Engineering Support Services

Engineering Support Services: *Defined*

HMC Engineering Support Services provides a specialized suite of analytic deliverables packaged with drilling fluids management for the purpose of supporting project managers and engineers from spud to TD.

Drilling Fluid Mandates

- ✓ Provide lubricity
- ✓ Provide inhibition
- ✓ Provide fluid density
- ✓ Provide hole cleaning

Engineering Deliverables

- ✓ Predict torque and drag
- ✓ Predict hole stability*
- ✓ Optimize hydraulics
- ✓ Predict drill string dynamics
- ✓ Calculate “friction factor”
- ✓ Predict ECDs
- ✓ Real-time fluid and drilling performance

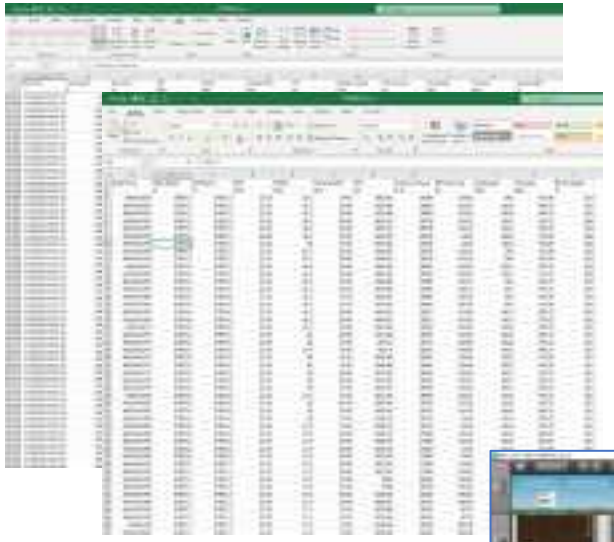
Drilling Fluid Services → Modeling through ERA® (Extended Reach Architect)

*Requires well log data

Engineering Support Services: *In Practice*

HMC Goal: To support our customers with the best information and chemistry possible in order to maximize the value of drilling fluid services and performance; to increase transparency and eliminate conflicts of interest; and to serve as a high-performing member of our customers drilling team.

Engineering Support Services: *In Practice*



Turn This

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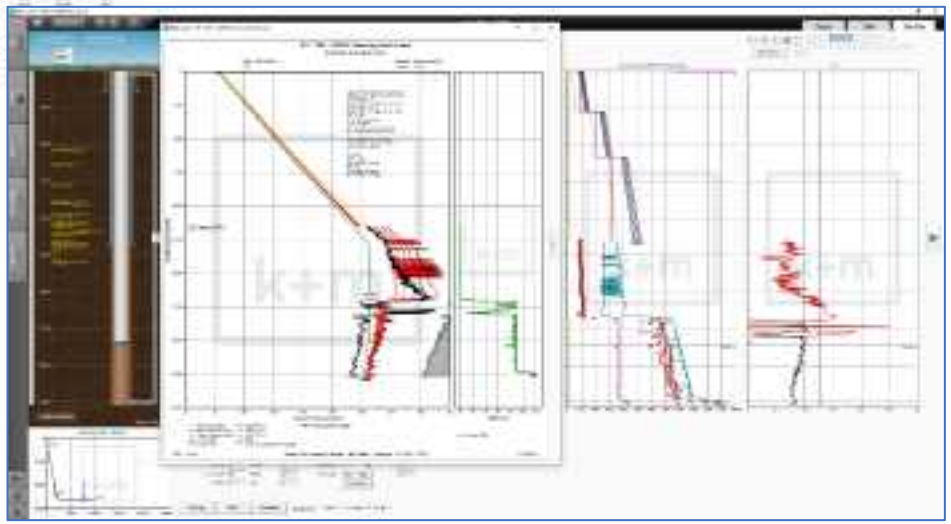
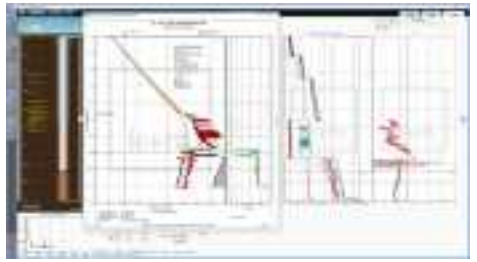


Engineering Support Services: *In Practice*

Project Management

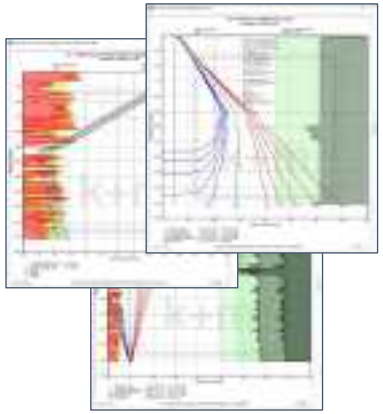
Real-Time Feedback

Efficient Decision Making

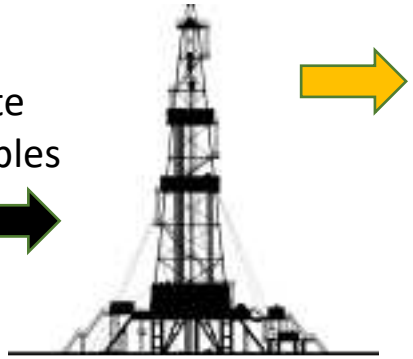


Engineering Support Services

Model Expectations



Wellsite Deliverables



Data Capture & Analysis

HMC

Drilling Fluid Services

Engineering Support Services: *Key Considerations*

- Curated service offering tailored to the project manager's or engineer's needs
- Embraces a true multi-disciplined, team model: fluids, directional, cement, drilling contractor, etc.
- Scalable, repeatable, reliable, ELIMINATE GUESS WORK
- Guaranteed, consistent support level across all rigs
- Provided in conjunction with drilling fluids and competitively priced
- Eliminate conflicts of interest, increase transparency
- Empowers all stakeholders to achieve continuous improvement

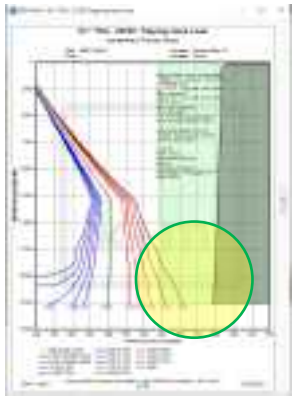
Engineering Support Services: *Sample Service Package*

- Wellbore design and review
  - Well path, system limits, tubular limits
- Torque and drag modeling
  - Anticipated hook loads, torque and friction factors
- Hole cleaning analysis
  - Anticipated pump pressures, ECDs, rheology sensitivities
- Casing and cementing analysis
  - Tubular limits, liner setting analysis, anticipated hook loads
- Mechanical earth modeling*
  - Analysis of hole stability based on well path angle and rock stress

*Requires well log data

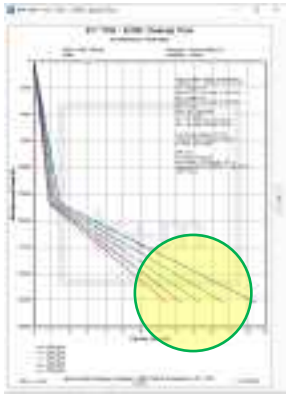
Engineering Support Services: *Case Study 1*

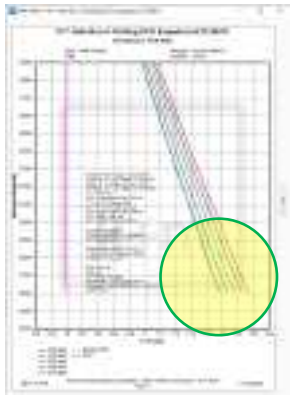
- Drilling 14,000’ VS at 13,000’ TVD
  - Back-reaming on trips – average round trip time 48 hours.
  - Model expected hook loads WITHOUT back-reaming. Refine SOPs relating to “clean-up cycles”, expected rotary torque and DETERMINE actual friction factor. Predict ECDs with MPD to maintain hole stability.
  - Monitor T&D trends REAL-TIME and provide insight into trends.



Eliminated “guess work” on ability to trip w/o reaching tube limits

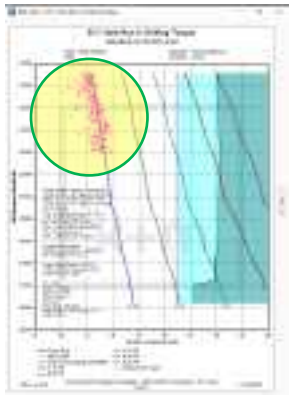
Provided minimum circulating time based on cuttings transport





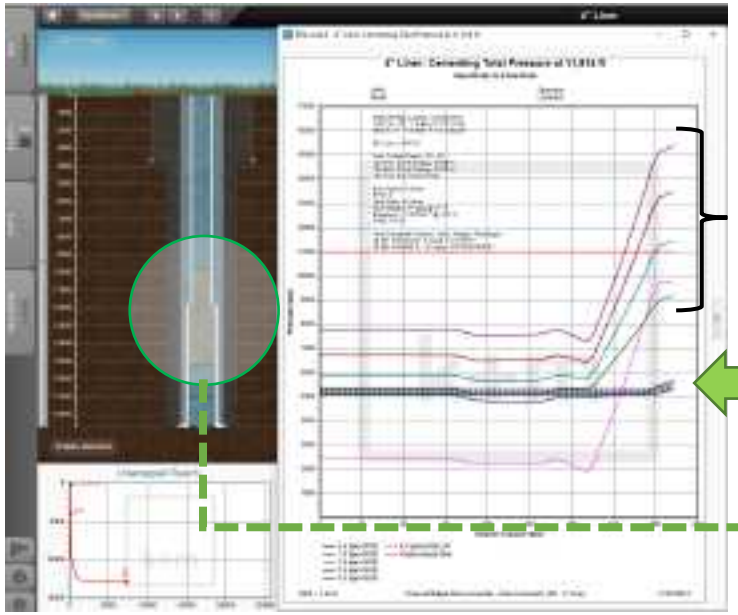
Calculated expected ECDs with sensitivity to MPD pressures and flow rate

Measured real-time torque vs. predicted torque to monitor trends



Engineering Support Services: *Case Study 2*

- Re-frac 7,500’ lateral at 12,500’ TVD. Run and cement 4” liner inside 5-1/2” original casing
  - Liner hanger/packer rupture disc MAXIMUM total pressure =11,000 psi.
  - Determine pump rate/pressure schedule to allow efficient cementing time without exceeding disc pressure limit.



Modeled total system pressures AND differential pressure at liner top with sensitivity to pump rate

Predicted annular pressures in order to account for ECDs

Animated “drag and drop” of cement slurry to illustrate pressures vs. depth