



Online Modeling of Single and Multiphase Flow Networks

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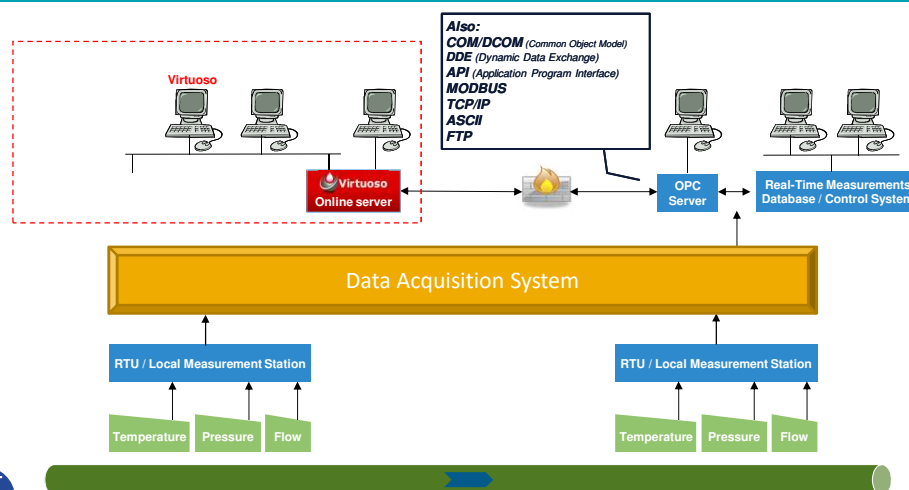


Safety Moment



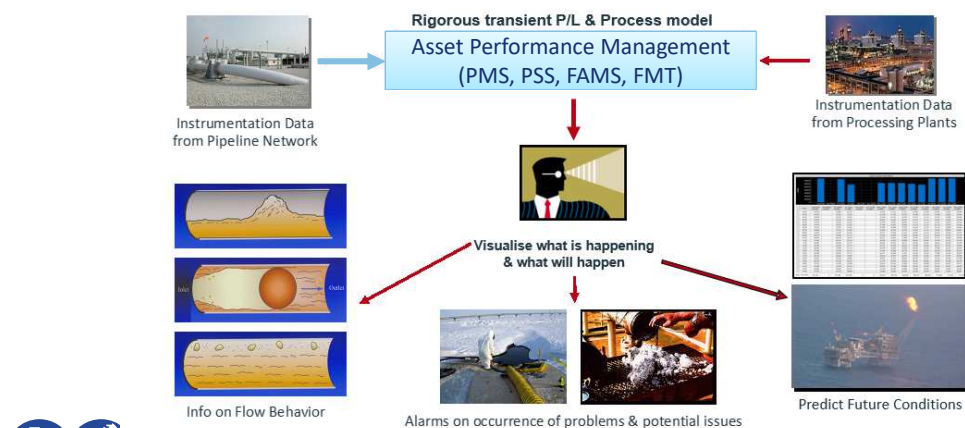
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What is Online



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Allows Operator To See the Unseen



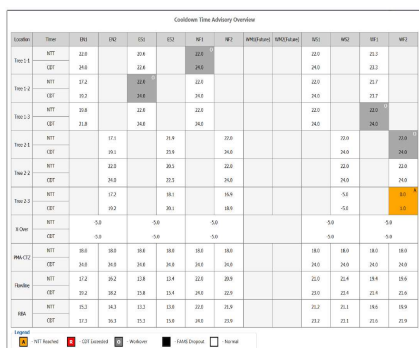
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Operator View

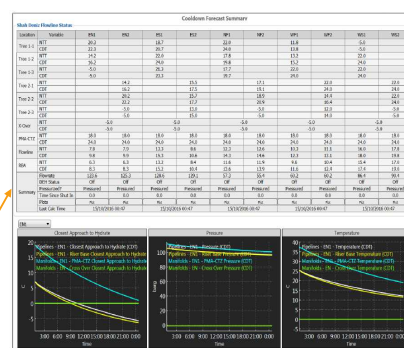
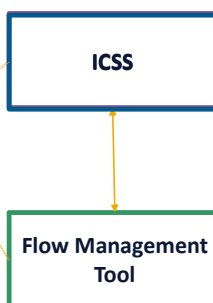


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Cool-Down Times



Control Room Operators



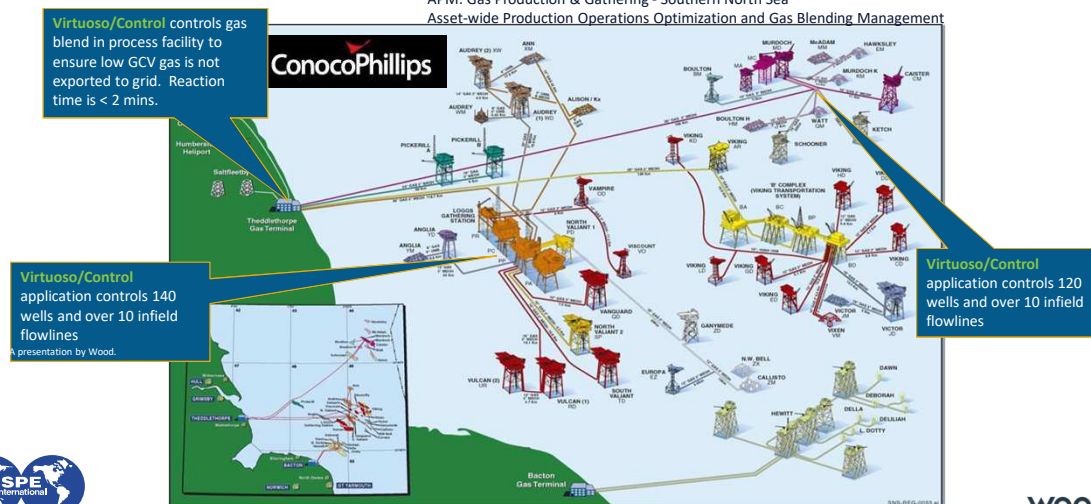
Production Surveillance Engineers



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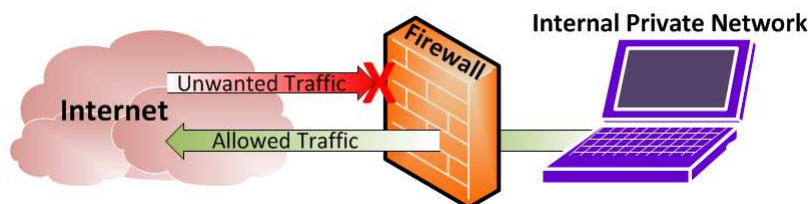
Example relevant to specific Client requirements

APM: Gas Production & Gathering - Southern North Sea
Asset-wide Production Operations Optimization and Gas Blending Management



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Limited Access



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Robust

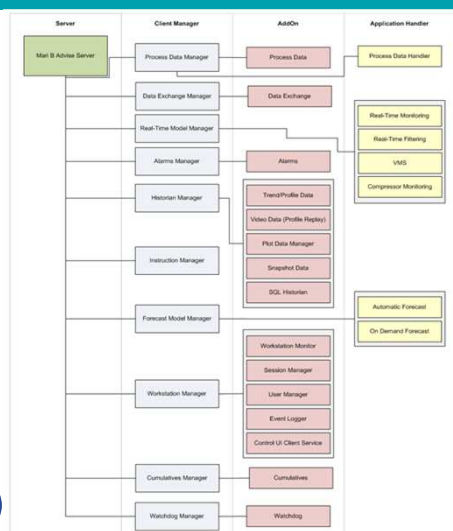


- Every Site is Different
- Mission Critical 24/7 Operation
- No Easy Access for System for up to 6 months at a time
- Must be Robust and No Margin for Error
 - System Components
 - Data Communication
 - Data Validation
 - Model



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System Components



- Many independent processes for robustness
- Send data to and from server (Data Warehouse)
- Watch dog watches health of all components
- Workstations are typically on different machines than the server

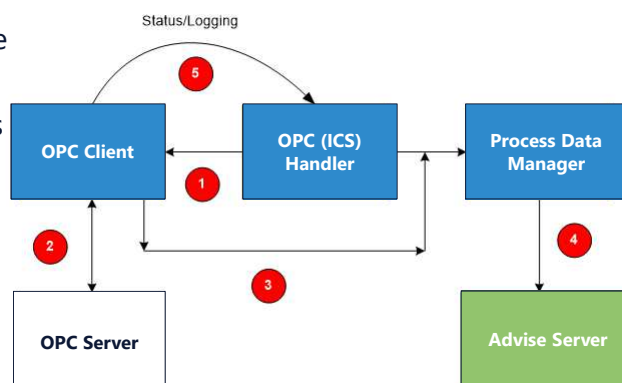
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Example of Data Communication



Key Points:

- Scada is on different computer (could be 100 km's away)
- Could be talking to many different types of Scada systems
- Must be able to recover for communication drop (cable pulling test)
- Can not lock up application server or Scada system
- Get data valves along with tag status



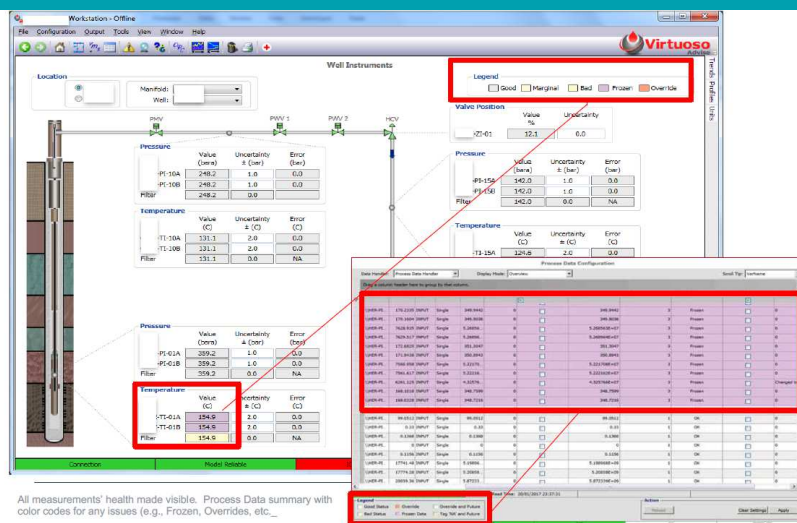
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The Importance of Good Measurement Data



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Data Filtering



All measurements' health made visible. Process Data summary with color codes for any issues (e.g., Frozen, Overrides, etc.)

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Field Data Filtering and Reconciliation

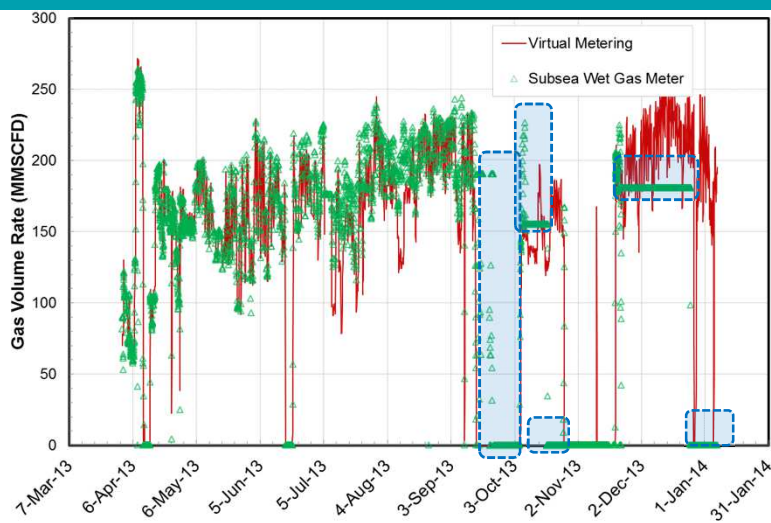


- Data Treatment Methods
 - Gross error detection and isolation using statistical tests, global tests, nodal tests, measurements tests, unbiased estimate techniques
 - Data filtering and reconciliation algorithms
- Outlier Removal and Best Filter Definition
 - Deliver a dataset which closer to the true process state than raw data



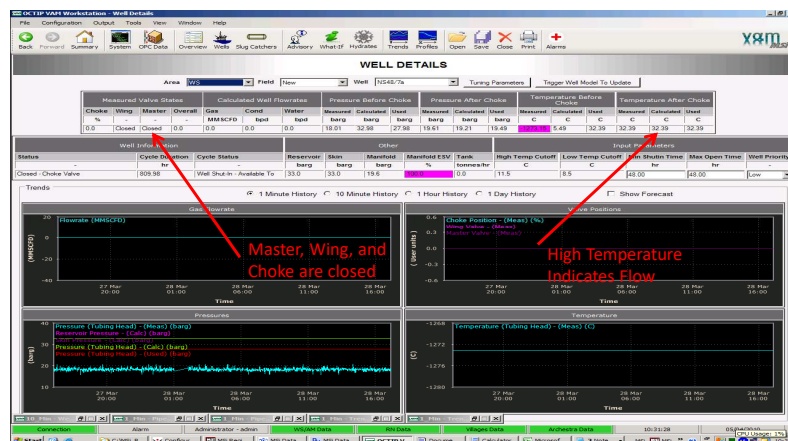
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Subsea Meter Dropout-Virtual Metering as Backup



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Handling Problematic Field Data

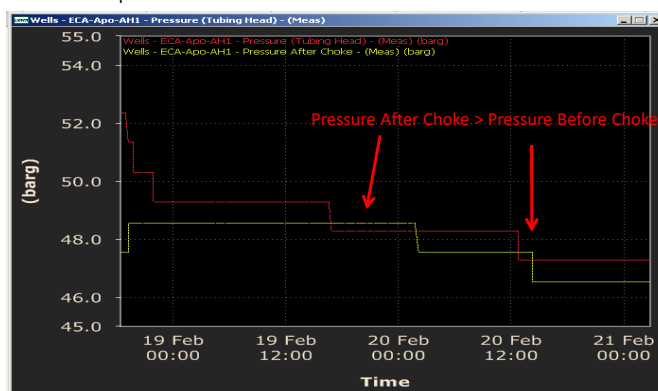


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Data Compression Problems



• Data Compression

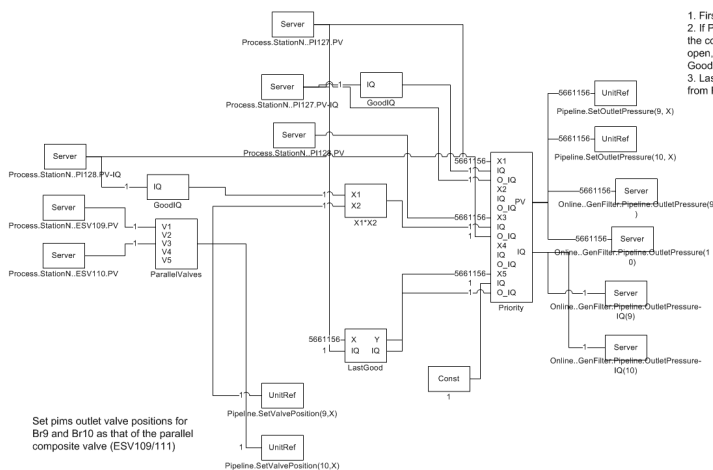


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Chameleon™ Filters



Outlet Pressure and Valve Position of 30-K6-N-KHUFF and 16-WHTPD-N-KHUFF



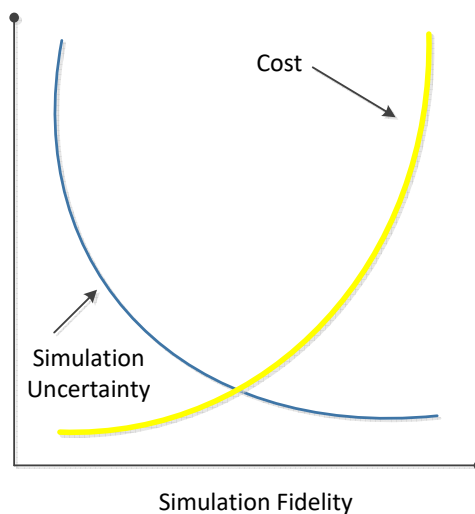
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Practical Trade-offs in Simulation Fidelity



Costs are:

- More Accurate Configuration Information
 - Measured of Pipeline Elevation
 - Soil Properties
 - Fluid Characterization
- Cost is also Speed of Simulation and Computer Power Required



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Example of Buried Pipes

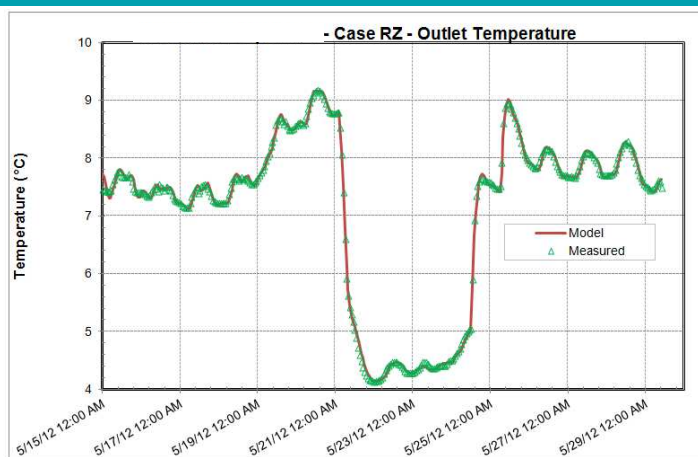


Ambient Temperature Problem



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Temperature Match with Field Data

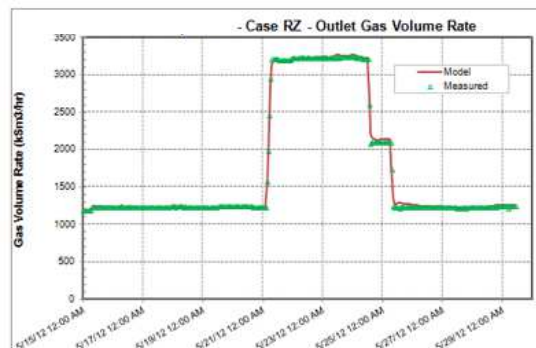
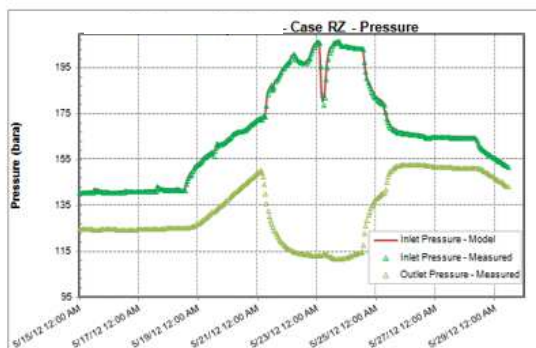


- Where possible use Measured Ambient Temperatures
- In remote cases, use Seasonal Temperatures



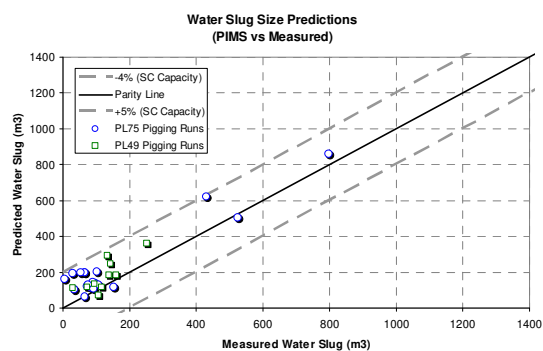
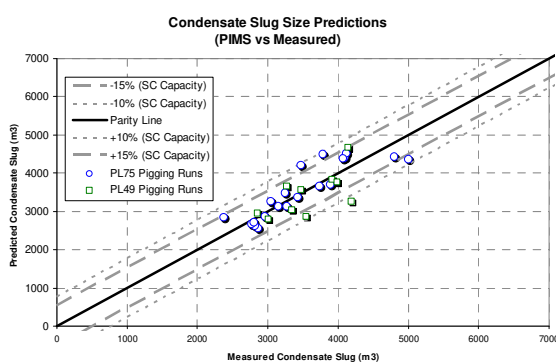
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Pressure Match with Field Data



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Field Slug Size

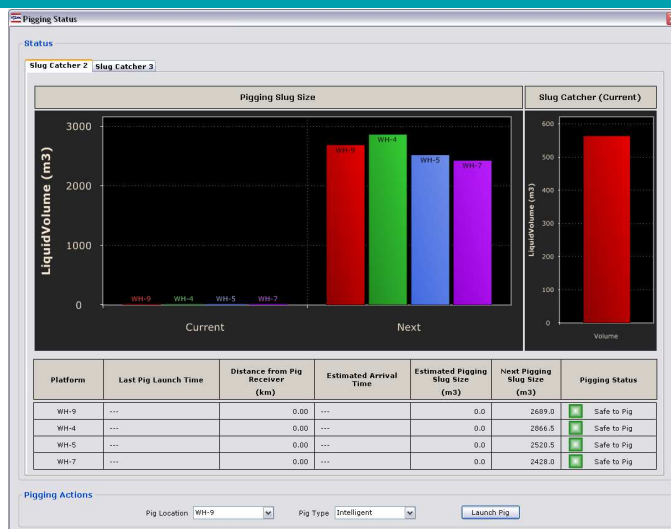


- Design Elevation Profile vs As Build Changed Holdup by 15%
- Condensate Loading vs Design Typically Differ by 20 to 50%
- Quality Control on Pig Diameter is Critical



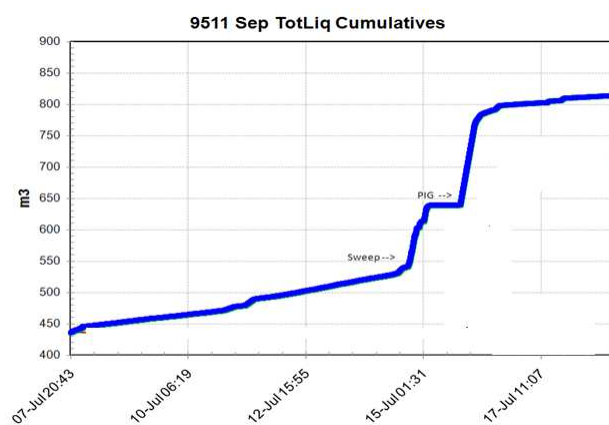
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Pigging Forecast



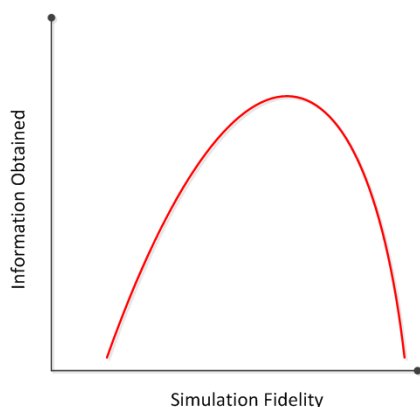
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Effect of Sweep vs Pigging



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Pick the Optimum Fidelity

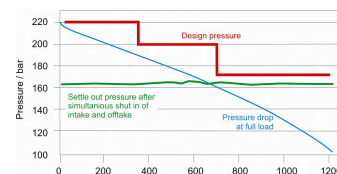


- Need fast simulations – to provide timely information with reasonable accuracy
- Operators need information within 5 minutes for a 1-day simulation that is 300X Real Time



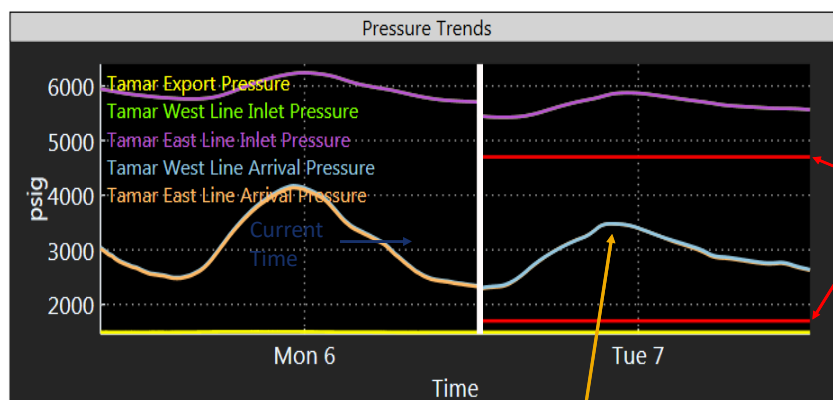
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Fast Automated Forecasts



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PMMS Gas Demand - Management



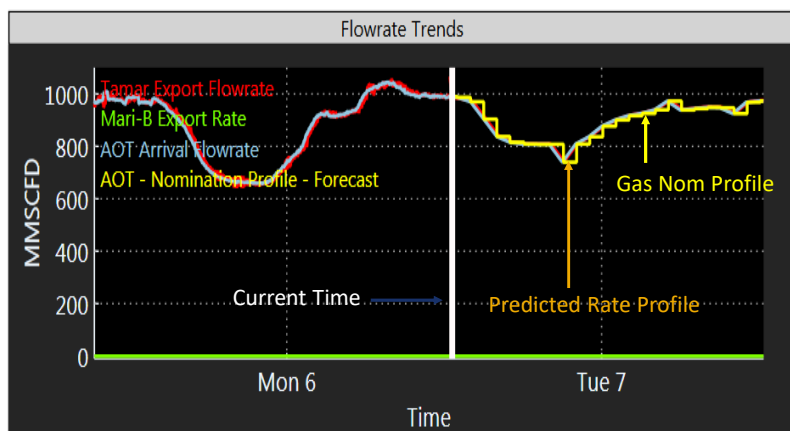
Upper and Lower Arrival Pressure Envelope

Predicted Future East and West Line Arrival Pressures



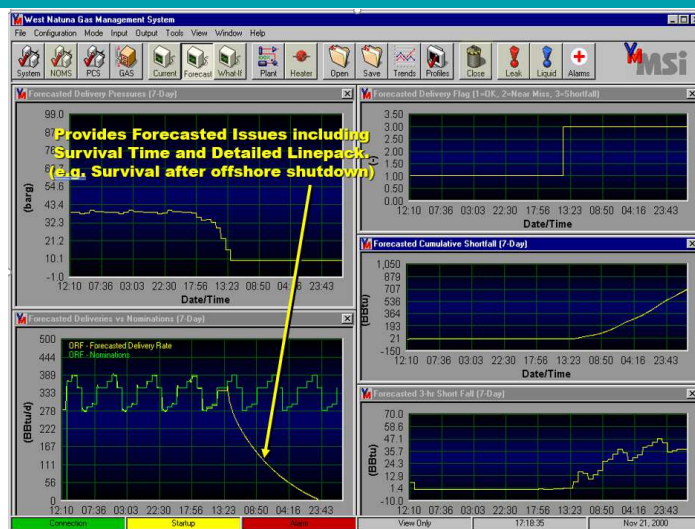
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PMMS Gas Demand - Management



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What-If Forecast



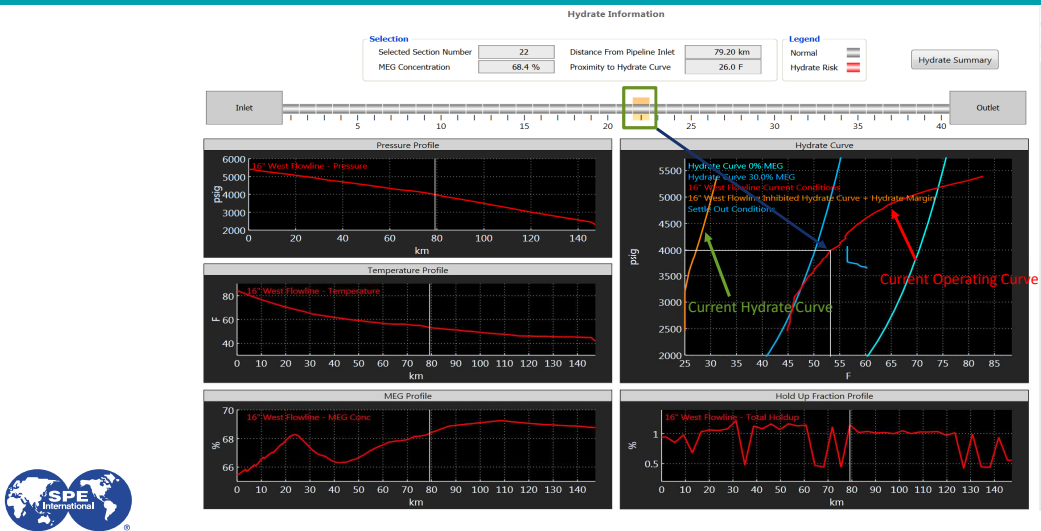
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Cool Down Forecasts for Hydrates



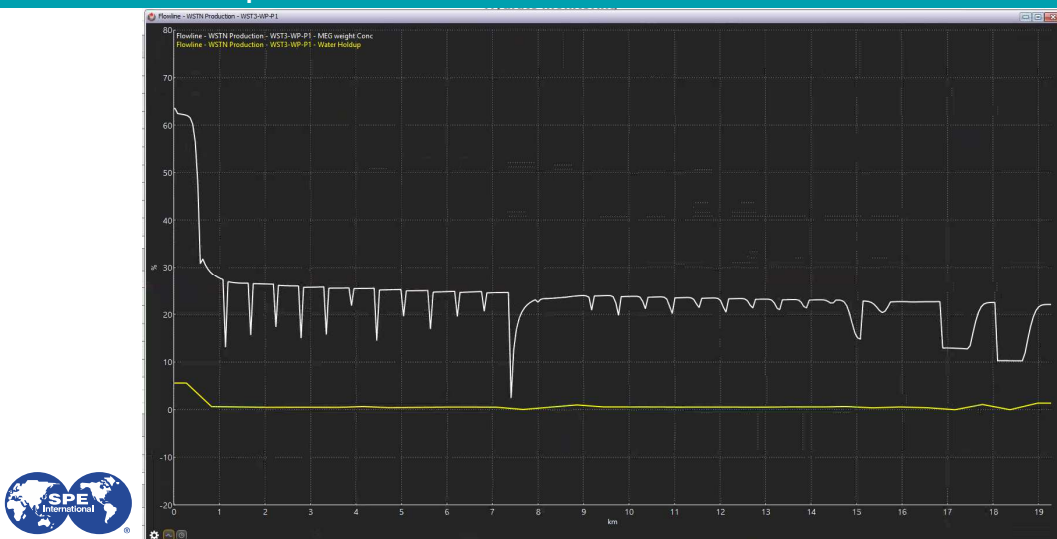
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PIMS Hydrate Warning



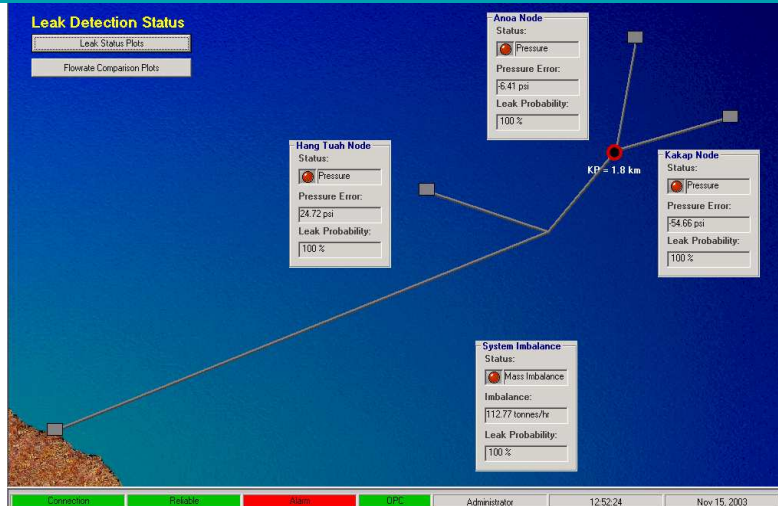
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MEG Concentration Drops During Turndowns – Low Holdup



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Leak Detection



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Operating Pipeline with a Leak

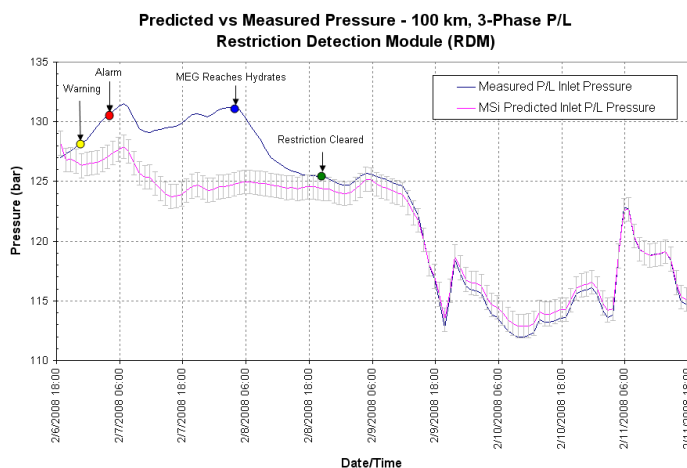


System enabled 2 of the 3 fields to continue producing, saving \$10M in contract penalties over period of 30 days.



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Hydrate Restriction Leads to Increase in DP



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Hot Oil Simulation



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Conclusions



To have a successful Online System:

- 1) Robust Data Communication and Filtering of Data
- 2) Workstation Fit for Operations Use
- 3) Fast Forecasting
- 4) Tunable Model



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