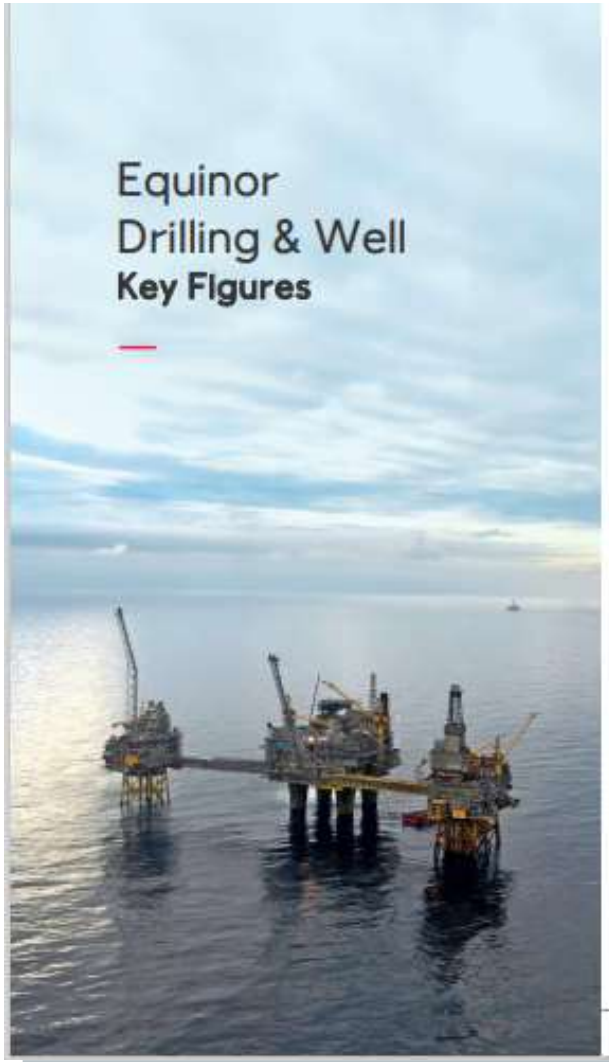
Fluid Engineer(ing) for the Future

Ove Braadland,

Leading Engineer,
Drilling & Completion Fluids



Equinor Drilling & Well
Key Figures

~ 120
new wells yearly

60
suppliers involved

~40
daily operations

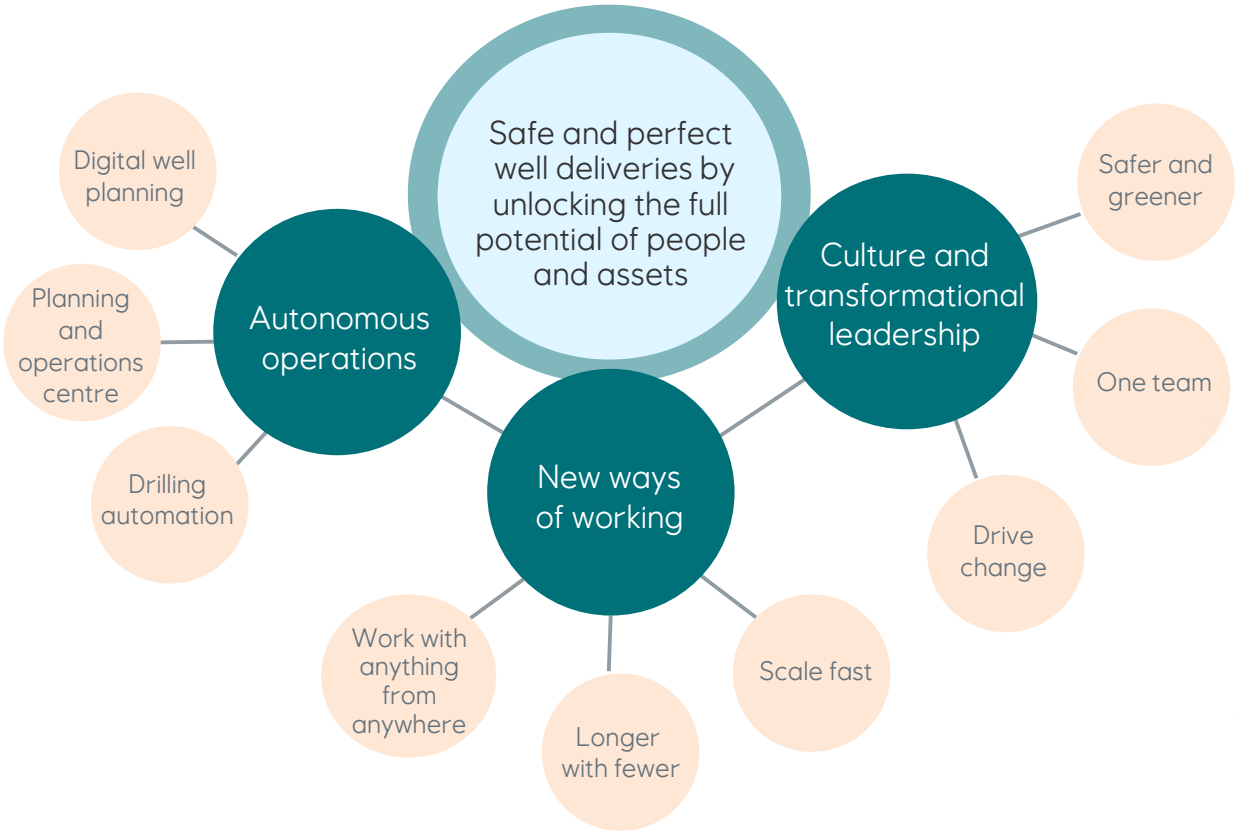
>500,000
meters drilled yearly

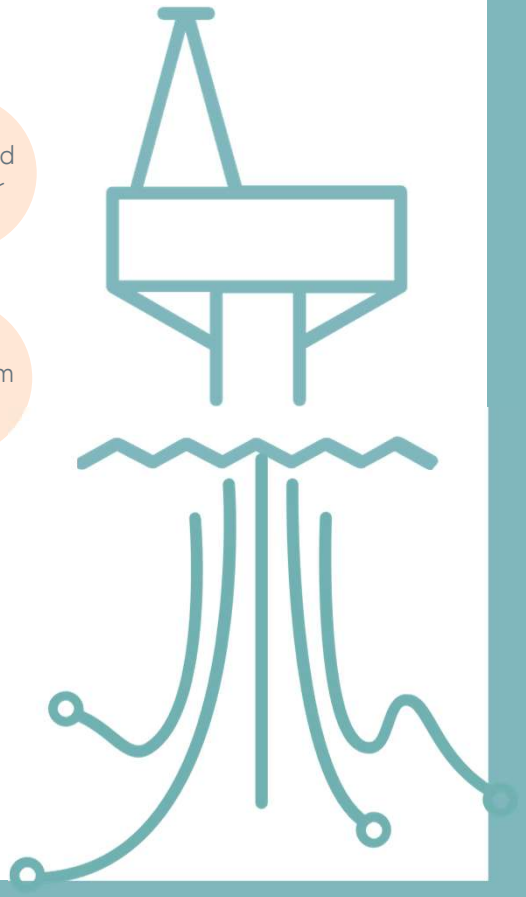
~360
yearly
well interventions

1,200
employees
across the world

Open

Shaping the future of the Drilling & Well industry





Open

Collaborative

Courageous

Caring

Always safe

High value

Low carbon

D&W Digital Transformation | Towards autonomous operations through new ways of working

Automated Drilling Control
Automated operations & Advisory

Rig management system – digital DOP and beyond
Automated drilling control on 13 rigs
Advisory solution for fixed platforms
Connecting downhole and surface

Integrated operations
Capitalize on high-speed connectivity

IO 3 on 16 rigs and increasing
IO 4 pilot on DSA on Johan Sverdrup phase 2
Operations run from shore
Digital Field Worker

Digital Well Planning
Digitize & automate well planning

Platform for D&W planning
Modernize D&W IT
Data & workflow integration with Subsurface
Connect to modern external digital solutions

Automatic Fluids Monitoring System in Equinor

- Equipment from three suppliers
  - Baker – AFM
  - Halliburton – DRU, BaraLogix
  - SLB - Rheoprofiler
- Continuous surveillance of MW(in/out) and Rheology
  - Data distributed on rig to dedicated personnel
  - Data sent to onshore control center
- Enabling real time hydraulic optimization
  - ECD
  - Hole cleaning
  - Surge swab calculations
- Input to automatic drilling services
  - Controlled tripping
  - Controlled ROP
  - Controlled pump start up etc

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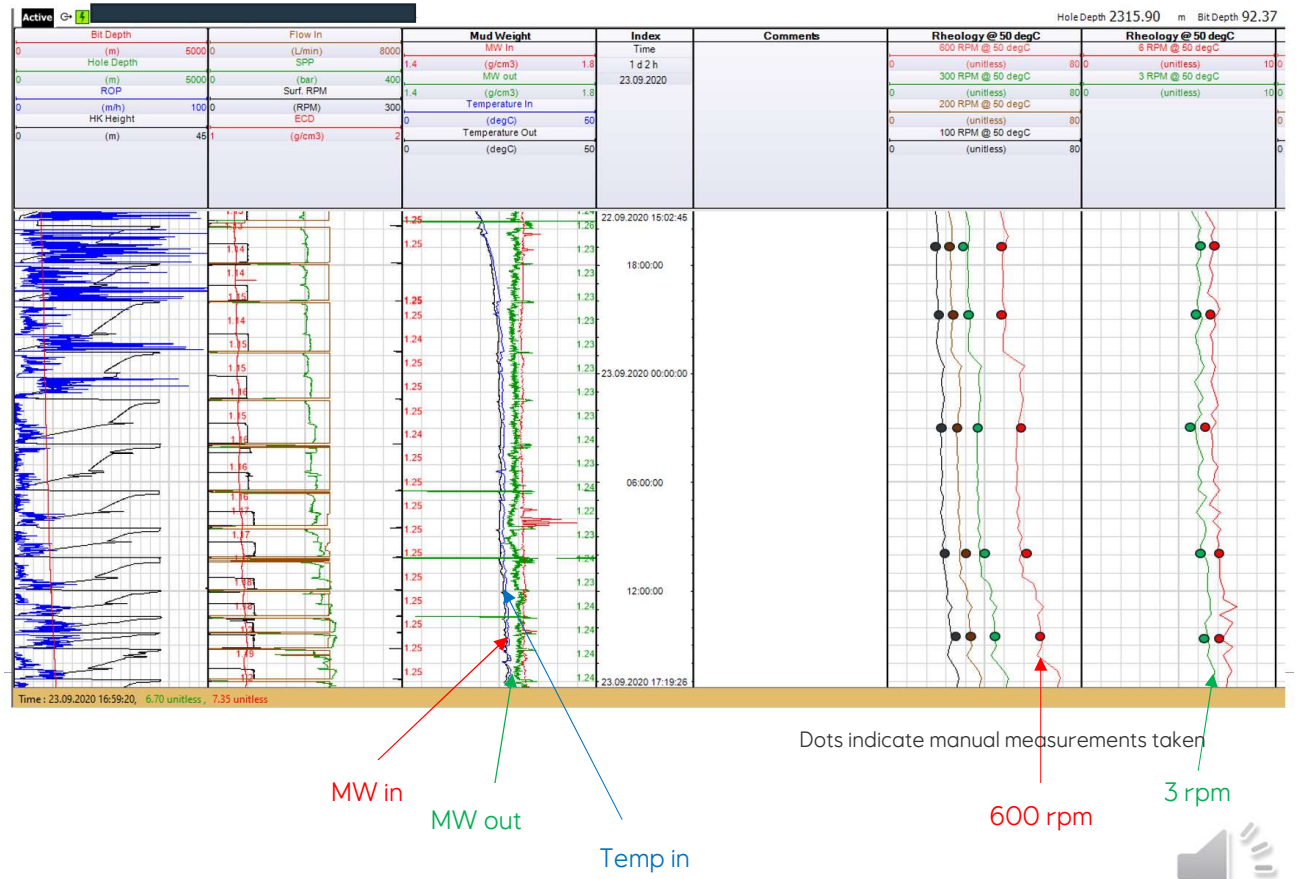
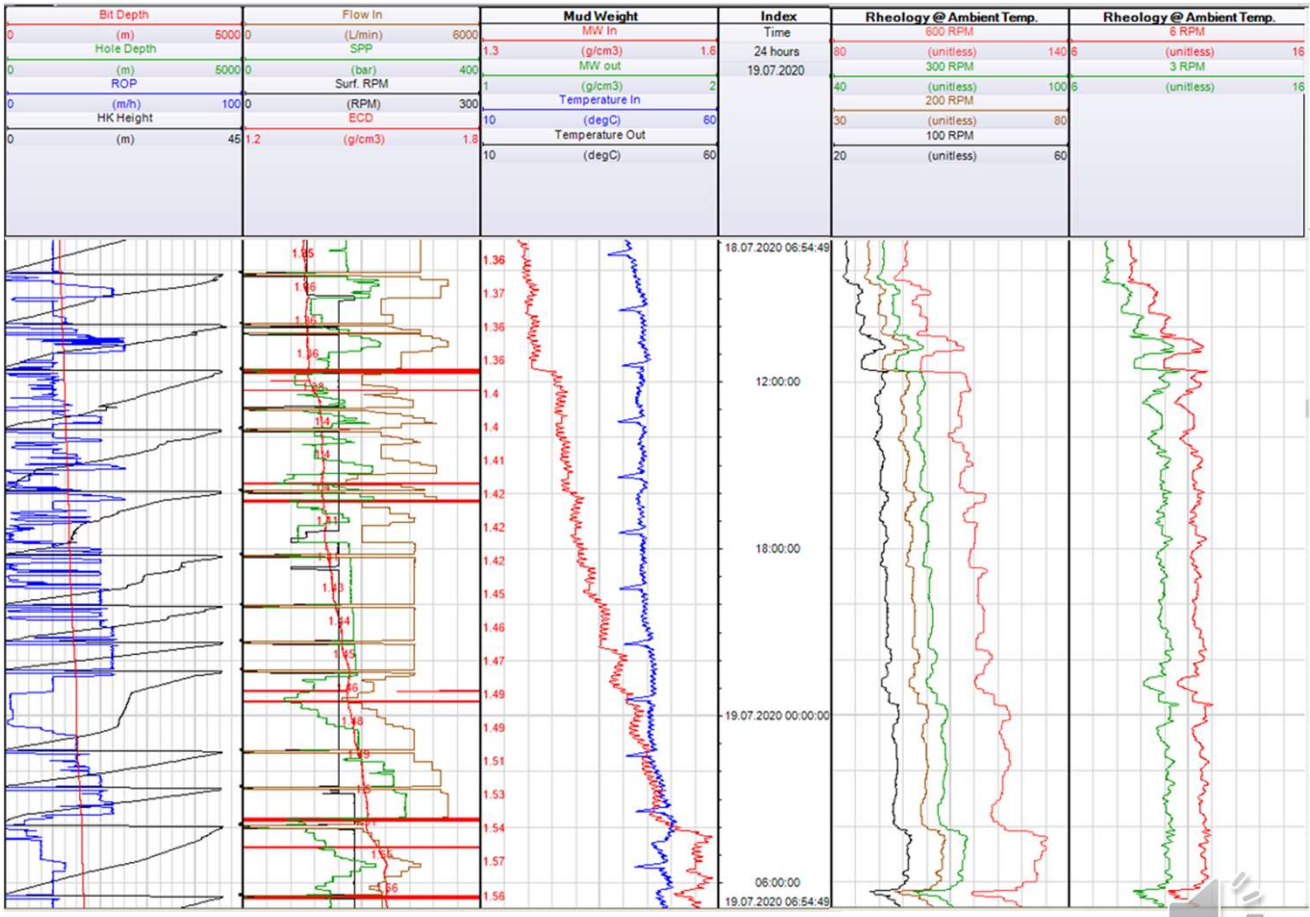
Automatic measurements- what do we get today?

- Rheology data according to API:
  - 600 rpm
  - 300 rpm
  - 200 rpm
  - 100 rpm
  - 6 rpm
  - 3 rpm
  - 96 full series within 24 hours (4 with manual measurements)
- MW
  - Density with 0.01 sg accuracy
  - Temperature of measured sample
  - Frequency every minute
- All data streamed to shore in real time



Field data

- Example
  - Change in fluid properties over 24 hours period
  - Weighing up OBM from 1.35 to 1.56 sg
  - Changing rheology
  - Drilling at 40 m/hr
  - Automatic MW and Rheology measurements
  - Full control of fluid during activity
    - Not possible with only manual testing



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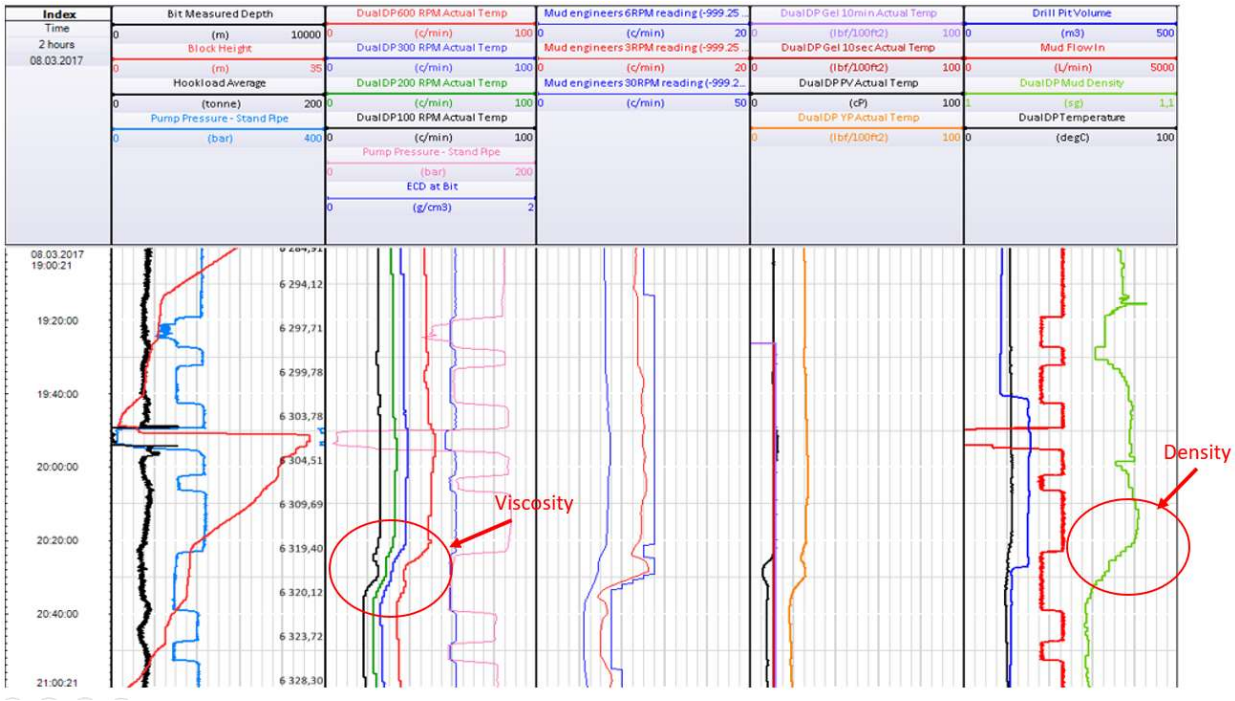
Onshore surveillance

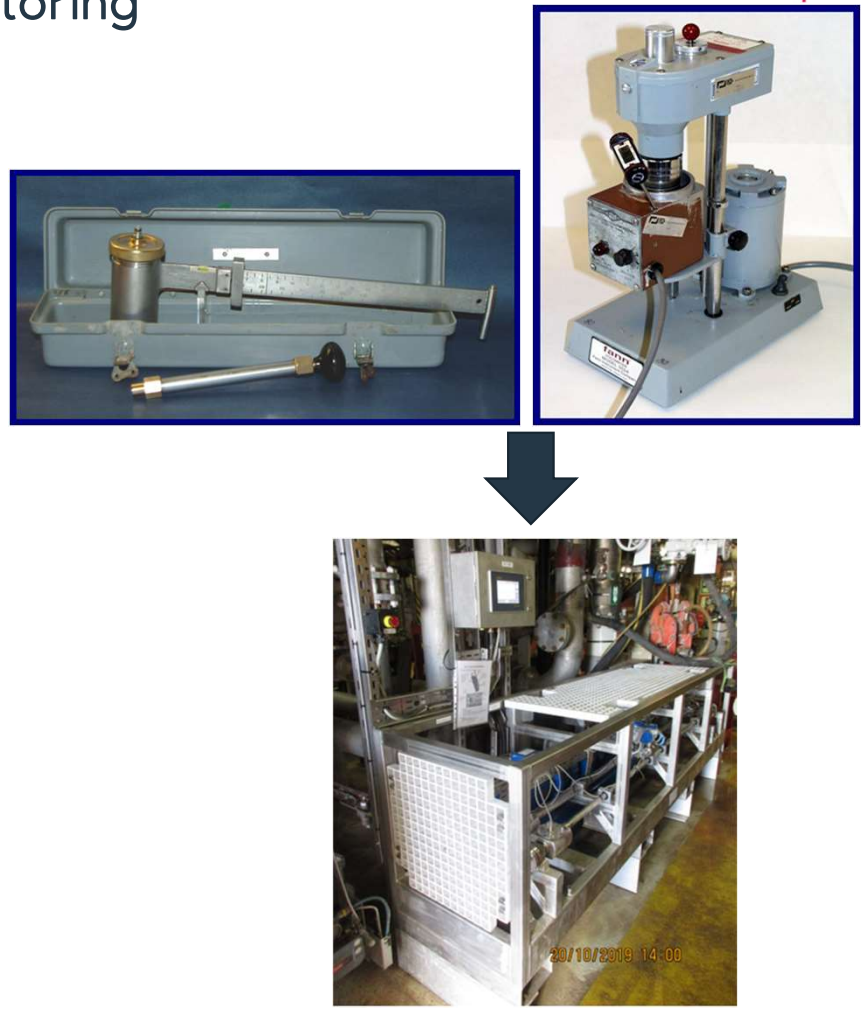
- Data collected and streamed from AFM unit
- Displayed locally at rigsite
- Transferred via ethernet to onshore support centre
- Onshore center staffed with personnel trained in fluid engineering and hydraulics
- Setting alarms on selected parameters will help detecting changes in fluid system



Challenges with introduction of Fluids monitoring

- Drilling Fluid is a conservative business
  - Low focus in technology development
  - Traditionally low interest in developing the industry to be more automated
  - Volume is the main driver

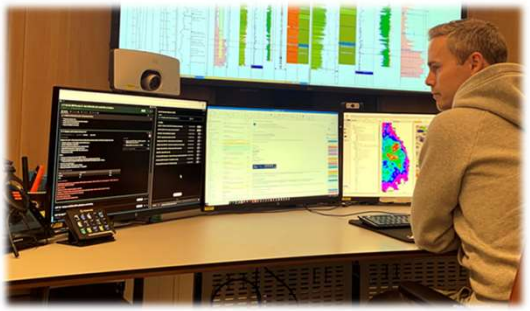
- Automatic measurements of rheology and MW requirement in Equinor IDWS contracts since 2018
  - Main driver for technology development
  - Main driver for implementation
  - Main driver for usage of data
    - Move manning from offshore to onshore control center



Fluid Engineering Today

- Several installations on IO3 has reduced personnel down to one mudengineer
  - Relies on automated fluids monitoring equipment
    - Still performs regular API check
  - Cross training of cementer to do mudchecks
  - Experienced personnel manning the fluid companies onshore support centers
    - Direct communication, CCTV
  - Dependent on stable and reliable fluids
  - Uptime on automatic fluids equipment, is a KPI

Real-time communication through digital tools and video

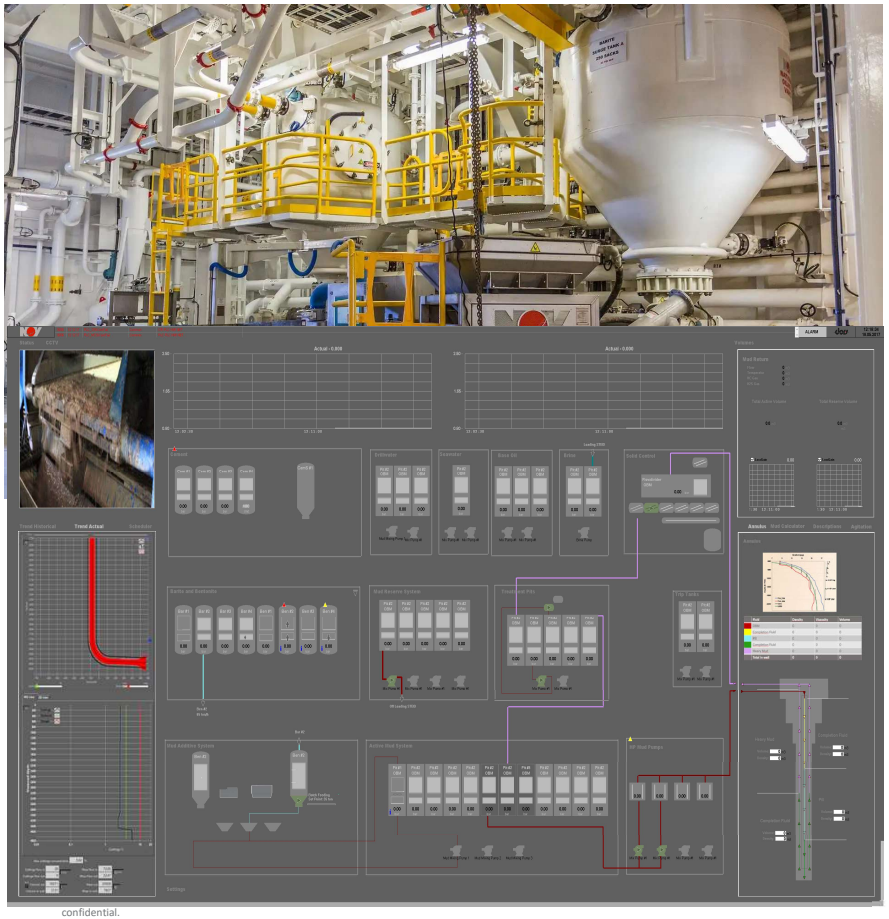


In the future

- Fully automated drilling fluid process (including testing, mixing, handling and treatment)
  - Partly possible with current technology
    - MW and Rheology are the main parameters to follow in fluid engineering
      - Diagnostics for most fluid changes
    - Pre-made premix and barite are main fluid treatments offshore
      - Can be controlled by current technology
  - Less exposure to personnel

- Full control of fluid will benefit development of additional sensors
  - Solids content, solids size/shape, mineralogy
  - Oil/water/solid content
  - Others (pH, KCl, ES ???)

- The main service provider will do almost all work from onshore expert centers, and rig contractor will be responsible for surface activities



Pictures from NOV

Acknowledges

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