

Daleel Production Surveillance via Real-Time Well Models

Muneer Al Balushi & Gian Marco Gioria

دليل للنفط ش.م.م.
DALEEL PETROLEUM L.L.C.

Name: Muneer Al Balushi

Location: Oman

Beautiful , friendly , Safe



Daleel Petroleum

Role: RTO & Smart Fields Team Leader

“Local Oil and Gas exploration and production company”

“One of Leading Producers in Oman”

“50,000 BBL/D + Average”

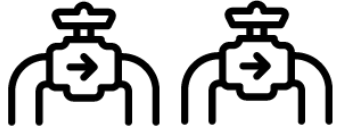


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DALEEL PETROLEUM L.L.C.

Real-Time & Smart Fields (Agenda)

- Daleel Real-Time Operation Journey (Daleel Portal)
Overview, Integration , Filtration , Analysis
- Daleel Dashboard (Key Features)
 - Daleel Real-Time Production
 - Well Surveillance
 - Exception Based Surveillance (EBS)
 - Beam Pumps Dyna Cards
 - Well Production Real-Time Surveillance (Model Based)
 - Virtual Metering
 - KPI's
- Implementation Details
- Benefits / Conclusion

Daleel Petroleum (Overview)



Manifolds



Wells



Station A

- Separation
- Oil Storage
- Shipping



Station B

- Water Process
- Separation
- Water Injection



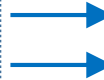
Gas Plant

- Lean Gas
- LPG
- NGL



Power Plant

- Gas Turbine
- Generate Power



Export Meter

- Oil Export



Daleel Automation (Before)

Automation Systems

- Execution
- Maintenance



Station A



Gas Plant



Station B



Power Plant



Wells



Export Meter

2.5 Mil/D
Real Time Data set

1k Data set / 5 hours



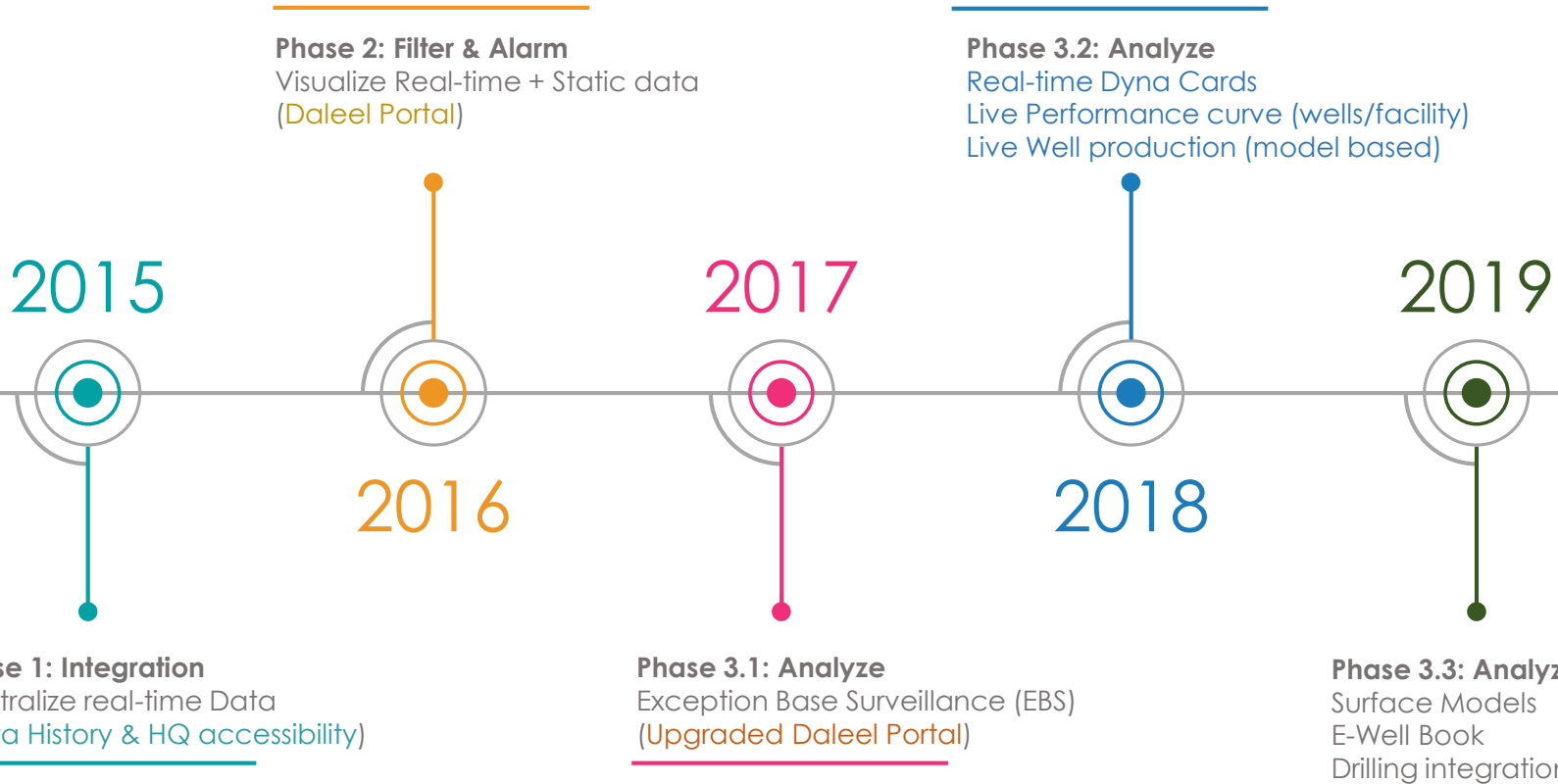
- Limited information
- Limited History
- Manual Entry
- Human Errors
- Transparency issues

Headquarter

- Analysis
- Development
- Decision Making



Daleel Real Time Operations (Plan)



Daleel Real Time Operations (Architecture) - 2015

Reporting tools

PI DataLink

PI ProcessBook

- Connecting Real-Time Data with Static Data
- Centralized visualized tool

Data Viewing/
Analysis

Data Archiving/
Processing

Data
Collection

Intelligence tool

DASHBOARDS PORTAL
“SMART DALEEL PORTAL”

PI System

AVOCET

Gas
Plant
SCADA

Wells
SCADA

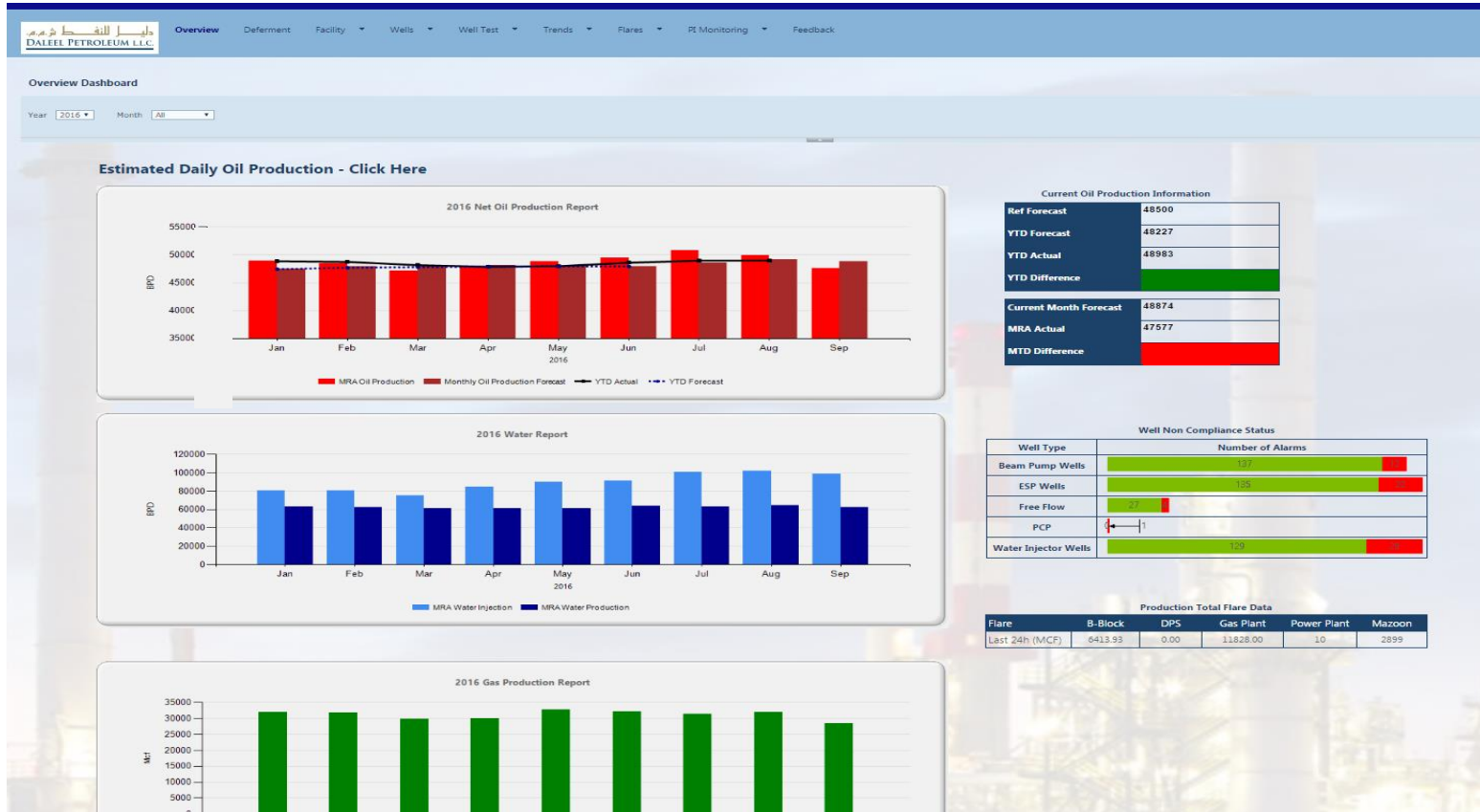
Station
A DCS

Station
B DCS

Power
Plant
DCS

Export
Meter

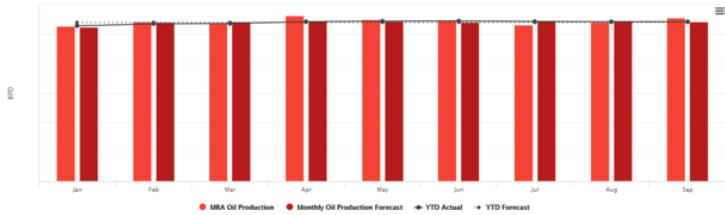
Daleel Dashboard (Stage 1) - 2016



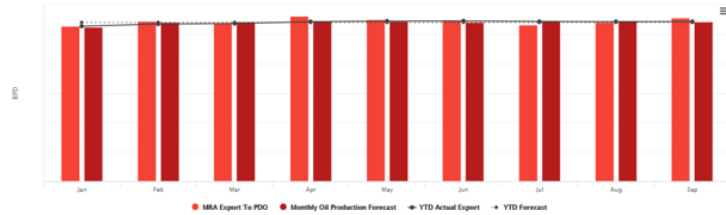
Daleel Dashboard (Stage 2) - 2017

Year: 2019 Month: All

Net Oil Production 2019



Export to PDO 2019



Ref Prod. Production

YTD Prod. Forecast

YTD Prod. Actual

YTD Prod. Difference

Ref Export Production

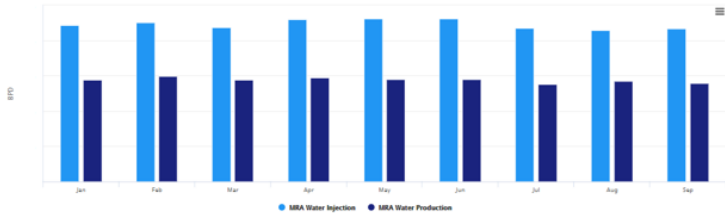
YTD Export Forecast

YTD Export Actual

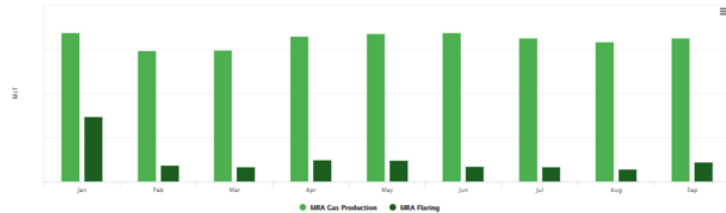
YTD Export Difference

YTD Flaring

Water Production 2019



Gas and Flare Production 2019

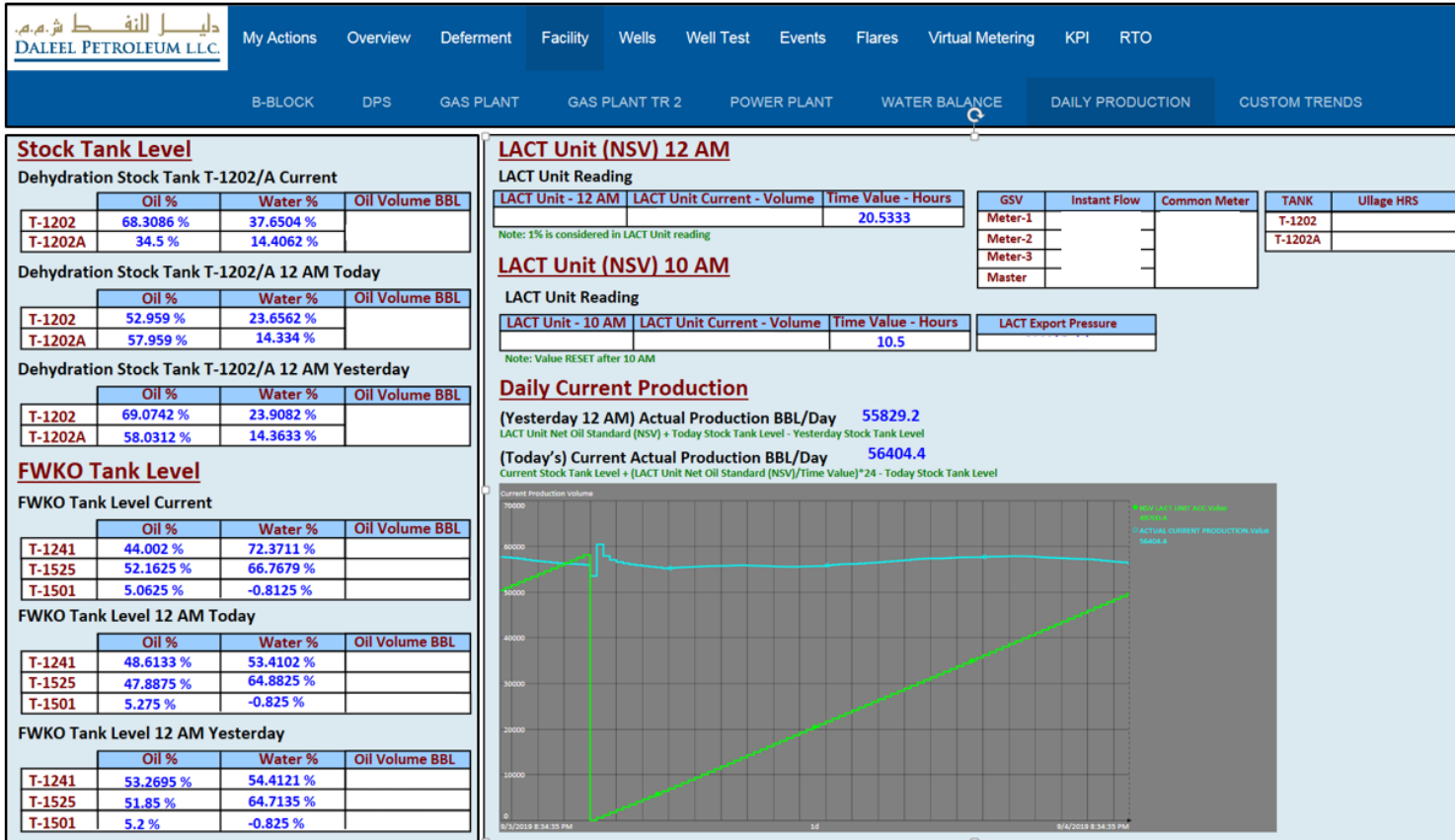


Daleel Dashboard (Stage 2) Key Features

- Field Real-Time Production
- Well Surveillance
- Exceptional Based Surveillance (EBS)
- Beam Pumps Dyna Cards
- Real Time Well Production (Based on a model)
- Virtual Metering

Field Real Time Production

Field Real Time Production



- Production Forecast
- Proactive Actions

Well Surveillance (Filter)

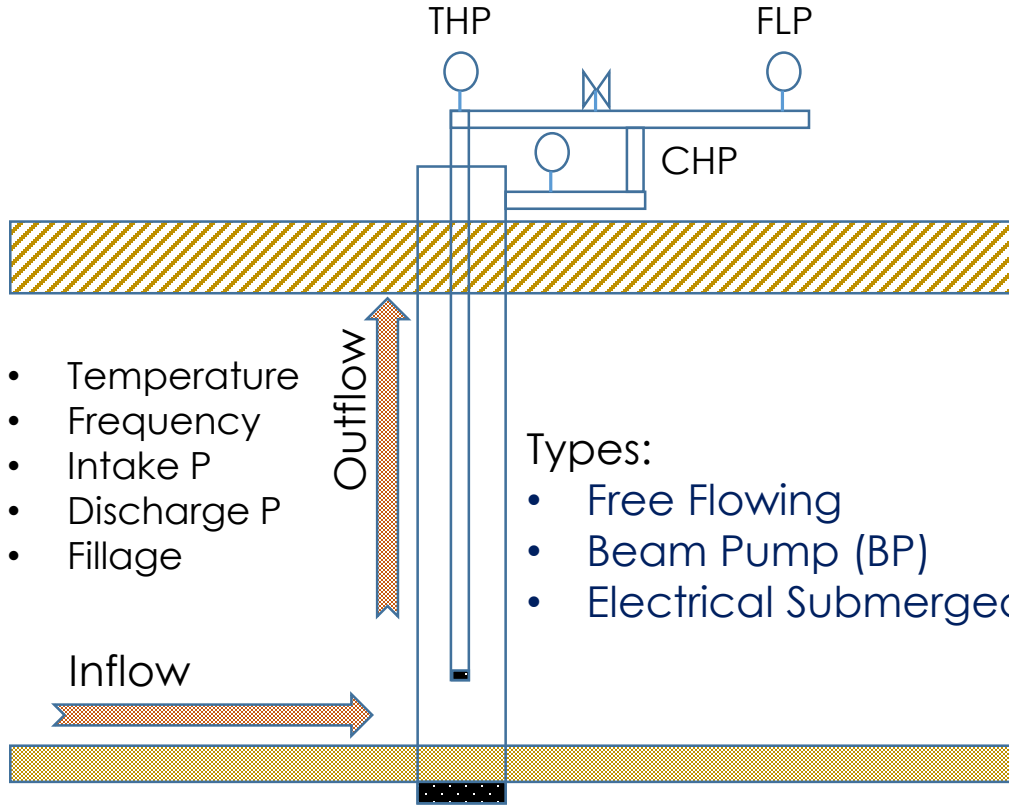
Well Surveillance



REAL TIME



Aggregated



- Temperature
- Frequency
- Intake P
- Discharge P
- Fillage

Outflow

Inflow

Types:

- Free Flowing
- Beam Pump (BP)
- Electrical Submerged pump (ESP)

- Location
- Well Test
- Allocation
- Deferment
- Type
- Zone
- Lab Data
- Forecast

Well Surveillance (template)

The screenshot displays the Well Surveillance software interface with the following sections:

- Navigation:** Top menu bar with options like Home, Dashboard, Well Info, Real-Time Data, Well Test, Allocation, Pump Curve, and Well Test History.
- Well Info:** A panel on the left showing well details such as Well Type (ESP), Well ID (W-001), and Completion Date (2019-07-15). To the right are three real-time data plots showing pressure and flow rate over time.
- Model Match:** A section containing three plots comparing observed data with model predictions for different parameters.
- Pump Curve:** A plot showing the relationship between flow rate and pressure for the well's pump.
- Well Test:** A table listing well test events with columns for Start Time, Category, Deferral Date, and Test Volume.
- Deferment:** A detailed table listing deferment events with columns for Well Name, Test Status, Start Date, Stop Date, and various dates (Start, Stop, Deferral, etc.).
- EBS Event History:** A table showing event logs with columns for Action, Start Time, End Time, Status, Assigned To, and Details.
- Model Manager:** A bottom section for managing simulation models, including buttons for 'Run Model' and 'Download Report'.

Well Info

Navigation

Real-Time Data

Model Match

Well Test/
Allocation

Pump Curve

Well Test

Deferment

EBS Event
History

Model Manager

Well Surveillance



My Actions Overview Deferment Facility Wells Well Test Events Flares Virtual Metering KPI RTO

BR-009 (ESP)

BMS NATIH SHUAIBA CUSTOM TRENDS OVERVIEW

BMS BRSM-01 BR-009

Start Date
03/09/2019 20:46

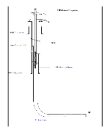
End Date
04/09/2019 20:46

Signals
INTAKE_PRESSURE x PUMP_DISCHARGE_PRESSURE x

Injectors

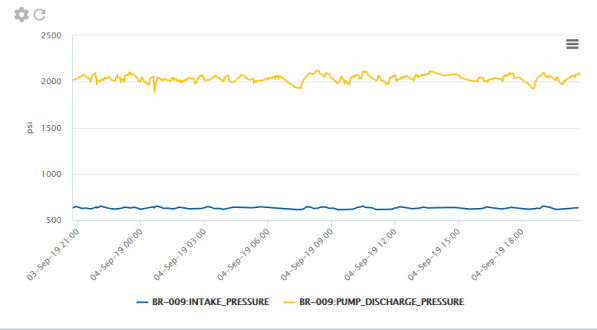
1 Hour | 1 Day | 1 Week | 1 Month |

Well Info

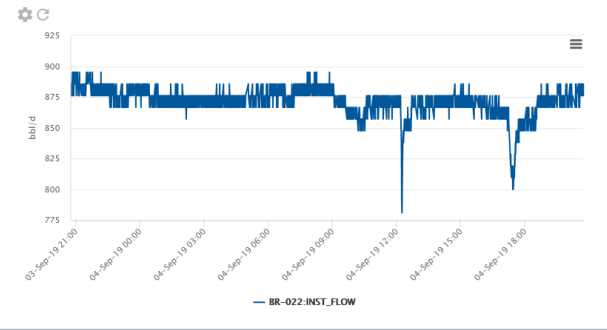


Well Type	ESP
Field	Bushra
Block	Bushra NW
Reservoir	Natih
Completion Date	24 May 2009
Avg. Estd. Liquid Rate	856.99 bbl/d
Cum. Prod.	1658617.78
Avg. THP	221.84 psi
Avg. CHP	161.69 psi
Avg. Intake Press.	630.29 psi
Avg. PDP	2037.43 psi

Producer

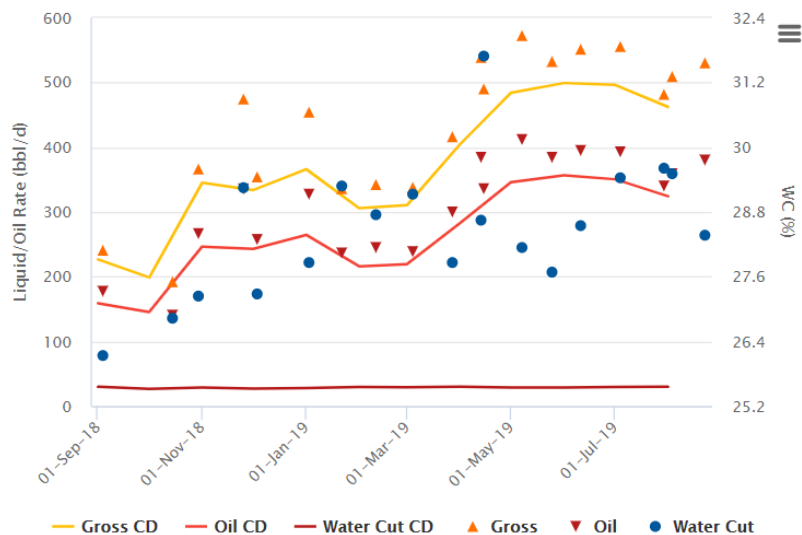


Injectors

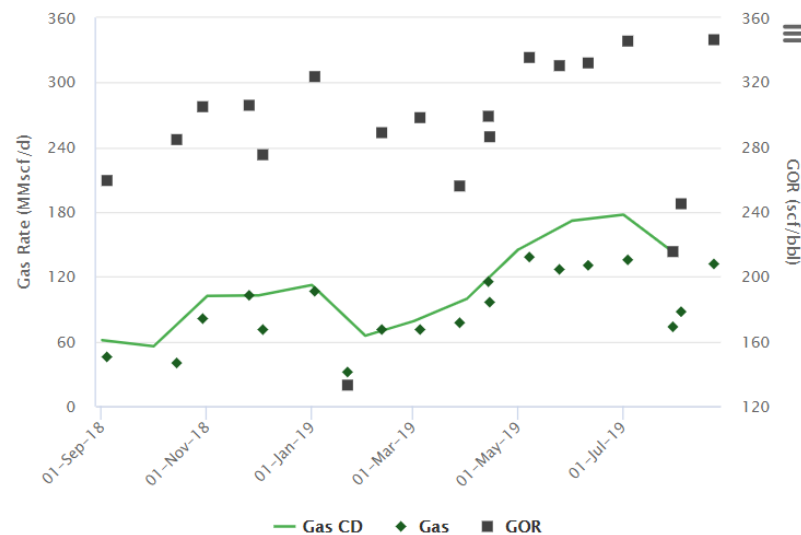


Well "Test" / Well "Allocation"

Liquid



Gas



Well Test History (Detailed)

Well Tests

Start Date	Test Status	Gross (Bbl/d)	Oil (Bbl/d)	Water (Bbl/d)	Gas (Mcf/d)	WC (%)	WHP (Psig)	GOR (scf/bbl)	Sep Pressure(Psig)	API (dAPI)	Choke (in/64)	Test Facility
28 Aug 2019	VALID	1043.07	281.67	761.4	159.93	73	232	567.79	203.66	30.32	491.52	MPFM_007
24 Aug 2019	VALID	1043.62	283.71	759.91	162.11	72.81	212	571.39	204.59	30.32	491.52	MPFM_007

Deferment History (Tracking)

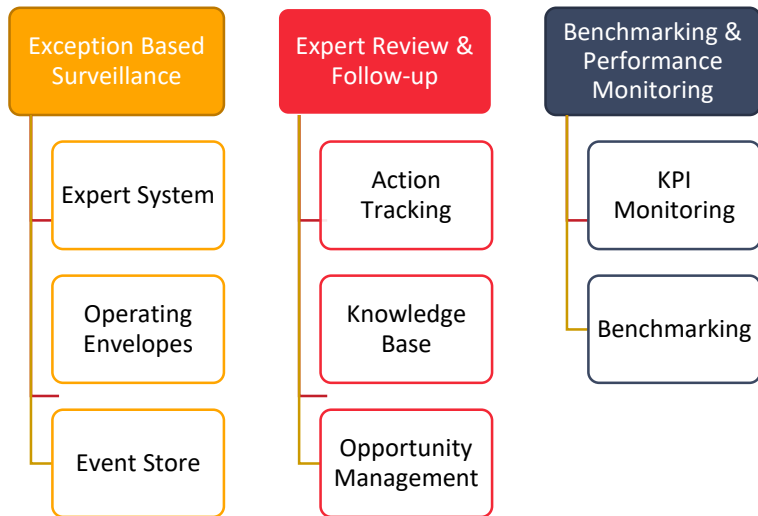
Deferments

Start Date	Category	Deferment Group	Lost Oil Volume	Description
13 Aug 2019	ESP RELATED	UNSCHEDULED	23.07	Tripped due to underload.
08 Aug 2019	WELL OPTIMISATION	SCHEDULED	11.1	Stopped manually for choke replacement.
07 Aug 2019	ESP RELATED	UNSCHEDULED	24.05	Tripped due to underload.
20 Jul 2019	OTHERS	UNSCHEDULED	65.07	Total field tripped due to adverse weather condition (due to Sandstorm ,Heavy Rain and lightning strike).
19 Jul 2019	OTHERS	UNSCHEDULED	24.05	Total field tripped due to adverse weather condition (due to heavy rain and lightning strike)
03 Jul 2019	ESP RELATED	UNSCHEDULED	123.39	Downhole Electrical failure. Restarted
02 Jul 2019	ESP RELATED	UNSCHEDULED	235.65	Downhole Electrical failure. Generator service
01 Jul 2019	ESP RELATED	UNSCHEDULED	235.65	Downhole Electrical failure.
30 Jun 2019	ESP RELATED	UNSCHEDULED	235.65	Downhole Electrical failure.
29 Jun 2019	ESP RELATED	UNSCHEDULED	235.65	Downhole Electrical failure.

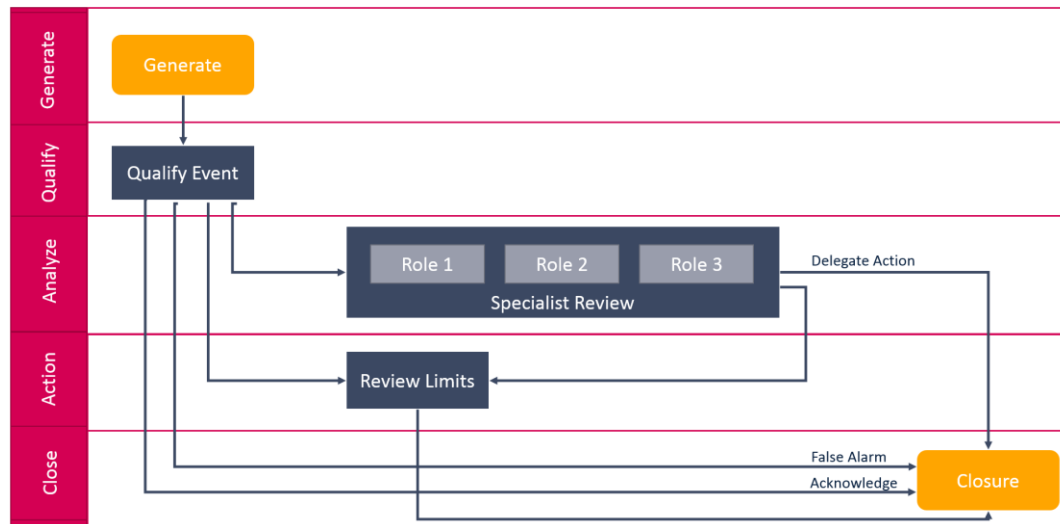
Exception Based Surveillance (EBS) (Analysis)

Exception Based Surveillance (EBS)

EBS Component



High Level Workflow



Exception Based Surveillance (EBS)

My Unhandled Events 1

Field	Asset Type	Asset	Event Type	Priority	Start Time	End Time	Status	
Shuaiba	ESP	DL-058	Test Event	Error	16 Apr 2018		New	ACKNOWLEDGE & CLOSE DETAILS

My Assigned Actions 2

Field	Asset Type	Asset	Event Type	Priority	Start Time	End Time	Status	
Shuaiba	ESP	DL-058	Test Event	Error	29 Mar 2018	29 Mar 2018	Acknowledged	DETAILS

My Participated Events 3

Field	Asset Type	Asset	Event Type	Priority	Start Time	End Time	Status	
Natih	ESP	DL-058	Test Event	Error	29 Mar 2018	29 Mar 2018	Acknowledged	DETAILS
Natih	Water Injector	DL-110	Test Event	Error	29 Mar 2018	29 Mar 2018	Acknowledged	DETAILS
Natih	Water Injector	DL-110	Test Event	Error	28 Mar 2018	28 Mar 2018	Acknowledged	DETAILS
Natih	Water Injector	DL-110	Test Event	Error	26 Mar 2018	26 Mar 2018	Acknowledged	DETAILS
Shuaiba	ESP	DL-058	Test Event	Error	22 Mar 2018	22 Mar 2018	Acknowledged	DETAILS
Shuaiba	ESP	DL-058	Test Event	Error	13 Mar 2018	13 Mar 2018	Acknowledged	DETAILS

- Focused on Well Restoration
- Reduce Deferment
- Track actions taken

EBS Events History (Well Level)

Events

Active Events

Type	Start Time	Assigned To	Details
Pump Intake Pressure High	22 Aug 2019 15:12:55	Sultan AlMahrooqi	DETAILS

Actions

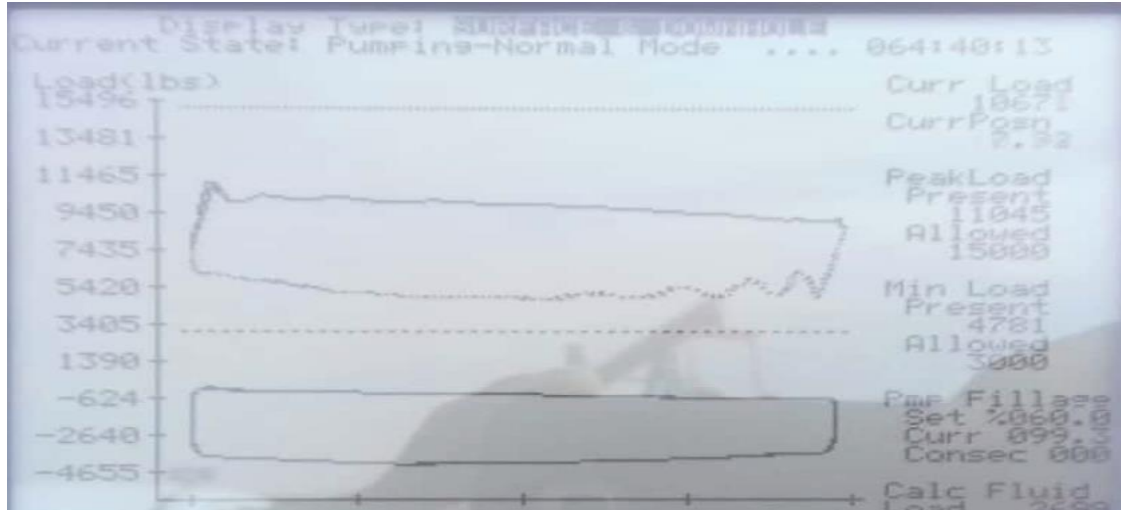
Type	Start Time	End Time	Status	Assigned To	Comments	Details
Pump Intake Pressure High	20 Aug 2019 11:22:54	22 Aug 2019 15:10:10	Closed	Sultan AlMahrooqi	Event timed-out. Closed by Ebs admin.	DETAILS
Pump Intake Pressure High	19 Aug 2019 11:12:51	20 Aug 2019 11:16:05	Closed	Sultan AlMahrooqi	Event timed-out. Closed by Ebs admin.	DETAILS
Pump Intake Pressure High	08 Aug 2019 15:57:44	18 Aug 2019 10:42:02	Closed	Sultan AlMahrooqi	Event timed-out. Closed by Ebs admin.	DETAILS

[REVIEW LIMITS](#)

Beam Pump Dyna Cards

Well Production Surveillance (Beam Pump)

Engineers take Pictures Manually



Beam Pump Panel



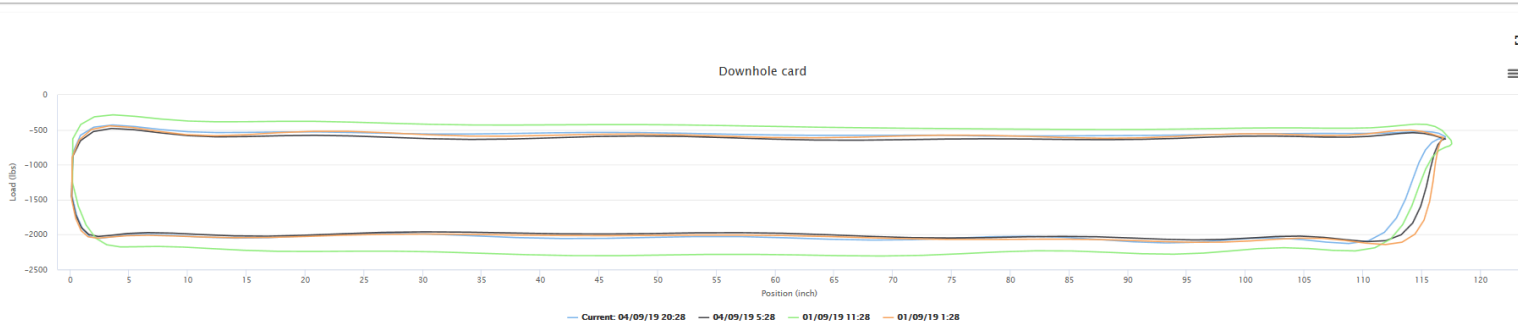
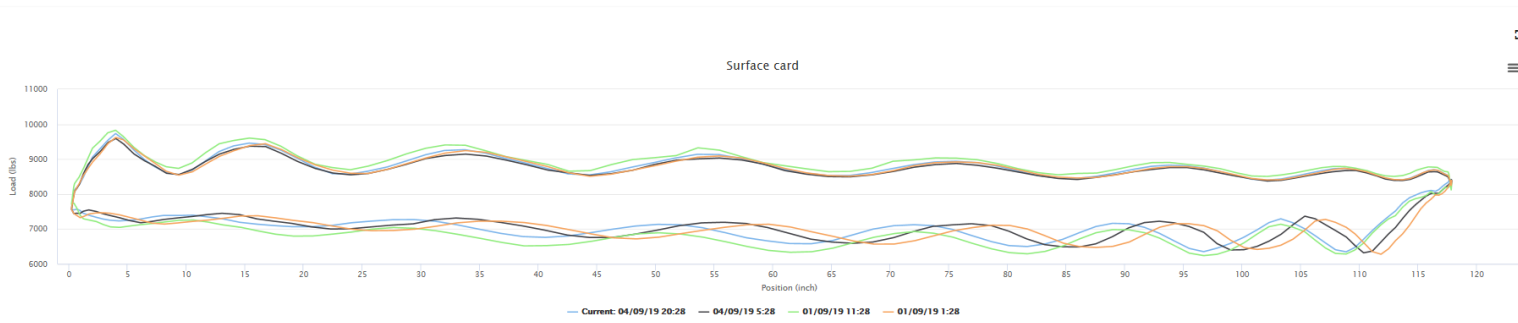
Well Production Surveillance (Beam Pump)

Beam pump dynacard

Add dynacard

01/09/19

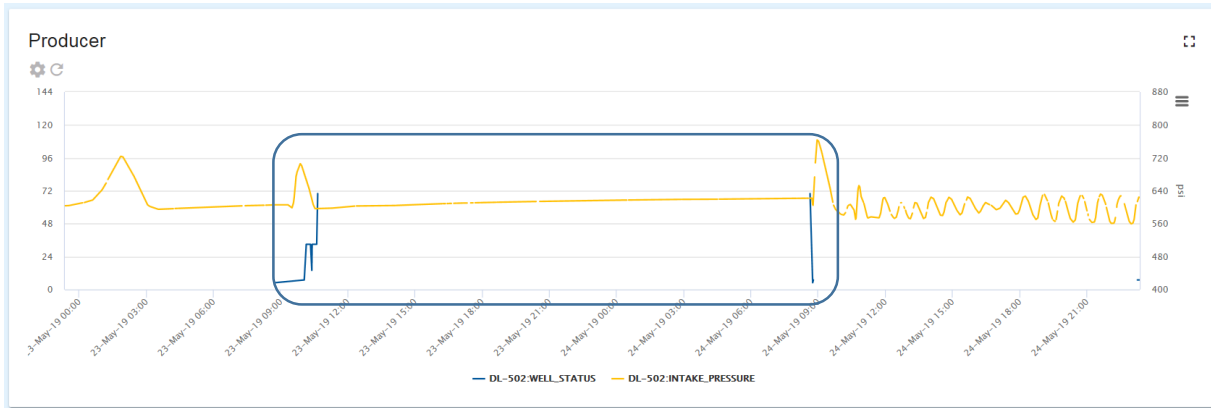
04/09/19 5:28 X 01/09/19 11:28 X 01/09/19 1:28 X



Stroke Length	117.01 inch
Net Stroke	111.82 inch
Max Load	9756 lbs
Min Load	6317 lbs
Load Limit	13000 lbs
Fluid Load	1377 lbs
Pump Fillage	95.56 %
Fillage Limit	0 %
SPM	4.27



Well Production Surveillance (Beam Pump)



- Introduced a new philosophy using Controller Well State codes



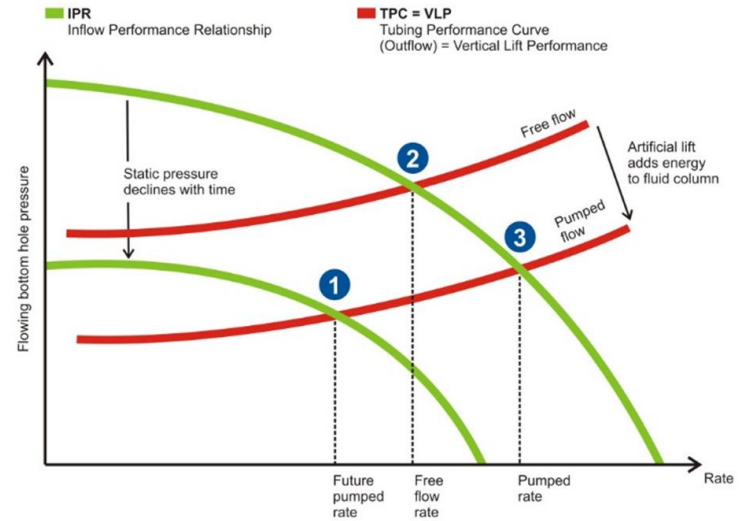
Well State	DL-502_WELL_STATUS	DL-502_INTAKE_PRESSURE
20-28 Stopped	0	~600
27- Valve Check State	1	~600
26- Main Break Diagnostic State	2	~600
25- Normal CP Motor Calibration State	3	~600
24- Stopped	4	~600
23- Disconnector Pump Off Separate State	5	~600
22- Disconnector Malfunction State	6	~600
21- Disconnector Pump Load State	7	~600
20- Disconnector Monitor Load State	8	~600
19- Disconnector DICA Off State	9	~600
18- Disconnector Load State	10	~600
17- Disconnector Pumping Start Position State	11	~600
16- Disconnector Pumping Stop Load State	12	~600
15- Disconnector Low RPM State	13	~600
14- Disconnector Cut Off State	14	~600
13- Disconnector Load Reverse State	15	~600
12- Stopped	16	~600
11- Disconnector Logic Expansion State	17	~600
10- Disconnector Low Speed Load State	18	~600
9- Disconnector Pump Tripper State	19	~600
8- Disconnector Low Reverse State	20	~600
7- Disconnector No Cook State	21	~600
6- Disconnector Pump Energy Demand State	22	~600
5- Disconnector Logic Expansion State	23	~600
4- Disconnector DICA On State	24	~600
3- Disconnector Stop Fault	25	~600
2- Disconnector PIP Control Disabled	26	~600
1- Stopped	27	~600

Real-Time Well Production (Based on Model) (Well Virtual Metering)

Real-Time Data



Well Model



Model Manager

UPLOAD PROSPER MODEL

DOWNLOAD PROSPER MODEL

Model History

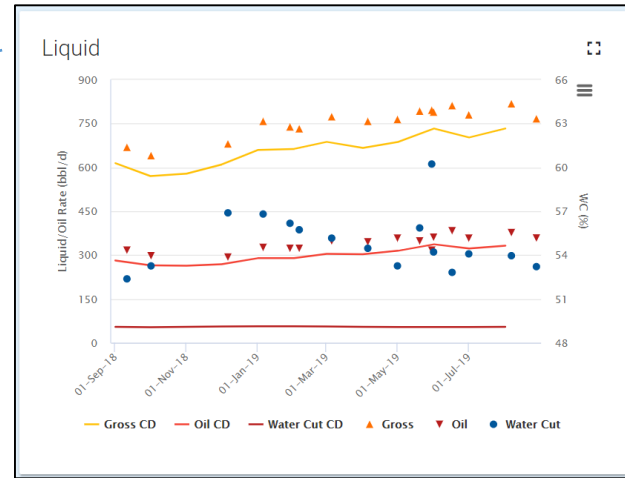
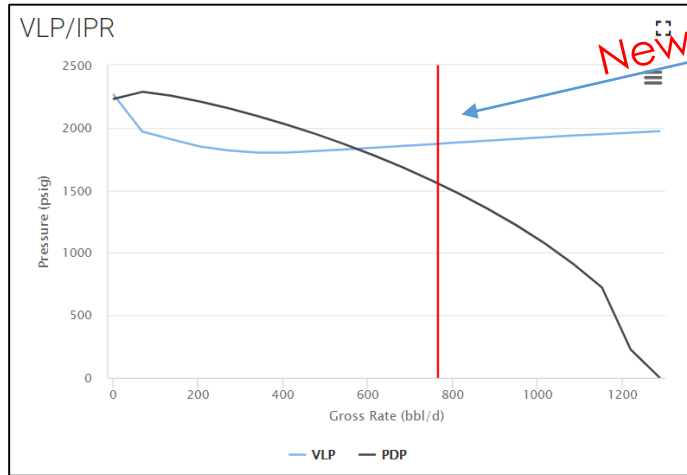
CreatedBy

Muneer Balushi

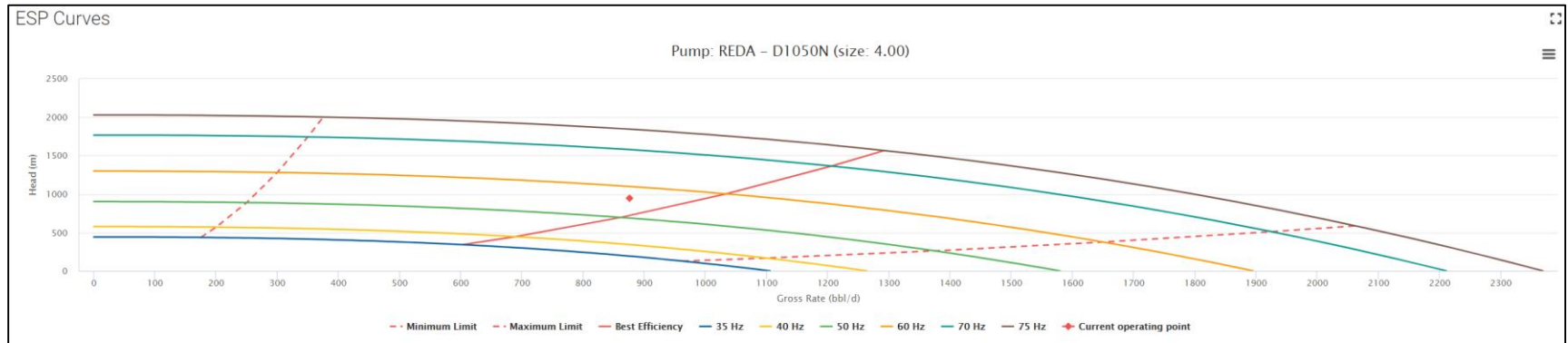
UpdatedTime

02 Jul 2019 8:43:02

Well Mismatch



ESP Pump Curve / Operating Point



Well Model Quick Calibration

Well Test Info

Well	BRE-006
Test Date	02 Sep 2019
Oil Rate	109.94 Bbl/d
Gas Rate	8.13 Mscf/d
Water Rate	510.38 Bbl/d
Liquid Rate	620.32 Bbl/d
GOR	73.95 scf/bbl
WC	82.28 %
WHP	331 psig
Test Status	VALID

Model Info

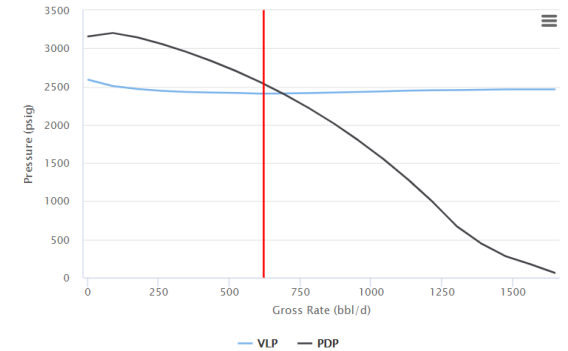
	Original Model	Altered Model
Calculated Liquid Rate (Bbl/d)	687.96	
Liquid Rate rel. Error (%)	10.9	
Reservoir Pressure (psig)	2000	
Productivity Index (bbl/day/psi)	1.19	
Watercut (%)	76	
Gas-oil ratio (scf/STB)	400	
Wear factor (1)	0	

RUN PROSPER

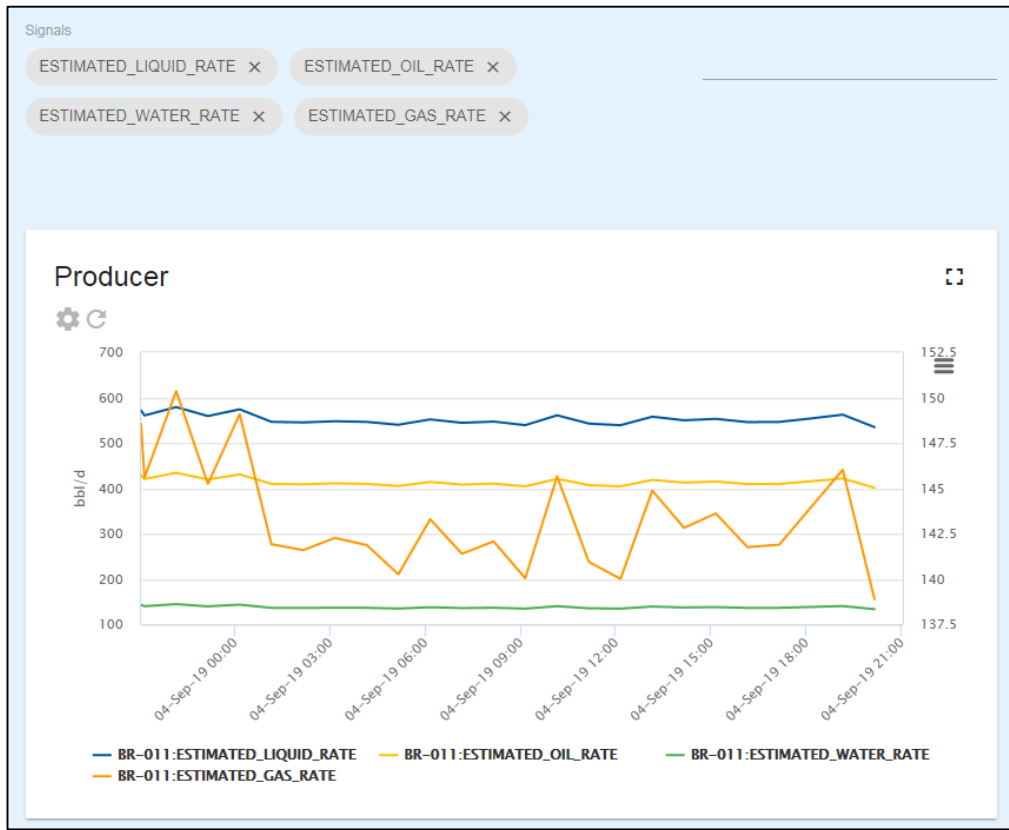
KEEP EXISTING MODEL

ACCEPT ALTERED MODEL

VLP/IPR



Production Estimate based on matched Well Model



ESP/Free Flowing Wells :
Based on Prosper Model

Beam Pump Wells:
Theoretical Formula

$$Q_{liq}(t) = \pi \left(\frac{Pump\ Diameter}{2} \right)^2 * Stroke\ Length * Stretch\ Factor * Fillage * SPM(t)$$

Virtual Metering

Virtual Metering

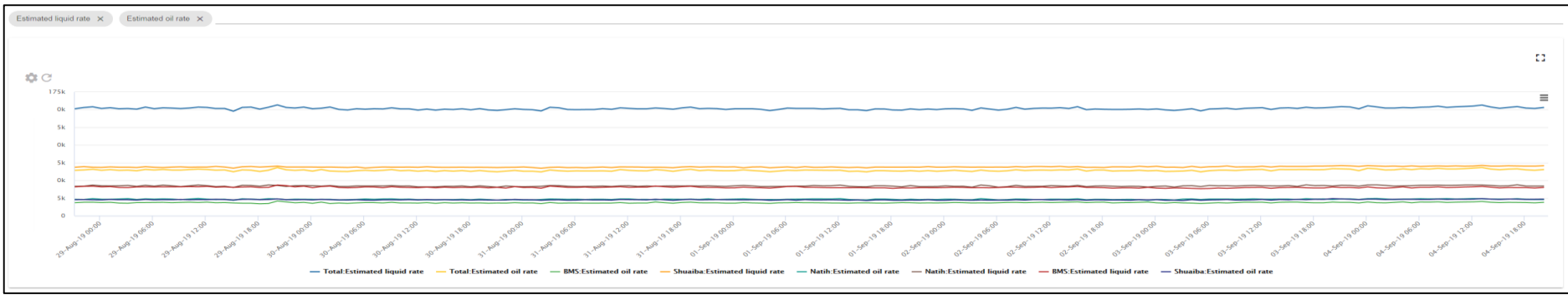
دليل النفط **DALEEL PETROLEUM L.L.C.**
My Actions
Overview
Deferment
Facility
Wells
Well Test
Events
Flares
Virtual Metering
KPI
RTO
Search Assets

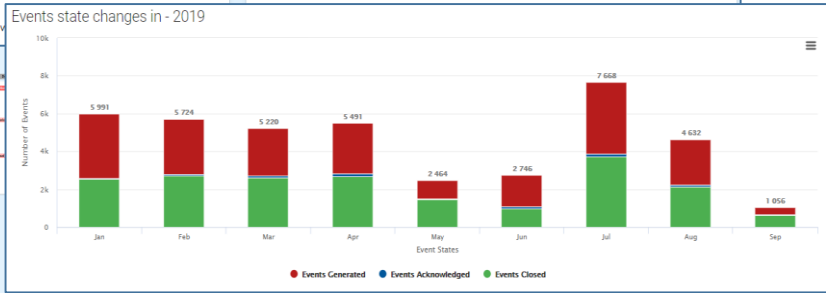
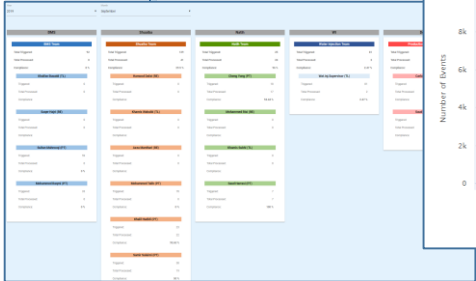
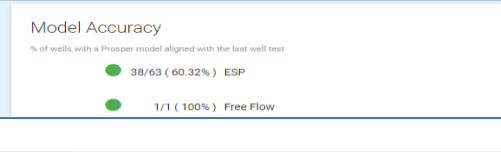
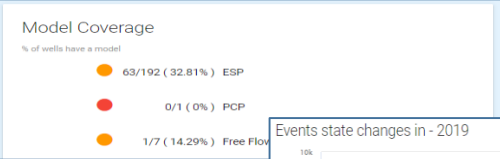
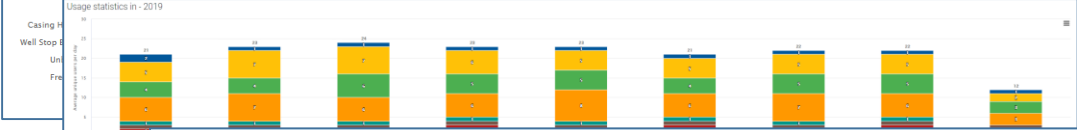
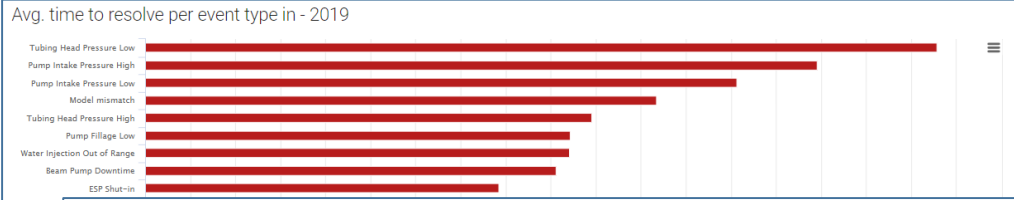
FIELD-BREAKDOWN
FACILITY-BREAKDOWN

Start Date: 28/08/2019 21:06 End Date: 04/09/2019 21:06

All areas

	Estimated liquid rate [bbl/d]	Estimated oil rate [bbl/d]	Estimated water rate [bbl/d]	Estimated gas rate [M scf/d]
Total				
BMS				
Shuaiba				
Natih	42109.58	22915.89	19193.69	3713.76





- Event Analysis
- Portal Usage
- Model Coverage
- EBS Tracking Compliance

Daleel Automation (Now)

Automation Systems

- Execution
- Maintenance



Station A



Gas Plant



Station B



Power Plant



Wells



Export Meter

Daleel's Real-Time Operational Infrastructure



- Production Forecasting
- Full History
- Automated Processes
- Exceptional Based Surveillance
- Production Virtual Metering
- Transparency

Headquarter

- Analysis
- Development
- Decision Making



Implementation Details

Key Design Principles

1. Maximize the use of off-the-shelf products
2. Give control to users
3. Use PI AF as foundation

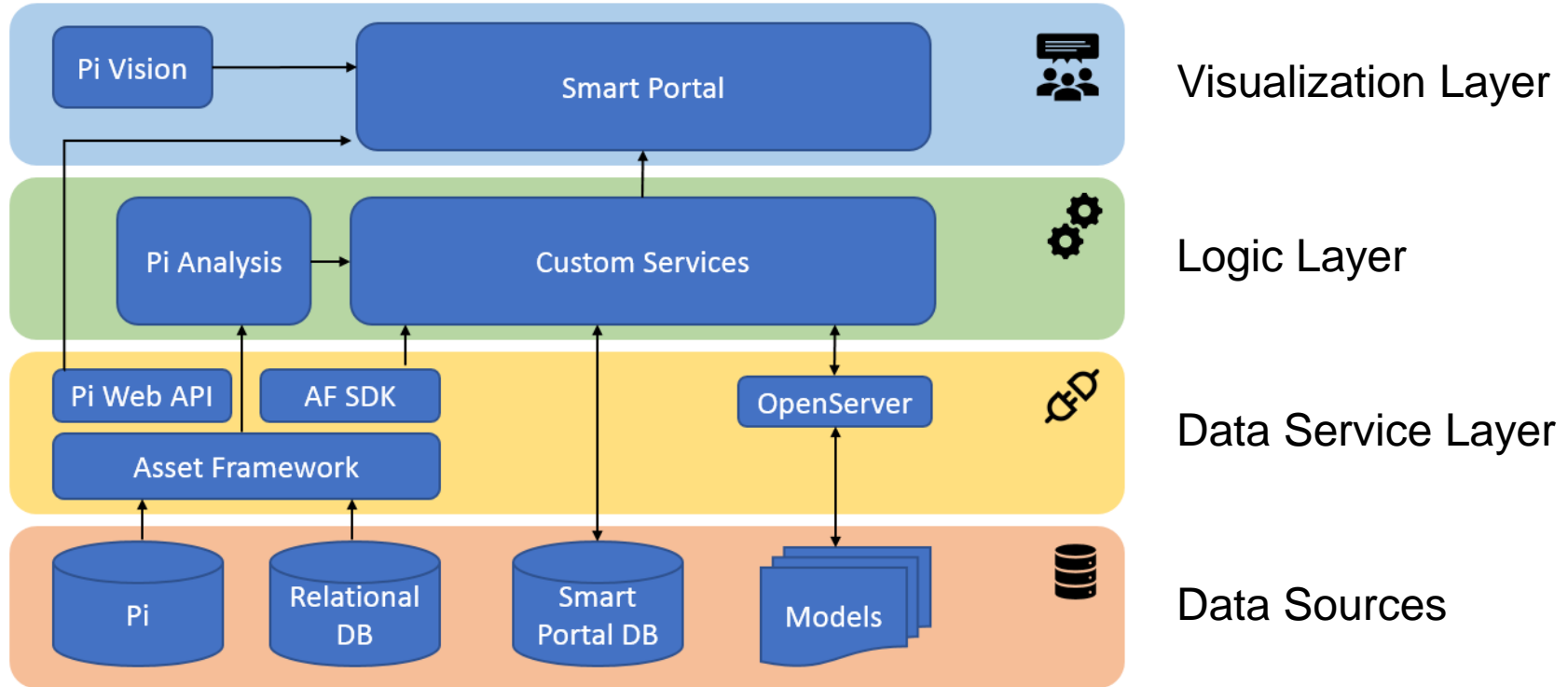
Implementation Details

- Architecture
- Visualization
- Exception Based Surveillance
- Model Integration
- Beam Pump Surveillance

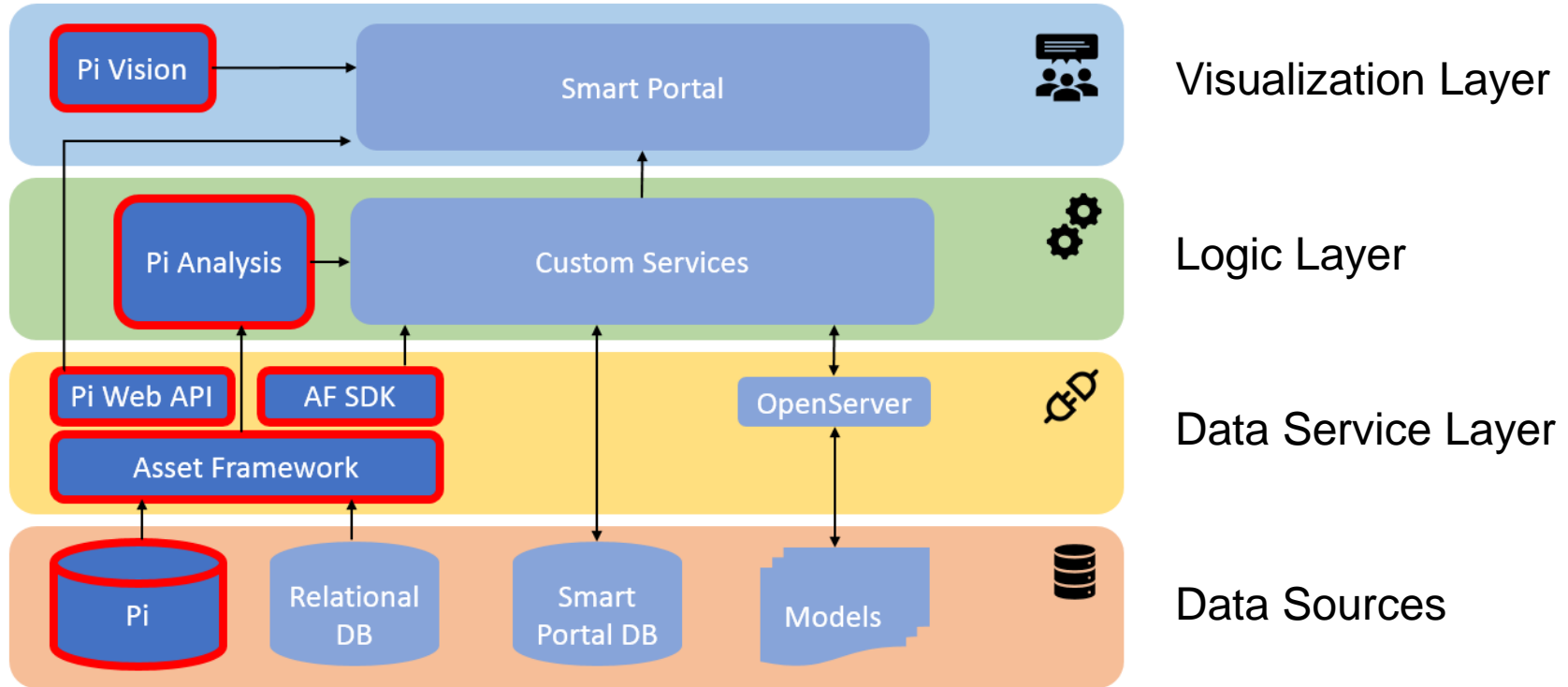
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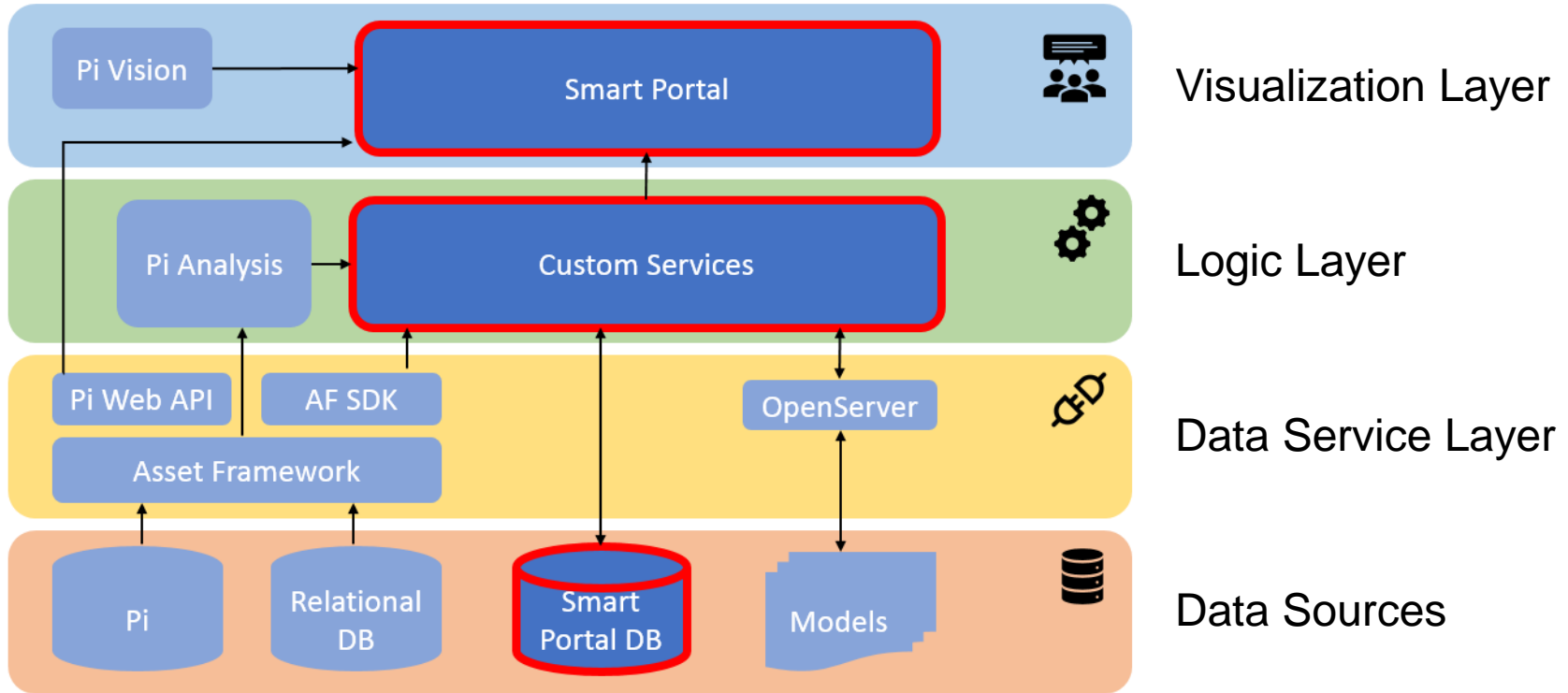
Architecture



Architecture – OSIssoft stack

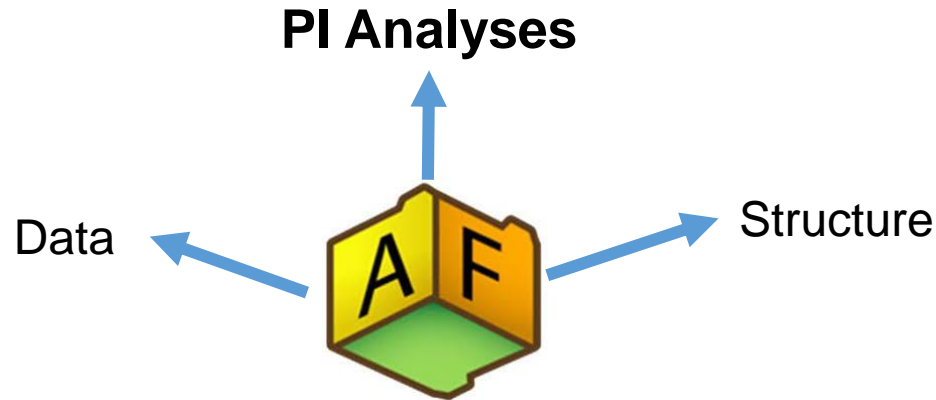


Architecture – Custom stack



PI Asset Framework (AF) as a foundation

Already available in Daleel

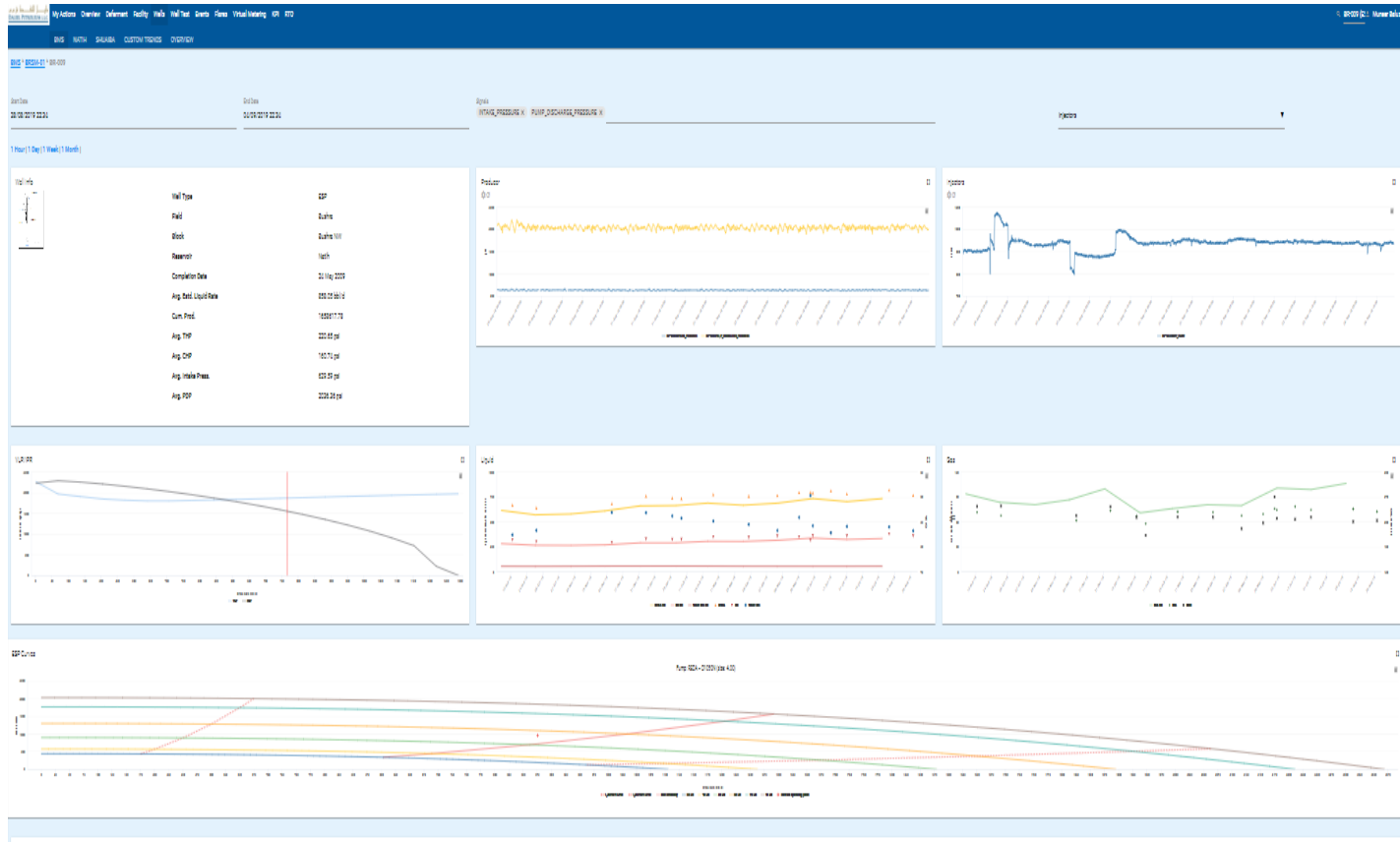


Not just data service, but logic layer

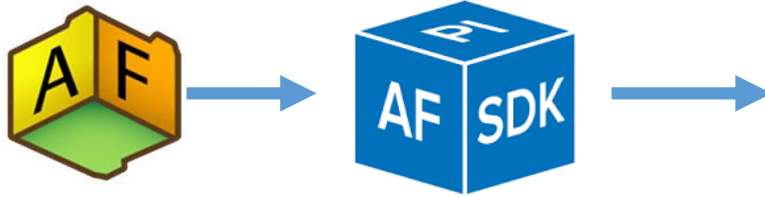
Implementation Details

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- Beam Pump Surveillance

Visualization



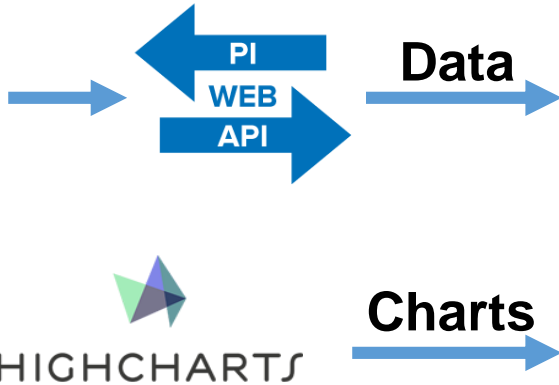
Visualization - Structure



The screenshot shows the BMS interface for DAIHEE PETROLEUM LLC. The interface includes a navigation menu with options like My Actions, Overview, Defermant, Facility, Wells, Well Test, Events, Flares, and KPI. Below the menu, there are tabs for BMS, NATH, SHUJABA, and CUSTOM TRENDS. The main content area is divided into two sections: Oil Manifolds and Water Manifolds. Each section contains a grid of buttons representing different manifolds, with search icons next to each button.

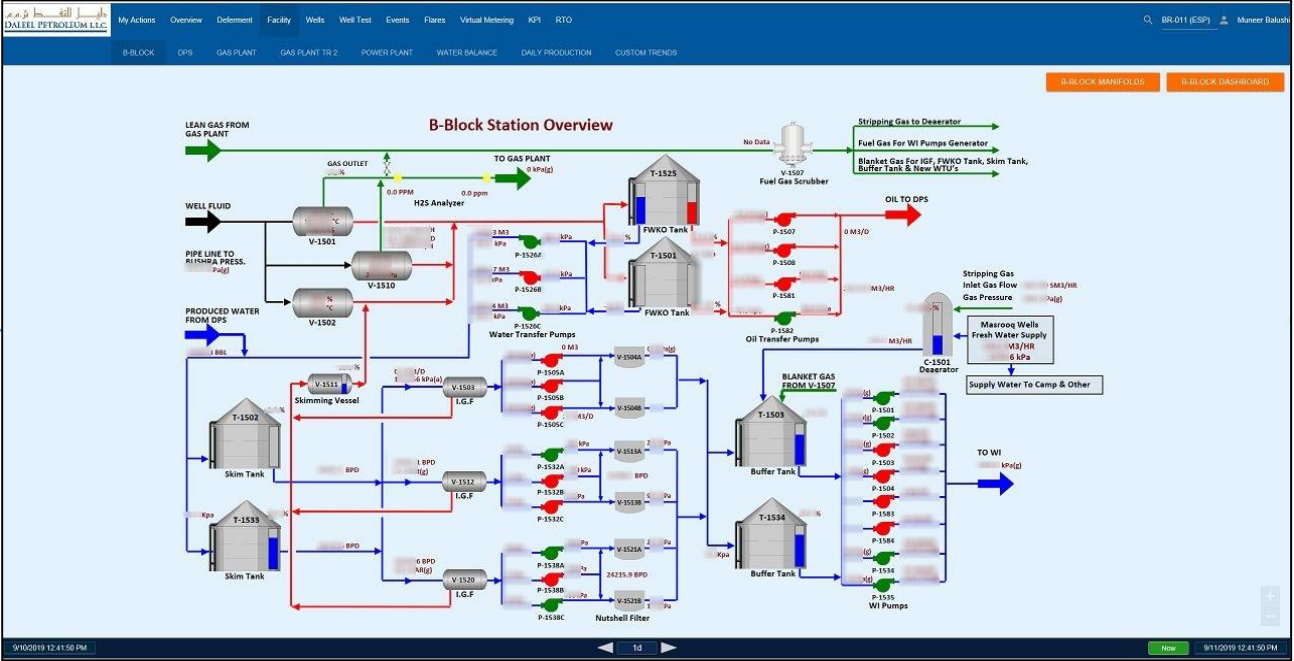
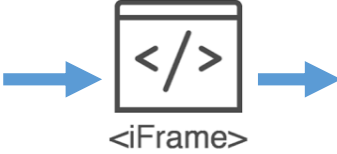
Oil Manifolds		Water Manifolds	
BRSM-01	BRSM-02	BRSM-01WI	BRSM-02WI
BRSM-03	BRSM-04	BRSM-03WI	BRSM-04WI
BRSM-05	BRSM-06	BRSM-05WI	BRSM-06WI
BRSM-07	FLOW BACK TANK	BRSM-07WI	MZSM-02WI
SM-02	SM-39	SM-39WI	

Visualization - Plots



Visualization – Process Schema

PI Vision



Implementation Details

- Architecture
- Visualization
- Exception Based Surveillance
- Model Integration
- Beam Pump Surveillance

Exception Based Surveillance (EBS)

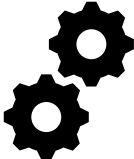
- Reactive surveillance
- Large well count and remote operations
- Capture events in real time
- Precise assignments to engineers

Exception Based Surveillance (EBS)

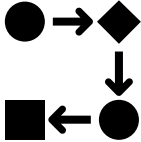
Real-Time Data



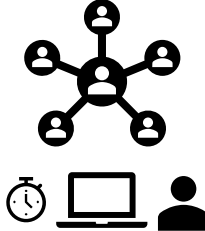
PI Analyses



Event Manager



Smart Portal



Custom developed

Exception Based Surveillance (EBS)

- PI Analyses
 - Out-of-the-box functionality
 - Perfect for real-time processing
 - Empowers the users
- Event Manager
 - Highly configurable
 - Ensures follow-up
 - Builds knowledge base

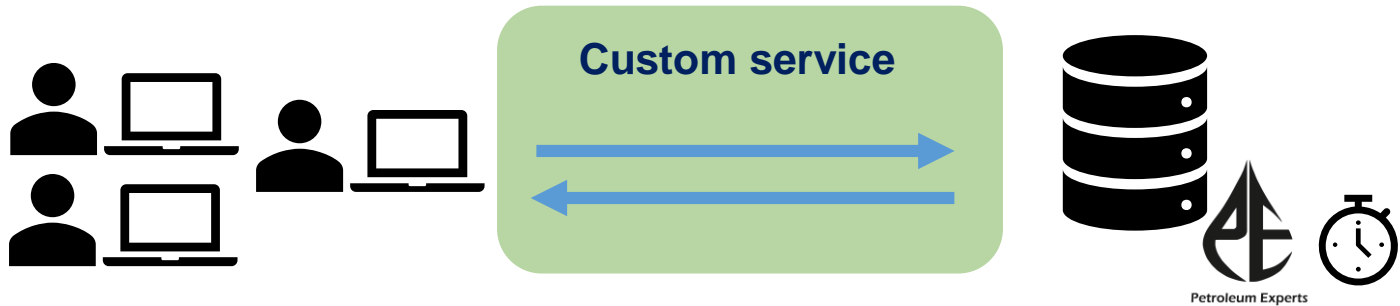


Implementation Details

- Architecture
- Visualization
- Exception Based Surveillance
- **Model Integration**
- Beam Pump Surveillance

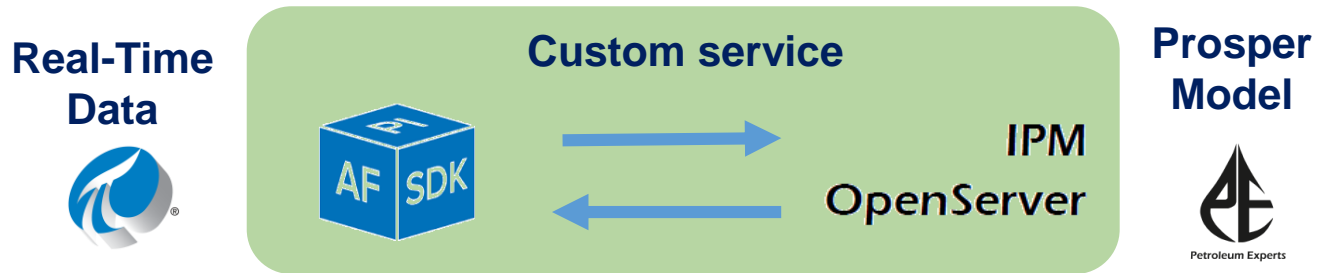
Model Integration

- Model Manager
 - Store models in the Smart Portal
 - Upload/download
 - Records history
 - Distribute



Model Integration

- Automated workflows
 - Connect real time data to models
 - Use existing API's
 - Run automatically
 - Store results in PI

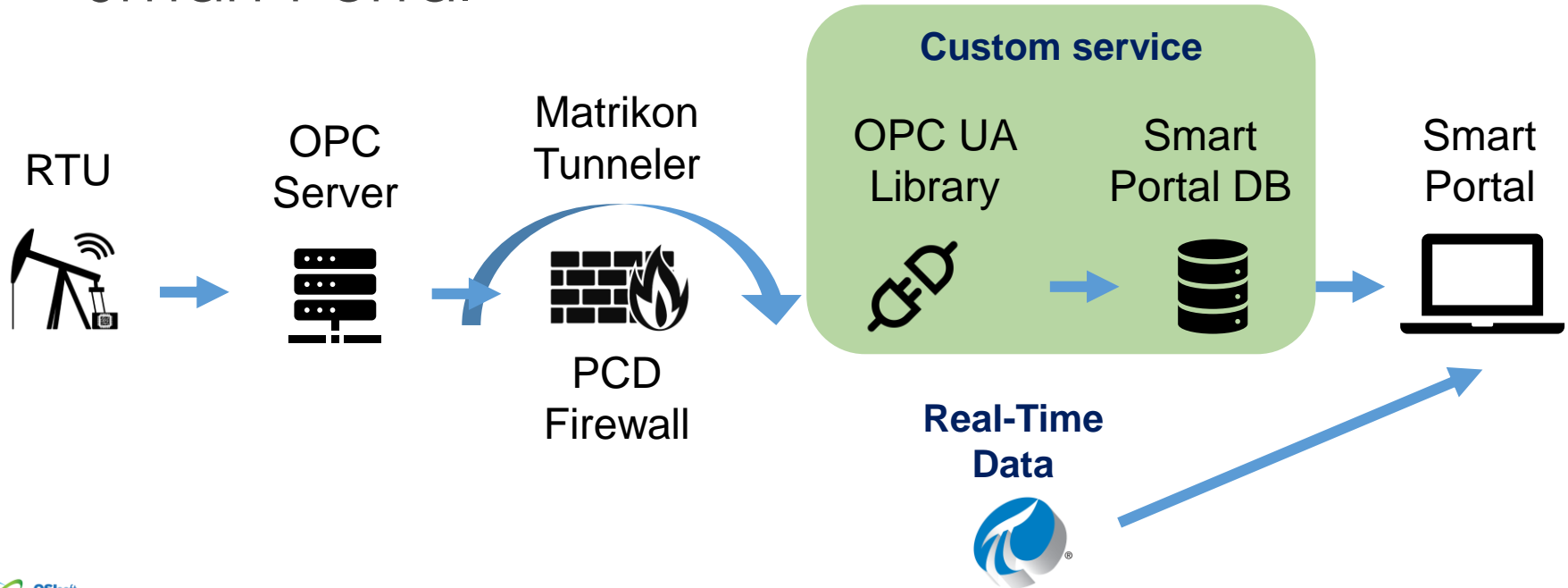


Implementation Details

- Architecture
- Visualization
- Exception Based Surveillance
- Model Integration
- Beam Pump Surveillance

Beam Pump Surveillance

- Streaming data from the controller to the Smart Portal



Benefits / Conclusions

Benefits

➤ Direct Impact

- Reduced the average monthly Beam Pump wells deferment by 2,000 BBL (1.4 Mil \$)
- Improved Deferment booking by 1% (Allocation from 0.90 to 0.91)

➤ Expected Impact

- Increase the NFA (No Further Action) Wells Production by focused optimizations (Using EBS/Virtual metering/Dyna Cards)
- Increase Beam Pump wells production efficiency by 10% +

Conclusion

- OSIssoft provided the building blocks for Daleel “Real-Time infrastructure”
- Asset Framework (AF) can enable your Surveillance by Exception (EBS)
- PI Tools integration with well models can enable Virtual Metering

Presenters



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- IPCOS
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Questions?

Please wait for
the **microphone**

State your
name & company



Please remember to...

Complete Survey!

Navigate to this session in
mobile agenda for survey

An advertisement for the OSISOFT PIWorld app. The background is a dark blue gradient with a subtle pattern. On the left, the text "TO DOWNLOAD APP, SEARCH OSISOFT" is written in white, bold, sans-serif font. Below this text are two black buttons: "Download on the App Store" with the Apple logo and "GET IT ON Google Play" with the Google Play logo. On the right, a smartphone is shown vertically, displaying the OSISOFT PIWorld logo on its screen. The logo consists of a stylized white atom symbol above the text "OSISOFT PIWorld" in white.

謝謝 KEA LEBOHA
 DZIĘKUJĘ CI TAPADH LEIBH 고맙습니다
 NGIYABONGA БАЯРЛАЛАА MISAOTRA ANAO
 TEŞEKKÜR EDERIM OBRIGADO شڪرا
 DANKIE TERIMA KASIH GRACIES DANKON TANK TAPADH LEAT SALAMAT
 KÖSZÖNÖM SPASIBO MULTUMESC
 PAKMET CIZGE OSIssoft.
 GO RAIBH MAITH AGAT PIWorld
 БЛАГОДАРЯ GRACIAS HVALA FAAFETAI
 ТИ БЛАГОДАРАМ МАНАДСАНИД HVALA ХВАЛА ВАМ
 TEŞEKKÜR EDERIM
 DANK JE EΥΧΑΡΙΣΤΩ GRATIAS TIBI GRAZIE
 AČIŪ SALAMAT MAHALO IĀ 'ŌE TAKK SKALDU HA ДЗЯКУЙ
 RAHMAT MERCI DI OU MÈSI
 HATUR NUHUN GRAZZI ПАККА ПÈR ǃAKUJEM
 PAXMAT CAĠA FALEMINDERIT ありがとうございました MATUR NUWUN
 SIPAS JI WERE TERIMA KASIH
 CẢM ƠN BẠN UA TSAUG RAU KOJ
 WAZVIITA ТИ БЛАГОДАРАМ
 СИПОС