

# Intelligent Asset Management

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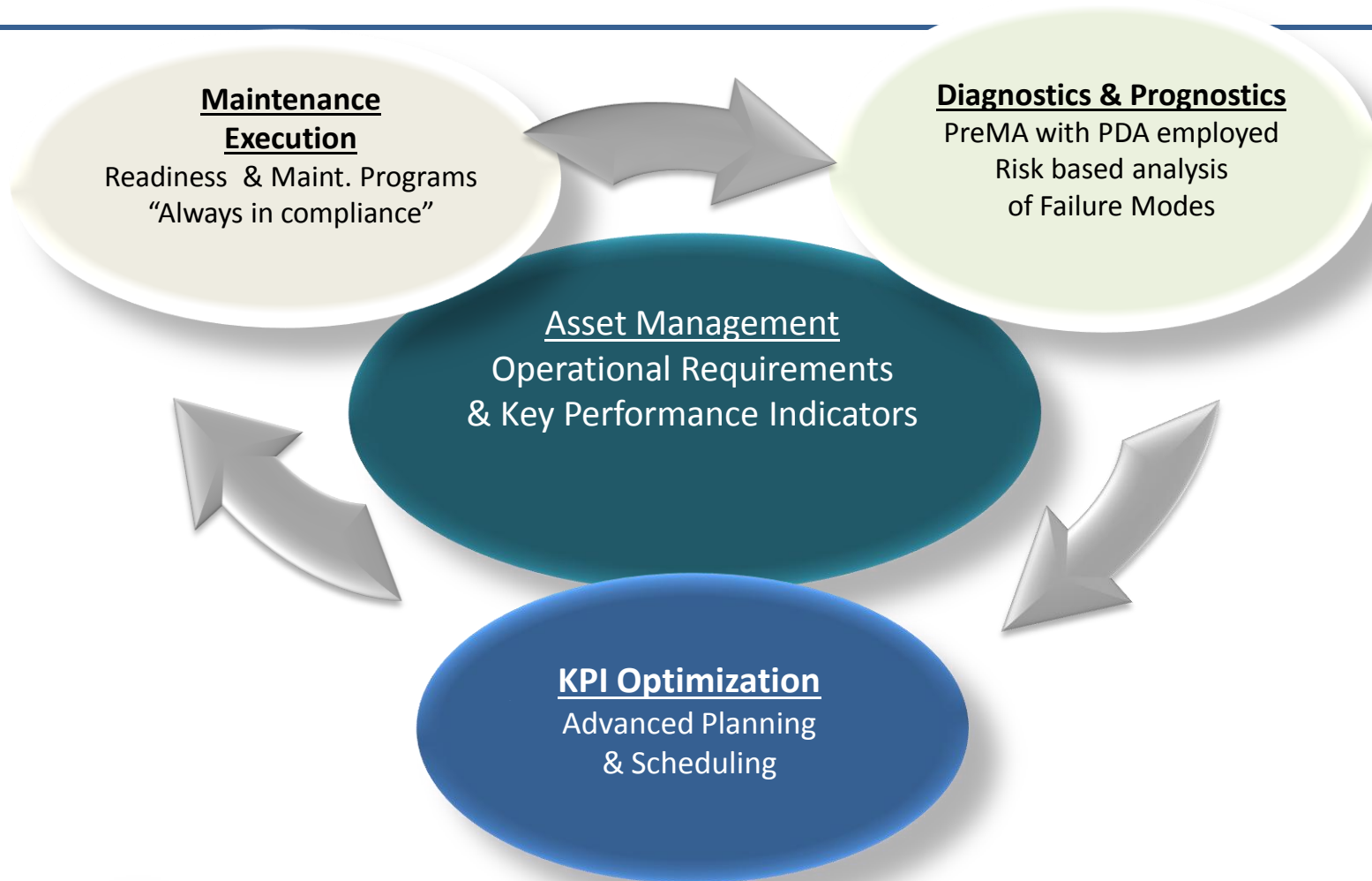
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October 31<sup>st</sup>, 2017

# 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

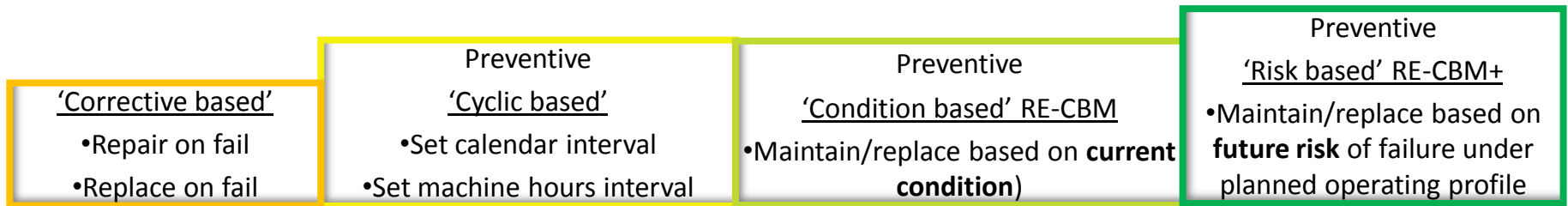
## Key Enablers

- 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



PreMA Portable Data Analyzer – Point of Maintenance Aid

# Maintenance Strategy Development



**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

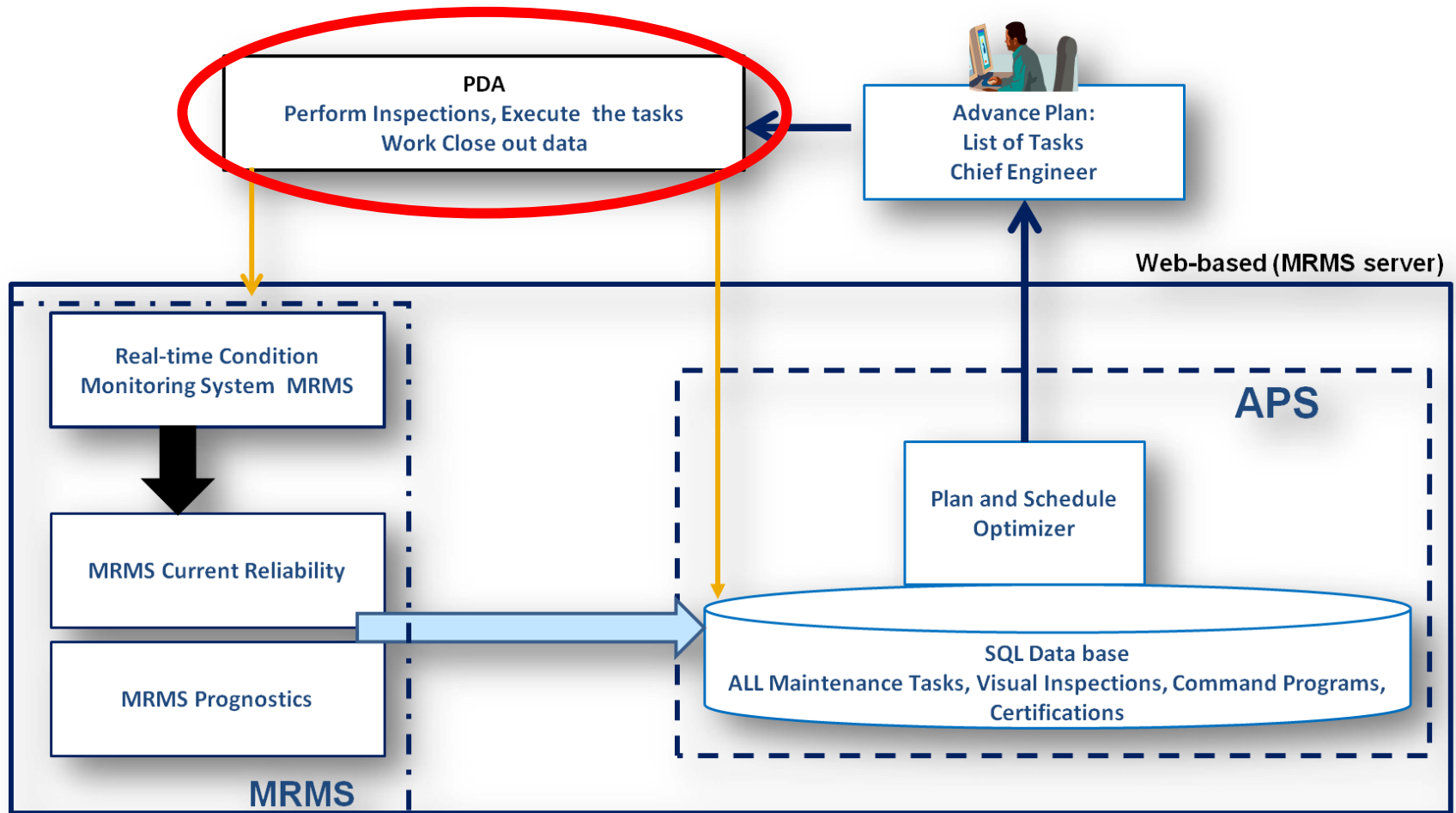
Preventive

'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

<u>WBS</u>	<u>Nomenclature</u>	<u>Dominant Failure Mode</u>	<u>On-Line Reliability Model</u>	<u>Inspection requirements</u>
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

<b>A</b>	Condition to be inspected and reported when the equipment is repaired. No specific periodic visual data collection requirements
<b>B</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
<b>C</b>	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
<b>D</b>	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).
<b>E</b>	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

### Visual Inspection Checklists


- ▼ Air System
- ▼ Ballast and Cargo
- ▼ Boiler System
- ▼ BOR Systems
- ▼ Power Generation [ADE]
- ▼ Power Generation [ALT]
  - ▼ HV Alternator [ALT]
    - ▼ Alternator 12 Inspection
    - ▼ Alternator 6 Inspection
  - ▼ Turbine Alternator [ALT]
  - ▼ Shaft Alternator [ALT]
  - ▼ LV Alternator 1 [ALT]
  - ▼ LV Alternator 2 [ALT]
- ▼ Propulsion System [ME]
- ▼ BOR Systems
- ▼ CW System
- ▼ FO System
- ▼ IG System
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Inspection: HV Alternator -> Alternator 6 Inspection

3/9/2017 11:07:15 AM















1.  Check alternator windings condition



2.  Condition of electrical connections, wiring insulation and equipment securing arrangement

Damaged  In tight and good condition

Record following parameters while generator engine is running on load

- 3.  Generator Output Load (KW)  
- 4.  Output current (in Amps)  
- 5.  Voltage (V)  
- 6.  Alternator NDE bearing temp (deg C)  
- 7.  Alternator DE bearing temp (deg C)  
- 8.  Alternator air cooler FW in temp (deg C)  
- 9.  ...  

PDA Library

# 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



INSPECTIONS



Run Hours!

[Menu](#) [Log Out](#)

**Visual Inspection Checklists**

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**Run Hours Log for Pegasus Voyager:** Please UPDATE Run Hours for highlighted Equipment!

Area List: 440V Distribution Main Switchboard-EL >> ADD >>

	Area Name	Equipment Name	Run Hours			
			Previous	Current	Update Date	Not Run
1	Power Generation	LVDG Set No 2	13000	13000	10/2/2017 9:55:57 AM	■
2	Power Generation	LVDG Set No 1	12000	12000	10/2/2017 9:55:57 AM	■
3	Power Generation	HVDG Set	10	10	10/2/2017 9:55:57 AM	■
4	Boiler Water Pump	Aux Boiler Main Feed Water Pump No 1	52	52	10/2/2017 9:55:37 AM	■
5	LO Purifiers	ME LO Purifier 2	10051	10051	10/2/2017 9:55:57 AM	■
6	LO Purifiers	ME LO Purifier 1	778	778	10/2/2017 9:55:57 AM	■
7	LO Purifiers	ADE LO Purifier 2	5	5	10/2/2017 9:55:57 AM	■
8	LO Purifiers	ADE LO Purifier 1	4	4	10/2/2017 9:55:57 AM	■
9	Separator	Sludge Separator	2223	2223	10/2/2017 9:55:57 AM	■
10	Purifier	HFO Purifier 1	3	3	10/2/2017 9:55:57 AM	■
11	Purifier	MDO Purifier	3	3	10/2/2017 9:55:57 AM	■
12	Purifier	HFO Purifier 2	3	3	10/2/2017 9:55:57 AM	■

Record Run Hours

# Portable Data Analyzer



INSPECTIONS

Run Hours!
Menu Log Out

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**Visual Inspection Checklists**

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⊕ PDA Library

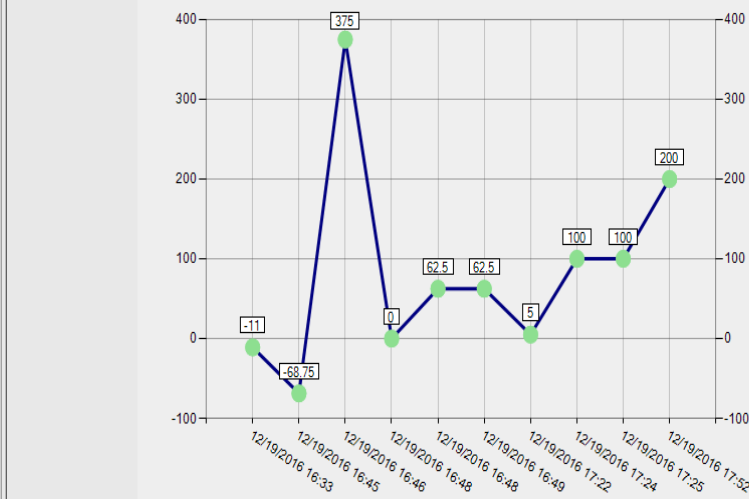
DUE NOW
ALERT REPORT
EVENT CHECKS
DAILY ER
HISTORY

CSW Pump Performance Check with Pump Index Calculation History Trends

From: 11/09/2016 To: 10/03/2017

Check Type	Check Point
Sliding Bar	Leakage from mechanical seal area
Sliding Bar	Leakage from pump casing
Sliding Bar	Pump for any signs of overheating
Sliding Bar	Pump casing, foundation, flanges and connections for rust and deposits
Sliding Bar	Check turbine casing, foundation, flanges and connections for rust and deposits
Numeric	Pump discharge pressure (Kg/Cm2)
Numeric	Pump suction pressure (Kg/Cm2)
Numeric	Amperes (A)
Calculation	<b>Pump Performance Index</b>

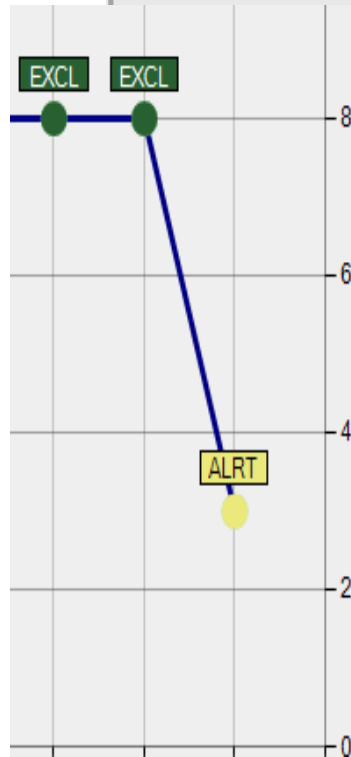
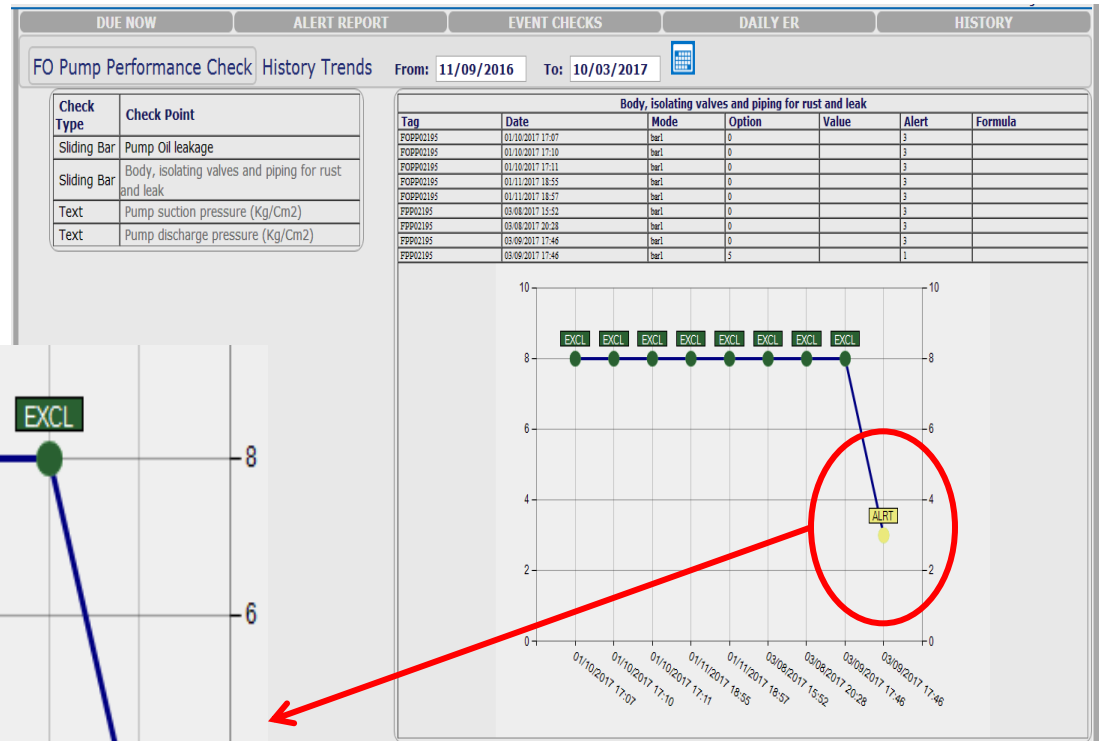
Pump Performance Index						
Tag	Date	Mode	Option	Value	Alert	Formula
CPGI1218	12/19/2016 16:33	ckc	0	-11	3	(A15-A14)/A16*100
CPGI1218	12/19/2016 16:45	ckc	0	-68.75	3	(A15-A14)/A16*100
CPGI1218	12/19/2016 16:46	ckc	0	375	3	(A15-A14)/A16*100
CPGI1218	12/19/2016 16:48	ckc	0	0	3	(A15-A14)/A16*100
CPGI1218	12/19/2016 16:48	ckc	0	62.5	3	(A15-A14)/A16*100
CPGI1218	12/19/2016 16:49	ckc	0	62.5	3	(A15-A14)/A16*100
CPGI1218	12/19/2016 17:22	ckc	0	5	3	(A15-A14)/A16*100
CPGI1218	12/19/2016 17:24	ckc	0	100	3	(A15-A14)/A16*100
CPGI1218	12/19/2016 17:25	ckc	0	100	3	(A15-A14)/A16*100
CPGI1218	12/19/2016 17:52	ckc	0	200	3	(A15-A14)/A16*100



# 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