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June 7-8, Sao Paulo

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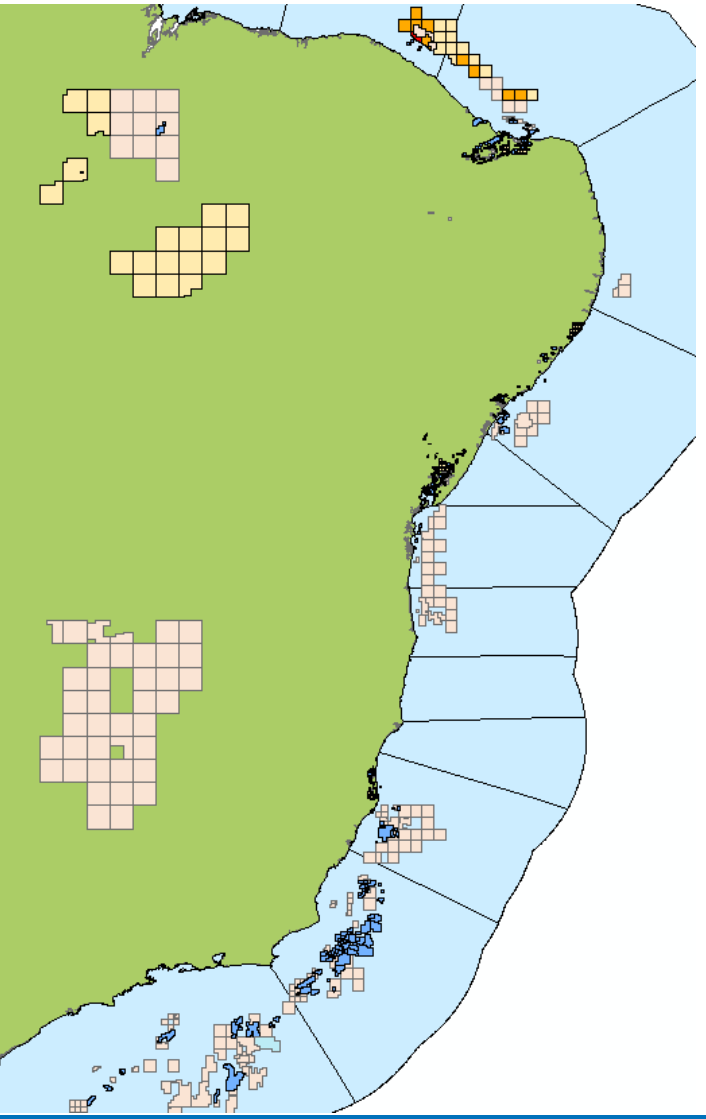
APRIMORANDO A CAPACIDADE DE MONITORAMENTO DA UNIDADE FPSO DE FRADE COM O PI SYSTEM

About Chevron

- Chevron was one of the successor companies of Standard Oil Company.
- Nowadays, its global workforce consists of 64,700 employees, including more than 3,200 service station employees.
- Chevron's average net production at the end of 2015 was 2.5 million oil barrels per day, with 73% of that production ocurring outside the United States.
- Furthermore, Chevron has a global refining capacity of 1.9 million barrels per day.
- OSI EA customer since 2011.

Chevron Brazil – Projects Overview



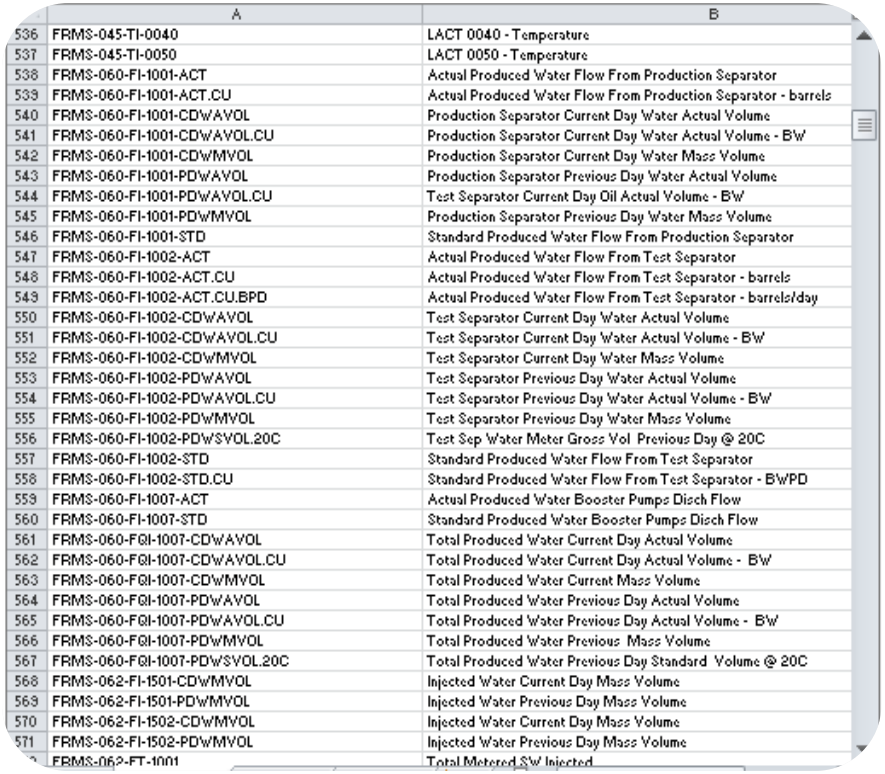
- Ceara CE-M-175: Chevron (50%) e Ecopetrol (50%)
- **Frade: Chevron (51%), Petrobras (30%), FJ (18%)**
- Papa-Terra: Chevron (37.5%), Petrobras (62.5%)
- Maromba: Chevron (30%) e Petrobras (70%)

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 depths ranging from 900 to 1200 meters;
- 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.

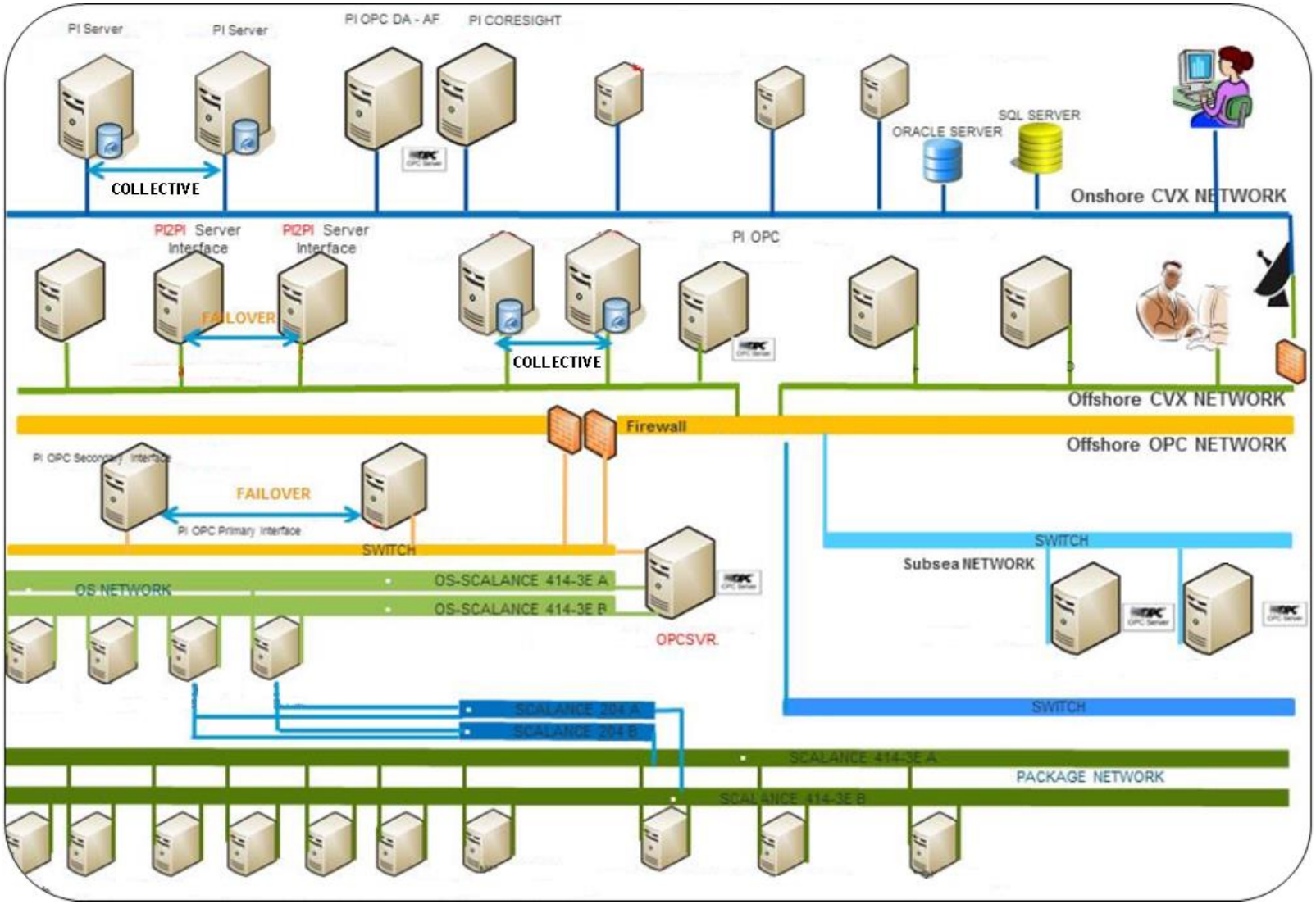
Frade's PI System Previous Scenario

- **6,000+** PI **tags** were **not structured**;
- The **users created** their **dashboards on demand** and it was **not** readily **accessible** to **others**;
- The similar **equipment** present on dashboards **could not be easily replicated** as templates;
- The **maintenance** proved **hard** to achieve;
- **Sheets** were being employed to **perform calculations**.



	A	B
536	FRMS-045-TI-0040	LACT 0040 - Temperature
537	FRMS-045-TI-0050	LACT 0050 - Temperature
538	FRMS-060-FI-1001-ACT	Actual Produced Water Flow From Production Separator
539	FRMS-060-FI-1001-ACT.CU	Actual Produced Water Flow From Production Separator - barrels
540	FRMS-060-FI-1001-CDWAVOL	Production Separator Current Day Water Actual Volume
541	FRMS-060-FI-1001-CDWAVOL.CU	Production Separator Current Day Water Actual Volume - BW
542	FRMS-060-FI-1001-CDWMVOL	Production Separator Current Day Water Mass Volume
543	FRMS-060-FI-1001-PDWAVOL	Production Separator Previous Day Water Actual Volume
544	FRMS-060-FI-1001-PDWAVOL.CU	Test Separator Current Day Oil Actual Volume - BW
545	FRMS-060-FI-1001-PDWMVOL	Production Separator Previous Day Water Mass Volume
546	FRMS-060-FI-1001-STD	Standard Produced Water Flow From Production Separator
547	FRMS-060-FI-1002-ACT	Actual Produced Water Flow From Test Separator
548	FRMS-060-FI-1002-ACT.CU	Actual Produced Water Flow From Test Separator - barrels
549	FRMS-060-FI-1002-ACT.CU.BPD	Actual Produced Water Flow From Test Separator - barrels/day
550	FRMS-060-FI-1002-CDWAVOL	Test Separator Current Day Water Actual Volume
551	FRMS-060-FI-1002-CDWAVOL.CU	Test Separator Current Day Water Actual Volume - BW
552	FRMS-060-FI-1002-CDWMVOL	Test Separator Current Day Water Mass Volume
553	FRMS-060-FI-1002-PDWAVOL	Test Separator Previous Day Water Actual Volume
554	FRMS-060-FI-1002-PDWAVOL.CU	Test Separator Previous Day Water Actual Volume - BW
555	FRMS-060-FI-1002-PDWMVOL	Test Separator Previous Day Water Mass Volume
556	FRMS-060-FI-1002-PDWSVOL.20C	Test Sep Water Meter Gross Vol Previous Day @ 20C
557	FRMS-060-FI-1002-STD	Standard Produced Water Flow From Test Separator
558	FRMS-060-FI-1002-STD.CU	Standard Produced Water Flow From Test Separator - BWPD
559	FRMS-060-FI-1007-ACT	Actual Produced Water Booster Pumps Disch Flow
560	FRMS-060-FI-1007-STD	Standard Produced Water Booster Pumps Disch Flow
561	FRMS-060-FQI-1007-CDWAVOL	Total Produced Water Current Day Actual Volume
562	FRMS-060-FQI-1007-CDWAVOL.CU	Total Produced Water Current Day Actual Volume - BW
563	FRMS-060-FQI-1007-CDWMVOL	Total Produced Water Current Mass Volume
564	FRMS-060-FQI-1007-PDWAVOL	Total Produced Water Previous Day Actual Volume
565	FRMS-060-FQI-1007-PDWAVOL.CU	Total Produced Water Previous Day Actual Volume - BW
566	FRMS-060-FQI-1007-PDWMVOL	Total Produced Water Previous Mass Volume
567	FRMS-060-FQI-1007-PDWSVOL.20C	Total Produced Water Previous Day Standard Volume @ 20C
568	FRMS-062-FI-1501-CDWMVOL	Injected Water Current Day Mass Volume
569	FRMS-062-FI-1501-PDWMVOL	Injected Water Previous Day Mass Volume
570	FRMS-062-FI-1502-CDWMVOL	Injected Water Current Day Mass Volume
571	FRMS-062-FI-1502-PDWMVOL	Injected Water Previous Day Mass Volume
	FRMS-062-FT-1001	Total Metered SW Injected

Current Frade PI Data Architecture Diagram



Project Deliverables

Pre-requisite

1. Data and System Structuring

2. Topsides Process Monitoring

3. Chemical Injection Monitoring

4. Emergency Valves Monitoring

1. Data and System Structuring

Challenges

- Over 6000 **tags not structured**;
- **Maintenance and security** required considerable effort;
- Users had no friendly interface to **search data and create applications**;
- **Analysis and logics** had to be implemented and **replicated inside each application**;

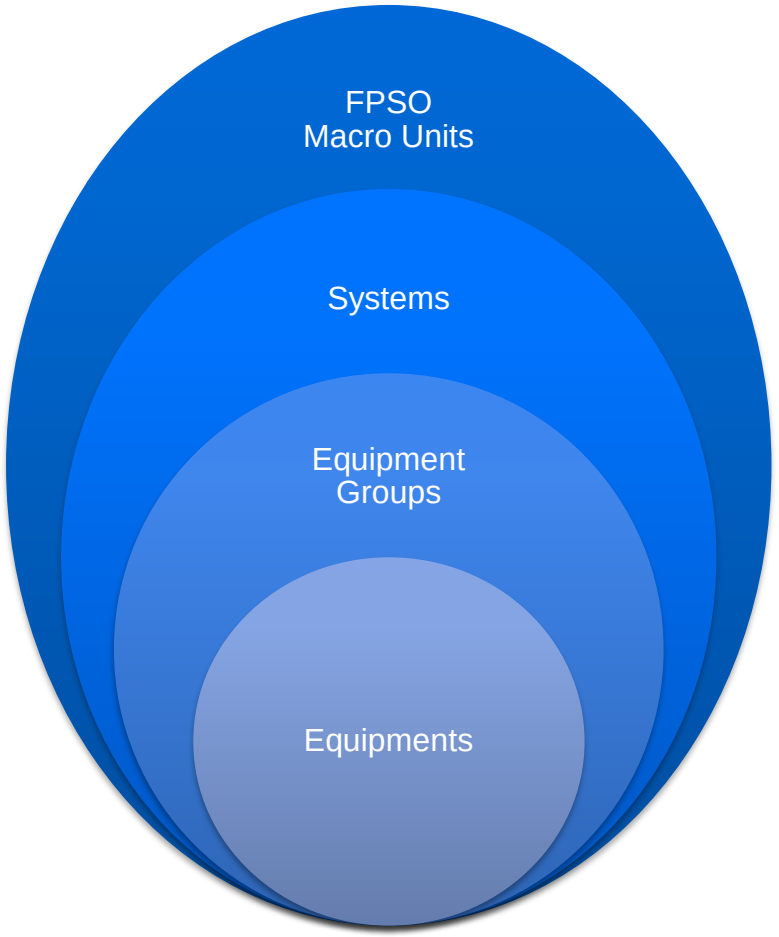
Solution

- Installation and configuration of **PI AF**;
  - Creation of **equipment templates**;
  - All instrument tags inserted and **ordered by equipment and systems**;
  - Rebuilt **system security**;
- Dashboards recreated on **PI ProcessBook referencing the PI AF** through Element Relative Displays.

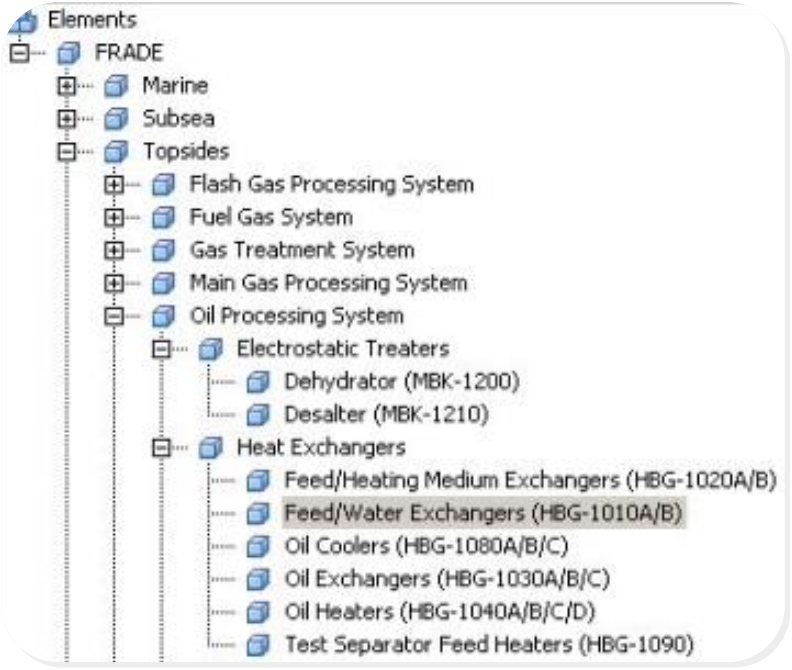
Results

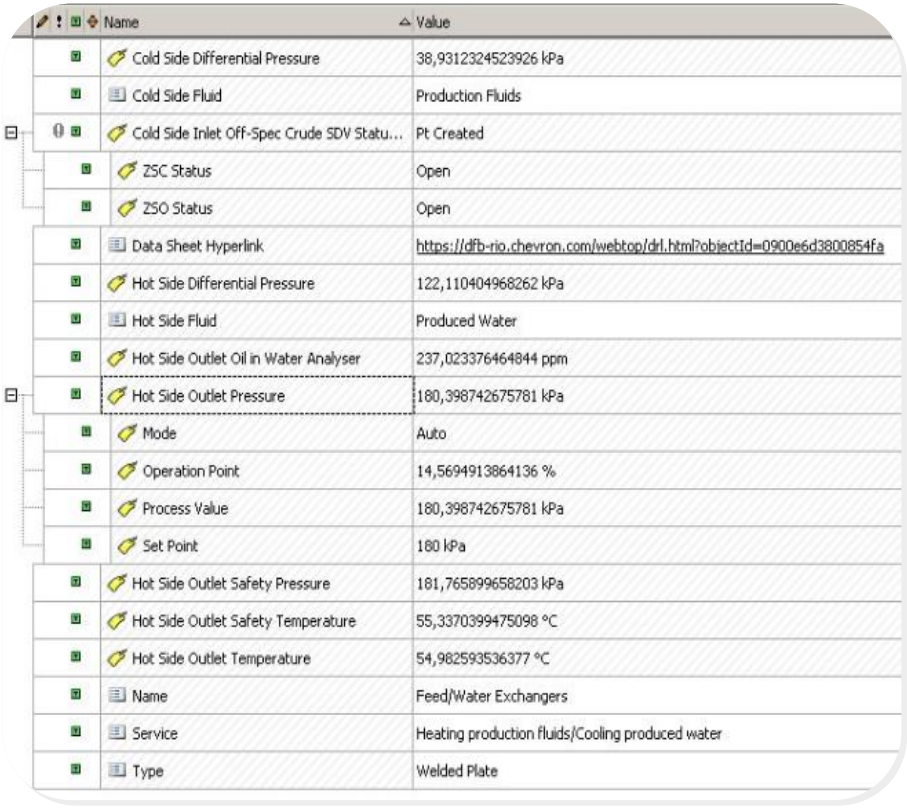
- **Reduction of hours** spent creating new dashboards;
- New **structured data**;
- More **scalability** due to elements templates;
- A complete **overhaul of the existing tags** was made, since it became easier to find errors and gaps during **Support and maintenance**.

1. Data and System Structuring



PI AF





Name	Value
Cold Side Differential Pressure	38,9312324523926 kPa
Cold Side Fluid	Production Fluids
Cold Side Inlet Off-Spec Crude SDV Statu...	Pt Created
ZSC Status	Open
ZSO Status	Open
Data Sheet Hyperlink	https://dfb-rio.chevron.com/webtop/drl.html?objectId=0900e6d3800854fa
Hot Side Differential Pressure	122,110404968262 kPa
Hot Side Fluid	Produced Water
Hot Side Outlet Oil in Water Analyser	237,023376464844 ppm
Hot Side Outlet Pressure	180,398742675781 kPa
Mode	Auto
Operation Point	14,5694913864136 %
Process Value	180,398742675781 kPa
Set Point	180 kPa
Hot Side Outlet Safety Pressure	181,765899658203 kPa
Hot Side Outlet Safety Temperature	55,3370399475098 °C
Hot Side Outlet Temperature	54,982593536377 °C
Name	Feed/Water Exchangers
Service	Heating production fluids/Cooling produced water
Type	Welded Plate

Project Deliverables

Pre-requisite

1. Data and System Structuring

2. Topsides Process Monitoring

3. Chemical Injection Monitoring

4. Emergency Valves Monitoring

2. Topsides Process Monitoring

Challenges

- Engineers rely mostly on **ad hoc visualizations** for process data in PI System;
- **Information context** is hard to achieve;
- Poor **sharing** capability;
- Require **vast knowledge** of the tags associated with each equipment;
- Some **tags were still missing** in the PI System.

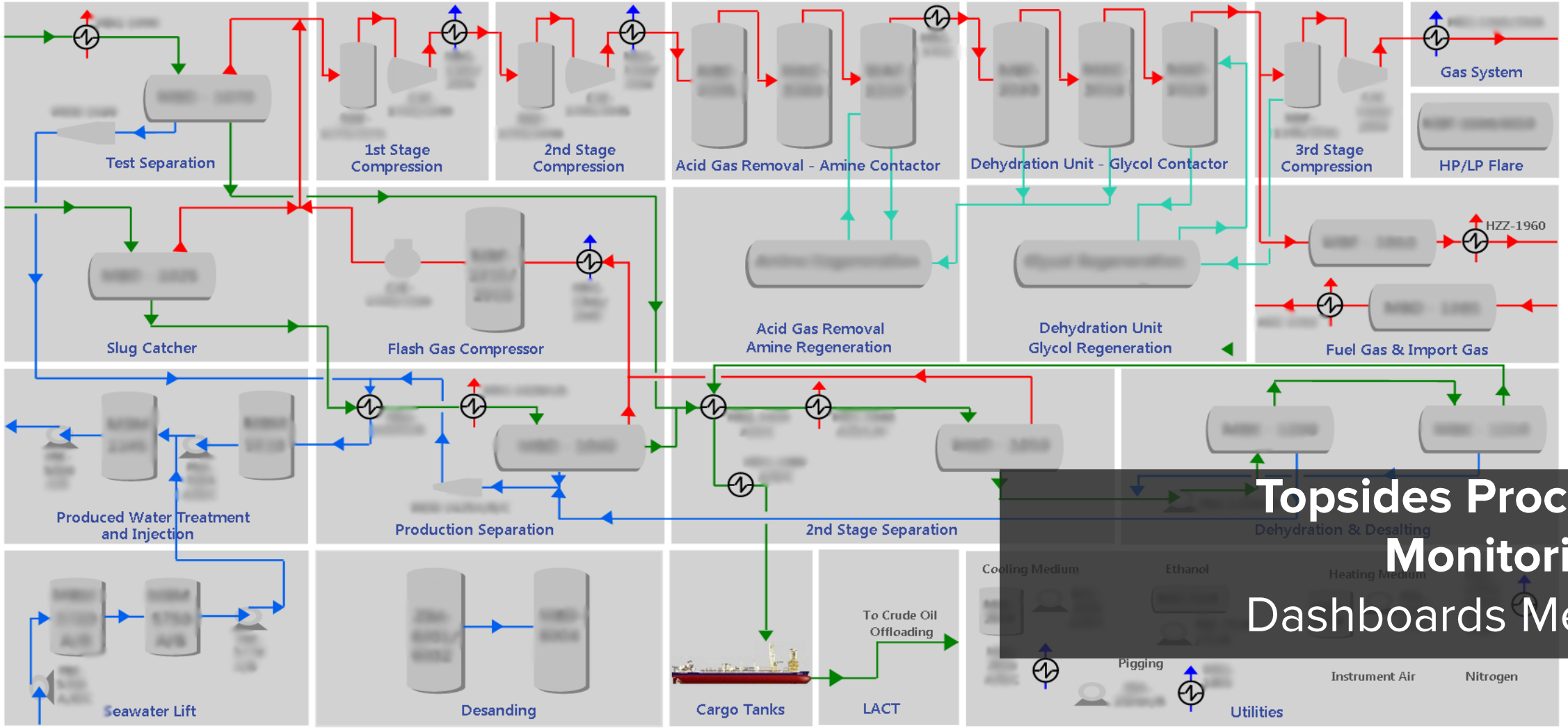
Solution

- **22 process monitoring dashboards** implemented in PI ProcessBook;
- Publication in **PI Coresight**;
- **Navigation menu** with complete **process overview**;
- All **relevant and accurate information** identified through extensive documentation analysis;
- **Imported all missing instrument tags** in the PI System;

Results

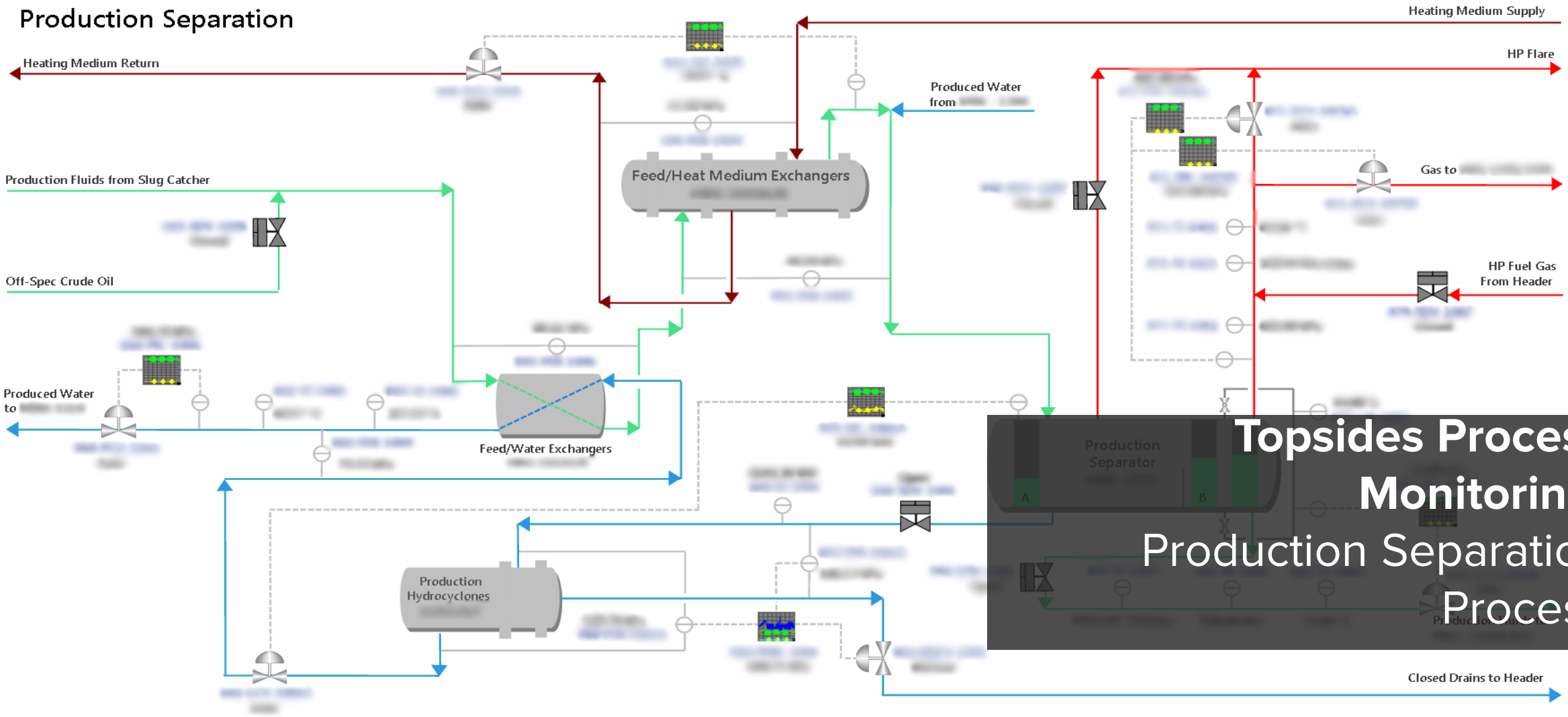
- Significant **decrease in effort to collect real data from offshore systems**;
- **Increased capability to execute analysis** due to better monitoring tools;
- **Enhanced collaboration** through the use of shared applications;
- **User friendly and standard interface** across all dashboards;
- **Increased monitoring capability** of critical control loops, critical process signals and safety valve performance

Frade Topsides Overview



Topsides Process Monitoring:
Dashboards Menu

18/05/2016 02:10:36 | 8h | Now | 18/05/2016 10:10:36



Topsides Process Monitoring: Production Separation Process

Project Deliverables

Pre-requisite

1. Data and System Structuring

2. Topsides Process Monitoring

3. Chemical Injection Monitoring

4. Emergency Valves Monitoring

3. Chemical Injection Monitoring

Challenges

- Monitor **5 chemical injection dosages to pursue target and variation** goals;
- The only measurement available is the **tank level**;
- Must be **accessible from the office and offshore** locations;
- Events such as **tank refuel and production shutdown** must be taken into consideration in the analysis.

Solution

- **PI AF element template** configured to provide and centralize the information;
- **Analysis templates** implemented to provide **operational intelligence**;
- Derived and statistical information calculated by **PI Analytics**;
- Dashboard implementation using **Element Relative** references to PI AF elements;
- Publication in **PI Coresight**;

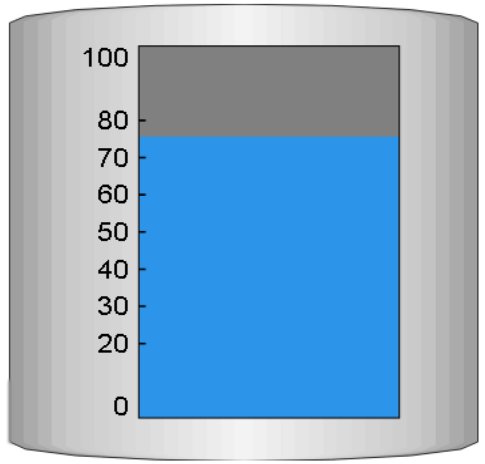
Results

- Chemical dosage **closer to target and reduced variation**;
- **Automated calculation** of all important indicators;
- Information update **frequency increased from daily to hourly**;
- Increased surveillance and collaboration in offshore and onshore teams.

Chemical Monitoring - Scale Inhibitor

Corrosion Inhibitor | Defoamer | Demulsifier | Scale Inhibitor | Calcium Naphtenate Inhibitor

Tank Level



Tank Usage per Hour

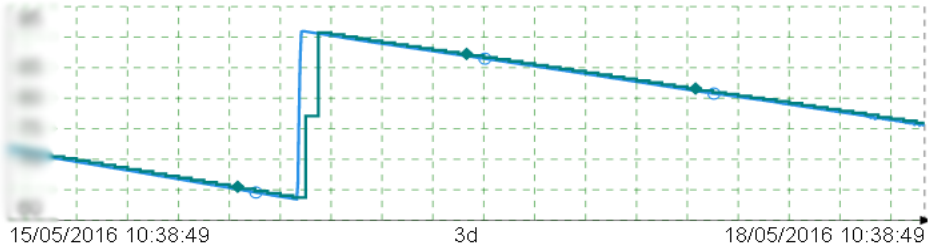
Yesterday Usage

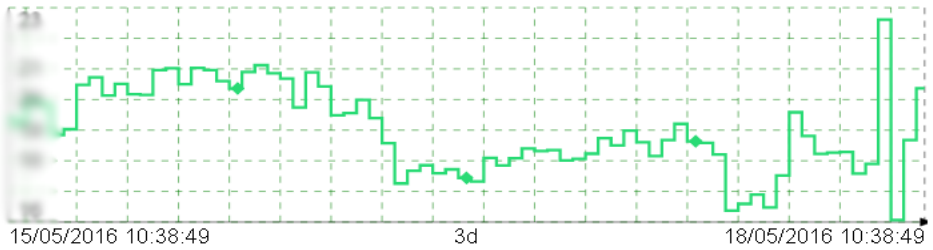
24h Average Dosage

Target Dosage

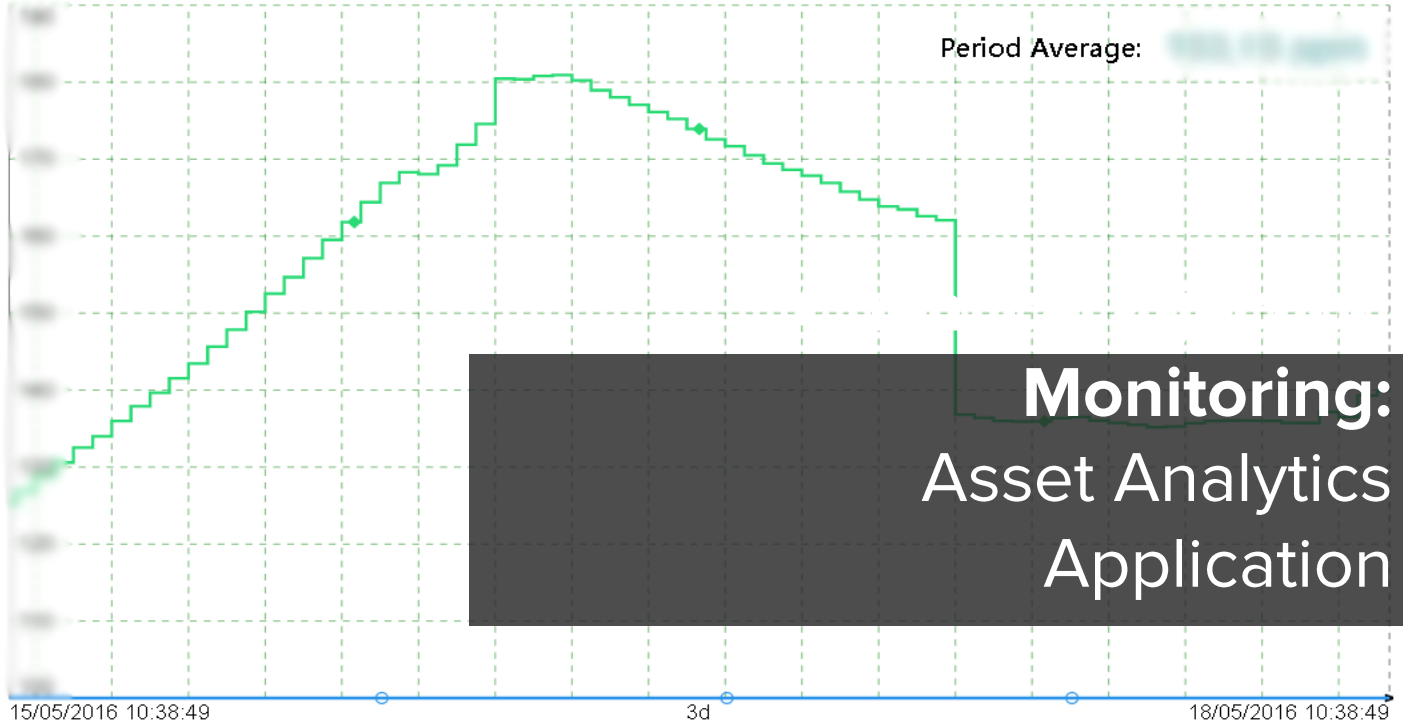
7-days Variation

Dosage Averages: 7d 30d 90d





Period Average:



Monitoring:
Asset Analytics Application

15/05/2016 10:38:50 | 3d | Now | 18/05/2016 10:38:50

Project Deliverables

Pre-requisite

1. Data and System Structuring

2. Topsides Process Monitoring

3. Chemical Injection Monitoring

4. Emergency Valves Monitoring

4. Emergency Valves Monitoring

Challenges

- Onshore engineers have **limited information** about the emergency valves;
- **Historical data** is necessary to analyze the valves behaviour;
- Extracting and formatting **data to a report** requires considerable effort;
- No **automated processing** is applied to recieved data;

Solution

- Valves represented in **PI AF** using **element template** and **PI Analytics** to determine complex status;
- Dashboard implementation using **Symbol Template** associated with PI AF;
- Publication in **PI Coresight**;
- Excel add-in implemented to **retrieve and process** historical data for **analysis and reporting;**
- **PI Event Frames** used to detect and present information with start and end conditions

Results

- Improved onshore **surveillance capabilities**;
- Increased **information quality** used to **plan and execute** equipment inspection and intervention;
- **Savings** due to reduced scope of work by performing **condition based maintenance**;
- **Reduced** application **implementation and maintenance efforts**;

Topsides 1

Marine SDV | Topsides BDV | Topsides SDV 2 | Topsides SDV 3 | Turret SDV 1 | Turret SDV 2

MOD 01

Test Separator HP Fuel Gas SDV
ZSO Open ET PT 10 s
ZSC Not Closed Time 15/05/2016 11:03:03

Test Separator Prod Water Outlet SDV
ZSO Not Open ET PT 10 s
ZSC Closed Time 18/05/2016 13:08:30

Test Separator Oil Outlet SDV
ZSO Open ET PT 10 s
ZSC Not Closed Time 12/05/2016 10:12:57

Off-Spec Crude to Feed/Water Exchanger SDV
ZSO Not Open ET PT 10 s
ZSC Closed Time 06/04/2016 13:52:56

Production Separator HP Fuel Gas SDV
ZSO Not Open ET PT 10 s
ZSC Closed Time 13/05/2016 14:02:45

Prod Separator Prod Water Outlet SDV
ZSO Open ET PT 10 s
ZSC Not Closed Time 18/05/2016 13:08:07

Production Separator Oil Outlet SDV
ZSO Open ET PT 10 s
ZSC Not Closed Time 12/05/2016 10:13:04

Test Sep Test Fluid to Off-Spec Tank SDV
ZSO Open ET PT 10 s
ZSC Not Closed Time 16/05/2016 10:40:38

MOD 02

2nd Stage Sep LP Fuel Gas SDV
ZSO Not Open ET PT 10 s
ZSC Closed Time 25/04/2016 15:57:16

2nd Stage Separator Oil Outlet SDV
ZSO Not Open ET PT 10 s
ZSC Closed Time 25/04/2016 15:45:03

Dehydrator Produced Water Outlet SDV
ZSO Open ET PT 10 s
ZSC Not Closed Time 18/05/2016 13:07:41

Desalter Produced Water Outlet SDV
ZSO Not Open ET PT 10 s
ZSC Closed Time 06/04/2016 13:52:56

Crude Oil to Cargo Tanks SDV
ZSO Open ET PT 10 s
ZSC Not Closed Time 25/04/2016 16:13:11

Crude Oil to Off-Spec Tank SDV
ZSO Open ET PT 10 s
ZSC Not Closed Time 23/04/2016 08:59:46

MOD 03

1st Stage Comp (1) Suct Scrubber Main SDV
ZSO Not Open ET PT 10 s
ZSC Closed Time 17/05/2016 09:17:26

1st Stage Comp (1) Suct Scrubber Bypass SDV
ZSO Not Open ET PT 10 s
ZSC Closed Time 17/05/2016 10:06:18

1st Stage Comp (1) Suct Scrubber Cond SDV
ZSO Not Open ET PT 10 s
ZSC Pt Created Time 06/04/2016 13:53:57

2nd Stage Comp (1) Suct Scrubber Cond SDV
ZSO Open ET PT 10 s
ZSC Not Closed Time 17/05/2016 09:43:29

2nd Stage Comp (1) Main Outlet SDV
ZSO Not Open ET PT 10 s
ZSC Closed Time 17/05/2016 09:17:49

2nd Stage Comp (1) Outlet Bypass SDV
ZSO Not Open ET PT 10 s
ZSC Closed Time 17/05/2016 10:12:32

3rd Stage Comp (1) Suct Scrubber Inlet SDV
ZSO Not Open ET PT 10 s
ZSC Closed Time 06/04/2016 13:53:57

Legend

Current Values:
ZSO = Open Tag
ZSC = Closed Tag
Historical Values:
ET = Measured Travel Time
PT = Travel Time Deadline
Time = Last ET Timestamp

Closed
Open
Closing/Opening
Status not available

MOD 03

3rd Stage Comp (1) Suct Scrubber Bypass SDV
ZSO Pt Created ET PT 10 s
ZSC Pt Created Time 06/04/2016 13:53:57

3rd Stage Comp (1) Suct Scrubber Cond SDV
ZSO Not Open ET PT 10 s
ZSC Closed Time 06/04/2016 13:53:57

3rd Stage Comp (1) Main Gas Outlet SDV
ZSO Not Open ET PT 10 s
ZSC Closed Time 06/04/2016 13:55:59

3rd Stage Comp (1) Outlet Bypass SDV
ZSO Not Open ET PT 10 s
ZSC Closed Time 06/04/2016 13:55:59

Emergency Valves Monitoring:
Operational Dashboards

19/05/2016 06:33:32 | 8h | Now | 19/05/2016 14:33:32

	A	B	C	D	E	F	G	H
1	In the list below are the events that occurred between 2016-05-01 00:00:00Z and 2016-05-19 23:59:59Z.							
2	Valve	Name	Event Time	ZSO	ZSC	Travel Time	Design Time	Max. Time
39		1st Stage Comp (1) Suct Scrubber Main SDV	2016-05-17 09:17:26Z	Not Open	Closed		19,80	10,00
40		1st Stage Comp (1) Suct Scrubber Main SDV	2016-05-03 17:49:14Z	Not Open	Closed		19,80	10,00
41		1st Stage Comp (1) Suct Scrubber Main SDV	2016-05-03 08:04:38Z	Not Open	Closed		19,80	10,00
42		1st Stage Comp (1) Suct Scrubber Main SDV	2016-05-03 06:03:00Z	Not Open	Closed		19,80	10,00
72		1st Stage Comp (2) Suct Scrubber Cond SDV	2016-05-17 10:36:30Z	Open	Not Closed		3,30	10,00
73		1st Stage Comp (2) Suct Scrubber Cond SDV	2016-05-03 17:46:19Z	Open	Not Closed		3,30	10,00
74		1st Stage Comp (2) Suct Scrubber Cond SDV	2016-05-03 17:42:39Z	Not Open	Closed		3,30	10,00
75		1st Stage Comp (2) Suct Scrubber Cond SDV	2016-05-03 17:24:50Z	Open	Not Closed		3,30	10,00
76		1st Stage Comp (2) Suct Scrubber Cond SDV	2016-05-03 17:22:23Z	Not Open	Closed		3,30	10,00
77		1st Stage Comp (2) Suct Scrubber Main SDV	2016-05-17 10:18:04Z	Open	Not Closed		19,80	10,00
78		1st Stage Comp (2) Suct Scrubber Main SDV	2016-05-03 19:28:49Z	Not Open	Closed		19,80	10,00
79		1st Stage Comp (2) Suct Scrubber Main SDV	2016-05-03 17:43:55Z	Not Open	Closed		19,80	10,00
80		1st Stage Comp (2) Suct Scrubber Main SDV	2016-05-03 17:23:14Z	Not Open	Closed		19,80	10,00
81		1st Stage Comp (2) Suct 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

Chevron

Valve search filter

Group: All

Valve: All

Search events by

Time Range Quantity

Start: 01/05/2016 00:00:00

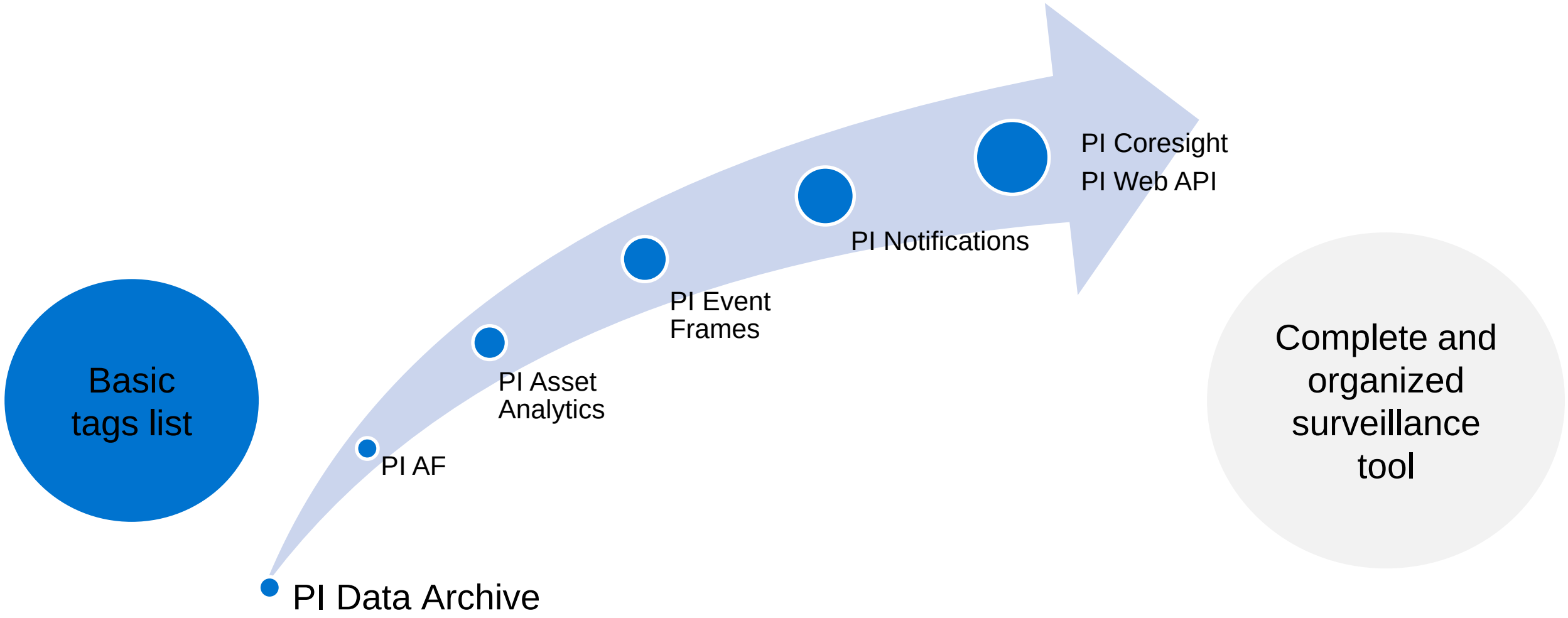
End: 19/05/2016 23:59:59

5 Last events per valve

Search

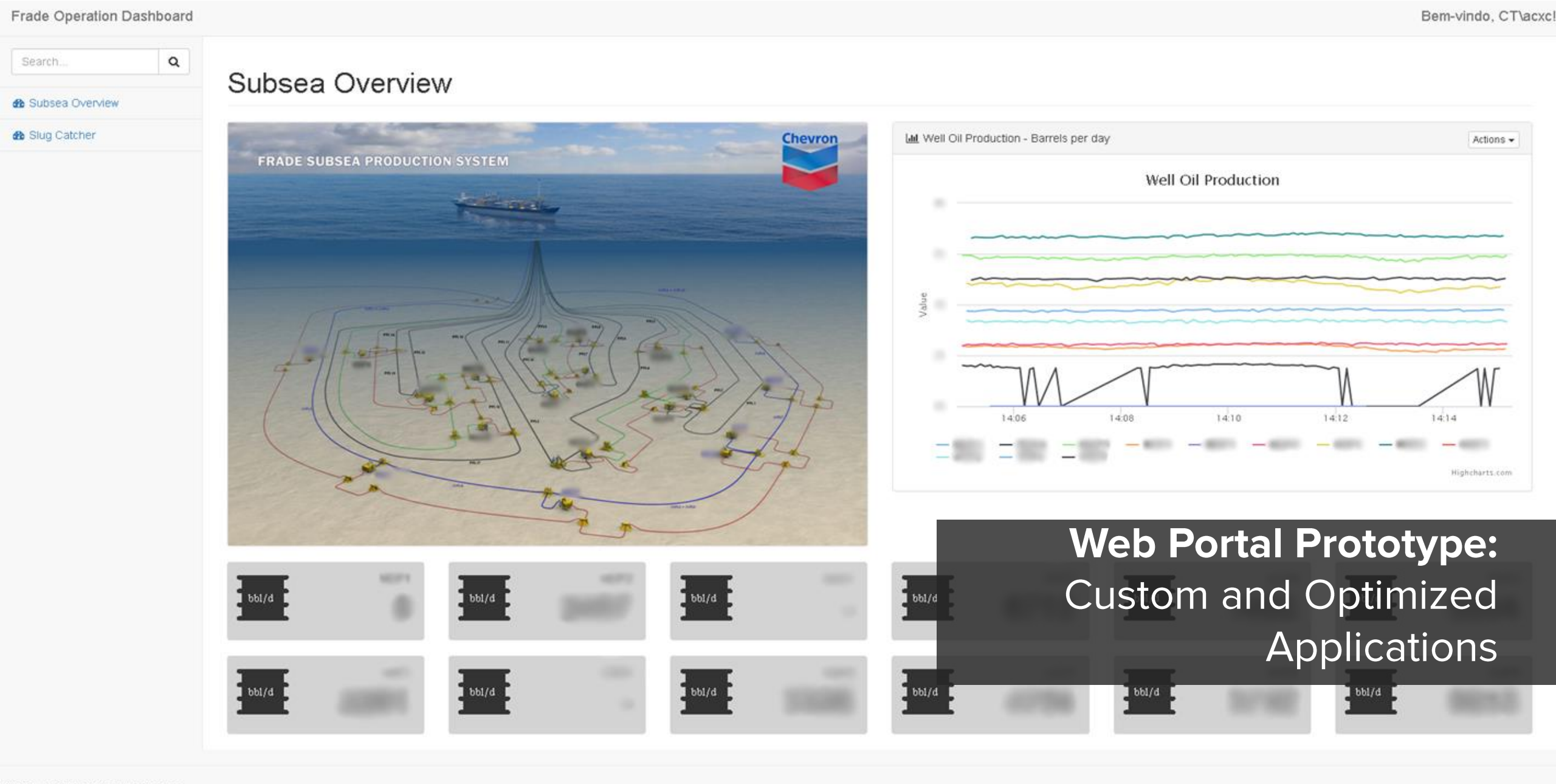
Emergency Valves Monitoring: Analysis Report

Lessons Learned: The PI Tools Can Be Powerful



Next Steps and Future Plans

- **Expand PI AF structure** with new data being added to the PI System;
- Implement **new dashboards** according to demands;
- Implement **PI Notifications** to automatically send important data to engineers;
- **Train engineers** on the implemented tools using the PI System;
- Implement a modern **Web Monitoring Portal** to integrate and expand PI System applications with new capabilities.



Enhancing Monitoring Capability in Frade FPSO Using PI Tools

Chevron

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.**

CHALLENGES

Increase efficiency in **data management**;

Provide **structured data** to support the development of better applications;

Increase **data quality and availability**;

Enhance **monitoring capability**;

Provide relevant **data to support decision making**;

Increase **collaboration** between teams.

SOLUTION

Data structured in a hierarchical asset model on PI AF and PI DA revision to **correct and expand data**;

Applications with new capabilities provided by PI Asset Analytics, PI Event Frames and PI AF.

Dashboards publication on the web using PI Coresight;

RESULTS

Reduced in 50% the development efforts and duplicated tasks;

Optimized **system maintenance, security and scalability**;

Increased Data Quality on 90%;

Increased collaboration between office and offshore through the PI System;

5% lower consumption of chemicals, which represents **$15,000/month**;

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감사합니다

谢谢

Danke

Gracias

Merci

Thank You

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Спасибо

Obrigado

Questions

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

- State your **name & company**