

Arctic/Frontier Drilling

Technical Issues

February 16, 2014



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Agenda

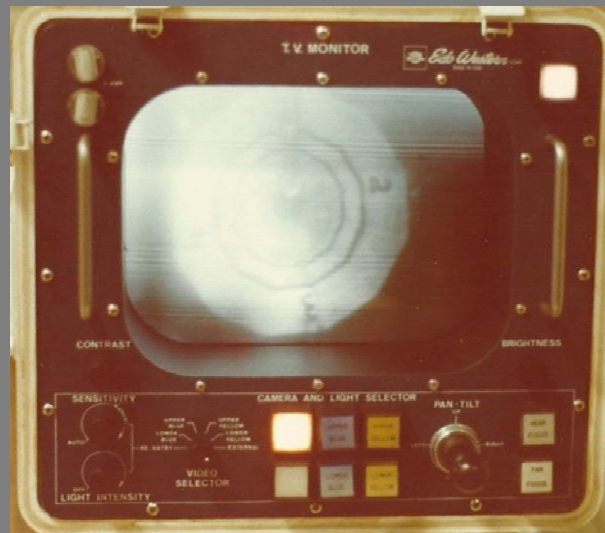
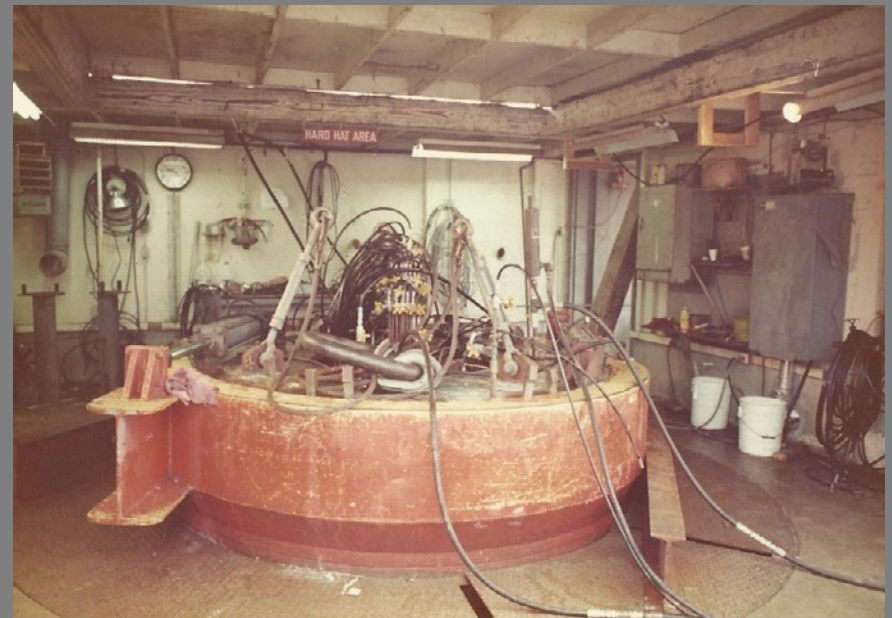
- Background
- Deepwater
- Arctic

Background

Drilling contractor building deepwater drilling units in 1970s - first time in 6,000 ft (1,800 m)

Responsible for underwater electrical systems

- BOP Controls, cables, connectors
- Re-entry equipment, sonar/TV



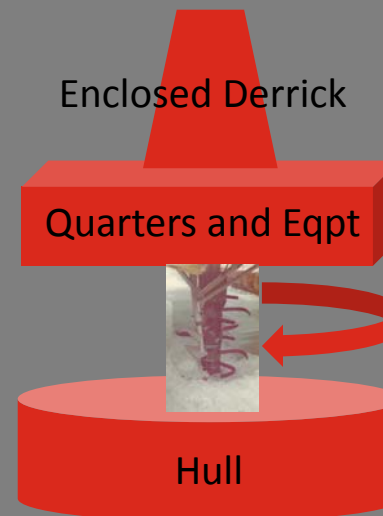
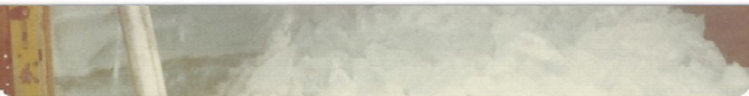
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Special Projects Team



Deepwater

Too many strings of casing, BOPs too big, too heavy

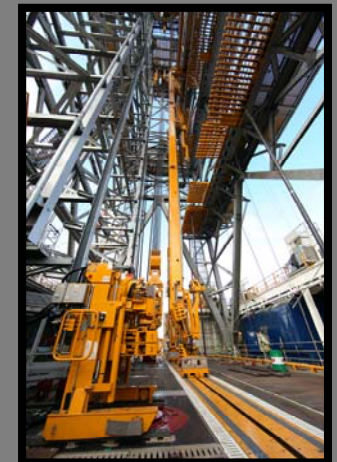
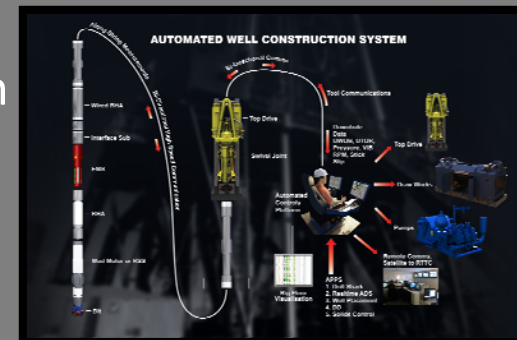
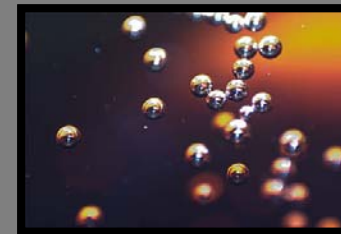
- Dual Gradient or Riserless or MPD

Kick detection, pit levels are too late

- Downhole or At-BOP sensors

Too much flat time

- Best people and equipment
- Optimization tools including automation



Arctic

The Cold

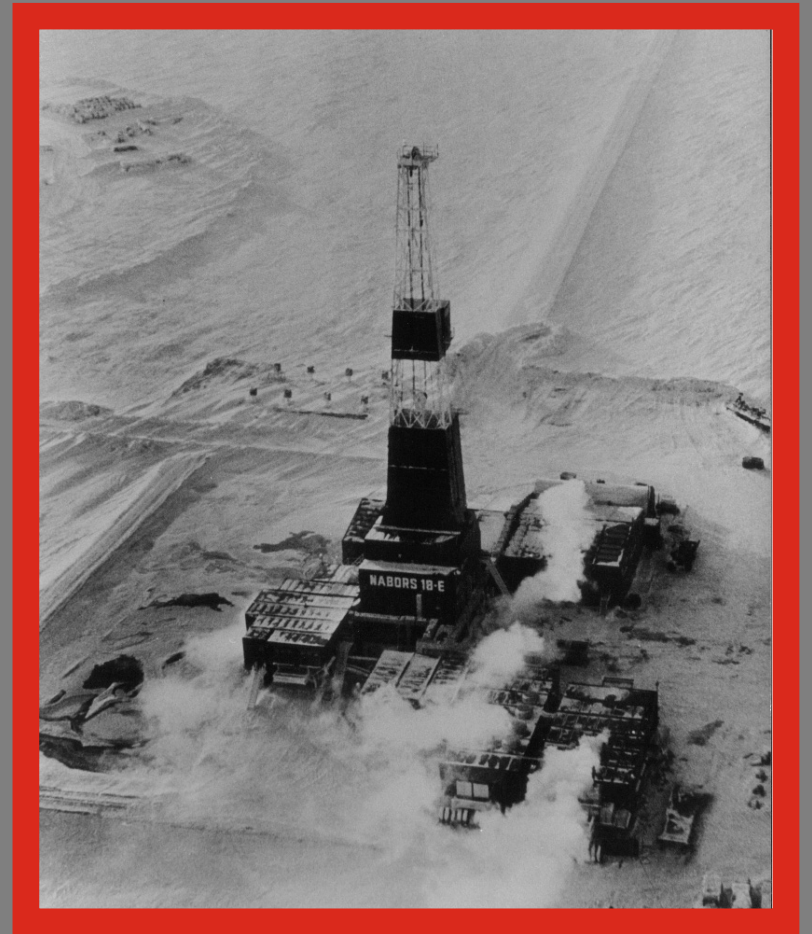
- < -40C Protect People and Machines
- Problem moving, rig up/rig down, restart
- Wind walls, heated drillfloor
- Heat tracing and insulation
- Special lubricants
- Special steels and welding

Moving

- Need cranes, trucks or build rig for it
- Fast connections

Environmental

- Zero discharge
- Animals
- Permafrost



Arctic

Logistics

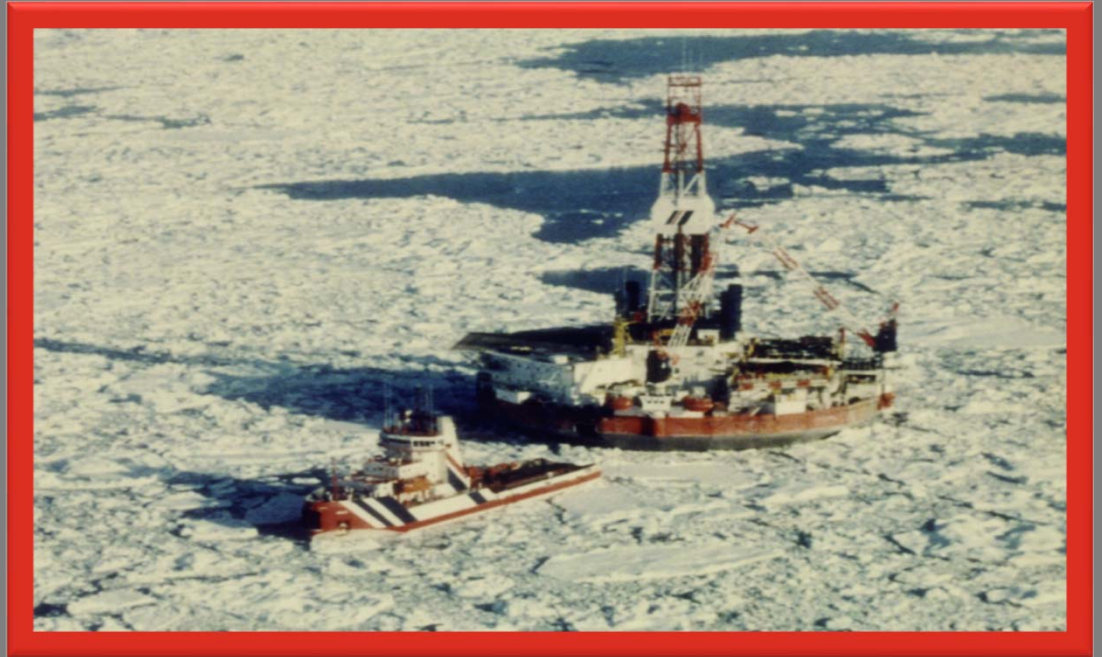
- Cost to haul fuel and supplies
- Camp and catering
- Moving personnel



Arctic

Offshore

- All the above plus boats
- Ice accumulation
- Limited drilling season

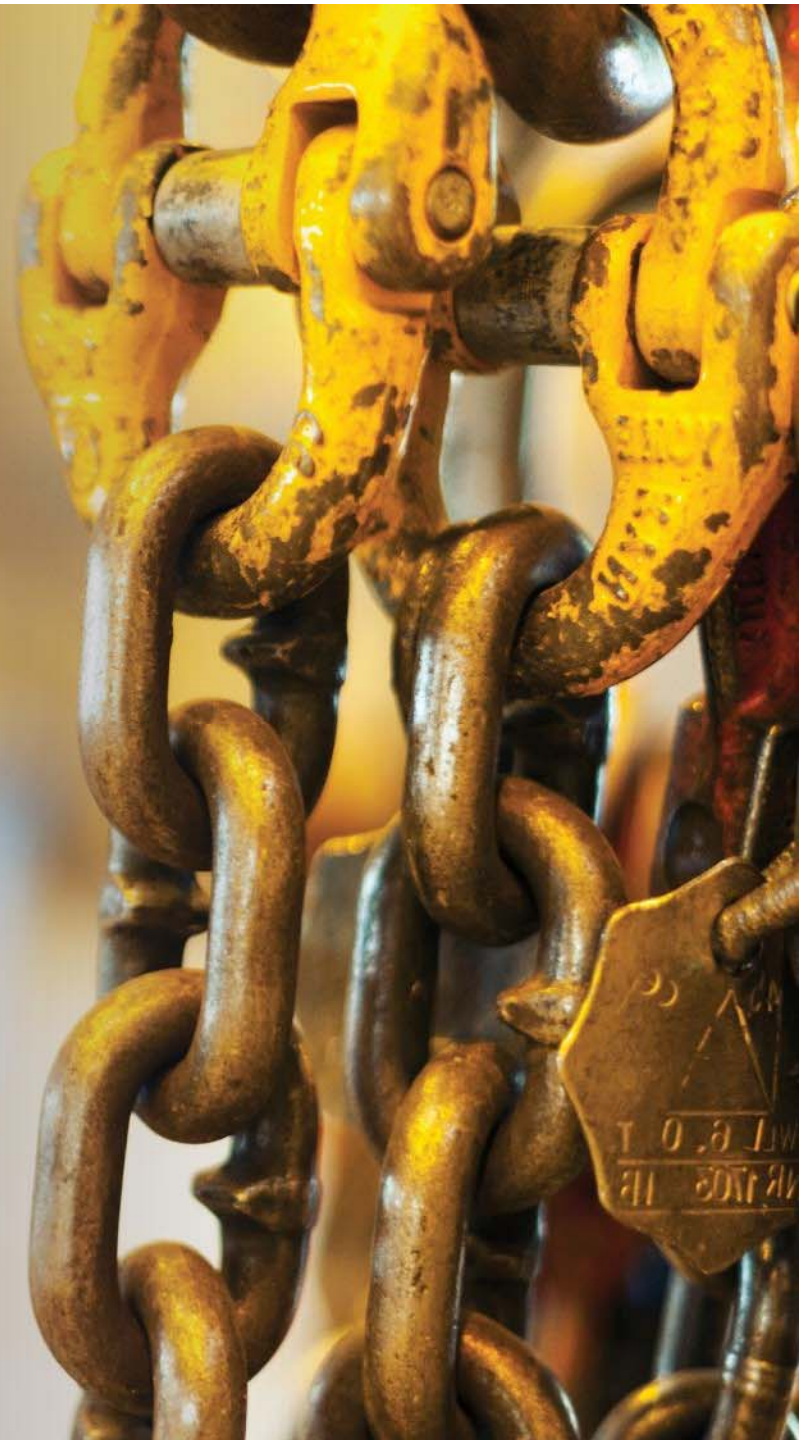


These problems mean more cost, so

- Design for efficiency when moving or walking
- Improve drilling efficiency
- Eliminate flat time

Questions?

Special thanks to Jay Thiessen of NOV Edmonton for his insightful comments regarding arctic operations.



NOV