



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

Presented by **Carlos Britto, Chevron**
Tárik Siqueira, Radix



Agenda

- About Chevron
- CBM for Emergency Valves
- Smart Monitoring
- Summary
- Q&A

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.
- OSIssoft EA customer since 2011.

Chevron Brazil – Projects Overview



- **Frade: Chevron (51%), Petrobras (30%), FJ (18%)**
- Papa-Terra: Chevron (37.5%), Petrobras (62.5%)
- Ceara CE-M-175: Chevron (50%) e Ecopetrol (50%)

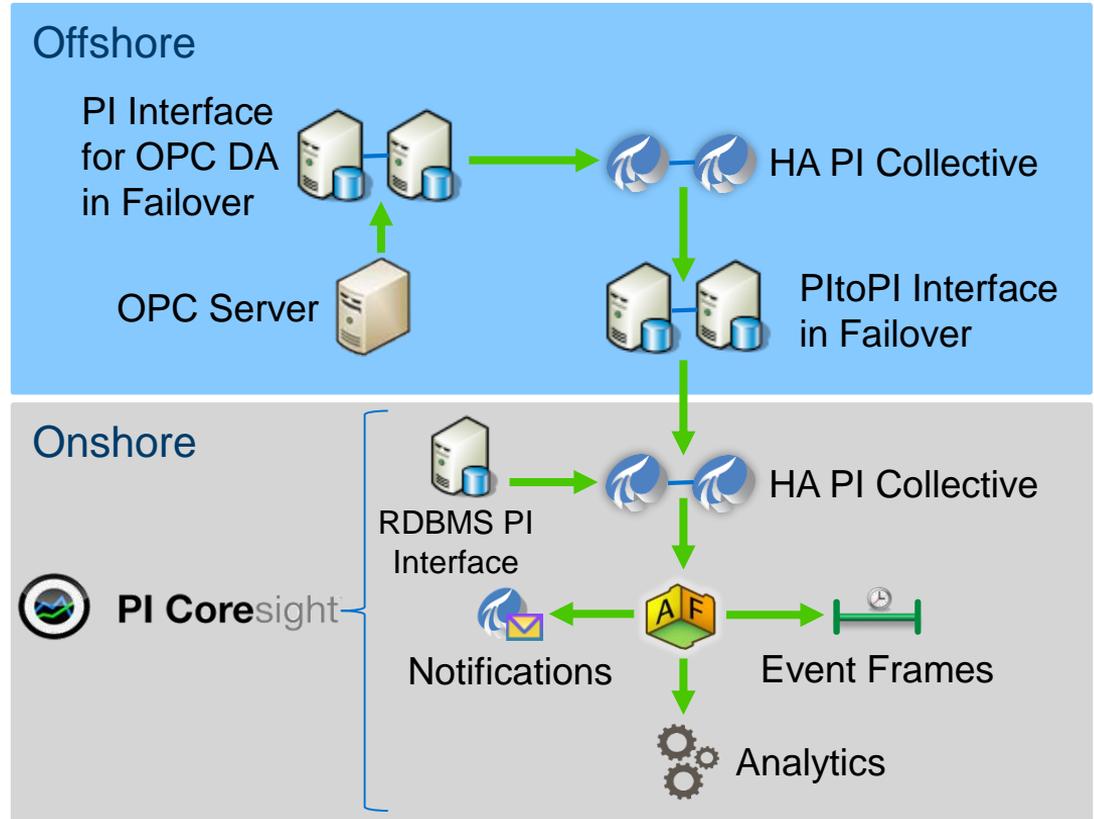
Chevron's Frade Asset in Brazil

- 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.

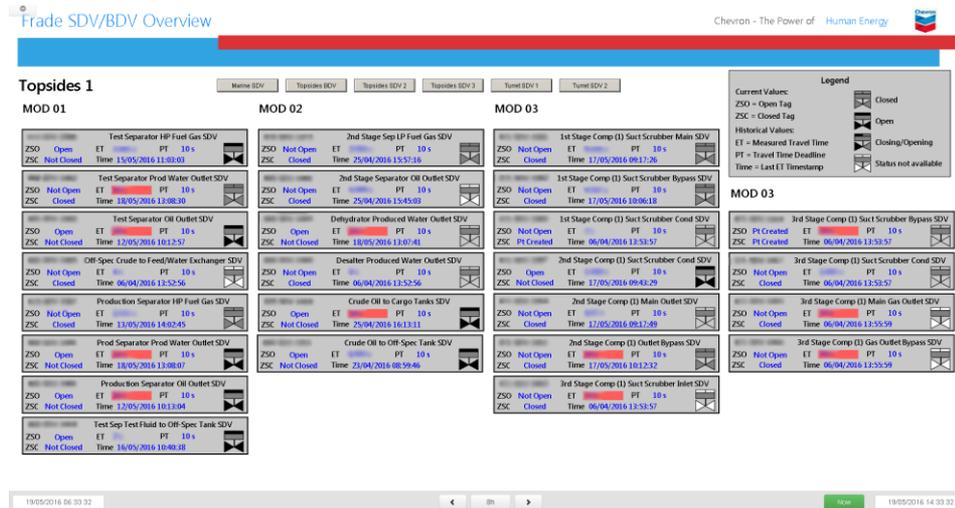
Previous Scenario:

- 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, contingency 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.

Valve	Name	Event Time	ZSO	ZSC	Travel Time	Design Time	Max. Time
39	1st Stage Comp (1) Suet Scrubber Main SDV	2016-05-17 09:17:26Z	Not Open	Closed		19,80	10,00
40	1st Stage Comp (1) Suet Scrubber Main SDV	2016-05-03 17:49:14Z	Not Open	Closed		19,80	10,00
41	1st Stage Comp (1) Suet Scrubber Main SDV	2016-05-03 08:04:38Z	Not Open	Closed		19,80	10,00
42	1st Stage Comp (1) Suet Scrubber Main SDV	2016-05-03 06:03:00Z	Not Open	Closed		19,80	10,00
72	1st Stage Comp (2) Suet Scrubber Cond SDV	2016-05-17 10:36:30Z	Open	Not Closed		3,30	10,00
73	1st Stage Comp (2) Suet Scrubber Cond SDV	2016-05-03 17:46:19Z	Open	Not Closed		3,30	10,00
74	1st Stage Comp (2) Suet Scrubber Cond SDV	2016-05-03 17:42:39Z	Not Open	Closed		3,30	10,00
75	1st Stage Comp (2) Suet Scrubber Cond SDV	2016-05-03 17:24:50Z	Open	Not Closed		3,30	10,00
76	1st Stage Comp (2) Suet Scrubber Cond SDV	2016-05-03 17:22:23Z	Not Open	Closed		3,30	10,00
77	1st Stage Comp (2) Suet Scrubber Main SDV	2016-05-17 10:18:04Z	Open	Not Closed		19,80	10,00
78	1st Stage Comp (2) Suet Scrubber Main SDV	2016-05-03 19:28:49Z	Not Open	Closed		19,80	10,00
79	1st Stage Comp (2) Suet Scrubber Main SDV	2016-05-03 17:43:53Z	Not Open	Closed		19,80	10,00
80	1st Stage Comp (2) Suet Scrubber Main SDV	2016-05-03 17:23:14Z	Not Open	Closed		19,80	10,00
81	1st Stage Comp (2) Suet Scrubber Main SDV	2016-05-03 16:47:13Z	Not Open	Closed		19,80	10,00
82	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 10:06:15Z	Open	Closed		2,20	10,00
83	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 10:00:27Z	Not Open	Not Closed		2,20	10,00
84	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 09:53:28Z	Not Open	Not Closed		2,20	10,00
85	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 09:38:24Z	Not Open	Not Closed		2,20	10,00
86	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 09:35:37Z	Not Open	Not Closed		2,20	10,00
87	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 09:32:49Z	Not Open	Not Closed		2,20	10,00
88	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 09:28:13Z	Not Open	Not Closed		2,20	10,00
89	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 09:25:28Z	Not Open	Not Closed		2,20	10,00
90	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 09:21:39Z	Not Open	Not Closed		2,20	10,00
91	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 09:17:06Z	Not Open	Not Closed		2,20	10,00
92	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 09:12:53Z	Not Open	Not Closed		2,20	10,00
93	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 09:10:10Z	Not Open	Not Closed		2,20	10,00
94	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 09:06:00Z	Not Open	Not Closed		2,20	10,00
95	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 09:03:21Z	Not Open	Not Closed		2,20	10,00
96	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 09:00:32Z	Not Open	Not Closed		2,20	10,00
97	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 08:57:47Z	Not Open	Not Closed		2,20	10,00
98	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 08:55:44Z	Not Open	Not Closed		2,20	10,00

Document Actions

SDV and BDV Report

Valve search filter

Group: All

Valve: All

Search events by

Time Range: Start: 01/05/2016, End: 30/09/2016

Quantity: 1

Search

Summary: Emergency Valves Maintenance

CHALLENGE

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.

SOLUTION

- 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.

RESULTS

- \$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

The screenshot displays the OSIsoft PI System Explorer interface, divided into several key sections:

- System Explorer (Left):** A tree view showing the hierarchy of the PI system, including folders for 'Control Loop' and 'Event Frames'.
- Control Loop (Middle-Left):** A detailed view of a control loop configuration. It includes a list of variables (e.g., 'Control Loop - Alarm', 'Control Loop - Base') and a table of 'Example Events' with columns for Name, Expression, Value at Evaluation, and Value at Last Tr.
- Event Frames (Middle-Right):** A table listing various event frames. The table has columns for Name, Start, End, Severity, and Template. A search filter is applied at the top.
- Event Frame Template (Bottom-Middle):** A configuration window for a specific event frame template, showing a table with columns for Name, Expression, True for, Severity, Value at Evaluation, and Value at Last Tr.
- Functions (Bottom-Right):** A panel titled 'Functions' that lists available functions for use in expressions, such as 'Abs', 'Acc', 'And', 'Avg', 'Avg2', 'BadVal', 'Bool', 'Bottom', 'Ceiling', 'Clear', 'Compare', 'Concat', 'Contains', 'Convert', 'Cos', 'Cosh', and 'Abs(Summary x)'. A description for 'Abs(Summary x)' is provided.

Smart Monitoring Applications – PI Notifications

The screenshot displays the MDP1 software interface. On the left, a tree view shows the hierarchy of elements, including 'Production Wells' and 'Injection Wells'. The main window is titled 'MDP1' and contains several panels:

- General:** A table listing notification rules. The selected rule is 'Latest Well Test Available'.
- Criteria:** A table showing the criteria for the selected rule, such as 'Analysis = Latest Well Tes...', 'Lo - HP Supply Pressure', and 'Above Hydrate Curve'.
- Trigger:** A section indicating that a notification is triggered when an event frame is created that satisfies all criteria. A 'Referenced Element' is listed as 'MDP1'.
- Subscriptions:** A section showing that there are currently 4 subscribers to this notification rule.

A notification event pop-up is overlaid on the interface, displaying the following details:

- Event:** Above Hydrate Curve 2017-02-10 14:11:04.310
- Name:** Above Hydrate Curve
- Server:**
- Database:**
- Start Time:** 2/10/2017 2:11:04 PM E. South America Daylight Time (GMT-02:00:00)
- Target:** FRADE/Subsea/Wells/Production Wells
- Severity:** None
- Send Time:** 2/10/2017 2:11:16 PM E. South America Daylight Time (GMT-02:00:00)

The bottom of the interface shows the version information: 'MDP1 Modified: 31/01/2017 16:02:31. Version: 01/01/1970 05:00:00, Revision 90'.

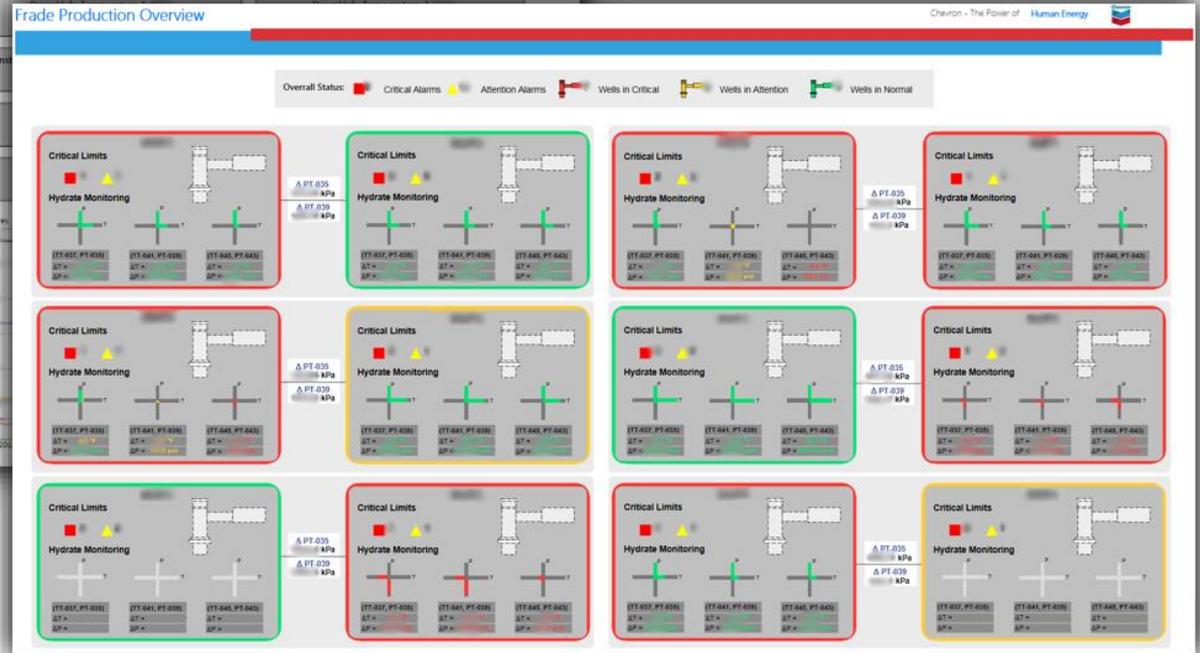
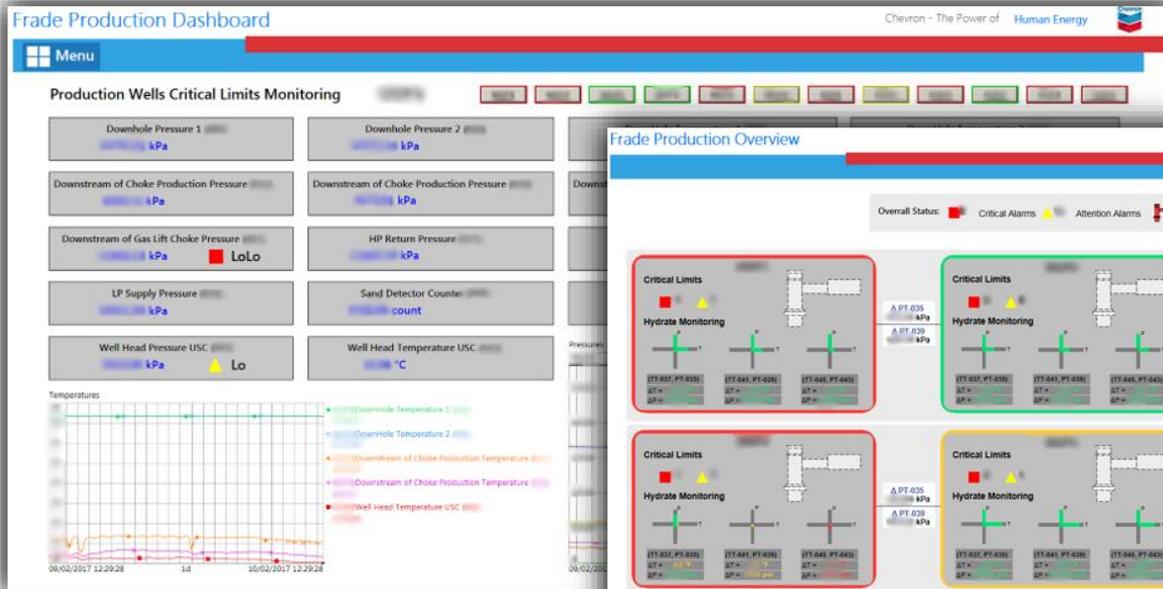
Control Loops KPI - Dashboards



Control Loops Monitoring 1 2



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**



Contact Information

Carlos Britto

cbritto@chevron.com

Technical Computing Supervisor
Chevron



Tárik Siqueira

tarik.siqueira@radixeng.com.br

Engineer
Radix Engineering and Software



Questions

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谢谢

Danke

Merci

Gracias

Thank You

ありがとう

Спасибо

Obrigado