

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

Presented by Carlos Britto, Chevron Tárik Siqueira, Radix





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- 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%)
- Ceara CE-M-175: Chevron (50%) e
 Ecopetrol (50%)

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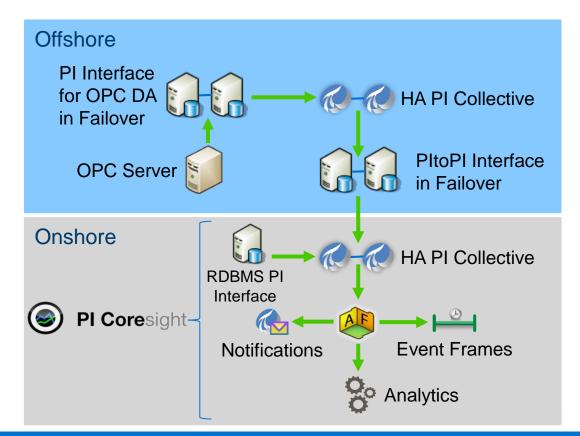
Chevron's Frade Asset in Brazil

- 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 maped 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 Coresighttm;
- Integration with other software databases.



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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 Coresighttm

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

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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 Coresighttm in a user friendly way.

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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.

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3	1st Stage Comp (2) Suct Scrubber Cond SDV	2016-05-03 17:46:192	Open	Not Closed	1.00	3,30	10,00	
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6	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 09:35:37Z	Not Open	Not Closed	10.00	2,20	10,00	
7	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 09:32:492	Not Open	Not Closed	1.00	2,20	10,00	
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2	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 09:12:53Z	Not Open	Not Closed	1.01	2,20	10.00	
3	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 09:10:10Z	Not Open	Not Closed	1.000	2,20	10,00	
4	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 09:06:00Z	Not Open	Not Closed	1.00	2,20	10,00	
5	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 09:03:21Z	Not Open	Not Closed	1.10	2,20	10,00	
6	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 09:00:32Z	Not Open	Not Closed	1.00	2,20	10,00	
7	2nd Stage Comp (1) Disch Cooler BDV	2016-05-03 08:57:472	Not Open	Not Closed	4,80	2,20	10,00	
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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.

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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 Coresighttm;
- 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.

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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;

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- 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 Coresighttm to present detailed information in user friendly interface.

Smart Monitoring Applications – Analytics & Events

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Smart Monitoring Applications – PI Notifications

	MDPL		
	General Child Elements Attributes Ports Analyses Viotification Rules Version		
		Name: Latest Well Test Available	
	0 x V Name Criteria	Description	
	🧭 💼 📇 Latest Well Test Available 🔋 Analysis = Latest Well Tes	Categories *	
ion Loops	🔗 🔹 📑 Lo - HP Supply Pressure (Finite Analysis + Lo - HP Supply	Construction (
ection Wells			
Surfor Wells	B Boole Hydrate Curve Analysis = PT-035_TT-037		
	ADC/Subses Wells Production Wells B		
	🔿 a 🚵 Nove Hydrate Curve Analysis = PT-043_TT-045		
	Trigger	Subscriptions	
	A notification will be triggered when an event frame is created that satisfies all of these criteria.		
		There are currently 4 subscribers to this Notification Rule.	
	Referenced Element = MDP1 Analysis = Latest Well Test Available	ViewEdit Subscriptions	
	View/Edit Trigger	Manage Formats	
	Reply Reply All Convert Com no-reply-notifications@chevron.com Above Hydrate Curve	Lages, Joao E [Radix] 2017-02-10 14:11:04.310 generated a new notification event.	
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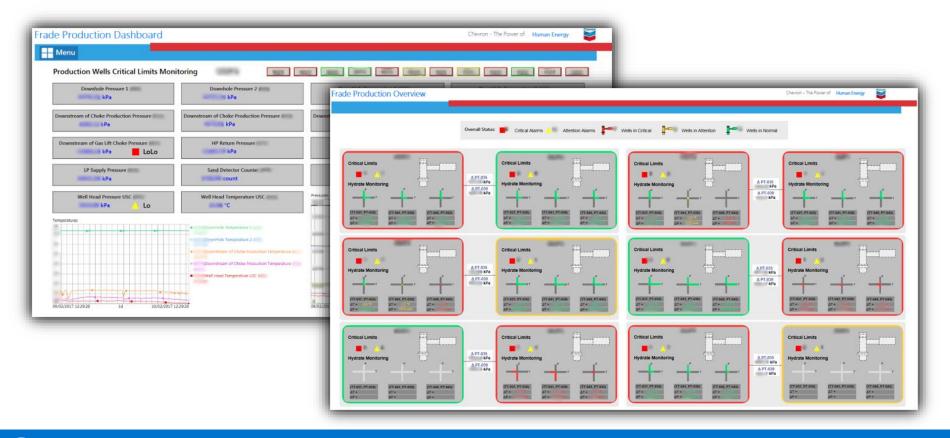


Control Loops KPI - Dashboards

ade Control L	.oops	Monitor	ing								Chev	ron - The Power of Hu	man Energ	
Control Loops	Monit	oring	1 2											
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Time with Output in 0%	- 5	Below 20 %	Time with Output In 0%	second w	Above 20%	Time with Output in 0%	STREET, SQUARE, SQUARE	Above 20%	Time with Output in 0%	114	Selow 20 %	Time with Output in 0%	1.00	Below 20 %
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Output Standard Deviation			Output Standard Deviation	1.44		Output Standard Deviation	-		Output Standard Deviation	1.5		Output Standard Deviation	15	
Output Average	-	Normal	Output Average	1.00	Below 10%	Output Average		Normal	Output Average	IN N	Above 90%	Output Average	1.0	Below 10%
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Production Tree Management Status - Dashboards



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Summary: Smart Monitoring & Notifications

CHALLENGE

Increase the ٠ engineering team efficiency on monitoring shifting by 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.

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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.

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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;

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- System Integrator
- Data Infrastructure:
 - Single Data Source;
 - Better Relational Structure;
 - Better Data Analysis;

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System Standardization and Optimization



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Carlos Britto

cbritto@chevron.com

Technical Computing Supervisor Chevron

Tárik Siqueira

tarik.siqueira@radixeng.com.br

Engineer

Radix Engineering and Software





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State your name & company



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