



2018

NORTH AMERICA
PERFORATING SYMPOSIUM

GALVESTON, USA

ORIENTED PERFORATING SYSTEM FOR SAND PREVENTION IN VERTICAL WELLS

2018-NAPS-17

AUTHORS: Jason Cook

Outline

- Background
- Customer Requirements / Challenge
- Solution
- Results
- Questions

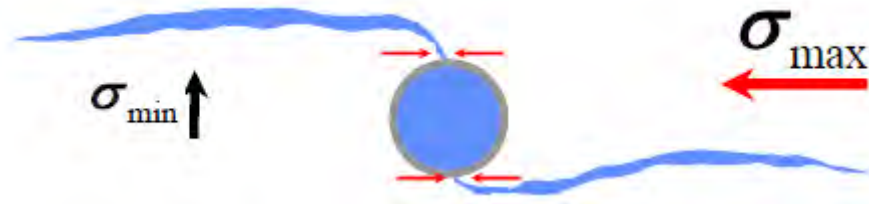
Background: Why Orient?

- Beneficial to orient perforations to formation geomechanics

- SPE 28555 (Abass, et al. 1994)
- OTC 19130 (Andrews, et al. 2008)

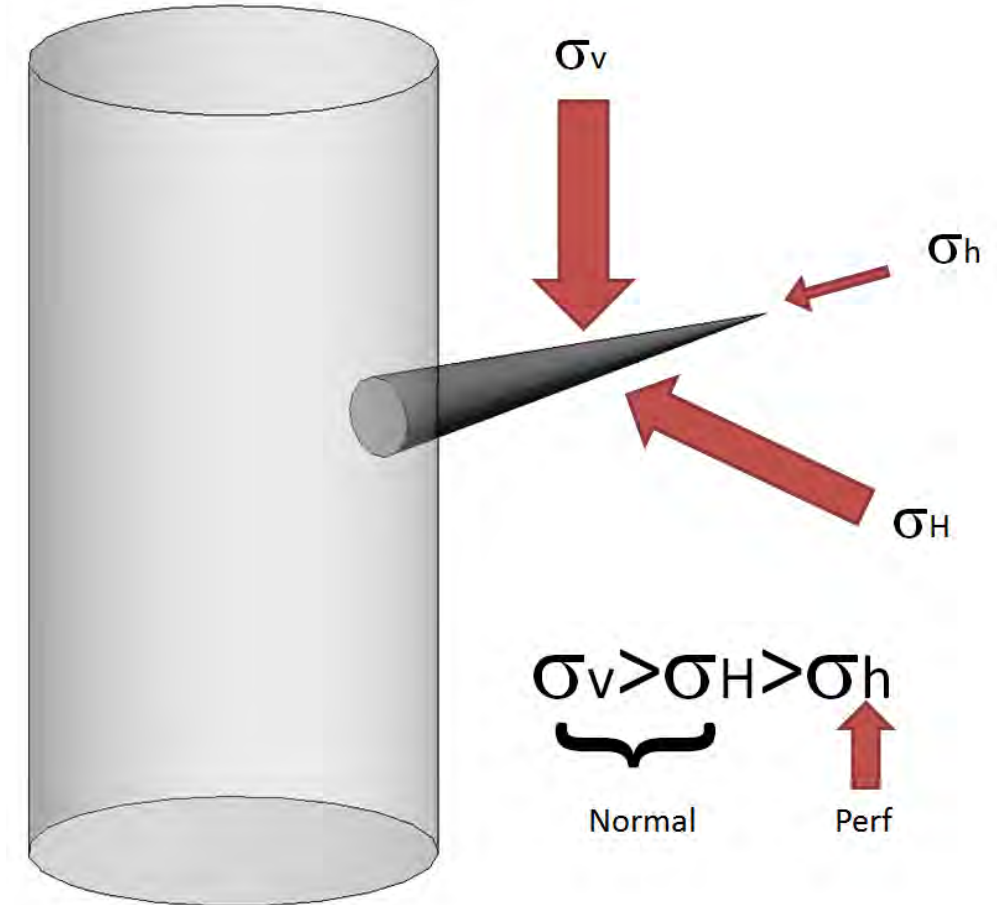
- Improved frac treatment in some formations

- Fractures grow perpendicular to least stress
- Reduced tortuosity
- Perforate in line with maximum stress



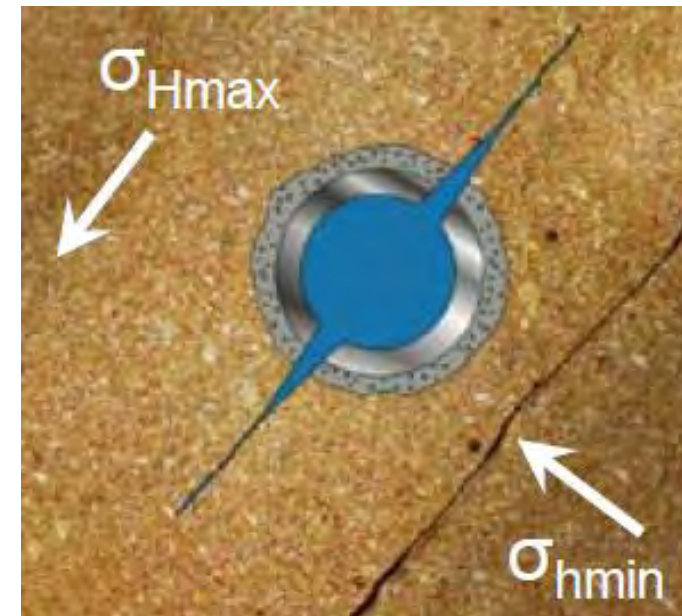
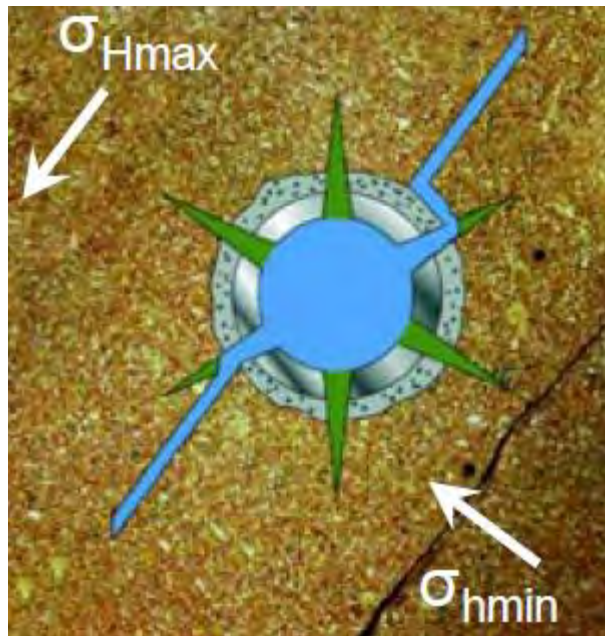
- Reduced production of sand in other formations

- Perf in direction to produce most stable tunnels
- Minimize contrast between normal stresses



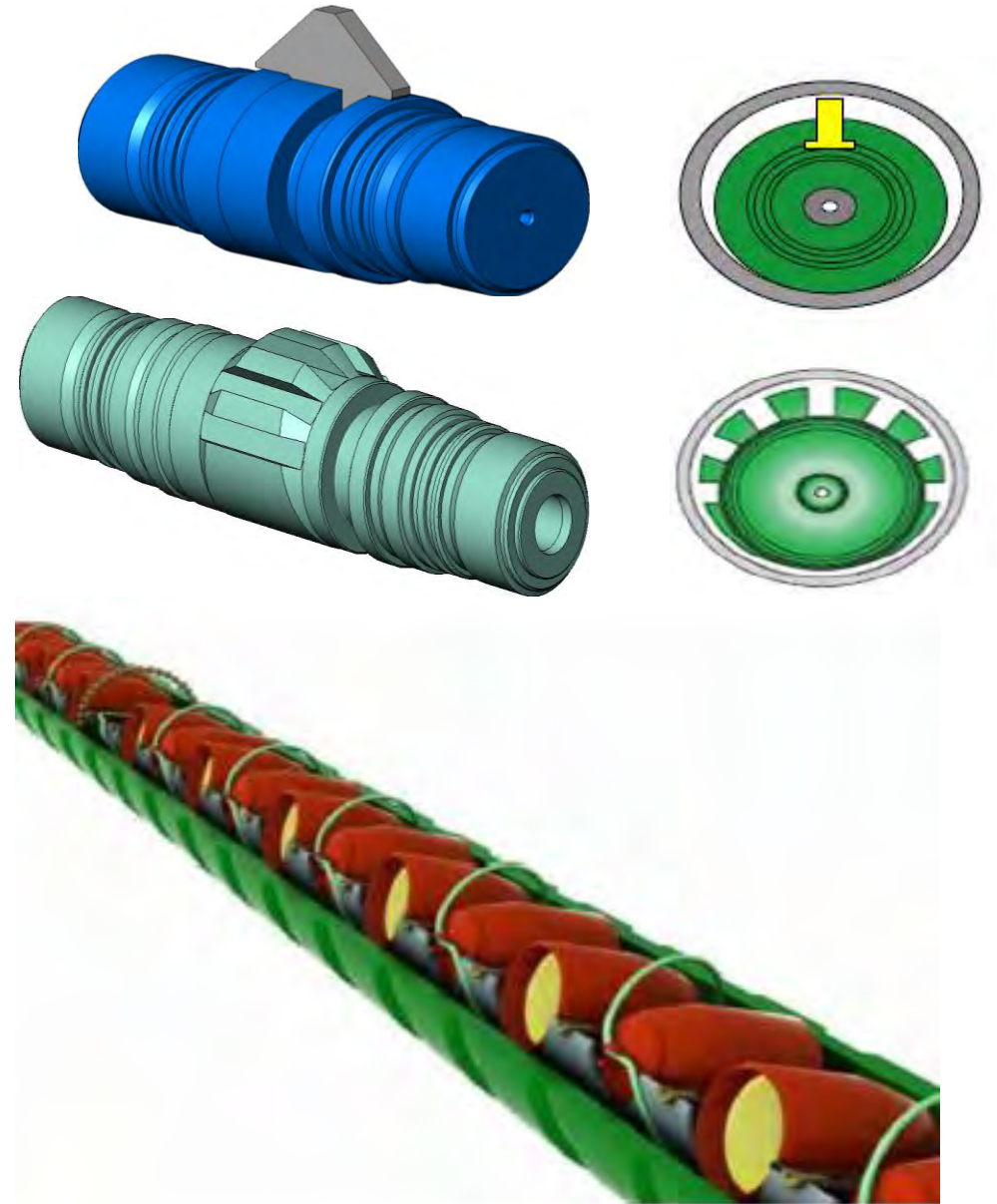
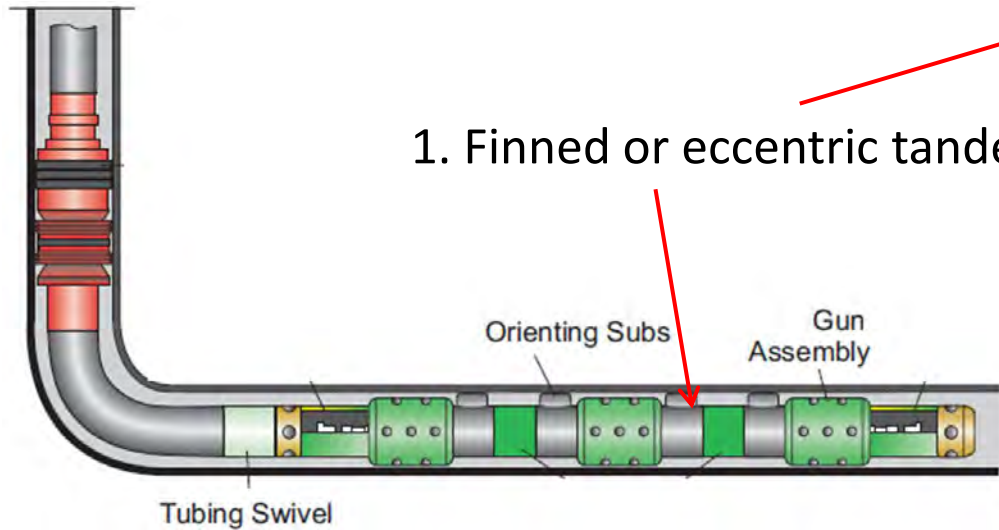
Background: Why Orient?

- Why Orient, stated another way:
 - 6spf, 60 deg, non-oriented gun
 - 2 SPF in line with fracture plane
 - 2/3 shots ineffective
 - 6spf, 0-180, oriented gun
 - 6 SPF in line with fracture plane
 - All shots effective



Background: How do we Orient?

- 2 main methods to orient perforations are gravity based



Customer Requirements

- Customer in Middle East-North Africa
- Orient perforating guns in a vertical well
- Flexibility of service:
 - Post-detonation options
 - Gun string lengths
 - Formation types
 - Hard rock (frac)
 - Weak rock (sand production)
- Time is money:
 - Deep wells: 14-16,000 ft
 - Short project lead time: 36 weeks or less



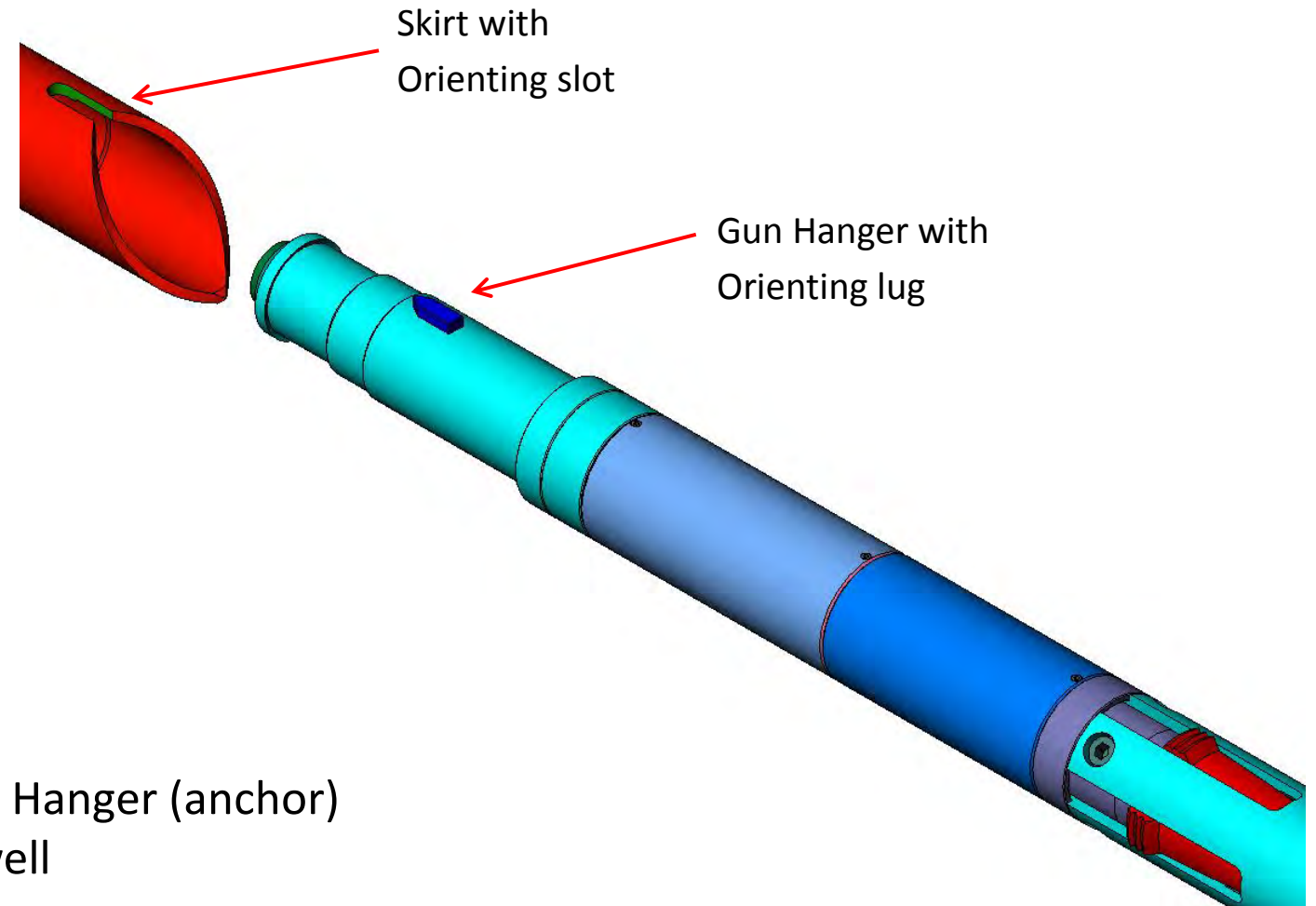
Challenge

- **How do we orient guns in a vertical well?**

Solution: Vertical Orientation

- Gyro tools?
 - Work well vertical
 - Not robust
- Need to measure orientation before guns are RIH

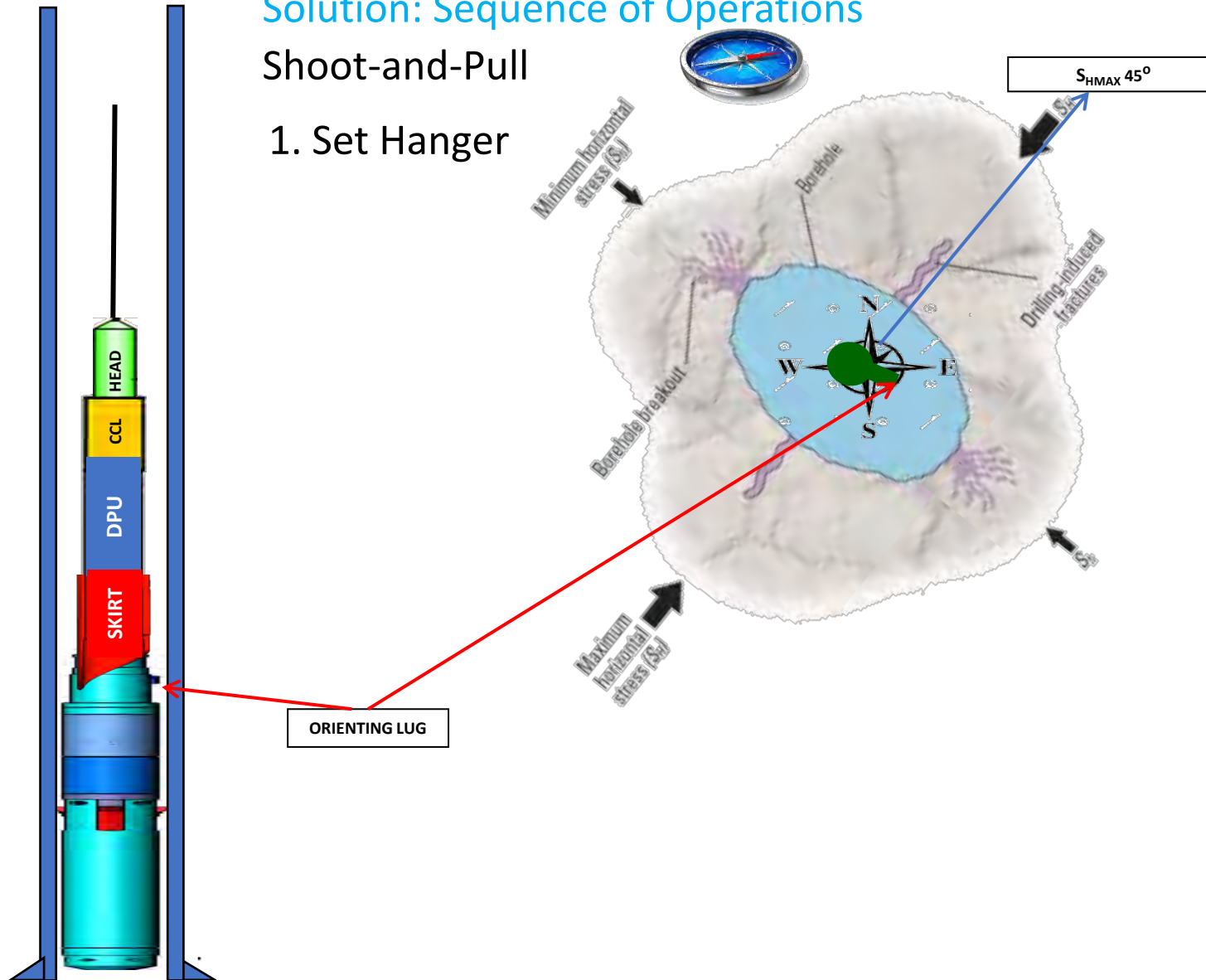
- **Solution:** Integrated system to place Gun Hanger (anchor) with measurable orientation feature in well



Solution: Sequence of Operations

Shoot-and-Pull

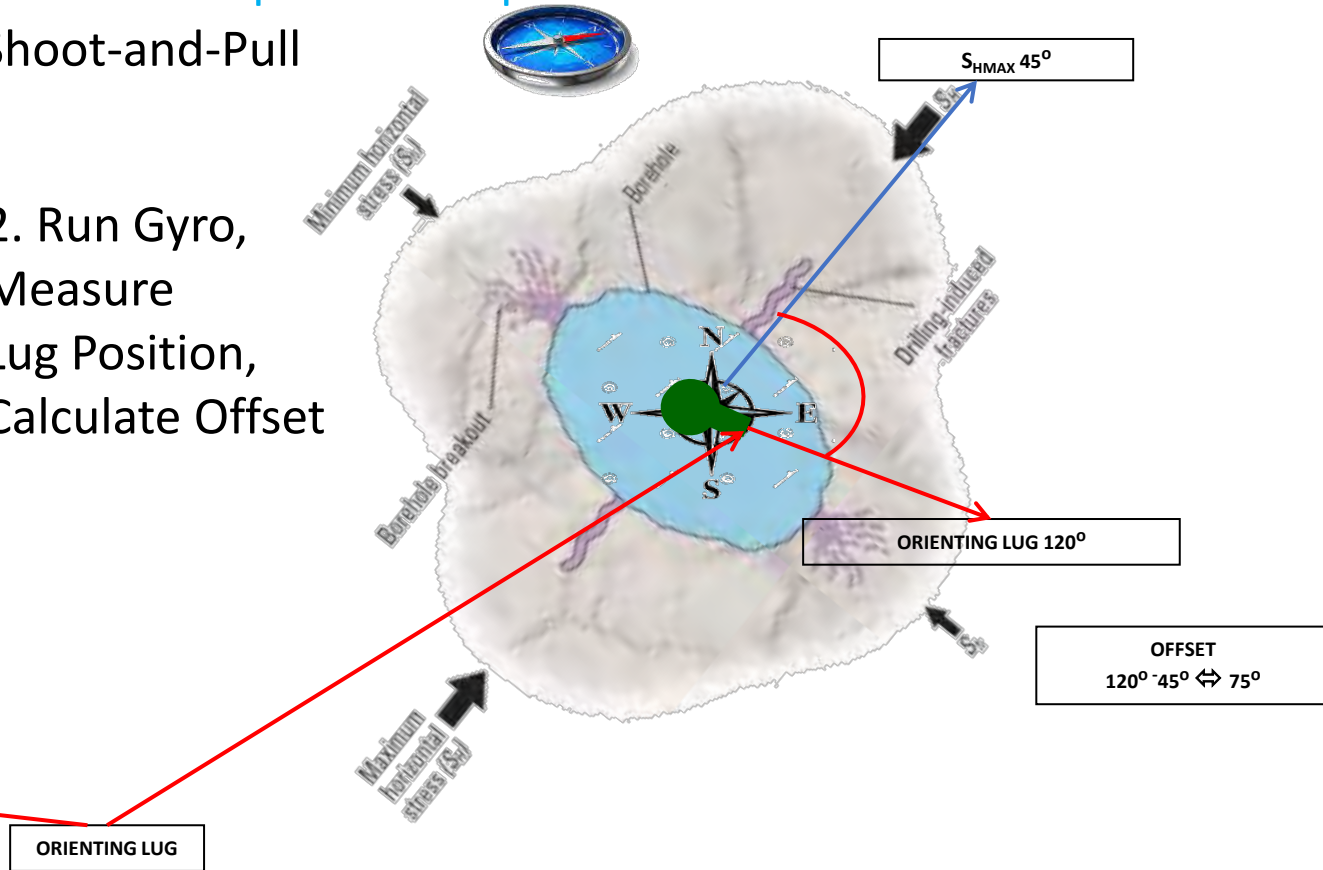
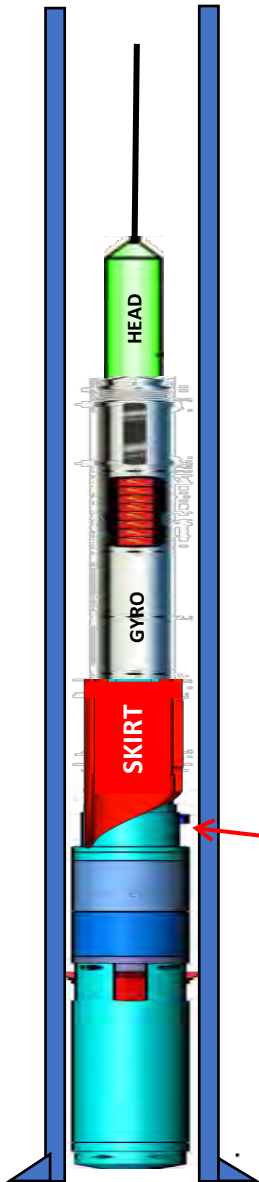
1. Set Hanger



Solution: Sequence of Operations

Shoot-and-Pull

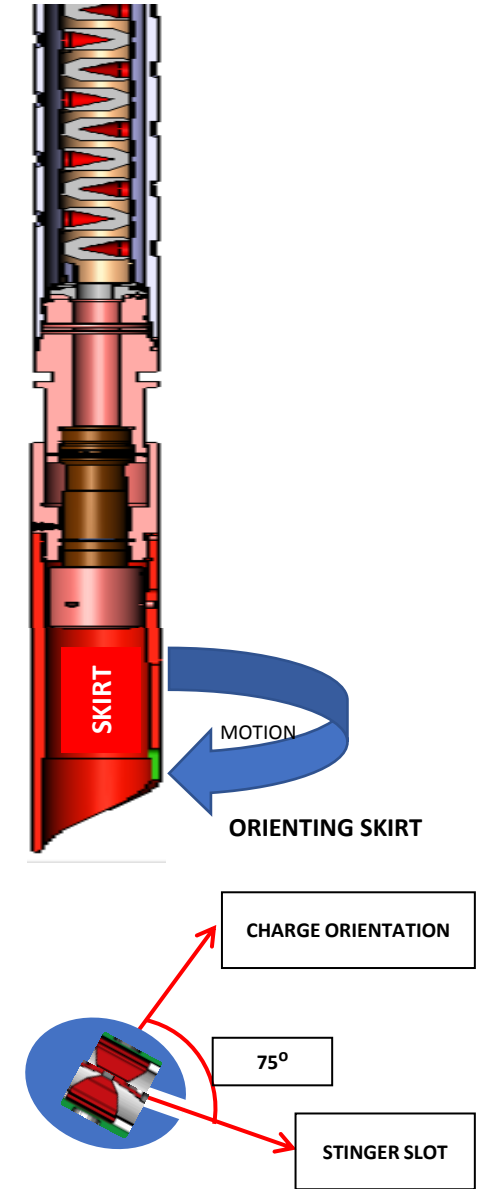
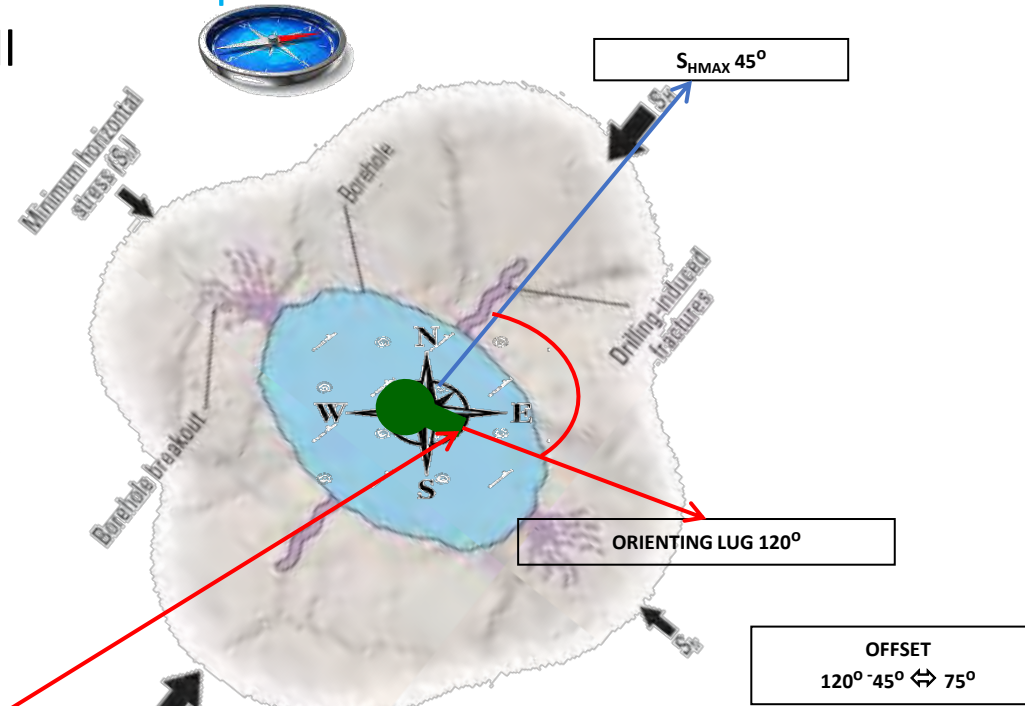
2. Run Gyro,
Measure
Lug Position,
Calculate Offset



Solution: Sequence of Operations

Shoot-and-Pull

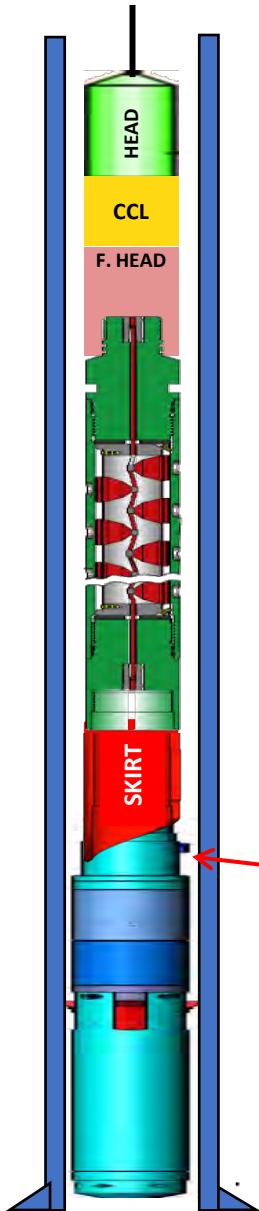
3. Adjust Skirt to Offset



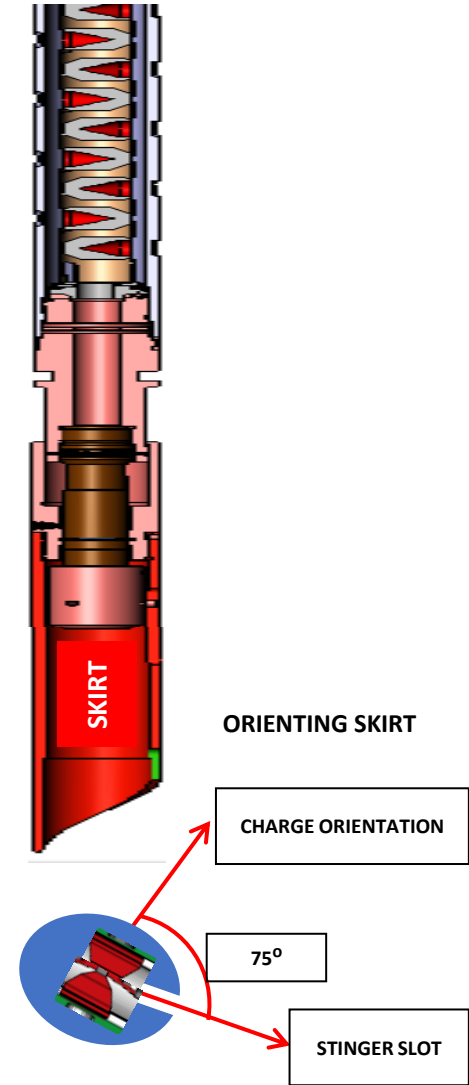
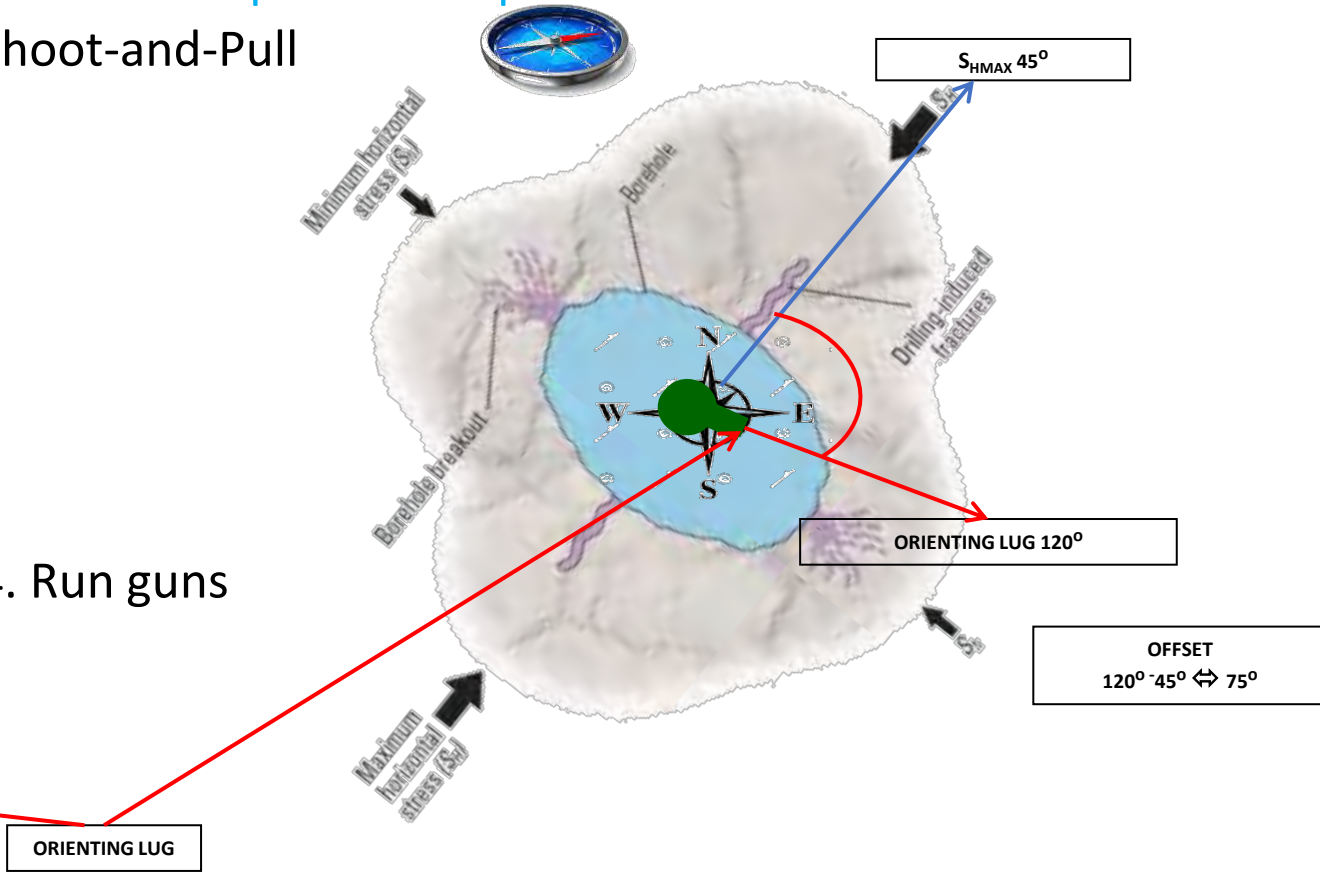
ORIENTING LUG

Solution: Sequence of Operations

Shoot-and-Pull



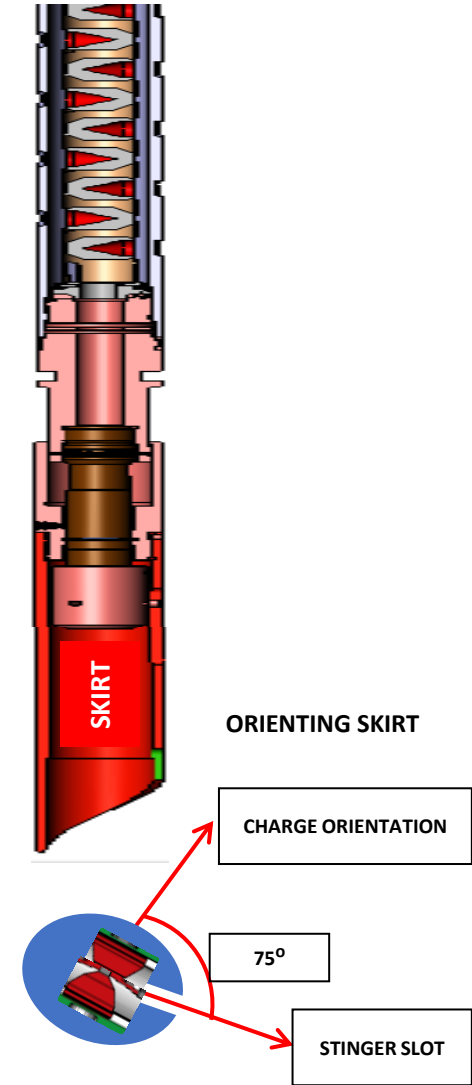
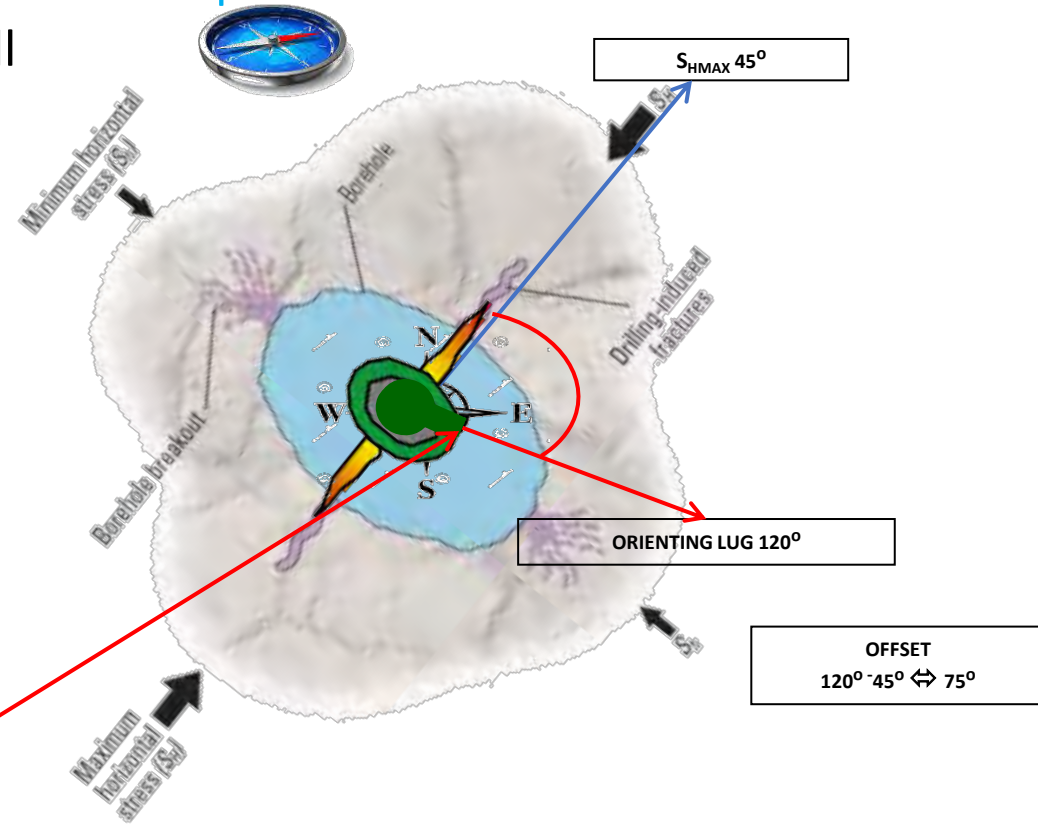
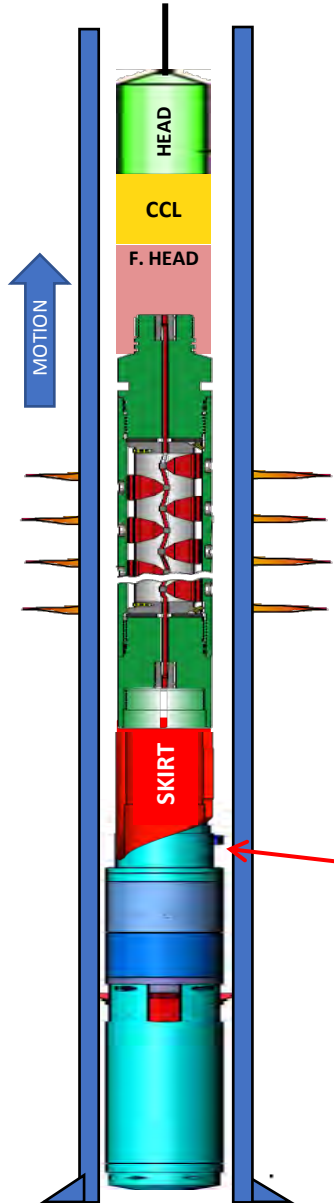
4. Run guns



Solution: Sequence of Operations

Shoot-and-Pull

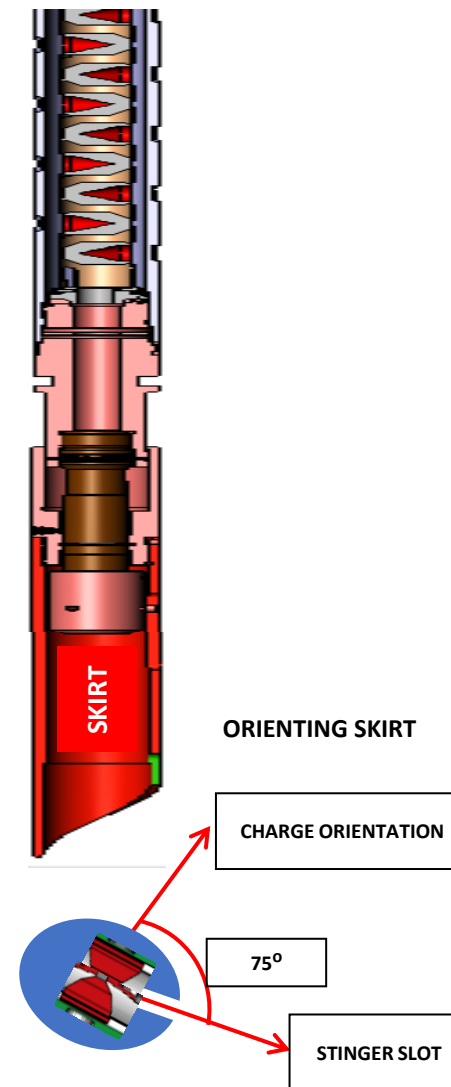
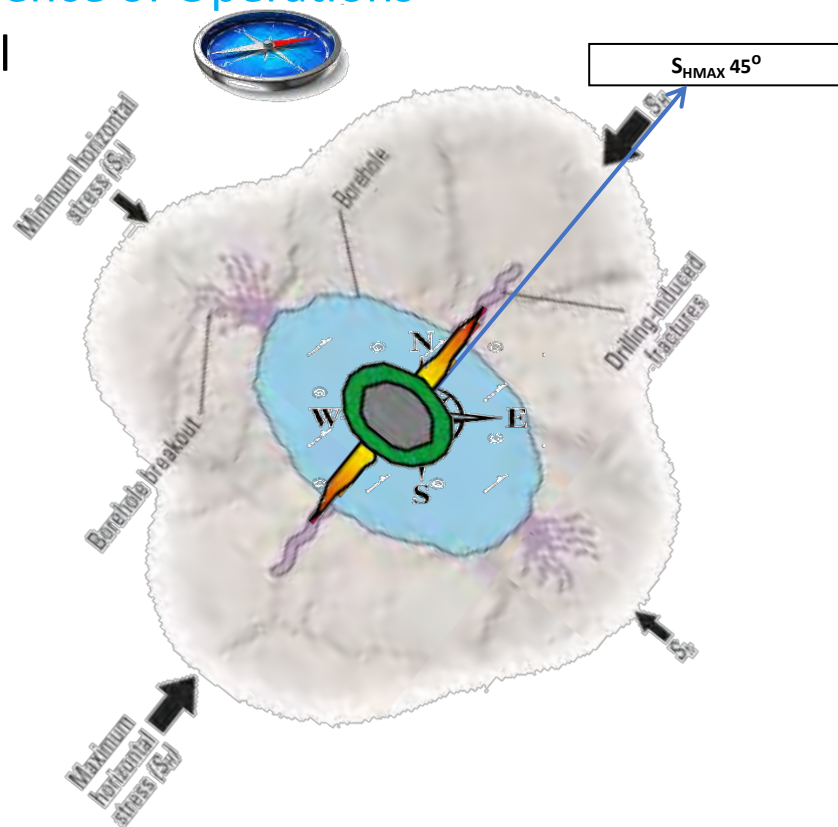
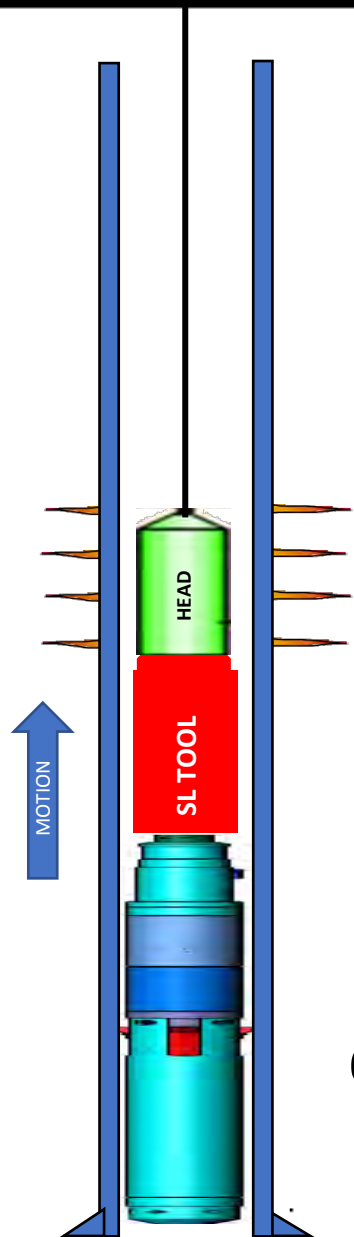
5. Shoot and retrieve guns



Solution: Sequence of Operations

Shoot-and-Pull

6. Retrieve hanger



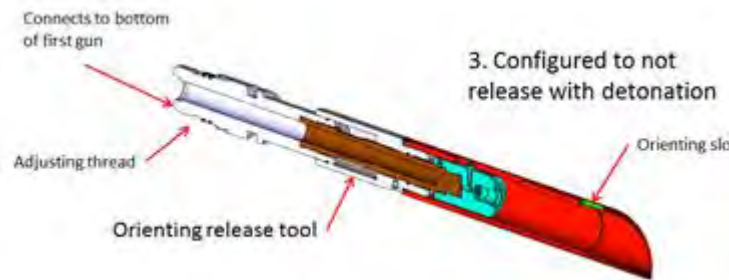
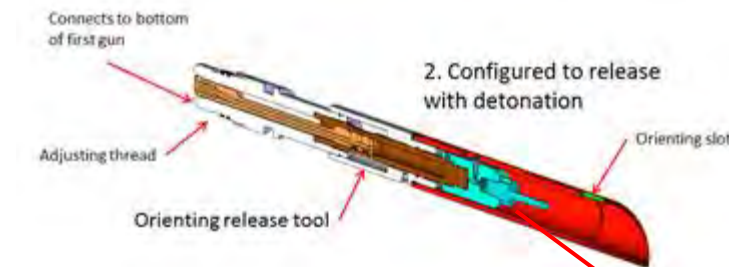
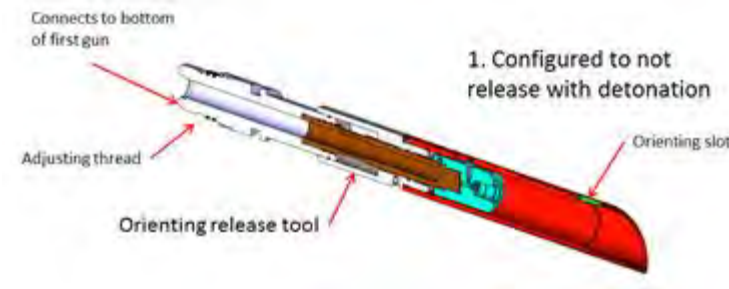
Solution: Flexibility of service

- Post-detonation options

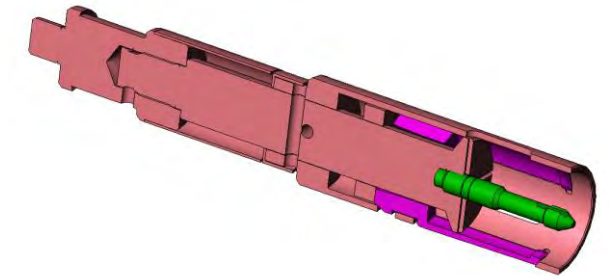
1. Shoot and pull

2. Shoot and drop

3. Pull guns, drop hanger



1. Mechanical retrieval tool

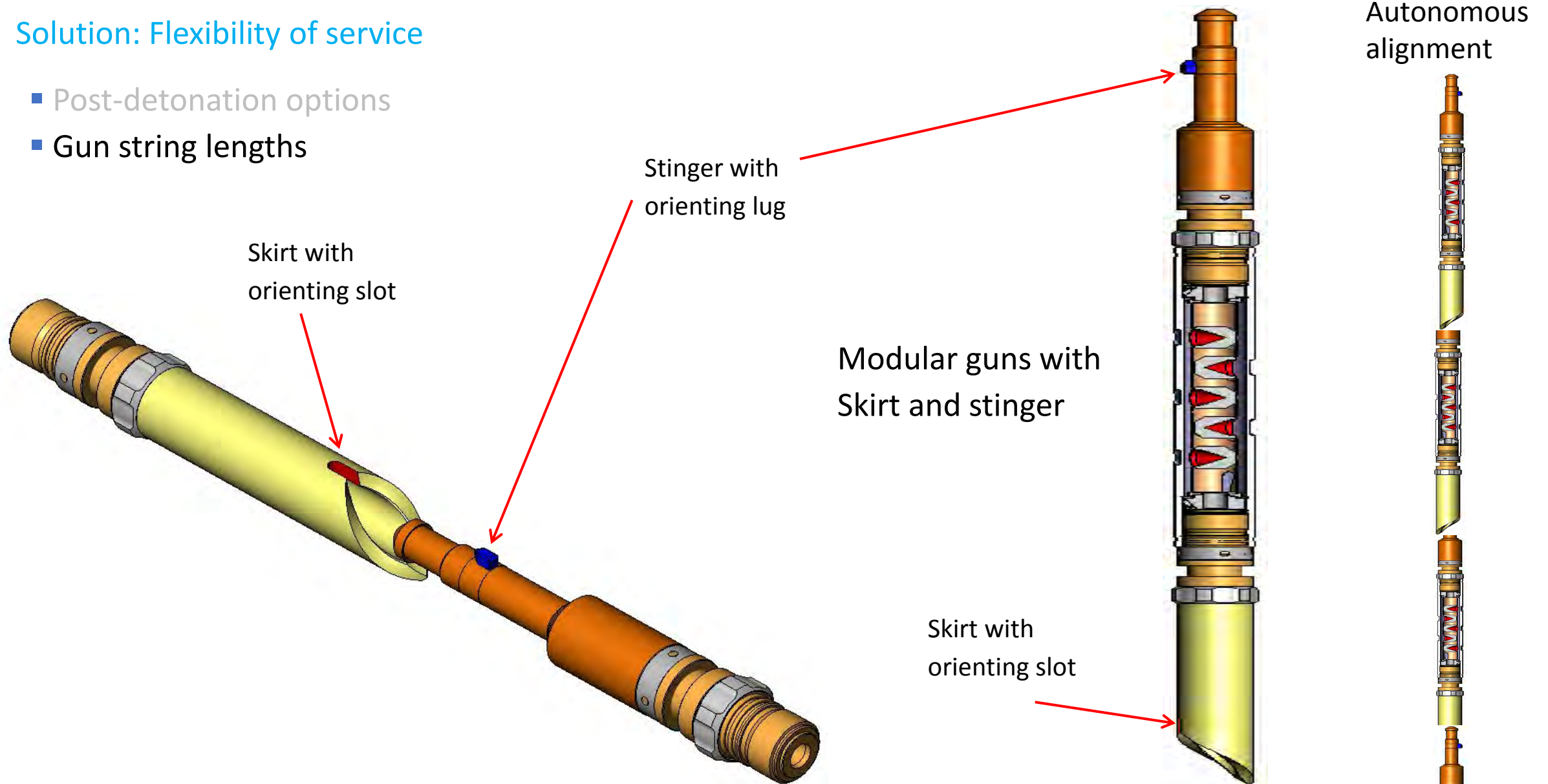


3. Mechanical release after gun retrieval



Solution: Flexibility of service

- Post-detonation options
- Gun string lengths



Solution: Flexibility of service

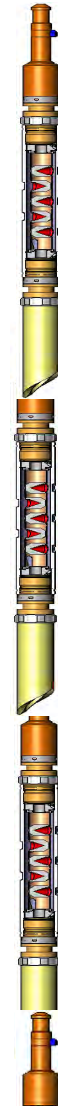
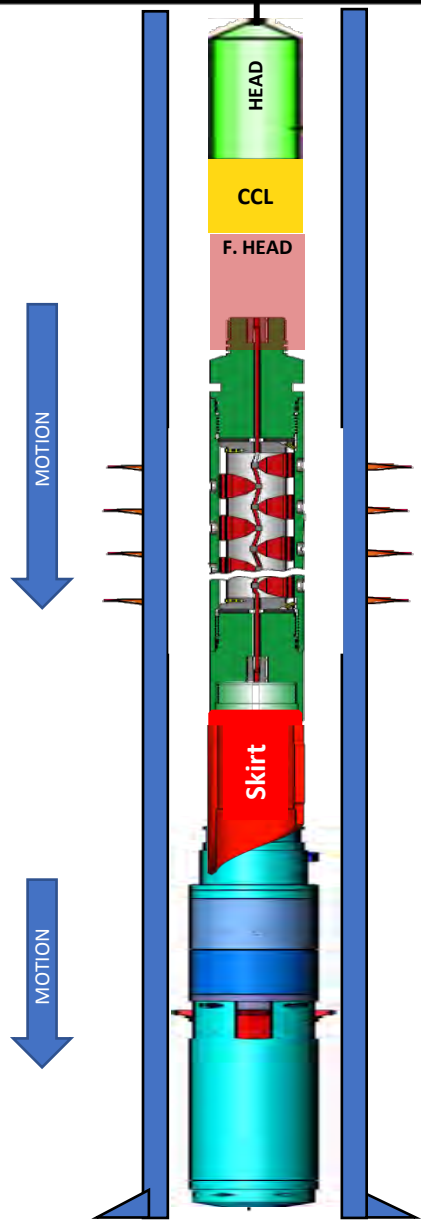
- Post-detonation options
- Gun string lengths
- Multiple formations:
 - Precise orientation
 - Works for any formation
 - Formation type only influences calculation after gyro
 - Adjusted in minutes, any direction.



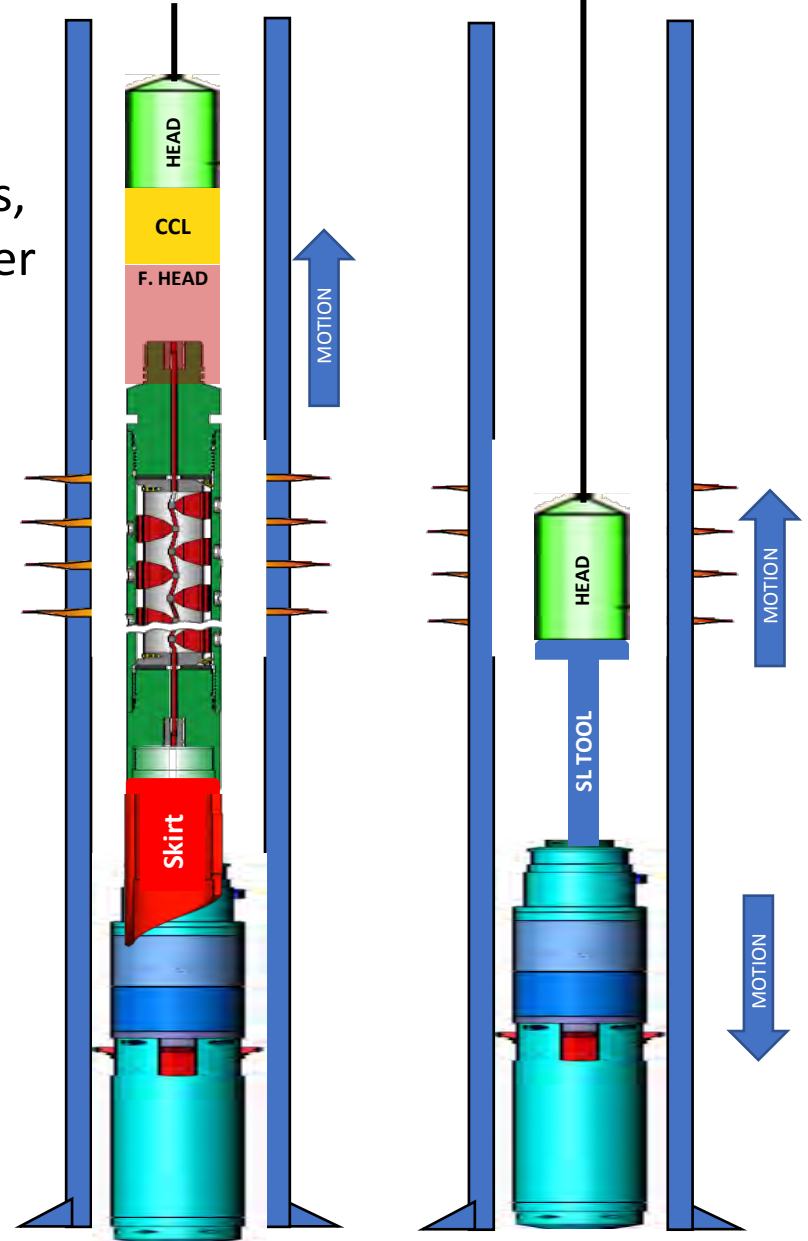
Aligning release tool
to first gun module

Solution: Flexibility of service

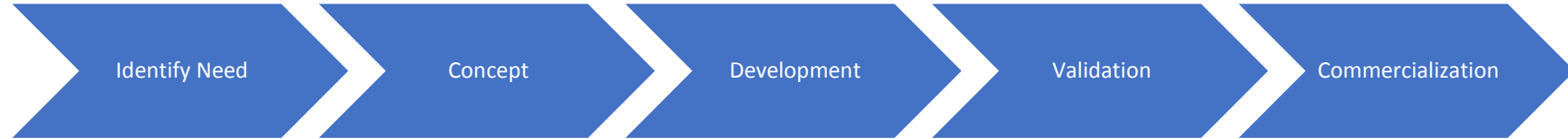
1. Shoot-and-Pull
2. Shoot-and-Drop
3. Pull guns, Drop hanger



3. Pull guns, Drop hanger

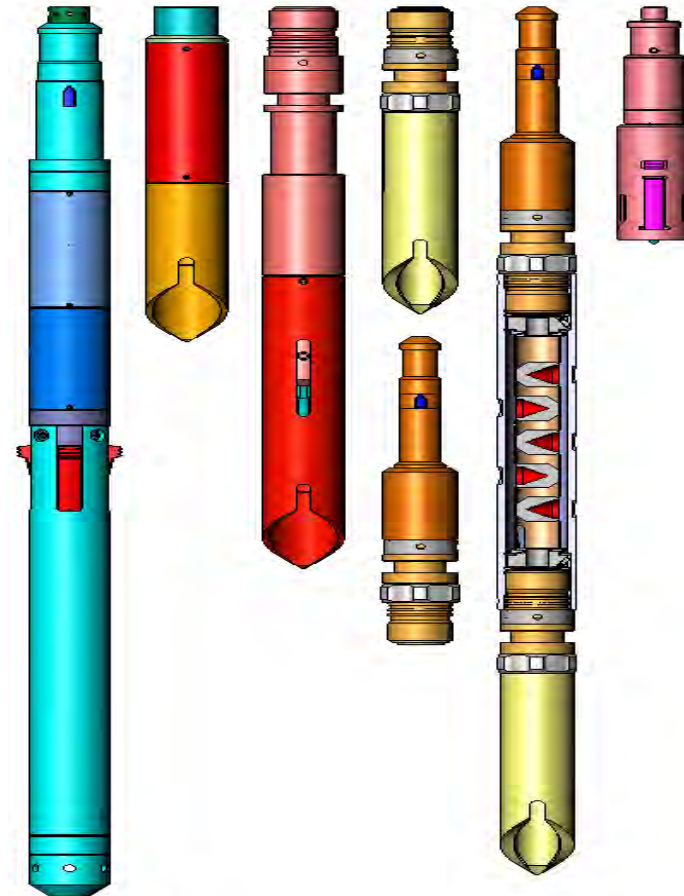


Results: Deliverables



- Gun Hanger with orienting lug
- Setting adapter kit
- Explosive release tool with orienting skirt
- Orienting skirt and stinger between gun modules
- Prongs for mechanical release
- Validation testing
- Training for operations

- Overall product realization in 24 weeks



Results: Customer feedback

Operational results and customer feedback

- 45 jobs over 23 months.
- From 1st well “The well was put on production flow back and did not produce any significant amount of sand at high flow rates.”
- “The production result is excellent, the technology helped them to achieve their main objective in which to improve frac result on *[one]* formation and reduce sand production of *[another unconsolidated]* formation.”



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QUESTIONS? THANK YOU

The authors thank Halliburton for permission to present this information.

Thanks to Kharisma Abdillah for providing customer feedback.

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