



Improving Equipment Reliability and Availability through Real-time Data

Presented by **Nada Khalfan Al Meqbali**
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أدنوك
ADNOC

We are one of the world's leading energy producers, and a primary catalyst for Abu Dhabi's growth and diversification.

12th

The largest oil producer in the world

3

million barrels per day

151

oil transportation & support vessels

ADNOC Business

Exploration & Production

We produce about 3 million barrels of oil per day, and over 9 billion standard cubic feet of gas per day, which places us among the largest energy producers

Processing & Refining

We positively impact the lives of millions of people throughout the world; generating the energy that is driving Abu Dhabi's development.

Marketing & Distribution

We are a trusted and reliable global energy provider. Our oil, gas, refined and petrochemical products are sold on six continents.

ADNOC Business

Exploration & Production

We produce about 3 million barrels of oil per day, and over 9 billion standard cubic feet of gas per day, which places us among the largest energy producers.

3.0

million barrels
of oil per day



9.8

billion cubic feet of
raw gas per day





ADNOC Onshore

We are the leading onshore producer within ADNOC Group, producing 1.6 million barrels of oil and 5.6 billion cubic feet of gas per day.



Established in
 1971

Oil & gas
fields
 11



ADNOC Onshore

Fields and Terminals



ADNOC Onshore

Digital Transformation

Operations

Production Optimization

Maintenance & Integrity

Terminal Operations

Remote Monitoring

HSE & Energy



Sensor to Decision

ADNOC

Location: ADNOC HQ

- 1 PANORAMA
- 2 Integrated Capacity Model

IT Network

Location: HQ & Field

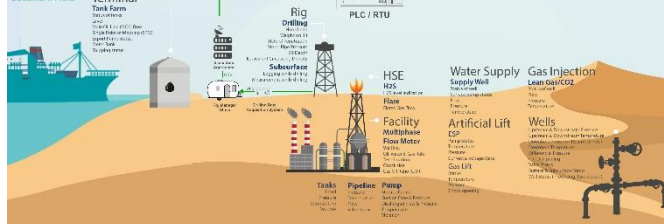


Control Network

Location: Field

Sensors

Location: Field



Business Case



Production Sustainability



Equipment Reliability



Equipment Availability



Challenge

Manual data entry of equipment run hours & status and manual calculation of KPI's related to equipment reliability and availability.

No effective condition monitoring of equipment's

Solution

Automated the capturing of equipment run hours & status in Asset Management System and equipment's KPI's calculation

Developed an effective condition monitoring with smart notifications for equipment's

OSIsoft PI - Maximo Integration

Overview



DCS/SCADA

- PROVIDES ACTUAL EQUIPMENT STATUS
- PROVIDES ACTUAL ASSET PARAMETERS



OSIsoft PI

- MONITORS EQUIPMENT
- PROVIDES INTERFACE TO ENTER EVENT REASONS
- CALCULATES EQUIPMENT KPIs
- PROVIDES VIEWS & REPORTS
- PROVIDES ALERTS WHEN EQUIPMENT HAS STOPPED
- INTERFACES TO MAXIMO



Asset Management System

- RECEIVES ACTUAL STOP REASON FROM OSI PI
- PERFORMANCE-BASED PM & WORK ORDERS

OSIsoft PI - Maximo Integration

Architecture



PI Modular
Database



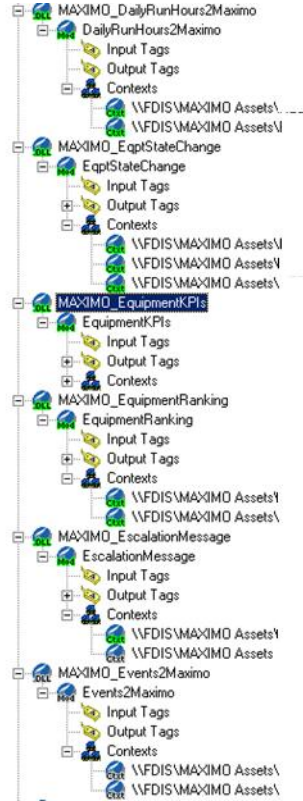
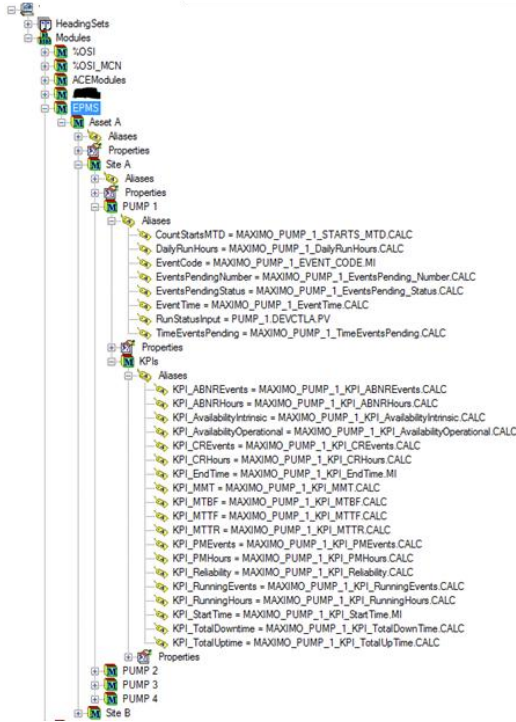
PI ACE



Output in PI
Process Book

OSIsoft PI - Maximo Integration

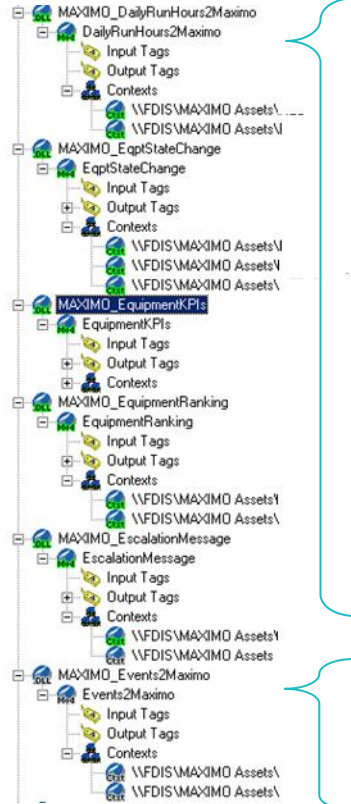
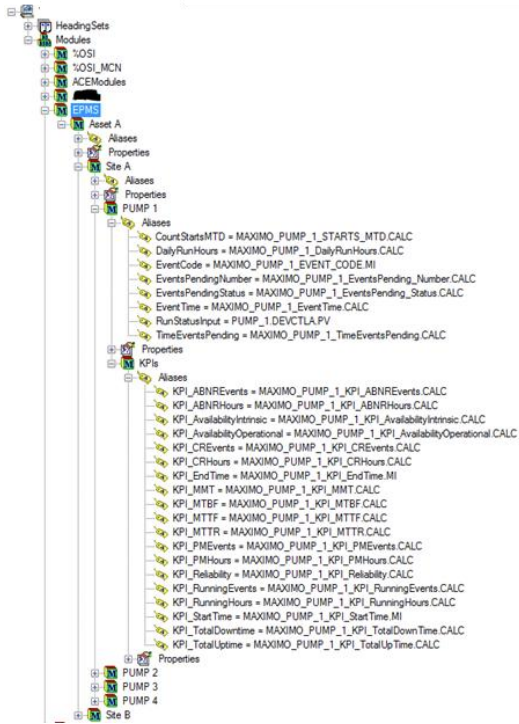
Architecture



The calculations are based on the definitions provided in ISO-14224

OSIsoft PI - Maximo Integration

Architecture



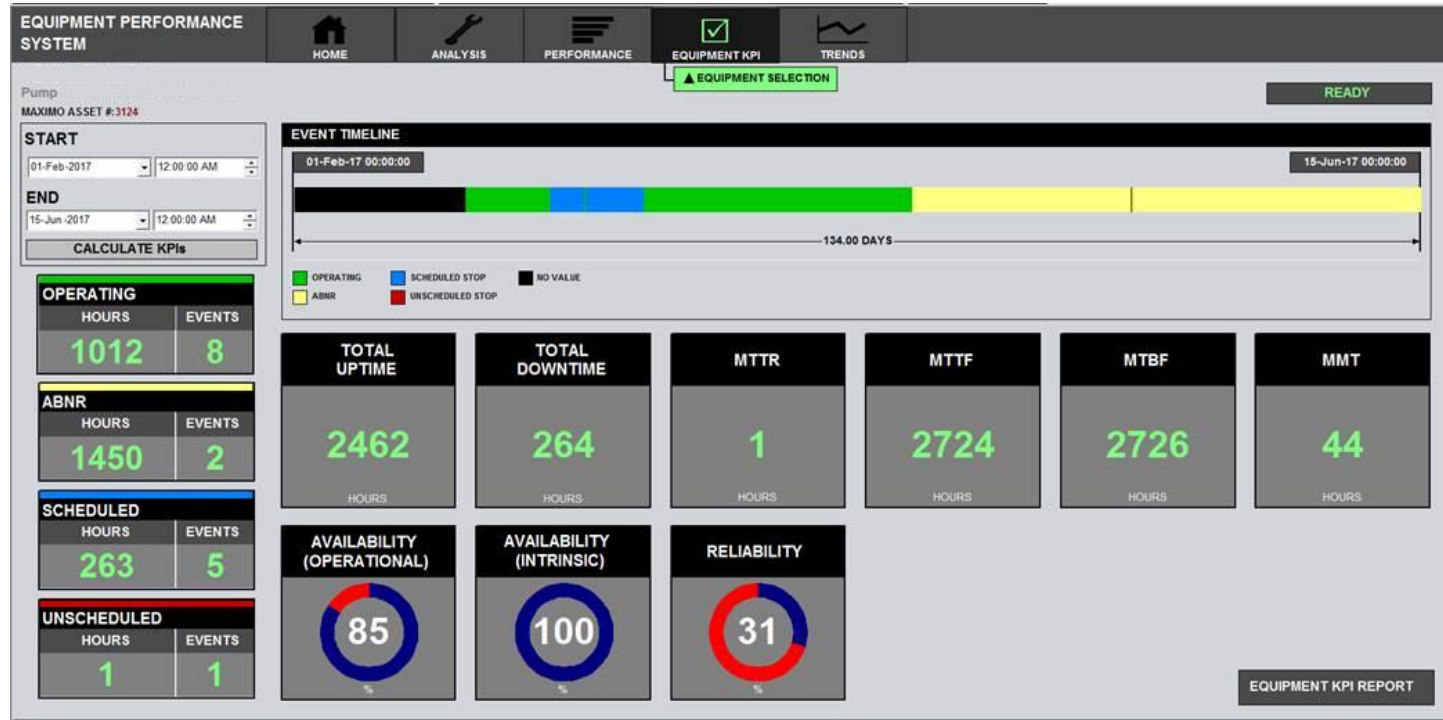
MAXIMO WebServices

getAssets: Provides a list of participating Maximo Assets, the Web Service will respond with a list of Asset

addMeterReading: Allows adding asset meter reading.

changeAssetStatus: Allows changing a specific asset status.

OSIsoft PI - Maximo Integration Application



OSIsoft PI - Maximo Integration

Equipment Status Capturing

EQUIPMENT PERFORMANCE SYSTEM ASSET A
HOME
ANALYSIS
PERFORMANCE
EQUIPMENT KPI
TRENDS

Compressor 1
TR2 COMPRESSOR
MAXIMO ASSET #: 3117

RUN LOG	TOTAL PENDING EVENTS	EVENTS PENDING TO MAXIMO	LOAD EVENTS	EVENTS ASSIGNED
Yes	22	0		12

#	Time	Status	Mode	Assignment	Action
1	04-Jun-17 17:31:21	STOPPED	OPERATING	[UNASSIGNED]	
2	04-Jun-17 17:31:42	RUNNING	OPERATING	ADR# Scheduled Stop Unscheduled Stop	
3	05-Jun-17 11:29:41	STOPPED	OPERATING	[UNASSIGNED]	
4	06-Jun-17 11:00:50	RUNNING	OPERATING	[UNASSIGNED]	
5	08-Jun-17 16:18:56	STOPPED	OPERATING	[UNASSIGNED]	
6	09-Jun-17 20:23:25	RUNNING	OPERATING	[UNASSIGNED]	
7	10-Jun-17 23:59:08	STOPPED	OPERATING	[UNASSIGNED]	
8	11-Jun-17 23:25:06	RUNNING	OPERATING	[UNASSIGNED]	
9	12-Jun-17 12:49:16	STOPPED	OPERATING	[UNASSIGNED]	
10	12-Jun-17 13:22:11	RUNNING	OPERATING	[UNASSIGNED]	
11	28-Jun-17 17:09:11	STOPPED	OPERATING	[UNASSIGNED]	
12	29-Jun-17 14:49:12	RUNNING	OPERATING	[UNASSIGNED]	
13	29-Jun-17 20:44:27	STOPPED	OPERATING	[UNASSIGNED]	
14	29-Jun-17 23:13:55	RUNNING	OPERATING	[UNASSIGNED]	
15	30-Jun-17 08:39:14	STOPPED	OPERATING	[UNASSIGNED]	
16	30-Jun-17 11:27:52	RUNNING	OPERATING	[UNASSIGNED]	
17	30-Jun-17 14:44:59	STOPPED	OPERATING	[UNASSIGNED]	
18	01-Jul-17 01:23:15	RUNNING	OPERATING	[UNASSIGNED]	
19	02-Jul-17 17:55:07	STOPPED	OPERATING	[UNASSIGNED]	
20	02-Jul-17 22:16:08	RUNNING	OPERATING	[UNASSIGNED]	
21	03-Jul-17 08:15:11	STOPPED	OPERATING	[UNASSIGNED]	
22	03-Jul-17 08:29:52	RUNNING	OPERATING	[UNASSIGNED]	

OSIsoft PI - Maximo Integration

Notifications - Escalation Matrix



Operator



Level 1 Escalation

24 Hours



Engineer



Level 2 Escalation

48 Hours



Manager

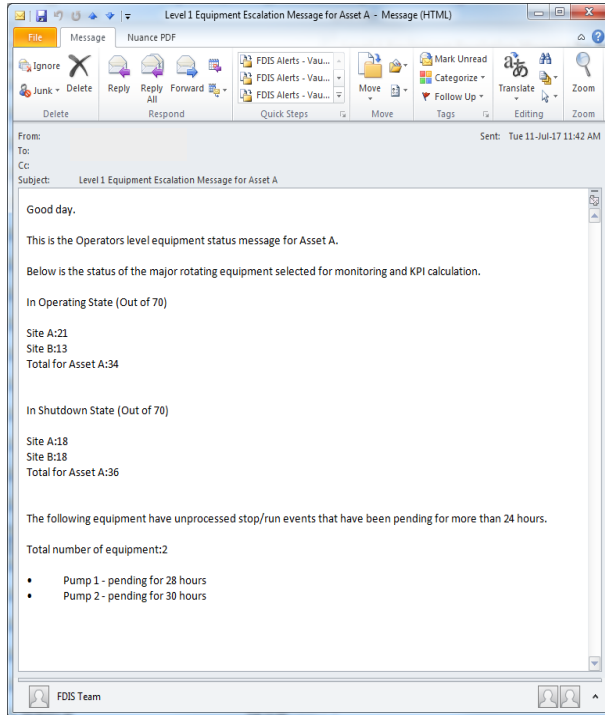


Level 3 Escalation

72 Hours

OSIsoft PI - Maximo Integration

Notifications - Escalation Matrix



Level 1 Equipment Escalation Message for Asset A - Message (HTML)

From: FDIS Team
To:
Cc:
Subject: Level 1 Equipment Escalation Message for Asset A

Sent: Tue 11-Jul-17 11:42 AM

Good day.

This is the Operators level equipment status message for Asset A.

Below is the status of the major rotating equipment selected for monitoring and KPI calculation.

In Operating State (Out of 70)

Site A:21
Site B:13
Total for Asset A:34

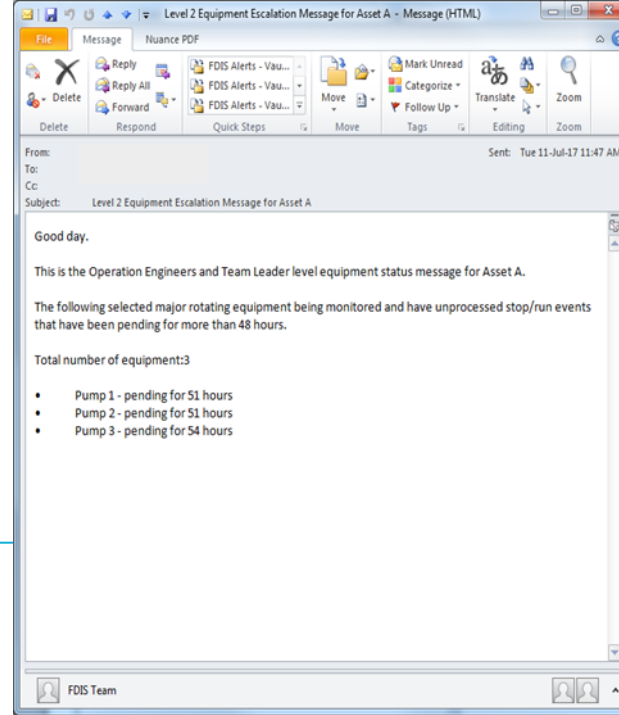
In Shutdown State (Out of 70)

Site A:18
Site B:18
Total for Asset A:36

The following equipment have unprocessed stop/run events that have been pending for more than 24 hours.

Total number of equipment:2

- Pump 1 - pending for 28 hours
- Pump 2 - pending for 30 hours



Level 2 Equipment Escalation Message for Asset A - Message (HTML)

From: FDIS Team
To:
Cc:
Subject: Level 2 Equipment Escalation Message for Asset A

Sent: Tue 11-Jul-17 11:47 AM

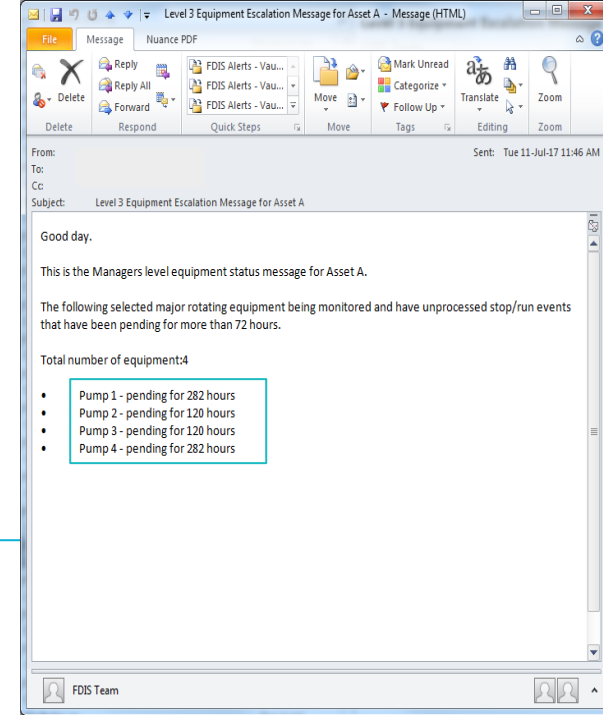
Good day.

This is the Operation Engineers and Team Leader level equipment status message for Asset A.

The following selected major rotating equipment being monitored and have unprocessed stop/run events that have been pending for more than 48 hours.

Total number of equipment:3

- Pump 1 - pending for 51 hours
- Pump 2 - pending for 51 hours
- Pump 3 - pending for 54 hours



Level 3 Equipment Escalation Message for Asset A - Message (HTML)

From: FDIS Team
To:
Cc:
Subject: Level 3 Equipment Escalation Message for Asset A

Sent: Tue 11-Jul-17 11:46 AM

Good day.

This is the Managers level equipment status message for Asset A.

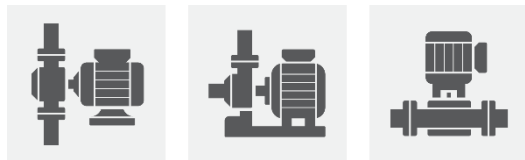
The following selected major rotating equipment being monitored and have unprocessed stop/run events that have been pending for more than 72 hours.

Total number of equipment:4

- Pump 1 - pending for 282 hours
- Pump 2 - pending for 120 hours
- Pump 3 - pending for 120 hours
- Pump 4 - pending for 282 hours

Condition Monitoring

Rotating Equipment




 Rate of
Change


 Alarm
Condition


 Trip
Condition



Real-time
Data Analytics



Alert



Real Time Data Analytics

Elements







Elements



Asset 1



Asset A

-  Pump 1
-  Pump 2
-  Pump 3
-  Pump 4

Name	Expression	Value at Evaluation	Value at Last Trigger	Output Attribute
Runtime	TimeEq('SURFACE PMP STATUS','y','t',"RUNNING")/3600	24	24	Map
Stoptime	TimeEq('SURFACE PMP STATUS','y','t',"STOPPED")/3600	0	0	Map
DailyRunHours	<pre>IF Runtime = 0 OR Runtime = 24 THEN Runtime ELSE IF Runtime < 24 AND Runtime + Stoptime > 23.99 THEN Runtime ELSE IF Runtime < 24 AND Stoptime = 0 THEN 24 ELSE IF Runtime < 24 AND Runtime + Stoptime < 23.99 AND Stoptime > 0 THEN (24 - Stoptime) Else NoOutput()</pre>	24	24	DailyRunHours

Name	Expression	Value at Evaluation	Value at Last Trigger	Output Attribute
SPDE_X_AXIS_VIBR	IF 'SURFACE PMP STATUS' = "RUNNING" THEN (IF TagVal('SURFACE PMP DE X A')			SURFACE PMP DE X A)
SPNDE_X_AXIS_VIBR	IF 'SURFACE PMP STATUS' = "RUNNING" THEN (IF 'SURFACE PMP I			SURFACE PMP NDE X
SPDE_Y_AXIS_VIBR	IF 'SURFACE PMP STATUS' = "RUNNING" THEN (IF 'SURFACE PMP I			SURFACE PMP DE Y A)
SPNDE_Y_AXIS_VIBR	IF 'SURFACE PMP STATUS' = "RUNNING" THEN (IF 'SURFACE PMP I			SURFACE PMP NDE Y
LUBEOIL_TANK_LEVEL	IF 'SURFACE PMP STATUS' = "RUNNING" THEN (IF 'LUBE OIL TAN			LUBE OIL TANK LEVEL)
SEALWATER_TANK_LEVEL	IF 'SURFACE PMP STATUS' = "RUNNING" THEN (IF 'SEAL WATER T			SEAL WATER TANK LE
LUBEOIL_TANK_TEMP	IF 'SURFACE PMP STATUS' = "RUNNING" THEN (IF 'LUBE OIL TAN			LUBE OIL TANK TEMP)

1500+ Analysis, 500+ Notifications

Component Level Monitoring Alerts

Pump Component Level Monitoring

- Rotor Condition
- Bearing Condition
- Seal Condition
- Cooling Fan

Motor Component Level Monitoring

- Rotor Condition
- Stator Condition
- Bearing Condition
- Casing Condition

Seal Oil System Component Level Monitoring

- Seal Oil Pump
- Seal Oil Cooler
- Seal Oil Cooler Fan

Lube Oil System Component Level Monitoring

- Lube Oil Pump
- Lube Oil Cooler
- Lube Oil Cooler Fan

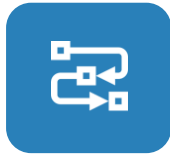


Component Level Alerts Details



Asset Details

- Asset Name
- Asset ID
- Asset Tag & Asset Description (Static information coming from PI AF Elements/Equipment Attributes)



Process Parameters Status

- Real-time - Value, Condition/Status
- Alarm Set Point Value & Trip Set Point Value (Static: PI AF Elements/Equipment Attributes)



Probable Effects & Proposed Solutions

- Static Data Entered in the PI AF Template per Equipment Type



Dynamic Links

- PI Coresight & Maximo (Unique links are generated for every equipment)



Spare Parts

- Details - Name, Spare Part Code & Installed Quantity
- Data Source - Static Data Entered in the PI AF Template per Equipment Type



Component Level Monitoring Alerts

Pump A Bearing Condition Alert - Message (HTML)

From: FDIS Team
To: Praveen Bangari (TTD)
Cc: Praveen Bangari (TTD)
Subject: Pump A Bearing Condition Alert

Sent: Mon 24-Jul-17 12:32 PM

Dear Reliability & Maintenance Team,

Pump A Bearing Condition Alert is observed.

Location Tag: **14-PUMPA-02**
Description: **Pump A (IR)**
Maximo Asset No.: **24561**
Event Start Time: **20/07/17 13:35:53**

Tag	Condition	Value	Alarm	Trip
PUMP A NDE X AXIS VIBR	ALERT - VALUE INCREASED BY 50%	11	76	102
PUMP A NDE Y AXIS VIBR	NORMAL	8	76	102
PUMP A DE X AXIS VIBR	NORMAL	4	76	102
PUMP A DE Y AXIS VIBR	NORMAL	4	76	102
PUMP A NDE BRG TEMP	NORMAL	67	85	95
PUMP A DE BRG TEMP	NORMAL	61	85	95

Probable Effects:

- Bearing life reduction
- Affecting seal life
- Affecting pump internals

Proposed Solutions:

- Check the trend for all the pump vibration probes
- See for any recent maintenance activity details in Maximo
- See if any operational changes and relate the same
- See the previous correlation with other parameters, if it's okay trend the same
- If abnormality observed, do the further advanced analysis for fixing the problem

Links:
FDIS: https://OSPI/Coresight/PB/#/PBDisplays/PUMPA_PMPJBVBR
Maximo: <http://maximo/assetnums=24561>

Spare Parts Details:

Sl.No.	Description	Mesc. No.	Installed Quantity
1	BEARING LINING, INGERSOLL RAND	53624	2
2	FLINGER, INGERSOLL RAND	8546	3

FDIS Team

Pump A THRT Bearing Condition Alert - Message (HTML)

From: FDIS Team
To: Praveen Bangari (TTD)
Cc: Praveen Bangari (TTD)
Subject: Pump A THRT Bearing Condition Alert

Sent: Mon 24-Jul-17 12:39 PM

Dear Reliability & Maintenance Team,

PUMP A THRT Bearing Condition Alert is observed.

Location Tag: **54-PUMPA-02**
Description: **Pump (I&R)**
Maximo Asset No.: **45223**
Event Start Time: **20/07/17 12:05:58**

Tag	Condition	Value	Alarm	Trip
PUMP A AXIAL DISPI A	NORMAL	0	-0.4	0.5
PUMP A AXIAL DISPI B	NORMAL	0	-0.4	0.5
PUMP A TH BRG INNER TEMP	ALERT - VALUE INCREASED BY 50%	62	115	120
PUMP A TH BRG OUTER TEMP	ALERT - VALUE INCREASED BY 50%	64	115	120

Links:
FDIS: https://OSPI/Coresight/PB/#/PBDisplays/PUMPA_PMPHTBR
Maximo: <http://maximo/assetnums=45223>

Spare Parts Details:

Sl.No.	Description	Mesc. No.	Installed Quantity
1	THRUST BEARING, INGERSOLL RAND	25468	1
2	THRUST COLLAR, 17, INGERSOLL RAND	54664	1
3	THRUST COLLAR KEY, INGERSOLL RAND	85841	1
4	LOCK NUT, INGERSOLL RAND	28154	1

Regards,
Maintenance & Reliability Team

FDIS Team

PUMP A Lube Oil System is Un-Healthy Alert - Message (HTML)

From: FDIS Team
To: Praveen Bangari (TTD)
Cc: Praveen Bangari (TTD)
Subject: PUMP A Lube Oil System is Un-Healthy Alert

Sent: Sun 9/10/2017 12:22 PM

Dear Reliability & Maintenance Team,

PUMP A Lube Oil System Un-Healthy Alert is observed.

Location Tag: **54-PUMPA-02**
Description: **Pump (I/R)**
Maximo Asset No.: **45223**
Event Start Time: **09/09/17 07:38:44**

Tag	Condition	Value	Alarm	Trip
LUBE OIL TANK LEVEL	ALERT - VALUE DECREASED BY 50%	276	200	135
LUBE OIL SYS HDR PRESSURE 1	NORMAL	1.198436	0.8	0.3
LUBE OIL SYS HDR PRESSURE 2	NORMAL	1.197233	0.8	0.3
LUBE OIL TANK TEMPERATURE	ALERT - VALUE INCREASED BY 50%	59	63	80
LUBE OIL SUPPLY TEMPERATURE	ALERT - VALUE INCREASED BY 50%	58	75	80

Probable Effects:

- Lube oil supply pressure will be reduced
- Lube oil return temperature will be increased
- Bearing temperatures will be increased
- Lack of lubrication situation might damage bearings

Proposed Solutions:

- Checking the lube oil filter DP trend
- Changeover the high DP filter to standby filter
- If the trend is 80% of alarm value, plan for lube oil filter cleaning or replacement
- Clogged filter analysis for debris for long term solution

Links:
FDIS: <https://OSPI/Coresight/PB/#/PBDisplays/PMPJBU02>
Maximo: <http://maximo/assetnums=45223>

Spare Parts Details:

Sl.No.	Description	Mesc. No.	Installed quantity
1	COUPLING SPIDER, 2345 3030000, MIRRELES (PLENTY LTD)	3476423	1
2	BEARING BALL BEEP GROOVE	8244882	1
3	INTERNAL CIRCLIP, MIRRELES (PLENTY LTD)	2348802	1
4	EXTERNAL CIRCLIP, FOR 17 MM SHAFT	2451483	1
5	SEAL, MECHANICAL, TYPE T302	5468189	1
6	SEL LOK PIN, MIRRELES (PLENTY LTD)	4578193	1
7	SEL LOK PIN, FOR KIA 25-4N PUMP	1250456	1
8	O-RING	3304485	1
9	GASKET, MIRRELES (PLENTY LTD)	5246120	1
10	STRAINER, AIRPEL FILTRATION LTD	4512870	1
11	O' Ring Filter cover		
12	O' Ring cock spindle		

Regards,
Maintenance & Reliability Team

FDIS Team

Smart Notification Benefits



Lube Oil System



Tank Level

Water Ingress (Level Increase)

Required Oil Quantity (Level Decrease)



Drop Rate/Day

Oil Leak Prediction (Design vs Actual)

Tank Level Prediction (Inventory Planning)

Way Forward



Migration of OSIsoft PI – Maximo Integration to PI AF and PI Coresight



Extend the Smart Notifications to all the pump types



Implementation of Smart Notifications for monitoring the Performance of the Equipment (Energy Optimization)



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Questions

Please wait for the **microphone** before asking your questions



State your **name & company**

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감사합니다

Danke

谢谢

Merci

Gracias

Thank You

ありがとう

Спасибо

شكراً

Obrigado