SNUBBING OPERATIONS
Snubbing Operations

Learning Objectives

- You will learn -
  - Various activities suitable for snubbing operations.
  - Best practices and techniques for conducting snubbing operations.
  - The types of snubbing units, components, tools and BOPs.

- How to handle common problems confronting snubbing operators, and how to handle equations relating to snubbing operations.
- Minimal safety and control procedures regarding snubbing operations.
(Hydraulic) Snubbing units are designed to run pipe into and out of a well under pressure.

Snubbing units can rig up/down in a fraction of the time of a conventional rig or workover unit.

Snubbing units can perform most operations normally performed by conventional rigs and workover units.

Certain safety issues must be addressed because of the small pipe size used.

Units can be used for drilling, or for workovers on live wells.
Snubbing Operations

Overview

- Snubbing Operations can be broken down into two major categories -
  - Live Well Operations
  - Dead Well Operations
Snubbing Operations

Overview

- In Live Well Operations there are usually production issues that require the well to be worked under pressure or there are mechanical problems that prevent the well from being killed.

- Dead Well Operations are usually done for issues related to rig costs or space and mobilization issues.
Snubbing Operations

Overview

- Live Well Operations
  - Well Control – Recovery
  - Formation Protection
  - Workovers with Mechanical Problems
- Dead well Operations
- Workovers – Tubing Changeouts
- Fishing Coil & Wireline Tools – also under Pressure
- Stimulation Procedures
Snubbing Applications

- Snubbing - pipe raising / lowering operations where specialized equipment is used to overcome forces trying to push the pipe out of the hole due to shut-in wellbore pressures.
- Running/pulling production strings
- Resetting weight on packers
- Fishing operations
- Squeezing cement slurry
- Washing perforations, sand
- Well control
- Milling / drilling
Hydraulic Unit - Components

Work Basket & Controls

- Platform for operators and helpers
- Operator console controls -
  - Jacking direction controls
  - Weight indicators & pressure gauges
  - Rotary direction & torque controls
  - Slips and stripping BOP bank

- Pump Controls & gauges
- Counterbalance console for pipe handling
- Tongs and controls
Work Basket

- **Jack Cylinders**
  - Provide lifting and lowering force.
  - Lifting forces from 120k to 600k.

- **Slip Assemblies**
  - Traveling slips attached to operating cylinders, move with Jack head.
  - Stationary slips hold tubing for connections and while additional strokes are taken.
  - Lower stationary slips used when pipe is “heavy.”
  - Inverted stationary slips used when pipe is “light.”
Slip Assembly

Telescoping Mast- Gin Pole (not shown)

- Lifts and lowers tubing and tools on and off platform
- Tong Pole Mast
  - Holds tong and hydraulically moves tong into working position.
- BOP Snubbing Loop
  - Used to equalize and bleed stripper ram cavities when snubbing from ram to ram.
The RA snubbing unit uses a rig’s block thru a pulley system for snubbing force.

As block moves up the pipe moves in the hole; as the block moves down the pipe moves up – confusing at first but effective.

Unit capacity limited by pulley cable load limit and well pressure against tubulars.
Once a balance point is reached, the snubbing unit is not needed and rig can then strip string to bottom.

Exercise care due to unsupported pipe lengths.

The RA unit has no guide tube so buckling is a concern.

The RA unit can be rigged up quickly and is less costly than hydraulic units.
Rig-Assist Unit Components

Applications

- Snubbing drill pipe back to bottom for well killing or UG blowouts.
- Running/pulling tubing, casing, or a workstring under pressure.
- Running / Installing / Resetting packers.
- Pulling tubing with a hole that prevents conventional kills.
- Drilling / Fishing / Milling under pressure.
- Acidizing and/or washing.
- Squeeze jobs and plug-backs.
Typical Snubbing Sequence

1. Close Lower Ram, bleed Cavity Pressure, open Upper Ram & Lower Tubing.
2. Close Upper Ram, Pressure Cavity, open Lower Ram and continue.
3. Snub until Tool Joint blocked by Closed Ram.
A Barrier is any device or substance that prevents the flow of the well bore fluids.

Primary Barrier

- Used during normal operations, e.g., a stripper rubber, BPV and stripping rams.
- A liquid (e.g., brine) used as a barrier must be able to control pressures.
  - Must be able to monitor density.
  - Must be able to adjust density.
Barrier

- Secondary Barrier
  - Used in support of normal operations or as a contingency, e.g., a BOP, stripping rams and back pressure valve

- Tertiary Barrier
  - Used in emergency, e.g., a shear seal, a master valve that cuts wireline, safety head
Barrier

- Closeable Barriers
  - Ability to open and close, e.g., BOP, safety valves
- Fluid Barriers
  - Seawater, brines, drilling fluid
- Mechanical Barriers
  - Closes off the flow path by sealing against casing or tubing wall - positive plug in tubing-N nipple
- Combination Barriers
  - A combination of mechanical and fluid barriers may be used
- Testing of a Barriers
  - Test in direction of Flow. (BPV against flow)
  - Test to maximum anticipated surface pressure
BOPs and Accessories

- Inside BOP - Stops flow up snubbing string.
- Annular BOP - Used at low pressure depending on well conditions.
- Stripper Rams - Used if well pressure exceeds annular rating - minimum of two stripper rams required to pass tool joints.
BOPs and Accessories

- Stripper rams must be separated by a spool for “lubricating” tool joints and have pump in and bleed off capability between strippers.
- Safety Rams - Actually pipe rams - allow safe replacement of stripper ram packing - two rams for well pressure > 5,000 psi.
- Shear or Blind Rams - Cut pipe or seal wellbore - two rams for well pressure > 5,000 psi.
- Wellhead - Should have a minimum of two master valves, two blind rams or a combination of both below the BOP stack.
This stripper relies on wellbore pressure for seal around pipe. Others use hydraulic pressure acting on a piston and packing element to maintain a seal.

BOPs and Accessories

- Tubing Stripper – Sometimes Called an Annular
- Capabilities and limitations
  - Provides seal around
  - Workstring under low
  - Pressure situations
  - Max. WP of 3000 psi
  - Accepts variety pipe sizes
BOPs and Accessories

- Hydraulic pressure applied through closing chamber to effect a seal.
- Opening by relieving pressure from closing chamber.
- Stripper is well bore assisted.
- Could be well pressure energized and may require reducing closing pressure with increasing surface pressure.
- Apply just enough closing pressure to gain a seal.
- Excessive closing pressure will shorten the life of the packing element.
BOPs and Accessories

- Hydril GK 7-1/16” 3,000 and 5,000 psi WP
- Model similar to drilling GK in function and design; sized for workovers.
- Hydraulic pressure applied through closing chamber to underside of piston. Piston rises and causes constriction of packing element.
- Hydraulic pressure applied via opening chamber, piston travels downward for element to open.
BOPs and Accessories

• Hydrl GS 4-1/16” 10,000 & 15,000 psi WP
• GS Snubbing Annular has all features of its drilling counterparts including well bore assistance.
• Install compensator bottle on closing line for tooljoints to pass through packing element.
Cameron 4-1/16” Snubbing Annular Preventer
And Tubing Stripper
10,000 psi & 15,000 psi WP
Cameron 4-1/16” S/QRC Snubbing Rams
15M psi WP
Cameron 4-1/16” S/QRC 25M psi WP
7-1/16 S/QRC 20M psi WP
Cameron Type UL 7-1/16” Ram Preventer
5M, 10M, and 15M psi WP
The Cameron Type UM is specifically designed for workover and well servicing operations.

Cameron 7-1/16”Type UM Ram Preventer
3,000 psi – 15,000 psi WP
Cameron Type U Preventer was designed for drilling applications, smaller sizes are used in workover and snubbing operations.

Cameron 7-1/16” Type U Ram Preventer
3,000 psi – 15,000 psi WP
Bowen Double Snubbing Rams capable of either conventional workover or snubbing service.
Sentry by Hydril 7-1/16” 3000 psi to 5,000 psi WP
Capable of either conventional workover or snubbing service.
Safety Head Shear Samples
BOPs and Accessories

Shear Tests Include

- 0.108” Slick Line w/o Tension, 1 strand
- 0.108” Slick Line w/o Tension, 10 strands
- 0.438” Cable w/o Tension, 1 strand
- 0.438” 5 Core Cables w/o Tension, 10 strands
- 1.25”, 0.109” Wall Coiled Tubing 10 strands
- 3 Parallel Strings of Heavy Wall 1.5”, 1.75”, & 2.0 CT w/ 7/16” Cable inside
BOPs and Accessories

Shear Tests Include

- 2 Parallel Strings of Heavy Wall 2.38” & 2.88” CT w/ 7/16” Cable inside
- 2” Sinker Bar, ANS 4230 Steel
- 3.5” Drill Pipe S-135, 226.2 N/m (15.5 lbs/ft)
- 4” Tubing 13 Chrome L-80
- 4.5” 184.0 N/m (12.6 lbs/ft) tubing
- 4-5/8” Gravel Pack Screen w/ 2-3/8” Wash Pipe inside
Snubbing BOP Stacks

- Stack configurations vary greatly and the component selection is based on –
  - Maximum anticipated surface pressure
  - Tapered or non-tapered workstring
  - Hydrogen sulfide (H2S) resistant
  - A non-tapered workstring
  - Stack provides primary pressure control
  - Configurations are examples only
0 - 3,000 psi Stack
Snubbing BOP Stacks

- **Notes for Testing ALL BOP Stacks**
- Use an environmentally friendly test fluid.
- Test at low pressures (200 - 300 psi).
- Test at rated working pressure of the stack.
- If rigged up on a drilling stack, the blind rams of the drilling stack may not hold working pressure from above. This may limit the test pressures of the snubbing stack.
Snubbing BOP Stacks

- **Testing < 3,000 psi Stack Configuration**

  - **STEP 1:** Pick up a muleshoe and a length of workstring to cover the BOP stack; tag top master valve and lift string one foot above master valve; install a full opening workstring valve (TIW), in the open position and install a pump-in line.

  - **STEP 2:** Open all valves on the stack, chokes, and equalizing loop.

  - **STEP 3:** Close the stationary slips and use the travelling slips to pull tension on the workstring to ensure the workstring is not pumped out of the stack during the test procedures.
Snubbing BOP Stacks

- **STEP 4** Close the lowest safety ram and perform the pressure tests (high and low); bleed the pressure and open the ram; repeat this procedure for the stripper ram. Fill with fluid before closing rams.

- **STEP 5** Test each valve individually; first in the open position and then in the closed position. Test all inside valves to shorten tests.

- **STEP 6** Function test each ram under rated working pressure.
Snubbing BOP Stacks

- 3,000 – 5,000 psi Stacks
- Non-tapered workstring.
- Stripper provides primary pressure control.
- Remove bleeder valve if ram-to-ram snubbing or stripping is to be done.
Snubbing BOP Stacks

- Stripper
- Upper Stripper Ram
- Lower Stripper Ram
- Upper Safety Ram
- Lower Safety Ram
- Wellhead/BOP Connection
- Bleed Valve
- Bleed Valves
- Spacer Spool
- Equalizing Loop
- Choke/Valve
- Outlet Spool

Diagram showing the components and connections of a snubbing BOP stack.
Snubbing BOP Stacks

- **Testing 3,000 – 5,000 psi Stack**
  - **STEP 1** Pick up a muleshoe and a length of workstring to cover BOP stack; tag top master valve and lift string one foot above master valve; install a full opening workstring valve (TIW) in the open position and install a pump-in line.
  - **STEP 2** Open all valves on the stack, chokes, and equalizing loop.
Snubbing BOP Stacks

- **STEP 3** Close the stationary slips and use the travelling slips to pull tension on the workstring to ensure the workstring is not pumped out of the stack during the test procedures.
- **STEP 4** Close the lower safety ram and test. Bleed pressure and open the ram.
- **STEP 5** Close the upper safety ram and test. Bleed pressure and open the ram.
- **STEP 6** Close the lower stripper ram and test. Bleed pressure.
Snubbing BOP Stacks

- **STEP 7** With the lower stripper ram closed, individually test the valves below the stripper rams. Bleed pressure and open the lower stripper rams.
- **STEP 8** Close upper stripper rams and test. Following test, bleed pressure but leave the rams closed.
- **STEP 9** With upper stripper rams closed, test each valve individually bleeding pressure after each test.
- **STEP 10** Function test each ram at full rated working pressure.
Snubbing BOP Stacks

- **Surface Pressure:** 5,000 – 10,000 psi
- Use for non-tapered string.
- Use an environmentally friendly test fluid
- Test at low and high pressures (200 - 300 psi; and rated working pressure).
- If rigged up on a drilling stack, the blind rams of the drilling stack may not hold working pressure from above, this may limit the test pressures of the snubbing stack.
5K – 10K psi Stack

- Stripper
- Upper Stripper Ram
- Lower Stripper Ram
- Upper Safety Ram
- Blind Ram
- Shear Ram
- Lower Safety Ram
- Wellhead/BOP Connection
- Choke/valve
- Equalizing Loop
- Spacer Spool
- Bleed Valve
- Bleed Valves
- Outlet Spool
Snubbing BOP Stacks

- **Testing 5,000 – 10,000 psi snub stack**
- **STEP 1** Pick up a muleshoe and a length of workstring to cover BOP stack; tag top master valve and lift string one foot above master valve; install a full opening workstring valve (TIW), in the open position and install a pump-in line.
- **STEP 2** Open all valves on the stack, chokes and equalizing loop. Close the stationary slips and use the travelling slips to pull tension on the workstring to ensure the workstring is not pumped out of the stack during the test procedures.
Snubbing BOP Stacks

- **STEP 3** Close the lower safety ram and test. Bleed pressure after the test and open the ram.
- **STEP 4** Release the slips and pick up the string above the blind rams. Reset the slips so the workstring is not pumped out of the stack. Close the shear rams. Pump into the outlet below the blind rams and test the valves and chokes individually.
Snubbing BOP Stacks

**STEP 5** Close the blind rams, pump into the outlet below the blind rams to test the blinds. Bleed pressure and open the blind rams. Open the blind rams. Close the upper safety rams and test. Bleed pressure and open the upper safety rams. Close the lower stripper rams.

**STEP 6** Test lower stripper rams. Bleed pressure but leave rams closed. Test valves on outlet below upper stripper rams individually. Bleed pressure and open the lower stripper rams.
Snubbing BOP Stacks

- **STEP 7** Close the upper stripper rams and test. Test the valves on the outlet below the upper stripper rams individually. Leave the upper stripper rams closed and function test each ram under rated working pressure.
> 10,000 psi Stacks

Snubbing BOP Stacks

WILD WELL CONTROL
Alternate Configuration

Snubbing BOP Stacks

- Upper Stripper Ram
- Lower Stripper Ram
- Upper Safety Ram
- Upper Safety Ram
- Blind Ram
- Shear Ram
- Lower Safety - Large Pipe Ram
- Lower Safety - Small Pipe Ram
- Wellhead/BOP Connection

- Choke/valve
- Equalizing Loop
- Spacer Spool
- Bleed Valve
- Bleed Valves
- Outlet Spool
Snubbing BOP Stacks

- **Testing 10,000 psi Configurations**
- **STEP 1**  
  Pick up a muleshoe and a length of workstring to cover BOP stack; tag top master valve lift string one foot above master valve; install a full opening workstring valve (TIW) in the open position and install a pump-in line.
- **STEP 2**  
  Open all valves on the stack, chokes, and equalizing loop. Close the stationary slips and use the travelling slips to pull tension on the workstring to ensure the workstring is not pumped out of the stack during the test procedures.
Snubbing BOP Stacks

- **STEP 3** Close lowermost safety rams (small pipe) and test. Bleed pressure and open the lowermost safety rams. Close the next up safety rams (large pipe) and test. Bleed pressure and open the safety rams.

- **STEP 4** Release the slips and position the workstring between the blind rams and #2 (2nd from the top) safety rams. Pump into the side outlets below the blind rams and test the valves/chokes individually.
Snubbing BOP Stacks

- **STEP 5**  Close the blind rams and test through the side outlet. Bleed pressure and open the blind rams. Close the #2 safety rams (2nd from the top) and test. Bleed pressure and open the safety rams.

- **STEP 6**  Close the upper safety rams and test. Bleed pressure and open the rams. Close the lower stripper rams and test. Bleed pressure but leave the rams closed. Test the valves/chokes on the lower portion of the equalizing loop. Bleed pressure and open the lower stripper rams.
Snubbing BOP Stacks

- **STEP 7** Close the upper stripper rams and test. Then test the valves/choke located on the upper portion of the equalizing loop. Following the tests, bleed pressure from the valves. Leaving the upper stripper rams closed, function test all rams under rated working pressure.
Snubbing BOP Stacks

- Choke manifold
- Fluids can be circulated in and out of well in a controlled fashion.
- Has same pressure rating as the BOP stack.
- Plumbed to allows normal and reverse circulation.
Snubbing BOP Stacks
Planning a Snubbing Job - 1

- **Snubbing Force Concerns**
  - Capacity required to push against well pressure
  - Force to snub the first joint of 2 7/8” tubing against 8,500 psi would be 0.7854 x 2.8752 x 8500 = 55,180 lbs.
  - After first joint, weight of tubing helps snubbing unit
  - Eventually weight of workstring may equal wellbore force
  - This is the “balance point”
Snubbing BOP Stacks

- After balance point the pipe is heavy - snubbing stops, and stripping begins.
- Lower stationary slips are used. (This is reversed when stripping out.)
- There are several companies that build snubbing units. Often the service company builds its own units. There are charts and tables that can be provided by the manufacturer.
**Hydraulic Snubbing Unit Capabilities**

<table>
<thead>
<tr>
<th>Unit</th>
<th>150</th>
<th>225</th>
<th>340</th>
<th>600</th>
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</thead>
<tbody>
<tr>
<td>Max Hook Load (lbs)</td>
<td>150,720</td>
<td>235,560</td>
<td>340,000</td>
<td>600,000</td>
</tr>
<tr>
<td>Max Snub Load (lbs)</td>
<td>65,940</td>
<td>120,000</td>
<td>188,400</td>
<td>260,000</td>
</tr>
<tr>
<td>Tubing Size Range</td>
<td>.75&quot; - 3.5&quot;</td>
<td>.75&quot; - 5.5&quot;</td>
<td>.75 - 7.875&quot;</td>
<td>1.0 - 9.625&quot;</td>
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<tr>
<td>Throughbore Limit</td>
<td>7-1/16&quot;</td>
<td>11-1/16&quot;</td>
<td>11-1/16&quot;</td>
<td>13-5/8&quot;</td>
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<tr>
<td>Rotating Torque</td>
<td>1,000</td>
<td>2,000</td>
<td>2,800</td>
<td>11,500</td>
</tr>
<tr>
<td>Jack Stroke</td>
<td>116&quot;</td>
<td>116&quot;</td>
<td>116&quot;</td>
<td>168&quot;</td>
</tr>
</tbody>
</table>
Planning a Snubbing Job - 2

- **Other Concerns**
  - Size unit for reasonable overpull above maximum estimated string weight. The maximum *allowed* is usually specified by the snubbing company.
  - If used on rig, verify unit will fit inside the derrick.
  - Drill pipe requires a higher snubbing force while stripping through an annular due to TJs. For this reason a surge bottle is often incorporated on the annular.
  - Drill pipe connections may not seal gas tight.
Snubbing BOP Stacks

- If the stripper can be used, tubing can be snubbed through without sequencing the rams.

<table>
<thead>
<tr>
<th>Rig Assist Snubbing Unit Capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit</td>
</tr>
<tr>
<td>Snubbing Capability (lbs)</td>
</tr>
<tr>
<td>Maximum Pipe Size</td>
</tr>
<tr>
<td>Snubbing Lines</td>
</tr>
<tr>
<td>Working Pressure</td>
</tr>
</tbody>
</table>
Snubbing BOP Stacks

• Pre-Job Considerations
• Pipe “Light”
  ▪ When pressure force greater than pipe weight (sq. inches of area)
  ▪ Snubbing required
• Pipe “Heavy”
  ▪ When pipe weight greater than pressure force
  ▪ Stripping allowed

*May be adjusted for buoyancy effect of fluid.
Snubbing BOP Stacks

- **Balance Point is affected by**
- Surface pressure.
- Dissimilar fluids in well (gas, liquid).
- Weight of the pipe being snubbed. Area of pipe.
- If pipe filled with fluid as it is snubbed in hole.
- If string light (macaroni tubing), balance point may never be reached and string will be snubbed in and out of well.
- Always fill pipe as it is snubbed into the wellbore.
Snubbing BOP Stacks

- Critical when snubbing into high pressure wells. Pump thru BPV occasionally to prevent plugging.
- String becomes heavier quicker and balance point achieved sooner than if the string not being filled.
- By filling the pipe the risk of collapse is minimized.
- Scenarios which influence balance point are -
  - The pipe is initially entering dry gas.
  - The pipe is initially entering liquid.

\[ \text{Force} = \frac{\text{Pipe Area Across Preventer} \times \text{Pressure}} {\text{Wellbore Xsec. Area}} \]
Snubbing BOP Stacks

Note

- Snubbing force is calculated by taking well pressure and applying it against the square inches of area that a BOP is closed around. You never calculate the OD of Packers unless you have annular velocity around these tools. Forces are calculated at the sealing area.

\[ \text{Force} = \text{Pipe Area Across Preventer Xsec. Area} \times \text{Pressure} \]
Snubbing BOP Stacks

- **Snubbing into Dry Gas**
  - Wellbore Force \( \text{lbs} = 0.7854 \times (\text{Pipe OD})^2 \times \text{Shut-in Pressure} \)
  - Balance Point = Wellbore Force \( \div \left( \{ 42 \text{ gal/bbl} \times \text{Pipe Capacity} \times \text{Fluid Weight} \} + \text{Pipe Weight} \right) \)
  - Example Snubbing Info:
    - Pipe Size = 2 7/8” OD, 10.40 ppf
    - Packer Fluid Weight = 10.2 ppg
    - Shut-in Annulus Pressure = 1,200 psi
  - At what point while snubbing in will the pipe go from “light” to heavy conditions.
    - Balance Point = \(0.7854 \times (2.875)^2 \times 1,200\)
    - \(\div \left( \{ 42 \times 0.0045 \times 10.2 \} + 10.4 \right)\)
    - \(= 7,790 \div 12.33 = 631.8 \text{ ft}\)
Snubbing BOP Stacks

- **Snubbing into Fluid**

  - Wellbore Force \( \text{lbs} = 0.7854 \times (\text{Pipe OD})^2 \times \text{Shut-in Pressure} \)

  - Balance Point = Wellbore Force \( \div \left( \left\{ \frac{42}{\text{gal/bbl}} \times \text{Pipe Capacity} \times \text{Fluid Weight}\right\} + \left\{ \text{Buoyancy Factor} \times \text{Pipe Weight}\right\} \right) \)

- Example Snubbing Info:
  - Pipe Size – 27/8” OD, 10.40 ppf
  - Packer Fluid Weight – 10.2 ppg
  - Shut-in Annulus Pressure – 1,200 psi

- At what point while snubbing will the pipe go from “light” to heavy conditions.

  - Balance Point = \( 0.7854 \times (2.875)^2 \times 1,200 + \left( 42 \times 0.0045 \times 10.2 \right) + \left( 0.84 \times 10.4 \right) \)
  - = \( 7,790 \div 10.66 = 730.8 \ \text{ft} \)
The force required to run and lift the workstring is provided by a multi-cylinder hydraulic jack.

When snubbing is taking place, hydraulic pressure is applied to the ‘top side’ of a piston contained within a cylinder.

To lift the string, hydraulic pressure is applied to the under side of the piston.
Snubbing BOP Stacks

- **Estimated Required Hydraulic Pressure To Snub**
- Hydraulic pressure required to snub a workstring into a well is based on:
  - Wellbore force against pipe area, and the geometry of the snubbing jack.
- Most snubbing units have 4 hydraulic cylinders. The operator determines if all four are needed, or just two, at any given time, based on snubbing/lifting requirements at the time.
- Use the following formula to estimate hydraulic pressure to apply to cylinder to snub:
Snubbing BOP Stacks

- Hydraulic Cylinder Pressure \( = \) Wellbore Force \( \div (0.7854 \times \{\text{Cylinder ID}^2 - \text{Piston Rod OD}^2\} \times \text{Number of Cylinders}) \)
- Consider friction created between the exterior wall of the workstring and the rubber elements of the BOP’s or tubing stripper in use at the time.
- Required hydraulic pressure would increase when taking this into account.
Snubbing BOP Stacks

- **Calculation of the string weight off bottom**

  - The weight of the string is affected by pipe weight, buoyancy of the wellbore fluids, hole angle, pipe drag, overpull, and surface pressures.

  - If the hole is near vertical, an estimate of the string weight is simple, but more difficult if the hole is deviated.
Snubbing BOP Stacks

String Weight Vertical Section:
\[ = (\text{Buoyancy Factor} \times \text{Weight }_{\text{ppf}} + 42 \text{ gal/bbl} \times \text{Pipe Capacity} \times \text{Fluid Weight}) \times \text{Length}_V \]

String Weight Build Section:
\[ = (\text{Buoyancy Factor} \times \text{Weight }_{\text{ppf}} + 42 \text{ gal/bbl} \times \text{Pipe Capacity} \times \text{Fluid Weight}) \times \text{Length}_B \times \cos(\text{max } \angle) \times \frac{2}{\text{max } \angle} \]

String Weight Build Tangent Section:
\[ = (\text{Buoyancy Factor} \times \text{Weight }_{\text{ppf}} + 42 \text{ gal/bbl} \times \text{Pipe Capacity} \times \text{Fluid Weight}) \times \text{Length}_T \times \cos \angle \]
Snubbing BOP Stacks

Total String Weight:

\[ = \text{String Weight in Vertical} + \text{String Weight in Build} + \text{String Weight in Tangent} \]

Required Hydraulic Pressure:

\[ = \frac{\text{Total String Weight} + \text{Overpull - Wellbore Force}}{0.7854 \times \text{Cylinder ID}^2 \times \text{Number of Cylinders}} \]
Snubbing Packer into Live Well
Snubbing BOP Stacks

- Calculate the estimated snubbing force required -

**Data** -
- Casing 5 ½” OD; 4.995” ID
- Tubing 2 3/8” OD; 4.7 Lbs/ft
- Well Pressure 5,000 psi
- Estimate Friction Force = 3,000 lbs

Estimated Force =

\[(4.995)^2 \times 0.7854 \times 5,000 + 3,000 \text{ lbs} = 100,979 \text{ lbs force against the bottom of the packer.}\]
Snubbing BOP Stacks

• Conclusions of this case
  ▪ Threads snapped at the top of the packer.
  ▪ Blowout caused the well to catch on fire.
Buckling of Snubbing String

- Buckling is when the pipe being snubbed is disfigured, fatigued, and possibly failed.
- Results can be catastrophic.
- Snubbing crew should recognize warning signs when buckling occurs.
- Two types of buckling:
  - Major axis buckling.
  - Local buckling.
Buckling of Snubbing String

- **Major axis buckling**
- Smaller diameter workstrings takes a sine wave or an “S” curve shape
- **Local buckling**
- Pipe “balloons” or diameter slightly increases, usually not noticeable to the naked eye.
- Occurs more often with larger diameter pipe.
- Pipe failure, in either case, can occur above a check valve in the string, creating instant communication between the annulus under pressure and the inside of the workstring.
Buckling of Snubbing String

- Major Warning Signs
  - High snubbing pressures
  - Low Yield Strength snubbing workstring
  - Rusted or severely worn snubbing string
Types of Buckling

- Deformation of the pipe due to the applied force, unsupported length, pipe wall thickness, and metal properties. Applied force created by existing surface pressure and friction bit of BOP.
Snubbing BOP Stacks

Pre-Job Considerations

- Compression Effects on Surface Pressure
- Surface and BH pressure changes occur while snubbing
- As the string is lowered it takes up space previously occupied by wellbore gases and/or liquids
- Surface and bottom hole pressure will therefore increase due to displacement of string in “closed system” environment of a well
Snubbing BOP Stacks

- Constant bottom hole pressure must be maintained to prevent excessive wellbore pressures and formation breakdown.
- Continuous manipulation of the choke is required.
- An individual is placed at the choke with instructions on how to maintain correct constant bottom hole pressure.
Snubbing BOP Stacks

**Required Accumulator Pressure To Shear Pipe**

- Snubbing stacks equipped with shear rams must have an accumulator able to supply sufficient pressure to shear the workstring.
- The equation below provides the accumulator pressure to shear the string: Use manufacturers recommendations.
  - Diameters of the BOP and booster pistons.
  - Grade of pipe.
  - Cross sectional area of pipe to be sheared.

\[
\text{Hydraulic Fluid Pressure} = \frac{0.7854 \times ( \text{Pipe OD}^2 - \text{Pipe ID}^2 ) \times \text{Minimum Yield}}{0.7854 \times ( \text{BOP Piston OD}^2 + \text{Booster Piston OD}^2 )}
\]
Snubbing BOP Stacks

- Working under pressure requires specialized tools in the workstring.
  - Downhole Tools
    - Back Pressure Valves (BPV), are installed in the workstring to prevent flowback, or pressure from below.
    - A BPV also allows pumping into the wellbore. This prevents plugging of the BPV.
    - A BPV is sometimes referred to as a check valve.
Snubbing BOP Stacks

- **Ball And Seat BPV**
  - The ball and seat BPV is a ball resting against a sealing surface and held in place by a spring.
  - The ball is held in place with the spring.
  - Fluids may be pumped through the BPV, the ball seats and the BPV holds pressure from below.
Snubbing BOP Stacks

- Back Pressure Valve Uses a Spring-Loaded Flapper to Seal.
- Holds pressure from below.
- Allows fluids to pump-thru.
- Some models use internal sleeve to retract the flapper.
- Allows for wireline work through the flapper.
Snubbing BOP Stacks

- A profile nipple used in production tubing strings and a corresponding locking device and pump-in plug are utilized when problems develop in the tubing string.
  - Holds pressure from both directions.
  - Once the positive plug has been pumped down then the tubing string must be pulled out of the hole.
Profile Nipples and Plugs

- Ball and Seat
- Plunger and Seat
- Profile Nipple
- Locking Mandrel and Plug
Snubbing BOP Stacks

- Back Pressure Valve Placement
  - Place the two BPV in the BHA. The pump seat nipple is placed either one joint above or just above a pup joint located above the BHA.
  - Run two BPVs in the string along with a profile nipple.
  - Spacing can be affected by stack configuration in use.
Snubbing BOP Stacks

- BHA is the portion of string with an irregular OD that cannot be stripped through the stripper rams. BHA is whatever you are running, sometimes only a muleshoe.
- BPV, Profile Nipple and BHA must be made up so they can be stripped into and out of the hole.
- BHA should allow the use of stripper rams. This allows for a longer BHA, useful in fishing operations.
- If fishing takes place, consider spacing where a long fish may be present.
Snubbing BOP Stacks

- Spacing
  - The length of the BHA that cannot be stripped through the top stripper rams must be less than the distance between the top stripper rams and the second lowest blind mechanism (ram or valve – preferably ram).
  - The BHA not covered by the BOP stack, must be properly supported if it is to be pulled above the top stripper ram.
Snubbing BOP Stacks

- **Workstring Selection**
  - Prior to the selection of a workstring, careful consideration must be given to the loads that will be placed on the pipe.

- **Four considerations in this area are** –
  - Tension
  - Collapse
  - Buckling
  - Burst pumping and volumes to clean the hole should be considered and calculated
Snubbing BOP Stacks

- **Design Safety Factors**
  - A design safety factor is the ratio of rated capacity to the anticipated or observed load. The anticipated load must not exceed a certain percentage of the rated strength. It can be calculated by the following equation:

  \[
  \text{Design Factor} = \frac{\text{Rated Strength of Pipe}}{\text{Anticipated Load}}
  \]
Snubbing BOP Stacks

- Design safety factors for workstrings in four previously mentioned categories are:
  - Tension $\leq 80\%$ of the pipe tensile strength (1.25 design factor).
  - Buckling $\leq 70\%$ of the critical buckling load (1.43 design factor).
  - Collapse $\leq 80\%$ of the rated collapse pressure (1.25 design factor).
  - Burst $\leq 80\%$ of the rated burst pressure (1.25 design factor).

- If the calculated design factor is less than the values given in tables, consider using a stronger or heavier and more competent pipe for the job.
Snubbing BOP Stacks

• Killing a Well During Snubbing Operations
  ▪ Stripping is the most used well control procedure using a snubbing unit to return the string into a pressured wellbore.
Snubbing BOP Stacks

- Long or short term stripping is the recommended procedure whenever snubbing the pipe into the well.
- Avoid using wellbore pressure when equalizing pressure between snubbing preventers, it’s much safer to use surface injected fluids. Caution should be used as this fluid may freeze in a gas well.
Killing a Well During Snubbing Operations

- Driller’s Method
  - Snubbing units are used to perform workovers on dead wells.
  - Should a kick occur, the kill procedure used may be a circulating technique or non-circulating technique.
  - The circulating technique would usually be the Driller’s Method.
Killing a Well During Snubbing Operations

- Wait & Weight Method
  - The Wait & Weight Method would seldom be used.
  - Should the workover fluid be lightened by inadvertent dilution on the surface or downhole the Wait & Weight Method may be used.
Killing a Well During Snubbing Operations

Argentina
Access Window
Killing a Well During Snubbing Operations

Unit Anchors

![Image of unit anchors in a muddy field](image-url)
Deluge System Test
Long Stroke Unit
Guide Tube
Snubbing Operations

Learning Objectives

- You learned -
  - Various activities suitable for snubbing operations.
  - Best practices and techniques for conducting snubbing operations.
  - The types of snubbing units, components, tools and BOPs.

- How to handle common problems confronting snubbing operators, and how to handle equations relating to snubbing operations.

- Minimal safety and control procedures regarding snubbing operations.
Snubbing Operations

On Dual String Job
Operator’s Control Console
Tubing Guide Support Bracket
Bell Nipple With Fill-up Line
Tool Baskets
Snubbing Operations

600K
Snubbing Operations

340K
Kill Manifold
Rotary/Power Drive