ASME

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Gas Lift Optimization and Surveillance Using Dedicated Resources

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ExxonMobil™

Outline

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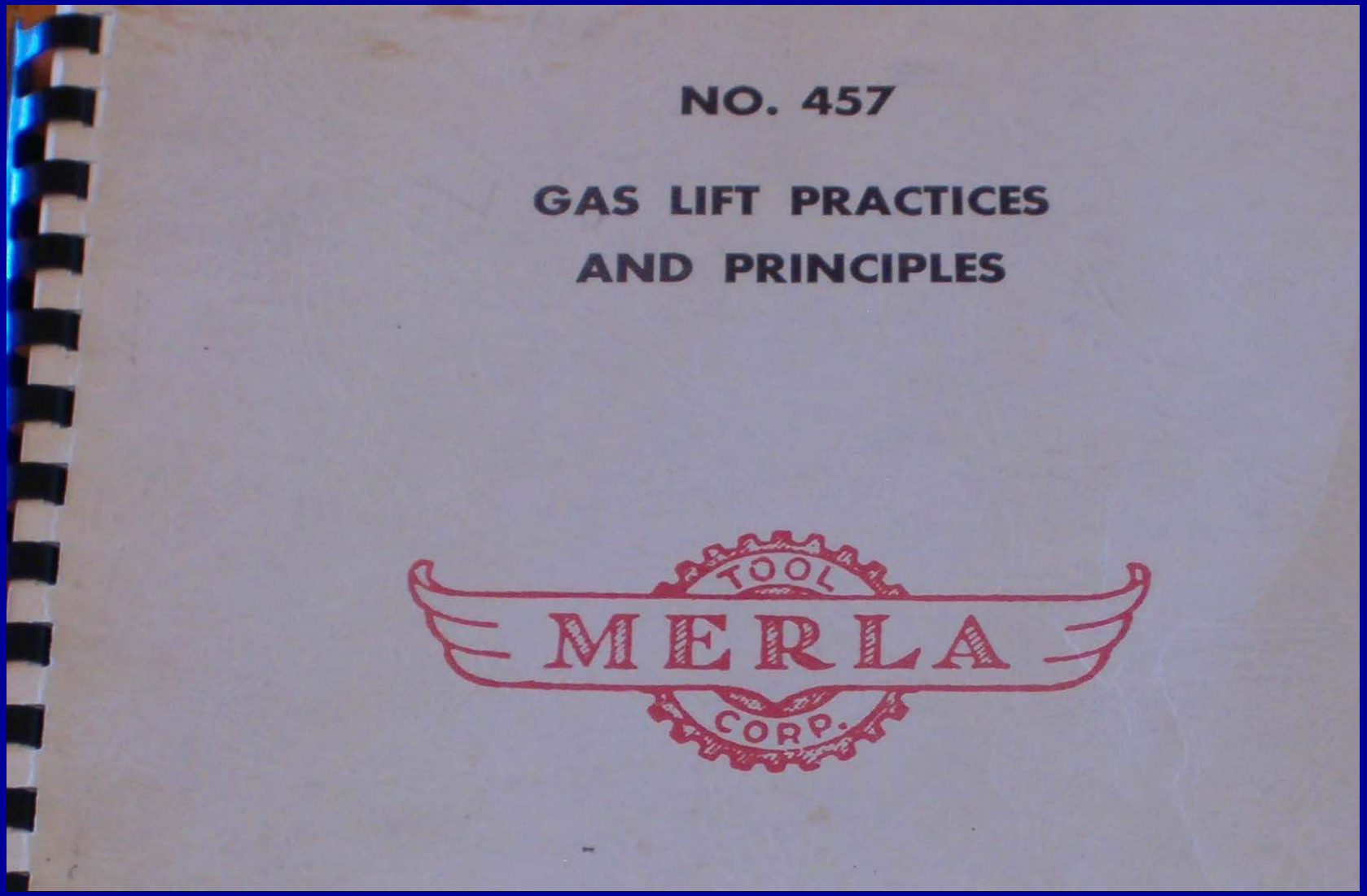
- **Surveillance and Optimization**
  - **What is true surveillance and optimization? How are they tied together? What are the real benefits?**
- **Two Case Examples**
  - **How was it done before, obstacles and inefficiencies? What processes and tools were used? Can improvements be made?**
  - **What new tools and processes were used? What was the benefit? What key learnings can be applied to future efforts?**

Historical Thoughts on Surveillance and Optimization



Historical Thoughts

'One of the major factors contributing to efficiency is operating personnel. Improper adjustment of chokes or surface controllers, caused by lack of knowledge or indifference, is probably the greatest factor contributing to inefficiency. '

Merla Tool Corp.

Gas Lift Practices and Principles

Historical Thoughts

'In continuous-flow gas-lift installations, there is a natural tendency to over-inject gas when a well is not making its required production and to leave the installation alone when the well flow appears reasonable.'

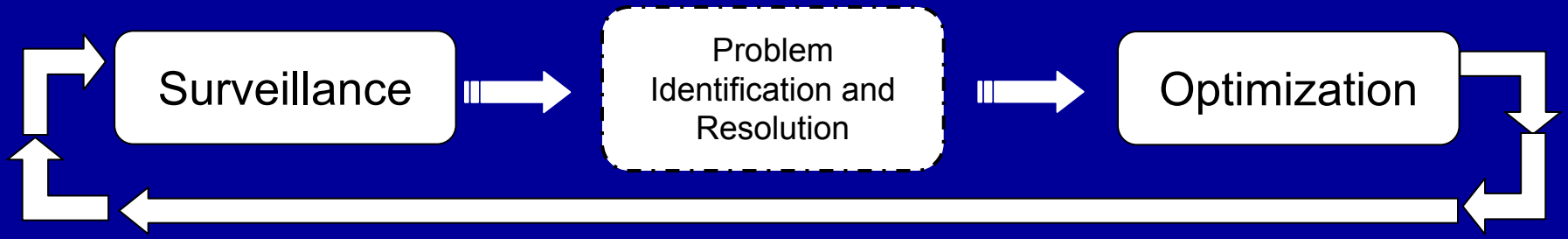
Exxon Production Research

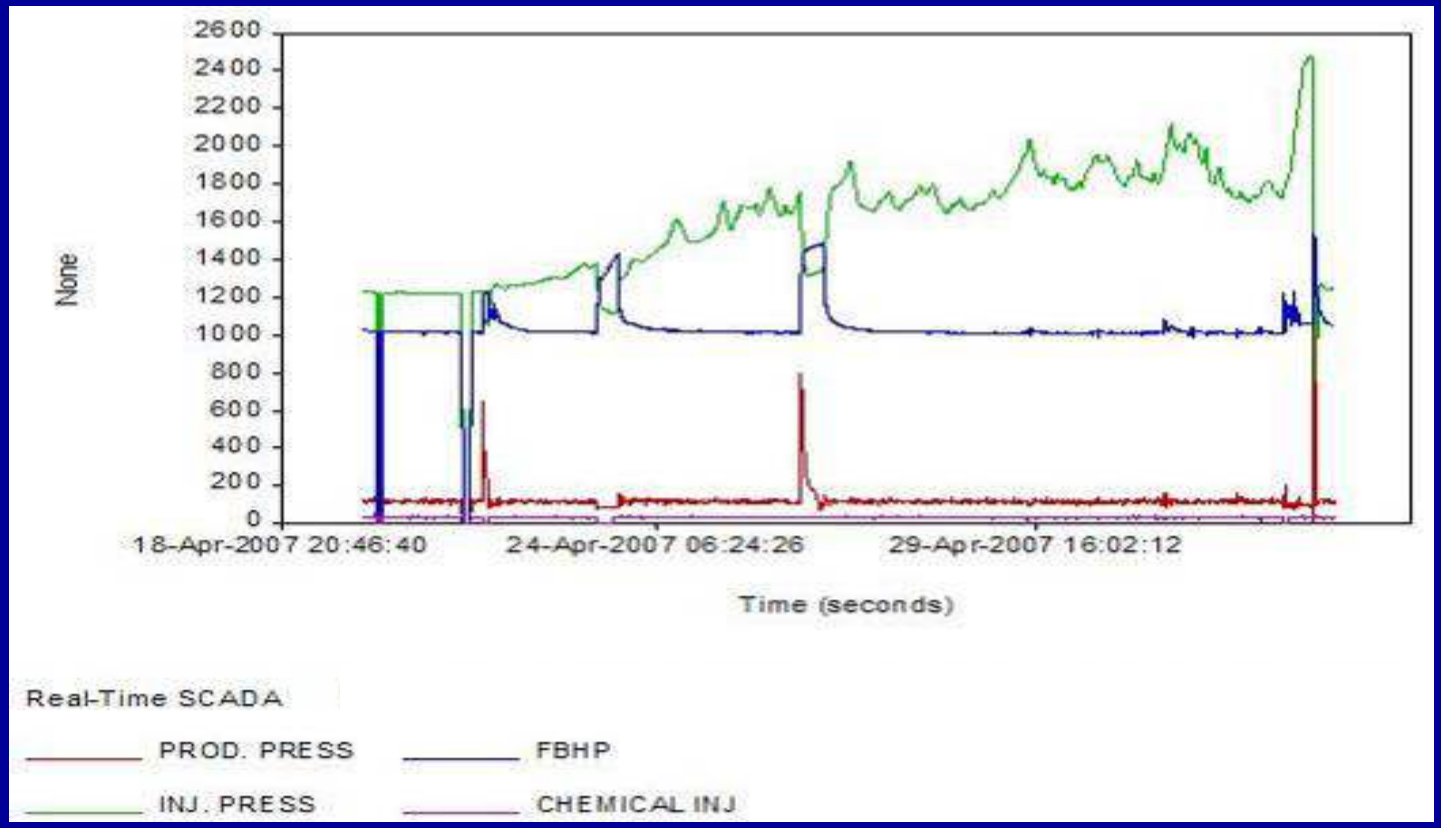
Artificial Lift – Volume 1

Gas Lift

1982

Optimization *and* Surveillance





Optimization and Surveillance Benefits

ExxonMobil operates ~ **600** Gas Lift Wells in US

> 100 Platforms

Oil Production > **140,000** BPD

Water production > **500,000** BPD

1% increase in production would result in 1,400 BOPD

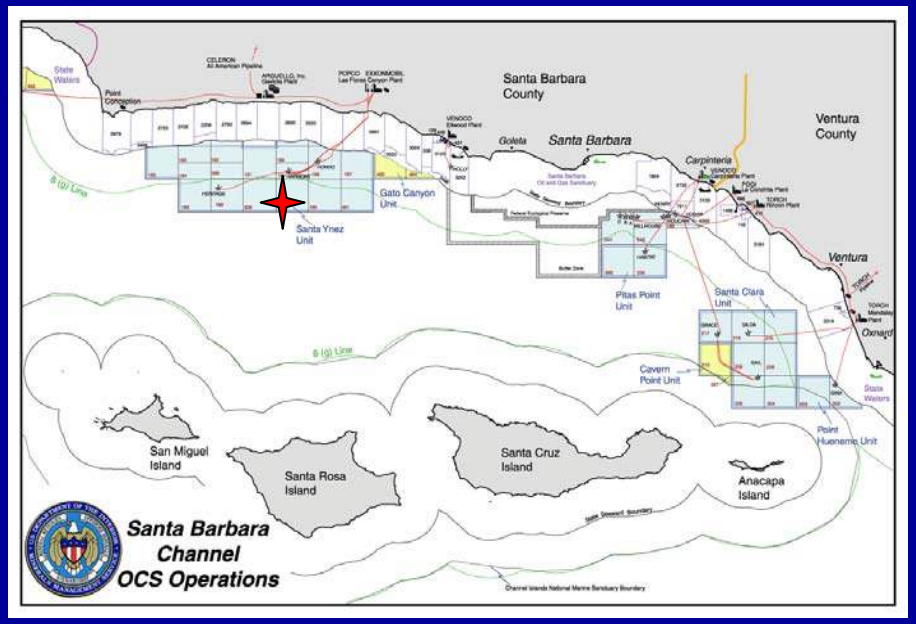
The total number of gas lifted wells increases each year. The more effective the optimization and surveillance the fewer man hours are needed to optimize the same number of wells.

Two Case Examples

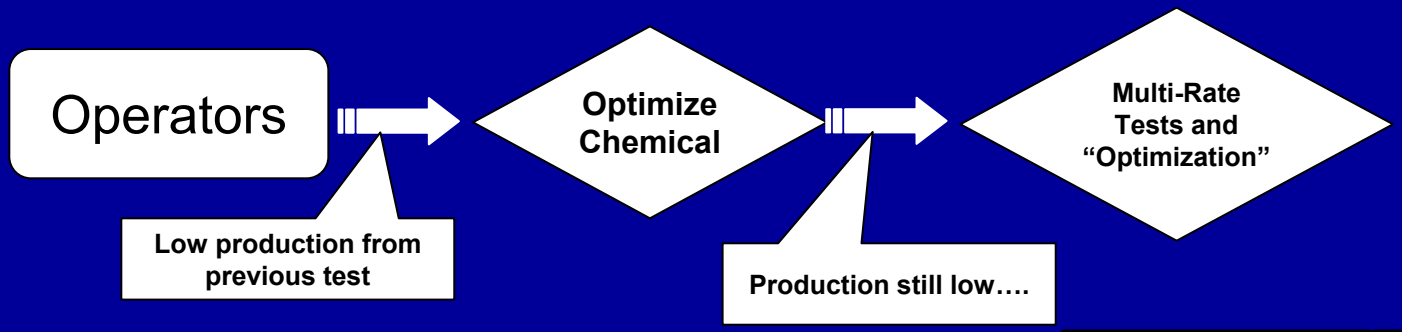
- SYU – Offshore California
  - 6 Month Pilot on Heritage Platform (Fall 2006)
    - Develop Optimization and Surveillance Process
    - Utilize Nodal Analysis / Gas Lift Modeling (WinGLUE by Appsmiths)
  - 6 Month Pilot on Harmony Platform (Summer 2007)
    - Extend Optimization and Surveillance Process
    - Utilize Nodal Analysis / Gas Lift Modeling (Prosper by Petroleum Experts)
  - Utilized existing tools
    - Production Database
    - Real-Time Bottom Hole Pressure Gauges
- Friendswood – Onshore East Texas
  - 6 Month Pilot on full field gas lifted wells (Fall 2007)
    - Utilize Nodal Analysis / Gas Lift Modeling (WinGLUE by Appsmiths)
    - Incorporated US Production BHP survey operations

Gas Lift in SYU

- SYU Asset – Offshore California
- Current Production: 3 Platforms (Heritage, Harmony and Hondo)
- Chemical injection currently being injected to lower emulsion viscosity
  - Crude gravity ranges from 10-20 API
- Relatively complex well geometry
  - Long reach wells
  - Highly deviated
- Majority of Wells on Gas Lift:
  - 50 wells
  - Pruett BHP Gauges
  - Gas Lift Rate and Pressure Gauges
  - Real Time Data Acquisition (PI Suitcase - OSI Software Inc.)
  - Typical 3 Mandrel Design (Unloading, Dummy and Orifice



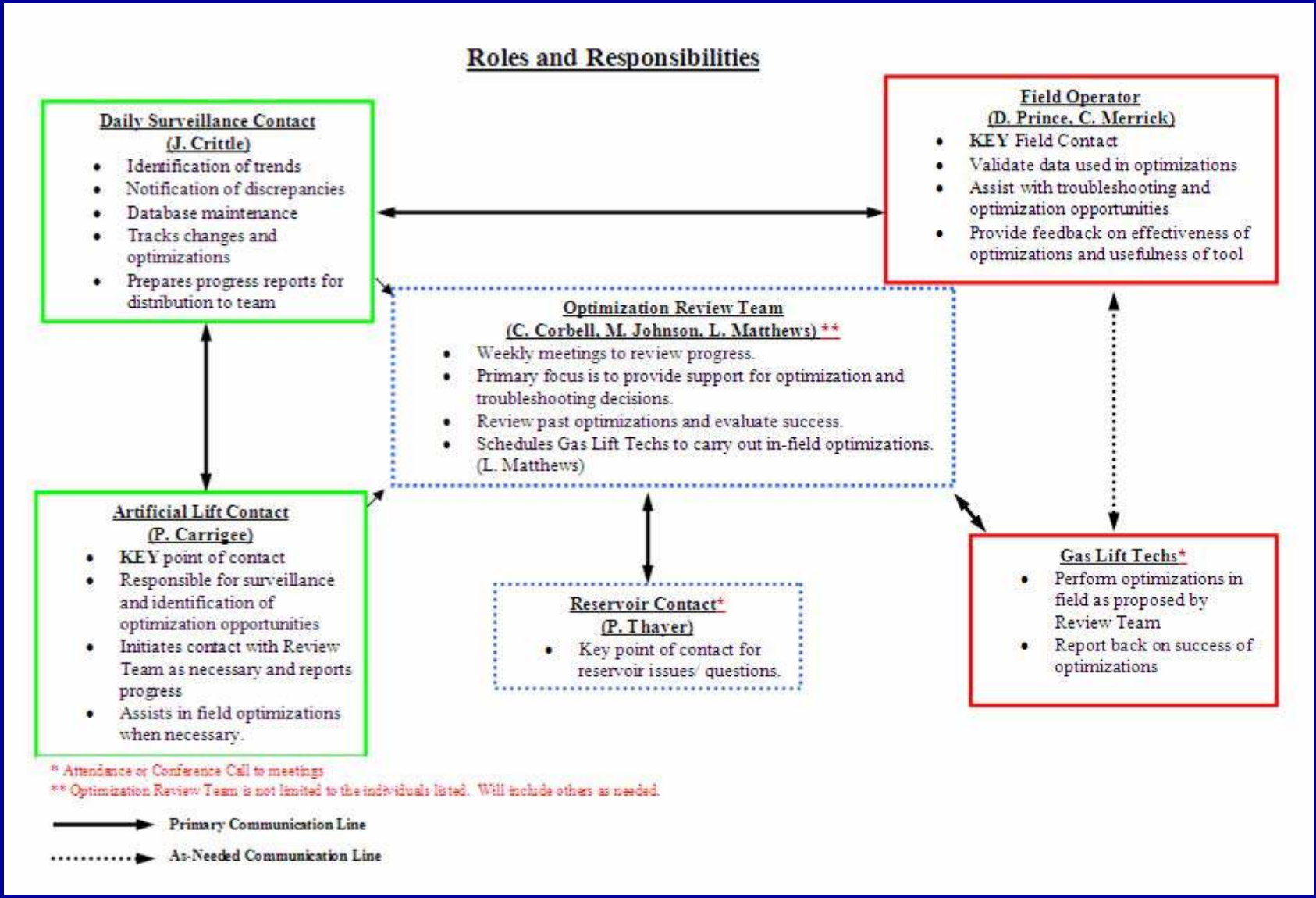
Gas Lift in SYU



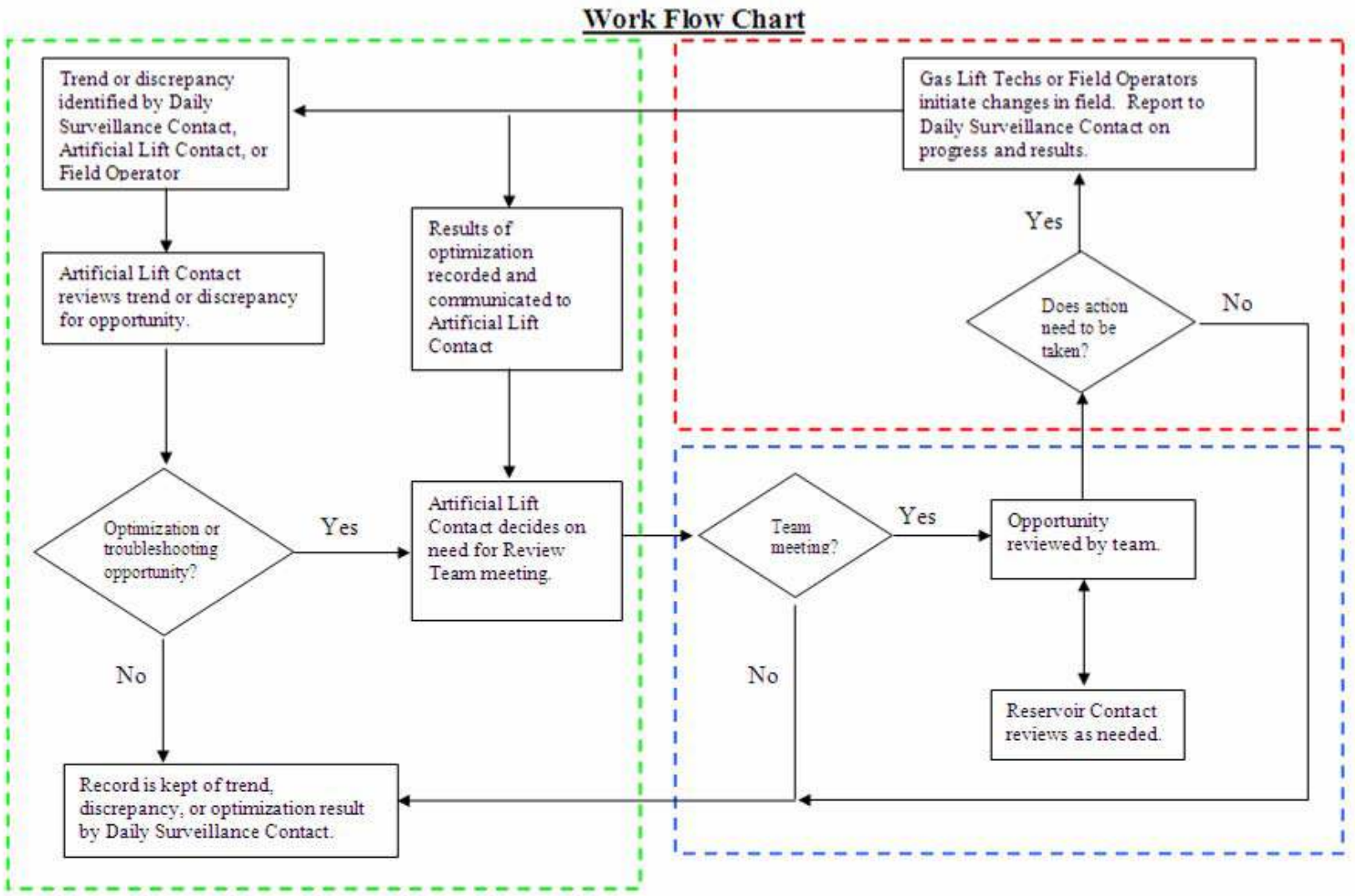
GAS LIFT OPTIMIZATION			COMMENTS
Y/N	DATE/TIME	OP INT	
N			Allocation well test
N			
Y	9/12/2007 12:00 PM	W9S	1st gaslift test at 2.0 gaslift rate. Diluent/NGLS included.
Y	9/13/2007 12:00 PM	DLK	2nd g/l test at 2.0 mil.
Y	9/14/2007 12:00 PM	DLK	1st g/l test @1.75mil
Y	9/14/2007 12:00 PM	W9S	2nd test @ 1.75 g/l rate. Diluent/NGLs included.
Y	9/15/2007 12:00 PM	DK	3rd test @1.75 mil. G/L
Y	9/16/2007 12:00 PM	W9S	1st gas lift opt test at 2.3. Diluent/NGLs included
Y	9/16/2007 12:00 PM	W9S	2nd g/l opt tests @ 2.3. Diluent/NGLs included
N			allocation test
N			ALLOCATION TEST
N			Allocation/Regg well test Diluent included.

- **Past Process**
  - One well per month multi-rate testing
    - Averaged 10 wells/yr on each platform
    - Inconsistent well test process
  - Gas Lift Rate adjusted based on production rate response
  - BHP gauges only used for chemical optimization (instability)
- **Past Tools**
  - Simple spreadsheet for optimization tracking
    - Often misplaced and not updated…

Roles and Responsibilities

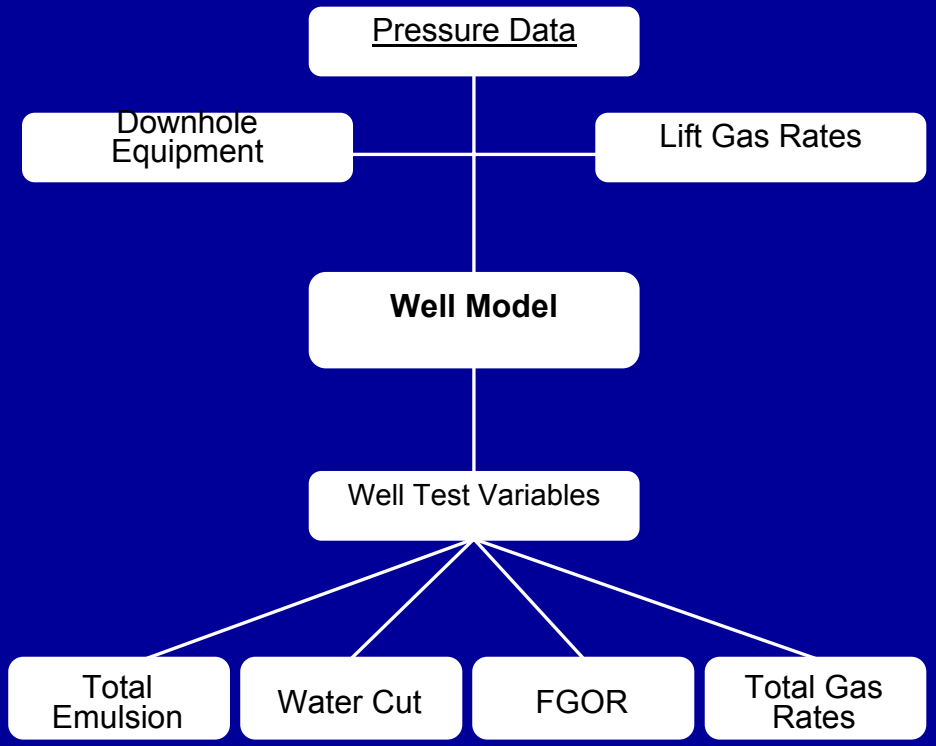


Work Flow


Work Flow Chart
Trend or discrepancy identified by Daily Surveillance Contact, Artificial Lift Contact, or Field Operator
Gas Lift Techs or Field Operators initiate changes in field. Report to Daily Surveillance Contact on progress and results.
Artificial Lift Contact reviews trend or discrepancy for opportunity.
Results of optimization recorded and communicated to Artificial Lift Contact
Yes
Does action need to be taken?
No
Optimization or troubleshooting opportunity?
Yes
Artificial Lift Contact decides on need for Review Team meeting.
Team meeting?
Yes
Opportunity reviewed by team.
No
No
Reservoir Contact reviews as needed.
Record is kept of trend, discrepancy, or optimization result by Daily Surveillance Contact.

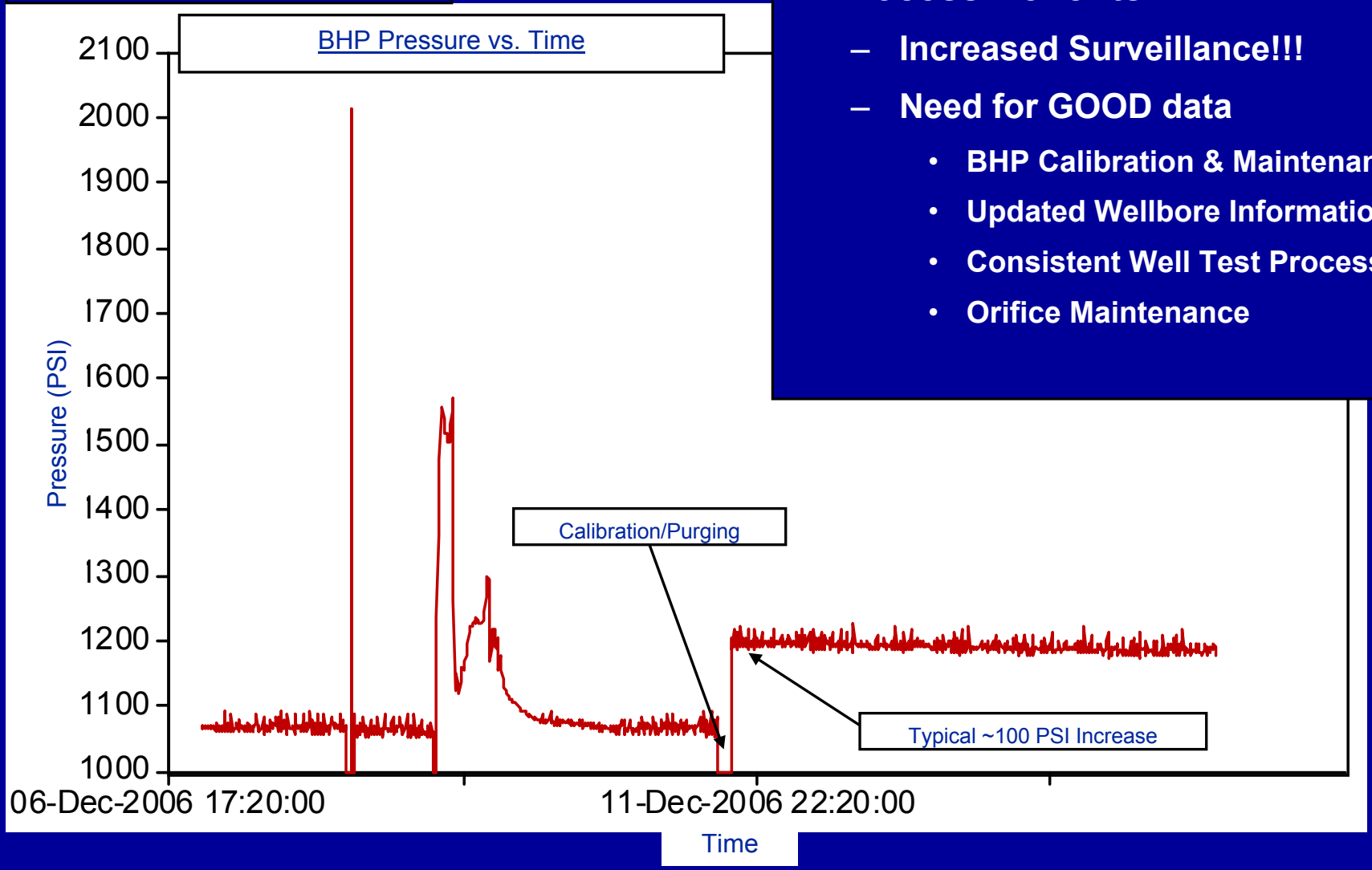
Well Modeling

- **Modeling Benefits:**
  - **Decrease number of well tests**
  - **Increase number of optimizations per year**
  - **Establish base line for surveillance**
  - **Act as optimization historian**
- **Data Collection:**
  - **Manual data input model creation**
  - **Initial matching/calibration of models to production rates**
  - **Real-Time feed of pressure and rate data into models for increased surveillance**



Heritage Pilot – Process Benefits

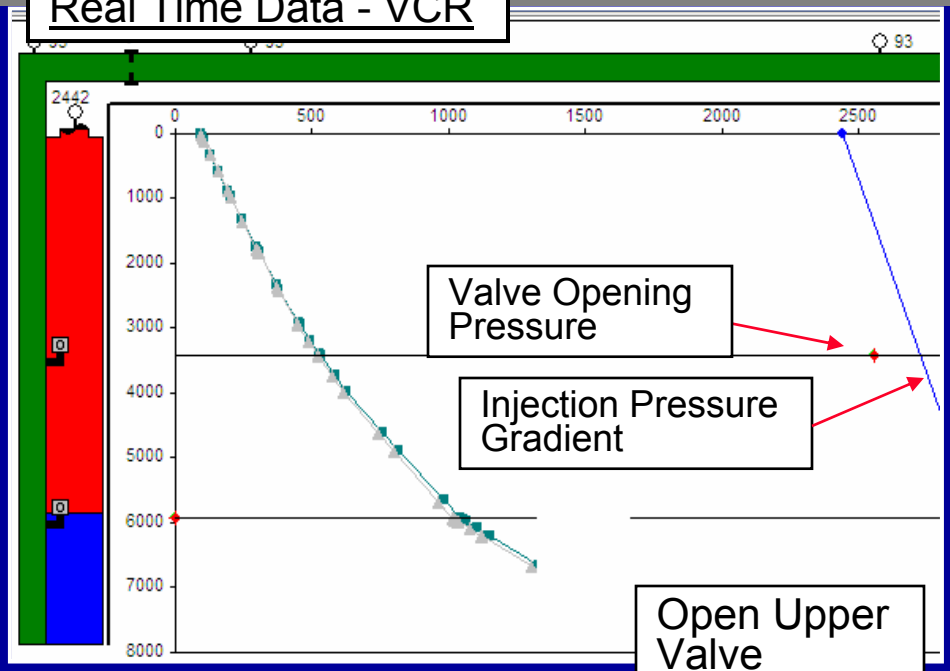
BHP Gauge Calibrations -

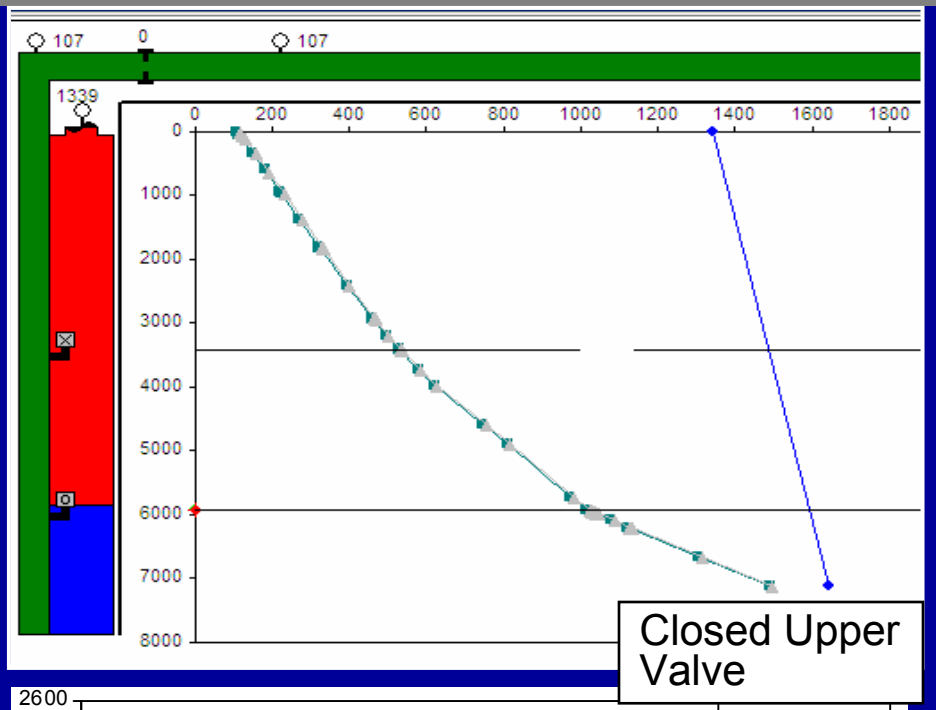


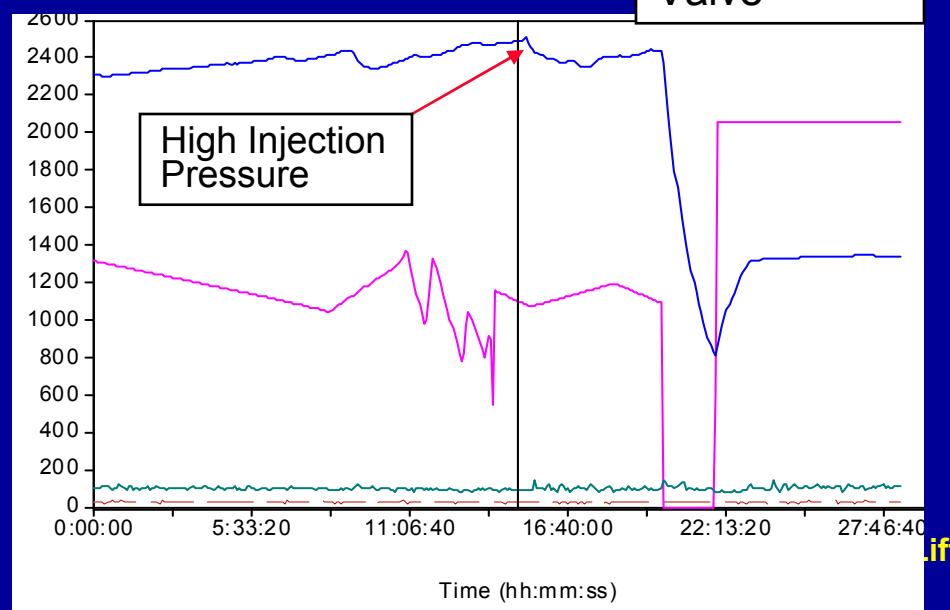
- **Process Benefits**
  - **Increased Surveillance!!!**
  - **Need for GOOD data**
    - **BHP Calibration & Maintenance**
    - **Updated Wellbore Information**
    - **Consistent Well Test Process**
    - **Orifice Maintenance**

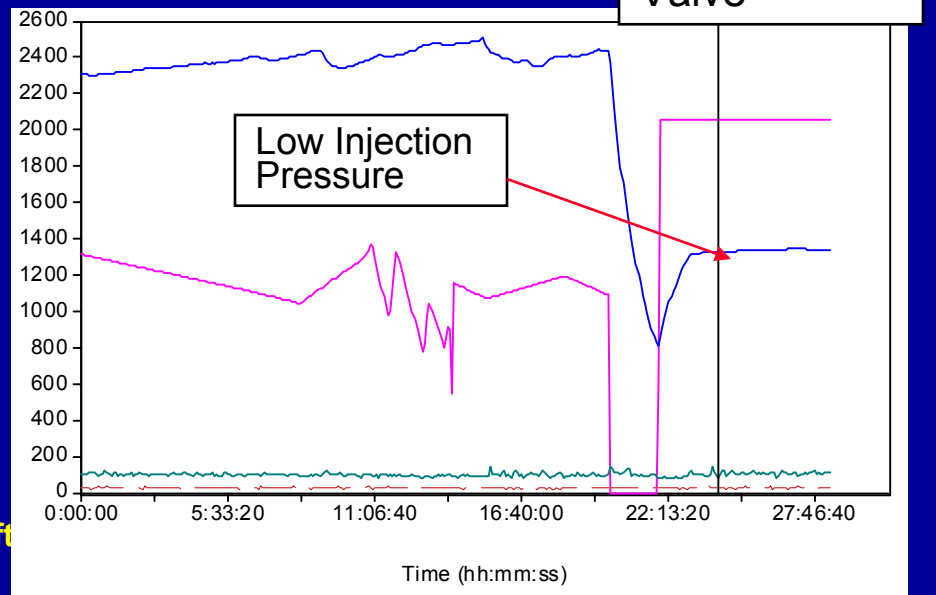
Heritage Pilot – Surveillance Benefits - Real Time Data Input

Real Time Data - VCR





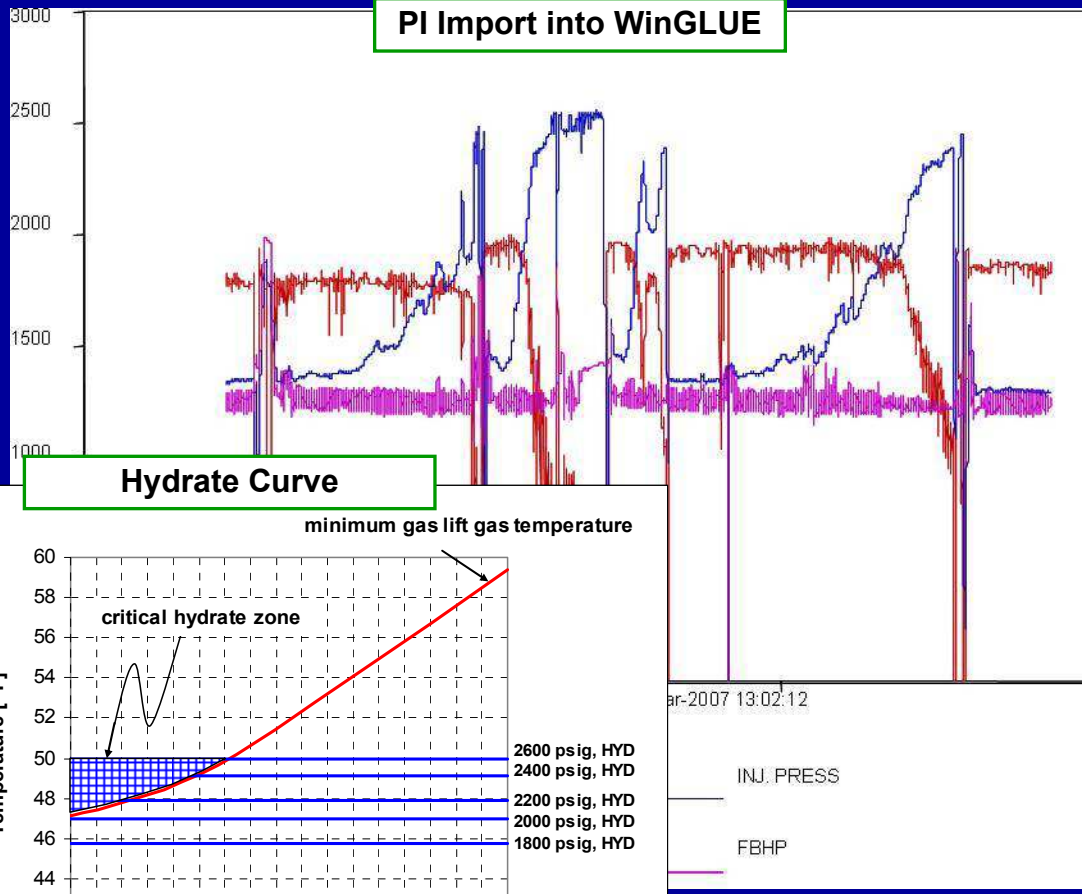




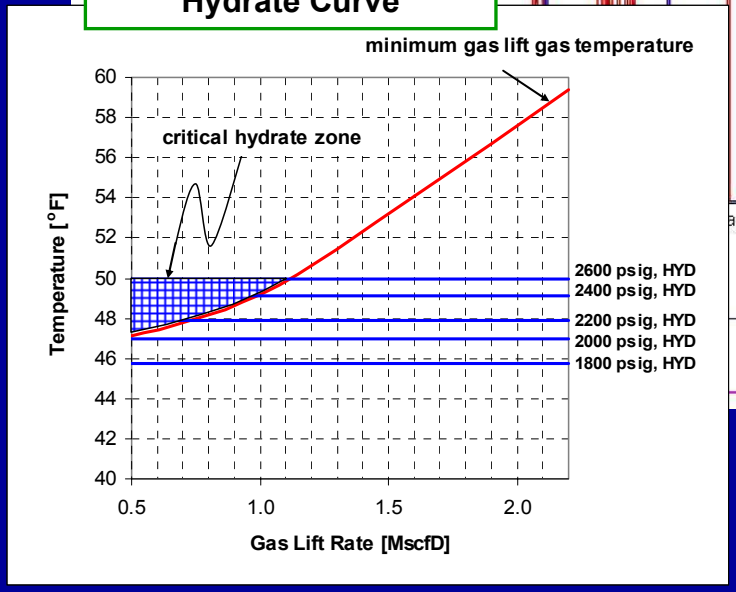
Heritage Pilot – Surveillance Benefits - Stability Issues

- **Overview –**
  - **– Heritage Stability Issues**
    - **Unstable lift gas injection pressures**
    - **High casing pressure – hydrates!!**
    - **Multi-pointing**
    - **Oversized orifice**
    - **Plugged orifice/restricted gas injection**
      - **– Casing pressure build-up**
    - **Paraffin/Asphaltene/Scale build-up**
    - **System Instability caused by unstable wells**
  - **–Instability Identification in WinGLUE**
    - **Valve Performance Curves**
      - **– Is it a design issue?**
    - **Data Historian**
      - **– What changed in the well conditions?**

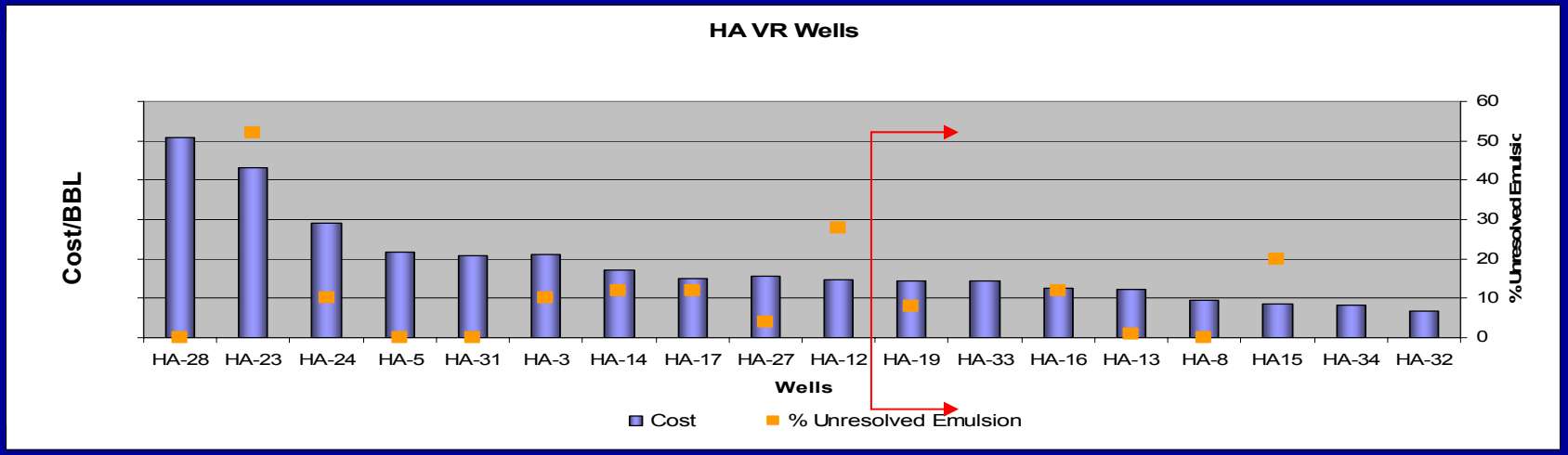
PI Import into WinGLUE



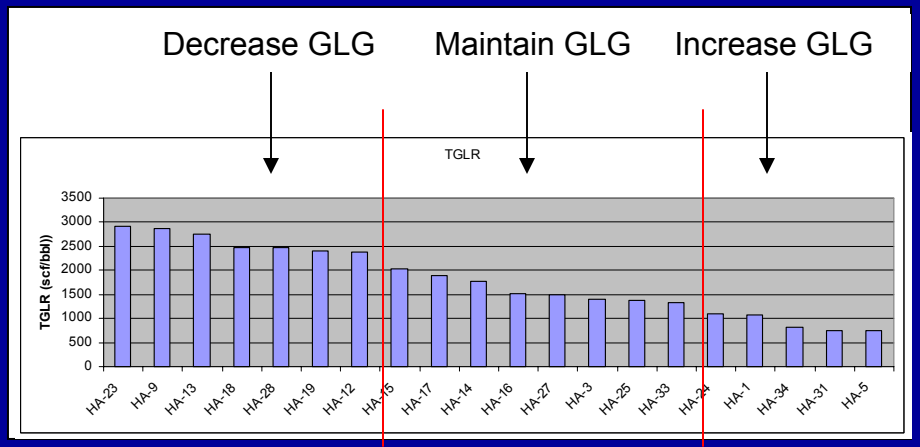
Hydrate Curve



Harmony Pilot

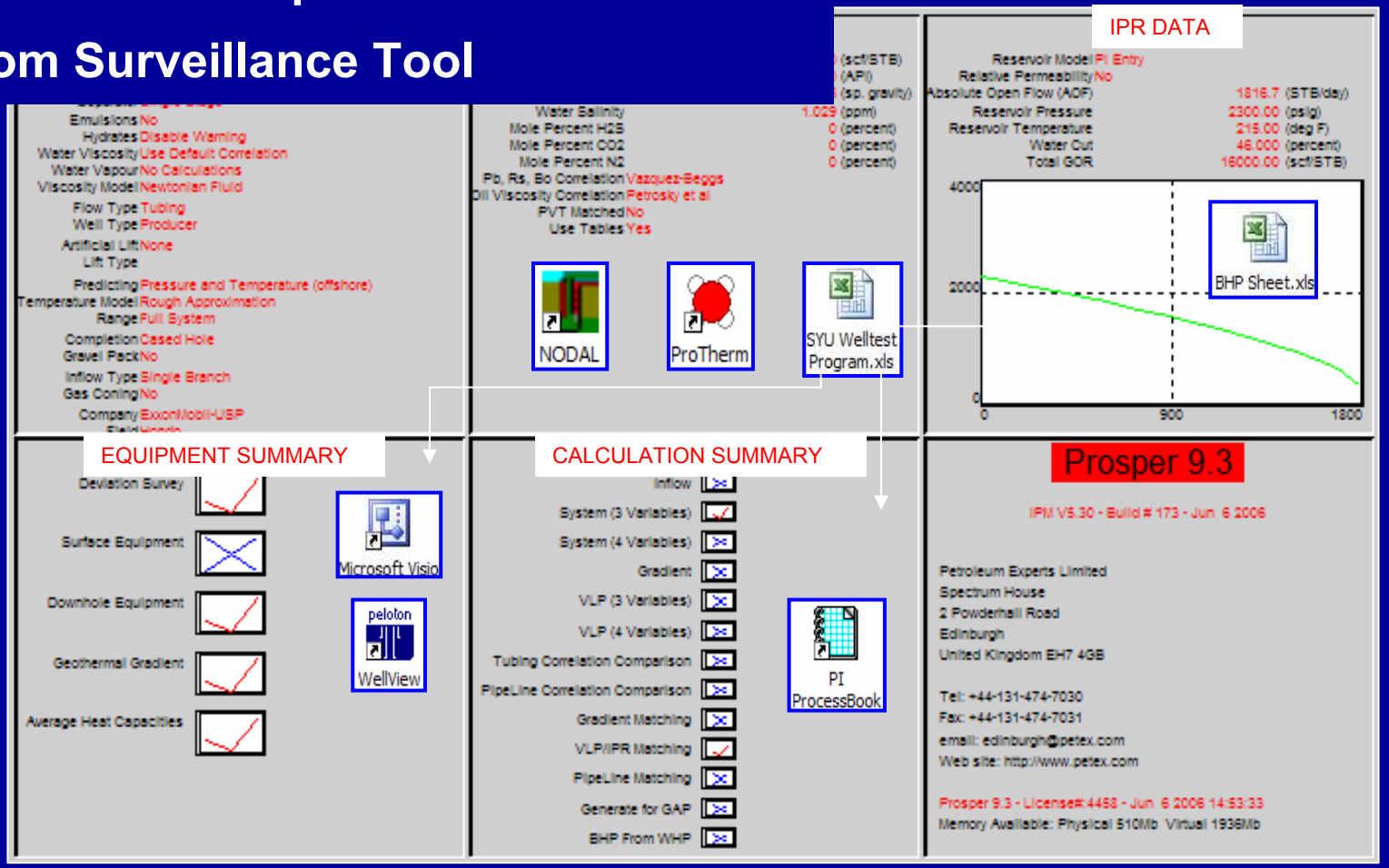


- **Continued surveillance work flow**
  - **Focused on balance of chemical and gas lift optimization**
    - **Avoid wells used for chemical optimization**
    - **Decrease gas lift gas in higher TGLR wells**
    - **Increase gas lift gas in lower TGLR wells**



Harmony Optimization – Well Modeling

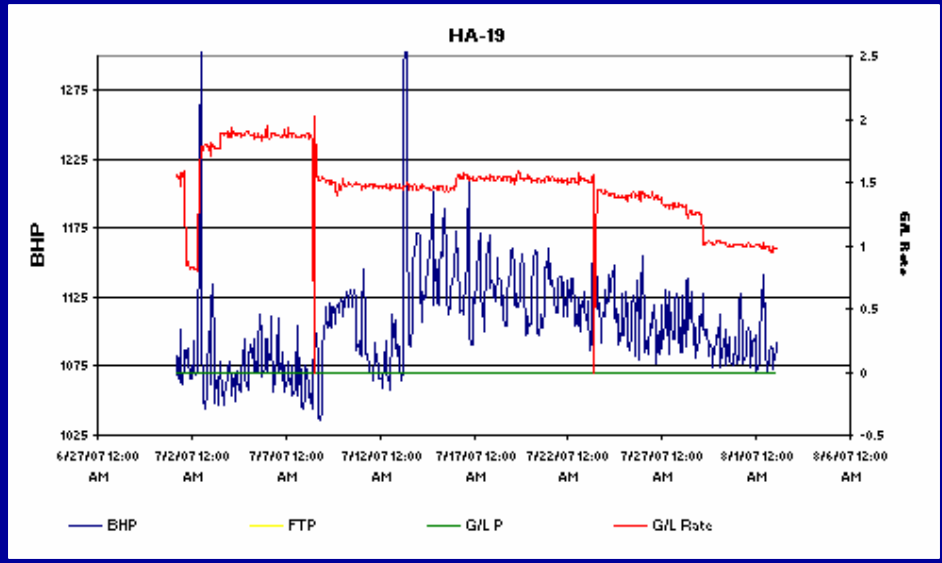
- **Well Modeling using Prosper**
  - **Identification of Optimization Potential**
  - **Custom Surveillance Tool**



Harmony Optimization - Results

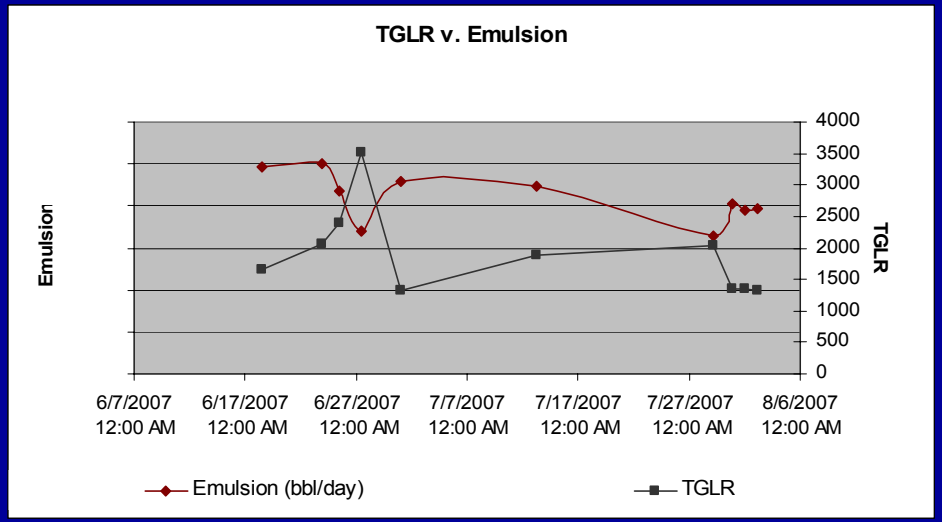
Greatest potential to decrease gas lift rates and maintain production

- HA-19 proved to be a prime candidate
  - –Chemical optimization prioritization
  - –TGLR higher than expected range
  - –GLG rate v. BHP
  - –TGLR v. Emulsion
  - –Model recommended gas reduction of 0.5 Mscf



Results:

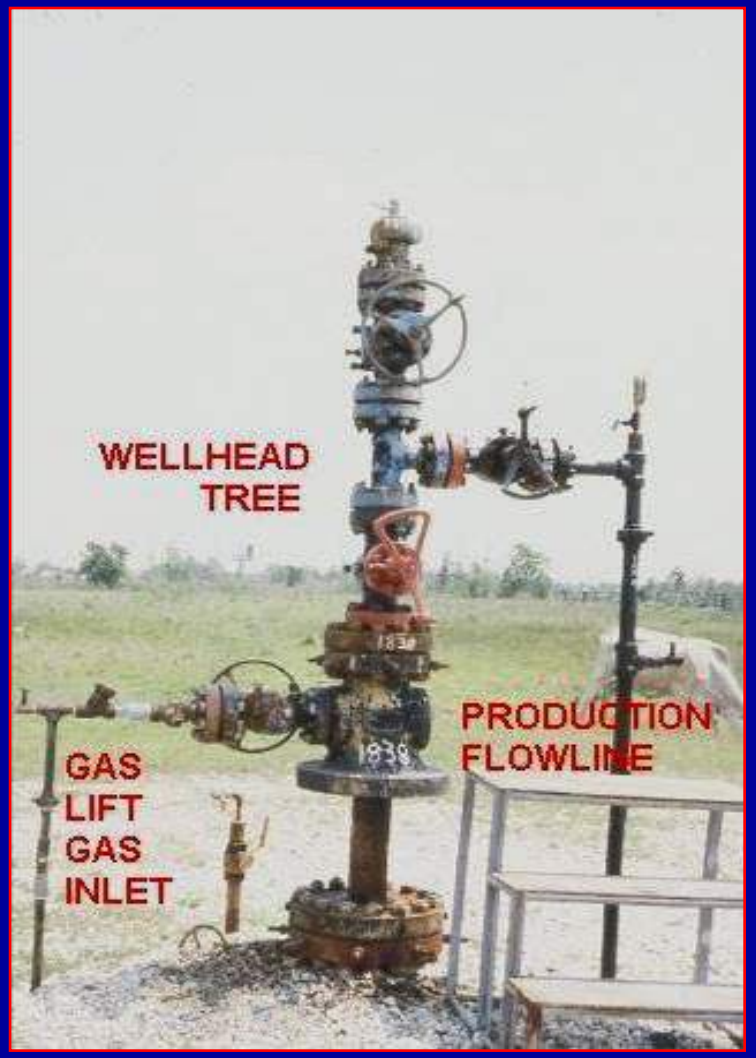
- The gas lift gas was reduced by 0.5 Mscf, and the well stabilized for 24 hours
- The current production stabilized at previous producing rates



The gas lift optimization for HA-19 was a success. Another 0.5 Mscf can be allocated to gas sales or to another well which can yield more oil.

Gas Lift in Friendswood

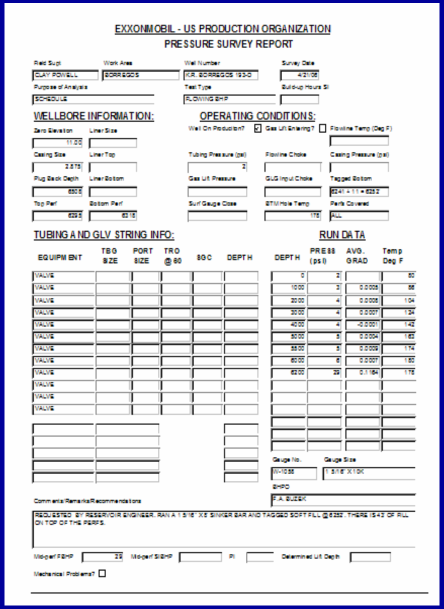
- Friendswood Asset – Onshore Texas
- Mature Field
  - Original Spud Date of 1937
  - Average field water cut at 97%
  - Crude gravity at 35° API
- Majority of Wells on Gas Lift:
  - 30 wells
  - No BHP Gauges
    - Periodic BHP Surveys
  - No Gas Lift Rate and Pressure Gauges
    - Manual calculation of dP across orifice



Gas Lift in Friendswood

How to get "near" time data for optimization and surveillance for a "mature" asset?

- Integration of BHP database into WinGLUE modeling software
  - BHP operators maintain pressure survey database
  - Engineer pulls latest survey data from database into WinGLUE



EXXONMOBIL - US PRODUCTION ORGANIZATION
PRESSURE SURVEY REPORT

Field Supt: CLAY POWELL
Work Area: BORREGOS
Well Number: K.R. BORREGOS 193-D
Survey Date: 4/21/06
Purpose of Analysis: SCHEDULE
Test Type: FLOWING BHP
Build-up Hours SI:

WELLBORE INFORMATION:

Zero Elevation: 11.00
Liner Size:
Casing Size: 2.875
Liner Top:
Plug Back Depth: 6505
Liner Bottom:
Top Perf: 6295
Bottom Perf: 6218

OPERATING CONDITIONS:

Well On Production? ☑ Gas Lift Entering? ☐ Flowline Temp (Deg F):
Tubing Pressure (psi): 2
Flowline Choke:
Casing Pressure (psi):
Gas Lift Pressure:
GLG Input Choke:
Tagged Bottom: 6241 + 11 = 6252
Surf Gauge Close:
BTM Hole Temp: 178
Perfs Covered: ALL

TUBING AND GLV STRING INFO:

EQUIPMENT	TBG SIZE	PORT SIZE	TRO @ 60	SGC	DEPTH
VALVE					
VALVE					
VALVE					
VALVE					
VALVE					
VALVE					
VALVE					
VALVE					
VALVE					
VALVE					
VALVE					
VALVE					

RUN DATA

DEPTH	PRESS (psi)	AVG. GRAD	Temp Deg F
0	2		80
1000	3	0.0005	86
2000	4	0.0005	104
3000	4	0.0007	124
4000	4	-0.0001	142
5000	5	0.0004	163
5500	5	0.0009	174
6000	6	0.0007	180
6200	29	0.1164	178

Gauge No.: W-1055
Gauge Size: 1 5/16" X 10K
BHPO: F.A. SUZEK

Comments/Remarks/Recommendations:
REQUESTED BY RESERVOIR ENGINEER. RAN A 1 5/16" X 5' SINKER BAR AND TAGGED SOFT FILL @ 6252'. THERE IS 43' OF FILL ON TOP OF THE PERFS.

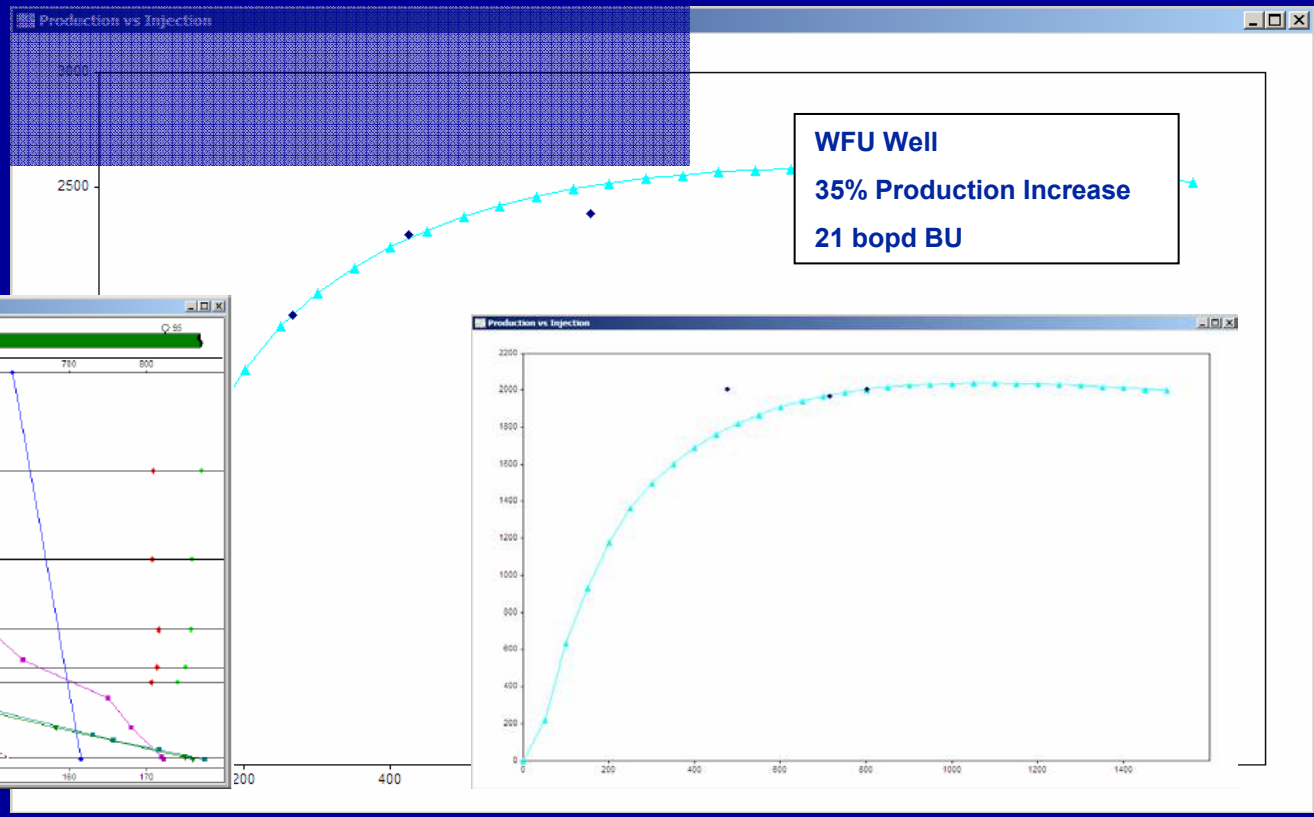
Mid-perf FBHP: 29
Mid-perf SIBHP:
PI:
Determined Lift Depth:
Mechanical Problems? ☐

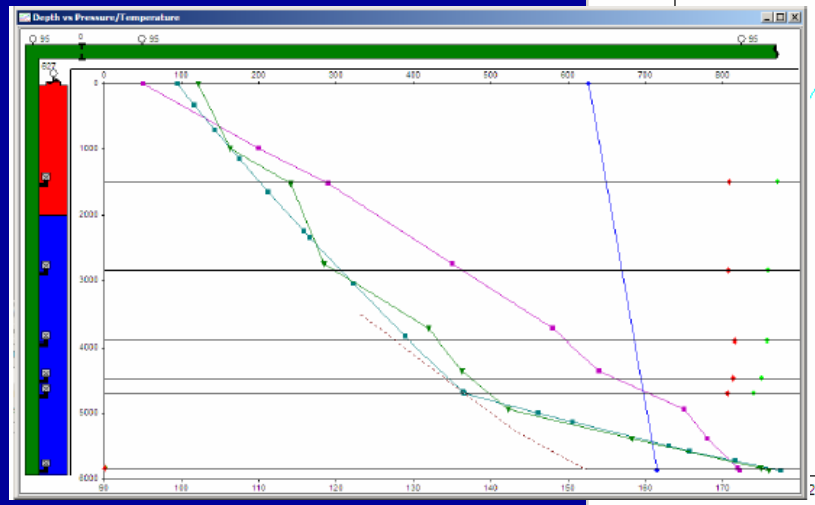
Friendswood Optimization

- Data Collection
  - BHP Surveys for Well Modeling
    - Database tie-in for WinGLUE
  - Multi-rate well tests
    - Calibration of well models
    - Orifice plate
  - Well test measurements
    - Oil/Water rate measurements are considered accurate
    - Accurate gas rate measurements are difficult to get
    - Lift gas is not measured with every test
    - Low gas rates are being measured
    - Difficult to identify multi pointing wells

Friendswood Optimization - Results

- **Optimization Results**
  - **Excellent tracking of Gas Lift Performance Curve**
    - **High Water Cuts, Predictable Productivity Index**
  - **7 Wells Optimized**
    - **11% increase in production (2% field wide)**
    - **1 MCFD of Gas Lift Gas Increase**
  - **New focus on mature field**
    - **Increased surveillance**
    - **Improved testing**





Key Learnings

- Optimization ***and*** Surveillance
- Need for new Surveillance Process
- Staged approach to build upon learnings
- Integration of existing tools with new tools
  - SYU Real Time Surveillance
  - SYU Production Rate Database
  - Onshore BHP Survey Database
  - Nodal Analysis
    - WinGLUE Gas Lift Modeling
    - Prosper Gas Lift Modeling

Questions?

Contributors – Thanks!!

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