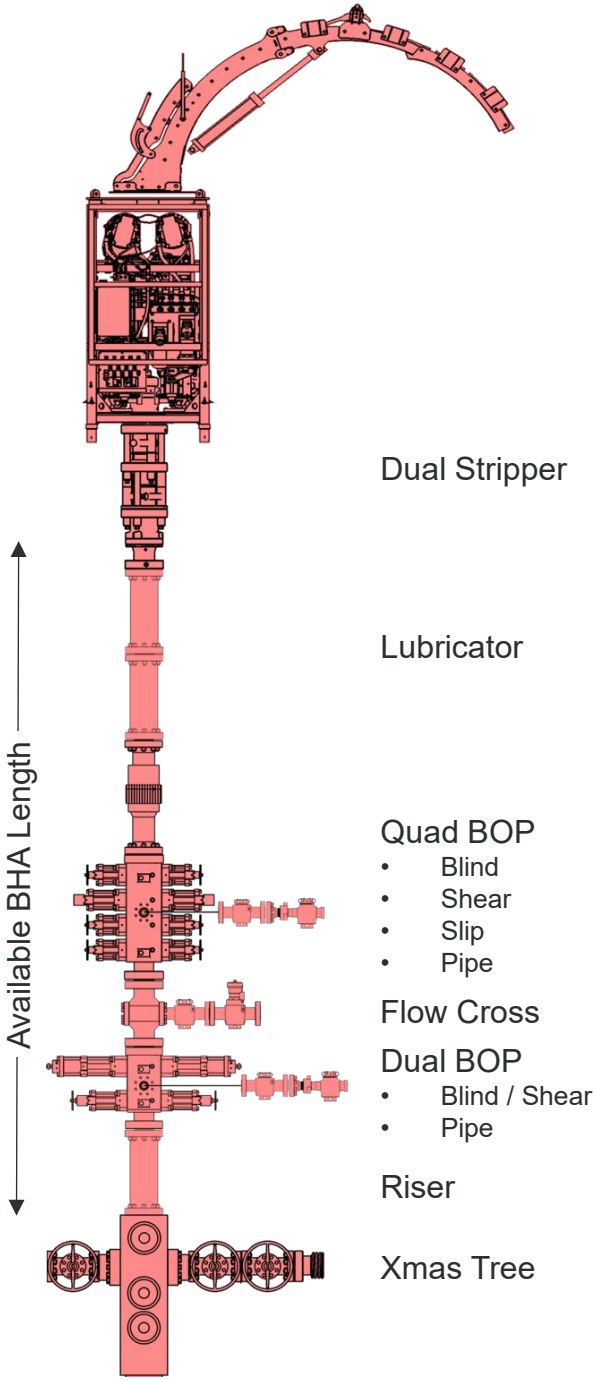
HALLIBURTON

Well Control during Complex Coiled Tubing Operations. Equipment Requirements and Methods

Richard Hampson

How to Handle….

- Long BHA's
  - Logging & Perforating
  - Sand Screens, Straddle Packers etc
  - Fishing (including fishing CT)
- Working over an open well
- Reverse Circulation

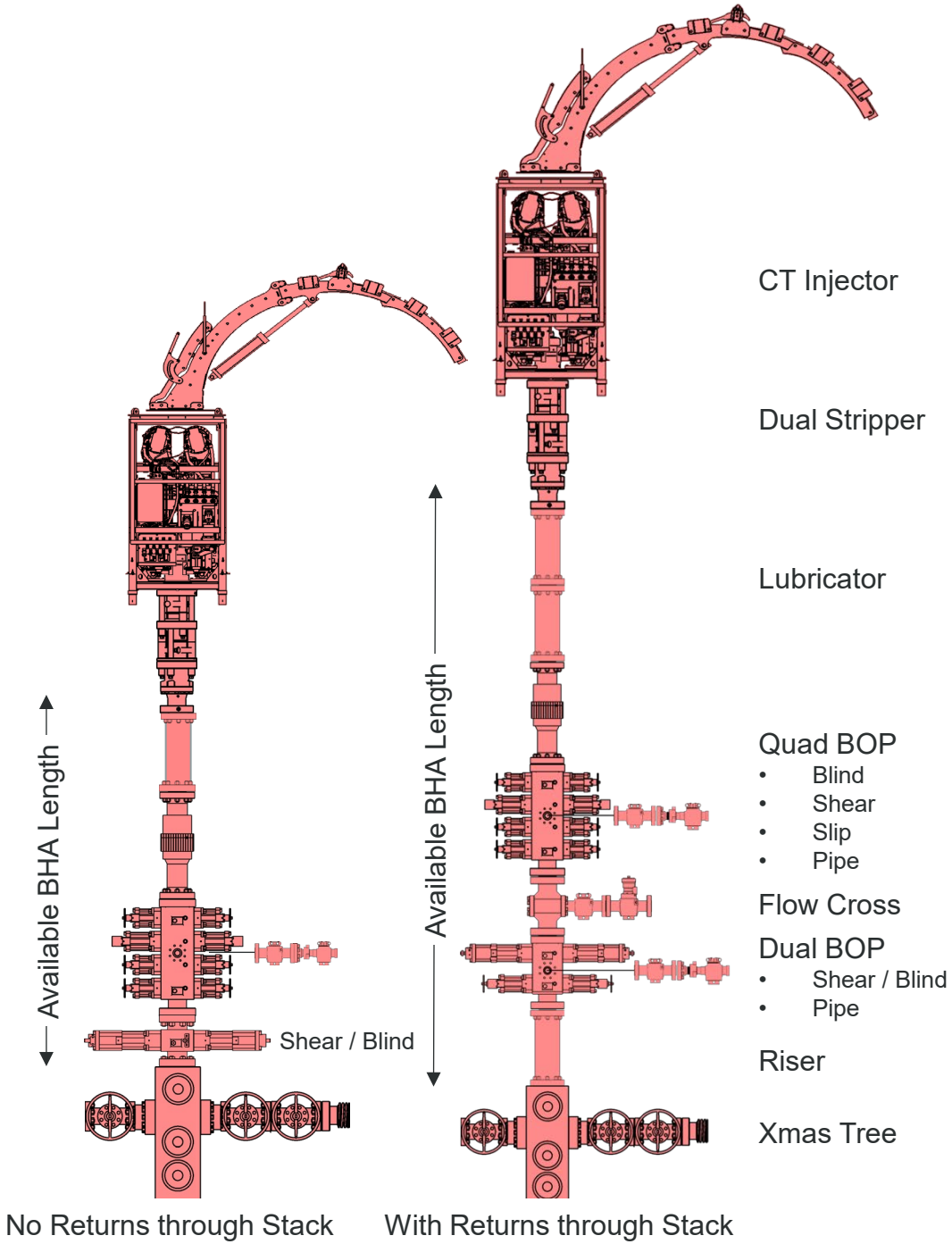


Industry Guidance & Standards

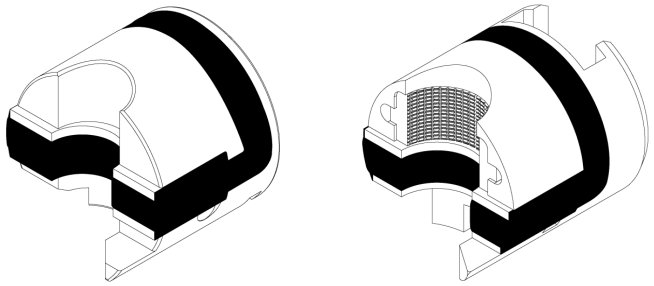
API RP 16ST	BSEE	NORSOK D-010
API American Petroleum Institute Coiled Tubing Well Control Equipment Systems 2nd Ed – Addendum 1, Feb 2022	Bureau of Safety and Environmental Enforcement BSEE	norsok standard NORSOK D-010:2021+AC2 Well integrity in drilling and well operations
5 Pressure Categories	Above and below 3500psi	No Difference for Pressure
2nd Stripper > 7500psi	No 2nd Stripper Requirement	2nd Stripper for all Pressures
Pipe Ram below flow cross	Pipe Ram below flow cross	No mention of flow cross & pipe ram
SBR above 1psi	SBR above 3500psi	SBR every time*

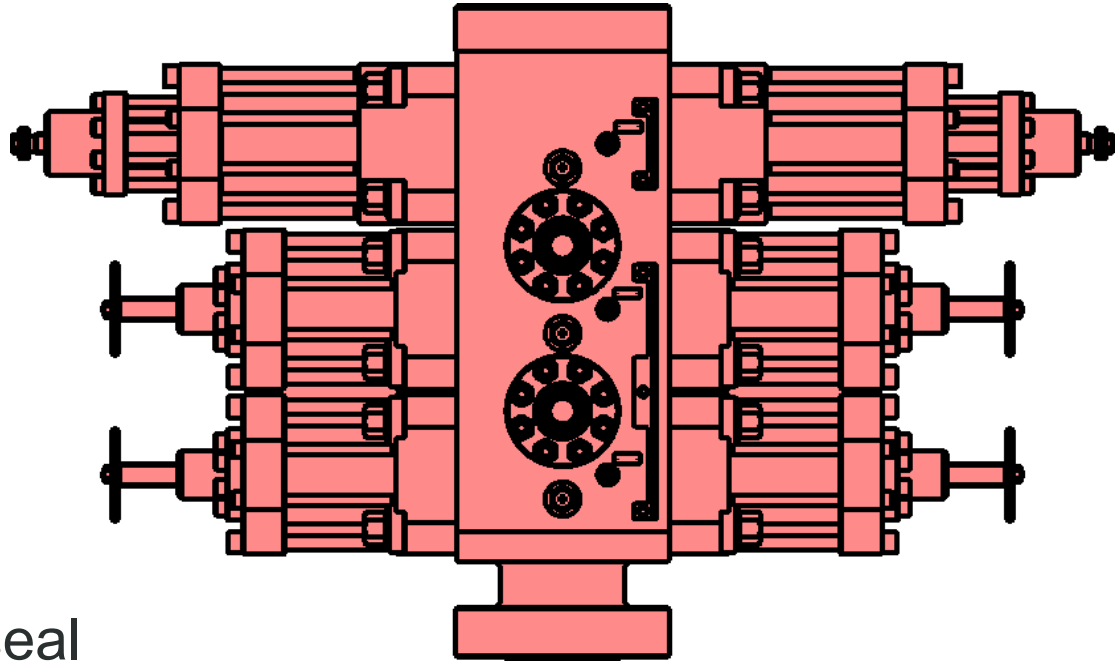
SBR = Shear/Blind Ram (or Safety Head)
Flow cross = flow cross or flow tee

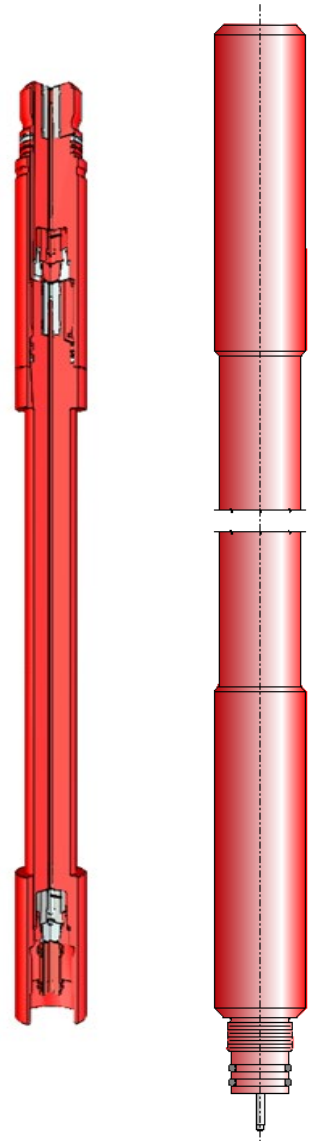
* Can be included subsea



CT Logging or Perforating Deployment







- Isolation or Deployment Bars
- 2 rams (either pipe or pipe/slip) seal around bar
- Requires manual make up of connections

CT Perforating Deployment – Automated Connectors

- Automatic Latchable Connector Joints
- Requires NO manual make up of connections
- Shearable or Non-Shearable option

IPTC-23046-MS

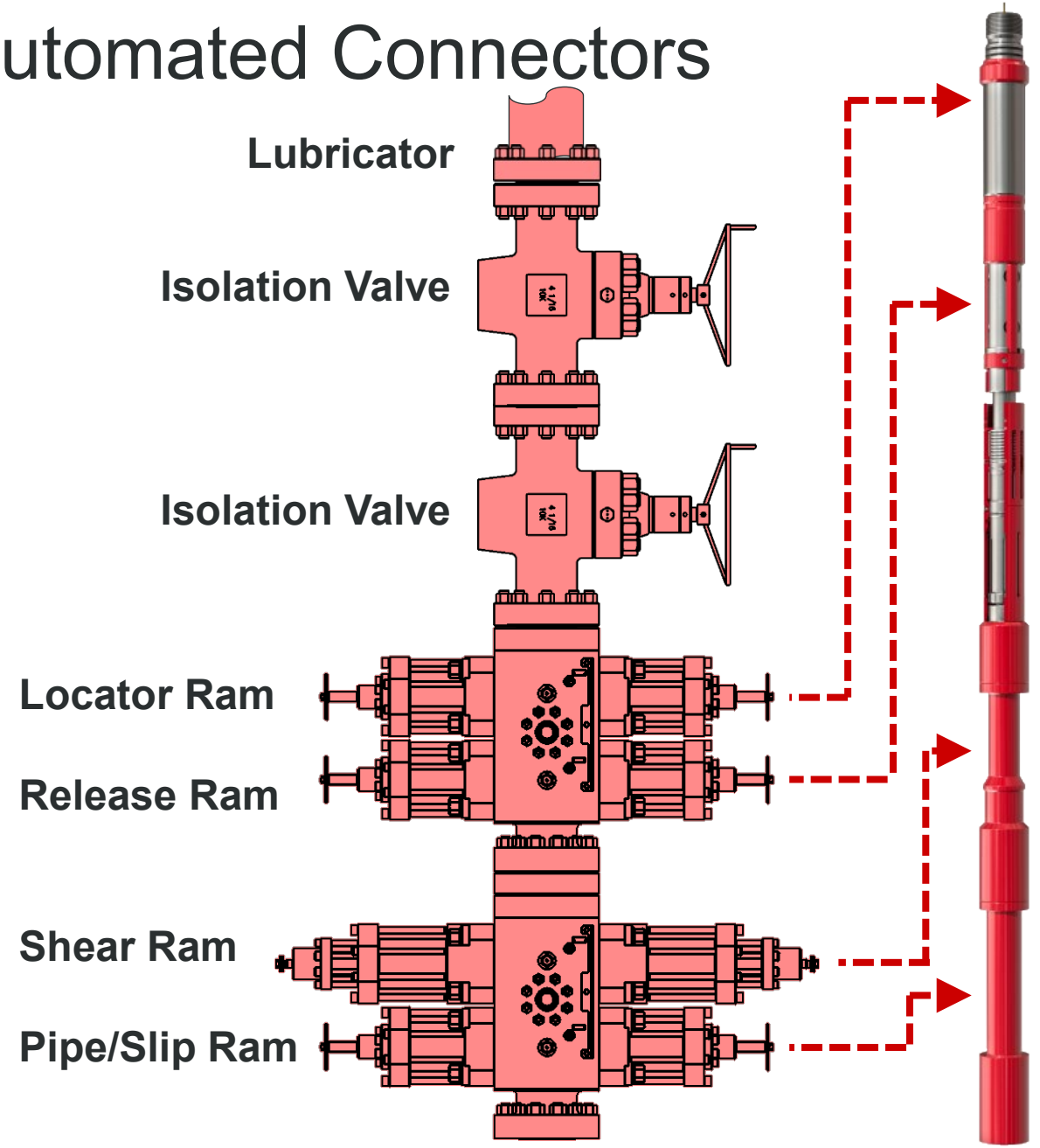
Real-Time Rig Less Intervention with a Catenary Coiled Tubing System to Perforate the Long Horizontal Section of a Well, Offshore Brunei

SPE-186948-MS

Extreme Underbalanced HPHT Coiled Tubing Conveyed Perforating: KN-Ultra Deep Field Study

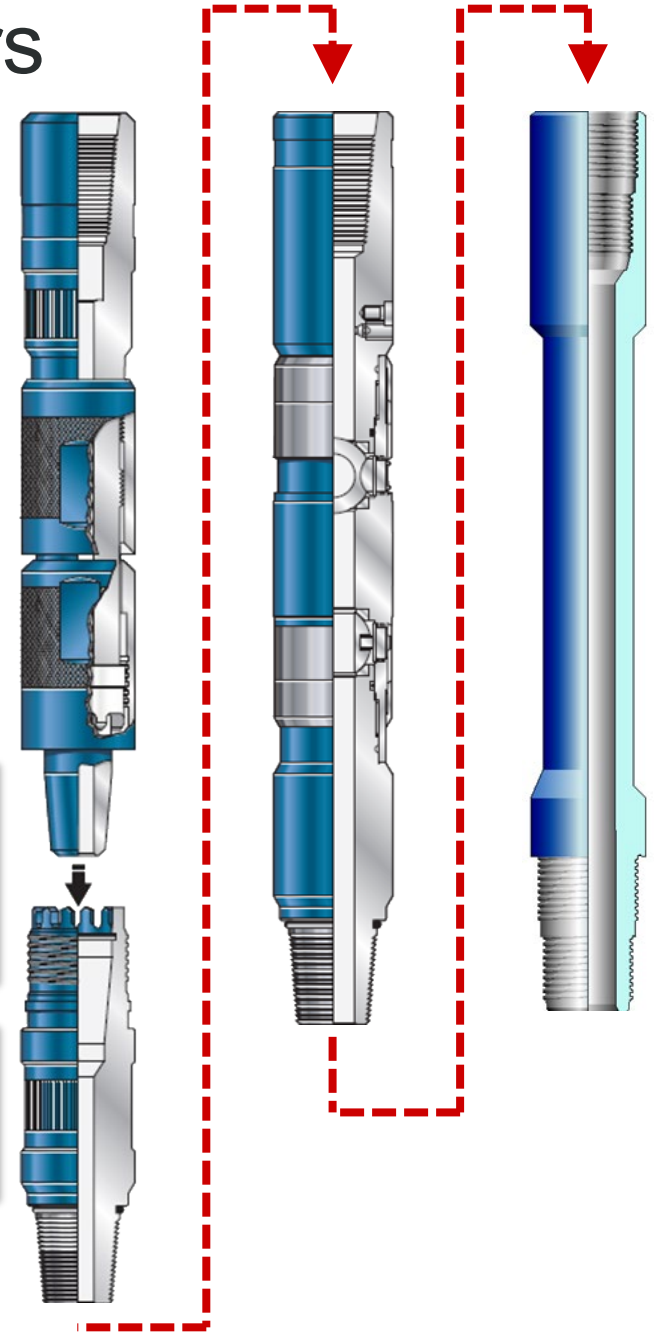
SPE 113835

HPHT WCCL Technology Aids Successful Deployment Perforating Operations on the Glenelg Field

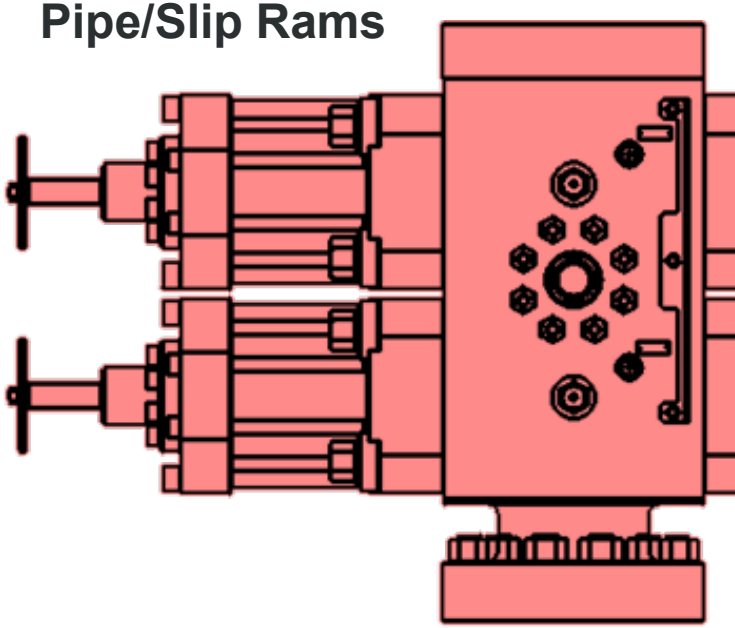


Pump Through Connectors

- CARSAC Connector
- Dual Ball (Kelly Cock) Valve
- Deployment Bar
- Requires manual make up of connections



Pipe/Slip Rams



IPTC-22820-EA

A Customised Solution Using Catenary Coiled Tubing to Deploy a Gas Lift Valve Deepening System With Straddle Packers For a Challenging Horizontal Well Offshore Brunei

OTC-26657-MS

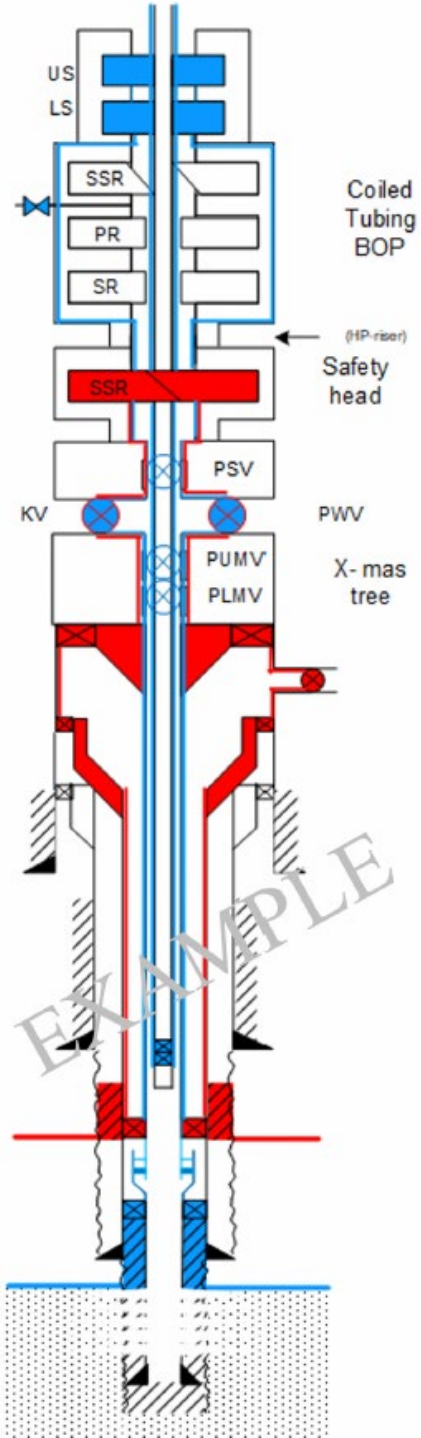
First Remedial Sand Control Treatment Case Study from Sumandak Field in Malaysia

Open Well Deployment & NORSOK D-010

- Well Barrier Envelope Philosophy
- Includes Element Acceptance Criteria (EAC) for each element Such as:
  - CT, CT BOP, stripper, DFCV
  - Fluid column
  - Lubricator Valves
  - Cement plugs
  - Mechanical tubular plugs
  - Alternative barrier material

Primary Well Barrier

Secondary Well Barrier

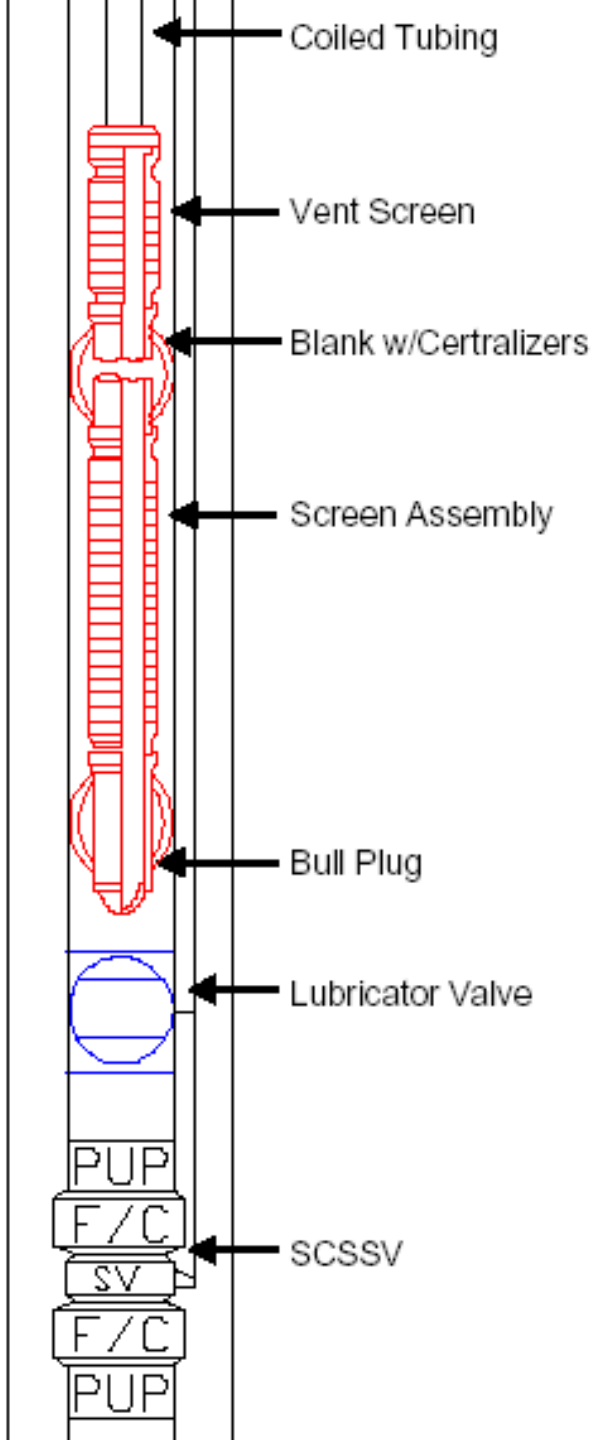


Open Well Deployment & NORSOK D-010

- Plugs… e.g.
  - Cement plugs
    - > Open Hole (100m)
    - > Cased Hole (50m)
    - > Additional guidance for PWC or Section Milled Methods
  - Mechanical tubular plugs
    - > The plug shall be set as close as possible to the source of inflow and set at a depth where the hydrostatic pressure above the plug balances the pressure under the plug.

Lubricator Valve

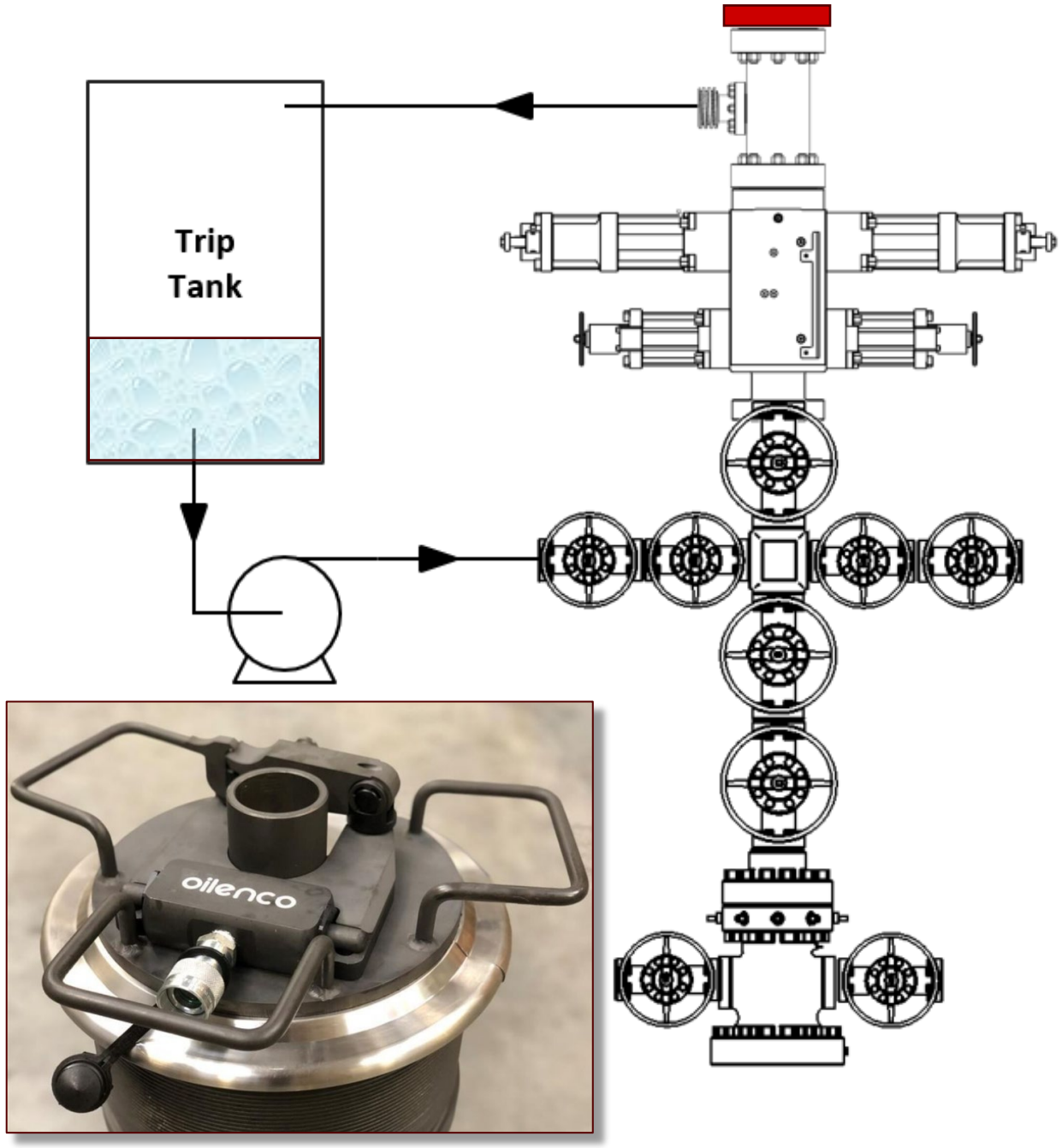
- Installed as part of the completion string
- Needs to be installed above the DHSV
- Controlled with hydraulic control lines, but not fail safe
- Ball type closure suitable for high impact loads
- Cost….
- Cost may soon be offset by reduced cost, increased safety, easier and faster well intervention
- NORSOK *recommends* having 2



Fluid as a Barrier

- Requires continuous monitoring by a well control trained supervisor.

- BOPs are not suitable for cutting all BHA types, particularly perforating guns
- Emergency Release C-Plates (also known as drop tables / drop plates) are available
- NORSOK D-010
  - When deploying a long BHA that cannot be cut, a contingency joint and/or a system for dropping the BHA in the well shall be in place.



Fluid as a Barrier

- API RP 16ST
  - “The use of a weighted fluid is not considered a barrier in this document, which relies on tested mechanical equipment for well control”
- BSEE
  - No provision for this
- NORSOK D-010
  - Includes provision to use fluid to deploy BHA
  - Table C.1 — EAC Table 1 – Fluid column

SPE-204419-MS

Challenging Catenary Coiled Tubing Thru Tubing Screen Deployment Operation Offshore Borneo

SPE-218368-MS

Complex Coiled Tubing Fishing Operation of Slickline Tools with No Kill Fluid in the Well in Danish North Sea

Open Well Deployment

- Working in the Line of Fire
- BOPs aren’t designed to cut BHA’s
- Emergency Drop Plate
- Manual versus Automated Connections
- Well Plugs
  - Cement versus Mechanical

Reverse Circulating

- BHA Check Valves are removed
- Industry Guidance Varies
- Manually activated BHA check valves

- API RP 16ST
  - “Where a flow check assembly cannot be used, a well control contingency plan shall be available and reviewed”
- BSEE
  - “Describe alternate procedures and equipment” if no DFCV
- NORSOK D-010
  - “The BHA shall be equipped with 2 check valves located in the lower part of the BHA”

Fishing of CT from a Well

- BHA check valves are often questionable, especially if CT state is unknown
- Fluid as a barrier
- Fishing from a live well, gel can be used to plug the CT

IADC/SPE-209856-MS

The Use of an Organic Crosslinked Polymer Sealant as a Barrier to Retrieve Stuck Coiled Tubing from a Live High Pressure Well After Over a Year: Case Study from Offshore Vietnam

SPE 129507

Fishing Coiled Tubing From a Live Gas-Condensate Well With Coiled Tubing While Under Production

Other Considerations

- H_2S
- Well Control Drills
- Geothermal Wells / Renewables

Conclusions

- Industry guidance varies, but…
- With the right planning and equipment, well control can be maintained during long BHA deployment against well pressure, or into an open well. Various options exist.
- This also applies to more complex operations such as reverse circulation and fishing.

THANK YOU

Acknowledgements

- DTI – Reverse Circulating Flapper Valve
- Oilenco – Drop Plate
- NOV – Dual Ball Valve & CARSAC connector