Artificial Lift R&D Council

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Optimizing Rod Lift VSD Wells Using Autonomous Control

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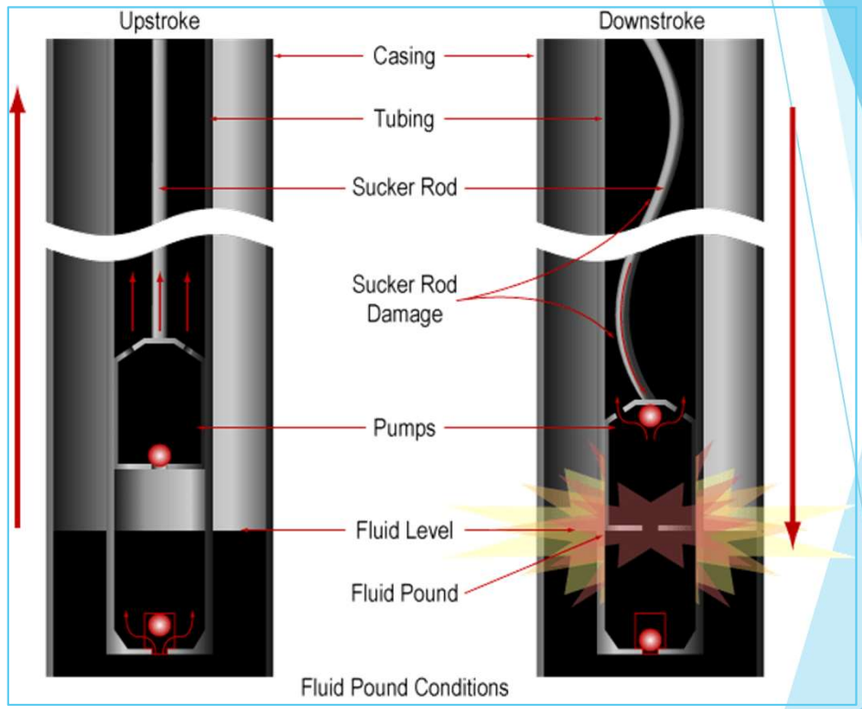
Weatherford®

Rod Lift Challenge

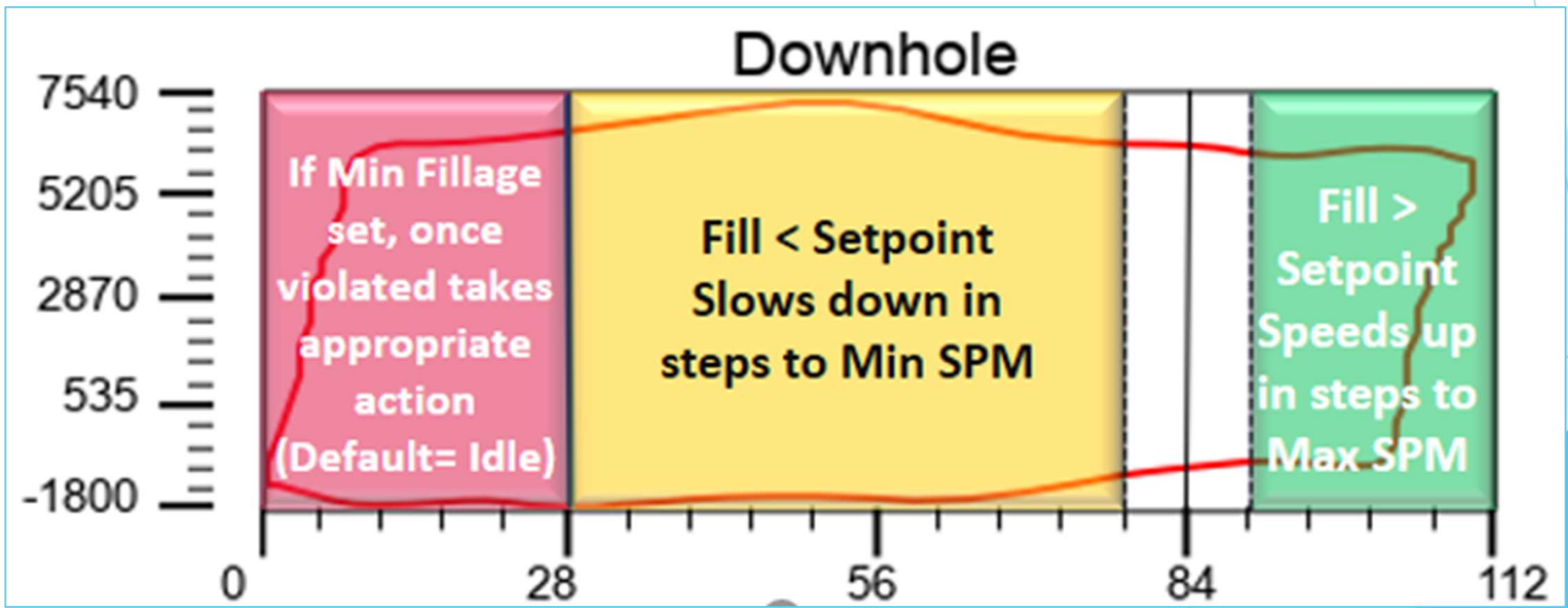
- Most commonly used artificial lift type in the world
- Common rod pump application problem:
  - Matching a well's dynamic inflow to the rod pump system's fixed displacement
  - The rate at which fluid enters the wellbore constantly changes due to
    - Reservoir pressure
    - Pressure in the well assembly (fluid level)
- Pump off/fluid pound



Fluid Pound Conditions

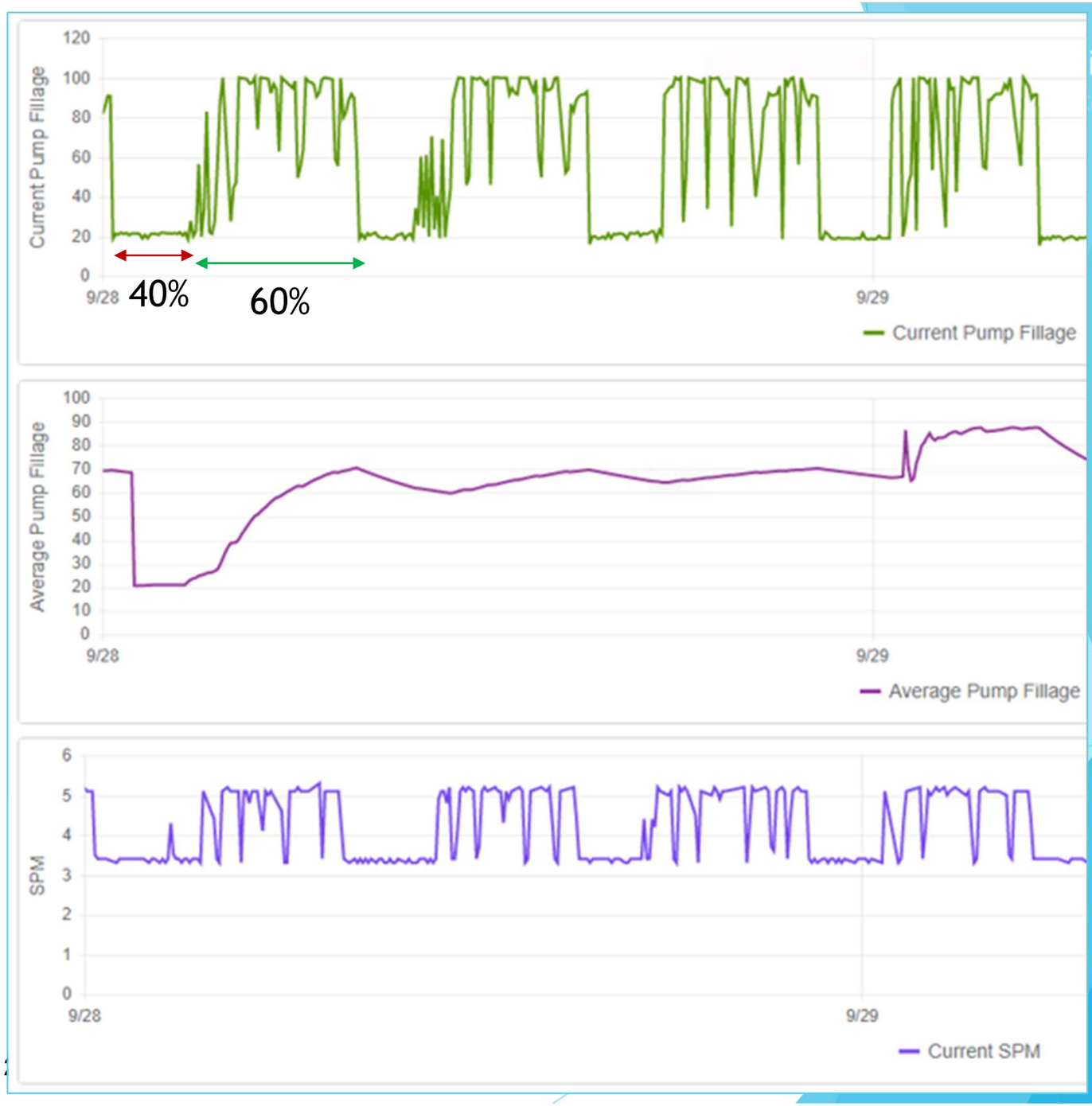
Rod Lift VSD Operation

- Optimizes SPM
- Prevents sand/sold accumulation
- Rotaflex® long stroke pumping unit application
- Floating condition



Traditional VSD - Unrealized Potential

- 60 to 65% runtime at Max SPM
- 35 to 40% runtime at Min SPM
- Manual intervention
  - Optimize SPM
  - Min fillage idle time
  - Gas interference



Edge Technology – Future of Rod Lift Optimization

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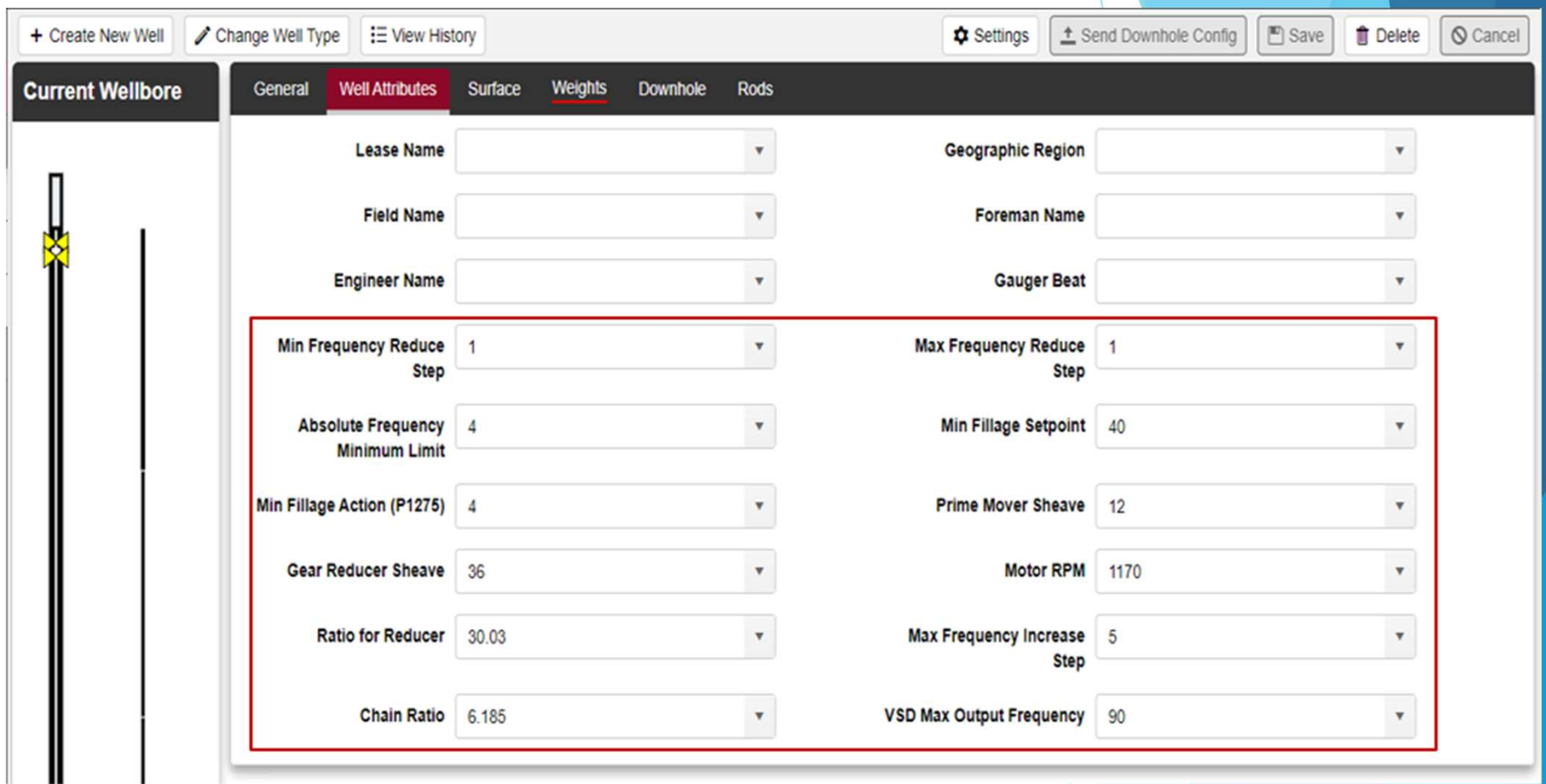
- High frequency data and storage for every stroke
- Operational and intelligent alerts
- IoT based, instant notification using MQTT
- Physics-based calculation (rod lift analysis via dynacard)
- Closed loop Autonomous optimization
- ForeSite® Edge embedded with ForeSite® and CygNet® platforms

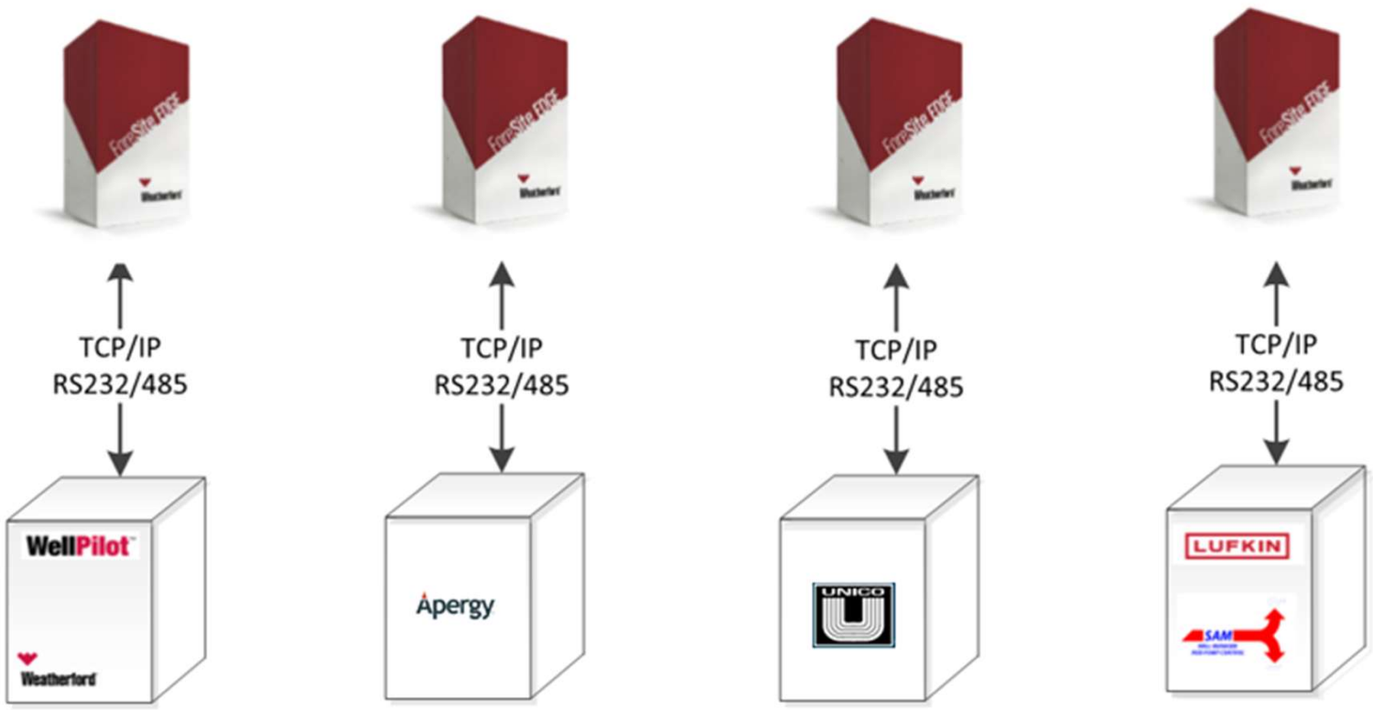
Achieving Autonomous Control –

Autonomous control improves operations without manual intervention

- Capturing high frequency data - runs analysis
- Using the well model – Edge calculates the Rod Lift alerts for each stroke
  - Beam load
  - Gearbox torque
  - Rod stress
- Edge autonomously changes the controller setpoints based on user defined threshold



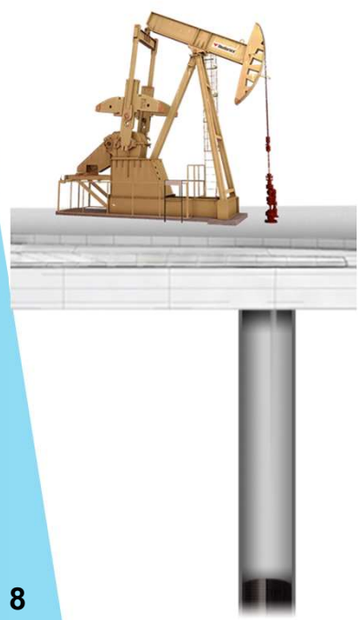
ForeSite Edge Autonomous Control Compatibility

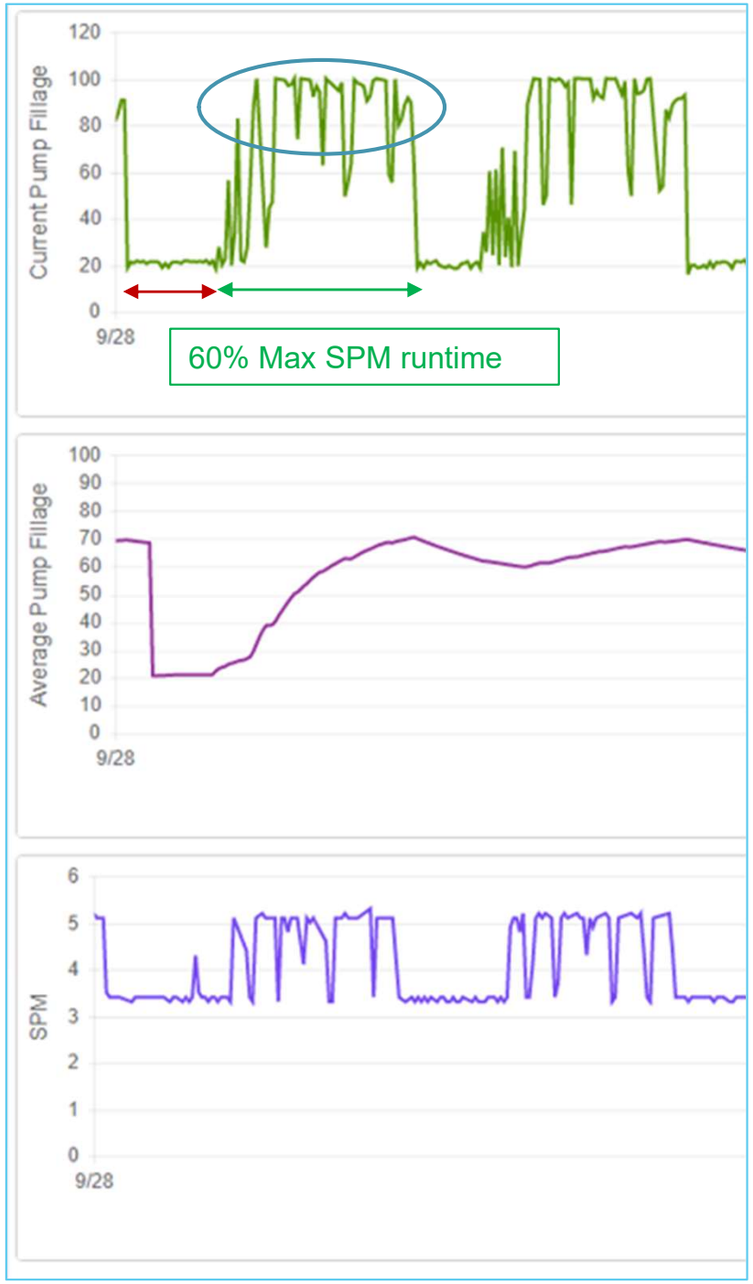


Autonomous Control – Optimizing VSD SPM

Traditional VSD

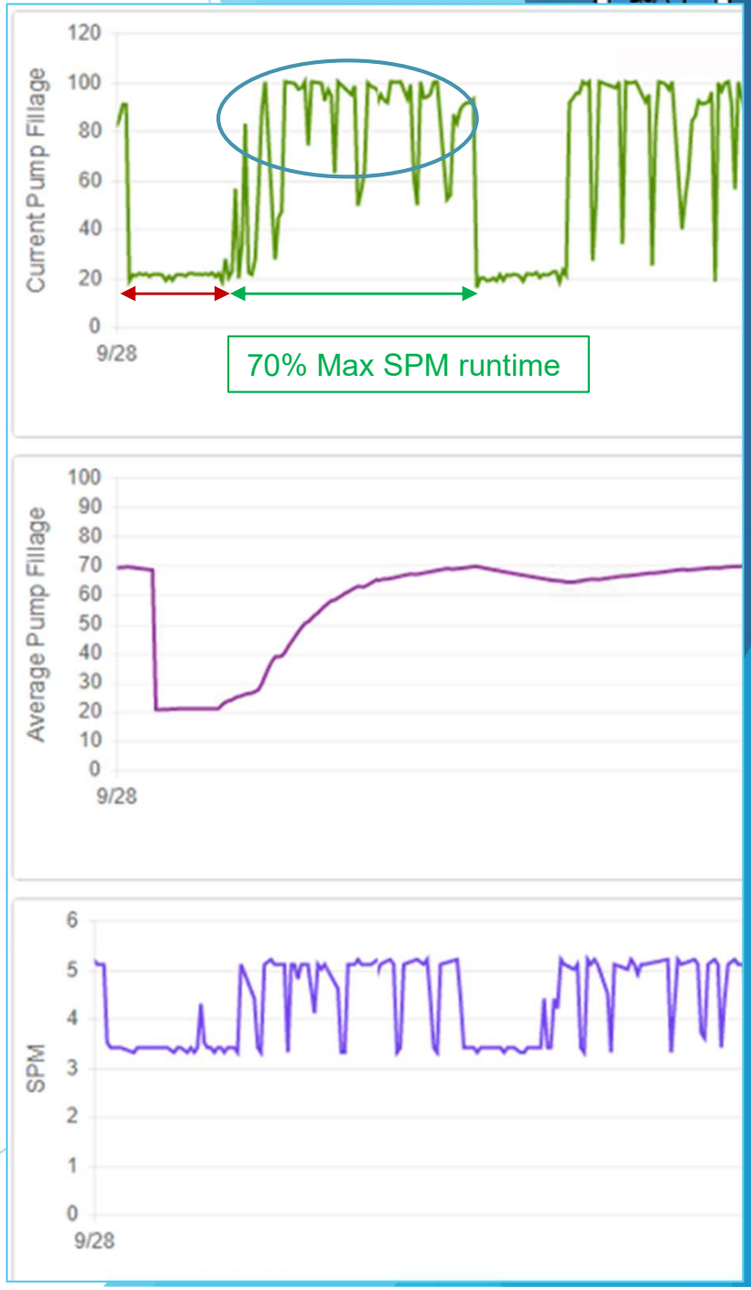
- Overpumping
- Fluid pound
- Equipment damage





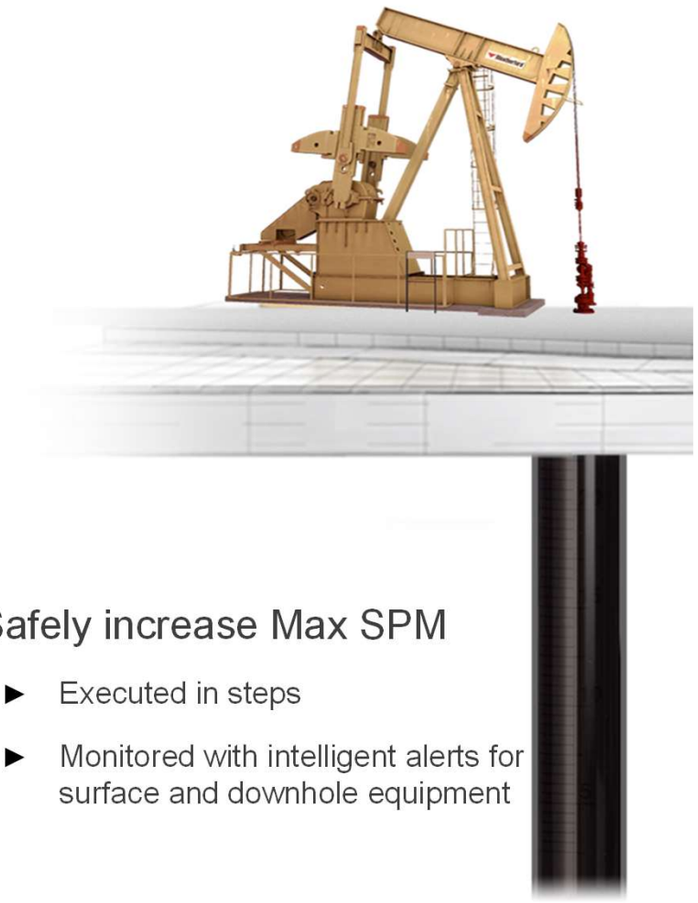
ForeSite Edge Controlled VSD

- Efficiently operate the VSD to maintain the desired pump fillage
- Reduced strokes per day and increased system life
- Reduced energy usage

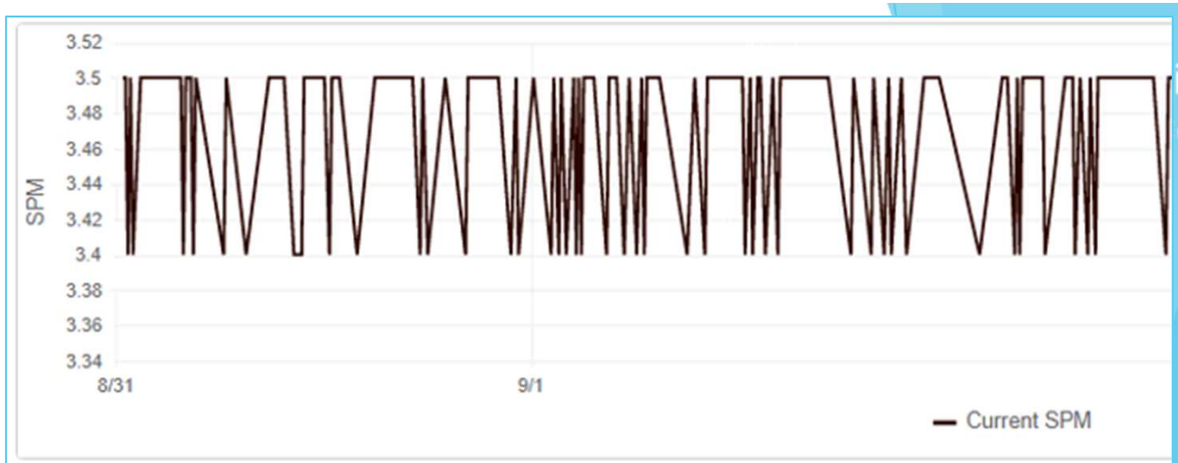


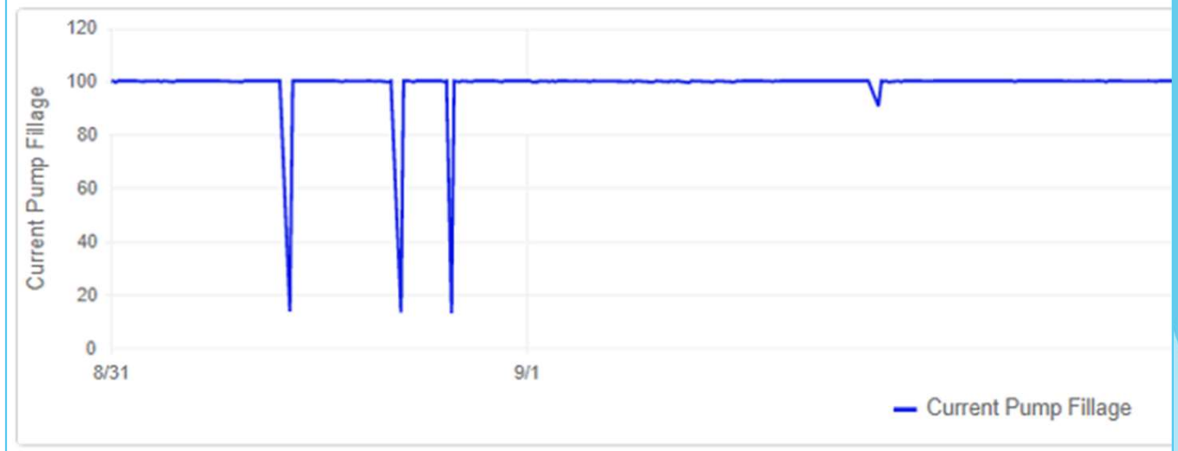
Autonomous Control – Maximizing Production

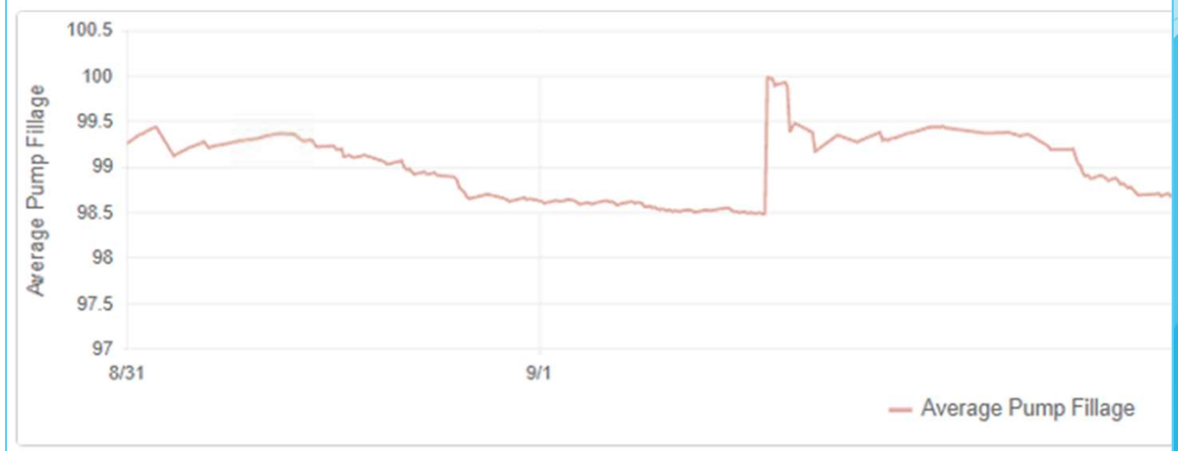
Untapped Well Potential



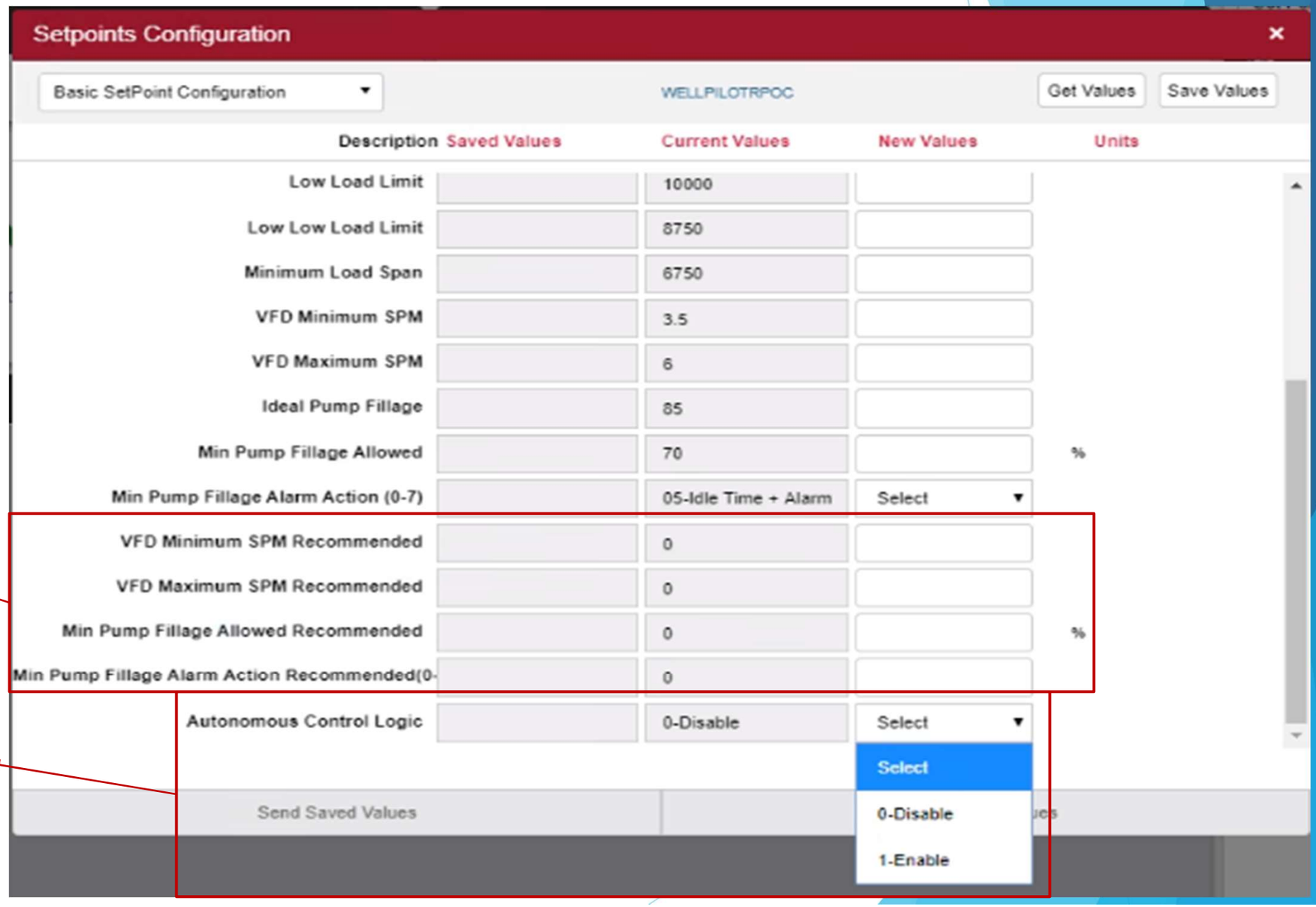
- Safely increase Max SPM
  - Executed in steps
  - Monitored with intelligent alerts for surface and downhole equipment







Autonomous Control - Recommendation mode



AC Logic Recommendation Outputs

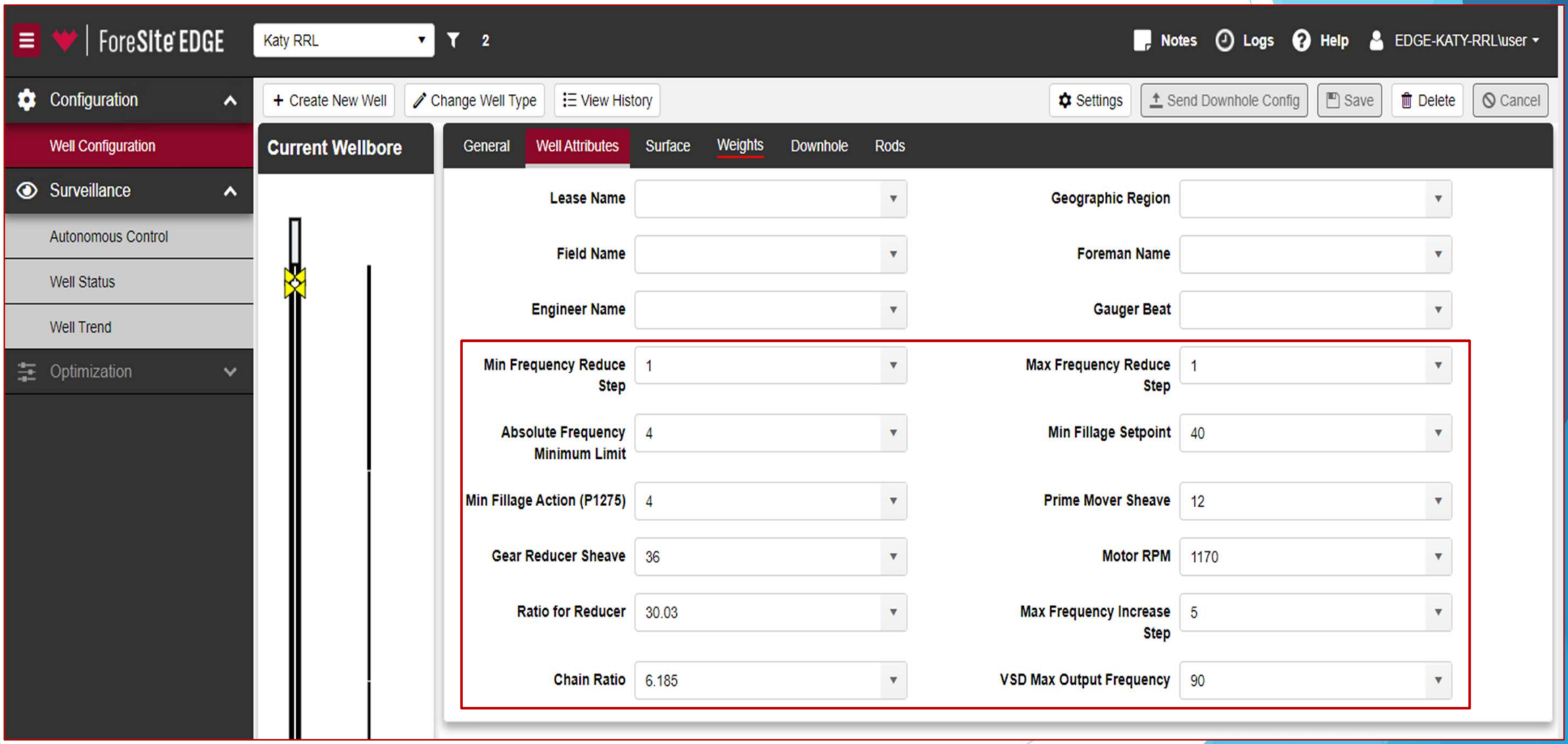
AC Logic Recommendation/Control Mode

Software Requirements – Autonomous Control Scripting

- SQL/ODBC database
  - ForeSite
  - CygNet (UIS, VHS)
- Python
  - Anaconda Navigator
- Power Shell
  - Cygnet services changes (alarms)
- Batch(.bat) files

SQL/ODBC Database –

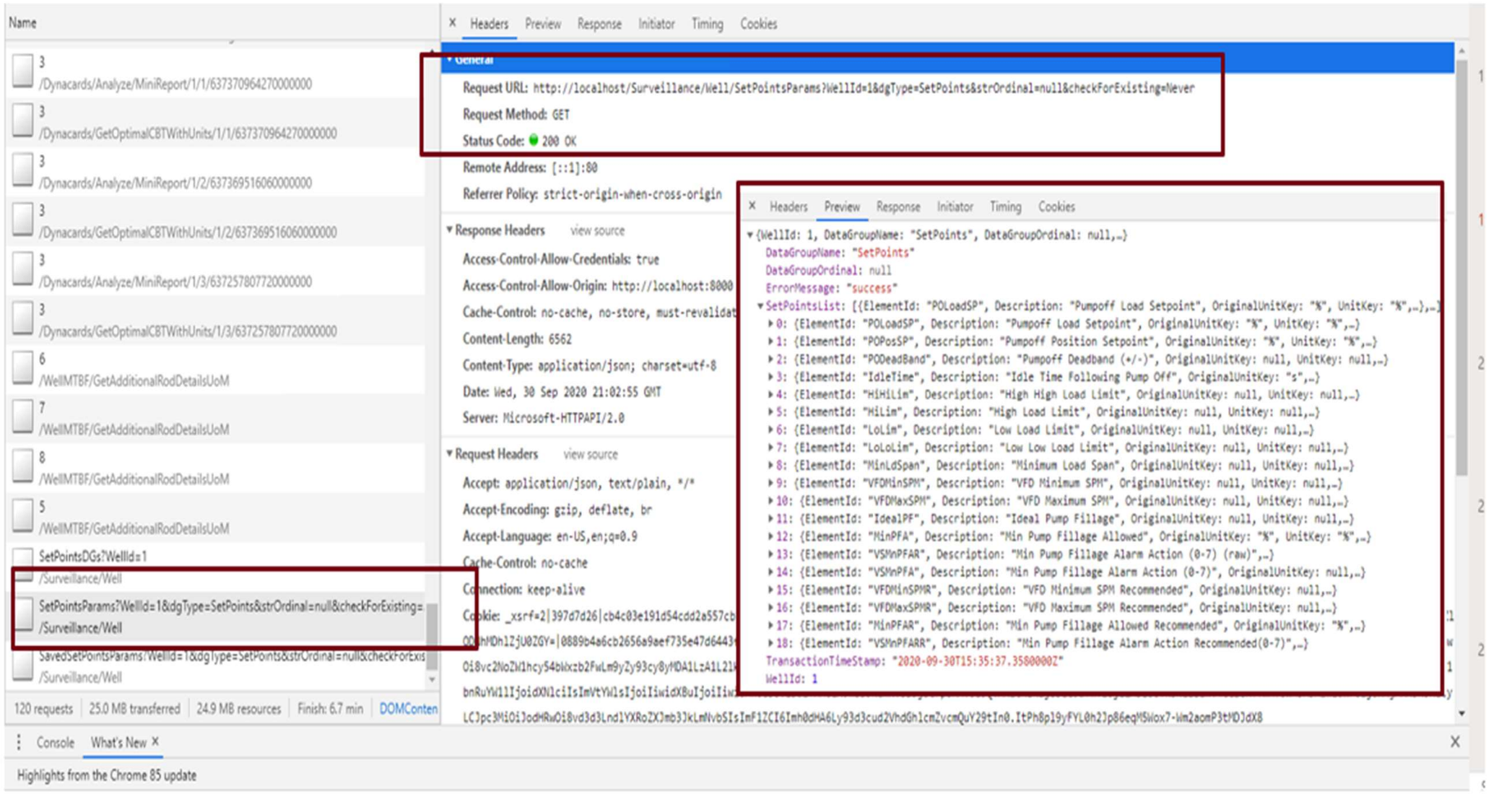
Adding Autonomous Logic inputs via the UI stored in SQL database on the Edge



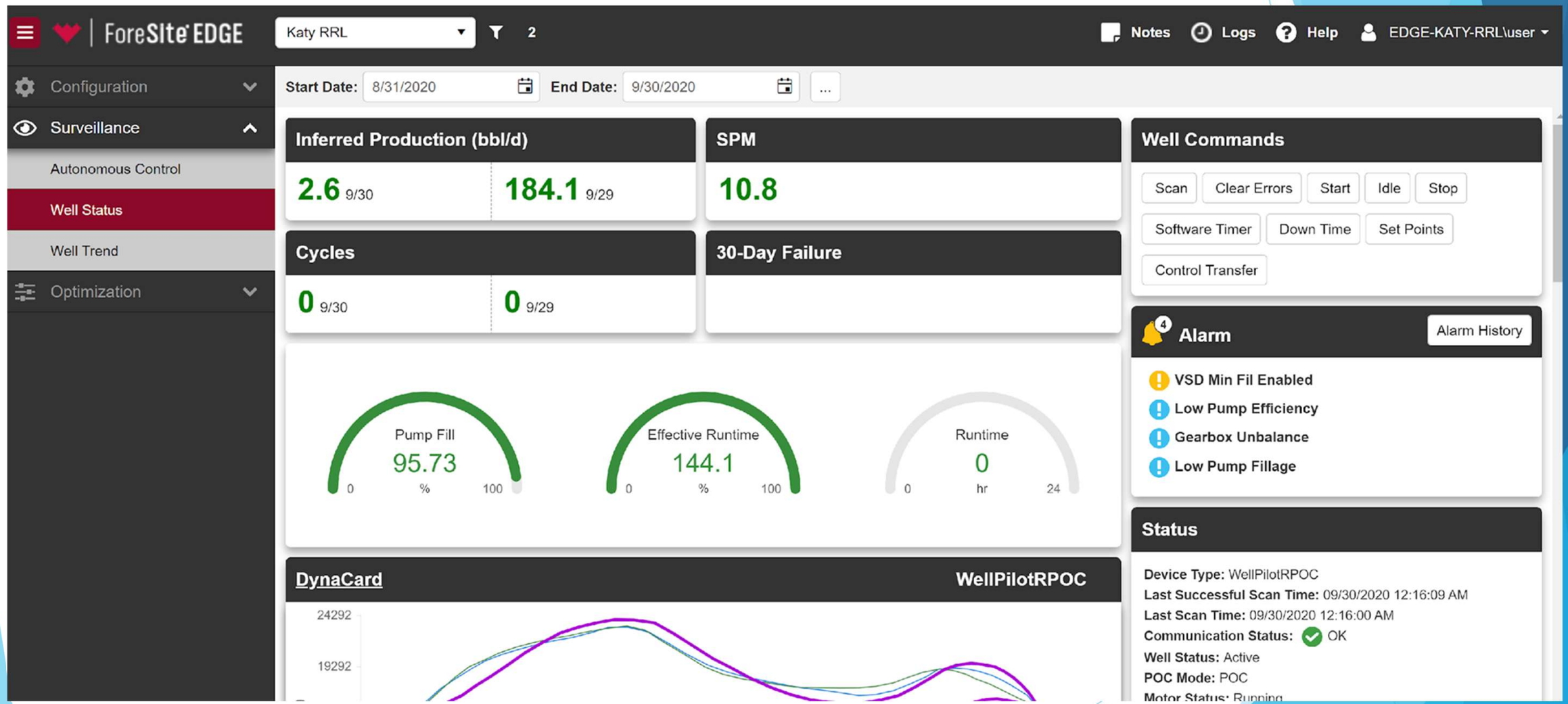
Scripting language used

- Any programming language that communicates with Web API (Python and PowerShell)

Accessing ForeSite Edge API

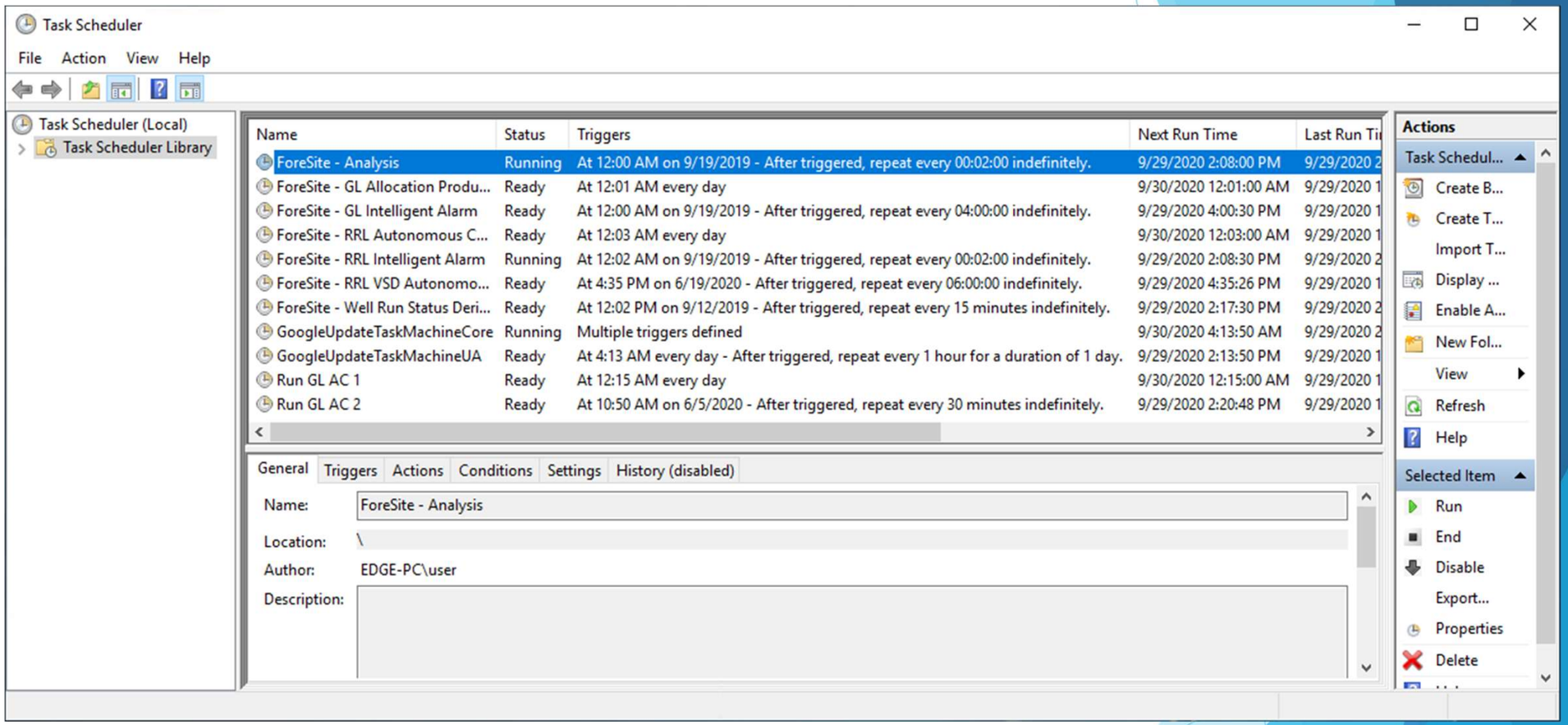


Trigger custom autonomous control alarms



Task Scheduler

- Create batch files
- Schedule batch file frequency
- Multiple ACL batch files that can run simultaneously



Generate Log CSV and Text files (Optional):

- ACL outputs can also be viewed in CSV files for analyzing well performance

Conclusion

- Edge enabled VSD
  - Existing traditional VSD with rod pump controller at wellsite can be enhanced with edge capabilities
- Value gained through autonomous control
  - Optimizing VSD SPM: Expected increase of rod lift surface and downhole equipment life by 20-30% and personal efficiency gain by 5-15%.
  - Maximizing production: Increase in production by 5-10% on potential wells.
- Customizable autonomous control
  - Using Python with interface to ForeSite well analysis software APIs allows Engineers to develop custom logic to autonomously optimize individual rod lift wells

Thank You

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