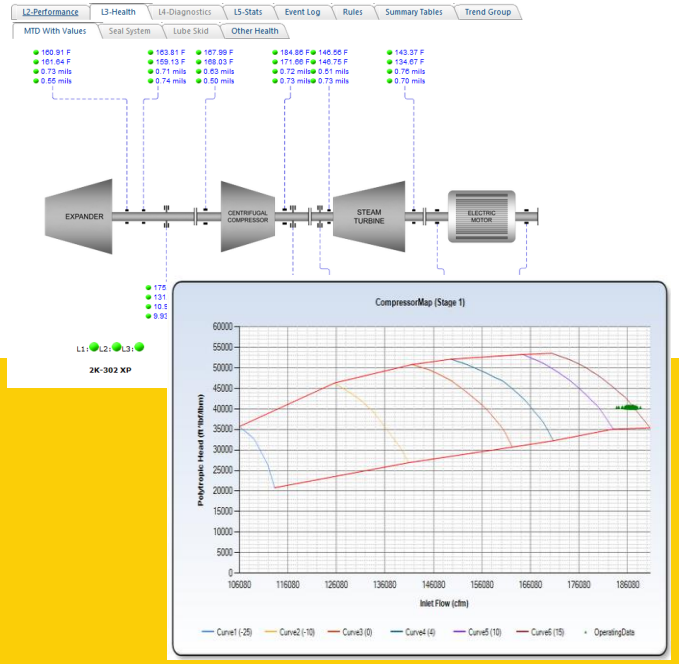
Shell SmartConnect

Improving Reliability and Production in Shell Oil & Gas Facilities

International Gas Turbine Conference 2016
Brussels, Belgium



Gert Hoefakker
Team Lead Shell SmartConnect

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Reserves: Our use of the term "reserves" in this presentation means SEC proved oil and gas reserves.

Resources: Our use of the term "resources" in this presentation includes quantities of oil and gas not yet classified as SEC proved oil and gas reserves. Resources are consistent with the Society of Petroleum Engineers 2P and 2C definitions.

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Resources plays: Our use of the term 'resources plays' refers to tight, shale and coal bed methane oil and gas acreage.

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Agenda

- What is SmartConnect?
- Why did Shell develop its own toolkit?
- Levels of “smartness”
- Application on gas turbines
- Future growth

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Introduction

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Introduction

- Gert Hoefakker, Team lead Shell SmartConnect
- 26 years in Condition & Performance Monitoring
- 17 years with Brüel & Kjær Vibro
- 9 years with Shell

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What is SmartConnect

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What is SmartConnect

- **What it is:** An integrated, **enterprise-wide** surveillance and condition monitoring system

- **What it does:** Leverages **existing data** and turns it into **actionable information**
  Predicts and **avoids failures** through real-time decision support and getting more performance from existing operations
  Integrates **reliability data** to forecast future plant performance (for existing assets and future projects)
  Integrates other vendor systems to deliver a single analysis of the data through one web portal
  Uses existing instrumentation, control systems, vibration monitoring hardware, data historians and follows global Shell IT standards

- **Where it's used:** Approximately 6000 rotating pieces of equipment covered to date.
  Deployed in Downstream, Upstream, LNG/XTL and piloting on Tanker fleet
  Developments ongoing for non Rotating Equipment

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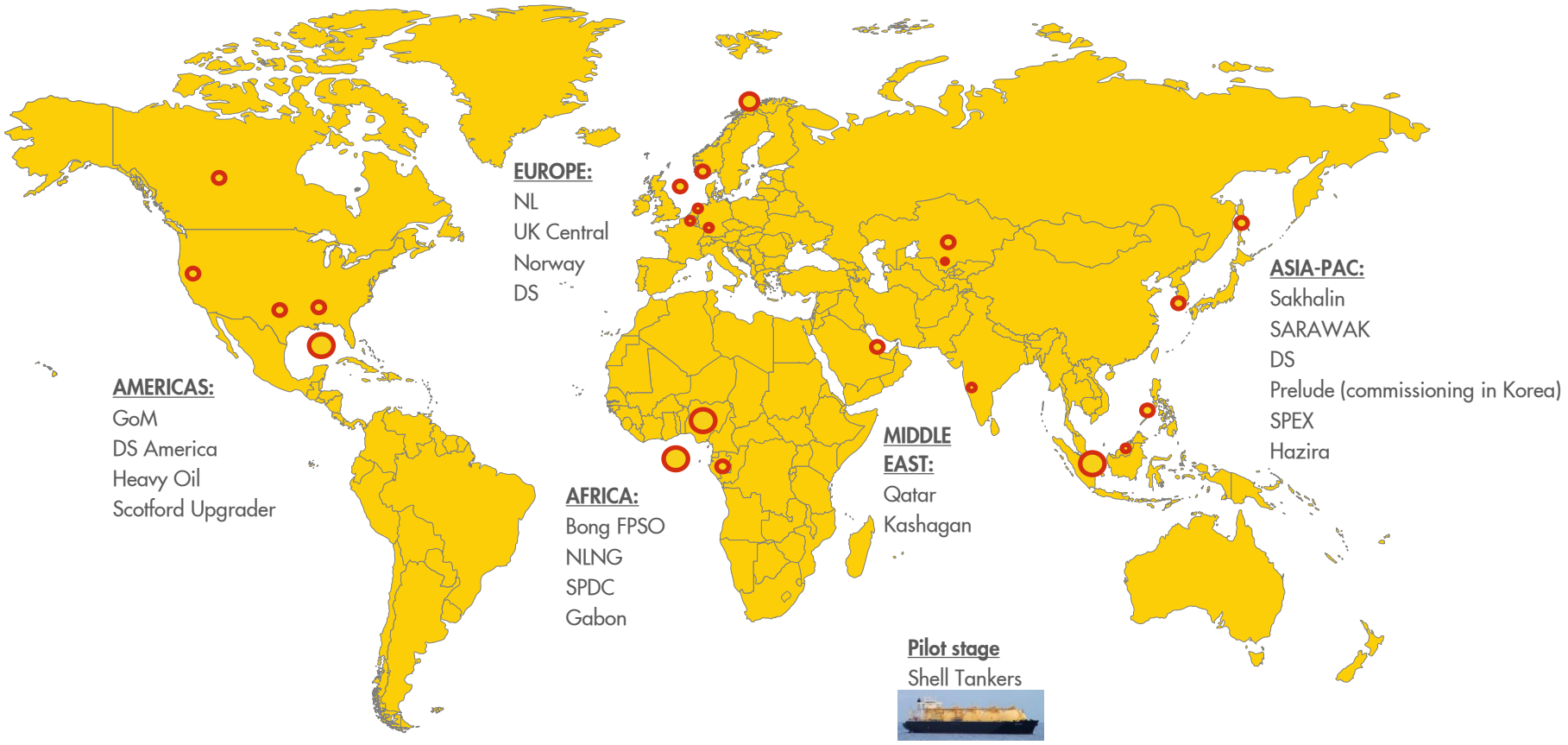
Global presence



Total rotating equipment deployed > 6000

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Why did Shell develop its own toolkit?

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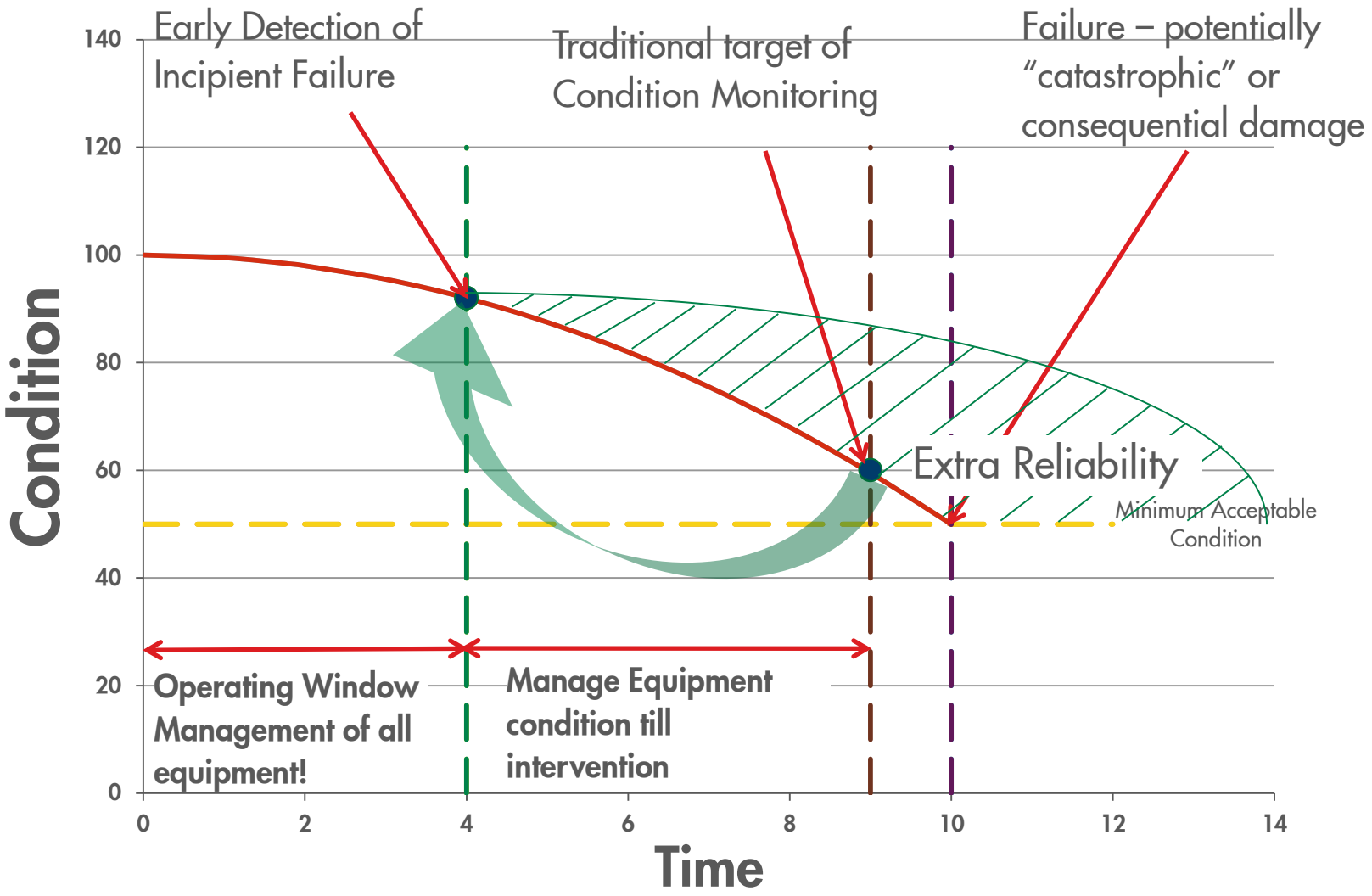
The need for a new approach

High-technology monitoring systems have been around for years…why do failures still occur?

Traditional systems focus on the damage and are often:

- Overcomplicated and badly embedded in IT infrastructure with poorly understood limitations (Data security and network issues)
- Designed by diagnostic (i.e. vibration) specialists, not facility operators
- Looking for damage, rather than seeking to prevent failure
- Lacking ownership

Remote monitoring & diagnostics target



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Levels of "smartness"

Level 0 I know Nothing	**No Equipment Information** Ignorance is Costly !
Level 1 Run Status	**Run Status, % Utilization & Reliability tracking** Know Your Downtime Dollars !
Level 2 Performance	**Actual vs. Potential Performance** Improve Your Performance – Maximize Output !
Level 3 Health	**Know The Mechanical Health of Your Equipment** Optimize Your Maintenance Intervals !
Level 4 Diagnostics	**Understand Your Equipments Dynamic Behaviour** Enhanced Mechanical Knowledge !
Level 5 Statistics & Assessments	**Understand Your Equipment Historic Performance** Achieve and Sustain Top Quartile Performance !

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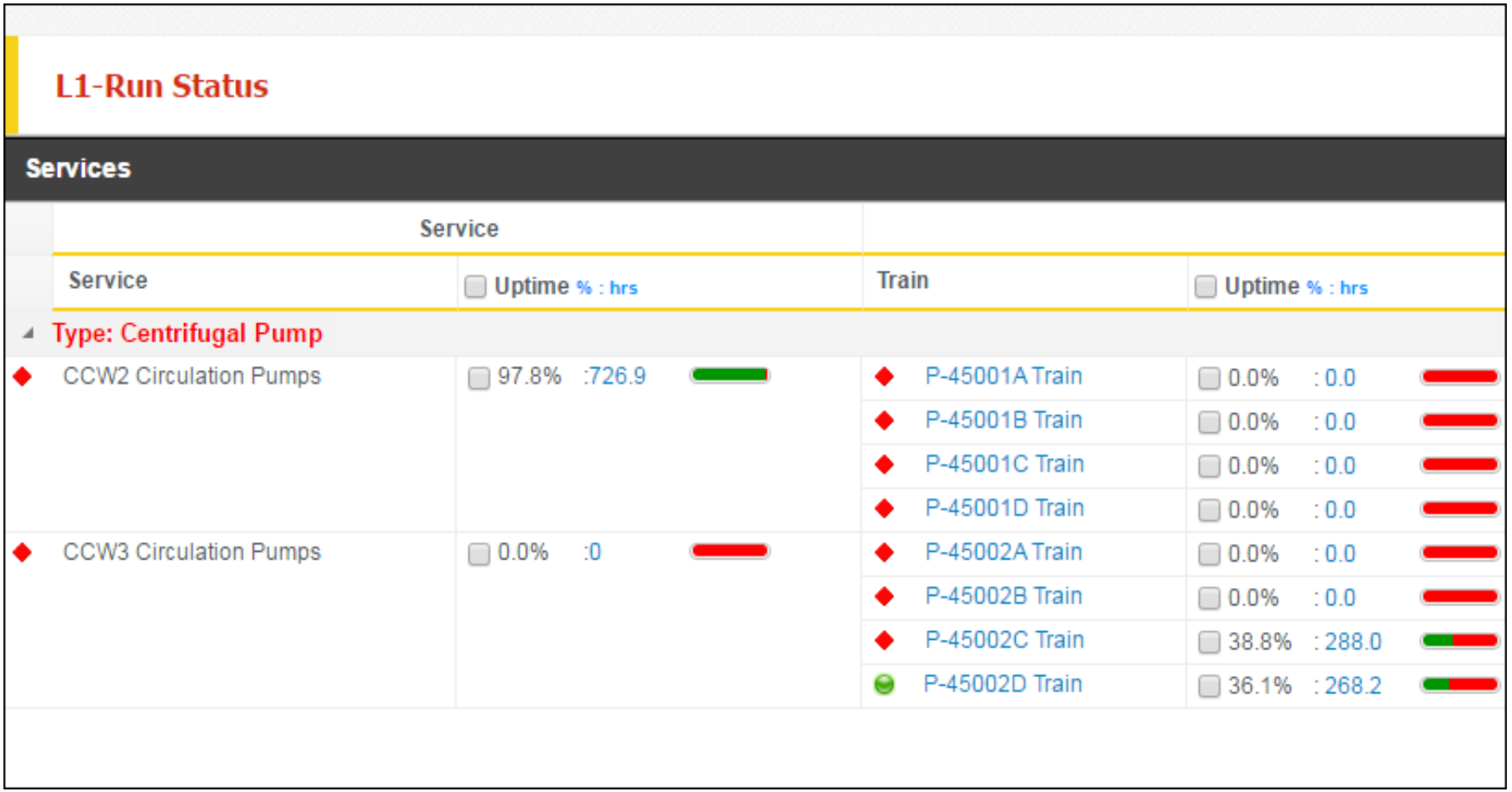
Level 1: Run status



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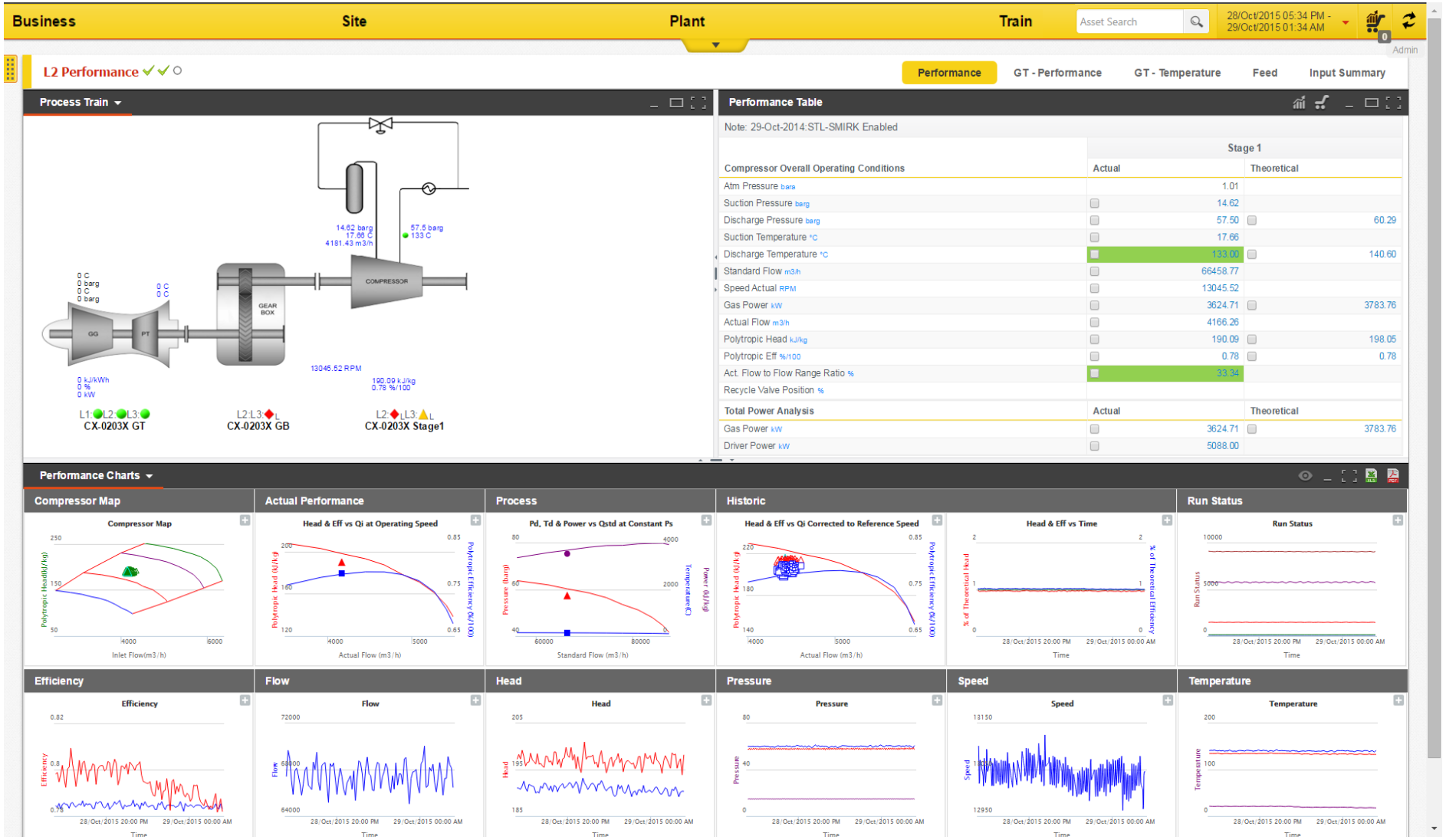
Level 2: Performance monitoring



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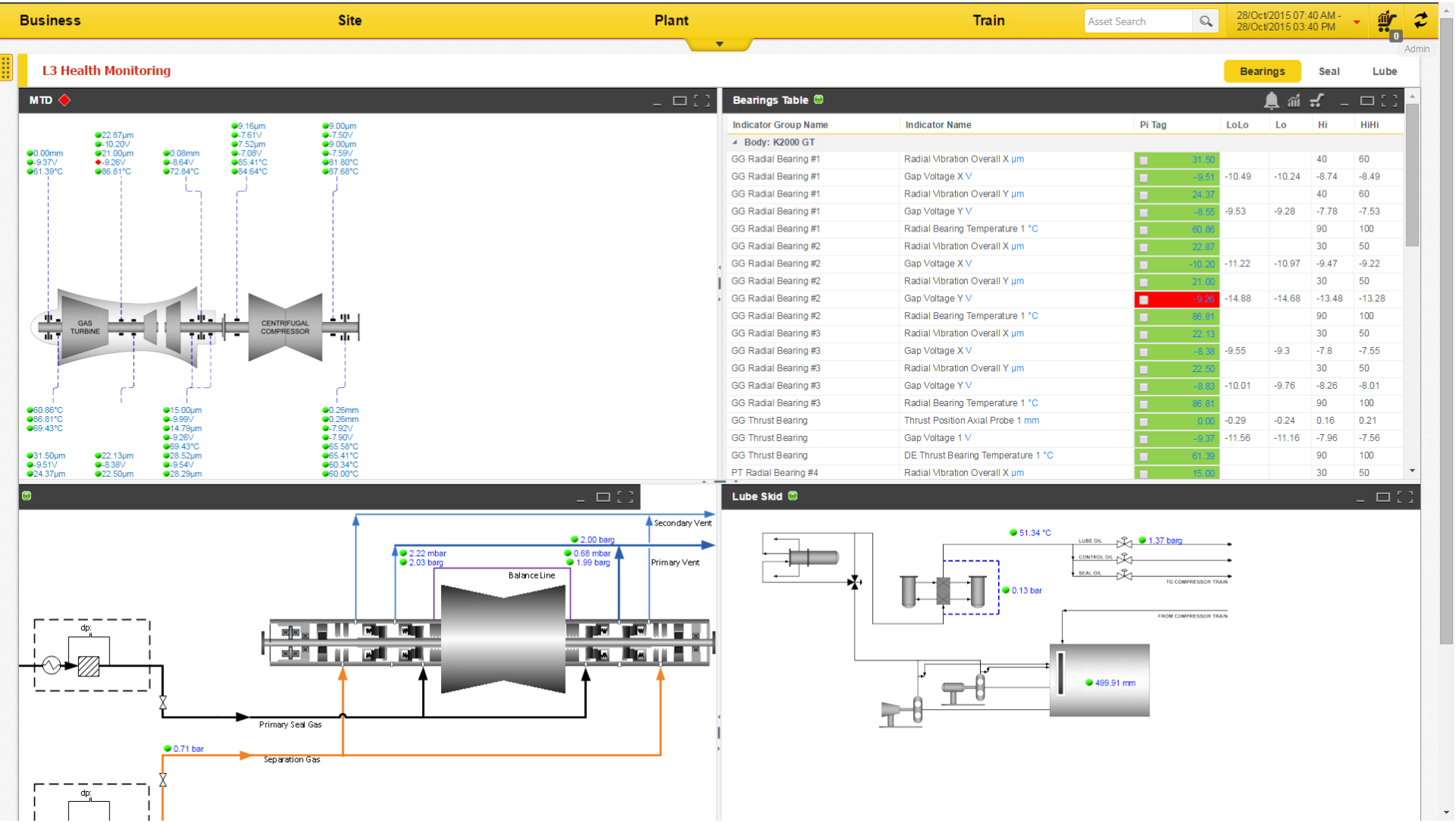
Level 3: Health monitoring



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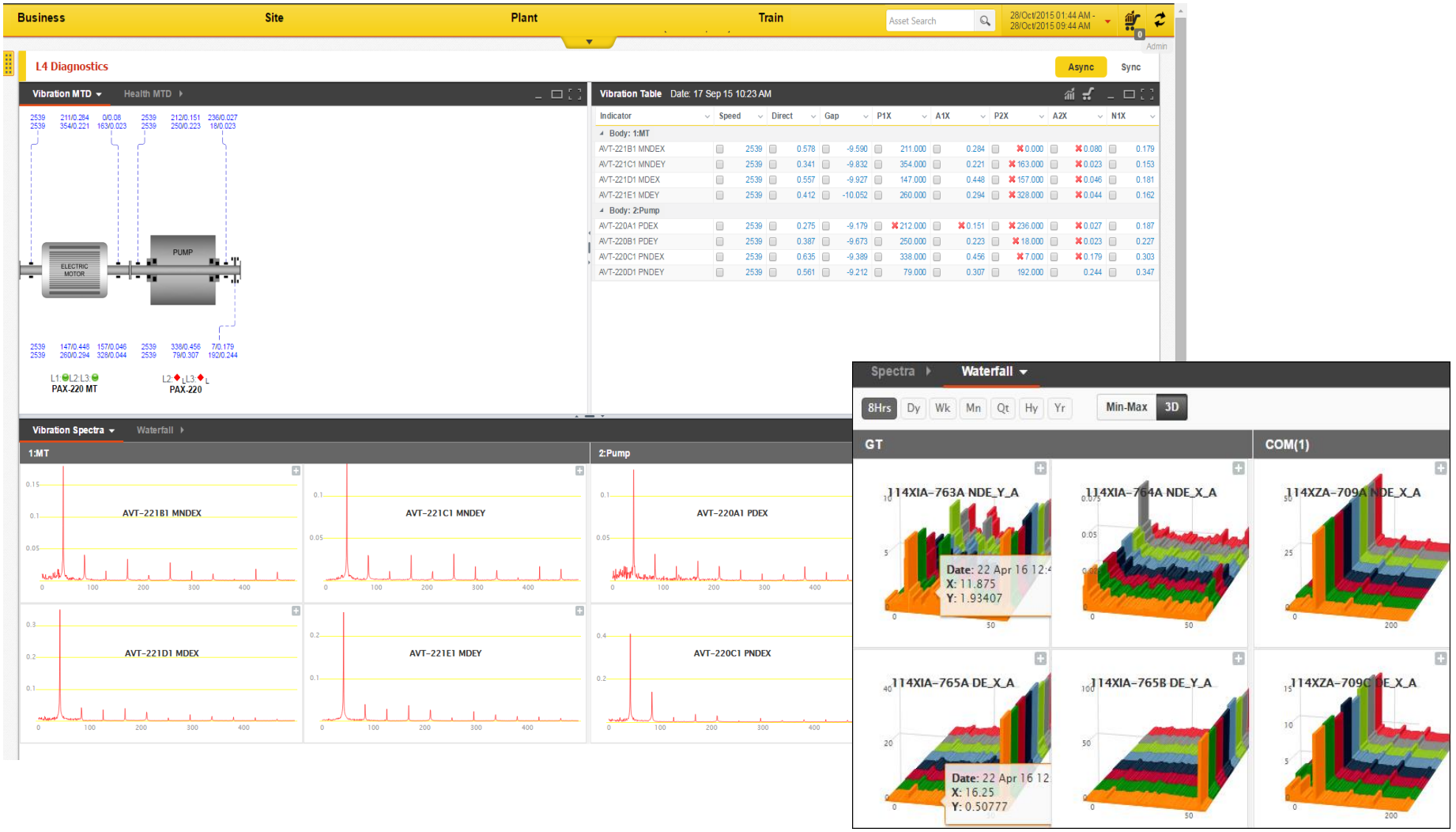
Level 4: Diagnostics



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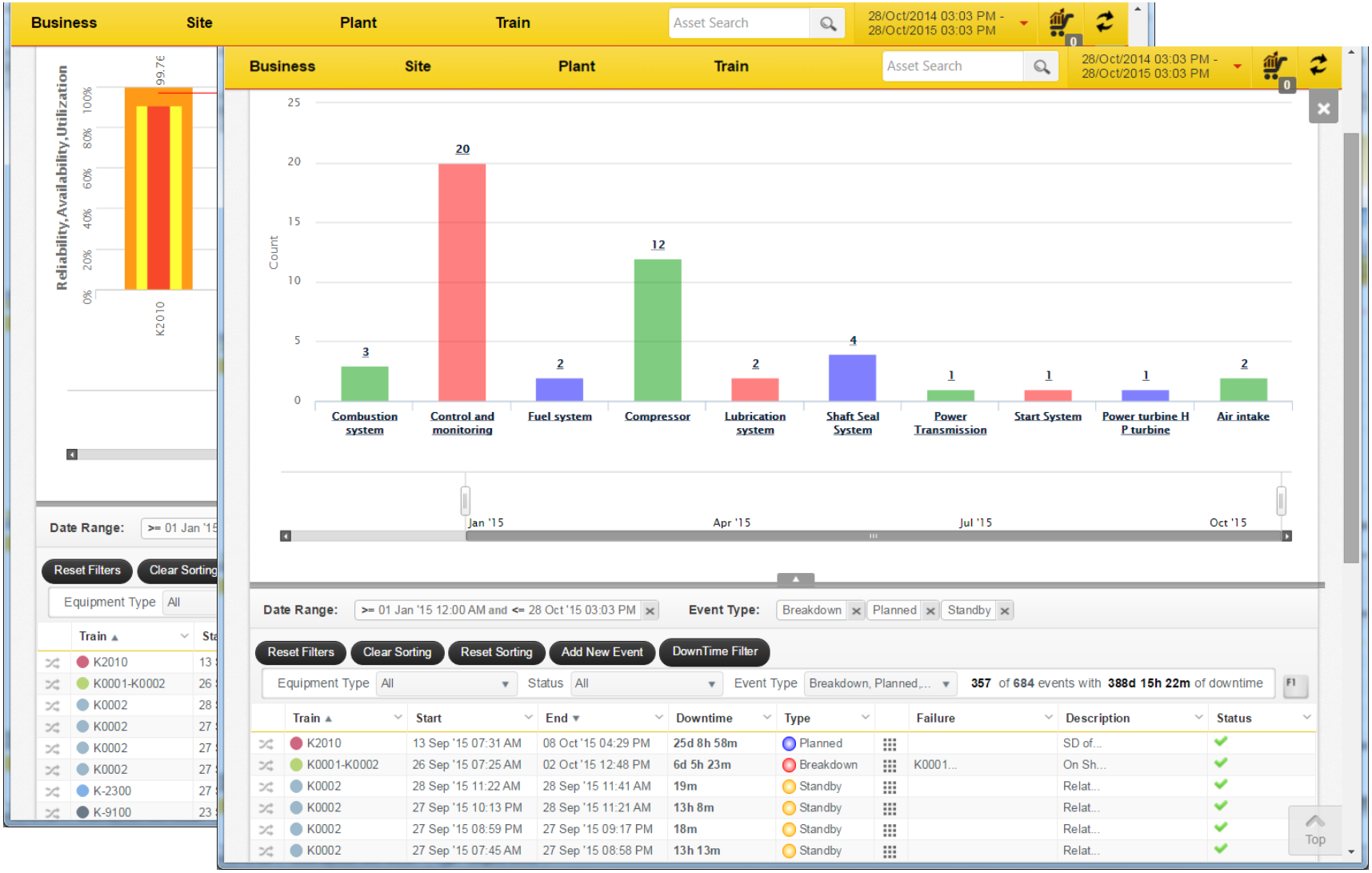
Level 5: Statistics and Assessments



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Application on gas turbines

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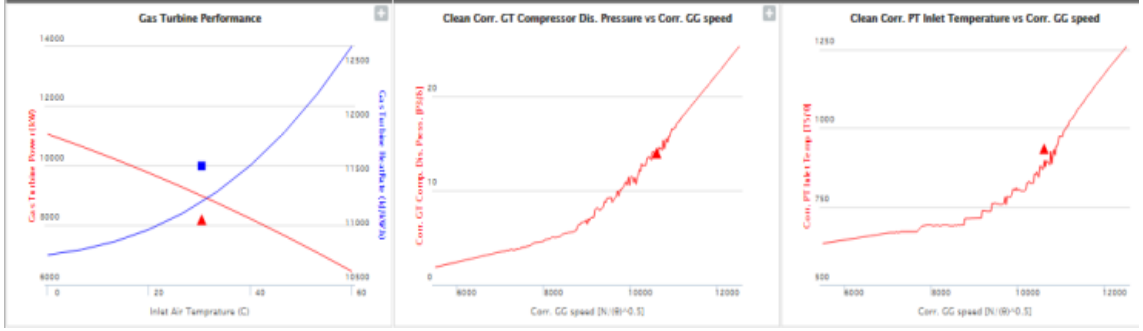
Gas turbine performance

GT Performance Table

	Uncorrected	Corrected	Full Load	Clean
Gas Turbine Performance	Actual	Actual	Theoretical	Theoretical
Power Output kW	8063.65	8186.38	8973.17	8566.21
Heat Rate kJ/kWh	11677.39	11601.58	11274.21	11133.03
Thermal Efficiency %	30.83			32.34
Exhaust Gas Mass Flow kg/s	35.48			36.96
Exhaust Gas Temp °C	490.00			467.70
Gas generator Exhaust Gas Temp °C	709.69			670.19
Gas Turbine Compressor Performance	Actual	Theoretical		
Inlet Temperature °C	30.43			
Discharge Temperature °C	459.27	423.10		
Inlet Pressure barg	0.00			
Discharge Pressure barg	12.90	13.32		
Air Flow kg/h	125671.75	130979.24		
Compressor Overall PR	13.77	14.19		
Compressor Isentropic Eff %	76.49	85.57		
Gas Generator/Power Turbine Performance	Actual	Theoretical		
Turbine Inlet Temp °C	1054.07	1003.18		
GG Exh Press barg	2.50	1.96		
Gas Generator Speed RPM	10880.83			
Power Turbine Speed RPM	8345.15			

Performance Charts

Driver | GT Corrected Performance



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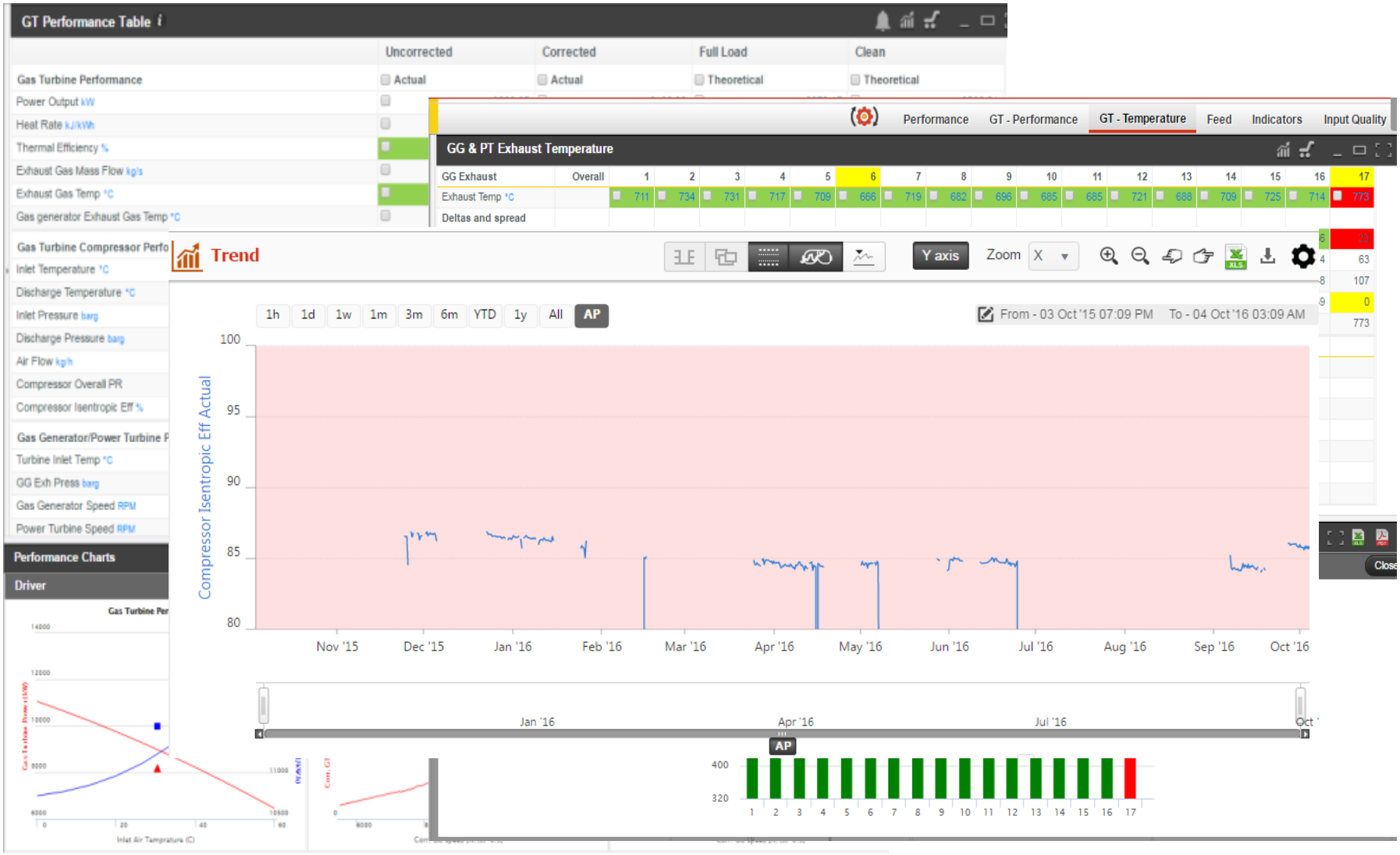
Gas turbine performance



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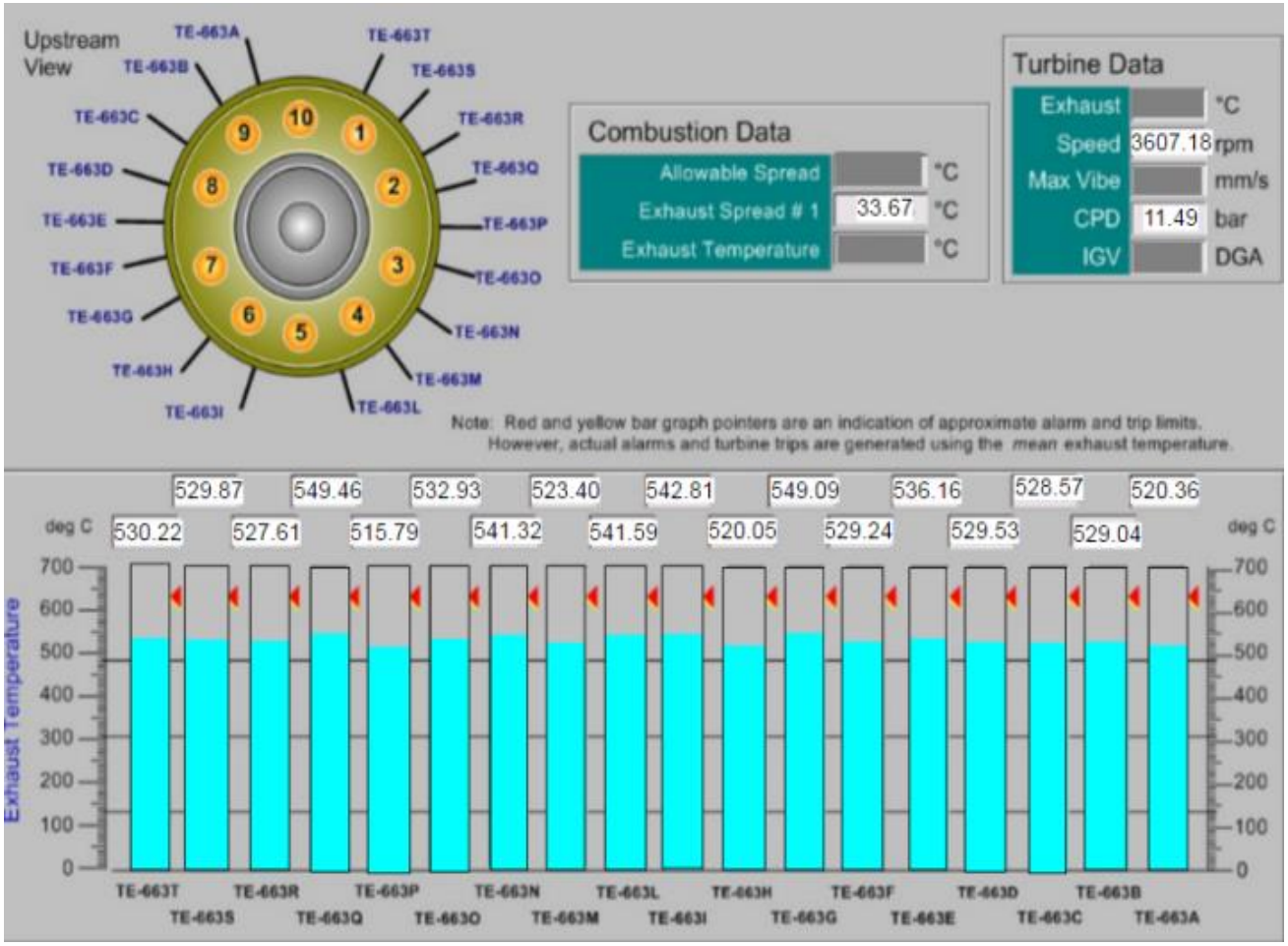
Gas turbine OEM interfaces in SmartConnect



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Future growth

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Wear is not the dominant cause of failure

Equipment does not die: it is killed…

Many failures are caused by operating window violations, operational issues and auxiliaries, including those involving:

- fuel quality
- combustion air quality
- Lubrication
- control mismatches
- off-design operation
- contamination (solids)
- seal failures
- liquid carry-over and fouling
- surge control
- valve problems

Non core Rotating Equipment Engineer issues, requires multi-disciplinary approach to solve

Hot corrosion damage to turbine blade

Fuel problem

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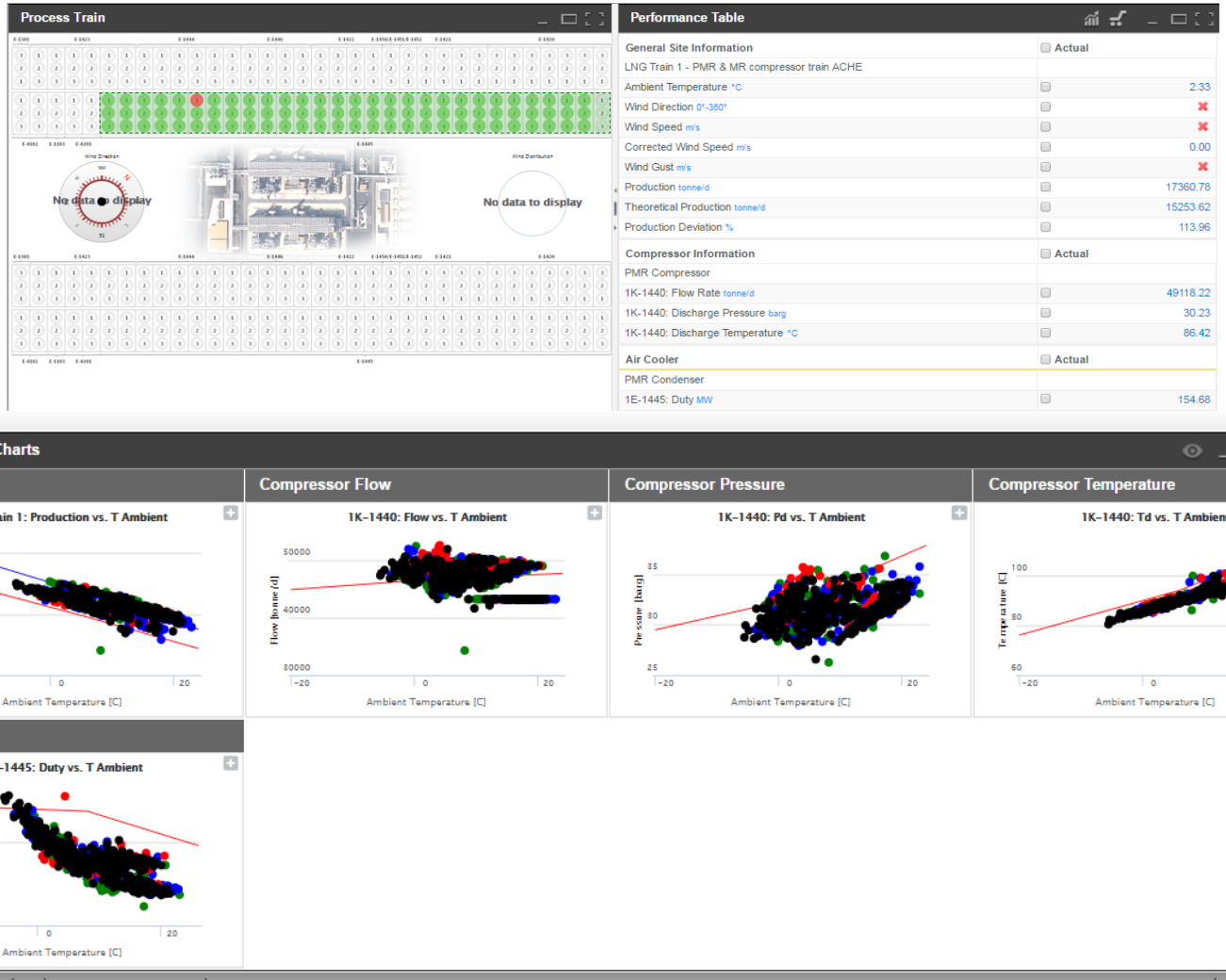
Air cooled heat exchanger



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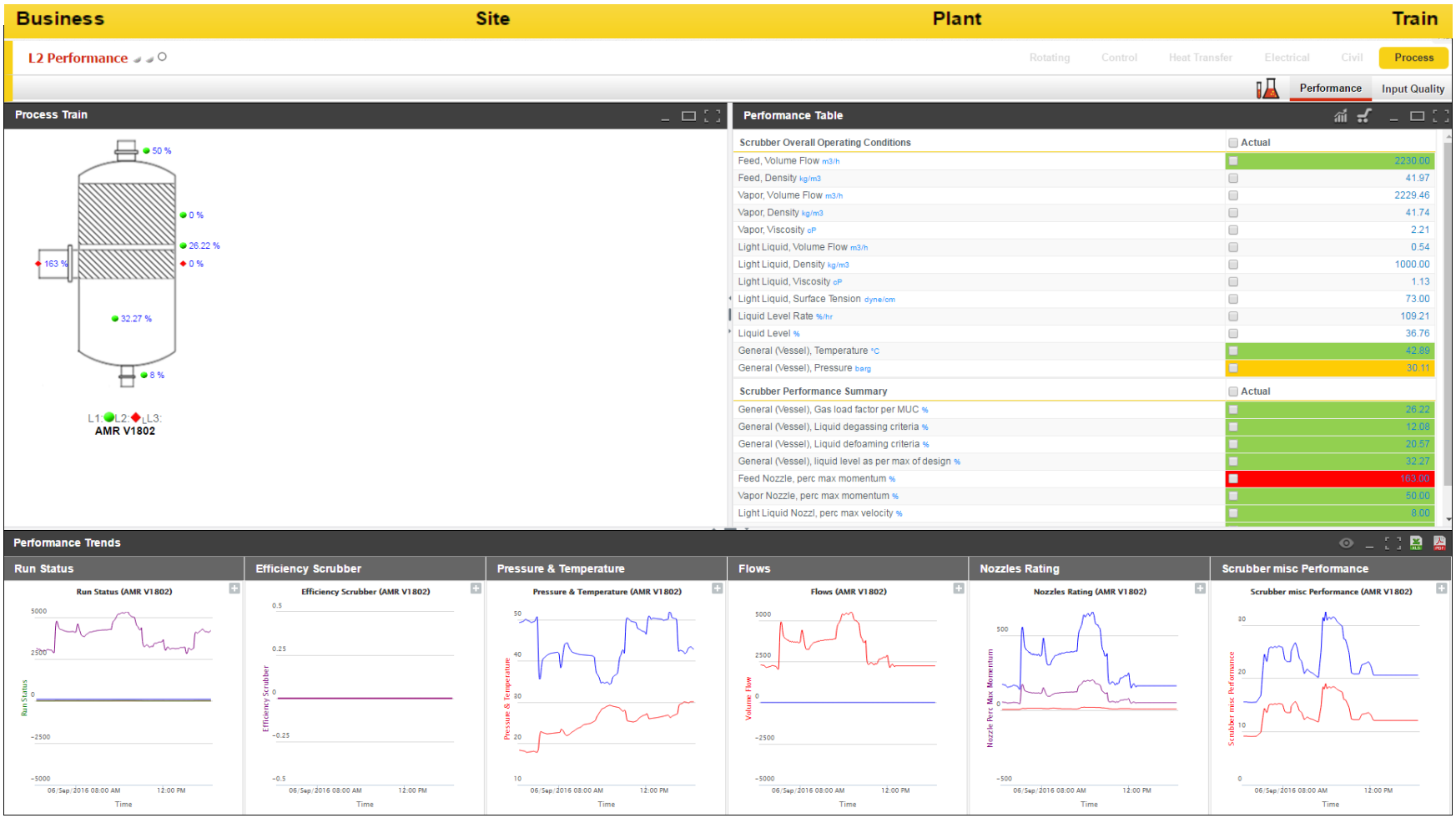
Pressure Vessels



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Questions and Answers

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