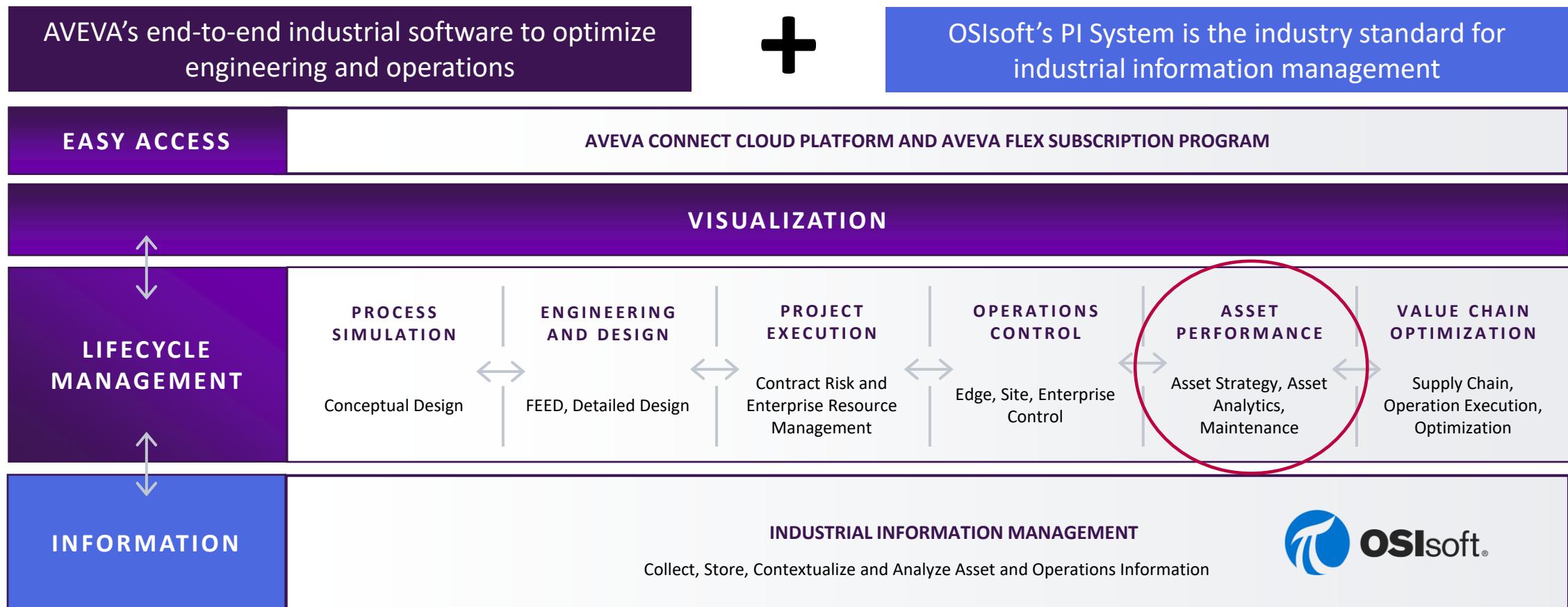


# AVEVA Predictive Analytics

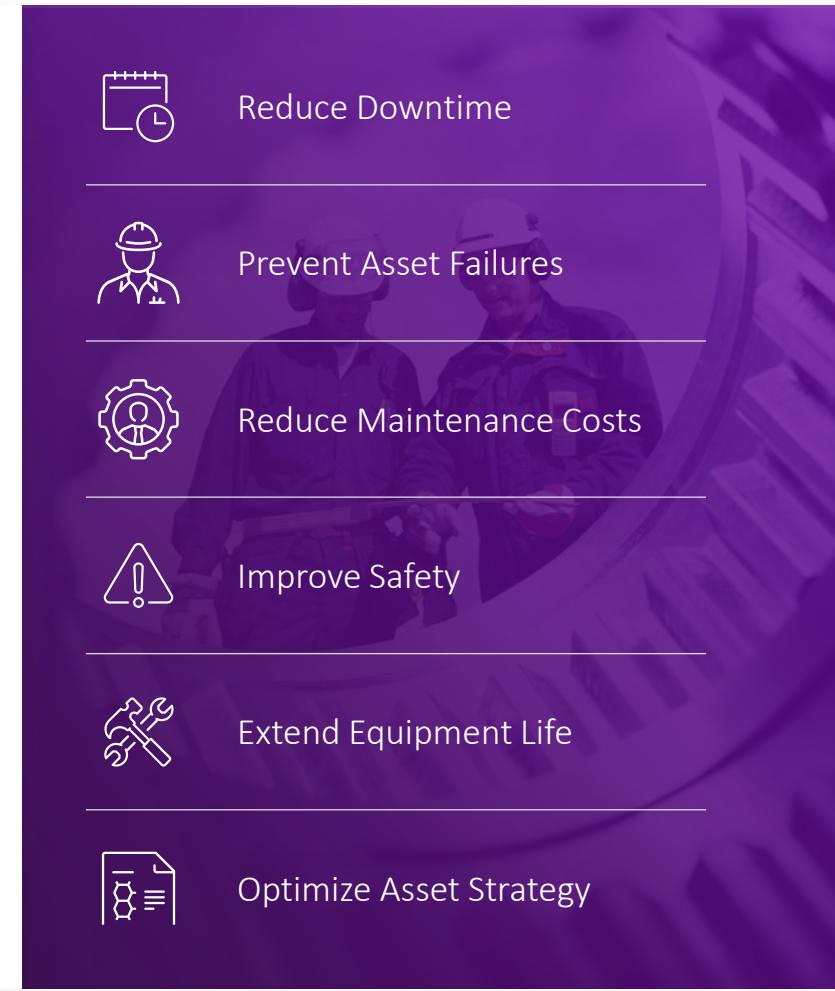
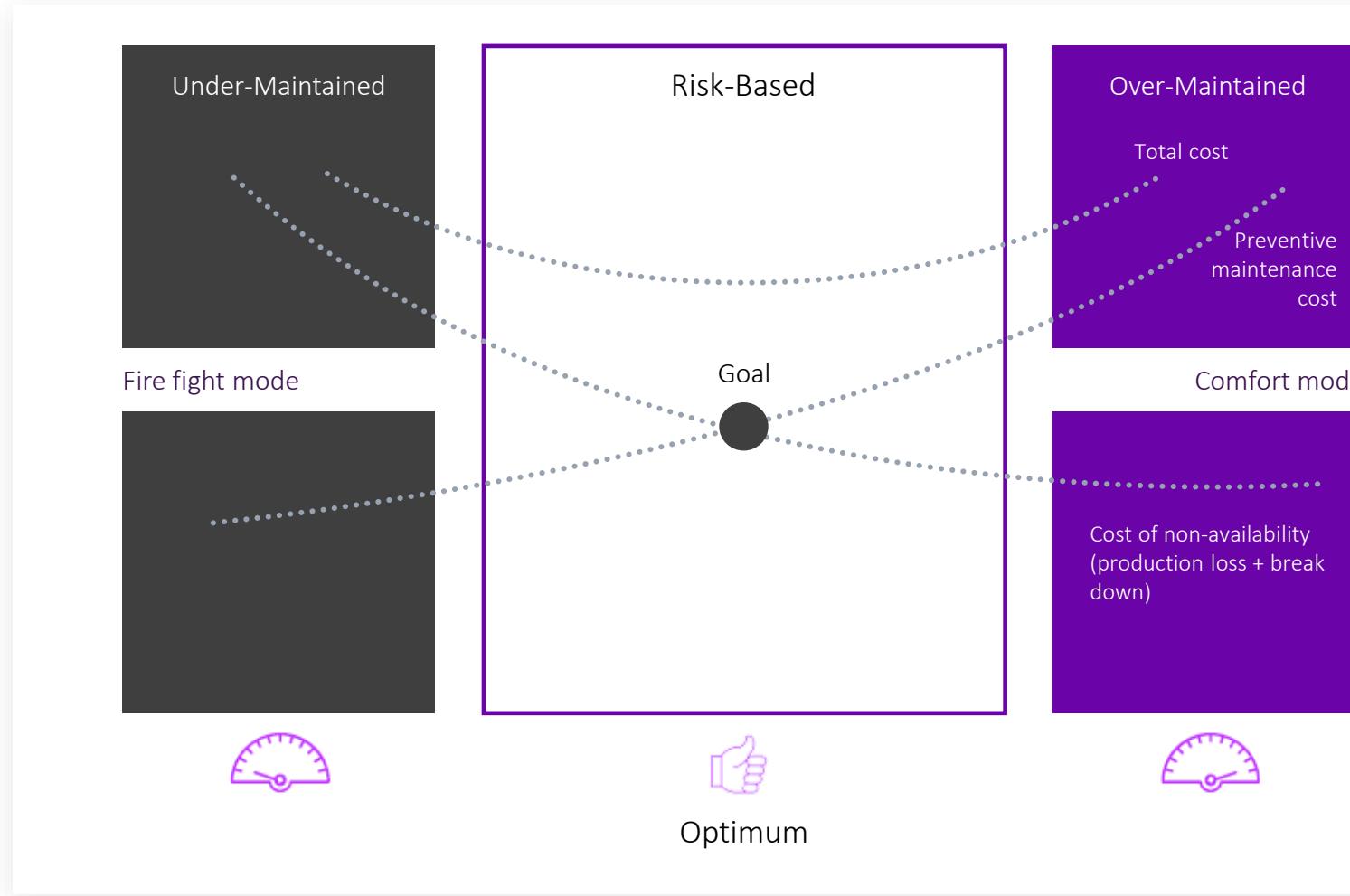
18<sup>th</sup> Aug'22

# Combining world-class software to drive Performance Intelligence

Accelerating digital transformation of the industrial world with complementary product offerings



# Increase Asset Reliability and Reduce Downtime

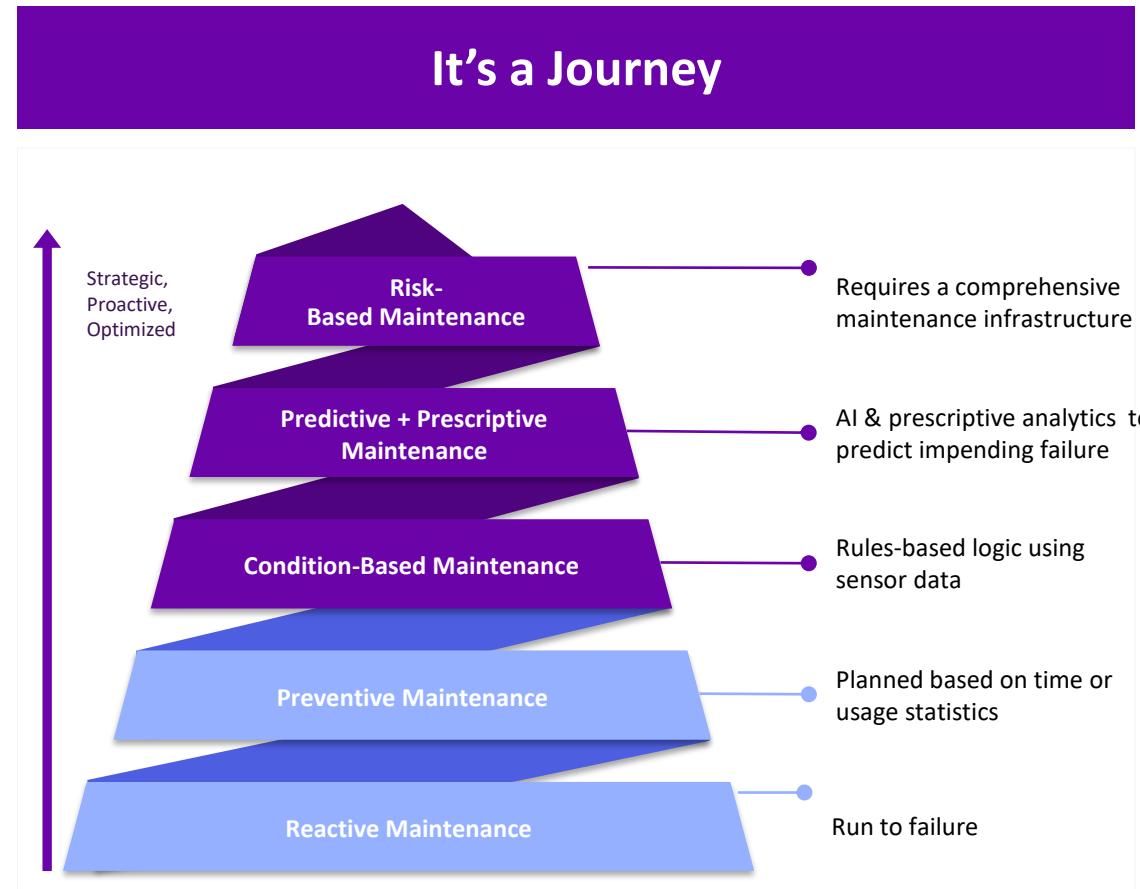
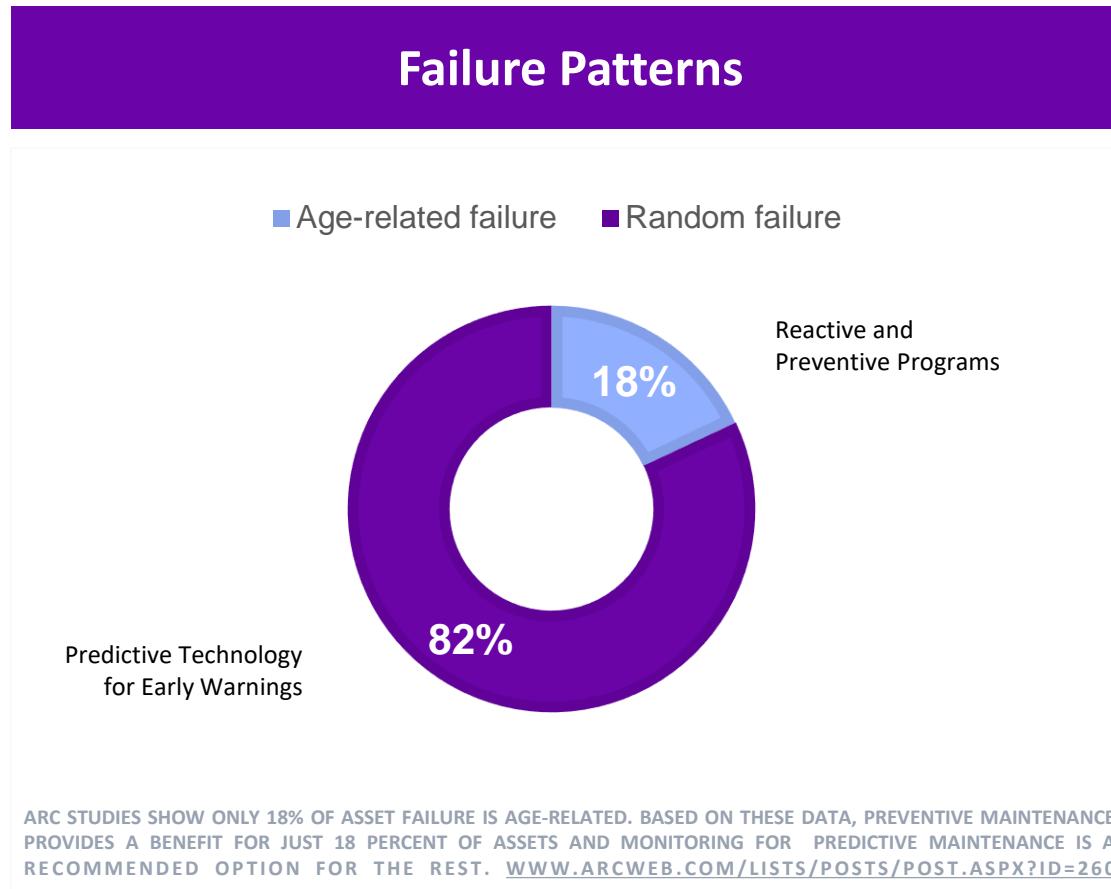


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# AVEVA Predictive Analytics

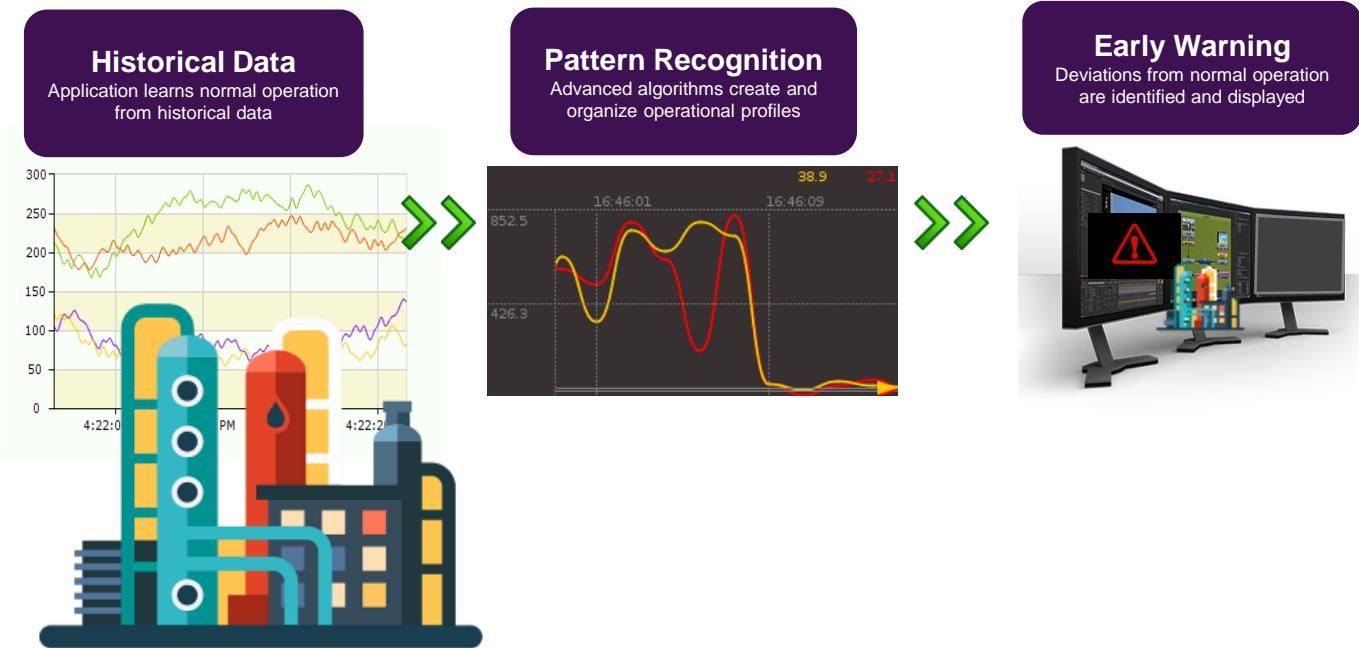


# AVEVA APM connects Asset Strategy to Corporate Objectives

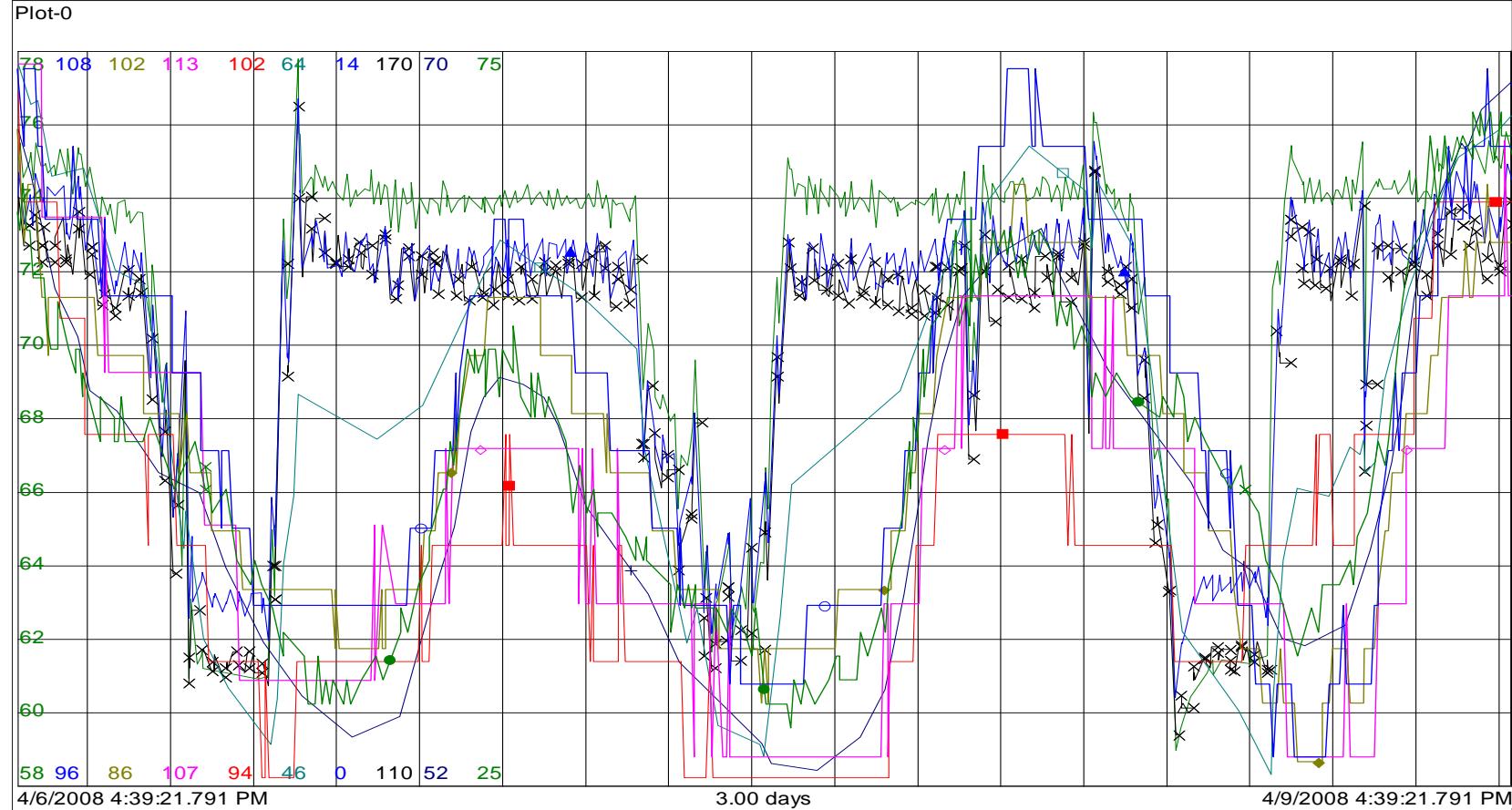


# Predictive Analytics

- Artificial Intelligence continuously monitors asset operational signature in real-time
- Early warning detection and diagnosis of equipment
- Predictive monitoring of industrial equipment assets
- Advanced analysis capabilities including problem identification & root cause analysis
- Purpose built OOB predictive monitoring of industrial assets achieves fast time to value

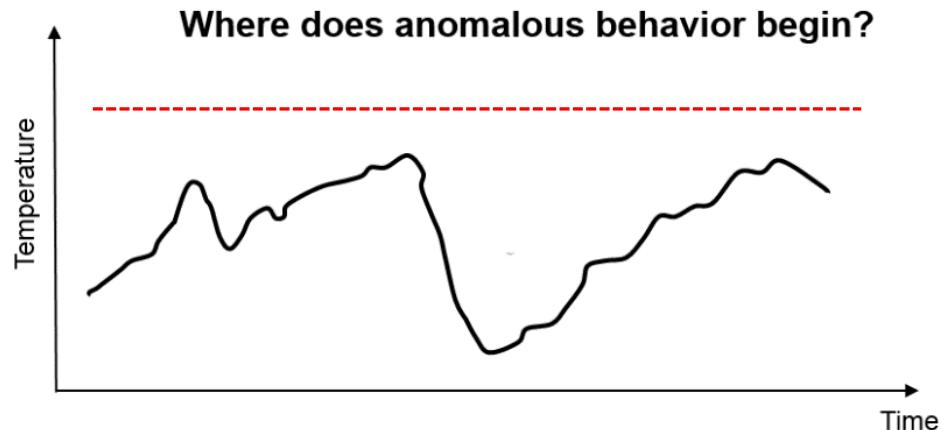


# Monitoring Without Predictive Analytics



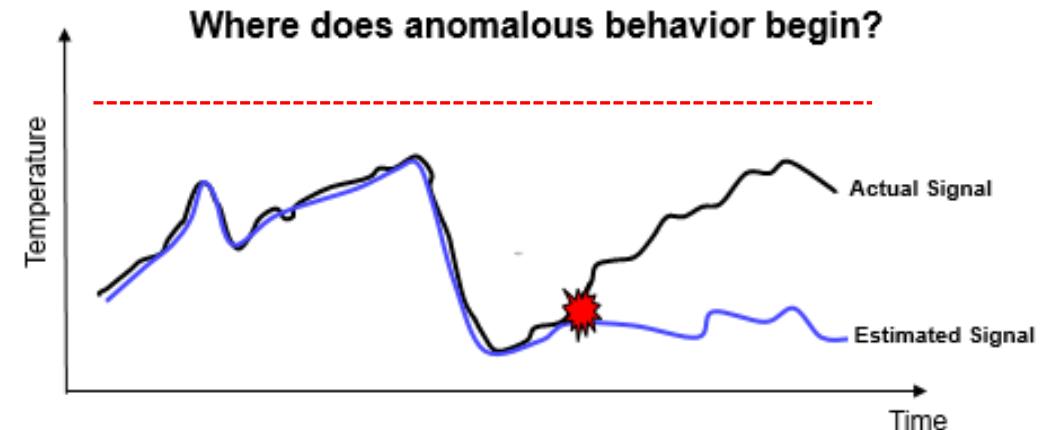
# Monitoring Approach

Traditional Monitoring



- Constant alert/alarm limits are typical
- Damage accumulates prior to reaching limit

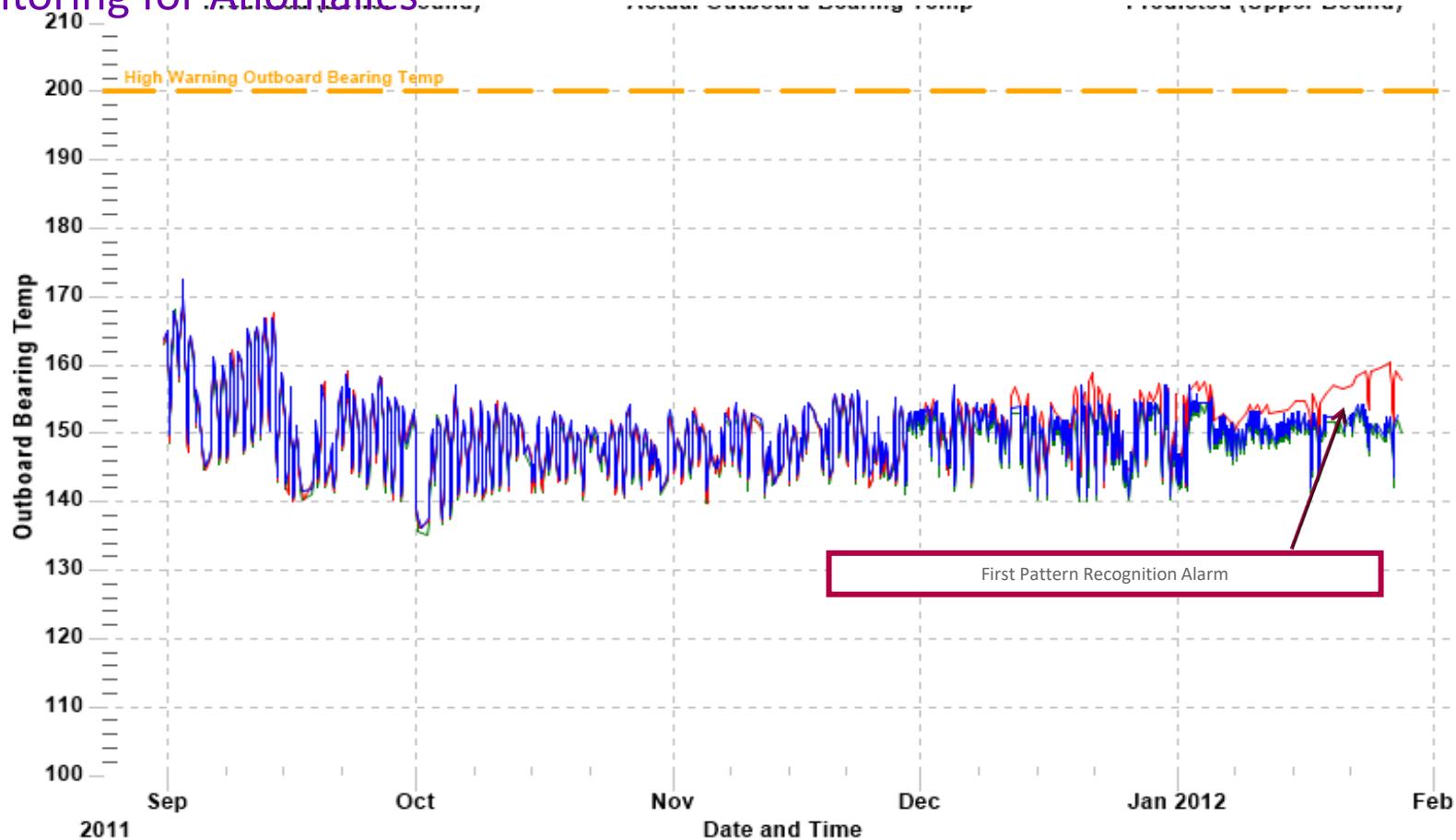
Predictive Asset Monitoring



- Actual minus estimated (residual) signal detects anomaly as-soon-as-possible

# Early Warning Prediction

## Monitoring for Anomalies



## Predictive Monitoring at Scale

We operationalize predictive analytics at scale better than anyone

 Model Templates

 Alert Management

 Fault Diagnostics

 Prescriptive Analytics

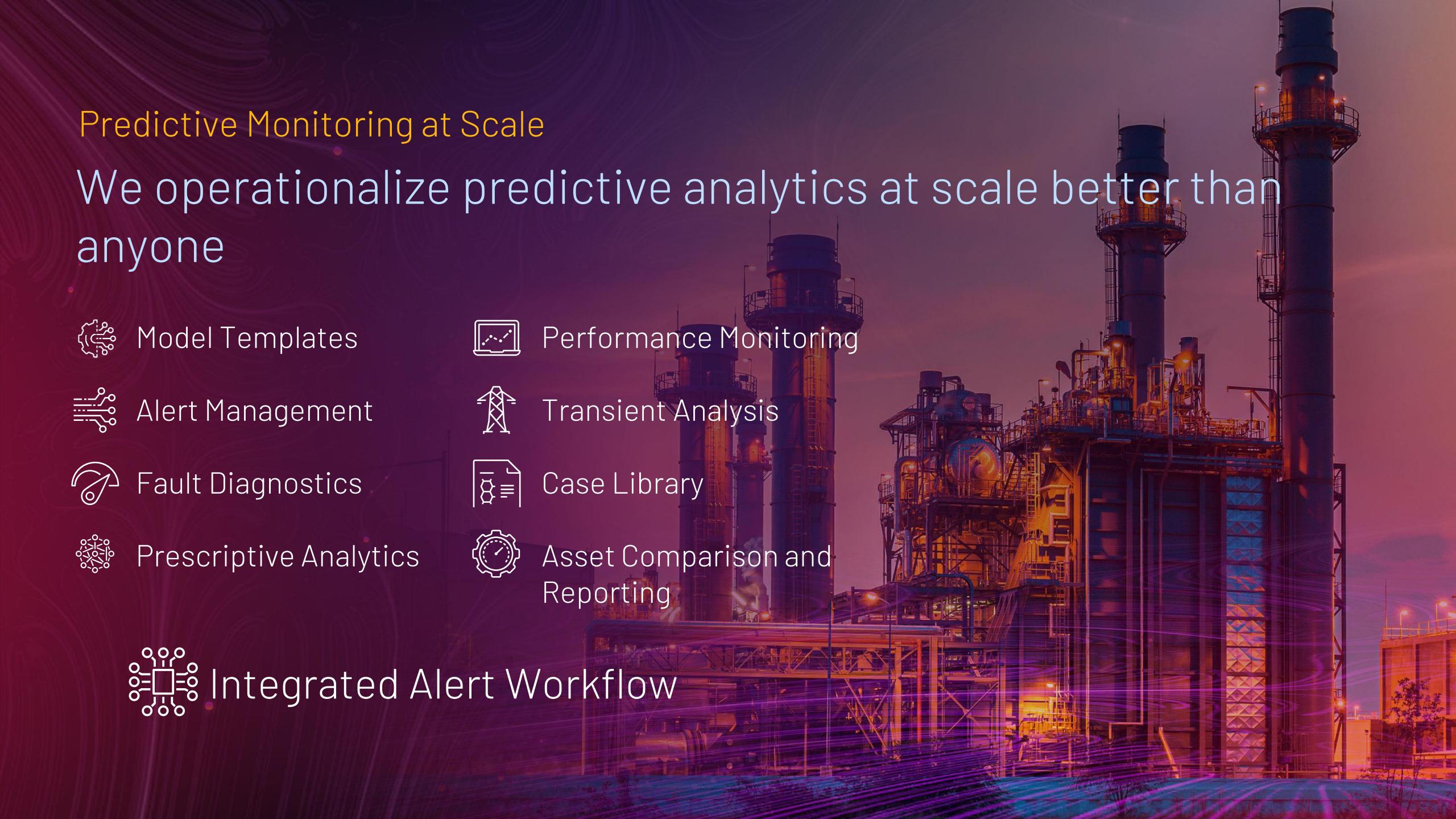
 Performance Monitoring

 Transient Analysis

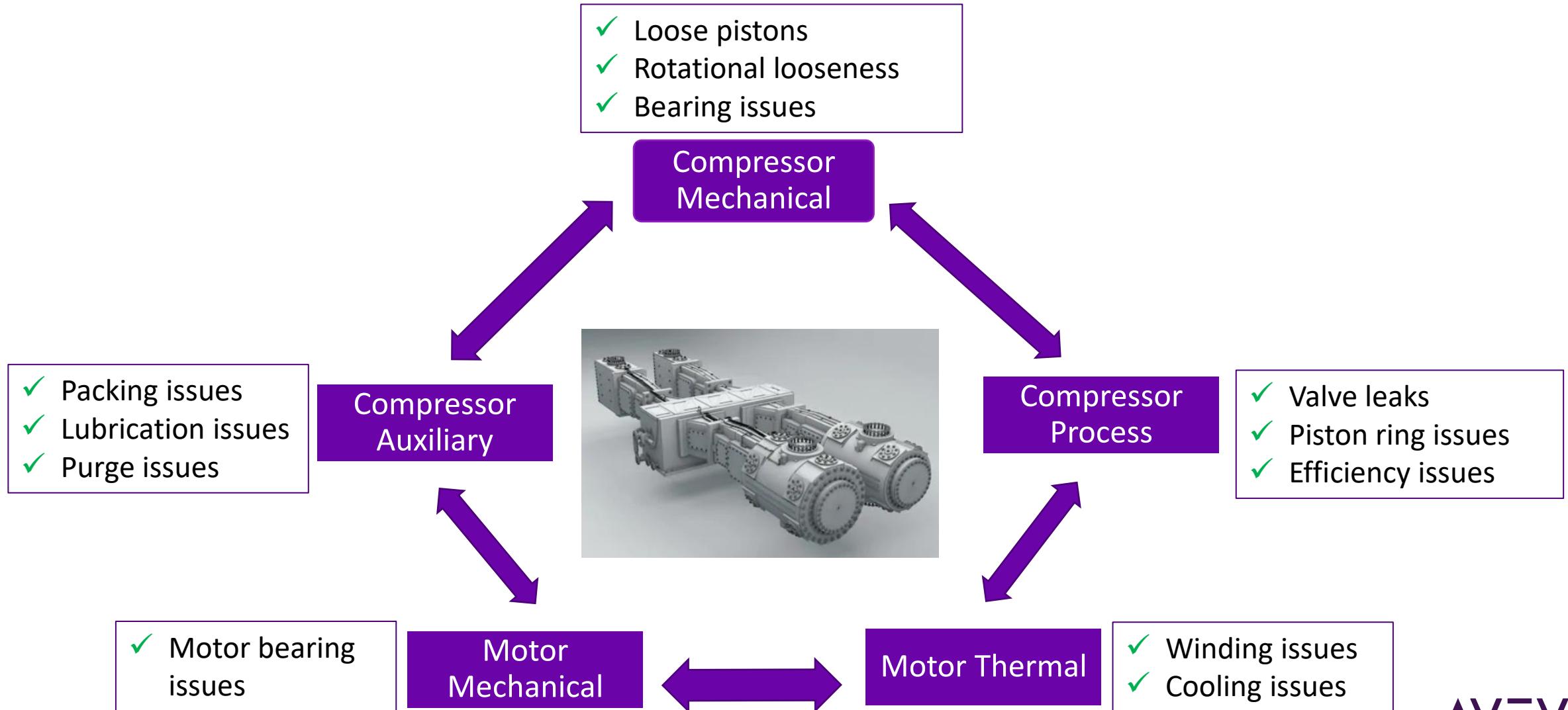
 Case Library

 Asset Comparison and Reporting

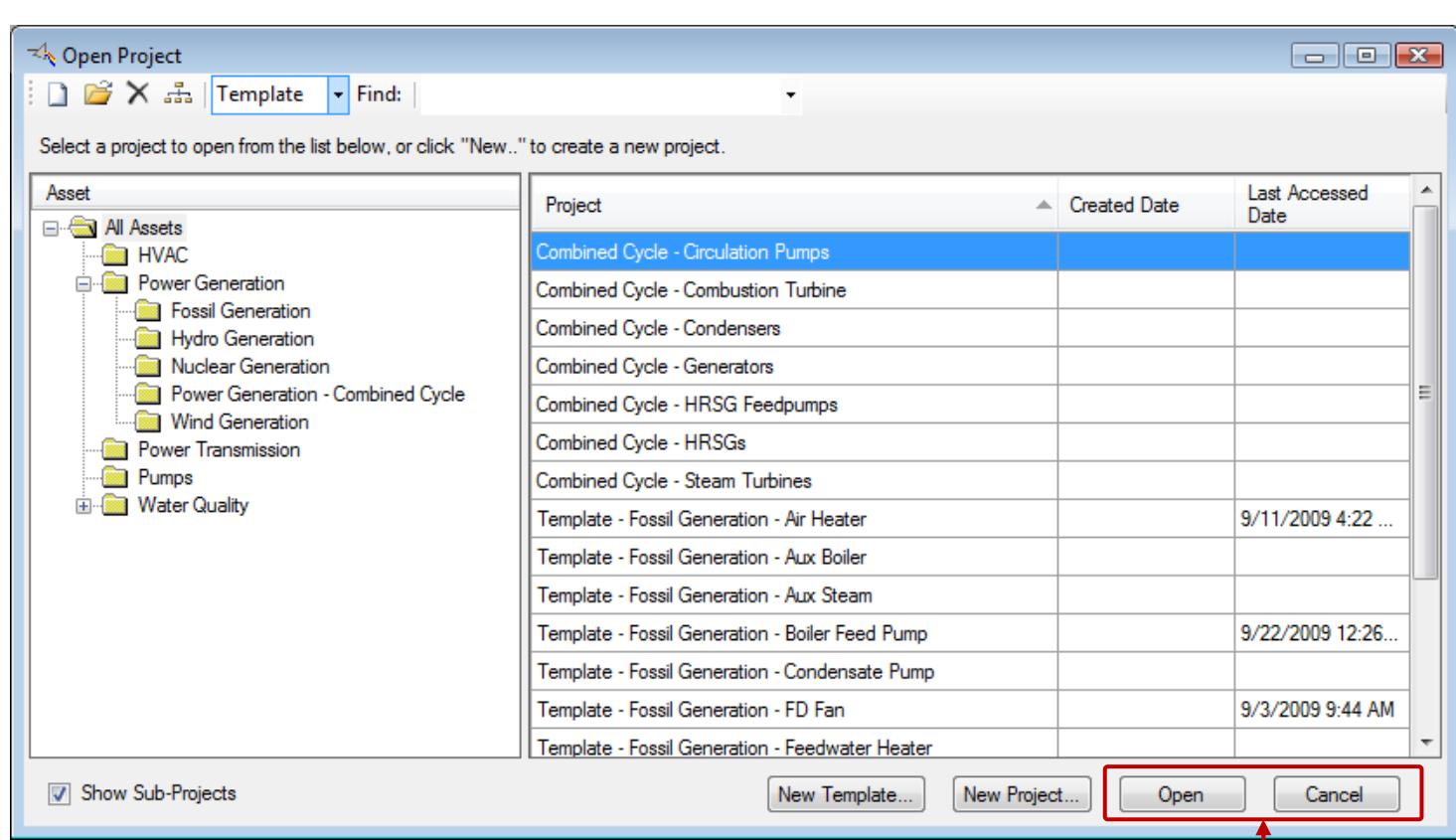
 Integrated Alert Workflow



# Reciprocating compressor models profile



# Model Templates



Make new templates or  
projects based on templates

- Develop core models once – reusability
- Centralized model updates
- Integrated security template layer
- Normalized sensor metric naming
- Asset comparisons
- Case library integration

# Web Alert Management and Diagnosis

AVEVA™ Predictive Analytics

Home Alerts Cases Reports Refreshed: 10/21/2020 11:31 AM C Auto

Alerts

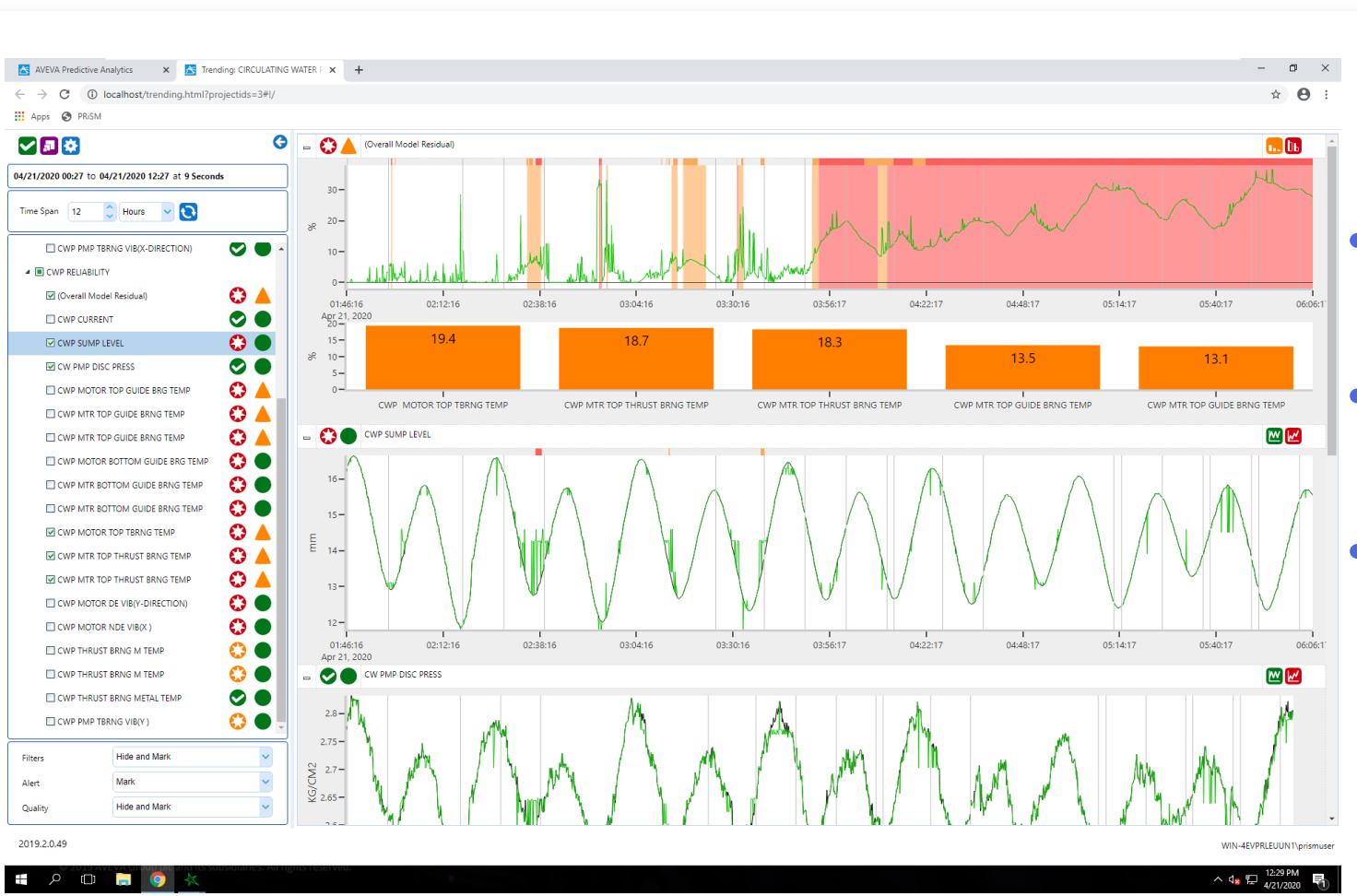
Show Trends Change State Project Notes Case History Quick Filter Search

Assets	Name	Alert State	Runtime Status	Case Status	7 Day Event History
- All Assets	<a href="#">Compressor - Mechanical</a>	✓	●	●	
	<a href="#">DRIVEN STEAM TURBINE - MECHANICAL</a>	*	■		
	<a href="#">DRIVEN STEAM TURBINE - PROCESS</a>	*	■		

Items per page 20 1 - 3 of 3 < < > >>

The screenshot shows the AVEVA Predictive Analytics web interface. At the top, there's a navigation bar with Home, Alerts (which is selected), Cases, and Reports. The main area is titled 'Alerts' and displays a table of assets. On the left, there's a sidebar for 'Assets' with categories like All Assets, Food and Beverage, Model Staging Area, Oil and Gas, and Power Generation. The main table has columns for Name, Alert State (with icons for checkmark, star, or red square), Runtime Status (with green, red, or grey circles), Case Status (with blue or grey icons), and a 7 Day Event History bar chart. Three rows are listed: 'Compressor - Mechanical' (green checkmark, green circle, blue icon, green bar), 'DRIVEN STEAM TURBINE - MECHANICAL' (red star, red square, grey icon, red/orange bar), and 'DRIVEN STEAM TURBINE - PROCESS' (red star, red square, grey icon, red bar). At the bottom, there are pagination controls for items per page (20) and a total of 3 items.

# Problem Analysis

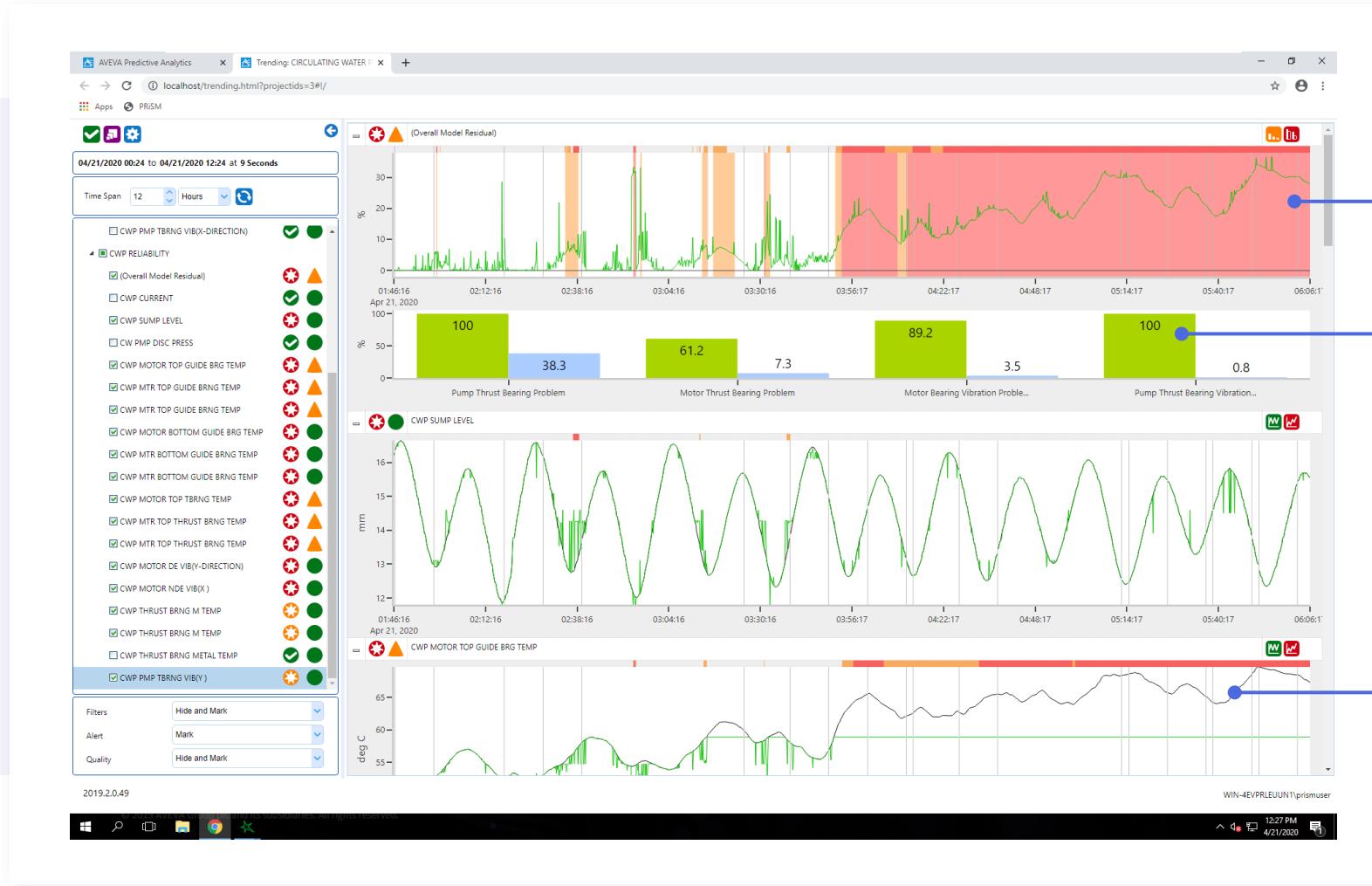


➤ Overall health indication

➤ Signal contribution to alert condition

➤ Signal actual vs predictive

# Fault Diagnostics

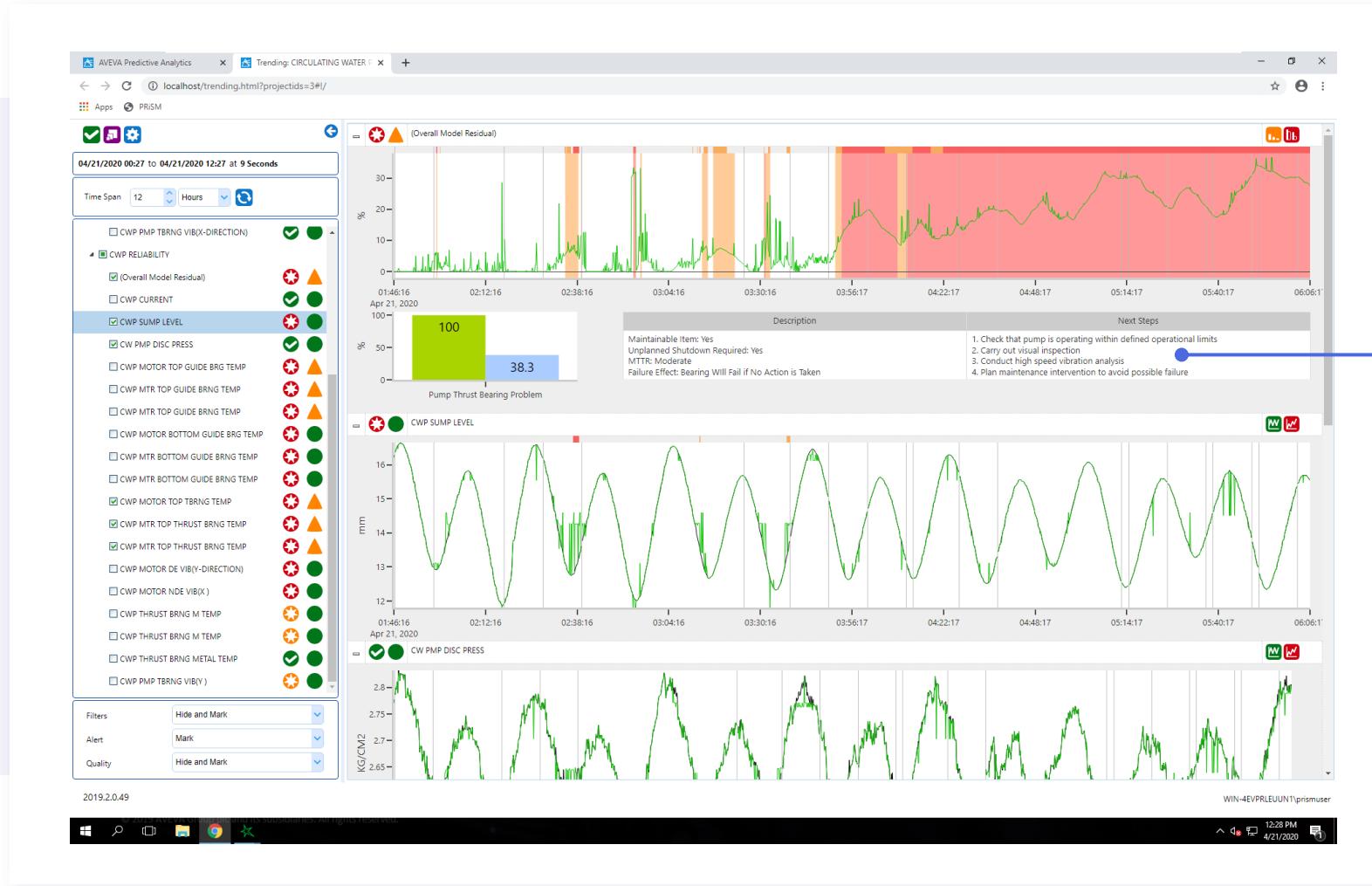


➤ Overall health indication

➤ Fault Diagnostics

➤ Signal actual vs predictive

# Prescriptive Analytics



Prescriptive Guidance

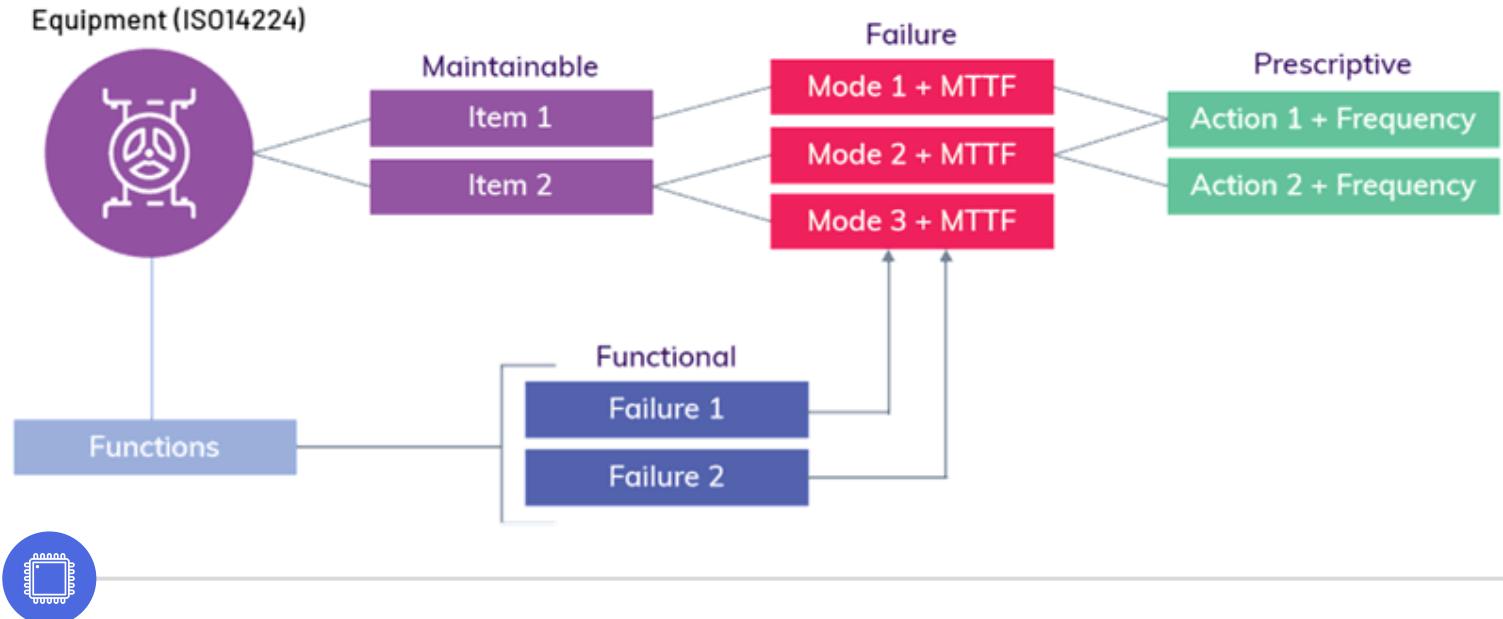
# Fault + Prescriptive Analytics Library - Deployment Acceleration

## AVEVA Asset Strategy Library



**By adding data and asset templates to the solution strategy deployment can be done up to 90% faster.**

The AVEVA Asset Library contains RCM-based equipment failure data and preventive maintenance for the most commonly found asset types in asset-intensive industries:



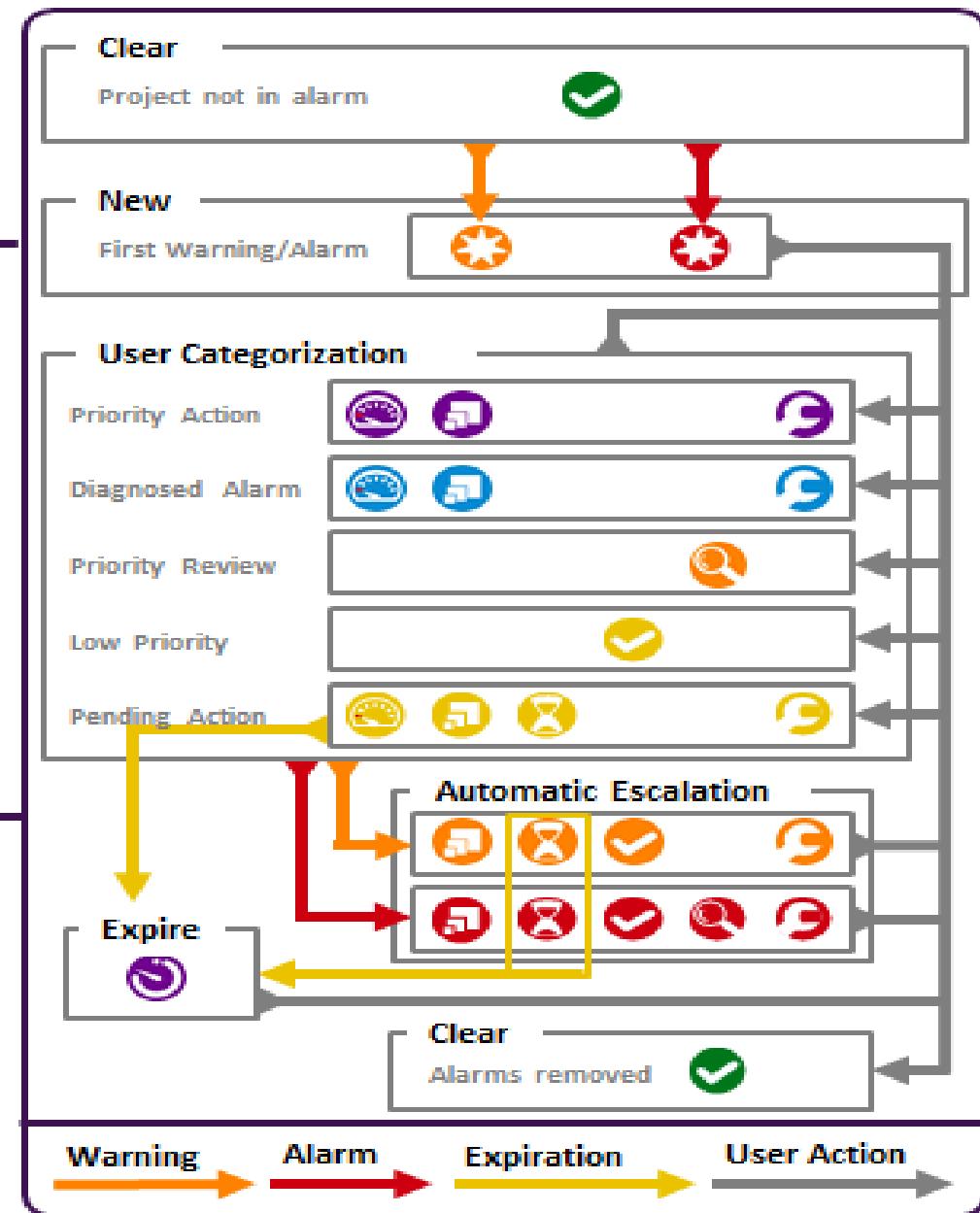
- 1,000 components
- 1,500 failure causes with failure conditions
- 2,000 preventative tasks
- 5,000 prescriptive tasks
- 20 years and 22,000 man-hours of experience

# Prescriptive Action – Discharge Valve Leak

FAULT DIAGNOSTIC	MAINTAINABLE ITEM	PRISM CATEGORY	PRESCRIPTIVE CATEGORY and ACTION	
Discharge Valve Leak	Check Valve	Compressor Process	<b>1. Operational</b>	1.1 Check Machine is within limits of defined Operating Window and Design Specifications
			<b>2. Inspection</b>	2.1 Check local instrumentation for correct operation to verify the fault diagnosis 2.1 Carry out visual and acoustic inspection on discharge valves and auxiliary systems 2.3 Check adequate functionality of valve actuating mechanism (springs) and valve dynamics (timing) 2.4 Check for obvious fouling on check valve that can be easily cleaned
			<b>3. Maintenance</b>	3.1 Plan maintenance intervention to replace the valve, refurbish valve if possible
			<b>4. Root Cause Analysis</b>	4.1 Check if any process conditions have changed that can lead to change in pressure, temperature or flow of processed gas 4.2 Check if any carryover of foreign material may have caused valve failure. 4.3 Check for pulsations in the system, which can cause valve flutter which decreases valve lifespan 4.4 Check wear on dampening plates which will increase wear on valve

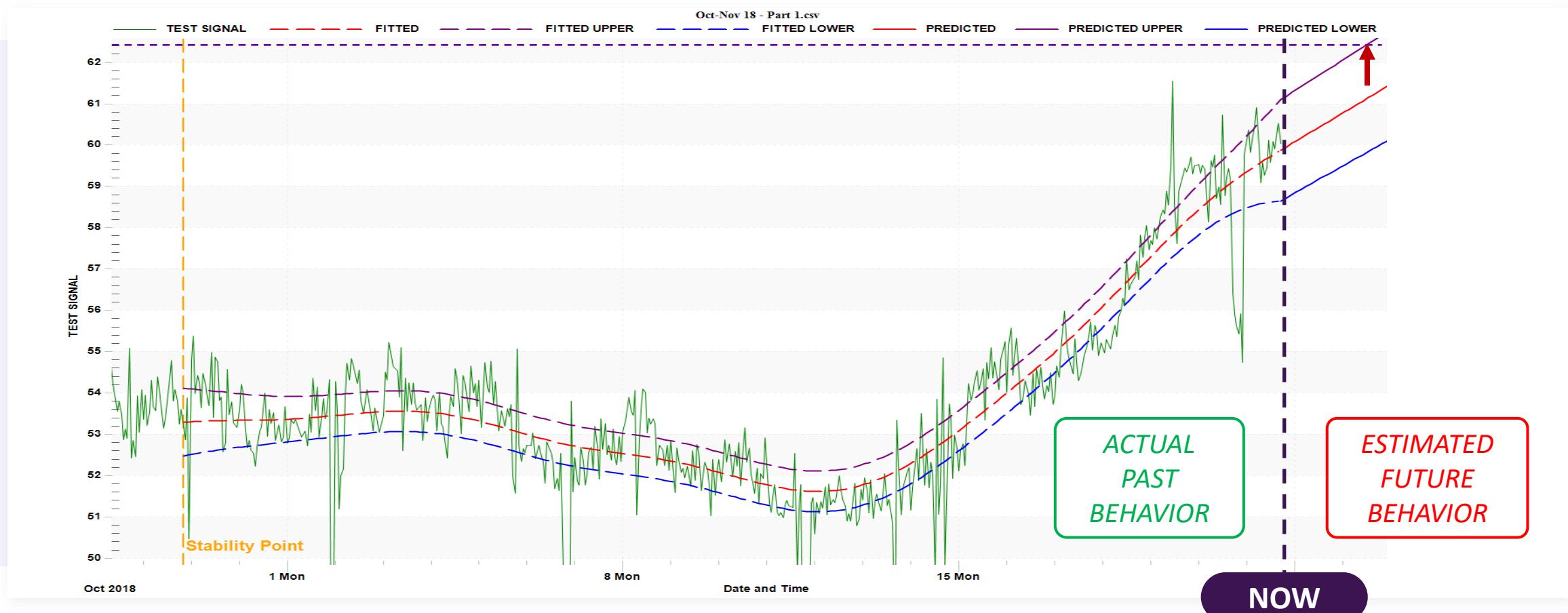
<b>Alarm State Category</b>	
Category determines the <u>shape</u> of the alarm state icon	
	<b>Clear</b> Project not in alarm
	<b>New</b> New warning or alarm
	<b>Acknowledge</b> Condition not of immediate concern
	<b>Pending</b> Condition not of immediate concern Expires when defer date met
	<b>Monitor</b> Condition is of immediate concern
	<b>Equipment</b> Condition caused by equipment issue
	<b>Model</b> Condition caused by model issue
	<b>Sensor</b> Condition caused by sensor issue
	<b>Action Due</b> A Follow-up action is due

<b>Alarm State Action</b>	
Action determines the <u>colour</u> of the alarm state icon	
	<b>Act</b> Follow-up action identified
	<b>Review</b> Information in need of review
	<b>Wait</b> Condition not of immediate concern
<b>Runtime Status</b>	
Current value evaluation of threshold	
	<b>Alarm</b> Alarm threshold exceeded
	<b>Warning</b> Warning threshold exceeded
	<b>OK</b> No thresholds exceeded



# Remaining Useful Life Estimate – Deep Learning

The earliest time when a projected value in the risk / uncertainty envelope cross the threshold



# Collaboration and Knowledge Transfer

The screenshot displays the AVEVA™ Predictive Analytics software interface. The top navigation bar includes Home, Alerts, Cases (selected), and Reports. The main content area shows a case details page for Case ID: 2006. The left sidebar lists Assets under All Assets, including Food and Beverage, Model Staging Area, Oil and Gas, and Power Generation. The central panel contains the following information:

- Title:** Driven Steam Turbine - Shaft Alignment Issue
- Start date:** 10/21/2020 11:40:54 AM    **End date:** 10/21/2020 11:41:34 AM
- Case state:** Closed
- Priority:** Normal
- Category:** Mechanical
- Assigned to:** prismuser

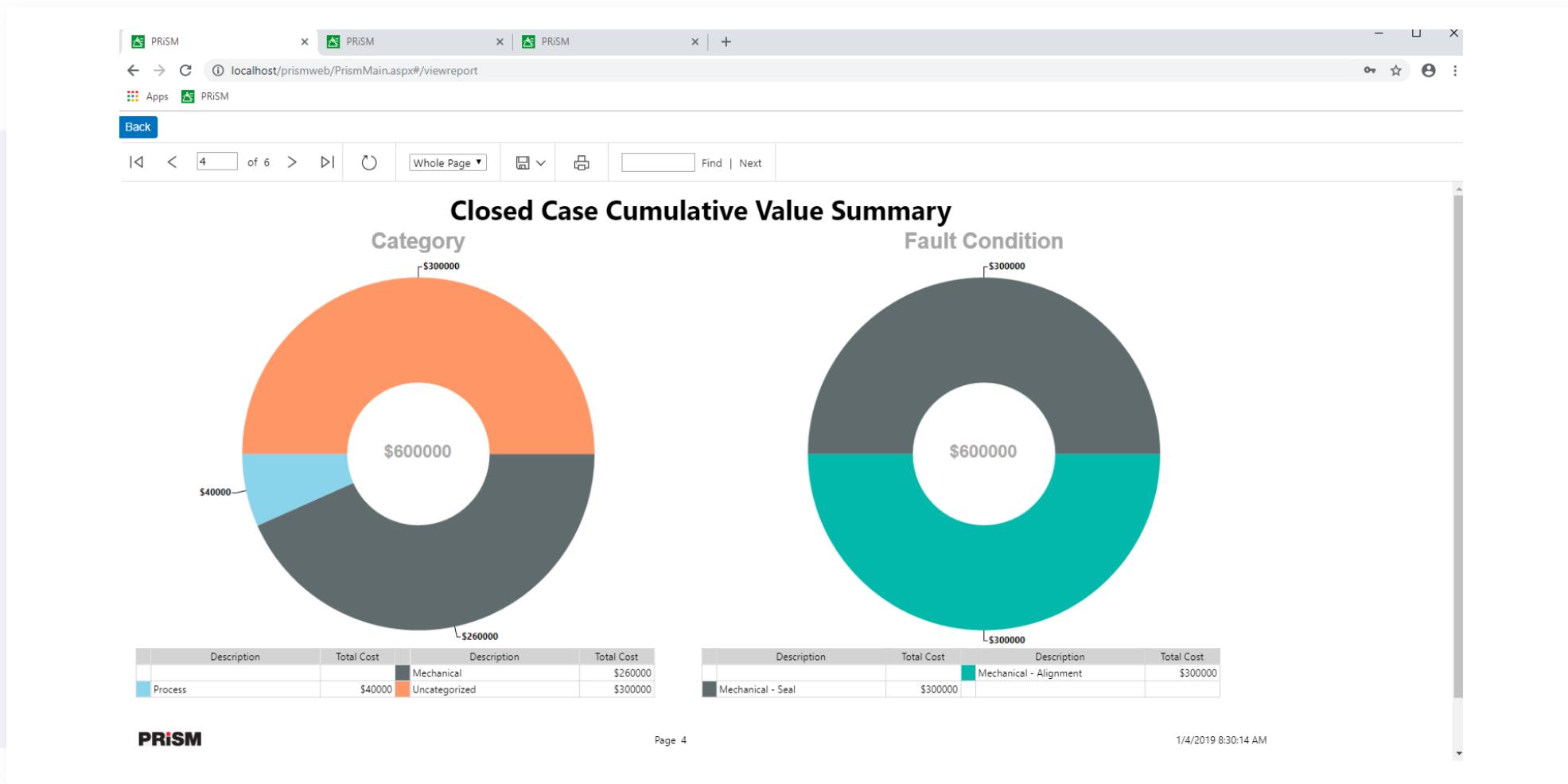
The description section notes:  
ST1 provides process steam for the oil extraction process at our APAC site.  
Case Alert: High OMR on ST1. High bearing temperatures detected. Moderately increased vibration.  
Diagnosis: Misalignment of drive shaft on ST1 after scheduled maintenance. High OMR detected on startup.  
Resolution: ST1 shutdown and high speed vibration analysis conducted. Shaft mass rebalanced and return to normal operation.

The Discussions tab shows two entries:

- prismuser 10/21/2020 11:40:54 AM: Case closed. Diagnosis provided in Case Description
- prismuser 10/21/2020 11:40:54 AM: Diagnosis
- prismuser 10/21/2020 11:40:54 AM: High OMR detected on ST1. Case notes provided in the description. Assigning case to site maintenance team.

At the bottom right, there are Save and Cancel buttons, and a footer with items per page (20), page 1-3 of 3, and navigation icons.

# Reporting



# Transient Analysis

Search History

Search Time Range

Starting Time: 12/ 5/2010 12:00:00 AM

Scan Every: 15 Minutes

Import Data Description:

Ending Time: 12/10/2010 12:26:00 PM

Sample Every: 1 Seconds

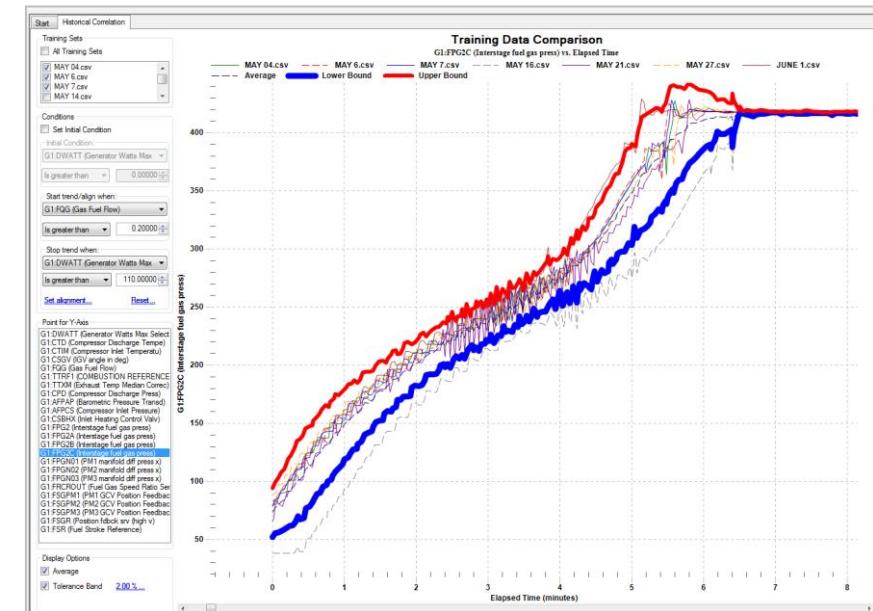
Buffer Data By: 75 Minutes

Import	Start	End	Duration	Name	In Project
<input type="checkbox"/>	11/3/2010 6:12 AM	11/3/2010 6:26 AM	00:14:02	HIST	YES
<input type="checkbox"/>	11/2/2010 7:10 AM	11/2/2010 7:25 AM	00:15:13	SEARCH IMPORT	YES
<input type="checkbox"/>	11/2/2010 11:06 AM	11/2/2010 11:21 AM	00:14:35	SEARCH IMPORT (1)	YES
<input type="checkbox"/>	11/2/2010 2:06 PM	11/2/2010 2:20 PM	00:14:06	SEARCH IMPORT (2)	YES
<input type="checkbox"/>	11/2/2010 7:28 PM	11/2/2010 7:44 PM	00:16:03	SEARCH IMPORT (3)	YES
<input type="checkbox"/>	11/2/2010 11:04 PM	11/2/2010 11:19 PM	00:15:09	SEARCH IMPORT (4)	YES
<input type="checkbox"/>	11/3/2010 2:33 AM	11/3/2010 2:48 AM	00:15:16	SEARCH IMPORT (5)	YES

Select All [Clear All](#)

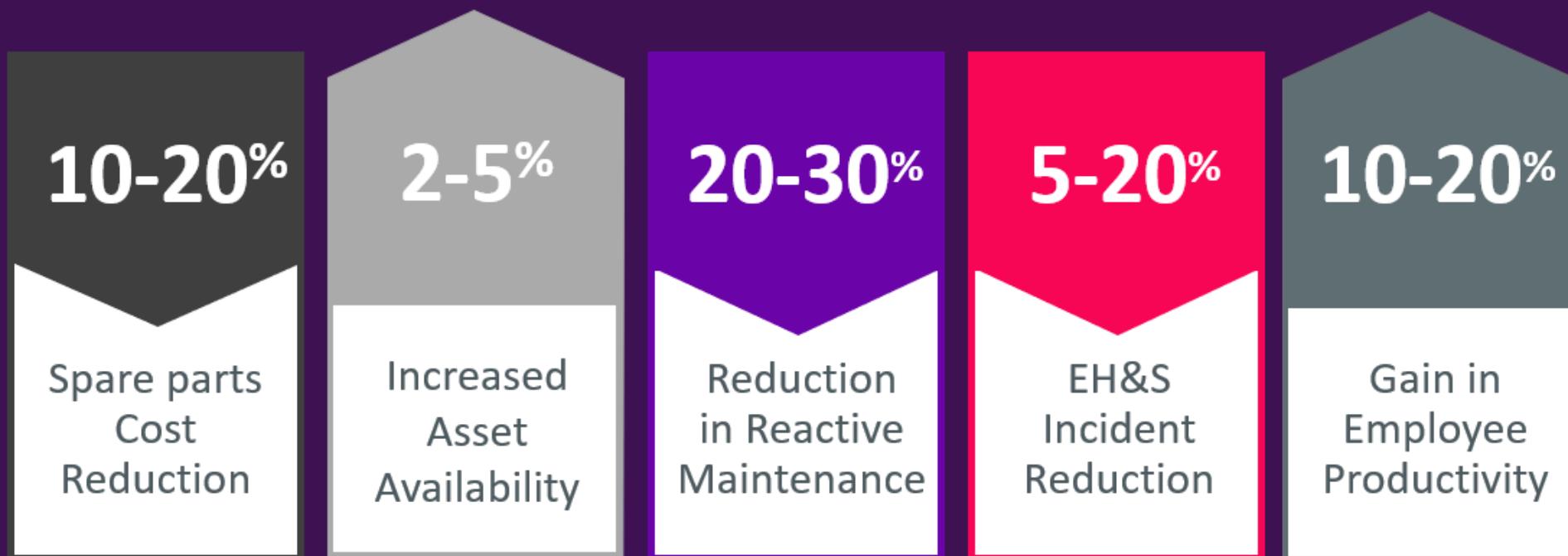
Import Search Close

## Turbine Startup/ Shutdown Monitoring



# Tangible Business Benefits

AVEVA APM is the only APM solution providing end-to-end value\*



- ▲ Reduce Unscheduled Downtime
- ▲ Prevent Equipment Failures
- ▲ Optimize An Assets Maintenance Strategy
- ▲ Reduce Maintenance Costs
- ▲ Increase Asset Utilization
- ▲ Extend Equipment Life
- ▲ Identify Underperforming Assets
- ▲ Improve Safety
- ▲ Adapt to Changing Workforce
- ▲ Digital Transformation Foundation
- ▲ Assurance (24x7 Monitoring)

\*It is recommended to do an assessment study to understand the baseline metrics and then set achievable targets

# Predictive Analytics – Key Benefits

## Delivering Measurable Value Across the Asset Lifecycle

### Optimize Availability & Production

- Reduce Unscheduled Downtime (-25%)
- Prevent Equipment Failures
- Extend Equipment Life
- Identify and Replicate Golden Batch

### Digital Transformation Foundation

- Adapt to Changing Workforce
- Enable Remote Monitoring of Sites (from 1 to 100+ sites)
- Enable Maintenance Team without Data Scientist

### Optimize Assets Maintenance Execution

- Reduction in inventory and supply chain costs (e.g. expedited orders, stock levels)
- Optimize Maintenance Planning & Workforce Efficiency (+25%) (e.g. reduce over-maintenance activities)
- Improve Safety

### Optimize Assets Maintenance Strategy

- Reduce Maintenance Costs (-30%)
- Identify normal and abnormal operating conditions
- Identify Underperforming Assets

### Enterprise Benefits

- Contribution to increased plant reliability & output
- Reduced environmental and safety risk
- Reduced risk to insurers (reduced premium)
- Holistic view of plant & fleet reliability

### Indications of data and instrument discrepancies

- Detect Faulty Sensors
- Detect Instrument Miscalibration
- Detect Data Connectivity Issues
- Enable indication of under-instrumented equipment

## Unified Operations Center unlocks value and drives efficiencies

### Challenges

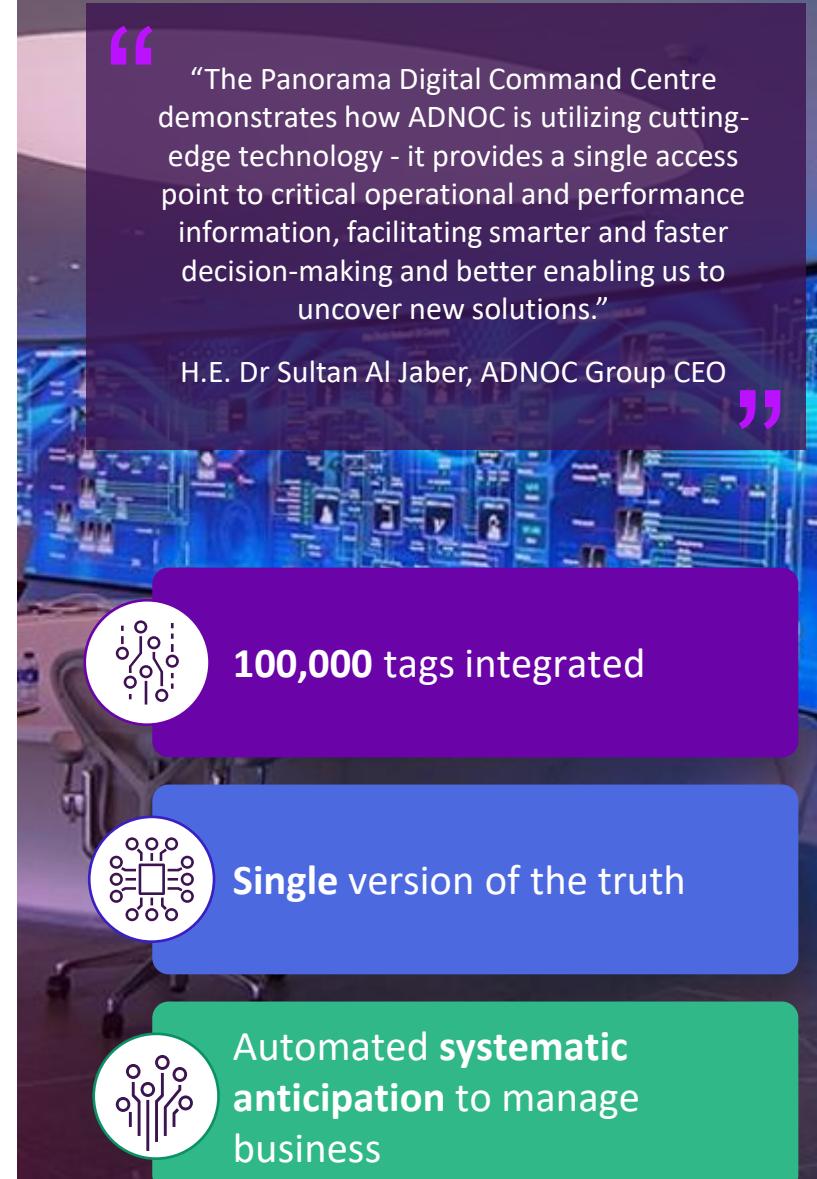
- Long cycle to produce production plans, inconsistency in reporting, location performance and discrepancy in transfer measurement between plants

### Solution

- Integrated Production Monitoring Platform, Performance Manager, Yield Accounting, System Platform and Historian
- Reduce “value leaks” and improve enterprise awareness with drill down on operations, equipment benchmarks, health and safety, energy usage, and production information
- Value optimization - macro and capacity planning with forecasting and What-if analysis of key inventories
- Information on cost/barrel as it moves through value chain

### Results

- Command Center integrates around 100,000 tags and aiming for more than 2 million tags
- Panorama provides access to information from one central location, enabling a “single version of the truth” via dashboards viewable from Pods and the 150ft x 10ft video wall centerpiece
- “Systematic Anticipation” a standardized, automated way of managing the business by looking at current and near future operations requirements, planned and actual performance
- Next: predictive analytics, decision automation and AI



“The Panorama Digital Command Centre demonstrates how ADNOC is utilizing cutting-edge technology - it provides a single access point to critical operational and performance information, facilitating smarter and faster decision-making and better enabling us to uncover new solutions.”

H.E. Dr Sultan Al Jaber, ADNOC Group CEO

**100,000 tags integrated**

**Single version of the truth**

**Automated systematic anticipation to manage business**

# Petronas



## Leveraged AVEVA Predictive Analytics to accurately predict and resolve equipment failures before they happen

### Goals

- Improve reliability of the rotating equipment in plants
- Reduce downtime at both onshore and offshore facilities
- Boost operational efficiencies and output

### Challenges

- Refineries were at risk of critical equipment failure
- Lack of information to warn of impending problems

### Solution

- Cloud-based AVEVA Predictive Analytics (APM)

### Results

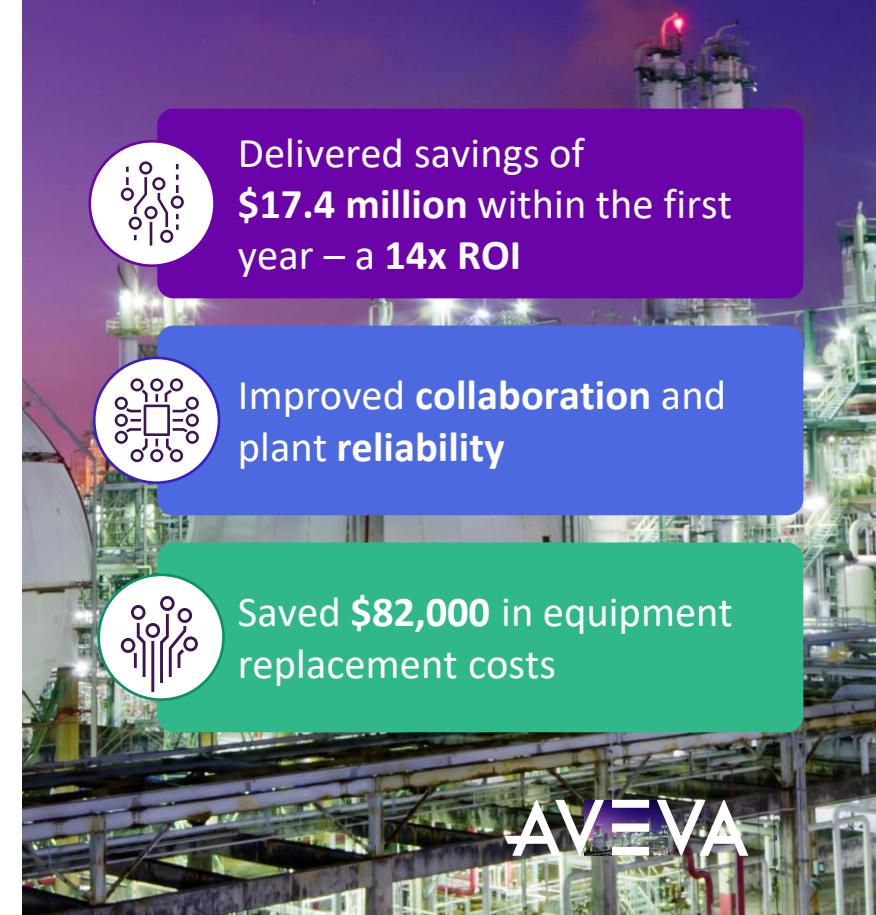
- Saved \$17.4M (RM73.1M) in the first year as a result of reduced unplanned downtime, from 51 warnings, of which 12 were considered high-risk
- Delivered 14x ROI within the first year
- Increased uptime as a result of the 51 avoided lost time incidents
- Safer working environment
- Increased asset utilization, via the identification of underperforming assets and pre-emptive improvement actions
- System expansion using cloud across 10 new sites with more planned

“

“Not only does our AVEVA solution deliver early detection of anomalies and failure, but it also enables us to institutionalise our years of machine operation experience into a digital platform”

Azizol Kamaruddin, Principal for Rotating Equipment, PETRONAS

”



Delivered savings of **\$17.4 million** within the first year – a **14x ROI**



Improved **collaboration** and **plant reliability**



Saved **\$82,000** in equipment replacement costs

# Total

## Selects AVEVA for Predictive Analytics

- Challenges
  - Our competitor had a significant install base of their software at Total for many years for the upstream side of Total's business
  - Total was looking for a solution that was easier for engineers to quickly learn
- Solution
  - PI System is deployed as the real-time industrial data infrastructure for the Total business.
  - AVEVA was able to demonstrate to Total that AVEVA's Predictive Analytics was best in class predictive maintenance solution resulting in AVEVA being selected for the entire downstream business.
- Results
  - Improved the reliability of Total refining operations
  - Early warning detection and diagnosis of equipment problems
  - Predictive monitoring of critical assets (compressors, pumps, expanders, turbines, etc.)



**“** Improving the reliability and performance of critical assets with predictive analytics.



**AVEVA™**

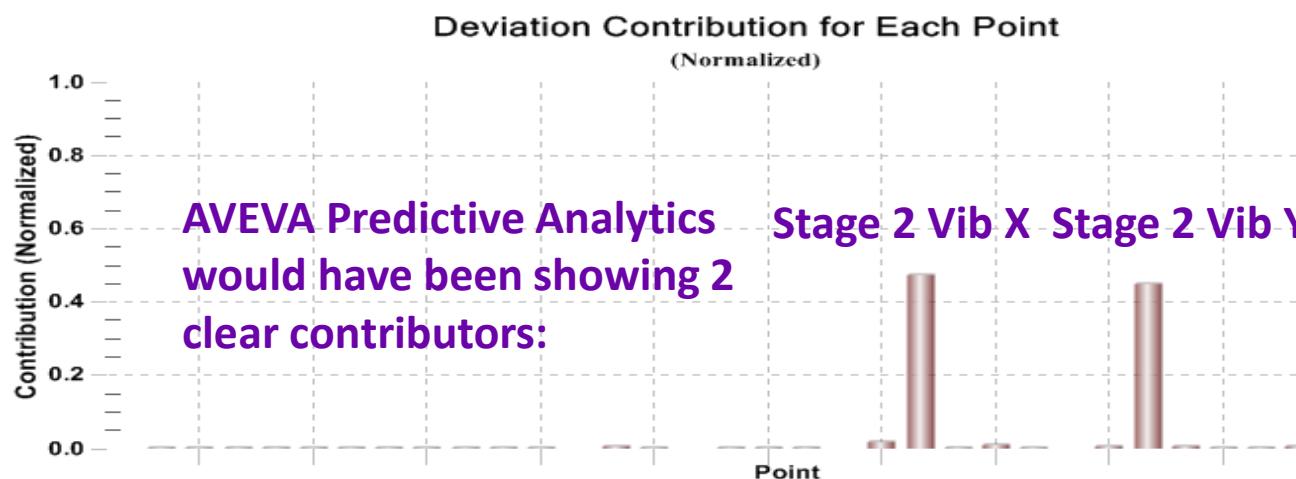
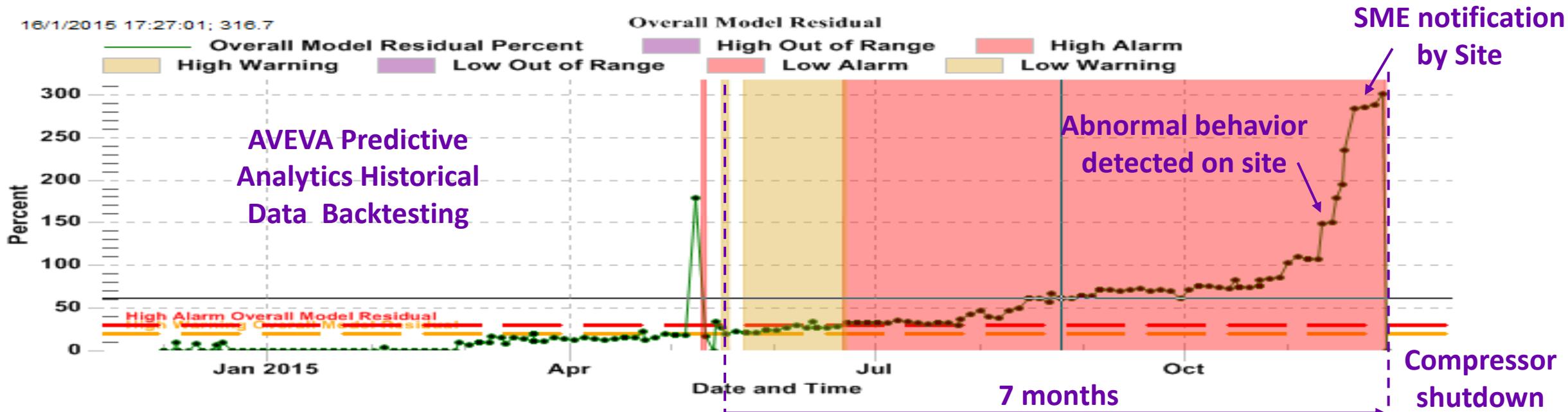
# Air Liquide

## Partners with AVEVA for Predictive Asset Analytics

- Challenges
  - Our competitor had a successful pilot running with the customer and customer was far into their decision process
  - We had not previously monitored some of the compressor types that Air Liquide wanted to monitor
- Solution
  - PI System is deployed as real-time industrial data infrastructure solution provides incident analysis, asset performance reporting and situational awareness.
  - Air Liquide has centrally deployed AVEVA Predictive Asset Analytics software in 3 remote monitoring centers (Europe, North American and Asia) for monitoring their critical production assets (compressors, motors, turbines, etc.)
  - The software will be deployed for monitoring up to 500 of their large industries plants as part of their Smart Innovative Operations digital transformation program
- Results
  - Ability to effectively plan and schedule maintenance and outages around customer demand
  - Early warning detection and diagnosis of equipment problems
  - Predictive monitoring of critical assets (compressors, pumps, expanders, turbines, etc.)

“ Reliably and confidently meeting customer commitments with their SIO Predict program. ”





First warning on May: failure predicted 7 months before unplanned outage occurred in December!

This would have allowed optimizing spares provision and maintenance planning.

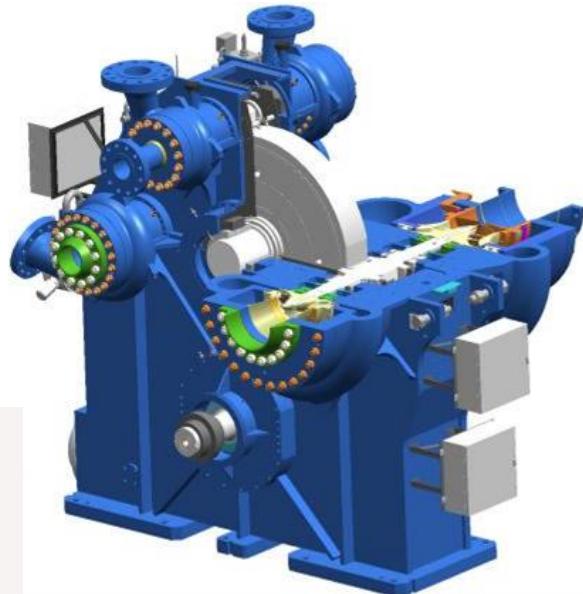
# Cracked Impeller

- Early warning with clear indicators of anomaly on the 2nd stage ~3 months before operators noticed it.
- No significant savings expected on the rotor repair as in any case the cracks were already developed
- Significant savings possible on:
  - Site activities (no emergency maintenance)
  - Production savings (a better window may be identified with the customer for the overhaul)

**Saving estimation  
>\$500k**



# ADNOC GAS PROCESSING

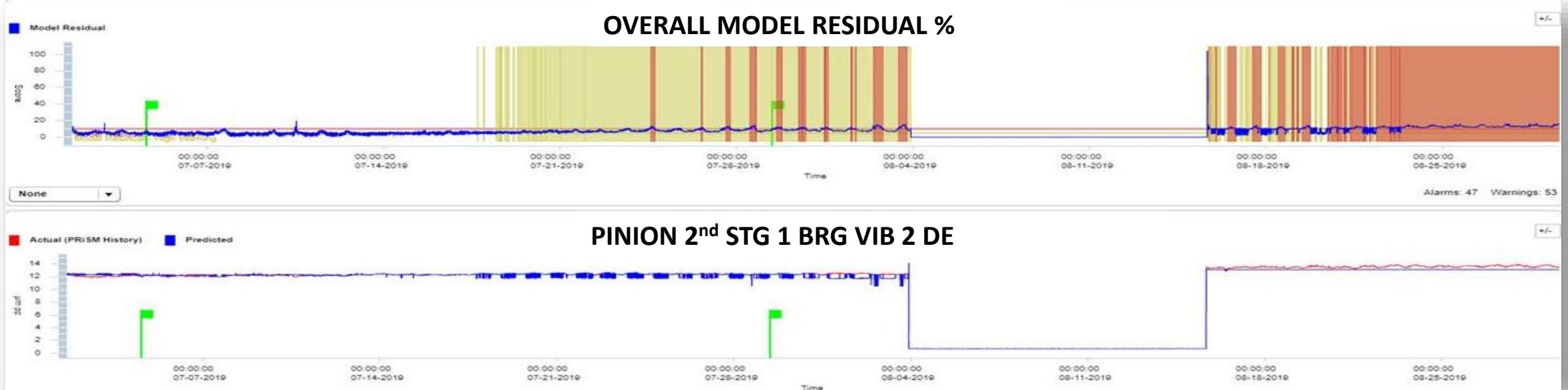


## Catch on an Integrally Geared Compressor



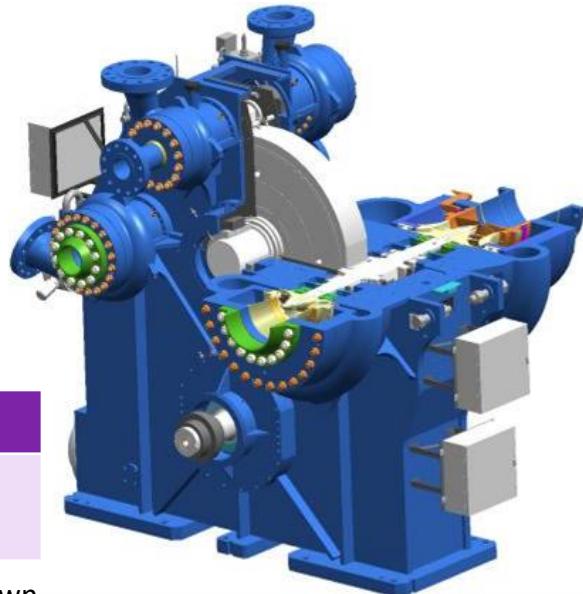
### What AVEVA Predictive Analytics found :

The vibration level of the second pinion on first stage bearing was increasing at a slow and steady rate. This was indication of a developing bearing issue that would have worsened with potential severe consequences on the compressor and unplanned shutdown.



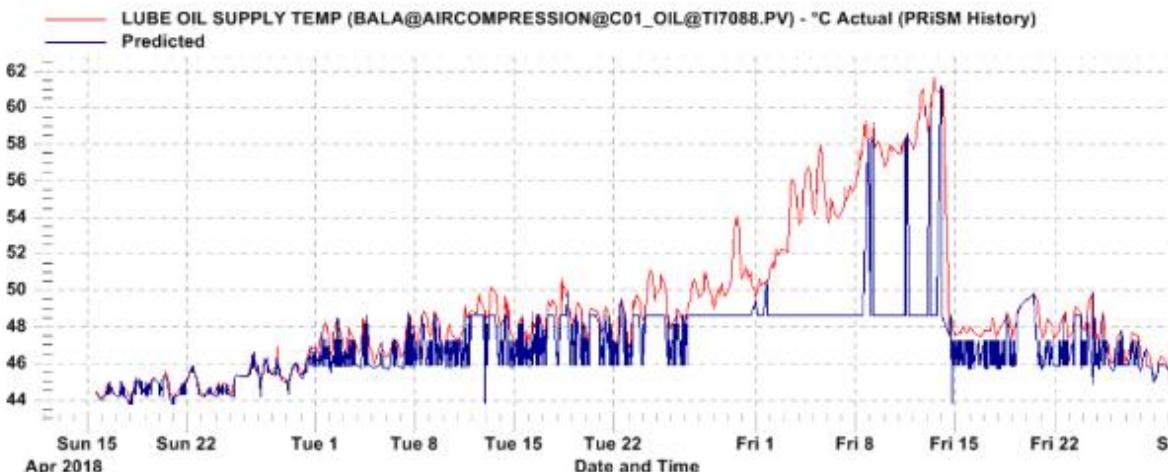
# ADNOC GAS PROCESSING

## Catch on an Integrally Geared Compressor



Fault diagnostic identified:											
FAULT DIAGNOSTIC	PREDICTIVE ANALYTICS MODEL	MAINTAINABLE ITEM ISO 14224	Failure Mode	Failure Effect (Risk)	Criticality of failure	Criticality Description					
<b>PINION 2 STG 1 BRG FAILURE</b>	IG Compressor Mechanical	Radial Bearing	Bearing failure	Bearing will fail if no action is taken	1	Unplanned Shutdown with MTTR=long					
Prescriptive actions provided:											
PRESCRIPTIVE CATEGORY and ACTION											
1	Operational	Check Machine is within limits of defined Operating Window									
2	Inspection	Carry out visual inspection.									
3	Inspection	Check Base Frame Foundation									
4	Inspection	Conduct high speed Vibration Analysis									
5	Maintenance	Plan maintenance intervention that will avoid possible unplanned breakdown									
Risk mitigation:											
ADNOC Gas Processing was able to monitor this vibration and plan the necessary spare parts and maintenance to carry out on next planned outage, thanks to AVEVA Predictive Analytics early warning detection											

## 2. A “second set of eyes” on Operations



Picture #1. MAC oil temperature and OMR



Picture #3. MAC oil cooler

THIS DOCUMENT IS PUBLIC

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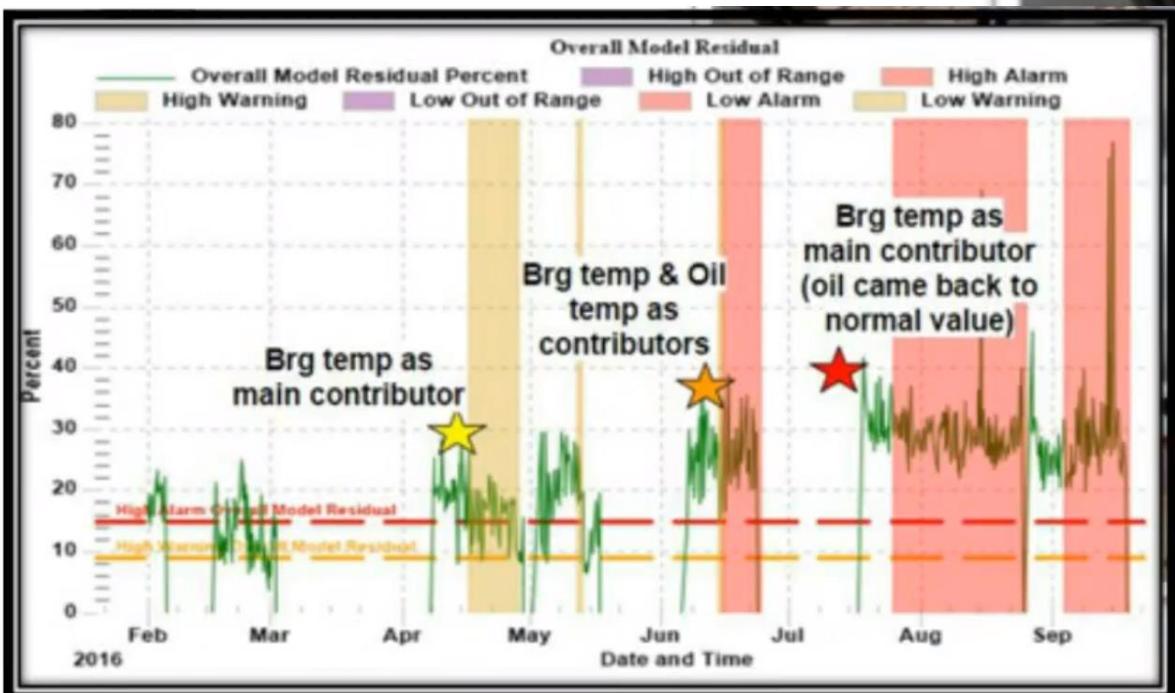
October 14, 2019 | Ann Attaway  
LI-WIM SIO.Predict Program Manager

AIR LIQUIDE, THE WORLD LEADER IN GASES, TECHNOLOGIES AND SERVICES FOR INDUSTRY AND HEALTH

| AFPM Summit  
San Antonio, TX

LARGE  
INDUSTRIES

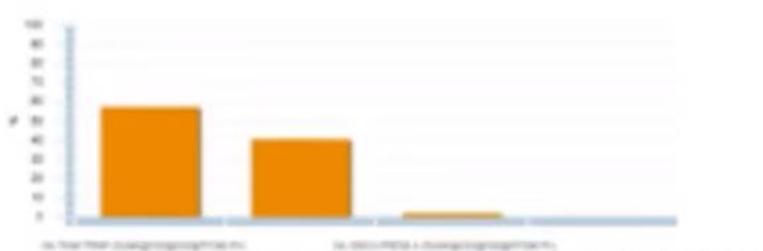
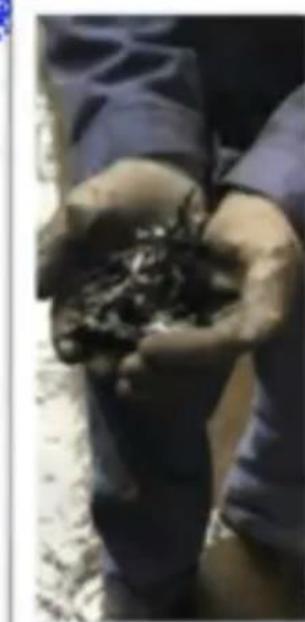
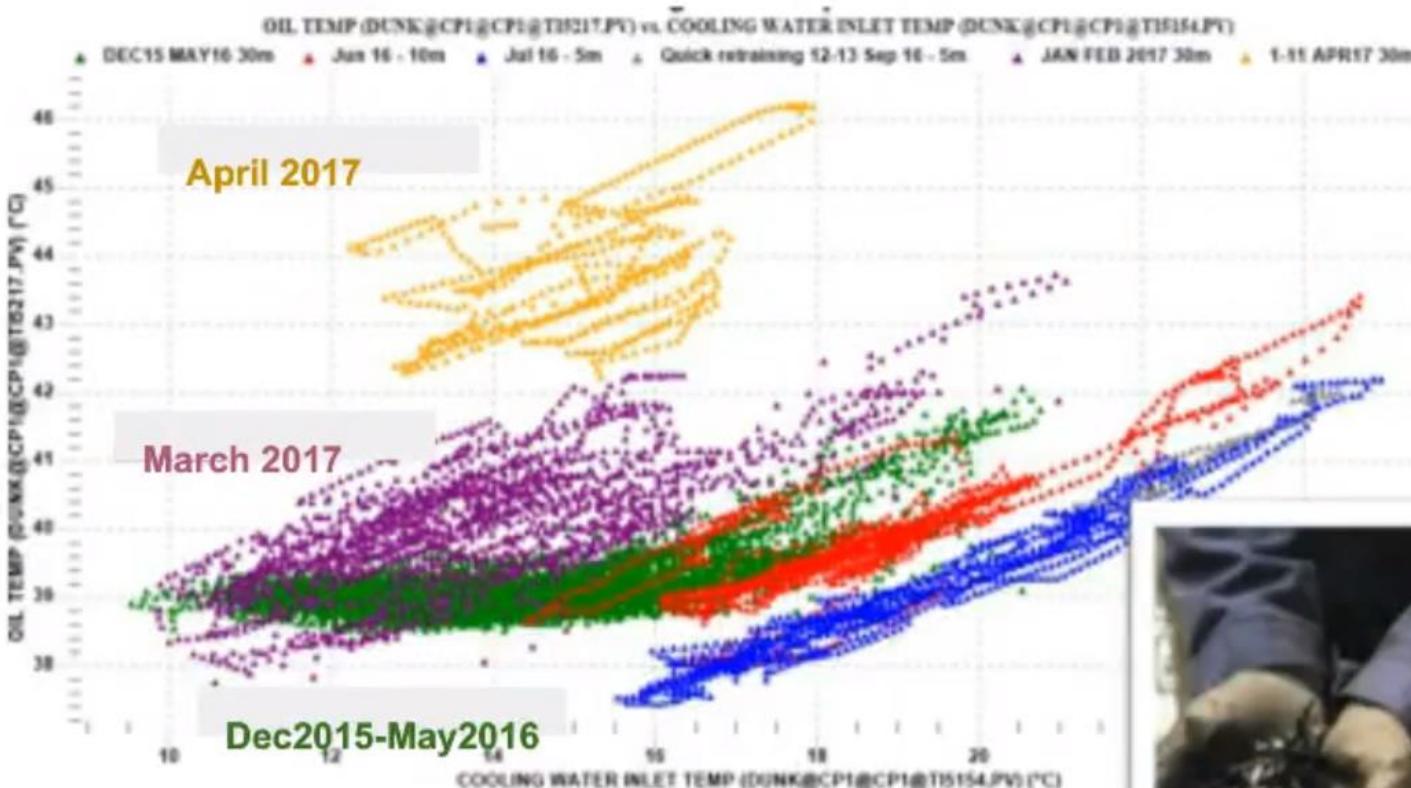
# A bearing failure



# Improving Operational Reliability and Availability

## Lube Oil Cooler Fouling

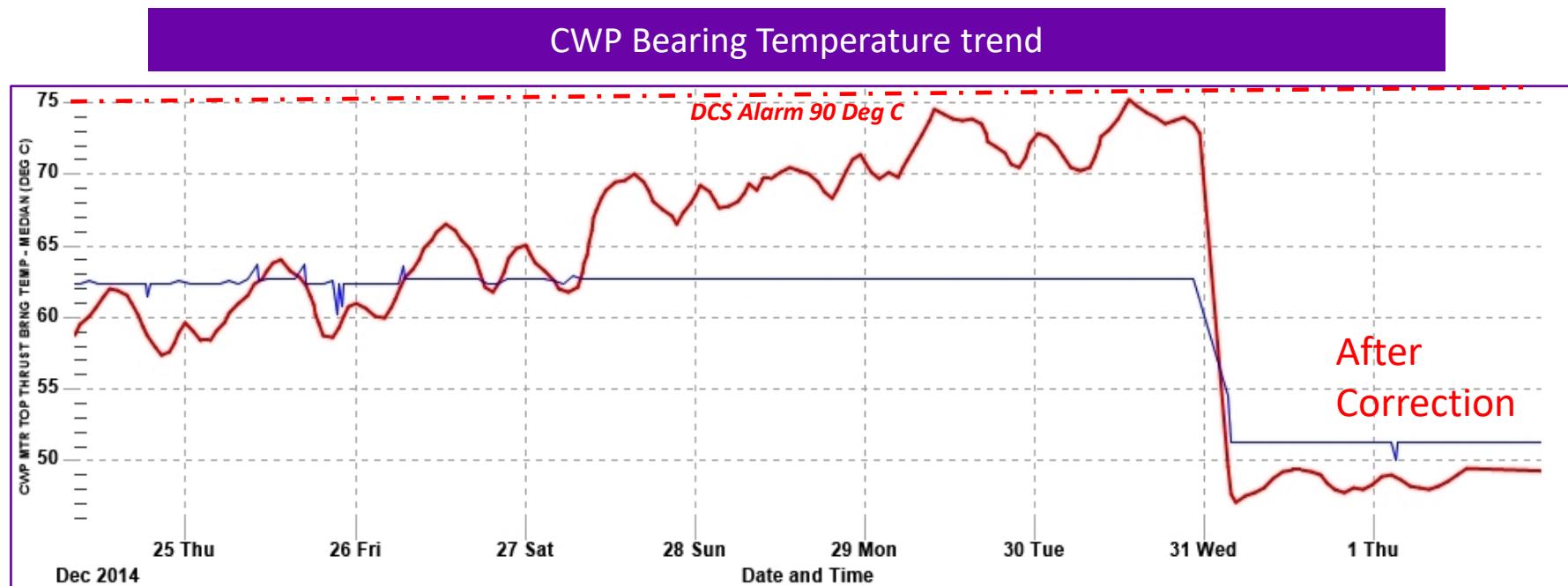
- Strong correlation between Oil Temp and CW Temp changes over time
- Lower oil temp extends bearing life



Signal Contributions			
Signal	Average Signal Contribution	Chart	Sort
OIL TANK TEMP (DUNK@CPI@CPI@TBC17.PV)	87.37%	<input checked="" type="checkbox"/>	
OIL DISCH TEMP (DUNK@CPI@CPI@TIS154.PV)	48.03%	<input checked="" type="checkbox"/>	
OIL DISCH PRESS & DUNK@CPI@CPI@TBC17.PTC	1.00%	<input checked="" type="checkbox"/>	
COOLING WATER INLET TEMP (DUNK@CPI@CPI@TIS154.PV)	8.10%	<input checked="" type="checkbox"/>	

## CWP A Reliability (29<sup>th</sup> Dec 2014)

**Alert Details:** CWP top thrust & guide bearing temps were on rising trend. Rise was of the order of 15 to 20 ° above the predicted values.



**Maint Action:** Pump outage taken during non-peak hours for inspection. Bearing cooling water line found clogged and was cleaned after which temp got normalised.

AVEVA™

We'll take you there.

# QUESTIONS





[linkedin.com/company/aveva](https://www.linkedin.com/company/aveva)



@avevagroup

#### ABOUT AVEVA

AVEVA is a global leader in engineering and industrial software driving digital transformation across the entire asset and operational life cycle of capital-intensive industries.

The company's engineering, planning and operations, asset performance, and monitoring and control solutions deliver proven results to over 16,000 customers across the globe. Its customers are supported by the largest industrial software ecosystem, including 4,200 partners and 5,700 certified developers. AVEVA is headquartered in Cambridge, UK, with over 4,400 employees at 80 locations in over 40 countries.

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