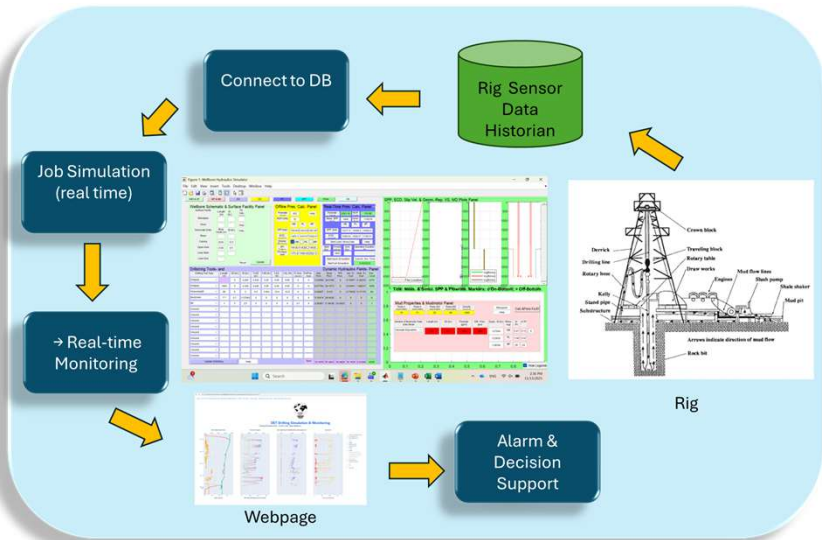


From Planning to Real-Time: Digital Integration of Drilling Hydraulics Simulation into Real-Time Operations via Web-Based Tools

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Drilling Simulation and Monitoring System Overview

Problem & Objective

Motivation

- High-risk windows: narrow PP-FG, depleted zones, ECD-sensitive formations.
- Conventional monitoring: fragmented, reactive (SPP trends, flow checks, DDRs).
- Need: real-time, physics-consistent view that connects planning hydraulics to live data.

Goal: show on real wells (Volve well F-15S) how a web-based hydraulics twin would:

- > Flag anomalies,
- > Quantify ECD vs mud window,
- > Visualize cuttings transport & surge/swab.

Plan → Simulate → Connect to DB → Real-time Monitoring → Alarm & Decision Support

Simulation Results Summary

Hydraulics simulation ran on recorded data of the well F-15S, 8.5" section drilling operation. Outputs: SPP, ECD, EMW, Cutting Removal.

Modelling revealed:

ECD vs Pore Pressure — UNDERBALANCE RISK

All three ECD curves always stay well above pore pressure.

ECD vs Fracture Pressure — LOSS RISK

~22% of the time, the ECD exceeds fracture pressure. This is a major concern.

For these days in the Daily Drilling Reports:\

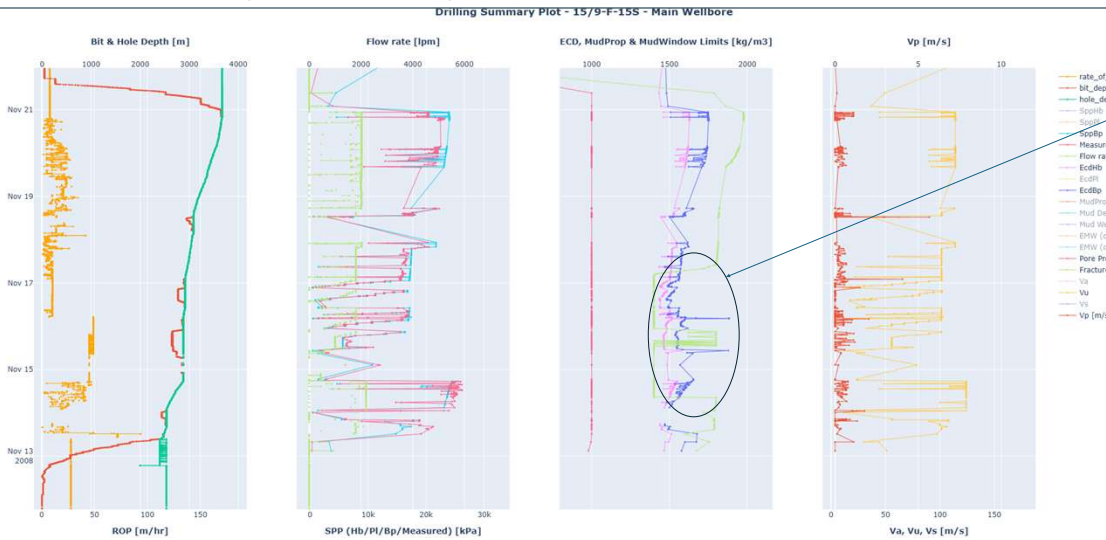
Losses in Ty Fm – the model shows ECD at FG before the observed losses.

Summary DDR's

Report Date	Problem Tags
2008-11-14	[High ECD/EMW or near fracture]
2008-11-15	[Losses / lost circulation, 'Surge/swab / flow checks']
2008-11-17	[Losses / lost circulation]
2008-11-19	[Stuck pipe / differential sticking]
2008-11-21	[Hole cleaning / pack-off / tight spot, 'Surge/swab / flow checks']
2008-11-25	[Losses / lost circulation, 'Surge/swab / flow checks']
2008-11-26	[Losses / lost circulation]
2008-11-28	[Hole cleaning / pack-off / tight spot]
2008-11-29	[Hole cleaning / pack-off / tight spot]
2008-12-12	[Kick / well control / gas]

Simulation Results Data Analysis

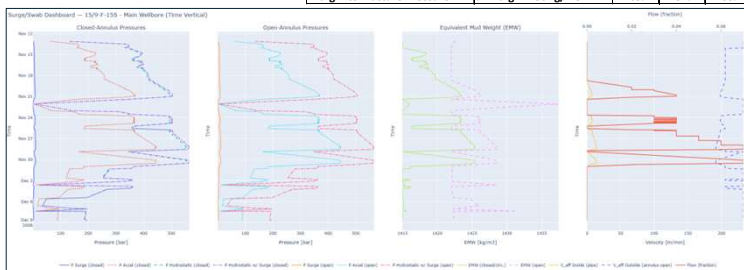
Category	Metric	HB	PL	BP
Margin to Pore Pressure	Mean Margin (kg/m3)	524	561	604
	Minimum Margin (kg/m3)	422	420	450
	% Below Pore	0%	0%	0%
Margin to Fracture Pressure	Mean Margin (kg/m3)	268	231	188
	Minimum Margin (kg/m3)	-1484	-1500	-1650
	% Above Fracture	21.48%	21.71%	22.00%
Margin to Fracture Pressure	% Margin < 50 kg/m3	21.65%	21.94%	22.35%



Real-time drilling summary with raw measurements and hydraulics modelling results



Real-time geometric visualization showing key operational parameters

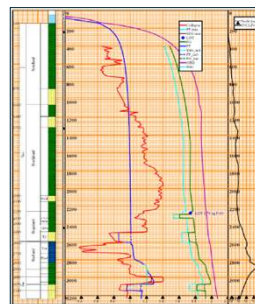


Real-time surge and swab modelling outputs

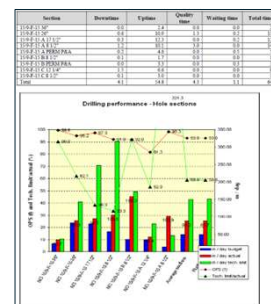
SPP modelling performance

- HB gives the best overall match, with the lowest RMSE and smallest spread.
- HB and PL underpredict SPP (positive mean errors), while BP overpredicts.
- Extreme deviations exist in all models, reflecting operational transients or incomplete modelling inputs.
- Overall, HB is the preferred calibration baseline for further tuning.

Model	Mean Error (bar)	Median (bar)	Min (bar)	Max (bar)	Std (bar)	RMS (bar)
HB	12.4336	9.8467	-207.6217	82.0245	20.4361	23.8956
PL	17.7118	14.8179	-195.0662	89.1623	30.975	27.4529
BP	-14.4768	-10.5709	-273.8312	52.8858	24.312	28.2998



Borehole stability overview with mud weight (MW) and pore/fracture pressure gradients



Drilling performance overview by hole section

SPP modelling performance charts