HIGH RATE UNCONVENTIONAL GLR BASED GAS LIFT

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ABSTRACT
The purpose of this paper is to discuss the history of different gas lift design methods and the theory behind a new design method. In January 2019, Production Lift Companies and Concho Resources ran a new gas lift design method in two unconventional wells in the Permian Basin. This new method is designed to exploit the initial high bottom hole pressure in unconventional wells to produce higher rates that, before now, were only possible with an ESP. This life of well design will also follow the well's decline and efficiently produce the well at lower rates. When completed correctly, the well can be switched to PAGL, Plunger Lift or GAPL without pulling the tubing.

The traditional gas lift design method for unconventional wells is to run unloading valves until you reach a minimum spacing of 500' (Fig. 1) and then continue the 500' spacing to the packer. The 500' spacing was adopted by the industry in the late 80's as "Best Practice" and has remained the standard today.

HISTORY OF THE BRACKETED GAS LIFT DESIGNS

In the late 80's The Giddings Austin Chalk wells changed everything. The oil and gas industry had to adjust from mostly vertical wells to horizontal wells. Many adaptations happened to make vertical tools work horizontally and those adaptations are still happening today.

The gas lift industry had to adapt also. At the time, most gas lift designs were still being done by hand. The Austin Chalk horizontal wells performed differently than the vertical wells. They headed terribly and no longer had predictable performance. They made lots of gas, made fines and gas lift was the preferred lift method because gas lift thrives in gassy wells producing solids. These new horizontal wells did not perform like vertical wells we were used to. Many things were tried, including running gas lift mandrels around the corner into the open hole. Dip tubes were also used to try to lower the pressure and make more fluid. This did not help to make more fluid. The next adaptation was a Multi-Rate Design for 1000 to 1500 BPD. Once the valve spacing reached 500' spacing, it was continued to the packer. As mentioned, this worked and became industry standard.

It was around this time when desktop computers became available and there were Nodal analysis programs around, but they were DOS programs for mainframe computers. One was called GLOP and one was called GLAD. A few of us were asked to redesign and modernize the GLAD program. We did and we now had a program that would run on a desktop computer.

The first program was a windows GUI program that allowed us to do a complex Nodal based gas lift design. It was the first program written that defaulted to the 500' spacing operating bracket for GLVs. As those programs were updated throughout the years, the 500' spacing was kept. Most of the gas lift companies and gas lift design programs operating today adopted the 500' bracket spacing. That's why you see it today on most designs. The bracketed design method works but is not as efficient as other methods being tested today.

WELL ANALYSIS UNCOVERS PROBLEMS

Recent flowing bottom hole pressure surveys showed what a lot of us thought for years (Fig. 6). These unloading designs, with the 500' brackets, are actually causing problems in today's unconventional wells. The unloading valves are routinely spaced too wide, which retards the transfer to the next valve. The valves will chatter (open and close very quickly) when they cannot transfer to the next valve. Chattering causes the valves to leak and hurt well performance. These surveys identified not only bad valve spacing, but also communication between the tubing and casing in places where none should be present.

Upon further research, we determined that the leaks were in places where a collar was in the tubing string. After checking with different companies, we discovered that many of them do not hydro test their tubing while running in the hole. They were testing the tubing once it was landed, but not while running in the hole. Unfortunately, when tested in this manner, you can't see small leaks or their location. Time and money can be saved by hydro testing tubing while going in the hole when running gas lift valves. Small holes become big holes and well performance will be compromised if not addressed.

TRADITIONAL NODAL BASED GAS LIFT

Nodal based gas lift designs work great for traditional vertical wells. Nodal analysis is used to create an IPR curve to predict well performance and to determine the best depth "Point of Injection" to lift fluid from within a well. Conventional vertical wells typically have a constant BHP, a consistent drive mechanism and a constant productivity index. In wells like these, the use of Nodal Analysis to predict well performance and aid in the gas lift design is very common and useful. Nodal based well analysis is not a valid method to predict an unconventional well's performance over the long term. Nodal measures a fixed performance point, but unconventional wells change so rapidly that Nodal will not give an accurate long-term performance answer.

UNCONVENTIONAL GLR BASED HIGH RATE GAS LIFT

The newest unconventional gas lift design method is the GLR Based High Rate Gas Lift Method. The GLR based method will produce higher rates than typical 500' bracketed designs and will transition from top to bottom with ease, using fewer valves.

The GLR based design method works best when the Static Bottom Hole Pressure (SBHP), Flowing Bottom Hole Pressure (FBHP) and Productivity Index (PI) are known. With that information, the Point of Injection can be pin pointed and will determine where the bracketed valves need to start.

If the SBHP is known or estimated and nothing else is available, then the GLR based method is used. The GLR based method requires some guesswork by the gas lift designer. The GLR based design starts by first plotting your SBHP on the graph (Fig. 2) and then, adding a family of GLR curves (Fig. 3). The bracket is started at the highest rate that can be made with the SBHP and GLR. This is an estimated depth and will become more accurate as more offset well data is acquired.

BACK PRESSURE

Back pressure in a gas lifted well will reduce the amount of fluid the well can produce now and for the life of the well. Every pound of pressure expended to move the fluid to the surface, is a pound of pressure that could have been lifting fluid. It is very important to conserve the well's bottom hole pressure to produce every barrel possible.

REDUCING BACK PRESSURE

Reducing back pressure is not always easy and there are many factors that cause back pressure: flowline size, the number of 90 degree turns in the flowline, chokes, choke bodies and distance from the tank battery can all be a cause of excess back pressure, along with many other factors. For the best performance, back pressure should be kept at or below 125 PSI.

CONCLUSIONS

The High Rate Unconventional GLR Based Gas Lift Design Method (Fig. 4) has plenty of merit. The transition from upper valves to lower valves can be greatly expedited on these unconventional wells by closely spacing the higher valves, or bracketing, and allowing for the rapid unloading process to create a higher rate. It's at this point where we have the most natural reservoir pressure helping the lifting process and the PI will be the greatest in the well's life. The opposite can be said when getting down to the lower portion of the well.

As we shift from upper to lower valves, the reservoir no longer gives up fluid at the same rate it did initially and thus we have an easier time keeping up and can transition more slowly from one valve to the next. This gives us the ability to adjust the antiquated 500' spacing, that was arbitrary to begin with, and adopt a more modern, tailored and suitable lower valve spacing for our unconventional horizontal wells.

Achieving 2,500+ BPD total fluid rates is well within the grasp of the High Rate Unconventional GLR Based Gas Lift system. Utilizing this system, we've seen 270+ psi of drawdown in several days following lift, based on data from an installed bottom hole pressure gauge (BHPG), and have reached fluid rates of nearly 2,800 BPD.

More installations would be needed to gather more conclusive data regarding the broad application of this system, but one thing is for sure: higher rates can be achieved and fewer valves can be used. There's no need to bracket the bottom valves into a 500' spacing based on the status quo or current practices, a better wheel has been invented.

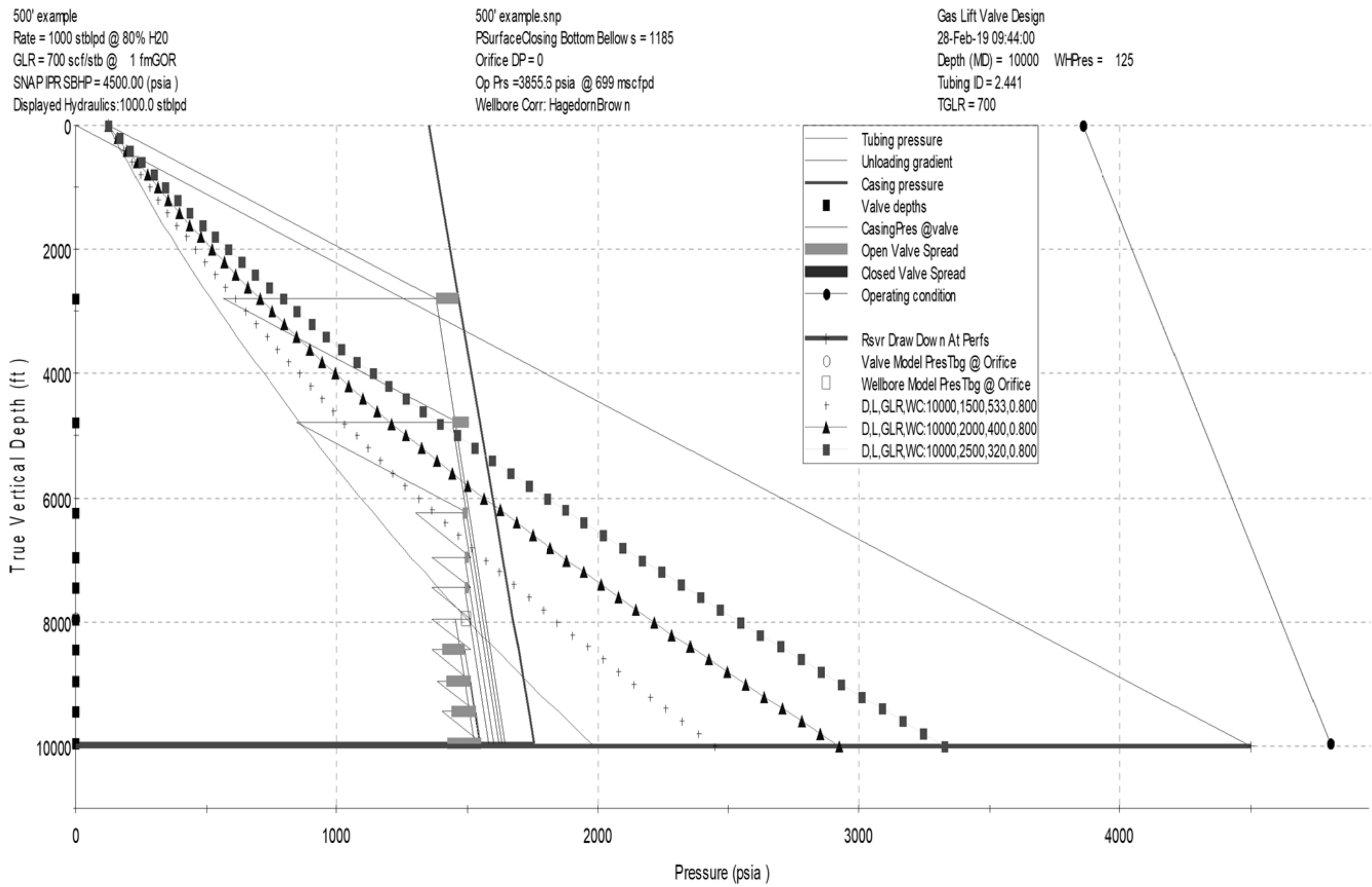

Figure 1 - Depicts 3 unloading valves and 7 valves spaced at 500’

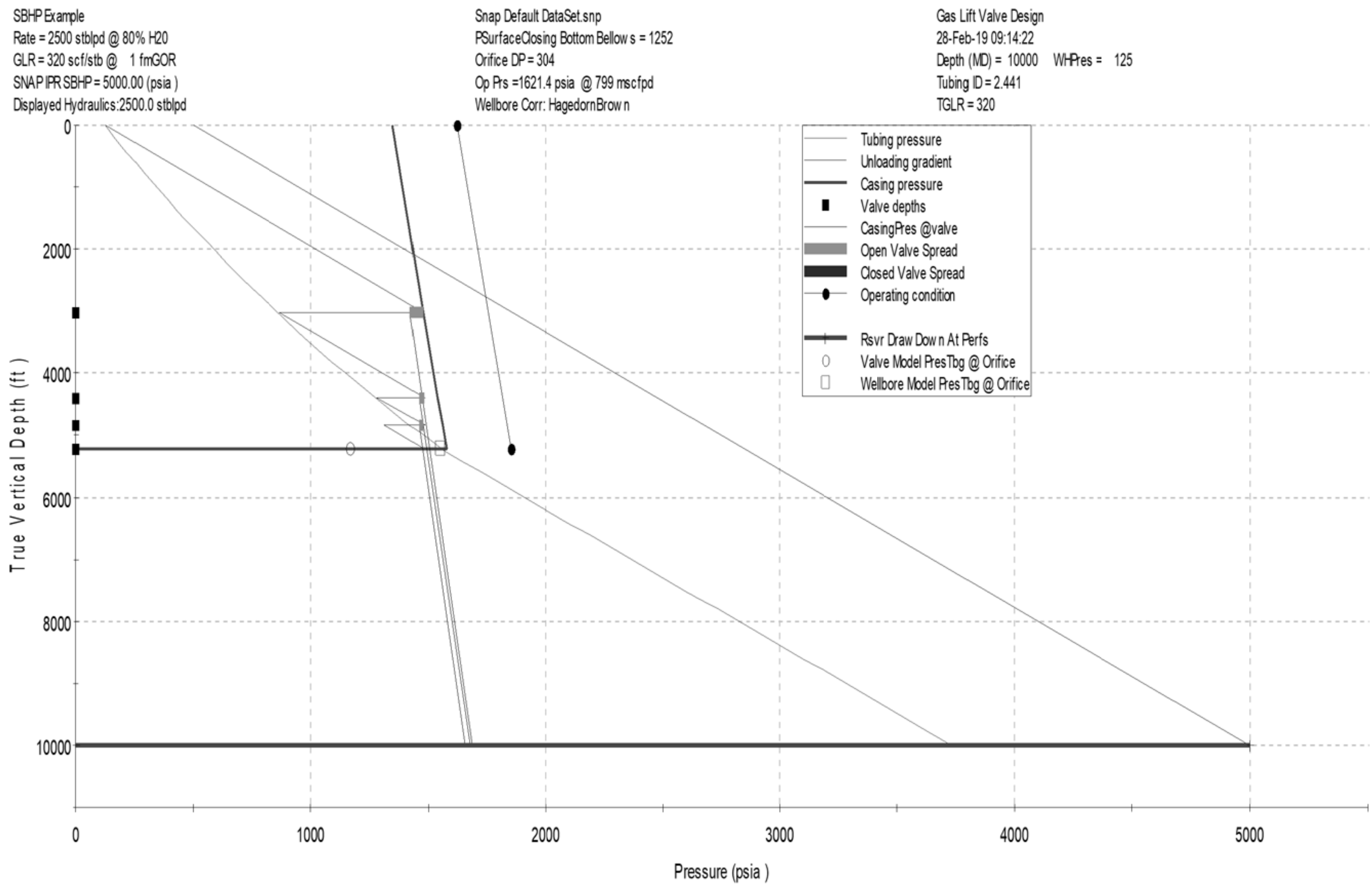

Figure 2 - The long line on the far right of the design represents the 5000 PSI SBHP.

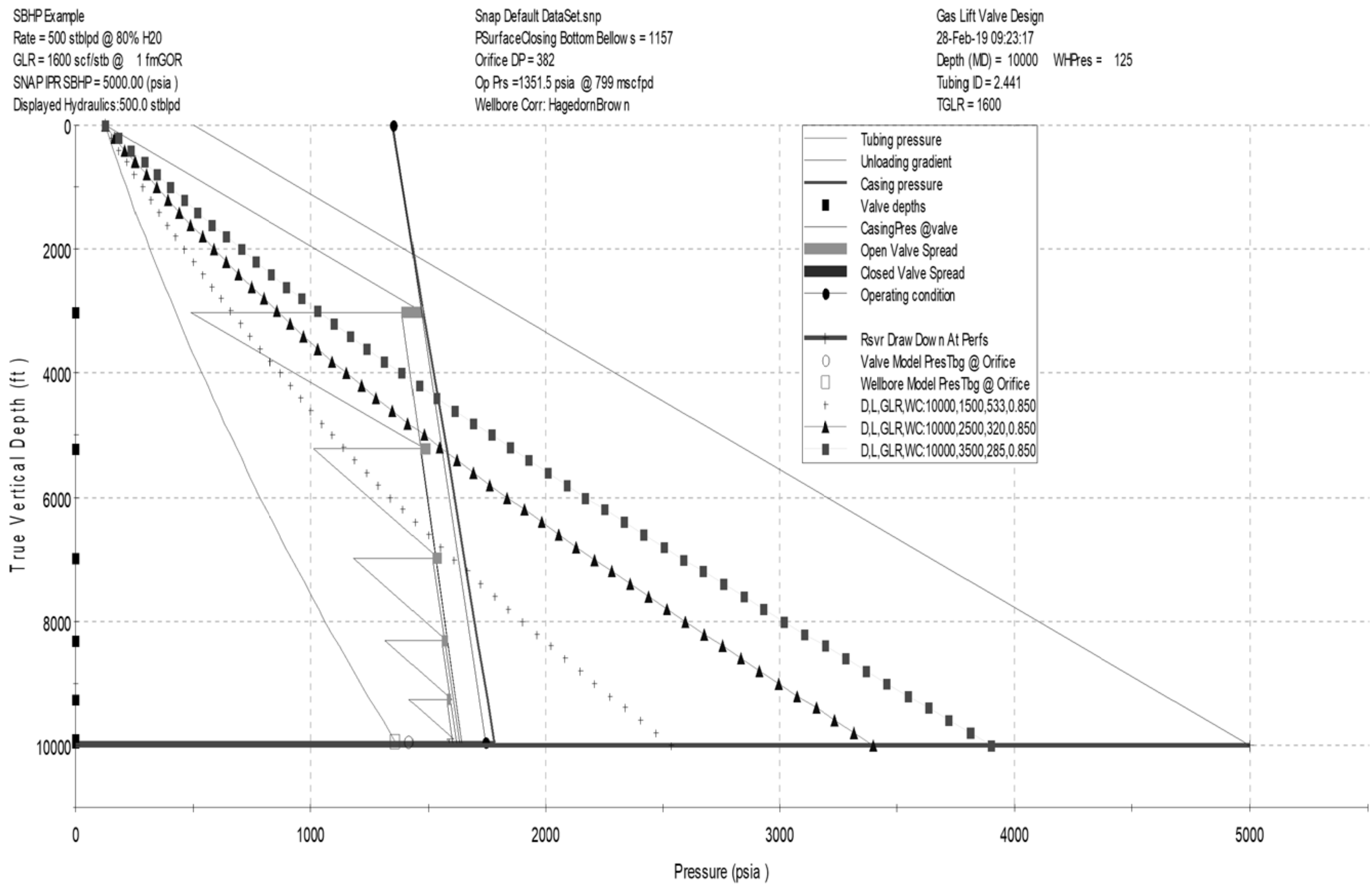

Figure 3 - A family of GLR curves added to the basis for a multi-rate GLR based design.

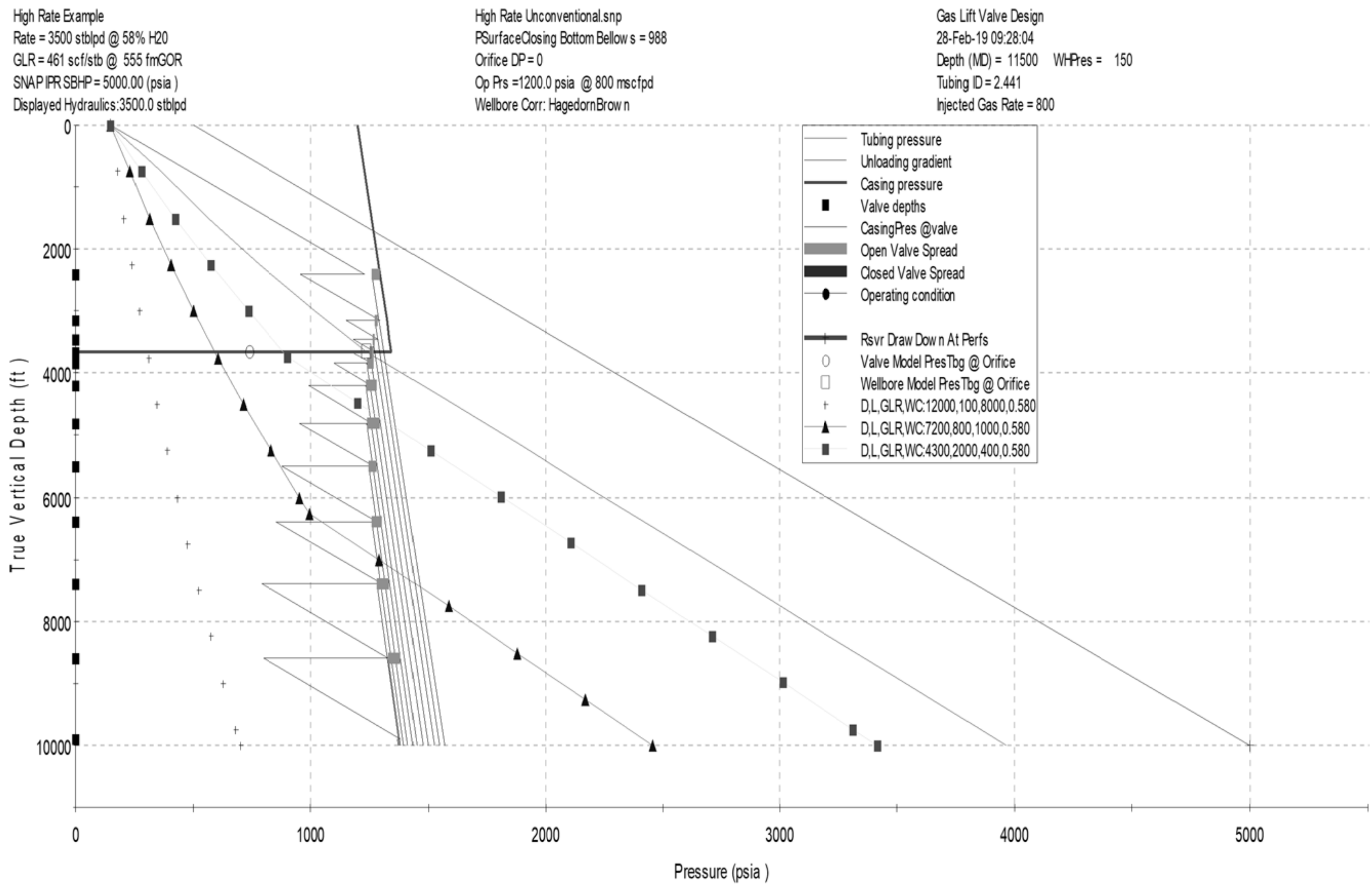

Figure 4 - High Rate Unconventional GLR Based Gas Lift Design.

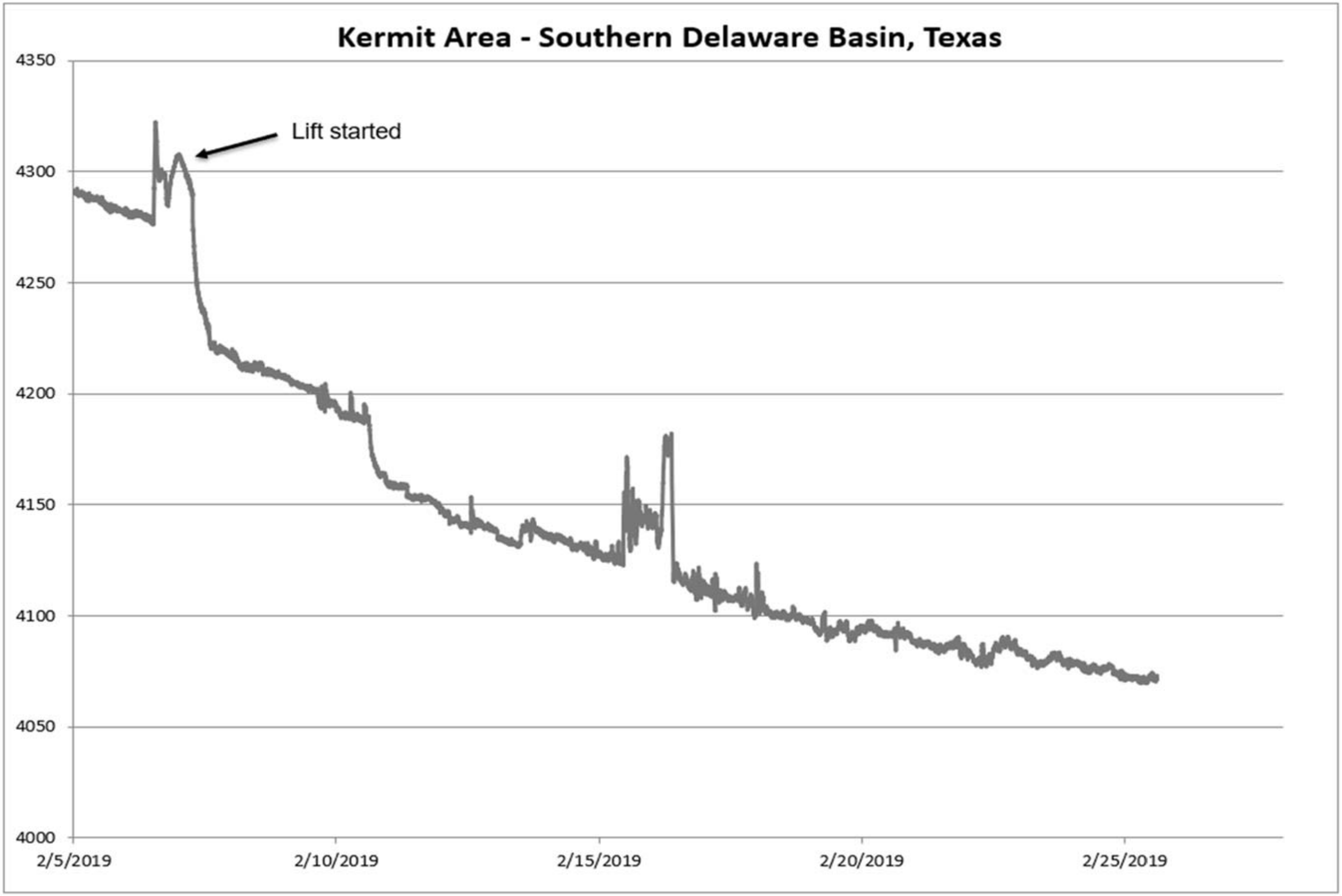

Figure 5 - Bottom Hole Pressure Draw Down utilizing the High Rate Unconventional GLR Based Gas Lift Design.

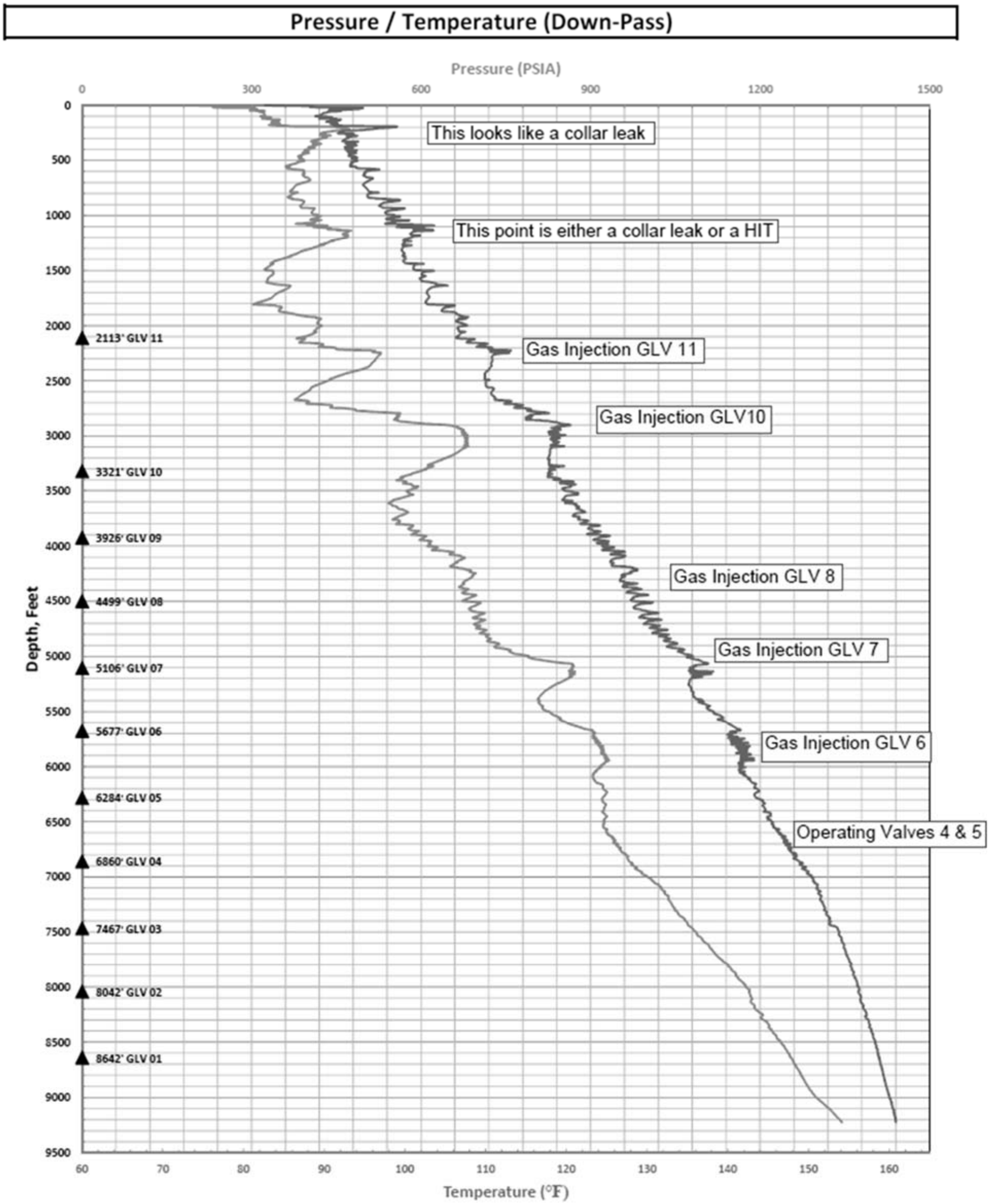

Figure 6 - Pressure and Temperature Survey