Artificial Lift R&D Council

Using What You've Learned to Improve Your Wells

Design Considerations

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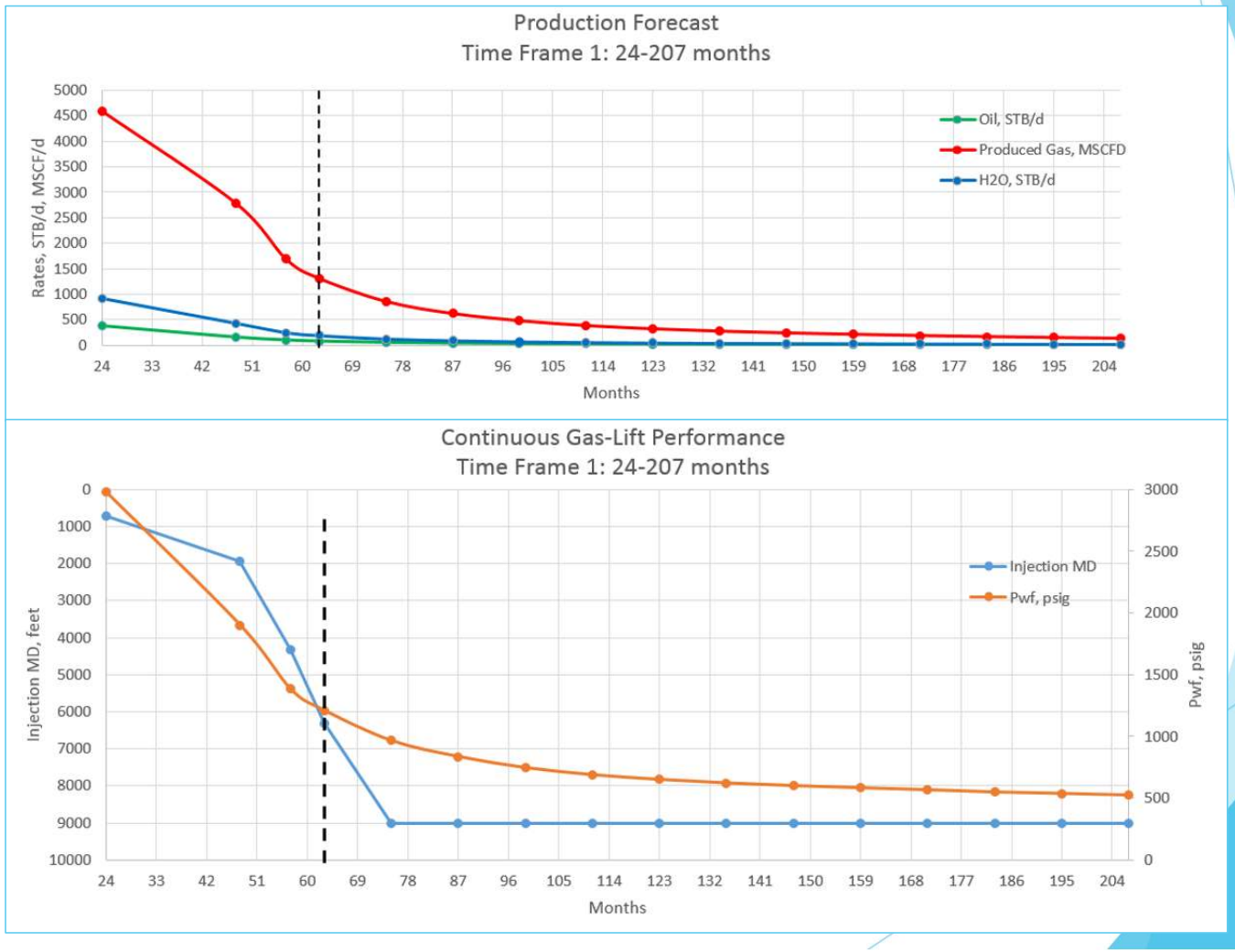

Selection of Flow Correlation

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Frequently used Vertical Flow Correlations:

- Hagedorn and Brown (slug flow regime)
- Duns and Ros (churn/annular/semi-annular flow regimes)
- Gray (mist flow regime / wet gas wells)

Proprietary methods in WinGLUE:

- Mobil Moreland Shell Method (MMSM)
- George Zabaras Method (GZM)

Proprietary methods in Prosper:

- Petroleum Experts 2
- Petroleum Experts 3
- Petroleum Experts 5

Other mechanistic models that can provide reliable results:

- Ansari
- Chokshi

Fluid Properties

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- Default static fluid gradient for unloading: 0.465 psi/ft
- Where possible, tune black-oil PVT correlations using representative laboratory data.
- Pay particular attention to the following:
  - Production rates (Qoil, Qwater, Qgas, Qgi)
  - GOR
  - Water Cut
  - API Gravity
  - Water Gravity
  - Gas Gravity (for both produced gas and injection gas)

Selection of Kick-off Pressure

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Kick-off Pressure (Pio of top valve) should be at least 50 psi less than the maximum available injection pressure that can be delivered to the wellhead on a consistent basis (365 days per year).

Rationale:

1. Under worst case conditions, there would be zero dP at the depth of the unloading valve if designing for Pio = max available.
2. Under certain cases (i.e. high ambient temperatures), compressor may not be able to deliver max available injection pressure.
3. When considering valve performance, there is often zero stem travel (or gas passage) at P_{iod}.

Selection of Kick-off Pressure

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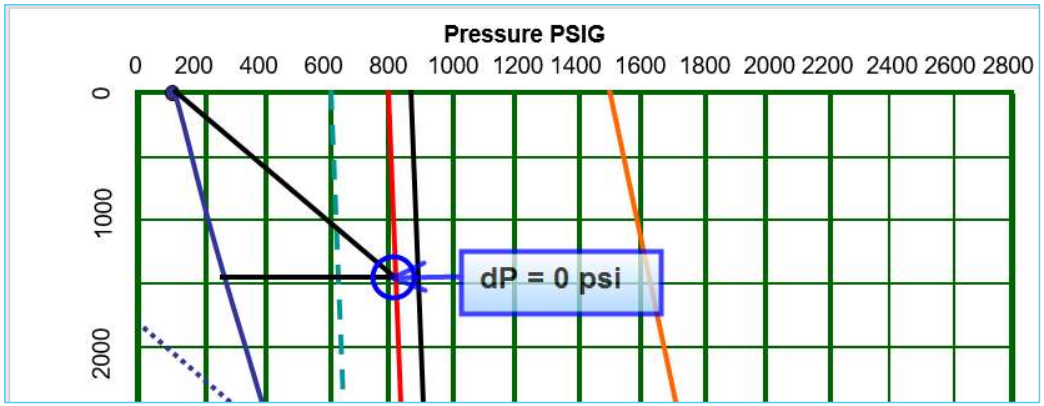
- Worst-case conditions for well that can support fluid level to surface



Selection of Kick-off Pressure

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- Supply pressure can vary significantly during course of year.

Selection of Kick-off Pressure

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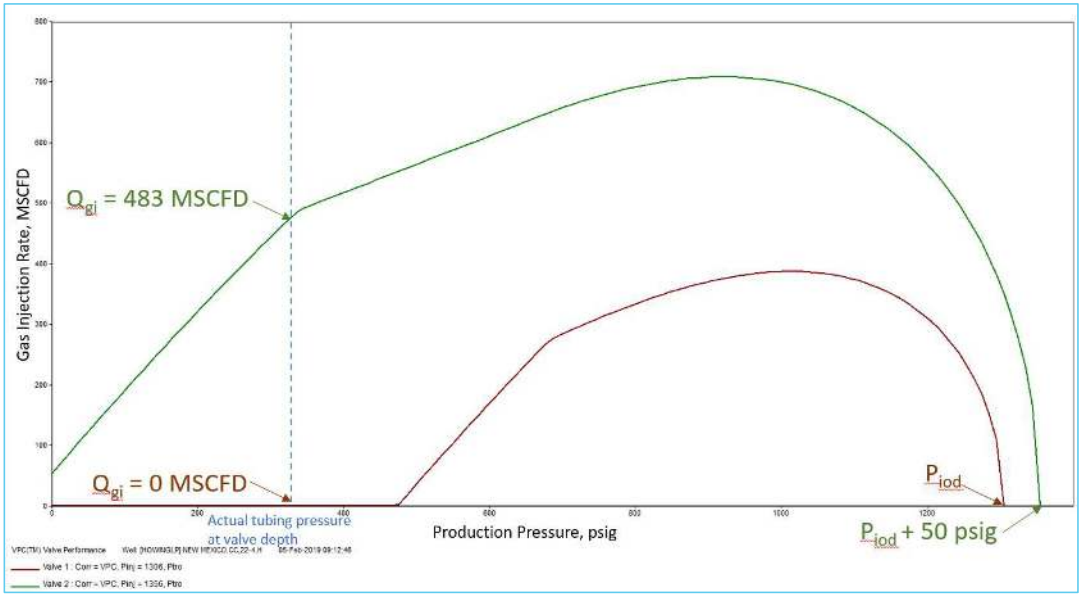
A valve that appears to be “open” may really be closed…



Surface opening and closing pressures should drop sequentially

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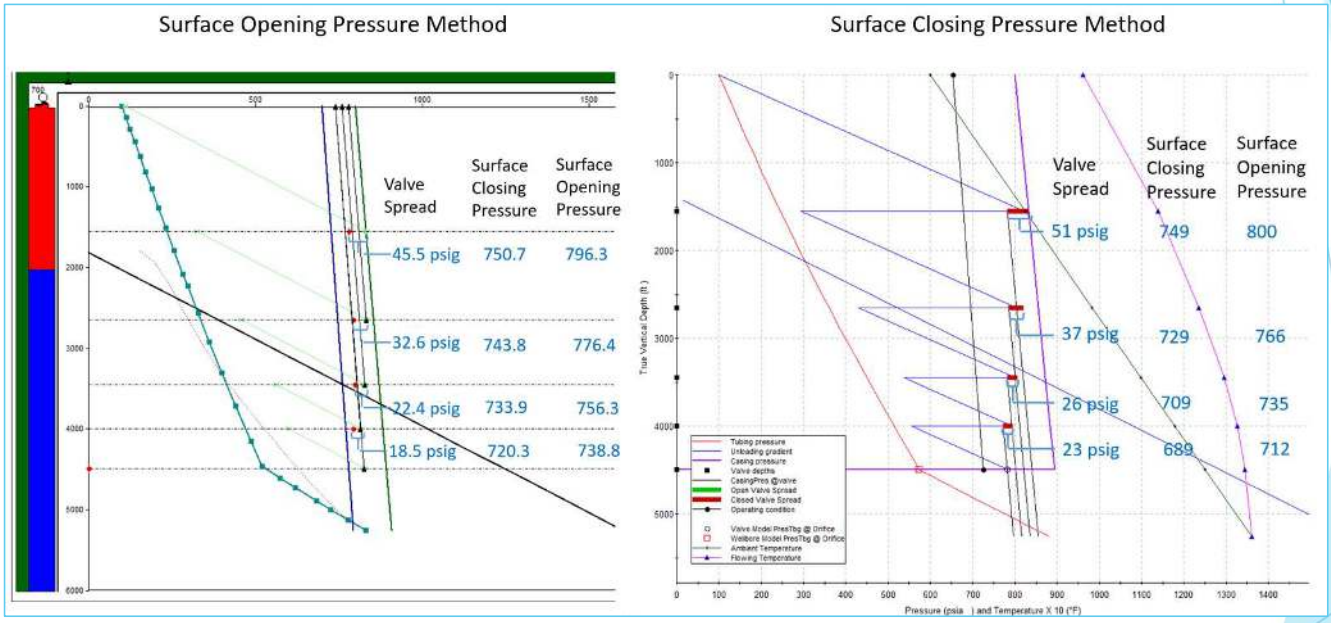
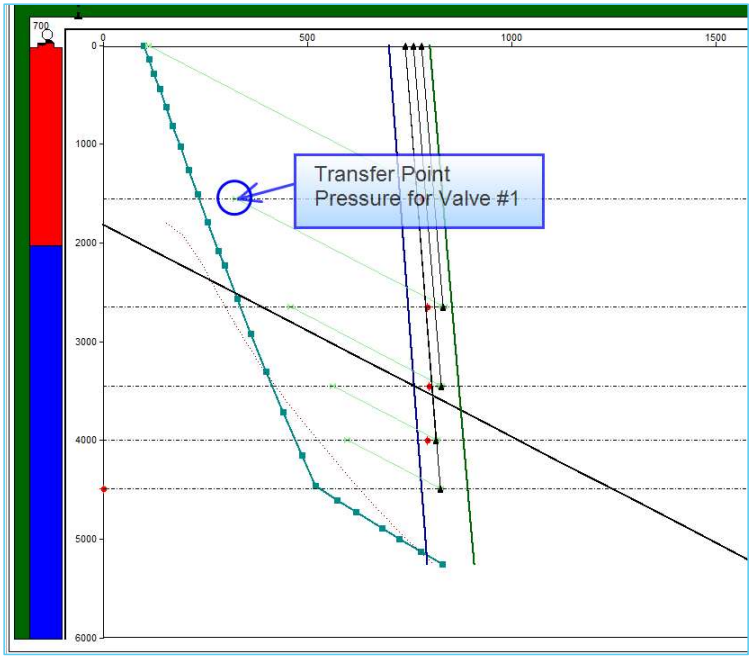
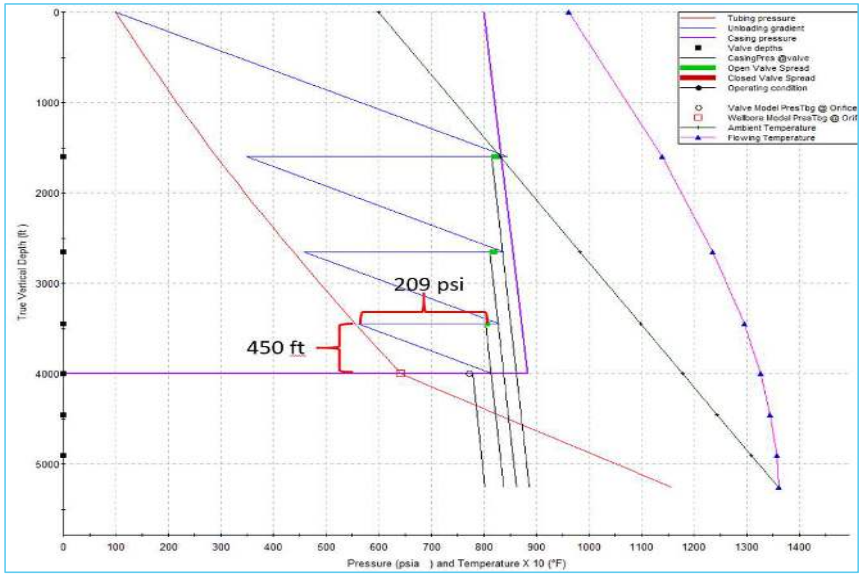


Transfer Point Pressures should be greater than Production Pressures



Minimum Mandrel Spacing

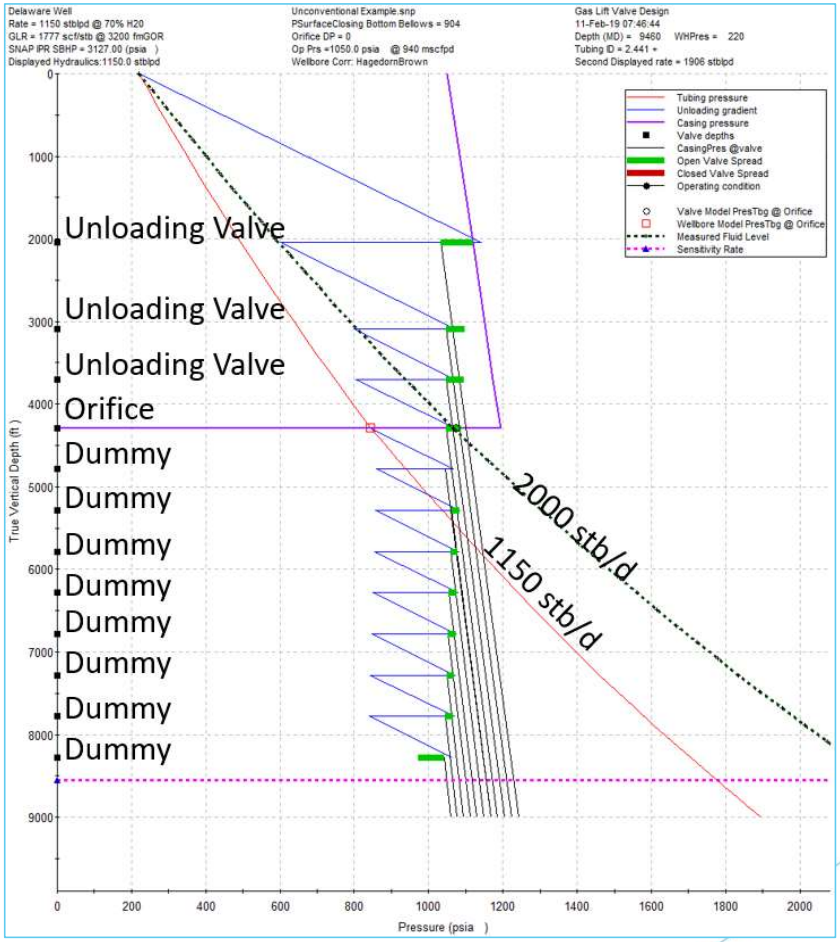
- The minimum spacing between mandrels is 450-650 feet TVD.



Based on P_{KO} = 1200 psi, P_{io} = 1050 -1000 psi	
BFPD	**Minimum Spacing (TVD)**
*50- 100	800’ - 750’
100-200	750’ – 650’
200-500	650’ – 500’
500-5000	500’ – 450’

*When no un-tapped potential is available behind pipe

Use Bracketing when Appropriate



Placement of Top Mandrel

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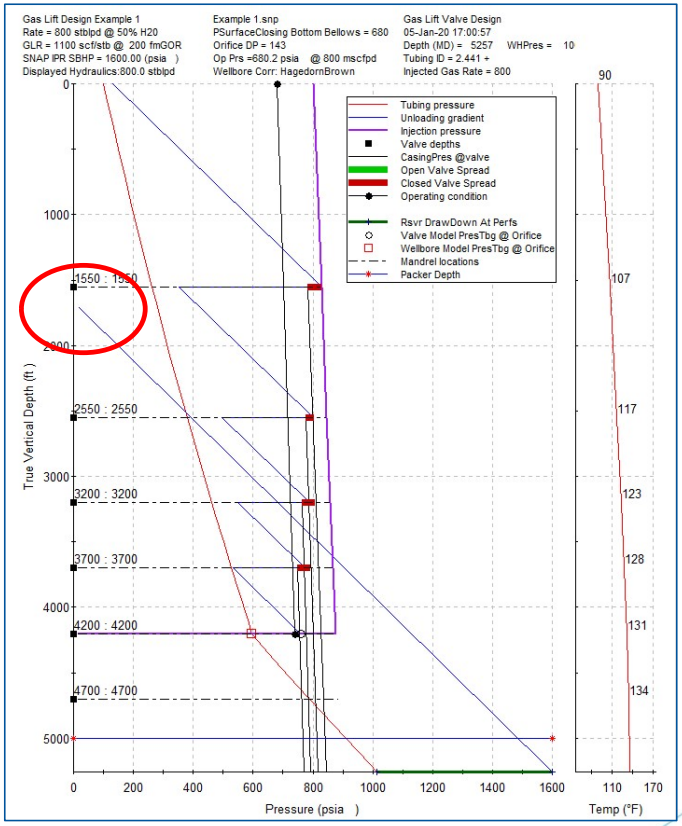
- The top valve should be placed at or above the depth of the static fluid level that can be supported by the reservoir pressure.

Do I really need to space the top valve from the top?



Placement of Bottom Mandrel

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- For installations with side-pocket mandrels, the bottom mandrel should be placed 1-2 joints above the packer.
- For installations with conventional mandrels, the bottom mandrel should be placed at the maximum anticipated depth of injection that can be achieved during the target producing period.

Are Test Rack Opening Pressures Correct?

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Spot check the valve calculations to ensure they are performed correctly, paying particular attention to the selection of Ap/Ab.

(These will be different for valves with TC trim than for valves with Monel trim)

Port Size (1/64")	Bellows Area (sq. inch)	Monel A_p/A_b	Tungsten Carbide A_p/A_b
1" Equipment			
8	0.31	0.042	0.068
10	0.31	0.067	0.088
12	0.31	0.094	0.119
16	0.31	0.165	0.187
20	0.31	0.255	0.313
24	0.31	0.365	0.416
1-1/2" Equipment			
8	0.77	0.017	0.027
12	0.77	0.038	0.048
16	0.77	0.066	0.075
20	0.77	0.103	0.126
24	0.77	0.147	0.168
28	0.77	0.200	0.216
32	0.77	0.260	0.299

Each valve should pass at least 100-200 MSCFD during unloading

- Use VPC analysis to evaluate gas passage.
- Evaluate valve performance at $P_{inj} = P_{iod}$ plus dP between stations.
- Kick-off simulator in SNAP can give a more realistic estimate of gas requirements.

Design should work over a range of conditions

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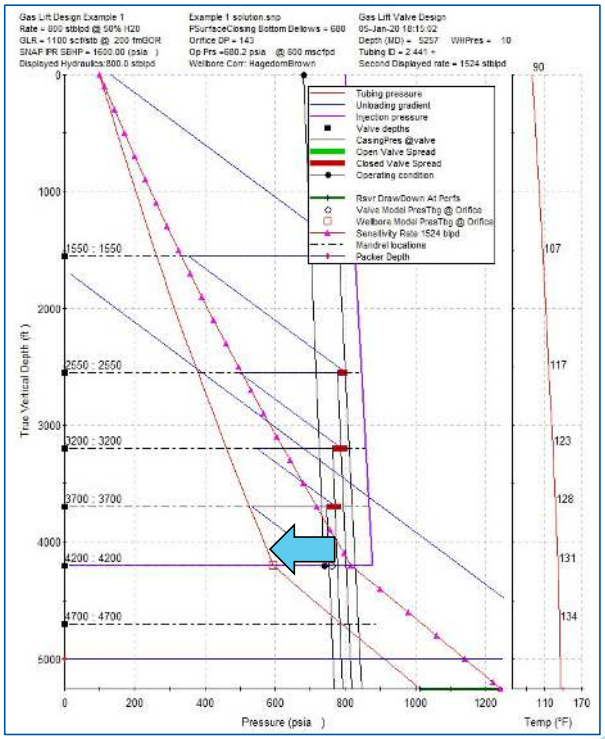
- Perform a sensitivity analysis and evaluate the performance of the gas lift system to ensure that it will meet the above criteria at various points in time over the anticipated operating life.



Discussion

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How do these guidelines compare to the designs in your wells?

Which of these practices do you see the most benefit in using?

Are there any guidelines you disagree with? What would you do differently?

Break

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- Stretch and move!
- Please return in 15 minutes.

Exercise: Evaluate your design using dynamic simulation

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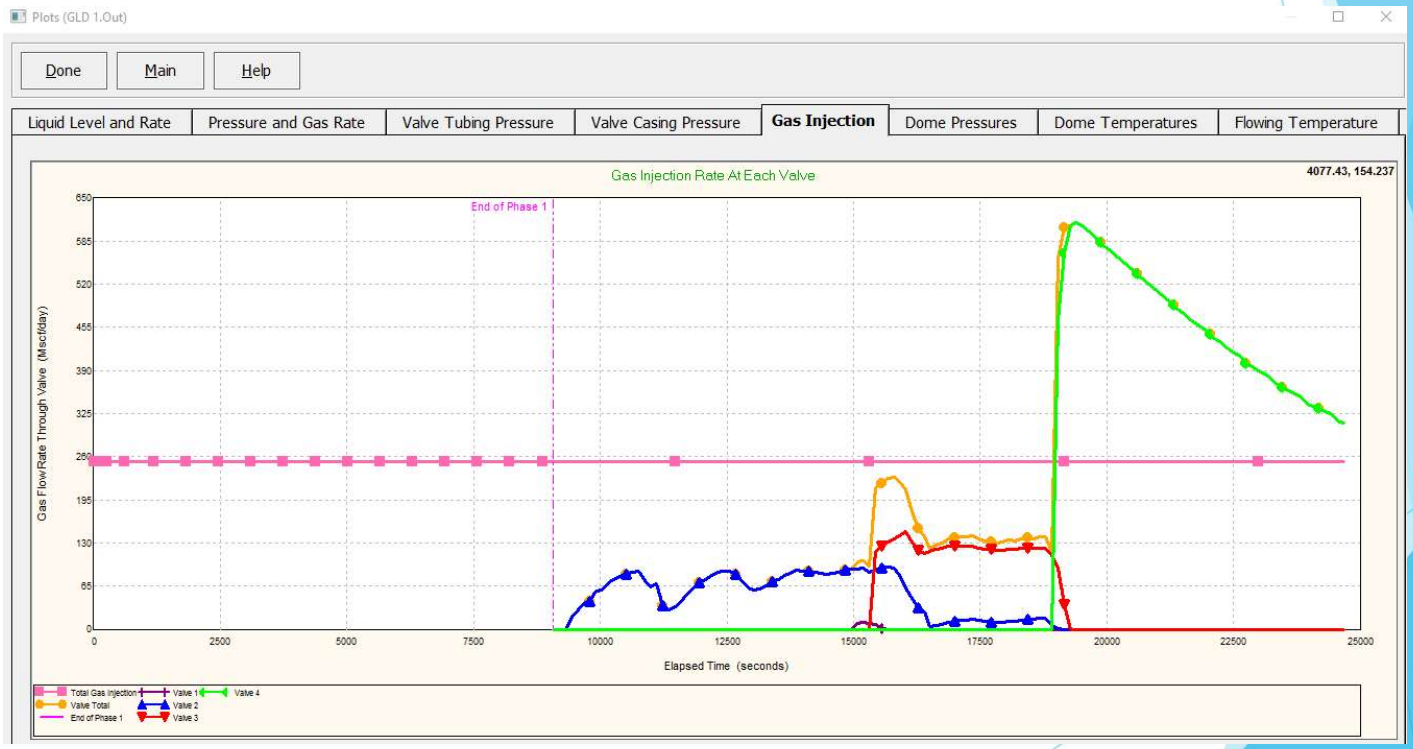
- Evaluate your new gas lift design using the transient gas lift simulator in Prosper.



Discussion

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Did your design perform as expected? If not, why not?

What would you do differently next time?

Design Reviews

- Shows us your wells!

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Break

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- Stretch and move!
- Please return in 15 minutes.

Trouble-shooting Gas Lift Wells with SNAP

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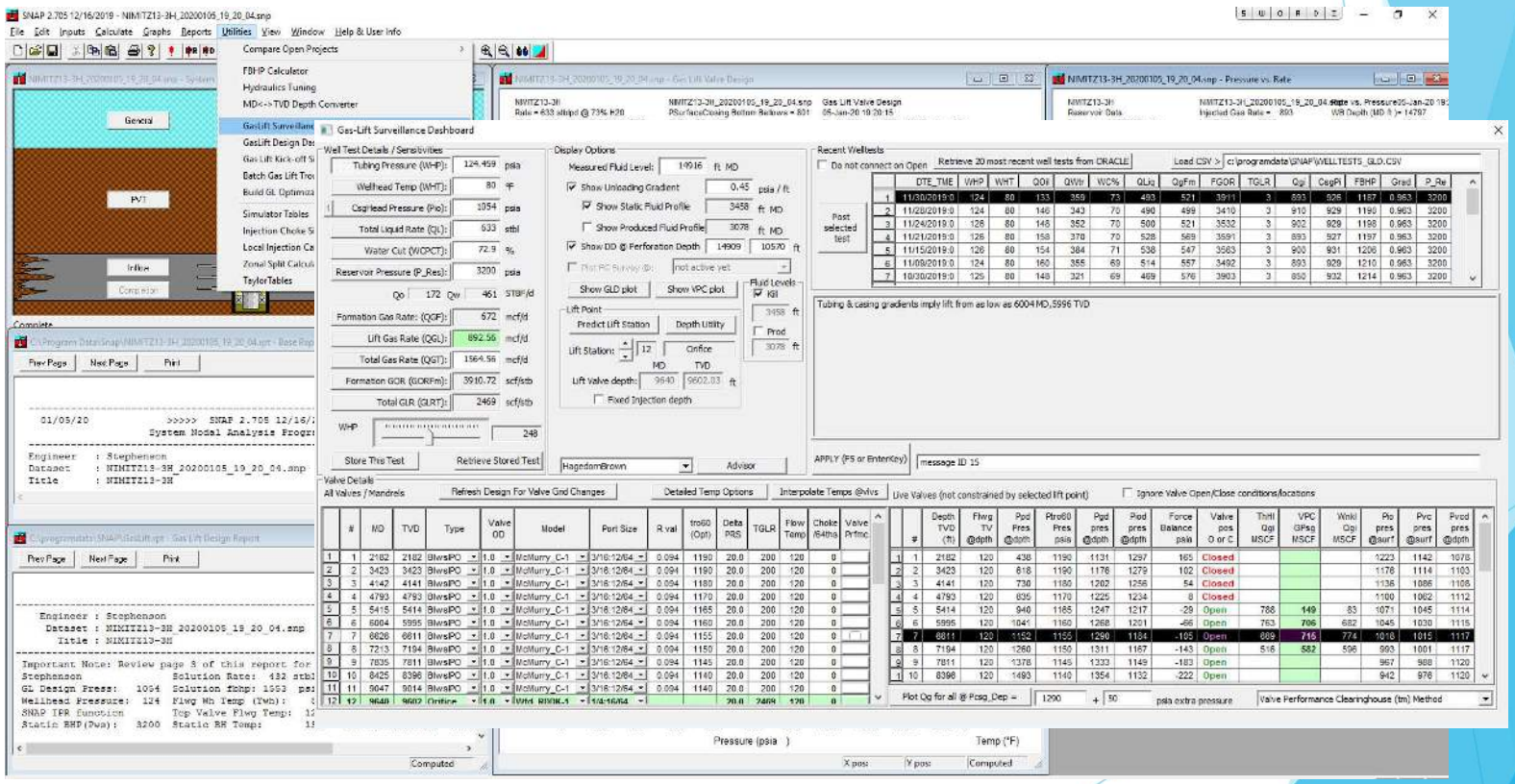
- Intro to Gas Lift Surveillance Dashboard



Trouble-shooting Exercise

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Use the SNAP Surveillance Dashboard to trouble-shoot one of your wells. Be prepared to present your results after lunch.

Well Reviews

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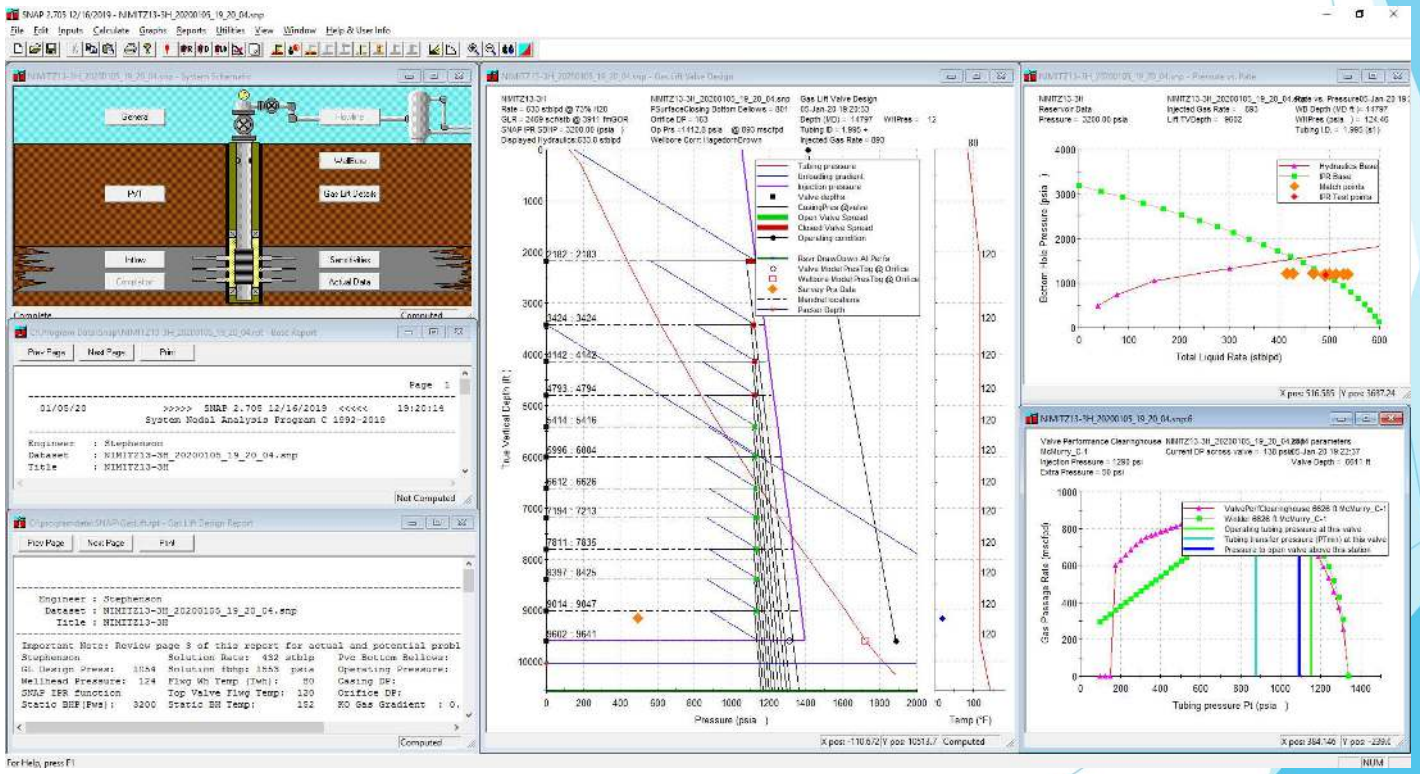
- Show us your wells!



Discussion

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What were your major findings?

What follow-up actions will you take?

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