WELL INTERVENTION WELL CONTROL

--IWCF WI LEVEL 3/4--

CHAPTER 4

Coiled Tubing Equipment

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OVERVIEW – COILED TUBING EQUIPMENT CHAPTER

Everything.. about Coiled Tubing Equipment...

- Applications
- Surface Equipment
- Pressure Control Equipment
- Equipment Rig Up Procedure
- Barrier Terminology
- BOPs
- Equipment Testing
- Shut In Procedures
- Contingency Procedures

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COILED TUBING EQUIPMENT

WHAT IS COILED TUBING?

Coiled Tubing is a continuous length of small diameter **steel** or **composite** tubing that is flexible enough to be wound on a large drum, much in the same way as wire or cable. In order to be snubbed and stripped into and out of the well, the Coiled Tubing has to be straightened and recoiled.

Main advantage of Coiled Tubing is that it can be run into production wells, **against high wellhead pressures** and down to the bottom of a well, **without killing the well**

SIZE RANGE: 7/8" TO 4-1/2" [STEEL]

COMPOSITE CT

CT WITH WIRE

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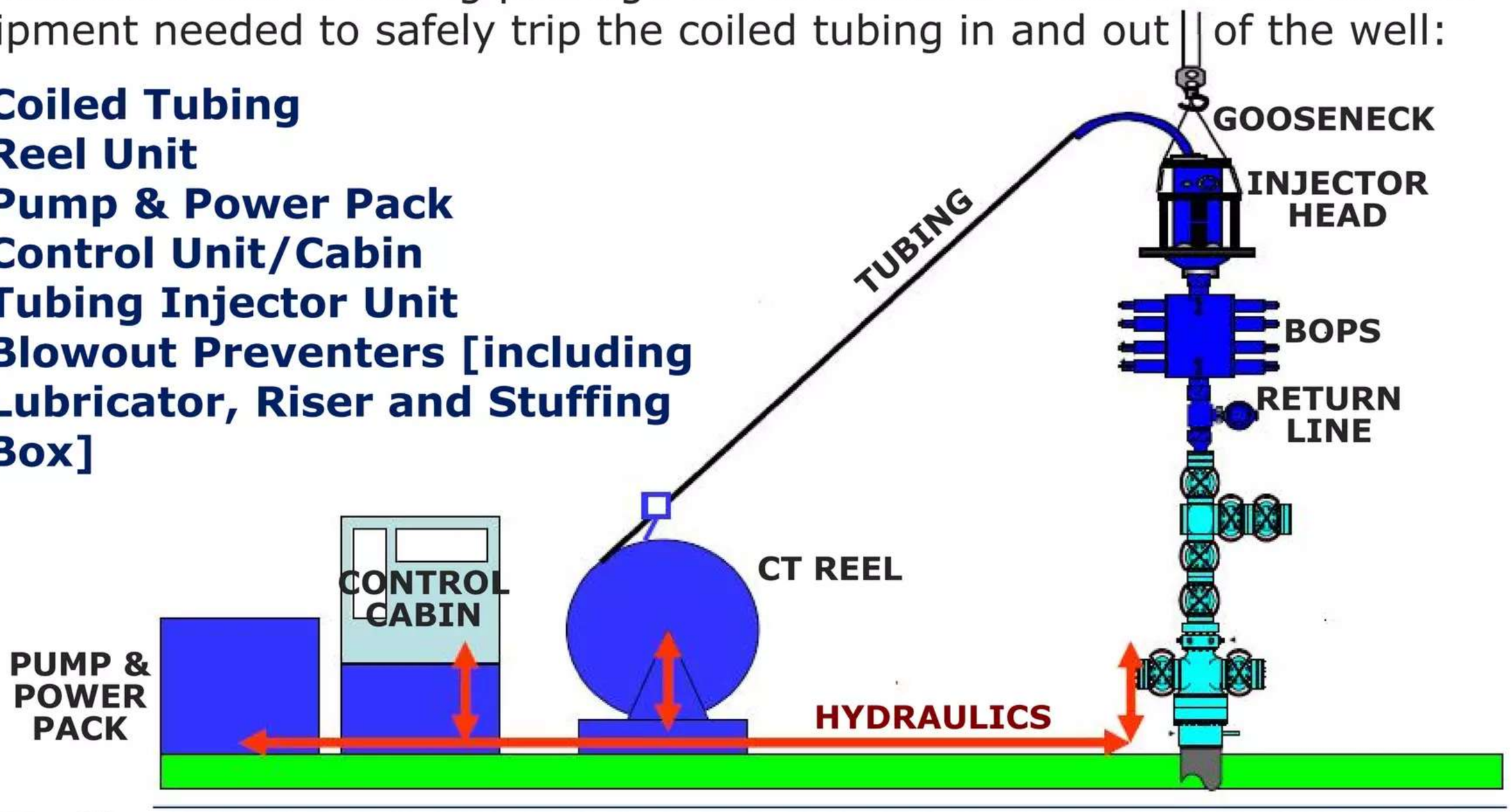
COILED TUBING EQUIPMENT

MAIN COMPONENTS

The standard Coiled Tubing package can be defined in terms of the surface equipment needed to safely trip the coiled tubing in and out of the well:

- ✓ **Coiled Tubing**
- ✓ **Reel Unit**
- ✓ **Pump & Power Pack**
- ✓ **Control Unit/Cabin**
- ✓ **Tubing Injector Unit**
- ✓ **Blowout Preventers [including Lubricator, Riser and Stuffing Box]**



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COILED TUBING EQUIPMENT

[DIS]ADVANTAGES

Portable, compact, efficient
Can do almost any job, and with circulation

Cannot rotate, except downhole when using mud motor
High stresses as a result of straightening/recoiling; must monitor

Common applications for **coiled tubing**:

- Sand washing and solids removal
- Paraffin/Asphaltene clean outs
- Perforating and sand consolidation
- Unloading wells and initiating production
- Formation Stimulation [Acidizing]
- Cementing
- Thru-Tubing milling
- Drilling [with down hole Motor]
- and many, many more…..

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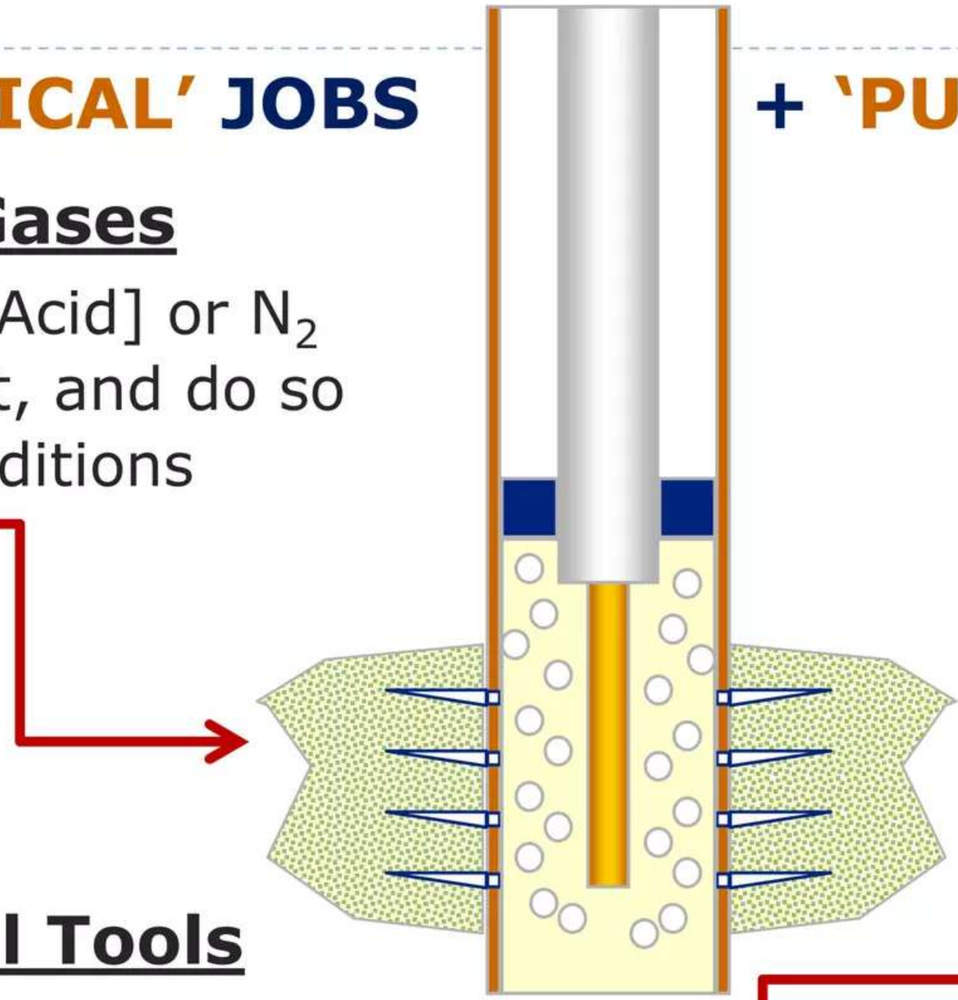
COILED TUBING EQUIPMENT

CT TASKS: 'MECHANICAL' JOBS + 'PUMPING' JOBS

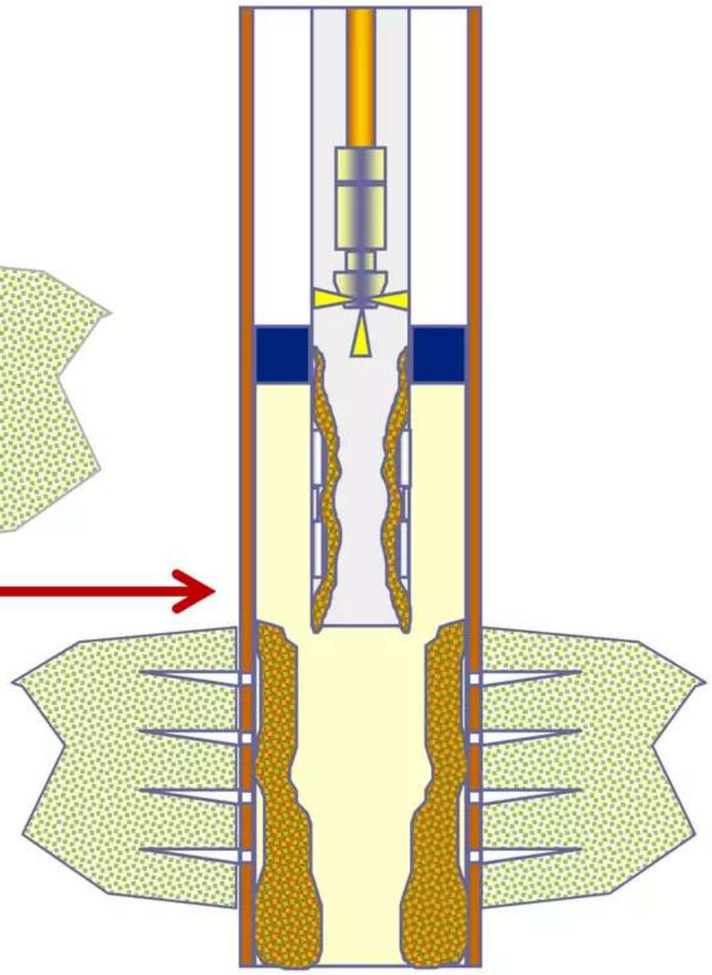
Conveying <u>Fluids or Gases</u>

- Circulating e.g. HCl [Acid] or N_2 [Nitrogen] or Cement, and do so often under 'live' conditions



Conveying <u>Mechanical Tools</u>

- Performing mechanical tasks e.g. pulling/running plugs, packers, fishing, removing scale, sand, drilling, re-entry and sidetracking etc.



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COILED TUBING EQUIPMENT

COILED TUBING EQUIPMENT IN MORE DETAIL

PRIMARY EQUIPMENT

- ✓ **CT Reel Unit**
  This chain driven system does NOT lower or hoist CT in the well, but its purpose is to uncoil and coil the tubing under constant tension between Reel and Gooseneck. Reel with tubing can weigh in excess of 35,000 lbs!
- ✓ **Injector Head [with Gooseneck]**
  Transfers force necessary to inject, retract or hold the CT. It is a critical items and consists of [1] an Injector Drive and [2] a Gooseneck.
- ✓ **Power Pack**
  Provides all independent power to hydraulic/electric pumps. Includes accumulators for well control/auxiliary equipment.
- ✓ **Control Cabin**
  Provides a clear view of all essential equipment and a means of control and permit monitoring for [almost] everything that run a CT package.

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COILED TUBING EQUIPMENT

COILED TUBING EQUIPMENT IN MORE DETAIL

PRIMARY EQUIPMENT

CT REEL UNIT

CT REEL WITH SPOOLING HEAD

ROTATING JOINT CONNECTION

CHAIN DRIVE SYSTEM

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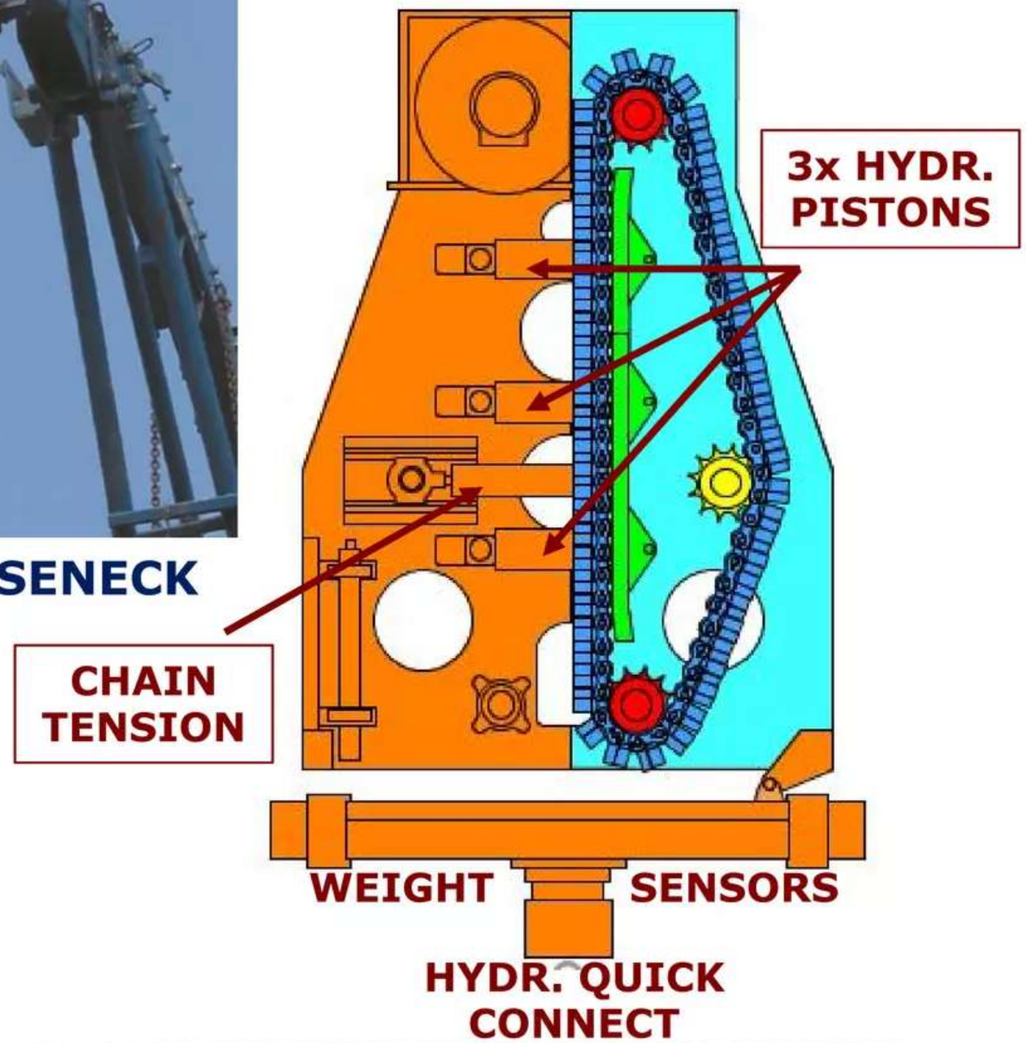
COILED TUBING EQUIPMENT

COILED TUBING EQUIPMENT IN MORE DETAIL

PRIMARY EQUIPMENT

INJECTOR HEAD

INJECTOR DRIVE ASSY



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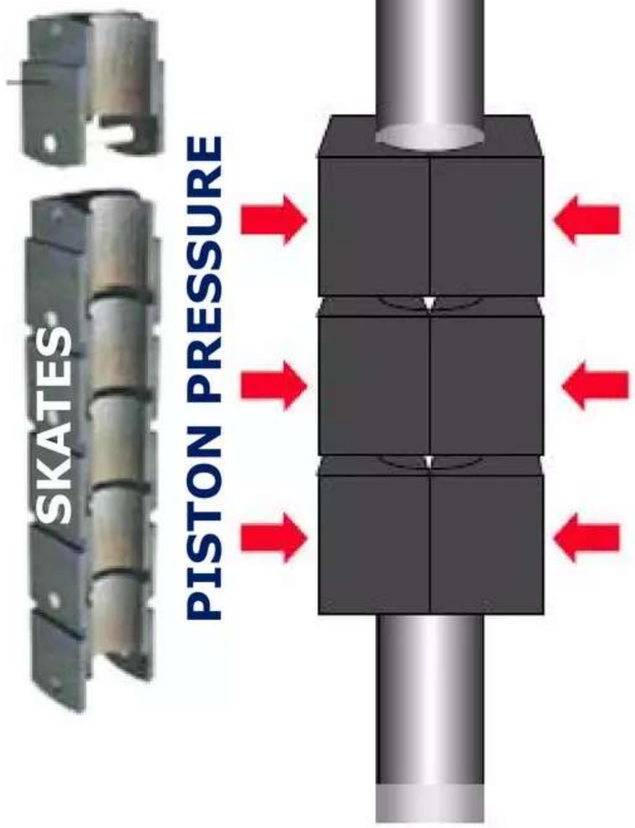
COILED TUBING EQUIPMENT

COILED TUBING EQUIPMENT IN MORE DETAIL

PRIMARY EQUIPMENT

INJECTOR HEAD



HYDRAULIC PISTON

GRIPPER

GRIPPER BLOCKS ON DRIVE CHAIN

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COILED TUBING EQUIPMENT

COILED TUBING EQUIPMENT IN MORE DETAIL

PRIMARY EQUIPMENT

POWER PACK

DIESEL ENGINE, USUALLY INSIDE SOUND-SUPPRESSED SYSTEM

HYDRAULIC SUPPLY HOSES AND QUICK CONNECTORS

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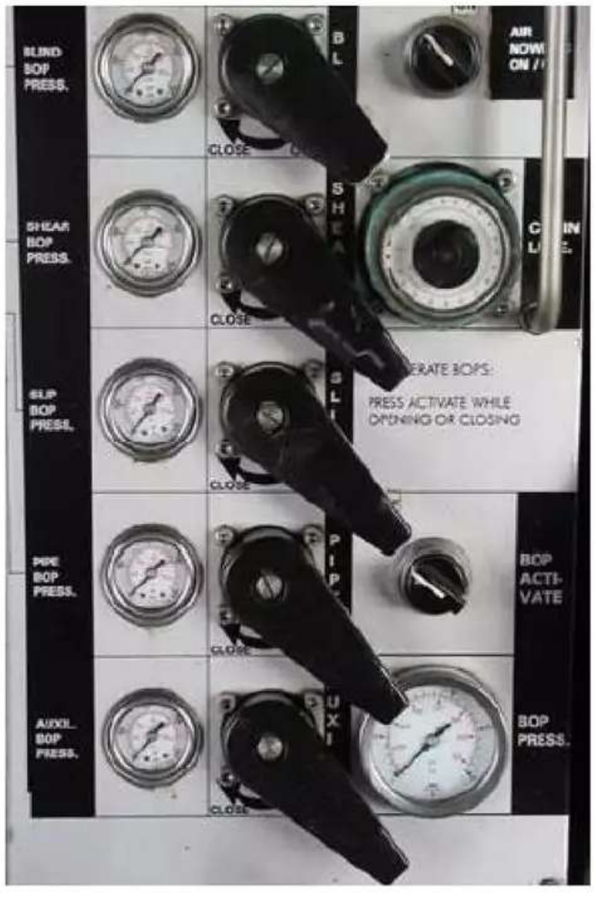
COILED TUBING EQUIPMENT IN MORE DETAIL

PRIMARY EQUIPMENT

CONTROL CABIN



BOP CONTROL SYSTEM

OVERVIEW OF ALL CONTROLS/GAUGES

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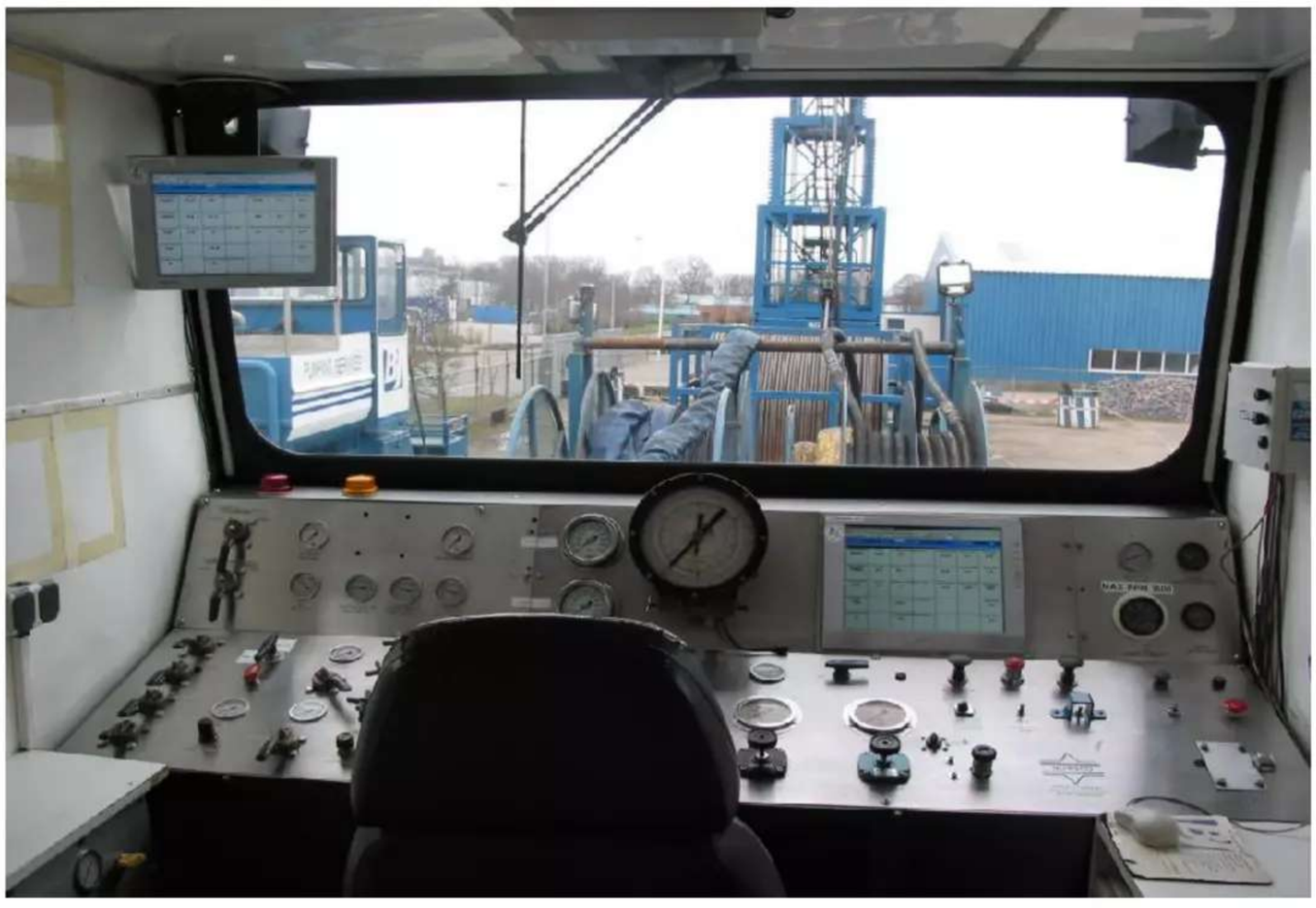
COILED TUBING EQUIPMENT

COILED TUBING EQUIPMENT IN MORE DETAIL

PRIMARY EQUIPMENT

CONTROL CABIN



Main recording includes:-

1. Hydraulic Pressure Gauges [injector traction cylinders]
2. Tubing Depth Meter
3. Tubing Load [Weight] Indicator
4. Wellhead Pressure Gauge
5. Power Pack Engine Temp. and Pressure Gauges
6. Circulating Pressure Gauge [reel/pump]
7. BOP Pressure Gauge

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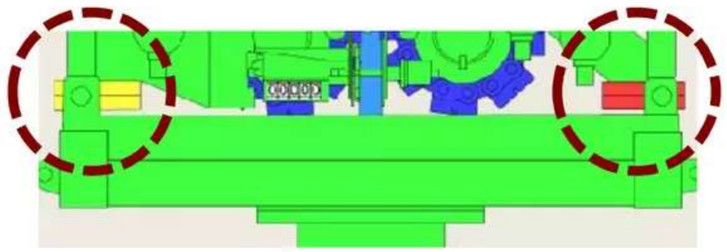
COILED TUBING EQUIPMENT

COILED TUBING EQUIPMENT IN MORE DETAIL

AUXILIARY EQUIPMENT

WEIGHT INDICATOR

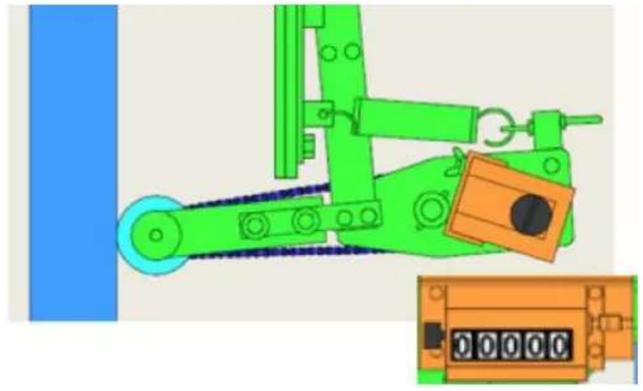
- Mechanical [Load Cell]
- Electronic [Strain Gauge]



MECHANICAL WEIGHT SENSORS [ONE SIDE HINGED – 2 LOAD CELLS]

DEPTH MEASUREMENT

- Mechanical [at Reel or Inj. Head]
- Electronic [at Injector Head]



MECHANICAL COUNTER [FRICTION WHEEL BETWEEN INJ. HEAD AND STRIPPER]

HYDRAULIC QUICK CONNECTOR

- Standard Connection
- Can stab with 10° offset
- Mechanical Latch w/ Locking Dogs

HYDRAULIC QUICK CONNECTOR [HQC] [BELOW STRIPPER AND ABOVE BOPs]

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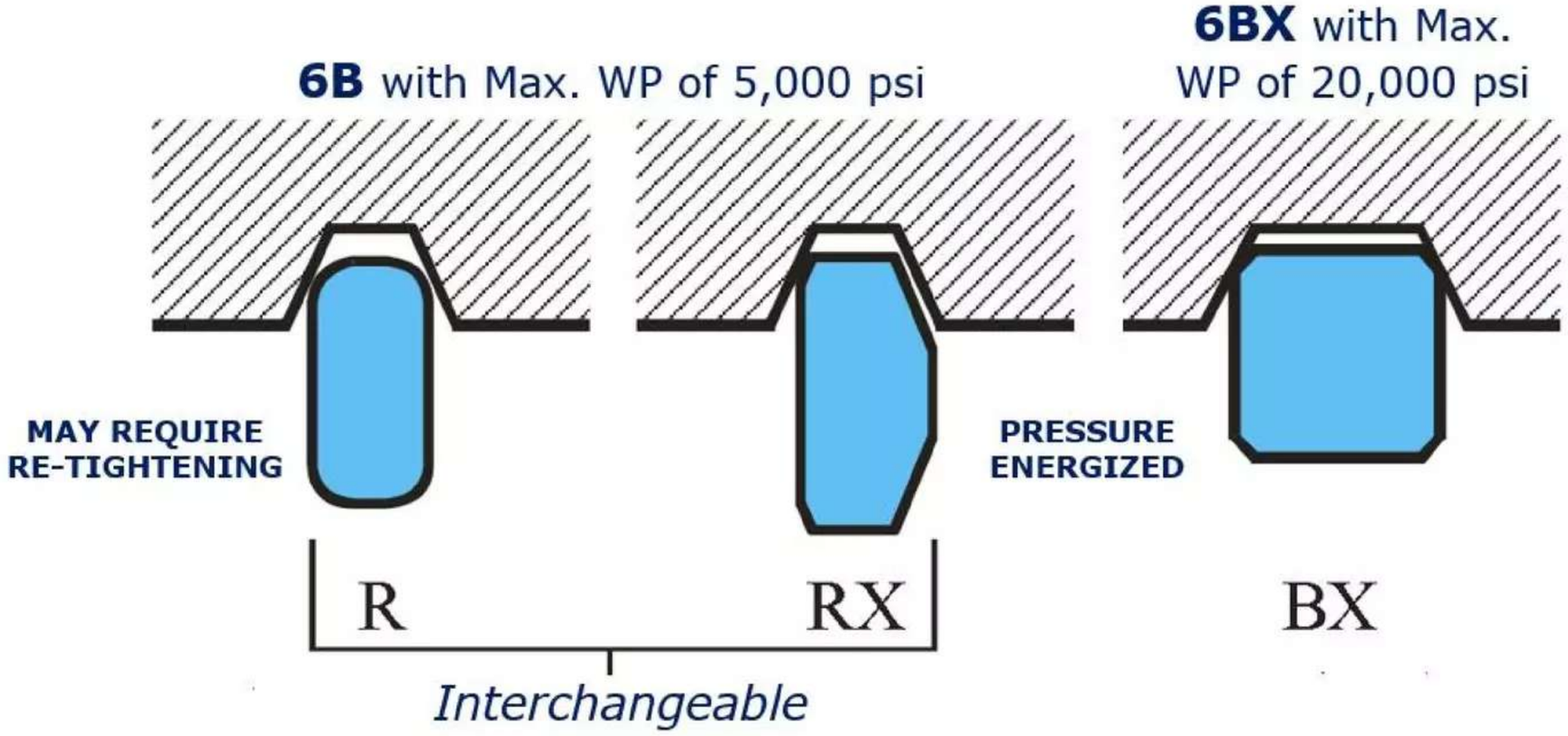
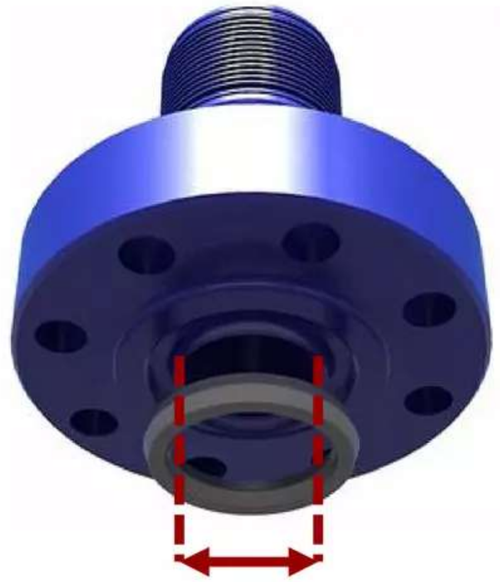
COILED TUBING EQUIPMENT

WELLHEAD ADAPTER [COILED TUBING]:

API FLANGES - 2 types/standards



API RINGJOINT GASKETS - 3 types [Surface]



Flange Expression:

7-1/16”, 10,000 psi Flange, means this flange has a 10,000 psi working pressure and has a 7-1/16” [through bore] **ID**

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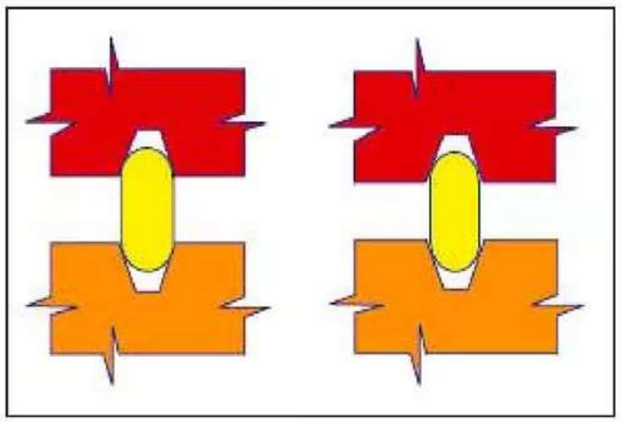
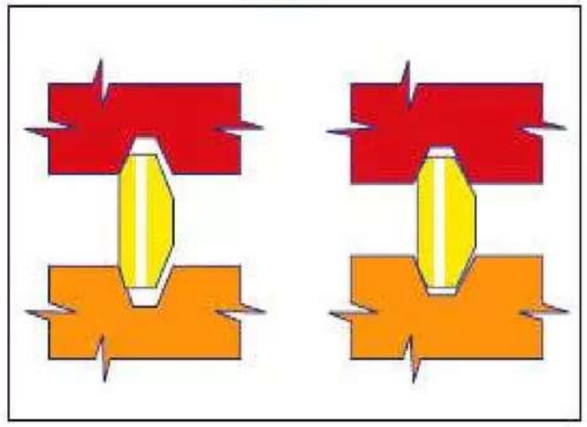
COILED TUBING EQUIPMENT

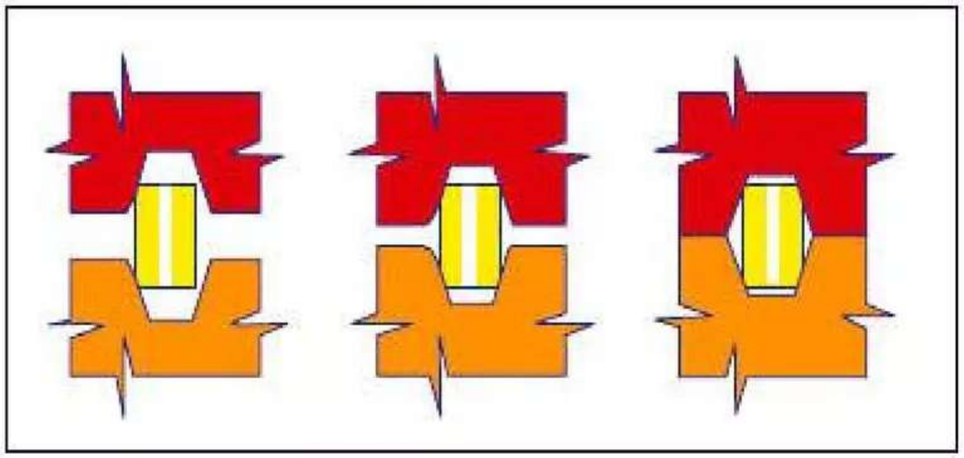
R



RX



BX



R & RX Ring Joint Gaskets can ONLY be used with 6B Type Flange

BX Ring Joint Gaskets can only be used with 6BX Type Flange

FLANGES + RJ GASKETS

- API **6B flanges** have a 'certain distance' between the flanges after make-up; will therefore need periodic **re-tightening** of bolts/nuts
- API **6BX flanges** are 'face-2-face' flanges; gaskets are slightly larger than groove, but when compressed, gaskets are deformed and create initial seal
- **RX** and **BX** are pressure **self-energizing gaskets**; this means that pressure from the well bore will act upon the inner face of the ring and assist in the flange sealing feature

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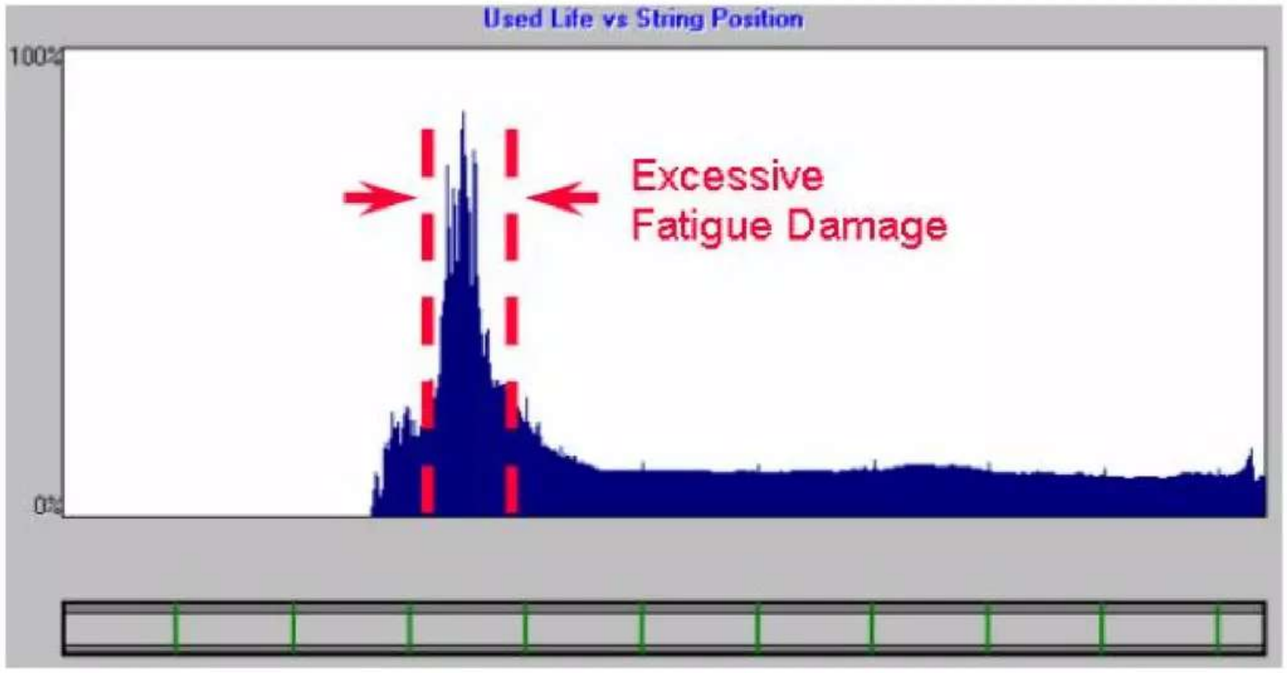
COILED TUBING EQUIPMENT



CT STRESSES

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COILED TUBING EQUIPMENT

COILED TUBING STRESSES

- **Life limits [Fatigue]**
  When CT is being run on/off the reel and over the gooseneck
- **Tension limits**
  As this depends on depth and weight of coiled tubing
- **Pressure limits**
  Burst and collapse pressure vary with tension and compression
- **Diameter and Ovality limits**
  Real time monitoring of the pipe is required to ensure that the pipe is not ballooned, ovaled, or mechanically damaged

Sub-sea coiled tubing operations from a floating rig requires...

- *The injector head and BOPs etc. to be compensated to allow for rig movement*
- *An Emergency Disconnect Sub above the BOP to allow the riser to be released and rig moved off location, leaving the well secured with the BOPs*

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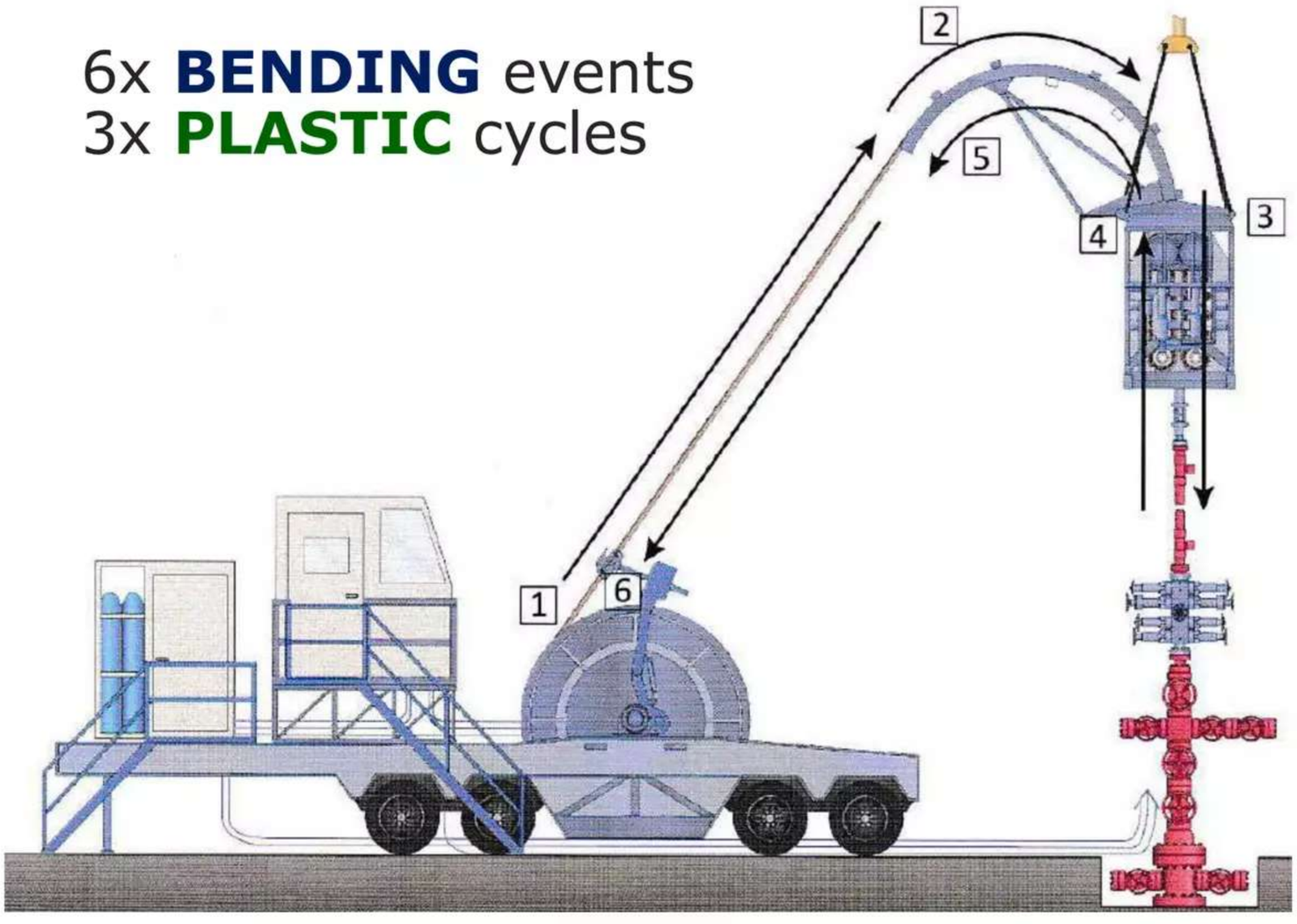
COILED TUBING EQUIPMENT

COILED TUBING STRESSES

6x **BENDING** events
3x **PLASTIC** cycles



- Normally maintained in an 'Elastic' stress state, but is subjected to **'Plastic'** stress state each time it is rolled on or off the reel and over the gooseneck
- Plastic stress states causes the CT to be **permanently deformed**
- This cycling fatigue causes the CT to weaken and burst. **Pinhole leaks** are common occurrence
- Usually, CT fails on the **underside** when on the Gooseneck while POOH

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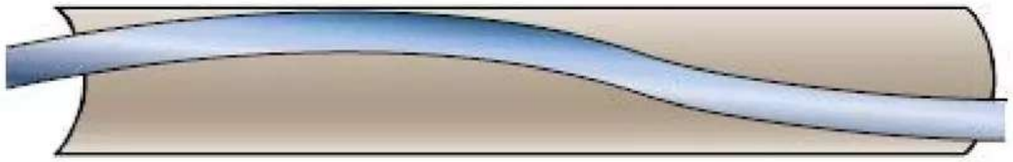
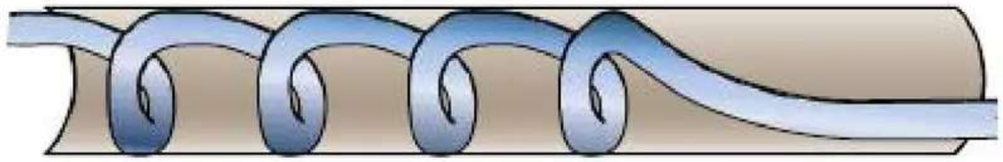
COILED TUBING EQUIPMENT

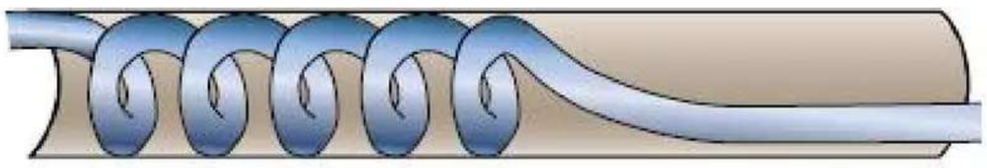
COILED TUBING STRESSES



SINUSOIDAL BUCKLING



HELICAL BUCKLING



LOCK-UP [MUST BE PREVENTED]

Contact forces will increase **Friction Force** and can eventually lead to Helical Buckling and ultimately to **'Lock-Up'**

We must consider:-

- ✓ Weight that can be applied on the tool within deviated/horizontal section
- ✓ Predict when CT being snubbed into the well is likely to buckle/bend
- ✓ Stay within CT operation limits for the well configuration and job requirement

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COILED TUBING EQUIPMENT

COILED TUBING STRESSES

FATIGUE is defined as progressive and localized structural damage that occurs when a material is subjected to **CYCLIC** loading

FACTORS 'AFFECTING' FATIGUE LIFE	
Bend Geometry	Increase reel/guide arch diameter **INCREASES** fatigue life [or longer CT operational life]
Internal Pressure	Increase internal pump pressure. During CT operation **DECREASES** fatigue life [or shorter CT operational life]
CT Size (OD)	Increase CT outside diameter [OD] **DECREASES** fatigue life. The bigger the CT size, the more difficult it is to bend.
CT Wall Thickness	Increase CT wall thickness **INCREASES** fatigue life because the overall hoop stress is reduced.
Reciprocation	Reciprocating the CT will **DECREASE** the fatigue life as it is repeatedly plastically deformed during routine use. Example of frequent CT reciprocating is performing jarring action, and cleaning out an obstruction downhole.

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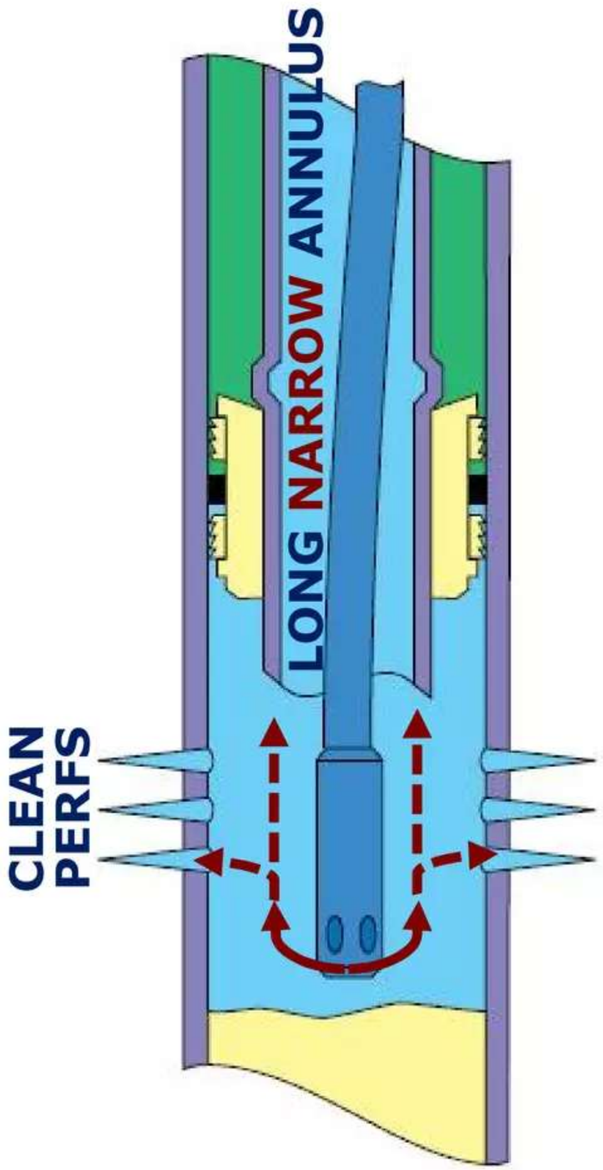
COILED TUBING EQUIPMENT

PUMPING EFFECTS



EXAMPLE: SAND CLEAN-OUT

Circulation often takes place in a narrow Annulus between Completion Tubing and CT. This effects the Annular Pressure Loss:

- Annular Pressure Loss [APL] will **increase**
- Circulating/Pump Pressure will **increase**
- Dynamic BHP will **increase…**

EFFECT: Because perforations are open/clean, the exposed formation may experience <u>losses</u>

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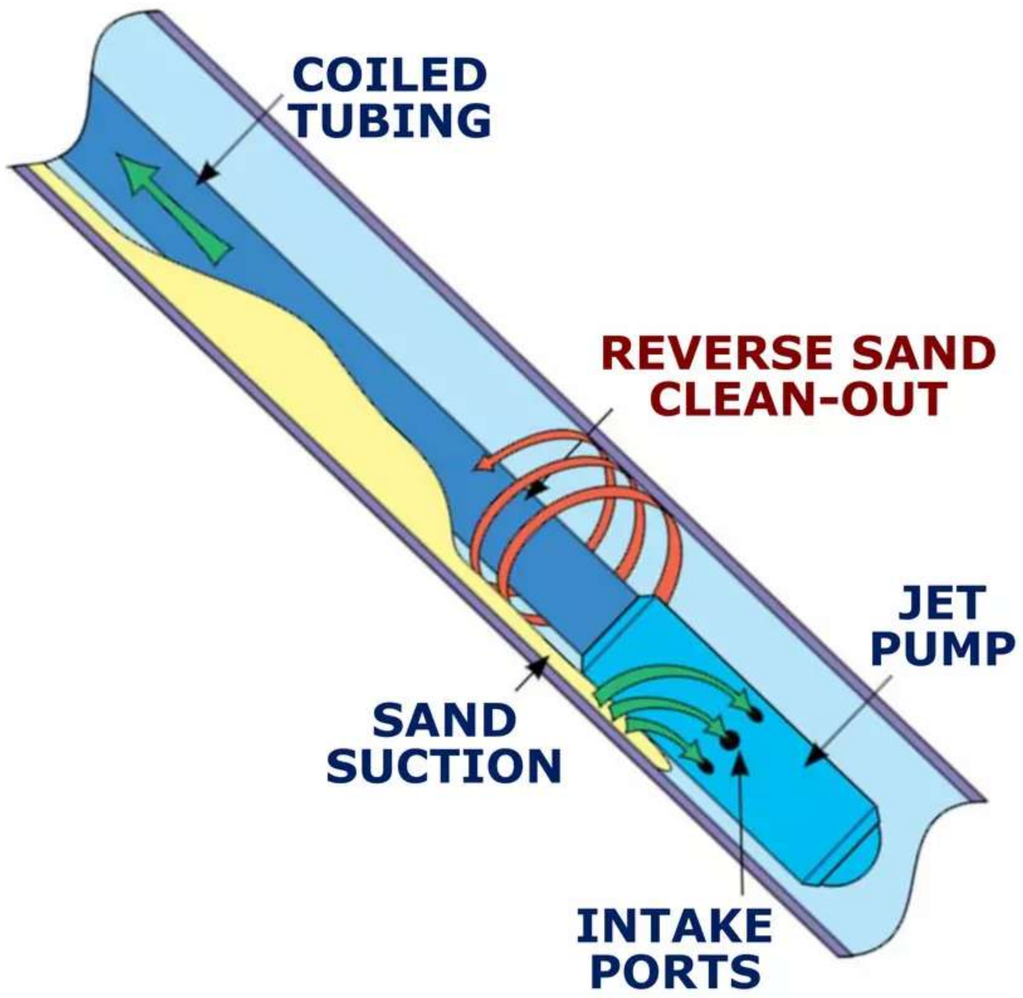
COILED TUBING EQUIPMENT

REVERSE CIRCULATION



Although **NOT** a common practice, the advantage of using CT for **Reverse Circulation** is that the flow **can lift solids** within the CT **more easily** than the CT to Compl. Tubing Annulus or CT to Casing Annulus.

However, Reverse Circulation can only be done when Check Valves are bypassed. If using a Circulation Valve, we must open this Valve with a ball. Once dropped to open the Circulation Valve, **NO Mechanical Barrier** left inside CT string !

If well is NOT dead, then, prior POOH, the well must be killed first !

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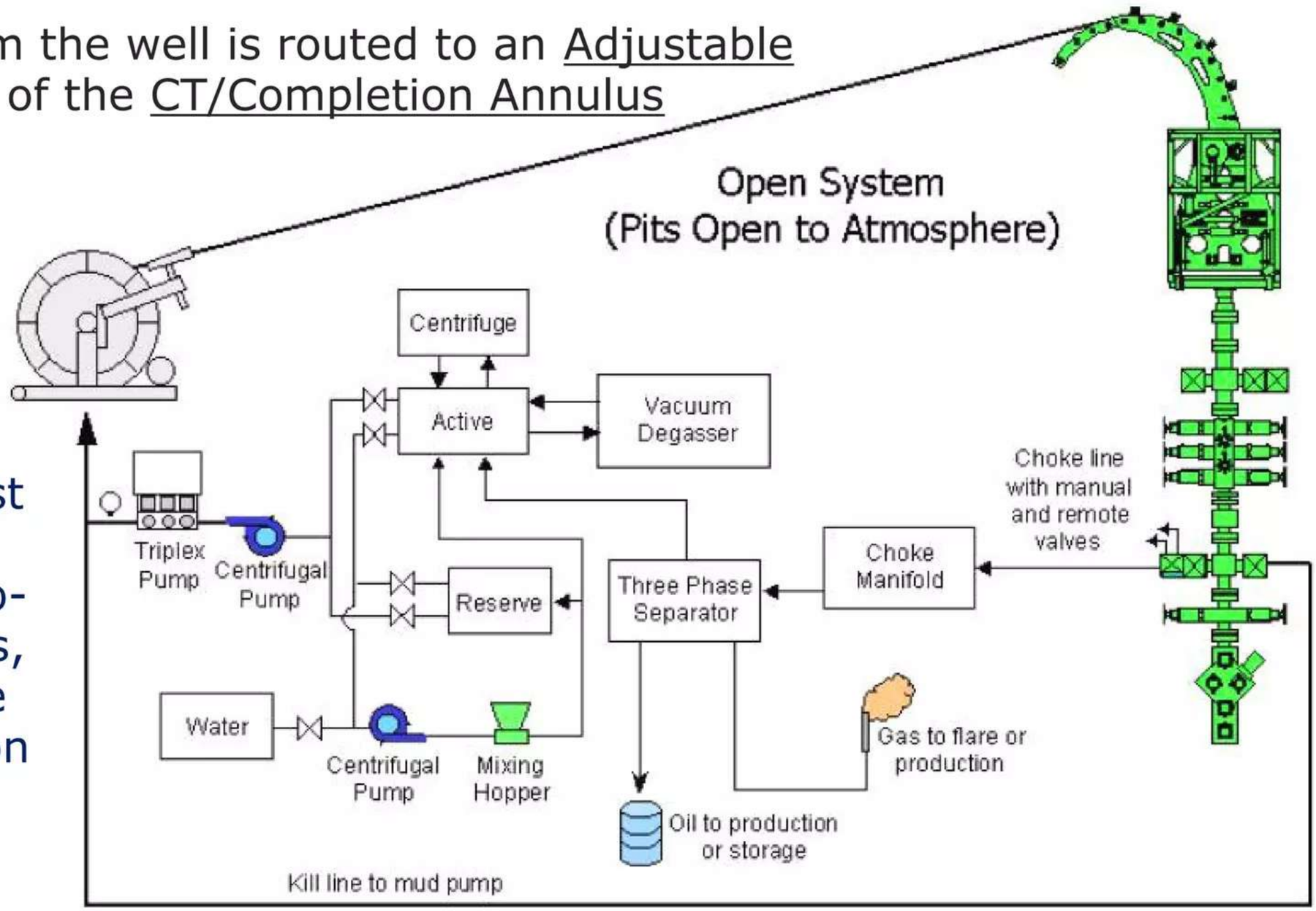
COILED TUBING EQUIPMENT

CIRCULATION ROUTING

The return flow from the well is routed to an Adjustable Choke downstream of the CT/Completion Annulus

This set-up is most suitable for flow returns with hydro-carbons and solids, which will require effective separation



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COILED TUBING EQUIPMENT

COILED TUBING BARRIER PRINCIPLES

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COILED TUBING EQUIPMENT

BARRIERS COILED TUBING OPERATIONS

PRIMARY

- **Stripper** [rigged up above BOPs to create the Primary Barrier Envelope]. Sometimes called Stuffing Box.
  - Usually a TANDEM Stripper to ensure back-up is readily available

SECONDARY

- **Quad BOP** [along with Riser/other equipment, like Shear/Seal BOP, rigged up above the Xmas Tree to create Secondary Barrier Envelope].
  - Consists of Blind Rams, Cutter Rams, Slip Rams and Tubing Rams

TERTIARY

- **Shear-Seal BOP [Safety Head]**, mounted close or onto the Xmas Tree and capable of cutting the tubing, but ***NOT*** the tool string, like mud motor and check valves

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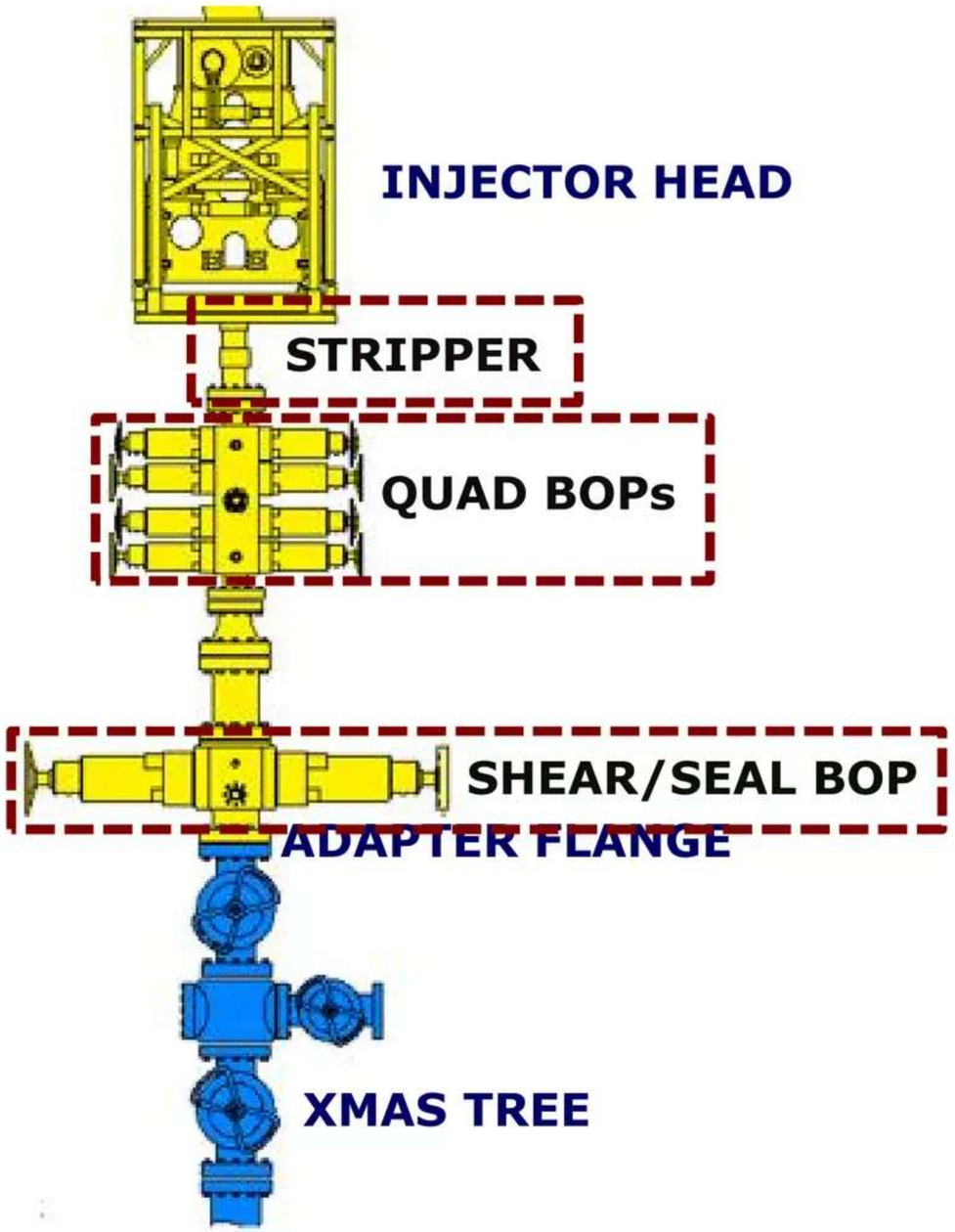
COILED TUBING EQUIPMENT



PRIMARY BARRIER

SECONDARY BARRIER

TERTIARY BARRIER

EXTERNAL BARRIERS
COILED TUBING
OPERATIONS

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COILED TUBING EQUIPMENT

BARRIERS COILED TUBING OPERATIONS

IN SUMMARY:

PRESSURE CONTROL equipment includes:

- *Stripper sealing devices [single or tandem]*
- *Annular BOP [if available for BHAs]*
- *Riser/Lubricator/Flanges/Hydraulic Quick Unions*
- *Multifunction BOPs [incl. Shear/Seal], remote controlled*
- *Kill Line, Choke Line and associated valves*

CONDITIONS

To prevent the accidental release of a sudden failure of a barrier, **at least TWO barriers** should be available at all stages of an operation.

All connections between wellhead and the nearest barrier device must be capable of forming a reliable seal and should therefore be a **MtM Ringed Sealed Flange** [Ring Joint Gaskets]

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COILED TUBING EQUIPMENT

DEPLOYMENT SYSTEMS – OPTION 1

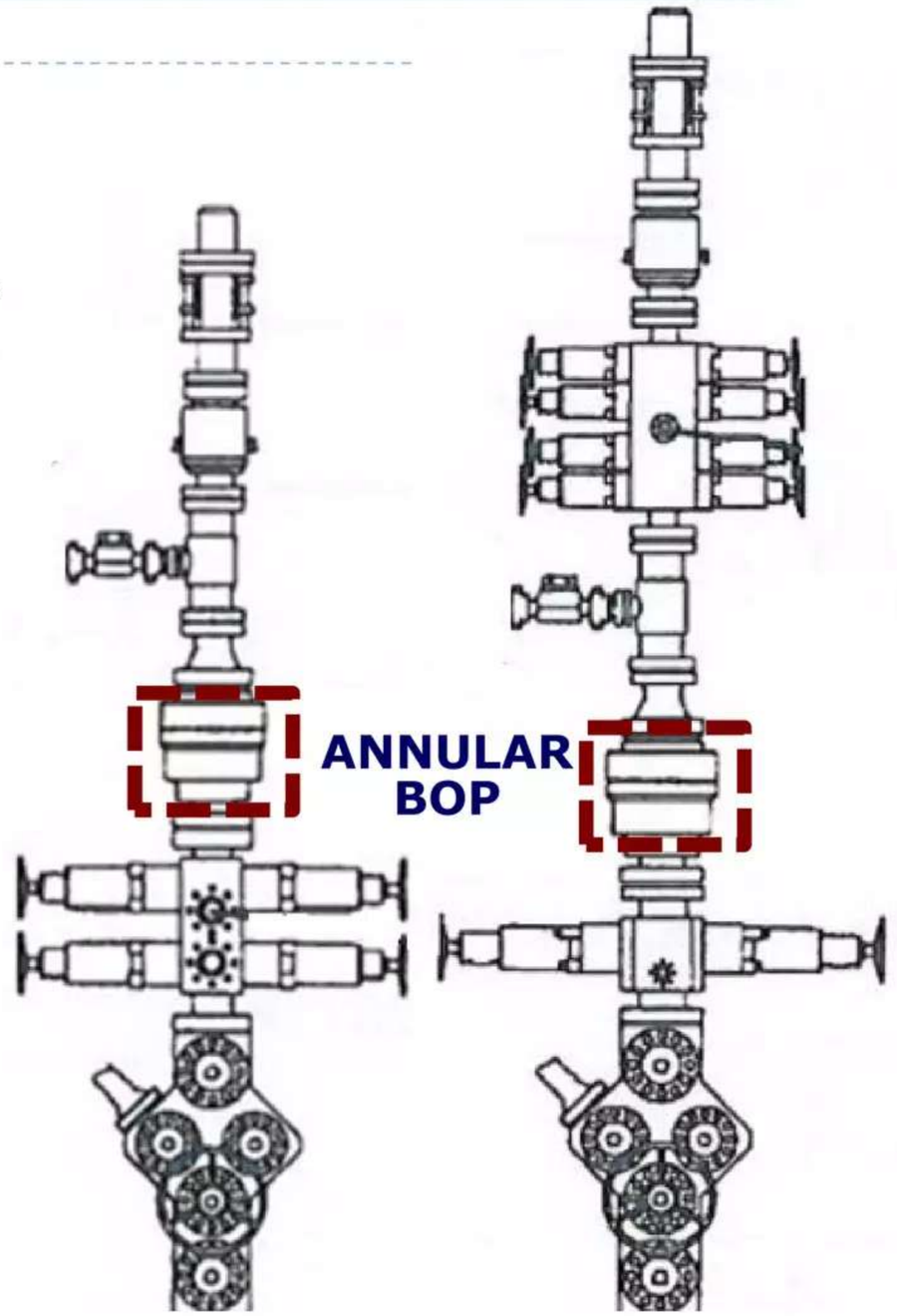
In normal circumstances, we will only have a Hydr. Quick Connector between Injector Head and BOPs. But… this makes it NOT possible to run Bottom Hole Assemblies!

If a BHA is run, the space between Injector Head and BOP will make use of a **Deployment System and Bar**, which could be accompanied by an **ANNULAR BOP**. The Annular BOP will be either:-

- Above CT BOPs, and below Stripper[s]

  or

- Below CT BOPs, but above Shear/Seal BOP [Safety Head]



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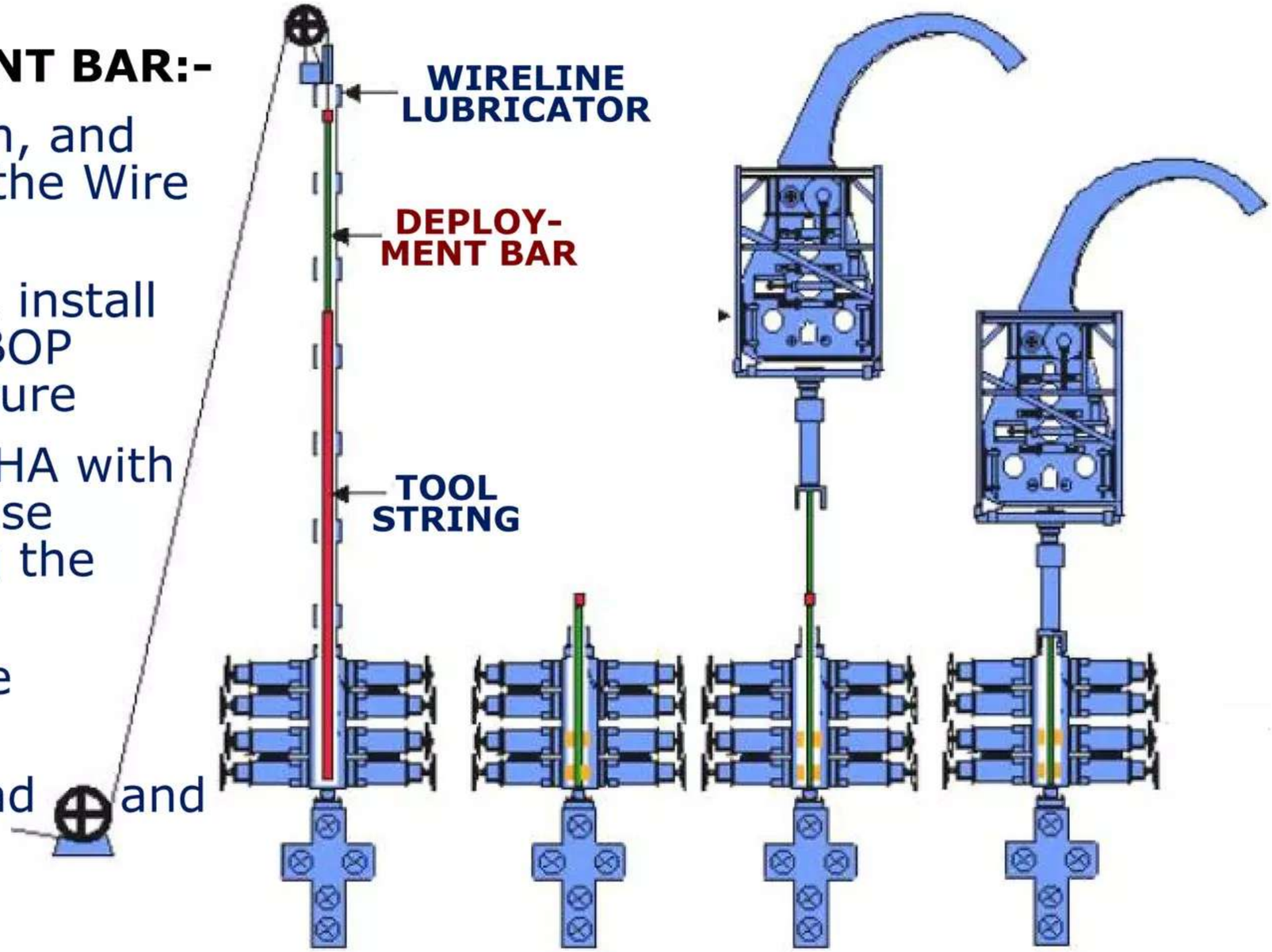
COILED TUBING EQUIPMENT

DEPLOYMENT SYSTEMS – OPTION 1

PROCEDURE DEPLOYMENT BAR:-

1. Use Wire Line system, and run long BHA inside the Wire Line Lubricator
2. With the SBR closed, install Lubricator onto the BOP stack, equalize pressure
3. Open SBR and run BHA with W/L into well and close Pipe/Slip Rams using the **Deployment Bar**
4. Bleed off and remove Lubricator
5. Connect Injector Head and Coiled tubing



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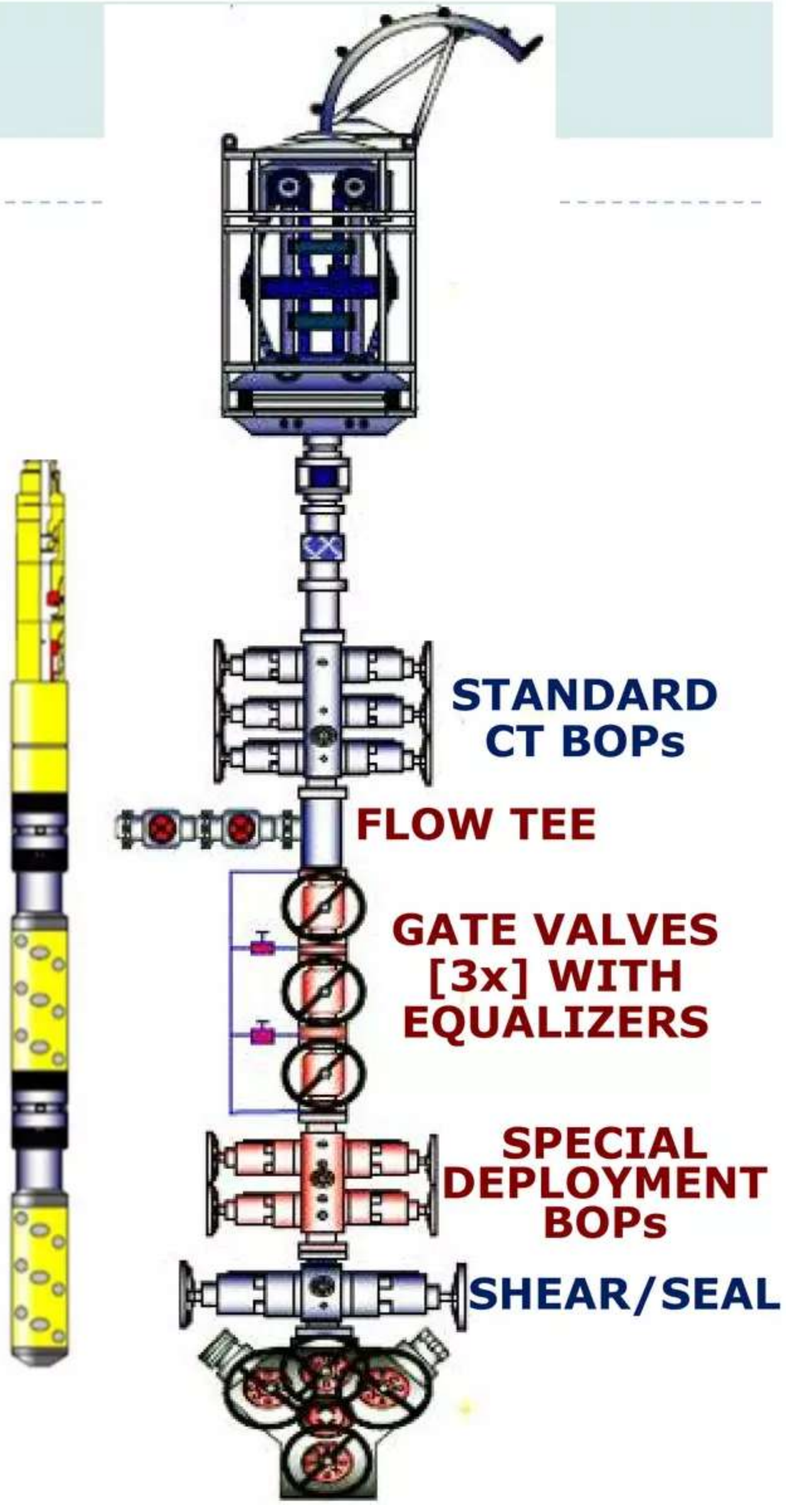
COILED TUBING EQUIPMENT

DEPLOYMENT SYSTEMS – OPTION 2

If an Annular Preventer, along with a Lubricator, is not adequate, and the BHA is very long [such as with Perf. Guns], then we must use a specific **Deployment System** [OPTION 2] to ensure absolute barrier integrity, at all times !

Applicable Situations:-

- ✓ *Long length of Perforating Guns*
- ✓ *Pump-Through Tools*
- ✓ *Long Suite of Logging Tools*
- ✓ *Mud Motor and MWD Drilling Tools*



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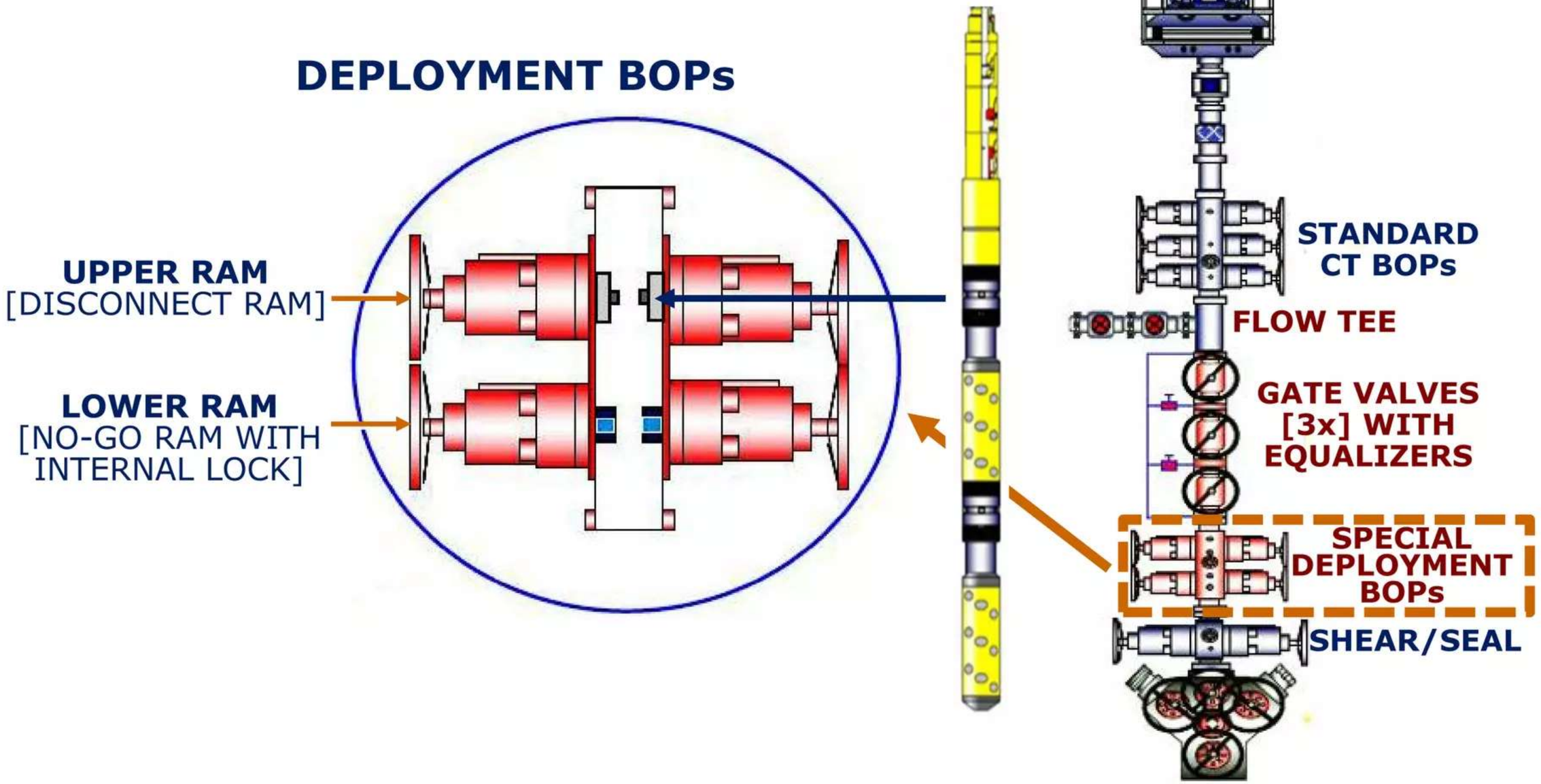
COILED TUBING EQUIPMENT

DEPLOYMENT SYSTEMS – OPTION 2



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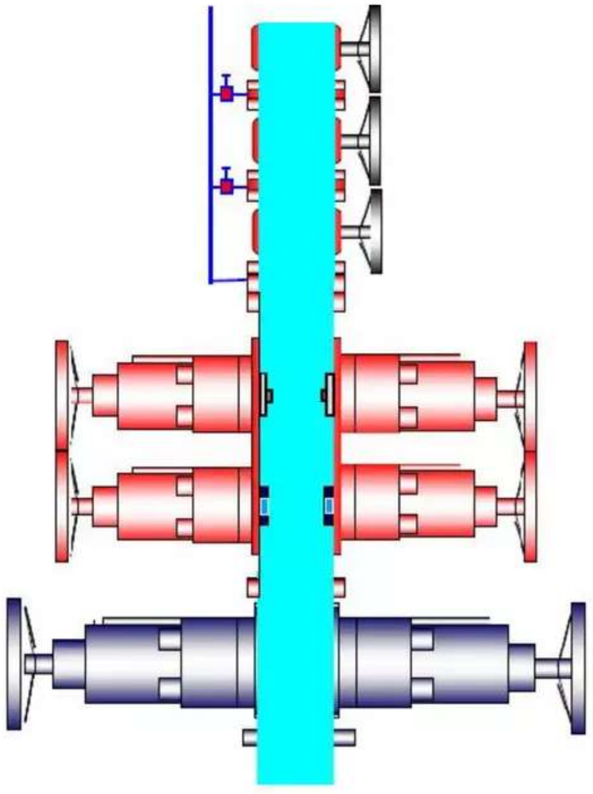
COILED TUBING EQUIPMENT

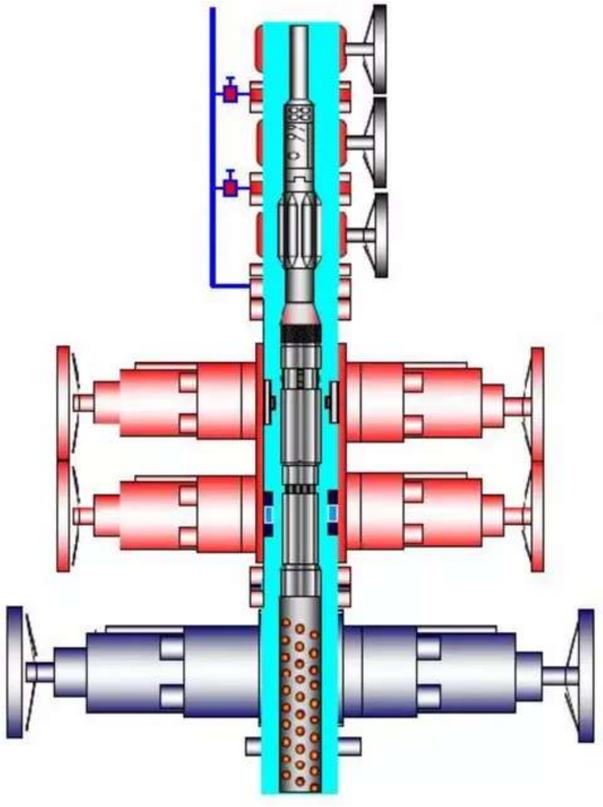
DEPLOYMENT SYSTEMS – OPTION 2 – 8 STEPS



STEP 1

Rig up Injector head and CT with the 1st Perforating Gun

Open BOPs, X/mas Tree and Gate Valves after Pressure Equalizing



STEP 2

RIH with the 1st Perforating Gun and position a Gun Connector across Ram

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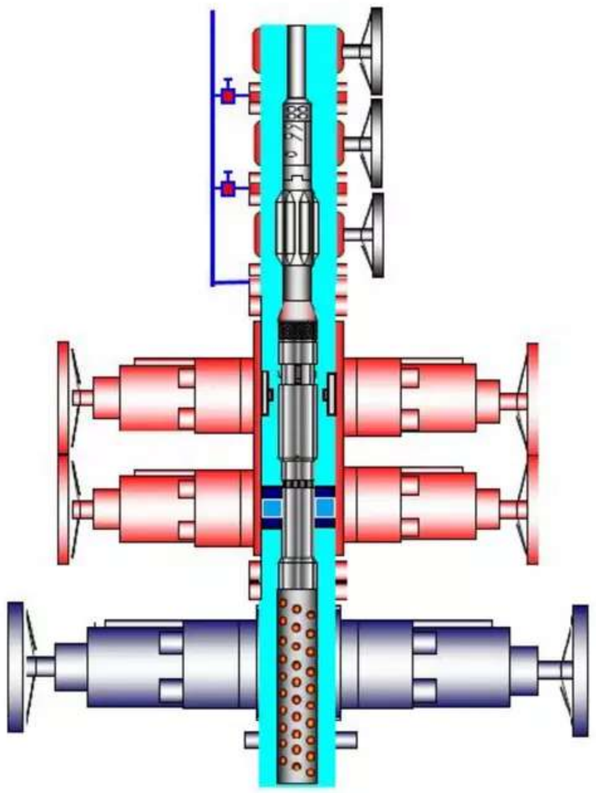
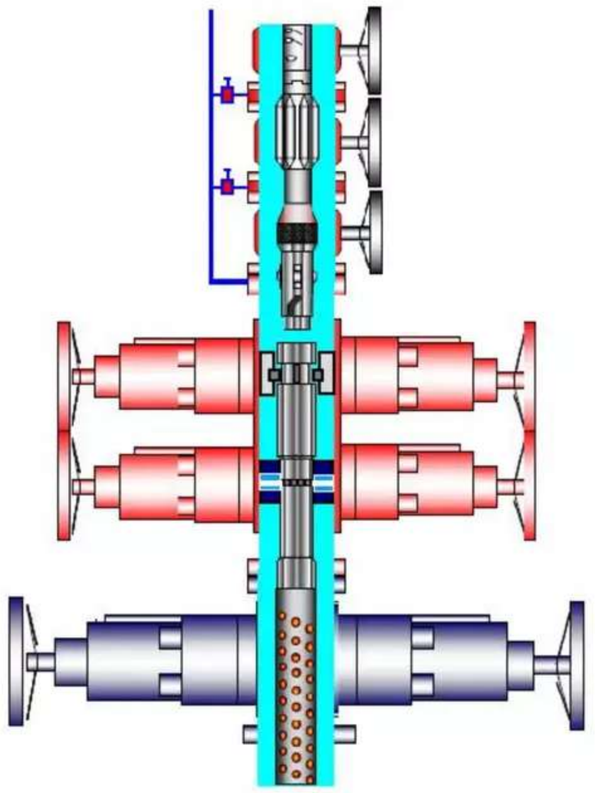
COILED TUBING EQUIPMENT

DEPLOYMENT SYSTEMS – OPTION 2 – 8 STEPS



STEP 3

Close Bottom Ram on a Gun Connector



STEP 4

Close Upper Ram and disconnect [unlatch] CT from Gun Connector

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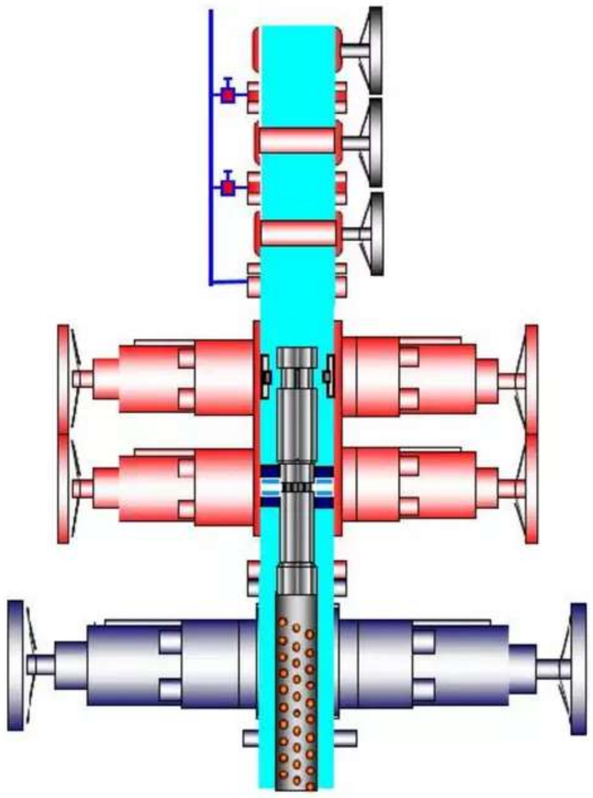
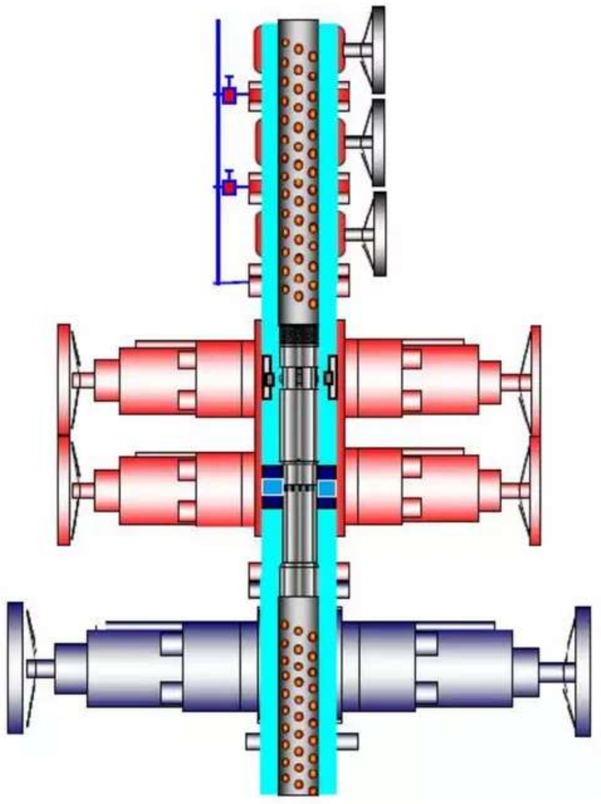
COILED TUBING EQUIPMENT

DEPLOYMENT SYSTEMS – OPTION 2 – 8 STEPS



STEP 5

Open Upper Ram and close Gate Valves



STEP 6

Make up the 2nd Gun with CT. Pressurize and open Gate Valves. RIH with CT

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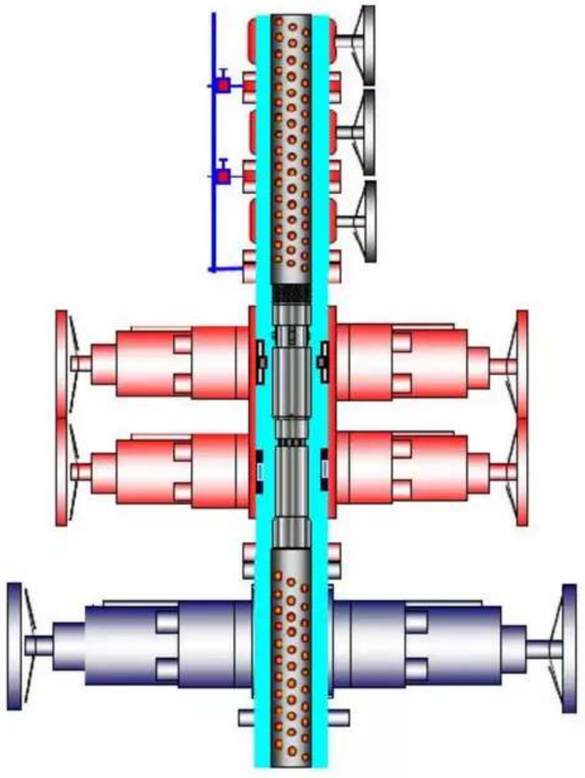
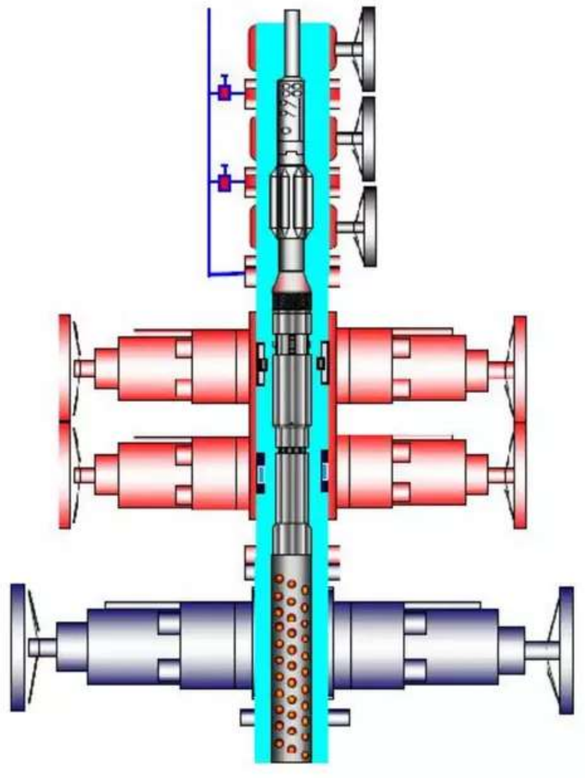
COILED TUBING EQUIPMENT

DEPLOYMENT SYSTEMS – OPTION 2 – 8 STEPS



STEP 7

RIH CT and latch into Receptacle. Confirm successful latch



STEP 8

Open Lower Rams. Repeat STEPS until all Gun Assemblies are deployed

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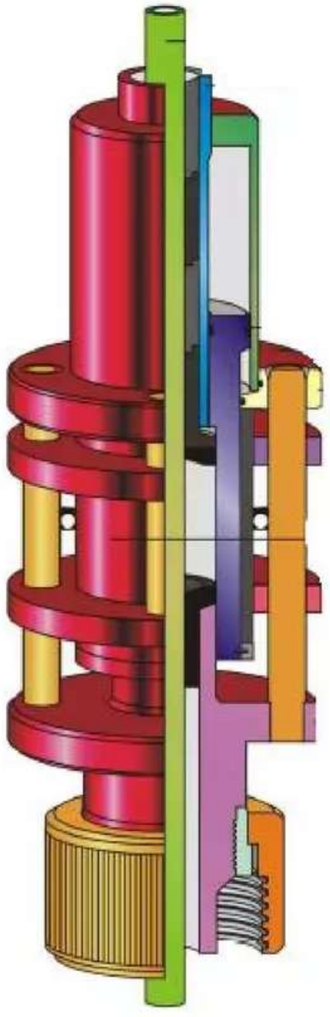
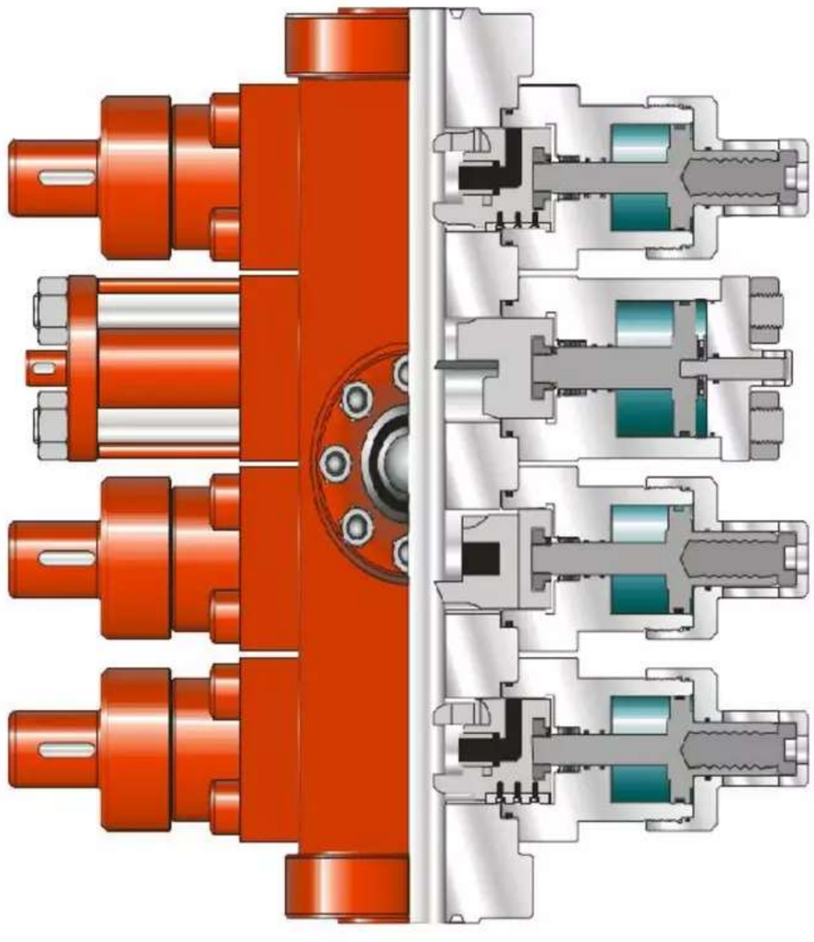
COILED TUBING EQUIPMENT





WELL CONTROL EQUIPMENT

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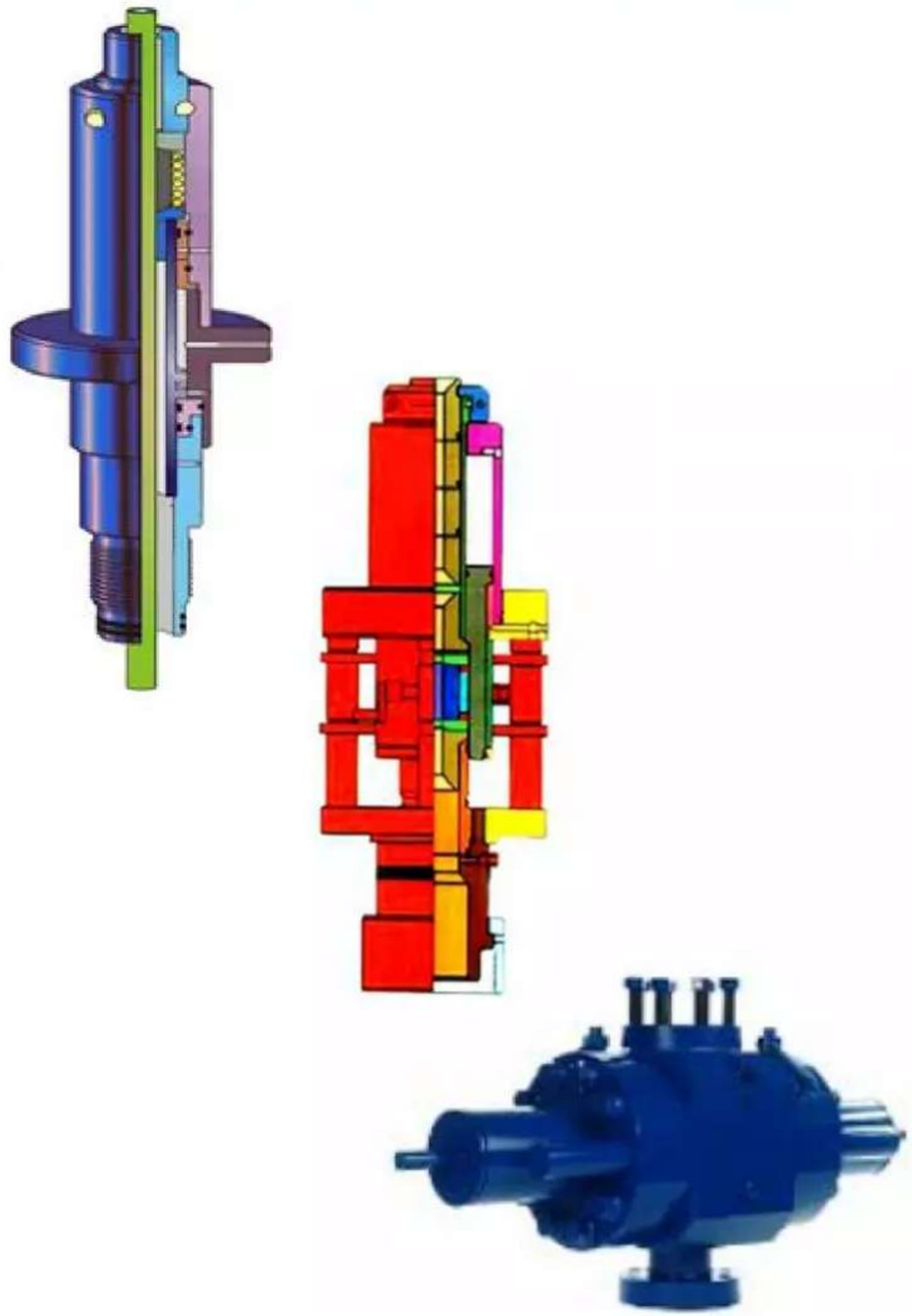
COILED TUBING EQUIPMENT

STRIPPERS [STUFFING BOX]

- ✓ This is a **Primary Barrier**
- ✓ Located immediately below the Injector Head
- ✓ Usually deployed as Tandem Strippers



There are three types in use:-

1. **Conventional Stripper Assembly**
   also known as 'Top Entry Stripper'

2. **Side Door Stripper Assembly**
   the most popular one

2. **Radial Stripper Assembly**
   [Side wider Stripper]

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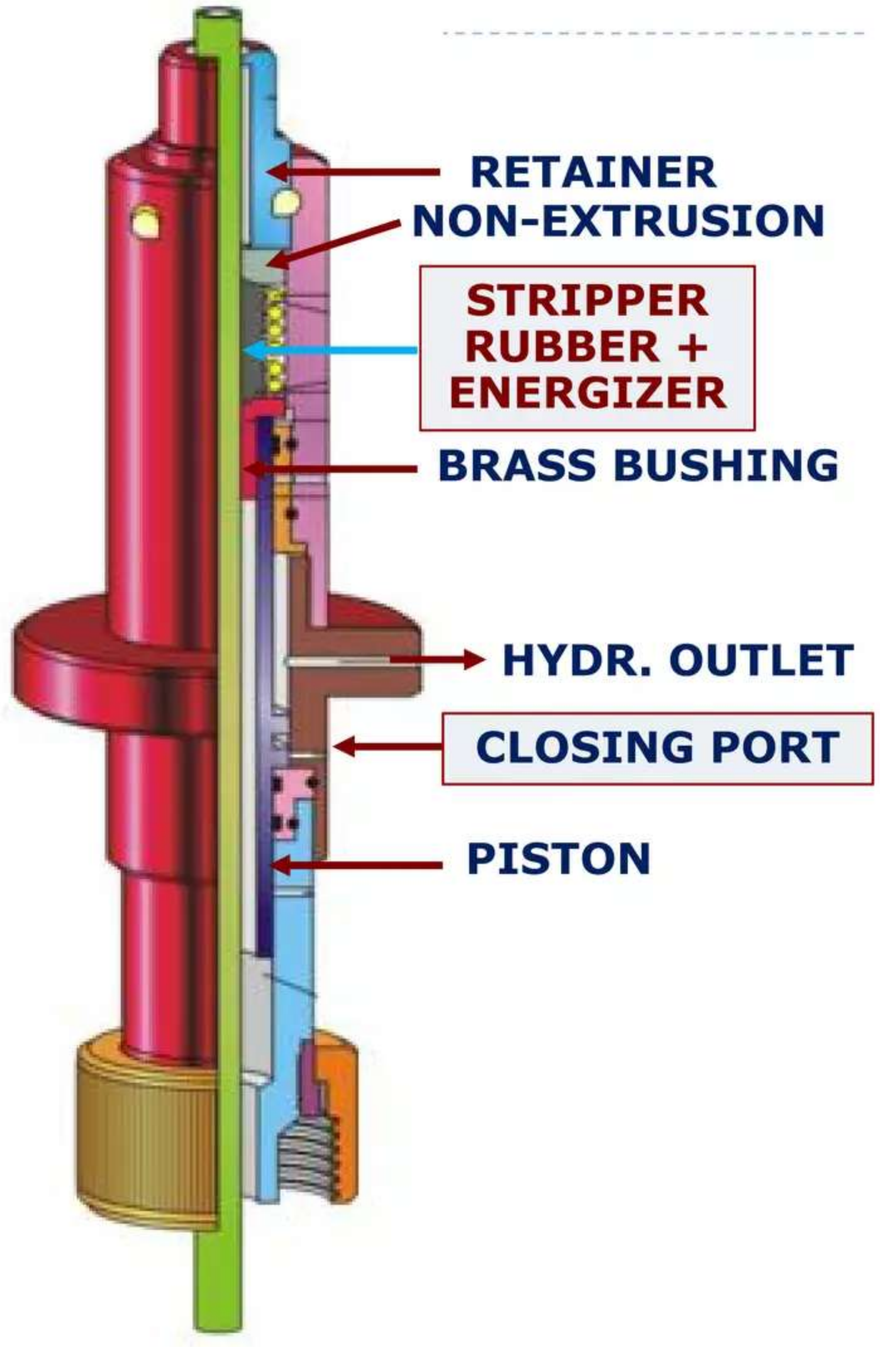
COILED TUBING EQUIPMENT

STRIPPERS [STUFFING BOX]

Conventional Stripper Assembly

The hydraulic pressure is applied to closing port to move piston upwards, forcing the wear bushing to compress the **polyurethane seal element** to create a seal around the CT.

With the split seal unit assembly it makes it easier to replace the parts by removing the top retainer. Therefore the seals units could be **replaced with** or **without** CT in the hole. However, changing out with CT in the hole, this is not an easy job, rarely done in practice



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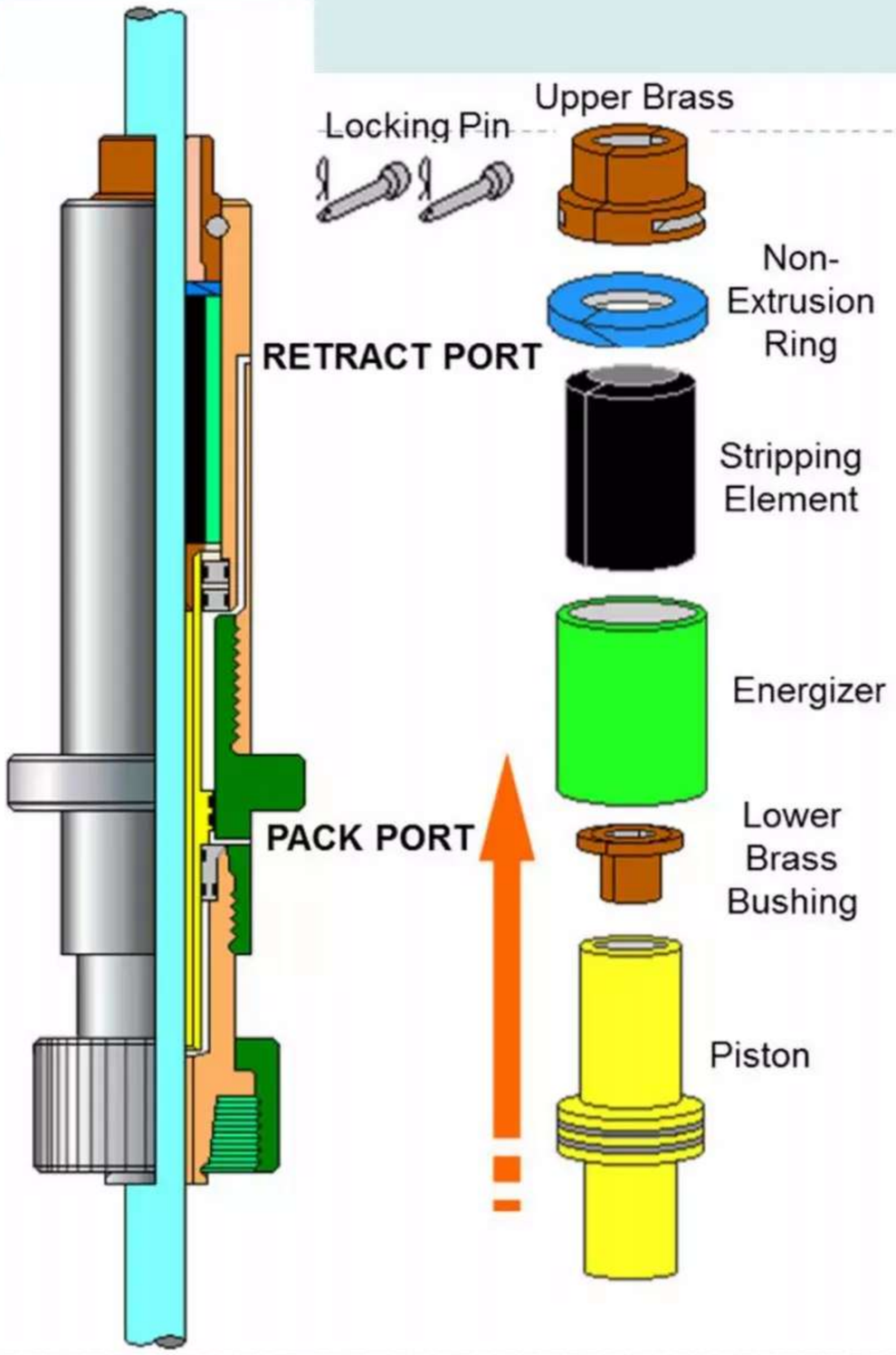
COILED TUBING EQUIPMENT

STRIPPERS [STUFFING BOX]

Conventional Stripper Assembly

Well Pressure <u>will</u> assist in sealing because the piston moves upward



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STRIPPERS [STUFFING BOX]

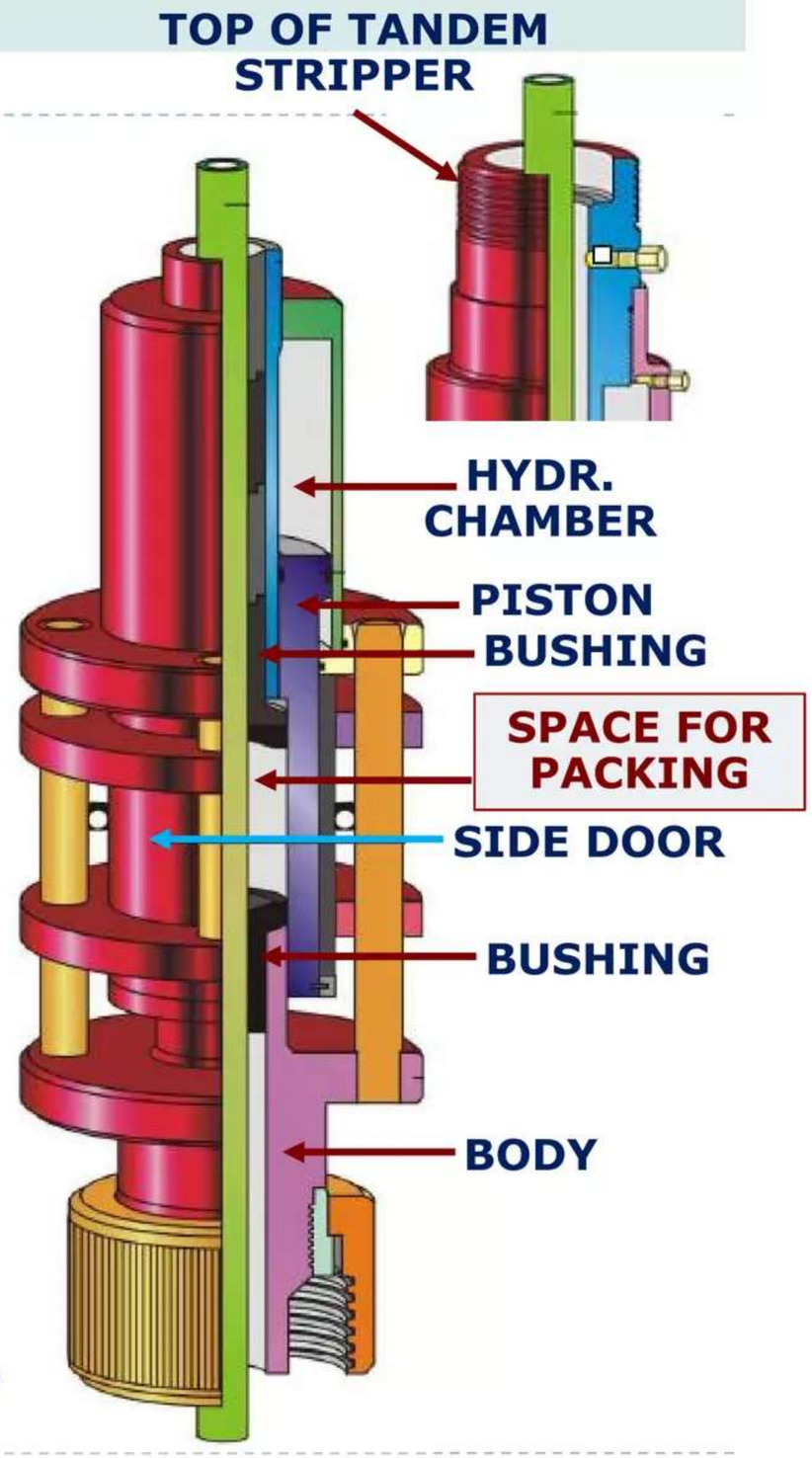
Side Door Stripper Assembly

Specifically designed to facilitate **easy access** to the Packer Insert, Primary Seal and Bushing with CT still in the well.

This Stripper has a piston, operating from **above** the sealing element [as opposed to from below with conventional design]. Similar to a Wire Line Stuffing Box ! It allows the force required to obtain a seal to be kept to a minimum.

Bushing and Packing Inserts are replaced by **inserting** these via the Side Access window.

Most Side Door Strippers are run in **Tandem** !
A Tandem Stripper is actually similar to the Single Stripper, with the exception, that it has a top threaded connection for a Tandem Stripper make up



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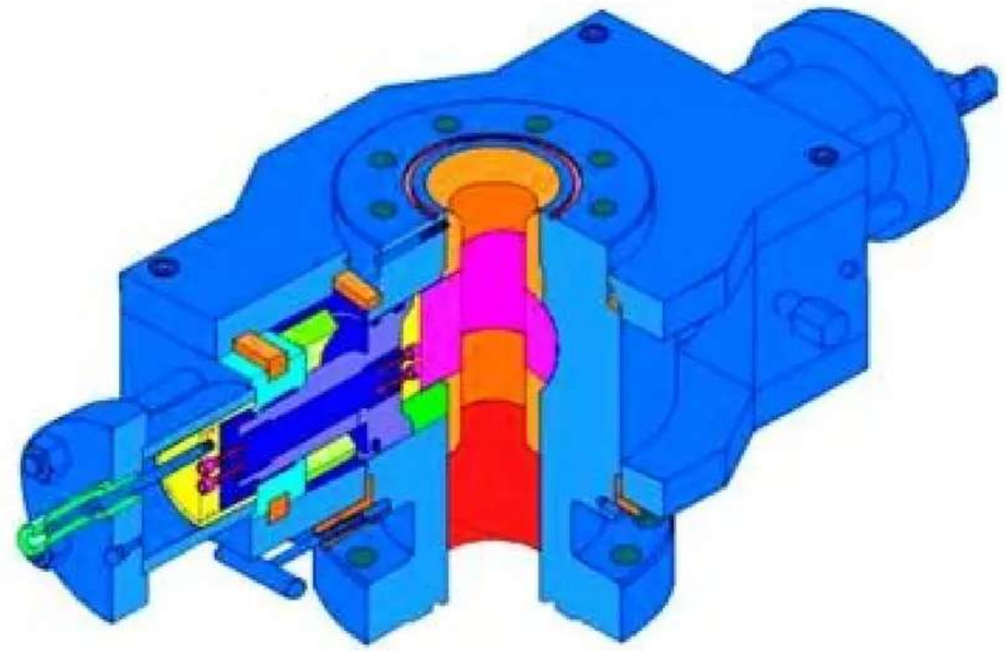
COILED TUBING EQUIPMENT

STRIPPERS [STUFFING BOX]

Radial Stripper Assembly

- Similar to conventional Pipe Ram, with pressure applied from side pistons
- It provides a lower [stack-up] height [50%], less space from Injector Head
- Can change Stripper Packing with coil in the well
- Well pressure will **not** assist. Used for high pressure gas wells
- Commonly used for large sized CT, such as 2-7/8” to 3-1/2” OD



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COILED TUBING EQUIPMENT

STRIPPER ELEMENTS

The different types of stripper elements are governed by their **Schure** Hardness.

Typically the low pressure type are 75 Schure Hardness [coloured **yellow**] whilst the high pressure are 90 rated [coloured **orange**].

The **efficiency** of the stripper elements rests on [1] external condition of CT, [2] lubrication used, [3] Stripper Pack-off Pressure and [4] Wellhead Pressure.

Materials used for CT Stripper:
- **Poly Urethan**
- **Viton [for High Temperatures]**

Max. Wellhead Press. for Standard Stripper Packer, under dynamic conditions, is **3,500 psi**

NEW

WORN OUT

INTERLOCKING

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COILED TUBING EQUIPMENT

STRIPPERS [STUFFING BOX] - *OVERVIEW*

Type	Advantage	Disadvantage
Conventional	Well Pressure assists in sealing	Greater distance from gripping chains [CT prone to buckling].
Side Door	Mounted closer to the Injector Head [less buckling] Designed for easy change out of stripper element while coil is still in the well.	
Radial	Similar to pipe ram, lower in height [50%], less distance from the Injector Head. Recommended in high pressure applications and large CT sizes	

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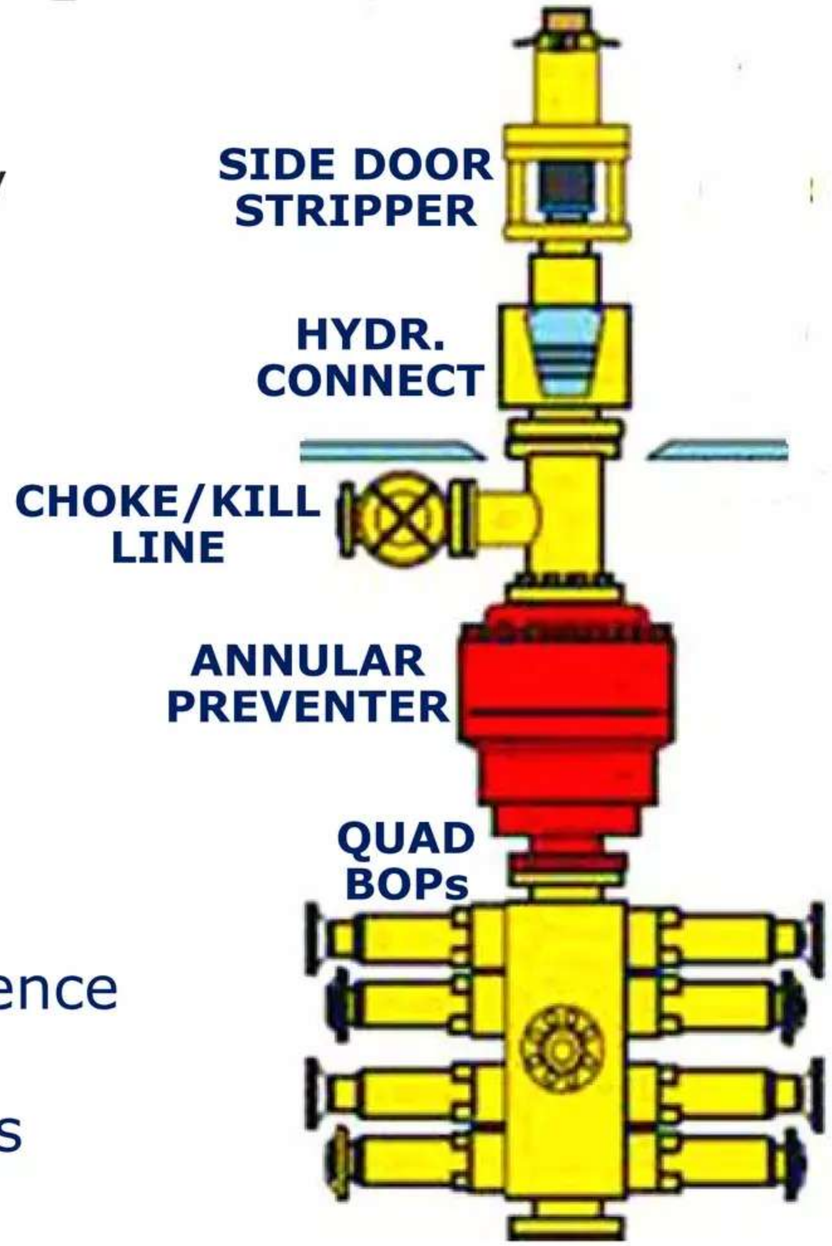
COILED TUBING EQUIPMENT

HOW TO 'CHANGE' STRIPPER [PACKER] ELEMENTS

Example: Side Door Stripper
Can be replaced with the CT still in the well, simply and quickly, and with BOP under pressure

Procedures:

- Stop CT movement and circulation
- Engage Injector Brake and Close Pipe Ram
- Bleed off pressure above Pipe Ram. Inflow Test
- Close Annular BOP [if available] as 2nd Barrier
- Open Stripper. Replace Stripper Elements via window access
- Re-test Stripper using Choke/Kill Line
- Open Annular Preventer and Pipe Rams in sequence after full pressure equalization
- Release Injector Brake. Recommence Operations



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COILED TUBING EQUIPMENT

BLOWOUT PREVENTER

SECONDARY BARRIER !

- **Perform a design [Body] Pressure Test before <u>ANY</u> deployment !**
  This test is to verify material strength of the equipment before use, without inducing fractures in the material. API guidelines as follows:-
  - **2 times** working pressure up to and including **5k Equipment**
  - **1.5 times** working pressure for **10k** and **15k Equipment**
  - **1.25 times** working pressure for **20k Equipment**
- Ram type BOPs are located below Strippers and may be a **Double**, **Triple** or **Quadruple** [Quad] BOPs
- Ram Preventer are designed to hold pressure from <u>below</u>
- Ram Preventer assembly is fitted with **equalizing valves** so as to allow pressure equalization across a closed ram before it is opened
- Ram Preventer is also fitted with a **Kill Port**

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COILED TUBING EQUIPMENT

BLOWOUT PREVENTER

Standard QUAD BOP configuration:

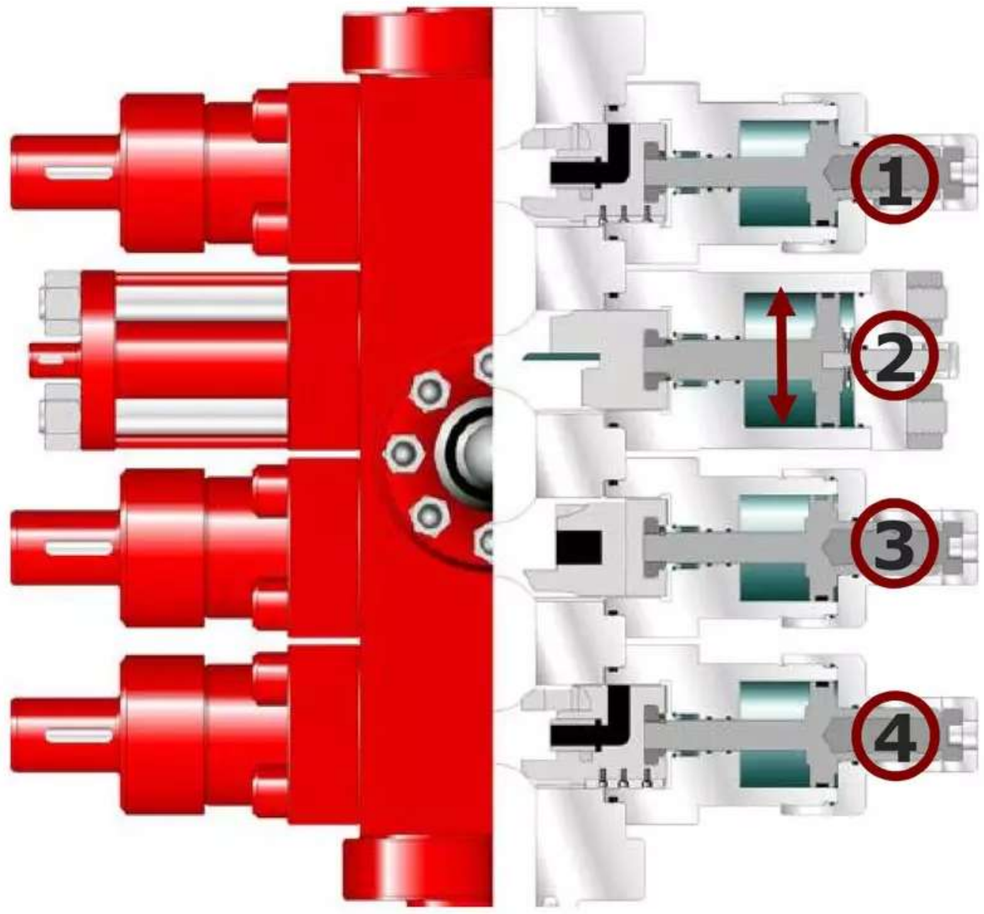
1. **Blind Rams** – Top Set of rams. Serves to seal off well pressure when no CT is across

2. **Shear Rams** - Second set of rams that serve to shear the tubing. Large bore !

3. **Slip Rams** - Third set of rams. Serves to hold CT in place while shearing, or for other applications

4. **Pipe Rams** - Bottom set of rams. Serves to seal around CT, thus isolating wellbore pressure below rams

We also have **EQUALIZATION PORTS** + we have a **KILL PORT**



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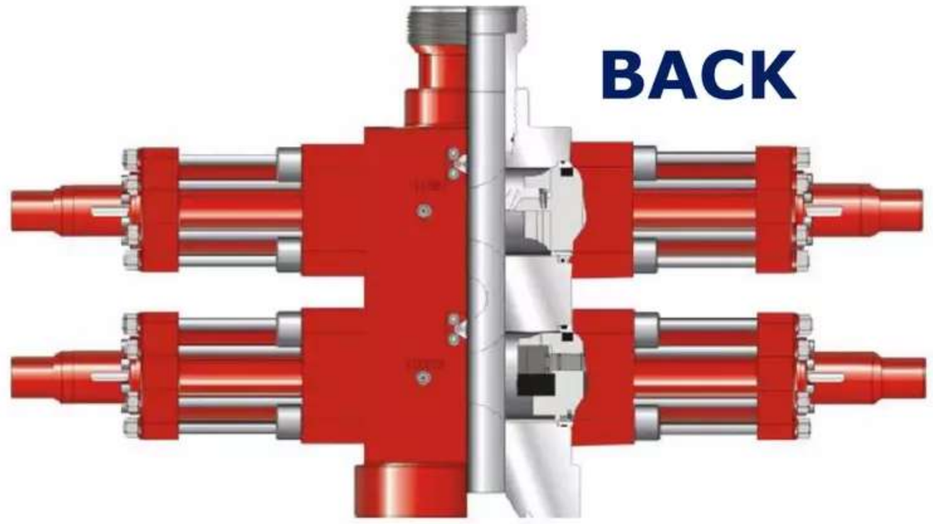
COILED TUBING EQUIPMENT

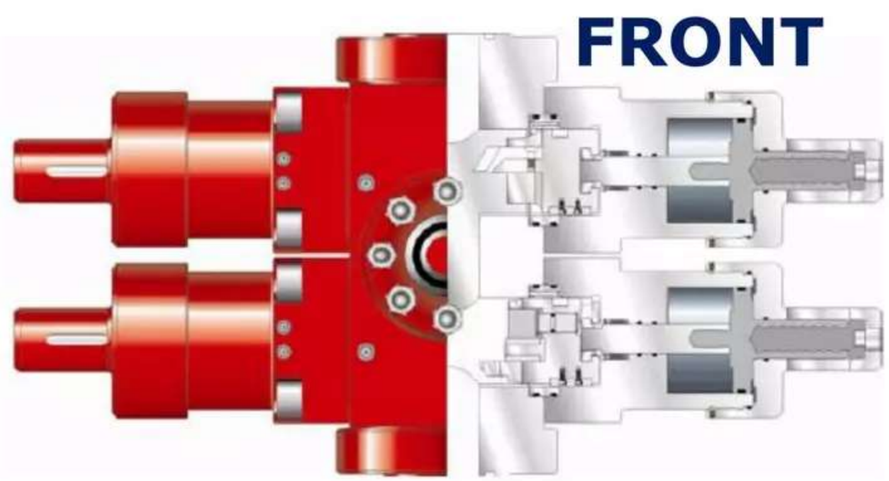
BLOWOUT PREVENTER

Standard COMBI BOP configuration:



1. **Blind/Shear Rams** - Upper set of rams that can shear CT, and seal off well pressure.

2. **Slip/Pipe Rams** - Lower set of rams serving to hold CT in place while shearing [or for other applications] and also seal around CT, thus isolating wellbore pressure below the rams



Advantages Combi BOP over Quad BOP

- Less Height
- Minimizes steps during an Emergency [Easy to Operate]

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COILED TUBING EQUIPMENT

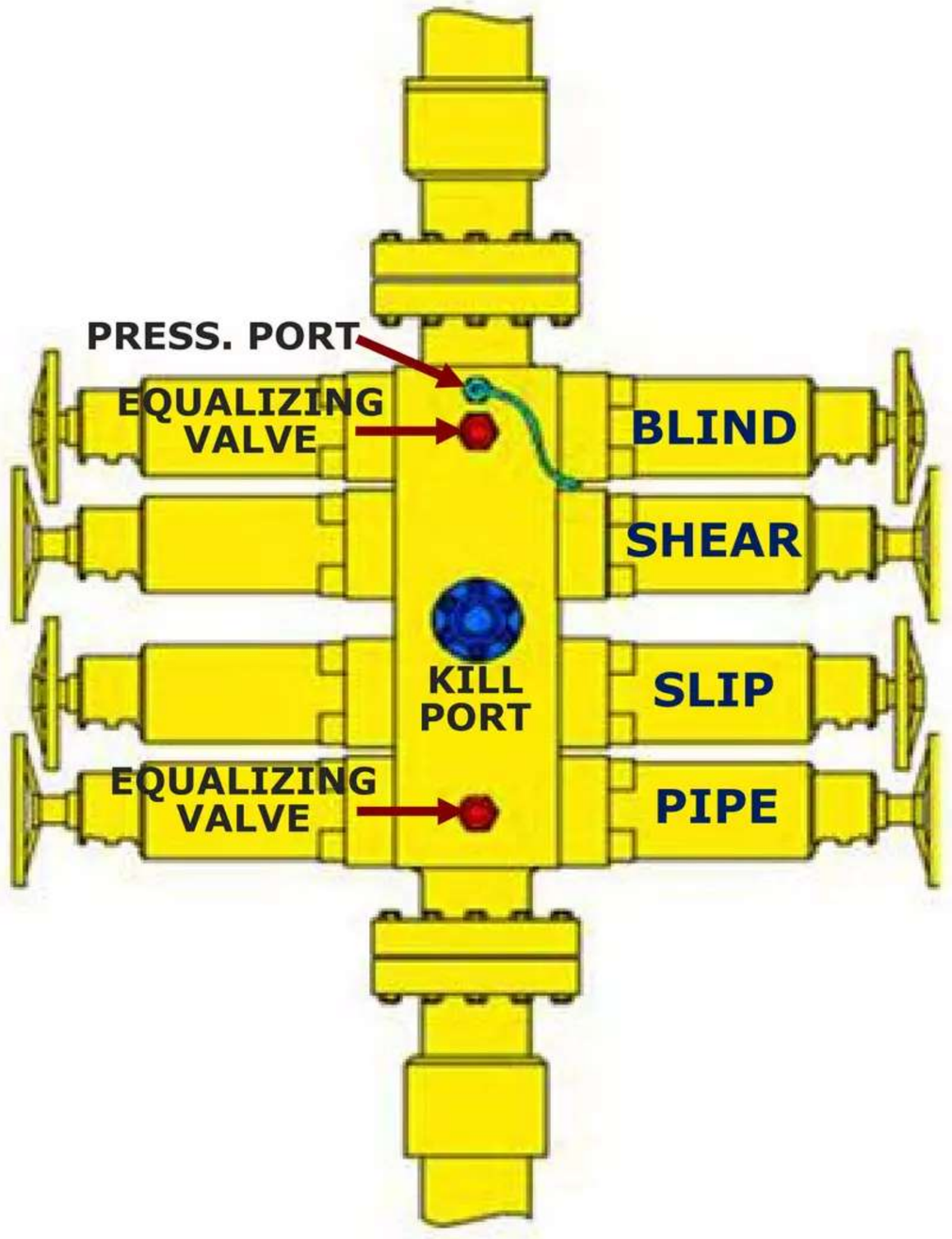
BLOWOUT PREVENTER

IN CASE OF EMERGENCY

1. **Close Slip Ram**
2. **Close Pipe Ram**
3. **Close Shear Ram [cut CT]**
4. **Pull CT <u>above</u> Blind Ram**
5. **Close Blind Ram**

then

- *Connect Kill Line to Kill Port*
- *Kill well through CT with returns via the Choke*



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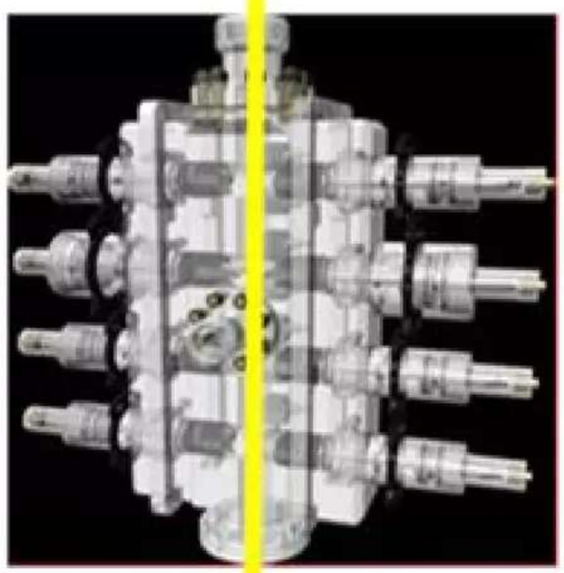
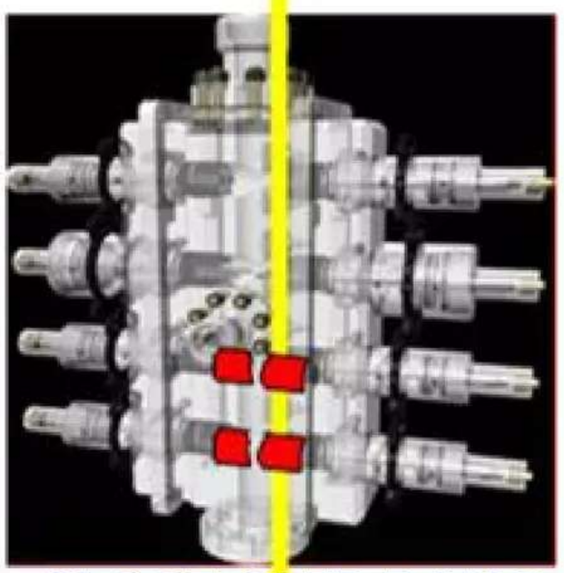
COILED TUBING EQUIPMENT

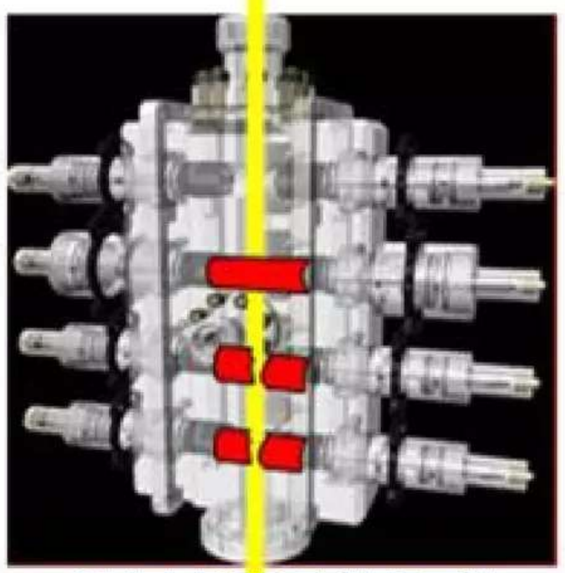
SEQUENCE 'CUTTING/REMOVING'



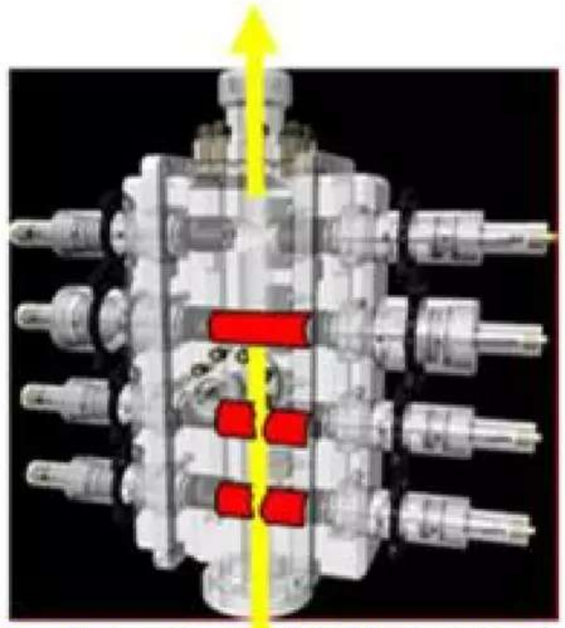
ALL RAMS OPEN



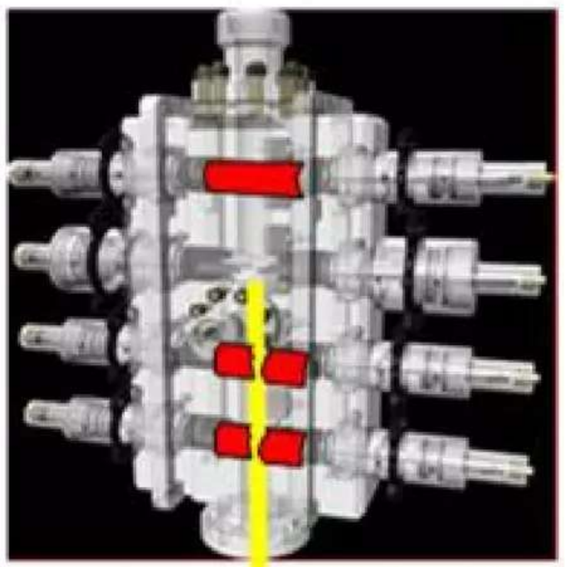
CLOSE SLIP RAMS
+ PIPE RAMS



CUT PIPE WITH
SHEAR RAMS



PULL OUT 'CUT COIL'
WITH INJECTOR



CLOSE BLIND RAMS

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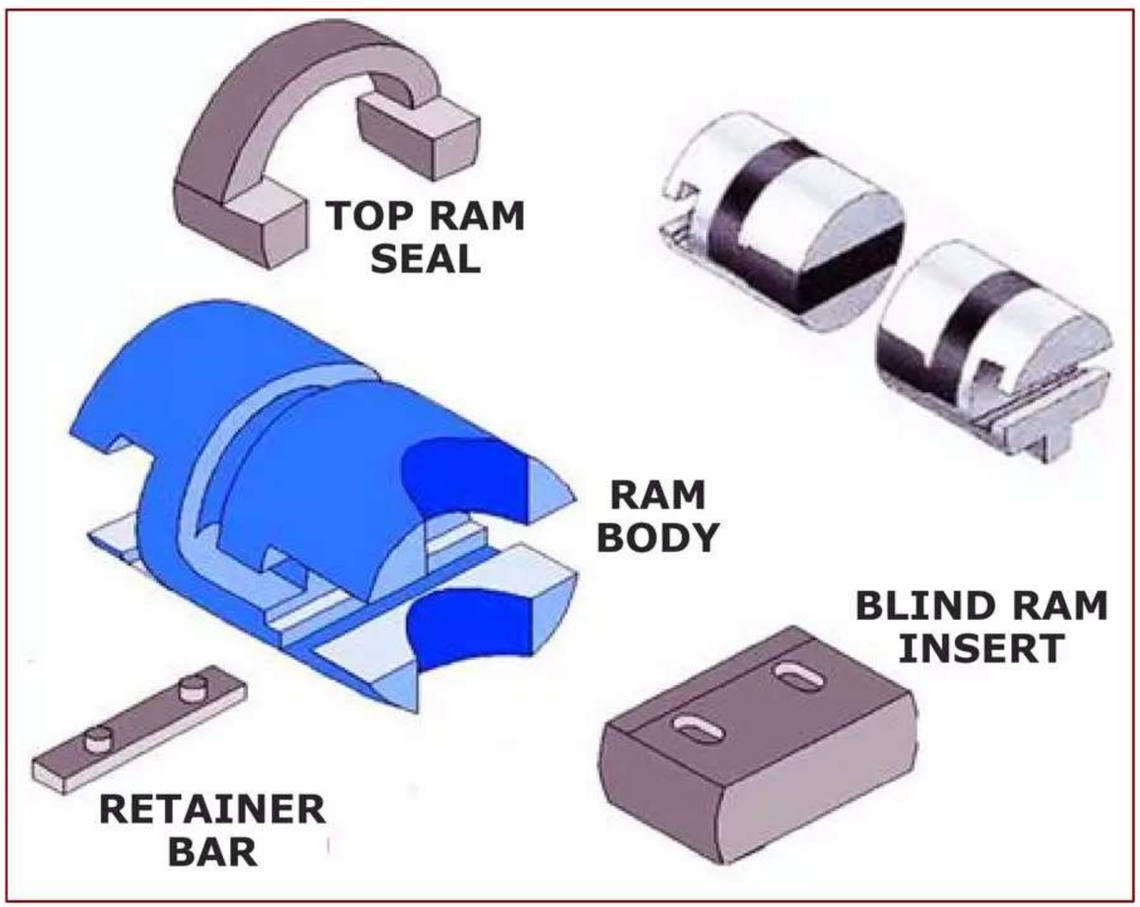
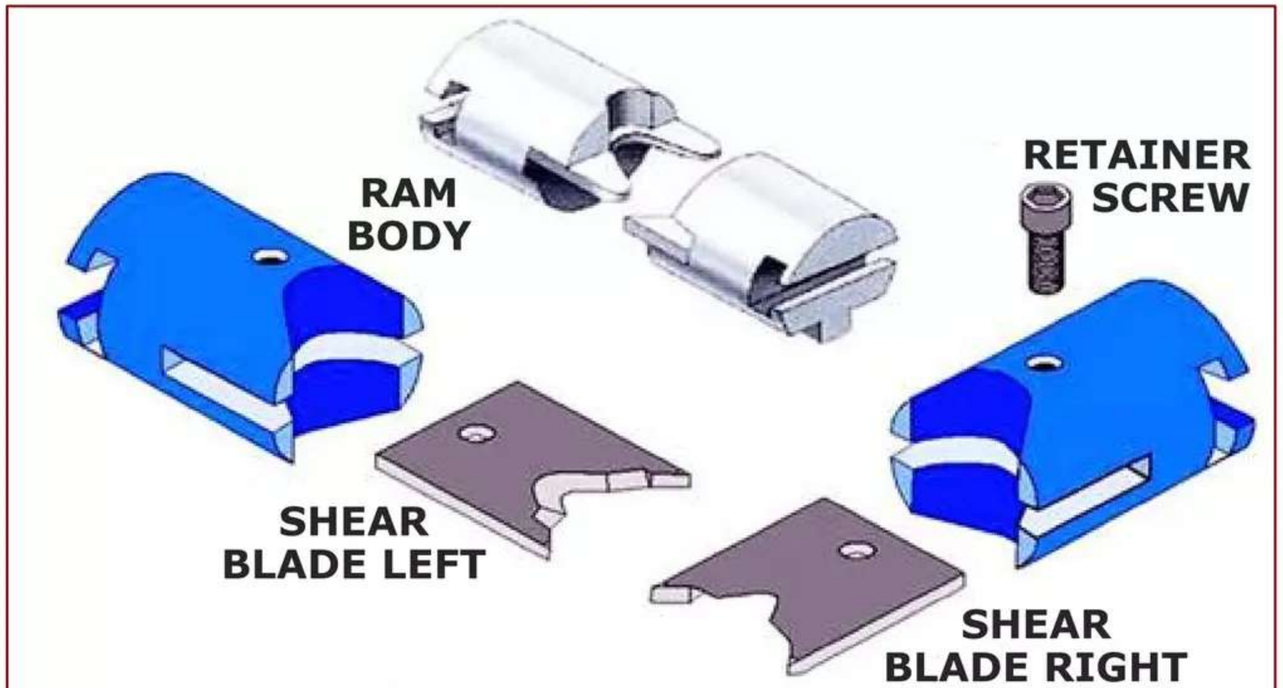
COILED TUBING EQUIPMENT

QUAD BOP

BLIND RAM
[QUAD BOP]





SHEAR RAM
[QUAD BOP]

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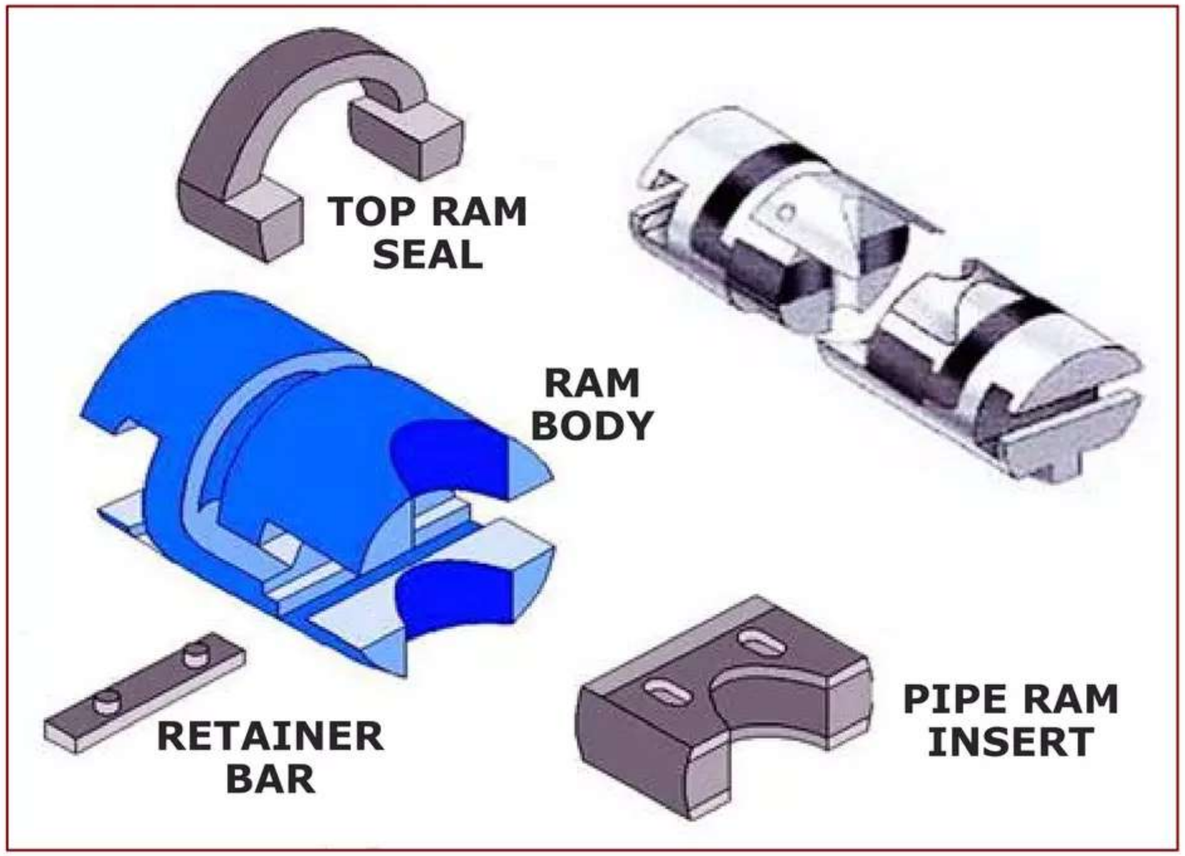
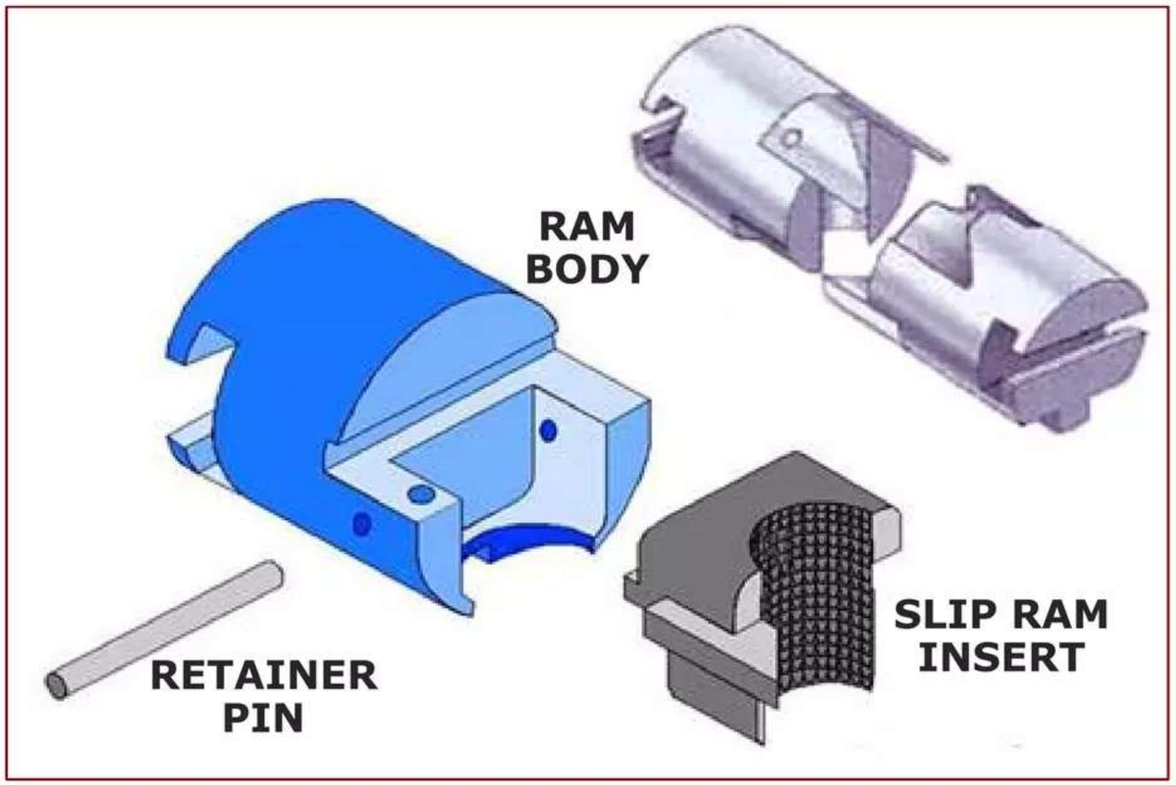
COILED TUBING EQUIPMENT

QUAD BOP

PIPE RAM
[QUAD BOP]





SLIP RAM
[QUAD BOP]

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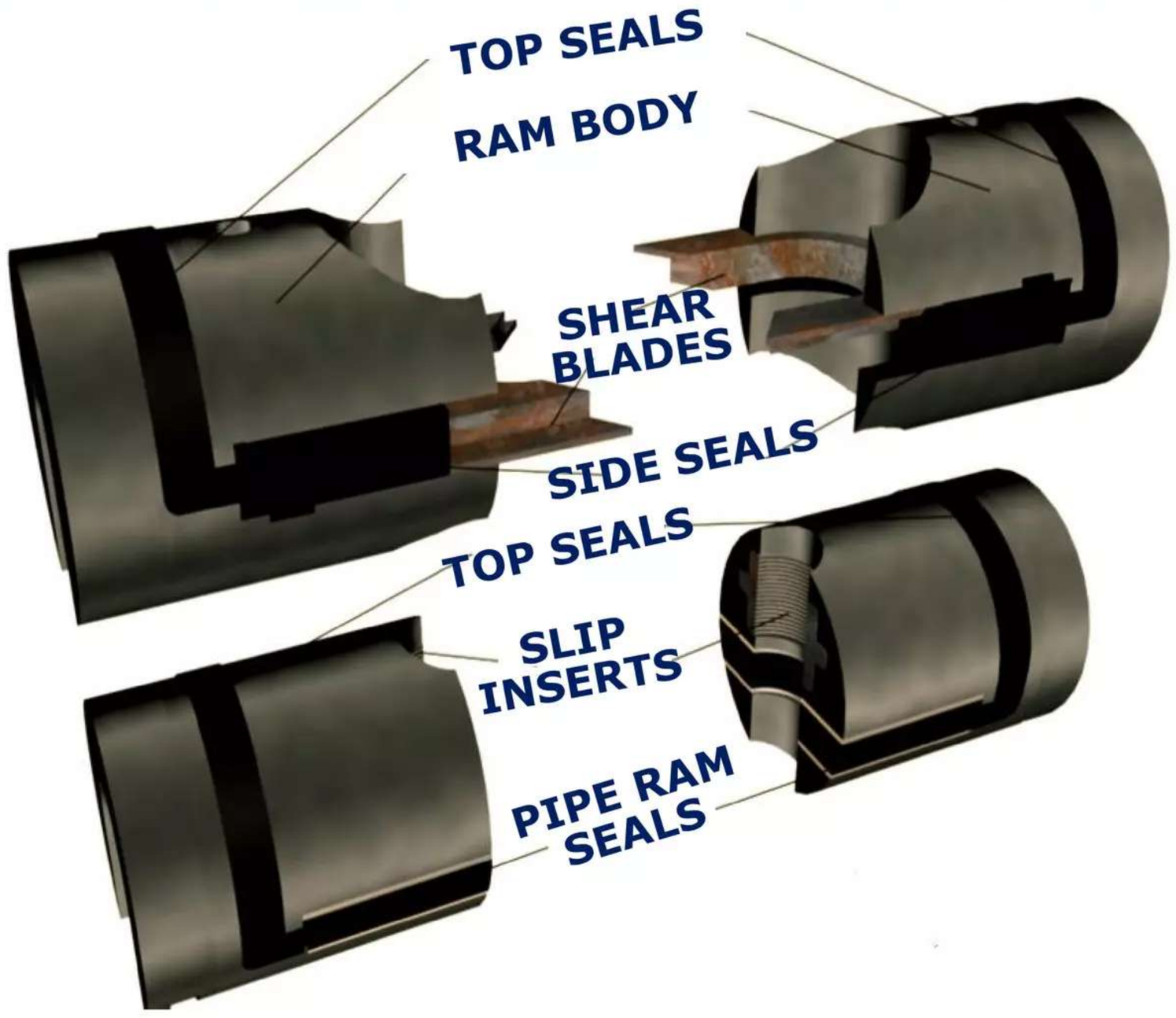
COILED TUBING EQUIPMENT

COMBI RAMS

SHEAR/BLIND RAMS

SLIP/PIPE RAMS



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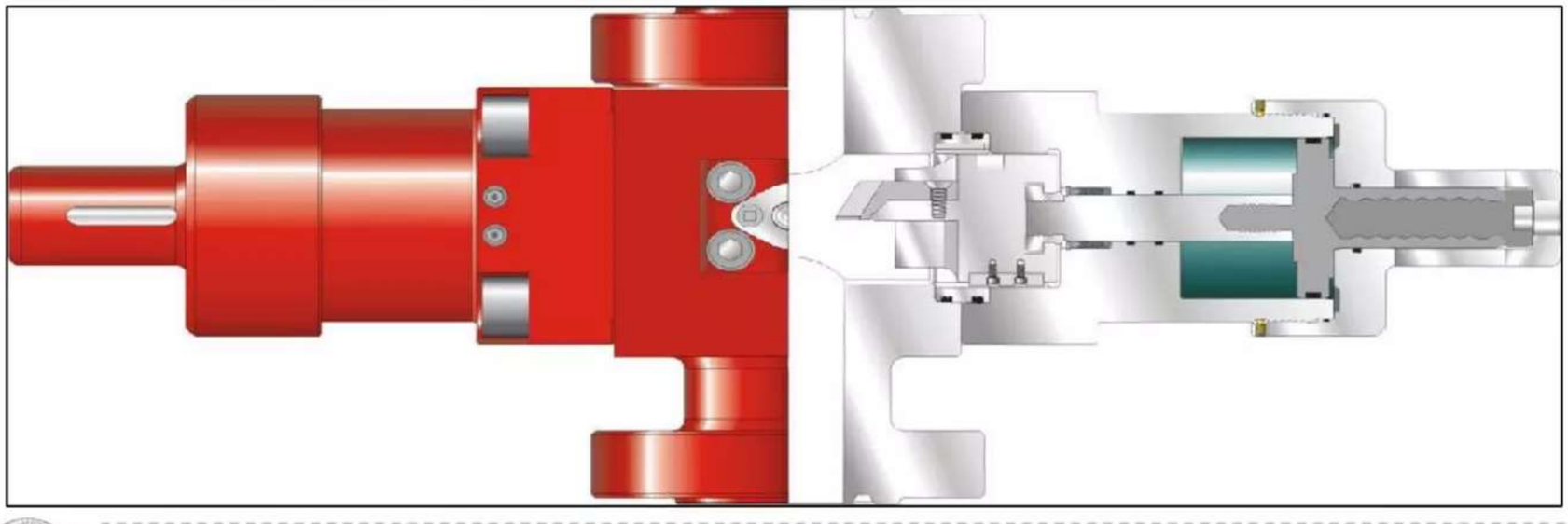
COILED TUBING EQUIPMENT

BLOWOUT PREVENTER – SHEAR SEAL

TERTIARY BARRIER !

- **Shear/Seal BOP** [*Safety Head],* is located *just above the Xmas Tree*
- Purpose is to provide ***additional shear*** capacity in set-up. *It is mainly installed in high pressure wells when Shear ram on Combi or Quad BOP can not successfully cut Coiled Tubing and drop down hole. It has a large bore [to cut large sized CT] and usually rated to 10,000 psi.*
- The **latest type** of the **Shear/Seal BOPs** are capable of shearing and sealing [after cutting CT], Slick Line, Braided Line, Sinker bar, even Drill Pipe, but BHAs may not be cut successfully!



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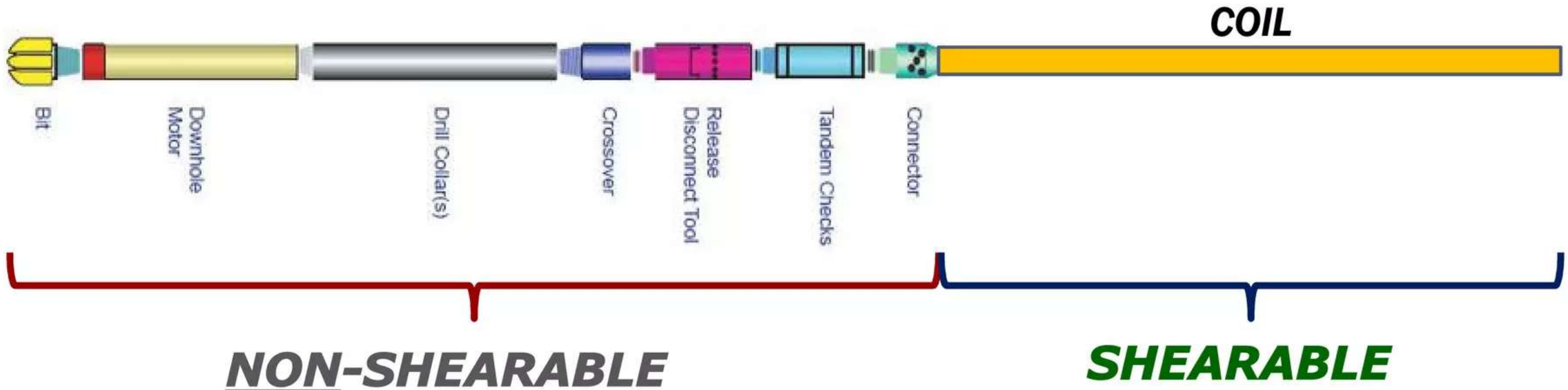
COILED TUBING EQUIPMENT

COILED TUBING – NON-SHEARABLE components in the string



If **not sure** about **shear capability**, then **DO NOT** attempt to shear ANYTHING ELSE, **but** the COIL !!

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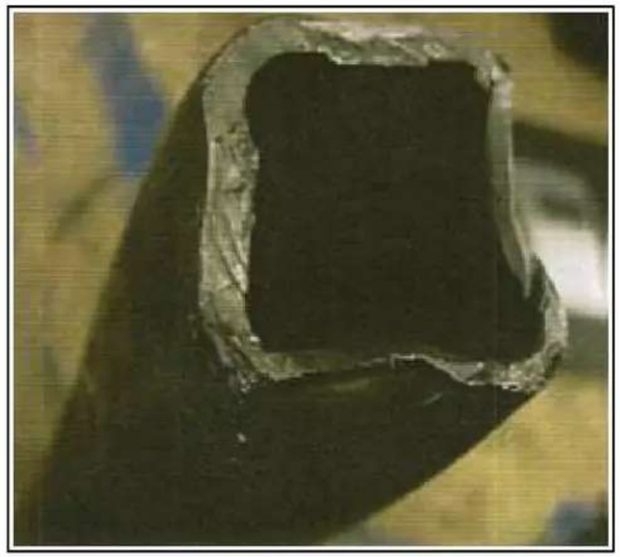
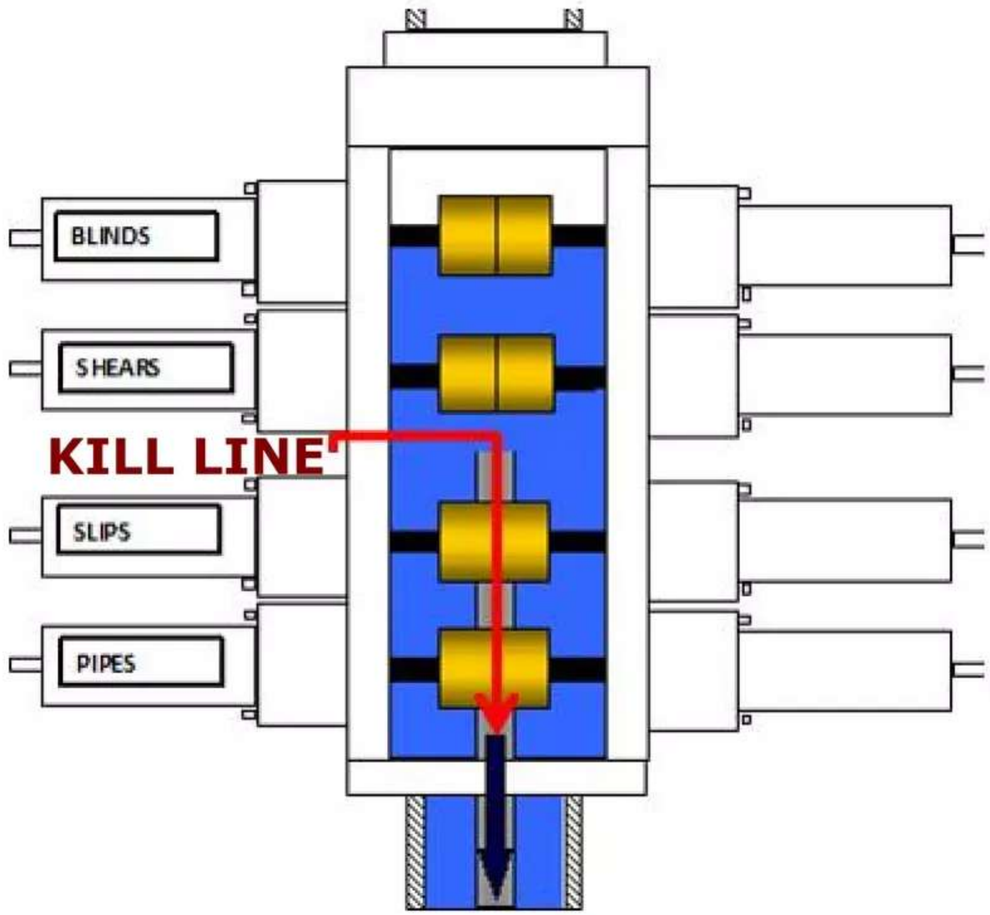
COILED TUBING EQUIPMENT

BLOWOUT PREVENTER – SHEAR/BLIND + SHEAR/SEAL



CLEAN CUT

CRIMPED CUT



The design of shear cutters should be such that they will **not** completely **crimp** the CT when cut. This allows monitoring and – above all – it permits fluid to be pumped through the coil, critical for **killing the well**.

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COILED TUBING EQUIPMENT

BLOWOUT PREVENTER – SUMMARY of DESIGN/ABILITY

Blind Rams	Designed to close and **seal** on open hole
Shear Rams	Designed to **shear** or cut CT in the hole
Shear/Seal Rams	Designed to **cut** CT and then **seal** the well [not cut the BHA !] – Also called Safety Head
Slip Rams	With Slip Inserts not sealing pressure. Used to **hang off** CT, prevent it from rotating and stripping down due to CT weight. [designed to grip only one direction]
Pipe Rams	Designed to **shut off** well pressure when a change out of Stripper Elements are required. Also called Safety Ram

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COILED TUBING EQUIPMENT

BLOWOUT PREVENTER – QUAD BOP

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COILED TUBING EQUIPMENT

BLOWOUT PREVENTER – ANNULAR PREVENTER

- If we need to **shut in** the well around **various sizes**, dimensions [OD, shape] of pipe and or BHA, THEN we need the Annular BOP to perform this operation

- Annular Preventer will provide an **extra Barrier** and this will be useful when Stripper Elements have to be changed

- Normally installed above Shear/Seal BOP or Safety Head, alternatively above Quad BOPs

- Annular Packing Element cannot be changed with CT in the hole. Therefore must be changed prior to start operating

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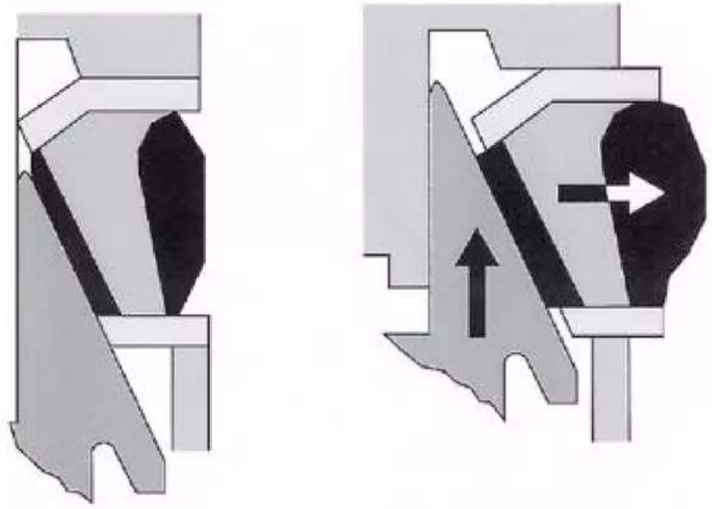
COILED TUBING EQUIPMENT

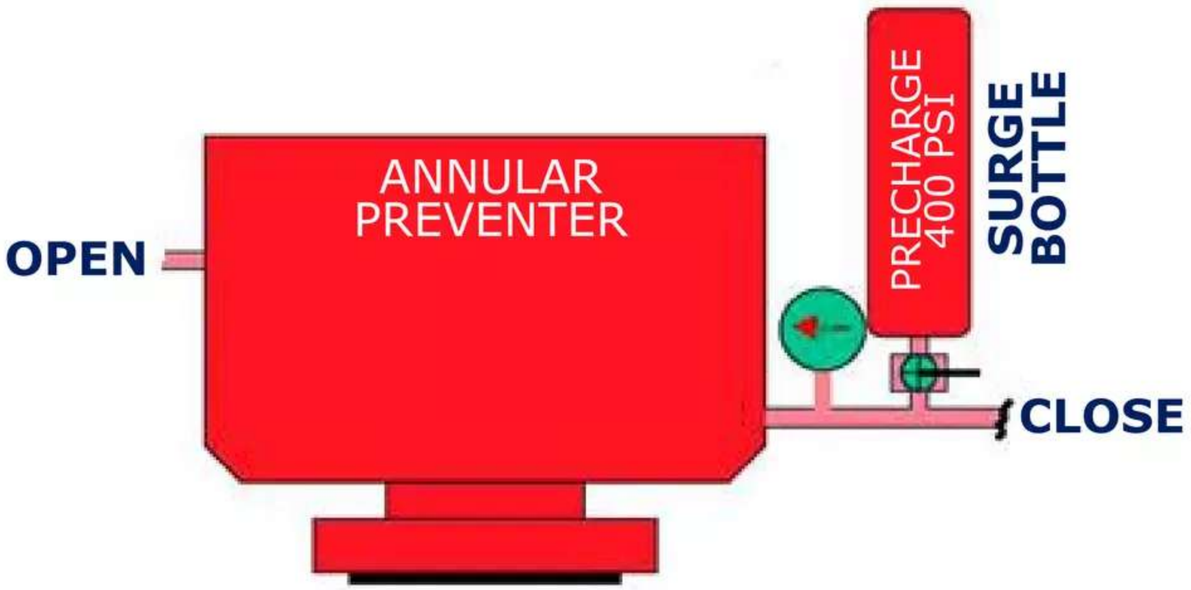
BLOWOUT PREVENTER – ANNULAR PREVENTER

The Annular Preventer is also used to permit **STRIPPING** of **CT** and/or other components. If we strip, then we must pay attention to: -

- ✓ ***Annular Preventer Operating Pressure***
- ✓ ***Weight Indicator, if string has various ODs***
- ✓ ***Info on Fishing Necks of Tool String***



Annular BOPs have a donut shaped rubber packing; it allows stripping of tapered strings maintaining a seal !



Annular BOP closing line connected to a 1 gallon Accumulator Bottle, facilitating the stripping of taper strings because bottle functions as a 'dampener', and thus avoids damage to Packing Element.

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PLAY VIDEO

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PLAY VIDEO

1. The Coiled Tubing Injector Head
2. The Coiled Tubing Hybrid Drilling Rig

DeepReach℠ coiled tubing arrives on location as a continuous string, all on one reel.

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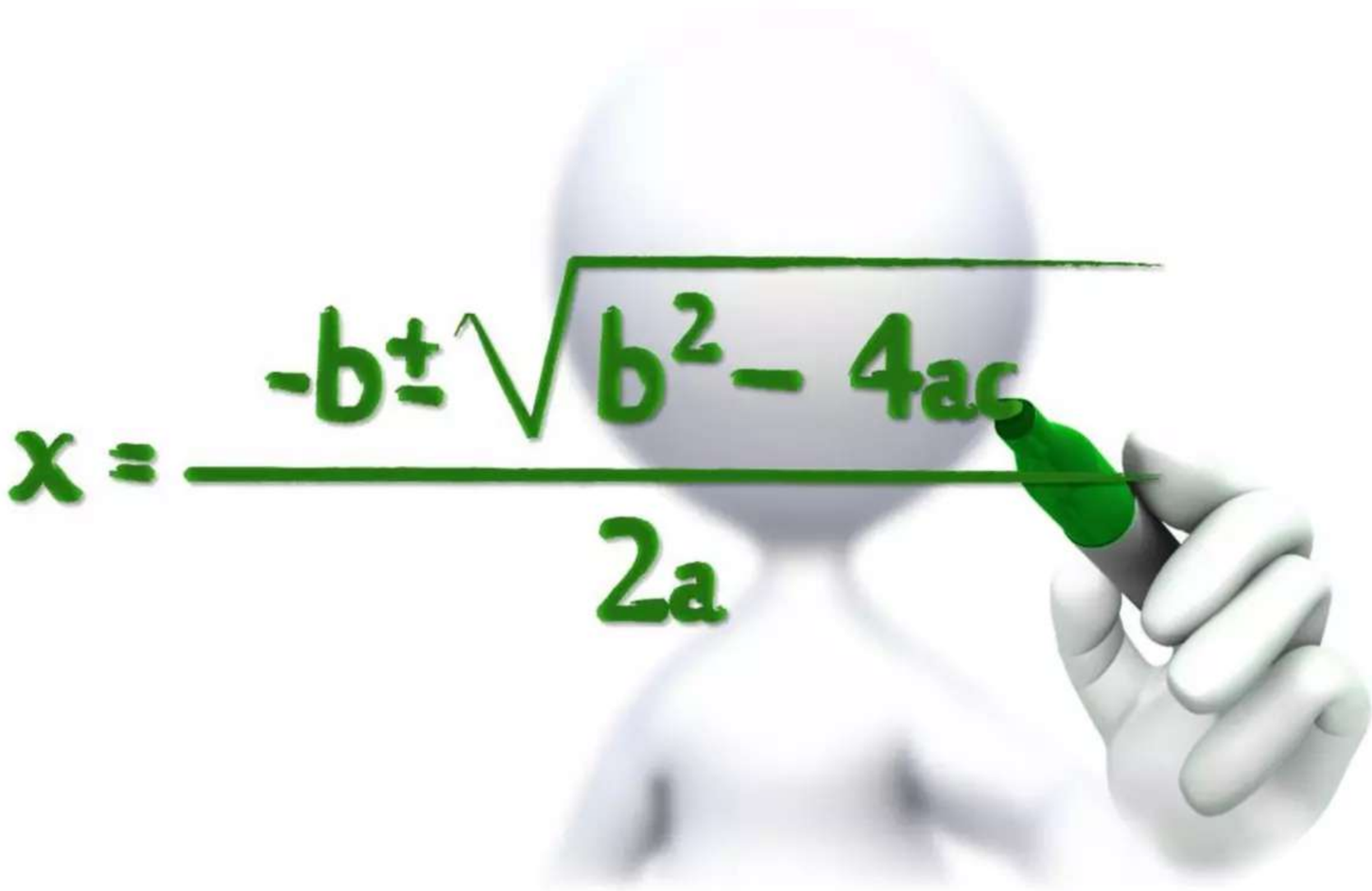

Start WorkBook Exercise 1 & 2

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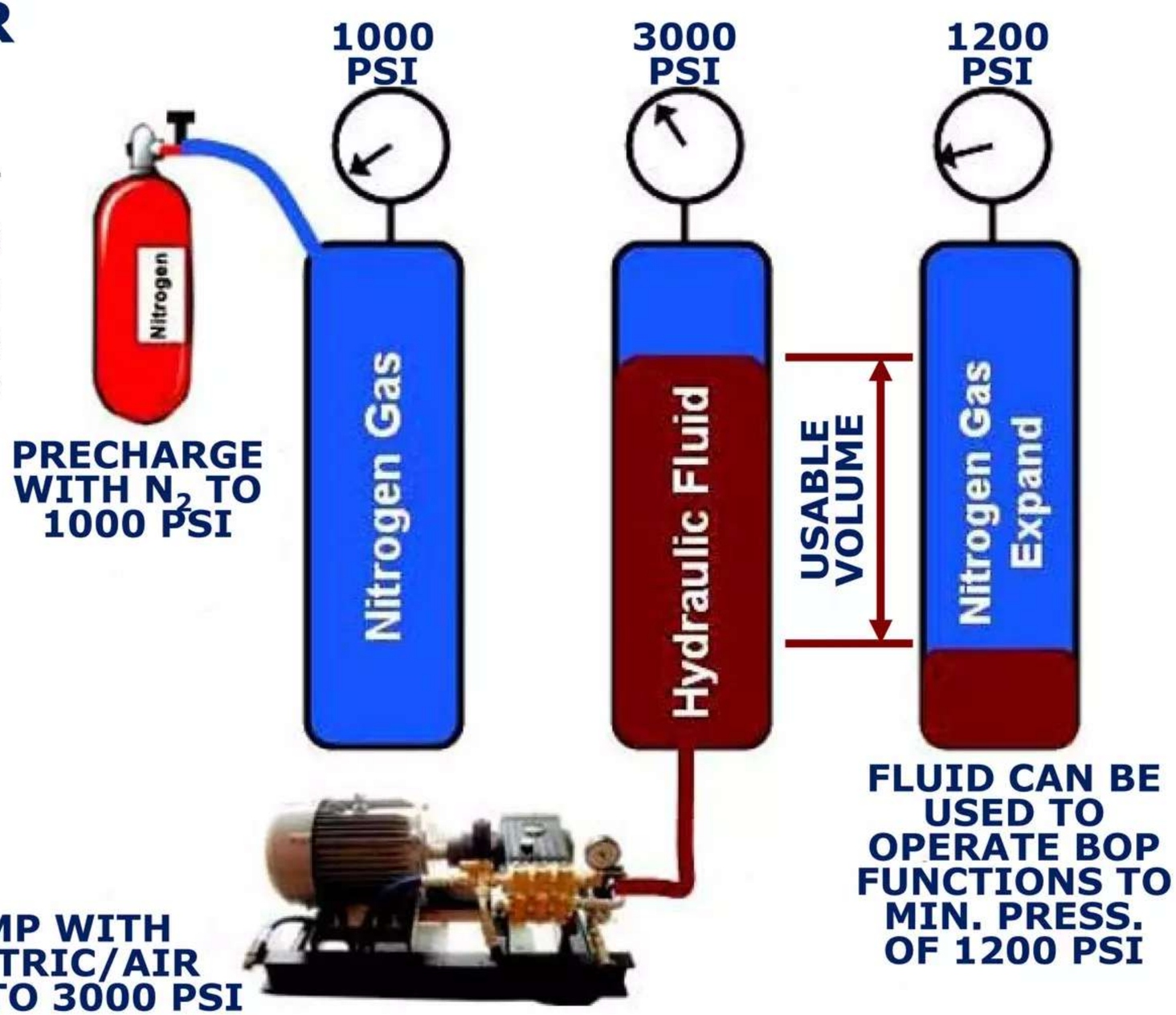
COILED TUBING EQUIPMENT

BLOWOUT PREVENTER CONTROL SYSTEM

The Accumulator System for BOP Operational Control has a number of **bottles**, which permit fluid under pressure to function the various BOP Rams and Hydr. Valves.

- The bottle is pre-charged with N_2 to **1000 psi**
- The max. pressure in the bottle is **3000 psi**
- The min. pressure in the bottle is **1200 psi**



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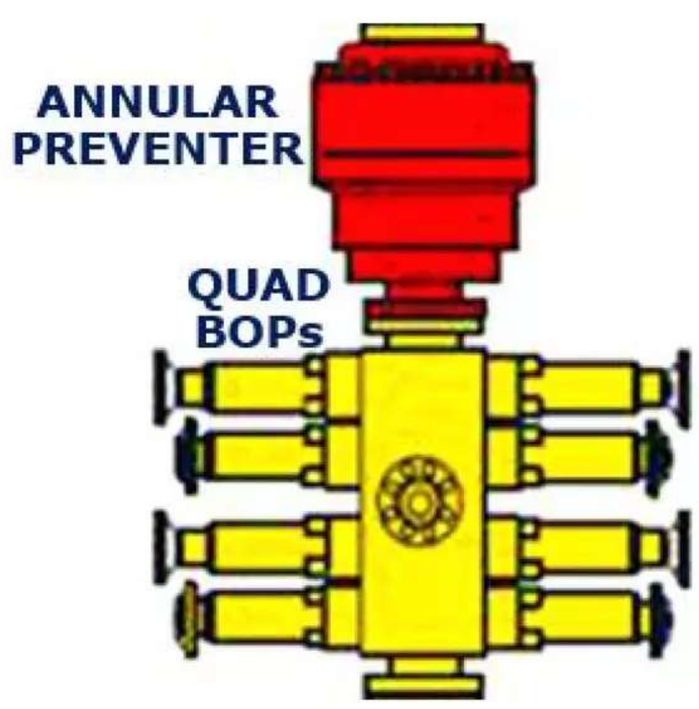
BLOWOUT PREVENTER - CONTROL SYSTEM

Volume Calculation and Number of Bottles Requirement

Example:

Company Policy is to provide *sufficient volume* to… e.g. **close**, **open** and **close** again **all Rams** and **Annular Preventer**, using information below.



Item	Open Vol.	Close Vol.
Annular BOP	7	8
Slip Ram BOP	3	4
Pipe Ram BOP	3	4
Blind Ram BOP	4	5
Shear Ram BOP	4	5

Calculate the Total Required Volume !

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COILED TUBING EQUIPMENT

INTERNAL BOP – CHECK VALVES

DUAL FLAPPER VALVE

INTERNAL PRIMARY BARRIER

- Installed at the **end of CT** but above the [rest of] BHA, with main purpose to **control** and/or to maintain **pressure** when CT fails at surface
- [**Dual**] **Flapper Type Valve** are most frequently used
- Flapper Type Valves allows Plugs and **Balls** to be **pumped through**, such as to operate special equipment in the BHA
- Reverse Circulation is not possible
- If **Reverse Circulation** is required, e.g. for optimal cleaning efficiency, then an extra circulating sub must be installed above check valves [not common]. However, once the ball for this circulation sub has been dropped, **NO** mechanical barriers remain to stop flow inside the CT

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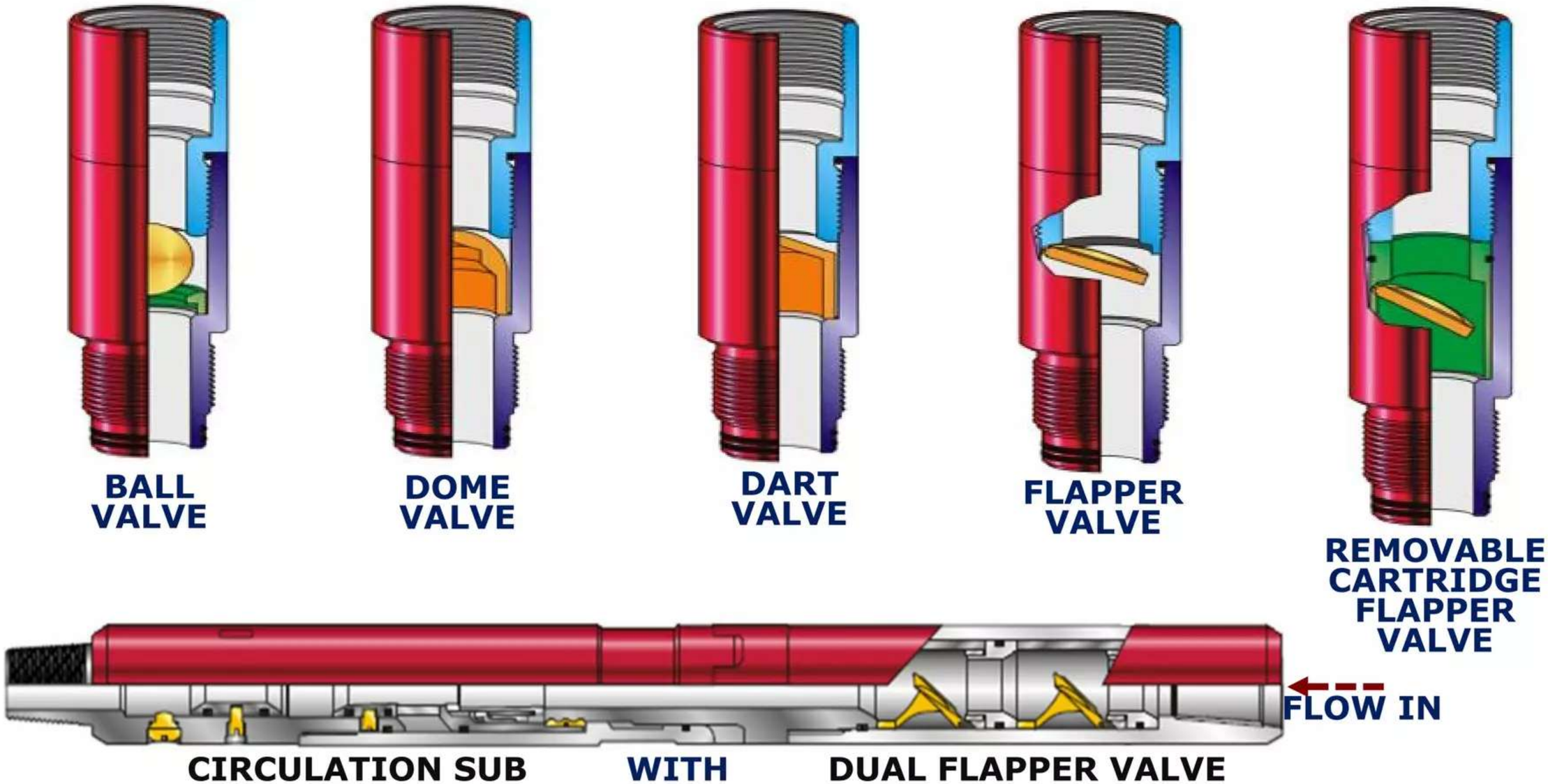
COILED TUBING EQUIPMENT

INTERNAL BOP – CHECK VALVES



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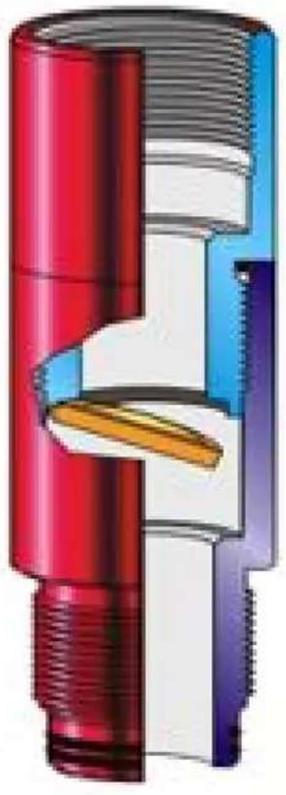
COILED TUBING EQUIPMENT

INTERNAL BOP – CHECK VALVES



CRITICAL INFORMATION:-

When check valves are fitted a risk exist that the coil may be exposed to high collapse loads [i.e. external pressure much higher than internal pressure], which may exceed the collapse pressure of the coil.

These possible **collapse loads** occur:-

- During **gas lifting operations** where nitrogen is in the reel and fluid is in the completion tubing, in particular if the gas pressure in the reel is bled off
- While running into a **closed system**, i.e. un-perforated casing or liner. Steel displacement will cause an increase in pressure, which must be bled off timely.
- If pressure around the CT builds up rapidly when a **flowing well** would be **shut in** [for operational reason]
- During **pressure testing** of BOP surface equipment

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COILED TUBING EQUIPMENT

INTERNAL BOP – CHECK VALVES → PUMP-OUT TYPE

- Used for **CT VELOCITY STRING** applications. This application involves hanging off a CT string in a well permanently as part of the completion. When installed, the string must be fully open to the flow of wellbore fluids
- A single **Pump-Out Check Valve** works as a standard ball check valve, thus assuring well control during normal CT operation, until a circulating ball is pumped to eject the sleeve containing the ball check valves
- **Procedure**:
  The pump out check valve is attached to the bottom of the CT. Before running the CT in, pressure required to pump it out is adjusted by varying the number/type of shear screws. Upon reaching final depth, a circulating ball is pumped down to a seat in the check valve. Pressure is applied to shear the screws, pushing the check valve cartridge out of the housing.

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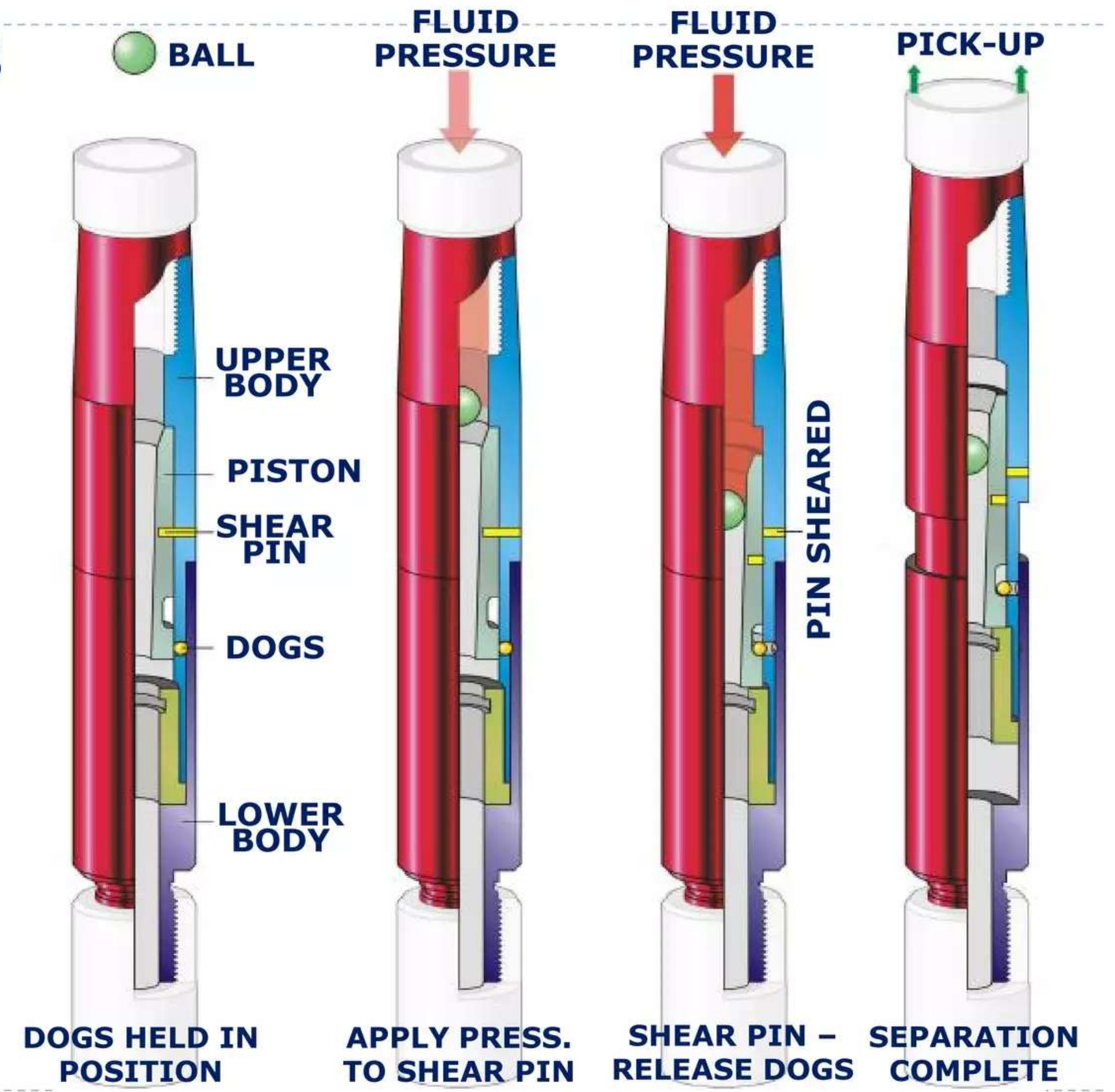
COILED TUBING EQUIPMENT

RELEASE MECHANISMS

There are <u>three</u> basic types of releasing mechanisms:-

1. **Ball Operated Shear Sub (BOSS)** as shown on the right !
2. **Tension Disconnect**
3. **Hydraulic Disconnect**



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COILED TUBING EQUIPMENT

RELEASE MECHANISMS - OVERVIEW

The selection of the **CT Release Mechanism** depends on the expected situation downhole and the operations that have to be performed.

- A **Ball Operated Shear Sub** [BOSS] works well in a highly deviated well, when the BHA can hang up and/or get stuck in solids. This is the most practical and most reliable system

- A less favoured option would be the **Tension Disconnect**. Appropriate tension will separate the two components that are pinned together, but due to lack of control on down hole tension forces, there is always a possibility of a premature release

- The **Hydraulic Disconnect** is similar in design to the BOSS, but operated by differential pressure inside the CT. The activating mechanism depends on depth and fluids in the well

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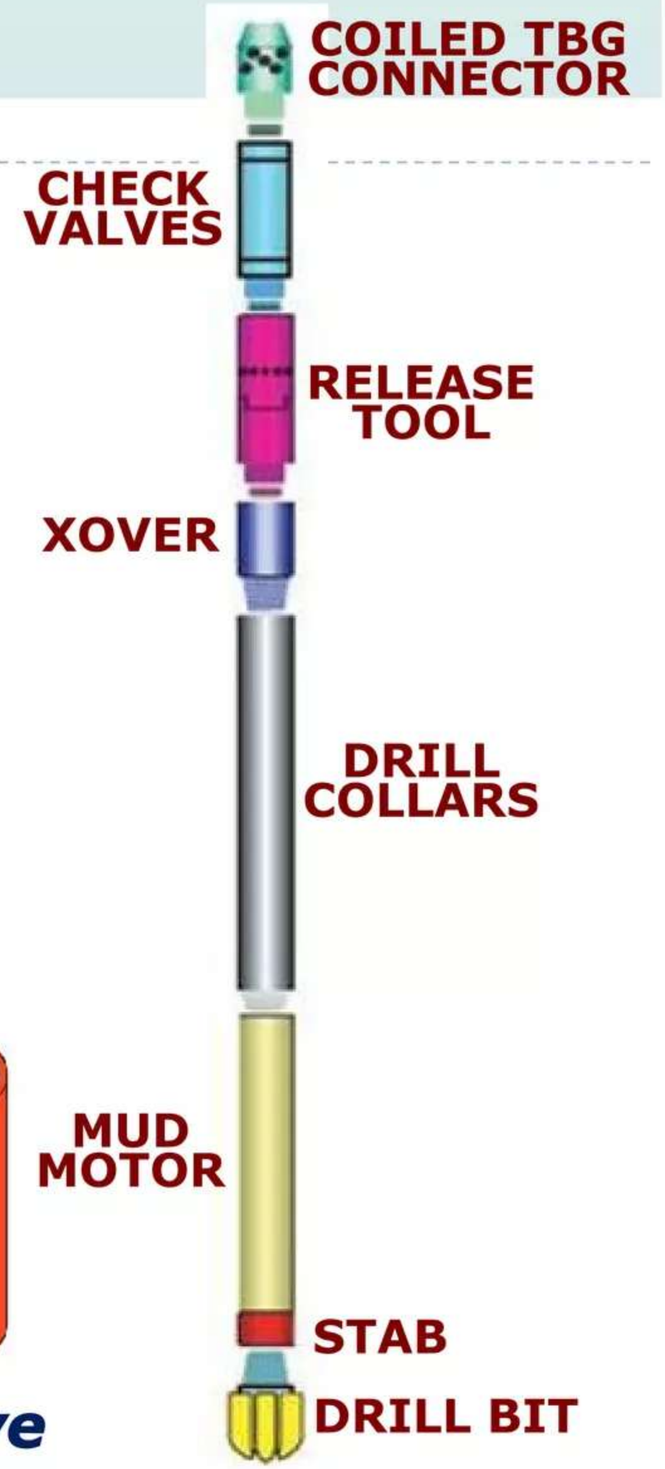
COILED TUBING EQUIPMENT

CT MUD MOTOR BOTTOM HOLE ASSEMBLY

From Top to Bottom:-

- **Coiled Tubing Connector**
- **Tandem Check Valves**
- **Release Joint/Safety Joint***
- **Drill Collars**
- **Coiled Tubing Motor**
- **Stabilizer** [Optional]
- **Bit**



Release Joint is usually run w/ a **By-Pass/Circ. Valve*

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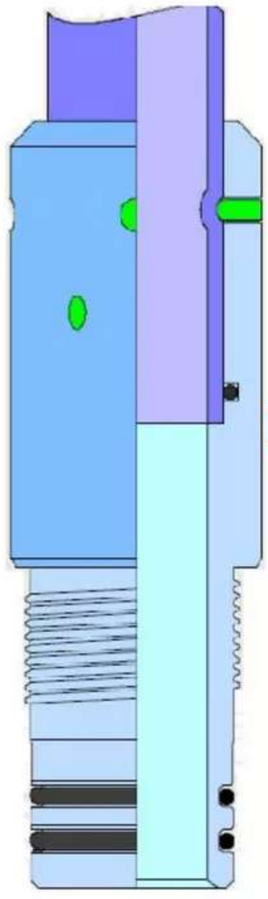
COILED TUBING EQUIPMENT

TUBING END CONNECTORS

The choice of **Tubing End Connector** depends on the type of duty to be performed and is [also] a critical item.

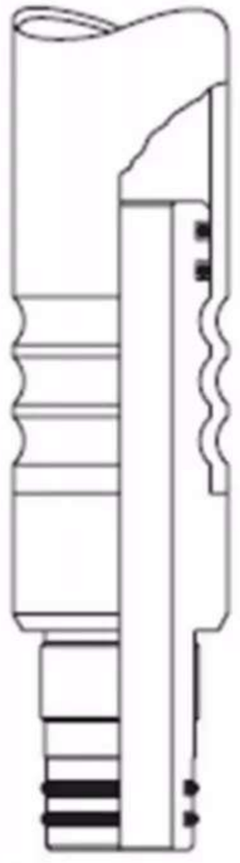


DIMPLE [GRUB-SCREW] CONNECTOR

FOR MOST 'GENERAL' OPERATION

EXTERNAL GRAPPLE CONNECTOR

DOES NOT RESTRICT ID OF TUBING



ROLL-ON/ CRIMPING CONNECTOR

FOR LIGHT DUTY OPERATION

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COILED TUBING EQUIPMENT

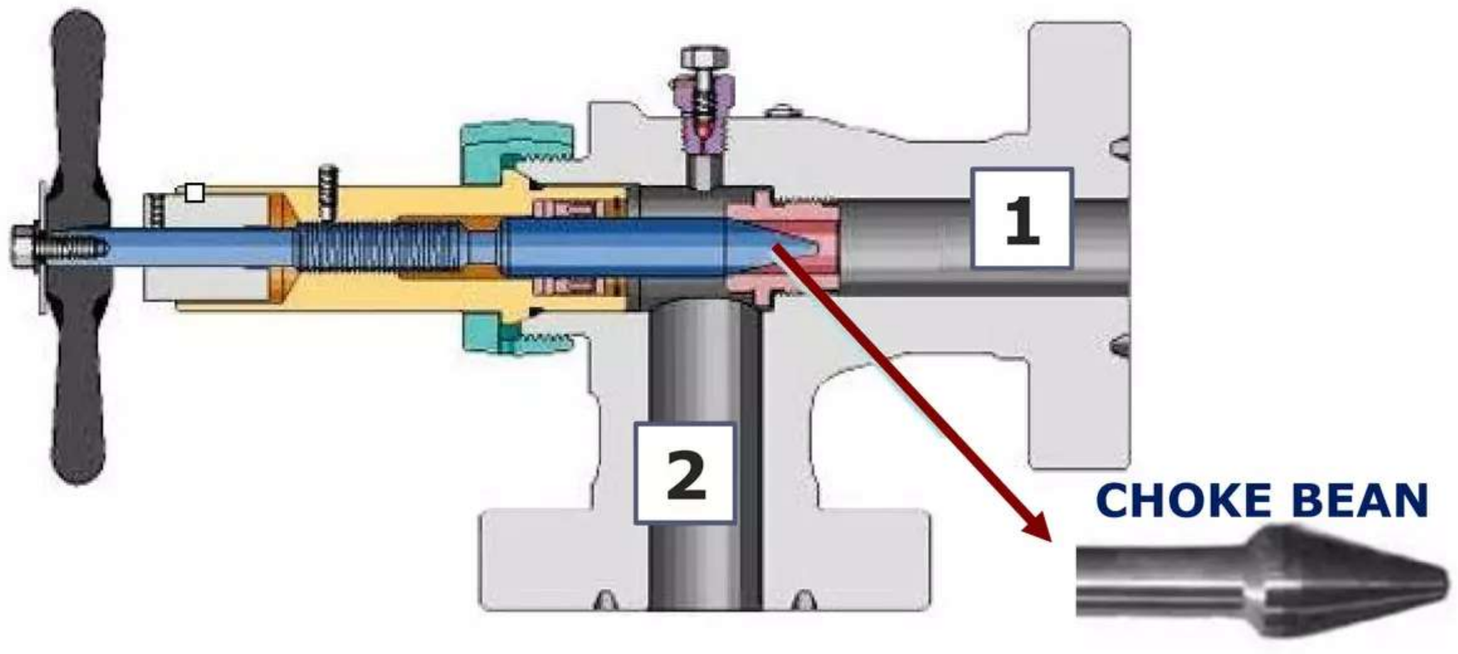
CHOKE [ADJUSTABLE] ON RETURN LINE

Return flow of the CT from the well will usually go to an **Adjustable Choke**, located at the fluid exit of the **Coiled Tubing/Completion Annulus**.

Before the Adjustable Choke, we install 2 choke line valves, with the outside valve operated hydraulically and inside one operated manually!

Question:
From figure on right, match the **inlet** and **outlet** connection:

INLET:
OUTLET:



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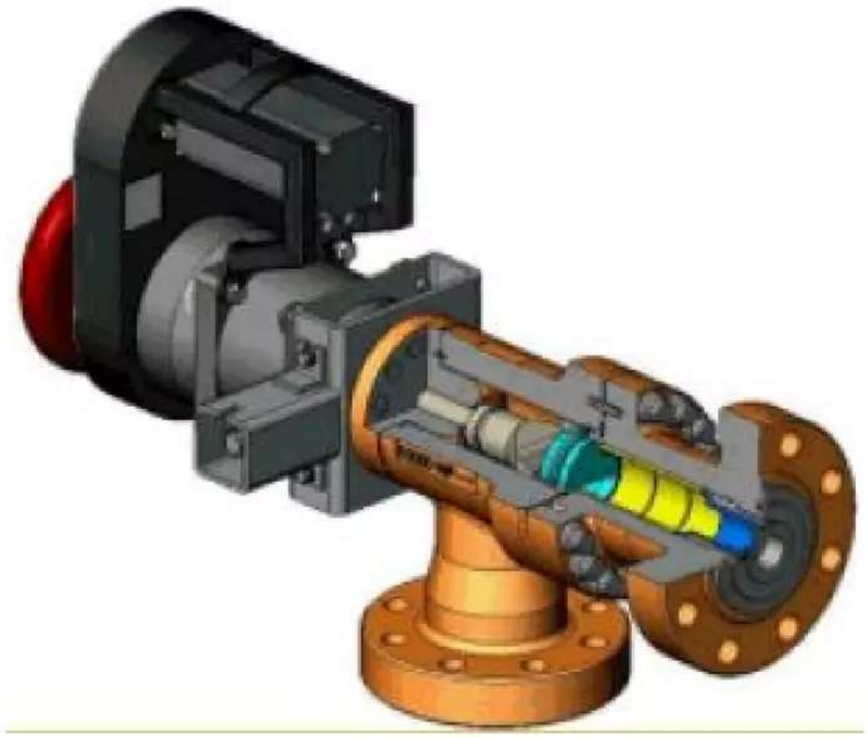
COILED TUBING EQUIPMENT

CHOKE [ADJUSTABLE] ON RETURN LINE
REMOTELY OPERATED



- **Hydraulic** and **Remotely** Operated Choke and Choke/Kill line Valves form an integral part of the control system and are often performed from the control cabin.
- Enables Choke Operator to communicate easily with other parties
- Enables Choke Operator to monitor Coiled Tubing and Annulus pressures and other critical parameters related to a forward circulation or to a well kill
- Choke panel also has a **hand pump** that can be used to operate the choke if the hydr. supply from the BOP Control Unit fails

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COILED TUBING EQUIPMENT

BARRIERS FOR INTERNAL COILED TUBING FLOW

PRIMARY

- **Check Valves**. Standard is to have 2 valves [in **TANDEM**] at the end of the CT or as part of the BHA that may be run below it

SECONDARY

- **Shear/Blind Rams** in **Quad or Combi BOP**, rigged up some distance above the Xmas Tree, and capable of cutting the tubing

TERTIARY

- **Shear/Seal BOP [Safety Head]**, mounted close or onto the Xmas Tree and capable of cutting the tubing

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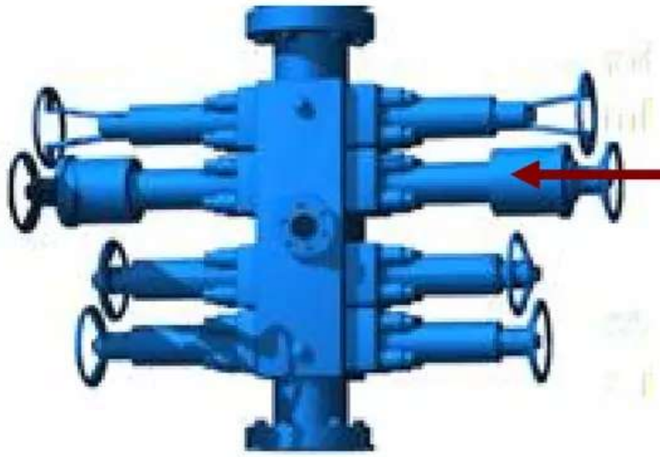
COILED TUBING EQUIPMENT

BARRIERS FOR INTERNAL COILED TUBING FLOW

PRIMARY BARRIER



SECONDARY BARRIER

TERTIARY BARRIER

INTERNAL BARRIERS
COILED TUBING
OPERATIONS

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COILED TUBING EQUIPMENT

RIG UP CHECKS

When rigging up CT on a well, **RIG UP** checks must be carried out prior any pressure tests !

- ✓ All connections, joints, BHA connections
- ✓ Quick Union 'O' ring or seal surface that may cause a leak at that joint
- ✓ Check Ring Joint Groove that may cause a leak on the flange connection
- ✓ Before X/mas Tree Valve or BOP Ram is opened, always equalize pressure
- ✓ Kill fluid, completion fluid, pumps must be available [or on standby] for fill-up of CT and for a well kill in an emergency

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COILED TUBING EQUIPMENT

DEFECTS OF EQUIPMENT – 1 of 2

Defects on and within the **PRESSURE CONTAINMENT SYSTEM [BOP, Lubricator, Riser]** could affect the function of any of the part(s) therein !

What should we do [PREVENTATIVE MODE]

1. On **Sealing Elements**:-
   - Must be checked VISUALLY prior any installation or use
   - Change Pipe Ram Elements when 80% of rubber remains
   - Closing BOP around tools with sharp edges should be avoided/minimized

2. **On Metallurgy and Working Pressure**:-
   - Equipment parts incl. seals must be OEM [Original Equip. Manufacturer]
   - Test certificates must originate from independent QA/QC Inspector
   - Rated WPs must fulfil the well program pressure requirements, and able to give adequate protection against potential corrosive environment

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DEFECTS OF EQUIPMENT 2 of 2

How to assess the extent of any damage to CT equipment
How to take the correct action?

3. **Identifying Wear or Damage**
   - If any doubt exists about the extent of 'damage or wear' on replaceable parts, either whole or part thereof, should be **replaced** and the BOP equipment **re-tested** to the **MASP** for that activity
   - If wear is on the body itself and this body is an integral part of the pressure containment system, then **NO** 'on-site' repair is permitted; the activity has to be suspended until certified replacement is [made] available
   - Monitor effects of **Explosive Decompression**. When high pressure gas migrates into an elastomer and if this elastomer is decompressed, it may result in explosive decompression wear [tears, holes, blisters, cracks]

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COILED TUBING EQUIPMENT

PRESSURE TESTING

OVERVIEW:

- The on site testing include Function test and Low Pressure test (250-350 psi)
- The High Pressure test is test up to maximum anticipated surface pressure [but less than burst resistance of CT]

1. Test **Blind Ram** and **Shear/Seal** by pumping through Kill Port of BOP
2. Test **Strippers** and **Pipe Ram** by pumping through CT
3. Test **Check Valves** is to invert a Check Valve and pump down through CT or inflow test after testing Pipe Ram

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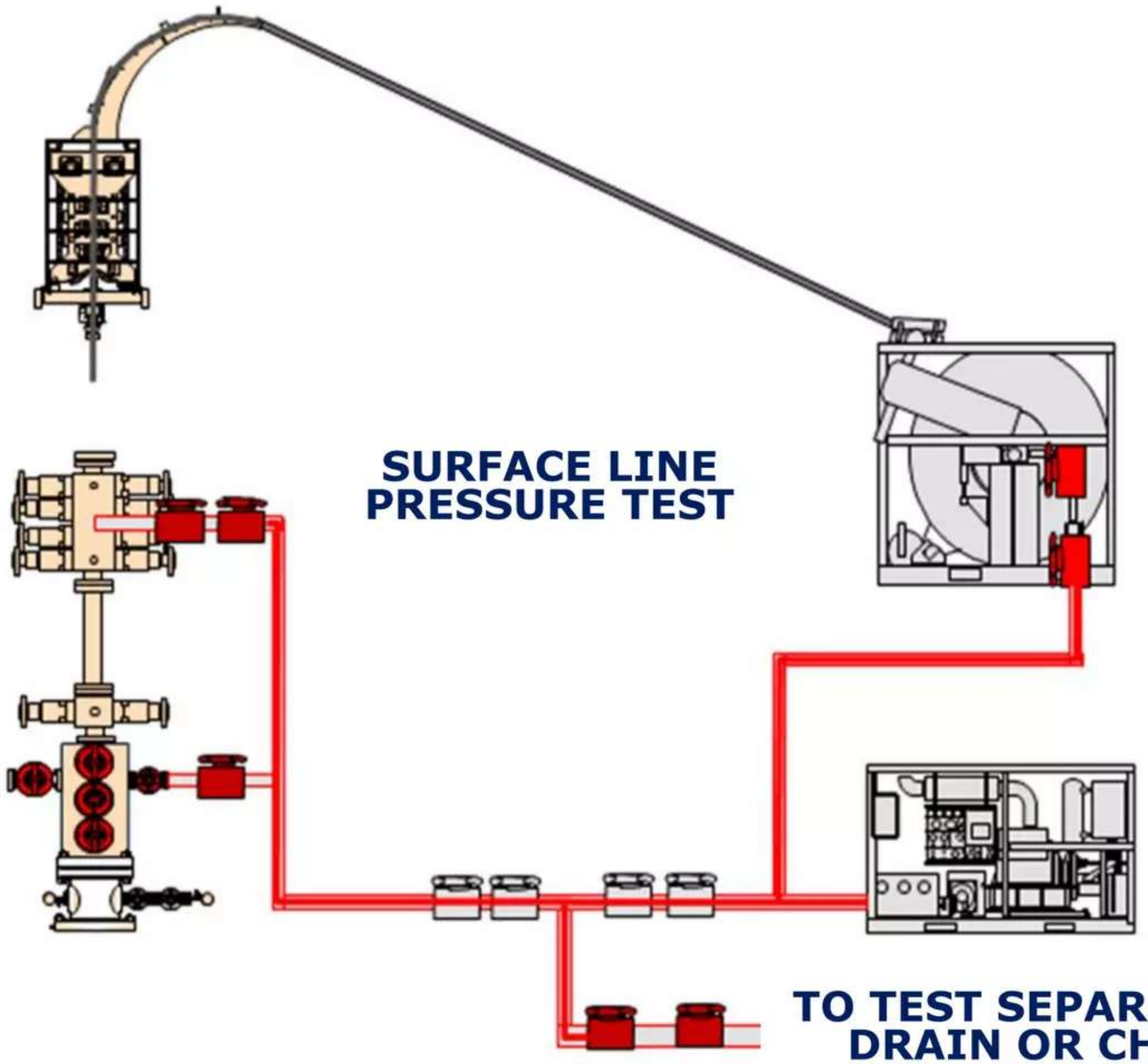
COILED TUBING EQUIPMENT

PRESSURE TESTING SEQUENCE – STEP 1



BEFORE any 'PRESSURE TEST'

Flush and then Test
Surface Systems

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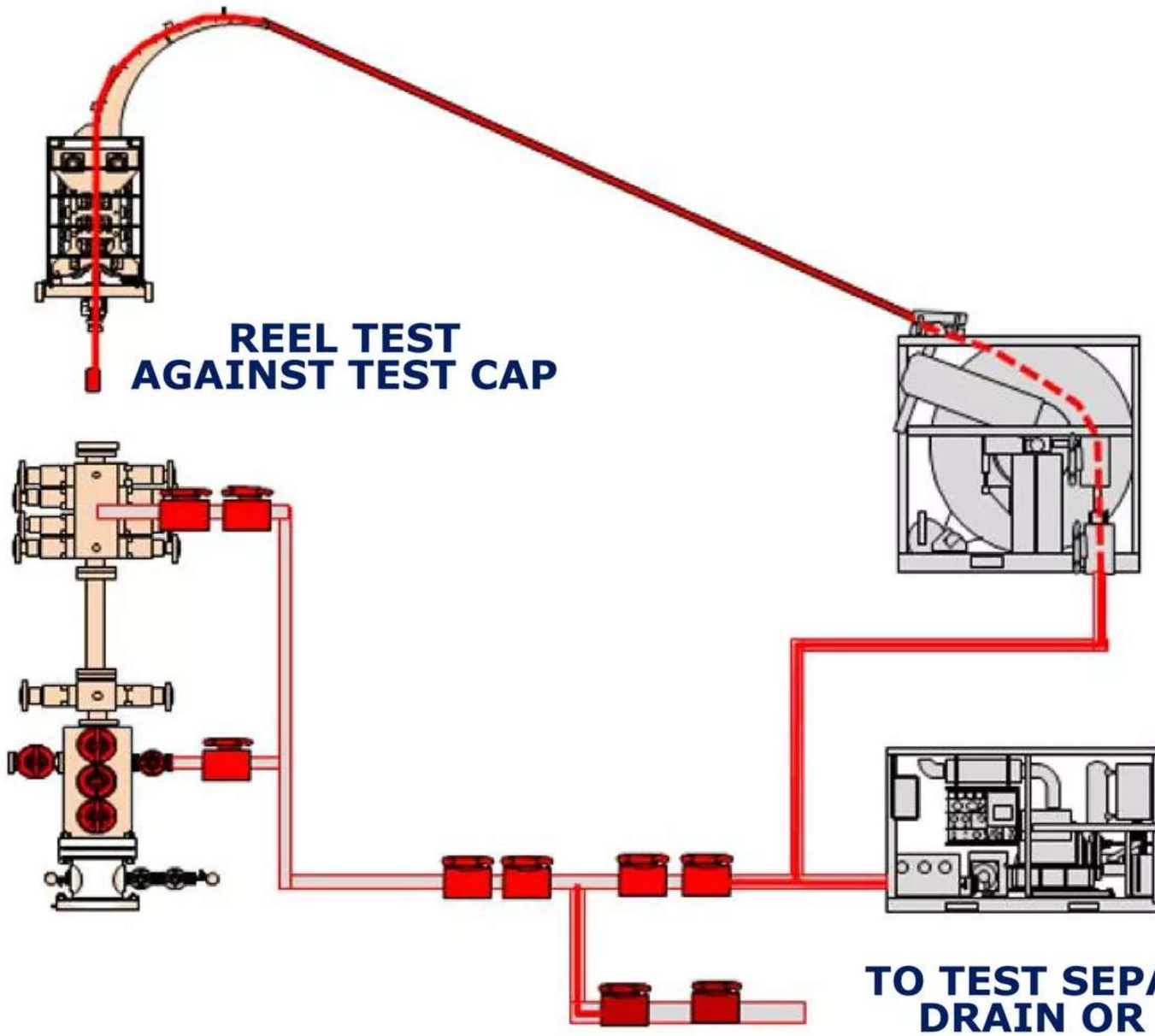
COILED TUBING EQUIPMENT

PRESSURE TESTING SEQUENCE – STEP 2



'PRESSURE TEST'

Flush/Test the Reel against **Test Cap**

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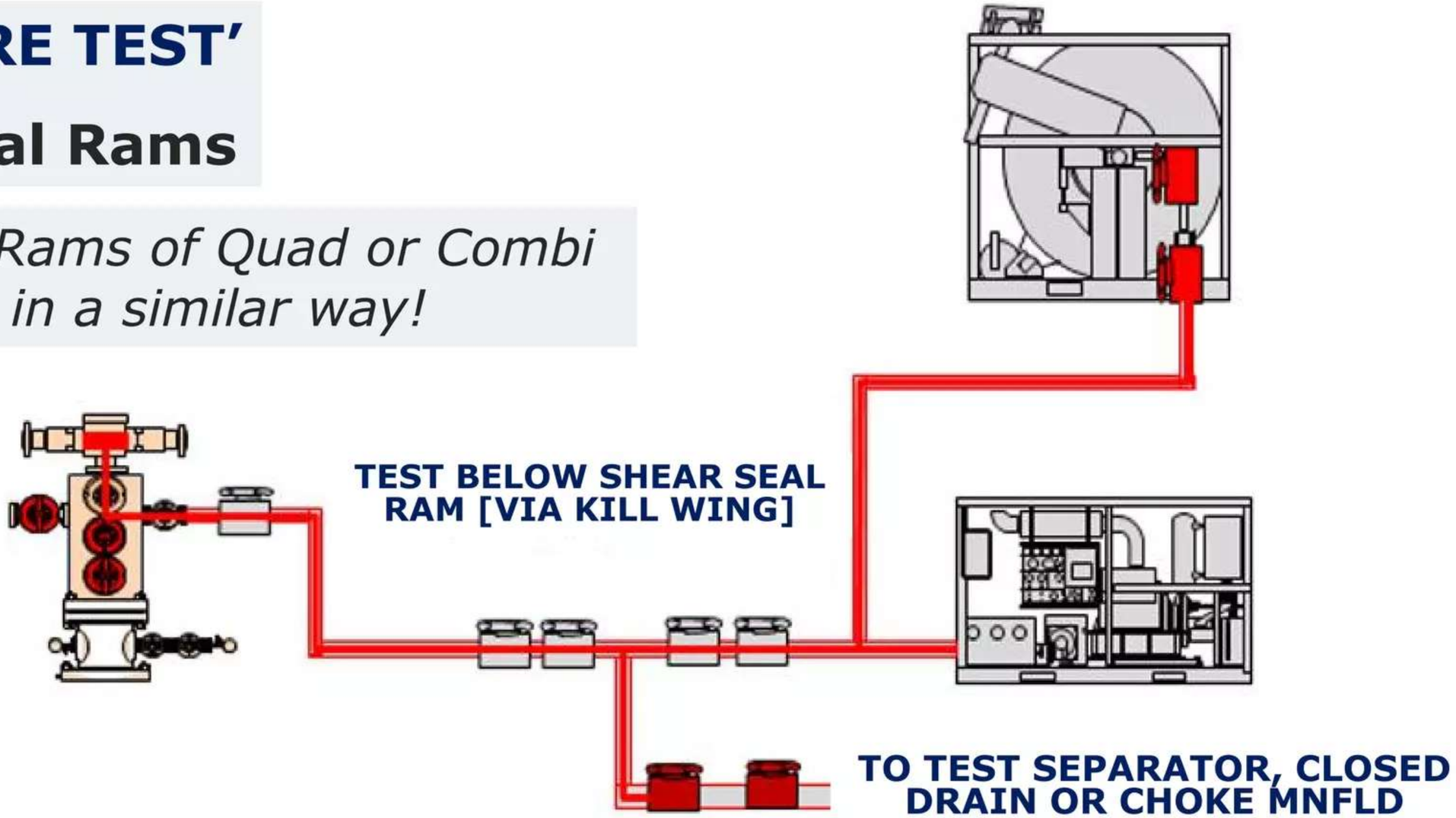
PRESSURE TESTING SEQUENCE – STEP 3

'PRESSURE TEST'

Shear/Seal Rams

Note: Blind Rams of Quad or Combi will be done in a similar way!



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COILED TUBING EQUIPMENT

PRESSURE TESTING SEQUENCE – STEP 4

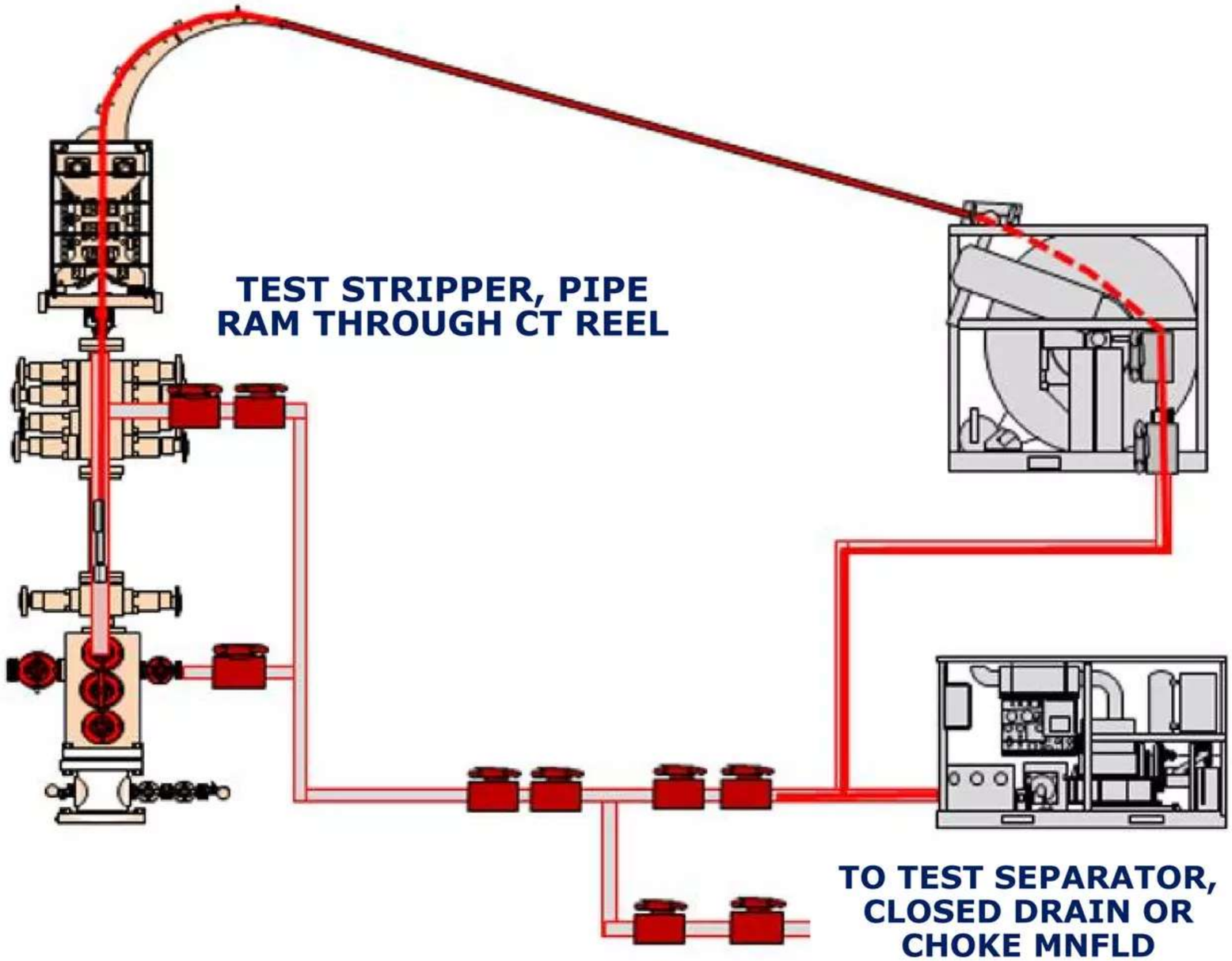
'PRESSURE TEST'

Pipe Rams

Annular
[if present]

Stripper[s]

Check Valves
[inflow test*]



Avoid CT collapse !

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COILED TUBING EQUIPMENT

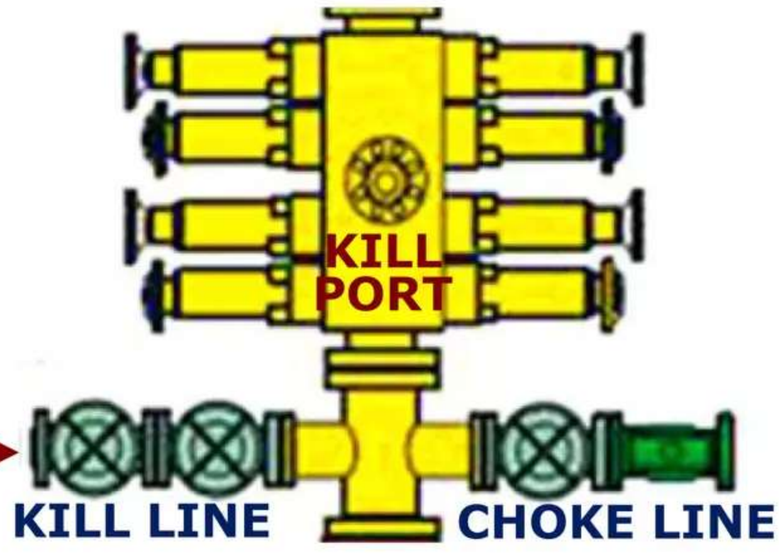
PRESSURE TESTING – STEP 3 of 4 details

Pressure Test Shear/Seal

- Close UMV and LMV. Then fill up Riser up to above Blind Rams via test line [Xmas Tree] or pumping tee
- Close Shear/Seal ram
- Apply test pressure via test line [Xmas Tree] or pumping tee

Pressure Test Blind Ram and Riser

- As above



MUD CROSS

Note: Although there is a Kill Port on a Quad/Combi BOP and Shear/Seal BOP, most companies prefer a **MUD-CROSS** as well and do not like to pump through or have returns through Xmas Tree valves

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COILED TUBING EQUIPMENT

PRESSURE TESTING – STEP 4 of 4 details

This can be performed with coiled tubing in place.

Pressure Test Strippers

- Ensure Swab Valve and Upper Master Valve are closed
- Using a **STRAIGHT BAR** to avoid CT being crushed if too much pressure applied and ran this bar across Stripper[s]
- Fill up via reel until water overflows from Stripper[s]
- Energize Stripper Packer
- Apply test pressure from the reel [i.e. pressure up from below] and repeat if we have Tandem Strippers

Pressure Test Pipe Ram or Annular Preventer

- With pressure still maintained from the Stripper test, close the Pipe Ram [or Annular Preventer], bleed pressure from above

Pressure Test Check Valves

- With pressure still maintained from the above test, release pressure from reel and perform inflow test on check valves

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COILED TUBING EQUIPMENT

STRAIGHT BAR INCIDENT

BOP TEST WITH STRAIGHT BAR, USING CEMENT UNIT

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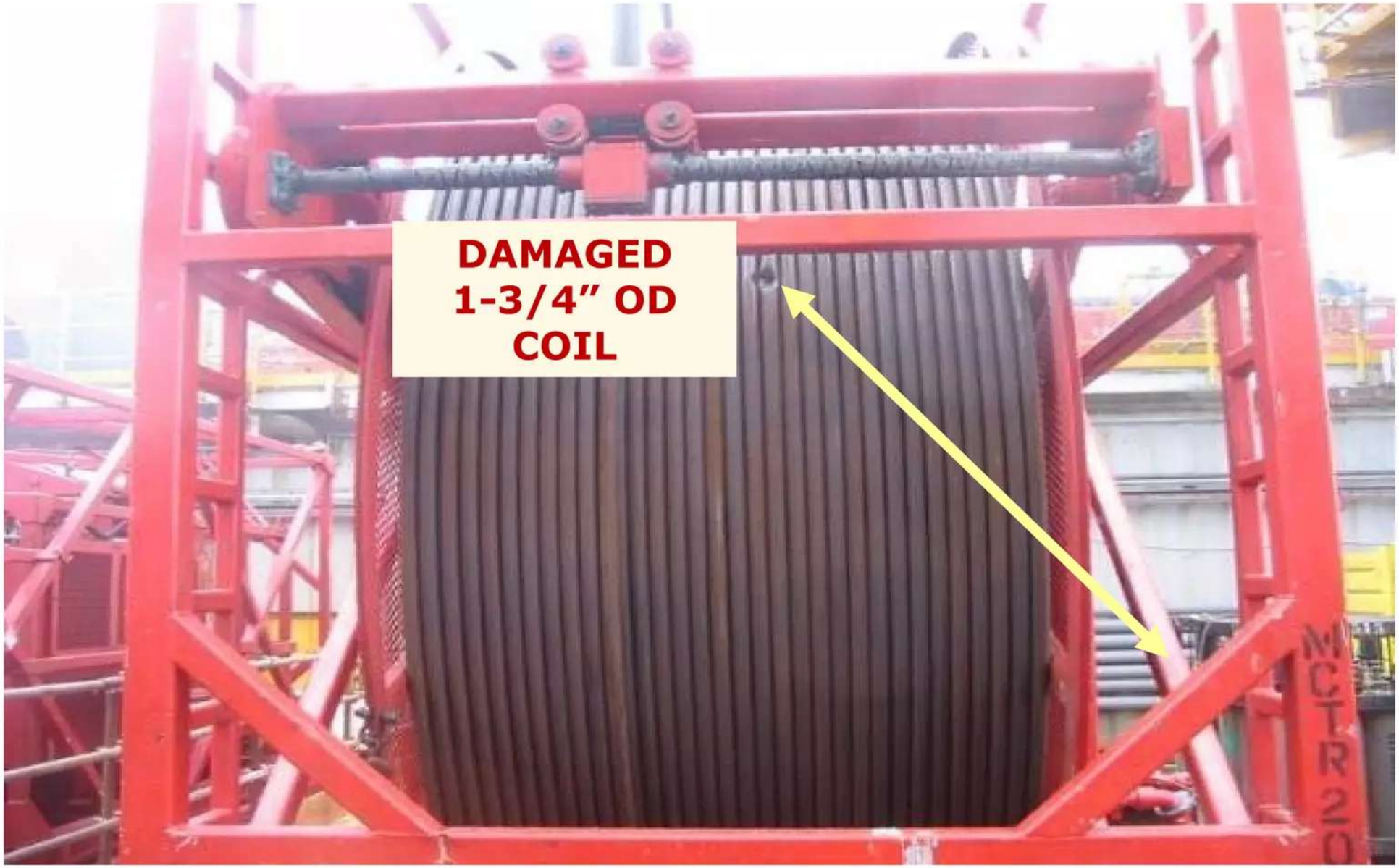
COILED TUBING EQUIPMENT

STRAIGHT BAR INCIDENT



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COILED TUBING EQUIPMENT

STRAIGHT BAR INCIDENT

WHERE IT LANDED...

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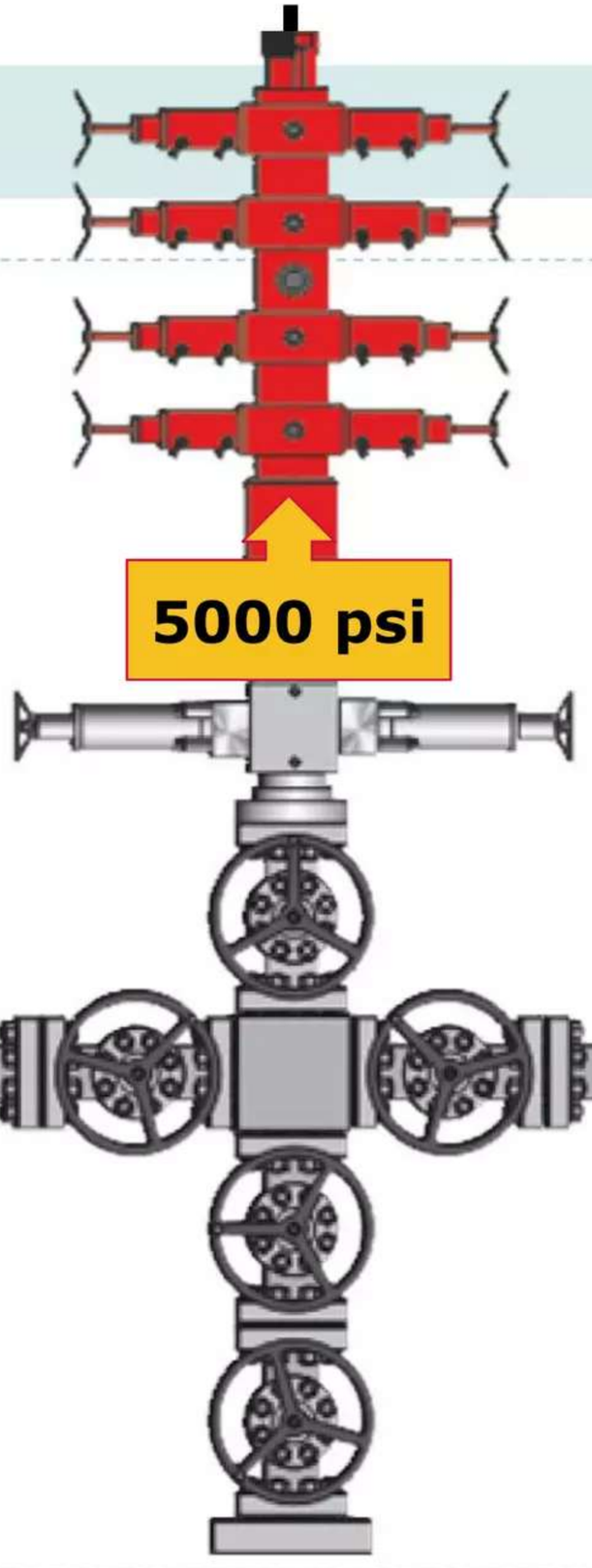
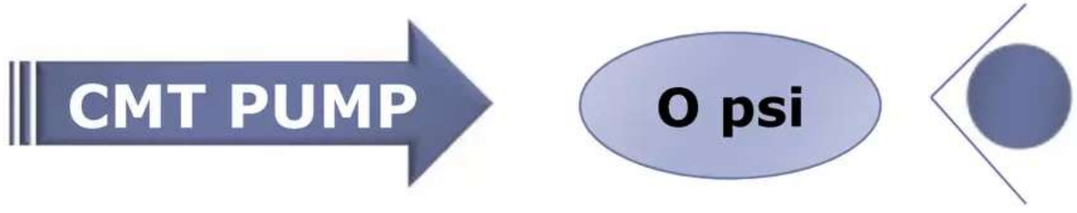
COILED TUBING EQUIPMENT

STRAIGHT BAR INCIDENT





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SHUT-IN PROCEDURES

In an **Emergency Situation** and if there is a need to immediately shut in well to return the well to safe conditions, the following shut-in procedures apply:-

1. **Stop the Coiled Tubing run**
2. **Stop pumping fluids**
3. **Close Slip Rams**
4. **Close Pipe Rams**
5. **Await for further instruction**
6. **A decision should be made to close the Shear/Seal BOP**

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RECORDING SHUT-IN PRESSURES

How to calculate **SHUT-IN COILED TUBING PRESSURE** (SICTP)?
How to calculate **DIFFERENTIAL PRESSURE** between CT and Annulus?

Example:

- Well Depth [TVD]: 10,000 ft
- SICP: 3500 psi
- Annular Fluid: 0.15 psi/ft
- Coiled Tubing Fluid: 0.45 psi/ft

Question: What is the 'anticipated' SICTP?

BHP is [10,000*0.15] + 3500 = 5000 psi
SICTP [anticipated] is 5000 – [10,000*0.45] = **500 psi**
Differential [at surface] between Annulus and CT is 3500–500=**3000 psi**

NOTE: By slowing down the pump rate through the check valves we will be able to record [and thus confirm] the SICTP

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COILED TUBING EQUIPMENT

CONTINGENCIES

- Failure of Power Unit, Injector Head, Tubing Reel or Control System
- Failure of Pump
- Pin Hole Leak in CT at Surface
- External Leak in Riser
- Leak in CT below Stripper[s]
- General Muster Alarm while CT in hole
- Coiled Tubing parting in the well
- Leak at Rotating Joint
- Failure of BPVs

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COILED TUBING EQUIPMENT

CONTINGENCY – GENERAL MEASURES

- ✓ For every and any emergency, **PRIORITY** must be to **make the well safe**
- ✓ Inform and alert company representative and clear all personnel from immediate area of the CT
- ✓ Following a pump failure or any surface pin hole leak or parting, **confirm** the **Check Valves** are holding pressure
- ✓ If pulling out because of pin hole or parting downhole, continue pumping [with water] and reduced pulling speed [15 ft/min], as this will stop migration of hydrocarbons up inside CT and reduce the risk of CT collapse
- ✓ If **hazardous chemicals** are in the reel, e.g. acid, flush through the reel with water. Wash down and neutralize any spillage
- ✓ If Check Valves are not holding and backflow is severe, do not hesitate to **shear** the CT to make the well safe. The Shear/Seal BOP, close or on top of the Xmas Tree, will then ensure CT will drop below Xmas Tree valves
- ✓ All possible risks must be discussed in detail. Following a safety analysis, **contingency measures** must be agreed, drills held and competent staff put in charge of operations

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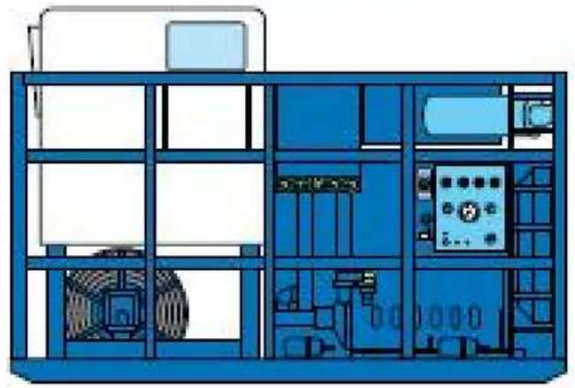
COILED TUBING EQUIPMENT

CONTINGENCY 1

POWER FAILURE

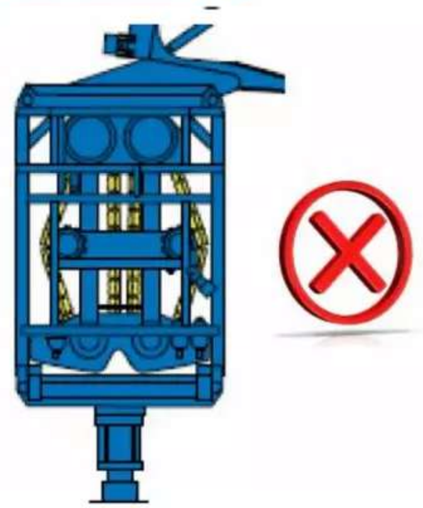


In case of **POWER PACK** failure, then Injector Head, and the CT reel and Control System will **not** function, but all functions on the unit are **fail safe** and/or there are manual locks as well !

NOTE: The **BOPs remain active** as they are controlled from the accumulator system !

ACTION:

- *Engage Injector Brake [if not already activated automatically as it should]. Set Reel Brake.*
- *Close Slip Ram and Pipe Ram. Lock manually!*
- *Repair/Replace Power Pack. Maintain circulation [as Mud Pump has independent power source]; this is to avoid solids settling!*
- *Disengage Brakes. Check weight and condition of CT*



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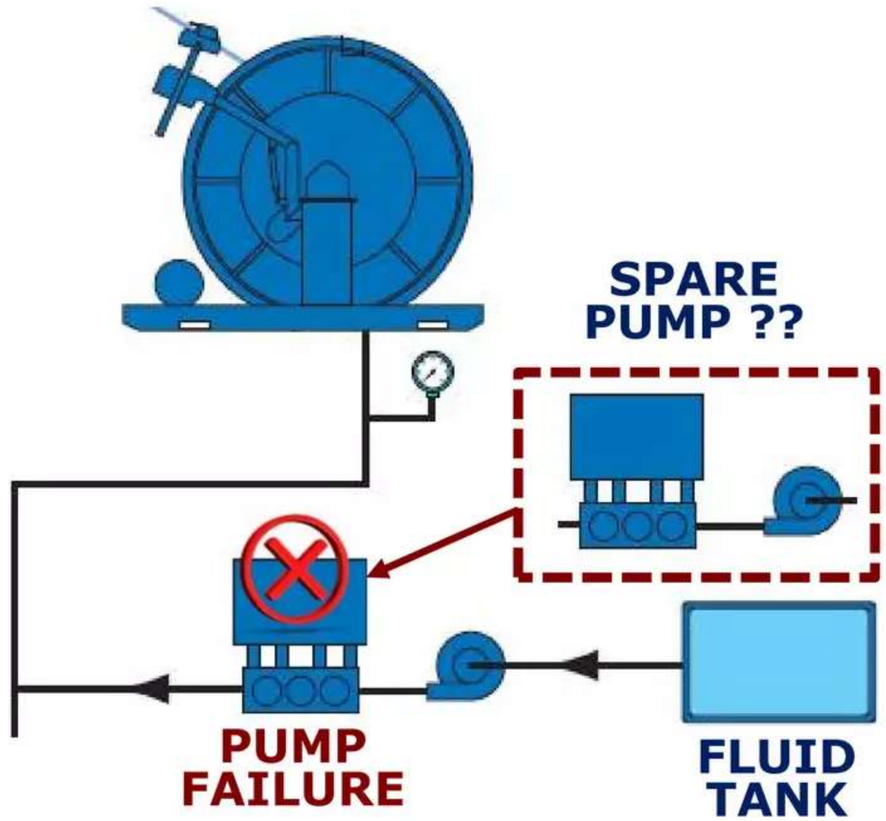
COILED TUBING EQUIPMENT

CONTINGENCY 2

In case of **PUMP FAILURE**, and a **SPARE** pump **is** or **is not** available:-

ACTION:

- *Pull CT some distance to a trouble-free position [to avoid solids sticking]*
- *Close Slip Rams/Pipe Rams. Lock manually!*
- *If CT Check Valves hold pressure, close 'reel isolation valve' (= lo-torque manual valve) adjacent to the Power Reel*
- *Switch to SPARE pump*
- *If **NO** spare pump is available, consider pulling out to surface, secure well, and awaiting pump replacement*



NOTE: A pump shut down **during CT clean-up** may cause CT to get stuck in the well, be aware

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CONTINGENCY 3

Leak due to **PIN HOLE** in the CT between Gooseneck and Reel Level Wind. Confirm if Check Valves at the end of CT are holding pressure [CT pressure will quickly drop]!

ACTION:

Option 1 *whereby leak is* ***small****:*

- *Pull CT slowly to bottom of reel*
- *Stop pumping and confirm CT Check Valves are holding pressure*
- *Close Slip Rams/Pipe Rams. Lock manually!*
- *Temporarily repair CT with tube-to-tube connector* 
- *Establish circulation. Open BOPs and pull out BHA*
- *Replace CT reel*

Option 2 *whereby leak is* ***moderate*** *but does not worsen*

- *Run back CT until Pin Hole below Stripper and above BOP*
- *Close Slip Rams/Pipe Rams. Lock manually!*
- *Decision to be made to kill the well [see* ***next page****]*

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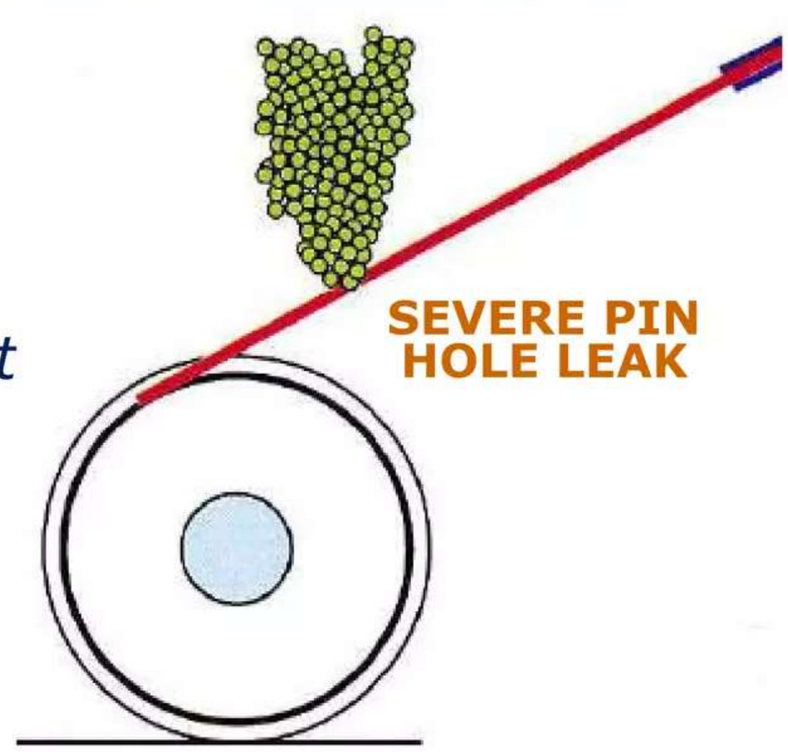
CONTINGENCY 3 [Continued]

Leak due to **PIN HOLE** in the CT between Gooseneck and Reel Level Wind. Confirm if Check Valves at the end of CT are holding pressure [CT pressure will quickly drop]!

ACTION:
Option 3 *whereby leak is* ***moderate or severe*** *AND is* ***worsening*** *or when* ***Check Valves*** *are* ***NOT*** *holding pressure*

- *Close Slip Rams and Pipe Rams*
- *Close Shear Rams. Pull CT above Blind Rams.*
- *Close Blind Rams. Manually lock all rams*
- *Prepare for killing the well through the Kill Port*
- *Replace reel [or repair leak]*
- *Retrieve remaining CT from well*



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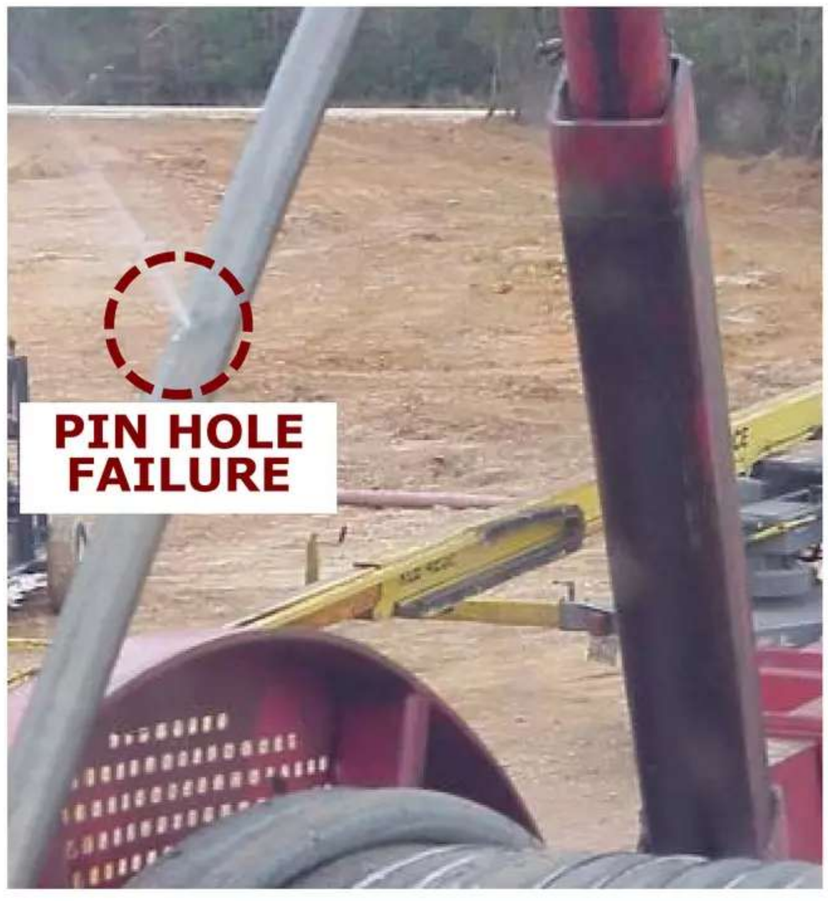
COILED TUBING EQUIPMENT

CONTINGENCY 3 [Continued]

From the previous 2 slides it will become clear that the ultimate decision will depend on a number of variables, which may even change over time. But **well integrity** must be retained and a CT fish can usually be retrieved.



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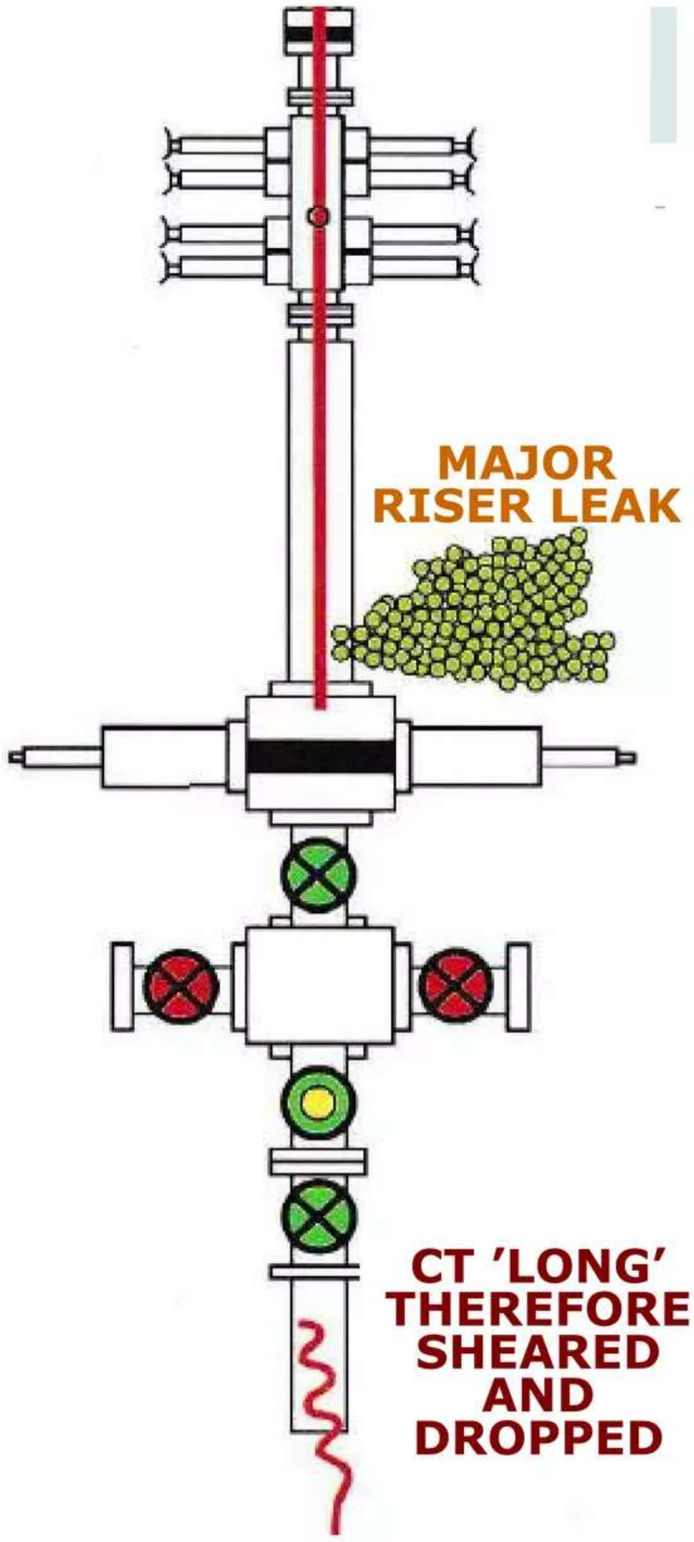
COILED TUBING EQUIPMENT

CONTINGENCY 4

Major RISER Assembly Leak between Xmas Tree and Quad/Combi BOPs with the Coiled Tubing 'well below' the Down Hole Safety Valve [DHSV]

ACTION:

- *Pull sufficient CT out of the hole to ensure CT will drop below Xmas Tree Master Gate Valves when Shear Rams are activated*
- *Close Shear Rams of Quad/Combi BOPs [or the Shear/Seal BOP, if available, and if Riser Length is substantial]*
- *Close Xmas Tree Swab and Upper Master Gate Valve [count turns]*
- *Bleed off pressure and repair leak. Pressure Test. Start fishing the dropped CT !*



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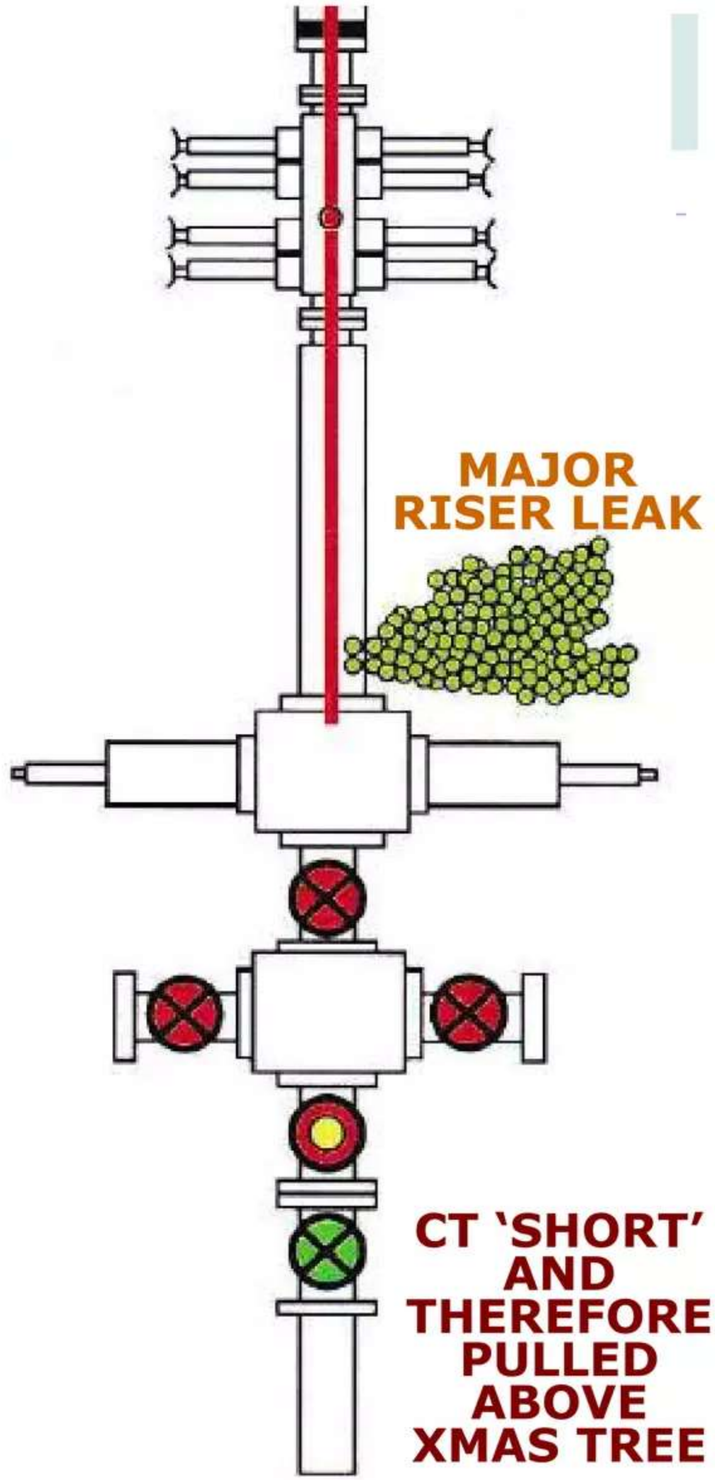
COILED TUBING EQUIPMENT

CONTINGENCY 4 [Continued]

As previous:
Major RISER Assembly Leak between Xmas Tree and Quad/Combi BOPs **BUT** with the Coiled Tubing just below surface and above DHSV !

ACTION:

- *Pull out of hole to above Xmas Tree [and above Shear/Seal BOP, if used]*
- *Close Xmas Tree Swab and Upper Master Gate Valve [count turns]*
- *Bleed off pressure and repair leak. Pressure Test.*



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COILED TUBING EQUIPMENT

CONTINGENCY 5

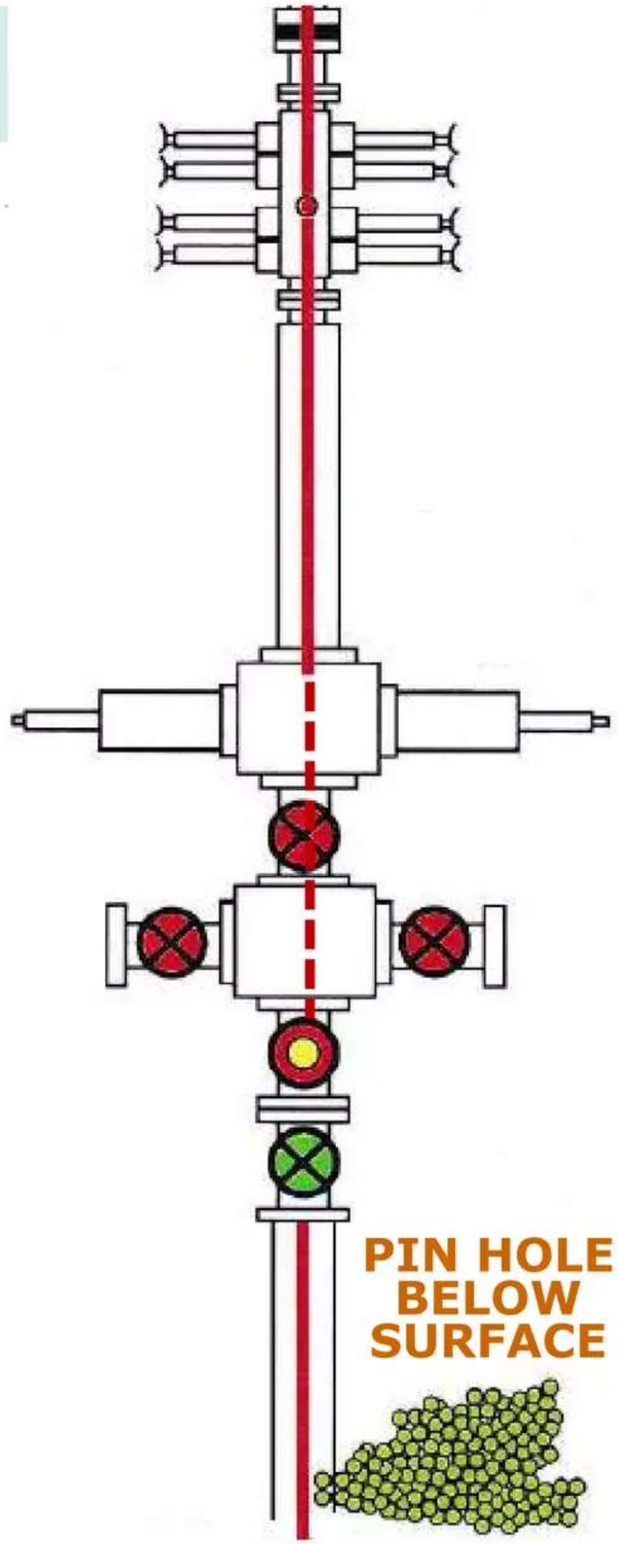
Leak due to **PIN HOLE** in the CT, somewhere below surface and above Check Valves. The most likely cause will be a **defect** or **area of weakness**.

The **PIN HOLE** will allow **well fluids** to enter the CT and therefore will make it impossible to depressurize the CT until the leakage point is out of the well.

ACTION:

- *Stop all CT movement*
- *Stop circulation and allow pressures to stabilize*
- *Perform calculations to estimate the leak point*
- *If, however, the leak point is severe and the wellhead pressure is high, then it is advisable to kill the well, before an attempt is made to pull out*

NOTE: If the Check Valves are leaking **instead**, the effect, and also the immediate action will be similar !



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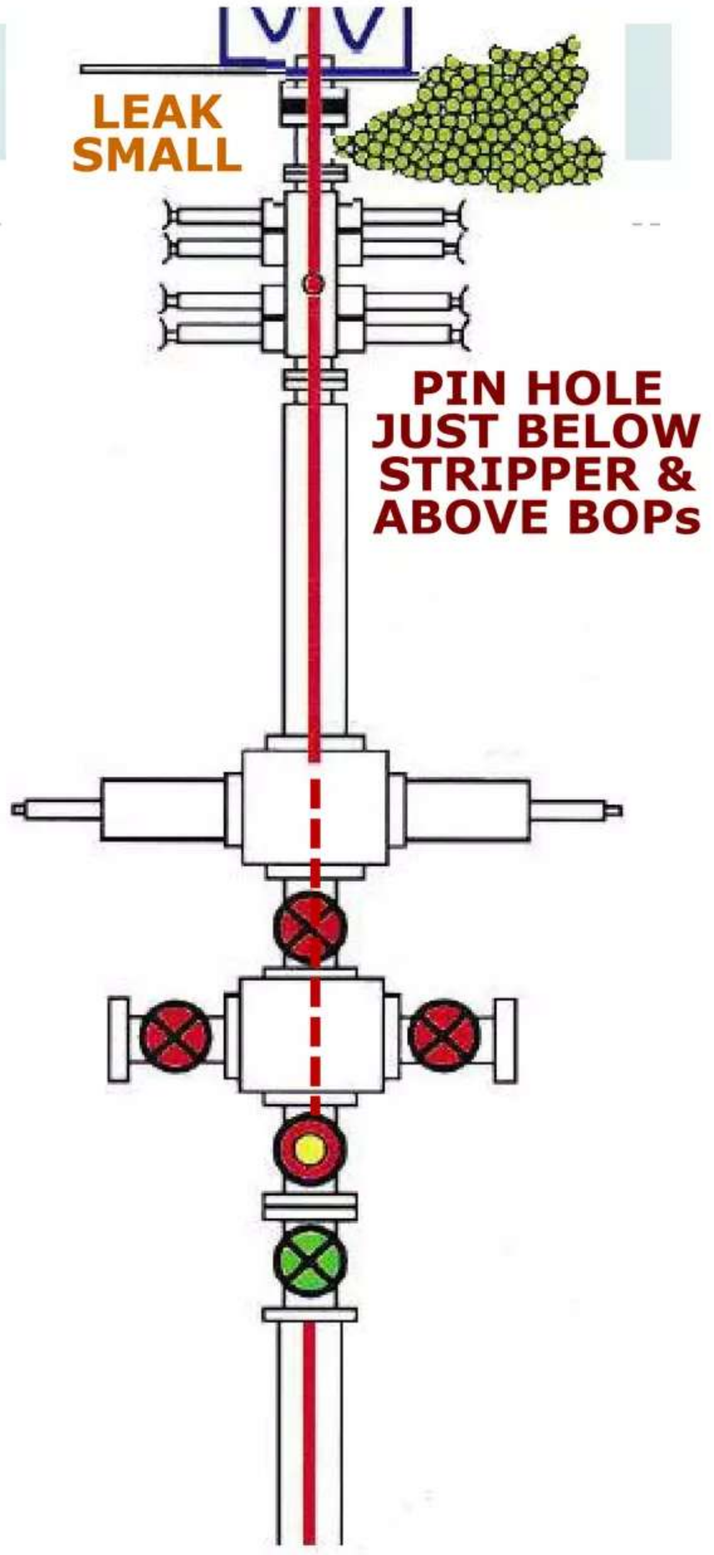
COILED TUBING EQUIPMENT

CONTINGENCY 6

Leak due to **PIN HOLE** in the CT, **just below the Stripper[s]**, but above the BOPs. Again, the most likely cause will be a **defect** or **area of weakness**.

ACTION:

- *With the **PIN HOLE** above the BOPs, close the Slip Rams and Pipe Rams. Lock manually. Bleed off pressure above.*
- *Observe CT pressure. A gradual drop in pressure confirms that the Check Valves are holding out !*
- *If leak point is **small**, equalize pressure, open Slip and Pipe Rams, pull CT slowly to bottom of reel.*
- *Close Slip Rams/Pipe Rams. Lock manually!*
- *Temporarily repair CT with tube-to-tube connector*
- *Establish circulation. Open BOPs and pull out BHA*
- *Replace CT reel*



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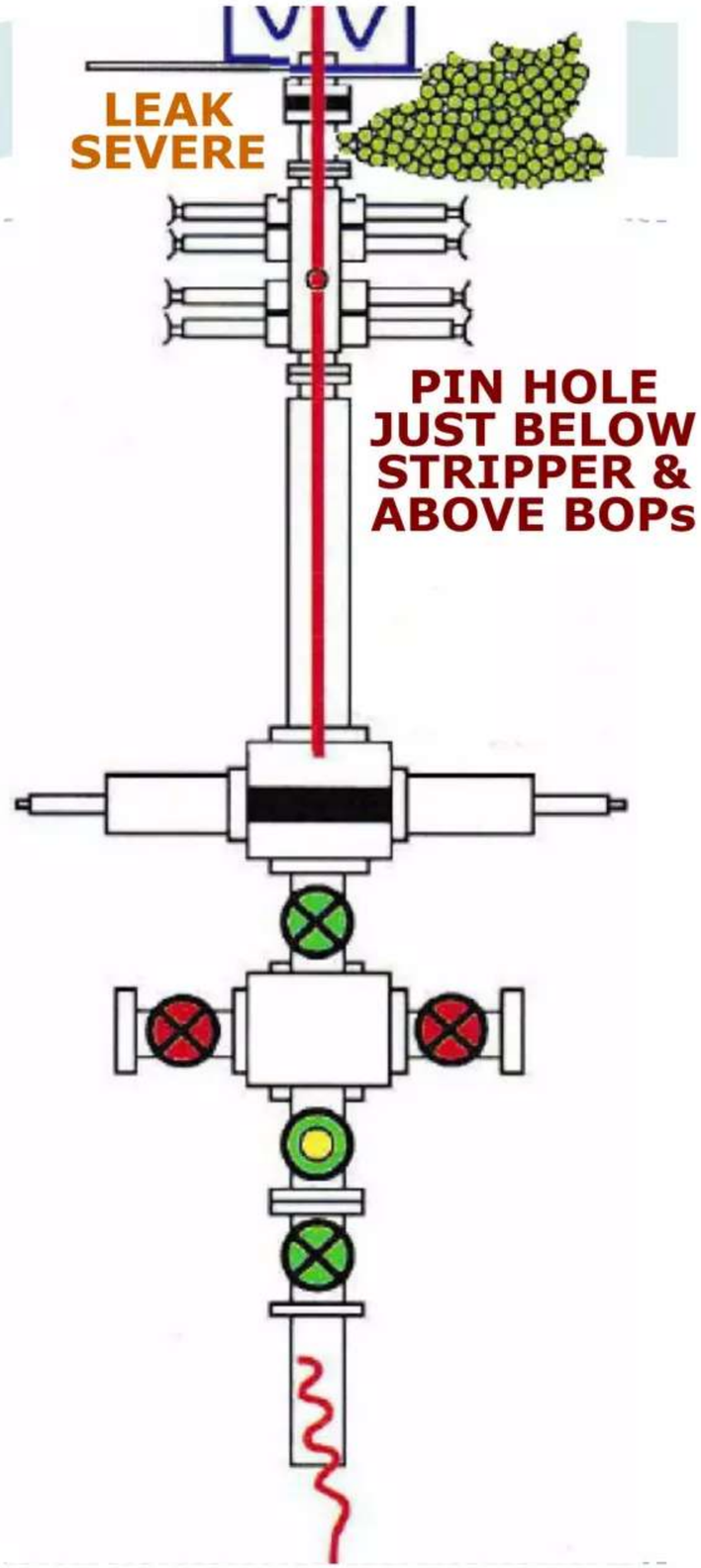
COILED TUBING EQUIPMENT

CONTINGENCY 6 [Continued]

HOWEVER:

- *If leak is **SEVERE** and/or fluids escaping are considered hazardous, then immediately close Slip Rams and Pipe Rams. Lock manually. Bleed off pressure above.*
- *Close Shear Rams of Quad/Combi BOPs [or the Shear/Seal BOP, if available, and if Riser Length is substantial]*
- *Close Xmas Tree Swab and Upper Master Gate Valve [count turns]*
- *Kill the well by **Bull Heading***
- *Perform fishing operation*



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CONTINGENCY 7

GENERAL MUSTER ALARM while RUNNING CT

- *If **pumping** is in progress, stop and shut down the pumping unit and close valve[s] to isolate the flow return line*
- *However, if **washing** or **milling** the CT should be lifted above the worked interval or above perforations [to prevent differential sticking or solids settling] prior to shutting down CT Unit*
- *If the CT end is above the DHSV then the DHSV should be closed*
- *If the CT end is below the DHSV close the Slip and Pipe Rams and lock them manually. Apply the Injector and Reel Brake*
- *Standby for further instructions*

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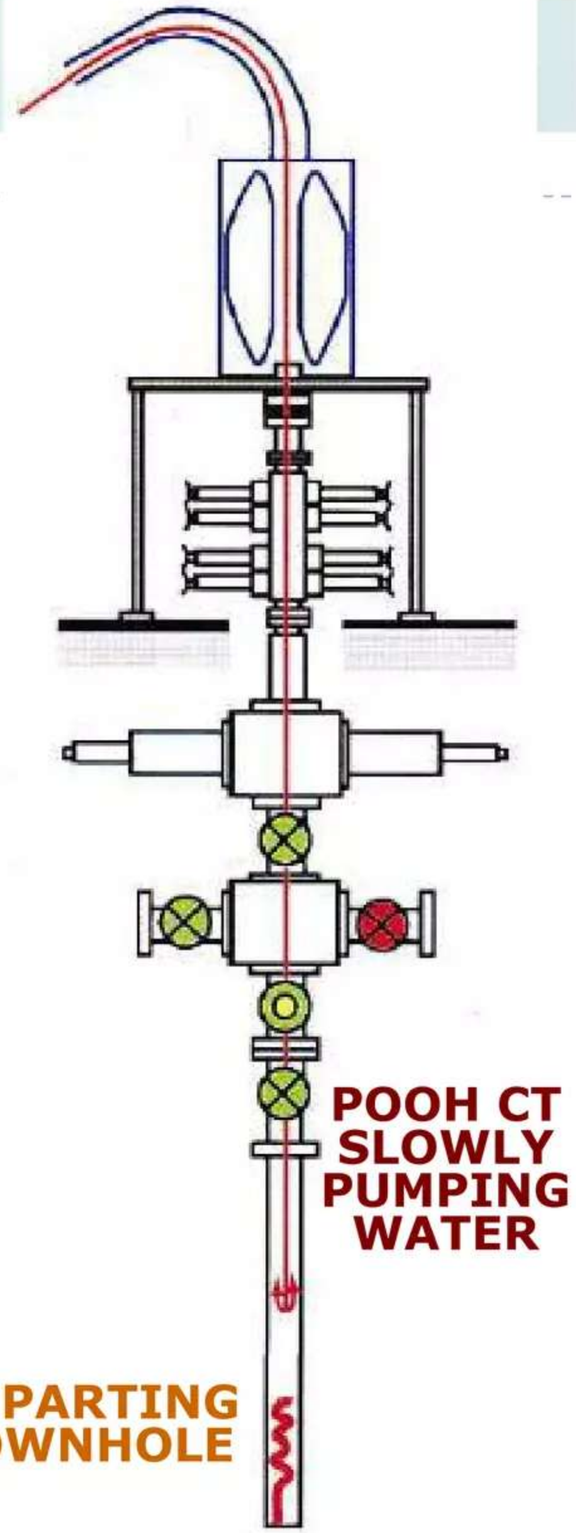
COILED TUBING EQUIPMENT

CONTINGENCY 8

PARTING of **CT Downhole** will show by a sudden reduction in weight and circulating pressure !

- *Continue **pumping water** to prevent migration of well fluids up the tubing [circulate with min rate]*
- *Determine approximate length of CT remaining from pick up and hanging weight*
- *Pull out of hole slowly until CT clears the Xmas Tree. Make absolutely sure this is the case!*
- *Close Xmas Tree Swab and Upper Master Gate Valve [count turns]*
- *Depressurize and continue pull out rest of CT*
- *Kill the well by **Bull Heading** and perform fishing operation*



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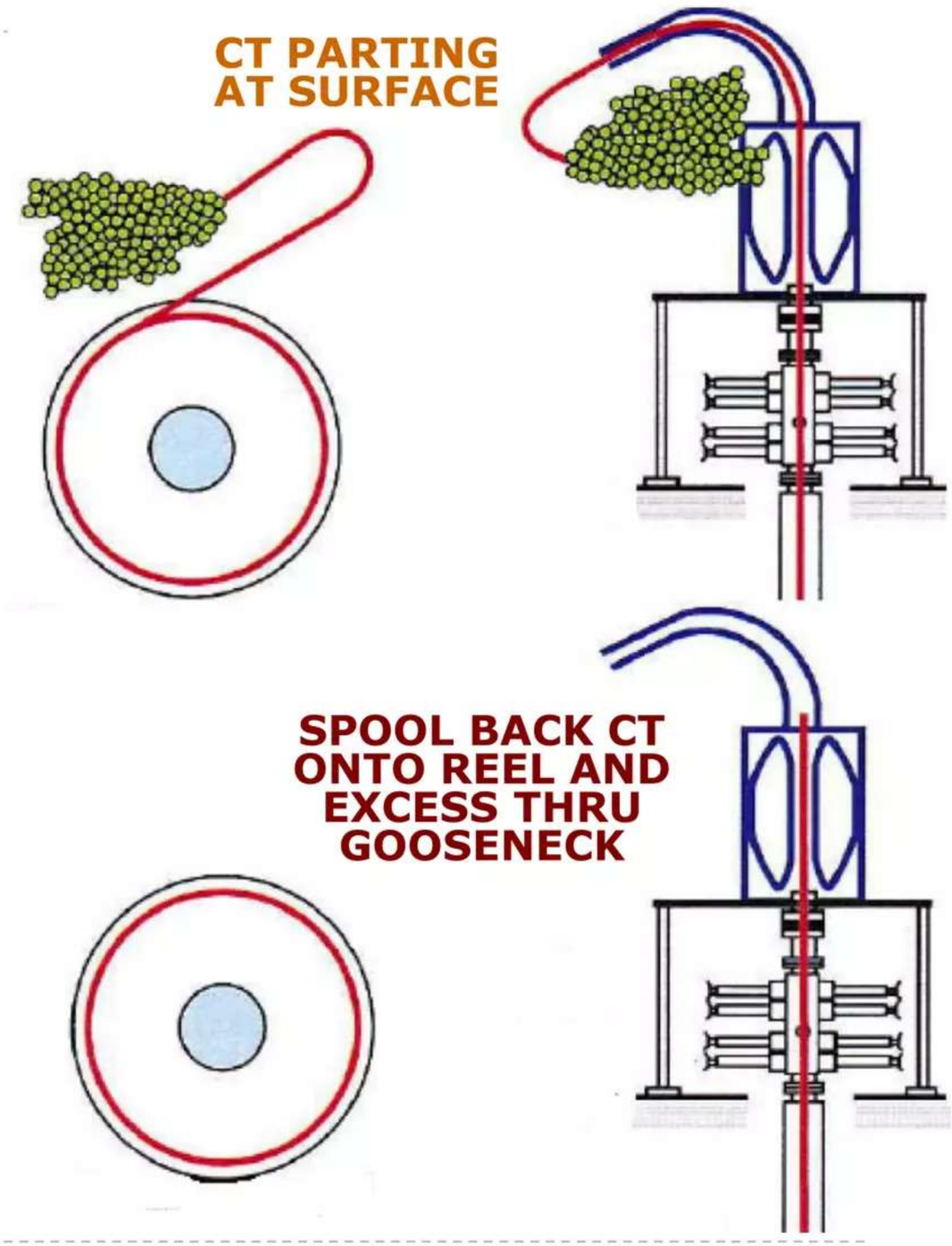
COILED TUBING EQUIPMENT

CONTINGENCY 8 [Continued]

PARTING of **CT** at **Surface** !

- *Stop CT movement and stop pumping*
- *Monitor CT returns to **confirm BPVs** are holding pressure*
- *Attempt to spool as much CT back onto the reel to avoid whiplash. Run excess CT through Gooseneck*
- *Set Injector and Reel Brake. Close Slip and Pipe Rams and lock manually*
- *Monitor WHP. Discuss contingency plans*
- *If BPVs are not holding, then use shear/ seal to cut/drop the CT.*
- ***Kill the well** and repair CT.*
- *Perform fishing operation*



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COILED TUBING EQUIPMENT

CONTINGENCY 9

LEAK at **ROTATING JOINT** !

- *Stop **Injector Head** and **Service Reel** and set the brakes on both*
- *Close the reel isolation valve [low-torque and manual valve] inside reel*
- *Repair or replace the Rotating Joint*
- *Re-test and resume operation*

ROTATING SWIVEL

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COILED TUBING EQUIPMENT

TUBING RUN-AWAY OUT OF THE WELL

*The CT String can be **ejected out of the well**, if WHP is high enough to overcome CT weight below the Stripper, and:-*

- *Injector Chains lose their grip*
- *Injector Motor spins freely*

If not stopped in time, the CT can create a catastrophic birds nest !

What can we do?

Increase Stripper Pressure, Chain Tension, manually set Injector Brake, close the Slip Rams etc…

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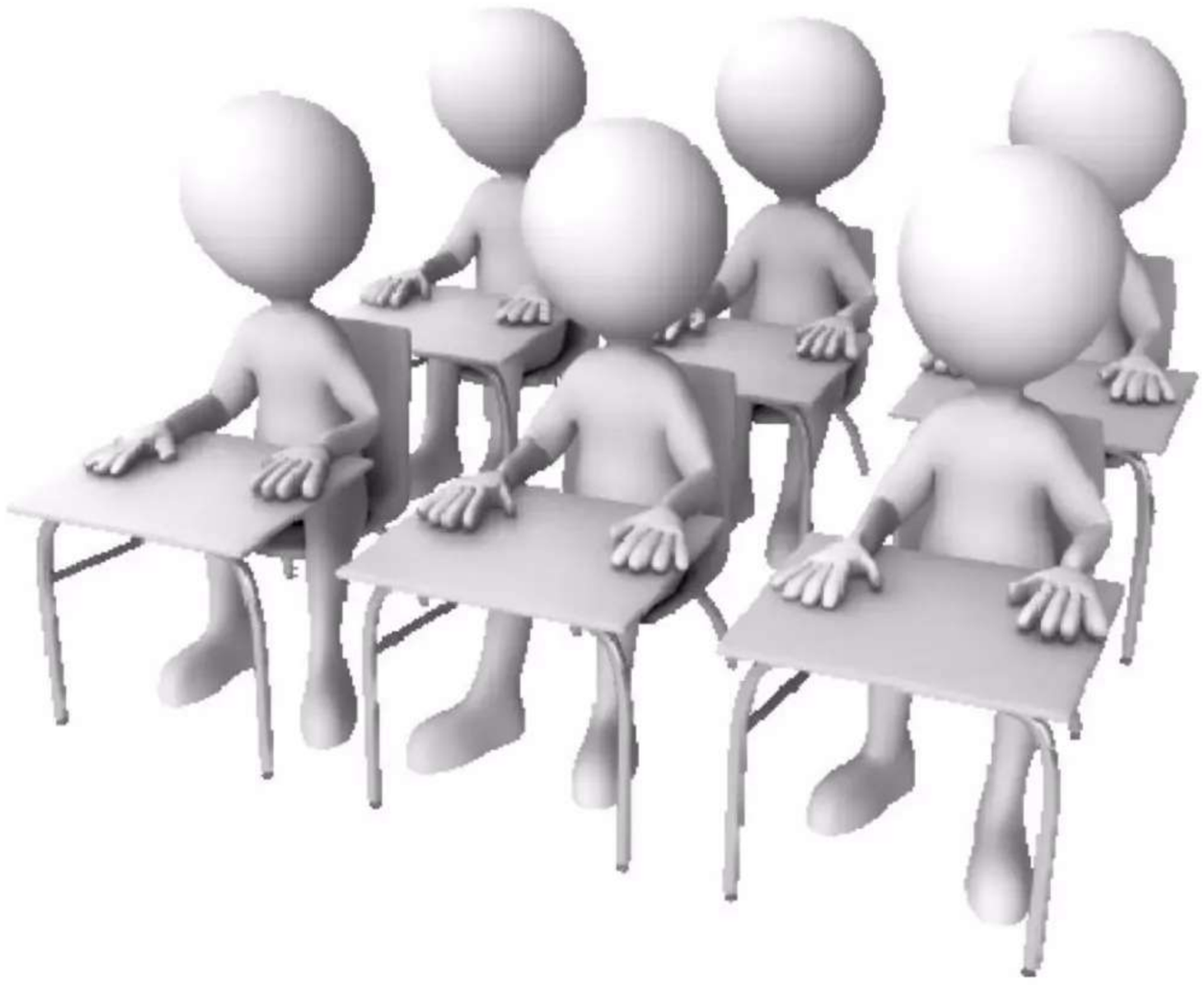
COILED TUBING EQUIPMENT



TESTING KNOWLEDGE

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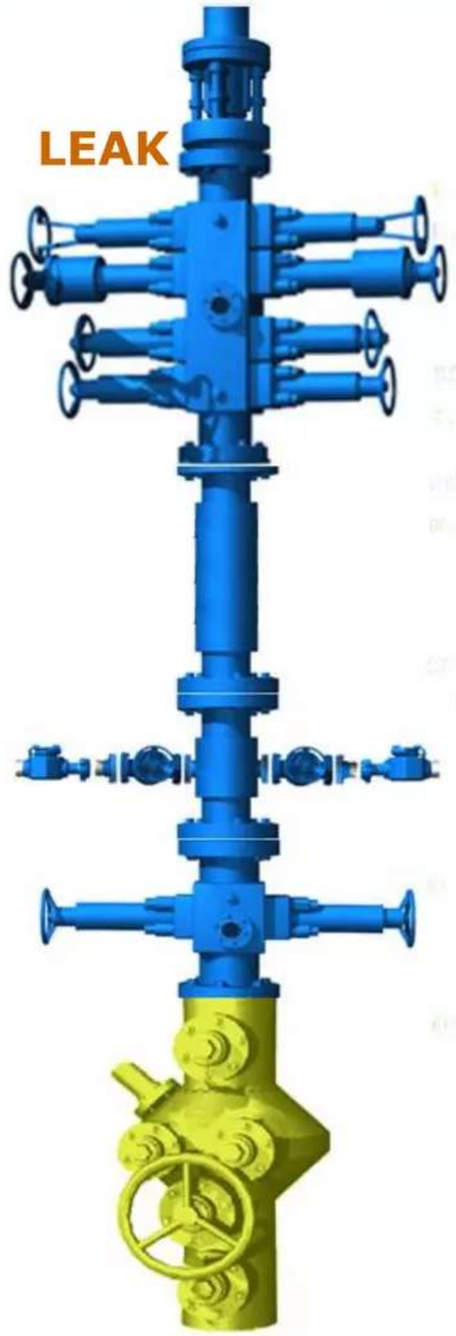
COILED TUBING EQUIPMENT

QUESTION 1:-

During a Rig Up activity, and with CT just across the Quad BOP, we observe there is a **leak** from the **Connector**, between Quad BOP and Stripper.

Which Barrier should be closed [or remain to be closed] in order to be able to repair this leak?

NOTE: Only consider CT Barrier terminology and not the practical operation or your policy?



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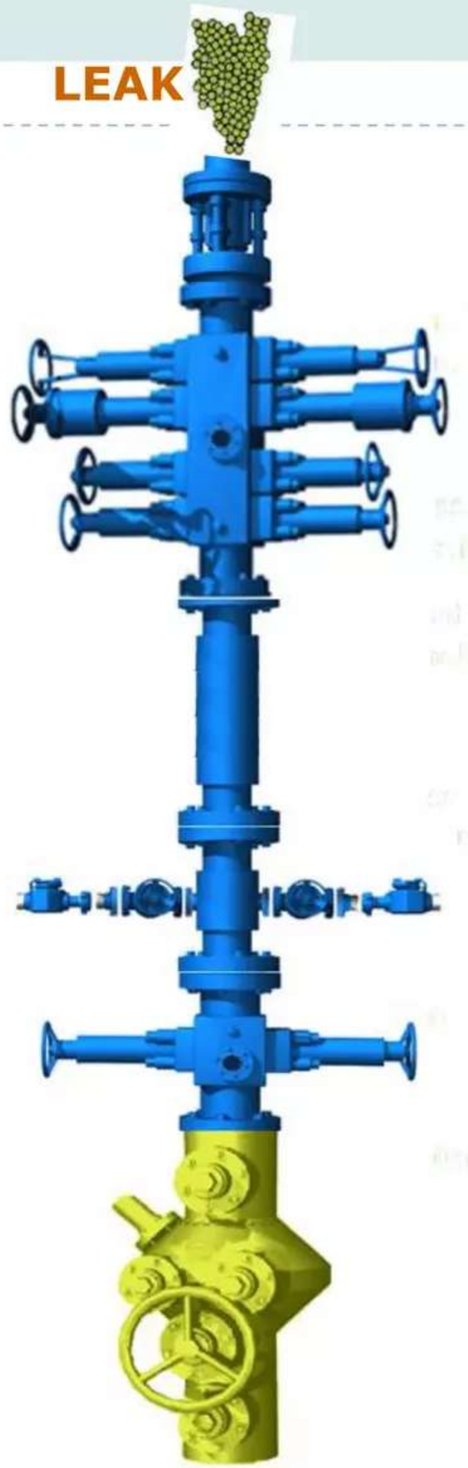
QUESTION 2:-

With CT in operation down the well, we observe a leak from the Stripper Packing Element, which is in need of an immediate replacement. Which two [2] Rams should be closed replace this Stripper Packer Element?



QUESTION 3:-

What is the normal method to pressure test the Pipe Rams of the Quad BOPs?

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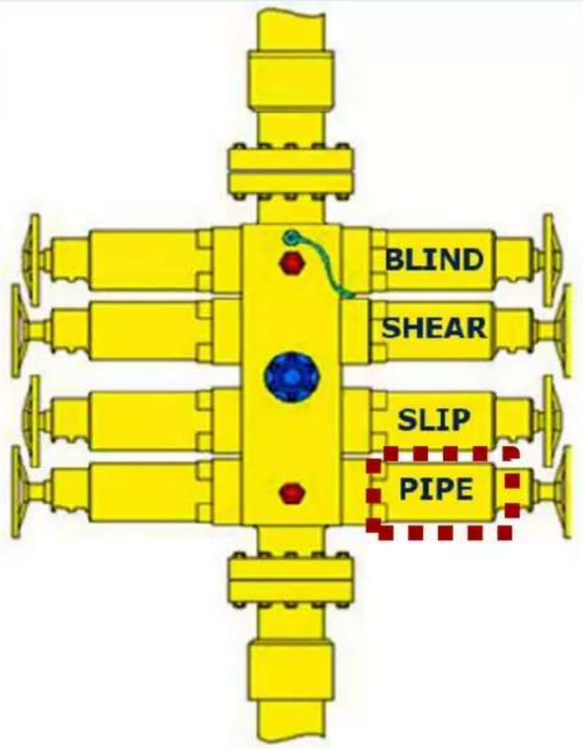
COILED TUBING EQUIPMENT

QUESTION 4:-

Given the drawing on the right and with CT being run in a live well, we observe the Pipe Rams are not holding pressure when it had to be closed. Can the Pipe Ram Seals be changed out [safely]?



QUESTION 5:-

CT has been rigged up on a production well. The pump is connected to the Kill Wing on the Xmas Tree. Which valves should be closed when performing a pressure test on Blind Rams and Shear/Seal?

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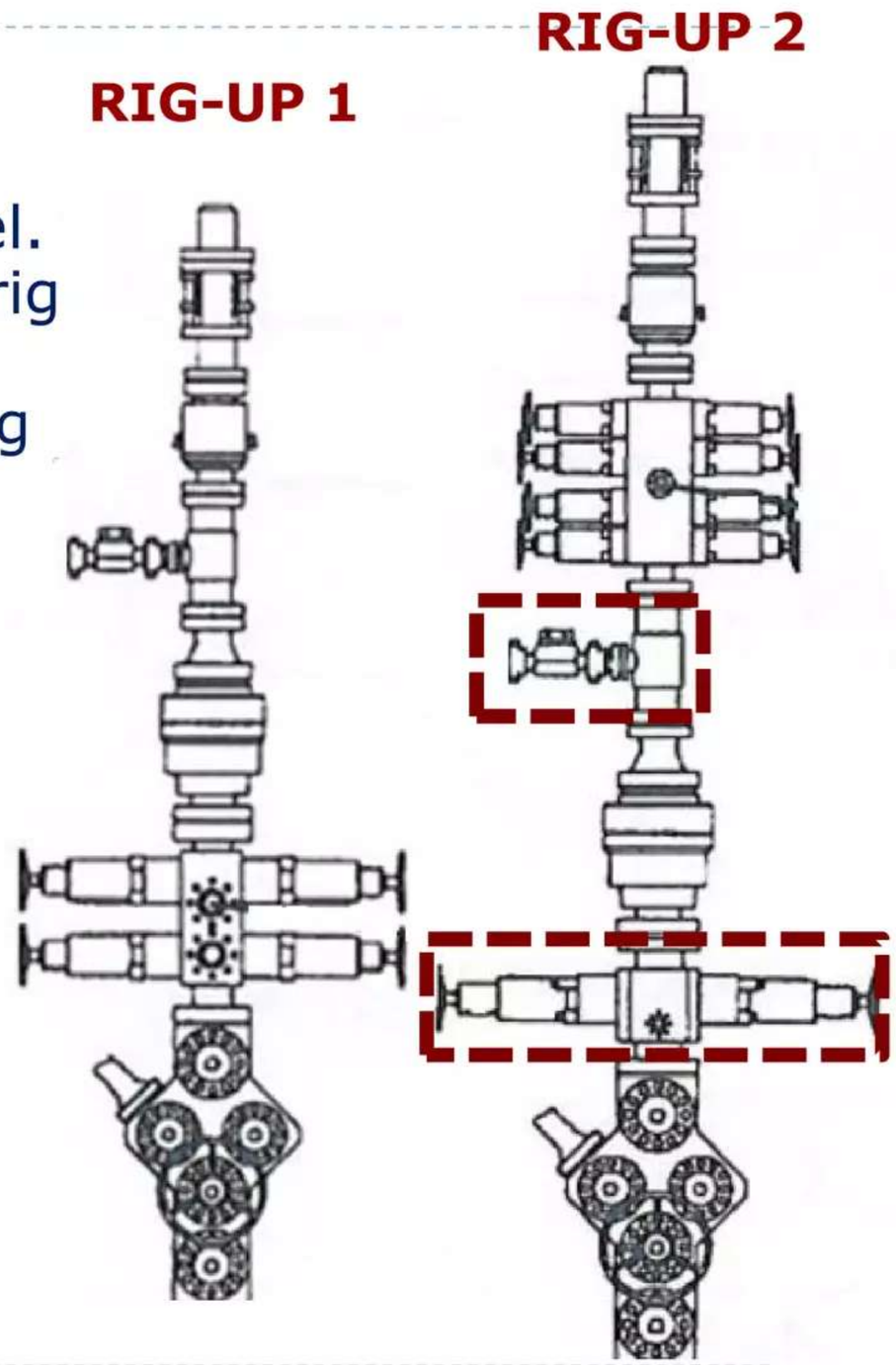
COILED TUBING EQUIPMENT

QUESTION 6:-

The CT has parted between Gooseneck and CT Reel. The CT Check Valves do not hold pressure. Which rig up configuration [see Pic 1 and Pic 2 on the right] allow you to secure the well and kill it by circulating down the [now fixed] CT with returns to choke?



QUESTION 7:-

Which Rig Up configuration [see Picture 1 and Picture 2 on the right] would be most suitable for HP wells?

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COILED TUBING EQUIPMENT

QUESTION 8:-

A CT rig up includes a **Tandem** Side Door Stripper. Is this considered a single barrier or a double barrier?

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PLAY VIDEO

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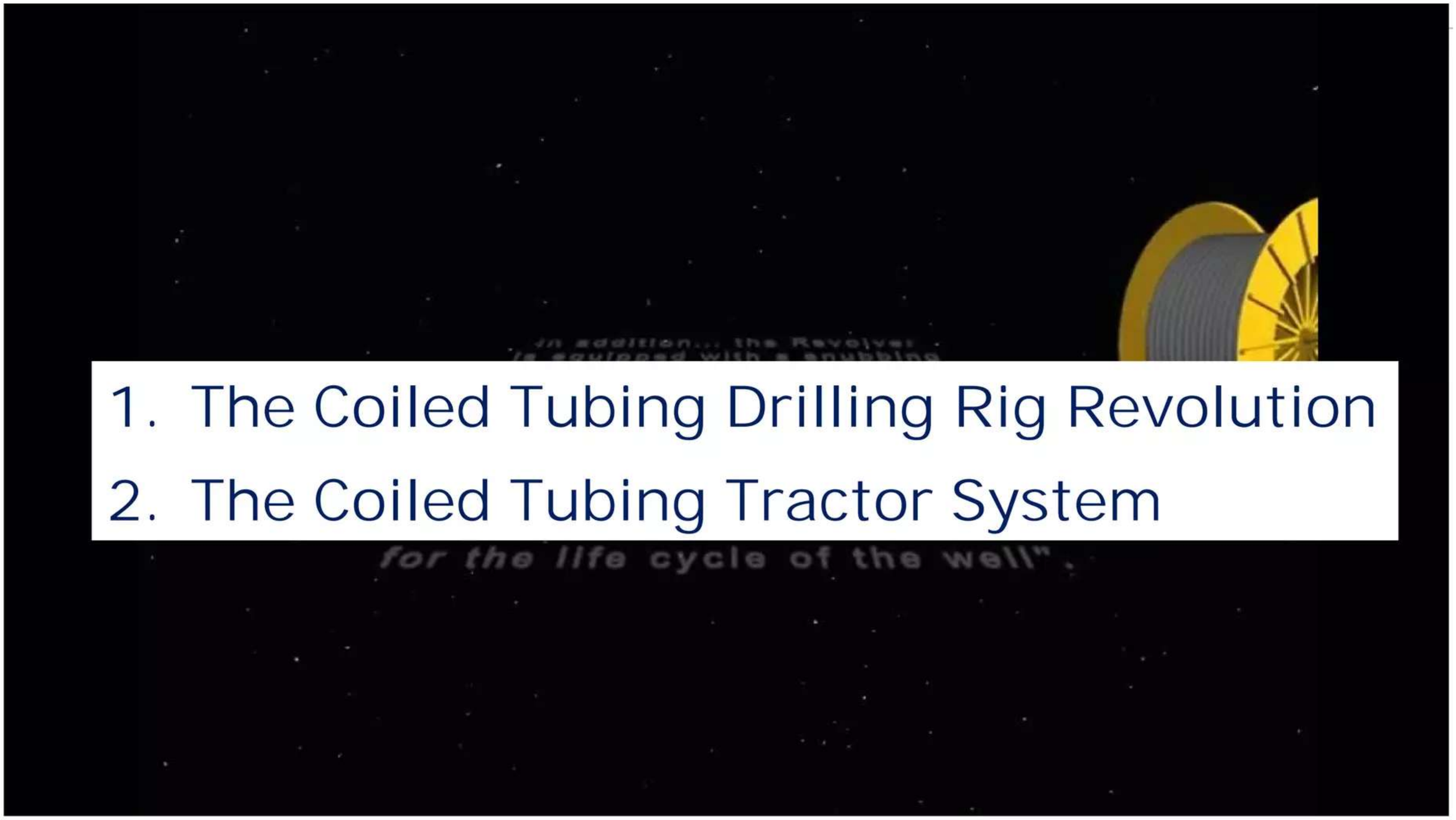
PLAY VIDEO



1. The Coiled Tubing Drilling Rig Revolution
2. The Coiled Tubing Tractor System

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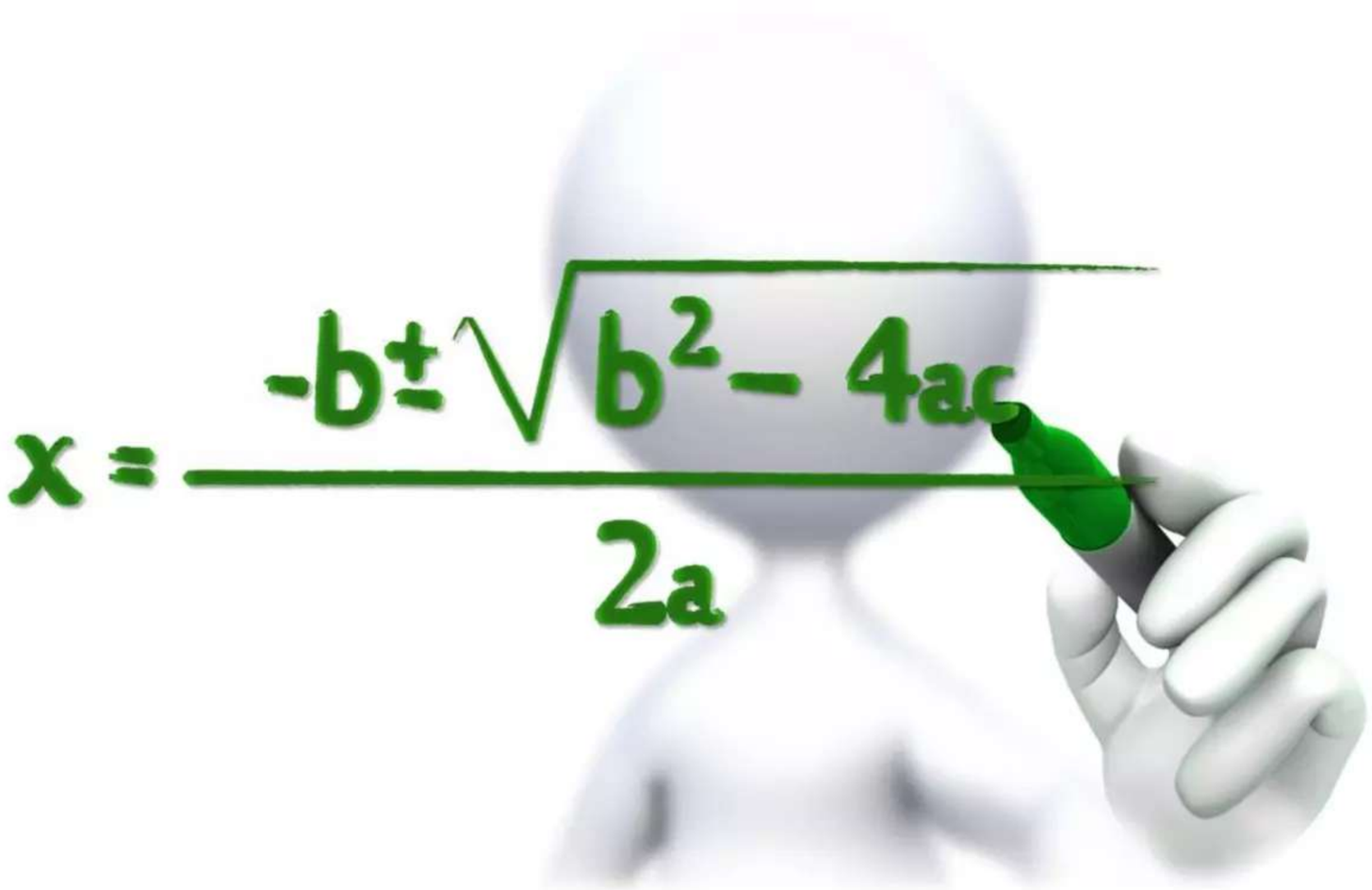
Thank you for Listening

Any Questions



Start WorkBook Exercise 3 & 4

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