

Managing the Chaos: Prometheus APM

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Agenda

- Who is Flint Hills Resources?
- Transformation Journey with Prometheus APM
- Use Cases
- IT Perspective
- Looking Ahead
- Q&A



Who is Flint Hills Resources?



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Flint Hills Resources

- Flint Hills Resources is a leading refining company
 - Operations primarily in the Midwest and Texas
- Based in Wichita, KS
 - Subsidiary of Koch Industries
- We produce fuels and aromatics
 - Gasoline, Jet Fuel, and Diesel
 - Chemical Intermediates
 - Asphalt, Base Oils, Liquid Fertilizer
- Key facts
 - ~3,000 employees
 - 3 refineries in MN and TX
 - 700,000 bbl/day refining capacity
 - 4,000 miles of pipeline

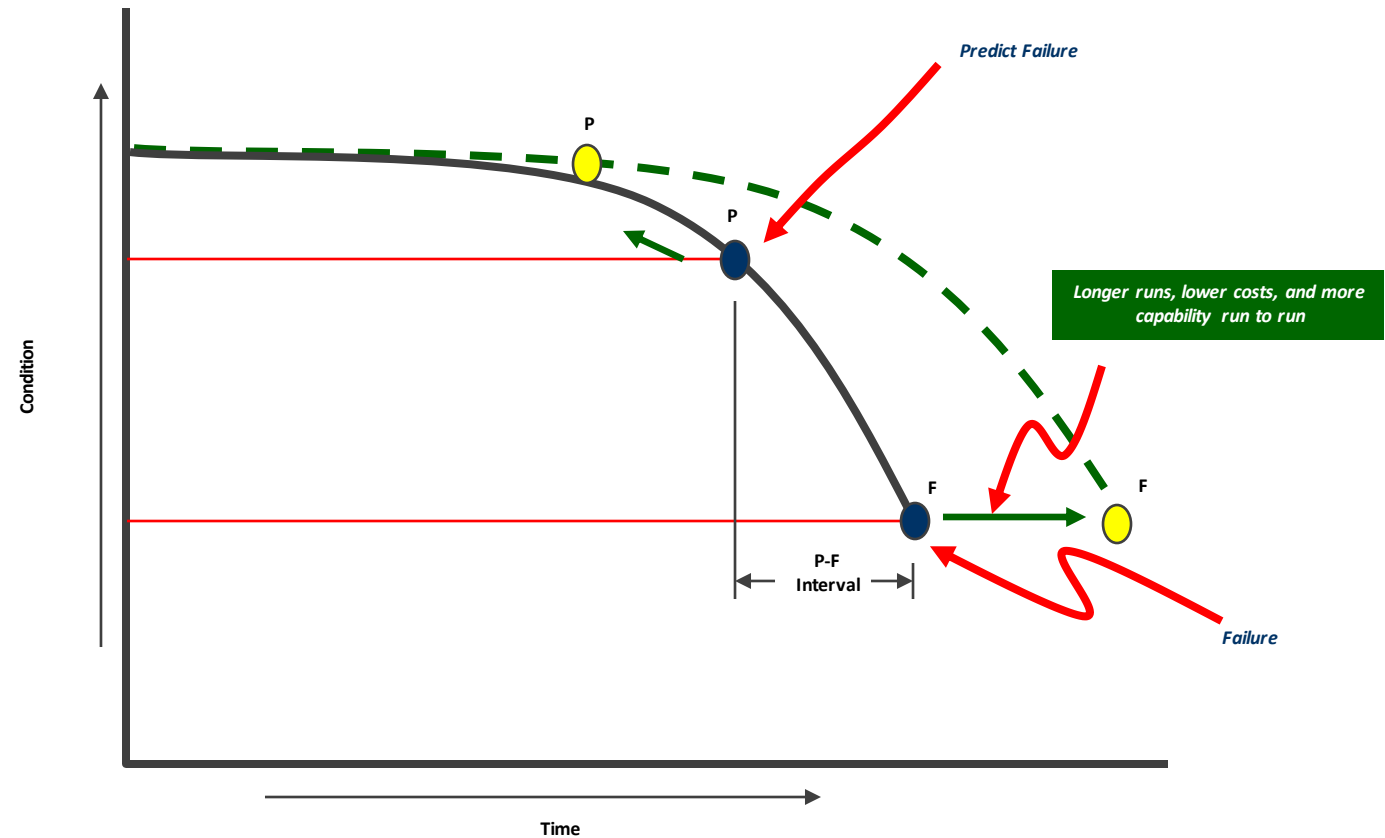


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Monitoring POV

- Transformation is necessary
- Data must be continuously collected
- Good models + good data = detect defects + predict failures earlier & more effectively
- Goal: extend the P-F interval



Analytics & Monitoring Partners



AMP is a trusted business partner that improves utilization, yields and costs by providing:



Earlier detection of operating issues and opportunities



Automated data analysis



Clear communication of actionable information



Collaborative problem solving across disciplines and sites



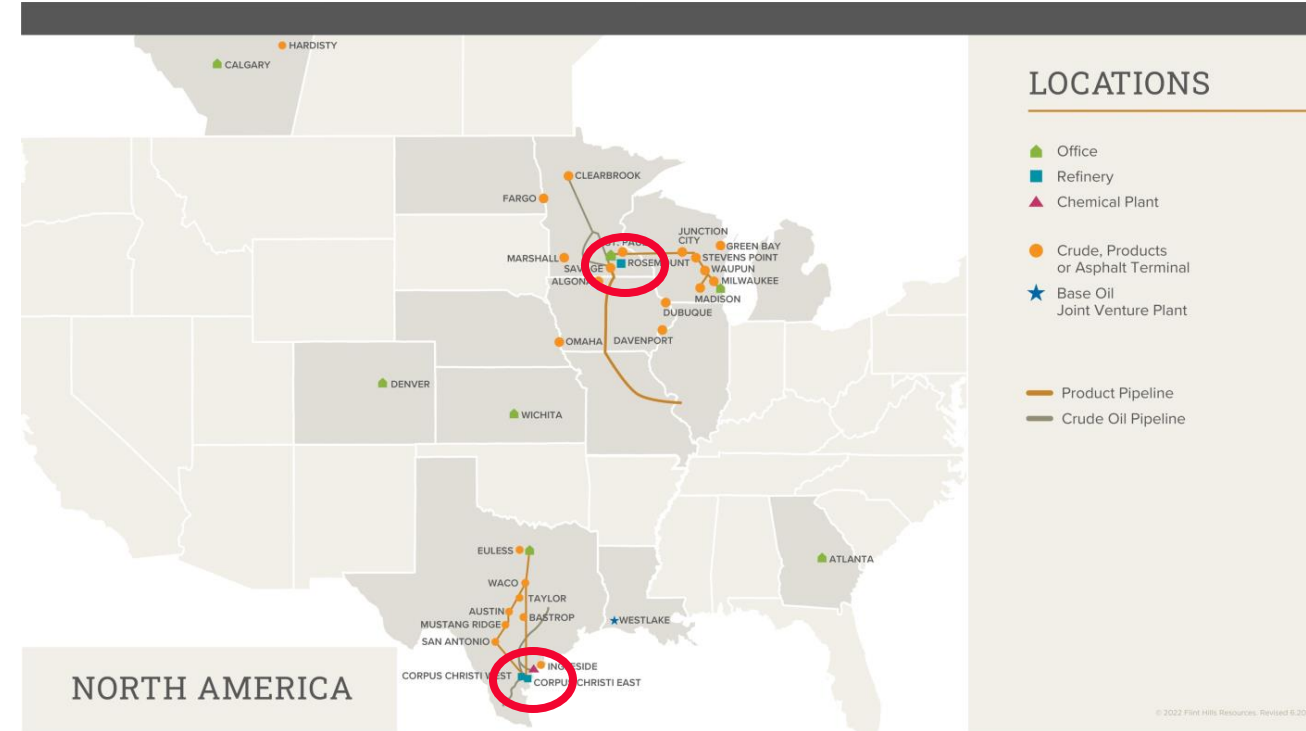
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Analytics & Monitoring Partners

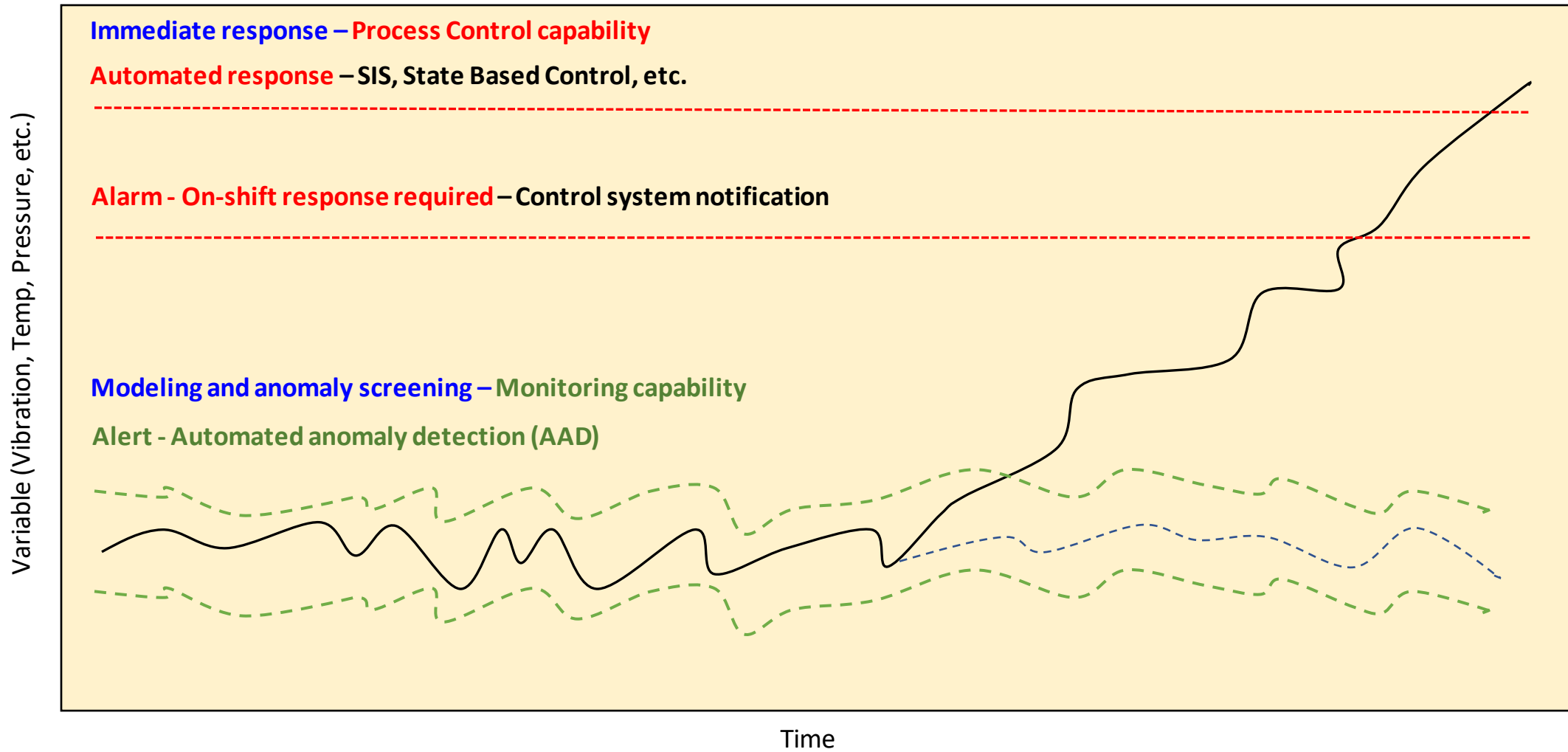
- 2 monitoring centers, 1 team
 - Monitoring Analysts
 - Process Engineers
 - Mechanical Engineers
 - Operations
 - Modeling/Analytics Engineers
 - Process Engineers
 - Data Engineers
 - Ownership by technology vs location



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Our Transformation Journey



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How did we get here?

Timeline

- 2017
 - Process Data focus: contextualization, models
- 2018
 - AMP Vision creation and alignment
- 2019
 - ASSET360 pilot + 3rd party services (other Koch customers: KAES & GP)
- 2020-2022
 - 13,500 models for 6 business lines
 - Reduced 3rd party dependency for config
 - Tag Backfill capability via API
- Today
 - 15,000 models for 3 business lines



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Manage The Chaos via the Funnel

- Sensor Deployment
 - ~100K-200K measured data points
- Model Prediction
 - ~15,000 models
- Alert Screening & Diagnosis
 - ~1,200 active alerts
 - ~700 alerts not in Watch/Ignore state
- Issue Escalation
 - ~10-20 escalations/week



Model Deployment

How

- Cover as much of the process and equipment as possible
- What model types to use?
 - APR
 - Fixed Limit
 - Forecast
 - Moving/Rolling Average
 - Rate of Change
 - External



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Who

- Asset Experts
- Monitoring Analyst/Engineer
- 3rd party service provider
- Data scientists

Why Prometheus APM? (Part 1)

- Alerts user interface is built for Screening
 - Save time & effort with Filter, Watch, and Views
 - Saved Trends – Prebuilt and Custom
 - Add Notes to an Alarm or Model
 - Quickly move to Op Mode / Model Configuration / Issues Management
- Advanced modeling techniques
 - APR – takes more work, but worth the effort
 - Fixed Limit – easy to use
 - Forecast – very useful but Context view is necessary vs the Trend view
 - Multivariate & Univariate



Navigator

Asset Search

Default Asset Tree

- Eastern PC2
 - AQC System
 - Ash Handling System
 - Auxiliary Steam System
 - Boiler Air & Gas System
 - Calculation Timestamps
 - Condensate System
 - Feedwater System
 - Fuel Handling System
 - Heat Rejection System
 - Losses
 - Steam Turbine Generator
 - Transformer
- Natural Gas Plants
- Industrial Plants
 - Fertilizer Plant
 - Pulp & Paper Company
 - Mine Sites
 - Oil & Gas Facilities
 - Ammonia Plant
 - Feed Gas Desulfurization S
 - Primary Reformer System
 - Secondary Reformer System
 - High Temp Shift Converter :
 - Low Temp Shift Converter :
 - CO2 Removal System
 - Methanation System
 - Syn Gas Compressor A2-10
 - 103-J Short Loop

Alert Watch Ignore

Total Models: 5 04/10/23 02:31PM

Model Name	% OOB	% EXP	Actual	Expected	Lower	Upper	Units	Last Note
ID Fan A Axial Brg Temp	2064	-19	156	193.6	191.9	195.3	DEGF	
HP Turbine NO.11 Bearing Vib X	822	166	2.343	0.8797	0.721	1.038	MIL	Bearing vibration spiki
Hotwell Pump Strainer A DP	573	383	0.1525	0.03157	0.01361	0.04953	PSID	Looks like strainer is p
GСУ Transformer Top Oil Temp	222	41	109.4	77.33	67.36	87.29	DEGF	
PA Fan 2A OB Bearing Vib X-Dir	139	11	6.313	5.713	5.463	5.964	MILS	Fan has been dirty but

PA Fan 2A OB Bearing Vib X-Dir (MEAS_2:2CBVT007A_M20)



09/27/16 7:35 PM 10/01/16 7:35 PM

Alerts Actions

Current Status [Clear Status](#)

In Alert

10/01/2019, 5:23 am

Watch

6 Hours 24 Hours 7 Days Custom

[Clear Diagnose](#) [Model Maintenance](#)

[Add Note](#)

Model Diagnostics

- Model Configuration
- OP Mode Configuration
- Data Explorer
- Diagnostic Drilldown
- Show Related Models
- Show Related Issues

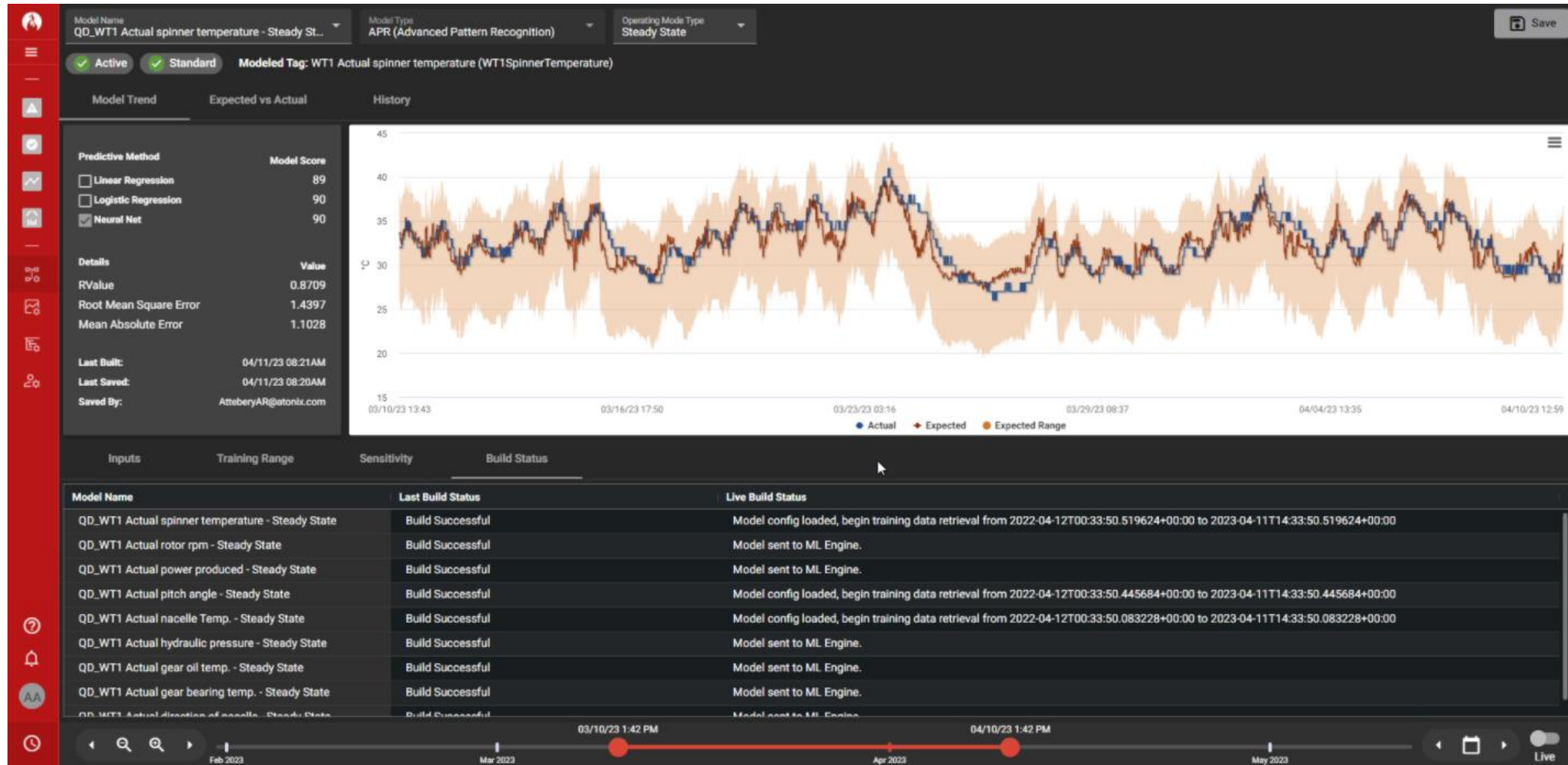
[Create Issue](#)

Alerts Display

Why Prometheus APM? (Part 2)

- Self-service configuration
 - Assets & Tags – “Greatest Addition Ever!”
 - Models – Build, Train, Re-train
- Issues management
 - Initial – great tool to communicate with other 3rd party monitoring services
 - Current – not using in favor of CMMS
 - Future – possible integration with CMMS





Model Configuration

#1023547: Cooling Tower Fan Motor and Gearbox Vibration Elevated

Resolution Status: Site Reviewing | Assigned To: | Resolve By Date: | Priority: High

Status: Open | ★

Created By: LauthJG@bv.com | Age: 6 years old | Last Modified: AtteberyAR@atonix.com

May 3, 2017 4:20 PM | Jun 7, 2021 10:39 AM

Save Following Send ⋮ ⓘ

and taken out the blades and checked the fan run report and had it be approved when they become available.

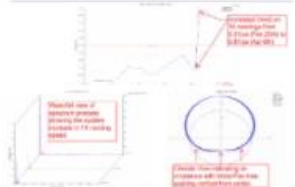


Image: Vibration Graph.png

New Discussion Post - 4/4/17 LauthJG@bv.com | May 3, 2017, 4:27:25 PM

211 CT Fan Motor and Gearbox vibrations spiked up to a 365 day highs of 0.48 IN/S while expecting 0.13 IN/S upon motor startup. The vibration velocity is still elevated at 0.33 IN/S. However it looks like something did change. Motor amps and outside temperature did not change during this event.

See the attached trends for details.




Image: 211 CT Fan Motor Vibrations Alert.jpg




Image: 211 CT Fan motor and Gearbox Vibrations 10 days.jpg




Image: 211 CT Fan Motor and Gearbox Vibrations 1 year.jpg




Image: 211 CT Fan Gearbox Vibrations Model Inputs.jpg




Image: All CT Fan Motor Vibrations 10 days.jpg




Image: All CT Fan Gearbox Vibrations 10 days.jpg

SHORT SUMMARY ⓘ

211 CT Fan Motor and Gearbox vibrations spiked up to 0.48 IN/S on 4/4. Vibration test measured 1.0 in/sec

DETAIL

Fan Bearing Type Increasing ⓘ

Potential Causes ⓘ

Issue Class: M&D | Issue Category: Outage Maintenance

IMPACT ⓘ

Impact: \$158,752.00 | Monthly Average: \$29,376.00

ASSET

CT Cell A ⓘ

Issues by Owning Asset: 1 | Alerts by Owning Asset: 8

ISSUE KEYWORDS

Keyword Search: ENTER adds the k | + Add Keyword

Find of the Week ⓘ | Outage ⓘ | Demo ⓘ



Use Cases



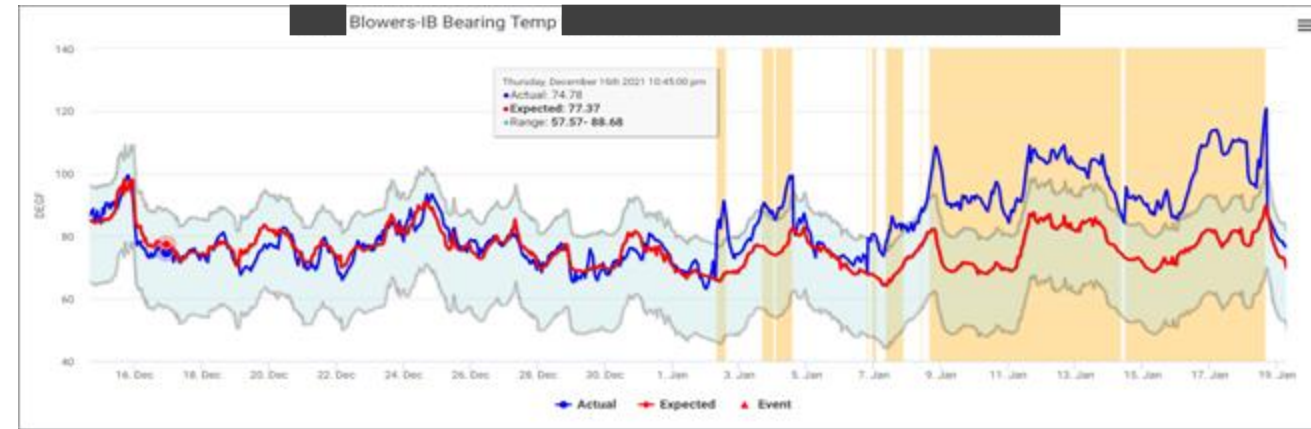
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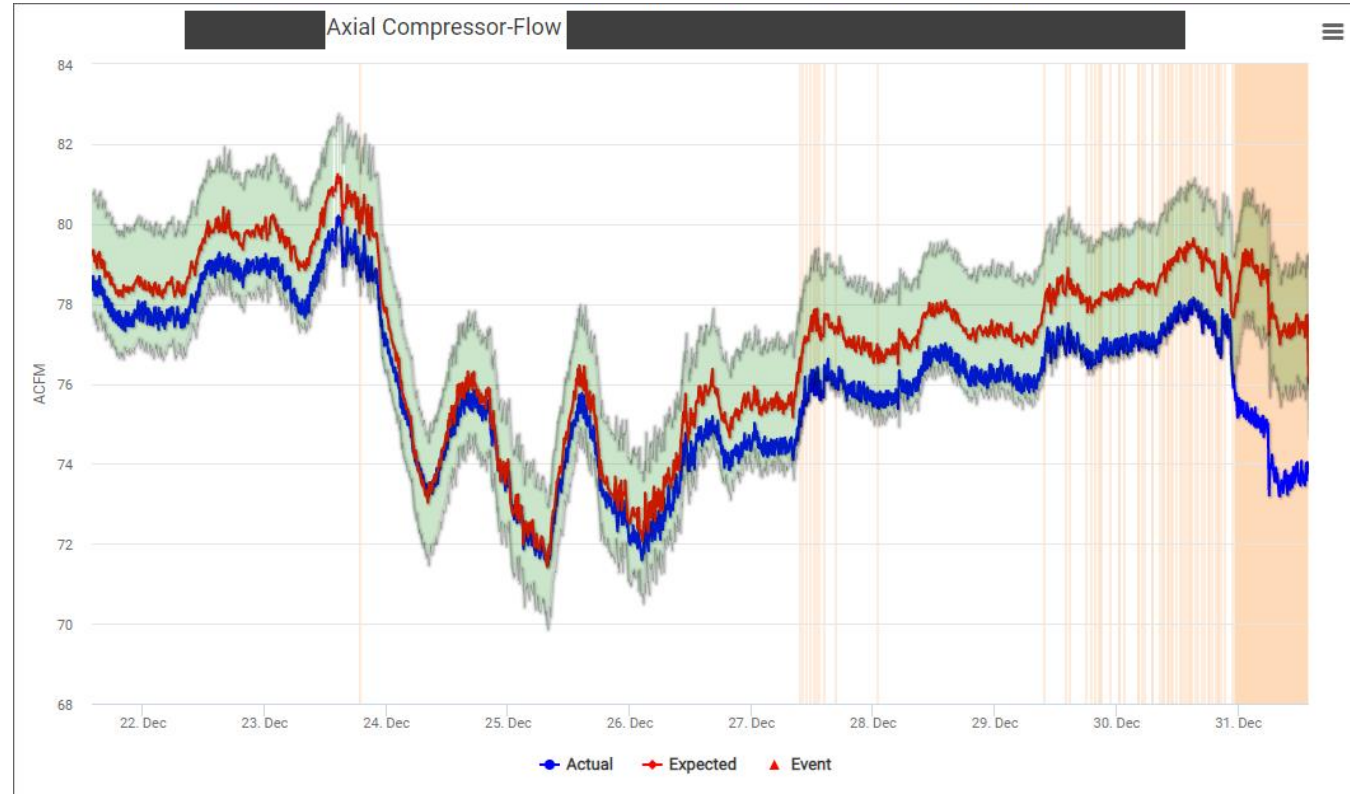
Furnace Draft Fan IB Bearing Temp

- Detect
 - Prometheus APM alert
- Diagnose
 - IB bearing temp 20-30°F higher
 - Initially not deemed an issue
 - Later found cooling water lines to the bearing housing plugged with black sludge
- Resolve
 - Maintenance opened the lines and cleared them
- Outcome

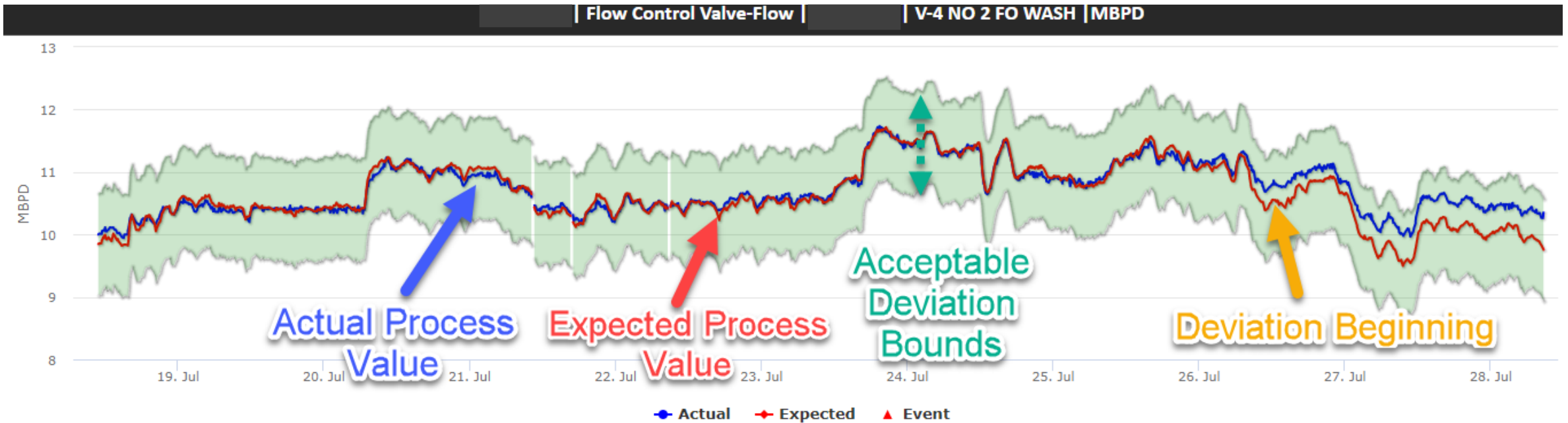


Main Air Blower Discharge Flow

- Detect
 - Prometheus APM alert
- Diagnose
 - Rain event caused wet caked dust/dirt to decrease airflow
- Resolve
 - Daylight board operator worked with Operations to walnut hull the blower
- Outcome



Example – Flow Control Valve



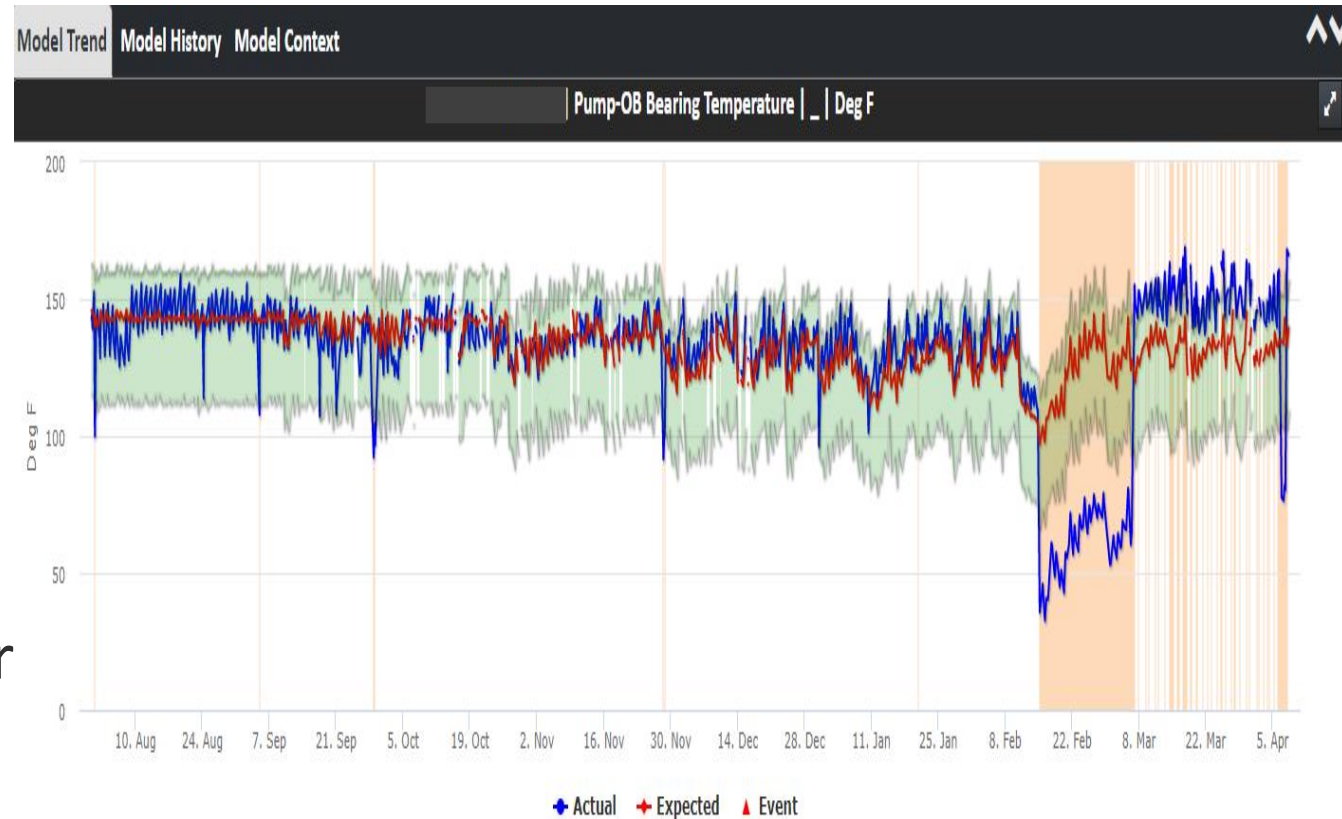
Actual vs. Expected Control Valve Flow Model

Why is the deviation occurring?

- Pump switch with unequal pump performance?
- Physical hydraulic change (valve/piping/filter/nozzle)?
- Change in fluid flows (more/less flow somewhere else, impacting pump pressure)?
- Change in process conditions (temperature, composition, etc.)?
- Something else?

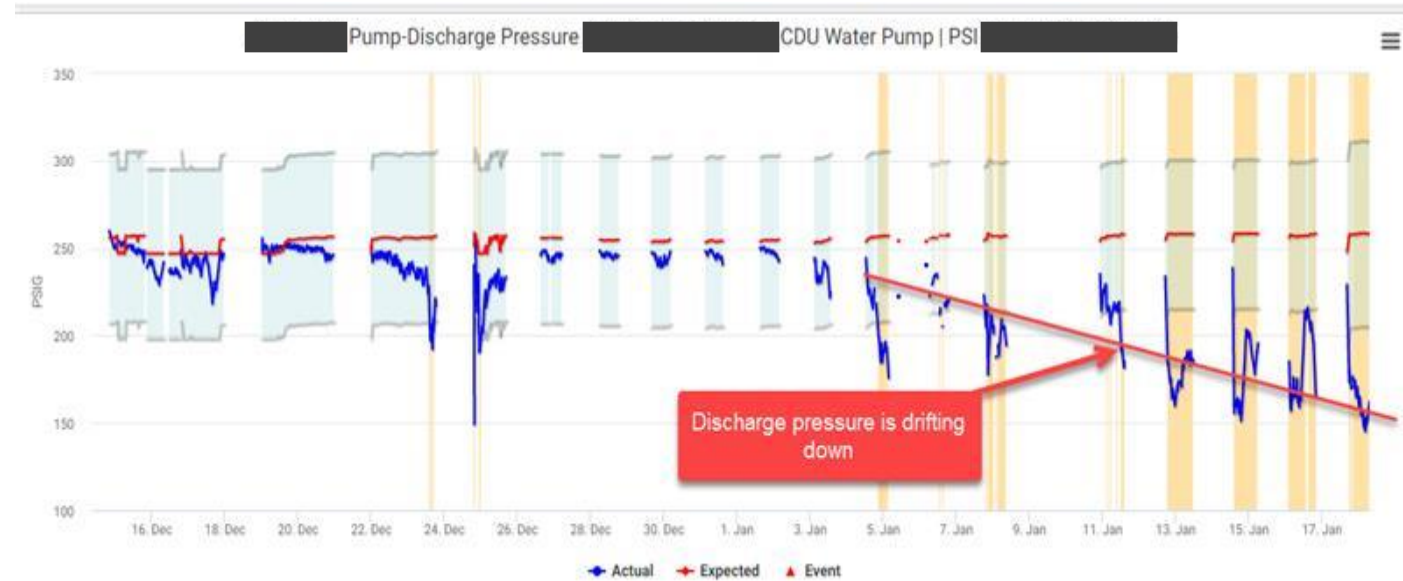
Steam Pump OB Bearing Temp

- Detect
 - Prometheus APM alert
- Diagnose
 - Bearing skin temp elevated after restart
- Resolve
 - Maintenance resource found cooling water blocked in at header and corrected the problem
- Outcome



Pump Degraded Performance

- Detect
 - Prometheus APM alert
- Diagnose
 - Water Pump discharge pressure was drifting down
 - Initial contact with Operations
 - Escalation to Business Team; Operations found the suction screen was plugged with grass and weeds
- Resolve
 - Operations cleaned the screen
- Outcome



Modern Technology



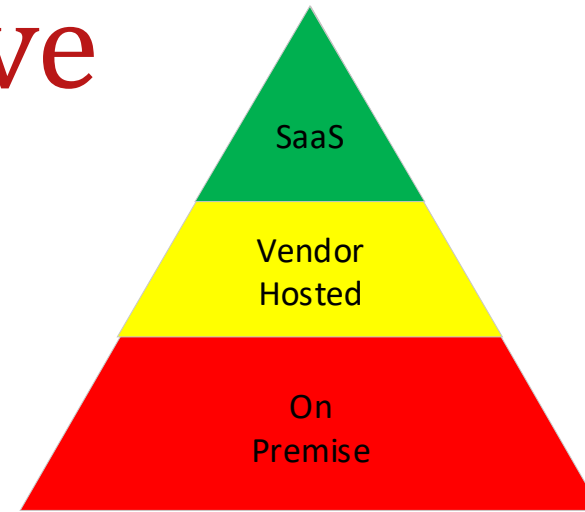
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IT/Technology Perspective

- Preferred Deployment Model
 - SaaS / Cloud
 - Multi-Tenant
 - Single Sign-On, Role-Based Access
- Lightweight Integration
 - MDTransfer connects your process data
 - APIs for reporting and tag backfill
- Responsive Support
 - Support Portal
 - Knowledge Base



 Assets API Retrieve asset details to understand the hierarchy.	 Files API Operates on files for a given asset. Used for external model ingestion.
 Issues API Retrieve issue details.	 Models API Retrieve model details.
 Process Data API Process data, or timeseries data, is used to in trends, calculations, and modeling. This API retrieves the servers and tagname details, and to get the time series data. Retrieval of model results is not supported in this API.	



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Looking Ahead



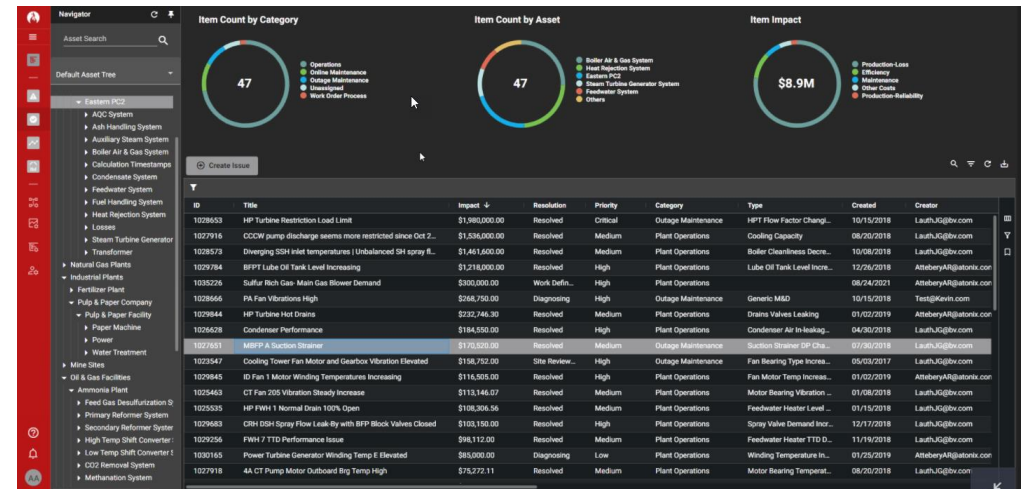
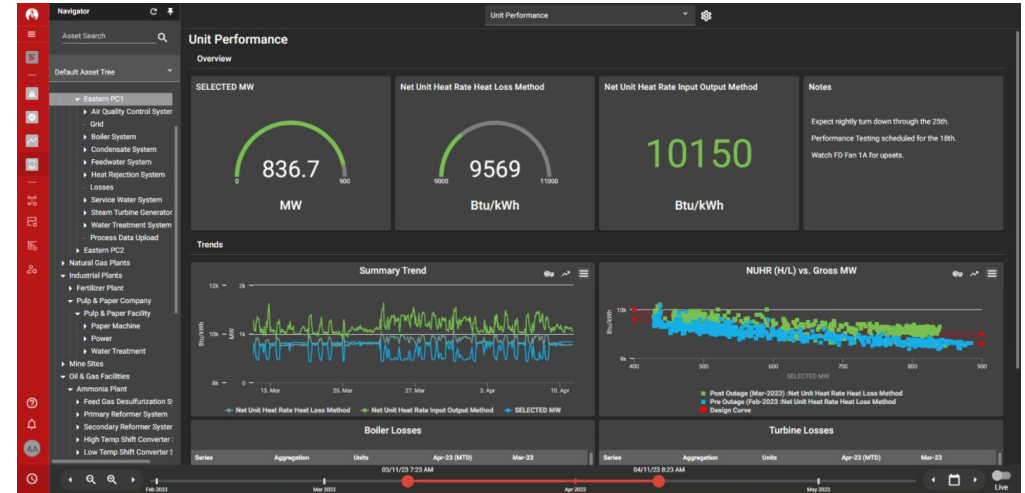
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Next Steps

- Univariate Models
- Dashboards
- Issues Management
 - Automated Issue creation
 - Send Issue to CMMS
 - Send CMMS status back to Issue



Thank You



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Questions?



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