Technical Talk: Latest in Completions

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About Myself

- Completions Product Line

- ~16 years at SLB:
  - 10 years in operations/field
  - 3 years teaching core completion
  - 3 years in gas lift marketing

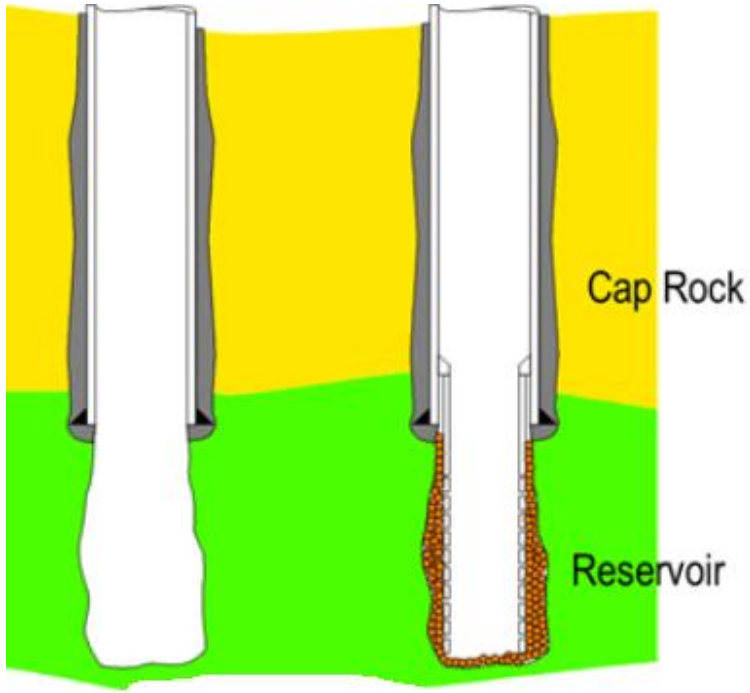
- From Balikpapan, Indonesia
- Education:
  - Universitas Gadjah Mada
  - Nanyang Technological University Singapore
- Assignments:

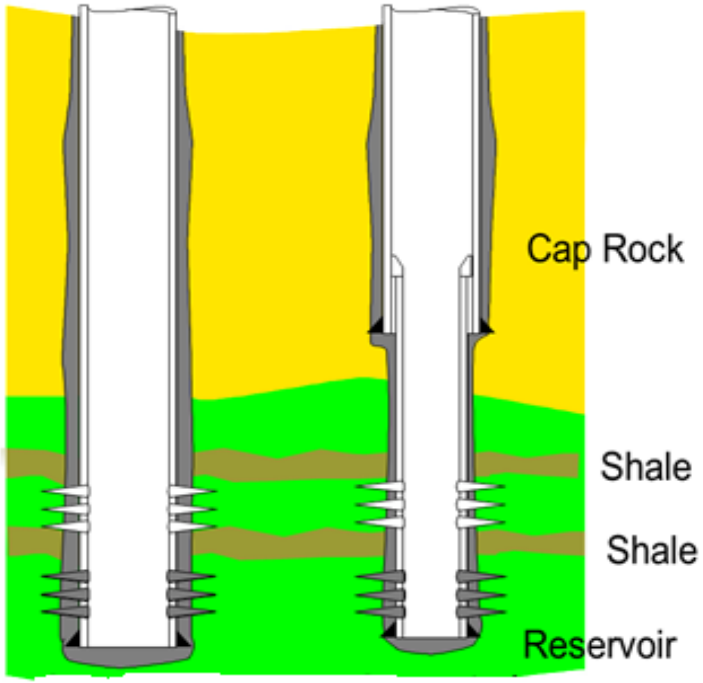
Cased hole vs Open hole

Completions

The design, selection and installation of tubulars, tools and equipment located in the wellbore for the purpose of conveying, pumping or controlling production or injection fluids.

- Safe
- Efficient
- Economical



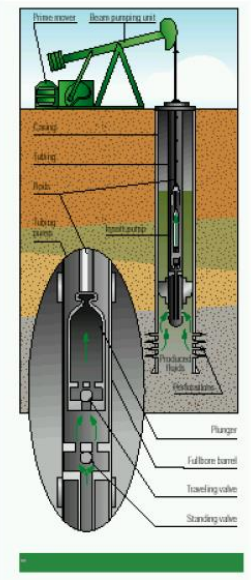


Artificially Lifted Wells

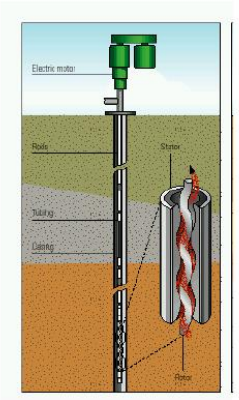
Artificial Lift

- Because they lack sufficient reservoir pressure to produce fluids to the surface, the majority of the world's oil and gas wells are unable to produce at economic rates without assistance.
- This condition may be the result of pressure depletion over time or be caused by low original reservoir pressure.

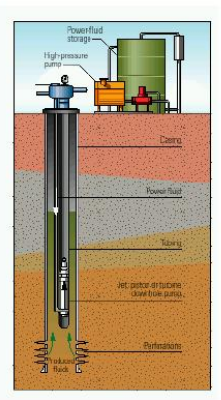
Beam pumps/SRP



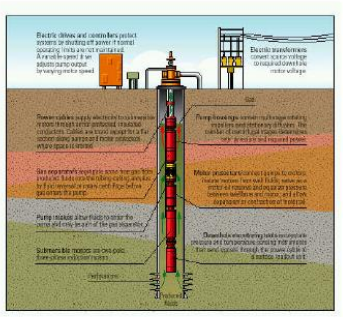
PC Pumps



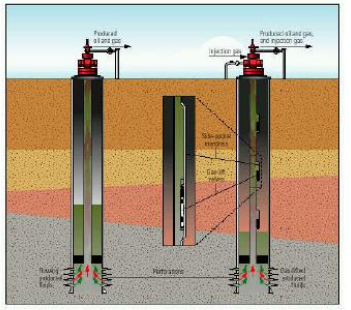
Hydraulic Pumps



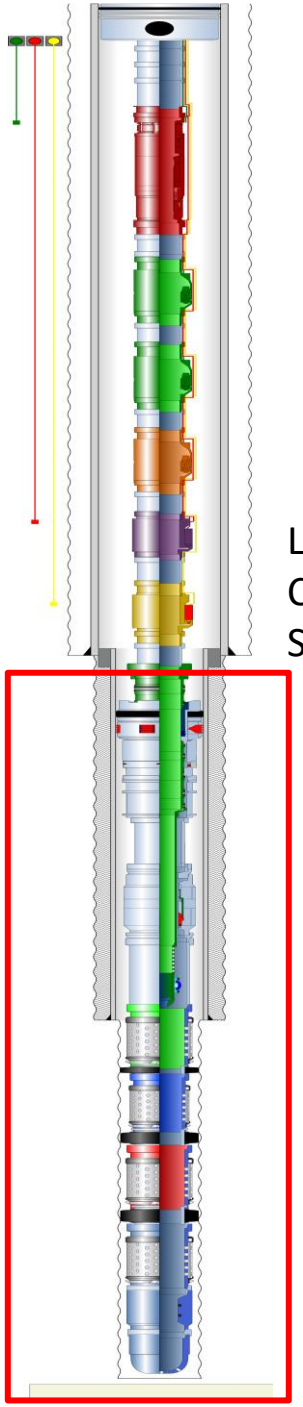
ESP's



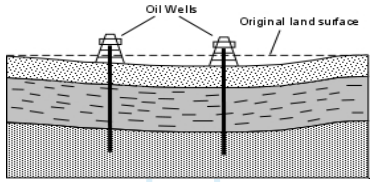
Gas Lift

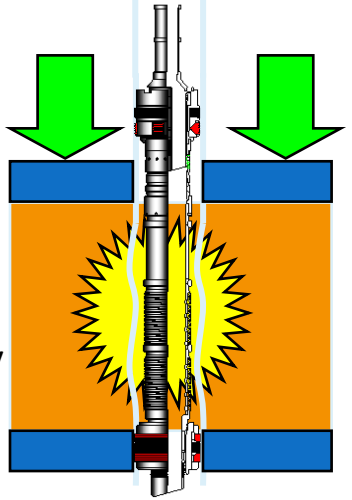


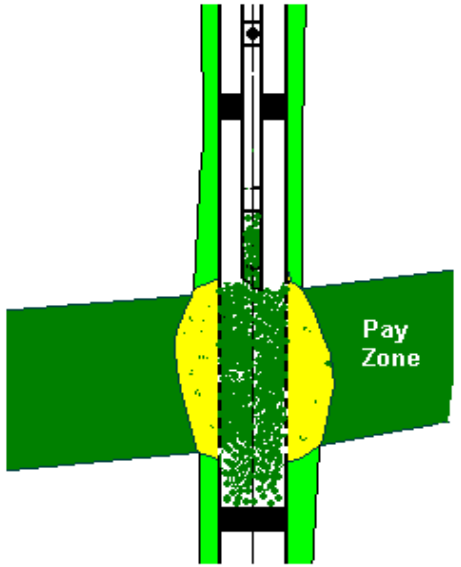
Sand Control: Why?

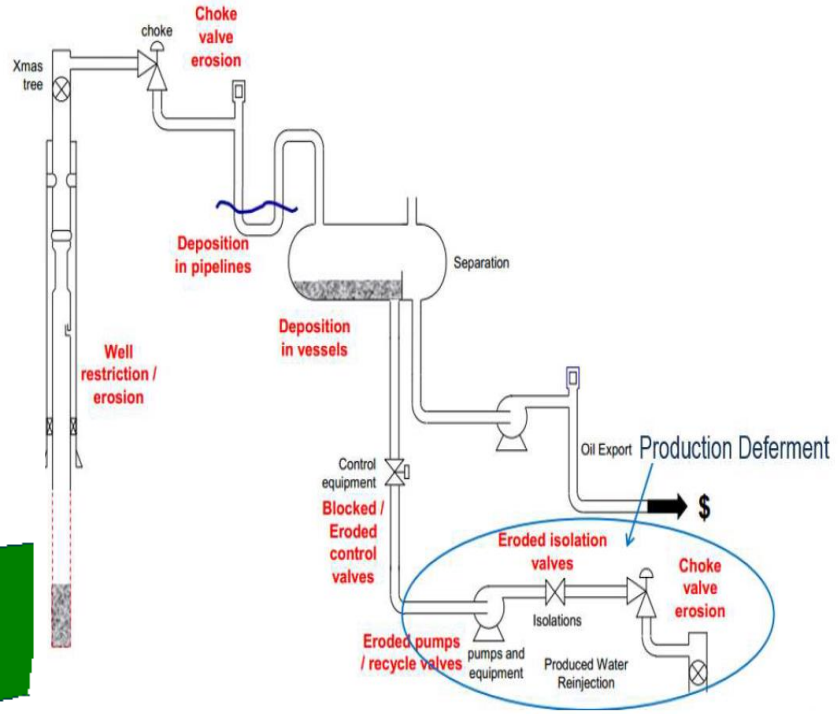


Lower Completion/ Sandface





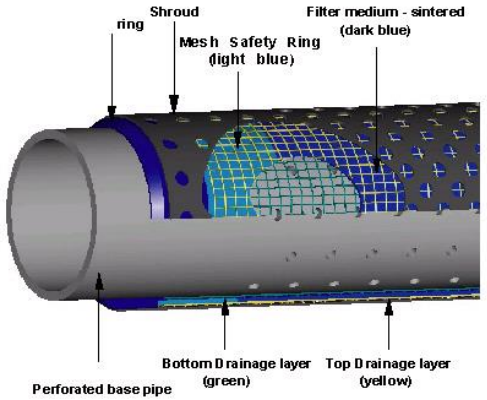


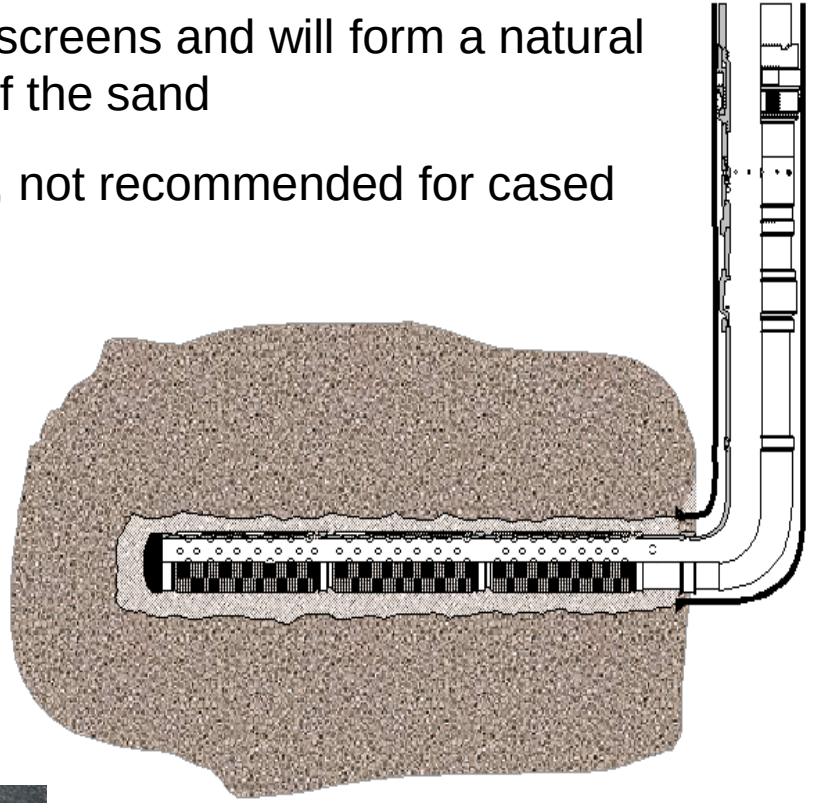


Sand Control: Stand Alone Screen and Inflow Control Devices (ICD)

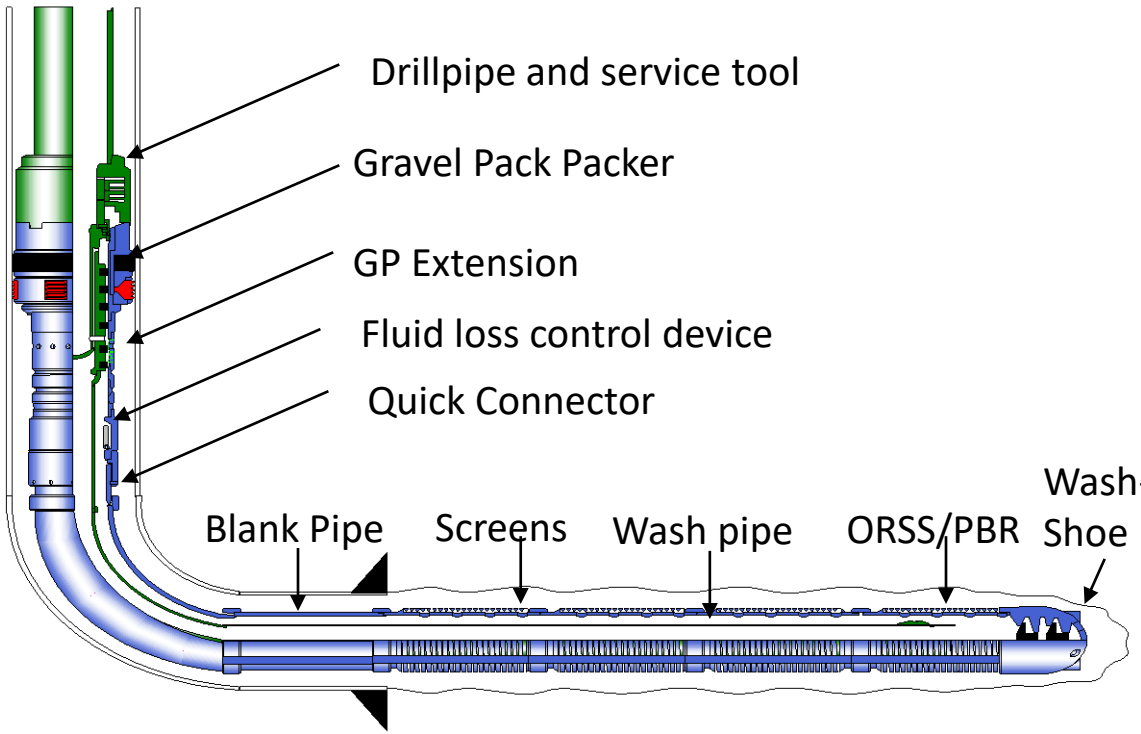
Installation of screens as a main barrier for formation sand (no gravel)

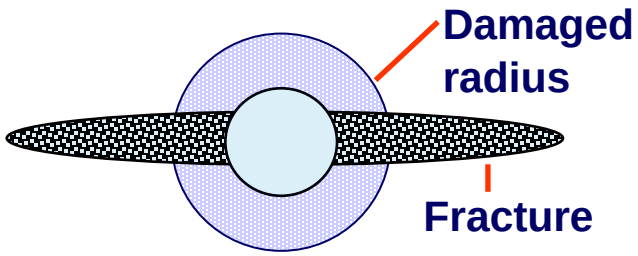
- Formation will collapse around the screens and will form a natural filter that would avoid the mobility of the sand
- Common in open hole completions, not recommended for cased hole



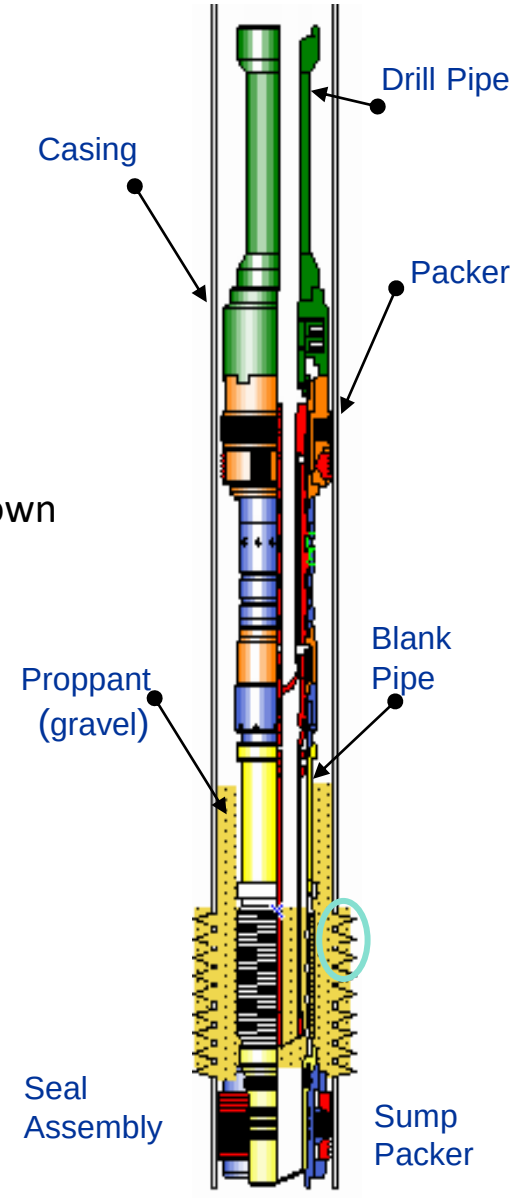


Sand Control: Gravel Pack and Frac Pack





Video



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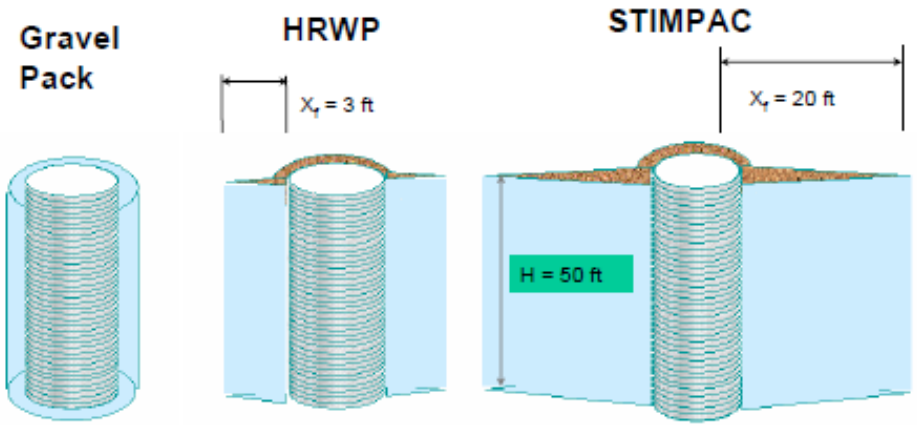
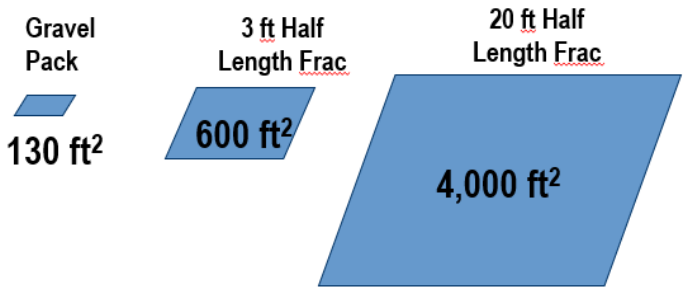
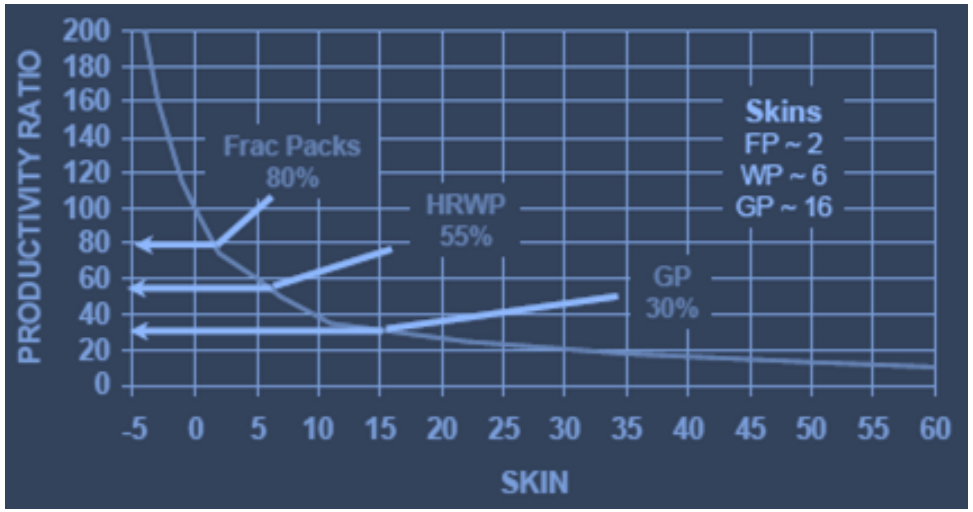
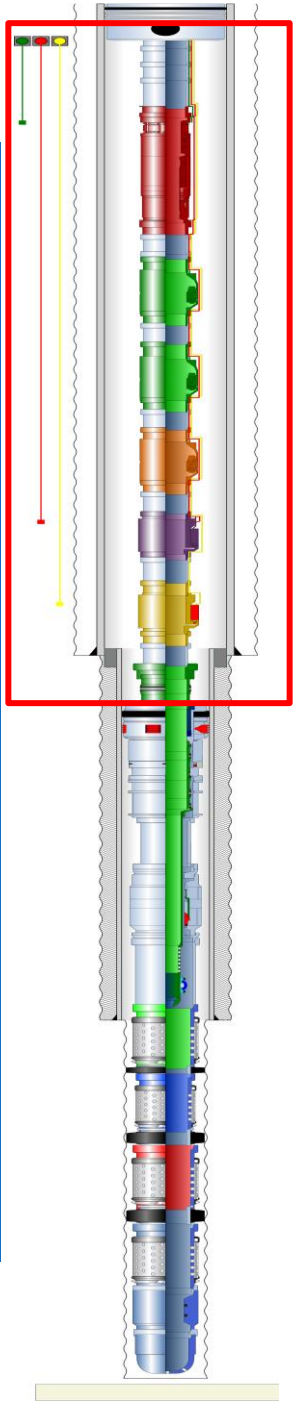


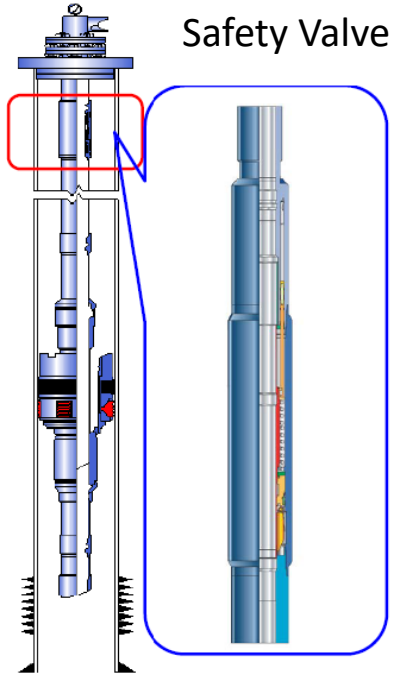




Upper Completion

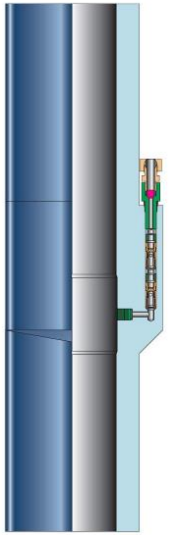


Upper completion



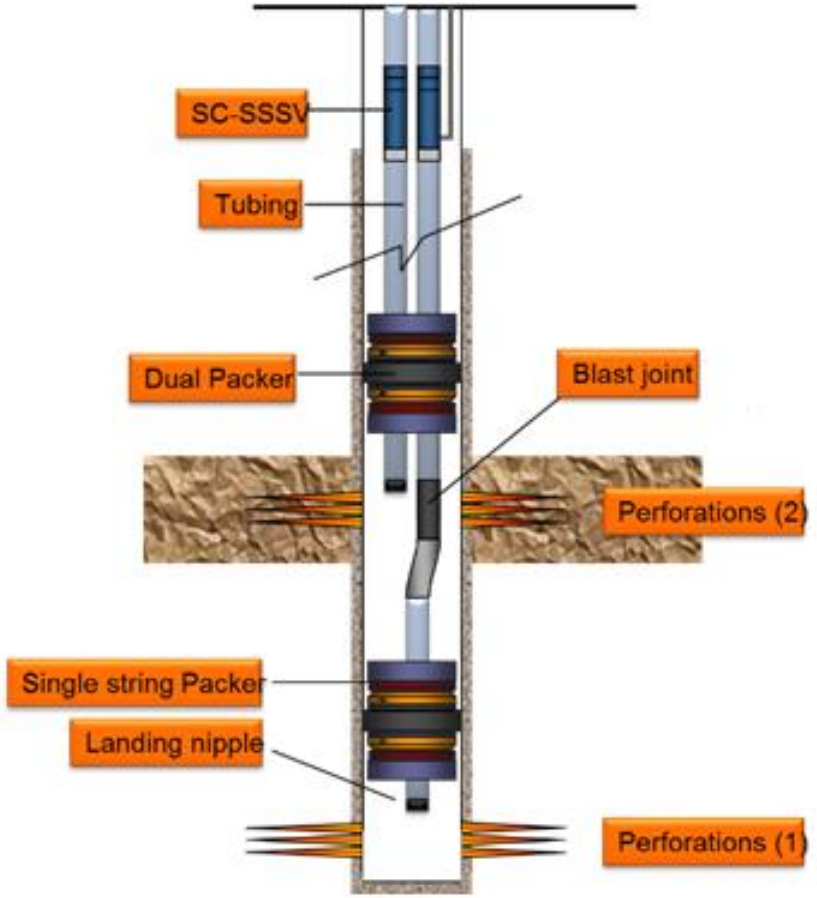
Safety Valve

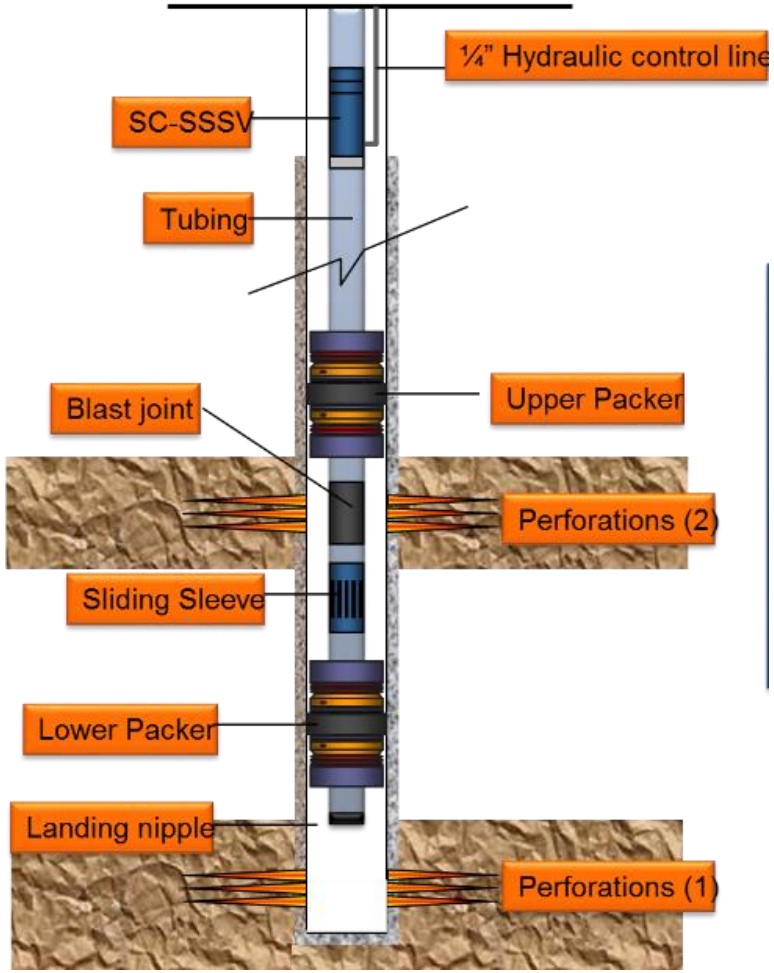
Hydraulic Control Line



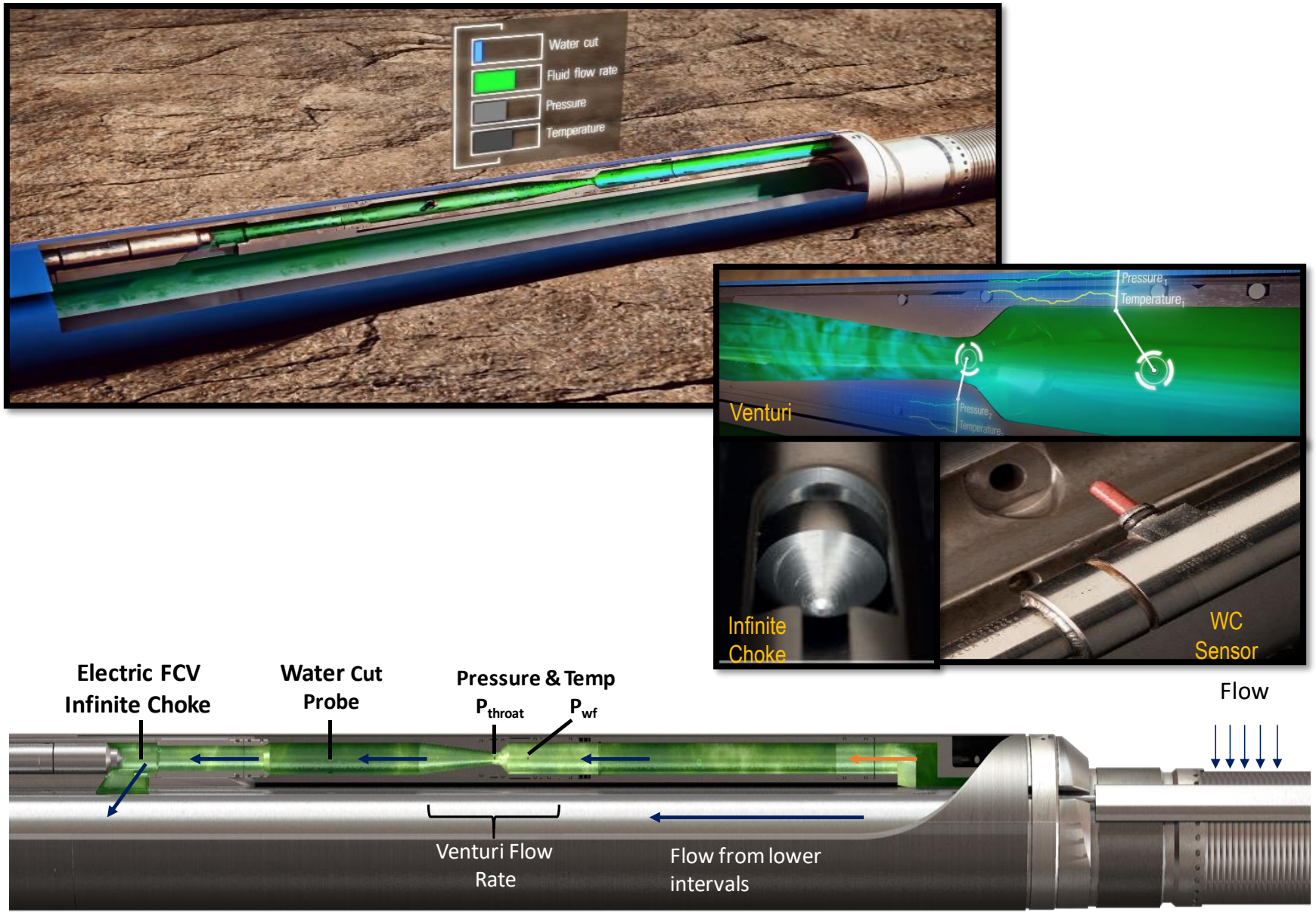
Chemical Injection Valve

Upper Completion: Multizone





Intelligent Completion: Electric Flow Control Valve



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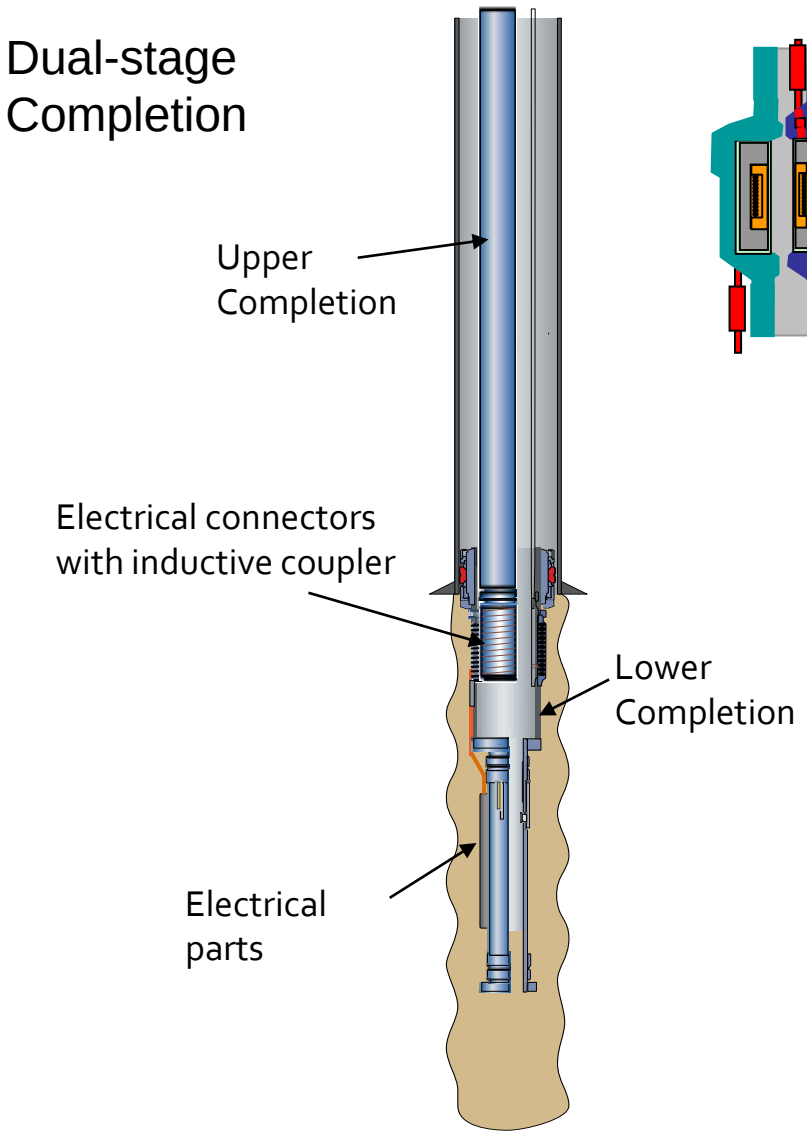
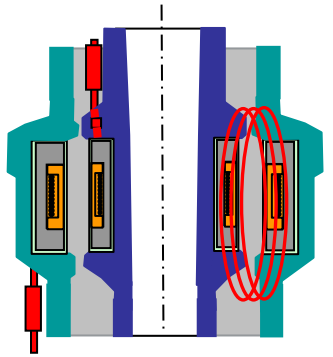
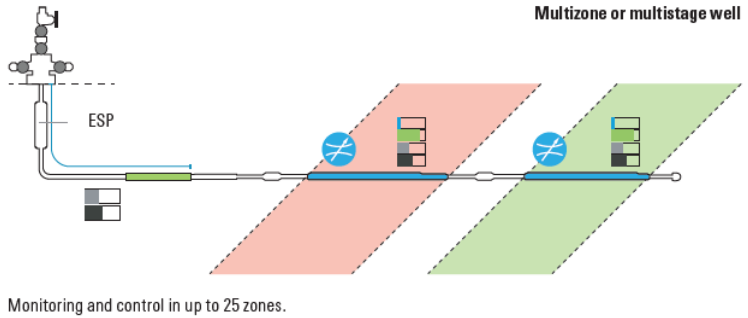
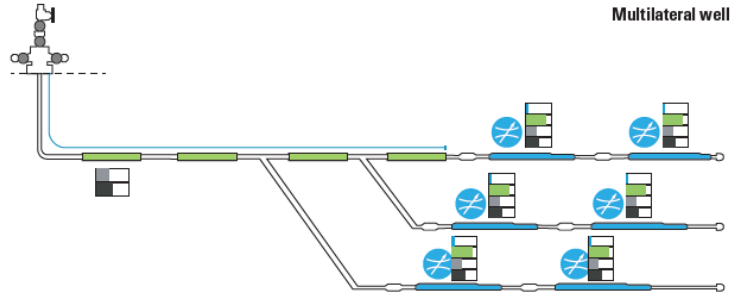






Monitoring and control in up to 25 zones.



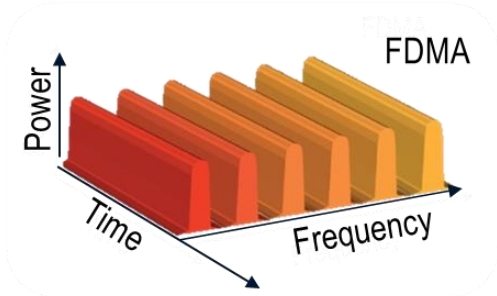
Deployed in all three laterals of a maximum reservoir contact well.

Intelligent Completion: Permanent Downhole Gauges

	Conventional	New
Pressure (ksi)	10, 16, 25, 30	10, 16, 25
Temperature (deg C)	180	150, 175, 200
MCM Temp Rating	180	200
Metrology	Excellent	Excellent
ESP immunity	No	Full immune
Distance between	1km	No limitation
Multidrop Capability	8 sensors	16 sensors
Systems compatibility	No	Yes
Telemetry	FSK	FDMA

FDMA –Frequency Division Multiple Access

- Gives individual allocation to several frequency bands
- Everyone speaks at once with a different pitch.



Multilateral: Why?

Drivers for multilateral completions

- **Reservoir**
  - Layered formations / limited size target blocks / Maximum Reservoir Contact wells
- **Subsea**
  - Minimize subsea wellheads and template size
- **Platform**
  - Slot recovery
    - Size
- **Land**
  - Hostile / remote locations
  - Space limitations
  - Environmental Impact

Cost

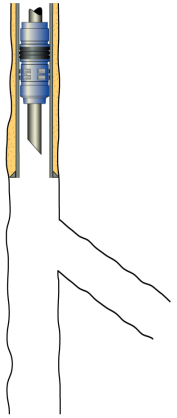
- Historically, to be economical, the Capex should be no greater than 50% additional for each lateral
- An additional lateral offshore may cost about 30% more than a single well
- An additional lateral on land may cost about 60% more than a single well

Production

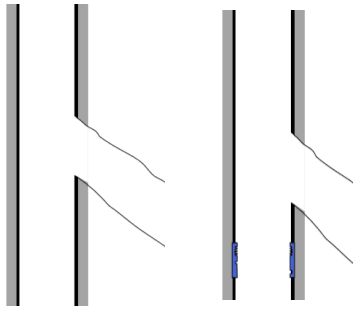
- Will probably be between 30-60% improvement over a horizontal well, not double

Multilateral: TAML (Technology Advancement of Multi-Laterals)

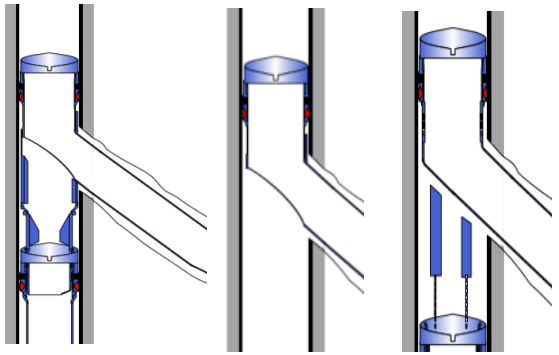
TAML LEVEL 1
Open / Unsupported Junction
Barefoot main bore & lateral or slotted liner hung off in either bore



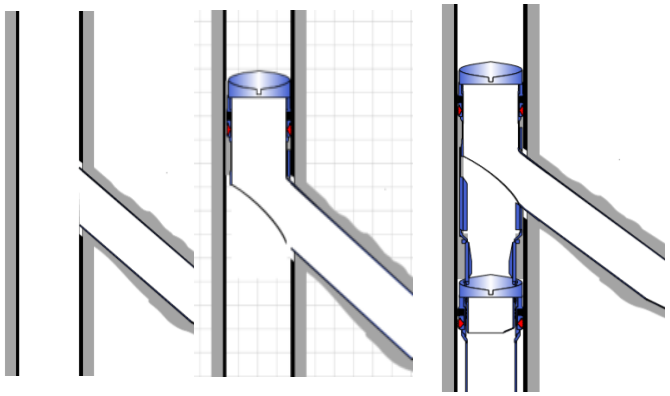
TAML LEVEL 2
Main Bore Cased & Cemented*, Lateral Open
Lateral either barefoot or with slotted liner hung off in open hole



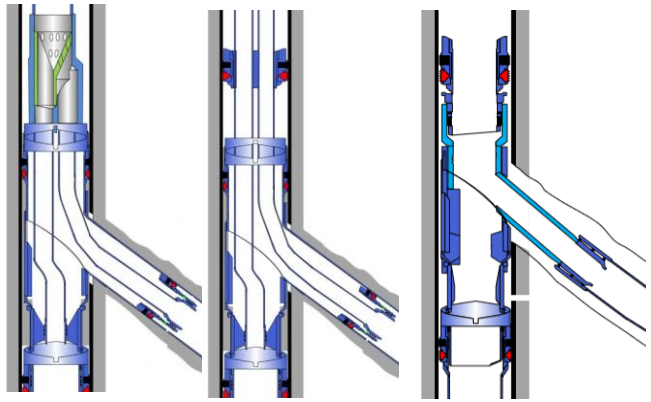
TAML LEVEL 3
Main Bore Cased & Cemented, Lateral Cased but Not Cemented
Lateral liner anchored to main bore but not cemented at the junction



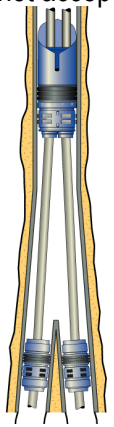
TAML LEVEL 4
Main Bore & Lateral Cased & Cemented
Both bores **cemented** at the junction



TAML LEVEL 5
Pressure Integrity at the Junction
Straddle packers or (integral) mechanical casing seal (may or may not be cemented)



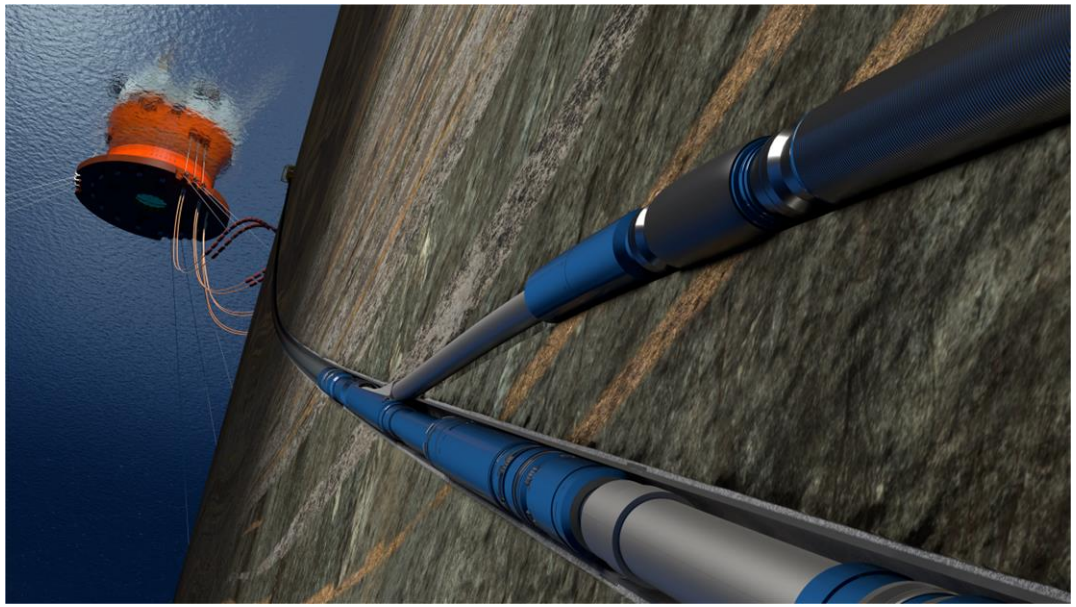
TAML LEVEL 6
Pressure Integrity at the Junction
Achieved with the casing (cement alone is not acceptable)



Multilateral: Case Study - Australia

TAML LEVEL 5

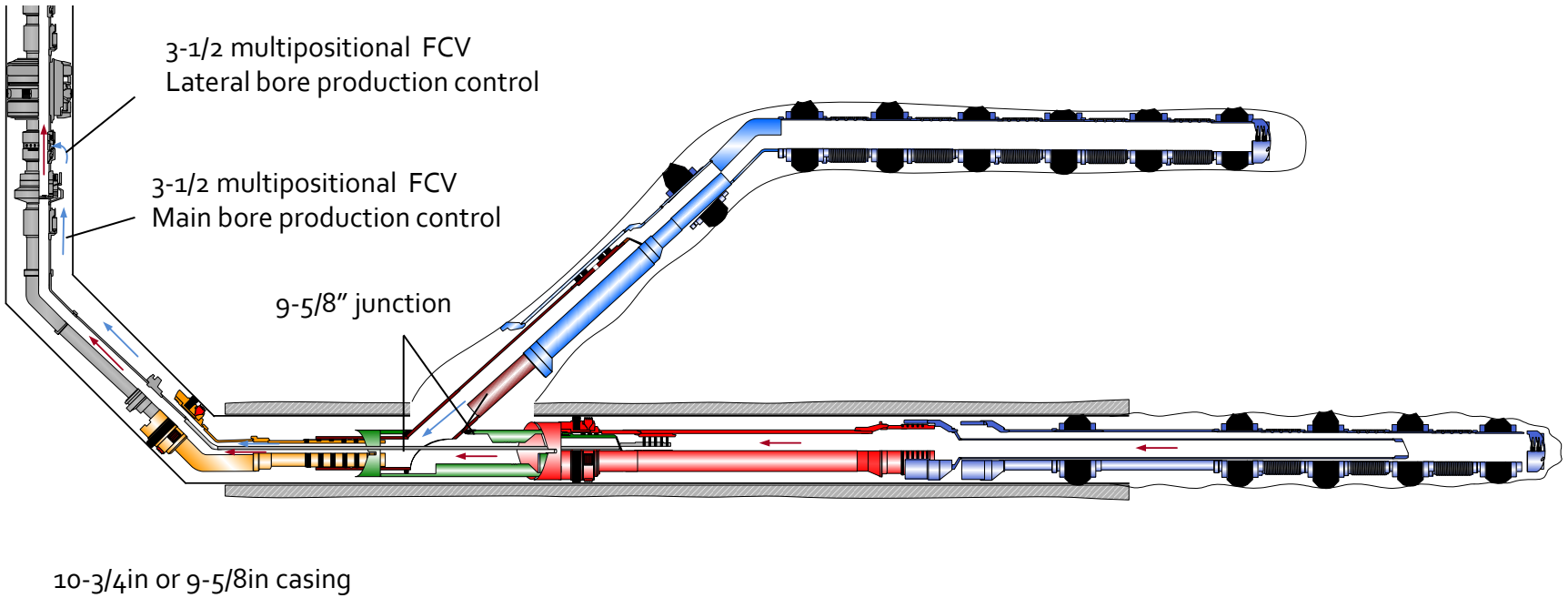
Junctions are used with stand-alone screens in the lateral combined with swell packers and ICDs



Multilateral: Case Study – Norway and Russia

TAML LEVEL 5

- Used on Filanovskoe and Korchagina fields, Sakhalin, Russia and Goliath, Norway
- Controlled comingled production
- Lateral and main bore production control
- SPE 189006, 181927

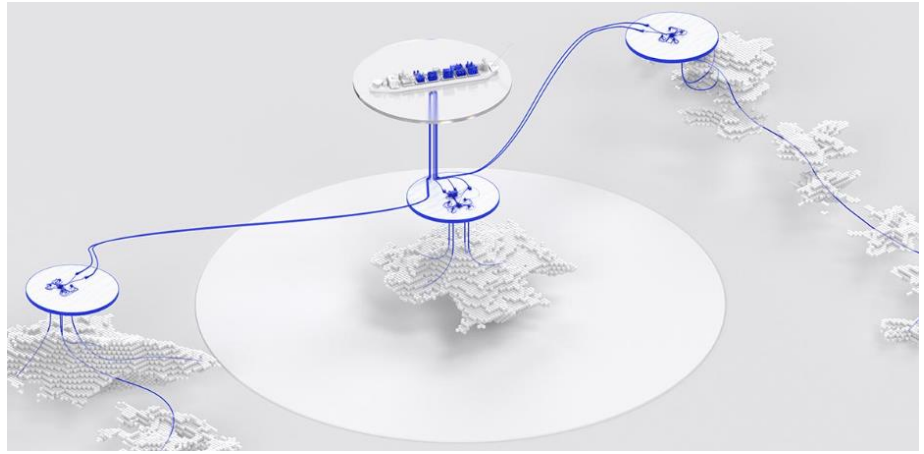


Junction are used with stand alone screens in the lateral combined with Swell packers and ICDs

Electrification

Maximize infrastructure and efficiency with fully electric production systems

- Converting hydraulic systems across drilling and production to electric, digital-ready systems.
- Hydraulic pressure must be generated close to the point of utilization, eventually requiring conversion from electric to hydraulic power (an inefficient transfer of energy).
- The pressure drop along hydraulic control lines limits how quickly energy can be transported over long distances. Here, electric lines have a technical advantage.
- Hydraulic power and control systems (and their actuators) require periodic maintenance and are sensitive to control fluid contamination.



Electrification