Less Footprints in the Snow for Salym Field in Western Siberia

SPE Moscow Section October 12th 2010

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Salym Petroleum Development

Outline

- Salym field and infrastructure overview
- Salym RTO/M (Real Time Operations and Monitoring) – Overview
- Management of change
- Resulting benefits

Salym Smart Fields Foundation Mark 1 Project Overview and Status to date

The Salym Smart Field project vision is that the Salym teams will have the information, workflows, tools and capabilities to continuously optimise the Salym fields – in the short term for production, and in the long term for lifecycle values.

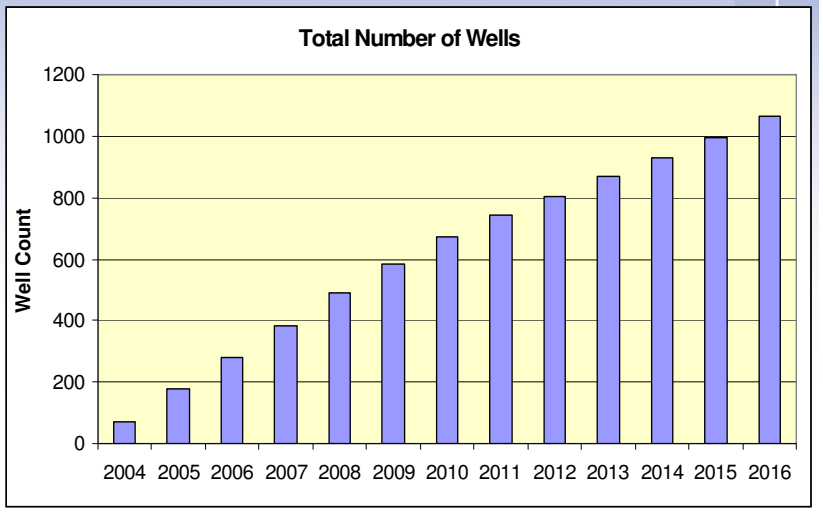
..... the 1950's..reading a wellhead pressure..we're a lot smarter..and safer now!.

Location


Salym Infrastructure
West Salym
Vadelyp
Upper-Salym
Salym

Salym Field Overview

- Field Overview
  - •170,000 b/d, API 31, 30% water cut
  - • 500+ wells directionally drilled from 30 pads (1000 wells by 2015)
  - • 80% producers, 20% water injectors
  - • All well artificially lifted using ESP's



- ESP's
  - • Remote/local ESP speed adjustment
  - • Surface choke – remote/local control
  - • Pressure/temp trasmitters (THP, THT, BHP, BHT)
  - • ESP frequency, volts, amps, power, power factor, load, vibration, intake pressures
  - • Mikon Automatic echo transmitters - casing liquid level

Salym Field Overview Continued

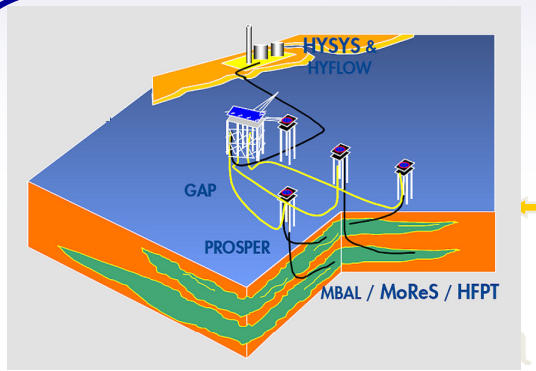
- Water Injection
  - Surface choke – remote/local control
  - Real time flow, pressure, temperature transmitters (Q, THP, THT)
- Surface Production
  - Real time bulk oil, gas, water flow, levels, pressure transmitters
  - Remote/Automatic test separator

Smart Fields Foundation Mark I

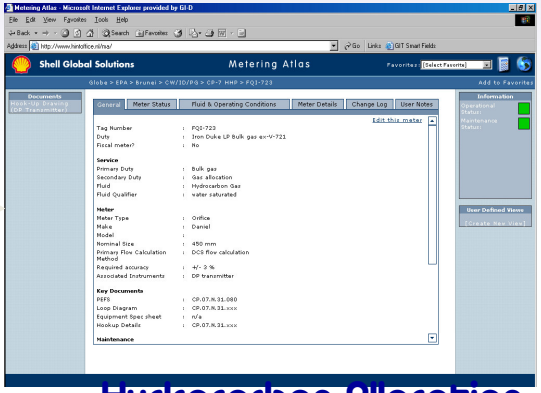
Hydrocarbon Development Planning

Well and Reservoir Management

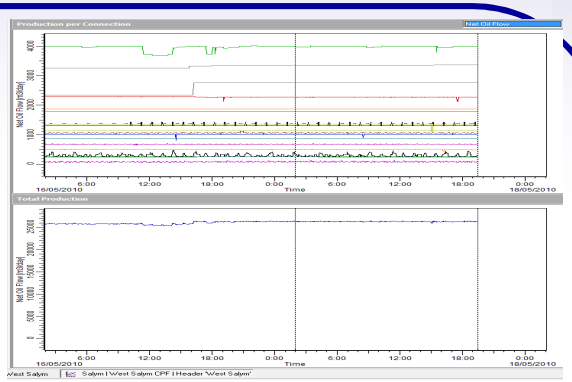
Surveillance



Integrated Production System Modelling (IPM + IFM suite)



Hydrocarbon Allocation (Energy Components/OIS)



Well Production Monitoring (Fieldware Production Universe)

Data Management

IT Architecture

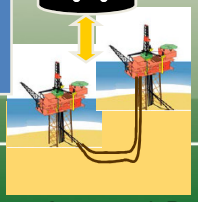
PI Historian

DACA

Office

Field

PI



Process Control Domain

Application

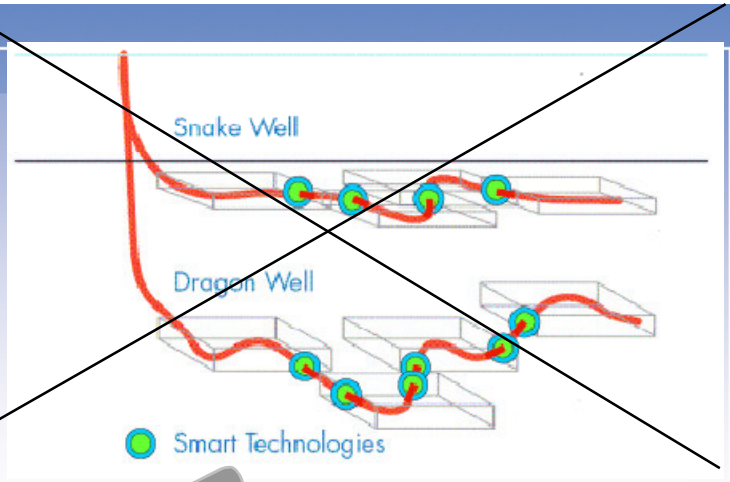
- Well Production and injection Monitoring
- Well Test and Production Data Gathering
- Hydrocarbon Allocation
- Production System Optimisation
- Forecasting (short/medium term)
- Enabler for WRM, Surveillance, HDP

ESP and Well Test Data Gathering (FieldWare WellTest/ESP)

Foundation

What is Smart Fields Foundation?

- What it isn't….
  - – Smart wells
  - – A bunch of Software projects
- What it is…



Technology and Tools

Fieldware Production Universe:

Well monitoring (RTM) & optimisation (RTO)

Fieldware Well Test & Fieldware E

•Well test validation and transfer of data

•ESP performance monitoring, optimisation and transfer of data

Energy Components:

Hydrocarbon allocation and reporting

IPSM / IFM

Production system modelling

"Dual" PI

Greater uptime and data security

DACA Security

Secure link between OD & PCD, procedures

INTEGRATED

5 Business Processes

Well Testing/data gathering

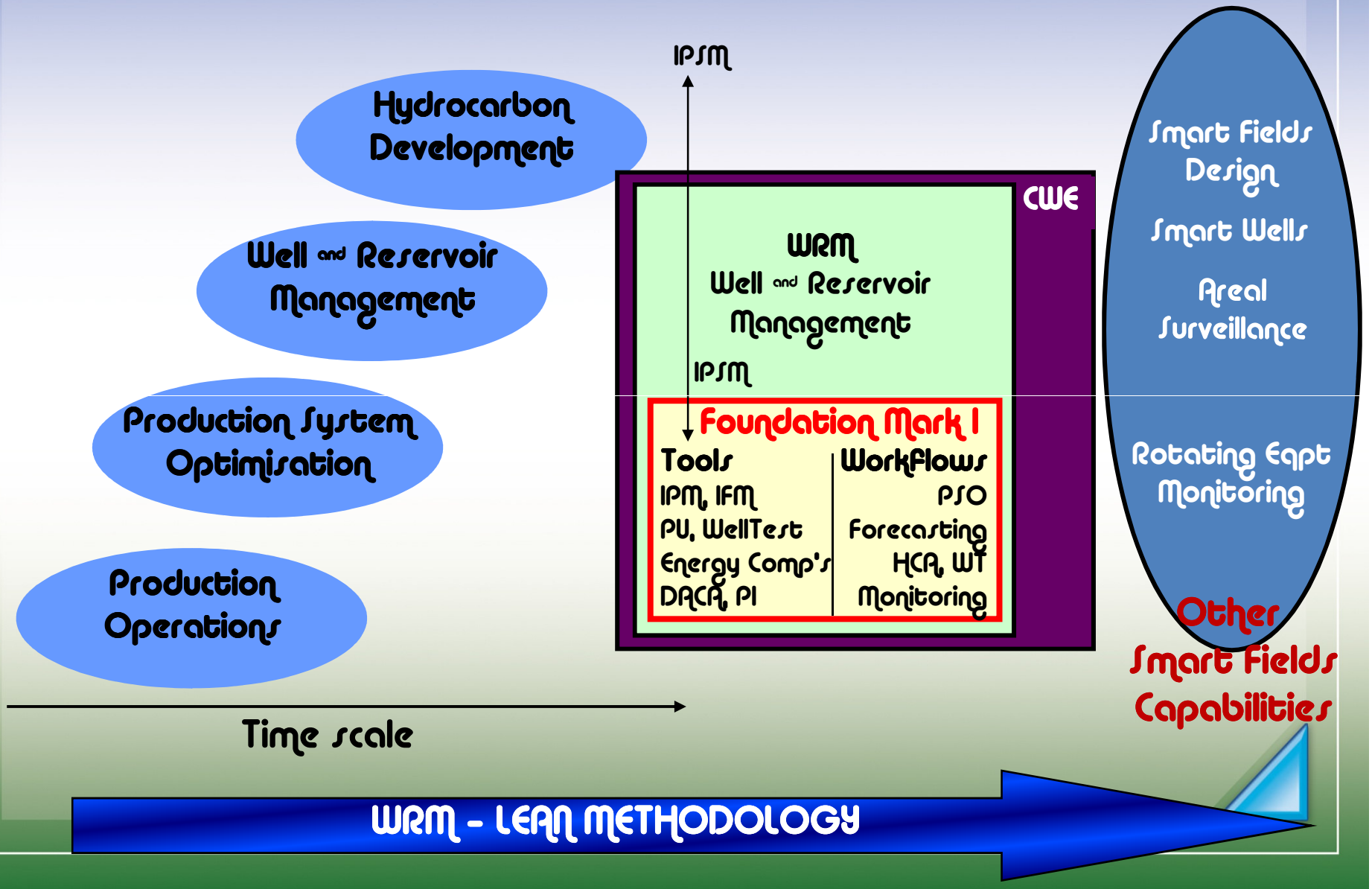
Well Production Monitoring

Hydrocarbon Allocation

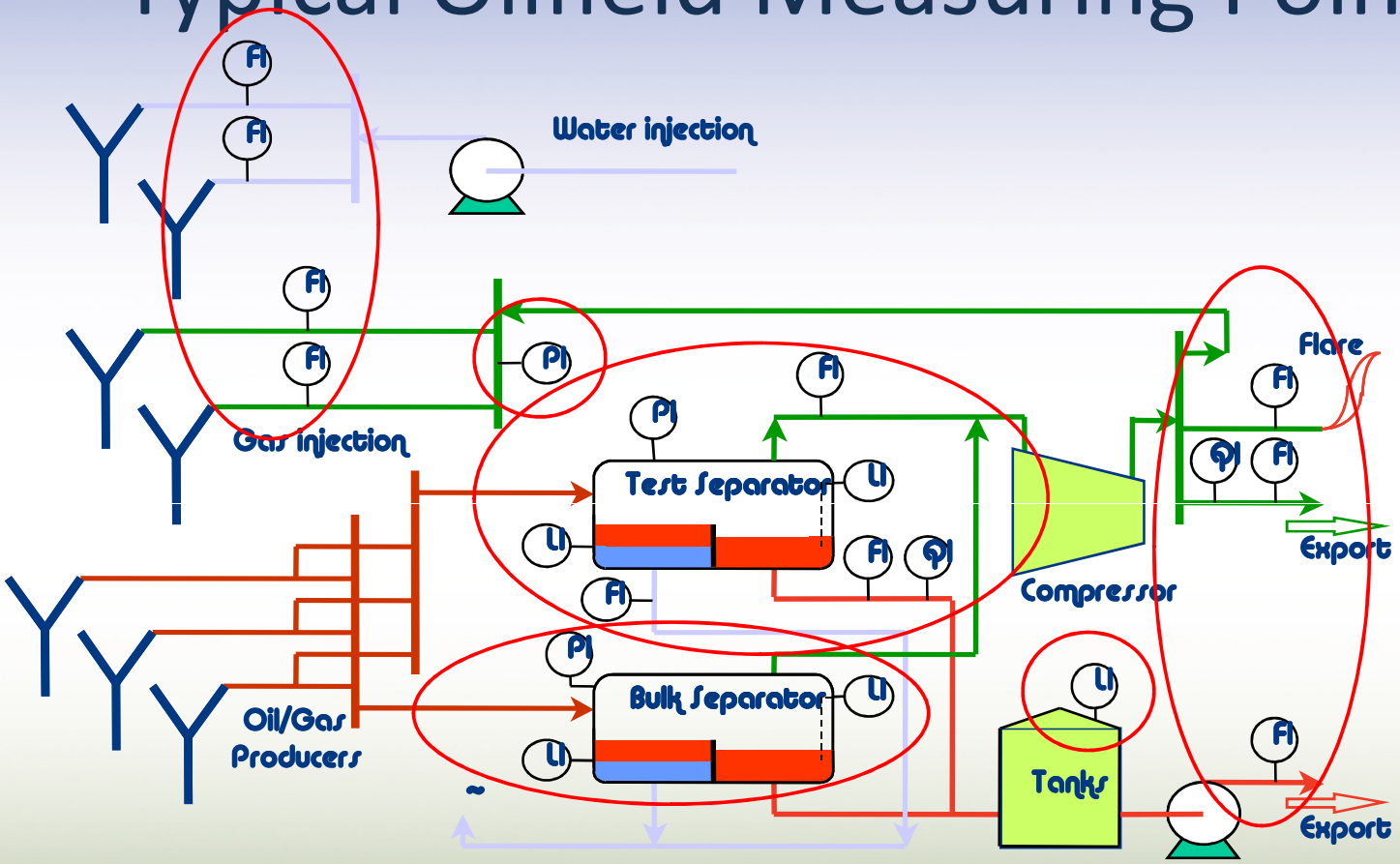
Production System Optimisation (PSO)

Production Forecasting (Short/Medium)

Foundation, WRM and Smart Fields



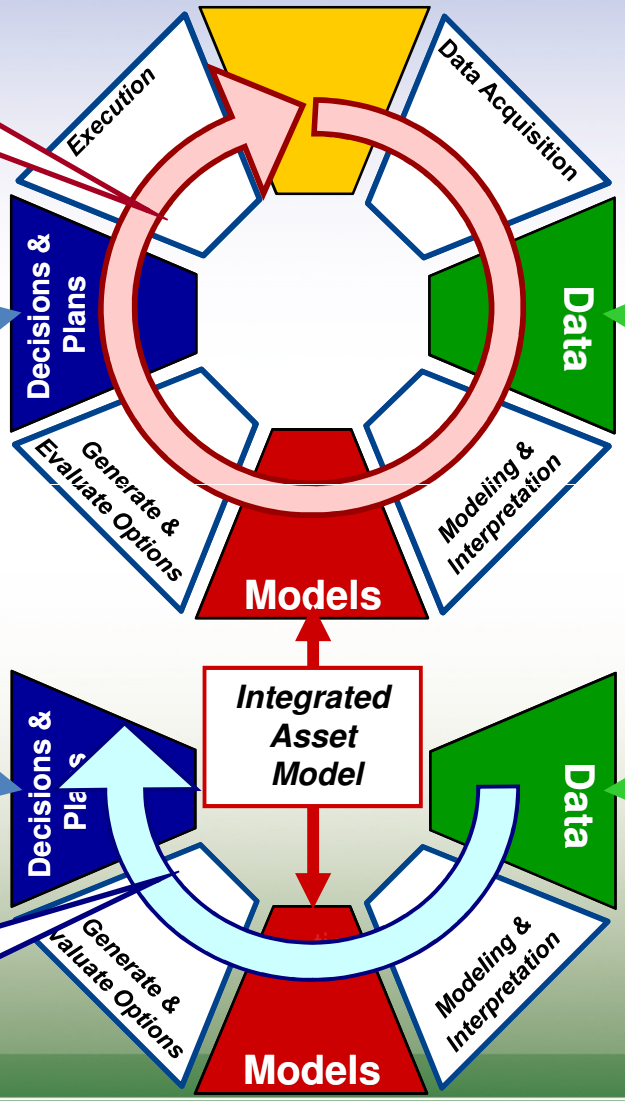
Typical Oilfield Measuring Points



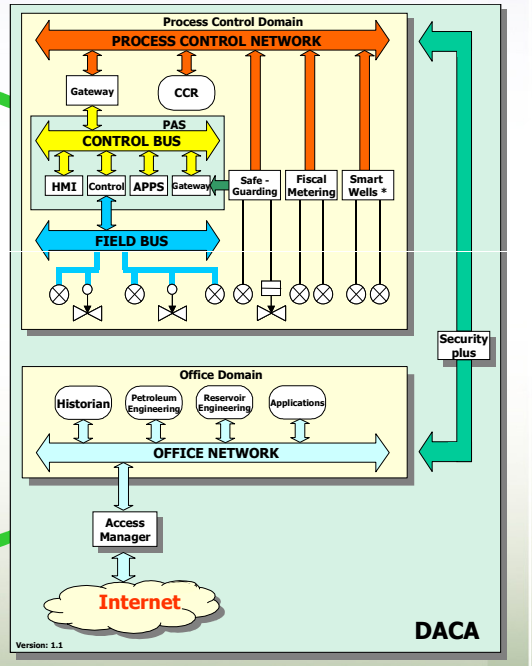
- Between the well bore and sales point we generate data from pressure sensors, temperature probes, flow instruments, position switches etc.
- To successfully extract benefit from this information we need to capture it and use it.

Linking the Real Time (RTO/M) to the Right Time (WRM) Domain

Real Time
Production Ops.
'Monitoring and Optimisation'



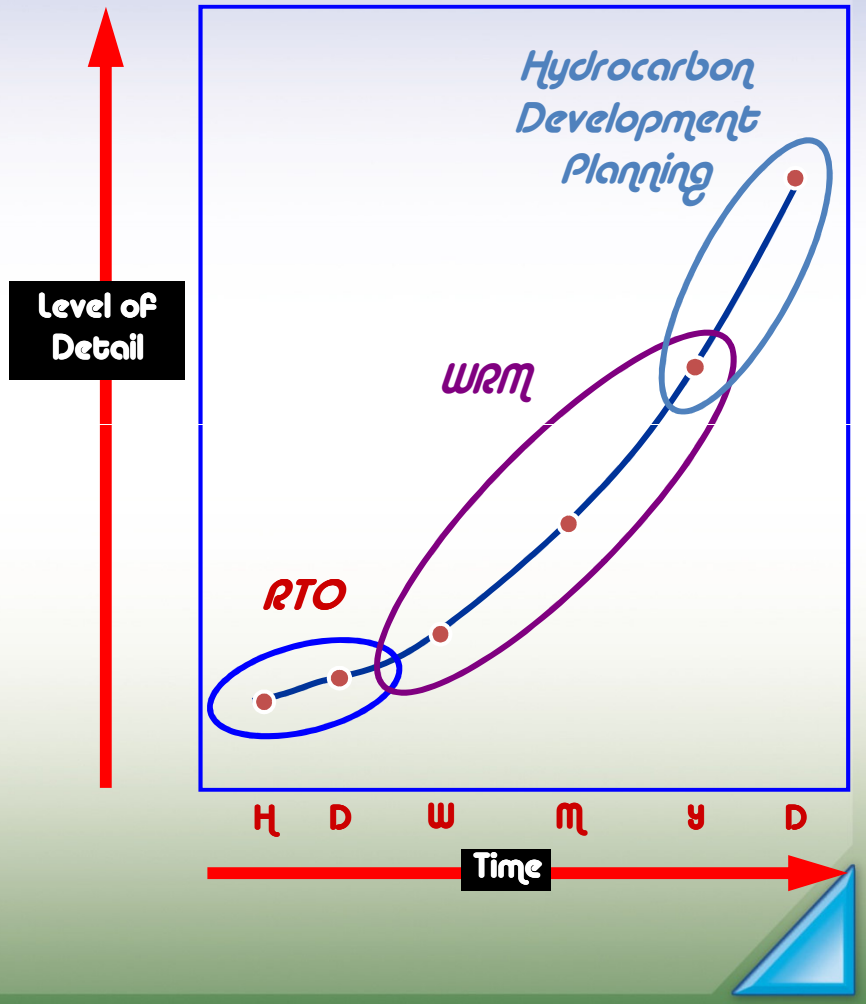
Data Acquisition & Control Architecture



Right Time
Well and Reservoir Management (PE/Ops)

Smart Fields RTO/M – WRM the Fast Way

- Smart Fields Real Time Operations is based on the WRM value loop concept – we measure, model, decide and implement.
- The time domain in which RTO completes this cycle is in minutes/ hours instead of days/months.
- Advances in IT and modelling mean the time domains get shorter. This improvement in technology provides opportunities for RTO applications.
- For example ESP frequencies change for optimisation in Salym Fields now take place on seconds/minutes basis instead of daily/weekly.



SPD Smart Fields Technology Implementation

100% of total Salym production & injection streams are connected to SF systems

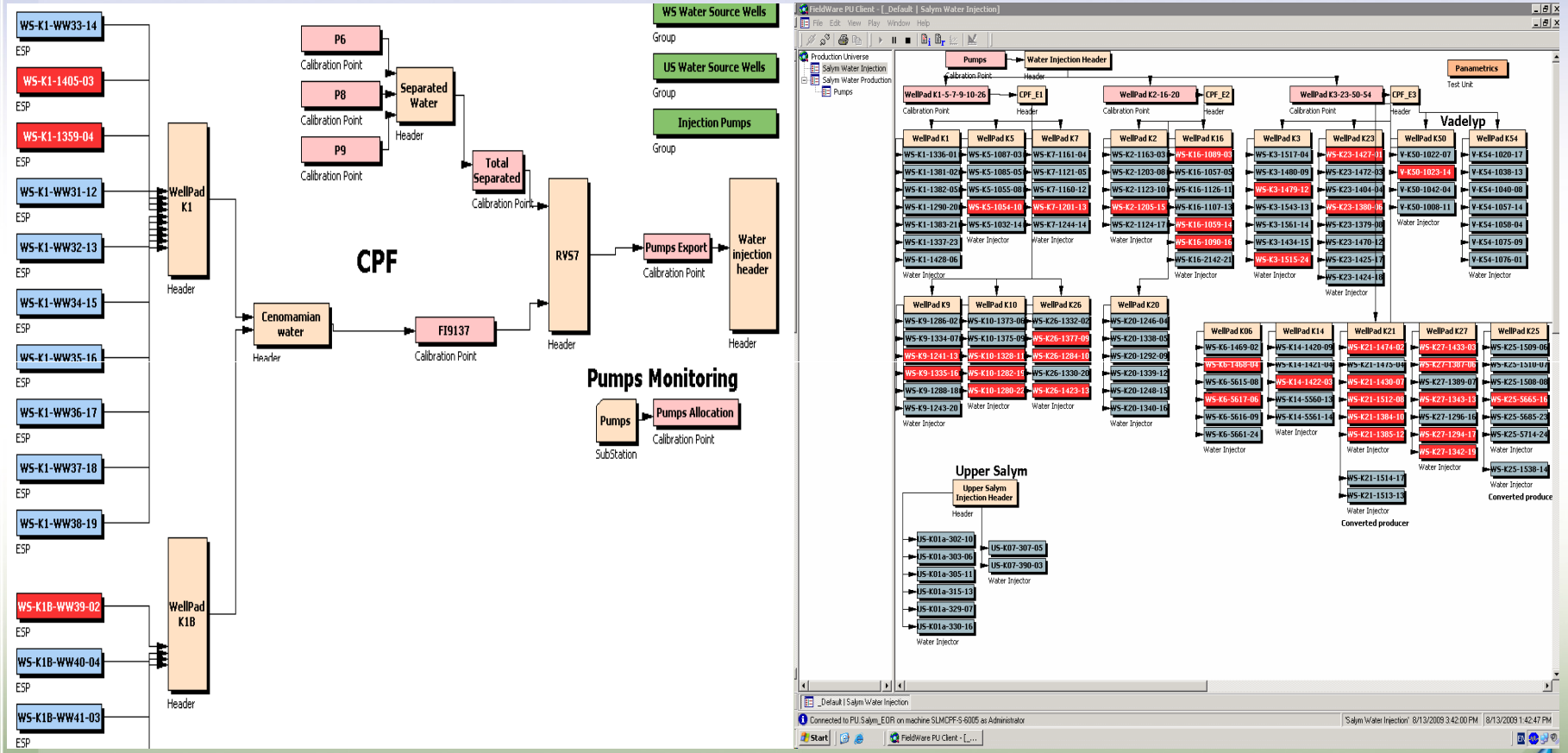
Salym Fieldware Production Universe - **FW PU** has been deployed on a total of 30 pads in West Salym, all Upper Salym and Vadelyp fields (100% of total producing wells). This enables real time operations and monitoring (RTO/M) on all producing wells (350+ wells). This is 100% of total Salym fields net oil production connected to SF RTM system.

Salym Fieldware Water Management - **FW EOR** is operational on all water source wells in West and Upper Salym fields (15 wells in total) and on all Salym fields well pads covering ~160 well injectors field wide (100%). The technology enables real time monitoring of surface vessels levels, surface pumps and wells injection pressures and rates.The technology enables real time monitoring of surface vessels levels, surface pumps and wells injection pressures and rates.

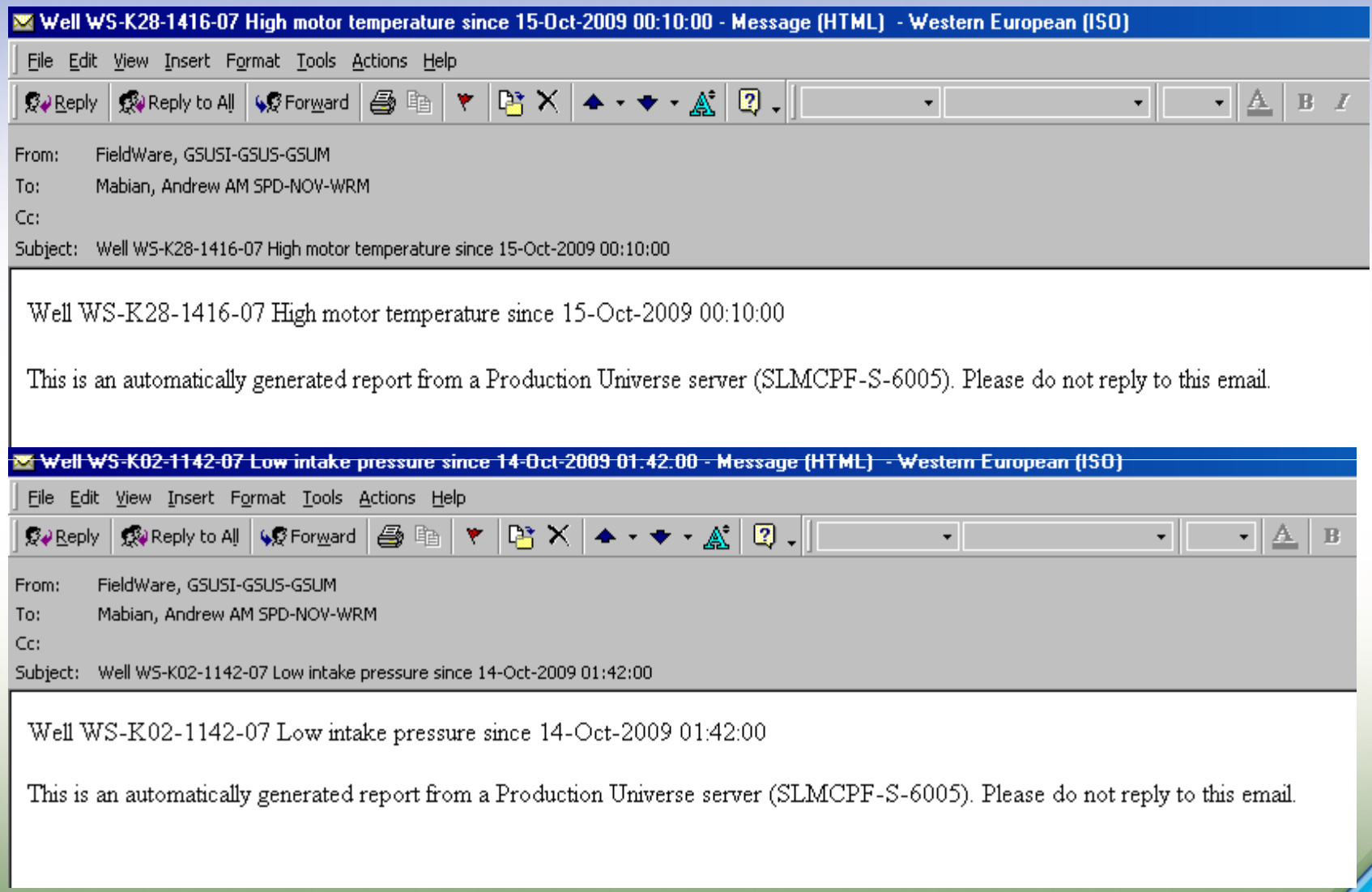
Salym Fieldware ESP - **FW ESP** - deployed on 350+ producing wells and water supply wells, enabling real time production/water supply operations, optimisation, surveillance with remote ESP frequencies changes, remote "stop/start" execution in a controlled manner. This is 100% of Salym wells equipped with ESP's (Producers and water suply wells)

Salym Fieldware Well Test - **FW WT** - deployed on 350+ producing wells (30 pads) enabling real time well test measurements screening, troubleshooting and automatic transfer of test data to the hydrocarbon accounting system.

Water Management – FW EOR Example



FW_Automatic Notification



Well WS-K28-1416-07 High motor temperature since 15-Oct-2009 00:10:00 - Message (HTML) - Western European (ISO)

File Edit View Insert Format Tools Actions Help

Reply | Reply to All | Forward

From: FieldWare, GSUSI-GSUS-GSUM
To: Mabian, Andrew AM SPD-NOV-WRM
Cc:
Subject: Well WS-K28-1416-07 High motor temperature since 15-Oct-2009 00:10:00

Well WS-K28-1416-07 High motor temperature since 15-Oct-2009 00:10:00

This is an automatically generated report from a Production Universe server (SLMCPF-S-6005). Please do not reply to this email.

Well WS-K02-1142-07 Low intake pressure since 14-Oct-2009 01:42:00 - Message (HTML) - Western European (ISO)

File Edit View Insert Format Tools Actions Help

Reply | Reply to All | Forward

From: FieldWare, GSUSI-GSUS-GSUM
To: Mabian, Andrew AM SPD-NOV-WRM
Cc:
Subject: Well WS-K02-1142-07 Low intake pressure since 14-Oct-2009 01:42:00

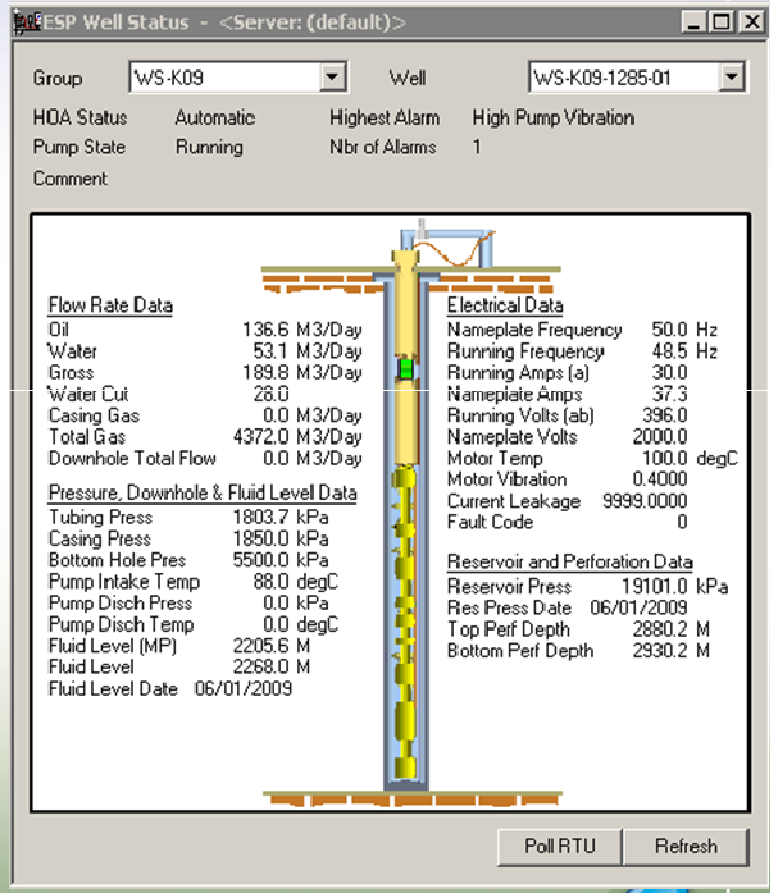
Well WS-K02-1142-07 Low intake pressure since 14-Oct-2009 01:42:00

This is an automatically generated report from a Production Universe server (SLMCPF-S-6005). Please do not reply to this email.

FW ESP on 350+ Salym wells

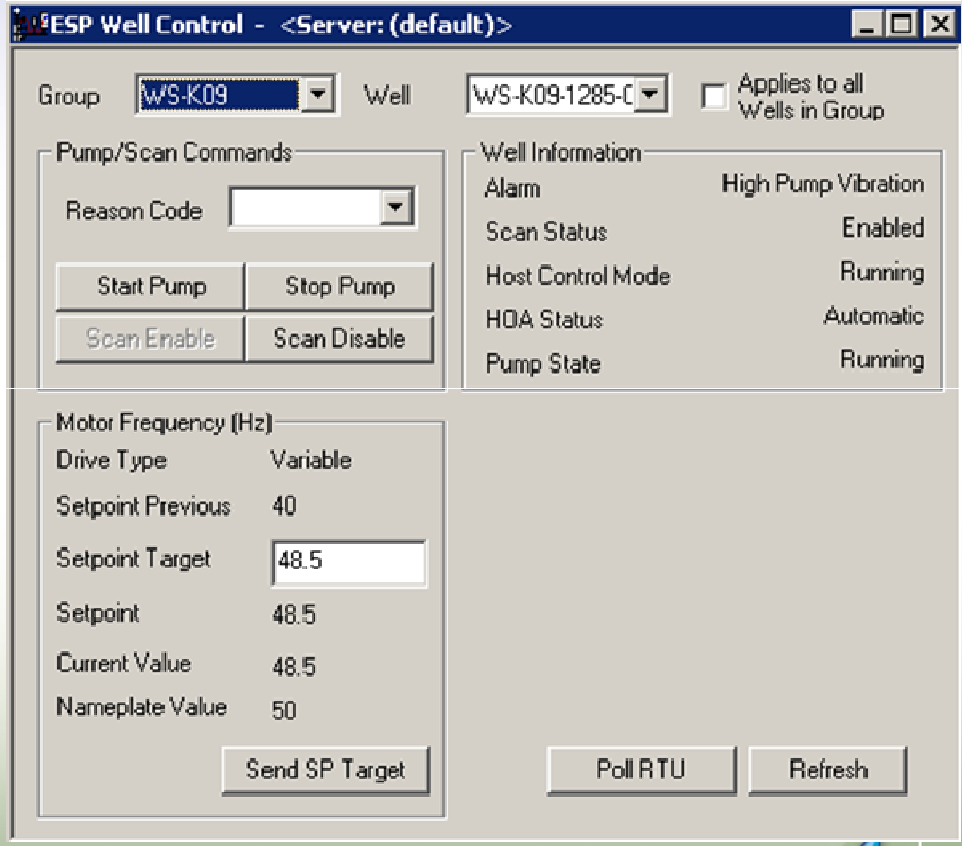
Real time software application providing:

- Continuous ESP surveillance and control
- Describes well/pump assembly - casing/ tubing dimensions, deviation, depth, mechanical/completion details, fluid properties, pressures, pump parameters, motor/motor controller details
- PU gives continuous pump flow rates for surveillance/optimization
- Rates may also be obtained from well testing - may be out-of- date and potentially misleading especially if well testing is infrequent



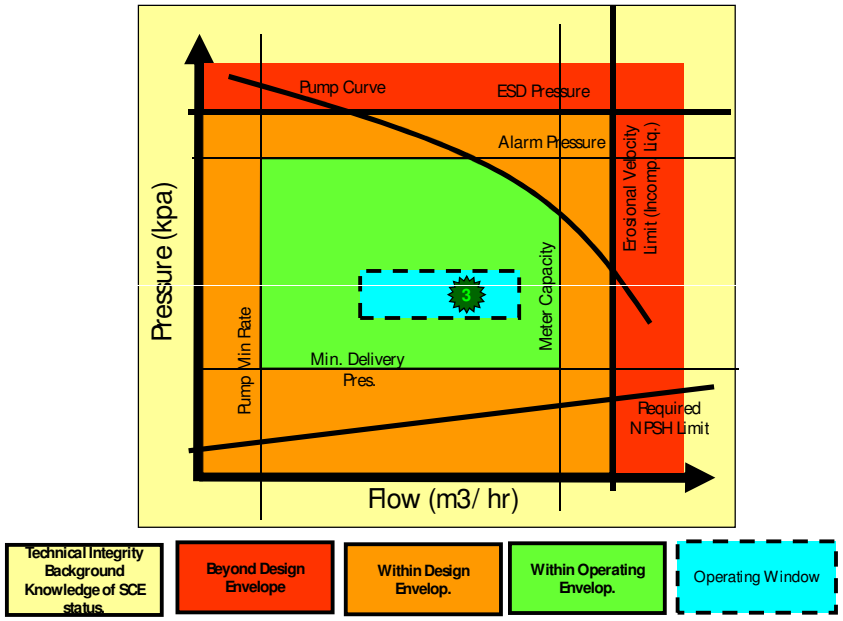
Salym ESP Pump Control using FW ESP

- ESP speed control by:
  - Closed-loop - continuously measuring liquid level above the pump - as level falls the pump is automatically slowed-down, when the level rises the pump is speeded-up, to maintain required NPSH
  - Real time remote ramp up/down of ESP wells.
  - Manually - adjusting pump speed based on analysis of pressure, IPR and pump performance curves
- Hence “sweet-spot” operation for increased production and maximum pump life



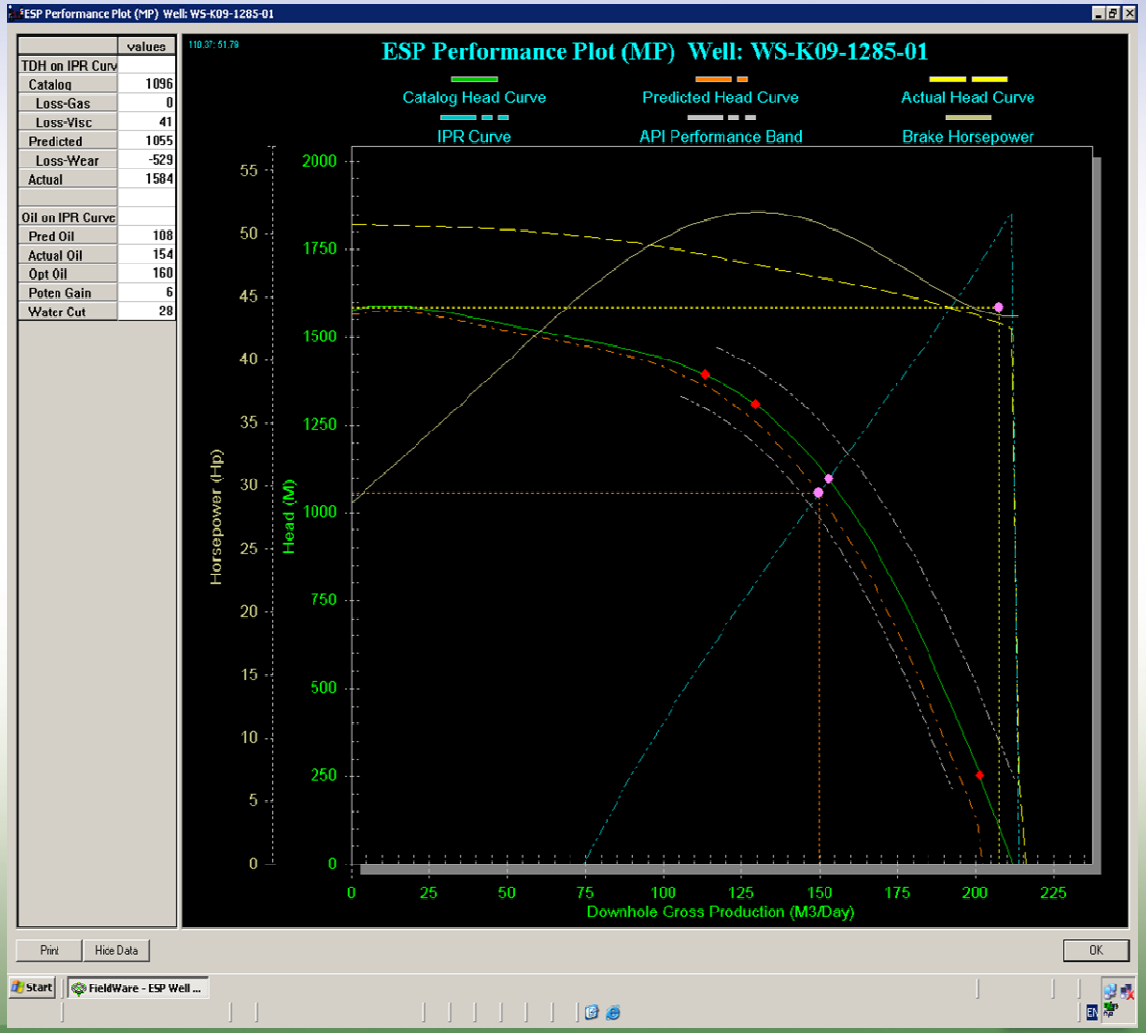
Salym ESP Performance Envelope monitoring using FW ESP

- The range of possible ESP operating points is constrained by a finite set of limits.
- The boundary defined by the overlay of all the limits is the operating envelope.
- To optimise production a further operating window can be defined within the operating envelope.
- This operating window is the desired sweet-spot for the ESP system



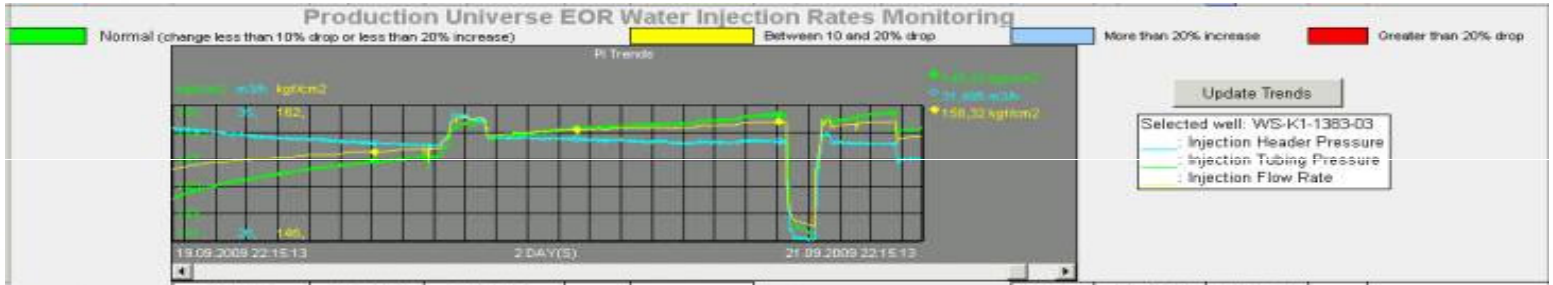
FW ESP generated pump performance curve

- Displays catalogue, actual and predicted production vs pressure curves.
- Well production rates automatically derived from PU to continuously provide the operating point on the performance curve
- Facilitates operation within the “sweet spot” for maximum pump run life and optimal production.



Injection Monitoring/Control via FW EOR

- Water Injection flows continuously measured, or estimated for all injection wells
- Traffic light display - “at a glance” injection system status, enables focus on problem wells and remedial actions to improve water injection performance
- Enables production/injection optimization within constraints, such as injection flow distribution, choke-size, pressure drops

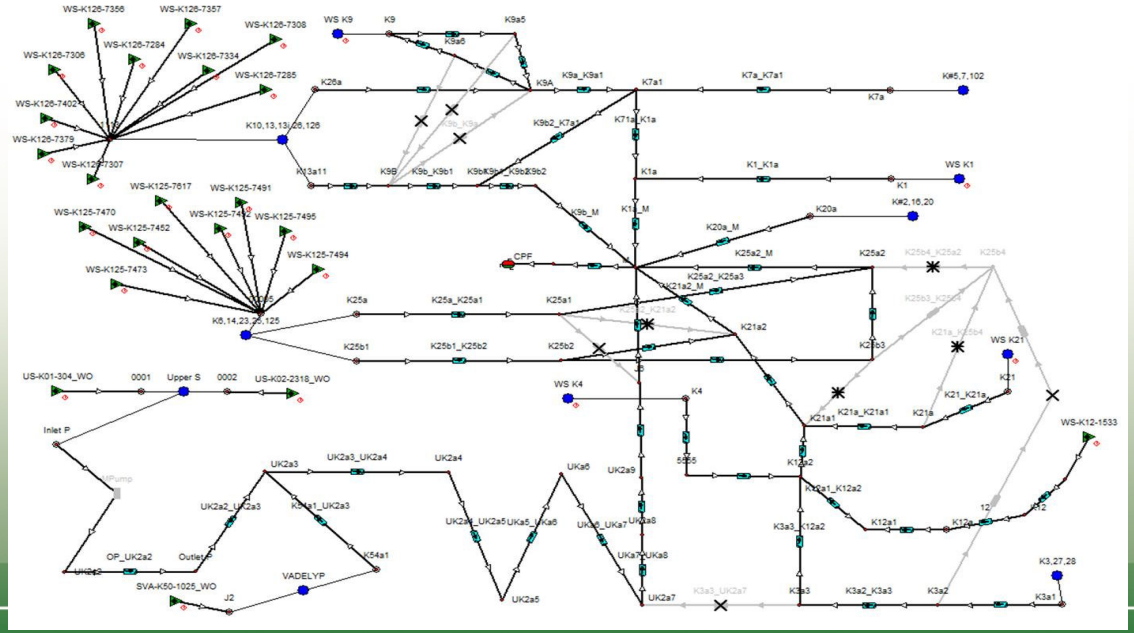


WellPad	Well	27.сен.09 yesterday	28.сен.09 3 hrs ago	28.сен.09 current	Status	Target Injection
01	1381	0,00	0,0	0,0	OPEN	96,1
01	1335	186,96	182,5	182,6	OPEN	173,6
01	1337	107,27	121,4	121,4	OPEN	99,8
01	1382	42,87	43,3	43,3	OPEN	40,0
01	1383	0,00	0,0	0,0	OPEN	46,5
01	1290	0,00	0,0	0,0	OPEN	0,0
01	1428	67,10	121,2	121,2	OPEN	0,9
02	1123	1224,10	1228,7	1228,7	OPEN	1137,8
02	1124	544,79	541,8	544,1	OPEN	528,7
02	1163	553,02	590,3	586,2	OPEN	534,3
02	1205	102,27	101,0	101,0	OPEN	101,1
02	1203	680,51	678,9	680,0	OPEN	692,9
03	1434	547,40	536,9	538,3	OPEN	535,2
03	1479	217,07	218,9	217,5	OPEN	215,0
03	1515	347,34	344,6	349,1	OPEN	340,7
03	1517	253,20	252,1	252,1	OPEN	248,8
03	1543	351,72	353,8	353,8	OPEN	347,9
03	1561	74,49	74,7	73,5	OPEN	75,4
03	1480	0,00	0,0	0,0	OPEN	0,0
05	1032	219,22	219,2	220,6	OPEN	216,3
05	1054	0,00	0,0	0,0	OPEN	0,0
05	1055	648,92	650,4	651,5	OPEN	575,4
05	1085	345,49	345,3	346,8	OPEN	339,6
05	1087	1176,97	1176,8	1176,8	OPEN	1130,1
06	1466	683,08	680,0	685,2	OPEN	671,5
06	1469	627,83	629,8	629,8	OPEN	612,2
06	5615	766,83	755,2	758,1	OPEN	754,2
06	5616	636,16	638,3	643,4	OPEN	620,3
06	5617	681,97	683,6	686,8	OPEN	663,3
06	5661	12,00	12,0	12,0	OPEN	50,2
07	1161	518,85	520,2	518,7	OPEN	505,2
07	1121	312,24	312,2	312,2	OPEN	308,2
07	1201	132,31	132,1	132,1	OPEN	130,0
07	1160	0,00	0,0	0,0	OPEN	0,0

WellPad	Well	27.сен.09 yesterday	28.сен.09 3 hrs ago	28.сен.09 current	Status	Target Injection
20	1246	249,07	244,3	246,5	OPEN	245,4
20	1248	74,77	75,1	75,1	OPEN	74,2
20	1292	89,04	89,1	89,1	OPEN	90,2
20	1339	32,40	33,0	33,2	OPEN	0,0
20	1340	5,00	5,0	5,0	OPEN	0,0
20	1338	72,84	72,2	72,2	OPEN	72,3
21	1430	0,00	0,0	0,0	OPEN	0,0
21	1384	29,43	29,7	29,9	OPEN	32,5
21	1385	17,27	14,3	0,0	OPEN	0,0
21	1474	215,23	214,9	214,9	OPEN	216,6
21	1475	49,48	50,1	48,6	OPEN	47,9
21	1477	4,62	0,0	0,0	OPEN	0,0
21	1512	277,70	271,6	274,2	OPEN	272,8
21	1513	112,75	111,1	112,6	OPEN	111,4
21	1514	0,00	0,0	0,0	OPEN	0,0
23	1379	1071,28	1073,6	1073,6	OPEN	1037,8
23	1380	231,84	233,3	233,3	OPEN	246,6
23	1404	99,81	102,4	102,4	OPEN	98,8
23	1424	778,21	543,1	543,0	OPEN	0,1
23	1425	349,81	348,9	348,9	OPEN	343,5
23	1427	78,96	78,9	77,5	OPEN	77,1
23	1470	479,87	480,4	479,0	OPEN	479,2
23	1472	283,75	287,3	288,8	OPEN	279,1
25	1508	844,09	846,4	853,2	OPEN	819,9
25	1509	990,16	946,6	949,6	OPEN	979,7
25	1510	664,11	664,3	666,5	OPEN	714,2
25	5665	503,99	499,7	501,2	OPEN	499,0
25	5685	110,68	111,1	111,1	OPEN	109,3
25	5714	230,26	221,8	223,2	OPEN	228,0
25	1538	328,71	329,2	329,2	OPEN	323,1
26	1284	420,00	415,1	415,1	OPEN	409,8
26	1330	171,12	170,8	173,8	OPEN	168,6
26	1332	964,31	963,3	966,1	OPEN	923,8
26	1377	460,89	460,8	460,8	OPEN	450,8

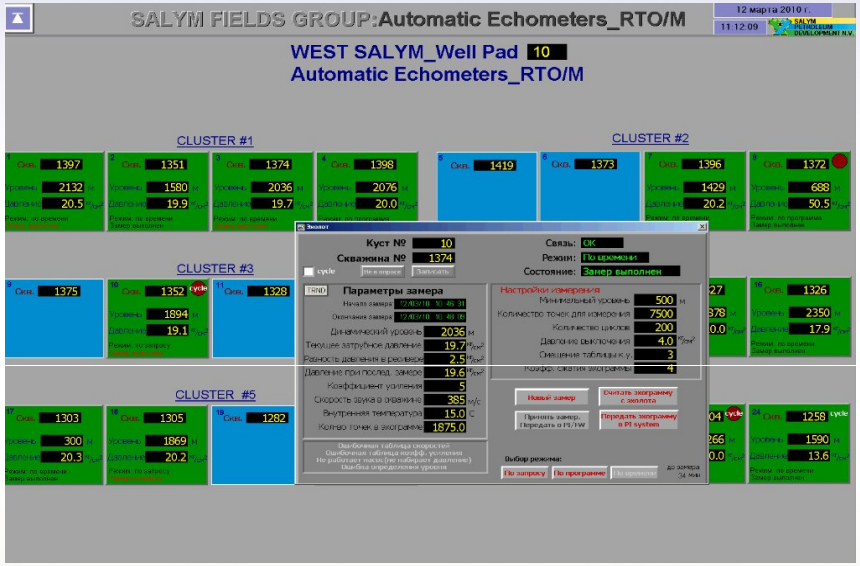
Integrated Production system Modeling

- SPD running 90 day plan and forecasting and PSO using wells and surface models. IPSM supports continuous optimization of the entire system from reservoir to point-of-sale
- The process of updating the model has been fully automated enabling engineers to focus on problem analysis rather than spending time finding data
- Assessed by Shell IPSM GDT as The Best Example seen and used in Shell.



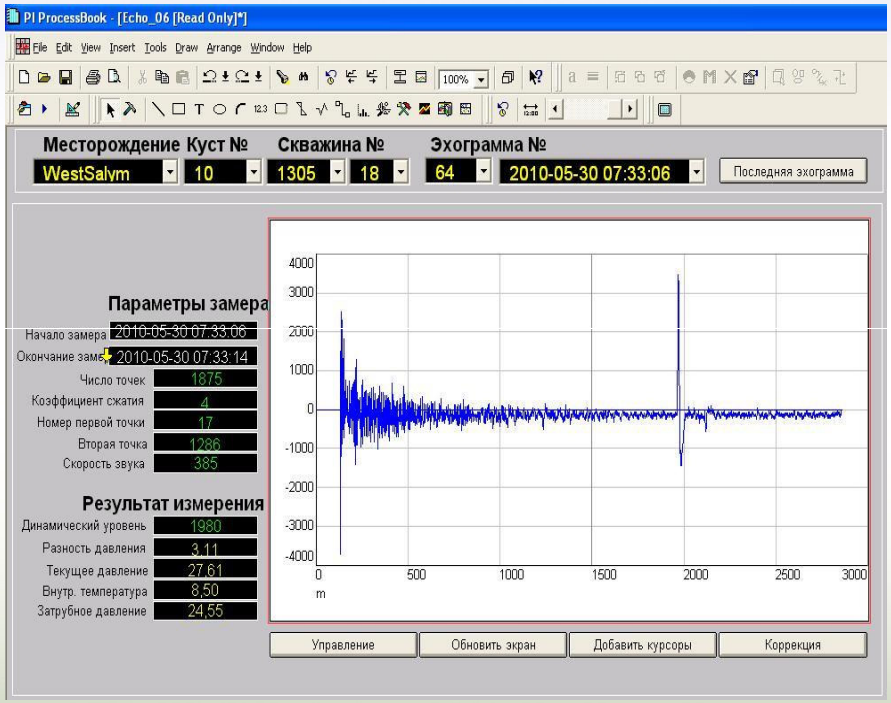
Salym ESP Liquid Level Above the Pump using Mikon Echometer

- Need to maintain sufficient fluid level above the ESP to prevent pump damage due to cavitation
- Mikon “Gun” sends an acoustic pulse into the well casing and a microphone “listens” for the reflected sound waves
- Gun/microphone housed in an explosion proof, Div 1, Class 1 enclosure
- Acoustic reflections converted to an electronic liquid level signal measured at frequencies up to once every 5 seconds.
- BHP calculation using DFL’s



Salym ESP Liquid Level Above the Pump using Mikon Echometer

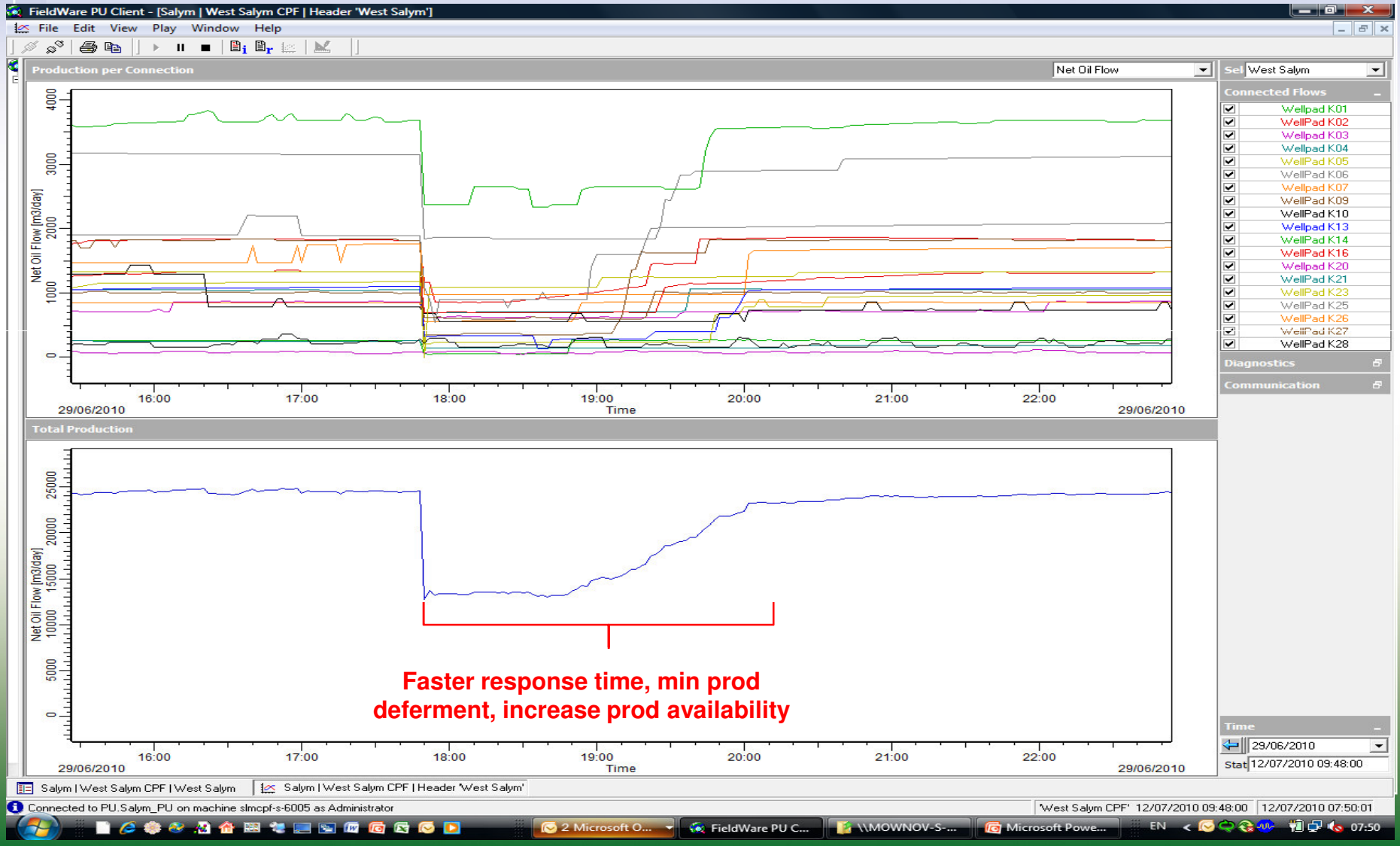
- Depth measurements are telemetered via the SCADA/Historian systems such that liquid level above ESP's can be monitored in the remote and local Salym offices
- Salym have currently installed automatic echometers on 30 wells and are installing these on all ESP wells – field wide.



Management of Change

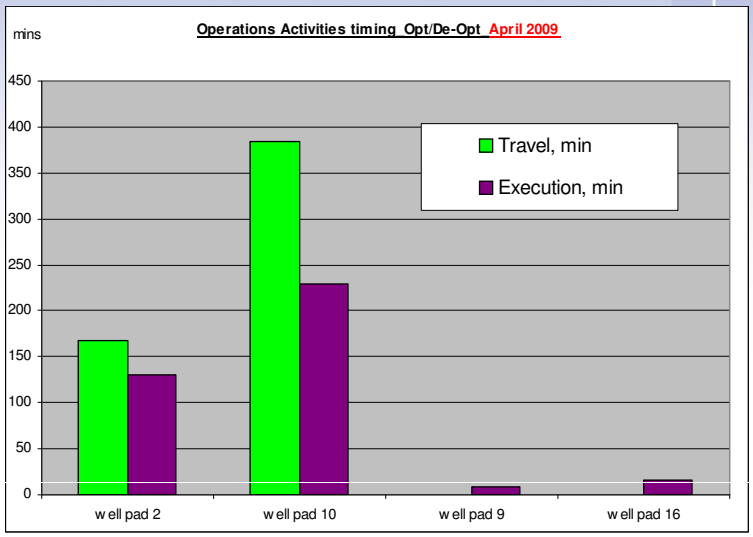
- It is one thing to install Smart Fields technology it is quite another to get it running, embedded and then sustained over the life cycle
- SPD are changing the work processes, roles/responsibilities and organization for most effective system utilization to permanently establish one standard, system-based way of working
  - User training - Total of 300+ staff
  - Super User Training - systems administration, configuration & maintenance
  - Mega user training – training the trainers
  - Development and deployment of Standard Operating Procedures for daily Smart Fields monitoring of water production, handling and injection performance, well testing, model maintenance,
  - Development and deployment of SOP's for the use of Salym SmartFields systems and Technologies.
  - Implementation of SFFMk1 workflows across all disciplines involved in RTO/M

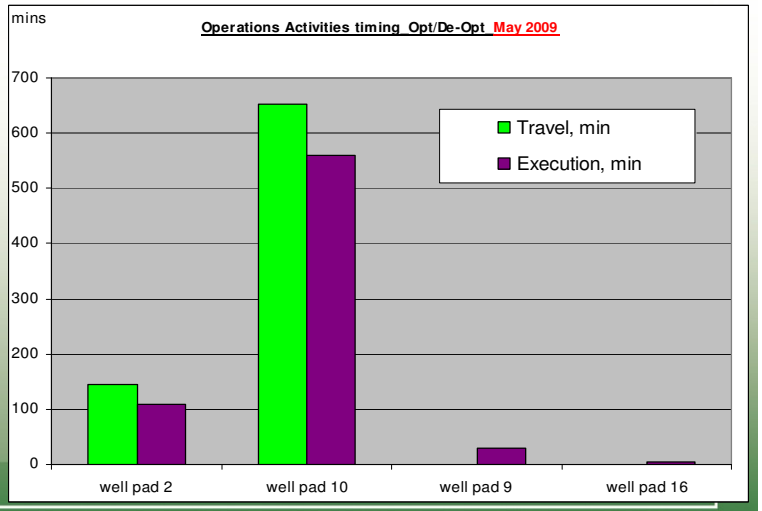
SPD Smart Fields Technology
RTO Fieldware Systems



Benefits – Improved HS&E

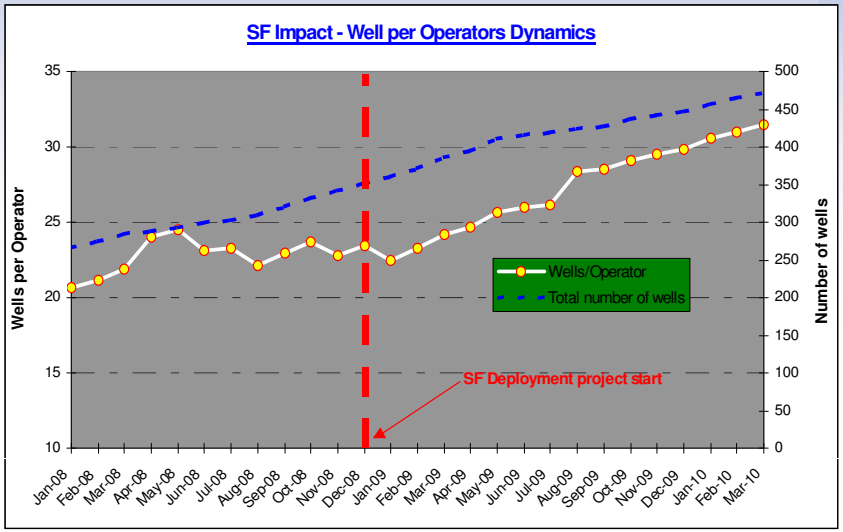
- Field visits to well pads have been reduced by the following optimization activities:
  - Well intervention by exception rather than routine
  - Remote ESP speed stop, start, adjustment
  - Remote adjustment of wellhead chokes
  - Reduced Well testing due to testing by exception
  - Automatic measurement of ESP casing fluid levels
  - All staff view the same information at the same time fostering reduced site visits, problem solving and optimization efforts
- Hence, Operators travel/work execution time associated with optimization has been reduced, allowing staff to control and operate an increased number of wells with minimum HSE exposure during field pad visits





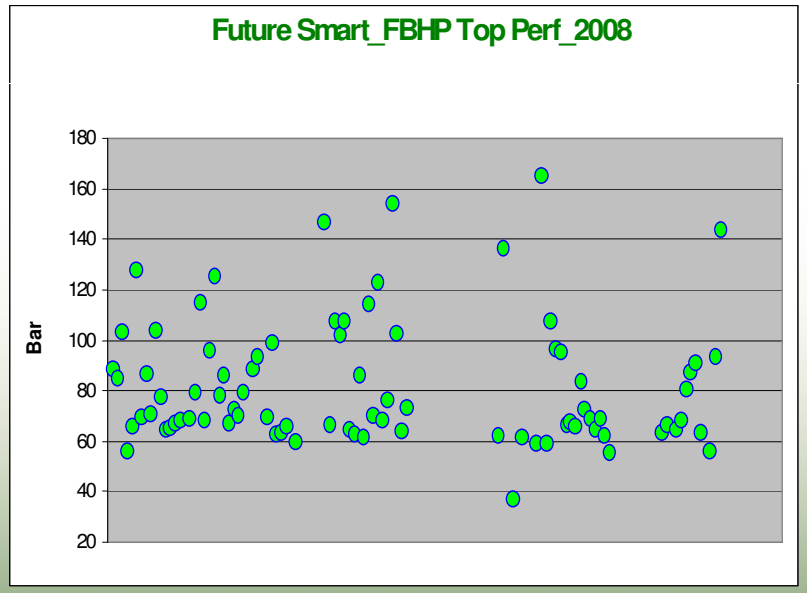
Benefits – Improved HS&E

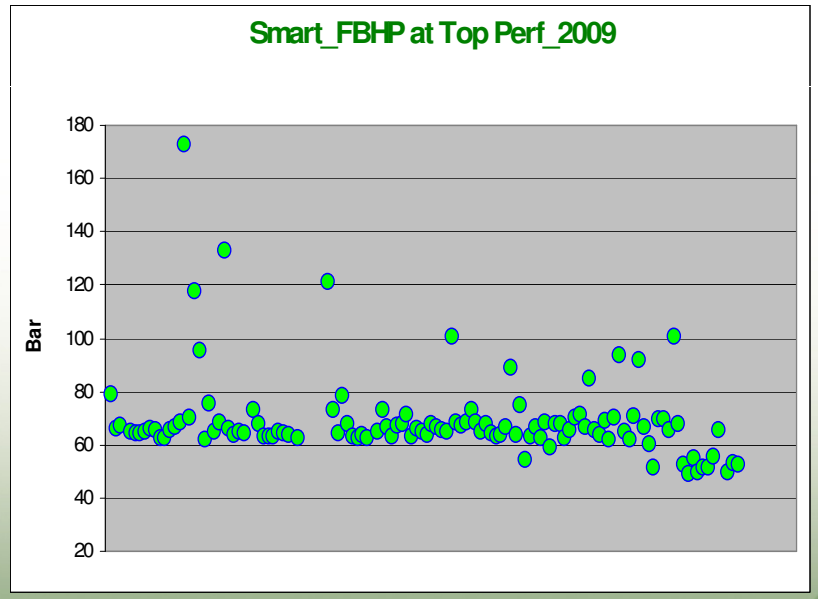
- The time savings have also allowed the existing operational staff to absorb the extra activities associated with running evolving newly drilled/completed wells
- Hence the operators makes fewer trips to the well pad, conduct fewer repetitive tasks, improve HSSE performance and make more time for themselves to carry out higher value work



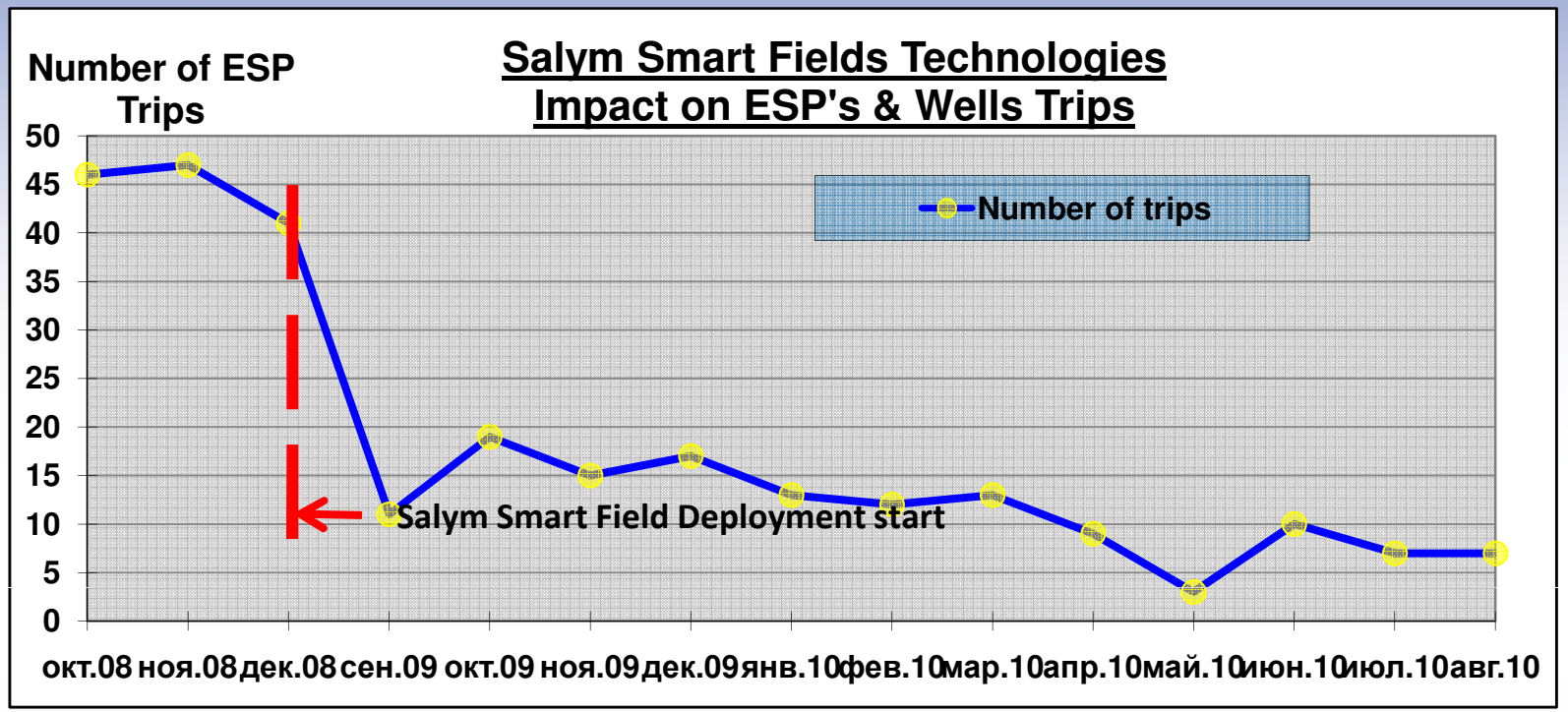
Benefits – improved well stability/Reservoir management

- Improvements are continuously being observed in well stabilization (FBHP) leading to increased production and better management of reservoir integrity





SALYM SMART FIELDS - IMPACT & BUSINESS VALUE



Reduction in monthly ESP trips from 45 to less than 10 resulting in:

- **Higher availability (production/equipment)**
- **Increased ESP MTBF from 605 to 650 resulting in expected OPEX costs savings of USD 2.5 million in 2010**

Reduction in production deferment from +/- 110 bbls/d to less than 10 bbls/d while enabling:

- **Faster response time to ESP trips**
- **Increased production availability**
- **Faster response time to well ramp up**
- **Reduction of journeys to well locations**
- **Operator/well ratio from 1:20 – 1:30**

Conclusions – benefits achieved so far

- Reduced ESP trips and increased production stability resulting in:
  - Higher availability (production/equipment)
  - Increased ESP MTBF from 605 to 650 days with projected OPEX costs savings of USD 2.5 million in 2010
  - Increased operator productivity and less journeys to well locations– operator/well ratio has improved from 1:20 to 1:30
  - Reduction in unscheduled deferments - .3%
- Water injection in compliance with requisite targets
- Increased engineer/analyst productivity due to automatic model updates
- Safer operations due to reduction in operator travel to remote wellheads
  - Reduced exposure to hazard,
  - Reduced environmental footprint, despite the increasing number of wells
- Less footprints in the Siberian snow!

Less Footprints in the Snow for Salym Field in Western Siberia