GE Oil & Gas

The Next Big Leap for the Fertilizer Plant Asset Management & Energy Efficiency using Digital tools

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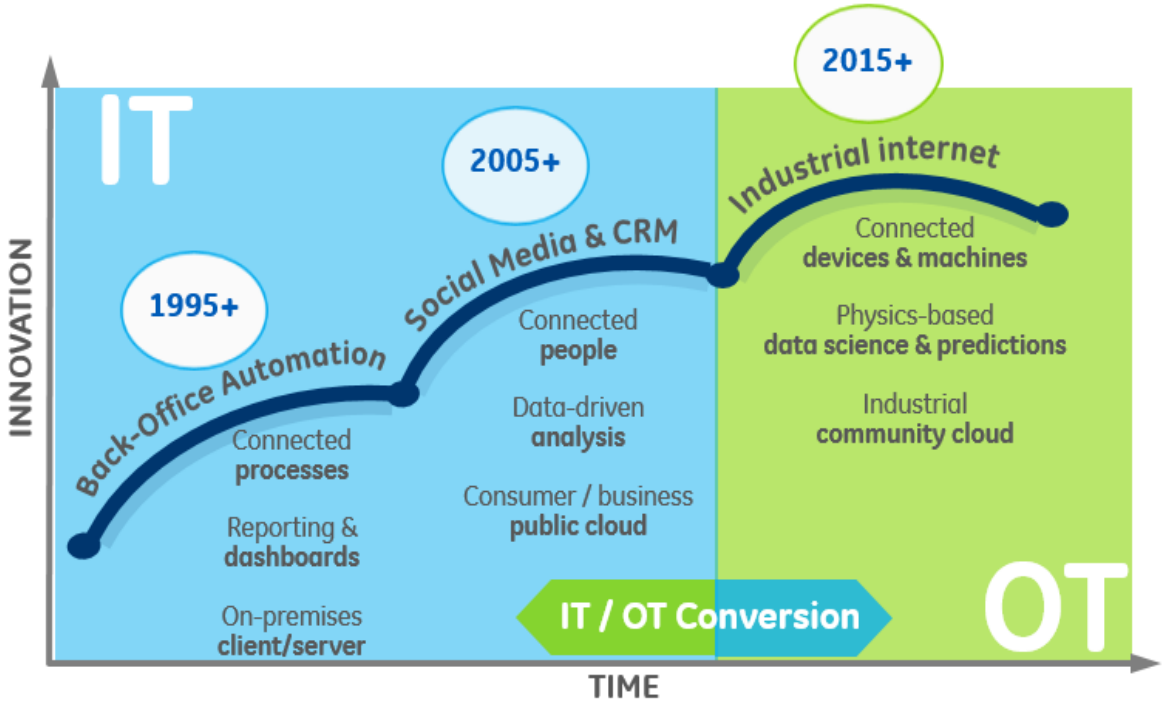
Industry Challenges

Business as usual won't Improve!
New ideas and approaches are needed.....and are available today

Digital Industrial Transformation

	Drivers	Required Outcomes
BUSINESS	Intelligence Around Process & Assets	Greater Profitability
PLANT / FLEET	Comprehensive View for Optimization	Greater Productivity
ASSET	Asset Visibility	Greater Reliability

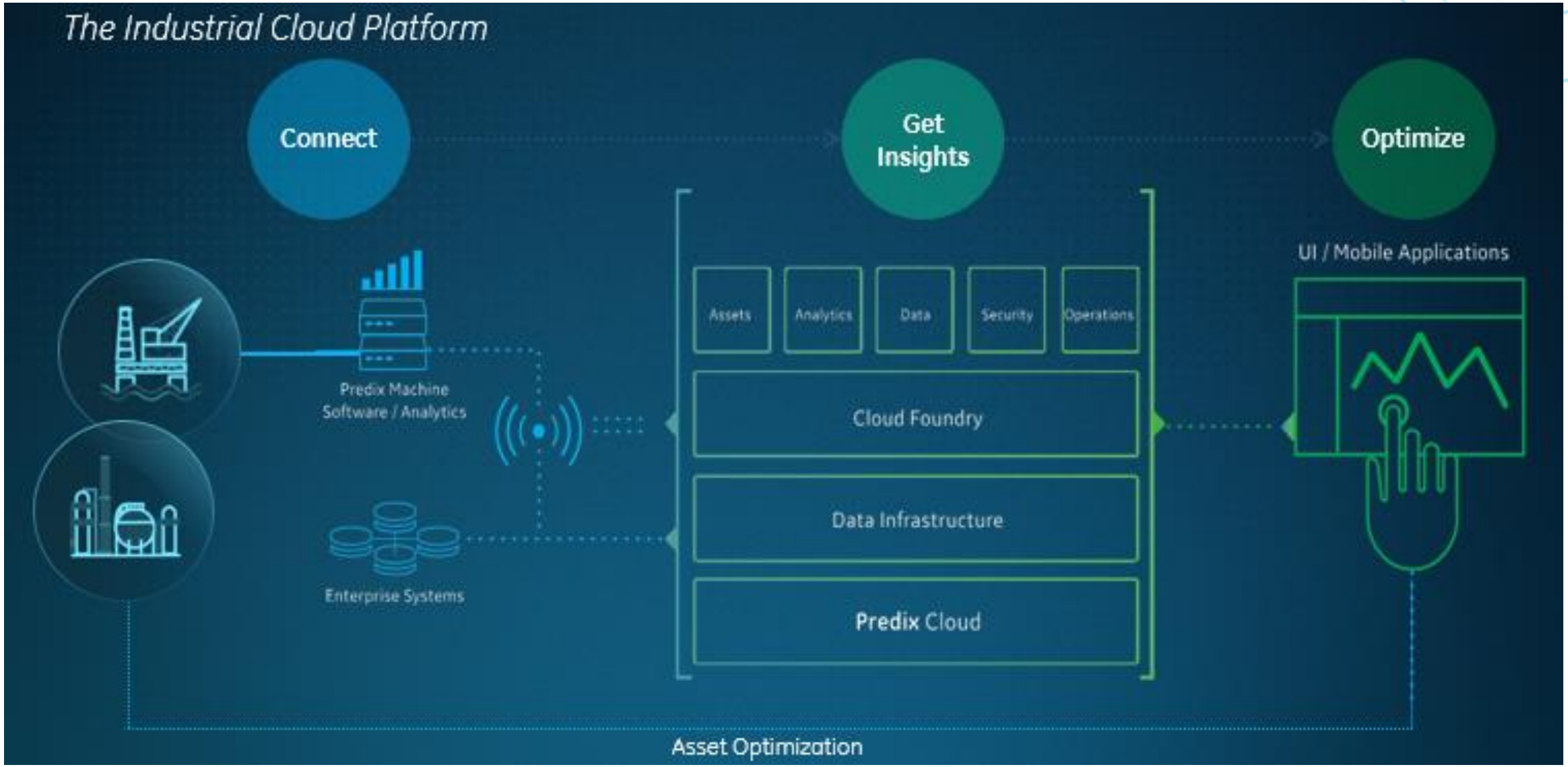


Enhance Value and Unlock the potential to increase Reliability, Productivity & affect bottom line

Converges OT and IT

IT/OT is converging representing a paradigm shift & is leading to new ways to do business.

PREDIX


The Industrial Cloud Platform
Connect
Get Insights
Optimize
Predix Machine Software / Analytics
Enterprise Systems
Assets
Analytics
Data
Security
Operations
Cloud Foundry
Data Infrastructure
Predix Cloud
UI / Mobile Applications
Asset Optimization

EARLY ADAPTORS OF PREDIX

Reliance Industries and GE form a global partnership to drive digital transformation in the industrial world

India Infoline News Service | Mumbai | November 17, 2016 17:37 IST

The first-of-its-kind partnership marks the coming together of two of the world's largest industrial conglomerates to provide Industrial IOT solutions to customers in oil & gas, fertilizer, power, healthcare, telecom and other industries

Reliance Industries Limited and GE announced the signing of a global partnership agreement in the Industrial IOT (IIOT) space whereby **RIL** and **GE** will work together to build out joint applications on GE's Predix platform.

The first-of-its-kind partnership marks the coming together of two of the world's largest industrial conglomerates to provide Industrial **IOT solutions** to customers in oil & gas, fertilizer, power, healthcare, telecom and other industries.

The agreement was signed in the presence of **Jeff Immelt, Chairman and CEO, GE** and **Mukesh Ambani, Chairman and Managing Director, Reliance Industries Limited.**

GE will provide its Predix cloud offering, Industrial Internet applications and data science expertise. RIL will develop solutions on Predix as an Independent Software Vendor (ISV), bringing to bear its over 30 years of data, process and operational expertise. RIL will also offer nationwide connectivity infrastructure to customers through a 4G network powered by Jio. GE would offer the security, availability and monitoring aspects of the platform to RIL and its customers. The potential for other revenue streams includes telecom, healthcare and agriculture.

The benefits to customers include driving operational efficiencies, profitability and new revenue streams by making use of data and analytics. A one per cent productivity gain for companies creates ~ $ 250 billion value over 15 years, across these key energy and infrastructure industries. The digital market is growing at a fast pace with IIOT contributing the highest degree of growth at over 10%. According to Gartner, there exists a market opportunity of over $ 25 billion by 2022 for IIoT solutions across the four key industries of oil & gas, power, healthcare and transportation.

"India's potential in driving the migration to digital is well appreciated. The partnership with Reliance Industries will shape the future of the Industrial Internet not just in India but globally. The possibilities that it opens to develop solutions on our Predix platform for the industrial sector are endless," said **Jeff Immelt, Chairman and CEO of GE.**

Big GE-Excelon deal signals transformation of electricity industry and puts GE on track to become $15 billion software maker

EUGENE KIM | NOV 15, 2016, 09.00 PM

DIGITAL INDUSTRY INSIDER

GE just signed one of the largest software deals in company history with Exelon, signifying a huge change occurring in the broader electricity space.

Under the deal announced Tuesday, GE will deploy its entire Predix software portfolio across the fleet of energy facilities owned by Exelon, a Fortune 100 company with millions of utility customers.

That means Exelon will run its wind, nuclear, hydroelectric, and solar power plants on top of the Predix platform, a cloud-based operating system GE developed to help energy companies run more reliably and efficiently.

GE forecasts it could help Exelon save up to 25% in maintenance and operations costs, while collecting tons of data to vastly improve the company's productivity. The two companies also agreed to co-develop applications built on top of Predix in the future. GE declined to disclose any financial details, but noted it's one of the top 3 biggest deals ever made.

Columbia Pipeline Group deploys new software solution from GE and Accenture

US-based Columbia Pipeline Group (CPG) has deployed the new Intelligent Pipeline Solution (IPS) that helps operators make better decisions regarding pipeline safety and integrity.

Operators can use the new software solution to prioritise the best location to apply the resources to help reduce the potential for unforeseen events.

IPS consists of GE's pipeline management software combined with Accenture's digital capabilities and was launched as part of a strategic global alliance formed by the companies in 2013.

Columbia Pipeline Group chief operating officer Shawn Patterson said: "The Intelligent Pipeline Solution provides an integrated, geospatial view of our pipeline assets aligned with critical factors related to pipeline integrity."

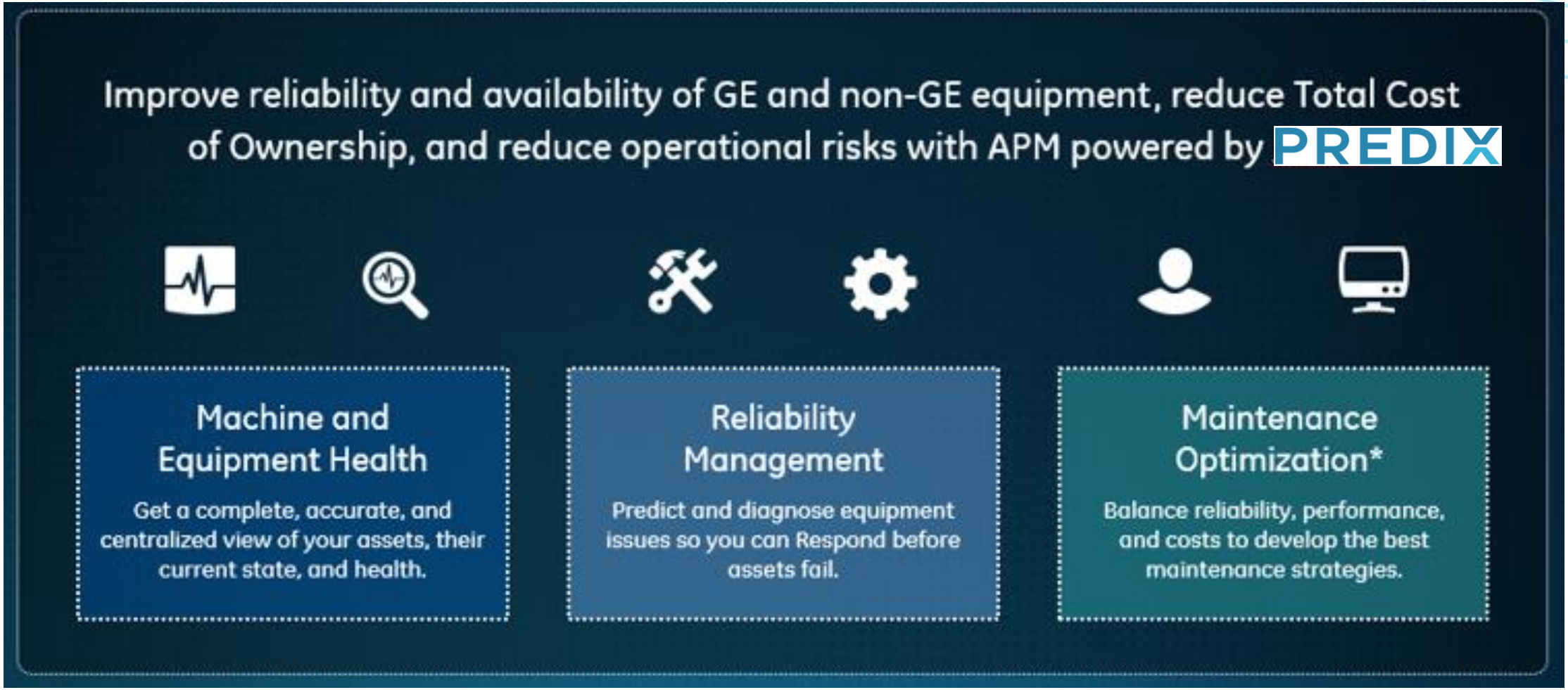
> "The Intelligent Pipeline Solution provides an integrated, geospatial view of our pipeline assets."

BP is using GE's Predix software to make its oil wells part of the internet of things.

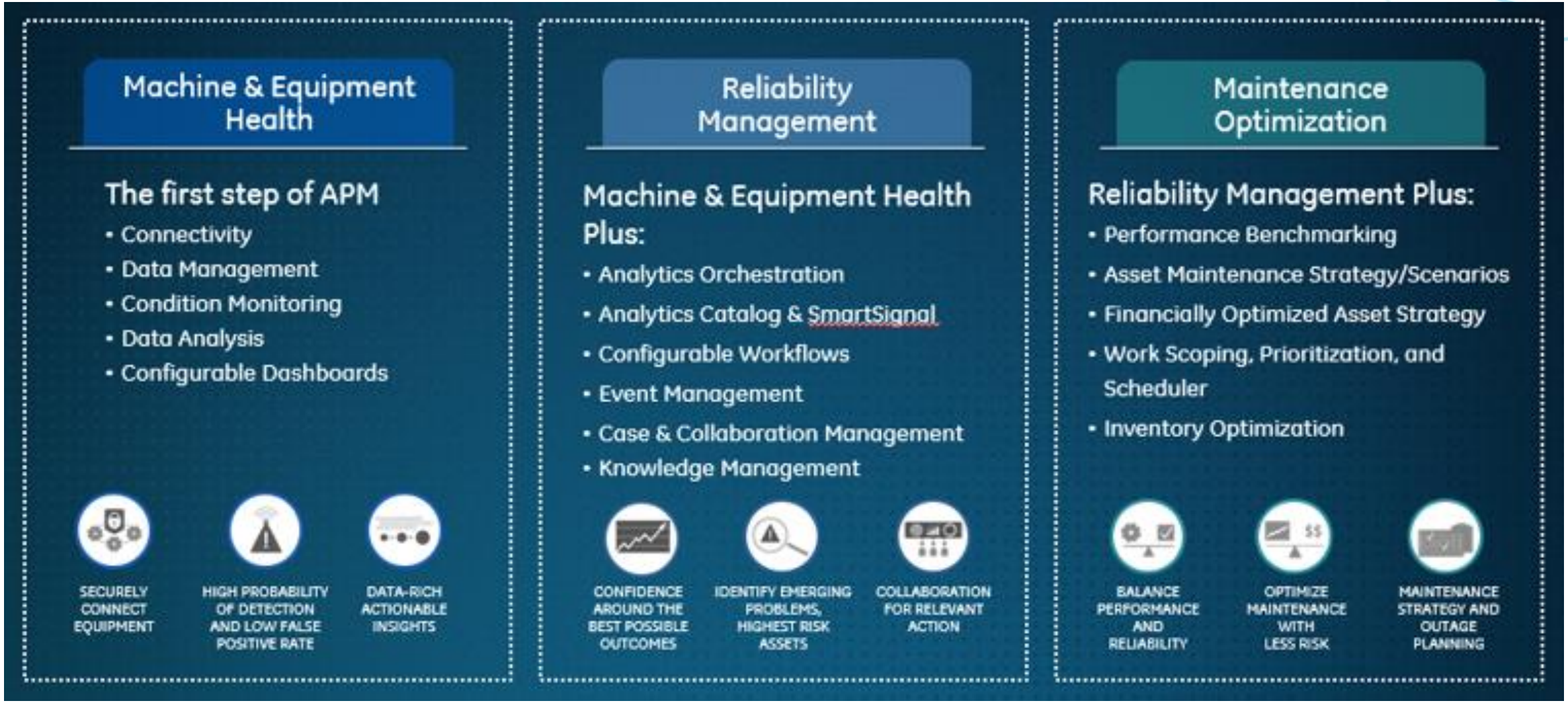
Oil-and-gas giant BP has thousands of oil wells scattered around the globe. This equipment pumps oil and some natural gas from the depths of the ocean to the surface to power our factories, cars, planes and any number of other industrial processes. And after more than a decade of monitoring these platforms using homegrown software, the London-based company is turning to GE to get an upgrade.

BP has started connecting 650 of its oil wells as part of a pilot project to test GE's Predix data gathering and analytics platform. Peter Griffiths, a strategist with BP, explains that the companies are in the design phase, but by the end of the year 650 wells will be connected, and each well will be dumping roughly half a million data points every 15 seconds into GE's software. If the pilot goes well BP will outfit a total of 4,000 wells before the end of 2016.

GE's Asset Performance management



GE's Asset Performance management



Improve Uptime & Efficiency of the Assets

Predictive Analytics System → Machinery Management System → Machinery Protection System

P =Potential

Steady State Operation:

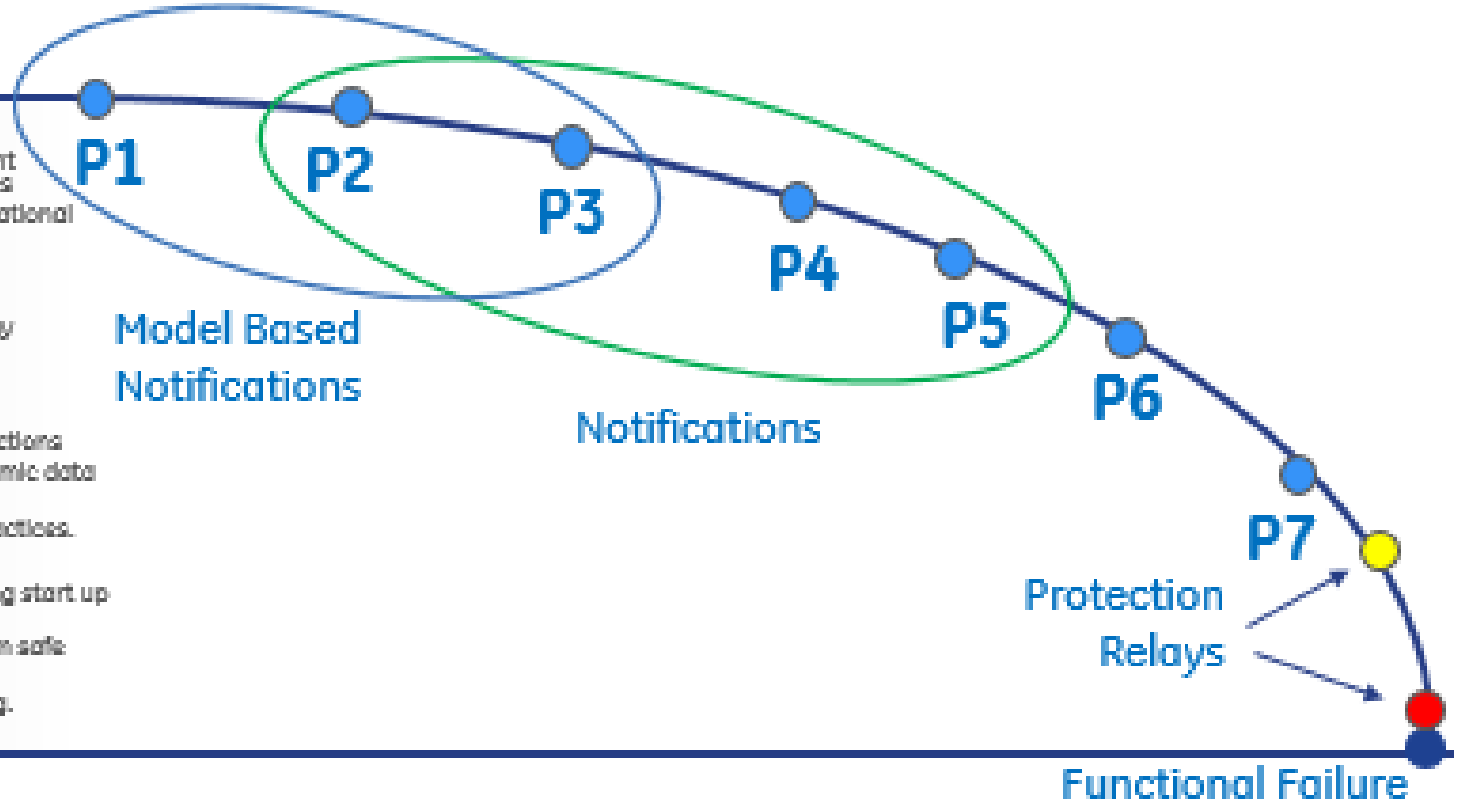
- Real time monitoring of failure modes, early event identification & diagnosis of developing anomalies
- Differentiate instrument v/s mechanical v/s operational issues
- Real time visibility of equipment thermodynamic performance and degradation
- Real time visibility of process optimization/ Energy Efficiency Enhancement opportunities

Alarm:

- PRE-TRIP: Provide insight to O&M team for risk identification, risk mitigation and maintenance actions
- POST-TRIP: Provide high resolution static & dynamic data for Trip-RCA, decide maintenance plan.
- Important data to get insight & optimize O&M practices.

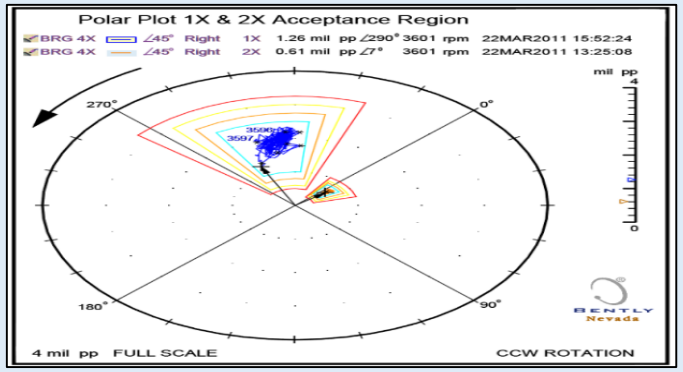
Post Start up:

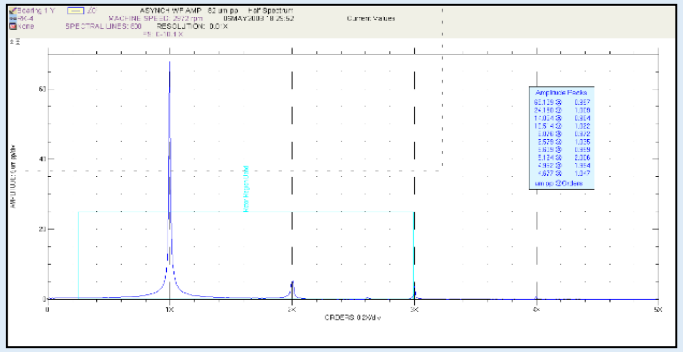
- Support any trouble shooting requirements during start up activities.
- Provide historical comparison to ensure long term safe operations.
- Create Base Line references for future monitoring.

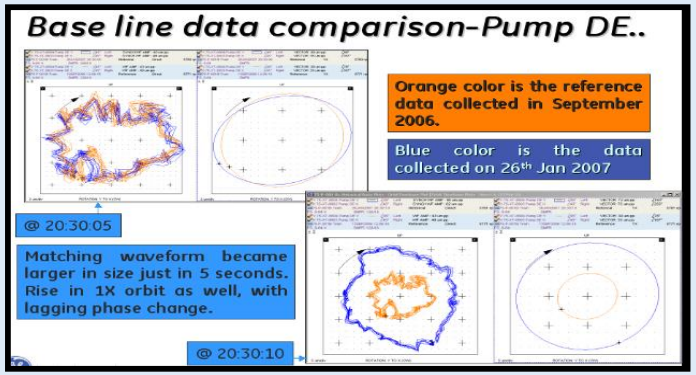


Diagnostics Examples

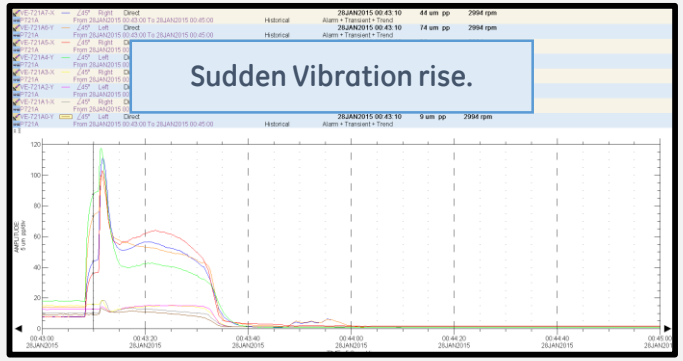
Health Report: Early warning of failure modes by Visual overlays.

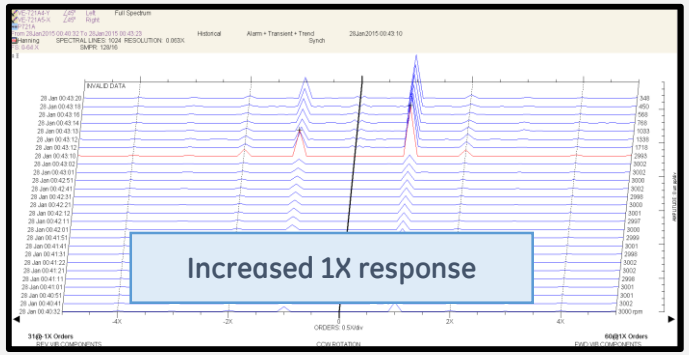


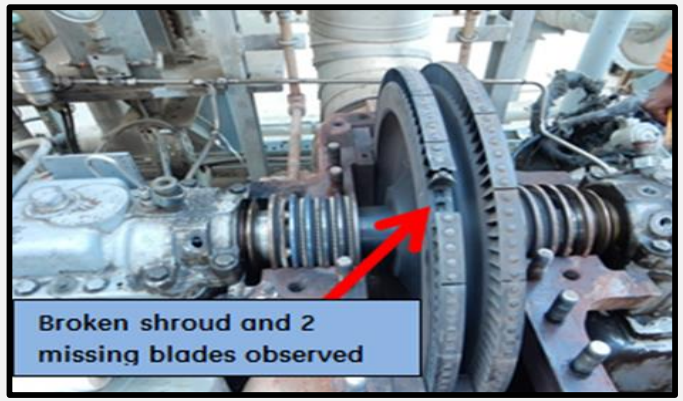




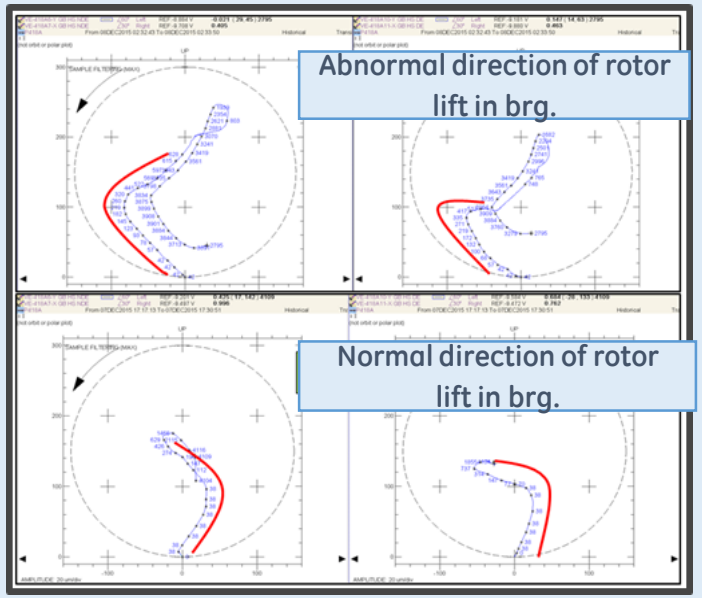
Event Diagnosis: BFPT blade loss causing pump shutdown

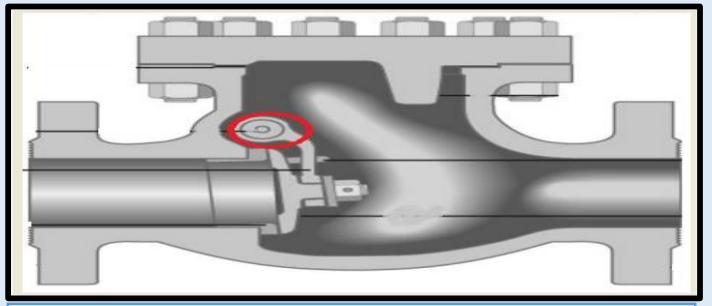






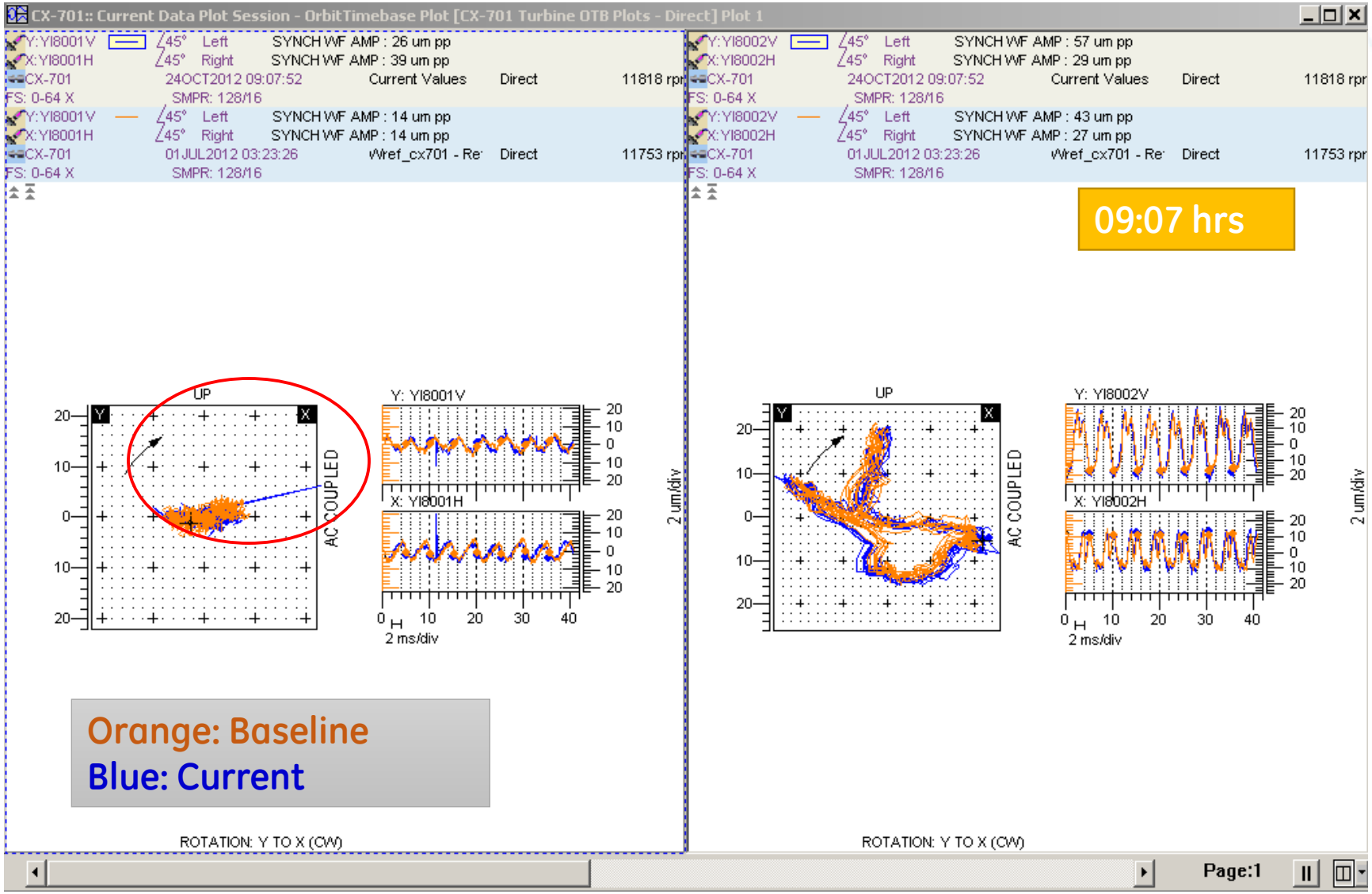
Start up Support: Pump NRV flipper malfunction causing reverse rotation





Damaged Pin of NRV flipper led to reverse rotation and increased vibration on Gear Box during shutdown.

Syn Gas Compressor Turbine

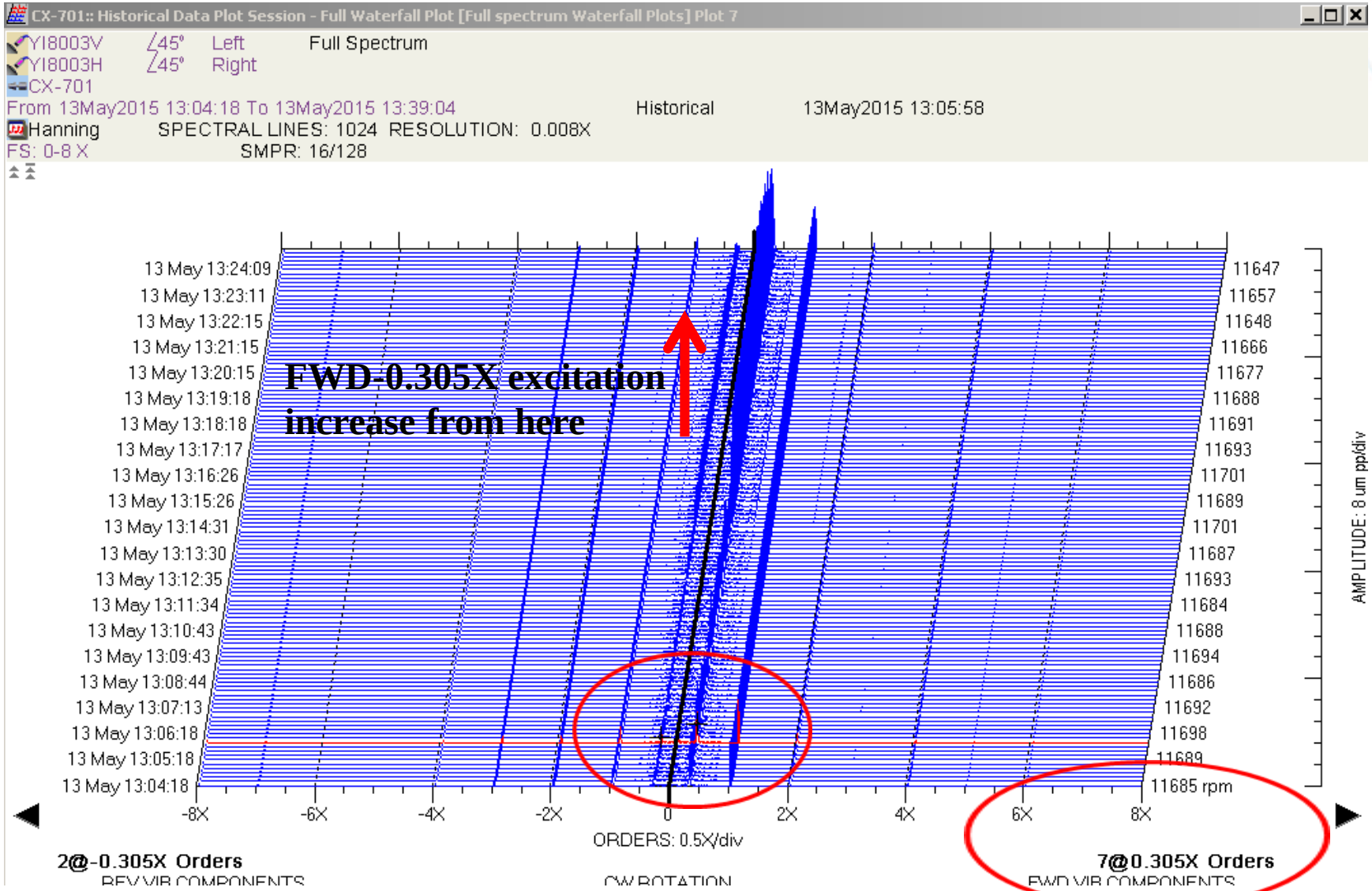


Corrective Actions - Worn out grousing brush replaced

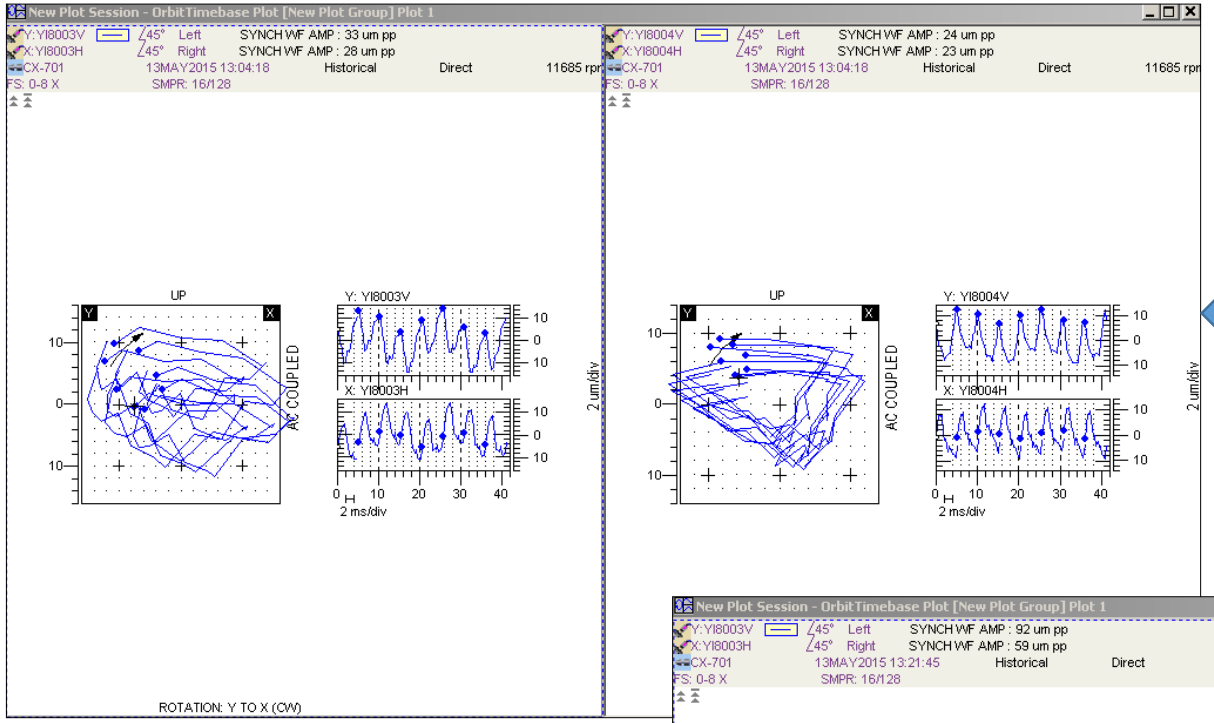
Old Brush- Worn Out

New Grounding Brush

Syn Gas Compressor: Not 1X- Forward 0.305X Excited

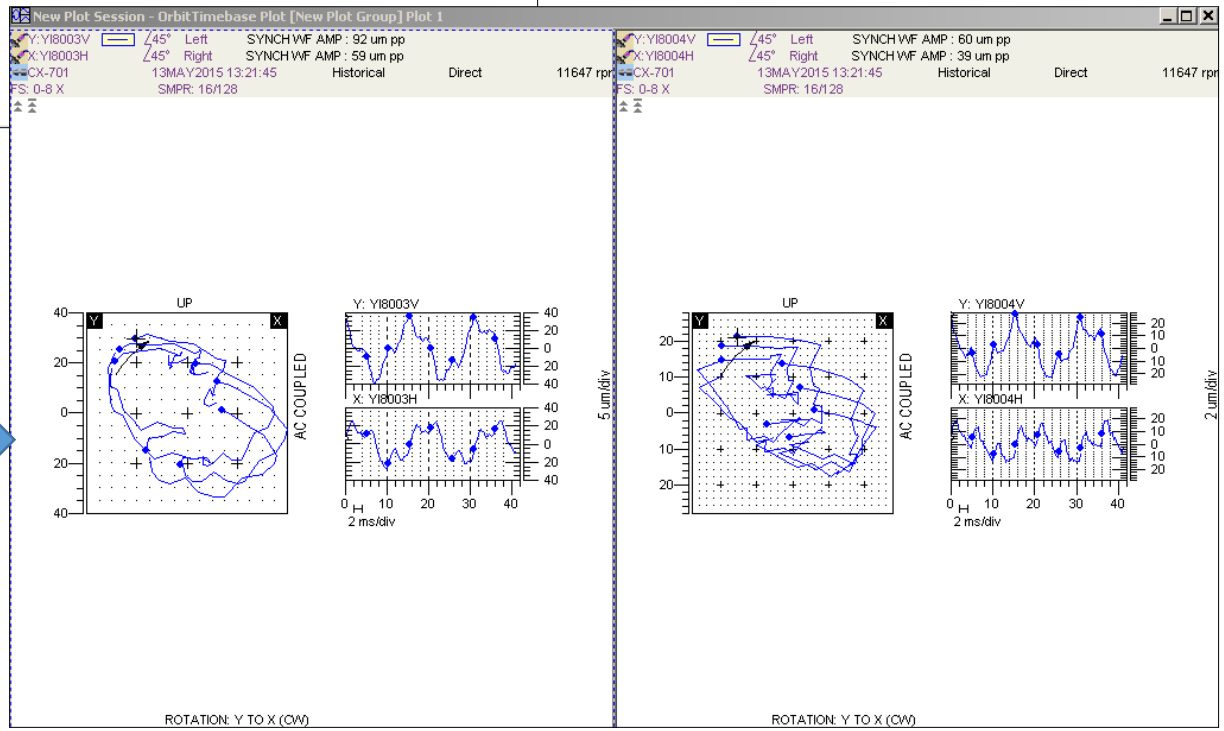


Machine running in steady state & with vibration level normal

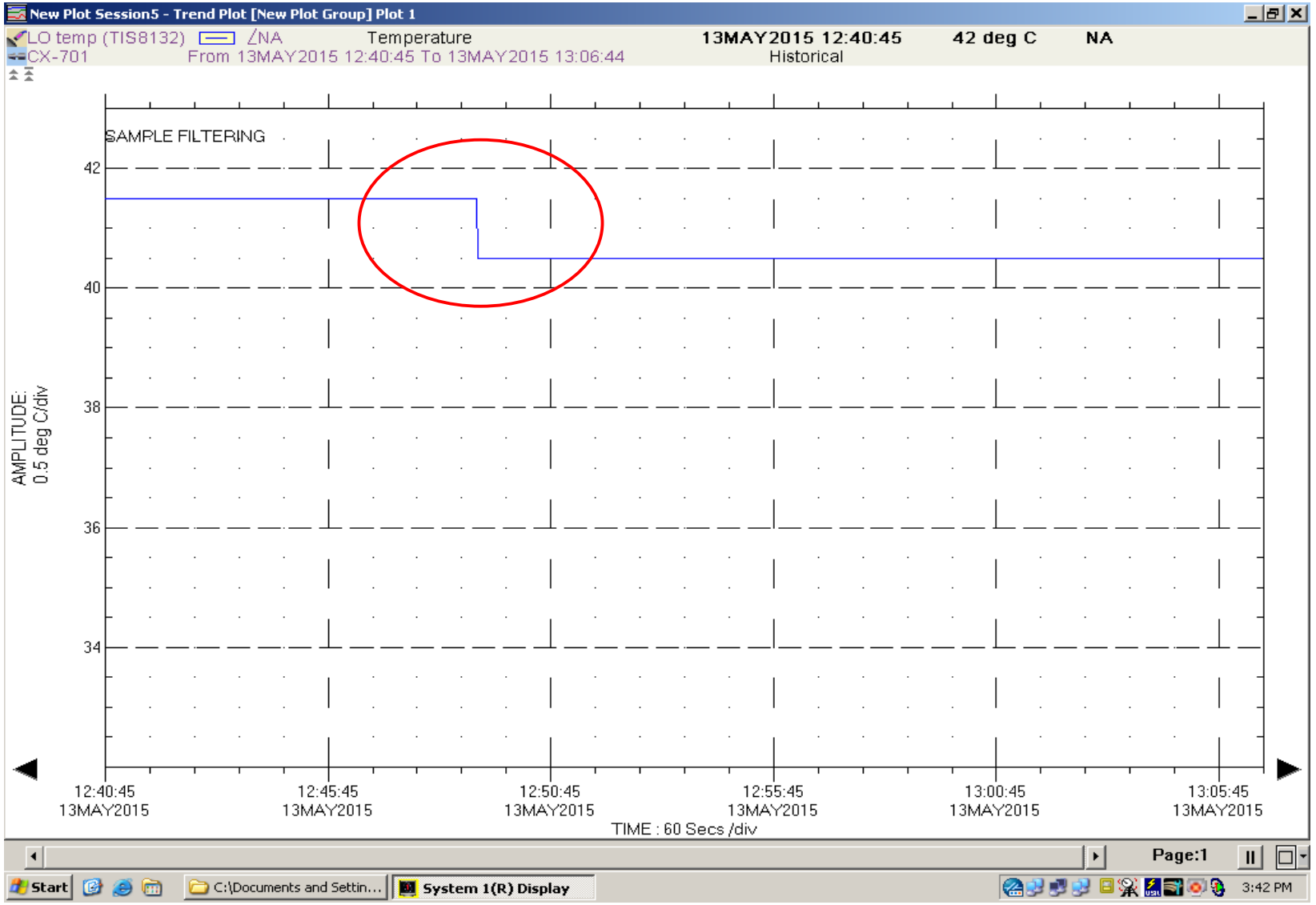


Normal Orbits

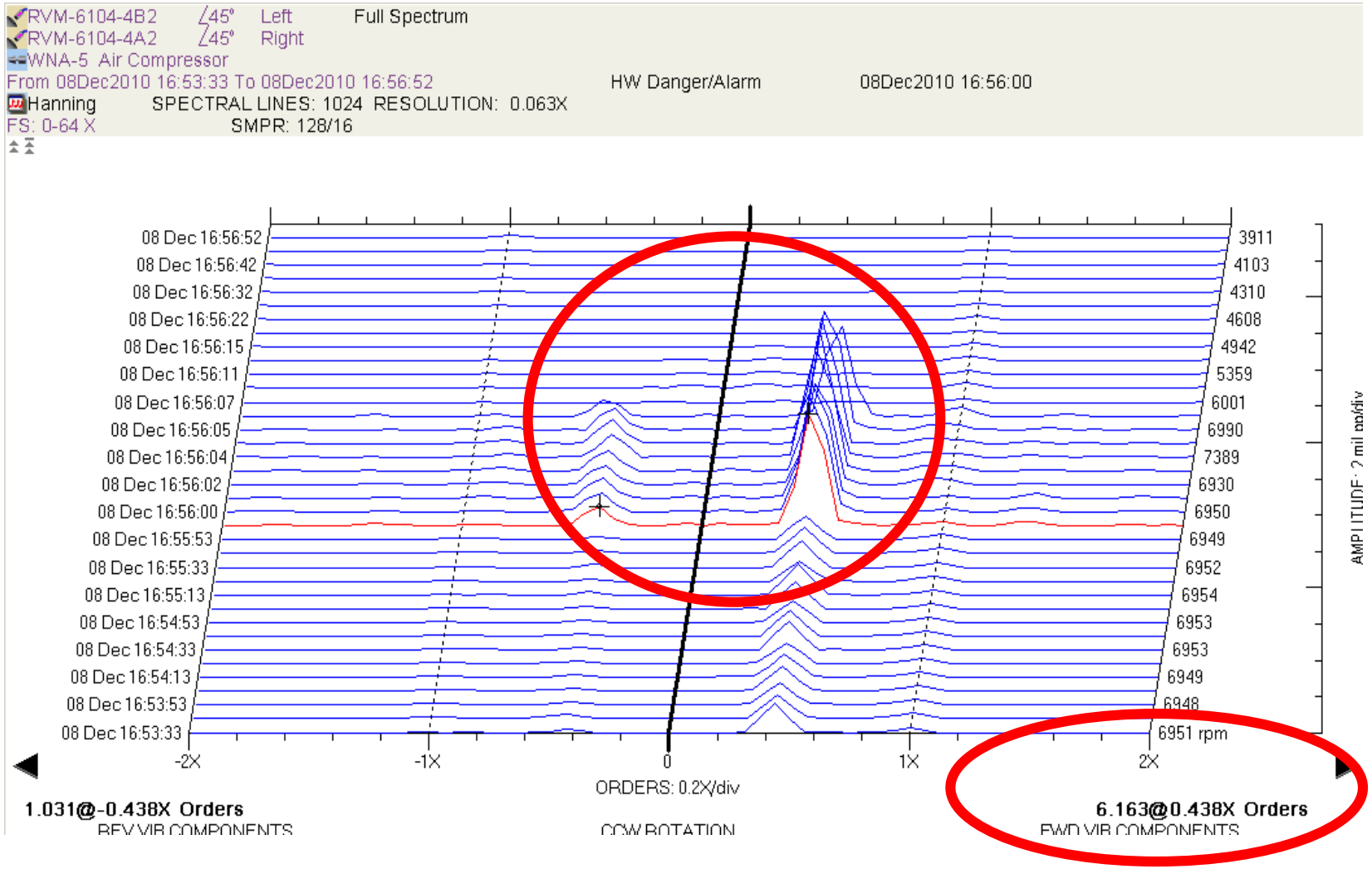
Scattered & Big Circular Orbits



Corrective Actions - Lube oil temperature reduced

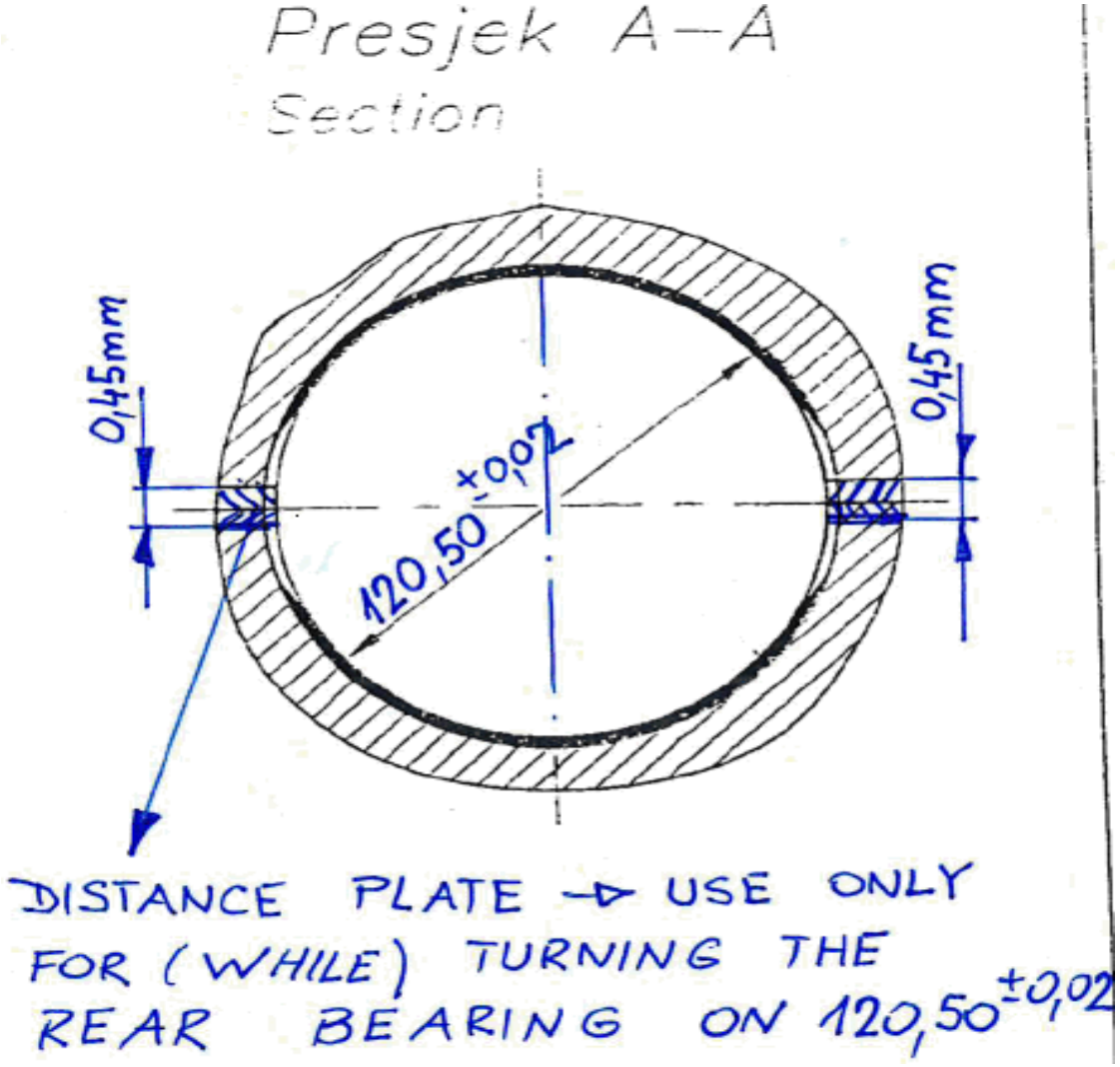


WNA Compressor Turbine: 0.438X excitation



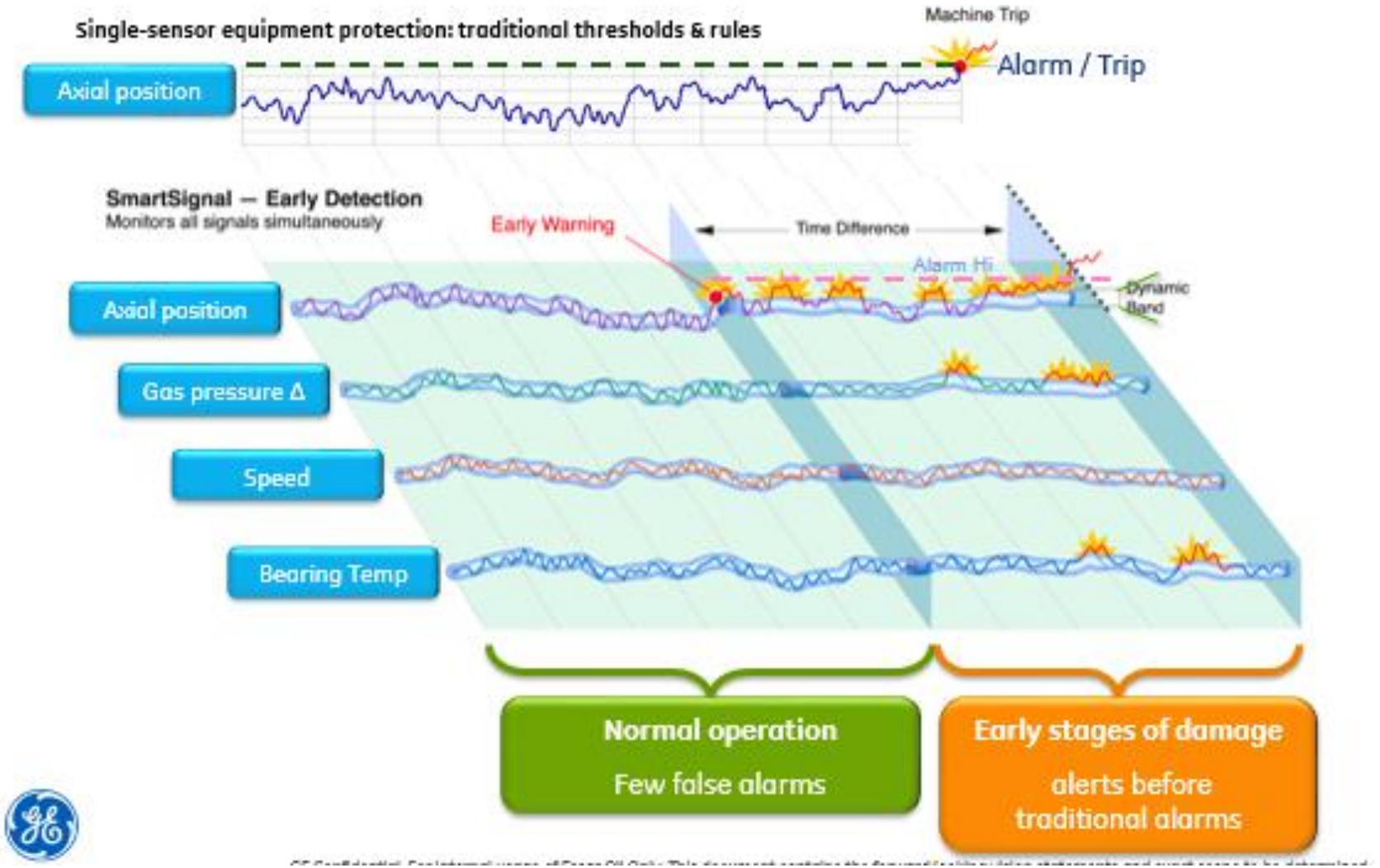
Waterfall plot suggests, forward 0.438X frequency excited. This caused high vibration amplitudes & shutdown.

Corrective Actions - Rear Bearing design change



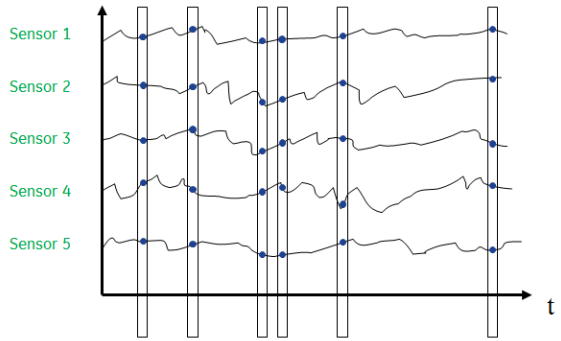
The GE SmartSignal Difference

Multiple Sensor, Dynamic Empirical Analysis in Real Time

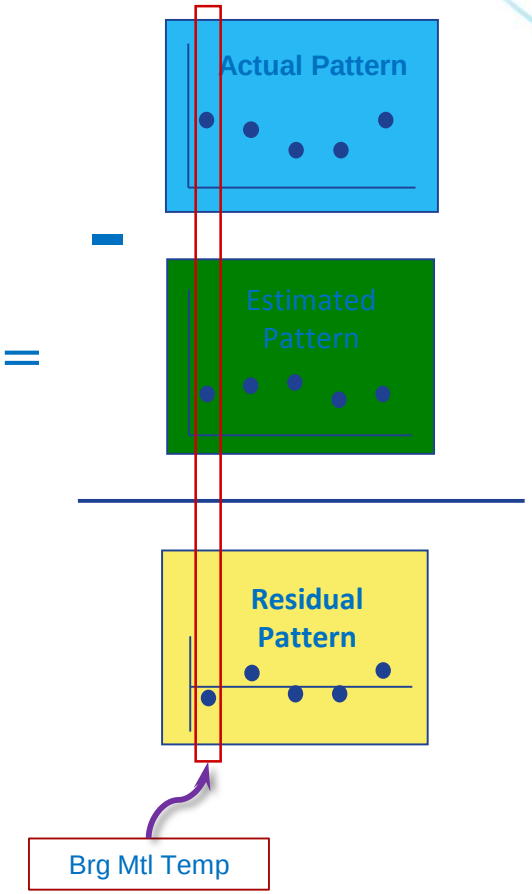


Pattern Reconstruction in Action…

Informed by Data Modeling, Physics Models and/or Commissioning Curves

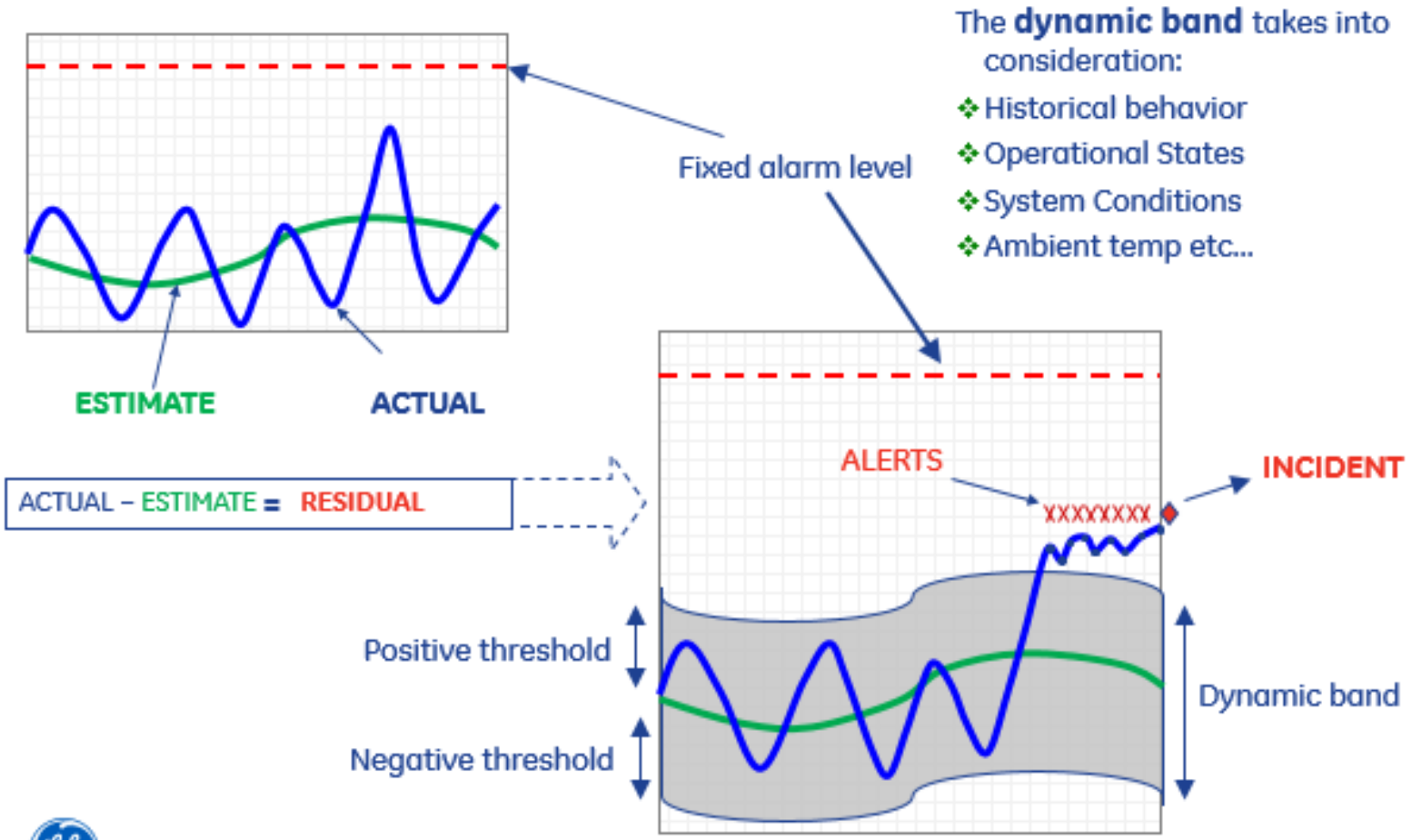


$$\hat{X} = \begin{pmatrix} \text{Pattern 6} \\ \text{Pattern 5} \\ \text{Pattern 4} \\ \text{Pattern 3} \\ \text{Pattern 2} \\ \text{Pattern 1} \end{pmatrix} \cdot W = \begin{pmatrix} \text{Pattern 1} \times w(1) \\ + \\ \text{Pattern 2} \times w(2) \\ + \\ \text{Pattern 3} \times w(3) \\ + \\ \text{Pattern 4} \times w(4) \\ + \\ \text{Pattern 5} \times w(5) \\ + \\ \text{Pattern 6} \times w(6) \end{pmatrix}$$



Normal variation is removed from actual patterns by subtracting the estimate thus producing a residual for improved analytics.

ALERTS BASED ON RESIDUALS

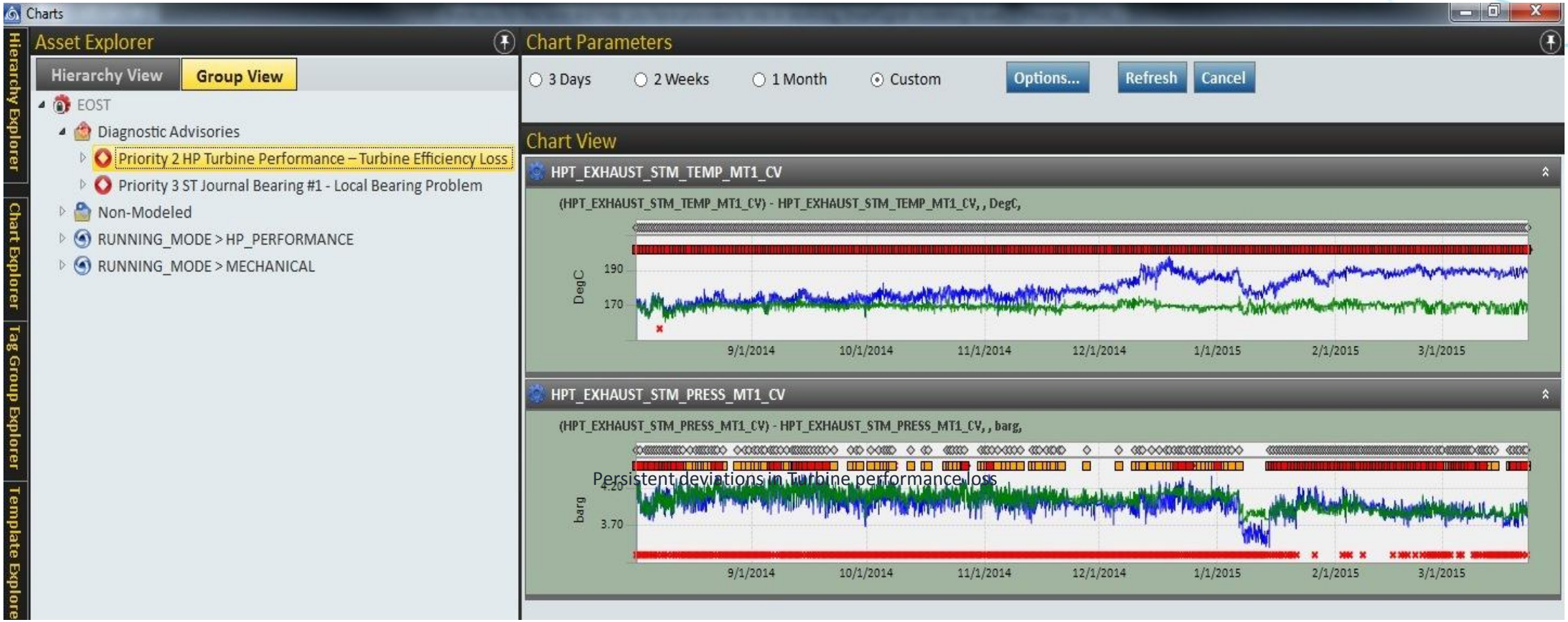


Improve Uptime & Efficiency of the Assets

How SmartSignal is used to detect anomalies and early signs of damage

Early Warning Case Study of Compressor Turbine

Actual Value – from historical data
Estimate Value – generated by SmartSignal
Residual = actual – estimate
Alert – statistically significant deviation



- Diagnostic Advisory is triggered by the persistent deviation on Turbine performance loss which has been steadily deteriorating (early September onwards). These deviations persist all the way up to the end of test data (23Mar 2015).
- HPT exhaust temperature and exhaust pressure continues to deteriorate impacting turbine performance.

Ordinarily, a deviation as persistent as this on a sensor indicating something as critical as Turbine efficiency Loss would have caused the GE Industrial Performance and Reliability Center (IPRC) to have repeatedly encouraged plant personnel to perform PDM work to determine an assignable cause for the deviation from expected behavior.

Any instruments, Any assets, Any OEM, Any operational mode

Equipment Make	Model	Equipment Type
OEM Agnostic		Steam Turbine

Proficy SmartSignal
CC_TG_ROTOR_SSC
CC_TRBPERF_SSC_V

Configurations Cove
Admission Steam T
Up to 3 Pressure St
Single Extraction P

System
Performance
Steam Seal System
Lubrication Oil Syst
Rotor

Equipment Make	Model	Equipment Type
OEM Agnostic		Oil and Gas Pump

Proficy SmartSignal B
OGEP_PUMP_SSC_V3

Configurations Cover
Centrifugal Pump
Any driver

System
Performance
Lubrication Oil Syste
Pump Rotor
Seals

Equipment Make	Model	Equipment Type
OEM Agnostic		Generator

Proficy SmartSignal Blueprint	Equipment Use
AIR_COOLED_GENERATOR_SSC_V3.0	Power Generation Fossil, Combined Cycle, Oil and Gas

Configurations Covered
TEWAC (Totally Enclosed Water-Air Cooled) Static, Brushed & Brushless excitation
TEAAC (Totally E
OV (Open Ventil
Reciprocating En
CT, Industrial CT,

System
Electrical
Lubrication Oil S
Rotor
Open Ventilation Cooling
Closed Cooling (TEWAC)
Stator

Equipment Make	Model	Equipment Type
OEM Agnostic		Electric Motor

Proficy SmartSignal Blueprint	Equipment Use
MOTOR_SSC_V3.0	Oil and Gas, Process, Power Generation

Configurations Covered	
Constant Speed Motor	Air or Water Cooled
Variable Frequency Drive (VFD)	

System	Sub System	Diagnostic
Motor	Motor Performance	High Stator Temperature
	Motor Bearings	Cooling Loss
	VFD Control	Local Bearing Problem
		Sensor Problem
		Electrical Problem
		Electrical Induced Vibration
		Insulation Health Problem
		Phase Imbalance
		VFD Control Problem

Vibration Problem

MERIDIUM SUITE OF SOFTWARE

ASSET ANSWERS

- Bad Actor Identification
- Comparative Analysis
- Data Quality

ASSET HEALTH

- Performance Indicators
- Rounds
- Lubrication Management

ASSET STRATEGY

- Asset Strategy Management
- Asset Risk & Cost Modeling

APM FOUNDATION

- Strategy Definition
- Asset Criticality Analysis
- Administration

FAILURE ELIMINATION

- Root Cause Analytics
- Reliability Analytics
- Production Loss Analysis

MECHANICAL INTEGRITY

- Risk-Based Inspection
- Inspection Management
- Thickness Monitoring

ASSET SAFETY

- Hazards Analysis
- SIS Management
- Calibration Management

APM Connect

- Enterprise Integration
- Historian Integration
- Data Connectors

Study on Energy Efficiency – Customer Engagement

GE undertook a study to outline a roadmap towards energy efficiency and to enable customers to meet their specific energy targets.

Our Approach...

Capturing Customer Requirements

Visited customer site to discuss plant layout, issues, collect necessary data, etc.

GE's Internal Study

Evaluated possible energy saving solutions, carry out calculations based on information collected.

Solution Proposal by GE

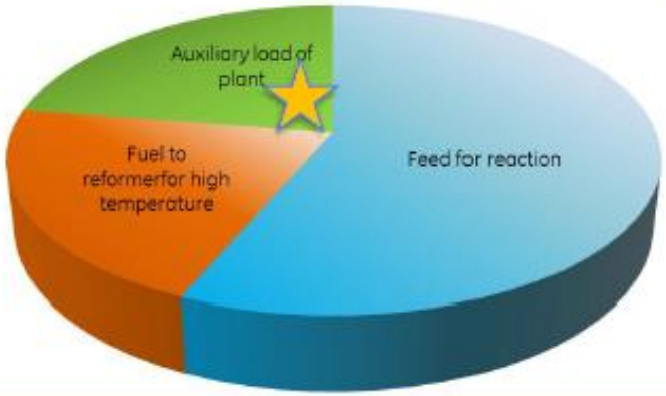
Visit to customer with energy saving solutions proposal with benefits.

Case Study 1 *Urea production capacity of ~5500 MTPD with energy consumption of ~6.3 Gcal/MT of Urea, part of Group-2 as per NUP 2015.*

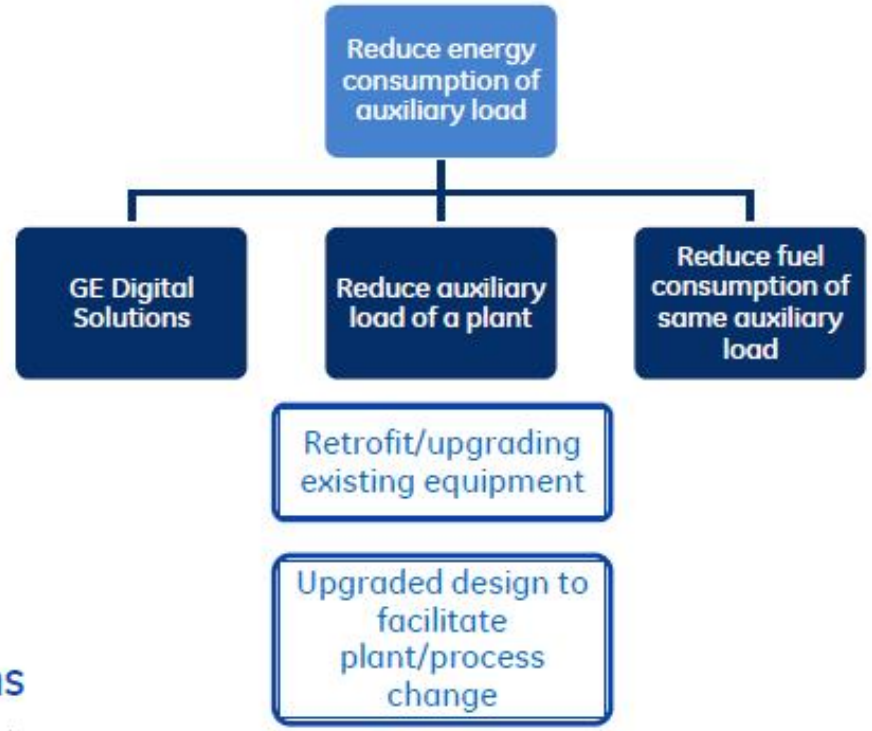
Case Study 2 *Urea production capacity of ~3200 MTPD with energy consumption of ~5.2 Gcal/MT of Urea, part of Group-1 as per NUP 2015*

Efficiency Improvement analysis

Urea Plant: Energy Consumption Map



"Optimizing auxiliary load consumption of plant is relatively easier route towards energy efficiency"

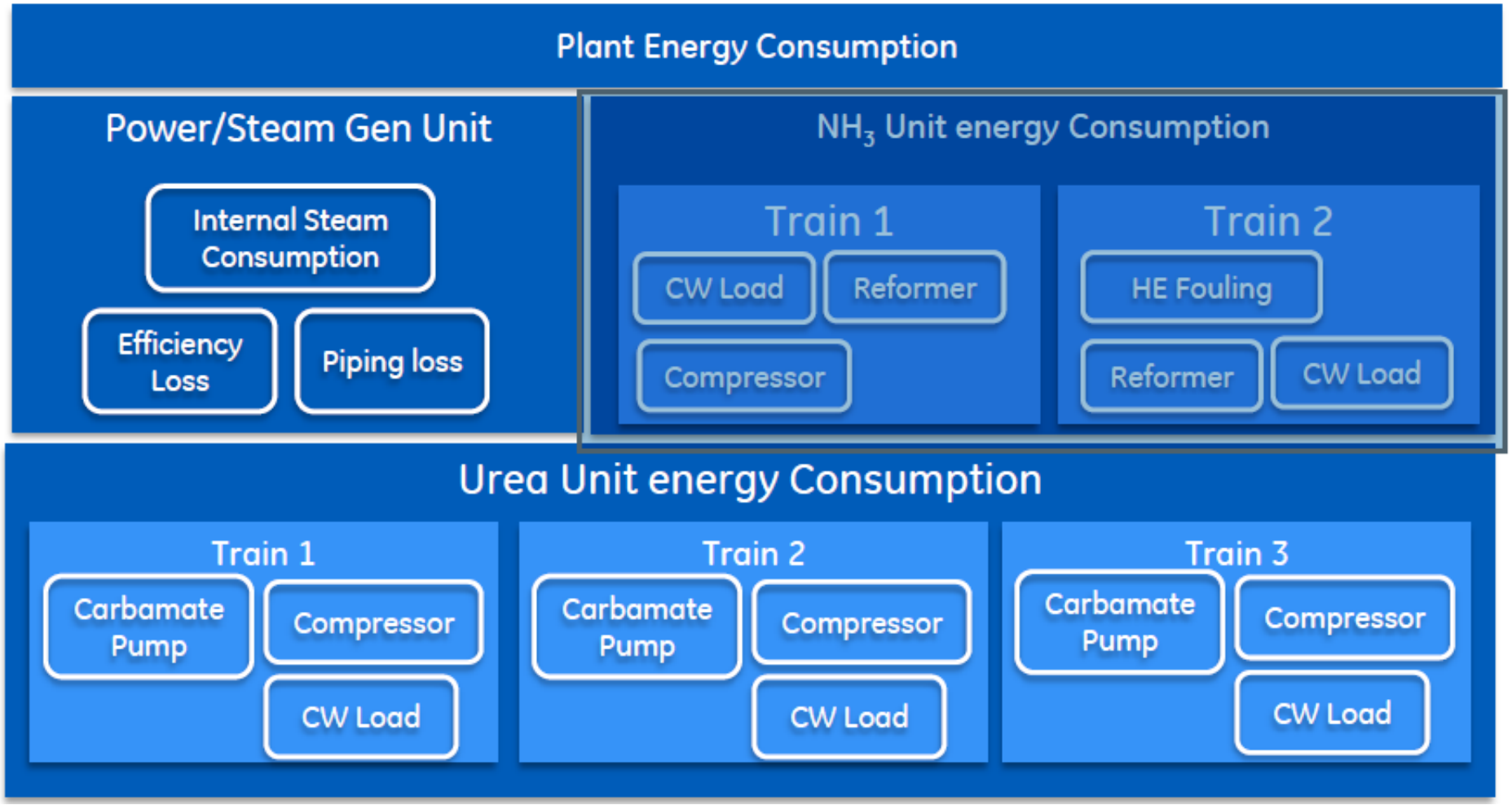


Potential Results: GE Energy Efficiency Solutions

- *~15% reduction in auxiliary load for a Group I,II plant*
- *~40% reduction in auxiliary load for a Group III plant*

Digital Energy Map

A tool to track your energy consumption at plant, sub-component and equipment level.
Enables trending and recommendations to reduce energy consumption at various levels




...Digital Industrial Transformation...
Why Not Us?
Why Not Now?

GE's Energy Saving Solutions

Retrofit/upgrading existing equipment

1. Compressor train upgrade

Technology advancements in last 2 decades

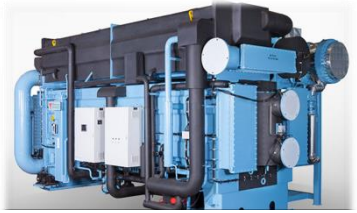
~ 5-10% reduction in steam requirement of ST & up to 5% capacity increase

2. VAM (Chiller) in Air Compressor Inlet

Industry best practice…for maintaining consistent inlet air temperature.

~250 KW saving of power by installing at the inlet line of air compressors

3. Improve existing Hydraulic Turbine for higher power recovery



Capacity enhancement to recover power from bypass stream.

~250 KW of additional power can be recovered from the bypassed stream

4. Gas Turbine Performance Enhancement Kit (PEK)

For a typical 25MW GT, power output can be increased by ~4%

GE's Energy Saving Solutions

Upgraded design to facilitate either plant/process change

1. Hydraulic Turbine in liquid Ammonia (NH_3) stream

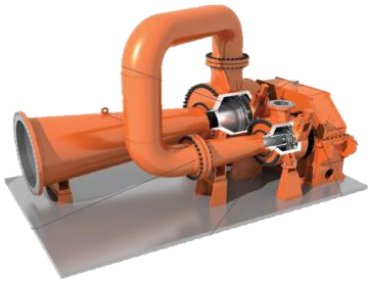
Typically liquid NH_3 from synthesis loop is let down from ~180 to ~ 20 barg

~300 KW of power recovery from the stream with flow rate of 70-80 TPH

2. Turbo-expander in the Fuel Gas

Typically NG fuel is throttled from ~40 barg (depending on source) to ~5 barg for reformer.

~1.3-1.5 MW power recovery from this high pressure NG supply



3. Waste Heat Recovery from Flue Gas

Organic Rankine Cycle (ORC) system recovers waste heat energy from Gas Turbines exhaust (or similar waste heat sources)

~500 KW power recovery from flue gas

4. Piping layout improvement

GE has engineering expertise and tools to perform piping pressure loss analysis to improve performance of the equipment.

GE's Energy Saving Solutions

Reduce fuel consumption of same auxiliary load

Gas Turbine based Captive Power Plant

Replacing Boiler with Gas Turbine to produce power can reduce the energy consumption significantly

***Requires specific plant study to assess the benefits*

Summary

- Energy saving solutions can come from multiple sources involving equipment manufacturers like GE, Energy Consultants and/or Process Licensors and the impact would vary widely depending on the chosen solutions.
- We primarily focused on evaluating solutions that can reduce energy consumption of the existing process/equipment and more specifically on reducing energy consumption of auxiliary load.
- All the solutions discussed, would be complimentary to the process improvement efforts taken up by the plants and are easy to implement without much changes to the Ammonia & Urea process flow.
- These solutions are scalable and applicable across other fertilizer plants and designs.
- If all the suggested solutions are implemented, fertilizer plants can reduce their energy consumption by 0.1 to 0.5 GCal / MT of Urea. The savings can be potentially higher for plants in Group III (as per NUP 2015).