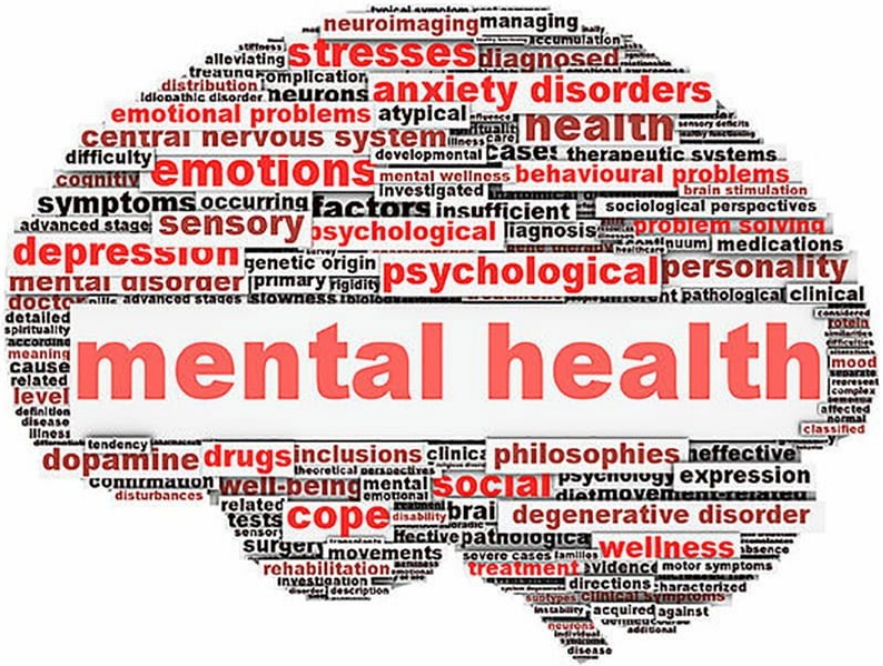
REVITALISING MATURE SHUT-IN NORTH SEA WELLS

SPE Stavanger Section - 9th February 2022

Colin Jordan

Global Applications Champion - Completions

SAFETY MOMENT – POST COVID RETURN TO WORK



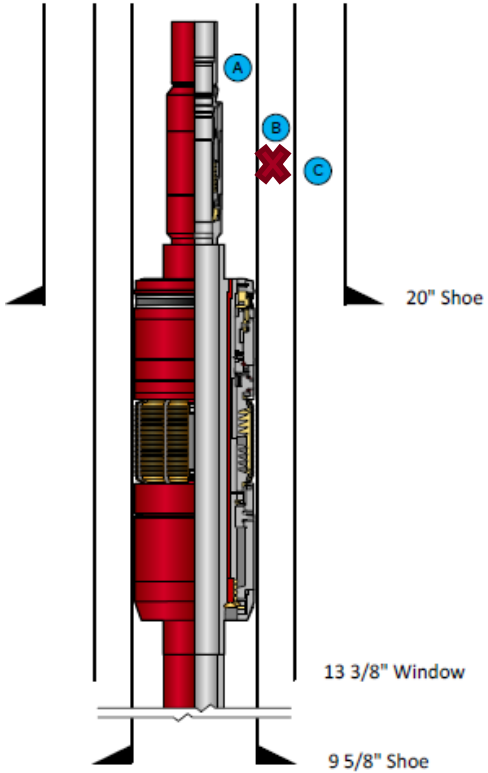
Ask your colleagues how they are feeling.

Then ask them again.....

AGENDA

- Challenge Accepted – How to do More With Less
- Tangible Solutions and the Technical Drivers
- AGLS Solution Case Study
- Solutions For The Future…..

WELL INTEGRITY IN MATURE WELLS – THE CHALLENGE



- Well integrity presents one of the biggest industry challenges today and amounts for over 60% of the wells shut in today.
- In the case of this North Sea Operator, the particular field of interest requires gas lift which adds its own regulatory challenges when utilizing mature wells. ASV requirements etc.
- In this case, the 13 3/8" casing could no longer be used as a secondary barrier due to shallow window.
- Field production extension primary goal – economically of course

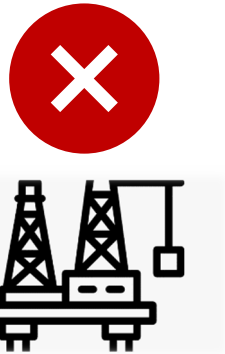
TO DRILL... OR NOT TO DRILL

Keeps drilling contractors happy!

Option to increase reservoir contact

Solve any emerging sand control issues

Fullbore Reservoir Access

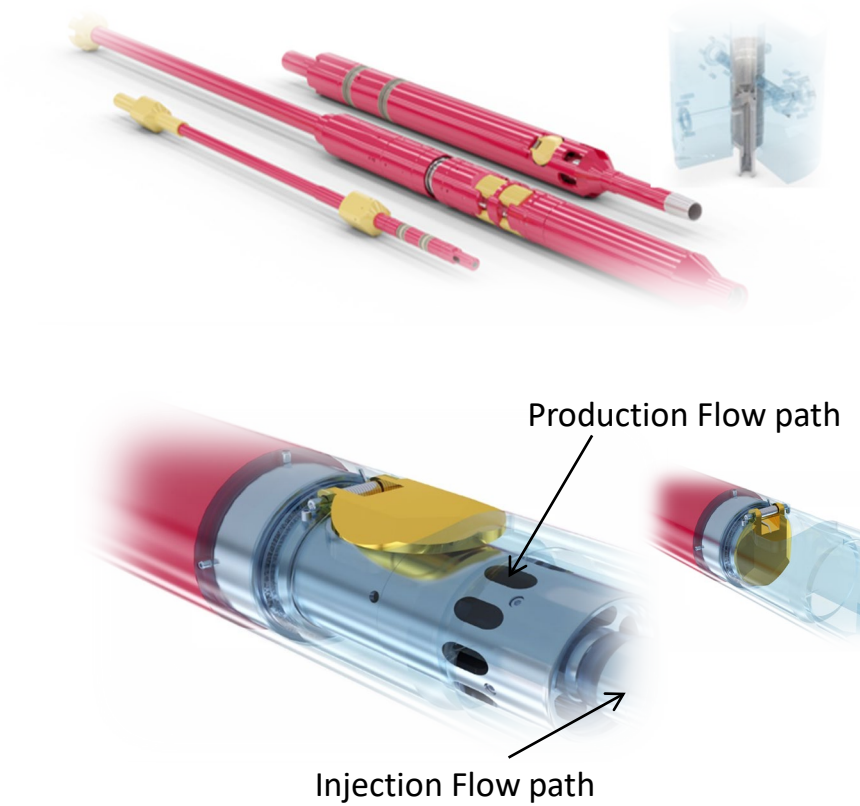


Cost

Carbon Footprint

TECHNOLOGY AVAILABILITY – INVERSE GAS LIFT SYSTEM

- The IGLS insert string consists of the following components (bottom to top):
  - Gas injection valve and coiled tubing to a Dual Flow Safety Valve.
  - A Dual Flow Safety Valve installed in the existing safety valve profile with a Dual Flow Hanger Lock (or Suspension Hanger).
  - A conduit from the DFH Lock to a Concentric Hanger.
  - A wellhead spool piece at surface



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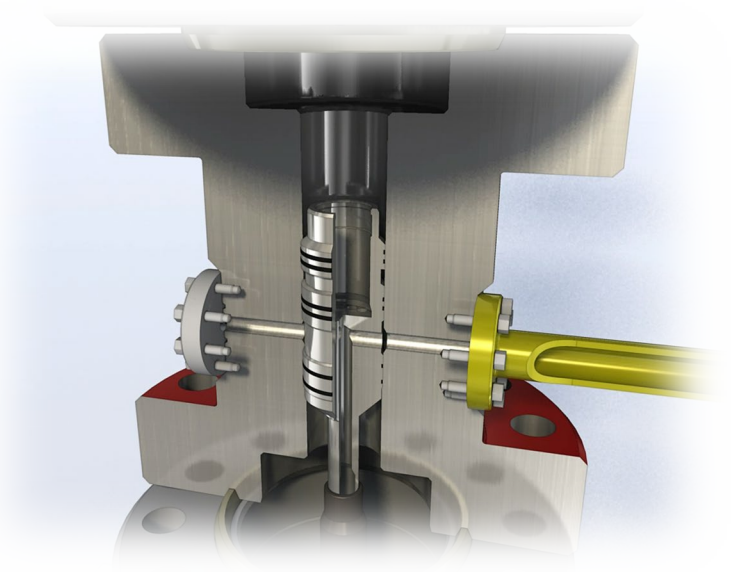


WHAT MORE CAN WE DO..... WITH LESS?

IGLS good option but not intervention friendly

How can the current B annulus be made into the C annulus?

What casing can be run inside the existing 9 5/8”?

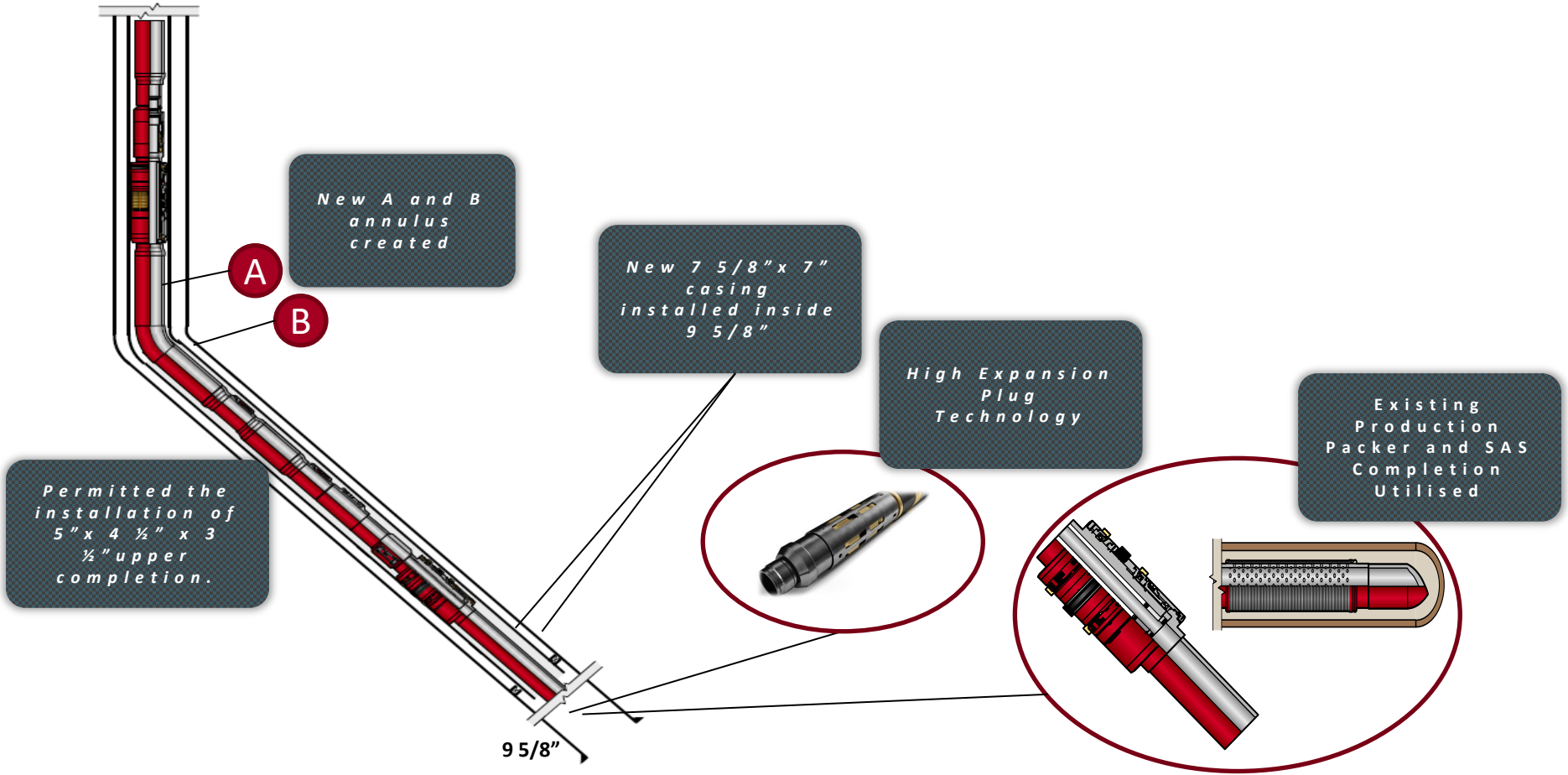
What needs to be done on the wellhead to achieve the goal?

What slimhole technology exists to realise a gas lift recompletion?

AGLS

Alternative Gas Lift System

ALTERNATIVE GAS LIFT COMPLETION DESIGN – SLIMHOLE CONCEPT



CHALLENGES TO REALISE THE SOLUTION

Wellhead modification for 7 5/8" gas lift completion

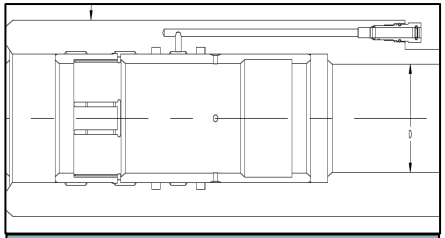
7 5/8" Annular safety valve – compliant to operator requirements

3 ½" Gas lift/chemical injection mandrels with 1 ½"valve capability.

Utilising existing packer sizes to suit well architecture

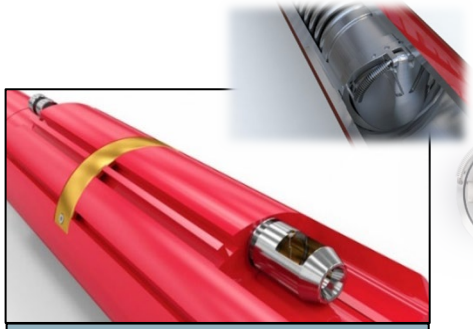
- ❑ Much reduced tubing size – 5" x 3 ½"
- ❑ Smaller bore = increased friction..... More water?
- ❑ Would the wells produce to the levels required?

ANNULAR SAFETY VALVE – WHAT WAS AVAILABLE?

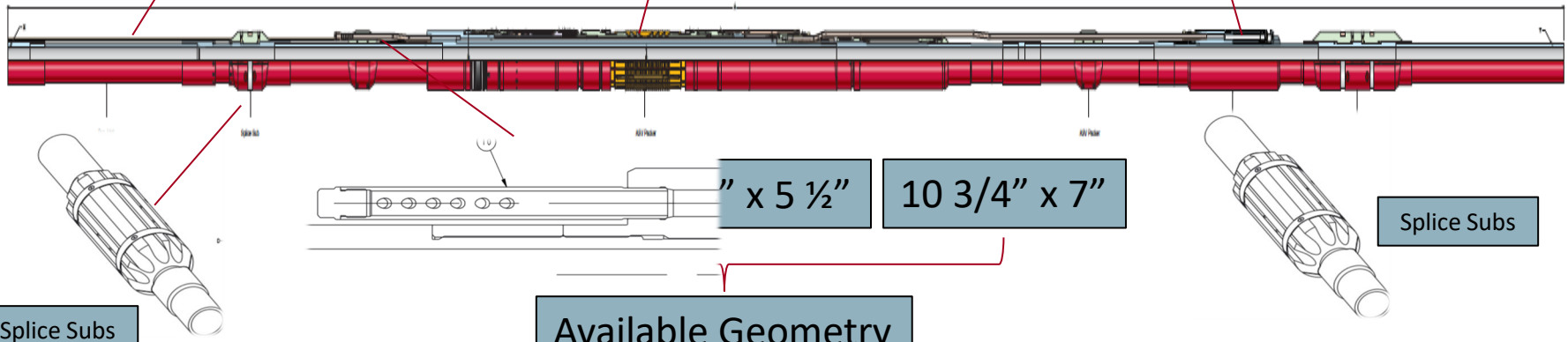


Packer Setting Sub

ISO 14310 V0 Qualified Packer



API 14A Qualified Flapper Valve



” x 5 ½”

10 3/4” x 7”

Splice Subs

Splice Subs

Available Geometry

7 5/8” ASV DESIGN AND OPTIMIZATION

Design Considerations
○ Maximise through bore in relation to host casing ○ Offer a choice of setting methods ○ Maintain reliability of existing designs ○ Maximise feed through lines ○ Safety valve above or below   ○ Pressure drop considerations ○ Retrievability

7 5/8” ASV DESIGN AND OPTIMIZATION

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- **Maximise through bore in relation to host casing**
- Offer a choice of setting methods
- Maintain reliability of existing designs
- Maximise feed through lines
- Safety valve above or below
  - Pressure drop considerations
- Retrievability

Multiple Options Considered

- **7 5/8” x 4 ½”**
- **7 5/8” x 4”**
- **7 5/8” 29.7# x 3 ½ 9.2#” (Preferred design)**

Design Considerations

- Maximise through bore in relation to host casing
- **Offer a choice of setting methods**
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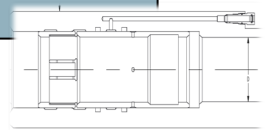
Two Options Considered

- **Direct hydraulic set from surface**
- **Mechanical setting sub**

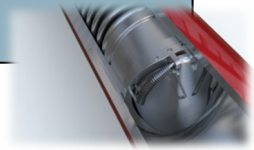


7 5/8” X 3 ½” ASV DESIGN AND OPTIMIZATION

Design Considerations

- Maximise through bore in relation to host casing
- Offer a choice of setting methods
- **Maintain reliability of existing designs**
- Maximise feed through lines
- Safety valve above or below
  - Pressure drop considerations
- Retrievability

Utilise current platform and keep existing safety valve design.



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- **Maximise feed through lines**
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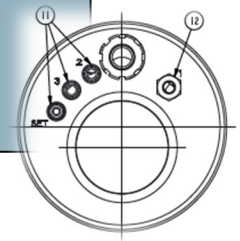
Optimised Line Configuration

- **2 x ¼” Feedthroughs (TEC)**
- **1 x ¼” Packer setting line**
- **1 x 3/8” Chemical injection**
- **1 x Gas injection line**



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- Maintain reliability of existing designs
- Maximise feed through lines
- **Safety valve above or below**
  - **Pressure drop considerations**
- Retrievability

Options to put safety valve above or below the ASV packer.

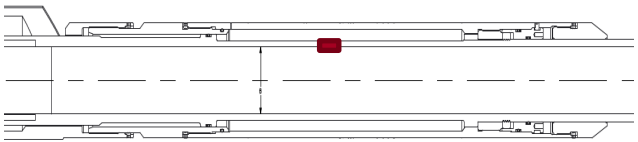
- **Above yielded ~50% pressure drop through system**

Design Considerations

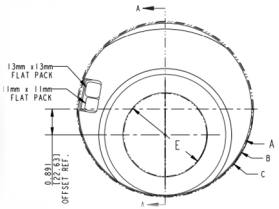
- Maximise through bore in relation to host casing
- Offer a choice of setting methods
- Maintain reliability of existing designs
- Maximise feed through lines
- Safety valve above or below
  - Pressure drop considerations
- **Retrievability**

Punch to release mandrel

- **3rd party collaboration for wireline deployed punch tool. Collet sub above.**



WELL PERFORMANCE – GAS LIFT AND CHEMICAL INJECTION

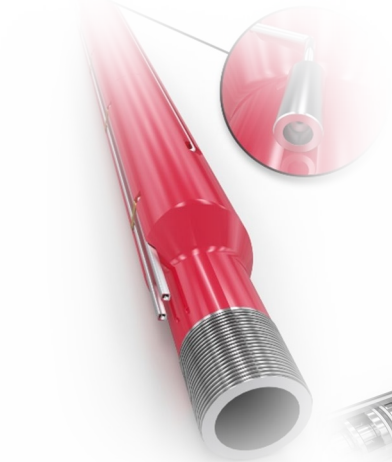


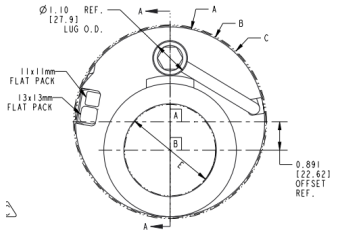
3 ½” Mandrel with 1 ½” Barrier qualified valve

High yield mandrel development

5.961” Max OD

Barrier qualified check valves





5.961” Max OD

3 ½” Side pocket chemical injection mandrel with 1 ½” chemical injection valve with Anti U-tube

MEASURING SUCCESS

- 5 wells completed utilizing this alternative well architecture
- Production rates higher than originally anticipated, helped by the ability to deploy gas lift as deep as possible
- P&A friendly well design
- Well integrity re-established by creating a “new” annulus

Cost

60-75% Reduction

Payback 5 months

Reduction in injection Gas Requirement

Carbon Footprint Overall

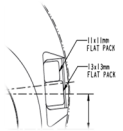
ALTERNATIVE SOLUTIONS FOR ALL SITUATIONS

9 5/8" and 13 3/8" Integrity Intact – AGLS Hybrid

- Deep sidetrack now becomes a more economic prospect
  - No need to sidetrack shallow out 13 3/8" or 9 5/8"
- A and B annulus remain intact
- Ability to utilize standard inventory 9 5/8" x 5 ½" Annular Safety Valves being utilized elsewhere
- No extended C-Section required
- 7 5/8" x 7" utilized to top of reservoir
- 3 ½" GLM's + 1 ½" GLV's still used however deeper than previously achievable

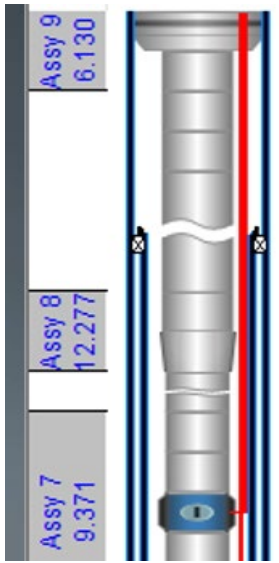
Ongoing Developments – Slimmer Line 3 ½" GLM/CIM

- Currently awaiting to install 3 ½" GLM and CIM with 1 ½" valves to be installed inside 7" 29# casing
  - 5.730" Max Running OD, 6,500psi
  - 6 wells 2022
- Gas lift and flow assurance as DEEP as possible



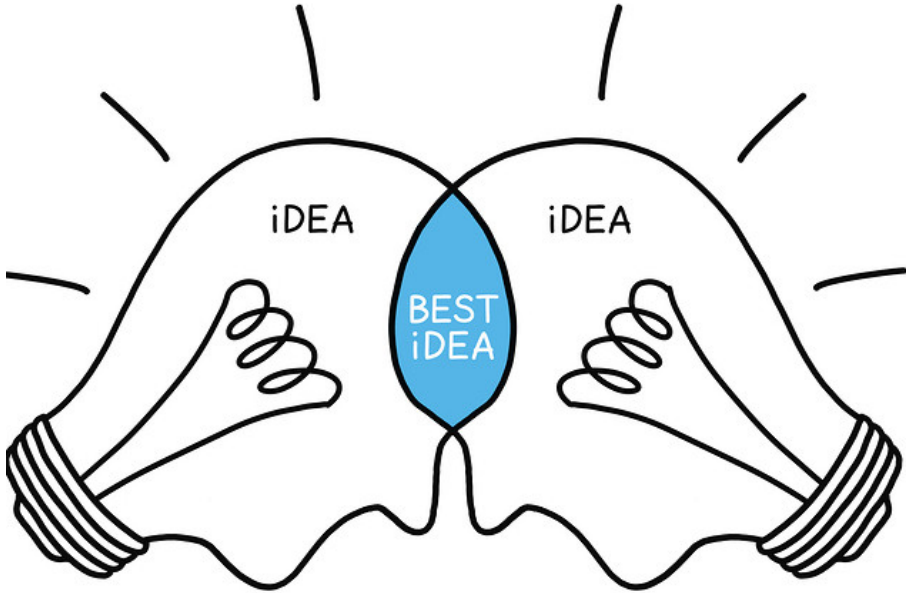
7 5/8" Liner Hanger as Casing Hanger

- No need to utilse extended C-Section and makes it possible to install AGLS with standard hanger
- Deep sidetrack possible, 7" liner
- Annular pressure system being developed to avoid requirement to punch 9 5/8" casing to bleed off pressure
- RIH 7 5/8" x 7" tie back seal stem with anchor
- Drill 6" Hole and run screens
- Install AGLS completion



And the options keep growing……

ITS NOT ONE SIZE FITS ALL - COLLABORATION

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