Introduction to Well Completions for CTS

Class-Based Training

Coiled Tubing Services Department

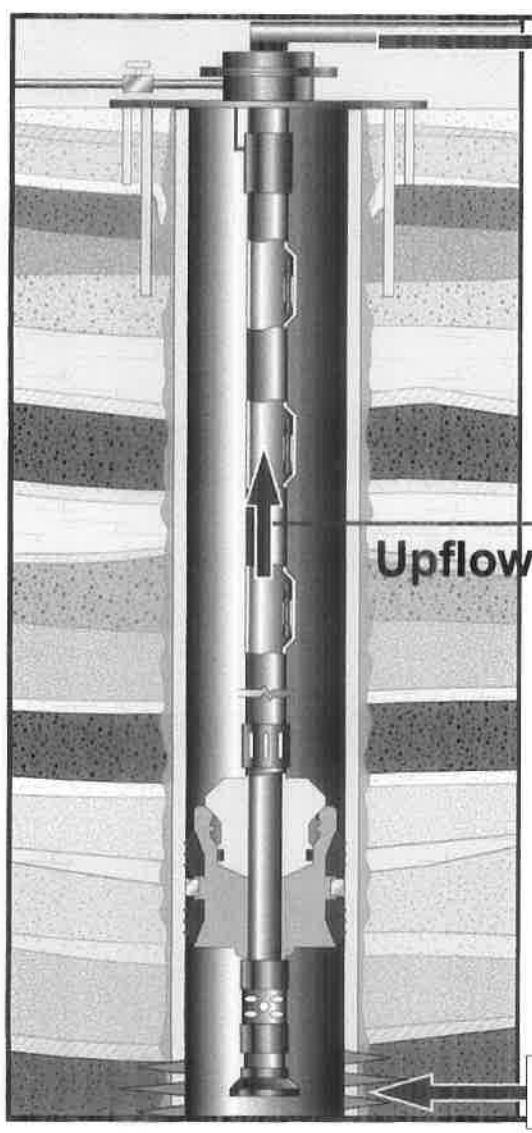
Presentation Outline

- What is Completion?
- Importance of Completion factor in Coiled Tubing well interventions
- Completion classifications
- Completion components
- Completion considerations in Coiled Tubing operations

Training Objectives

- To define the Completion, its purpose and objectives
- To describe the 3 different Completion classifications and list examples of each
- To name the typical Completion components, describe the purpose and principal functions of each
- To identify the common Coiled Tubing considerations related to Completion
  - Specific to job planning & design
  - Specific to Job execution

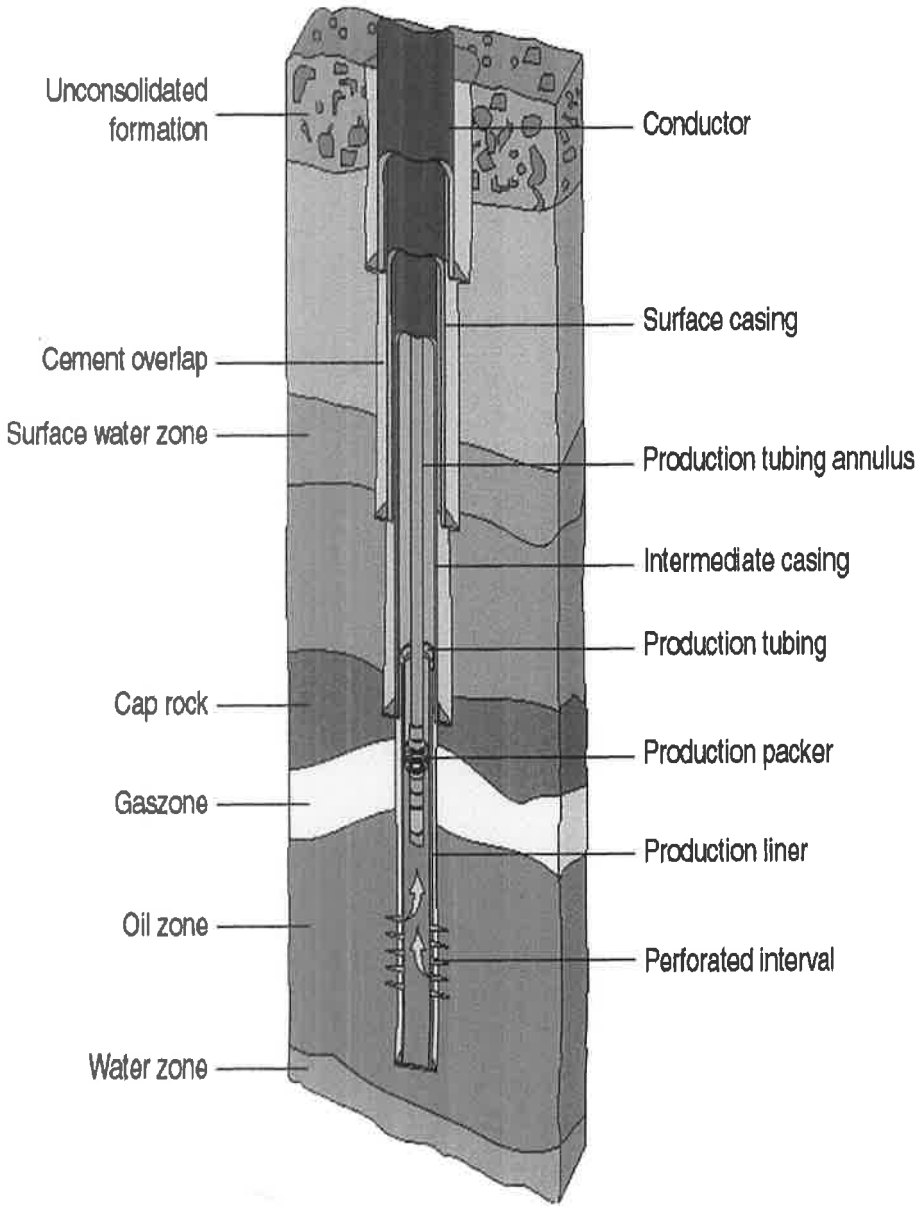
What is a completion?



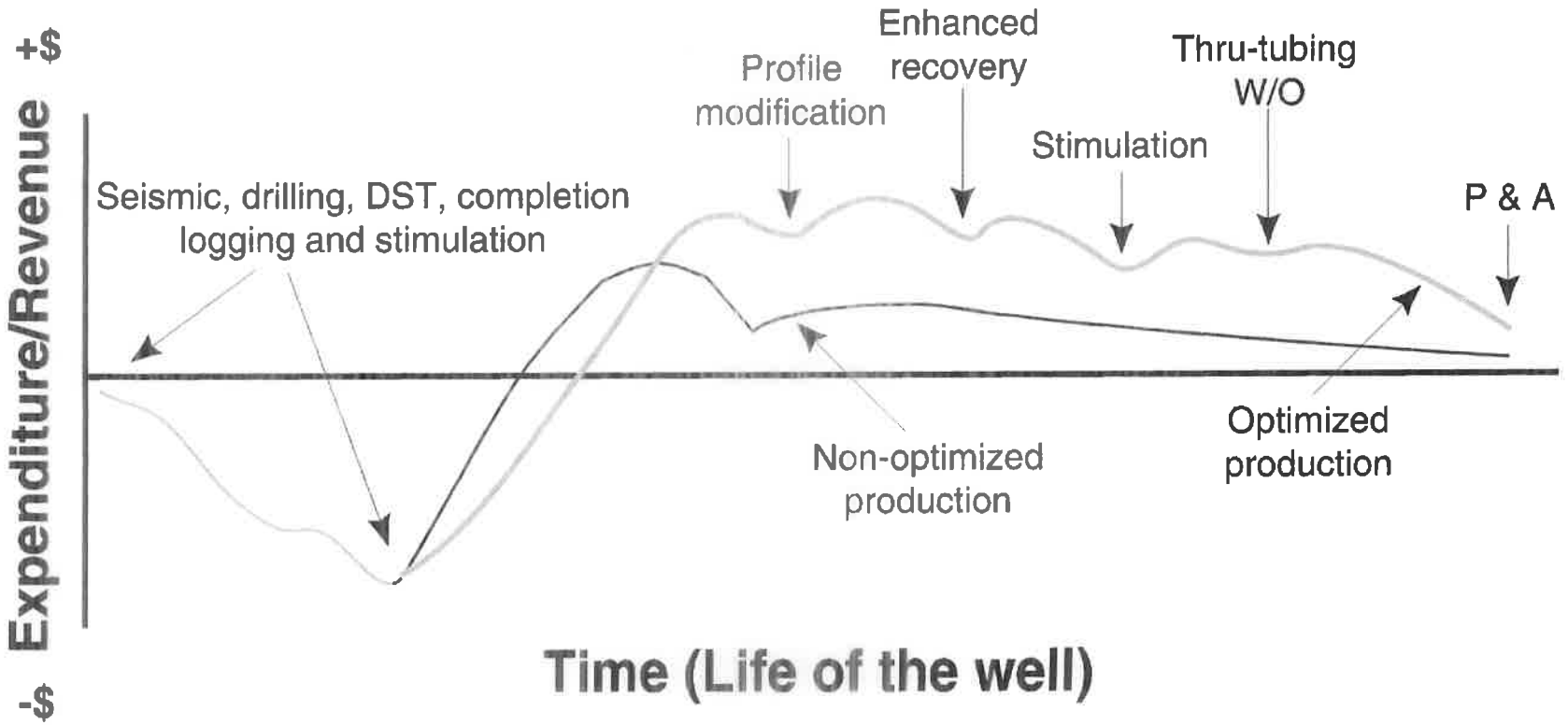
- The operation to complete a well for production or injection after it has been successfully drilled
- The completion string:
  - transports hydrocarbons to the surface in a safe, controlled, and cost effective manner
  - transports injected fluids into the reservoir
- The completion is designed according to information provided by logs and well tests run after the hole is drilled

Completion Objectives

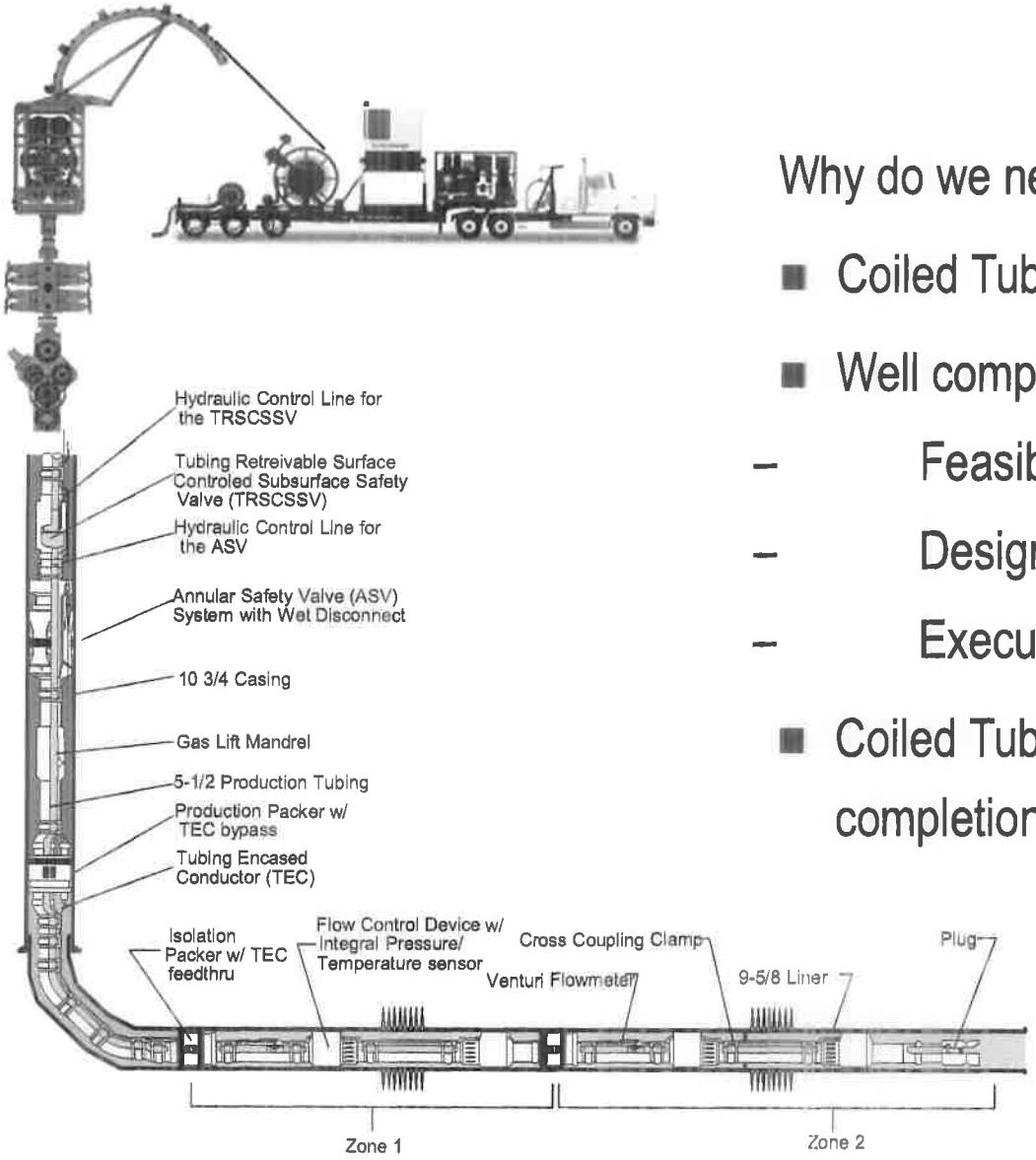
- Ensure potential for optimum production / injection.
- Provide for adequate monitoring and servicing.
- Be as simple, reliable and safe as possible.
- Provide some flexibility for changing conditions, applications or contingency measures.
- Contribute to efficient field/reservoir development and production.
- Ensure cost efficient installation, operation and retrieval



Optimized Completion Design



Importance of the Completion factor



Why do we need to know Completion?

- Coiled Tubing => Well Servicing (Intervention)
- Well completion may, in many ways, affect CT job
  - Feasibility
  - Design
  - Execution
- Coiled Tubing potentially can, in many ways, affect completion tubulars and jewelry

Completion Classifications

By wellbore and reservoir interaction

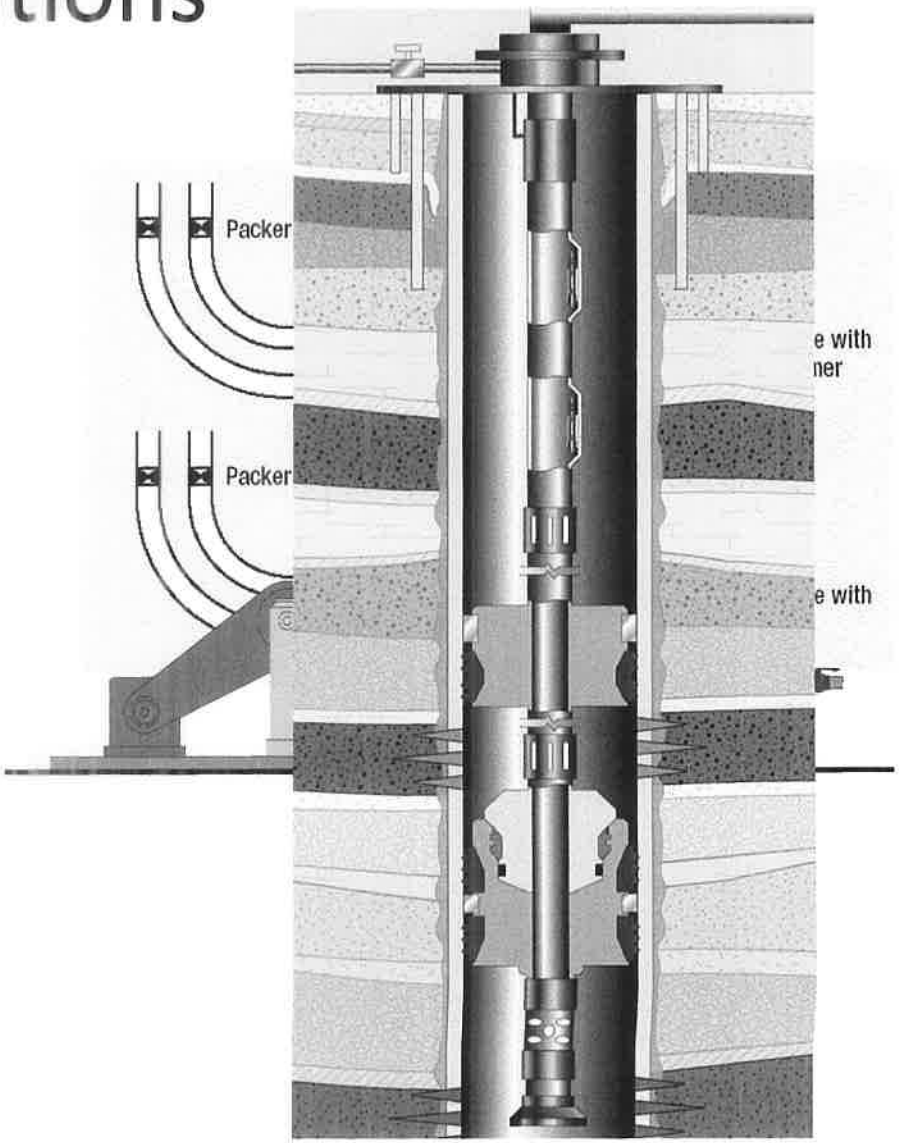
- Open hole
- Un-cemented slotted liners
- Cased and perforated

By flowing method

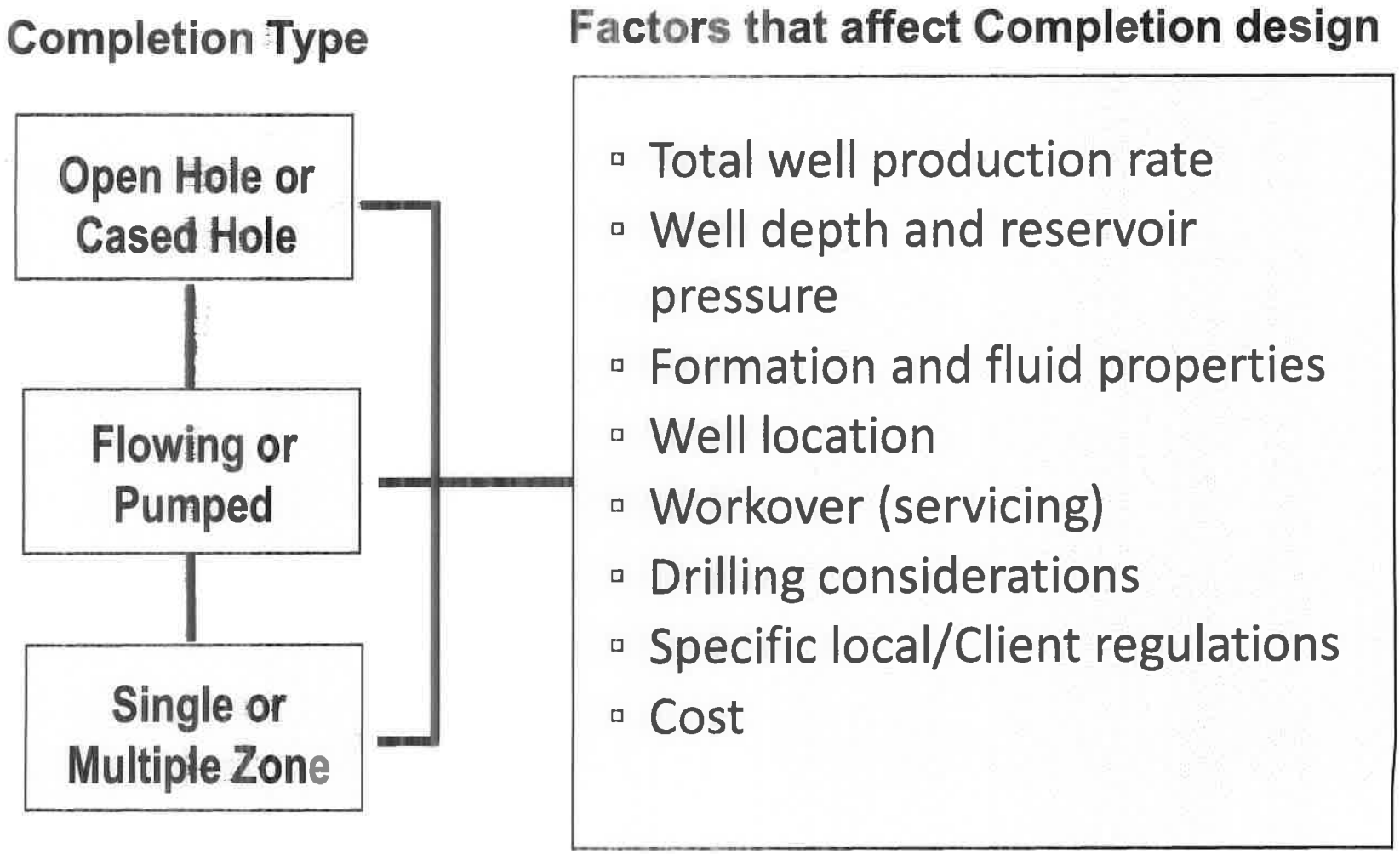
- Flowing
- Artificial Lift

By number of zones to be completed

- Single
- Multiple



Completion System Design



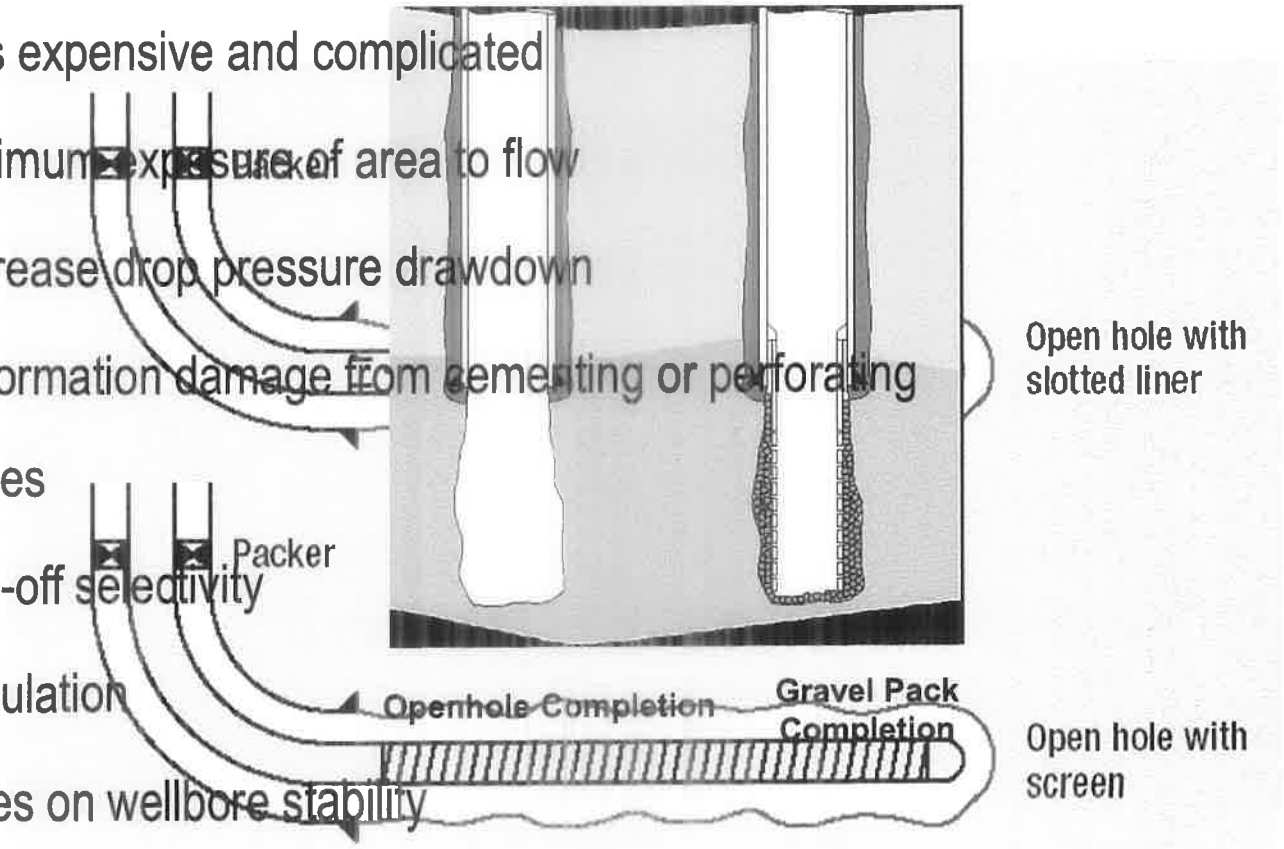
Open Hole completions

Advantages

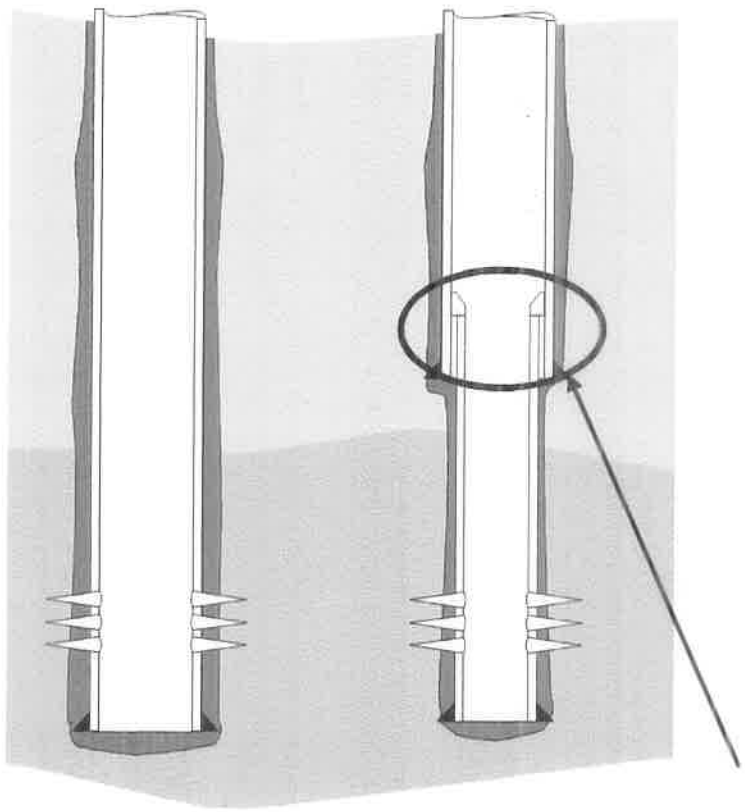
- Less expensive and complicated
- Maximum exposure of area to flow
- Decrease drop pressure drawdown
- No formation damage from cementing or perforating

Disadvantages

- Plug-off selectivity
- Stimulation
- Relies on wellbore stability



Cased and Cemented Completions



Cemented casing Cemented liner

- By far, the most common type of completion
- Selectivity to produce, stimulate and plug-off zones
- Multiple zones completed in a single wellbore
- Casing prevents wellbore from caving in

Top of liner may create difficulty for CT and BHA entry

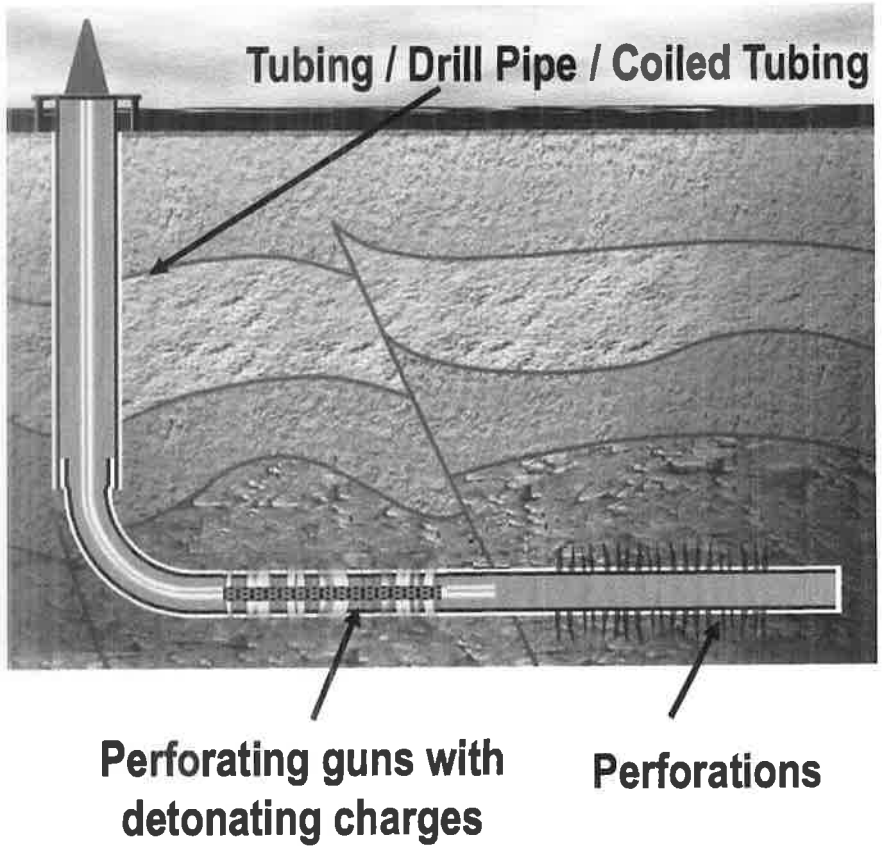
⇒ Use knuckle joints

⇒ Straighten the DH section of CT string

Perforating: "Connecting wellbore to the Reservoir"

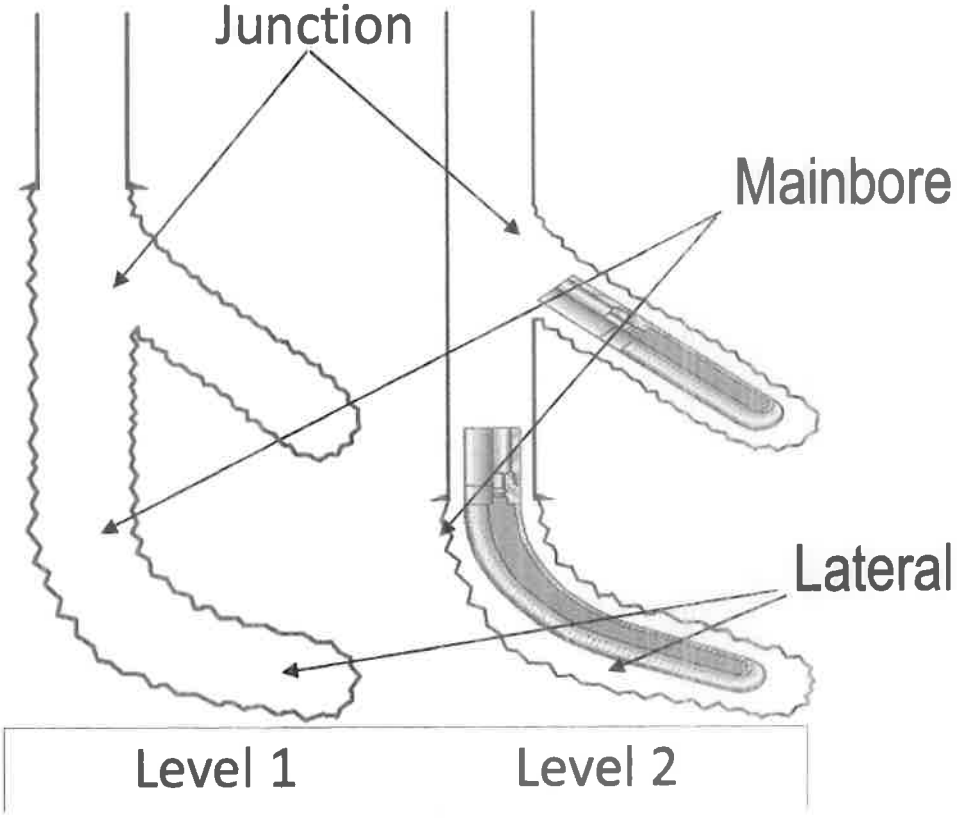
The process of creating a clear channel of communication between the reservoir and wellbore.

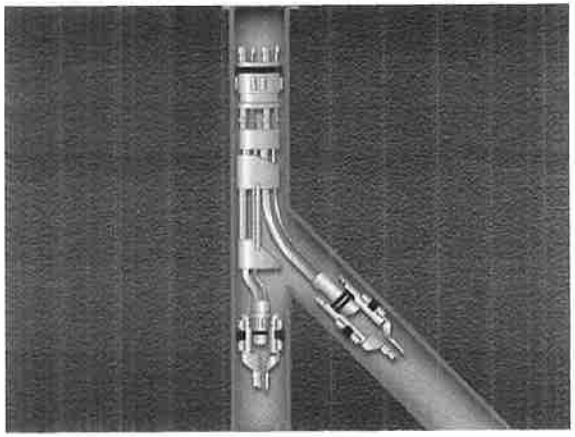
- Technique selection depends on:
  - Completion type and dimensions
  - Conveyance method
    - Wireline / Slickline
    - TCP
    - Coiled Tubing
  - Reservoir conditions, e.g., stability/consolidation
  - Local experience and preference



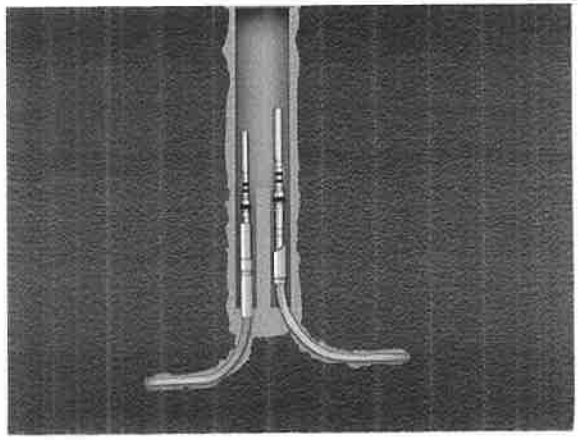
Multilateral Completions

A well in which there is more than one horizontal or near horizontal lateral well drilled from a single mainbore and connected back to the same main bore.





Level 5

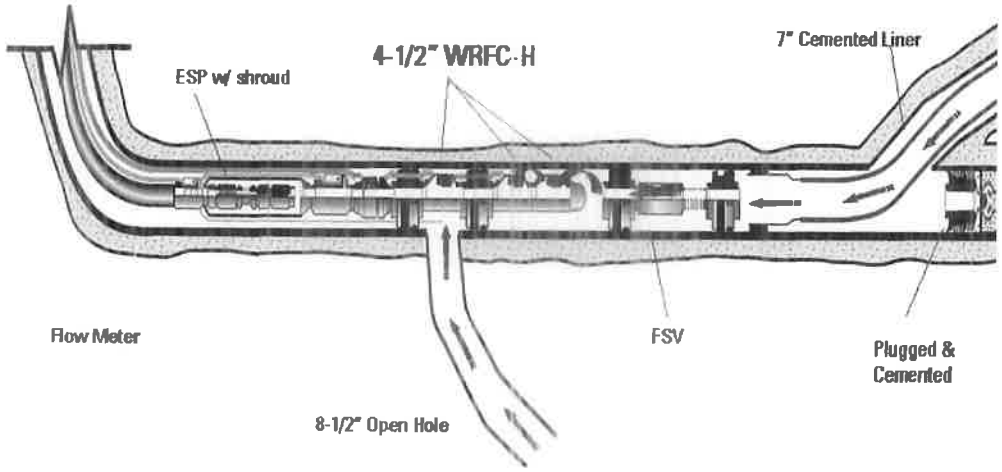


Level 6

Intelligent completions

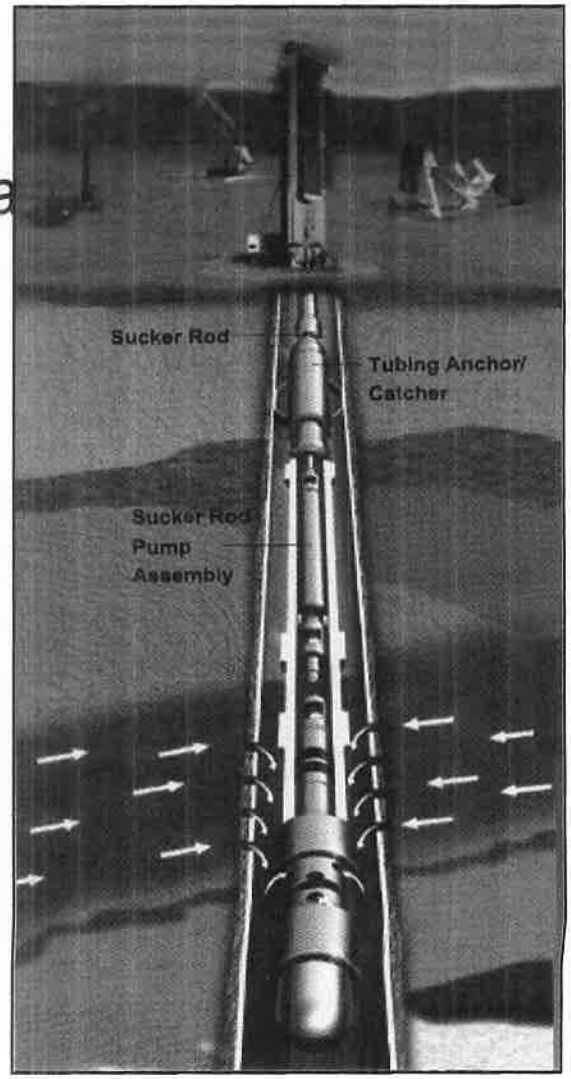
Applications:

- Enhanced production performance
  - Ability to control zones selectively
- Enhanced reservoir performance
  - Improved recovery and/or sweep
- Reduced need for intervention
  - Ability to control remotely



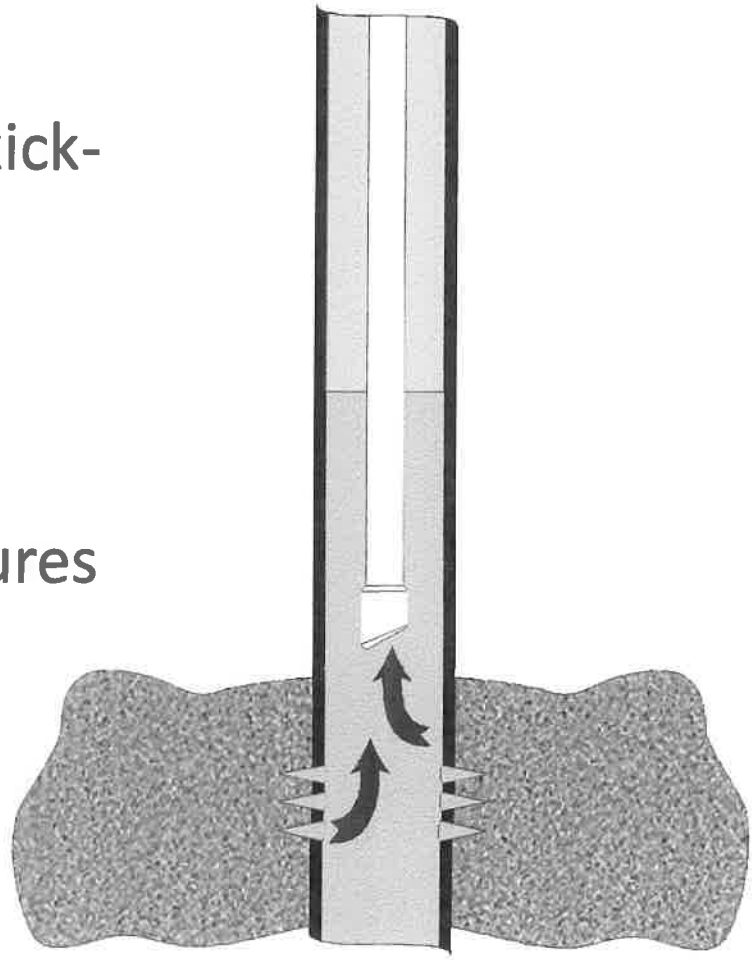
Flowing and Artificial Lift Completions

- Naturally flowing
  - enough reservoir pressure to bring fluid to surfa
- Artificial lift (depleted reservoirs)
  - Gaslift
  - Mechanical driven
  - Hydraulic operated
  - ESP pumps
  - Always requires tubing
  - CT Access to wellbore may be restricted



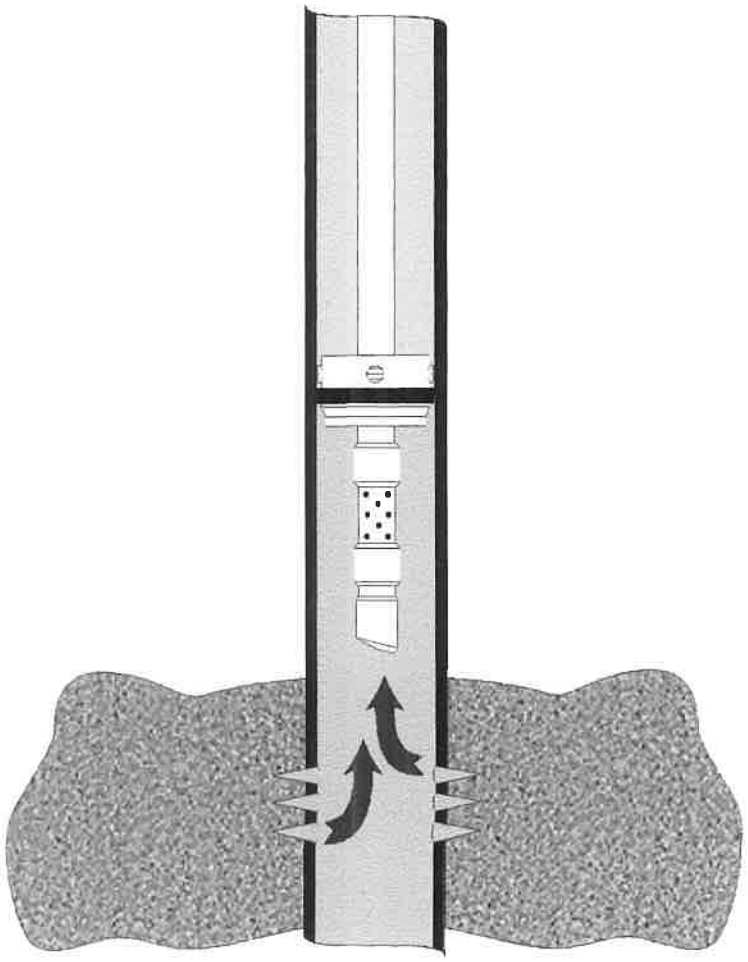
Single Zone Completion - Simple Tubing Completion

- Key features
  - Circulation capability (well kill or kick-off)
  - Improves hydraulic performance
    - In comparison with monobore completions
  - Limited protection for casing
  - Limited safety & contingency features



Single Zone Completion - Packer

- Key features
  - Circulation capability (determined by design and setting of packer)
  - Casing string protected from fluid and pressure effects
  - Additional flexibility for downhole production (flow) control, e.g., plugs
  - Facility for downhole instruments (gauges)

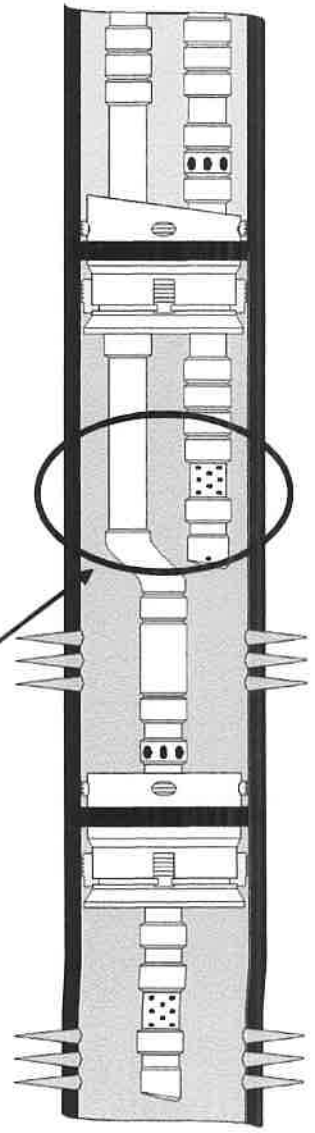


Multi-zone Completion – 2 zone/2 packer

Key features:

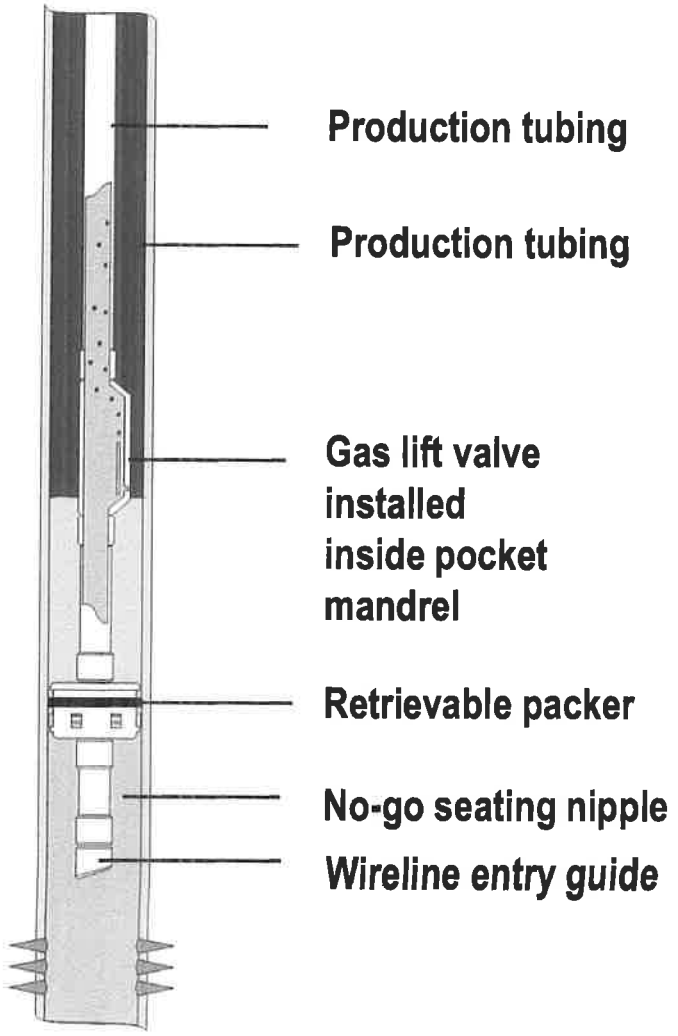
- More than one zone will be produced at the same time
- Zones are prepared to produce at different periods of time without need of major intervention (workover)
- May need: dual/triple strings, sliding sleeves
- Remedial work difficulty when more than one tubing is used

Potential risk of SL/WL or CT "snaking" around the long string

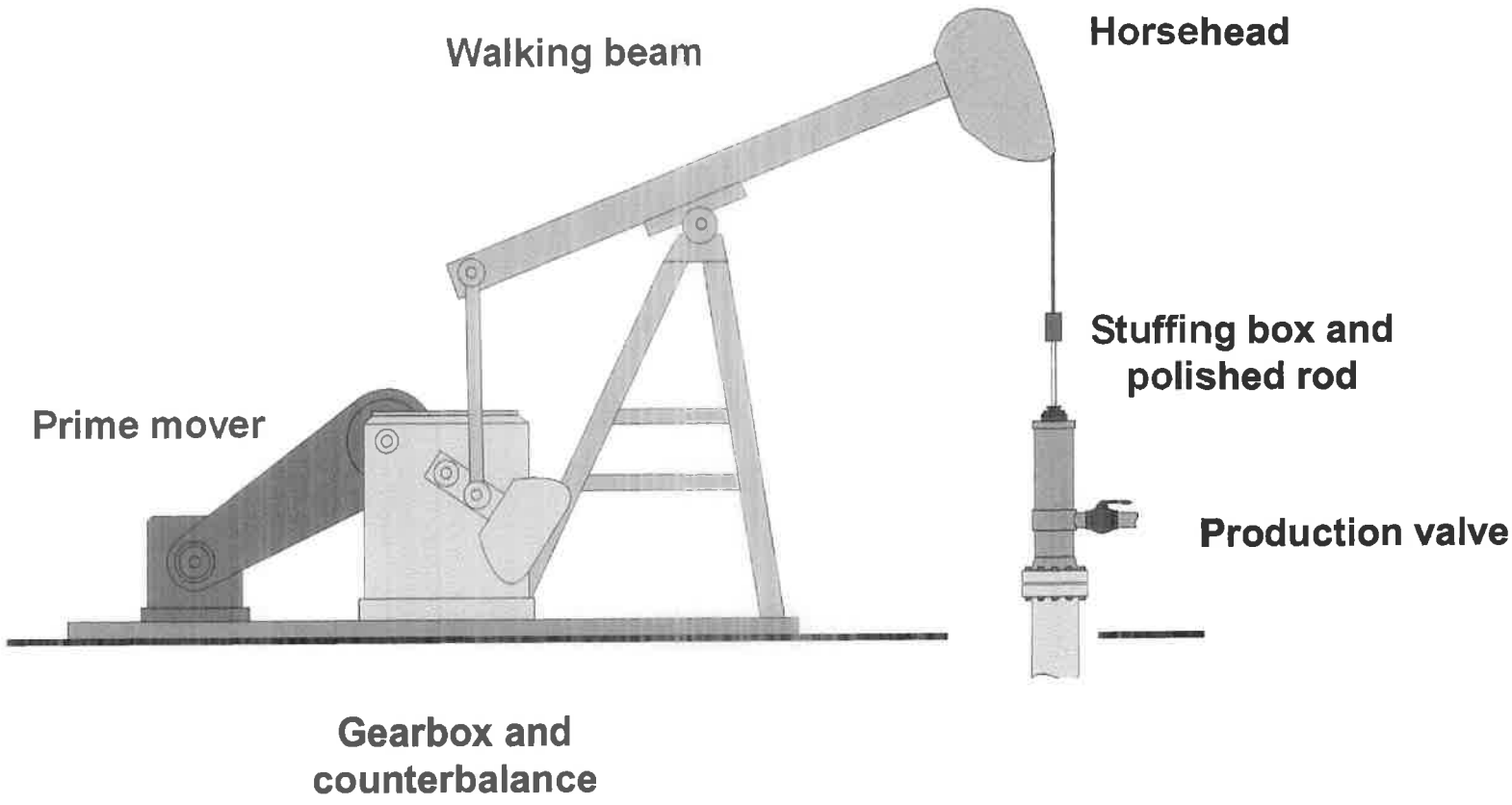


Artificial Lift Completions - Gas Lift

- Gas lift accounts for approximately 90% of offshore artificial lift completions
- System may be designed to suit most wells
- Wireline and Coiled Tubing serviceable
- Few mechanical parts
- Sand and fill tolerant



Artificial Lift Completions - Rod Pump

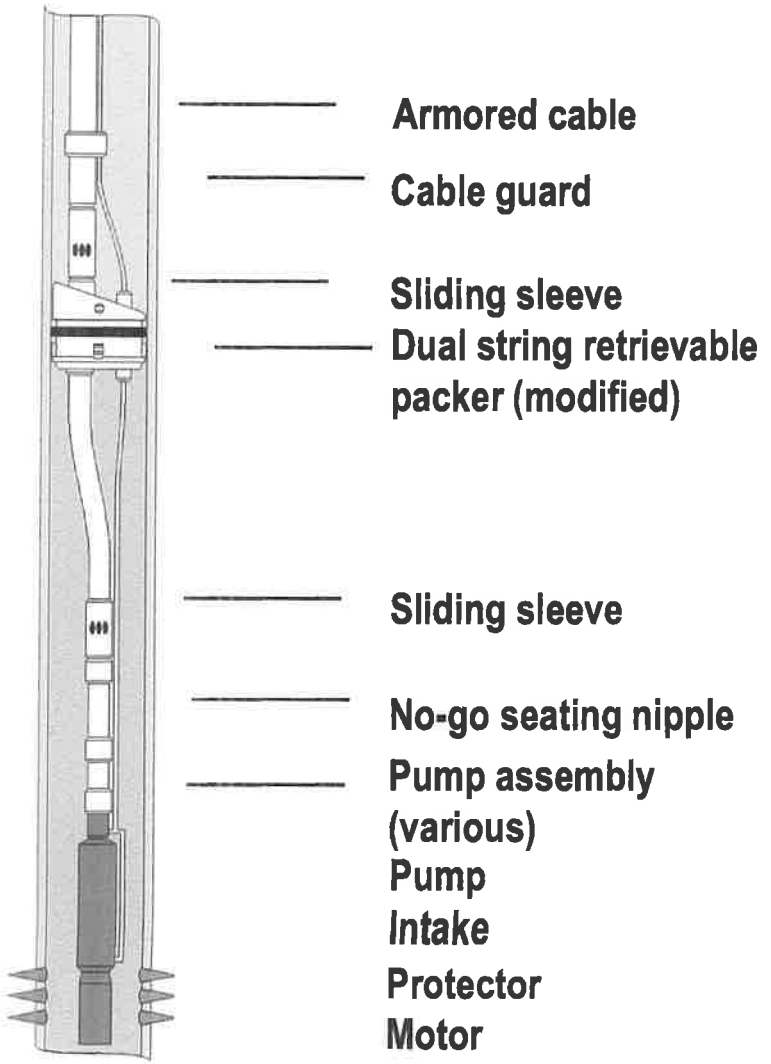


Rod Pump - Disadvantages

- Limited efficiency
- Maintenance intensive
- Well depth and deviation limitations
  - requires near vertical wellbores
- Sand sensitive
- Gas sensitive
- Wireline and CT access not possible
- Requires surface power (diesel/electric)

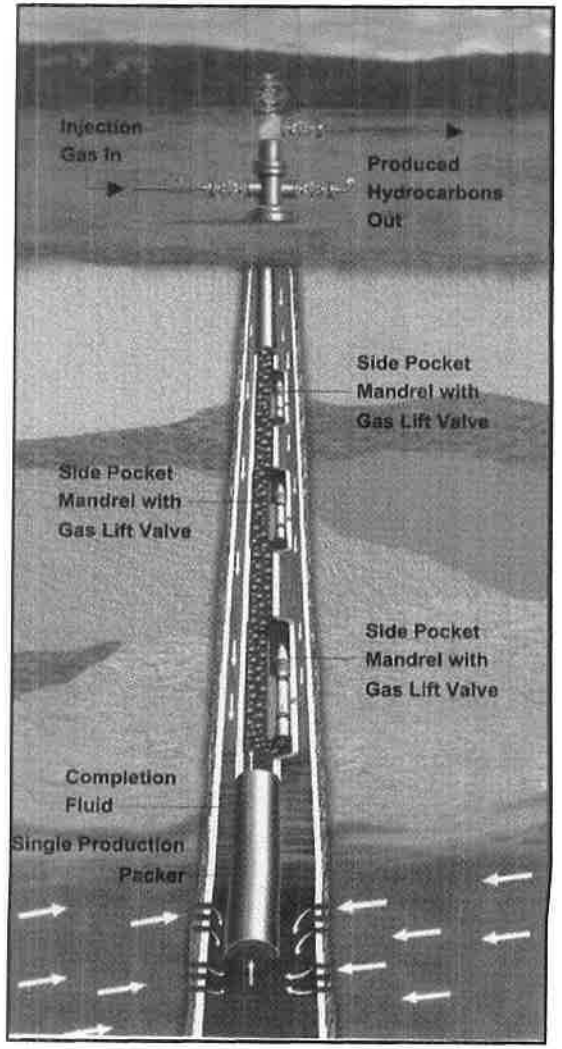
Artificial Lift Completions - Electric Submersible Pump

- Extremely high liquid production capability
- High installation and operating cost
- Suitable for low gas-to-oil ratio applications only
- Electrical components easily damaged
- Access to the wellbore for Wireline and CT restricted
  - Unless Y-Tool is present



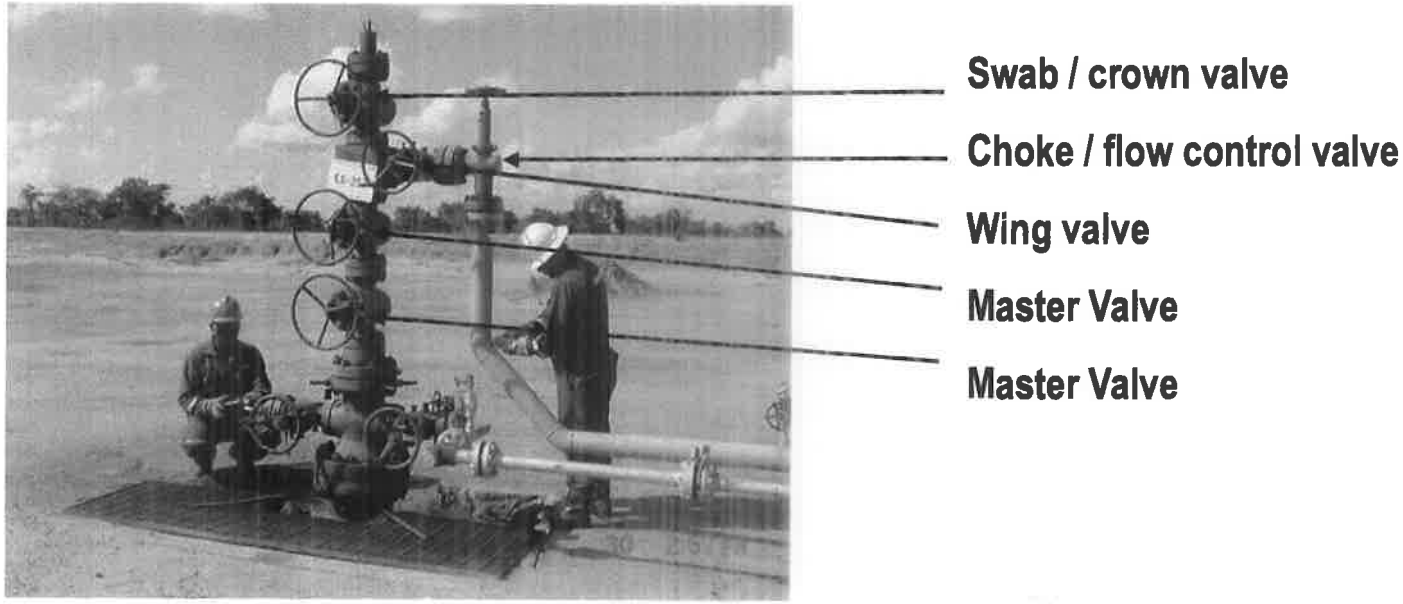
Completion main components

- X-mas tree & Tubing Hanger
- Tubing
- Sub-surface safety valves
- Side pocket mandrels
- Sliding Sleeves
- Landing Nipples
- Packers
- Wireline entry guide
- Y-Tool



The X-mas tree

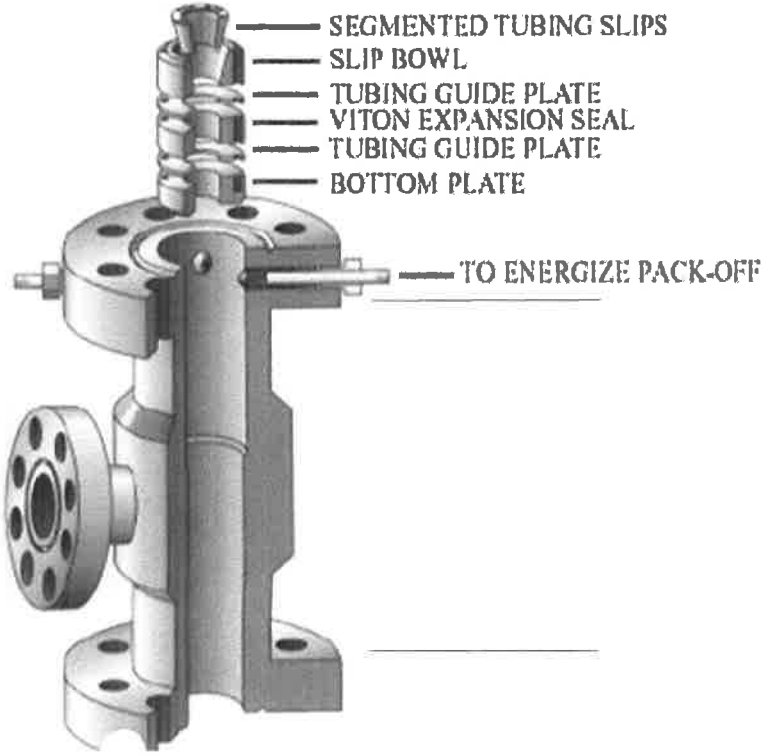
- Surface component of the completion
- Allows control of the well
- Directs the fluid to the appropriate flow line
- Allows well access/ intervention using the swab valve
- Where the surface safety valves are mounted

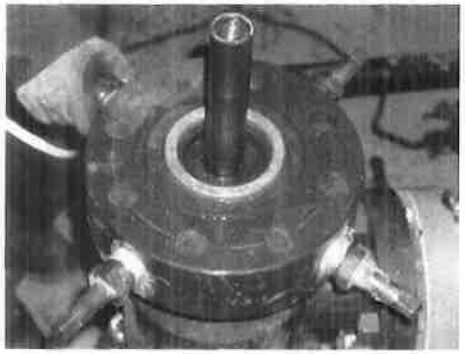


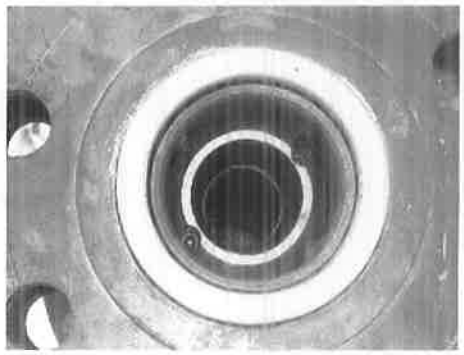
Tubing hanger

- The tubing is suspended from the tubing hanger
- Seals the annular space between the tubing and casing
- Locks tubing in place
- Provides a base for wellhead
- Provides access to annular space

Cameron
dual tubing hanger





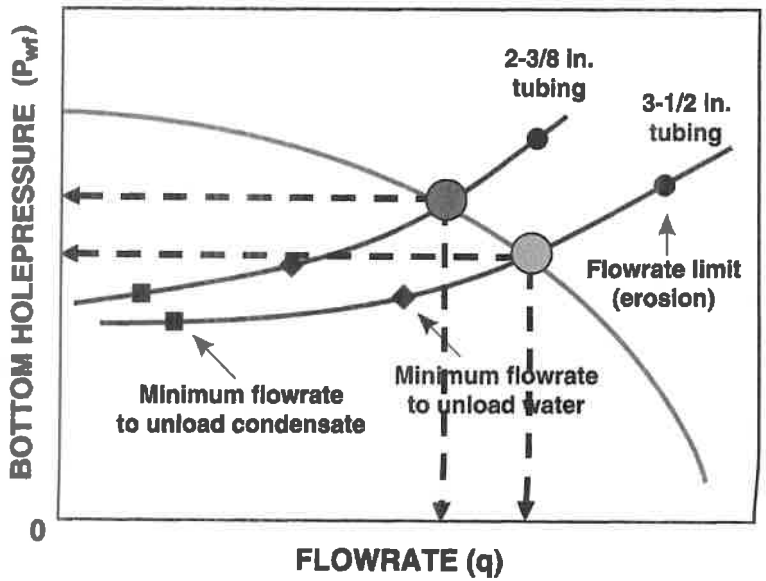


Tubing

- Small diameter pipe inside the casing or liner
  - Jointed tubing completions
  - Coiled Tubing completions
- Where hydrocarbons will flow to surface
- Allows the operator to place special devices in the string
- Protects the casing from corrosive fluids
- Different thread types and materials

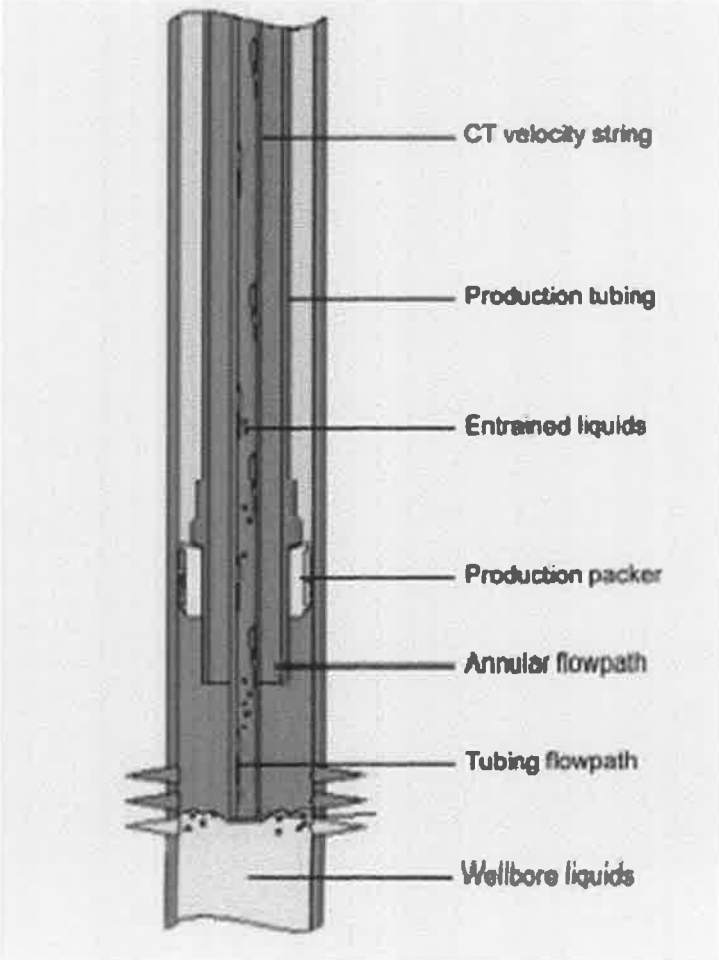
Tubing Size - Constraints

- Constraints on tubing size include:
  - Out-flow performance
  - Erosion
  - Condensate unloading rate
  - Water unloading rate

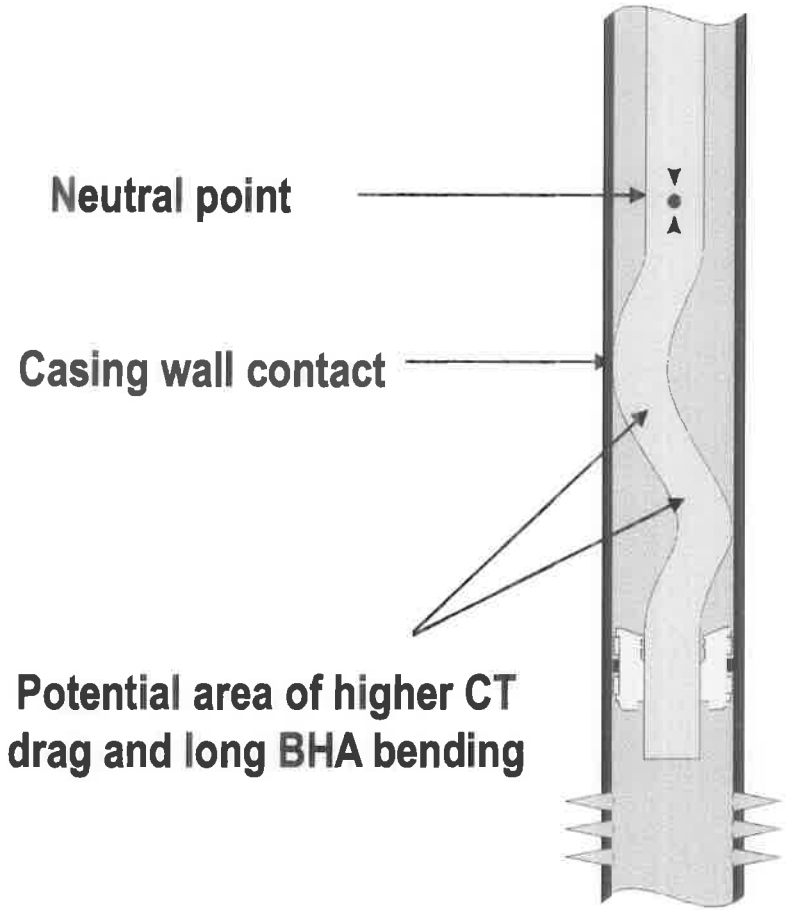


Coiled Tubing Completion - Velocity String

- Objective: help gas wells unload liquids.
- Velocity string production options:
  - CT production
  - Annulus production
  - Combined production
  - Staged, i.e. initial production through largest flow area, switching to smaller flow area as reservoir/production characteristics determine



Tubing Buckling Effect



Compression buckling example

Causes of Tubing buckling:

- Weight applied on tubing end
- Pressure changes
  - High internal delta P
- Temperature changes
- Amplified in large casings

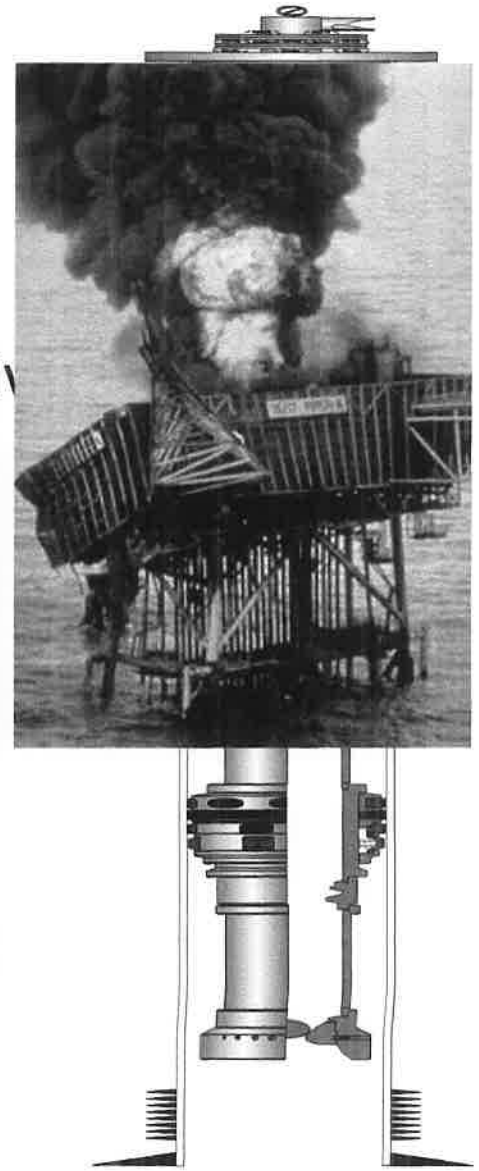
Potential problems for CT:

- Additional drag force for CT string during RIH/POOH
- Bending of longer BHA's
- Inability to pass

Sub-surface safety valves

Primary Purpose:

- Emergency well flow control device
- Prev
  envi
- It is

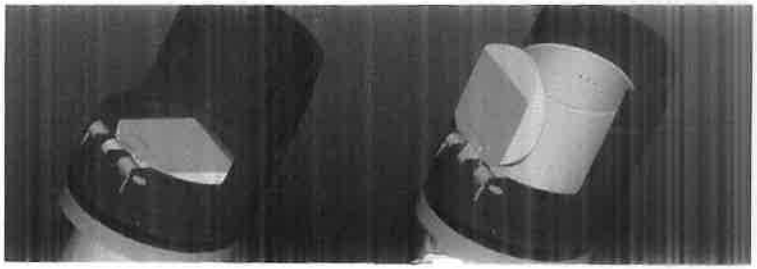


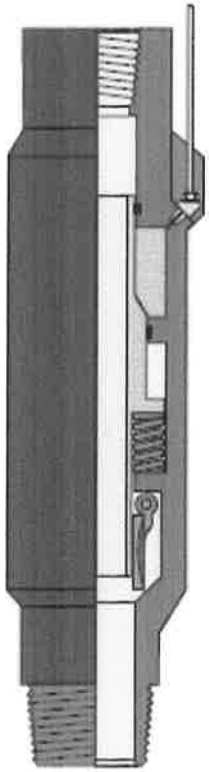
Secondar

- Dow
- Allo
  - Serves as a contingency barrier

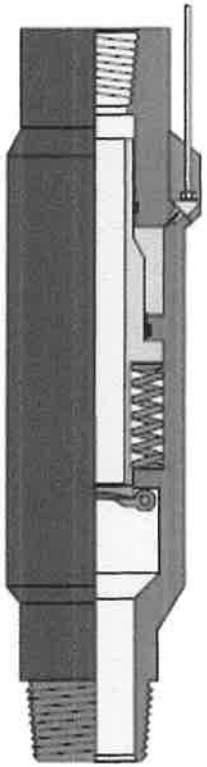
Sub-surface safety valves

- Slickline or Wireline -retrievable (WRSV)
  - VERY Restricted ID
  - scale build-up, local erosion
- Tubing retrievable (TRSV)
  - full bore ID
- Flapper or Ball Valve type
  - Flapper are most common due to higher reliability





Flapper open



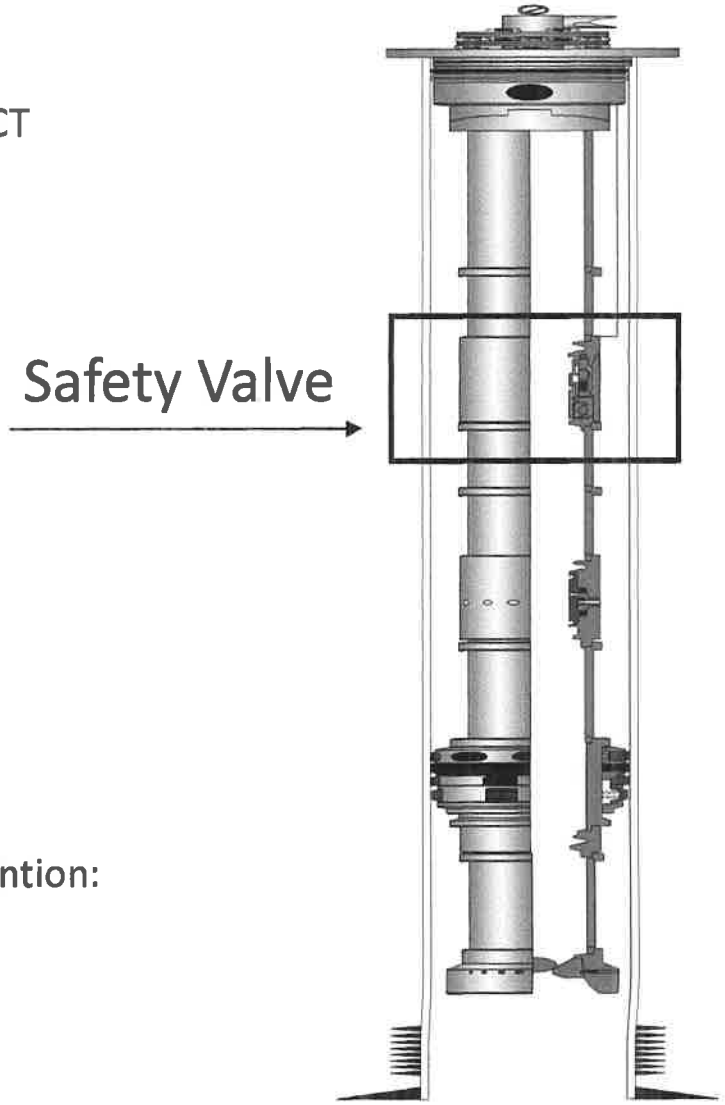
Flapper closed

WRSV and TRSV Criteria

WRSV Applications	TRSV Applications
General application: where intervention by wireline is available	General application: where larger flow area is desired for the tubing size
High pressure gas wells	High volume oil and gas wells
Extreme hostile environments where well fluids or temperatures tend to shorten the life of component materials	Subsea completions
High velocity wells with abrasive production	Multiple zone completions where several flow control devices are set beneath the TRSV
	Greater depth setting capabilities

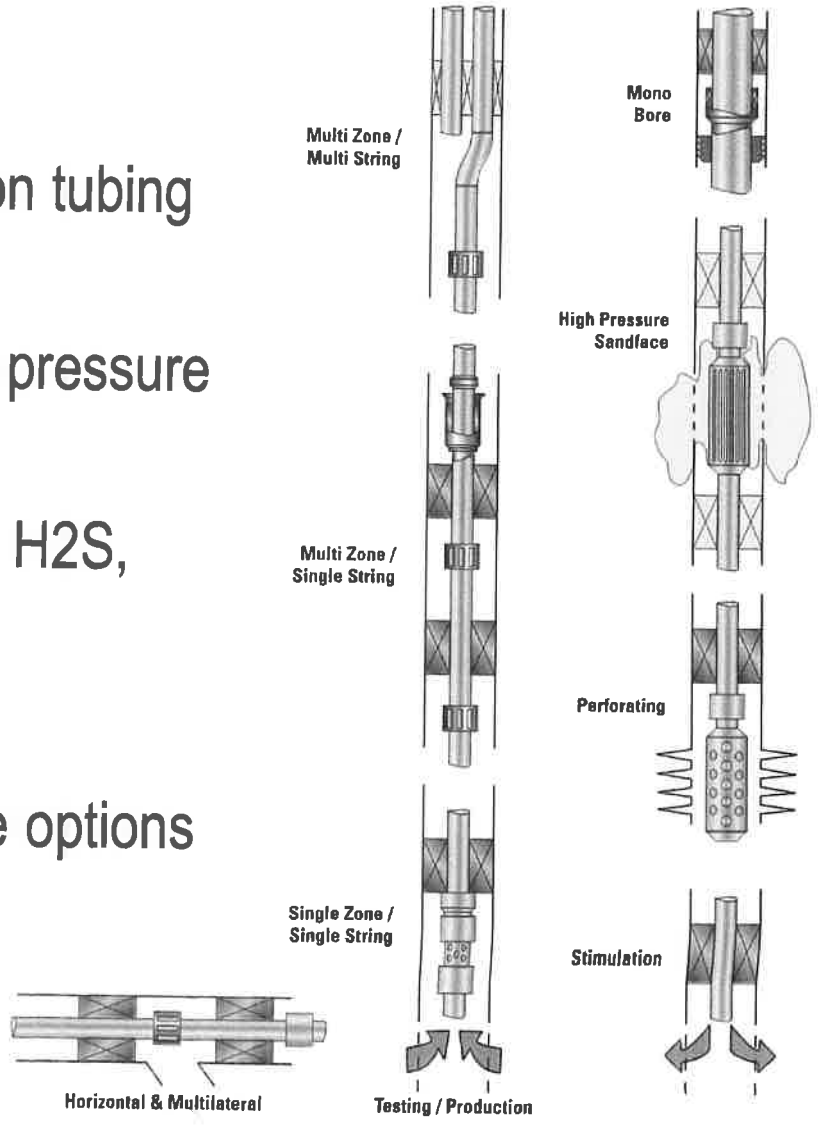
Subsurface Safety Valves – CT Considerations

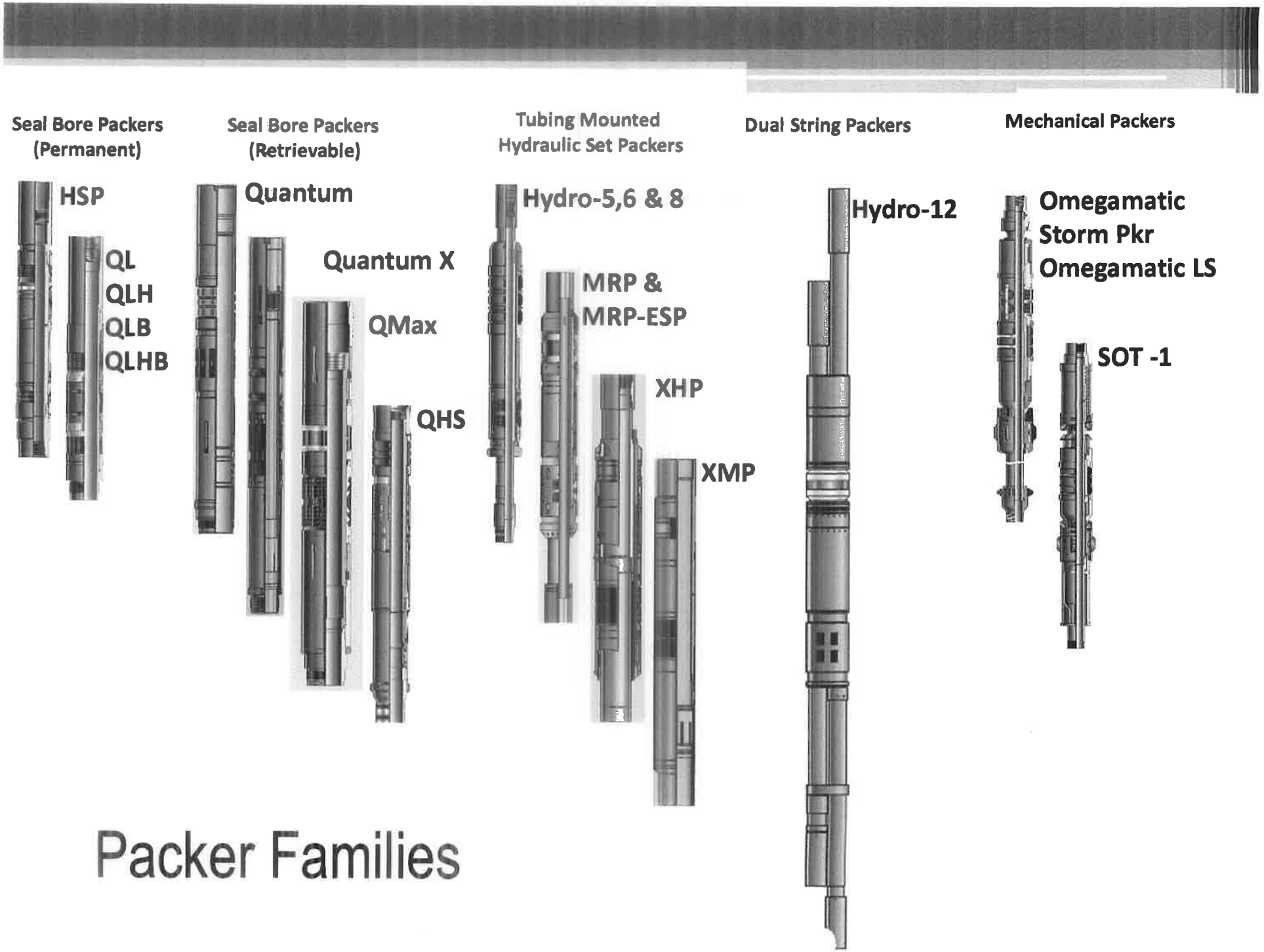
- Use of SSSV as a pressure barrier to control the well in CT operations is forbidden
- ID restriction (SSV or Hold-open sleeve)
  - CT Tools selection
- Accidental SSV closure
  - Damage to CT and SSV
- Mechanical damage of SSV
  - Milling / impact BHA's
  - Abrasion / erosion
  - Corrosion due to acids
- SSSV should be removed / protected prior to CT intervention:
  - Primary option – wireline / slickline
  - Contingency option – Coiled Tubing
  - Ultimate contingency – Workover Rig



Completions Packers - Application Summary

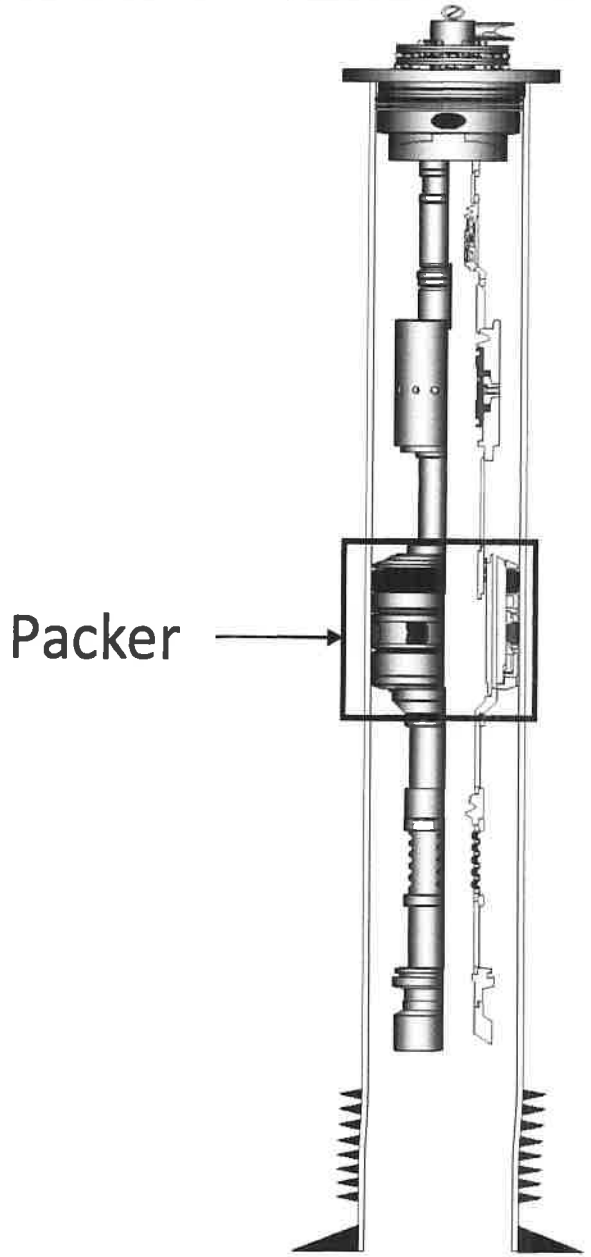
- Means of isolating annulus
- Provide anchorage for the production tubing string
- Pressure barrier between formation pressure and upper annulus
- Protect the upper casing (corrosion, H2S, pressure,..)
- Tubing-mounted and Seal-bole
- Available in Permanent / Retrievable options
  - Permanent packers have larger ID



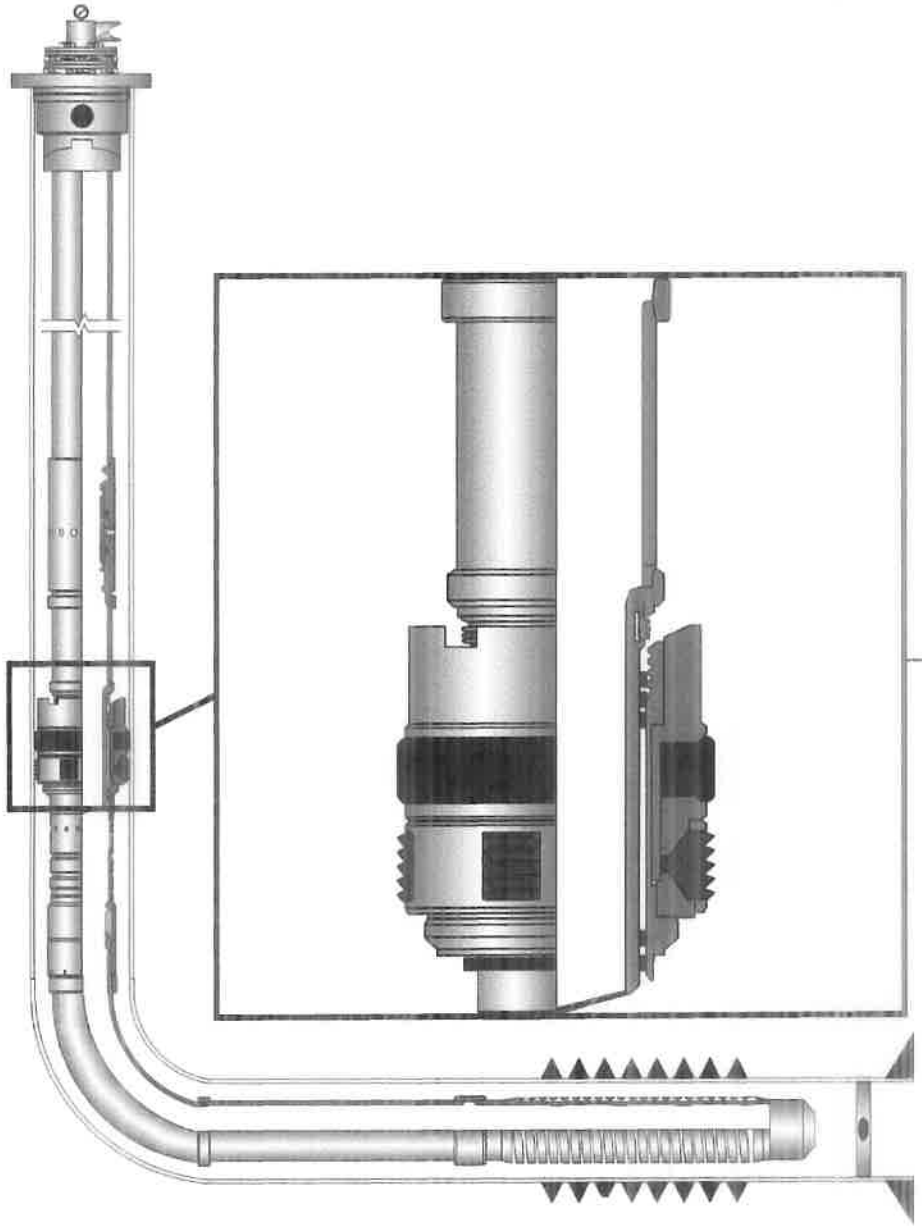

Seal Bore Packers (Permanent)
HSP
QL
QLH
QLB
QLHB
Seal Bore Packers (Retrievable)
Quantum
Quantum X
QMax
QHS
Tubing Mounted Hydraulic Set Packers
Hydro-5,6 & 8
MRP &
MRP-ESP
XHP
XMP
Dual String Packers
Hydro-12
Mechanical Packers
Omegamatic
Storm Pkr
Omegamatic LS
SOT -1
Packer Families

Packer setting options

- Mechanically set: drill pipe or tubing string (turn)
- Hydraulically set: with drill pipe or tubing (Ball drop or pressure diff.)
- Electrically set: wireline setting tool

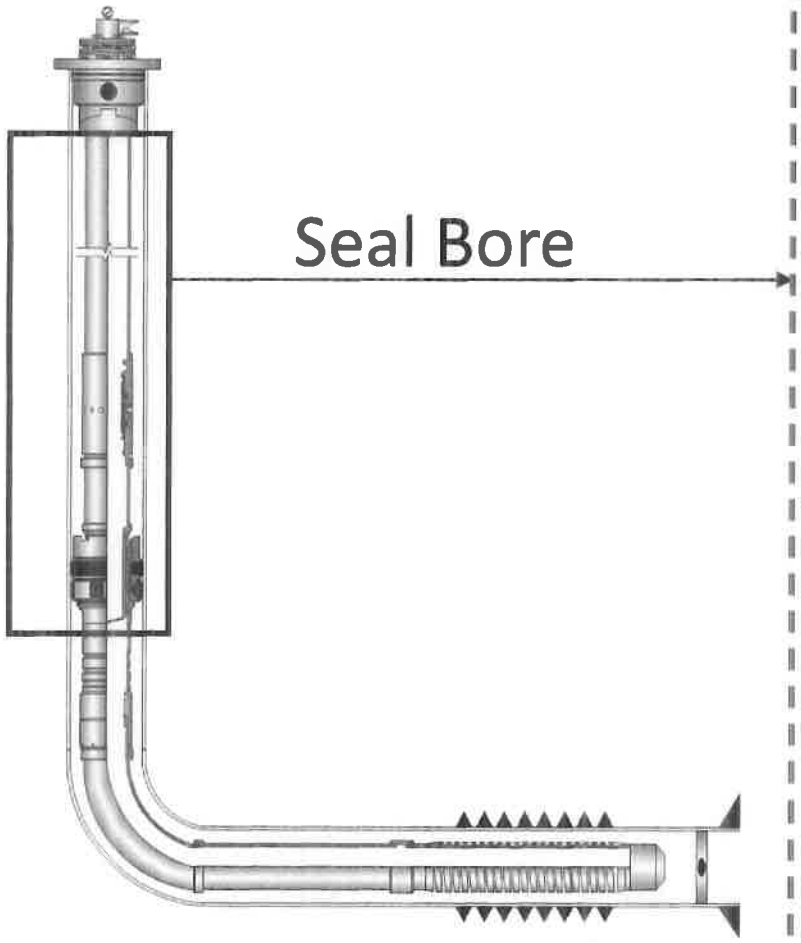


Permanent Seal Bore Packer

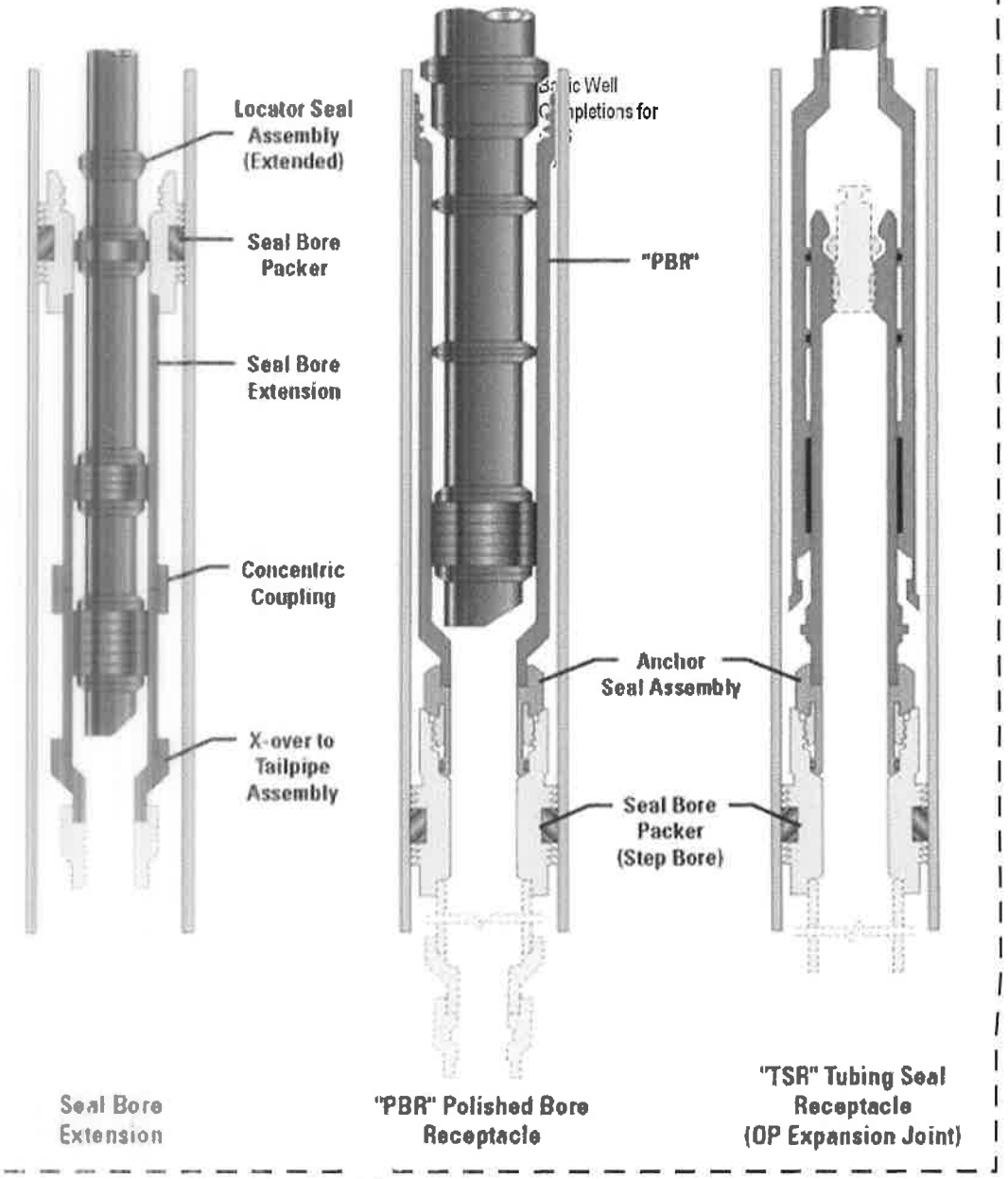


- Setting Mode
  - W/L Setting Tool
  - Hyd. Setting Tool
  - Hyd. Tubing Set
- Seal Bore Configuration
  - Single Bore
  - Dual Bore (Step Bore)
- Milled out by WO Rig

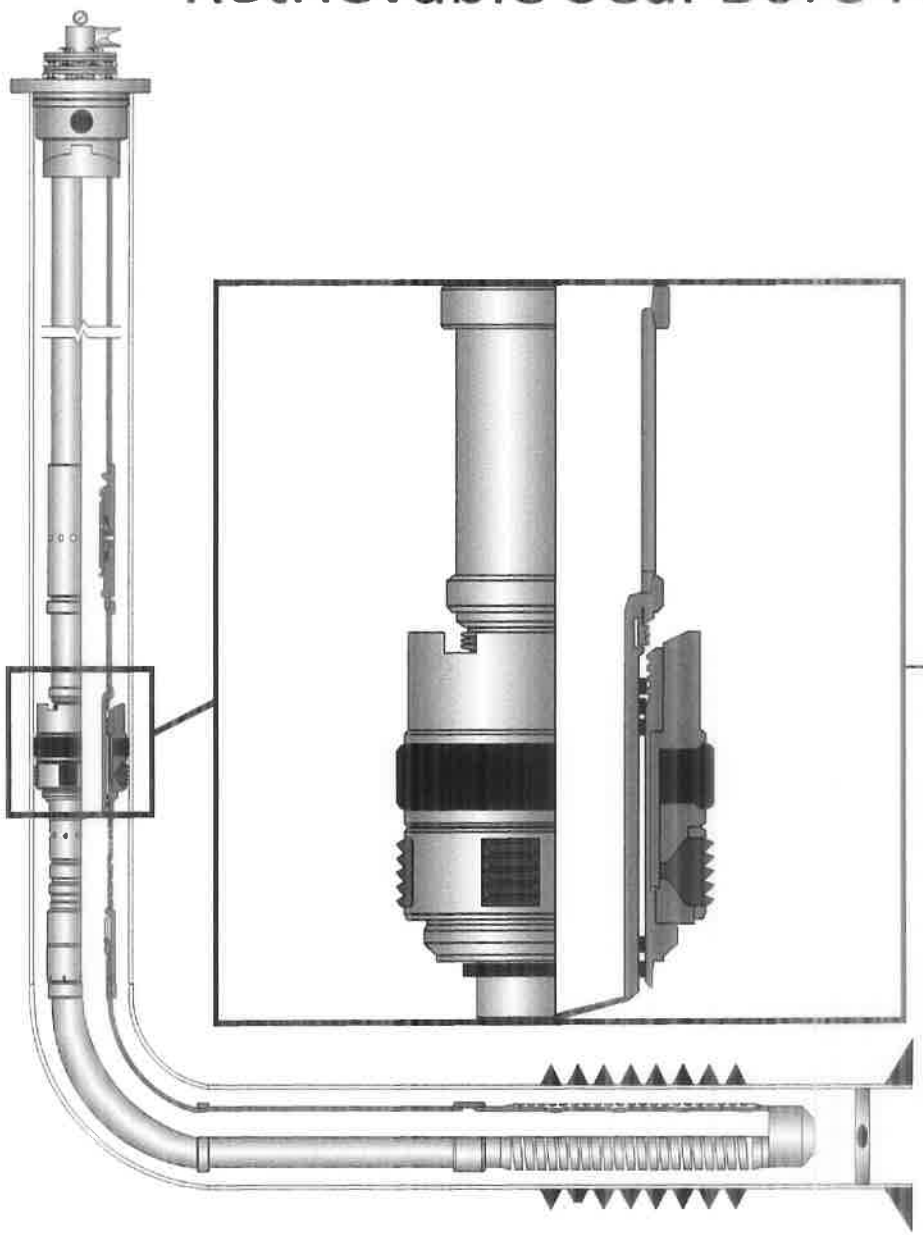
Permanent packers



Seal Bore



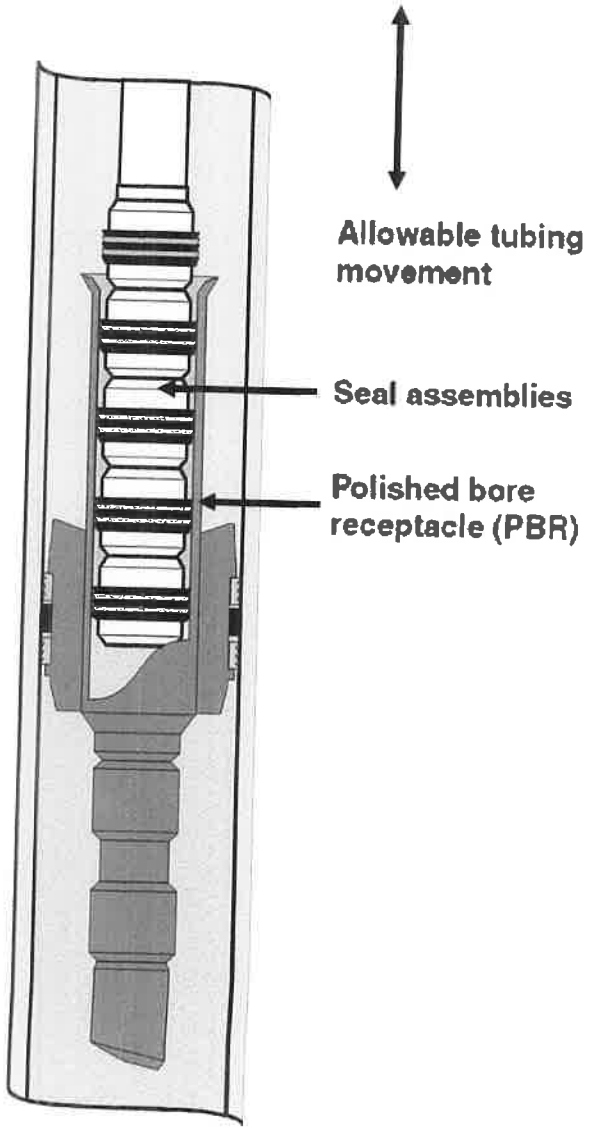
Retrievable Seal Bore Packer



- Setting Mode
  - W/L Setting Tool
  - Hyd. Setting Tool
  - Hyd. Tubing Set
- Seal Bore Configuration
  - Single Bore
  - Dual Bore (Step Bore)
- Retrieved by WO Rig

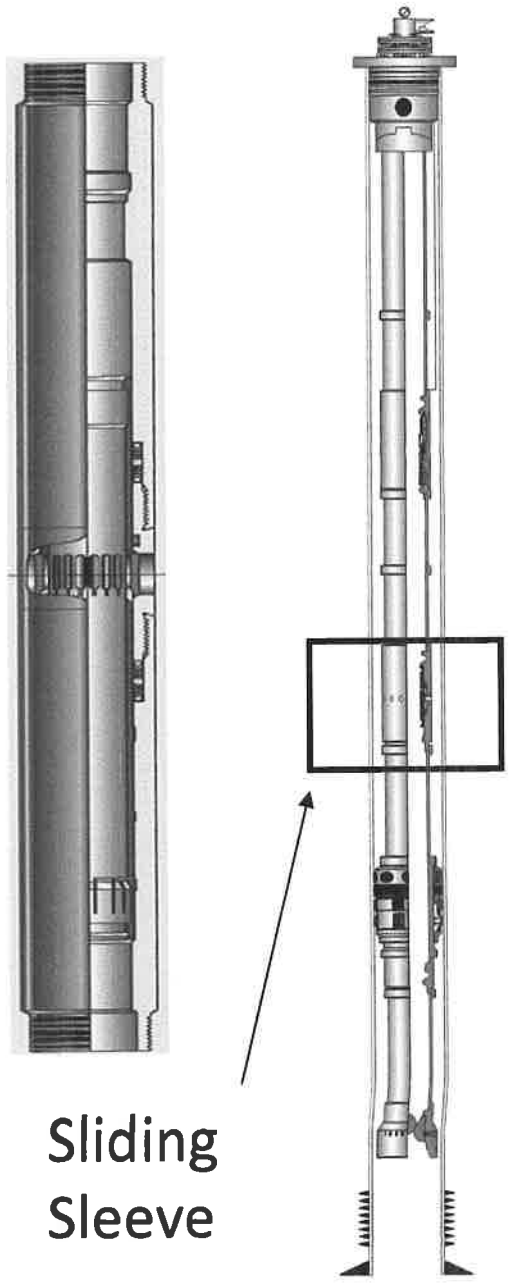
Polished bore receptacle (PBR)

- Allow thermal expansion and contraction of tubing string between fixed points
- Allows tubing disconnection and re-connection of the upper completion (with sealing)
- Composed of a selection of elastomers and wiper rings depending on down hole conditions



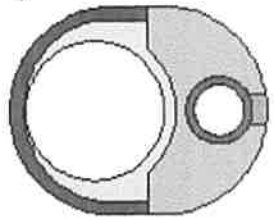
Sliding Sleeves

- Provide an efficient, high volume, method of circulating between tubing and annulus
  - Selective zone producing
  - Selective zone testing
  - Fluid circulation (treatment)
  - Gaslift (in absence of proper GLM) or with concentric GL valves
  - Well kill prior to WO or in contingency
- Reduced internal diameters
- Can be operated by WL/SL or CT by using special shifting tools
  - Downward and upward
  - Intentionally or unintentionally
    - Avoid tapered BHA design!

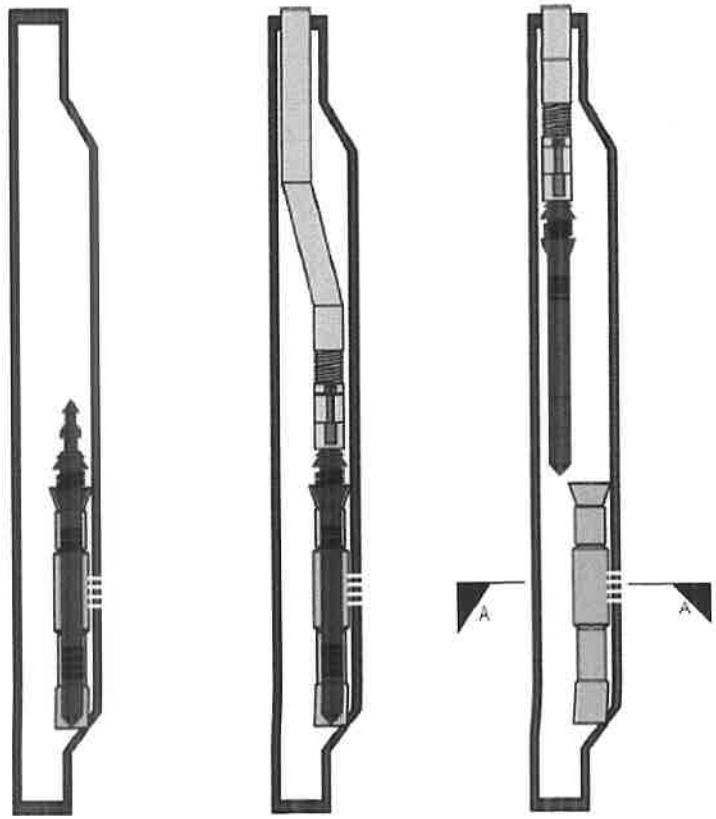


Side pocket mandrels (GLV / GLM / CIV)

- Communication annulus/tubing as part of:
  - an artificial lift completion – GLV
  - Chemical injection - CIV
- A valve is located to let the gas/chemical enter the tubing
  - to lift the oil
  - Corrosion / scale inhibition
- More than one may be found in a well
- Presence of CIV's may indicate potential scale/corrosion problems in the well

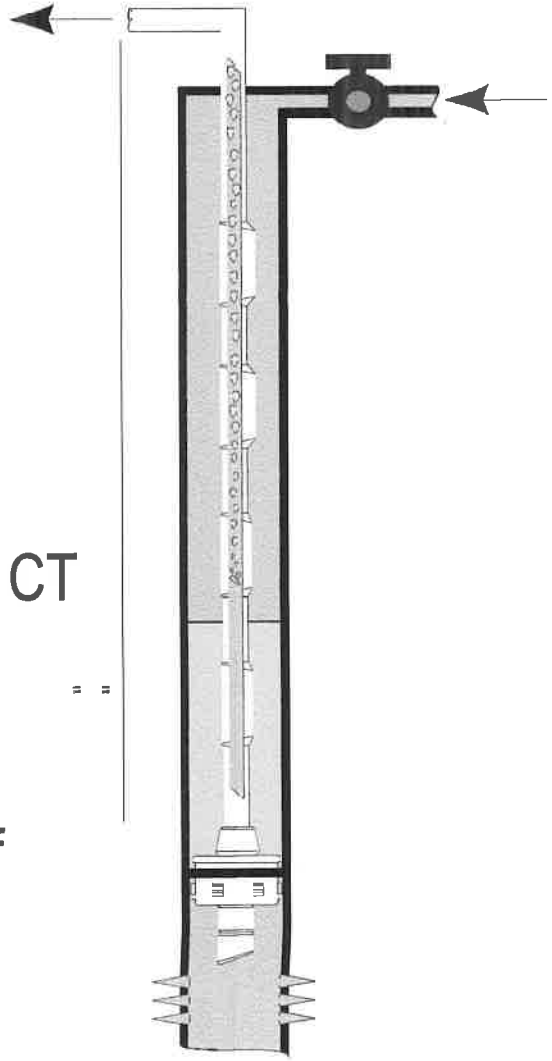


Section A - A



GLV / GLM – Coiled Tubing Considerations

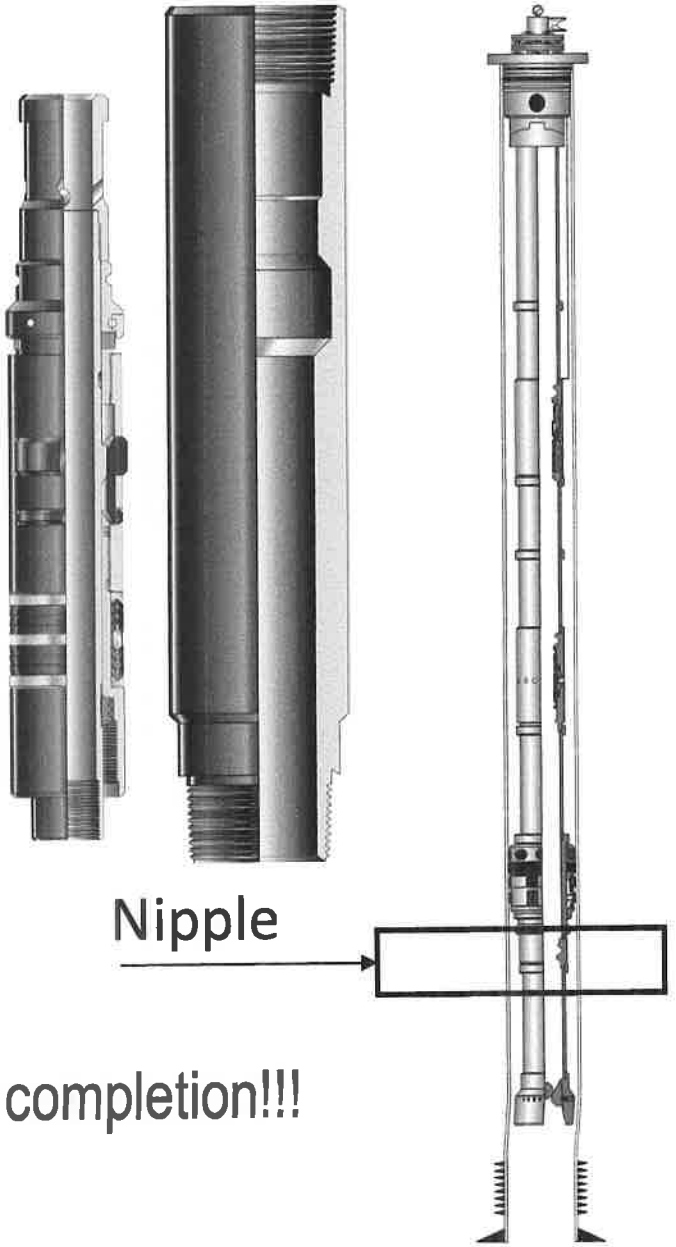
- A presence of GLM / GLV may potentially indicate
  - low reservoir pressure
  - ID restriction (scale build-up due to PVT changes)
- CT may have problems passing
  - Consider use of knuckle joints
- Side pockets may accumulate some debris during CT wellbore cleanouts and scale removal jobs
  - A cleaning pass may be a good idea as CT is POOH
- Presence of GLM may eliminate / reduce usage of Nitrogen on CT jobs
  - Discuss with Client first



Landing Nipples

Allow the landing & locking of multiple accessories in the tubing string

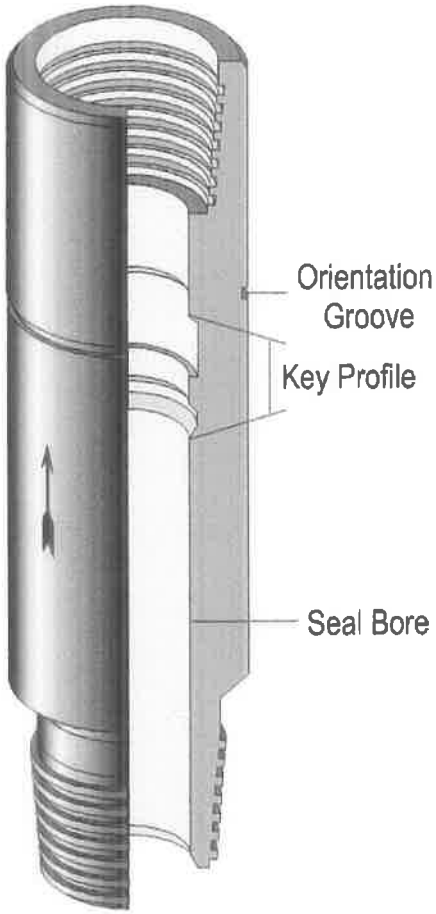
- Flow control
- Plugging devices
- Coming with different profiles
- Basic types:
  - selective
  - no-go (non-selective)



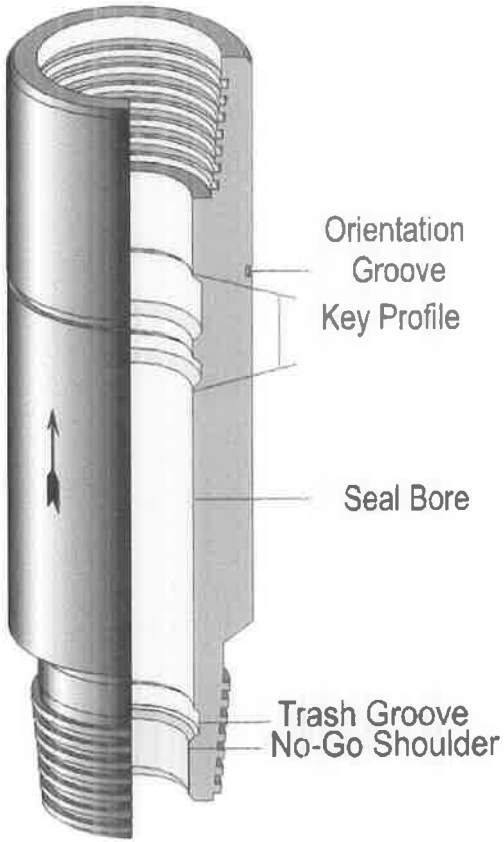
They are normally the minimum restriction in the completion!!!

- this is also where the debris can rest

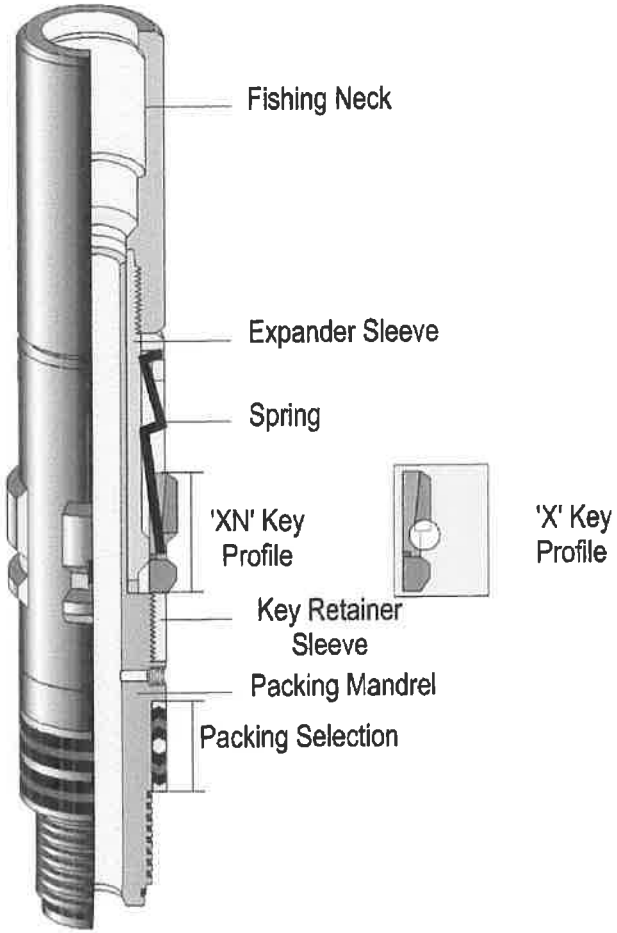
Landing Nipples and Lock Mandrel example



'X' Selective Landing Nipple



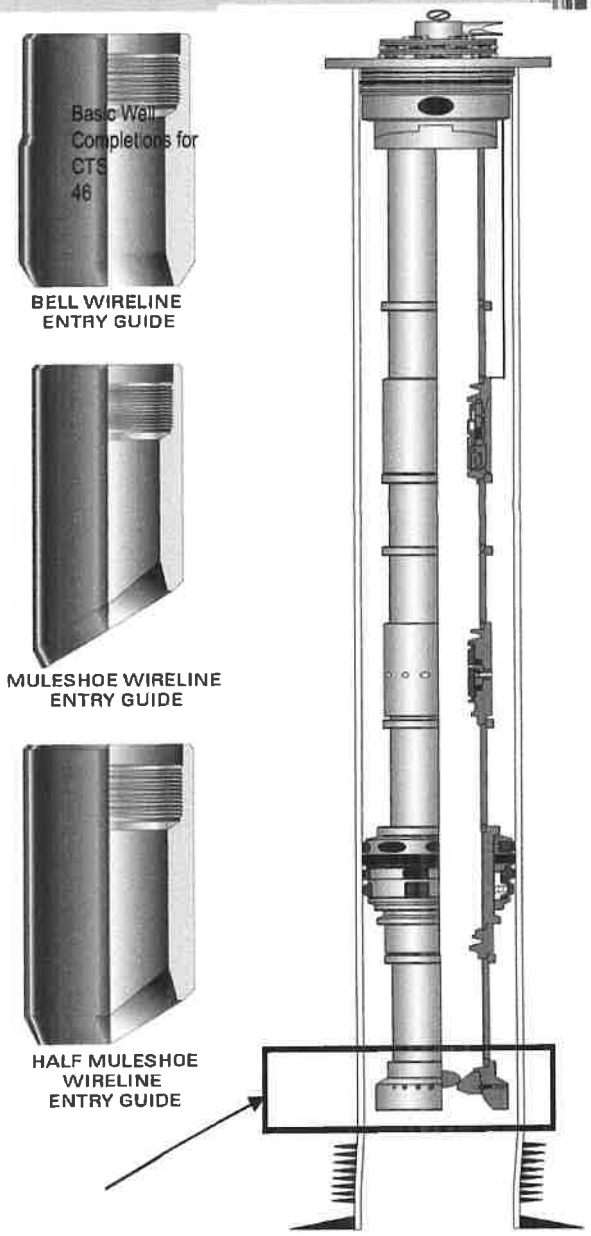
'XN' No-Go Landing Nipple



Type 'X' or 'XN' Lock mandrel

Wireline entry guide

- Base component of production tubing string
- Guide re-entry of intervention tools into tubing
- Allows for ease of liner top entry (e.g. high deviation wells)



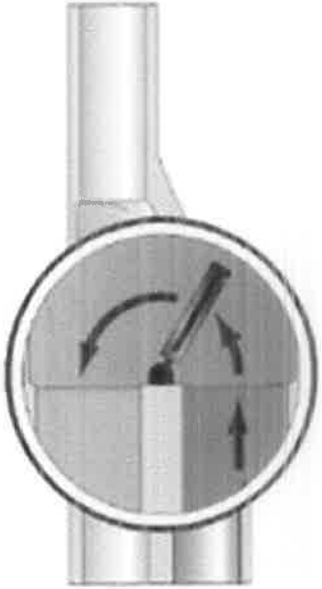
Wireline Entry guide

ESP By-Pass Components

- Coiled Tubing and Wireline Logging
- Well stimulation through CT or By-Pass tubing
- Retrieval of plugs below ESP
- Bridge plugs can be set for water shut-off
- TCP guns deployed and detonated below ESP
- Memory gauge deployment below ESP
- Wireline perforating below ESP
- Bottom hole samplers can be deployed
- Back-up ESP deployed on By-Pass Tubing

ESP By-Pass Components - Auto Y-Tool

Pump Not in Operation



Pump Start-Up

Pump in Operation

Wireline or Coiled Tubing Operations with Pump Running

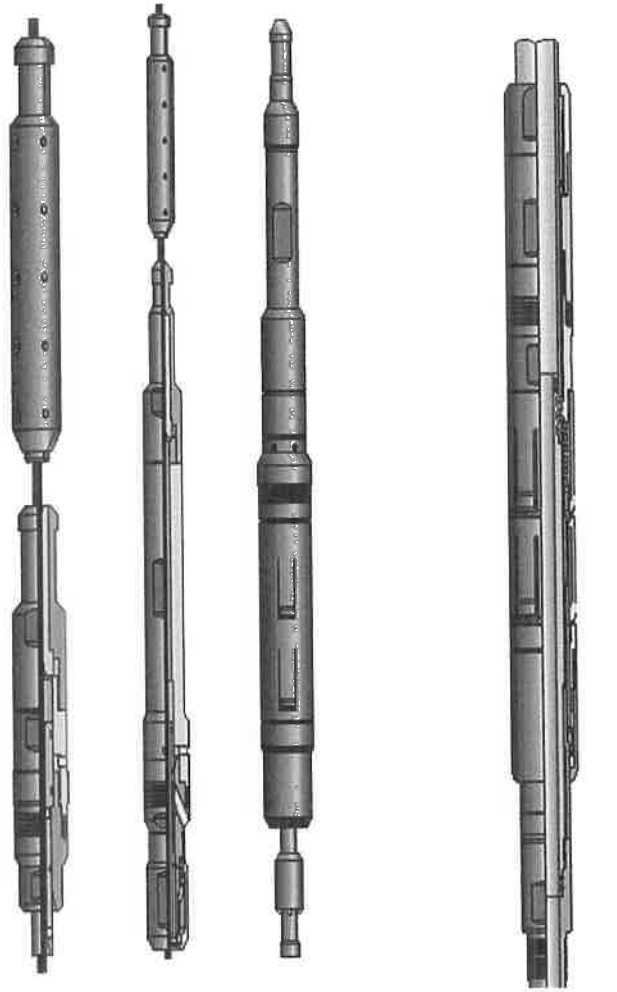
Blanking Plugs

- With Collets
  - Simple
  - Easy to run / retrieve
  - Compatible with Auto Y-Tool
- With Lock
  - As above
  - Suitable for free flowing wells
  - Can be deployed with Coiled Tubing

Logging Plugs

- Wireline Logging Plugs
  - Standard Wireline Logging Plug
  - Wireline Logging Plug with Catcher
  - Self Seating Logging Plug

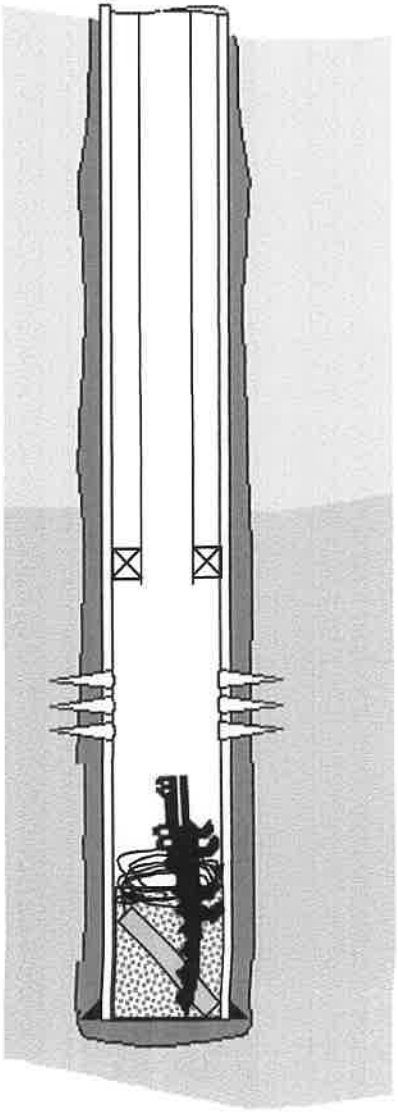
- Coiled Tubing Logging Plug
  - Automatic Release
  - Lock Facility
  - Easy to Redress
  - Suitable for various sizes of Coil Tubing
  - Field Proven



Wireline LP CT LP

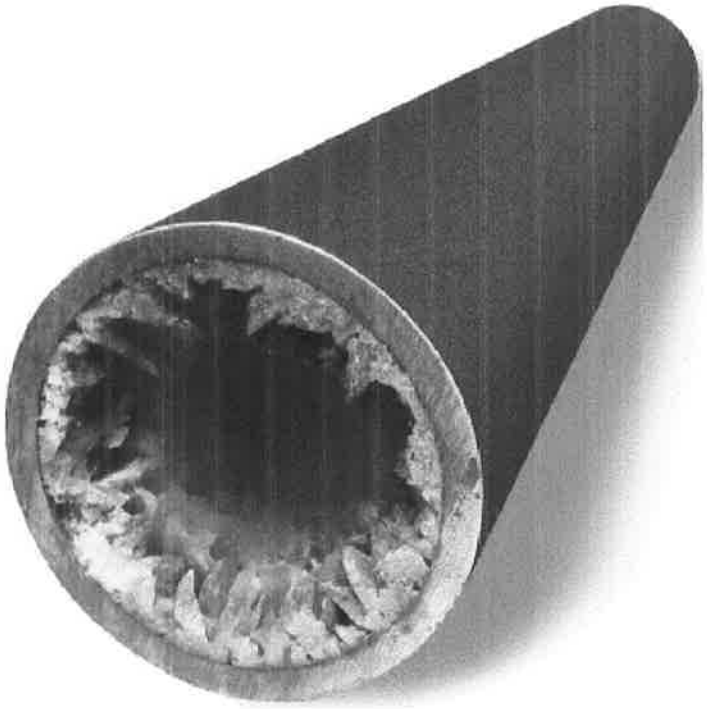
Performing CT Operations on Bottom

- Wellbore sump (rat-hole) designed to contain completion and workover debris
- Potential problems for CT operations:
  - Potential BHA nozzle plugging
  - CT string sticking (solid tag, overpull, wedging)
- Preventive measures:
  - Obtain detailed well information
  - Expect the unexpected:
    - Observe string weight at all times
    - Do not go in the sump without a reason:
      - This is where fish sleeps, waiting for its prey…



Completion Deposits consideration

- Scales
  - Organic (wax, asphaltenes, paraffines, hydrates)
  - Inorganic (FeS, $CaCO_3$, $BaSO_4$, gypsum)
  - soluble and insoluble
- Can effect:
  - Production efficiency
    - production restriction
    - increased pressure loss
    - interference with production equipment
  - Wellbore and reservoir maintenance
    - obstructed access
    - compatibility with proposed reservoir treatments



CT Considerations Summary

- Obtain detailed well information including recent well interventions (WO, CT, wireline, slickline etc). This is important to:
  - Avoid CT entry problems due to
    - ID/OD mismatch
    - Additional drag forces in the wellbore (Tubing Deformation Analysis)
    - Potential wellbore problems (ice plugs, scale, parted tubing, etc.)
  - Eliminate accidental jewelry manipulation
  - Eliminate jewelry damage (mechanical, chemical, abrasive)
  - Maximize treatment efficiency
  - Make sure you:
    - Understand all unfamiliar components (do's and dont's)
    - Confirm the well history events

CT Considerations Summary (continued)

- Review Job design with the Client.
  - Resolve any remaining concerns
  - Develop contingency plans
- Execute job carefully with respect to treatment objectives AND Completion factors
  - Minimize sharp OD changes in the CT BHA
  - slow down, weight checks, circulation vs. no circulation
  - Expect the unexpected => STOP, THINK, ACT

TEST PAPER
Basic Completions
10 Questions / Maximum 30 minutes

Instruction:

1. *This questions paper consists of 1 Section: Basic Completions*
2. *All question in Objective form*
3. *Answer all the question*

NAME	
POSITION	
DATE	

.....FOR ASSESSOR USE ONLY.....

Section	SCORE	MAX SCORE	REMARKS /COMMENTS
1.Basic Completion		10	
TOTAL SCORE %			
ASSESSOR NAME			
TEST RESULT (Passing Marks = 75%)	☐ PASSED	☐ FAILED	

Sections 1: Basic Completions

1. What is a completion
   A) Operation to complete a well for P/ A job
   B) Operation to complete a well for production
   C) Operation to kick of a well for production
   D) Operation to drill of a well for production

2. Define SPM
   A) Side pocket mandrel
   B) Side pocket manifold
   C) Side production mandrel part

3. What part is smallest Id in the completion well
   A) Landing Nipples
   B) Re-entry guide
   C) Side pocket mandrel
   D) Flow coupling

4. How many number of casing will be available after completion of drilling
   A) 1
   B) 2
   C) 3
   D) 4

5. What the name of first layer of casing
   A) Surface casing
   B) Conducted casing
   C) Production casing
   D) Intermediate casing

6. Where is the back pressure valve (BPV) installed in the tree
   A) Blast joint
   B) Landing nipple
   C) Tubing hanger
   D) Side pocket mandrel

7. Name two type of wireline Entry guide
   i. _____
   ii. _____

8. Name two type of packer
   i. _____
   ii. _____

9. Permanent packer can only be retrieve by milling
   A) True
   B) False

10. How is SSV operated
    i. Pneumatic
    ii. Differential pressure
    iii. Ambient control
    iv. Hydraulic

    A) I & II
    B) I & IV
    C) II & III
    D) I, II, III, IV

Neu Dimension

ATTENDANCE FORM

TOPIC/SUBJECT : Well completion
DATE : 24/02/2020
VENUE : CTS Meeting Room

DAY : Monday
TIME : 2:30 p.m

NO	NAME	POSITION	SIGNATURE
1.	Yusoff		
2.	Taufiq		
3.	Nazri		
4.	Hamis		
5.	Shahril		
6.	Ufizaal		
7.	Firdaus		
8.	Engku Nazri		
9.	Syukri		
10.	Mat Nor		
11.	Zalam		
12.	Aizam		
13.	Nursi		
14.			
15.			
16.			
17.			
18.			
19.			
20.			

TRAINING COORDINATOR:

NO	NAME	POSITION	SIGNATURE
1.			
2.			
3.			

REMARKS:

DIMENSION BID

CTS PRESENTATION ASSESSMENT FORM

Presenter's Name	MOHAMED Faiz .	**Date**	24/02/2020 .
Position	SENIOR EO .	**Location**	K.S.B .
Topic	COMPLETION .		
Objective			

Rating: ***Improvement Needed*** *(IN)* ***Adequate*** *(A)* ***Strong*** *(S)*

	Presentation Skill	**Rating**	**Comment**
	a. The presenter was well prepared and delivered the material in a clear and structured manner.	S	
	b. The presenter was knowledgeable about the topic and able to relate the importance of the subject matter to his job	S	
	c. The presentation contained practical examples and useful techniques that applied to current work.	S	
2	**Creativity**		
	a. Did the presenter show creative thinking in the method of development and presentation?	S	
	b. Did presenter get audience involved in "learning" the material?	S	
3	**Content**		
	a. Did the presenter cover all the key points of the subject matter	S	
	b. Did the presentation incorporate strong, effective supporting material throughout?	S	
	c. Did the presenter give clear and concert explanation and example?	S	
	d. Was the presenter able to answer questions on subject matter? Answers were correct and corresponded with the required understanding?	S	
4	**Overall Assessment**		

Additional Comments:

- GOOD PRESENTATION -

Assessed By:	Verified By:
Name: YUSOF MUDA .	Name: NAZRI
Position: FOREMAN .	Position: FRM
Date: 24/02/2020 .	Date: 24/02/20

CTS PRESENTATION ASSESSMENT FORM

Presenter's Name	MOHD FAIZ BASHIR	Date	24/02/2020
Position		Location	CTS MEETING Room
Topic	BASIC COMPLETION		
Objective			

Rating: ***Improvement Needed*** *(IN)* ***Adequate*** *(A)* ***Strong*** *(S)*

		Rating	Comment
1	**Presentation Skill**		
	a. The presenter was well prepared and delivered the material in a clear and structured manner.	S	
	b. The presenter was knowledgeable about the topic and able to relate the importance of the subject matter to his job	S	
	c. The presentation contained practical examples and useful techniques that applied to current work.	S	
2	**Creativity**		
	a. Did the presenter show creative thinking in the method of development and presentation?	S	
	b. Did presenter get audience involved in "learning" the material?	S	
3	**Content**		
	a. Did the presenter cover all the key points of the subject matter	S	
	b. Did the presentation incorporate strong, effective supporting material throughout?	S	
	c. Did the presenter give clear and concert explanation and example?	S	
	d. Was the presenter able to answer questions on subject matter? Answers were correct and corresponded with the required understanding?	S	
4	**Overall Assessment**	S	

Additional Comments:

Assessed By:	Verified By:
Name: TAUFIQ ISMAIL	Name: NAZKI
Position: CT SUPV	Position: FSM
Date: 24/02/2020	Date: 24/02/20