Intelligent Asset Management

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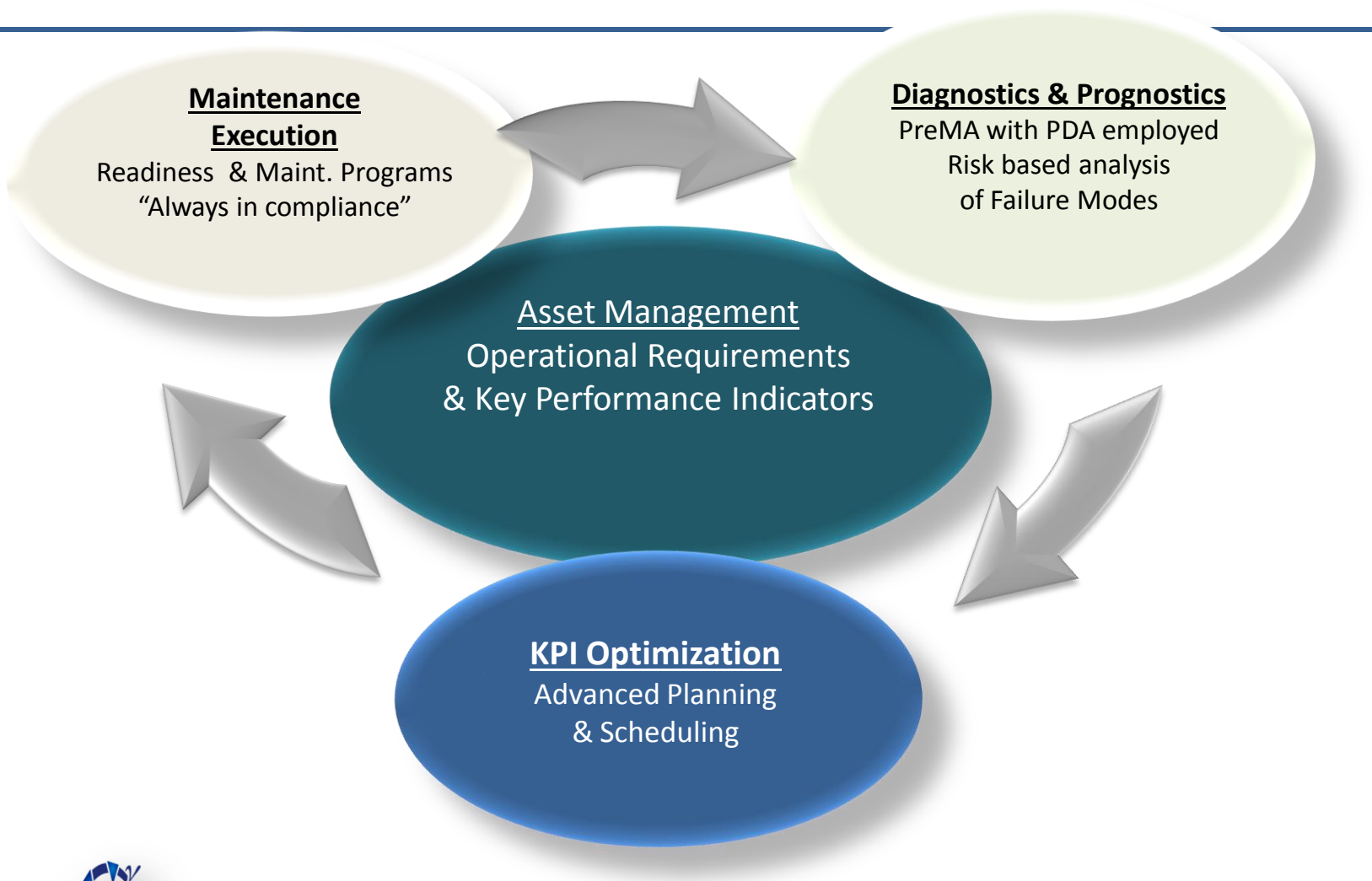
DEI Approach to Intelligent Asset Management

Reliability Centered Maintenance - CBM



PreMA employs Continuous Assessment in a closed loop

The Goal of Maintenance

The goal of an effective maintenance team is to provide the required system performance with optimal resource use. To be effective, the Maintenance approach **must** be based upon a **clear understanding of all system and sub-system level**

- ❑ Critical failures – What equipment causes functional failure or mission failure?
- ❑ Failure modes – How does critical failure occur?
- ❑ Failure Causes – What needs to be influenced to avoid failures?

With this Maintenance approach, you can:

- ✓Recognize an upcoming failure
- ✓Estimate the remaining time to failure
- ✓Pre-plan required repairs to minimize the Mean Time to Repair (MTTR) and associated downtime, to maximize equipment effectiveness and optimize resource constraints

  (Time, People, & Money)

Intelligent Asset Management

Key Enablers

- Failure Modes, Effects, and Criticality Analysis(FMECA)
  - Design, and historical performance
- Accurate Data in a Closed Loop:
  - Current conditions
  - Sensor input
  - Parametric Analysis & Feature Extraction
- Diagnostics: Analytics associated with anomaly classification, as related to specific failure modes of interest
- Prognostics: Planning & Scheduling can be done in advance

Portable Data Analyzer – Point of Maintenance Aid

Maintenance Strategy Development

‘Corrective based’	Preventive ‘Cyclic based’	Preventive ‘Condition based’ RE-CBM	Preventive ‘Risk based’ RE-CBM+
•Repair on fail •Replace on fail	•Set calendar interval •Set machine hours interval	•Maintain/replace based on **current condition**)	•Maintain/replace based on **future risk** of failure under planned operating profile

The best choice of an equipment maintenance strategy depends on objectives and constraints

For critical systems, a risk based strategy offers many advantages

Maintenance Strategy Development

Within a CBM maintenance strategy:

- Sensor data use is maximized where applicable
- Neither sensors or continuous input are likely available, or preferred, to monitor every failure mode
- Visual assessments provides assessments where sensors and other techniques are not viable
  - CBM strategy provides targeted visual assessments
  - Avoids duplication of effort from existing sensor data

Preventive

'Risk based' RE-CBM+

•Maintain/replace based on **future risk** of failure under planned operating profile

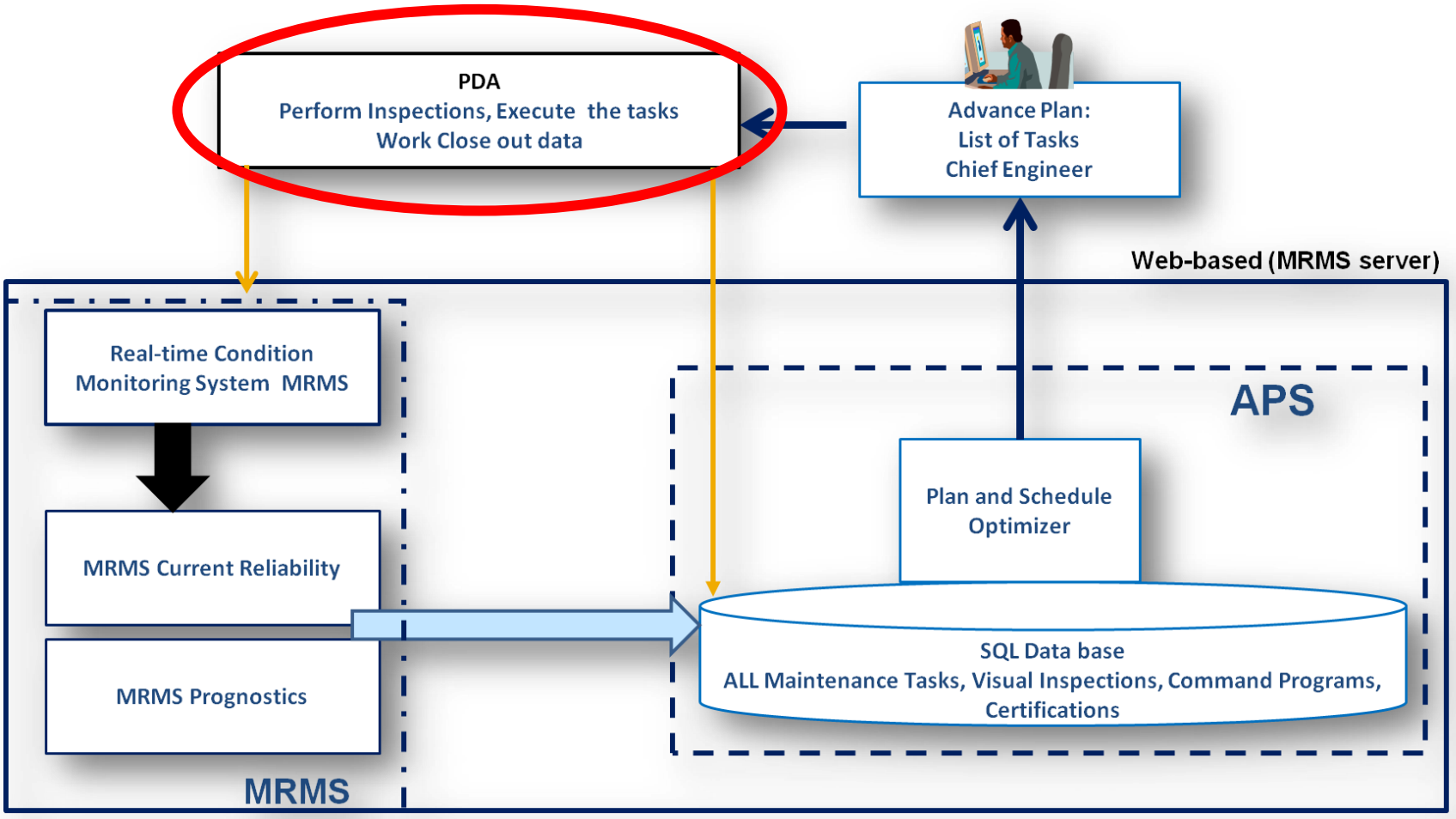
Preventive

'Condition based' RE-CBM

•Maintain/replace based on **current condition**

PDA enables efficient and repeatable Visual Assessment for Intelligent Asset Management

At the Point of Maintenance…



The Portable Data Analyzer…
…completes data assimilation requirements for a CBM based strategy

Visual assessments with the PDA enables

- Failure mode monitoring where sensors cannot
- Feedback regarding maintenance actions
- Specific & standardized assessment criteria
- Safety related checks best done by visual cues

WBS	Nomenclature	Dominant Failure Mode	On-Line Reliability Model	Inspection requirements
Engine	Cylinder Head (8) Seals	**YES**	**Weibull Events**	A
	Intake Valve, Stems, seats	**YES**	**Weibull PHM**	B
	Exhaust Valve, Stems, seats	**YES**	**Weibull PHM Events**	B
	Camshafts (and bearings)	**NO**		B
	Ring	**YES**	**Weibull PHM Events**	B
	Liner	**YES**		B
Gov / Control				
	Governor / Actuator / Linkage	**NO**		C
	Overspeed Control Unit (Flywheel Mount.)	**NO**		D
	Sensors / Instruments / Gages / Gage vlvs & Lines	**NO**		D
	Wiring / Electrical / 24 VDC System	**NO**		E
	Speed Governor Injection Pump Drive / Coupling	**NO**		C
	Low L/O Press. Shutdown Solenoid Valve	**NO**		D

A	Condition to be inspected and reported when the equipment is repaired. No specific periodic visual data collection requirements
B	Measurements and visual condition (as specified in data collection requirements) to be taken and reported when the equipment is repaired. Information will be used to update reliability models
C	External condition to be checked visually and reported. Periodicity will be determined based on consultation with CHENG and SME. Where applicable, generic reliability models to be used until failure/condition data is collected
D	Applicable to sensors and electrical fittings. To be checked for looseness of fitting in the place holder. Wiring and connections to be checked at regular intervals (to be determined based on consultation with CHENG and SME).
E	Undetermined

Portable Data Analyzer

PDA INSPECTIONS

Visual Inspection Checklists

- Air System
- Ballast and Cargo
- Boiler System
- BOR Systems
- BOR Systems
- CW System
- FO System
- IG System
- LO System
- Logbook
- Steering System
- Stern Tube

Configuration

PDA Library

PDA

DUE NOW | ALERT REPORT | EVENT CHECKS | DAILY ER ROUNDS | HISTORY | HISTORY TREND

Portable Data Analyzer

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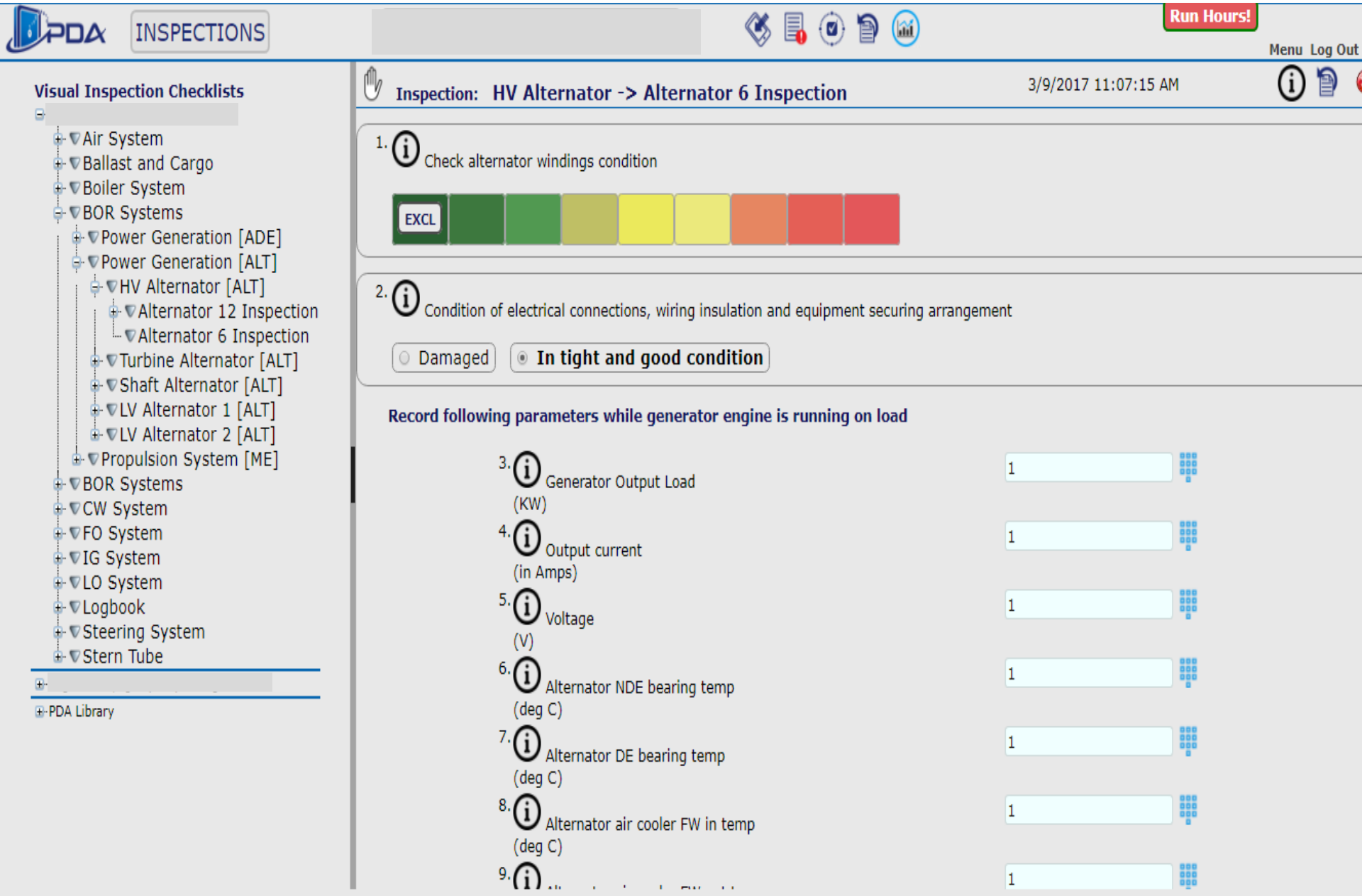
Systems Engineering for Intelligent Asset Management



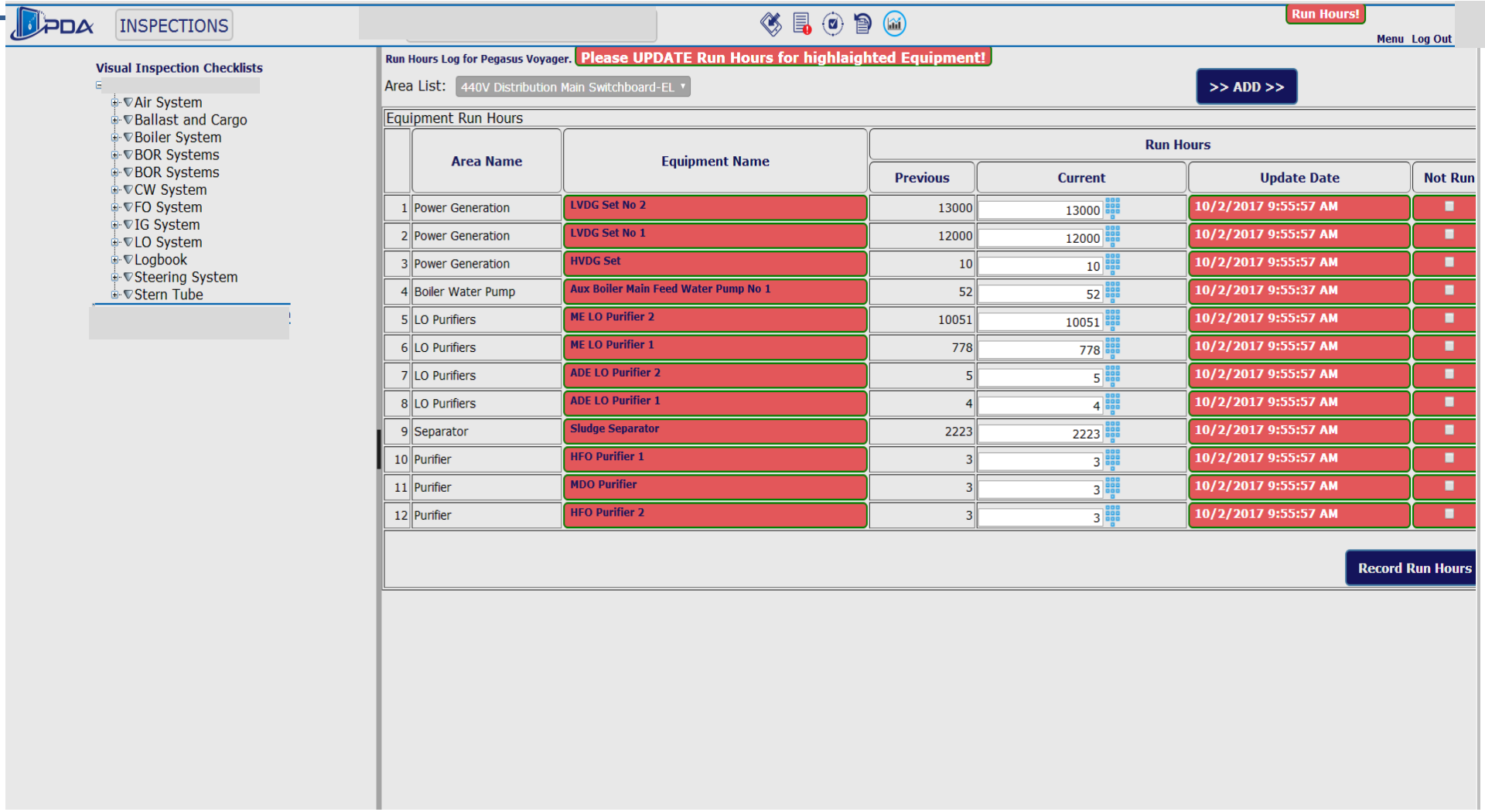
Portable Data Analyzer

- History of previous inspections provides intuitive trending of results

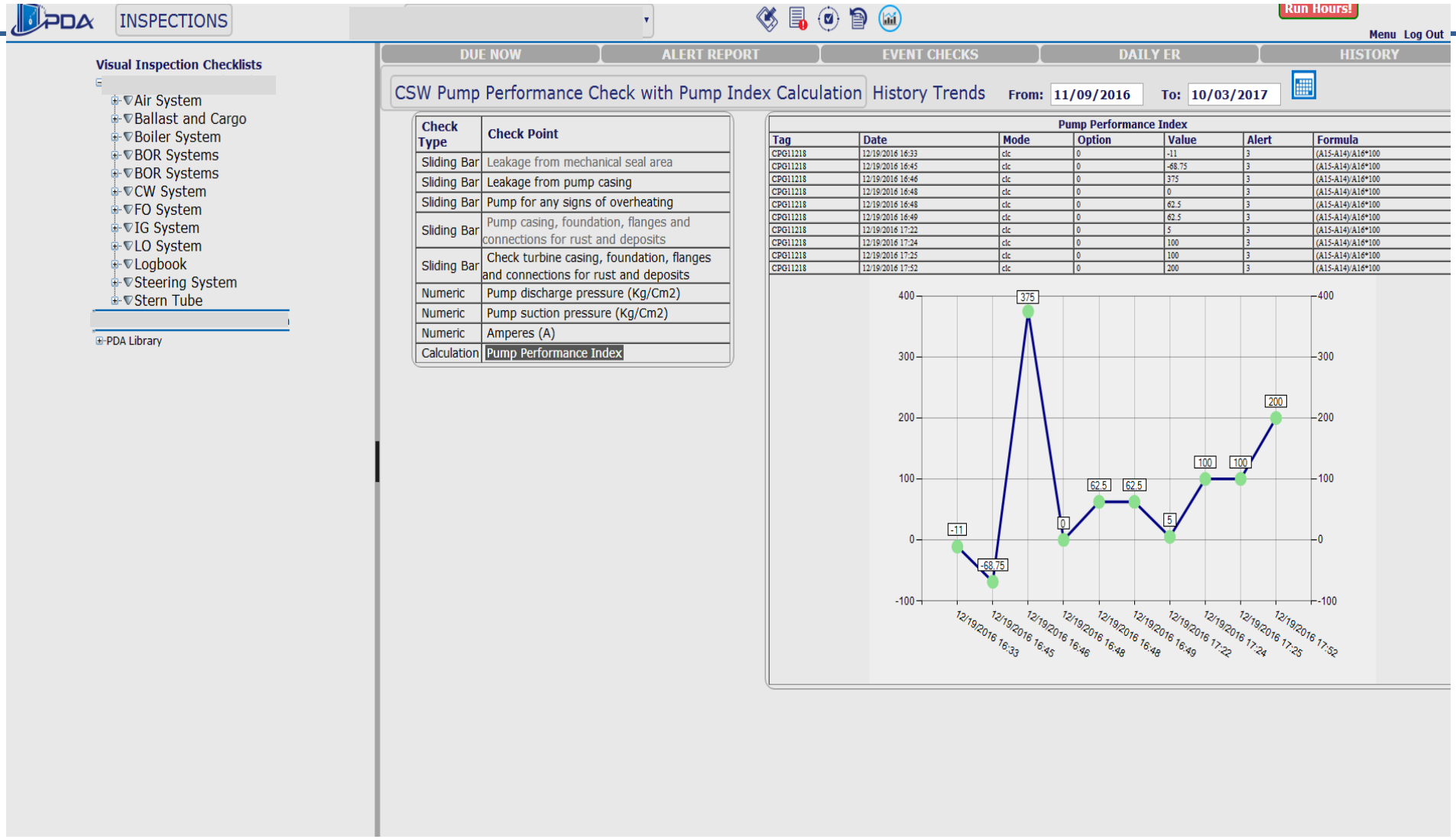
Inspection History for Steering Gear 1 Monthly Inspection

Date	Name	No 1 cylinder Ram V-Packing	No 2 cylinder Ram V-Packing	Automatic Greasing Machine	No 3 cylinder Ram V-Packing	No 4 cylinder Ram V-Packing	Oil Seal of Pump Control Unit (No.1 Pump)	Oil Seal of Pump Control Unit (No.2 Pump)	Oil Leakage	Communication Equipment	Automatic Greasing machine	Machined parts	Steering Gear	Status	Comments
2016/12/12 14:43	Ilya	TRBL	TRBL	Grease level low	TRBL	TRBL	TRBL	TRBL	Oil leaks present (Provide details)	Interferences in communication	Grease level low Operates correctly	Poor	Abnormal noise present	OK	
2016/11/09 16:39	Ilya	ALRM	TRBL	Grease level low	EXCL	TRBL	ALRT	WARN	Oil leaks present (Provide details)	Satisfactory	Operates correctly	Clean and good condition	Abnormal noise present	OK	

Portable Data Analyzer



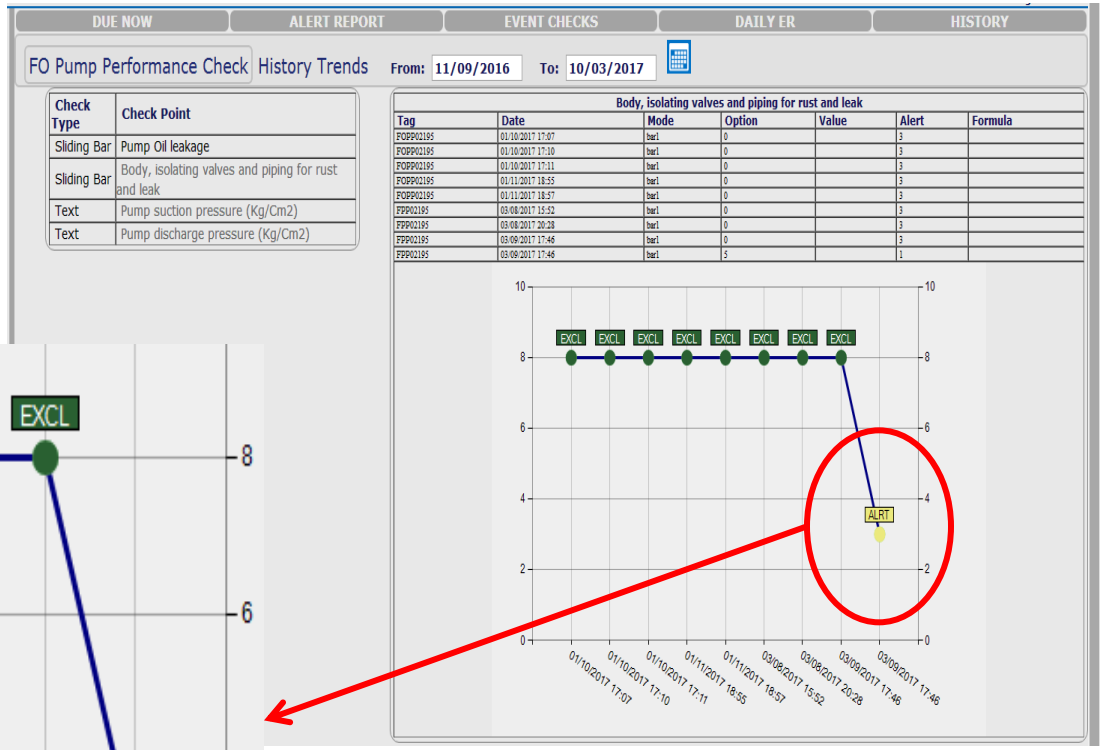
Portable Data Analyzer

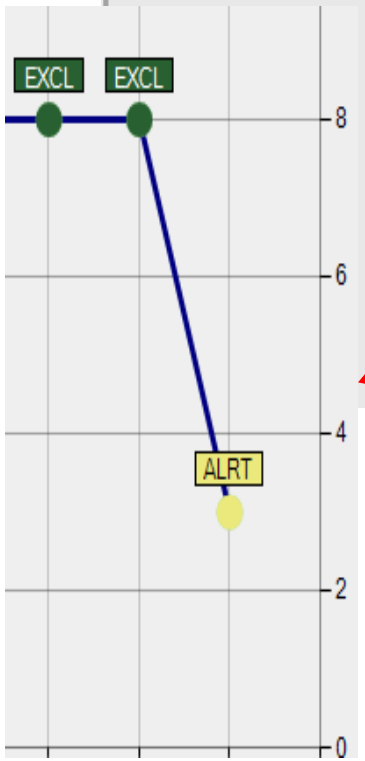


Portable Data Analyzer

Trends viewable at the PDA

- Pump Check
- Assessment in absence of sensor data
- Assessment resulted in "Alert"
- Technician can take action or plan to repair





Other PDA capabilities

- Some Visual assessment outcomes can be analyzed at the point of maintenance, and data collection
- Technical Documentation for reference
- Maintenance process related documentation
- If enabled, allows for web based applications for maintenance support related, server based information
- Toughbook provides camera and webcam capabilities, to allow for condition documentation
- Familiar interface – Windows 7 or greater

Portable Data Analyzer Summary

- Key component to a 

Condition Based Maintenance strategy
- Enables efficient and repeatable maintenance actions for a maintenance team
- CBM provides future health awareness enabling better long term planning
- Long term planning enables optimization of your key performance indicators and resources
- PDA – a maintenance process improvement tool providing a key element for a CBM strategy, as well as supporting execution at the point of maintenance