Managing the Chaos: Prometheus APM

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Flint Hills Resources, LC

May 16, 2023

Agenda

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

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Who is Flint Hills Resources?

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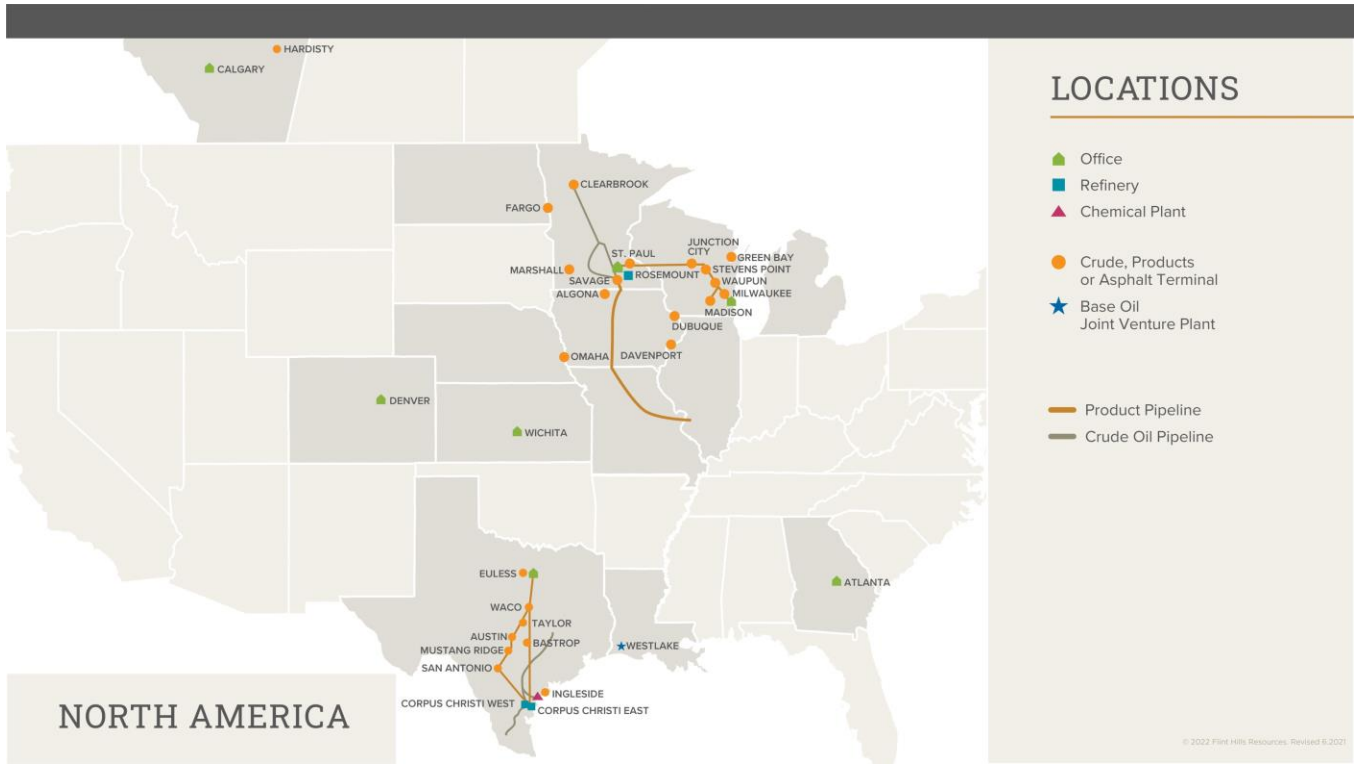
Flint Hills Resources

- 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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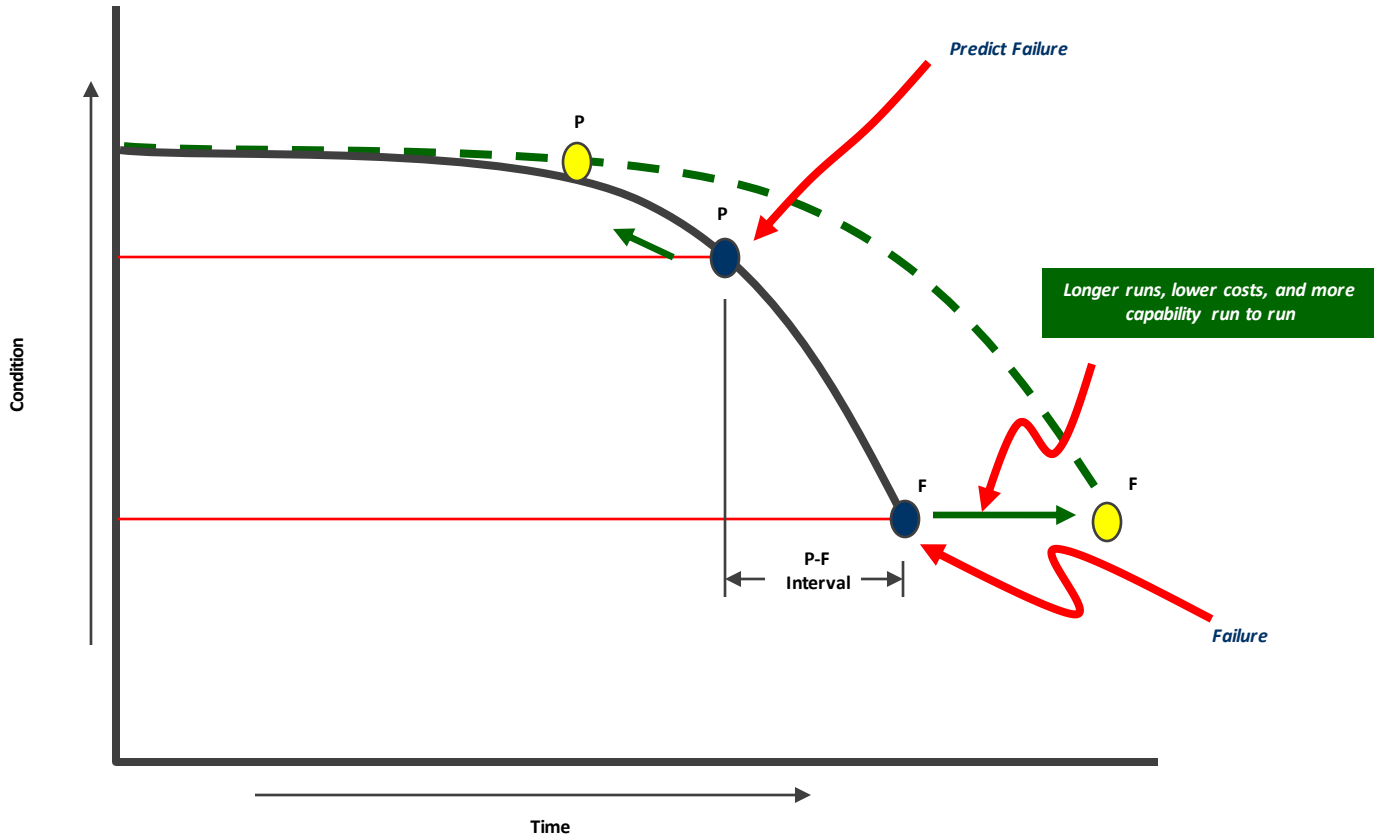
Monitoring POV

- 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



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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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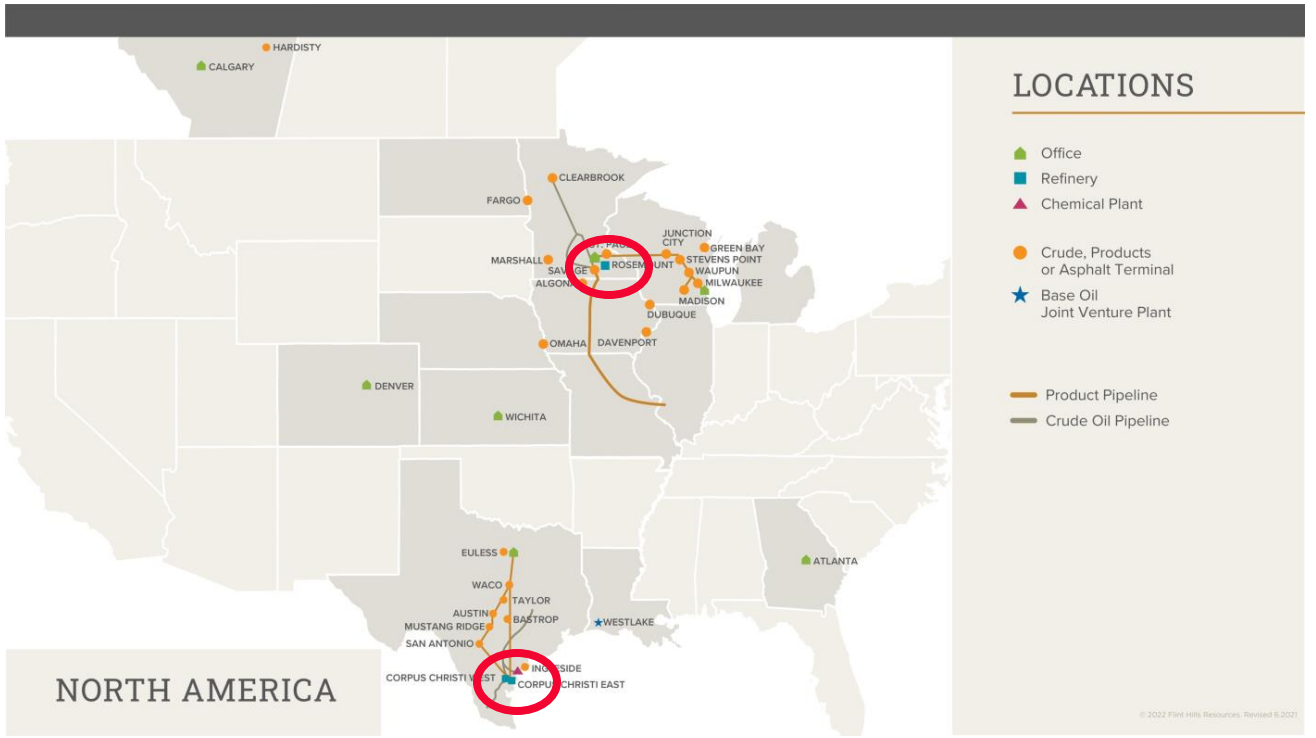
Analytics & Monitoring Partners

- 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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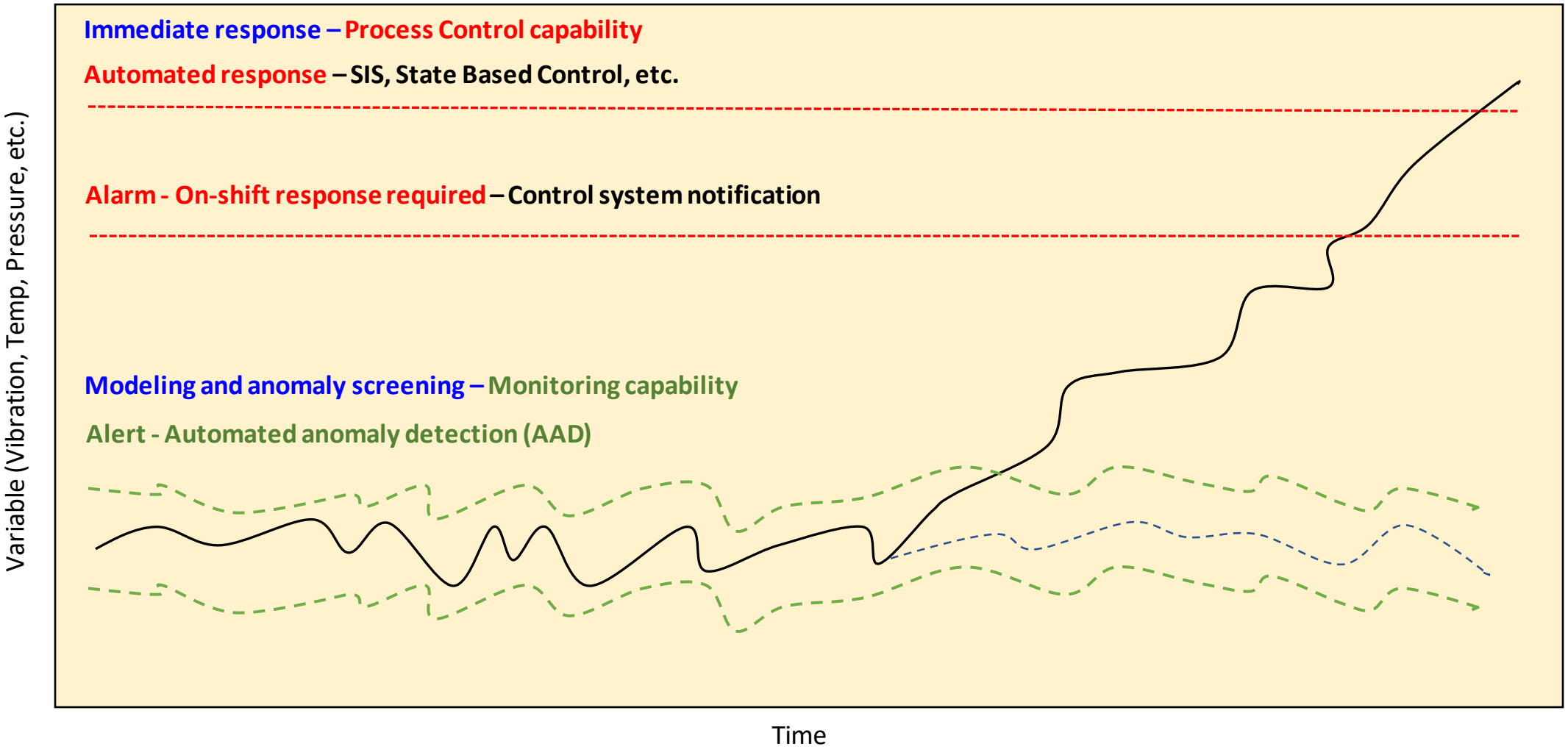

Automated Anomaly Detection

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

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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

Who

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

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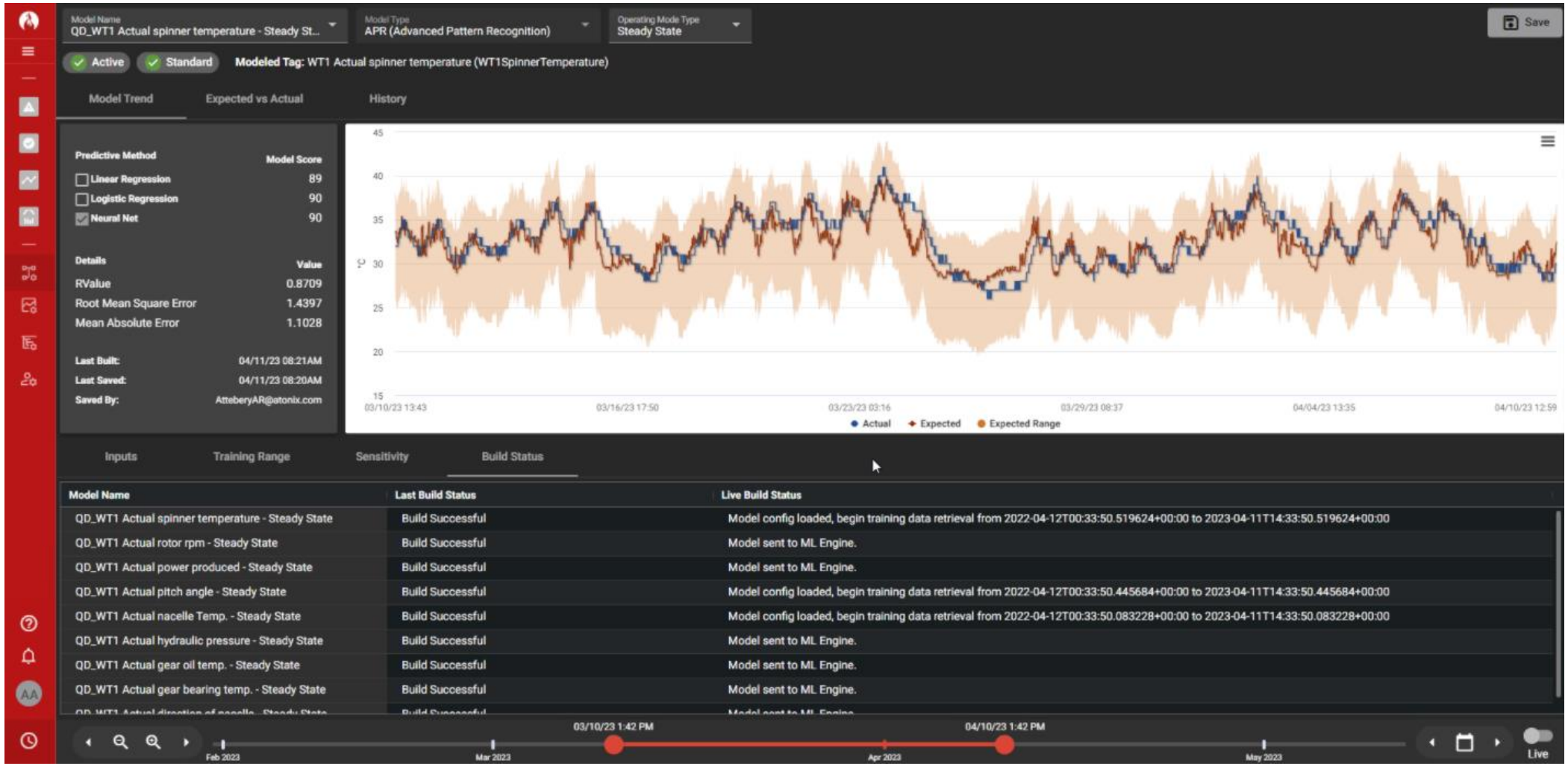
Why Prometheus APM? (Part 1)

- 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

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

Status: Open

Created By: LauthJG@bv.com
May 3, 2017 4:20 PM

Age: 6 years old

Last Modified: AtteberyAR@atonix.com
Jun 7, 2021 10:39 AM

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

Save | Following | Send

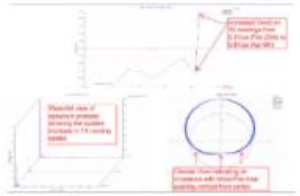


Image: Vibration Graph.png

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.

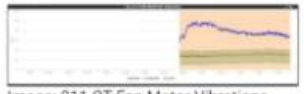


Image: 211 CT Fan Motor Vibrations Alert.jpg

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

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

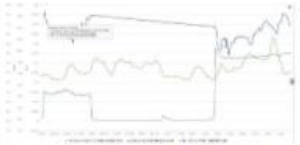


Image: 211 CT Fan Gearbox Vibrations Model Inputs.jpg

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: 0

ISSUE KEYWORDS

Keyword Search. ENTER adds the k | Add Keyword

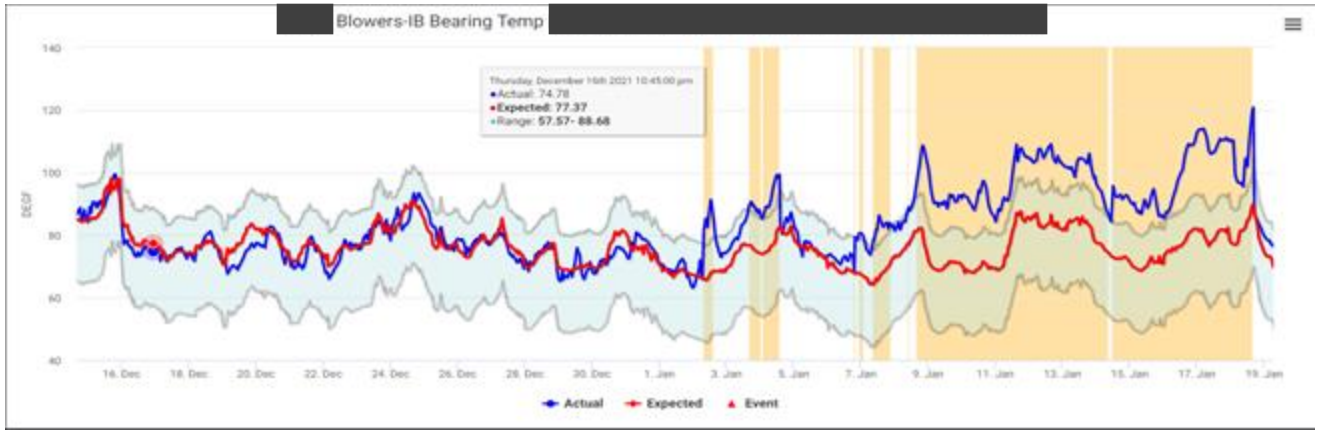
Find of the Week | Outage | Demo

Issue Management

Use Cases

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



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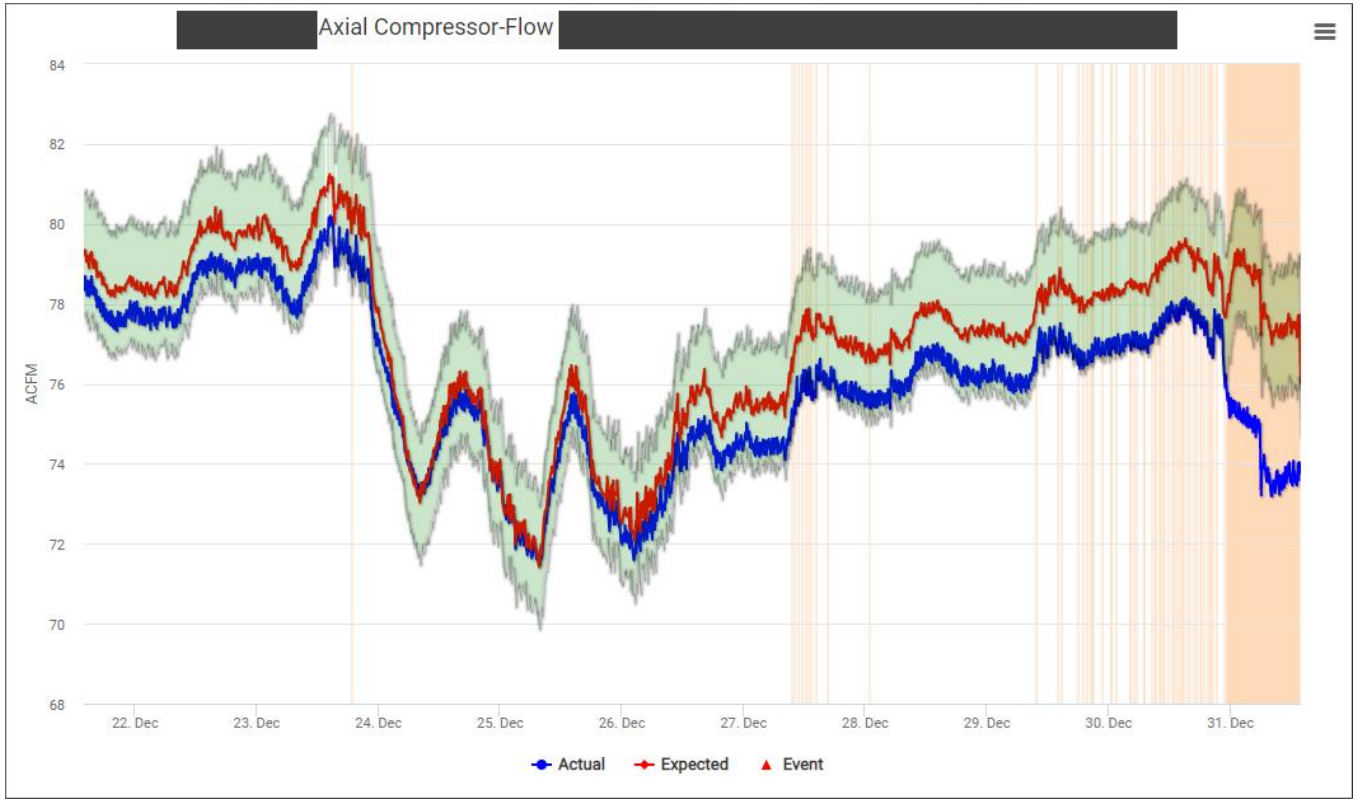
Main Air Blower Discharge Flow

- 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



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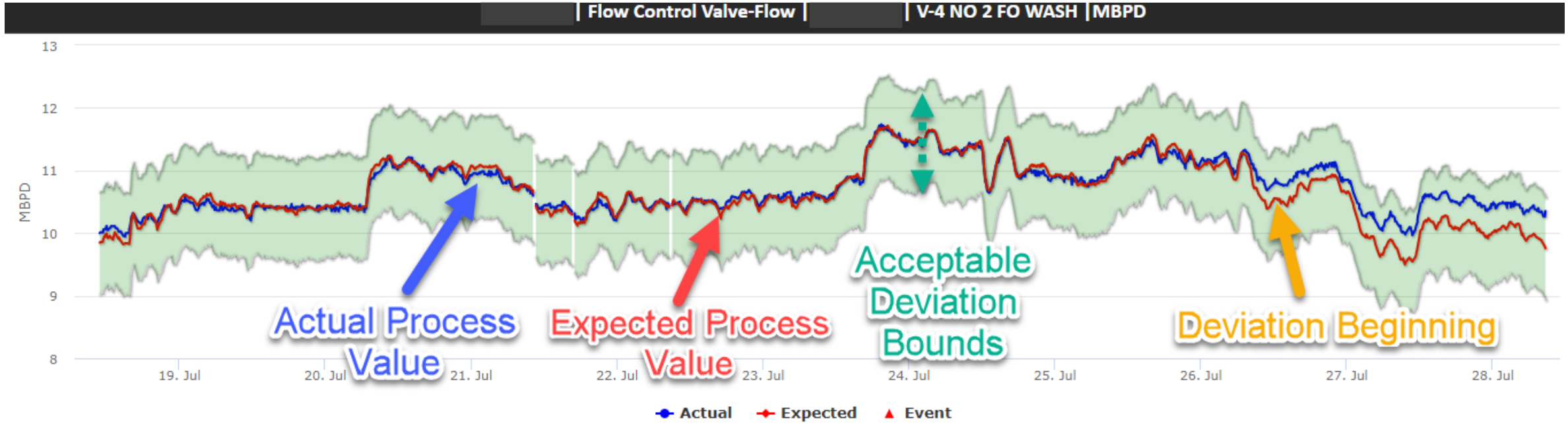
Example – Flow Control Valve



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?

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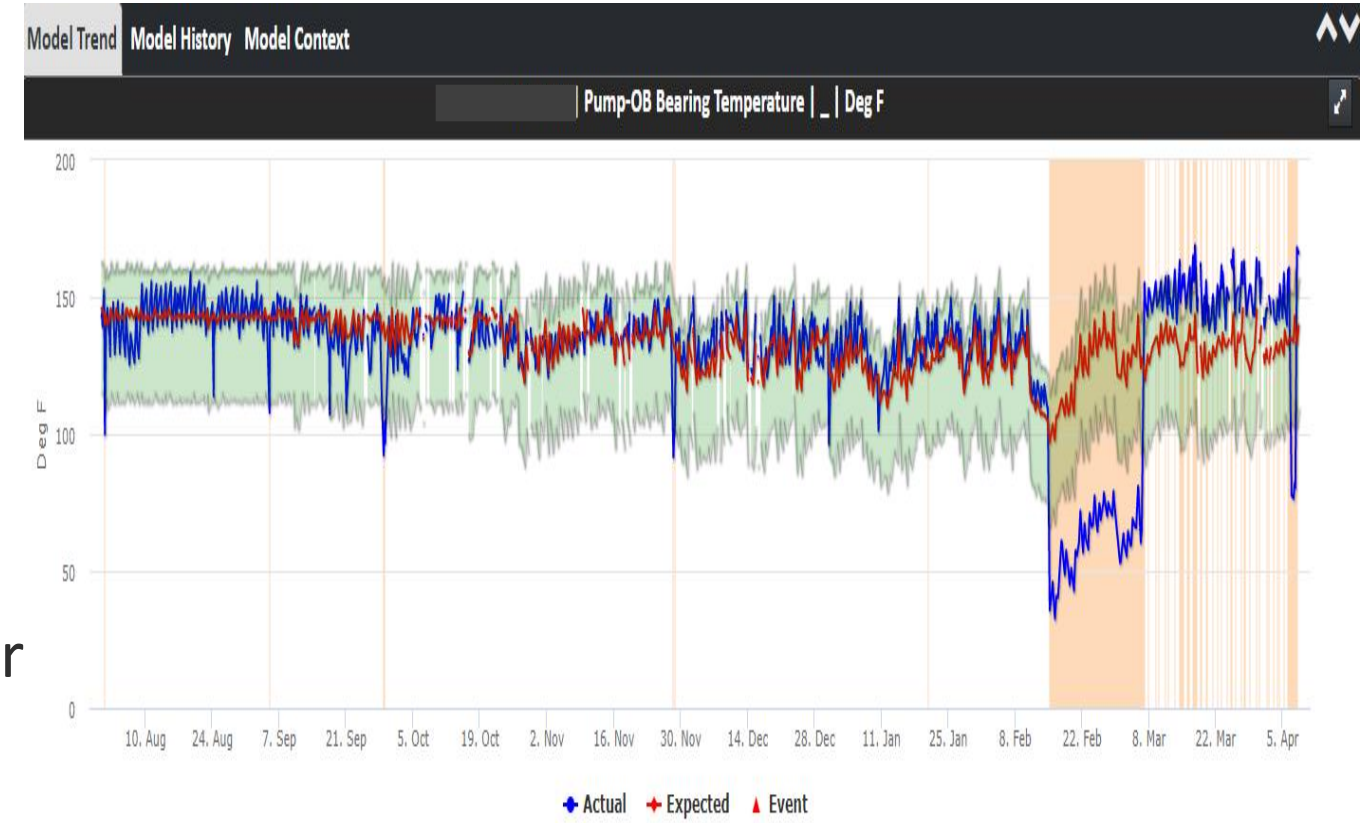
Steam Pump OB Bearing Temp

- 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



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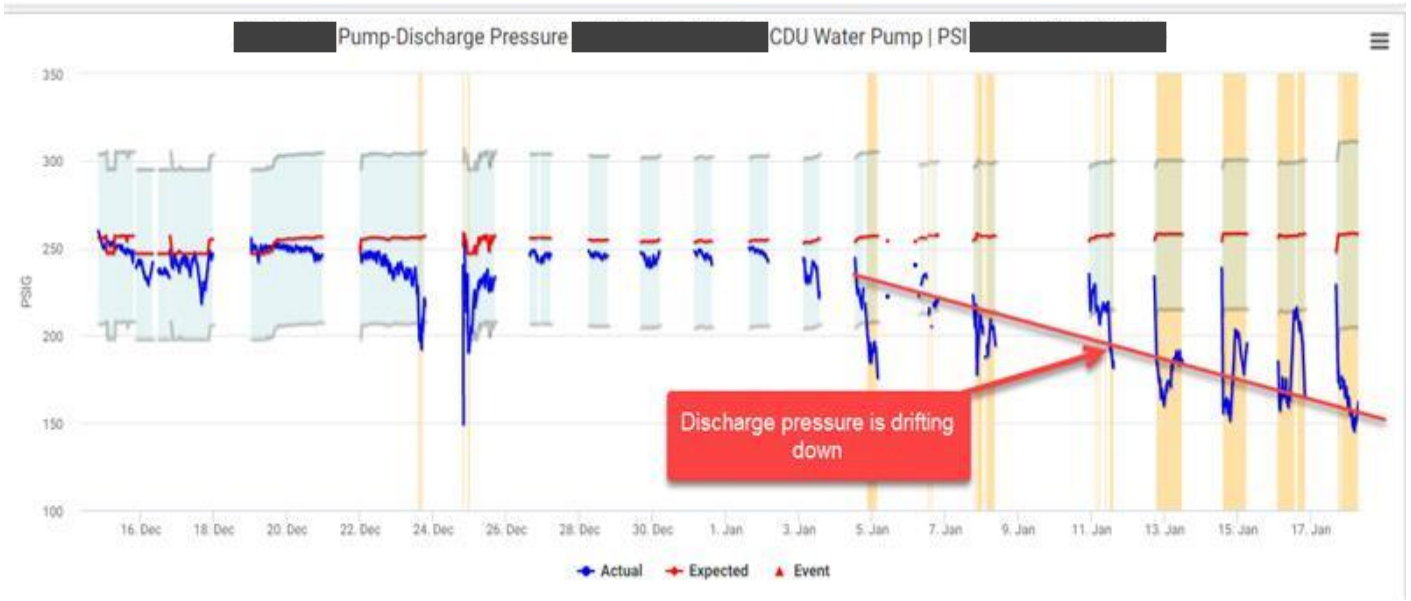
Pump Degraded Performance

- 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



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Modern Technology

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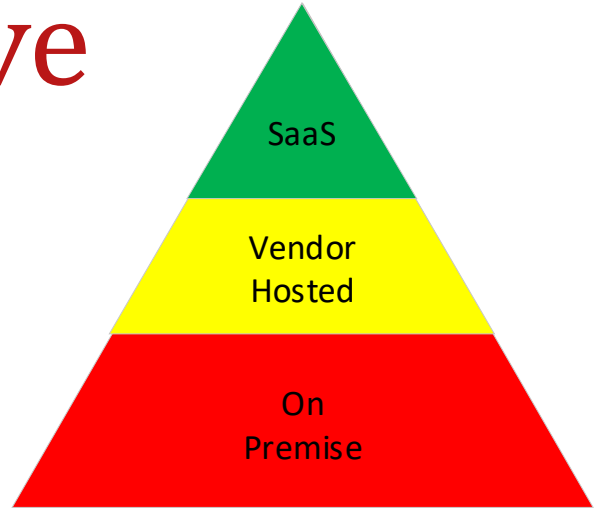
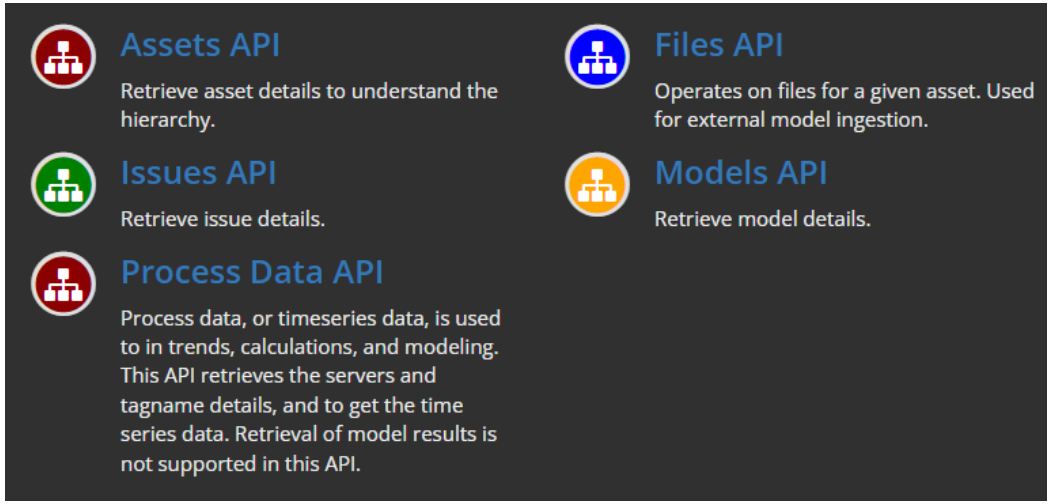
IT/Technology Perspective

- 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





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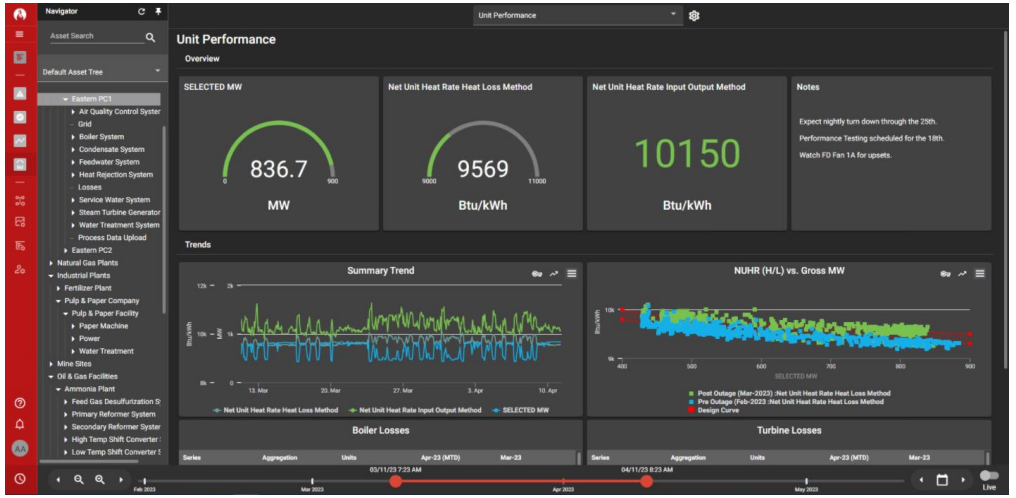
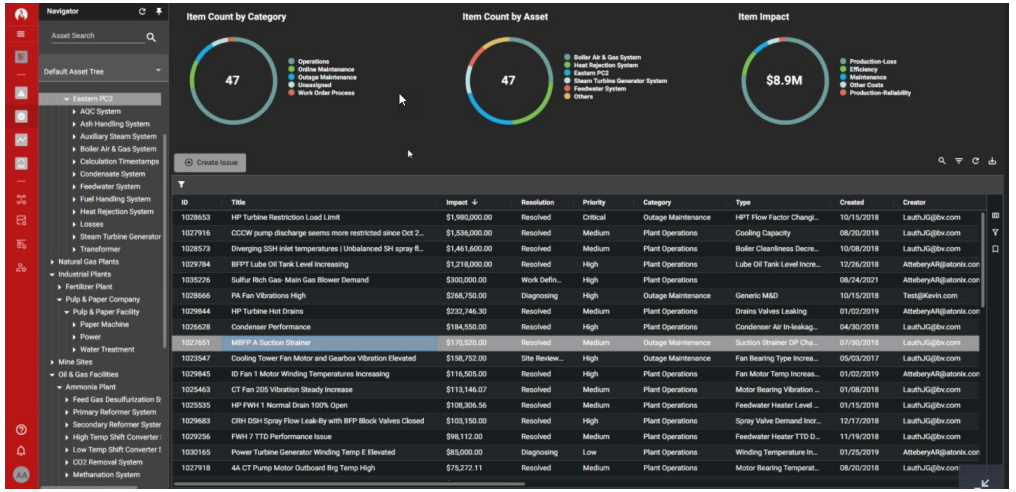
Looking Ahead

Next Steps

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





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Thank You

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Questions?

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