

The Power of SilverJack – Optimization

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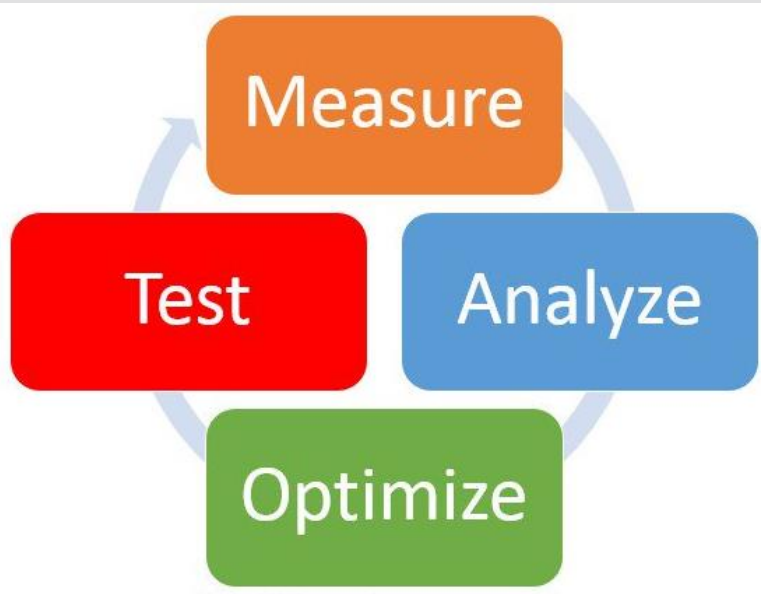
Optimization Case Studies - Examples of common problems identified and often resolved remotely via Zedi Access

SilverJack Optimization Process

- Optimization with SilverJack is typically done remotely using the Zedi Access web host
- Remote Access provides several tools to provide visibility into well performance.
 - Long term data trending and graphing
 - Current parameter settings
 - Remote Alarming
 - Surface & downhole pump cards (current and historical)
- Remote Access allows remote parameter changes
- Three levels of SilverJack Optimization:
 - End User Manual Optimization – User determines issues and manually adjusts parameters on Zedi Access
 - TCB Optimization Service – Emerson Optimization Team provides support for initial setup and manual optimization via remote Access
 - Autonomous – SilverJack controller identifies issues and makes parameter changes in real time

Section 1: SilverJack Manual Optimization – What Tools Are Used?

Goal: Reduce Time to Complete Optimization Cycle



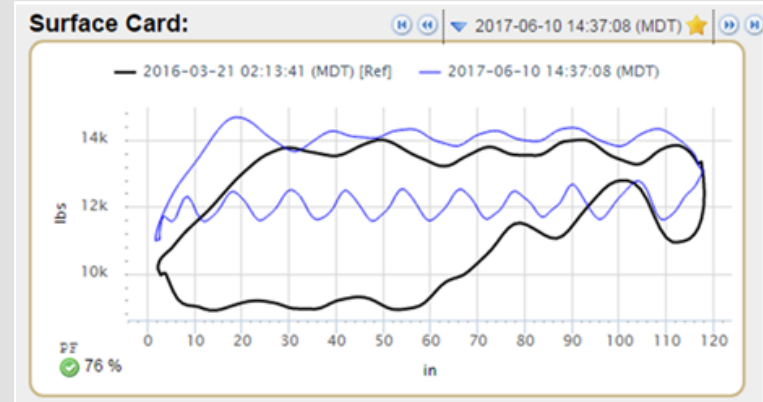
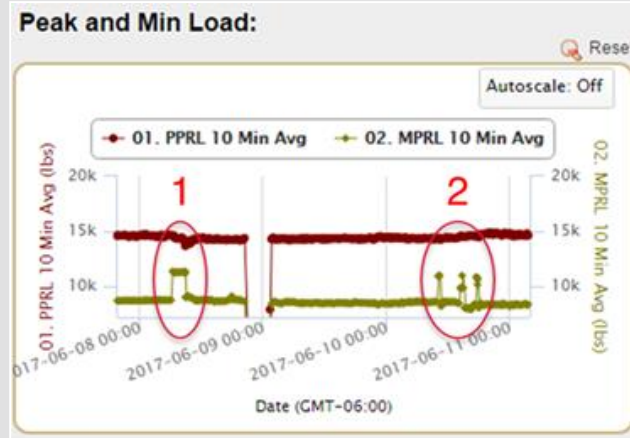
(A) User Initiated Optimization

- **Measure**
 - Remote data collection every 15 to 60 minutes (or less with high resolution option)
- **Analyze**
 - Use remote access tools analyze performance (long term trending, pump cards, alarm history, etc.) and decide on changes
- **Optimize**
 - Use remote Access to change pumping parameters. No site visit, no mechanical changes, no downtime.

User Initiated Optimization Example: Standing Valve Stuck Open

Measure

- Downloading polish rod loads every 15 minutes



Analyze

- Alarm set on MPRL trend → High MPRL alarm sent
- Alarm triggers user to investigate (manage by exception)
- User connects to remote Access to investigate and determine problem

Optimize

- User remotely increases down stroke speed via Zedi Access (or Zedi Go)
- Increases fluid velocity passing open valve to flush debris

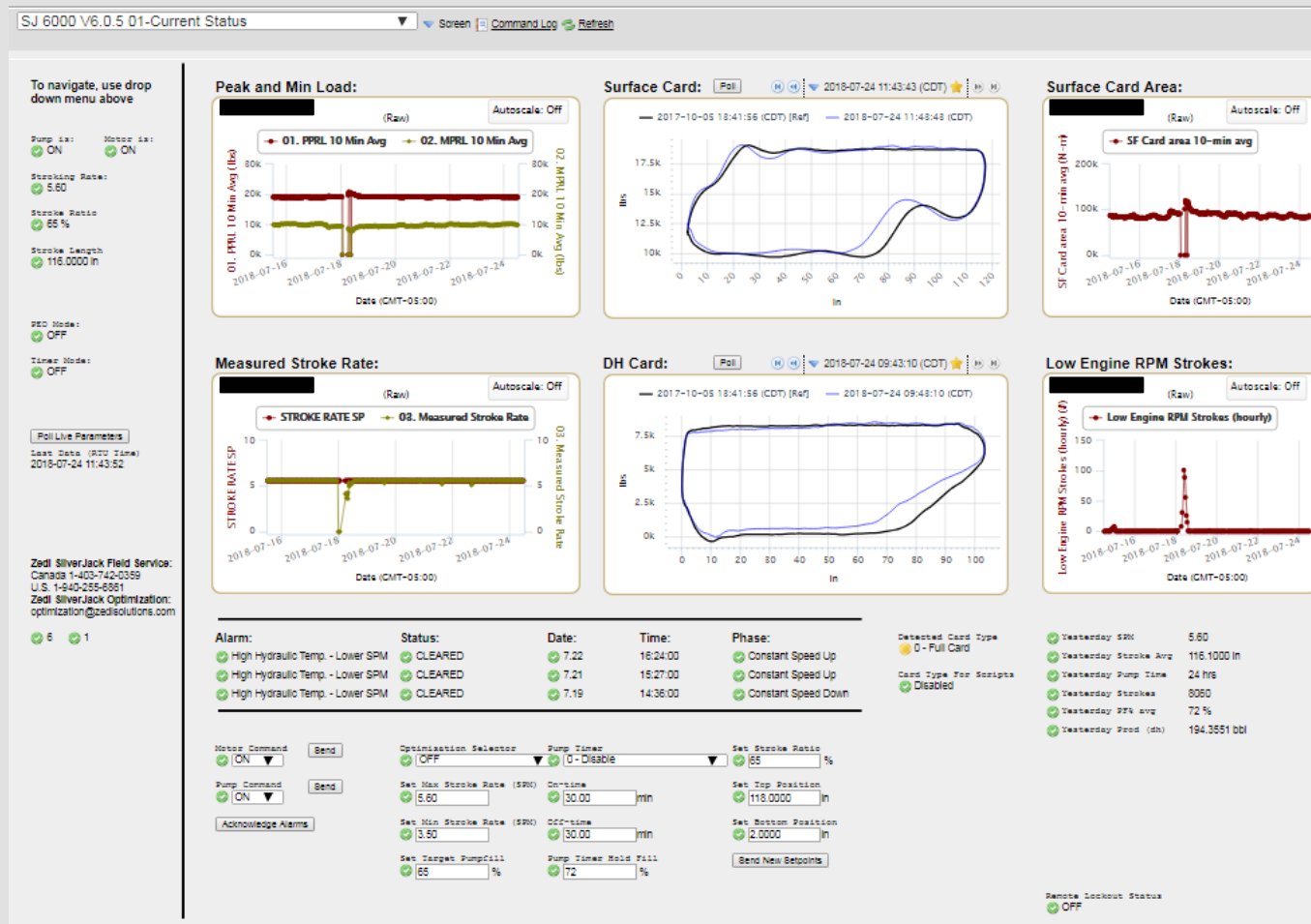
Test

- Monitor data trends on remote Access to determine if problem is resolved or further action required.

Problem Resolution / Confirmation ~ 30 to 45 min (depending on user response time)

Zedi Access Tools – Live Data Screen Example

Status Screen



- Landing page that shows current status of key parameters and control features
- Graphs show short term trends
- Pulldown menu in upper left used to view different live data screens

Remote Access Tools – Live Data Screen Example

Control Screen

SJ 8000 V6.0.0 05-Basic Controls

Screen Command Log Refresh

To navigate, use drop down menu above

Pump is: ON

Motor is: ON

Stroking Rate: 5.30

PEO Mode: OFF

Timer Mode: OFF

Poll Live Parameters

Last Data (RTU Time)
2018-03-29 11:36:14

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U.S. 1-940-255-6861
Zedi SilverJack Optimization:
optimization@zedisolutions.com

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Remote Lockout Status
OFF

Poll Setpoints

SilverJack Control

Set Motor ON/OFF
ON

Send

Reset Min/Max RL
OFF

Send

Set Top Position
233.0000 in

Send

Motor Status
ON

Set Pump ON/OFF
ON

Send

Set Stroke Ratio
50 %

Send

Set Bottom Position
6.0000 in

Send

Pump Status
ON

Set Stroke Rate (SPM)
5.50

Send

Piston Stall Delay
60.0000 Seconds

Send

Acknowledge Alarms
OFF

Send

Valve Testing Setup:

Valve Test Schedule
2 - DAILY

Travelling Valve Test Measurement Pos.
80 %

Traveling Valve Test Settling Time
5.0000 Seconds

Travelling Valve Test Measurement Time
20.0000 Seconds

Standing Valve Test Measurement Pos.
20 %

Standing Valve Test Settling Time
5.0000 Seconds

Standing Valve Test Measurement Time
20.0000 Seconds

Send Changes

Remote, Manual Go-To Function:

Go-to Enable
DISABLED

Target Position Setpoint
6.0000 in

Hold Time
4 hrs

Send Changes

Tank Volume:

Tank Volume Correction
100 %


Send Changes

Tank Volume Enabled?
DISABLED

PLC Temp
99.0000 °F

- Most commonly changed parameters on separate screen for easy access

SilverJack Optimization Case Studies

 TCB MANUFACTURING

Remote Access Tools – Live Data Screen Example

Alarm Screen

SJ 8000 V6.0.0 04-Alarms

Screen Command Log Refresh

To navigate, use drop down menu above

Pump is: ON Motor is: ON

Stroking Rate: 5.30

PEO Mode: OFF

Timer Mode: OFF

Poll Live Parameters

Last Data (RTU Time)
2018-03-29 11:36:14

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Alarm:	Status:	Time:	Date:	Phase:	Assisted Lift
Power Failure	CLEARED	21:52:00	3.28	Bottom Dwell	Rod Load LOW OFF Rod Load HIGH OFF N2 Bleed Valve Fault OFF Clsd Loop Pump Fault OFF Hi AccumPress - Stop OFF Hi AccumPress - SD OFF Piston Imb. Top OFF Piston Imb. Bot. OFF
Log:					
Power Failure	CLEARED	21:52:00	3.28	Bottom Dwell	
Power Failure	CLEARED	21:45:00	3.28	Bottom Dwell	
High Accum Pressure - Stop Pump	CLEARED	13:58:00	3.06	Constant Speed Up	

2018-03-28 22:38:11 (UMDT)

Hydraulic Alarms

High Oil Pressure OFF
High Oil Temp - Stop OFF
High Oil Temp - Slow OFF
Low Oil Level OFF
Temp Sensor Fault OFF
Press Sensor Fault OFF
Replace In-tank F... OFF

Position Alarms

Pos Sensor Fault OFF
Pos Sensor Lost OFF
Position Low Limit OFF
Position High Limit OFF
Piston Stalled OFF

Miscellaneous Alarms

Presco OFF
ESD Status NORMAL
Ext. Alarm 1 graph NORMAL
Ext. Alarm 2 graph NORMAL

Power Alarms

Power Failure OFF
High DC Volts OFF
Low DC Volts OFF
Power Failure Reset OFF

Engine Status Alarms
Combustible Engines Only

Low Oil Pressure OFF
High Coolant Temp OFF
Low Engine Speed OFF
High Engine Speed OFF
Press Sensor Fault OFF
Temp Sensor Fault OFF

Engine Fault Alarms
US Combustible Engines Only

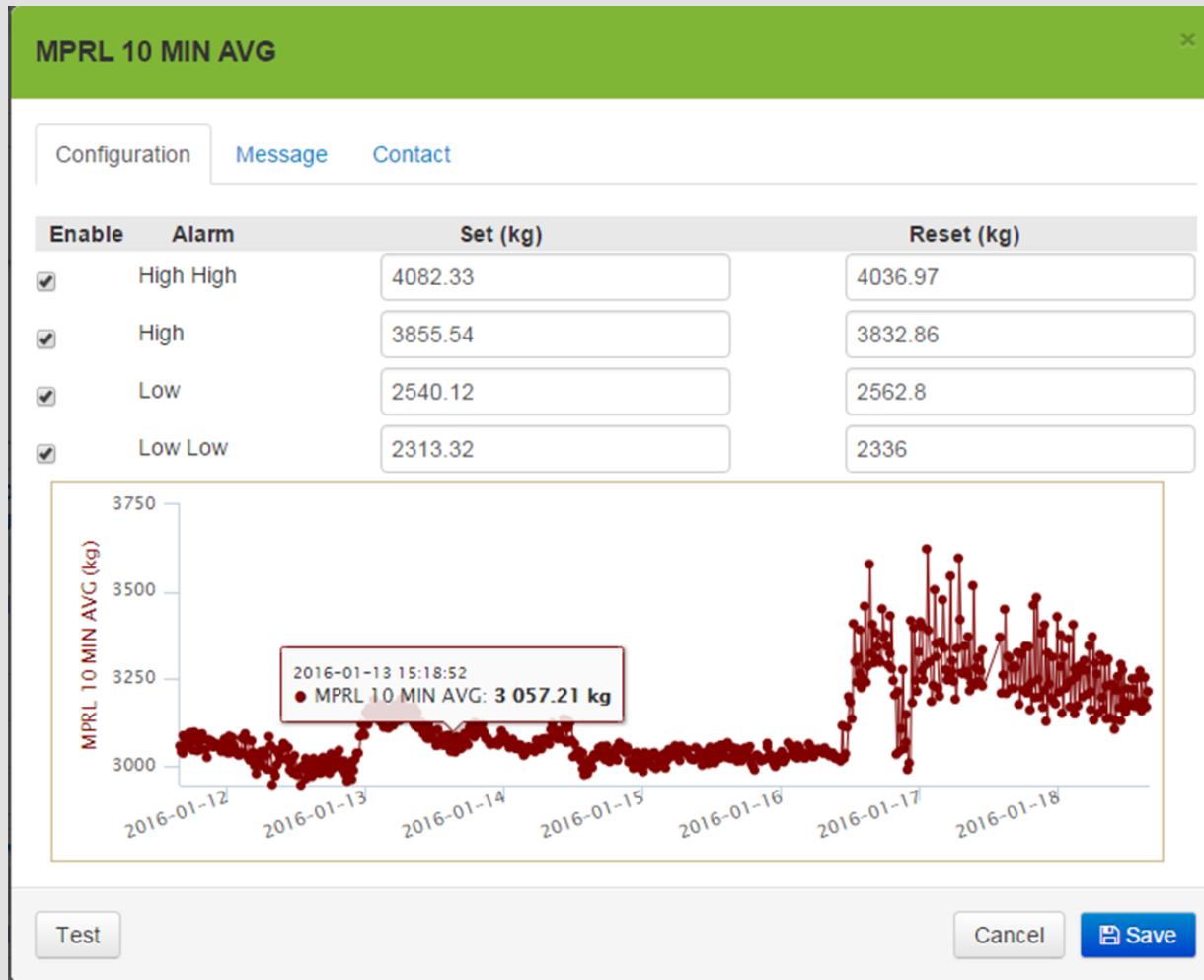
Check Engine OFF
Stop Engine OFF
Engine Protect OFF
Engine Malfunction OFF
Number of Faults 0
Engine Code (J1939) 0

EDC:

Hourly Faults 0
FAULT A 0
FAULT B 0

- Shows recent alarm history and current status of all alarms

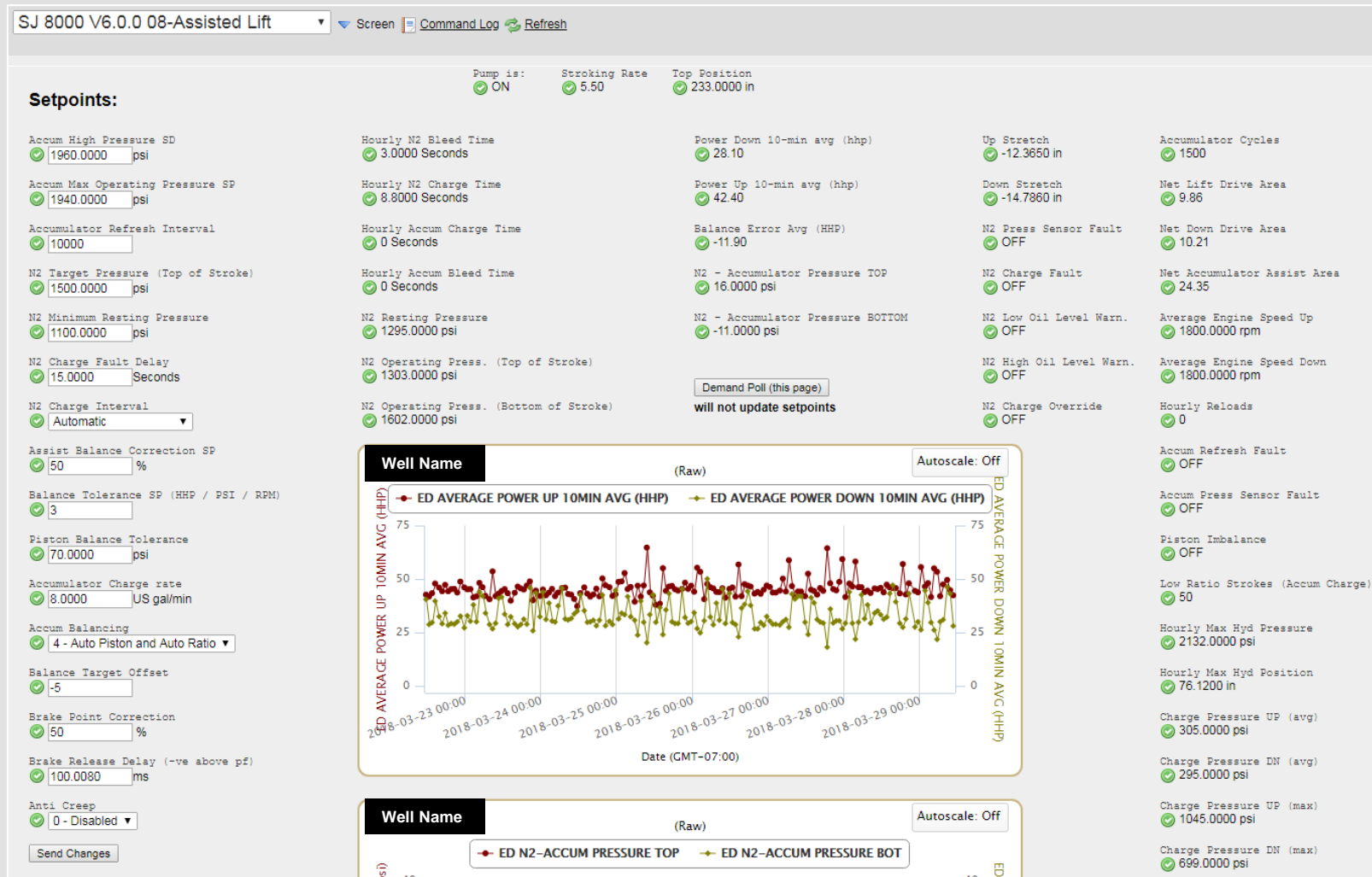
Remote Access Tools – Alarm Config Screen



- User sets high and low thresholds that will be used to generate alarms (management by exception)

Remote Access Tools – Live Data Screen Example

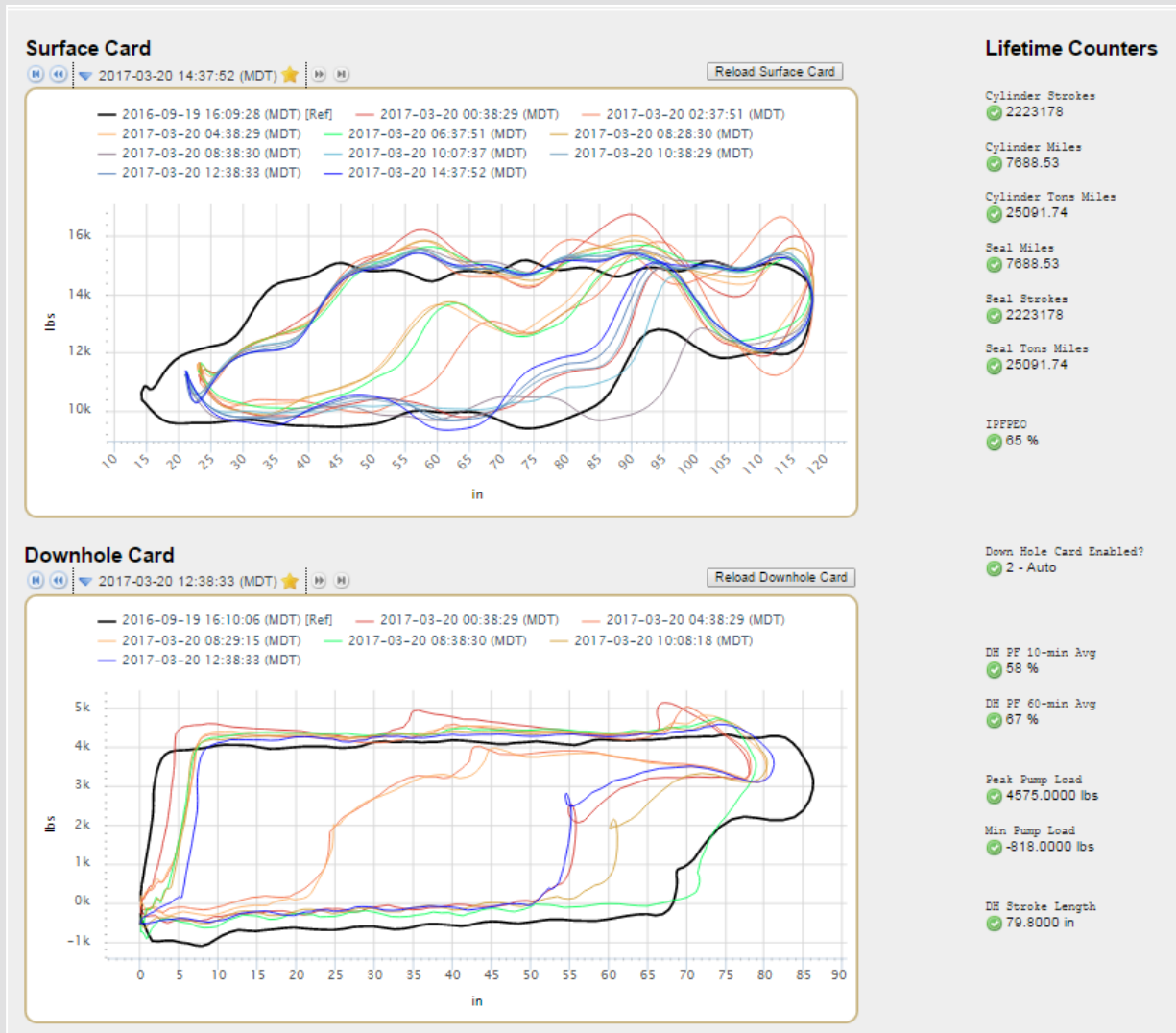
SJ8000 Assisted Lift (Admin Screen)



- Parameters used to monitor balance of N2 lift assist

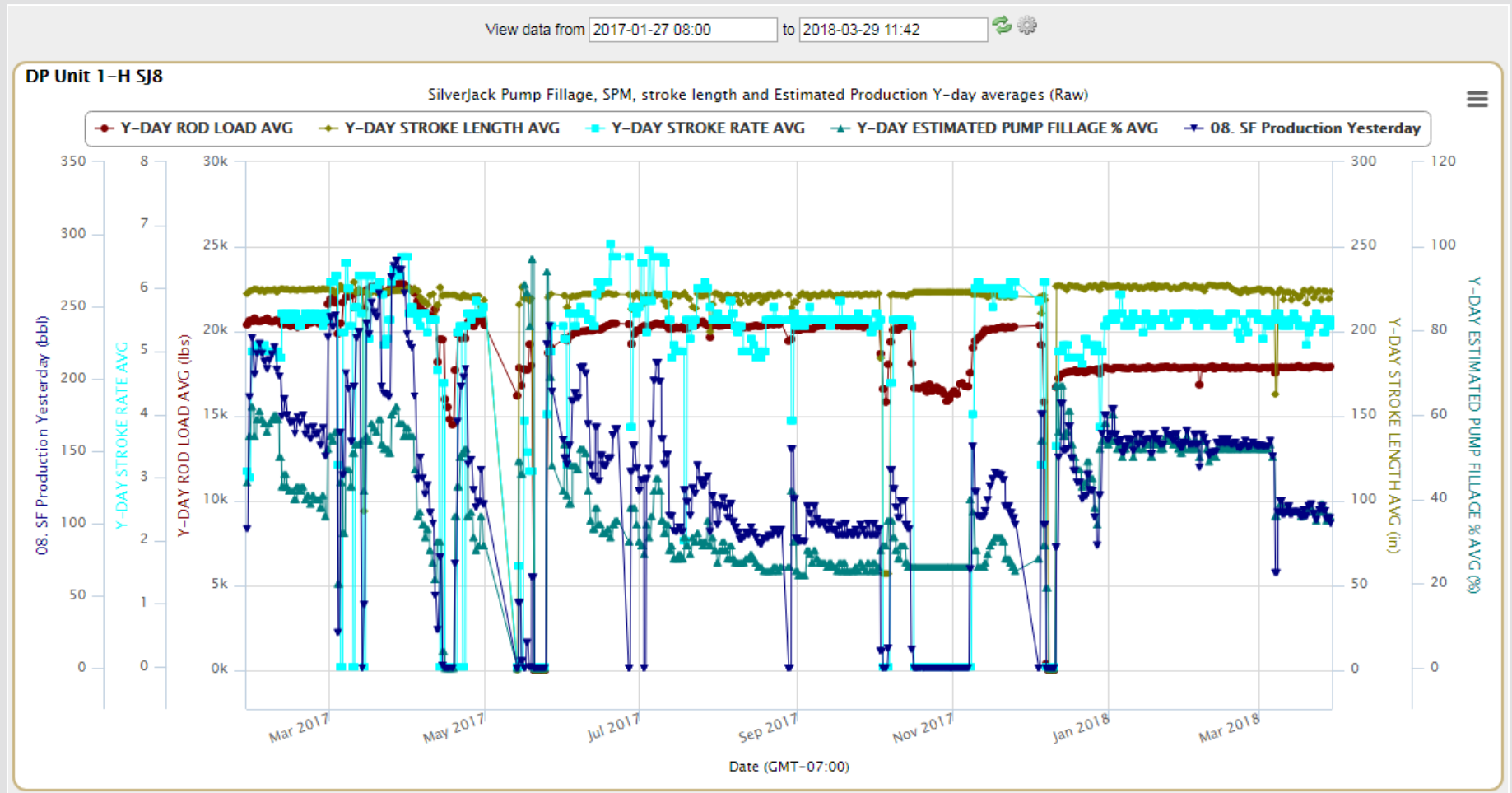
Remote Access Tools – Live Data Screen Example

Pump Card Screen



- Both Surface & Downhole cards available
- User can select multiple cards to overlay to show trends
- Long term card storage on Zedi Access

Remote Access Tools – Report Center



- Ability to create user defined graphs of any parameters in Zedi Access
- Can set up multiple parameters per graph so correlations are easier to see
- User can select time period of interest

Section 2: SilverJack Autonomous Optimization

Detect and respond
to well dynamics
with no user intervention
after initial setup

SJ Autonomous Optimization - Pump Efficiency Optimizer (PEO)

PEO Screen

SJ 8000 V6.0.0 06-PEO

Screen Command Log Refresh

To navigate, use drop down menu above

Pump is: ☒ ON Motor is: ☒ ON

Stroking Rate: ☒ 5.40

PEO Mode: ☒ OFF

Timer Mode: ☒ OFF

Last Data (RTU Time)
2018-03-29 13:36:11

Pump Efficiency Optimizer Controls:

PEO Spm Adjust Interval ☒ 5

PEO Spm Adjust Value ☒ 0.10

Target Pump Fill ☒ 10 %

PEO Spm Minimum Value ☒ 2

Pump Bore Diameter ☒ 1.5000 in

Estimated Rod Stretch ☒ 17.0000 in

PEO Fluid Weight ☒ 4500.0000 lbs

Inst Pump Fill - PEO Method ☒ PEO Optimized Rate 0

MPRL 10-min Average ☒ 13650.0000 lbs

FW Quick Calc ☒ 67.0000 lbs

PEO Mode ☒ OFF

PEO Script Card Select ☒ Disabled

Stuck SV Start ☒ 1 - Ratio 70%

Stuck SV End ☒ 0 - Disabled

Stuck TV Start ☒ 1 - Ratio 35%

Stuck TV End ☒ 0 - Disabled

Script Interval (Cards) ☒ 3

Script Retry Delay ☒ 0 min

High Flowline:

Set High Flowline Autoreset Time 1-2000 ☒ 10.0000 min

Set High Flowline Autoreset Retries 1-50 ☒ 5

Pump Timer:

On-Time ☒ 20.0000 min

Off-Time ☒ 20.0000 min

Pump Timer Hold Fill ☒ 48 %

Energy Saver Enable ☒ Enable

Battery Saver Enable ☒ Disable

Pump Hourly Control Enable ☒ Disable

Pump Hourly Control Start ☒ 700 hrs

Set Low Voltage Alarm Value ☒ 12.20 V

Pump Timer Enable ☒ Disable

Pump Timer Time Left ☒ 24

Energy Saver Status ☒ Off

Battery-Saver Min Engine Temp ☒ 57.0000 °F

Pump Hourly Control Stop ☒ 2300 hrs

FLUID WEIGHT

6 2

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Zedi SilverJack Optimization:
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1. Pump off Control
- Auto adjust SPM based on pumpfill
2. Cycle SilverJack on and off
3. Auto shutdown & restart based on flowline pressure
4. Autonomous detection and real time resolution of specific downhole issues

SJ Autonomous Optimization - Pump Efficiency Optimizer (PEO)

Pump Off Control

1

SJ 8000 V6.0.0 06-PEO Screen Command Log Refresh

To navigate, use drop down menu above

Pump is: ☒ ON Motor is: ☒ ON
Stroking Rate: ☒ 5.40
PEO Mode: ☒ OFF
Timer Mode: ☒ OFF
Poll Live Parameters
Last Data (RTU Time)
2018-03-29 13:36:11

Pump Efficiency Optimizer Controls:

PEO Spm Adjust Interval ☒ 5 PEO Mode ☒ OFF
PEO Spm Adjust Value ☒ 0.10 PEO Script Card Select ☒ Disabled
Target Pump Fill ☒ 10 % Stuck SV Start ☒ 1 - Ratio 70%
PEO Spm Minimum Value ☒ 2 Stuck SV End ☒ 0 - Disabled
Pump Bore Diameter ☒ 1.5000 in Stuck TV Start ☒ 1 - Ratio 35%
Estimated Rod Stretch ☒ 17.0000 in Stuck TV End ☒ 0 - Disabled
PEO Fluid Weight ☒ 4500.0000 lbs Script Interval (Cards) ☒ 3
Script Retry Delay ☒ 0 min
Update PEO Parameters

Inst Pump Fill - PEO Method ☒ PEO Optimized Rate 0
51 % ☒ PEO Efficiency 0 %
MPRL 10-min Average ☒ 13650.0000 lbs FW Quick Calc ☒ 67.0000 lbs

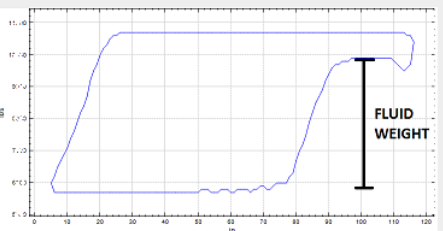
High Flowline:

Set High Flowline Autoreset Time 1-2000
☒ 10.0000 min
Set High Flowline Autoreset Retries 1-50
☒ 5
Update Autoreset Parameters

Pump Timer:

On-Time ☒ 20.0000 min Pump Timer Enable ☒ Disable
Off-Time ☒ 20.0000 min Pump Timer Time Left ☒ 24
Pump Timer Hold Fill ☒ 48 %
Energy Saver Enable ☒ Enable Energy Saver Status ☒ Off
Battery Saver Enable ☒ Disable Battery-Saver Min Engine Temp ☒ 57.0000 °F
Pump Hourly Control Enable ☒ Disable
Pump Hourly Control Start ☒ 700 hrs Pump Hourly Control Stop ☒ 2300 hrs
Set Low Voltage Alarm Value ☒ 12.20 V
Update Pump Parameters

FLUID WEIGHT



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Zedi SilverJack Optimization:
optimization@zedisolutions.com

☒ 6 ☒ 2

1. Pump off control

- Controller monitors pump fill and adjusts stroke speed accordingly
- User can define all related parameters to find best settings for specific wells

SJ Autonomous Optimization - Pump Efficiency Optimizer (PEO)

2

Pump Timer:

On-Time ✓ 20.0000 min	Pump Timer Enable ✓ Disable ▾
Off-Time ✓ 20.0000 min	Pump Timer Time Left ✓ 24
Pump Timer Hold Fill ✓ 48 %	
Energy Saver Enable ✓ Enable ▾	Energy Saver Status ✓ Off
Battery Saver Enable ✓ Disable ▾	Battery-Saver Min Engine Temp ✓ 57.0000 °F
Pump Hourly Control Enable ✓ Disable ▾	
Pump Hourly Control Start ✓ 700 hrs	Pump Hourly Control Stop ✓ 2300 hrs
Set Low Voltage Alarm Value ✓ 12.20 V	
<input type="button" value="Update Pump Parameters"/>	

Mode 1: Simple timer

- “x” minutes on / “y” minutes off

Mode 2: 24 hr timer

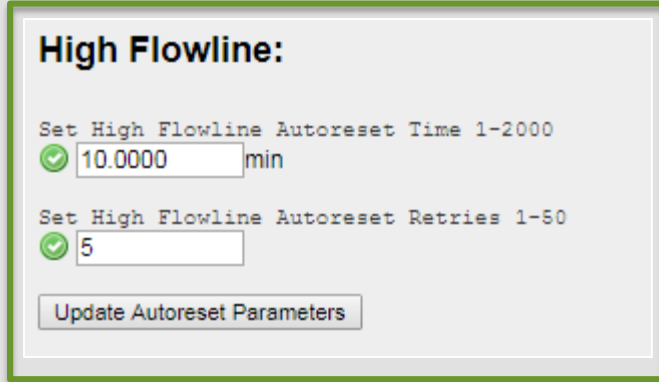
- On at 0x00 hrs/off at xx00 hrs

Mode 3: Shutdown based on pumpfill

- Set min pumpfill threshold
- Controller shuts down if pumpfill drops below threshold for given # strokes for defined period of time
- For gas powerpacks engine monitors battery level and turns engine on to charge battery if required.

SJ Autonomous Optimization - Pump Efficiency Optimizer (PEO)

3



High Flowline:

Set High Flowline Autoreset Time 1-2000
✓ 10.0000 min

Set High Flowline Autoreset Retries 1-50
✓ 5

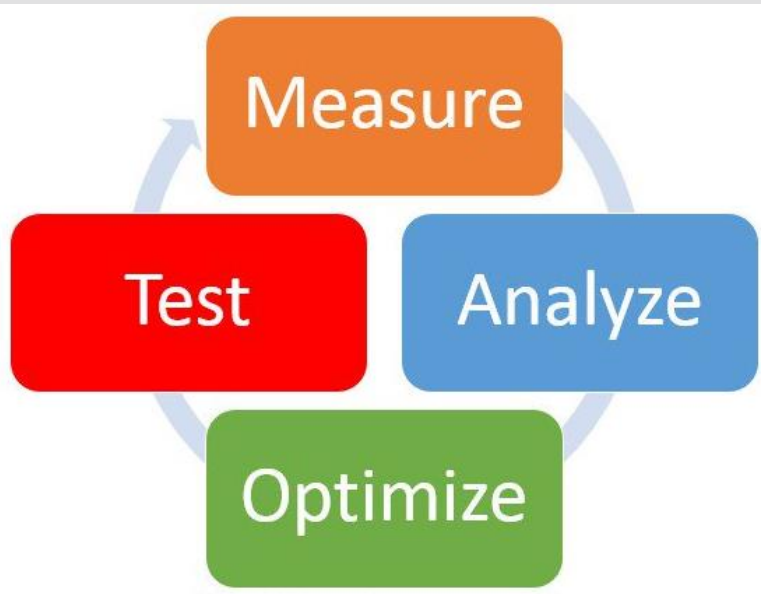
Update Autoreset Parameters

- Shutdown based on high flow line pressure (if high flowline pressure valve engages SJ shuts down)
- Ability to configure auto reset/restart if flowline pressure valve is auto reset
- Number of restart attempts configurable before shutdown requires manual restart

SilverJack – Enhanced Optimization Capabilities

Limitations of User Initiated Optimization:

- Polling interval (~ 15 minutes)
- User response time (? minutes)
- User knowledge / troubleshooting time



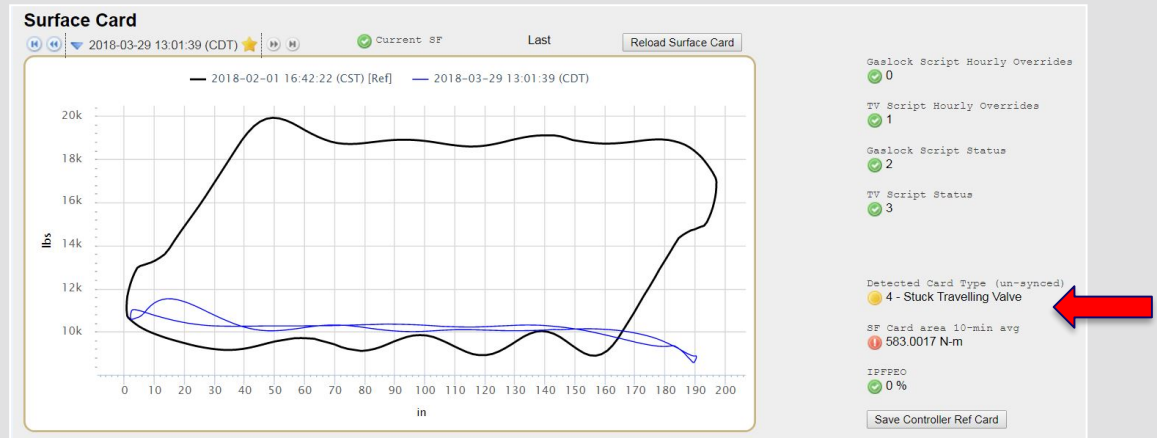
(B) Autonomous Optimization

- Controller identifies issue and makes real time changes to pumping parameters
- No user intervention required
- Currently available for:
 - Pumped off condition
 - Standing Valve Stuck Open
 - Traveling Valve Stuck Open
 - Gas Lock

Autonomous Optimization Example

Measure

- System identifies problem not just symptom



Pump Efficiency Optimizer Controls:

PEO Spm Adjust Interval ✓ 4	PEO Mode ✓ OFF
PEO Spm Adjust Value ✓ 0.20	PEO Script Card Select ✓ Disabled
Target Pump Fill ✓ 70 %	Stuck SV Start ✓ 1 - Ratio 70%
PEO Spm Minimum Value ✓ 2.50	0 - Disabled
Pump Bore Diameter ✓ 1.5000 in	1 - Ratio 70%
Estimated Rod Stretch ✓ 3.0000 in	2 - Ratio 70%
PEO Fluid Weight ✓ 6000.0000 lbs	3 - Ratio 70%
	4 - Light Tap
	5 - Max Tap
	6 - Max Tap
	7 - Ratio 70%
	8 - Ratio 35%
	9 - Ratio 70%
	10 - Go To Tap
	11 - Light Tap
	12 - Max Tap
	13 - Max Tap + Ratio 70%
	14 - Max Tap + Ratio 70% Med Hi...
	15 - Max Tap + Ratio 70% Med H...
Update PEO Parameters	
Inst Pump Fill - PEO Method ✓ 43 %	PEO Optimized Rate 0
MPRL 10-min Average ✓ 12858.0000 lbs	PEO Efficiency 0 %
	FW Quick Calc 67.0000 lbs

- System engages pre-defined script depending on issue identified
- End user defines extend of Autonomous changes (starts with least aggressive action)

Problem Resolution / Confirmation - as little as 3 to 4 minutes

SJ Autonomous Optimization - Pump Efficiency Optimizer (PEO)

Autonomous Detection and Real-Time Resolution of Downhole Issues

Pump Efficiency Optimizer Controls:

PEO Spm Adjust Interval ✓ 4	PEO Mode ✓ OFF
PEO Spm Adjust Value ✓ 0.20	PEO Script Card Select ✓ Disabled
Target Pump Fill ✓ 70 %	Stuck SV Start ✓ 1 - Ratio 70%
PEO Spm Minimum Value ✓ 2.50	Stuck SV End ✓ 0 - Disabled
Pump Bore Diameter ✓ 1.5000 in	Stuck TV Start ✓ 1 - Ratio 35%
Estimated Rod Stretch ✓ 3.0000 in	Stuck TV End ✓ 0 - Disabled
PEO Fluid Weight ✓ 6000.0000 lbs	Script Interval (Cards) ✓ 3
	Script Retry Delay ✓ 60 min

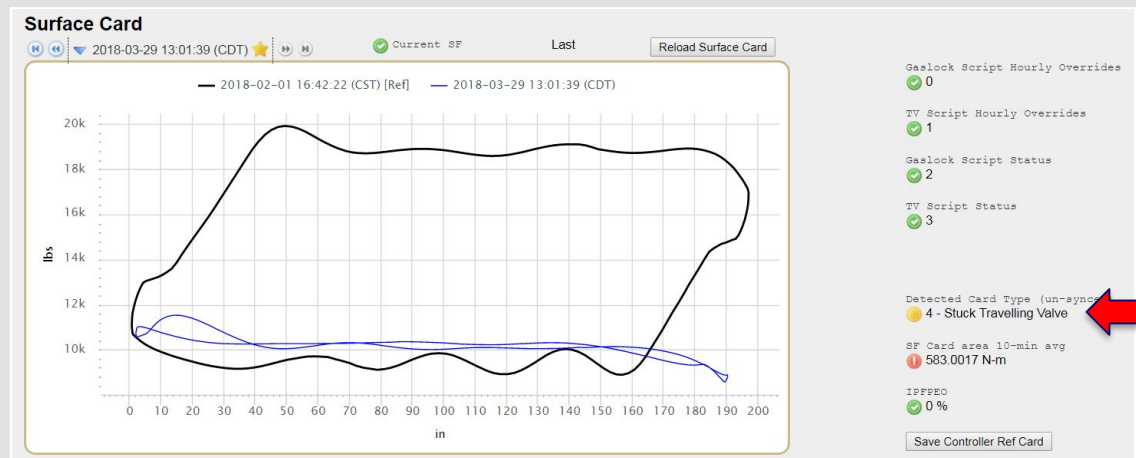
Update PEO Parameters

Inst Pump Fill - PEO Method ✓ 43 %	PEO Optimized Rate ✓ 0
MPRL 10-min Average ✓ 12858.0000 lbs	PEO Efficiency ✓ 0 %
	FW Quick Calc ✓ 67.0000 lbs

- SJ Controller uses card shape (Reference vs Current), rod loads, and other parameters to identify issues. Notifies user of suspected issue.

Step 1: Autonomous downhole issue detection, identification & notification

- Stuck traveling valve
- Stuck standing valve
- Gas lock
- Parted rods
- Hole in tubing
- Partial pump fill



SJ Autonomous Optimization - Pump Efficiency Optimizer (PEO)

Autonomous Detection and Real-Time Resolution of Downhole Issues

Pump Efficiency Optimizer Controls:

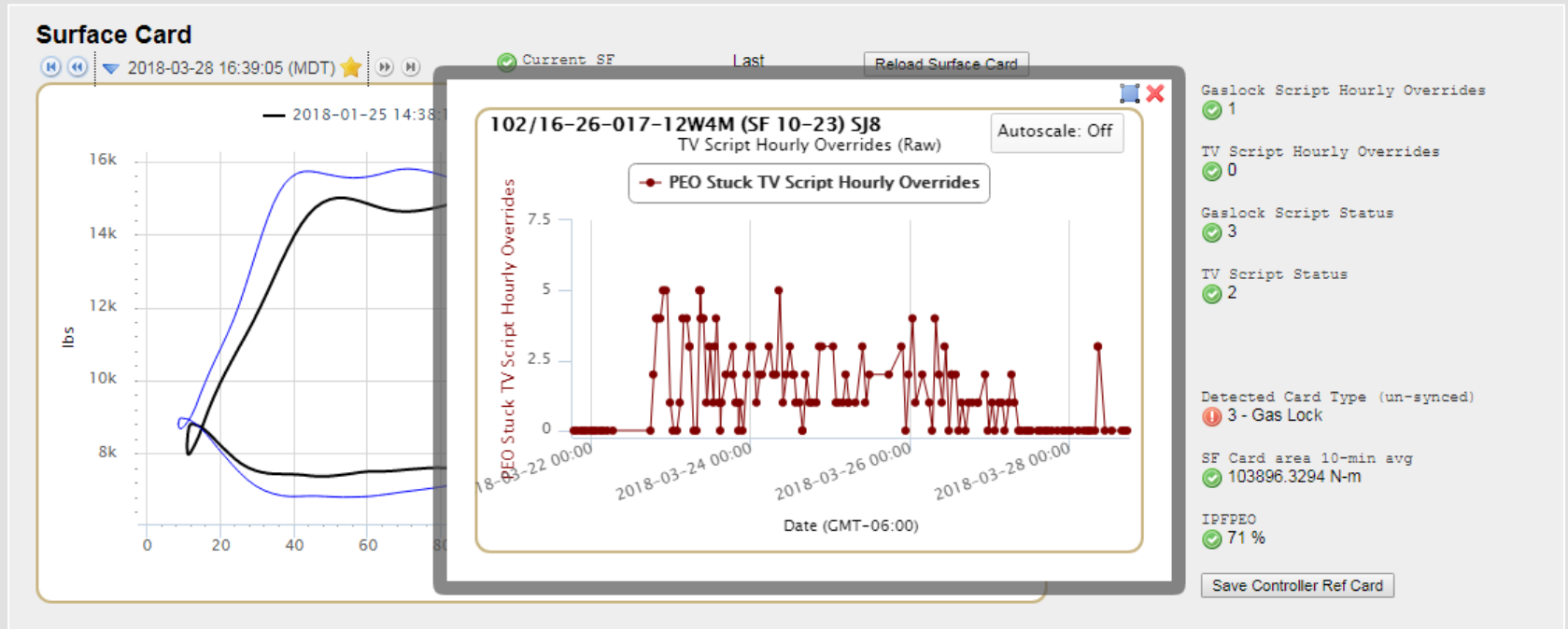
PEO Spm Adjust Interval ✓ 4	PEO Mode ✓ OFF
PEO Spm Adjust Value ✓ 0.20	PEO Script Card Select ✓ Disabled
Target Pump Fill ✓ 70 %	Stuck SV Start ✓ 1 - Ratio 70%
PEO Spm Minimum Value ✓ 2.50	Stu ✓ 0 - Disabled
Pump Bore Diameter ✓ 1.5000 in	Stu ✓ 1 - Ratio 70%
Estimated Rod Stretch ✓ 3.0000 in	Stu ✓ 2 - Ratio 70%
PEO Fluid Weight ✓ 6000.0000 lbs	Stu ✓ 3 - Ratio 70%
Update PEO Parameters	Stu ✓ 4 - Light Tap
	Stu ✓ 5 - Max Tap
	Stu ✓ 6 - Max Tap
	Stu ✓ 7 - Ratio 70%
	Stu ✓ 8 - Ratio 35%
	Scr ✓ 9 - Ratio 70%
	Scr ✓ 10 - Go To Tap
	Scr ✓ 11 - Light Tap
	Scr ✓ 12 - Max Tap
	Scr ✓ 13 - Max Tap + Ratio 70%
	Scr ✓ 14 - Max Tap + Ratio 70% Med Hi...
	Scr ✓ 15 - Max Tap + Ratio 70% Med H...
Inst Pump Fill - PEO Method ✓ 43 %	PEO Optimized Rate ✓ 0
MPRL 10-min Average ✓ 12858.0000 lbs	PEO Efficiency ✓ 0 %
	FW Quick Calc ✓ 67.0000 lbs

Step 2: Autonomous downhole issue resolution

- Stuck travelling valve
- Stuck standing valve
- Gas lock
- Controller initiates script sequence to attempt to resolve identified issue.
- User pre-selects script start and end points
- Significantly reduces issue resolution time for these specific issues compared to manual intervention.

SJ Autonomous Optimization - Pump Efficiency Optimizer (PEO)

Autonomous Detection and Real-Time Resolution of Downhole Issues



- Controller keeps history of how often PEO overrides are engaging to address detected issues

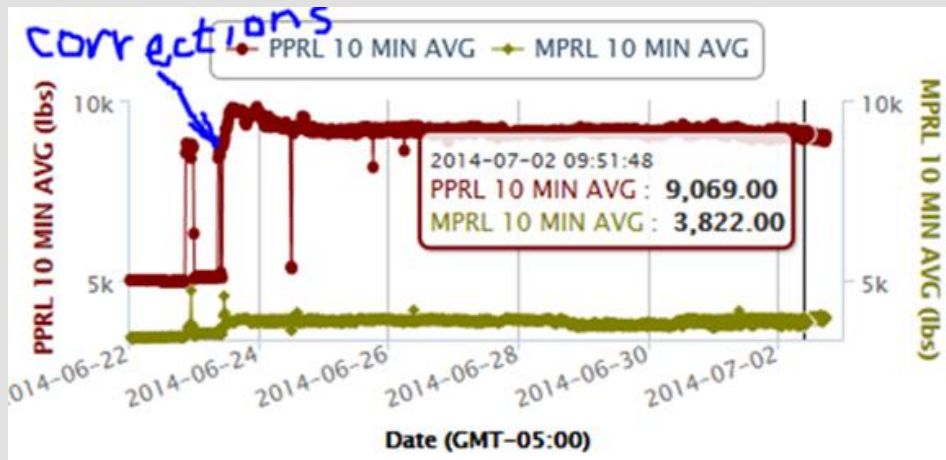
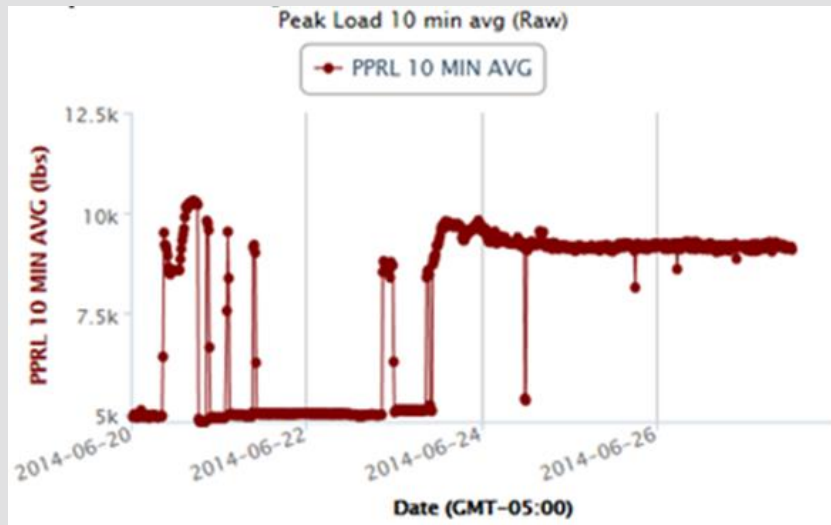
Optimization Case Studies

- Examples of manual Optimization Case Studies performed by the SilverJack Optimization Team

Case 1: Travelling Valve Not Seating

Symptoms:

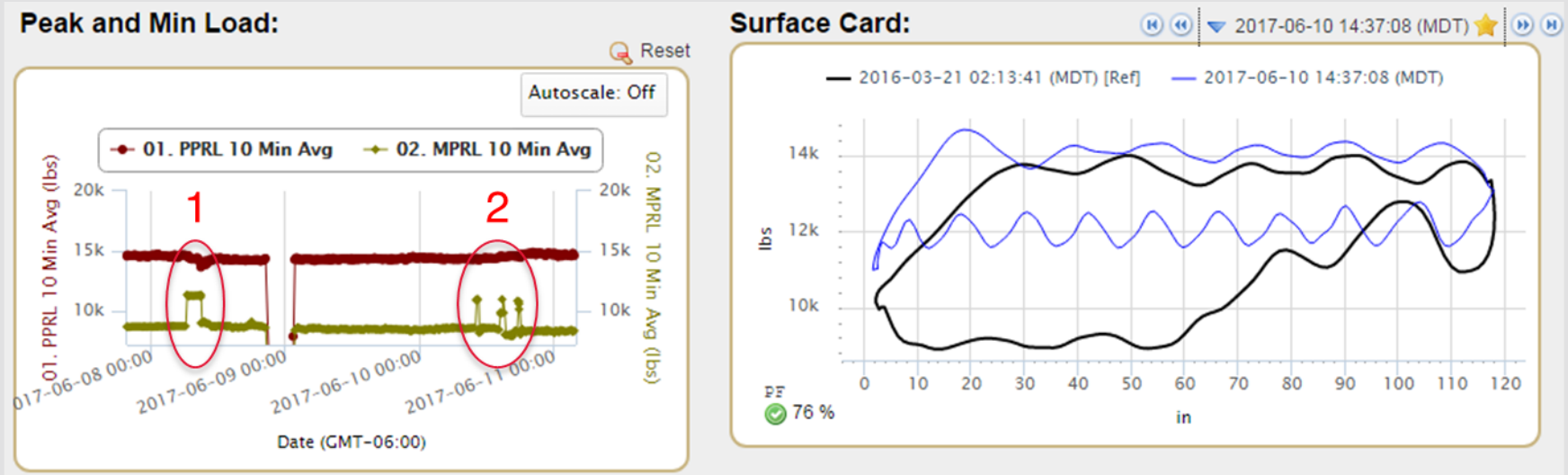
- Sharp drop in upstroke rod load detected via rod load alarm
- Upstroke rod load would return to normal periodically
- **Conclusion:** Travelling valve not seating properly.



Solution: Decrease Stroke Ratio and “Accel time up” to move plunger up faster and snap travelling valve closed.

Benefit: Quick detection avoids lost production. Remote repair avoids trip to site.

Case 2: Standing Valve Stuck Open



Symptom: Min Polish Rod Load (MPRL) “High/High” alarm

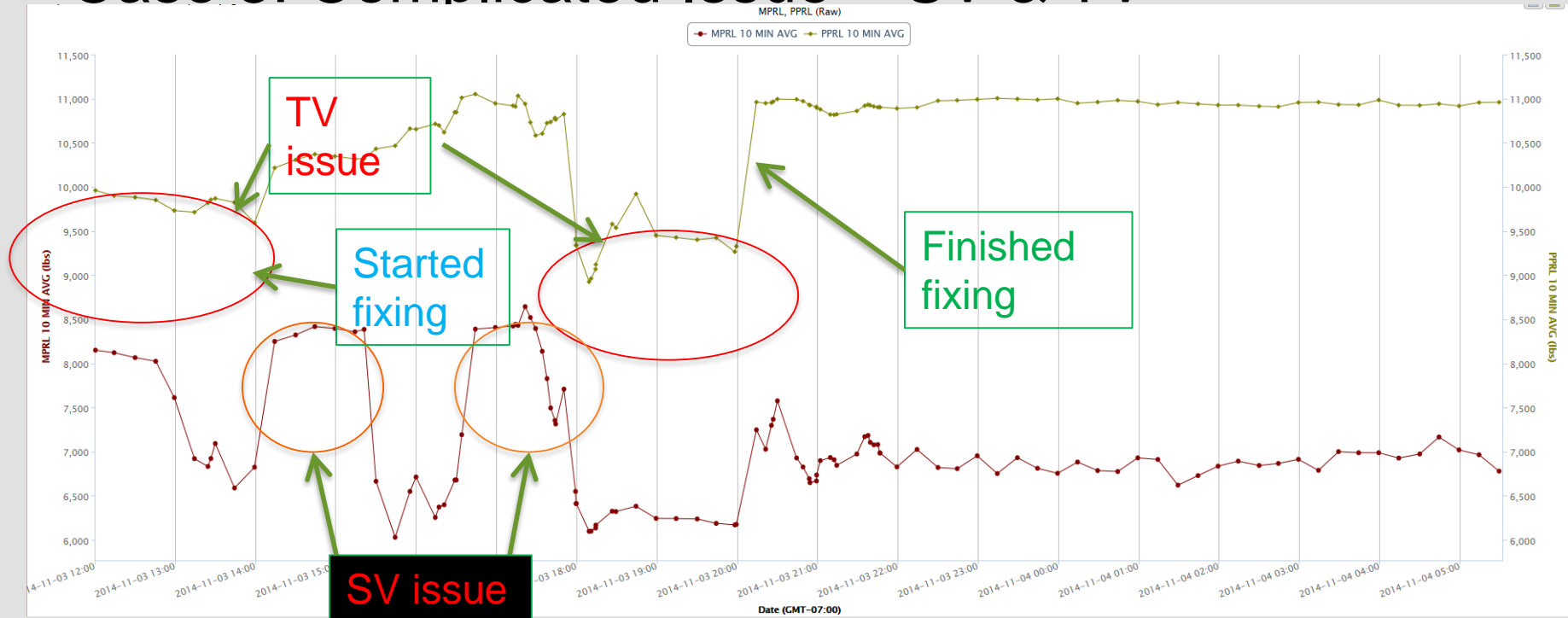
Conclusion: Stuck Open Standing Valve

Action: Remote parameter change - increase stroke ratio (faster down stroke).

NOTE: resolution delayed at “1” due to customer approval delay. Quick resolution at “2” with customer pre-approval.

Benefit: Avoid production loss via rapid remote detection (1-15 min) and remote problem resolution (10-20 min). No site visit required.

Case 3: Complicated Issue – SV & TV



Symptoms:

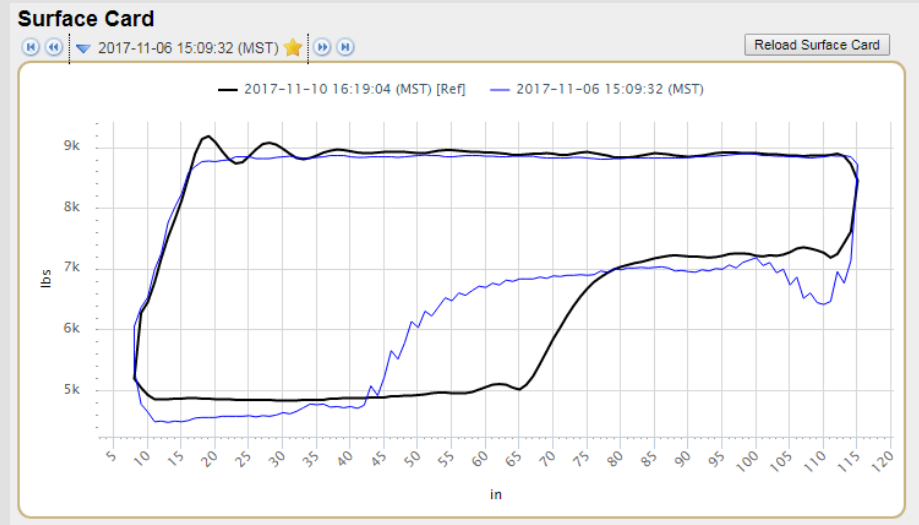
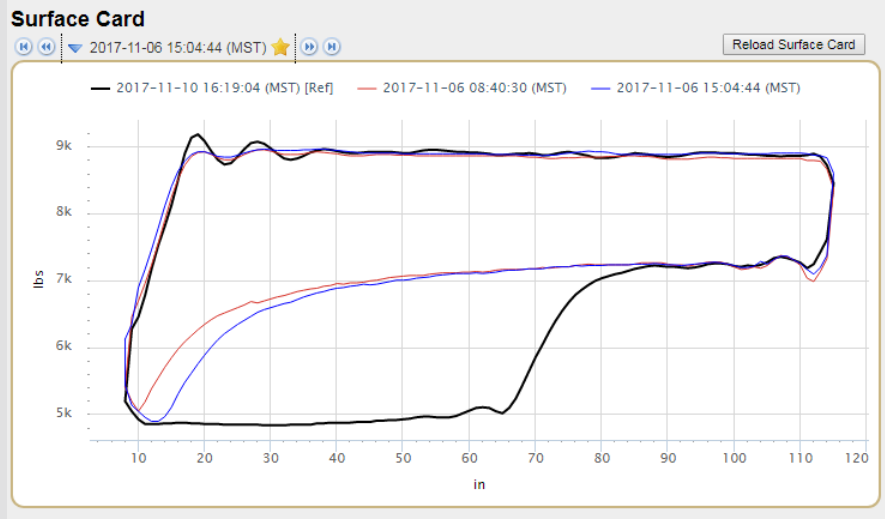
- Reduced upstroke rod load indicating issue with travelling valve
- Increased downstroke rod load indicating gas interference.

Conclusion: Standing Valve and TV issue. Fix for one compounded problem with other.

Solution: Increase upstroke speed, increase downstroke speed, add long bottom dwell to slow overall SPM and avoid pumped off scenario.

Benefit: Significantly increased production

Case 4: Gas Lock



Symptoms: The pump stopped lifting liquid. Pumpfill dropped to zero and pump card showed extreme gas interference.

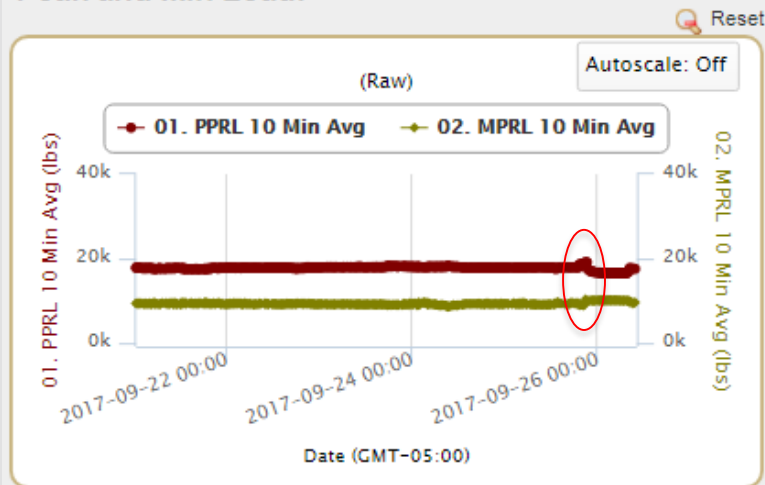
Conclusion: Gas lock

Solution: Stroke ratio setpoint was raised to 70% (slow up and fast down) to create light vibration on traveling valve. Gas lock fixed in a few minutes.

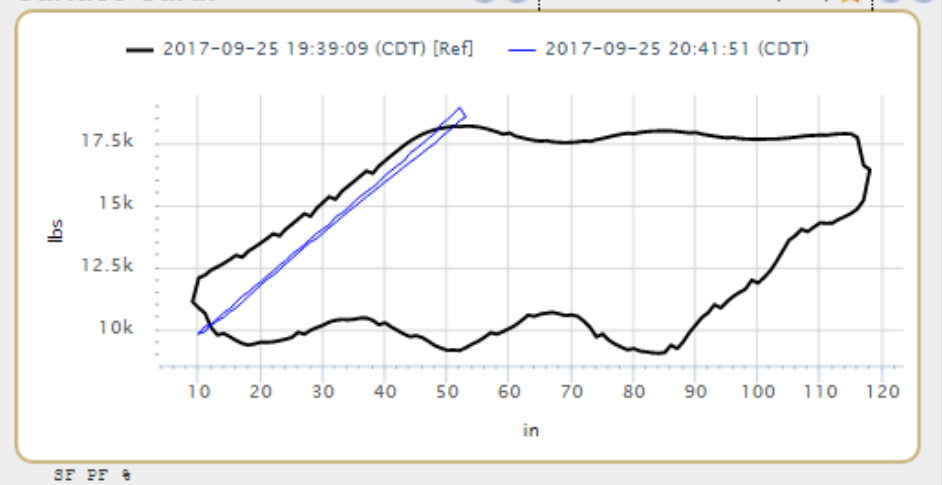
Benefit: Fast detection. Remote diagnosis & resolution. Unfortunately history shows this only works in 50-70% of cases .

Case 5: Seized Insert Pump

Peak and Min Load:



Surface Card:



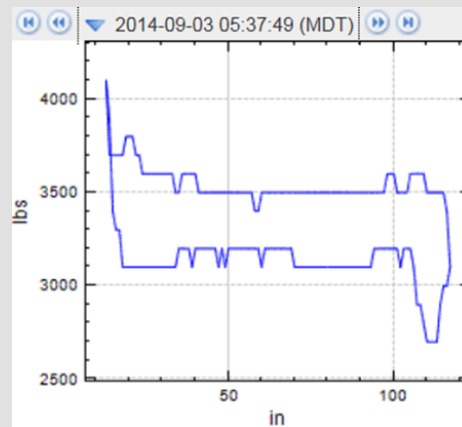
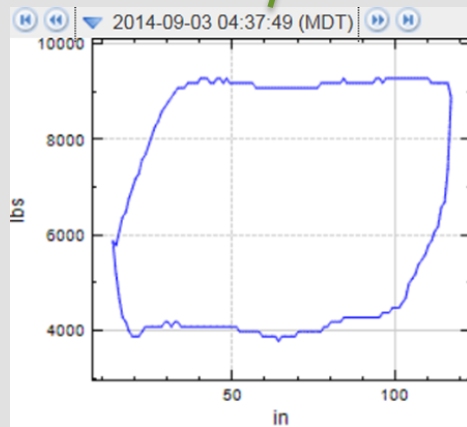
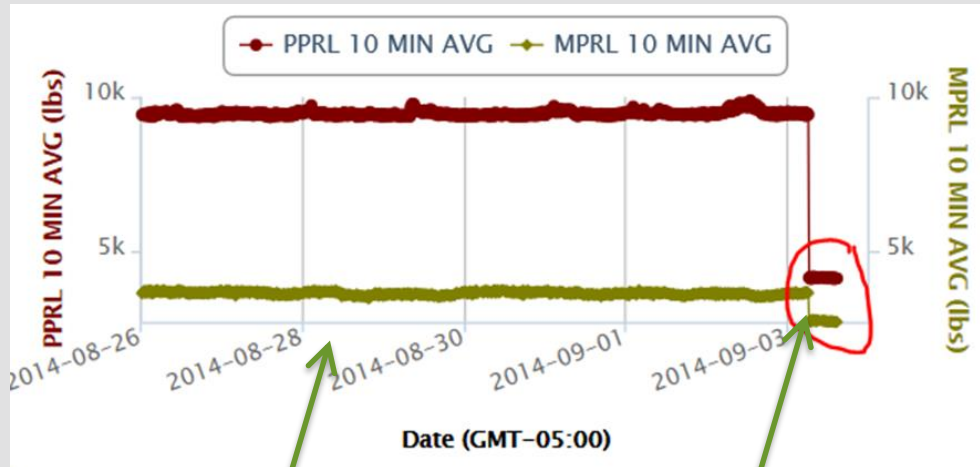
Symptoms: Pump shutdown due to high rod load alarm. Shutdown card shown too high rod load at upstroke above 60 inches.

Conclusion: The plunger seized in the barrel.

Solution: Top position setpoint was lowered at 55 inches and restarted for overnight for natural clean up and pump release.

Benefit: Fast detection, diagnostic, restart. The plunger was released itself next morning and top position raised step by step. Remote manipulations allowed avoiding trip to site, clean up treatment and possible pulling the pump.

Case 6: Parted Rods



Symptoms:

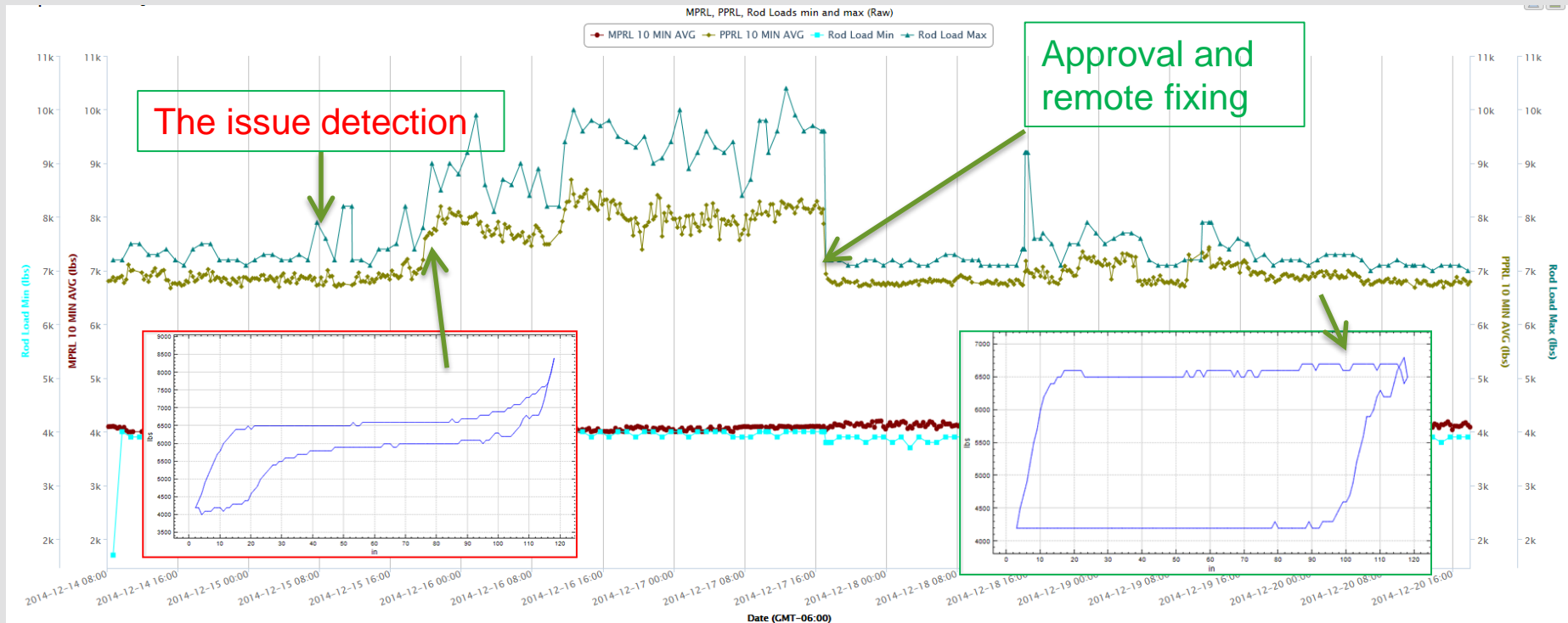
- Both upstroke and downstroke rod loads sharply decreased at the same time (flagged by alarms)
- Rod loads flat-lined

Conclusion: Parted rods

Solution: Well work-over

Benefit: Fast detection minimizes lost production

Case 7: Top Tapping Due to Debris in Pump



Symptoms: On upstroke, PPRL increased at 90 inch mark. Detected via rod load alarm.

Conclusion: Top tapping due to debris at the top of the pump

Solution: Top position setpoint was decreased for a few days for natural clean up

Benefit: Quick detection avoided equipment damage. Remote fix avoided trip to site.

Case 8: Bottom Tapping Due to Debris in Pump



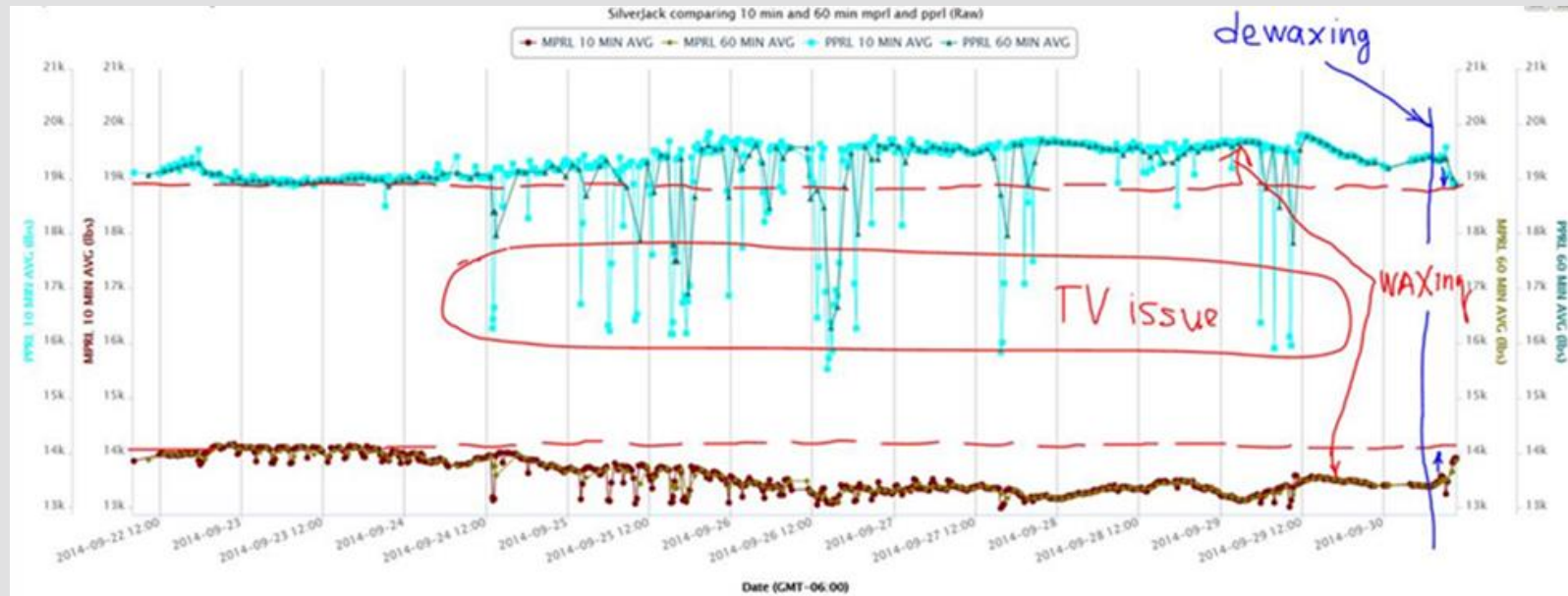
Symptoms: On downstroke, min rod load dropped at 10 inch mark. Detected via rod load alarm.

Conclusion: Bottom tapping due to debris at the bottom of the barrel

Solution: Bottom position set point increased to 15" for 1 day for natural clean up

Benefit: Fast detection avoided equipment damage and production drop. Remote fix avoided trip to site and clean up treatment.

Case 9: Complicated Issue – Waxing & TV



Symptoms:

1. Upstroke rod load increased at the same time as downstroke rod load decreased
2. Several more severe drops in upstroke load indicating travelling valve issues

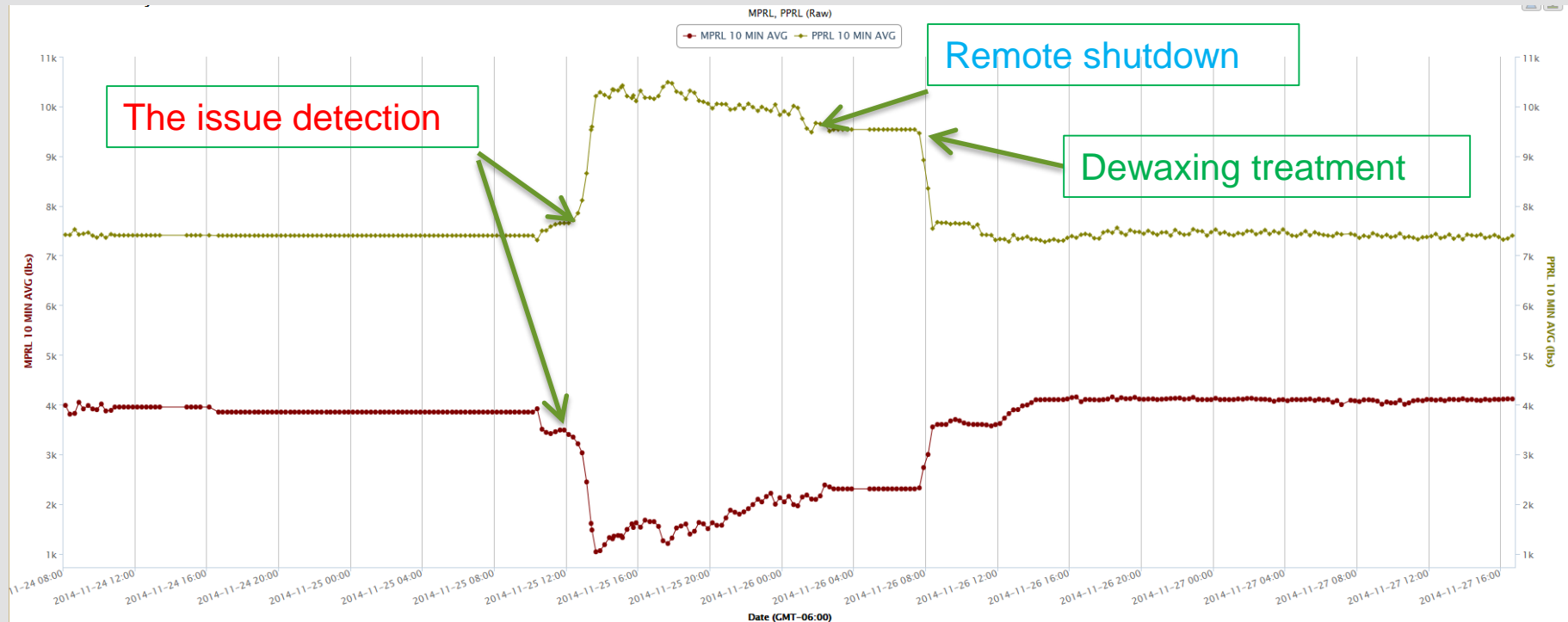
Conclusion: Waxing issues and travelling valve not seating properly

Solution: Dewaxing treatment

Benefit: Quick detection avoided equipment damage

SilverJack Optimization Case Studies

Case 10: Wax Build-Up



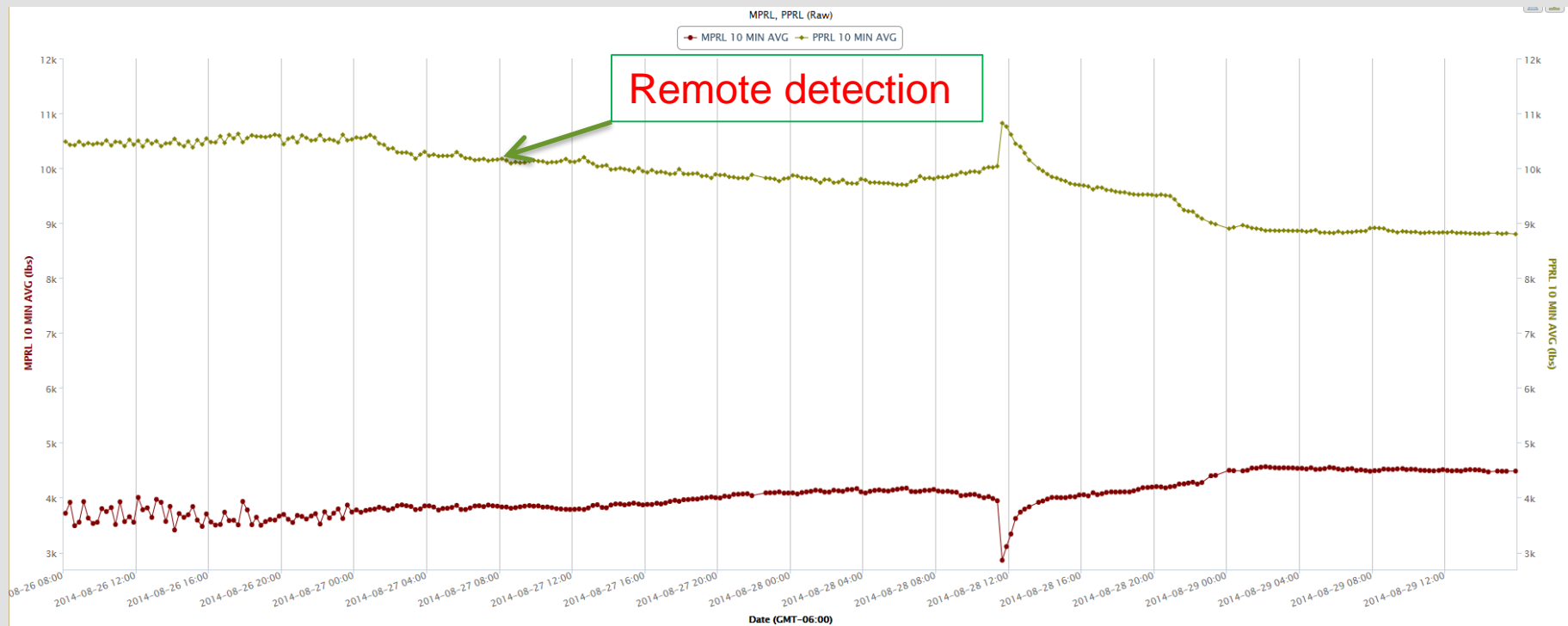
Symptoms: Mirrored change to max and min rod loads. Detected via rod load alarms.

Conclusion: Waxing build-up issue

Solution: Dewaxing treatment

Benefit: Fast detection prevents damage from parted rods. Optimize use of dewaxing chemicals.

Case 11: Hole in Tubing



Symptoms: Smooth upstroke rod load decrease. Detected via rod load alarm

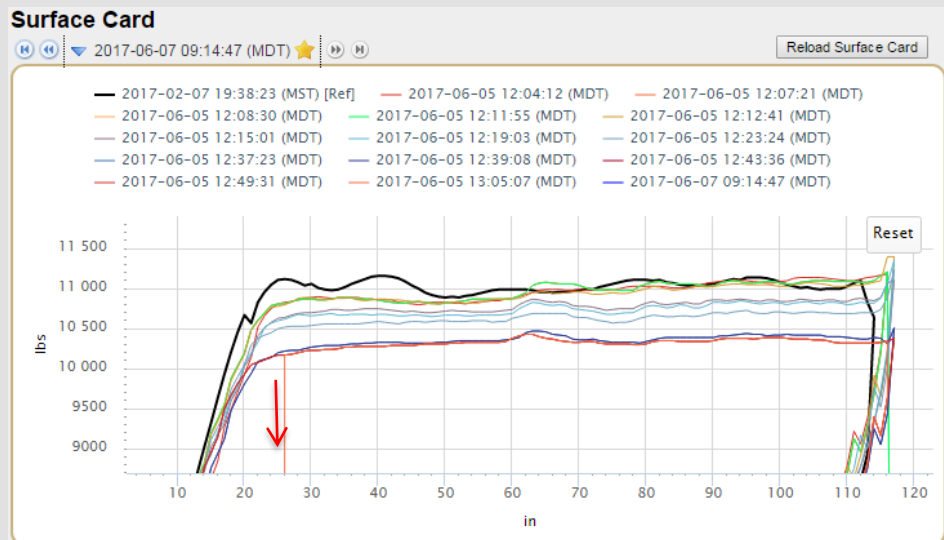
Conclusion: A hole in the tubing (or pump)

Solution: Well work-over

Benefit: Remote detection. Avoid lost production.

Case 11: Hole in Tubing (con't)

Example of Troubleshooting Technique



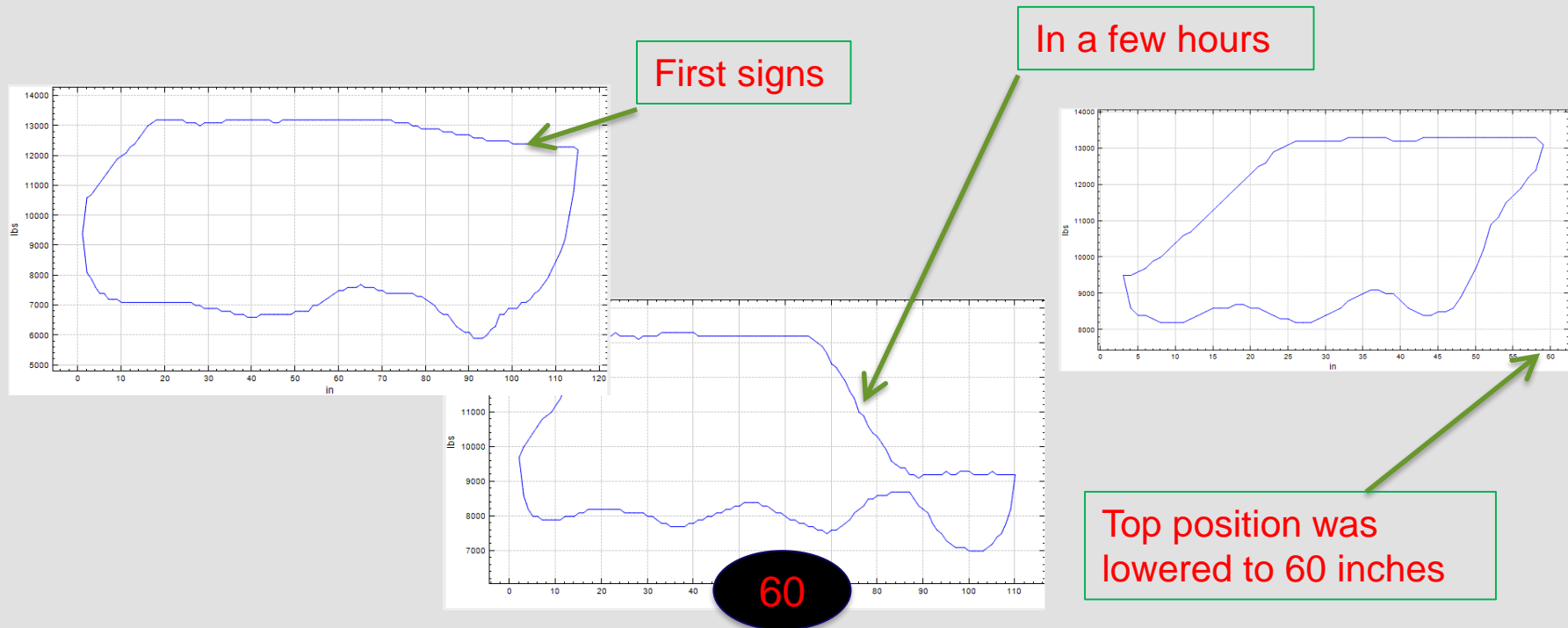
Reported Problem: Production dropping. No obvious problem. No visible change in PPRL.

Troubleshooting Steps: (1) Remotely reduced stroke rate, 5 SPM to 1 SPM, (2) Demand polled pump cards, (3) overlaid pump cards to compare.

Conclusion: At 1 SPM, PPRL slowly dropping (fluid escaping through hole exceeded amount being lifted). Column of fluid dropping. No surface production.

Benefit: Minimized troubleshooting time & cost. Identified problem remotely in 1hr with no field testing.

Case 12: Worn or Split Barrel



Symptoms: Sharp rod load drop part way through upstroke. Only visible on pump card as reported PPRL is not impacted.

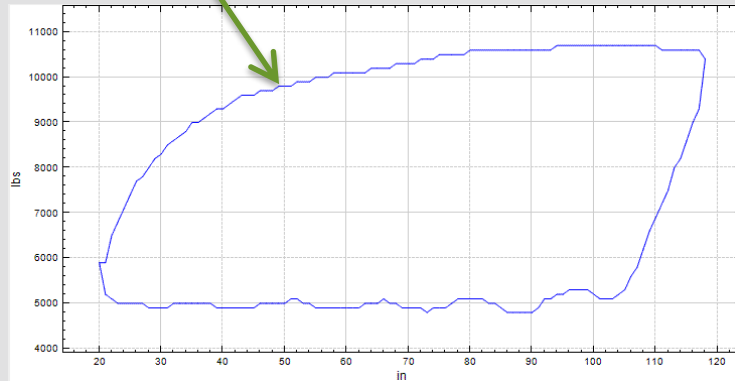
Conclusion: Worn or split barrel

Solution: Well work-over. Possibly continue with reduced production by lowering top set point to just below start of rod load drop.

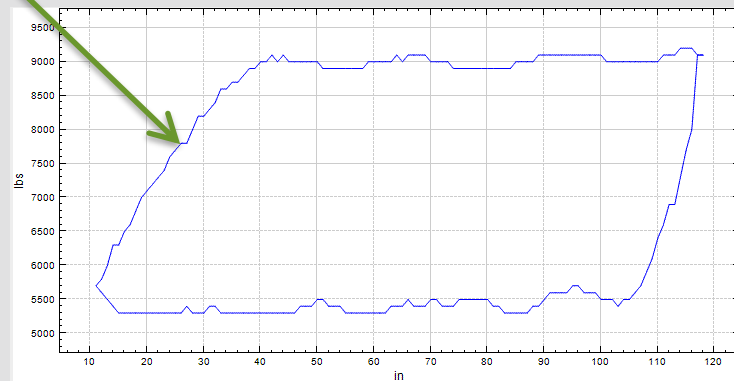
Benefit: Remote detection. Avoid lost production.

Case 13: Worn plunger or travelling valve

First signs



Fastest upstroke and acceleration time up



Symptoms: Gradual transferred weight gain through the start of upstroke. Only visible on pump card. PPRL drops at lower stroke rate.

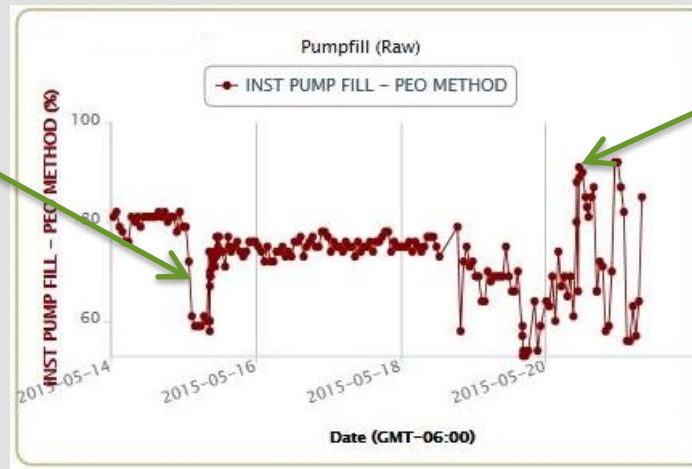
Conclusion: Worn plunger or travelling valve

Solution: Possibly continue with fast upstroke, high acceleration and deceleration at upstroke or well work-over

Benefit: Remote detection. Avoid lost production.

Case 14: Clogged Pump Intake

Fast Pump fill
drop



Pump fill
recovering during
the soaping

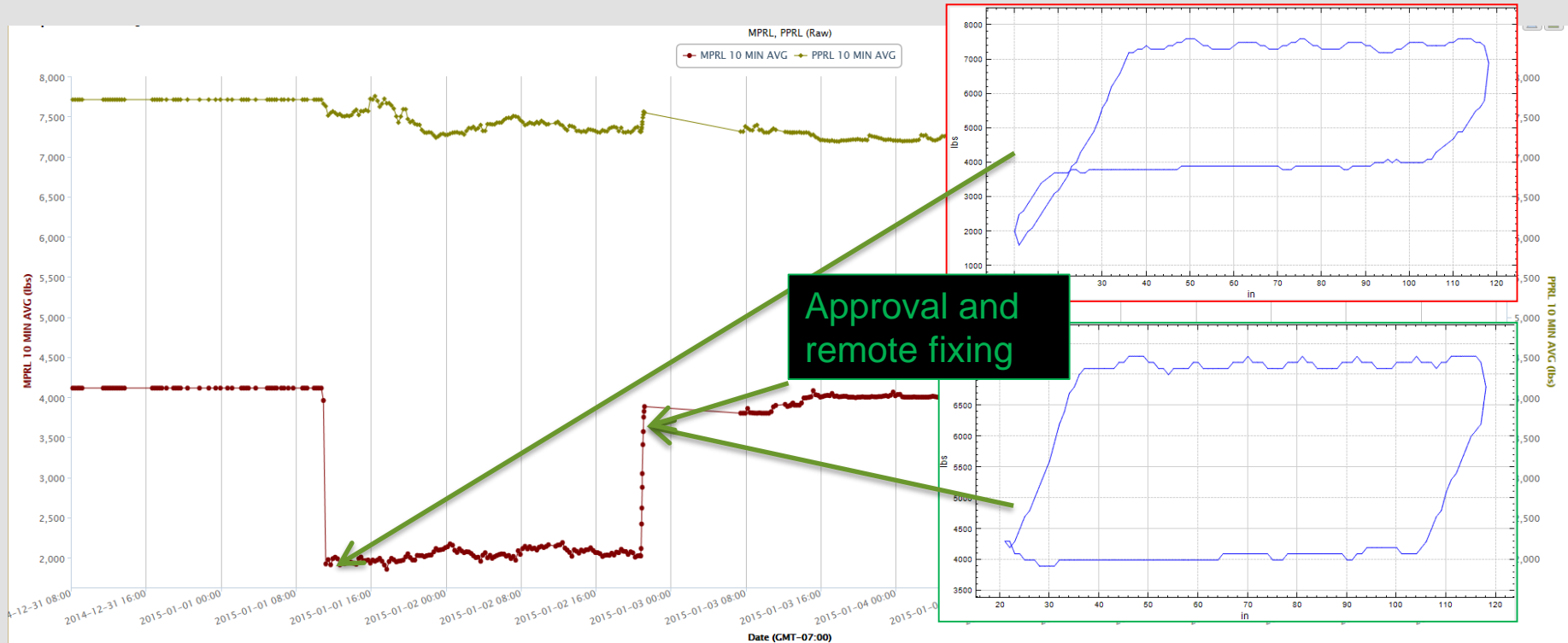
Symptoms: Too fast pump fill drop (1-2 hours) and stabilization next. Pump fill does not grow enough at lower stroke rate.

Conclusion: Restriction in pump intake (debris).

Solution: Producer Flushed the pump as there was no benefit of slowing stroke rate as it was not a “pumped off” condition.

Benefit: Fast remote detection. Avoid lost production.

Case 15: Bottom Tapping



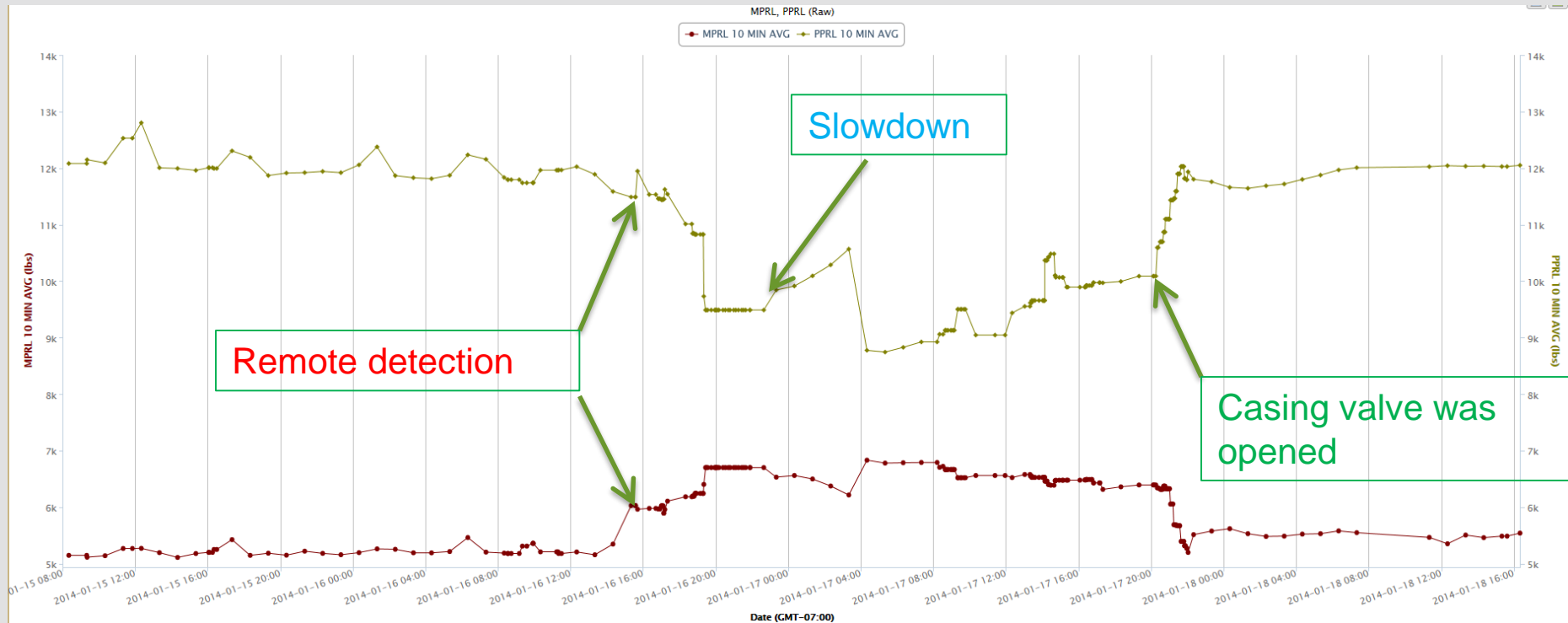
Symptoms: MPRL significantly dropped after well work-over. Detected via rod load alarm.

Conclusion: Bottom tapping (rig crew had bottom position set too low)

Solution: Bottom position setpoint increased to 10 inches

Benefit: Fast detection to avoid equipment damage. Remote fix to avoid trip to site.

Case 16: Casing Valve Left Closed



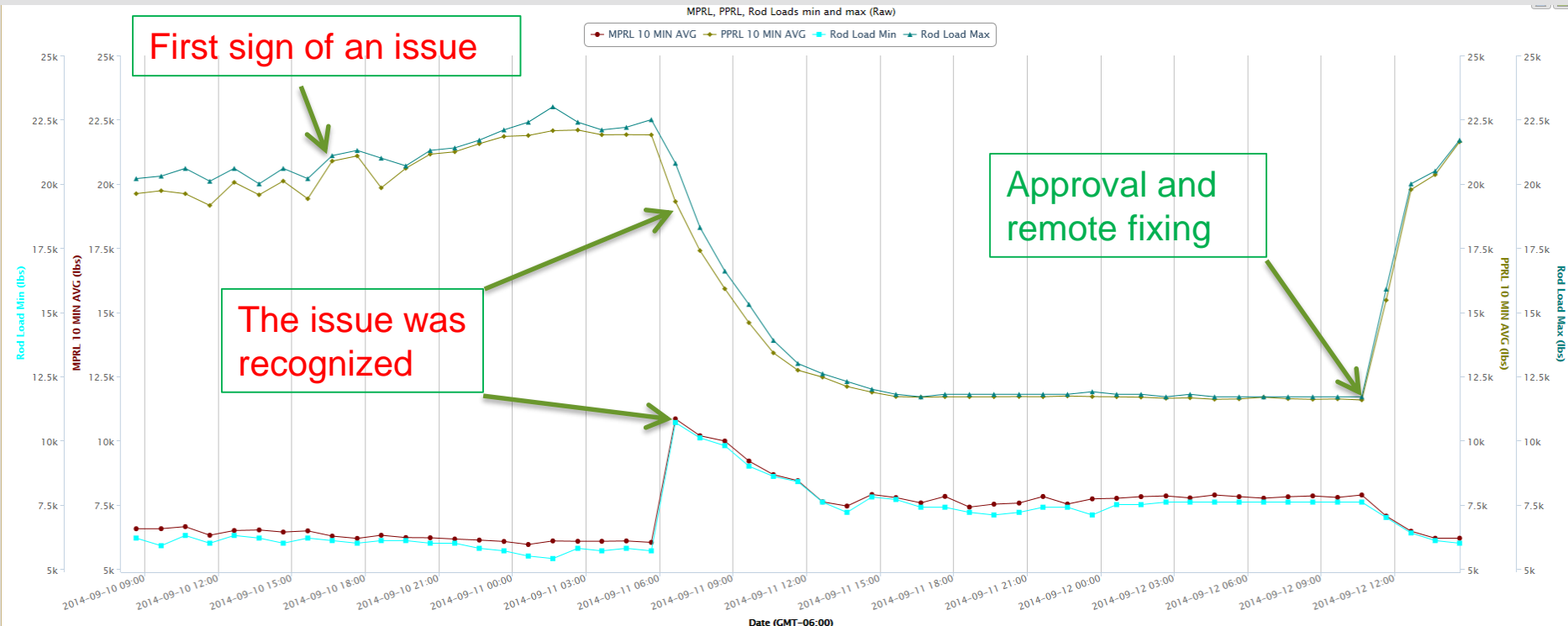
Symptoms: Quick, significant drop in pump fill and upstroke rod load, increase in downstroke rod load. Detected via rod load alarm.

Conclusion: Casing valve closed

Solution: Travel to site and open casing valve

Benefit: Quick detection avoided lost production.

Case 17: Debris in Downhole Pump Valves



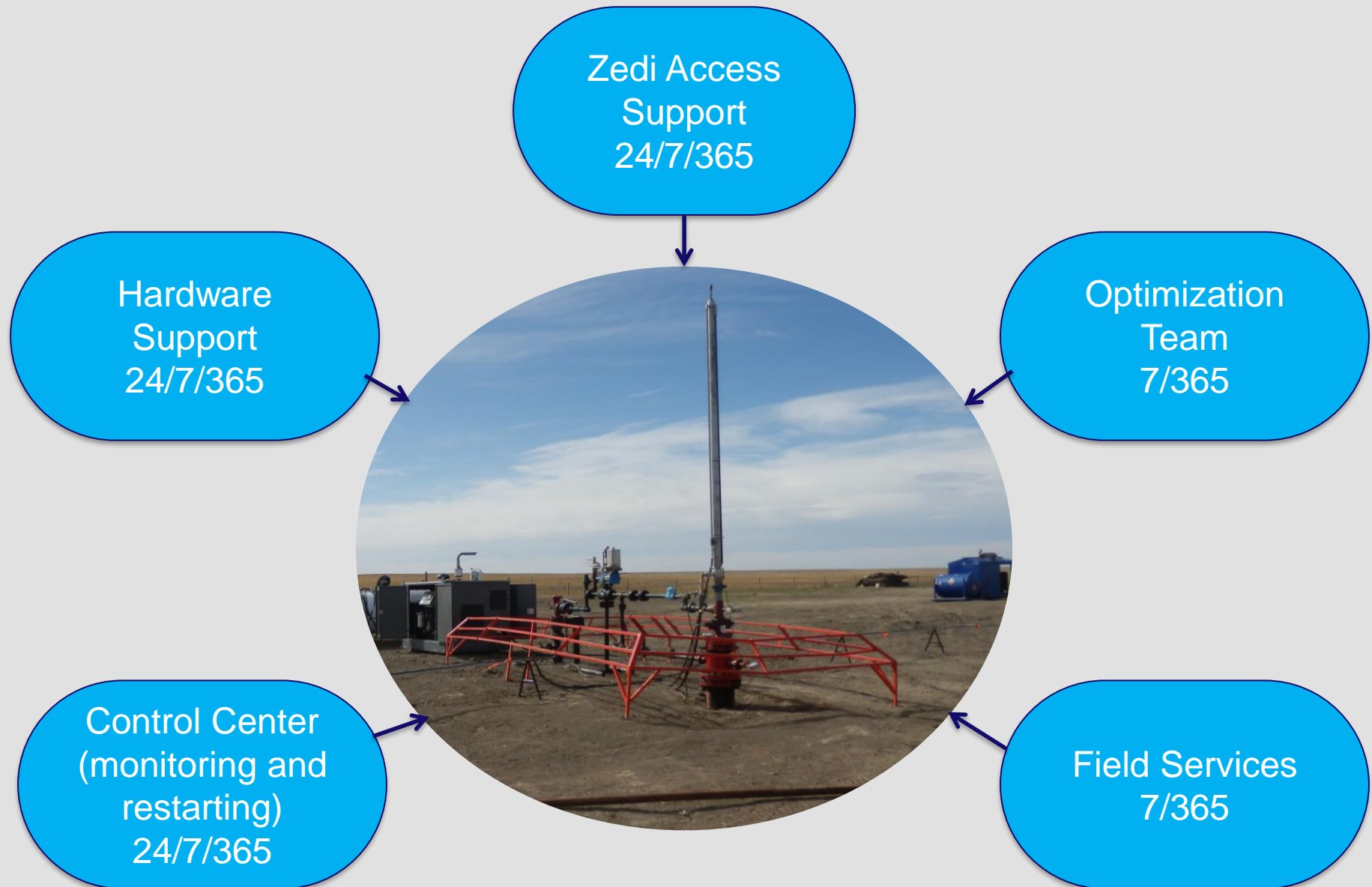
Symptoms: Smooth drop in upstroke rod load detected via rod load alarm

Conclusion: Downhole pump valves not seating properly due to debris

Solution: Stroke Ratio and “Accel time up” changed for faster upstroke, short term tagging regime. Backside if remote action doesn’t work.

Benefit: Relatively fast detection to avoid lost production. Remote resolution avoids trip to site.

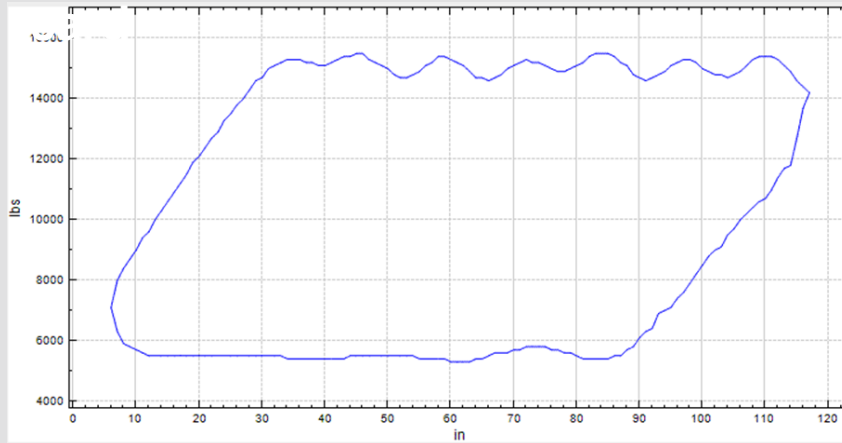
Customer Support Model



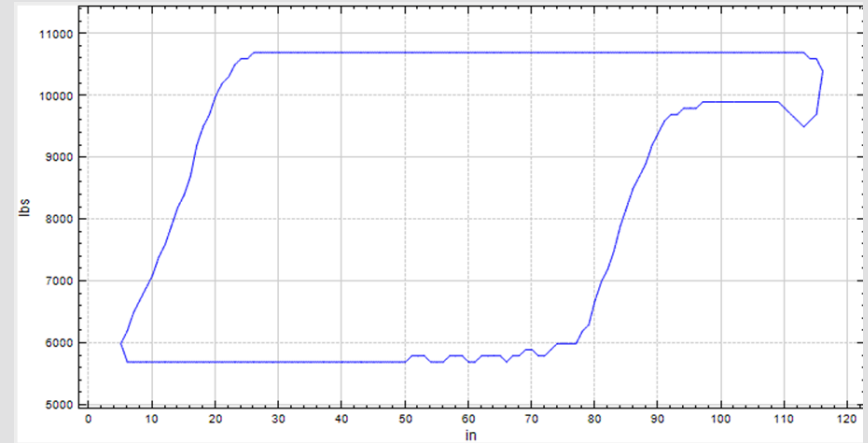
Appendix

Pump Cards (Surface) - Common Shapes

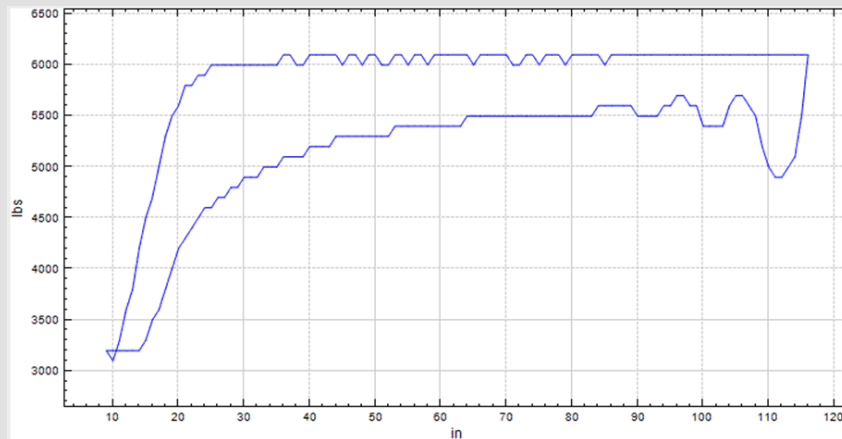
Full



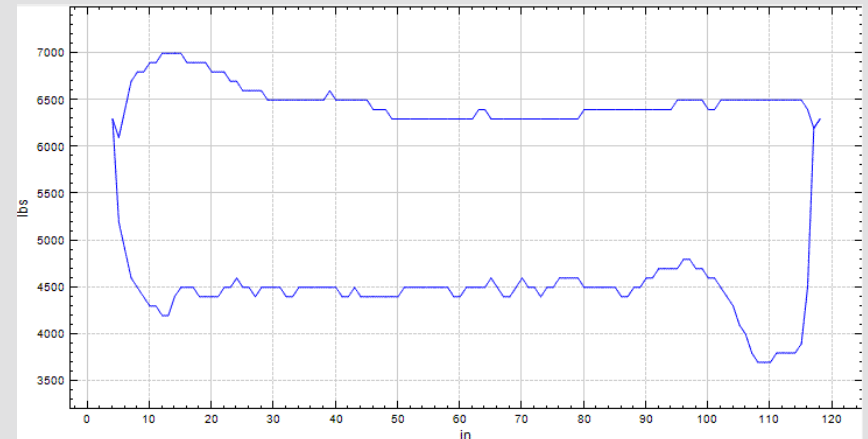
Partial Pump Fill



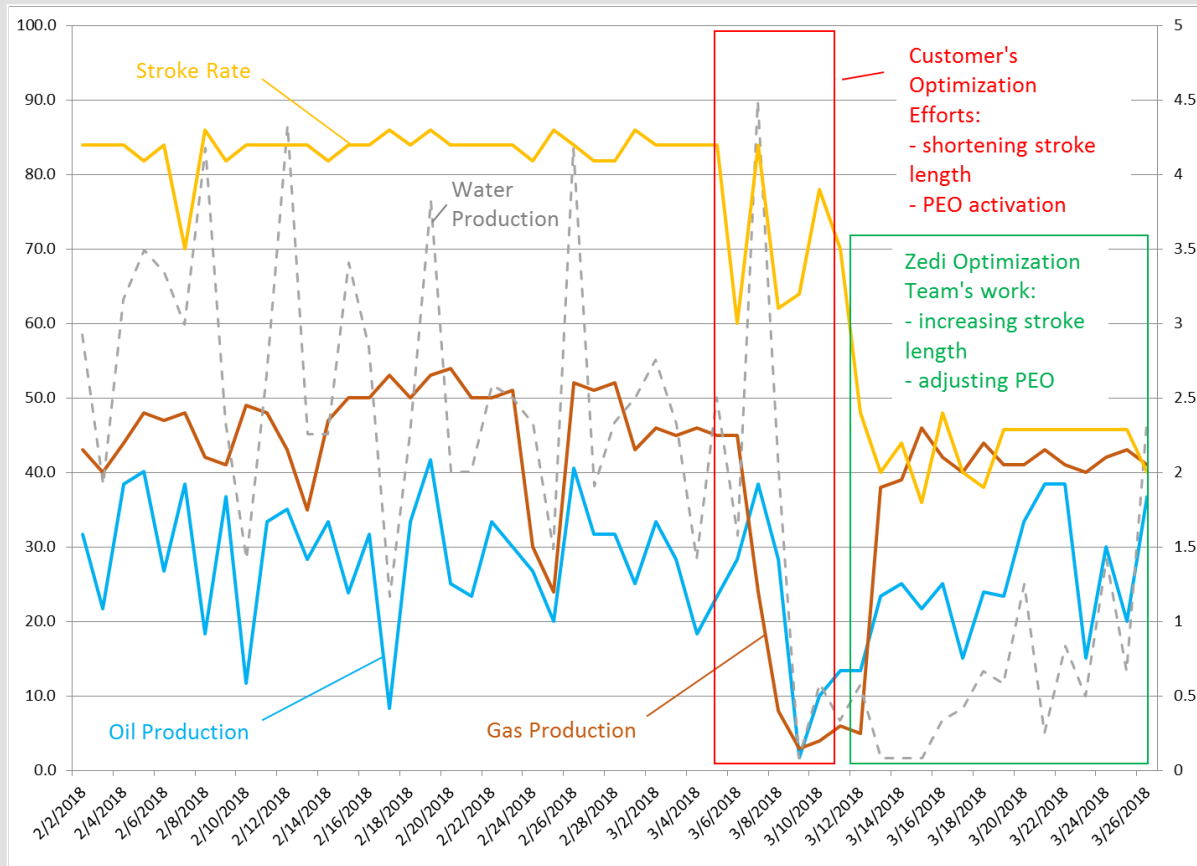
Gas interference



Flowing well



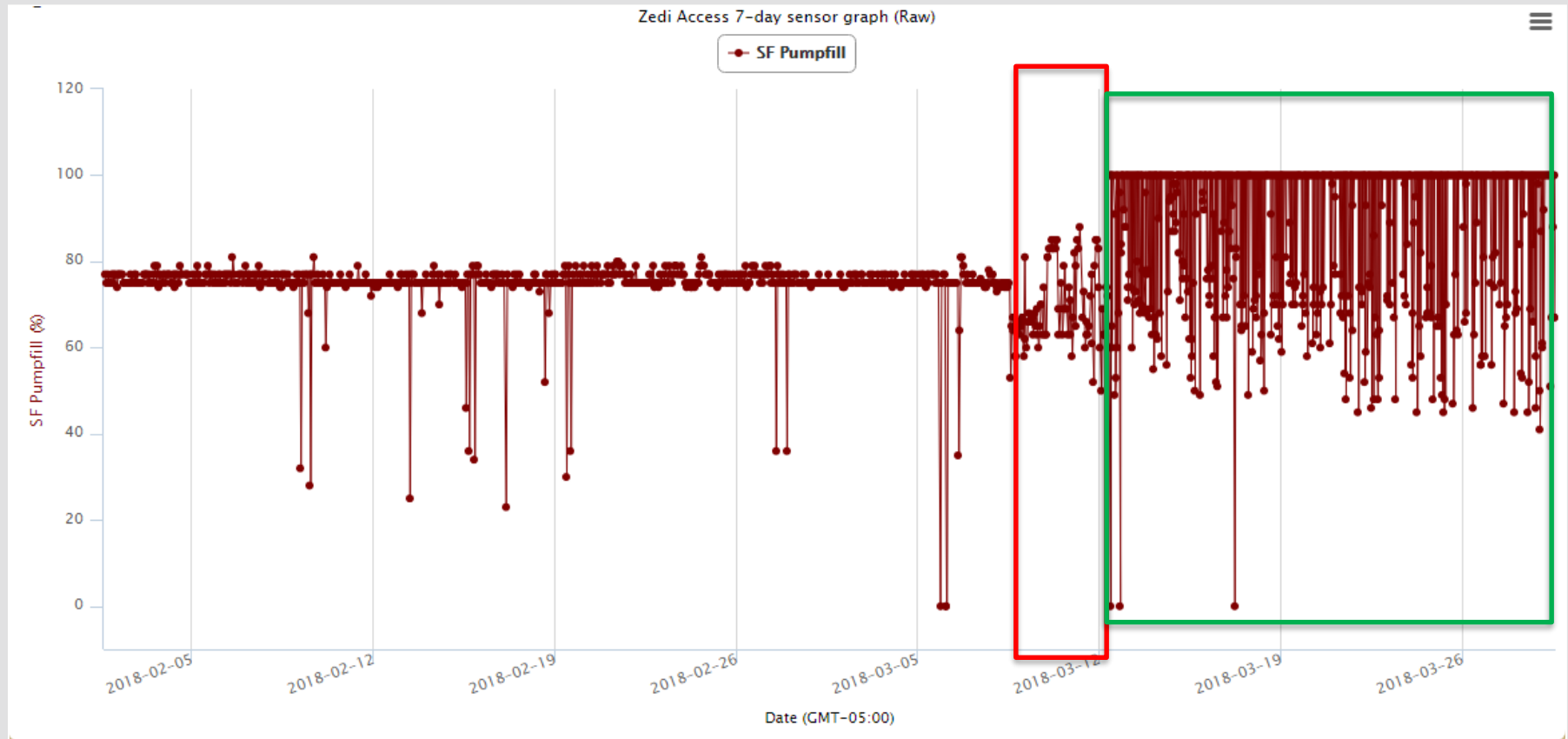
Optimization Example – Fluid Pound Issue



Initial To Resolve: Fluid Pound

- Customer had initial thoughts on how to address fluid pound but changes resulted in drop in oil and gas production
- Engaged Zedi Optimization team and found operating parameters that re-established oil and gas production, reduced fluid pound and cut SPM in half

Optimization Example – Fluid Pound Issue (con't)



- Initial changes resulted in lower average pumpfill making problem worse.
- Increasing stroke length, reducing stroke speed and fine tuning PEO settings significantly increased average pumpfill.
- Autonomous pump off control functionality engaging whenever pumpfill drops