Condition Based Maintenance & Smart Monitoring in the Frade FPSO with the PI System®

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Agenda

• About Chevron
• CBM for Emergency Valves
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About Chevron

• **Second-largest integrated energy company** headquartered in the United States and among the largest corporations in the world based on market capitalization as of December 31, 2015.

• Global workforce consisting of approximately **61,500 employees**, including more than **3,300 service station employees**.

• Produced **2.594 million** net oil-equivalent barrels per day, with about **73 percent** of the volume outside the United States.

• OSIsoft EA customer since 2011.
Chevron Brazil – Projects Overview

- **Frade**: Chevron (51%), Petrobras (30%), FJ (18%)
- **Papa-Terra**: Chevron (37.5%), Petrobras (62.5%)
- **Ceará CE-M-175**: Chevron (50%) e Ecopetrol (50%)
Chevron’s Frade Asset in Brazil

- Floating, Production, Storage and Offloading (FPSO) facility in Frade Field.
- Located 120km from the nearest Brazilian shoreline in the Northern of Campos Basin.
- It lies in water depth of about 3,700 feet (1,128 m).
- Capable of storing – 1.5 million barrels of oil and processing of 100,000 bopd.
- Compressing and treating 106 MMscfd of gas and injecting 150,000 bwpd of water.
Chevron Brazil – PI System Overview

- ~12,000 tags mapped in the PI Data Archive (Onshore & Offshore);
- Over 1,300 assets and 150 templates in PI AF;
- More than 2,000 PI Asset Analytics running;
- 114 dashboards developed and published in PI Coresight™;
- Integration with other software databases.
# CBM and Smart Monitoring in Frade FPSO with the PI System®

## COMPANY and GOAL

One of the world’s leading oil producer wanted to improve its Frade FPSO monitoring capability and information quality through the PI System®.

## CHALLENGE

Reduce the maintenance cost and increase monitoring capability

- Perform real time and historical data analysis on the condition of the Emergency Valves
- Shift the monitoring philosophy to event driven

## SOLUTION

Implementation of PI System applications to automate the data analysis, event detection and notifications delivery

- Real time data analysis through Asset Analytics and Event Frames
- Custom Excel Report using PI AF SDK
- Web monitoring displays published in PI Coresight™

## RESULTS

Emergency valves maintenance cost reduced and significant improvement on Operational Intelligence

- $350k investment saving on offshore system solution
- Potential $300k/year cost saving on third party monitoring solution
- 90% time reduction on intelligence gathering
Challenges: Emergency Valves Maintenance

Provide a solution that enables real time and historical data analysis on the condition of the Emergency Valves, allowing maintenance to be planned in advance according to the equipment condition.

Previous Scenario:

• Preventive routines set in Computerized Maintenance Management System (CMMS) which required to have the asset integrity and guarantee the reliability verification;
• Equipment inspection was executed in all critical valves due to lack of equipment condition information;
• Implementing a solution in offshore systems implicate in costs and risks:
  – Complete production shutdown for ICSS full download;
  – Activity planning including comissioning hours, troubleshooting, contigency plans, engineering onshore support, AMS report...
Solution: Emergency Valves Maintenance

Dashboards

- PI AF Element Template associated with a Symbol Template significantly reduced the application development and maintenance time;
- PI Asset Analytics enabled the calculation of complex status for multi-state symbols;
- Web publication in PI Coresight™ in a user friendly way.
Solution: Emergency Valves Maintenance

Report

- Excel file with custom UI for searching and filtering data;
- Add-in implemented in C# using the .NET Framework and PI AF SDK;
- It can search directly for Event Frames or PI Data Archive tags and process the data to identify relevant events.
## Summary: Emergency Valves Maintenance

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<th>CHALLENGE</th>
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<th>RESULTS</th>
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| Provide a solution that enables real time and historical data analysis on the condition of the Emergency Valves, allowing maintenance to be planned in advance according to the equipment condition. | • PI AF Element Template and PI Asset Analytics to determine the complex status;  
• Dashboards using Symbol Template associated with PI AF;  
• Publication in PI Coresight™;  
• Excel add-in to retrieve and process historical data for analysis and reporting;  
• PI Event Frames to detect and present information with start and end conditions. | • $350K investment saving on offshore system solution;  
• Improved onshore surveillance capabilities;  
• Improved the quality information used to plan and support the decision making on execute equipment inspection and intervention;  
• Savings due to targeted inspection scope by performing condition based maintenance. |
Challenges: Smart Monitoring & Notifications

Increase the engineering team efficiency on monitoring by shifting the applications approach from displaying unprocessed data to analyzed information, detecting and notifying events in real time.

Previous Scenario:

- Status of measurements in relation to critical control limits (LL, L, H, HH) were unknown in real time for onshore engineers;
- No KPI automated calculations for Control Loops;
- Hydrate monitoring information was spread across different systems and calculated manually in spreadsheets;
- No automated event detection or notification to onshore team;
- No aggregate status per production tree based on its measurements;
- The visualization displays didn't have calculated multi-state color representation.
Solution: Smart Monitoring & Notifications

- PI AF Asset Analytics automated KPIs for control loops and real time status calculation that requires complex equations;
- Imported data from other systems via PI RDBMS Interface;
- PI Event Frames implementation to detect critical limits bypass and undesired operating conditions;
- PI Notifications alert the engineers whenever critical event detection occur;
- Dashboards published in PI Coresight™ to present detailed information in user friendly interface.
Smart Monitoring Applications – Analytics & Events
Smart Monitoring Applications – PI Notifications
Control Loops KPI - Dashboards

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<tr>
<th>Control Loops Monitoring</th>
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<tr>
<td>Operation Mode Statistics</td>
<td>Time in Manual Mode</td>
<td>% Below 20</td>
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<tr>
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<td>Time with Output in 100%</td>
<td>% Below 20</td>
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<td>Time with Output in 85%</td>
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<td>Time with Output in 80%</td>
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<td>Time with Output in 75%</td>
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<td>Time with Output in 60%</td>
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<td>Number of Value Cycles</td>
<td>% Below 20</td>
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<td>Output Standard Deviation</td>
<td>% Below 20</td>
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<td>Output Average</td>
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<tr>
<td>Error Statistics</td>
<td>PV - SP average</td>
<td>% Below 20</td>
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<td>Average Squared Error</td>
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| Error Statistics | PV - SP average | % Below 20 |
|                         | Average Squared Error | % Below 20 |
|                         | MSE / MSE | % Below 20 |

Note: This image shows a dashboard for monitoring control loops with various KPIs and statistics.
Production Tree Management Status - Dashboards
### Summary: Smart Monitoring & Notifications

#### CHALLENGE
- Increase the engineering team efficiency on monitoring by shifting the applications approach from displaying unprocessed data to analyzed information, detecting and notifying events in real time.

#### SOLUTION
- PI AF Asset Analytics to transform raw data into actionable intelligence;
- PI Event Frames to detect critical limits bypass;
- PI Notifications to alert engineers;
- PI Coresight dashboards published to present detailed information in user friendly interface.

#### RESULTS
- Potential $300k/year cost saving on third party control loops monitoring solution;
- Decreased intelligence gathering effort by 90%;
- Aggregate status per Production Tree;
- Significantly reduced response time.
Next Steps and Future Plans

• Expand Reactive Monitoring application for others control loops;

• Expand CBM applications to other assets, such as Compressors & Filters;

• Automate more event detections through Event Frames;

• Increase and enhance the PI Notifications usage;

• Implement the predictive analytics for CBM applications.
Benefits: PI System® Tools

• Better Governance Model:
  – Increased the effectiveness of support and maintenance;
  – Reduction of hours spent on creating new dashboards;

• System Integrator

• Data Infrastructure:
  – Single Data Source;
  – Better Relational Structure;
  – Better Data Analysis;

• System Standardization and Optimization
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Questions

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Thank You

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谢 谢
Merci
Danke
Gracias
ありがとうございます
Спасибо
Obrigado