Weatherford

“Inverse Gas Lift System Installation in the UK North Sea”

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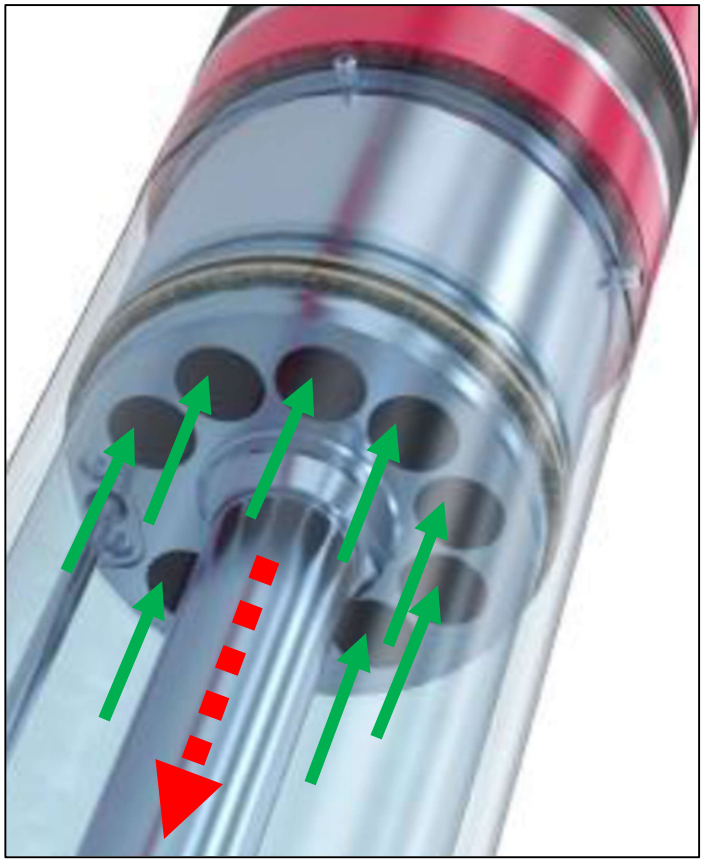
Presentation Outline

- Introduction
- Setting The Scene
- Solution – Inverse Gas Lift (IGLS)
- IGLS System Overview
- IGLS System Components
- IGLS System Variants
- Installation Procedure
- Lessons Learned
- Conclusion
- Questions



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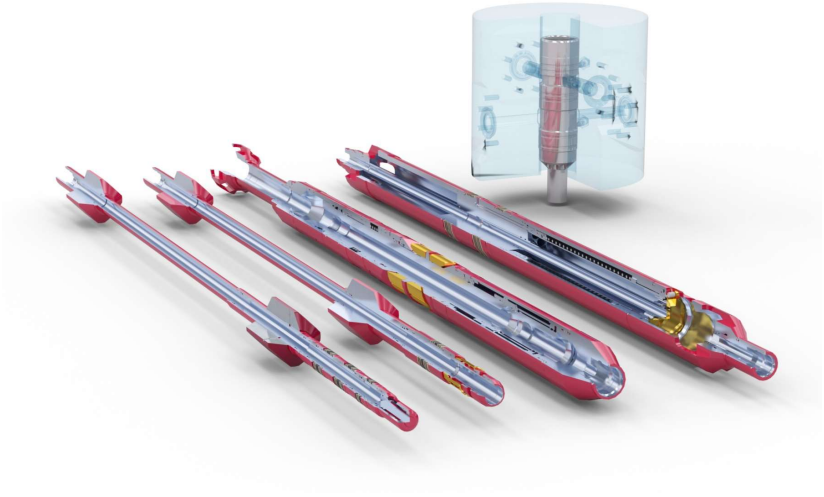
Setting The Scene

In General

- Numerous wells are now reaching the stage they require gas lift.
- Many of these wells were not designed to allow conventional gas lift.
- Annulus integrity may be compromised preventing gas injection.
- Gas Lift may be required below the production packer

This Particular Installation

- Major UK Operator in the North Sea
- 5-1/2” Completion
- 4.562” Existing Safety Valve
- Liquid Loading Issues – Cyclic Flow
- A to B annulus integrity questionable
- Required Injection depth close to the reservoir



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Solution - Inverse Gas Lift - IGLS

What is IGLS ?

- IGLS allows a method of gas injection via an insert string.
- Gas injected through insert string – Coiled Tubing or Macaroni pipe.
- Production via annulus between insert string and existing production tubing.
- Installed Rigless in a live well using traditional intervention techniques.
- Utilises existing tree with new intermediate spool or Retrofit tree valve.
- Maintains fully functional master valves and SCSSSV.
- Fully retrievable for later in life abandonment
- NORSOK Compliant

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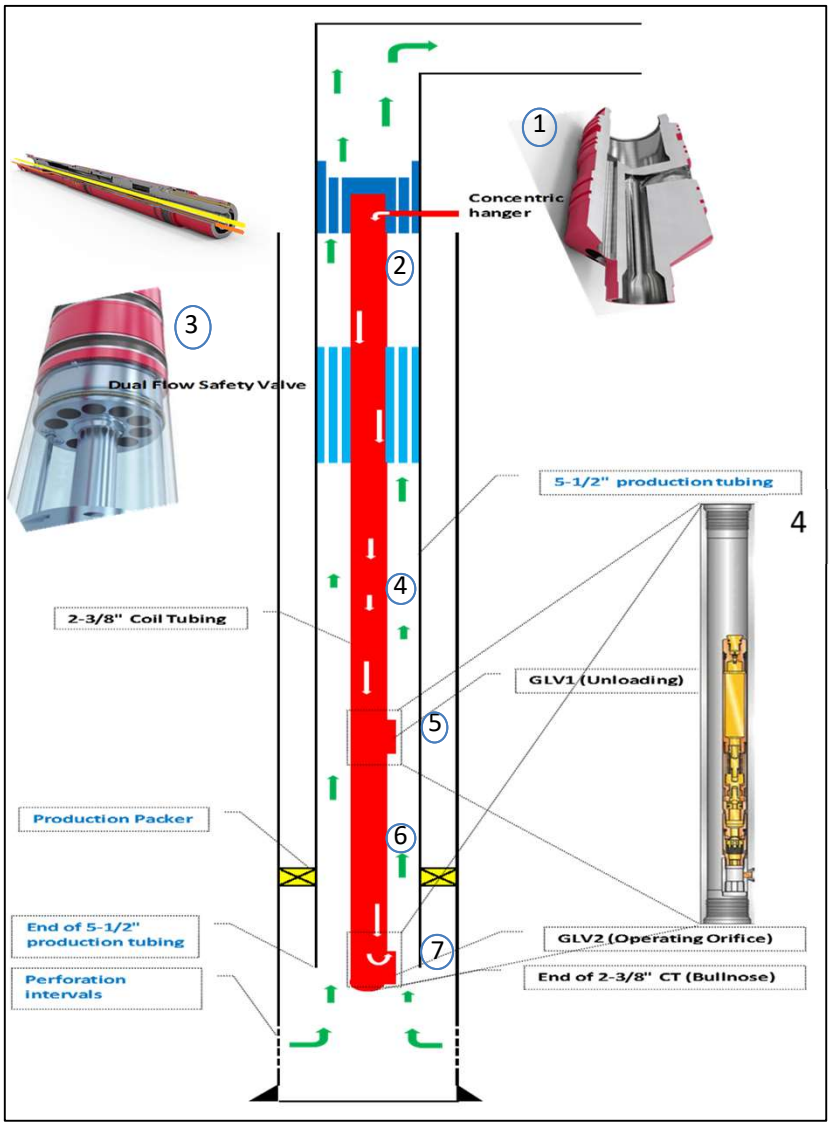
Renaissance – IGLS Overview



1. Intermediate Spool / Retrofit Valve c/w Concentric Hanger.
2. Intermediate IGLS Completion (Coiled Tubing or Jointed tubing)
3. Dual Flow Lock and Dual Flow Safety Valve
4. Coiled Tubing / Jointed Tubing Tail
5. Unloading Gas Lift Mandrel
6. Coiled Tubing / Jointed Tubing Tail
7. Gas Injection Valve

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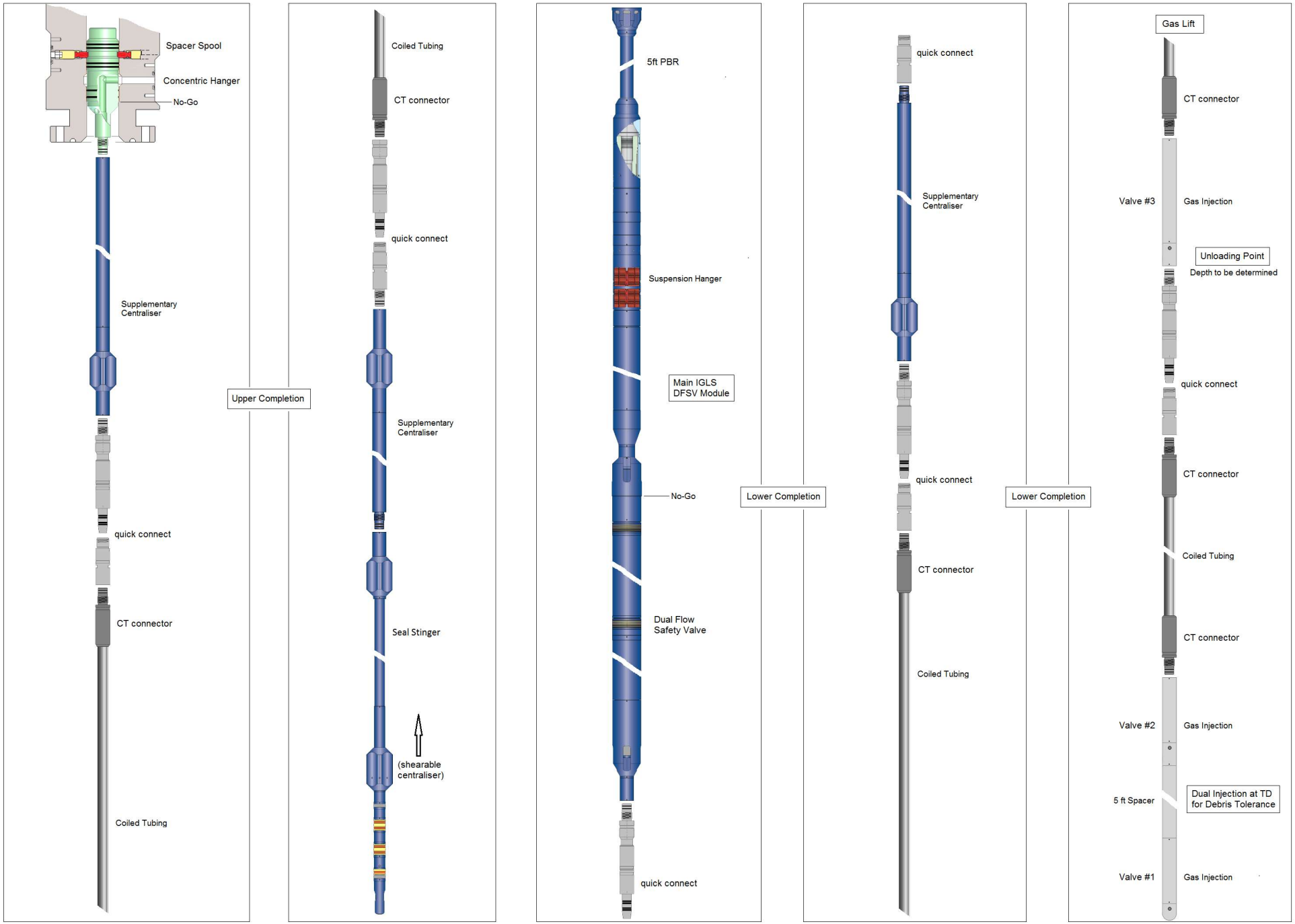
Spacer Spool
Concentric Hanger
No-Go
Supplementary Centraliser
quick connect
CT connector
Coiled Tubing
Upper Completion
Coiled Tubing
CT connector
quick connect
Supplementary Centraliser
Seal Stinger
(shearable centraliser)
5ft PBR
Suspension Hanger
Main IGLS DFSV Module
No-Go
Dual Flow Safety Valve
quick connect
Lower Completion
quick connect
Supplementary Centraliser
quick connect
CT connector
Coiled Tubing
Lower Completion
Gas Lift
CT connector
Valve #3
Gas Injection
Unloading Point
Depth to be determined
quick connect
CT connector
Coiled Tubing
CT connector
Valve #2
Gas Injection
5 ft Spacer
Dual Injection at TD for Debris Tolerance
Valve #1
Gas Injection

5-1/2” x 4.562” IGLS Flow Areas

No	IGLS Component	Approx. length, ft	Equivalent Flow Diameter, in	Remarks
1	DFSV flow-by	1.5	1.846	13 x 0.512” diameter holes, flow area = 2.677 sq.-in
2	DFSV hanger centraliser	1.0	2.042	Flow area = 3.274 sq.-in
3	DFSV hanger top	0.3	1.996	Flow area = 3.130 sq.-in
4	Concentric hanger	1.7	2.064	9 x 0.688” diameter holes, flow area = 3.346 sq.-in

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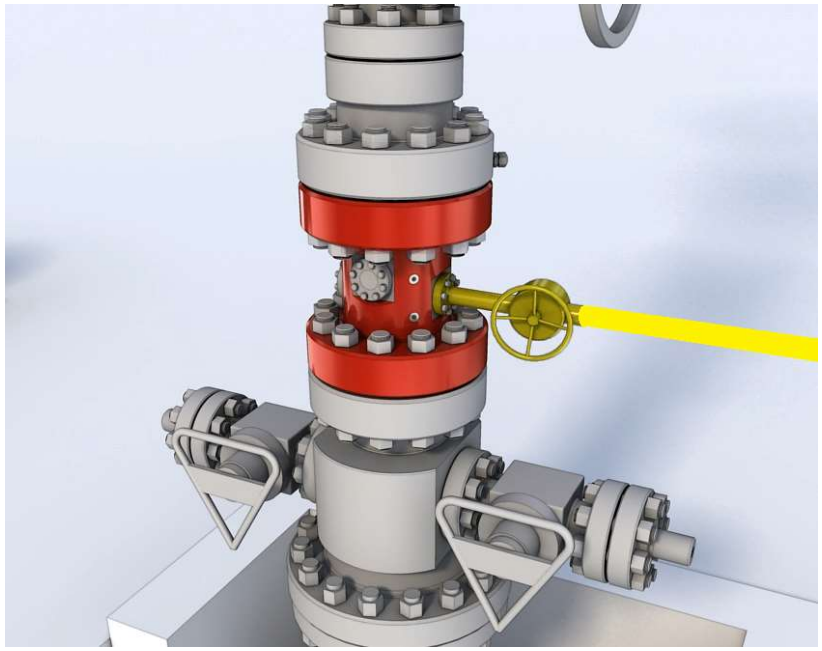
IGLS Components - Intermediate Spool

- The one alteration required to the existing well for IGLS installation is at the wellhead, where an intermediate spool is inserted below the production tree.
- Internally, the spool has a profile to accept a concentric hanger, which separates the injection and production flow paths.



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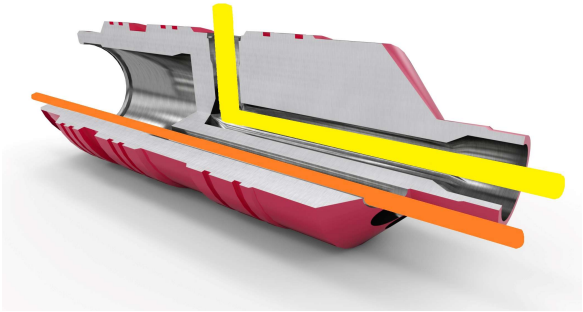
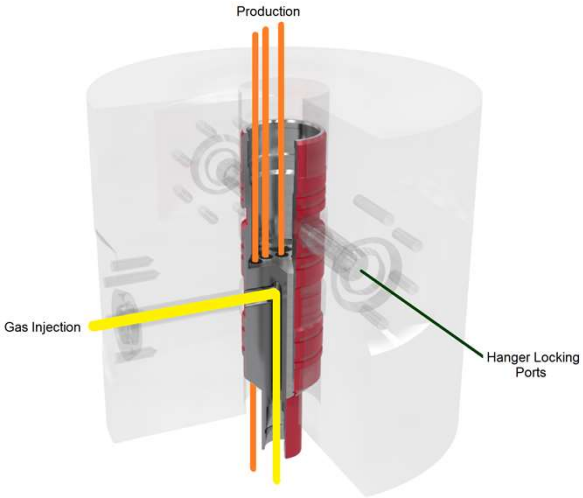
IGLS Components – Spool & Concentric Hanger

- Intermediate Spool / Tree Valve Modification
  - Supplied by Weatherford or Xmas tree OEM.
  - No modification to existing Xmas tree required.
  - Application specific ID and length.





- Concentric Hanger
  - No-go within intermediate spool.
  - Lock-down or self locking.
  - Gas injection and production paths.
  - Run with standard industry tools.

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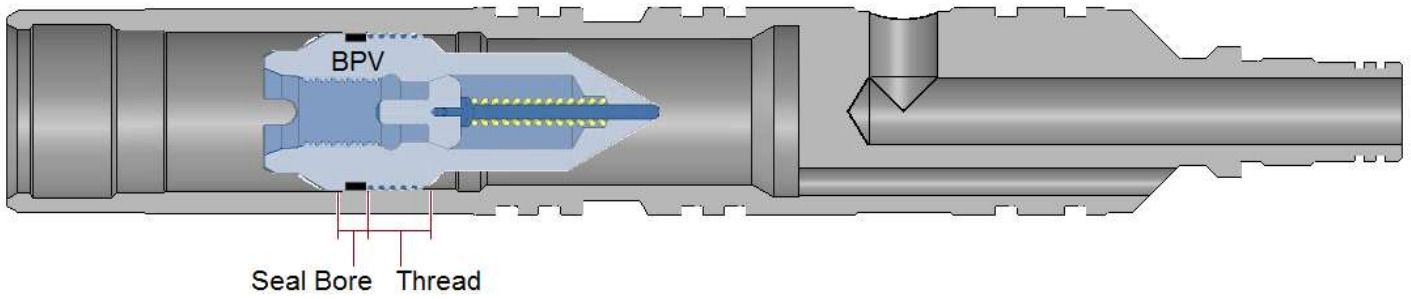
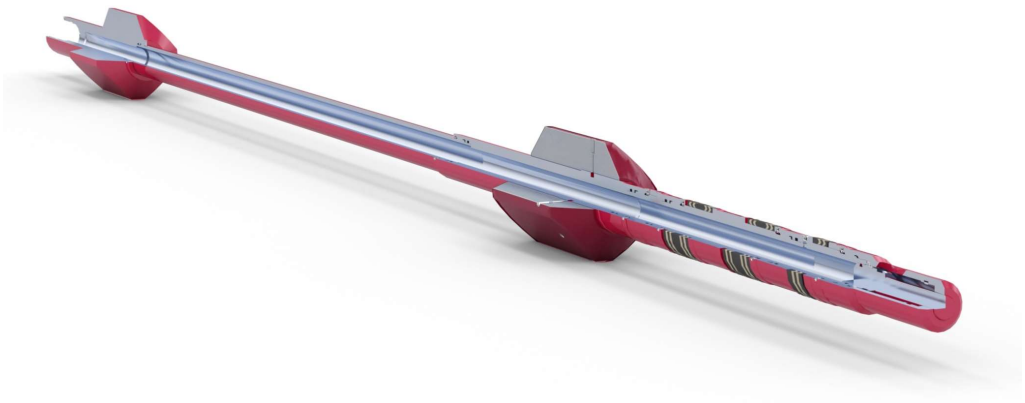
IGLS Components - Concentric Hanger Plug

- Concentric hanger plugs
  - BPV's
  - Barrier plugs
  - Flow through plugs



IGLS Components – Seal Stinger

- Seal Stinger
  - Seals injection path between lower, intermediate and upper IGLS.
  - Stings into PBR on Suspension Hanger
  - Shear-able centraliser provides positive indication of space out.
  - Seal stinger c/w pump out plug, located into the safety valve lock PBR, connecting upper and lower sections.



IGLS Components – Hangers

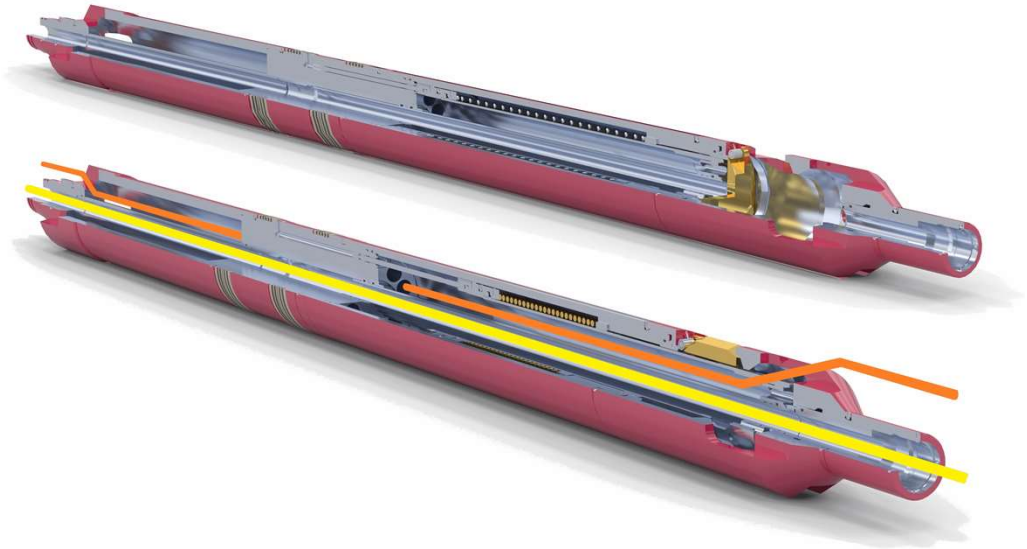
- Suspension Hanger
  - Carries full gas injection string weight, takes load off no-go by setting slips in the tubing ID above the existing Safety Valve
  - Gas injection through centre bore
  - Production via annular spaces and past slips.
  - Polished Bore Receptacle to sting into with upper IGLS.
- Dual Flow Hanger
  - Incorporates points above.
  - Carries full gas injection string weight, takes load off no-go by setting in the existing Safety Valve Nipple Profile – “retractable no-go” to remove string weight from no-go shoulder into lock profile.
  - Production via annular area throughout the hanger.

Suspension Hanger

Dual Flow Hanger

IGLS Components – Dual Flow Safety Valve

- Insert valve that locates within existing safety valve seal bores.
- Controlled via existing SSV control line.
- Dual flow path, gas through centre & production through annular bore.
- Metal to metal seal on flapper & flow tube nose.
- Flapper closes off both injection & production paths.
- The DFSV is a rod piston activated safety valve with full API 14A 12TH Edition V4-1(Standard Service) & V4-2(debris & sand tolerant) ISO qualification. The key is the dual path, or concentric, flow tube that isolates the injection and production paths from each other.



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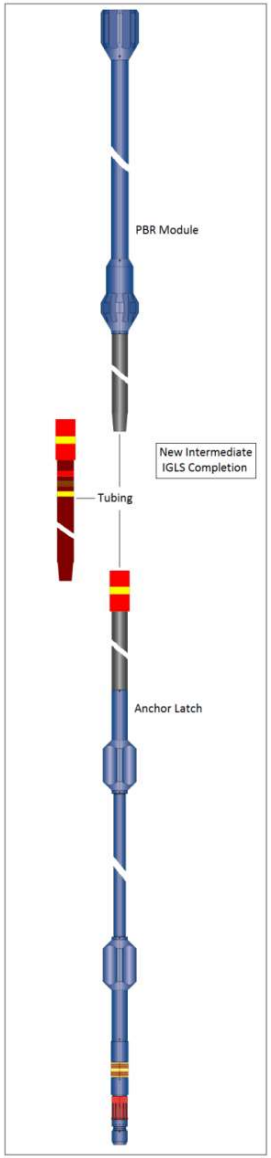
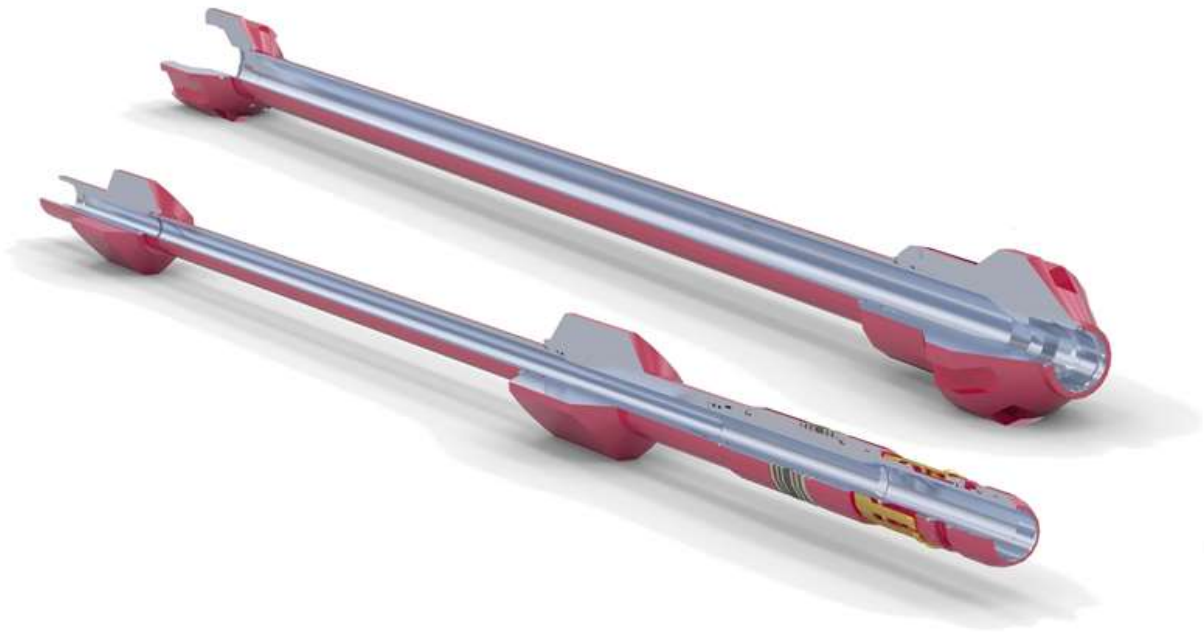
IGLS System Variants

- Upper section can be API Tubing or Coiled Tubing to surface.
- Split upper section, 2 stage or 3 stage module
- Addition of supplementary PBR and anchor latch style stinger.
- Allows concentric hanger / stinger to be run as wireline module.
- Hanger can easily be pulled, allowing the well to be fully plugged with minimal effort, thus allowing topside work with full well control.



System Variants – 3 Stage System



Additional PBR and Anchor Latch tools in 3 stage IGLS completion.

Installation – Procedure / Technique

- Rigless Intervention
- Execution March / April 2018
- Multiple conveyance methods utilized during the Installation
- 2 x Well Control Barriers in place during the installation.
  - Deep Set Packer with Pump Out Sub set in Liner
  - Fluid column (well is sub-hydrostatic)

- Coiled Tubing
  - Lower IGLS Assembly was deployed using 2-3/8” Coiled Tubing as the tail and landed off in the Dual Flow Lock by the CT Injector head.
- Jointed Tubing
  - Intermediate IGLS Assembly was deployed using 2-3/8” FJ joint Tubing using the CT tower winch with a work basket and a false rotary table.
- Slickline
  - Upper IGLS Assembly deployed using Slickline to land the Concentric Hanger Landed off in the Intermediate Tubing Hanger Spool.

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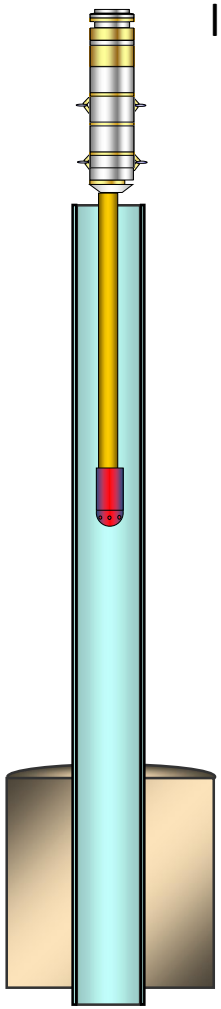
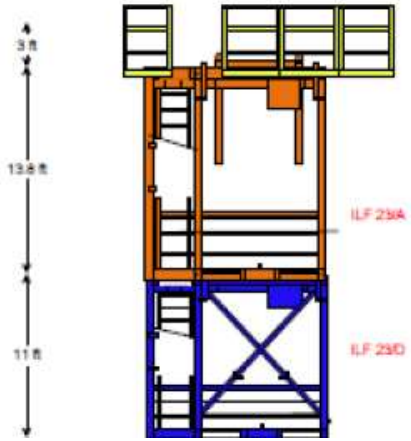
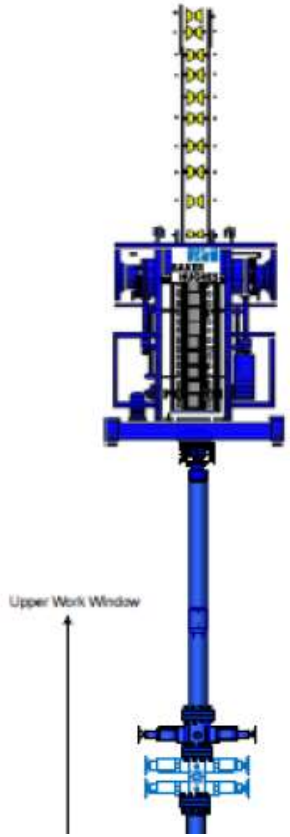
Installation – Procedure / Technique

- Multiple Conveyance Methods - Coiled Tubing - 1
  - Lower IGLS Assembly Deployed using 2-3/8” Coiled Tubing as the tail and landed off in the CT BOP’s once correct length had been run.







- Standard CTU Rig Up
- Injector on top of CT Tower
- BOP Stack below weather deck

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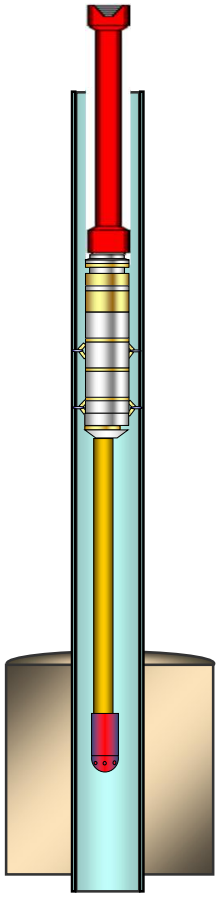
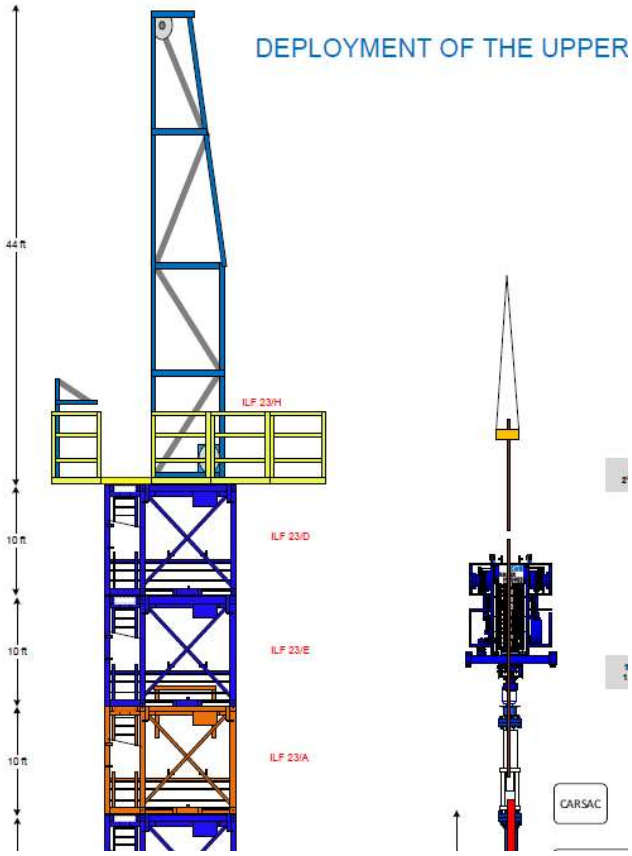
Installation – Procedure / Technique

- Multiple Conveyance Methods - Jointed Tubing - 2
  - Lower IGLS assembly was landed off in the Dual Flow Hanger using the Coiled Tubing Injector and 2-3/8” FJ jointed Tubing with a work basket above the Injector head.





- Standard CTU Rig Up
- CT Injector inside CT Tower
- CT Gooseneck removed
- BOP Below weather deck
- Tubing was made up above the injector head using false rotary table.
- CT injector head used to deploy and land off the DHSV

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Installation – Procedure / Technique

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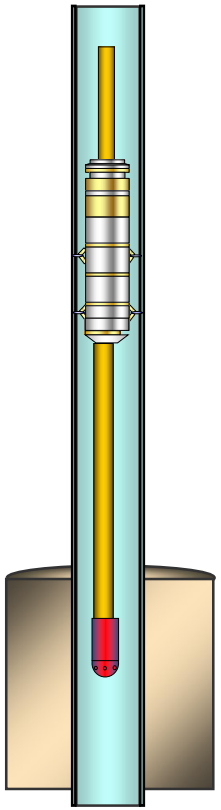

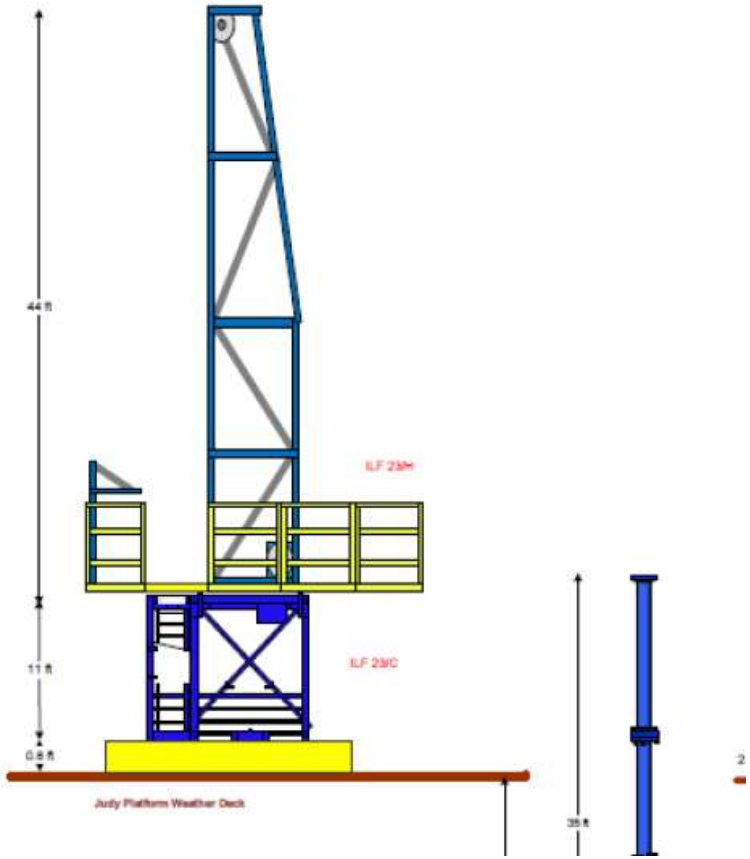

- CT Tower winch used to deploy and land off Intermediate IGLS section
- Jointed Pipe BOP Stack below weather deck
- Tubing was made using false rotary table.

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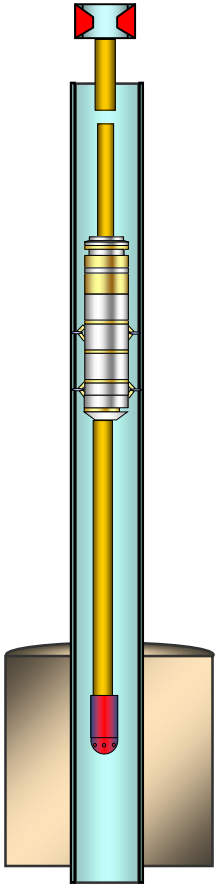
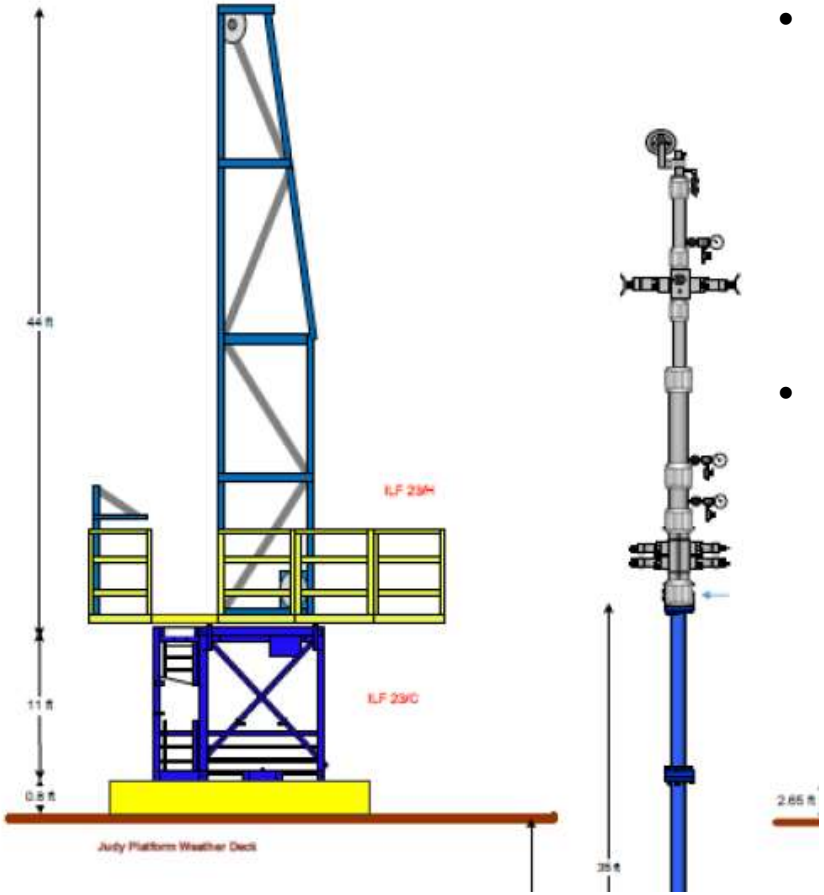
Installation – Procedure / Technique

- Multiple Conveyance Methods – Slickline - 3
  - Upper IGLS Assembly Deployed using Slickline to land the Concentric Hanger in the Intermediate Tubing Hanger Spool.





- Slickline was rigged up inside of the CT Tower and used to deploy he upper section of the IGLS
- Upper section was landed off in the pre installed Concentric Hanger.

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Lessons Learned

1.
S.I.T prior to going offshore. Land off, lock & pressure test Concentric Hanger in O.E.M spool piece.

2.
Stack up test: Pull test connectors on Coiled Tubing – prove concept and equipment.

3.
Workshop Integration checks between O.E.M and WFD Tools.

Conclusion

- UK Installation
  - The IGLS system was deployed in an efficient and professional manner with no technical or safety concerns raised during the installation or operation.
  - “Inverse Gas Lift System” Eliminated a workover while increasing production to a well which had no gas lift capability nor annular integrity
  - Production up time was increased from 3 months per year to 12 months per year.
  - If platform ESD “trips” well can be taken back online immediately with no “down time”.

- Norway : Case History
  - Uplift on production from flowing a few days in a month to continuous flow, additionally, production rate has been doubled
  - Well moved from being a P&A candidate to an “online” producer
  - The full IGLS system was deployed using Coiled Tubing making it a Rigless intervention operation thus saving cost.

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* Under development

OBJECTIVE is to ACHIEVE

INCREASED UPTIME
REDUCED COSTS
ENHANCED PRODUCTION
REDUCED FIELD PRESENCE

Thank You & Questions

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