Live well deployment of long perforating gun system using combined CT technologies

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High Level Case Study

- Major operator – Caspian sea

- Live well deploying guns not new
  - Identify key successes & best practices
    project planning…
    to job execution
Challenge

- Quick oil - perforate new reservoir
  - 1,007 ft of 3 3/8” guns
  - perf 5 ½” tbg and 7 5/8” tbg
  - highly deviated well

- Perforated w e-line tractor historically
  - 16 runs required
  - sand problem for tractor?

- Single run solution
  - reduce HSE exposure
    - one well entry / exit
    - elec + hyd firing system
  - reduce rig time
What’s New? - Proprietary Connectors, Firing Head & Intelligent CT

- Simple, Robust Connectors
  - extensive debris testing
  - set down motion only to engage
  - compatible with universally available quad BOP

- New generation intelligent CT used
  - better disconnect contingency
  - improved safety
    - hydraulic redundant firing option
  - first time combination of firing head with intelligent CT
Job Planning

- “Quick incremental oil” – aggressive time frame
  - planning team in place
- Manufacturing of connectors & BOP rams reqd
- Extensive tubing force analysis
  - long BHA through multiple dog-legs
  - firing loads on CT
- Extensive rig-up geometry checks
- Educate/train local team
  - custom training course
  - work through job check sheets
Job Planning

- **PCE Selection**
  - two x PCE stacks considered

- **Contingency retrieve BHA’s**
  - if not possible to latch connector

- **Choice of gun charges**
  - extensive CT end force modelling
  - high force / low debris

- **Well condition when fire**
  - allow immediate flowback
  - mitigate sand influx
    - static ov.balance
    - dynamic un.balance
Lower Deployment Stack

- Koomey Unit 1
- Koomey Unit 2
- Koomey Unit 3

- Skid Deck
- Wellbay

- 4 1/16” Annular BOP
- 4 1/16” Gate Valve
- 4 1/16” Flow Cross
- 4 1/16” Hyd Gate Valve
- 4 1/16” Deployment BOP
- 7 1/16” Shear Seal BOP

- Shear Seal Ram
- Disconnect Ram
- Locate Ram
- Slip Ram
Pre-Job Yard Testing

- Function test connectors (pair them)
- Pull test connectors
- Pressure test connectors
- Slip rams – hold weight of guns
- Elec comms check to firing head
- Fish tools catch connectors
- Elevators fit connectors
- Koomey units function test
Koomey Unit Yard Test

- Variable closing force to locate ram
- Variable closing force to disconnect ram
- Max closing force to slip ram
- Regulated closing force to annular BOP
Well Control

- Check at different stages of operation
- Barriers - dead well deploy guns
  - Bridge plug / liner hanger packer
  - KW brine
  - SS BOP cannot be closed
- Barriers - live well retrieve guns
  - Stripper / BHA check’s
  - Gate valves (during break out tools)
  - CT BOP
  - SS BOP cannot be closed when guns at surface
Drills Carried Out Pre-RIH

- Cannot close SS BOP on guns
  - how to secure well during gun deployment?

- Emergency procedures before RIH:
  1. rig to place guns at deploy BOP in emergency
  2. drop guns in well
Job Execution

- All guns fired electrically first attempt
- No over-pull post firing
- All gun connectors performed as expected
- BHA gauges confirmed model pressures
- Zero HSE incidents
- Very close to zero NPT
- Just over two days to retrieve all guns
- Four days rig time saved vs e-line tractor
Conclusions

- Combination of technologies simple to use and reliable
- First time combination of firing head + intelligent CT
- Early identification of planning team - essential to delivery
- Deployment check sheets - essential to execution

Lessons Learned

- Further time savings possible
  - remove more drill pipe from derrick
- Add additional swivel below centralizer in retrieve BHA
- Annular BOP optional
- Make up connector on every gun
- Add flow cross between deploy BOP and lower GV
Thank you – Questions?