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ENERGY: OIL & GAS

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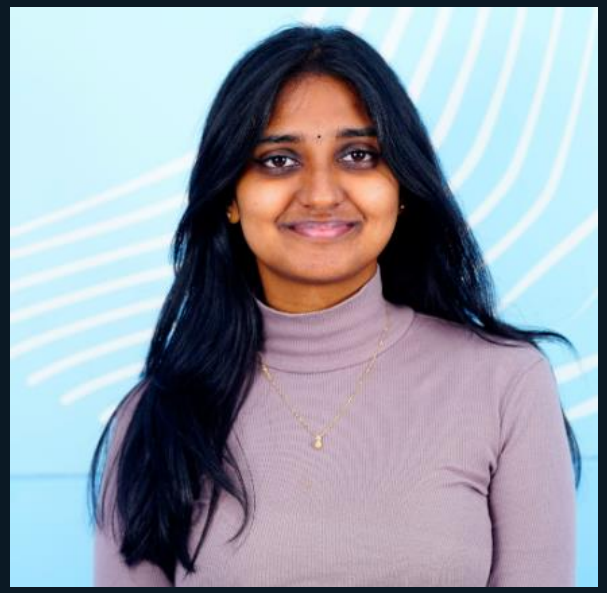

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Promoting Deepwater Production Stability with Slugging Analytics

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Guyana Stabroek Overview

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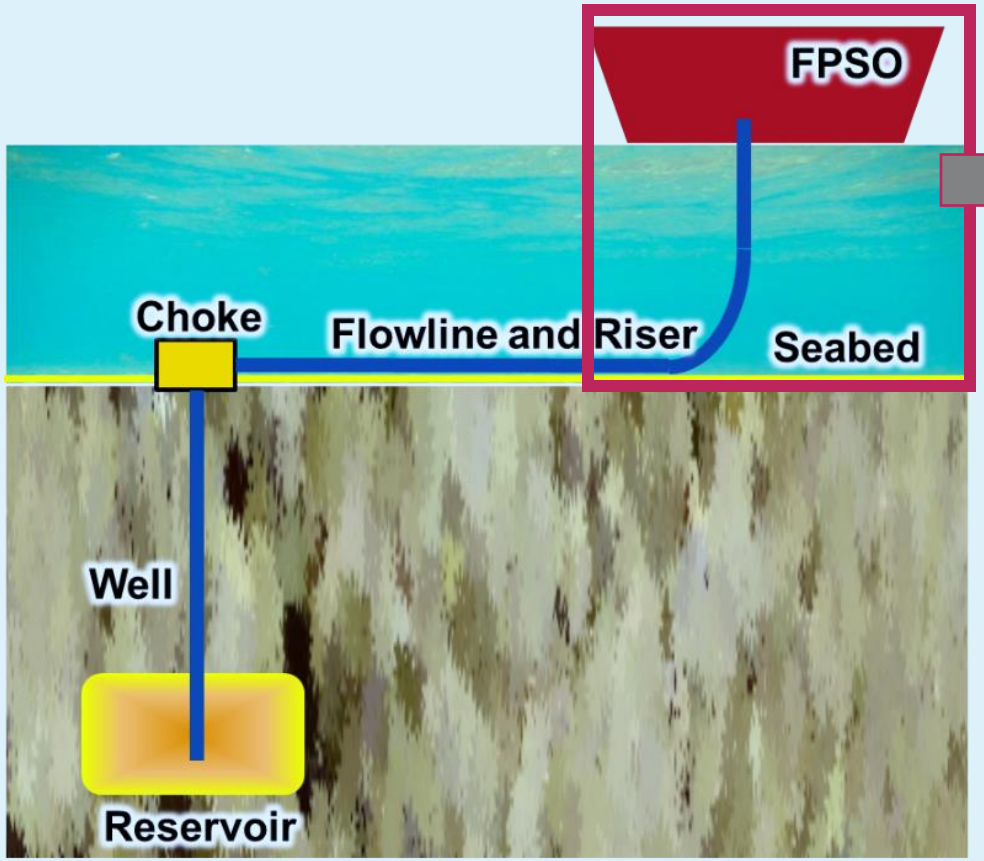
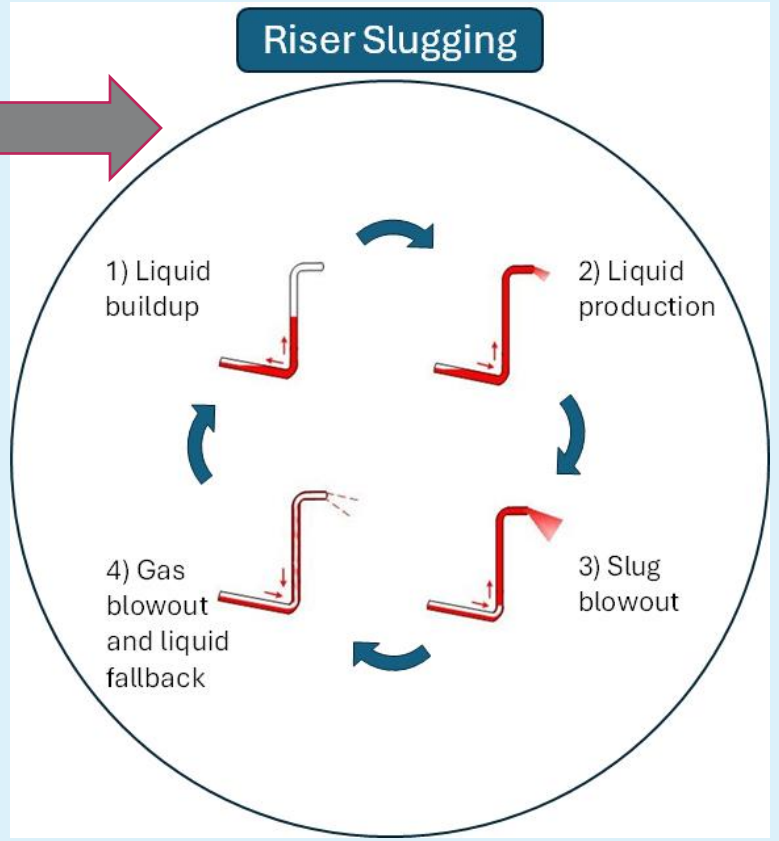
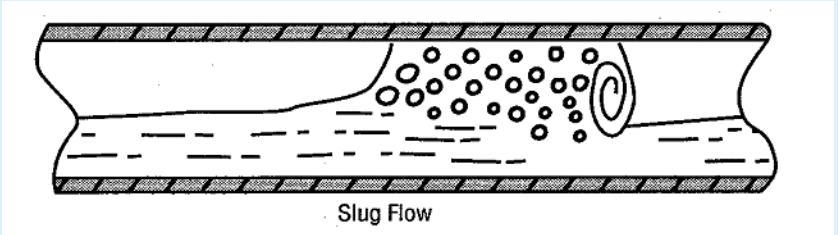
Deepwater Steady-state Slugging Challenges

Property	Hydrodynamic
Operation	Steady State, well testing
Influence of Pipeline Geometry	Moderate
Primary Impact	Flow instability, poor well test quality
Technology	OLGA, Analytics *moderate*







Slugging is categorized by variations in phase flowrates, temperature, and pressure

Problem Statement

Guyana Hydrodynamic Slugging

Guyana Operations is challenged by **flow instability** during normal & well testing operations in production risers

Caused by hydrodynamic slugging mechanisms that can contribute to:

- Flow instability
- Poor Well Test Quality
- Process Upsets

Guyana Hydrodynamic Slugging Surveillance

Problem Statement

Guyana Operations is challenged by **flow instability** during normal & well testing operations in production risers

- Caused by hydrodynamic slugging mechanisms that contribute to process upsets and unreliable data

Flow Assurance Challenges

- Multiphase flow modeling has trouble predicting hydrodynamic slug flow accurately
- Real-time simulation capability cannot accommodate slug tracking with desired simulation speed

Analytics Solution

- Utilize Seeq data analytics and Guyana PI Historian data to:
- **detect** past and current hydrodynamic slugging events
- **generate** experiential slug map
- **determine** analytical minimum flowrate to avoid hydrodynamic slug flow during steady operations
- **develop** monthly classification reports to monitor stability

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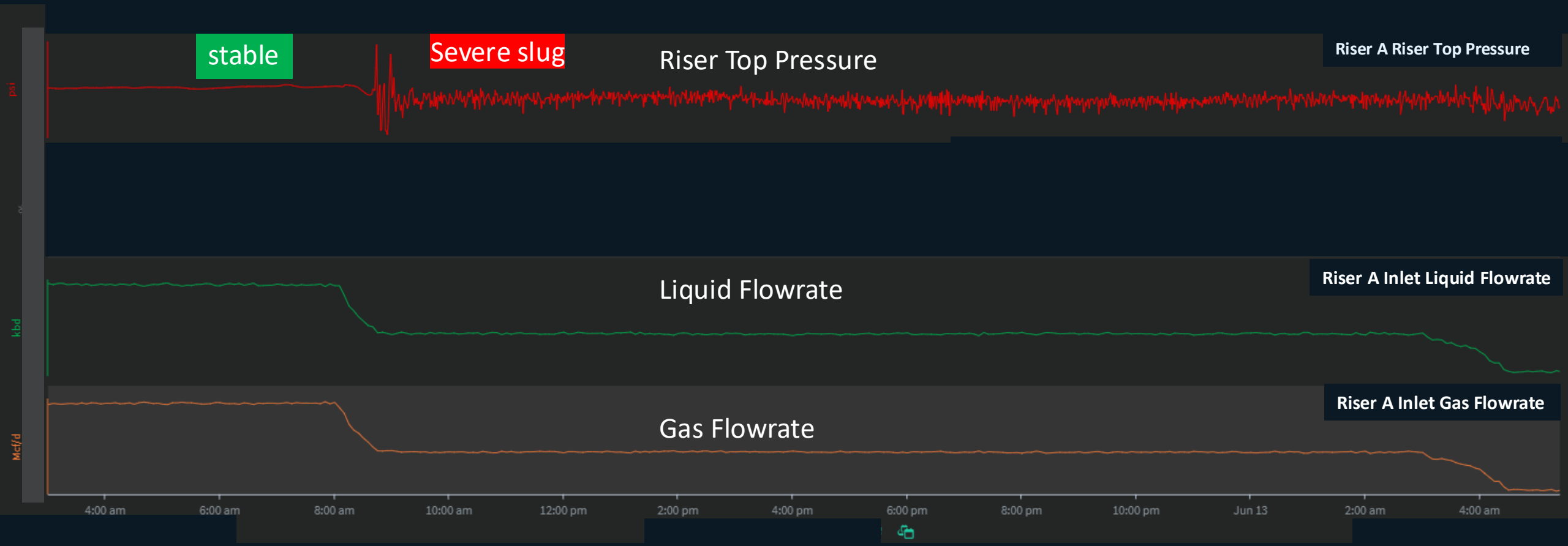
Leveraging Seeq for Slugging Detection

Classify riser top pressure fluctuation

Hourly CoV calculation:
(StdDev/mean) * 100%

Severe – CoV > X%
Moderate – X% < CoV < X%
Stable – CoV < X%

Internal Field Slugging Trial



- Riser Top Pressure deviation increases as flowrate is decreased
- Riser top pressure deviation thresholds tuned based on field trial

Leveraging Seeq for Slugging Event Detection

Classify riser top pressure fluctuation

+

Identify if stable flow condition is present

=

Slugging Classification Output

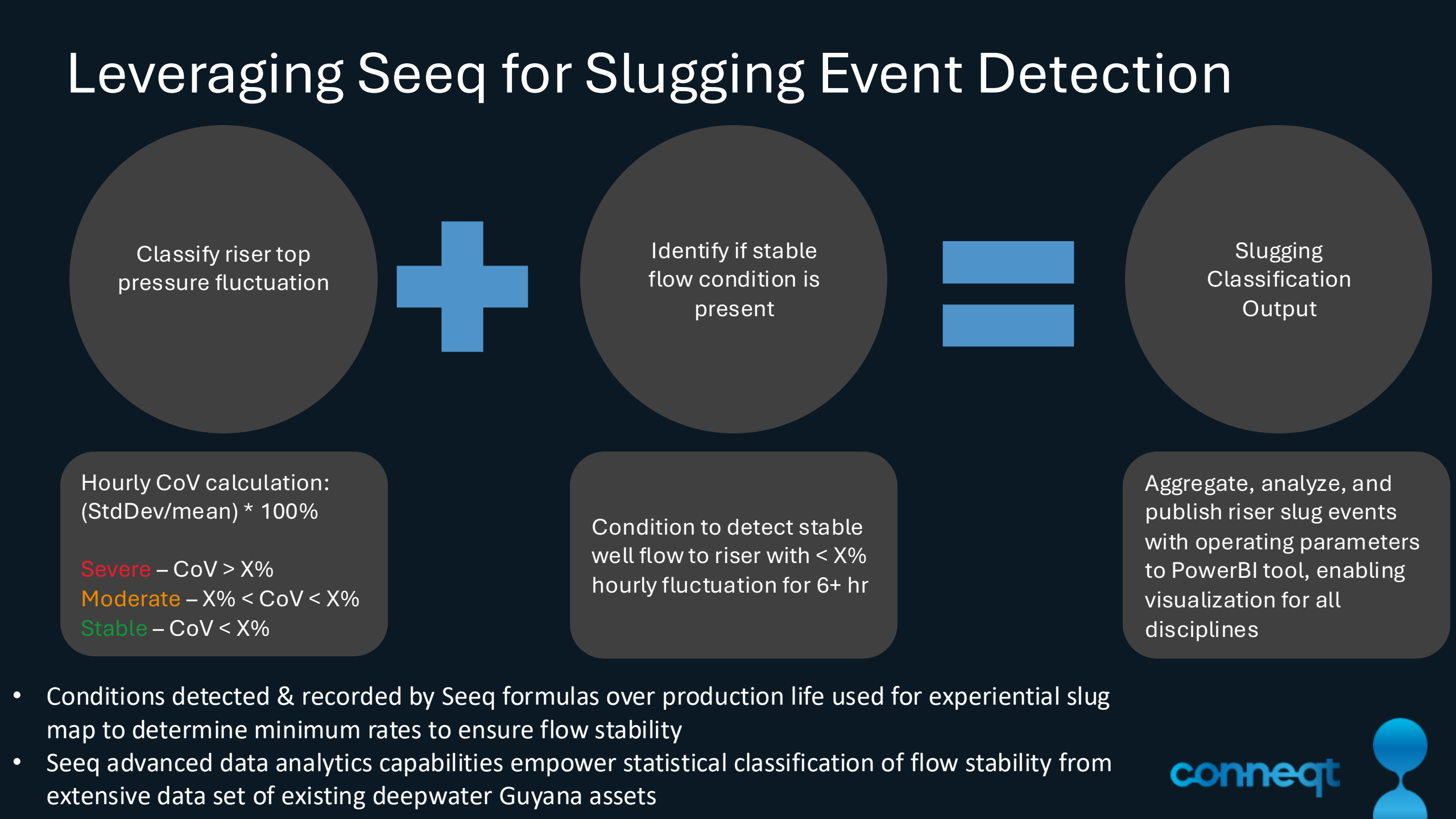
Hourly CoV calculation:
(StdDev/mean) * 100%

Severe – CoV > X%
Moderate – X% < CoV < X%
Stable – CoV < X%

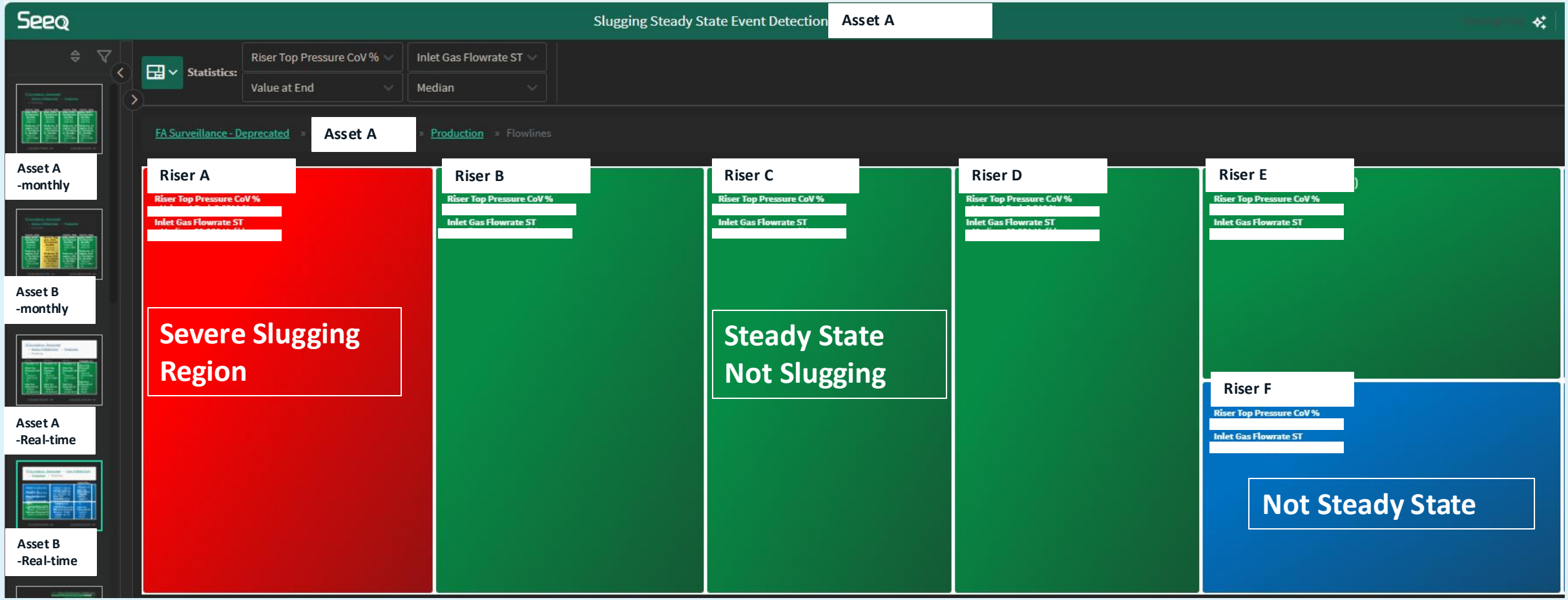
Condition to detect stable well flow to riser with < X% hourly fluctuation for 6+ hr

Aggregate, analyze, and publish riser slug events with operating parameters to PowerBI tool, enabling visualization for all disciplines

- Conditions detected & recorded by Seeq formulas over production life used for experiential slug map to determine minimum rates to ensure flow stability
- Seeq advanced data analytics capabilities empower statistical classification of flow stability from extensive data set of existing deepwater Guyana assets



Real-Time & Monthly CoV Classification Overview Tree Map

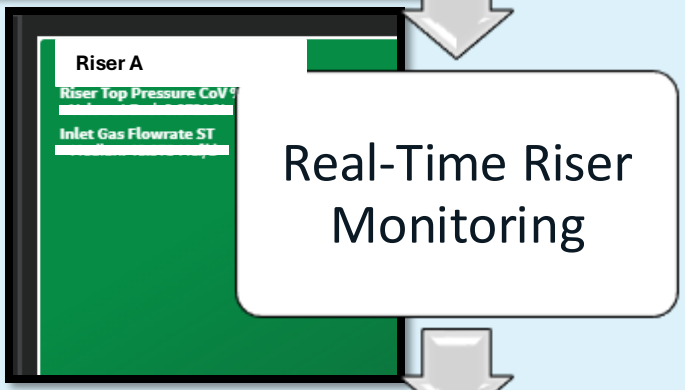


Treemaps utilized for real time & monthly average overview screens

Slugging Analytics for Operations Monitoring

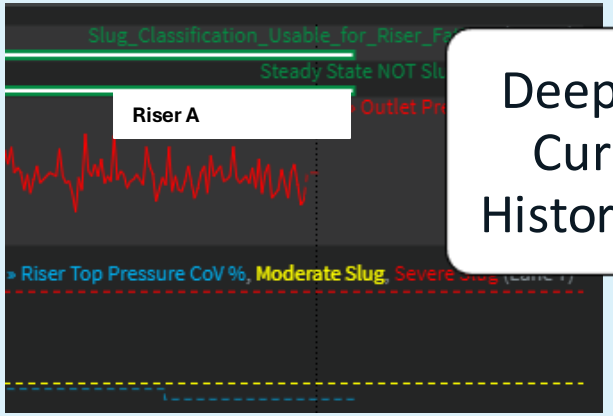
Monthly Riser Reports

Steady state production time
>25% in Severe Riser Slug
>25% in Moderate Riser Slug
Otherwise



Real-Time Riser Monitoring

Display riser slug classification over previous operating hour

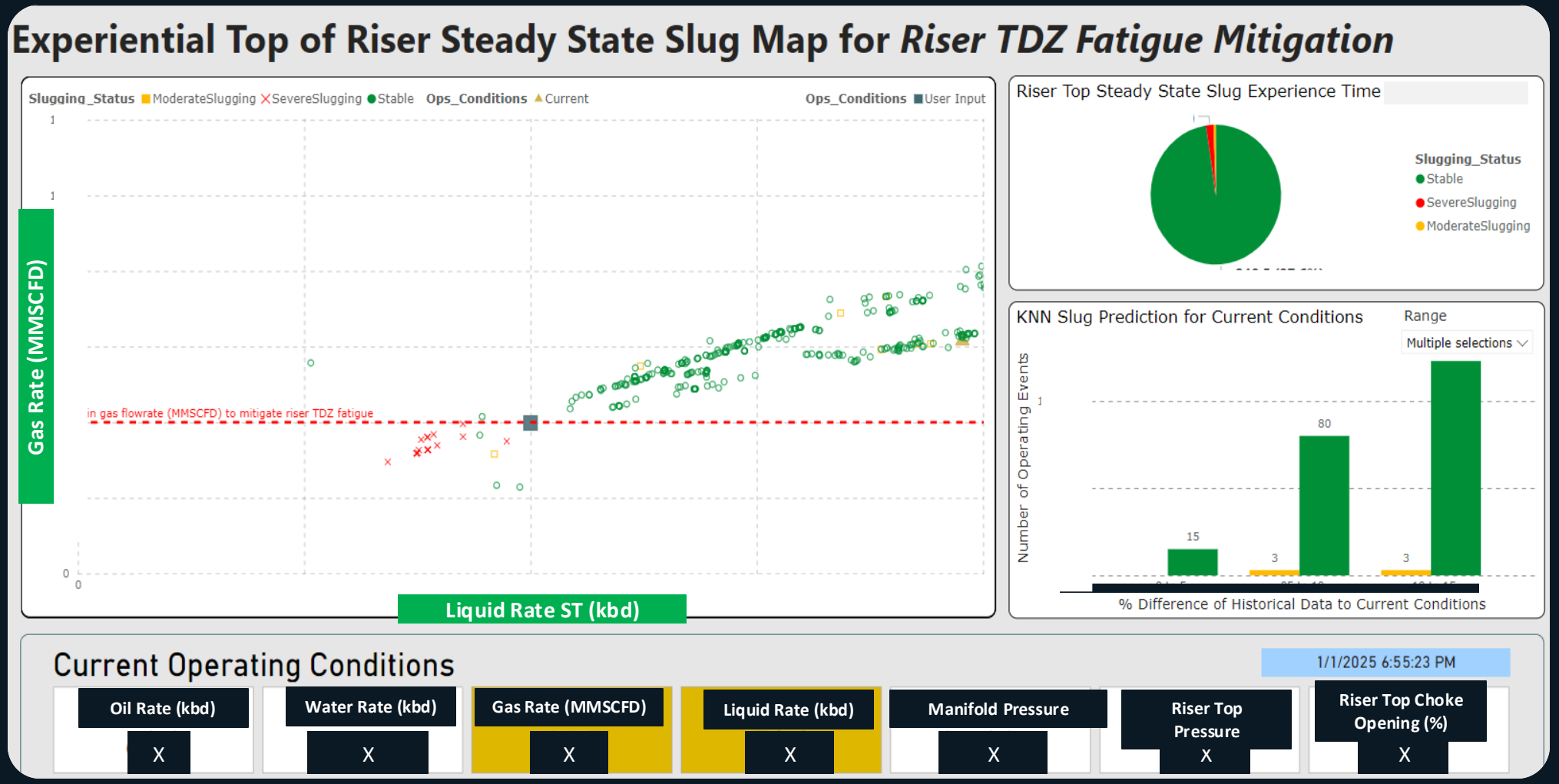


Deep Dive into Current and Historical Trends

Analyze time-series operations parameters (WC, riser top choke %, flowrates) to explain variance in riser top slugging

Increasing Granularity

Production Flowrate Advisory



FA Surveillance Slug Dashboard

- Dynamic, riser-specific minimum gas rate recommendation to ensure flow stability
- Production duration by slugging classification throughout life of each riser
- Visualize most relevant experiences to current conditions with histogram and filterable dataset
- Estimate slugging propensity of custom operating conditions by indexing of similar experiences

Analytics Solution

- Identify and characterize flow stability in production flowline/risers in Guyana
  - ✓ Compile experiential slug map from previous operating conditions
- Utilize characterization to establish operational envelope to ensure flow stability during normal operations
  - ✓ Informs operations of minimum flowrate
- Continue to build experiential slug map as operating conditions continue to evolve
  - ✓ Changing oil/gas/water flowrates as field life progresses

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Questions?


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Thank You