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High Pressure/Single Point Gas Lift Applications

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ALRDC Gas Lift Workshop

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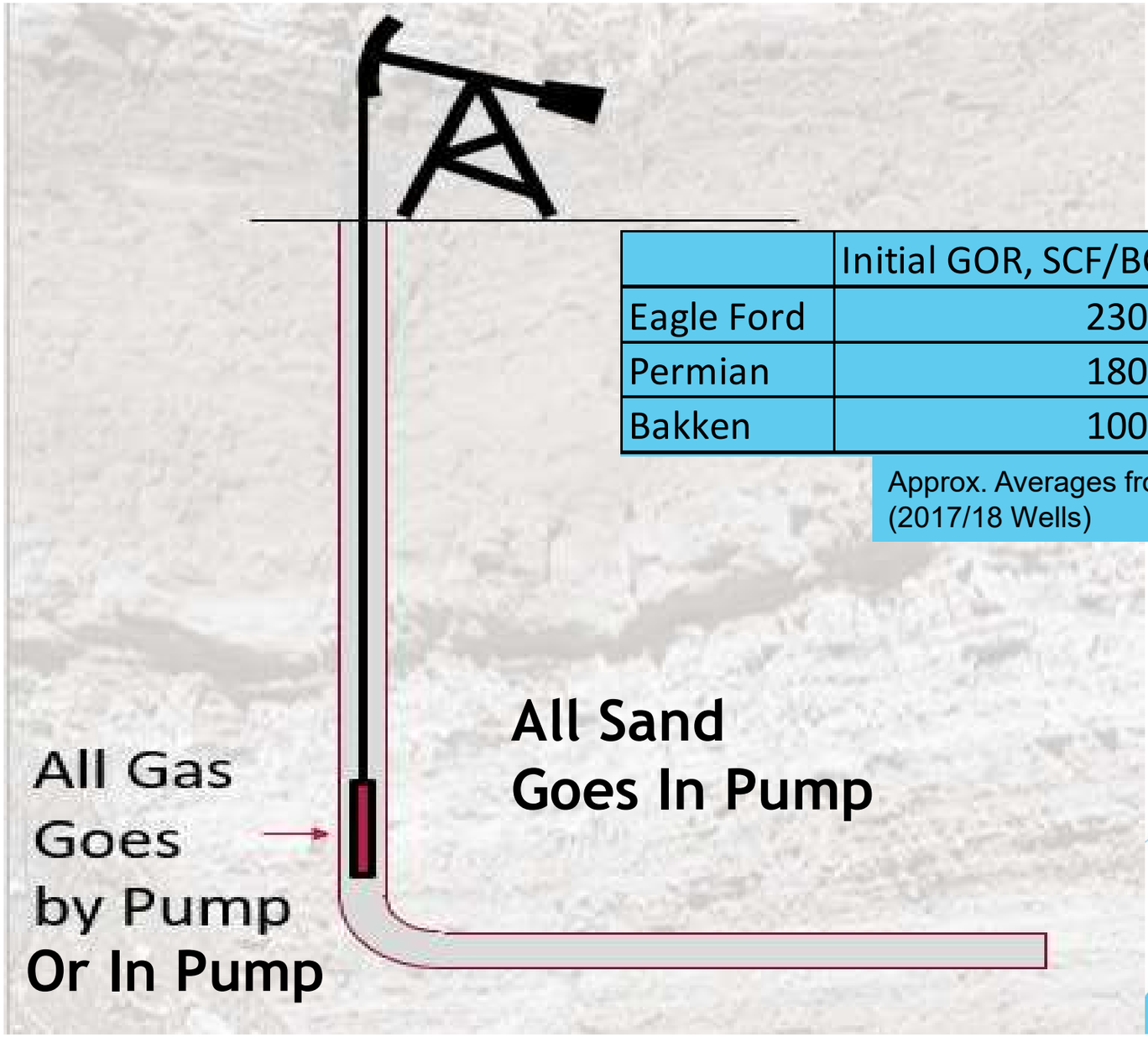
WHY Gas Lift???



	Initial GOR, SCF/BO	2 YEAR GOR, SCF/BO
Eagle Ford	2300	5000
Permian	1800	5000
Bakken	1000	2500

Approx. Averages from Shaleprofile.com (2017/18 Wells)

Beam Pumps in Unconventionals

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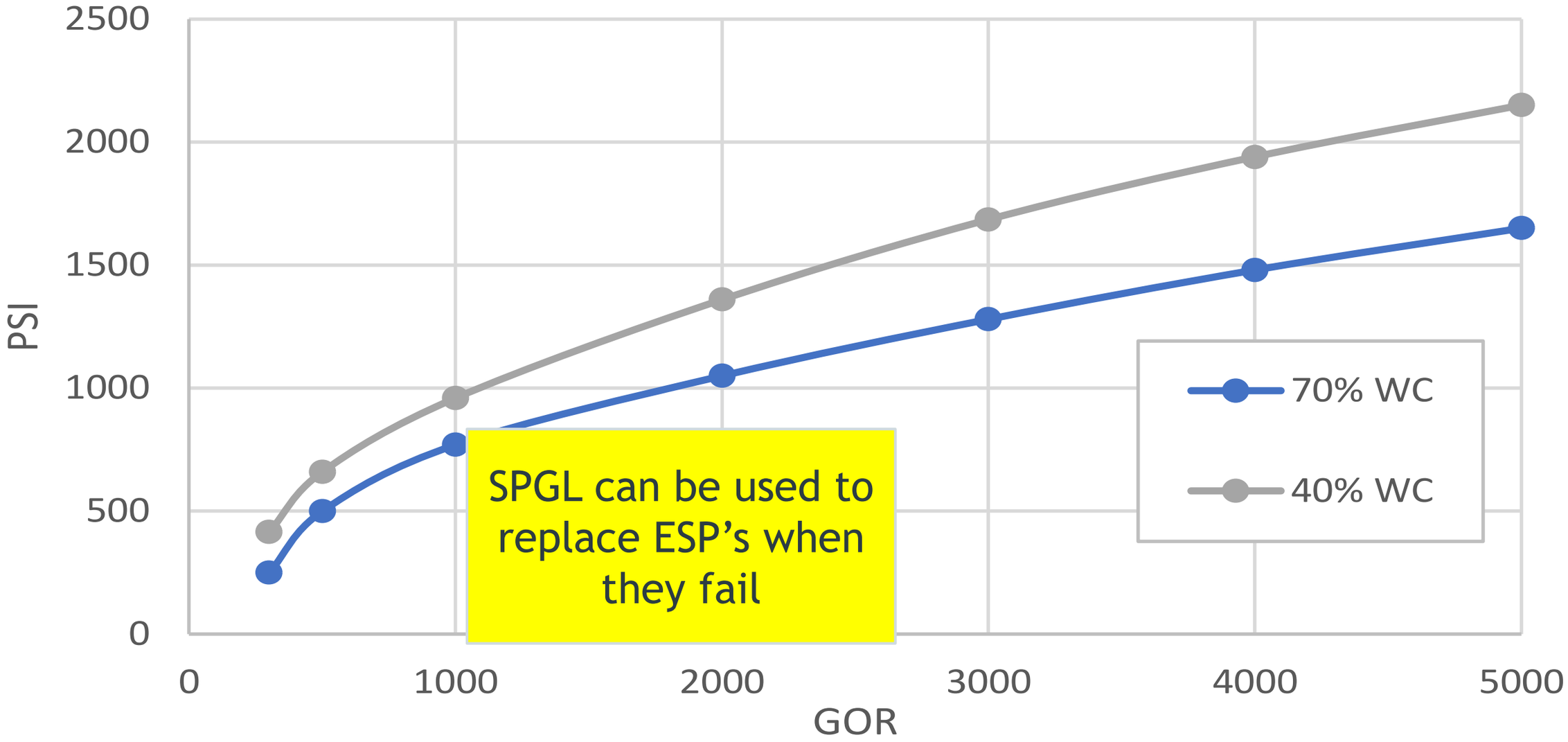
- Cannot go to rates needed for initial production
- Gas interference reduces ability to achieve low producing bottomhole pressure (PBHP)
- High failure rate = low runtime and high costs
  - Especially with significant dog legs

ESP's in Unconventionals

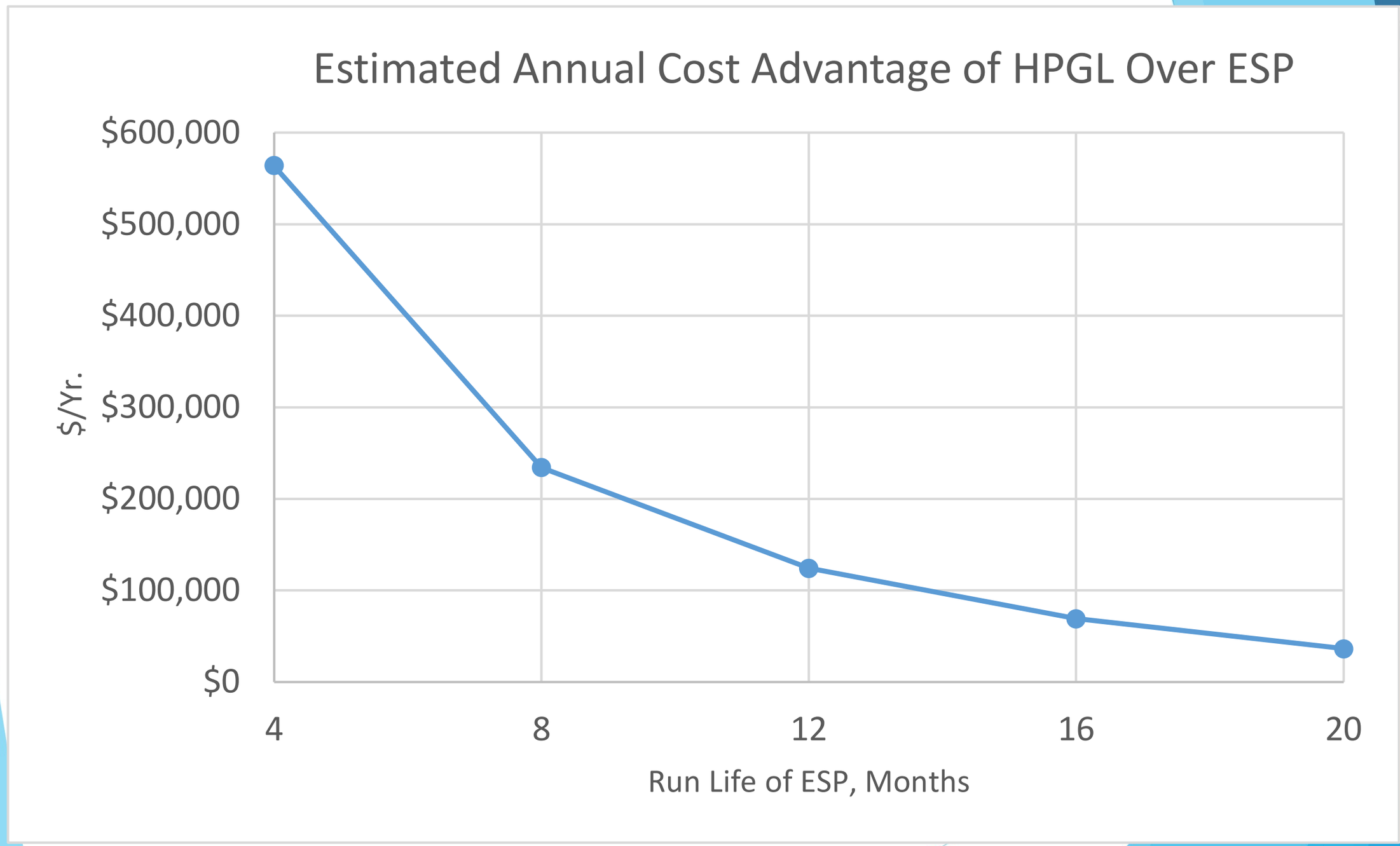
- Can achieve high rates
- High Failure Frequency = High Cost and Lost Production
- Limited flexibility
  - Need multiple pumps or move to different lift method = high cost
- Hard to distribute Corrosion Inhibitor
- Gas Interference limits PBHP attainable

Lowest "Stable" ESP Intake Pressure -Dunbar

90% Gas Separator Eff., 260 F, 40 API



Dunbar, C. E. 1989. Determination of Proper Type of Gas Separator. Presented at the Microcomputer Applications in Artificial Lift Workshop, SPE Los Angeles Basin Section Los Angeles, California, USA


Estimated Annual Cost Advantage of HPGL Over ESP
$600,000
$500,000
$400,000
$300,000
$200,000
$100,000
$0
$/Yr.
4
8
12
16
20
Run Life of ESP, Months

Conventional GL

- Method of “lightening a fluid column” with gas to artificially lift oil wells
- Has packer/valves- Lift gas injected in casing
- Injection gas pressure typically 900-1200 psig
- Dates from 1945 Invention by W. R. King of the “bellows” type gas lift valve

HPGL

- **Lightens column and ensures gas rate above critical velocity when needed**
- **No Packer, Gas injected down Annulus or Tubing at one point (like “jetting” with coiled tubing)**
- **Injection gas pressure 200-4000+ psig as needed**
  - **Constraints of Low Strength Casing/No HP Compressors no longer exist**
- **Dates from 1864 when air used in Pennsylvania oil wells**

Why HPGL Instead Of CGL?

HPGL Has all the strengths of CGL Plus:

- Achieves flow rates comparable to ESP's
- Simple
  - Running Equipment Downhole has costs/risks
- Easy to optimize/FBHP monitored easily
- Easily switched to PAGL (or other lift method)
- Allows corrosion inhibition from surface to the lowest point tubing is run into the well

HPGL Process Flow from SPE 195180

HPGL with booster, without booster we normally call it Single Point Gas Lift (SPGL)

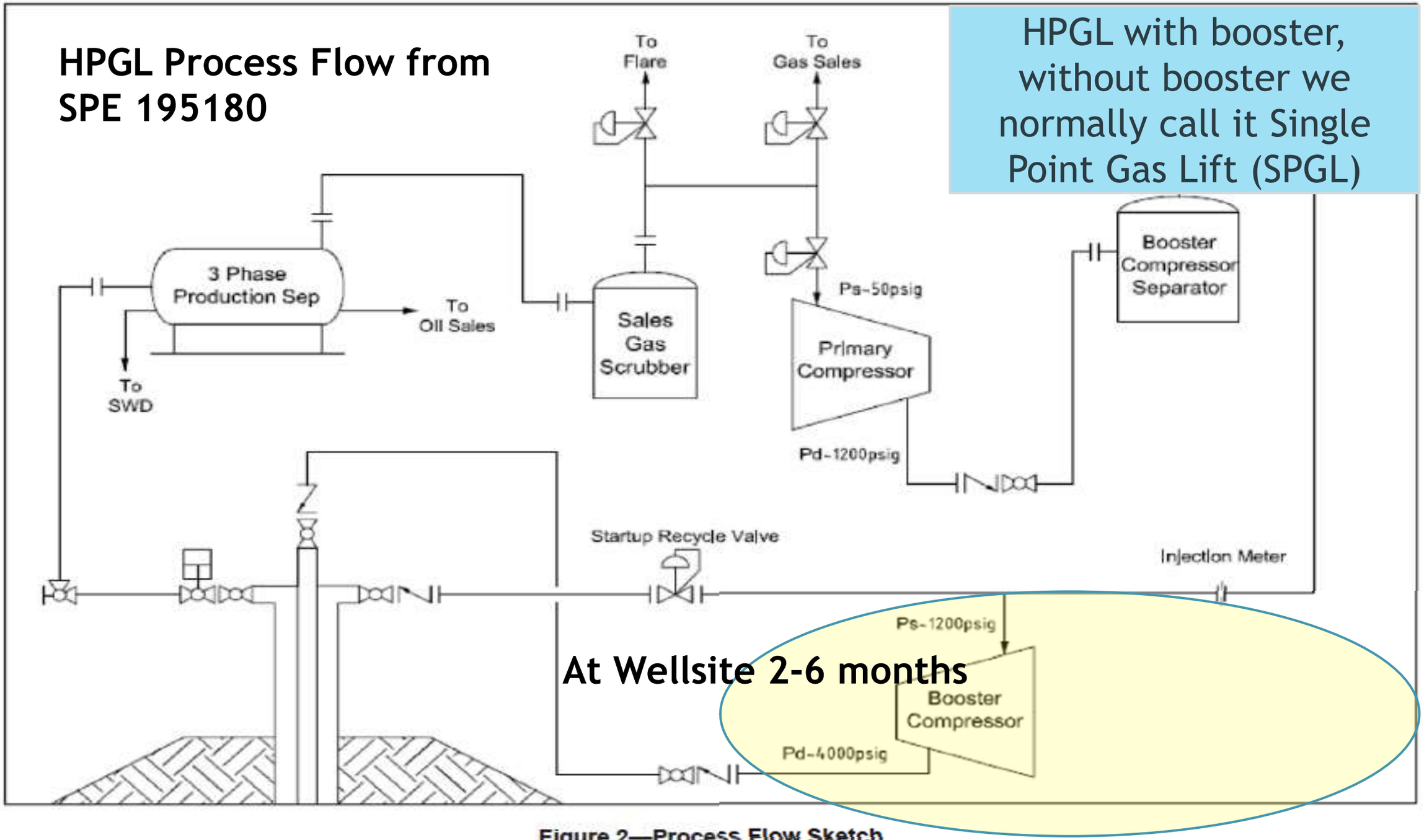
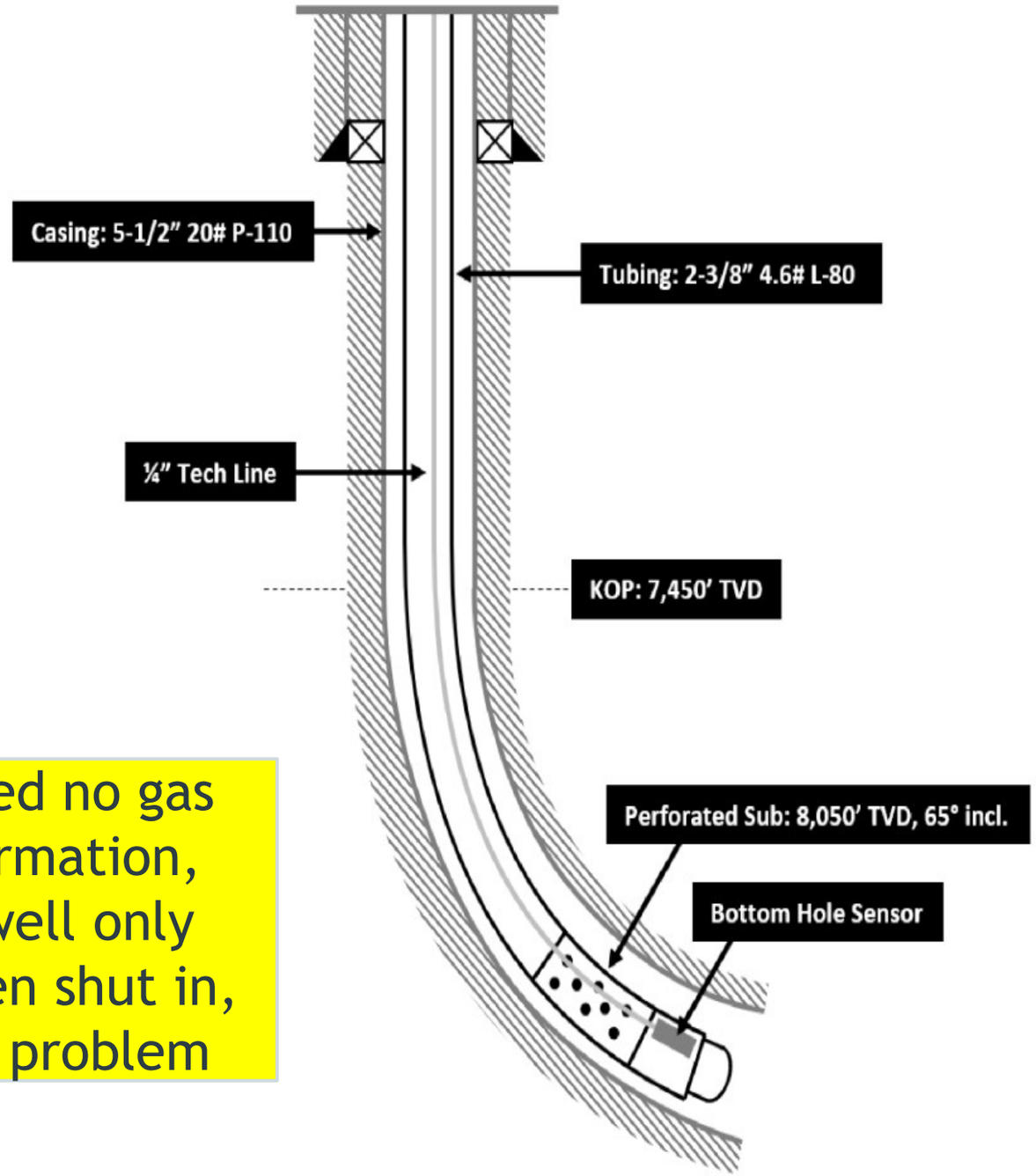


Figure 2—Process Flow Sketch

WBD for HPGL well- SPE 195180



Data confirmed no gas going into formation, pressure in well only increasing when shut in, Surging not a problem

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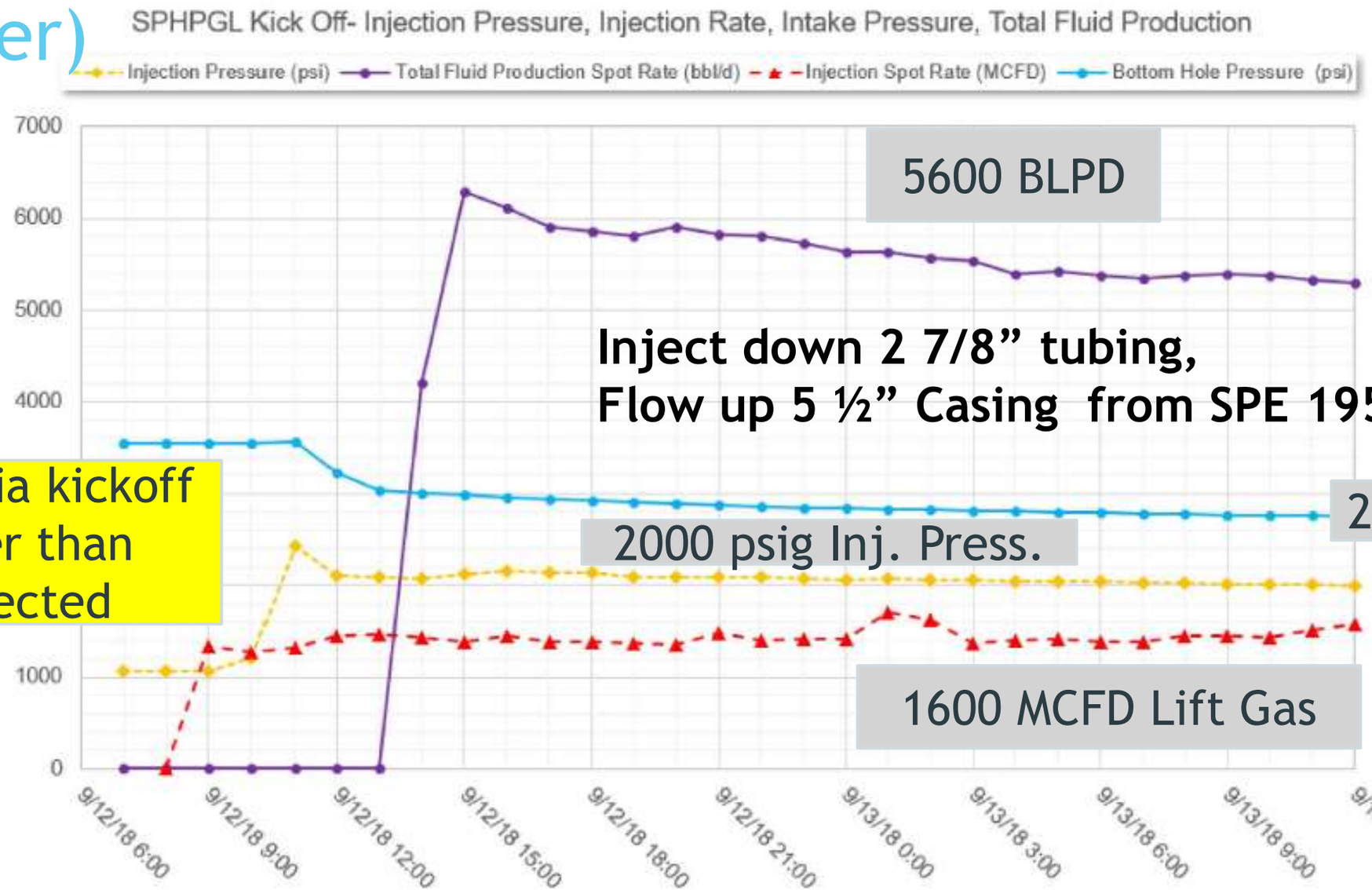
Permian HPGL Well-SPE 195180 (Initial flow- full of water)



5600 BLPD

Inject down 2 7/8" tubing,
Flow up 5 ½" Casing from SPE 195180

2600 psia kickoff
Lower than expected

2800 psia PBHP

2000 psig Inj. Press.

1600 MCFD Lift Gas

Figure 4—SPHPGL Kick Off Data

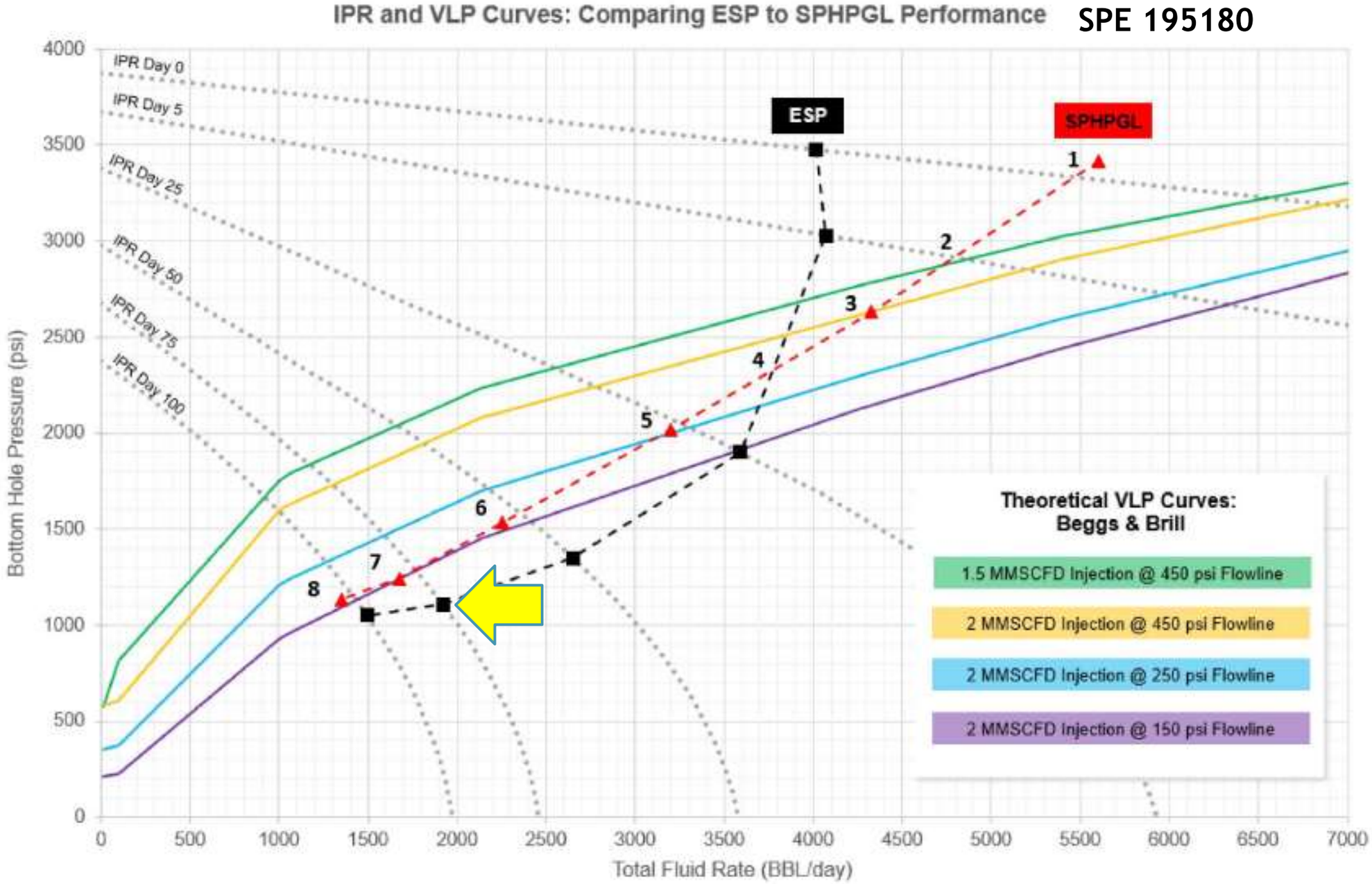


Figure 6—Comparing ESP to SPHPGL over time

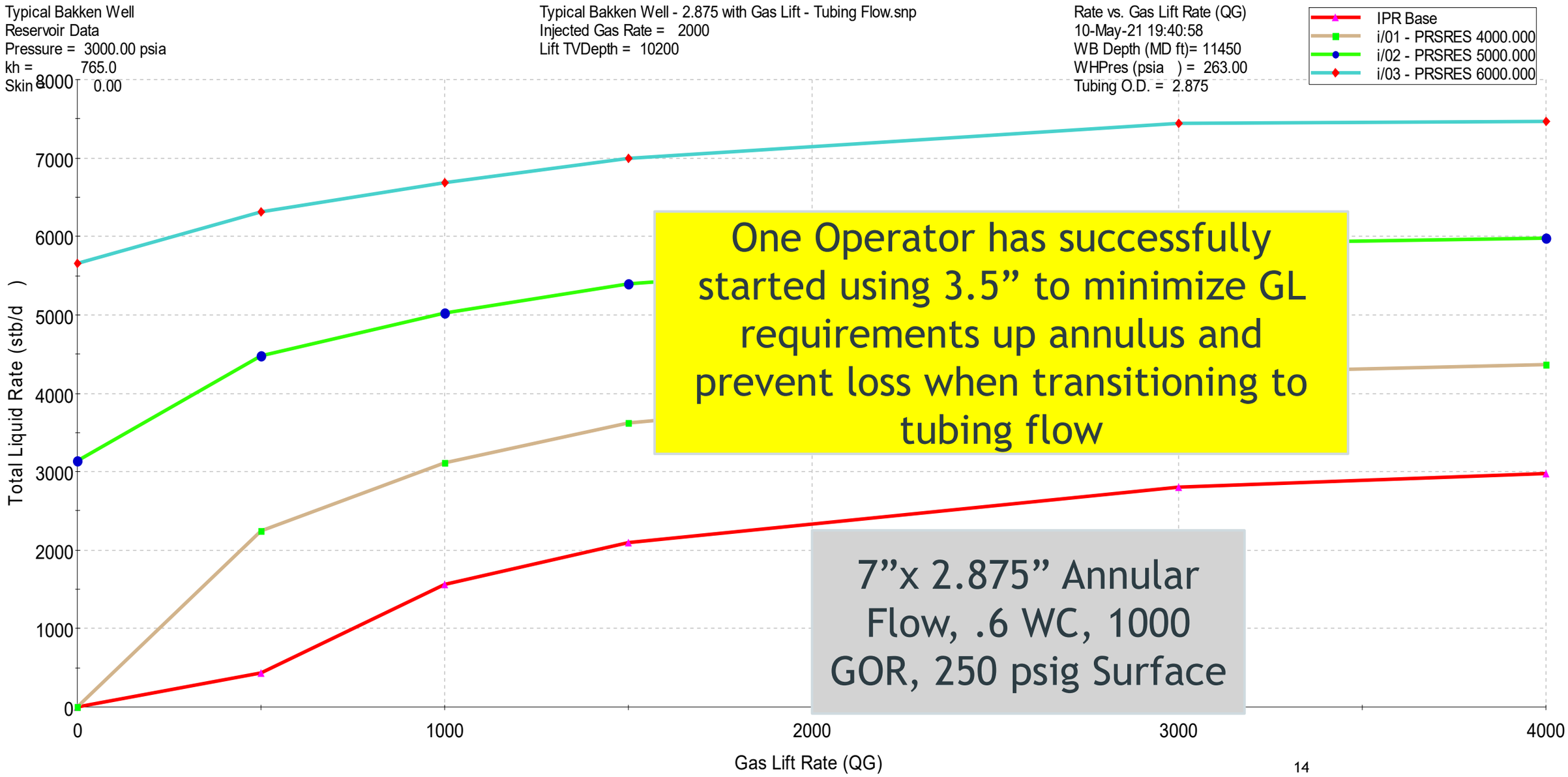
Estimate for Late Life SPGL on Eagle Ford Well (SPE 187443)

Table 3. Low Productivity Case with Tubing Flow

Flow Path	Max. BLPD	Lift Gas, MCFD	BHP, psia
2 3/8" Tubing	49	200	290
2 7/8" Tubing	50	300	260

SPGL Can Be Cradle to Grave AL Method (Especially with PAGL)

GL Rate vs BLPD for “Typical” Bakken Well



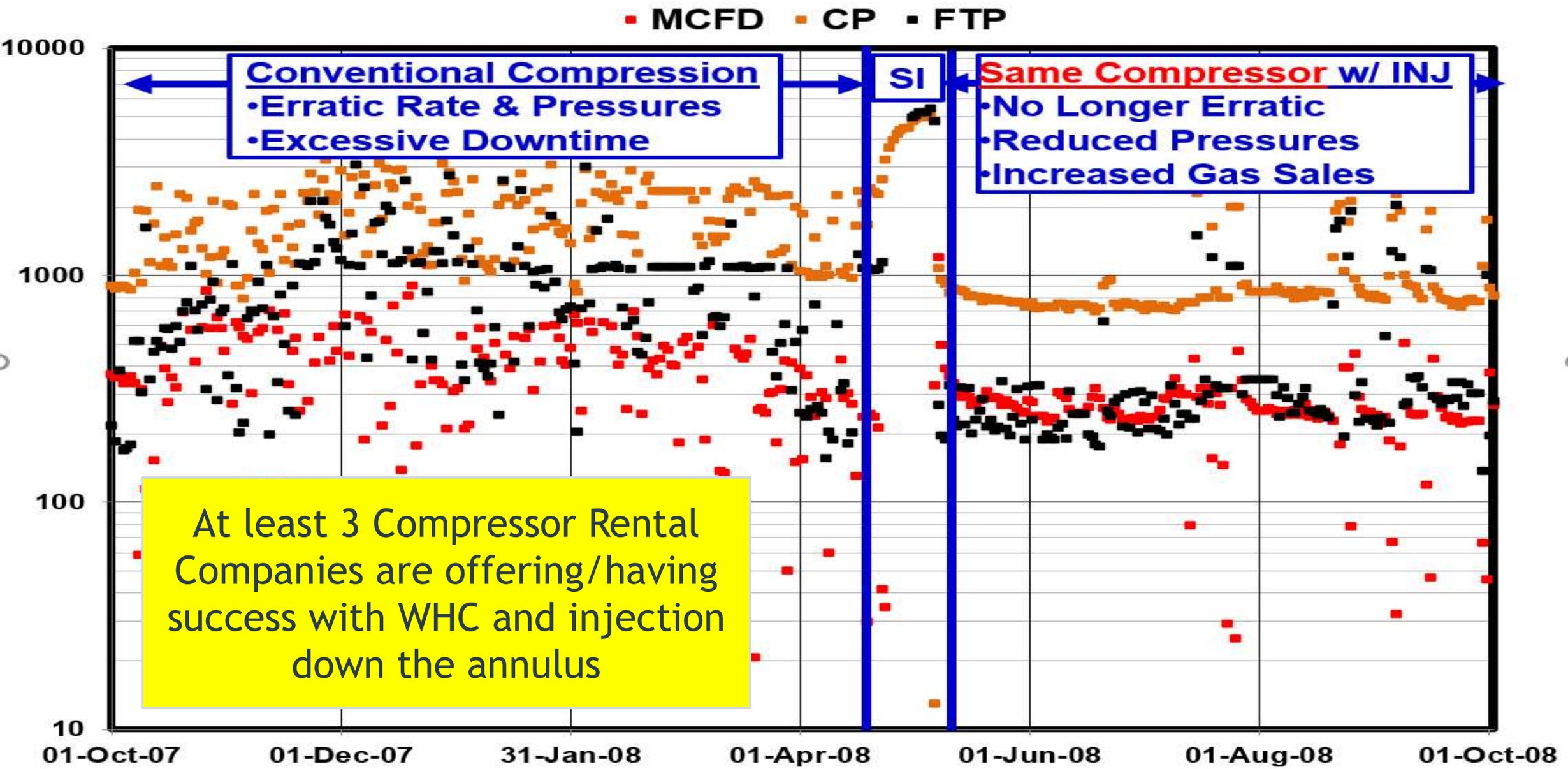
One Operator has successfully started using 3.5” to minimize GL requirements up annulus and prevent loss when transitioning to tubing flow

7”x 2.875” Annular Flow, .6 WC, 1000 GOR, 250 psig Surface

Indication of success of HPGL is refusal to publish on the topic or share data/information???

- Major Shale player is routinely doing HPGL
- Another Major Shale player just completed a successful 15 well HPGL pilot
- One smaller operator is saying they see it as a competitive advantage

Adding SPGL to Wellhead Compressor in Conv. Gas Well- Thanks Jim Hacksma (father of CGC, 1997)



Examples of Using HPGL with SCSSV's/Packers

- Kuparuk drillsites with no "gas-lift" lines use reinjection gas at 3000 psig to lift 5500' tvd wells

- One major operator uses 6000 psig lift gas for deep subsea wells

Negatives for HPGL

- Booster Availability – Not a problem since March 2020
- Booster Cost – As more people use it, price will come down
- Loading up well after the booster is gone
  - Hasn't been as big a problem as many of us initially believed
    - In one known case CNG was used to unload
  - One operator indicated intention of always keeping a booster in the field

Shutting in SPGL well tubing and casing when lift gas stops is very effective in preventing loading up the well

Negatives for HPGL

- Compressor reliability is KEY!!!
  - In L48, Cold weather has been a challenge for GL in general and HPGL has even more compression
  - Proper Designs can handle
  - One data point says HPGL compression had equal and usually better run time than the ESP's even with "old" compressor design
- One operator shut down their HPGL compressors because they were getting too much production (not surging) and facilities could not handle it.

Wells where HPGL is not the right choice?

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- Bakken operator with steady low GOR, high productivity, low pressure wells where ESP's have long lives and pump intake pressures of 50 psig

- High Productivity/High GOR (over 3000 to start and increasing) wells These wells should flow for a substantial period of time

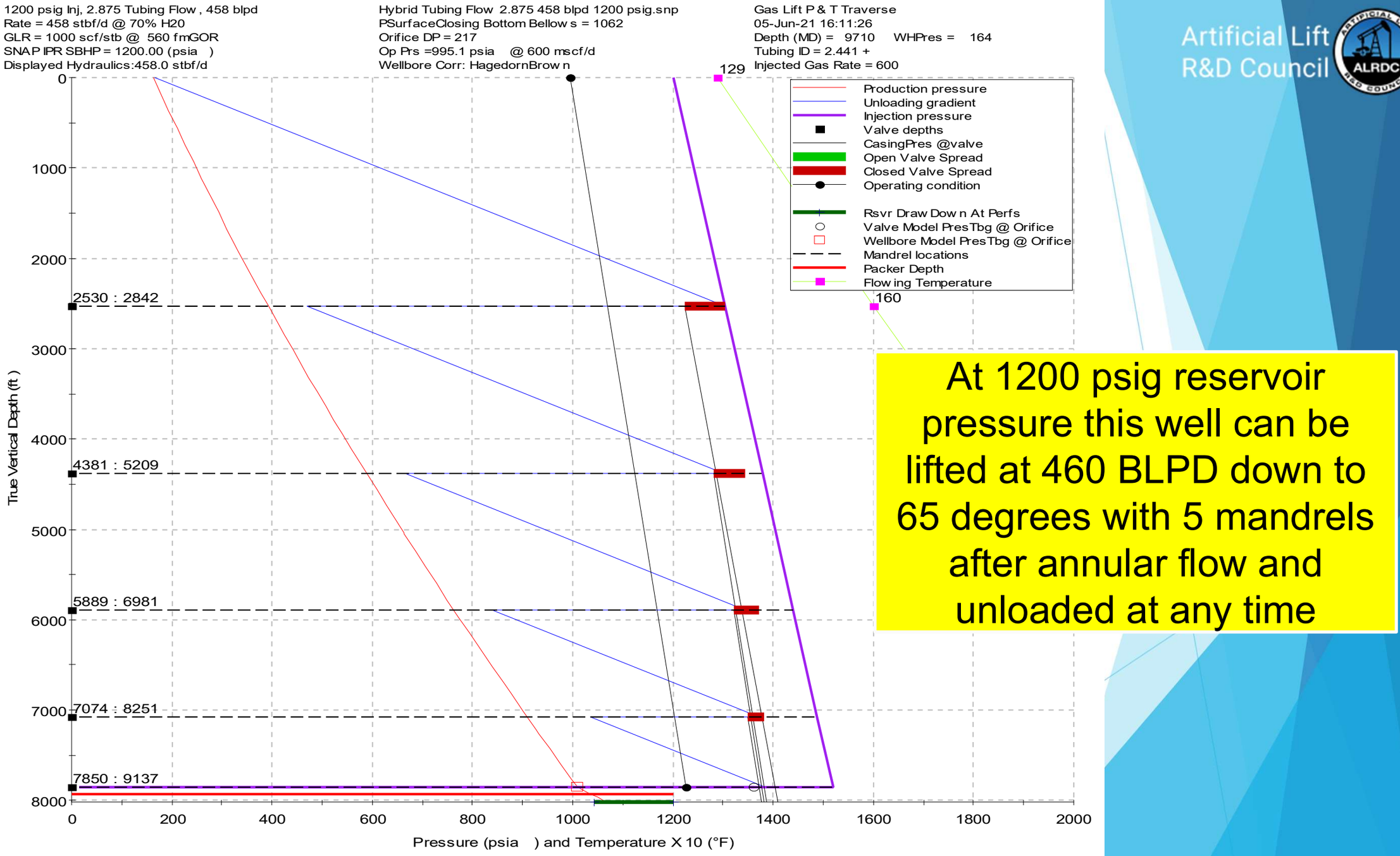
The vast majority of unconventional wells are HP/SPGL candidates along with many conventional wells

One easy hybrid of HPGL/CGL- remove the packer

- Enables the ability to do HPGL with annular flow and high rates if you want
- Stability has not been a problem on HPGL and with proper design should not be on Hybrid
- Increases ability to do PAGL, refrac, etc.

Another Useful Hybrid CG/SPGL

- Install a few mandrels in the tubing to enable original unloading of water from the well.
- Start by unloading the tubing with injection down the annulus, once well is unloaded and has oil and gas flowing, shut the well in and switch to injection down the tubing.
- HP/SPGL Example from 195180, could kick off well and only need +-2000 psig max discharge pressure on the compressor.
- Through rest of life can always unload/lift the well if it loads up



At 1200 psig reservoir pressure this well can be lifted at 460 BLPD down to 65 degrees with 5 mandrels after annular flow and unloaded at any time

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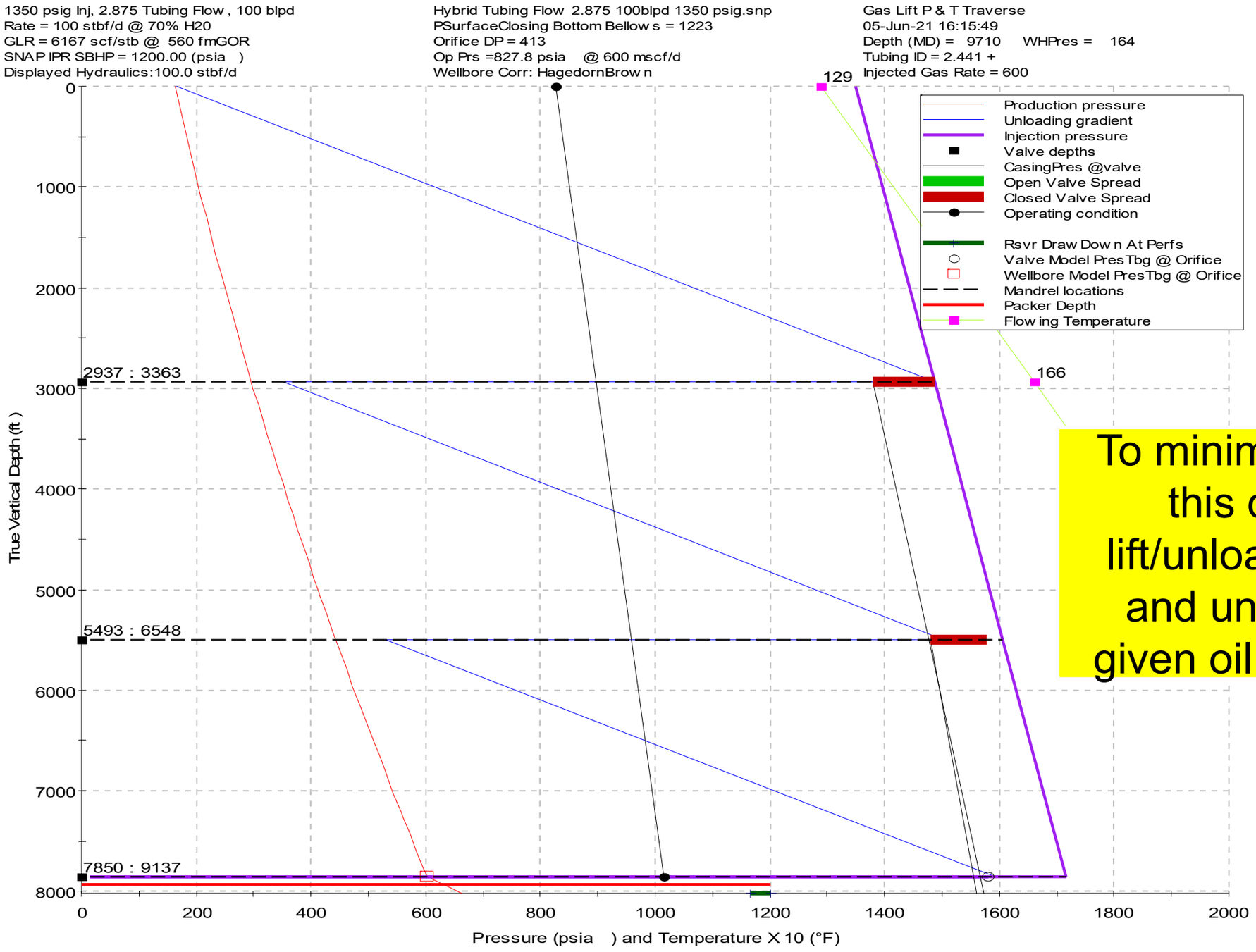

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To minimize mandrels, this design can lift/unload 100 BWPD and unload the well given oil and gas influx

Summary

- Characteristics of unconventional wells make GL Preferred Over Pumps in most cases
- HP/SPGL has advantages vs. CGL, is being used effectively in hundreds of unconventional wells and should be considered in thousands more
  - Conventional wells can also be good candidates
- Hybrids (e.g. getting rid of the packer, a few mandrels in tubing) of HP/SPGL/CGL can be useful
- In lieu of available data from HP/SPGL wells, the fact that operators will not publish/share information may be the best indicator of HP/SPGL's success

Questions

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