# PREDICTIVE GASLIFT TOOL AT DELAWARE BASIN LEVEL SURVEILLANCE

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## INTRODUCTION

Gas lift is the primary artificial lift system utilized across approximately 2,000 wells in Oxy's Delaware Basin assets. As the number of wells increase and personnel resources remain constrained, production engineers frequently focus on resolving urgent operational issues, such as well or equipment failures. This situation results in limited time for consistent and proactive surveillance and analysis of well performance. Advanced analytics offers a solution by enabling the evaluation of gas lift well performance and the rapid identification of wells with a high likelihood of operational issues. Traditionally, this analysis was performed manually, an inefficient and time-consuming process. The need for an end-to-end digital solution for basin-level surveillance arises to improve the workforce efficiency and detect optimization opportunities in a timely manner. Therefore, the predictive gas lift surveillance tool was developed to streamline this workflow by providing a single-page interface that highlights problematic wells, allowing production engineers to efficiently manage multiple wells simultaneously.

## THE OBJECTIVES

The tool was designed to support an "Operate-by-Priority" and "Report-by-Exception" framework, enhancing operational efficiency and effectiveness. A hybrid approach, combining physics-based simulation with data-driven methods, is employed to achieve the following objectives:

- **Streamline the surveillance process**: The tool aggregates data and highlights wells requiring attention, reducing the need for individual well analysis.
- **Develop predictive surveillance capabilities**: Physics-based simulations and time series analysis identify wells with potential operational issues, prioritizing those based on potential production uplift.
- **Promote operational efficiency**: The tool provides prioritized well and task lists, improving overall operation effectiveness.
- **Identify data quality issues**: Wells with data problems are flagged, allowing engineers to address these impediments to analysis as necessary.

## METHODOLOGY

The tool employs an in-house, proprietary physics-based algorithm to analyze gas lift performance, determining gas lift injection status (e.g., multipointing, single-point injection). It also applies time series analysis to high-frequency sensor data from wells to detect operational anomalies. By combining these approaches, the tool classifies wells into multiple production scenarios.

A traffic light system groups these scenarios into four categories:

- **Red**: Critical issues leading to missed oil production, requiring immediate action.
- **Yellow**: Warnings or non-critical issues needing attention, with no urgent action required.
- **Green**: Normal, ideal operational conditions.

- **Blue**: Other variances such as data issues affecting analysis quality, to be addressed as time permits.

Table 1 illustrates detailed scenarios for each color-coded category. For instance, a potential hole-in-tubing would be categorized as red, multipoint injection as yellow, and steady injection at the deepest valve as green. The blue category also provides several good flags such as annular flow wells ready for CGL conversion, choking on wells and gauge issues.

A feedback loop has been implemented to continuously improve the digital solution. This feature allows

1) End users, such as production engineers, to provide comments and feedback regarding well diagnostics on specific dates. All feedback is automatically saved to a database for periodic review.
2) The "Look-Back" function, powered by GenAI, aims to improve the accuracy of potential production uplift predictions by comparing predicted outcomes with actual results. The workflow chart below illustrates this process.

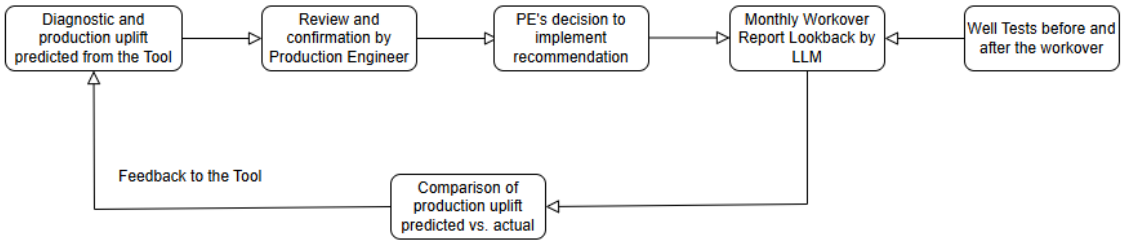



*Figure 1 – Look-Back Function Using GenAI*

User interface and user experience (UIUX) is also very important for such a digital tool. Figure 2 is the end user interface mockup of the daily overall KPI page which reflects the traffic light approach.

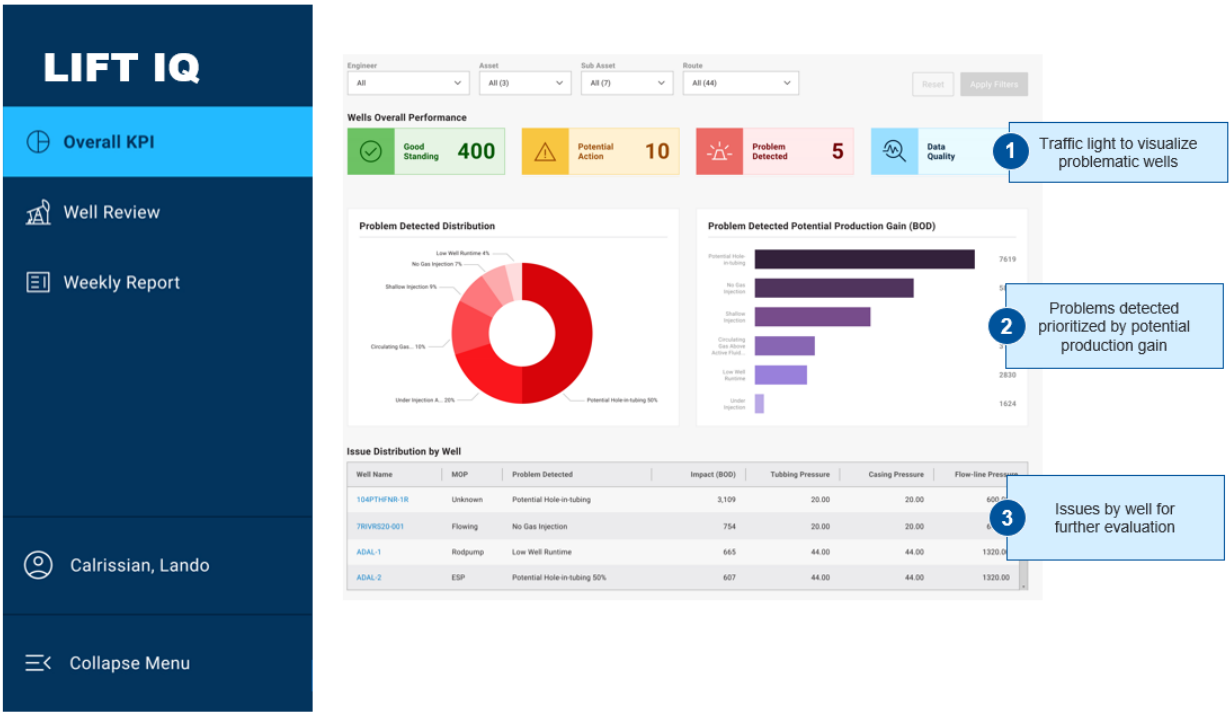



*Figure 2 – End User Interface Mockup Design*

*Table 1 - Scenarios included in each of the color groups*

| Category | Case Description | Case Details |
|---|---|---|
| Red | Potential HIT (Hole-in-tubing) | The pressure gradient indicates that all downhole valves including orifices should be closed with zero gas flow while gas is still injected from the surface. |
| | Well Down | The well is down. |
| | Shallow Injection | Gas is injected through a single valve and the calculated gas injection depth is shallower than 5000 ft (TVD). |
| | No gas injection | Gas injection rate is 0 for the whole day. |
| | Under Injection | Compare actual injection rate with set point from the closed loop optimizer, flag the well if actual < setpoint |
| Yellow | Multi-pointing | Gas is injected through more than one valve simultaneously. |
| | Valve Cycling | Due to pressure changes, gas injection point is alternating between two valves. |
| | Surging single-point injection through deepest valve | Gas is injected through the deepest valve. However, gas is not injected continuously due to pressure fluctuation. |
| | Unstable injection at deepest valve | Gas is injected through the deepest valve. However, gas is not injected continuously due to pressure fluctuation. |
| | Unstable single-point injection above deepest valve | Gas is injected through a single valve above the deepest with pressure fluctuation. |
| Green | Steady single point of injection, valve barely open. | Gas is injected through a single valve with small DP across it, injection depth > 5000 ft (TVD) |
| | Steady injection at deepest valve | Gas is injected continuously at the deepest valve. |
| | Steady injection above deepest valve | Gas is injected at a single valve above the deepest valve. |
| Blue (Other Variances) | Tubing Flow Conversion | The annular gaslift well is ready to be converted to the conventional tubing flow gaslift wells. |
| | Choked Wells | Production curtailment - the well is choked back during part of the day. |
| | Outlook Variance | Well test rates vs. Outlook rates 30-day average Discrepancy > 25% for wells' Oil Rate > 100 BPD. |
| | Well Test Needed | wells with latest well test being older than 30 days. |
| | Gauge Issue | frozen pressure/rate readings, negative readings |
| | Missing Data | for example, Missing flowline pressure. |
| | Analysis Failure | Gaslift analysis of the well has failed for the last 7 days. |
| | Allocation Variance | Well test rates vs. allocation rates of the day have a discrepancy larger than 25%. |

## RESULTS

The production engineer begins by reviewing the overall KPI page for a high-level understanding of asset performance on a given day. If needed, they can delve deeper into specific wells by clicking on their names, which leads to a well review page containing detailed information and historical data. This page provides sufficient context for engineers to identify issues and make informed business decisions. A feedback button on the page allows users to share comments or notes with colleagues.

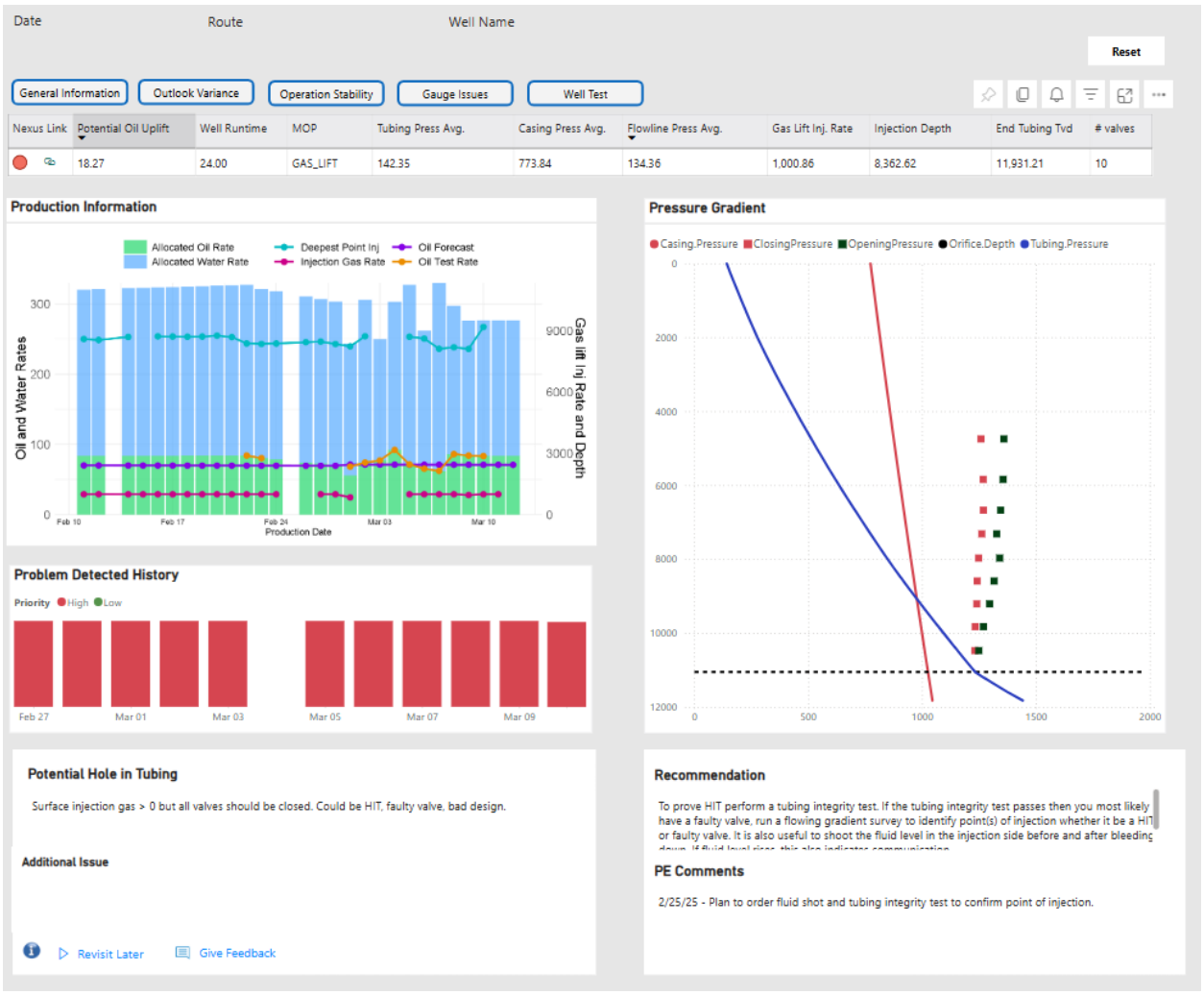



*Figure 3 – The Well Review Page*

In addition to the daily overall KPI page and well review page, a weekly report page was also implemented to provide a rolling 7-day summary of well diagnostics, highlighting ongoing issues with priority. The production engineers also receive an automatic email of the weekly summary of wells assigned to them every Monday morning. Figure 4 shows us an example of a weekly summary for a production engineer which is sent through email as an attachment and a link to the actual page of the tool.

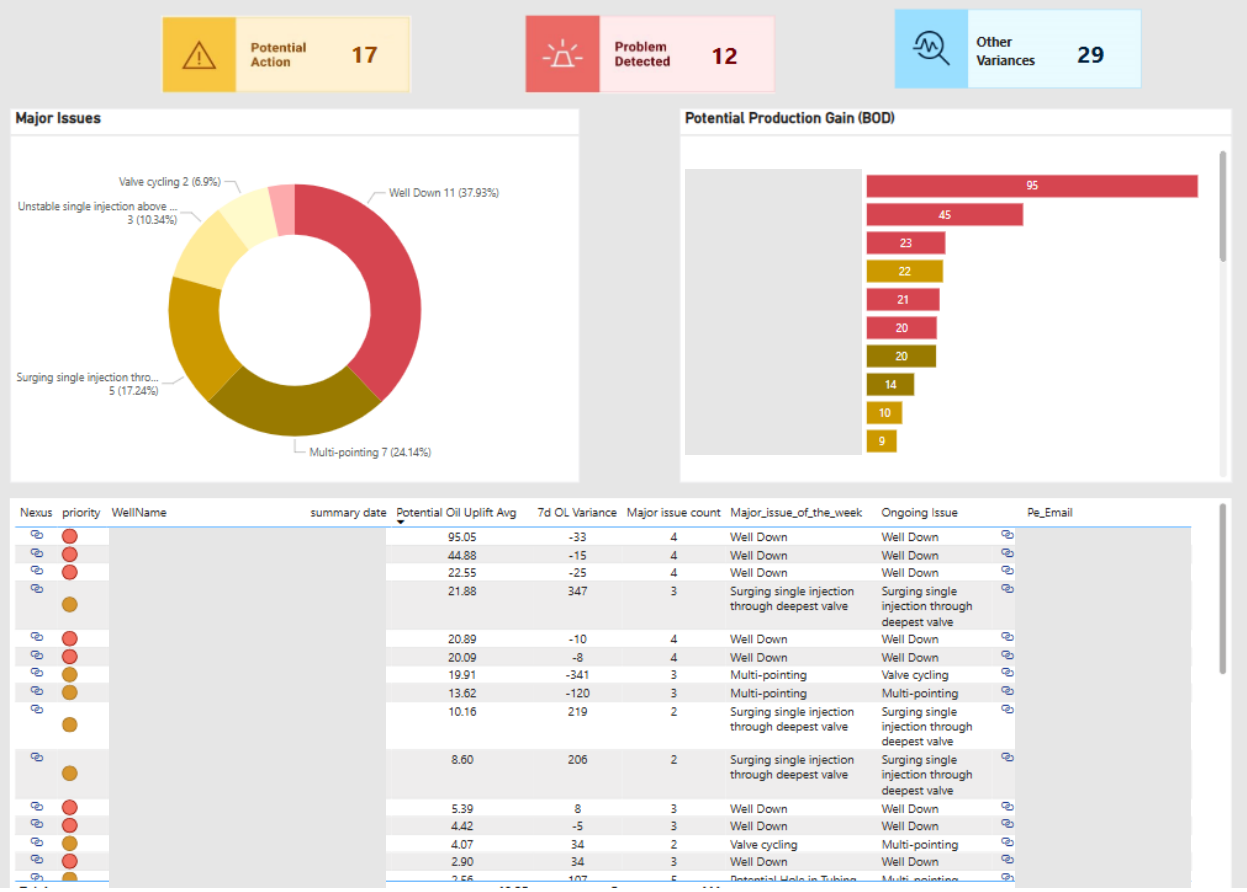
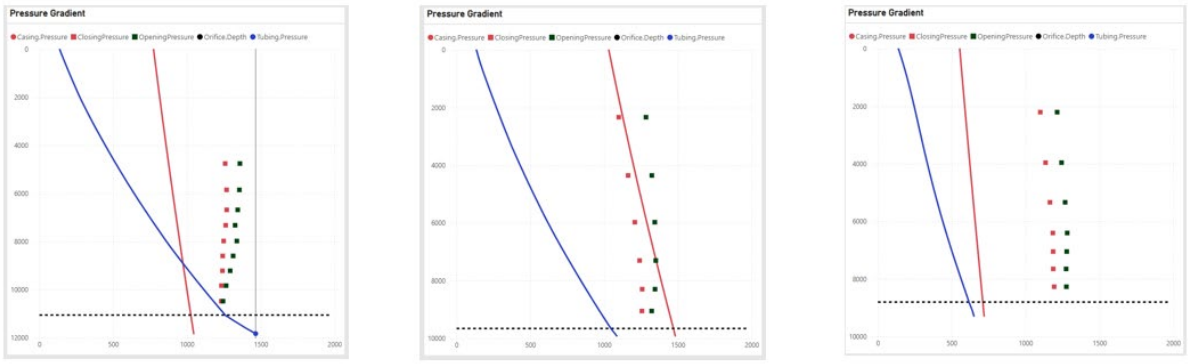



*Figure 4 – The Weekly Report Page*

Figure 5 shows three well examples of the pressure gradient graphs generated from the tool. The one on the left shows a well with a potential hole in tubing. The well in the middle was experiencing multi-pointing injection and the well on the right has steady injection at the deepest station.




Potential Hole in Tubing

Multi-pointing

Steady Injection at Deepest Orifice

*Figure 5 – Example Well Pressure Gradient Graphs from the Predictive Gaslift Surveillance Tool*

The tool has greatly enhanced production engineers' efficiency by reducing the need for manual well analysis and providing a prioritized list of wells requiring attention. For example, identification time for major issues, such as tubing leaks, has been reduced from weeks or months to just a few days.

Additionally, automated workflows have been developed to calculate potential oil production uplift based on remedial actions. The tool not only recommends corrective actions but also forecasts the potential production gains, aiding production engineers in decision-making.

The tool is estimated to reduce engineers' time for gaslift well analysis by 70%. Additionally, it accelerates production by enabling engineers to identify and resolve well issues more quickly. This comprehensive solution, which combines issue detection with uplift calculations on such a large scale, represents a significant advancement in the field.

## FUTURE WORK

To further enhance value for the asset operation team, a near-real-time anomaly detection component is planned to identify more time-sensitive issues and tasks. This component will use machine learning techniques and will be integrated into the existing solution, supporting well performance specialists and enabling the assignment of tasks to surface leads for prompt action. The entire solution is expected to be deployed in a cloud environment to enable near-real-time algorithm processing. Figure 6 demonstrates the complete vision of the program.

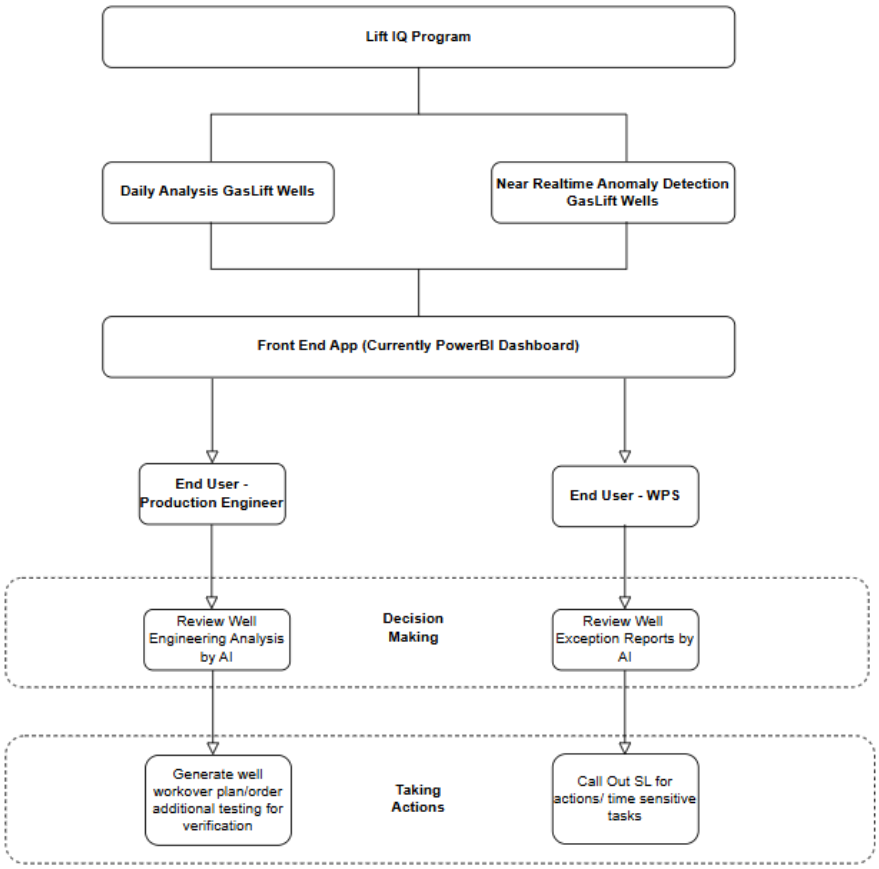



*Figure 6 – Overview of Workflows in the Predictive Gaslift Surveillance Tool*

## REFERENCES

G. Stephenson, Occidental Petroleum; R. Molotkov, Weatherford; N. De Guzman and L. Lafferty, Intelligent Agents Corporation “Real Time Diagnostics of Gas Lift Systems Using Intelligent Agents: A Case Study”, SPE 124926, 2009 SPE ATCE, New Orleans, Louisiana, USA.

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