PETRONAS Rotating Equipment Analytics
Enhancement and Scale Up
Malaysia at a Glance

A Nation of Wondrous Diversity

• Malaysia consists of Peninsular Malaysia, and the states of Sabah and Sarawak on the island of Borneo.
• Population: Approx. 32 million people in a melting pot of races and cultures
• Covering 329,758 square km area - landscape features coastal plains rising to forested hills and mountains, the highest being Mount Kinabalu at 4,095.2 m
• A gastronomical paradise and home to colourful festivals
• PETRONAS Twin Towers: The BrandLaureate Nation Branding Award 2017-2018
About PETRONAS

**UPSTREAM**
- Total LNG sales volume of **28.94 million metric tonnes**
- **Over 390** BCE LNG loadable delivered from the PETRONAS LNG Complex in Bintulu, Sarawak
- Average production of **2,361 kboe/d**

**DOWNSTREAM**
- Revenue of **RM128.0 billion**
- Sales volume at **25.2 billion litres**
- **Total of 265 million man hours**
- Roll-out of Setel and ROVR to drive new customer experience

*Source: PETRONAS Annual Report 2018*
What is PROTEAN?

An online remote monitoring system and predictive maintenance solution for rotating equipment

- Uses existing OSIsoft PI data from remote facilities.
- The data will be analyzed within PI AF software suite running various analytics.
- It detects anomaly at incipient stage and subsequently alert the user for any changes and potential threat to the machine.
What is PROTEAN?
What is PROTEAN?

Analytic monitoring display enables monitoring of overall equipment health at glance and suggests focus area.

Legend for Equipment Health:
- Green: No concern
- Yellow: Concern
- Purple: Data Quality

PETRONAS CARIGALI
PRODUCTION MALAYSIA OVERVIEW

KAKG K2400
UNIT RUN STATUS
Compressor
Gas Turbine
Control & Monitoring
Lubrication System
Accessory Drive
Power Turbine
Fuel System
Air Intake
Miscellaneous
What is PROTEAN?
What is PROTEAN?

Email Alert Notification & Analytics Report

No. | Name         | Fault Code | Operating Value | Low Limit | High Limit |
--- | ------------ |------------ |-----------------|----------- |----------- |
1   | C1_DISC_P1   | Normal     | 7.22837         | 5.144     | 8.444     |
2   | C2_BUCT_P1   | High Limit | 7.16898         | 1.187     | 2         |
3   | C3_DISC_P1   | Normal     | 11.29411        | 1.87352   | 13.17331  |
4   | C2_BUCT_P1   | Normal     | 4.00056         | 3.051582  | 10.50156  |

Alert triggered for Criticality 1 - C1 - Comp&C&M-Prodisc Sensor as below:

No. | Name         | Fault Code | Operating Value | Low Limit | High Limit |
--- | ------------ |------------ |-----------------|----------- |----------- |
1   | C3_DISC_T1   | Normal     | 103.9089       | 76.60771  | 131.8907  |
2   | C3_BUCT_P     | Normal     | 96.1865        | 55.4474   | 122.9713  |

Alert triggered for Criticality 1 - C1 - Comp&C&M-Temp Sensor as below:

No. | Name         | Fault Code | Operating Value | Low Limit | High Limit |
--- | ------------ |------------ |-----------------|----------- |----------- |
1   | C3_DISC_T    | Normal     | 98.0059        | 57.55575   | 153.9157  |
2   | C3_DISC_P    | Normal     | 24.02554       | 0.10878    | 25.326    |
3   | C2_BUCT_P    | Normal     | 11.077         | 0.2204359  | 11.24599  |

Check for below hyperlink for details:
[Event Details hyperlink](#)

Thank You In Best Regards,
Pacific Upstream Support
Group Technical Data
Project Delivery & Technology
PETROMAS

Analytics Report

**Supporting Trend**

Action Required

Possible Consequence of no Action

The use of excess temperature as the function to assign the risk band for the components avoids future failure because temperature is a continuous trend that might evolve into failure.

Region to complete and return

Oredicted Temperature

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PROTEAN Solution Architecture

1. Data Sources
2. Data Management
3. Applications
4. Workflows & Integration
5. Smart Visualization

- Monitoring Surveillance
- Analysis & Predictive
- Action & Optimization

- PI AF & PI Vision
- PI System

- Business Process Automation Engine
- Analysis & Predictive Engines
- Optimization Engines

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Protean Capability in 2017 (London)

- Simple check mechanism
- High/low limits on analog values
- Follow simple abstraction
- Automatic email notification
Current Protean Capability & Features

- Simple check mechanism
- High/low limits on analog values
- A distributed architecture maximizes staff availability
- Ability to deal with large amount of data
- Management of diagnostics

- Follow simple abstraction
- Automatic email notification
- Reporting of alarm and machine status
- Gradient checker/Deviation
- Additional support tools to identify faults
What we have achieved so far ….

TOTAL ALERTS

225

+ 

RESOLVED

145

Saved

135

DAYS

Avoided

15

CASES

Production Deferment

Catastrophic Failure

Covering multiple OEMs

ONE STOP SOLUTION
Success Story #1: Safety – Eliminate Fire Hazard

**CHALLENGES**

- Abnormal rate of lube consumption - Lube oil tank level drop triggered alert.
- Operator top-up the lube oil without investigating the cause of leak.

**SOLUTION**

- Deviation limit triggered and PROTEAN alert notification issued.
- Inspection done and found lube oil leak.
- Unit shutdown and rectified.

**BENEFITS**

- Lube oil leak may cause fire (hot surfaces of gas turbine engine and exhaust). Early detection of anomaly and timely intervention had prevented potential fire.
- Cost Avoidance: Equipment damage due to fire.

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*Insight*

Lube oil leak inside Gas Turbine Enclosure
Success Story #2: Prevention of Platform Shutdown

CHALLENGES
• Instrument air header pressure dropped significantly
• Operator did not notice as the reading was within DCS alarm limit

SOLUTION
• Alert limit triggered.
• PROTEAN alert notification sent to site Operation team.
• Troubleshoot and resolved the issue.

BENEFITS
• Early detection of anomaly and timely intervention had prevented total platform shutdown
• Cost Avoidance: 2 days of major production deferment and excessive value leakage (gas flaring)

Insight
Severe leaking of instrument air supply
Success Story #3: Prevention of Gas Turbine Catastrophic Failure

**CHALLENGES**

- Fuel gas temperature dropped below dew point during Storm Pabuk affecting two (2) gas turbine engines at an offshore platform in South China Sea

**SOLUTION**

- Deviation limits triggered and PROTEAN alert notification sent to site Operation team.
- Adjustment made to the superheater firing set-point.

**BENEFITS**

- Early detection of anomaly and timely intervention prevent permanent damage and catastrophic failure of the gas turbine combustor liner.
- Cost avoidance: Gas Turbine engine repair and 10 days of gas production curtailment

**Insight**

Superheater performance degraded realized during low ambient temperature during storm.
Success Story #4: Prevention of Gas Compressor Prolonged Downtime

**CHALLENGES**
- Gas compressor running exceeded rated capacity during high gas demand
- Operating at higher compressor vibration levels exceeded OEM alarm

**SOLUTION**
- Alert limit triggered and PROTEAN alert notification sent to site Operation team.
- Troubleshoot and resolved issue.

**BENEFITS**
- Early detection of anomalies triggered detail vibration diagnostic requirement to understand the vibration behavior and its impact during high gas demand (flow). Requirement to run three (3) instead of two (2) trains.
- Cost avoidance: Compressor internal component damage and 14 days production deferment.

Insight
Changes in Operating Philosophy is required during high gas demand.

![Compressor on LOAD](chart.png)
Success Story #5: Detect Small & Fix Small – Lube Filter Clogged

**CHALLENGES**
- Aero derivative Gas Turbine engine lube oil filters experienced frequent clogging.

**SOLUTION**
- Alert limit triggered and PROTEAN alert notification sent to site Operation team.
- Switched to standby filter (duplex system) online without unit shutdown.

**BENEFITS**
- Proved that frequent high filter dP was not normal. It indicates the lube was contaminated and prolong running will lead to component damage and catastrophic failure.
- Cost avoidance: 6 hours unplanned production deferment (unit trip) and potential prolonged downtime.

**Insight**
Contaminated Turbine Lube Oil
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Questions?

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