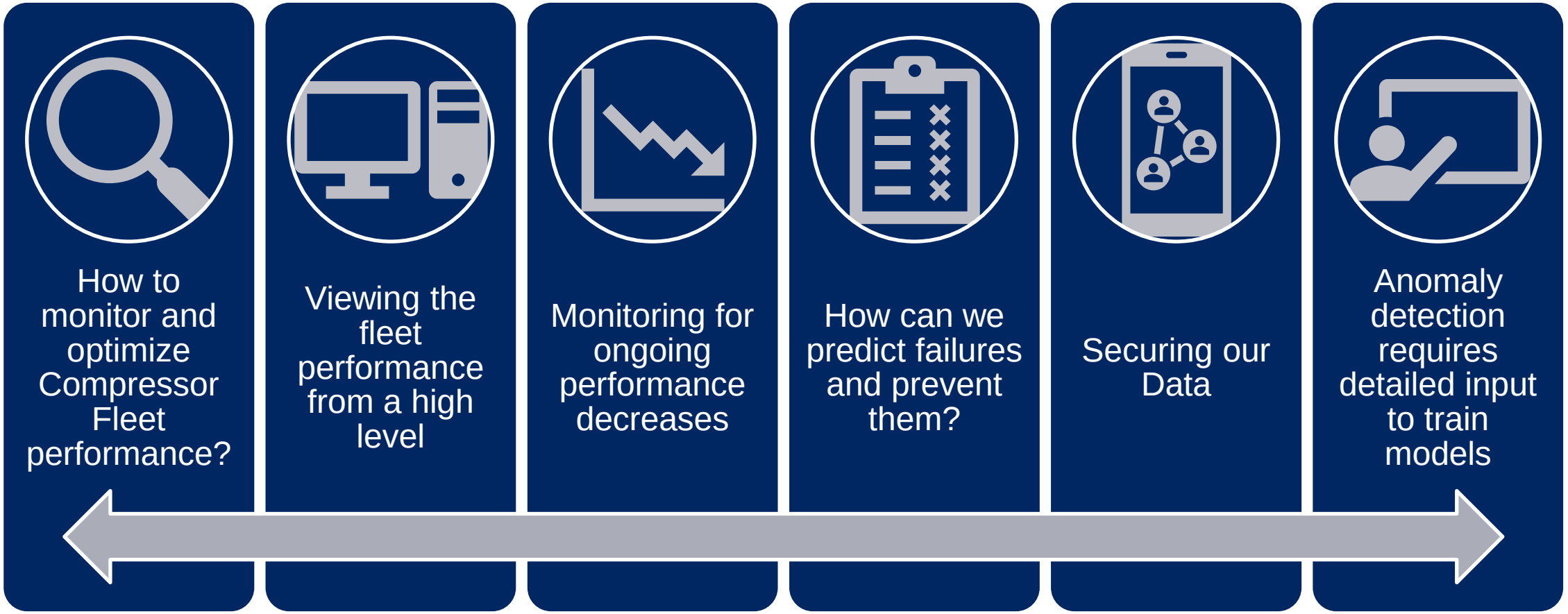
Nawar Fattah
Joseph Rose

SoCalGas™

Agenda

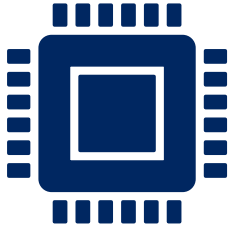
- Challenges
- Solution
- Implementation
- Results
- Lessons Learned
- Next Steps

Challenges


How to monitor and optimize Compressor Fleet performance?
Viewing the fleet performance from a high level
Monitoring for ongoing performance decreases
How can we predict failures and prevent them?
Securing our Data
Anomaly detection requires detailed input to train models

The Solution

A compressor performance dashboard that integrates data from multiple sources and provides real-time insights and alerts



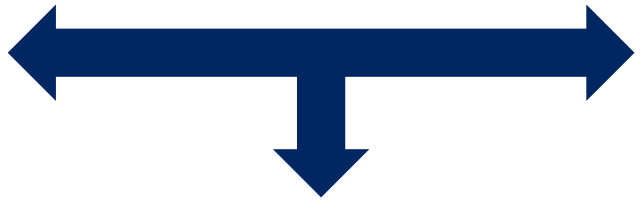
A customizable PI System platform that uses PI AF template plug-ins and detailed compressor maps to analyze and visualize data

Service providers that offers expertise and support for dashboard implementation and maintenance

Implementation

Process Innovations
ProcessPlugins™

- Data Quality: Checks the validity and accuracy of data
- Compressor Map: Plots the operating point of a compressor on a map based on its specifications
- Efficiency: Calculates the efficiency of a compressor based on its operating conditions
- Load Step: Measures the load step response of a compressor



Compressor Fleet Dashboard (PI Vision)

ACI SERVICES
THE COMPRESSOR EXPERTS

- Leading provider of compressor performance software and services
- Extensive knowledge and experience in creating and validating compressor maps
- Custom compressor maps to suit different types of compressors and applications

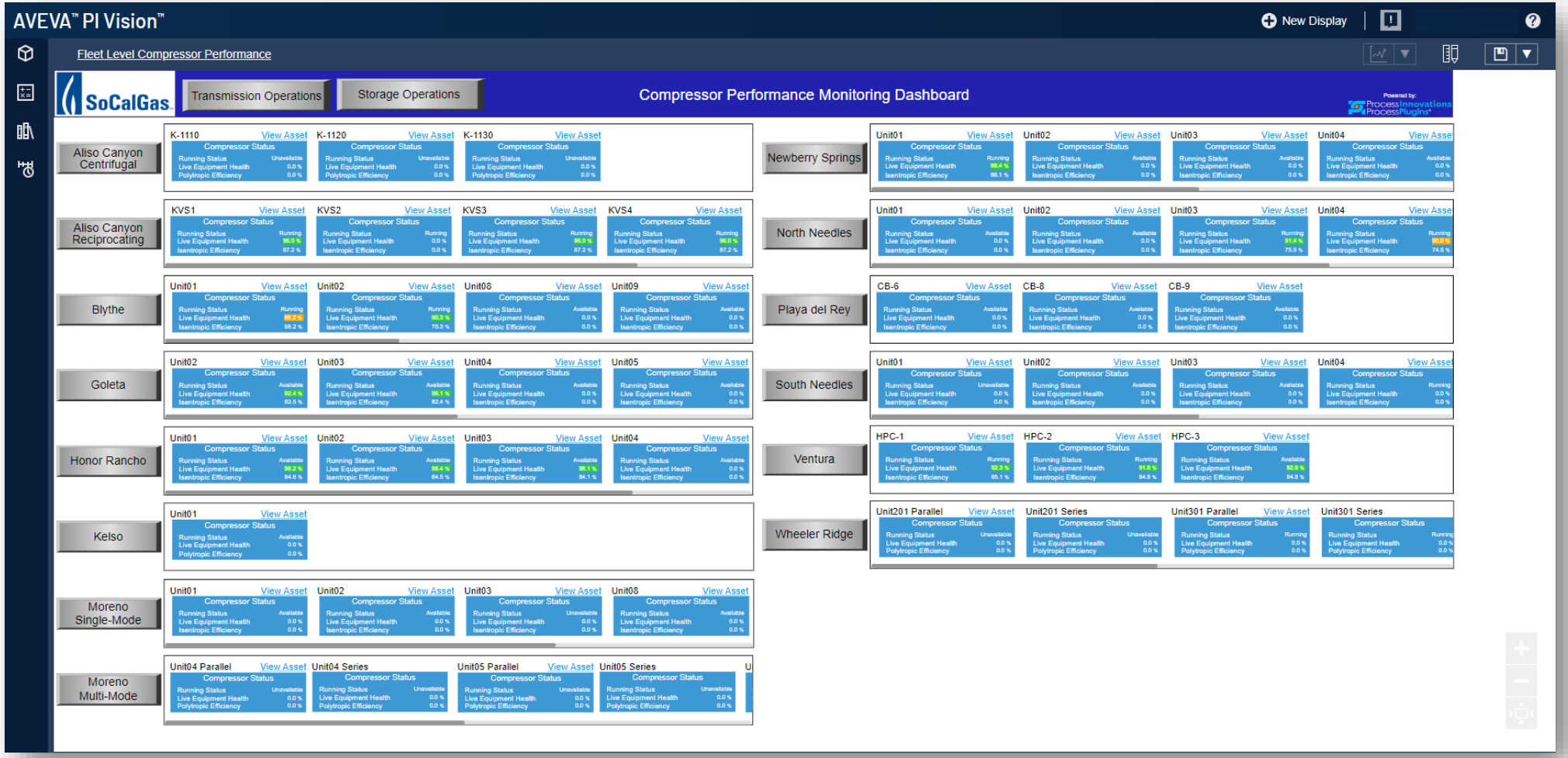
SoCalGas™

- Compressor Services: Gather compressor maps/curves, verify and ensure data points and accuracy, & categorize failure types and causes.
- Integrity Management: Gather KPI's and propose projects for increased efficiency, reduced emissions, & report potential failure conditions.
- Subject matter experts in rotating & reciprocating machinery evaluate equipment performance and optimization

AVEVA

- AVEVA PI System
- AVEVA PI Vision
- AVEVA PI AF
- AVEVA PI Event Frames

Dashboard



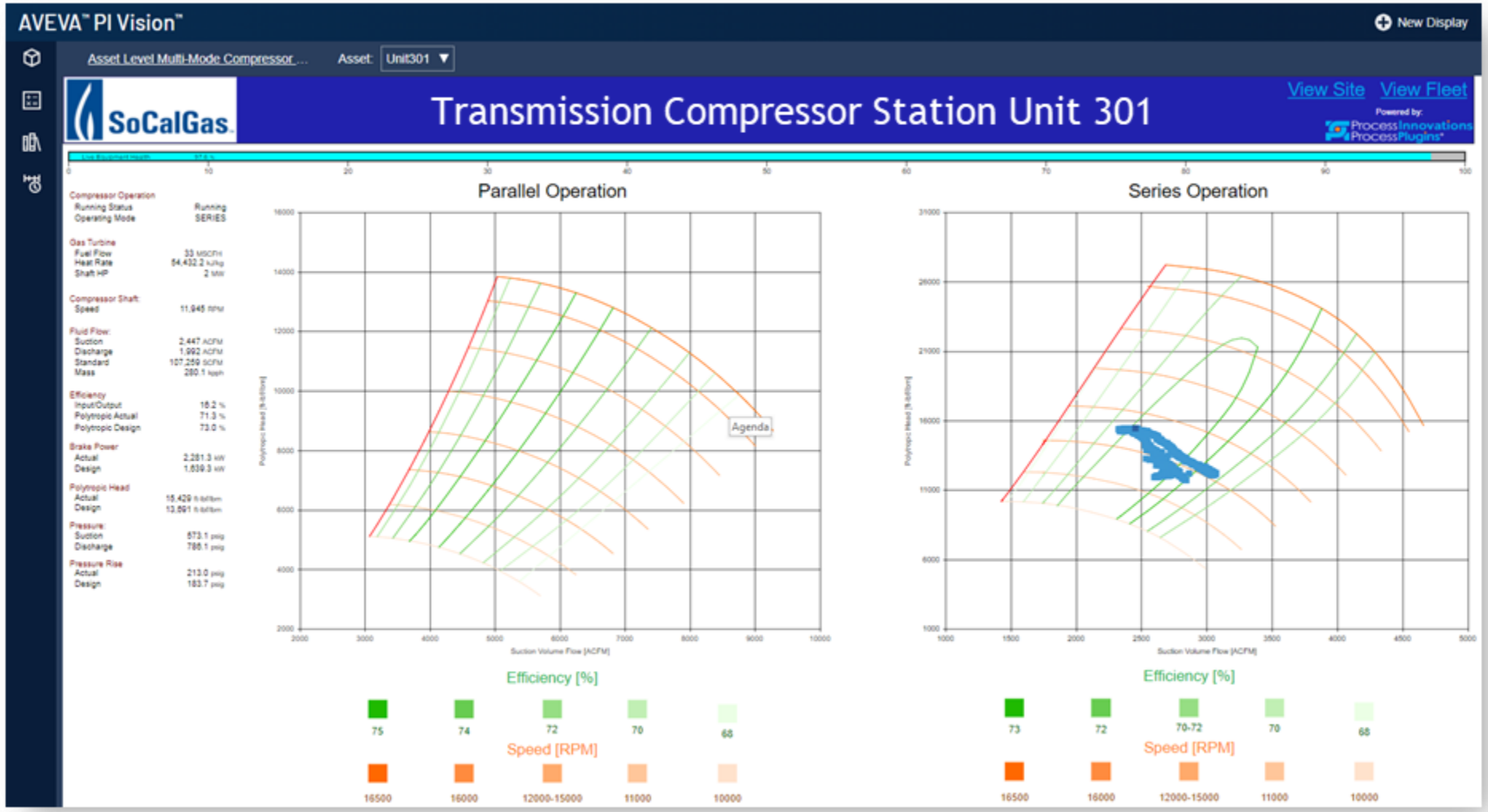
» High Level Metrics:

- Operating Status
- Series/Parallel Flow
- KPI's:
  - Isentropic & Polytropic efficiency
  - Availability
  - Health Score

Site-level

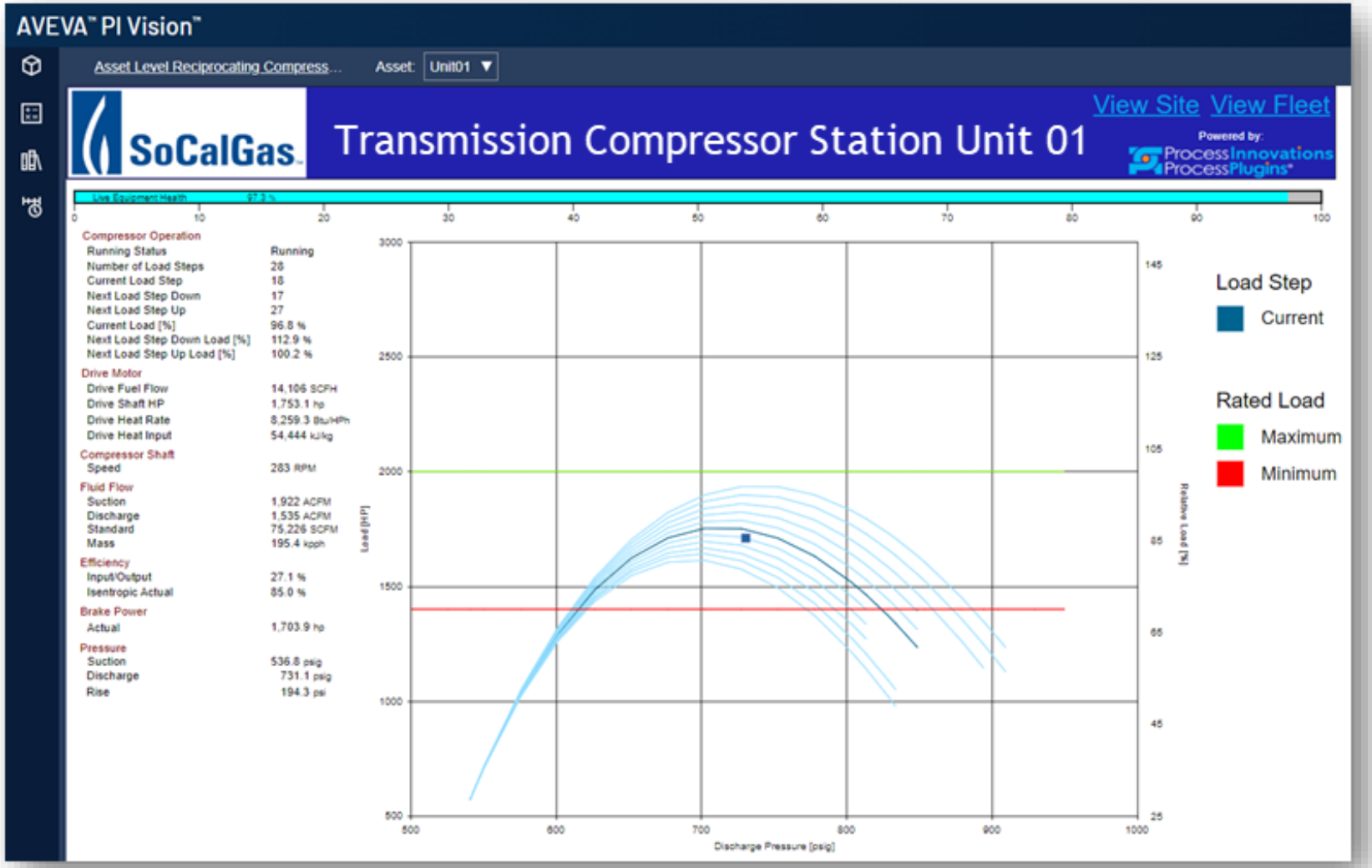
Facility visibility with detailed driver and compressor information

Asset-level (Centrifugal)



- Detailed Metrics:
  - Detailed Metrics and analysis for a Centrifugal compressor with two operation modes.
- Key features include:
  - Displaying the current operating point of the compressor on its map
  - Historical trend of the compressor's efficiency temperature, pressure.
  - Indications of Surging or Choking of Turbines

Asset-level (Reciprocating)

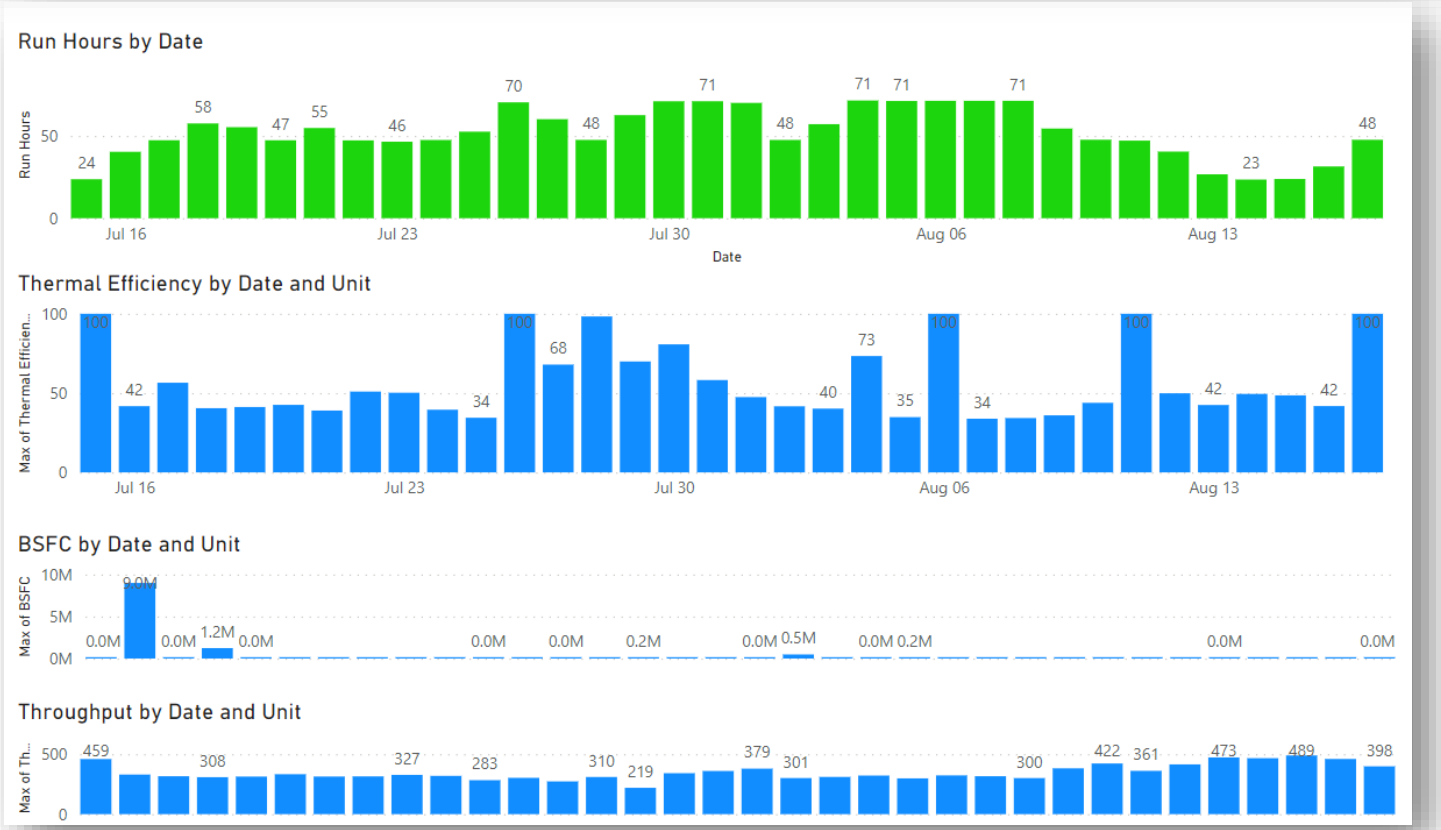


- Detailed Metrics:
  - Detailed Metrics and analysis for a reciprocating compressor
- Key features include:
  - Load Step analysis
  - Pressure Differential
  - Loading Efficiency
  - Indication if data is within Range of ACI Services Model limits

Results – Data Reporting

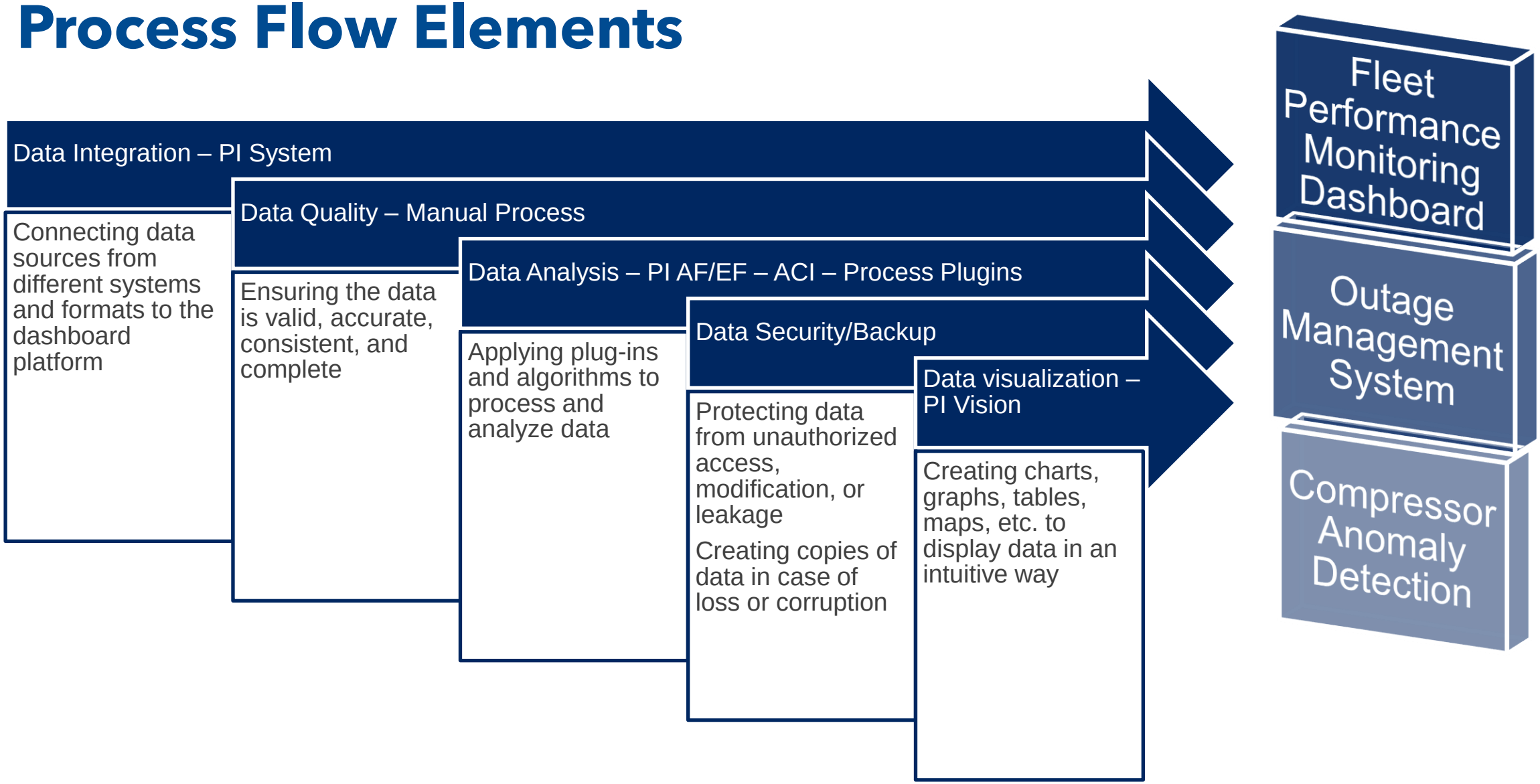
- KPI's
  - Performance
  - Runtime
  - Reliability
  - Cost Based
- Reporting
  - Monthly/Quarterly
    - Detailed Report
    - High Level Report
- PowerBI
  - Daily updated for visualization of Trends.

Peformance Based KPI's						Runtime Based KPI's		Reliability	Cost Based KPI's	
Average Load Factor (%)	Throughput (MMSCF)	Average Brake-Specific Fuel Consumption (Btu/HPh)	Average Brake-Specific Throughput (MMSCF/HP)	Fuel Consumption (MSCF)	Average Compressor Health Score (%)	Average Compressor Utilization (%)	Average Compressor Availability (%)	Number of Starts	Fuel Cost ($)	Cost per HP-Hour ($/HPh)



Glad to be of service.®

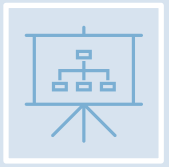
Process Flow Elements



Lessons Learned

One centralized PI data system is preferable to multiple disparate data sources

* Simplifies data integration, quality, and security.
* Helps ensure data consistency & completeness.



Detailed history of all compressor failures, causes and solutions is essential for failure prediction and prevention

* Failure history provides valuable data for training machine learning models.
* Helps users understand the root causes and effects of failures and how to avoid them.

Less unique types of compressors

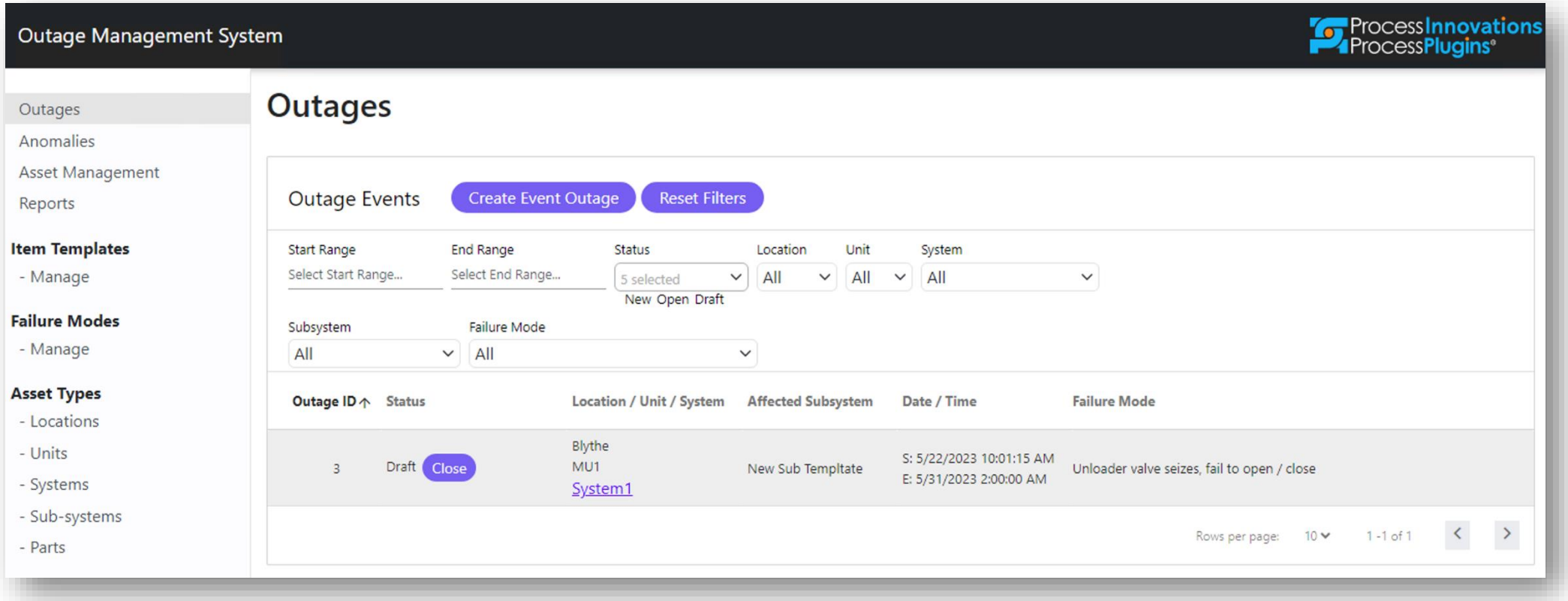
* Makes implementation much quicker and easier
* Reduce the complexity and diversity of data analysis and visualization
* Increase the accuracy and reliability of data models and results

Next Steps

Utilize PI Information to build an Outage Management System to track compressor issues and tie them to anomaly detection.

Developing Compressor Specific Predictive Analytics

Outage Management System



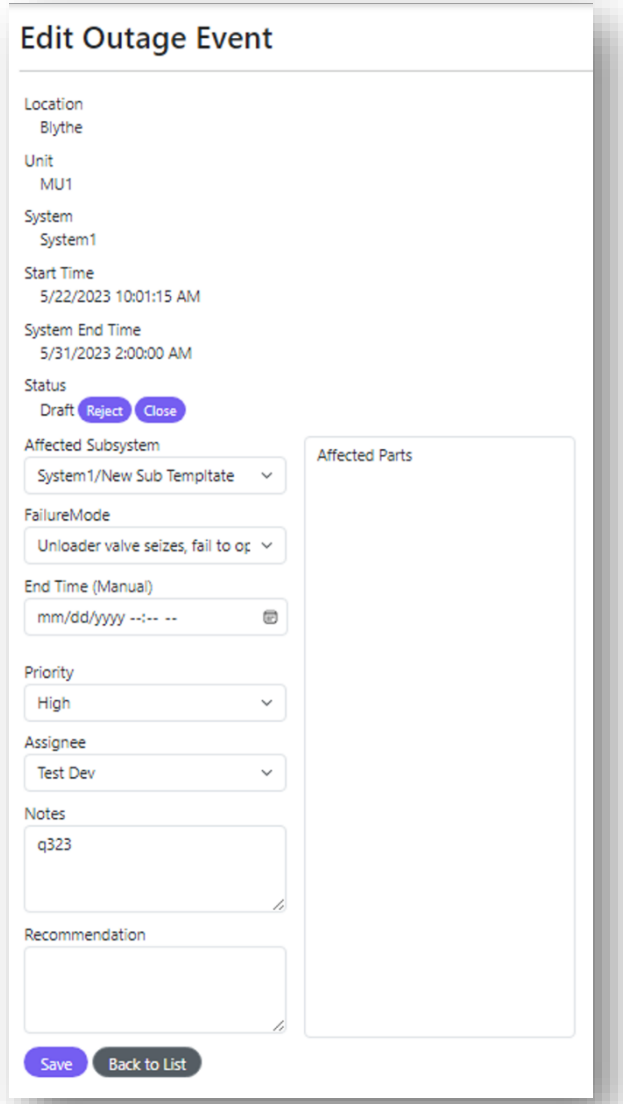
- Outages automatically generated based on Event Frames.
- Ability to create events manually if Event Frame not generated.
- Template database allows quick repeatability of assets.
- This enables advanced learning by building a successful data repository for Compressor Failures

Outage Management System (cont.)

Failure Modes

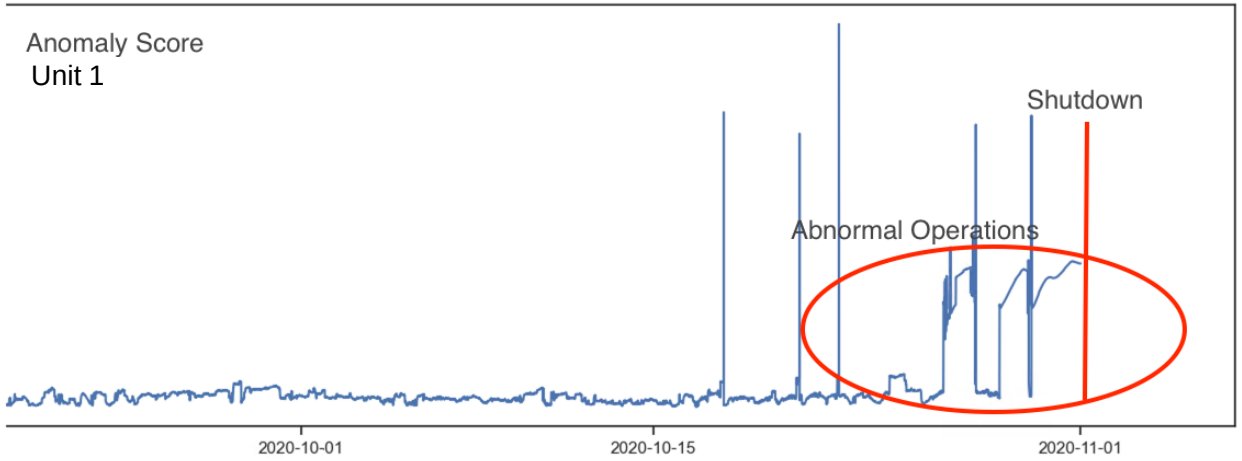
Create New

ID	Description	Effects
2	Unloader valve seizes, fail to open / close	Unable to vary compressor output capacity
3	Rider bands wear out	Excessive leakage from piston and cylinder wall, can break the piston rod, overheating, leak gas vented out Leads to compressor shutdown
4	Rod packings worn	Excessive leakage from packer, overheating, leak gas vented out Leads to compressor shutdown



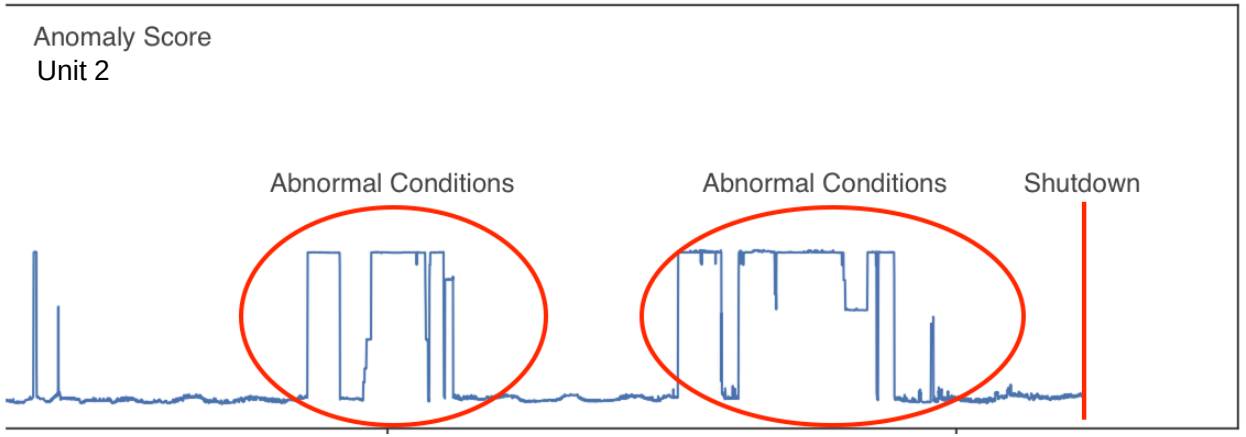
- Failure Mode database based on industry known failures.
- Ability to edit Outage events to failure modes and affected systems. This enables the ability for Machine Learning of failures based on types of failure.
- The Outage Management System formalizes the equipment failure database that maintains history, file attachments, and information including notes and recommendations.

Compressor Predictive Analytics



- After two weeks of consistent operations, anomalies start to show up.
- Anti-rotation pin severed and sent main bearing rotating with shaft.

- Abnormal conditions start due to lowering of compression
- Loss of compression due to piston rod - complete break from crosshead.



OCTOBER 25, 2023

Modern AVEVA™ PI System™ Implementation with Process Innovations

The Process Plugins Solutions

Presented By: Caleb Sargent

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Behind the Project

- About Process Innovations and ACI Services
- Review Process Plugins Data Processing
  - ACI eRCM Model Integration
  - Asset Framework Templates
  - Analyses
  - Notifications
  - Event Frames

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Process Innovations and ACI Services

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Process Innovations
ProcessPlugins™

Leading provider of software and consulting for advanced data analytics, visualization, and integration for the AVEVA PI System.

- Focus to maximize the performance of assets through providing cost effective, APM integrated solutions to Oil and Gas, and Power Generation companies.

AVEVA CERTIFIED OPERATIONS System Integrator

Certified Operations System Integrator supporting over 100 companies as their PI System trusted advisor.

The leader in the reciprocating compressors industry for providing engineered solutions and developing advanced, compressor performance models.

- ACI's eRCM is the backbone of many commercial and OEM software packages.
- eRCM is integrated into edge computing devices, PLCs, hydraulic pipeline simulation software, real-time monitoring systems, and Big Data Analytical systems.

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AVEVA

Process Plugins PI System/PI AF Accelerators

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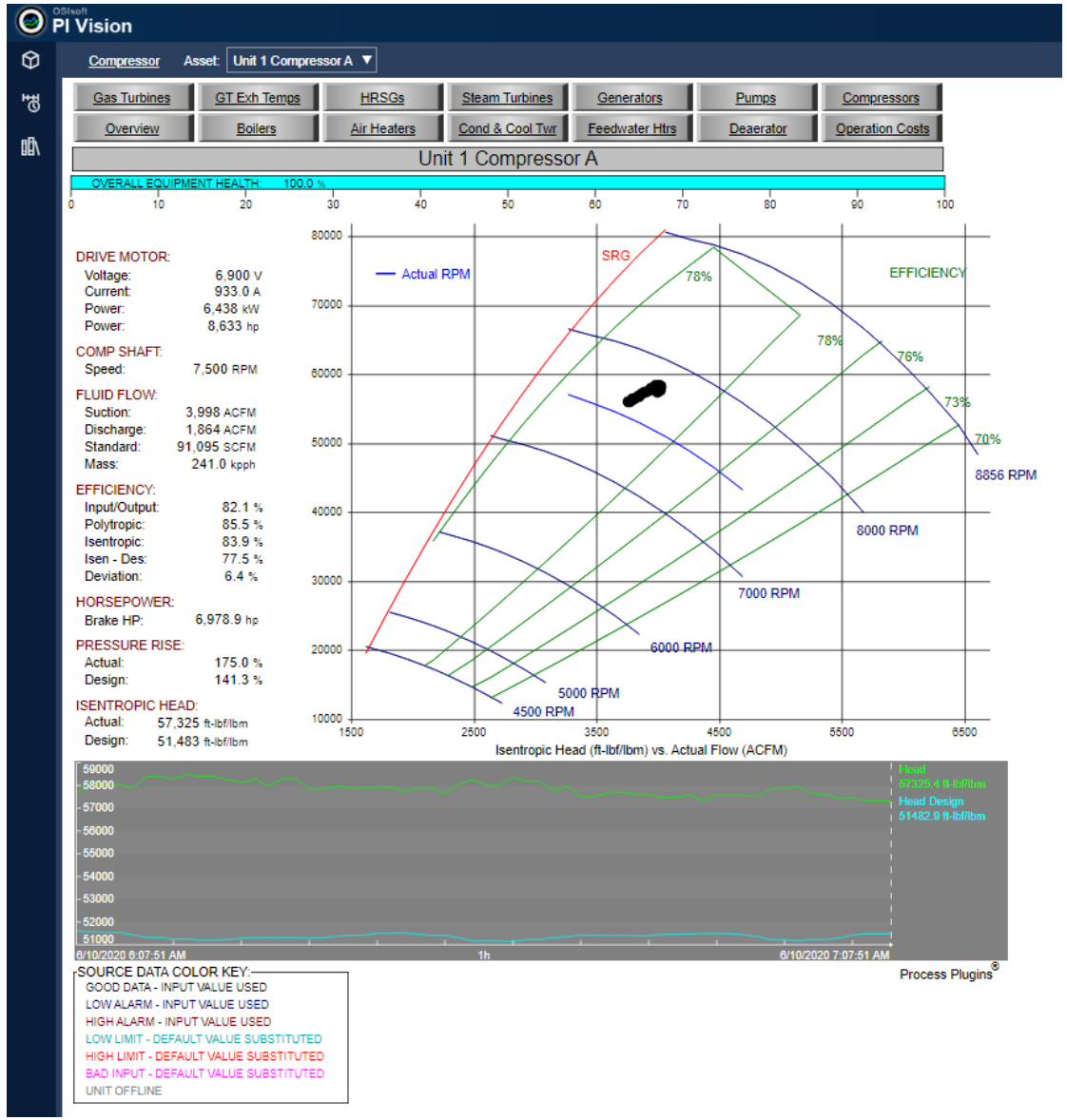
Rapid TTV with PI AF Plugins

- Solutions are tightly integrated with the Modern AVEVA PI stack, leveraging Asset Framework (AF) for templates, analyses, and event frames
- Calculations and visualizations enable quick analysis of complex systems
- Equations from ASME Standards and engineering best practices are embedded in enterprise software vs spreadsheets

Process Innovations
ProcessPlugins™



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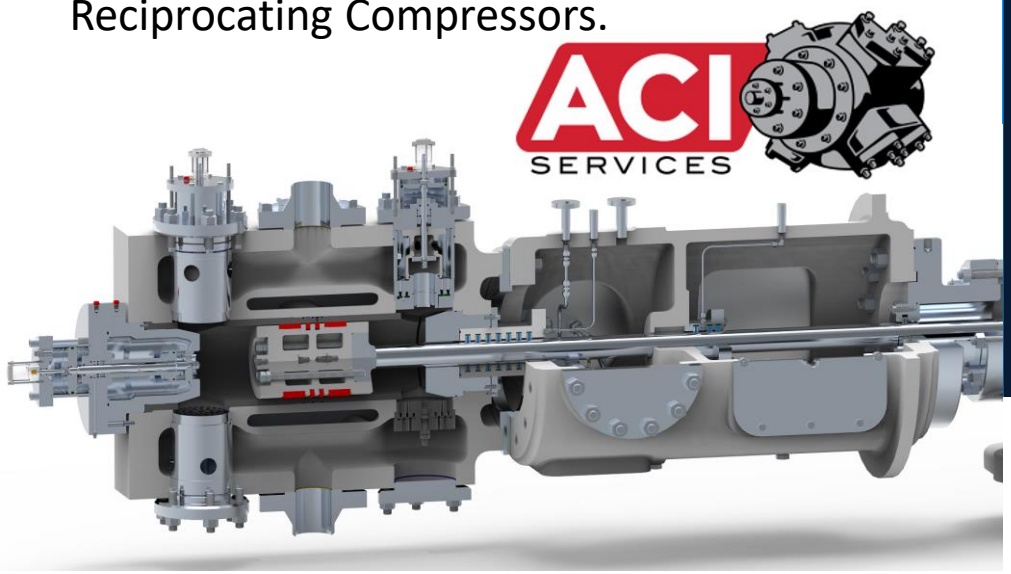
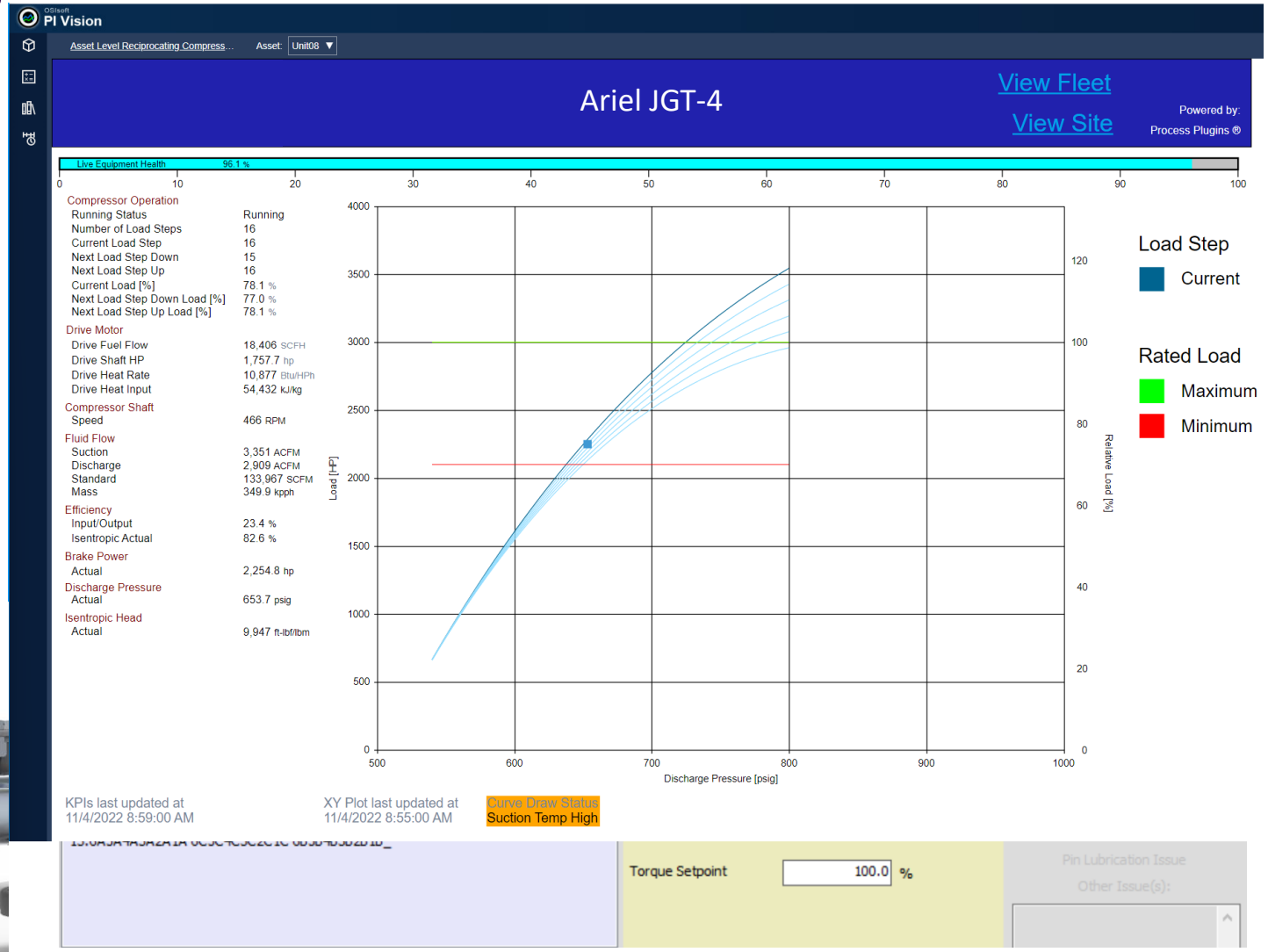
ACI Services eRCM Models

- Accurate, tunable compressor models that reflect OEM safety specifications.
- Models are easily used by Engineers, Operators, Automation & Controls, Gas Control, Data Analytics, and Management.
- ACI's eRCM™ Technology is integrated into Process Plugins APM Solution for Reciprocating Compressors.





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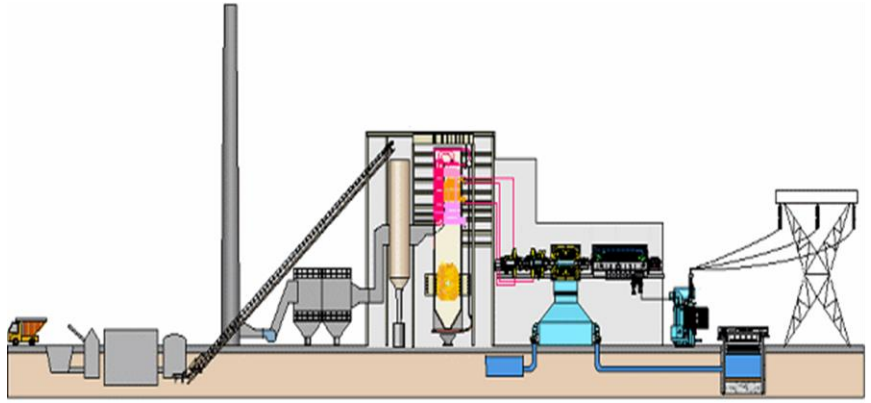
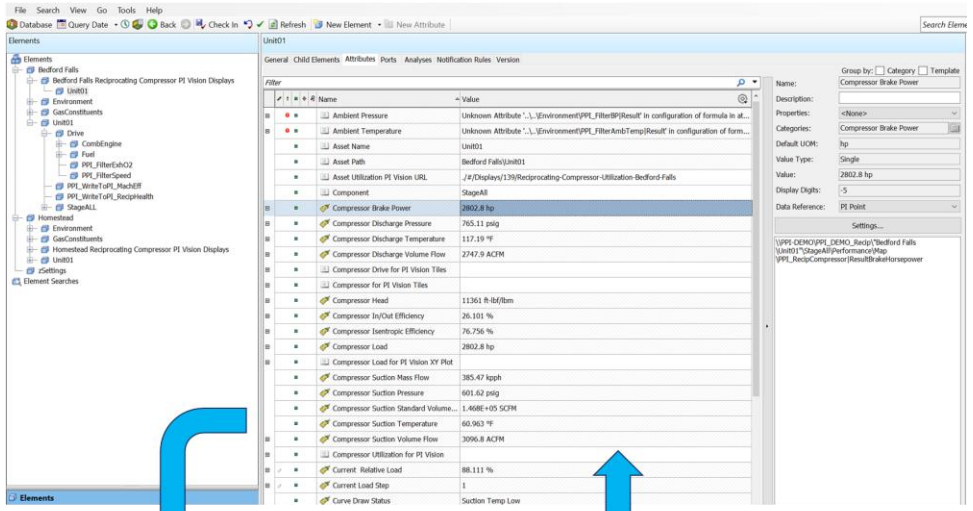
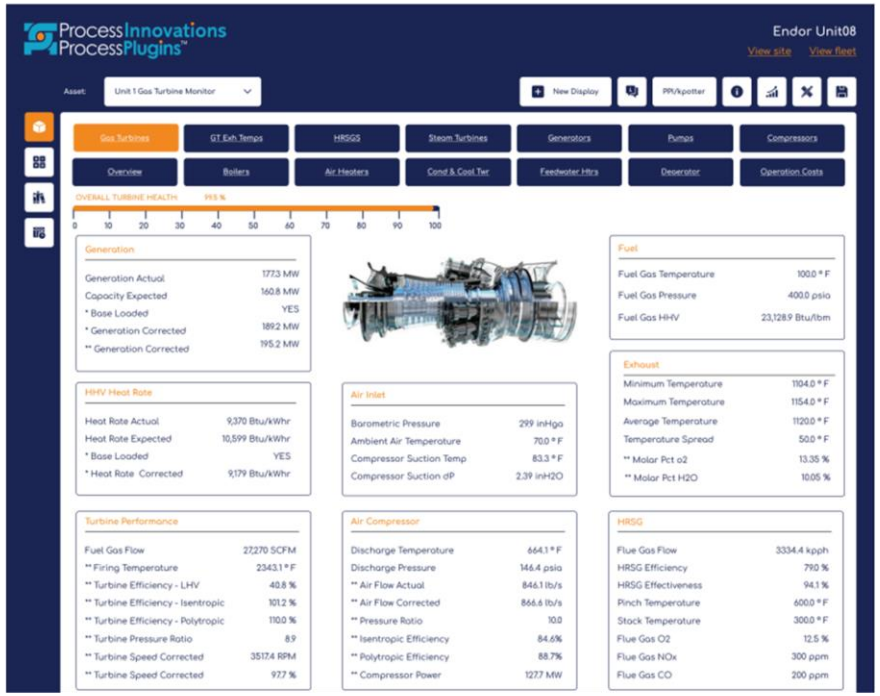
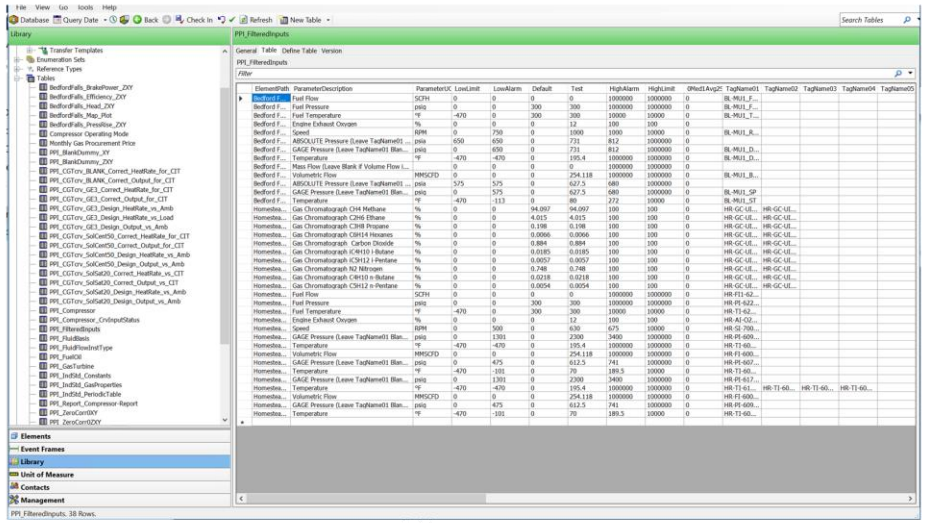






ProcessPlugins™



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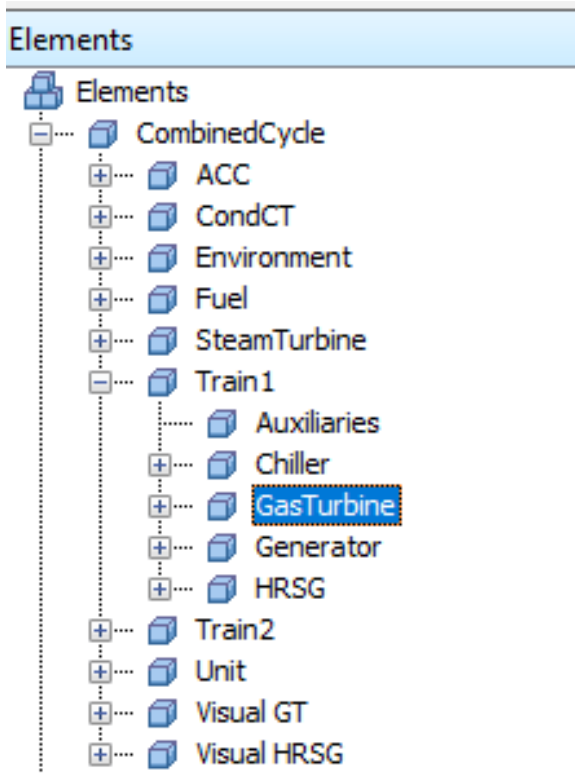
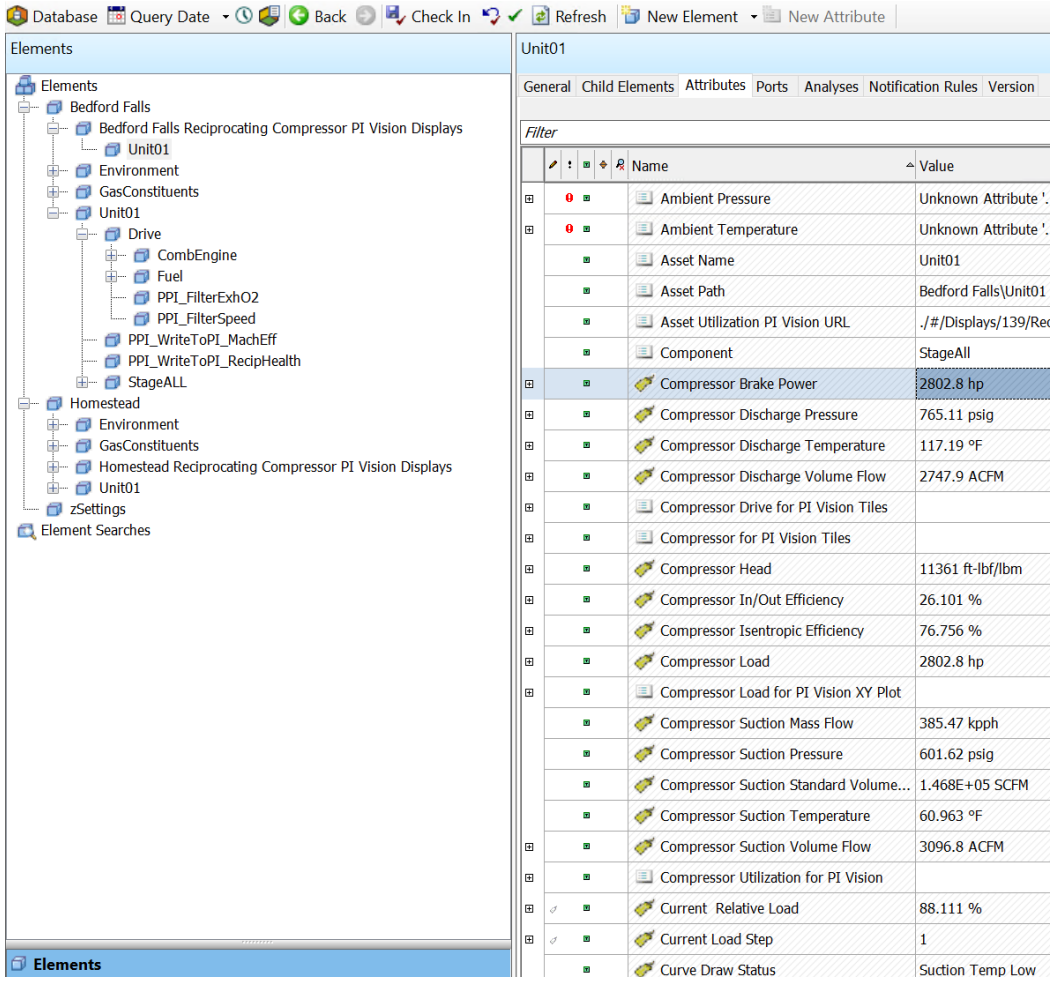
Complete AF configuration for all assets monitored

We build the entire structure in your AF server that contains all calculations and links for visualization with PI Vision. Scalable to hundreds or thousands of assets.





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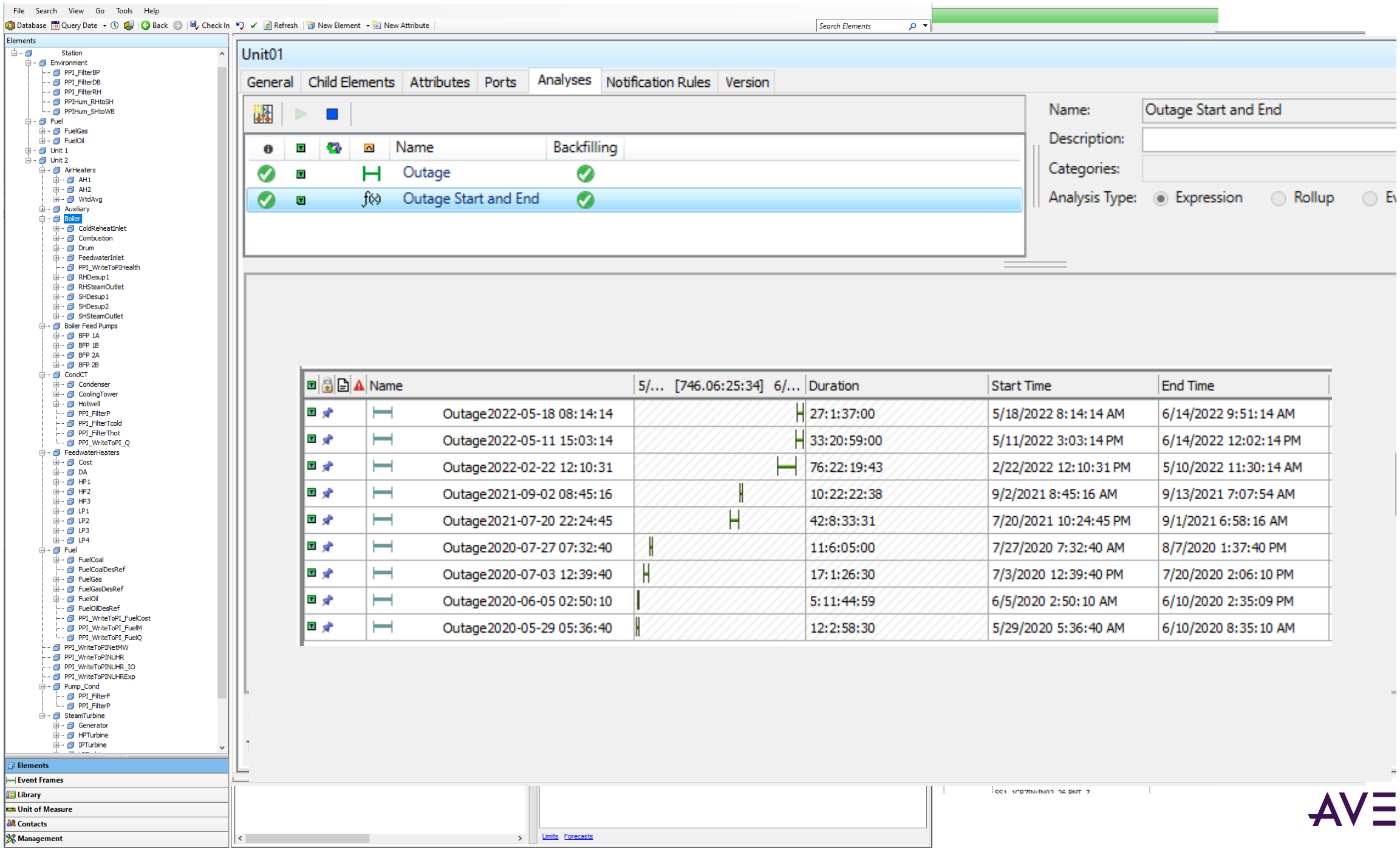
File Search View Go Tools Help
Database Query Date Back Check In Refresh New Element New Attribute
Search Elements
Elements
Station
Environment
PPI_FilterBP
PPI_FilterDB
PPI_FilterRH
PPIHum_RHtoSH
PPIHum_SHtoWB
Fuel
FuelGas
FuelOil
Unit 1
Unit 2
AirHeaters
AH1
AH2
WtdAvg
Auxiliary
Boiler
ColdReheatInlet
Combustion
Drum
FeedwaterInlet
PPI_WriteToPIHealth
RHDesup1
RHSteamOutlet
SHDesup1
SHDesup2
SHSteamOutlet
Boiler Feed Pumps
BFP 1A
BFP 1B
BFP 2A
BFP 2B
CondCT
Condenser
CoolingTower
Hotwell
PPI_FilterP
PPI_FilterTcold
PPI_FilterThot
PPI_WriteToPI_Q
FeedwaterHeaters
Cost
DA
HP1
HP2
HP3
LP1
LP2
LP3
LP4
Fuel
FuelCoal
FuelCoalDesRef
FuelGas
FuelGasDesRef
FuelOil
FuelOilDesRef
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PPI_WriteToPI_FuelM
PPI_WriteToPI_FuelQ
PPI_WriteToPINetMW
PPI_WriteToPINUHR
PPI_WriteToPINUHR_IO
PPI_WriteToPINUHRExp
Pump_Cond
PPI_FilterF
PPI_FilterP
SteamTurbine
Generator
HPTurbine
IPTurbine
Elements
Event Frames
Library
Unit of Measure
Contacts
Management
Unit01
General
Child Elements
Attributes
Ports
Analyses
Notification Rules
Version
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Outage Start and End
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Analysis Type:
Expression
Rollup
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7/3/2020 12:39:40 PM
7/20/2020 2:06:10 PM
Outage2020-06-05 02:50:10
5:11:44:59
6/5/2020 2:50:10 AM
6/10/2020 2:35:09 PM
Outage2020-05-29 05:36:40
12:2:58:30
5/29/2020 5:36:40 AM
6/10/2020 8:35:10 AM
Limits
Forecasts

Sample of Process Plugins Modules

- Combustion Gas Turbine Performance Monitor & Plant Heat Rates
- Combustion Gas Turbine Power Curves
- Reciprocating Compressor Performance Monitor
- Centrifugal Compressor Performance Monitor
- Turbine Compressed Air Cooler Condition Monitor
- Pump Condition Monitor
- Water Cooled Condenser CW Pump Optimizer
- Air Cooled Condenser Condition Monitor
- … and many (20+) more

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Questions?

Please wait for the microphone.

State your name and company.

Please remember to

Visit Process Innovations at **Booth 38** for more information and to discuss your opportunity.

Thank you!

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AVEVA is a world leader in industrial software, providing engineering and operational solutions across multiple industries, including oil and gas, chemical, pharmaceutical, power and utilities, marine, renewables, and food and beverage. Our agnostic and open architecture helps organizations design, build, operate, maintain and optimize the complete lifecycle of complex industrial assets, from production plants and offshore platforms to manufactured consumer goods.

Over 20,000 enterprises in over 100 countries rely on AVEVA to help them deliver life's essentials: safe and reliable energy, food, medicines, infrastructure and more. By connecting people with trusted information and AI-enriched insights, AVEVA enables teams to engineer efficiently and optimize operations, driving growth and sustainability.

Named as one of the world's most innovative companies, AVEVA supports customers with open solutions and the expertise of more than 6,400 employees, 5,000 partners and 5,700 certified developers. The company is headquartered in Cambridge, UK.

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