# PTTCO WELL CONTROL COURSE OUTLINE

1. **BASIC TERM, DEFINITIONS AND CALCULATION**

   1.1 WHAT IS WELL CONTROL TRAINING? WHY WE ARE HERE?  
   1.2 GENERAL INFORMATION
      - 1.2.1 Primary Well Control  
      - 1.2.2 Secondary Well Control  
      - 1.2.3 Tertiary Well Control  
   1.3 PRESSURE  
   1.4 HYDROSTATIC PRESSURE  
   1.5 TRUE VERTICAL DEPTH (TVD) VS MEASURED DEPTH (MD)  
   1.6 PRESSURE GRADIENT  
   1.7 BOTTOM HOLE PRESSURE  
   1.8 SURGE & SWAB PRESSURE EFFECTS
      - 1.8.1 Conditions for Surge and Swab  
      - 1.8.2 Swab indication at surface  
   1.9 Equivalent Mud Weight (EMW)  
   1.10 EQUIVALENT CIRCULATING DENSITY (ECD)  
   1.11 CIRCULATING PRESSURE
      - 1.11.1 Circulating Pressure or Pump Pressure  
      - 1.11.2 Frictional Pressure Loss Components in the Rig Circulating System  
      - 1.11.3 Parameters that affect pump pressure are as follows  
   1.12 FORMATION PRESSURE
      - 1.12.1 Under Compaction Shale Formation  
      - 1.12.2 Faulting  
      - 1.12.3 Artesian Effects  
      - 1.12.4 Gas Cap  
      - 1.12.5 Charge Sands  
      - 1.12.6 Salt Dome  
   1.13 FORMATION FRACTURE PRESSURE  
   1.14 GAS-CUT MUD  
   1.15 TRIP MARGIN  
   1.16 SHALLOW GAS  
   1.17 BASIC PRESSURE AND PUMP STROKE CALCULATION  
   1.18 POROSITY  
   1.19 PERMEABILITY
2. WELL VOLUME CALCULATION

2.1 VOLUME OR CAPACITY CALCULATION 1
2.2 STRING CAPACITY AND METAL DISPLACEMENT CALCULATION 2
2.3 STRING CAPACITY IN THE WELL 3
2.4 ANNULAR CAPACITY CALCULATION 4
2.5 ANNULAR CAPACITY IN THE WELL 5
2.6 PUMP STROKE CALCULATION 6
2.7 TIME TO PUMP CALCULATION 6
2.8 GENERAL VOLUME CALCULATION - SURFACE BOP 7

3. SLOW PUMP RATE, LEAK OFF TEST AND MAASP

3.1 SLOW CIRCULATION PUMP RATE 1
3.2 LEAK-OFF TEST (LOT) 1
   3.2.1 Leak Off Test (LOT) 1
   3.2.2 Formation Integrity Test (FIT) 1
3.3 MAXIMUM ALLOWABLE ANNULAR SURFACE PRESSURE (MAASP) 5
3.4 FRACTURE PRESSURE IN THE WELL 6
3.5 SAFETY MARGIN AFTER WELL SHUT-IN 9
3.6 SAMPLE OF SURFACE BOP STACK KILL SHEET CALCULATION 9
   3.6.1 Determine Initial Circulating Pressure (ICP) 9
   3.6.2 Determine Final Circulating Pressure (FCP) 9
   3.6.3 Determine Kill Mud Weight (KMW) 10
   3.6.4 SAMPLE OF SURFACE BOP STACK KILL SHEET CALCULATION 10
3.7 DETERMINE CHOKE LINE FRICTION LOSSES ON FLOATING RIGS (SUBSEA BOP) 13
   3.7.1 SAMPLE OF SUBSEA BOP STACK KILL SHEET CALCULATION 15

Exercise - 2 19
Exercise - 2 Answer 25
Kill Sheet Exercise-1 [Surface BOP Stack] 26
Kill Sheet Exercise-1 [Surface BOP Stack] Answer 28
Kill Sheet Exercise-2 [Surface BOP Stack] 29
Kill Sheet Exercise-2 [Surface BOP Stack] Answer 31
Kill Sheet Exercise-1 [Subsea BOP Stack] 32
# Kill Sheet Exercise-1 [Subsea BOP Stack] Answer

# Kill Sheet Exercise-2 [Subsea BOP Stack]

# Kill Sheet Exercise-2 [Subsea BOP Stack] Answer

## 4. REDUCTION IN HYDROSTATIC PRESSURE

### 4.1 U-TUBE CONCEPT

### 4.2 PRESSURE REDUCTION DUE TO PULLING OUT DRY PIPE

### 4.3 PRESSURE REDUCTION DUE TO PULL OUT WET PIPE

### 4.4 PRESSURE CHANGE DUE TO STRIPPED PIPE BACK ON BOTTOM AND VOLUME CALCULATION ON STRIPPING OPERATION

### 4.5 PRESSURE REDUCTION DUE TO PULLING OUT REMAINING COLLARS/BHA

### 4.6 LOST OF OVER BALANCE PRESSURE DUE TO PULLING OUT PIPE

### 4.7 PUMPING SLUG PRIOR TO PULL OUT OF HOLE

#### 4.7.1 Barrels of Slug Required for a Desired Length of Dry Pipe

#### 4.7.2 Weight of Slug Required for a Desired Length of Dry Pipe

#### 4.7.3 BARRELS OF PIT GAIN AFTER STOP PUMPING SLUG

### 4.8 WELL CONTROL DURING CASING AND CEMENTING OPERATIONS

### Exercise-3

### Exercise-3 Answer

## 5. KICK & SHUT-IN PROCEDURES

### 5.1 Risk Management

### 5.2 DEFINITION OF KICK

### 5.3 CAUSES OF KICK

### 5.4 EARLY KICK SIGNS AT SURFACE

#### 5.4.1 While Drilling

#### 5.4.2 POSITIVE KICK SIGNS AT SURFACE

#### 5.4.3 While Drilling

#### 5.4.4 BALLOONING EFFECT

#### 5.4.5 While Tripping

### 5.5 SUMMARY OF KICK INDICATORS

#### 5.5.1 Kick Influx Rate

#### 5.5.2 Kick Size - Kick Tolerance

#### 5.5.3 HARD SHUT-IN PROCEDURE

#### 5.5.4 SOFT SHUT-IN PROCEDURE
6. SHUT-IN DATA

6.1 SHUT-IN DATA

6.2 SHUT IN DRILL PIPE PRESSURE (SIDPP)

6.3 SHUT IN CASING PRESSURE (SICP)

Exercise-4

Exercise-4 Answers

7. BEHAVIOR OF GAS INFLUX

7.1 TYPE OF INFLUX

7.2 GAS INFLUX BEHAVIOR IN OPEN WELL

7.3 GAS INFLUX BEHAVIOR IN CLOSED WELL

7.3.1 Percolation Rate (Gas Migration Rate)

7.3.2 Volume of mud to be bled-off:

7.3.3 STRIPPING PIPE

7.4 Gas Influx Behavior in Killing Well

7.5 BEHAVIOR OF DIFFERENT TYPES OF INFLUX

7.6 GAS KICK IN OIL BASED MUD (OBM)

Exercise 5

Exercise 5 Answer

Kill Sheet Exercise-3 [Surface BOP Stack]

Kill Sheet Exercise-3 [Surface BOP Stack] Answer

Kill Sheet Exercise-4 [Surface BOP Stack]

Kill Sheet Exercise-4 [Surface BOP Stack] Answer

Kill Sheet Exercise-3 [Subsea BOP Stack]

Kill Sheet Exercise-3 [Subsea BOP Stack] Answer

Kill Sheet Exercise-4 [Subsea BOP Stack]

Kill Sheet Exercise-4 [Subsea BOP Stack] Answer

8. WELL KILLING METHODS

8.1 WELL KILLING PRINCIPLE

8.2 WELL KILLING METHODS

8.2.1 Driller’s Method

8.2.2 Wait & Weight Method

8.2.3 CONCURRENT METHOD

8.2.4 VOLUMETRIC METHOD

8.2.5 Bullheading
9. PROBLEM IN WELL KILLING OPERATION

9.1 SUMMARY OF INDICATIONS ON PROBLEMS WHILE WELL KILLING

9.1.1 Bit Nozzle Plugged
9.1.2 Bit Nozzles Washed out
9.1.3 Pump Failure
9.1.4 Chicksans or Drilling Hose Parted
9.1.5 Choke Plugged
9.1.6 Washed Out Choke
9.1.7 String Washed Out
9.1.8 Loss Circulation
9.1.9 Unusual Pressure Fluctuations

Exercise-6
Exercise-6 Answer
Gauge Problem Question-Vertical Well[Surface BOP Stack]
Gauge Problem [Surface BOP Stack] Answer
Gauge Problem Question-Vertical Well(Subsea BOP Stack)
Gauge Problem [Subsea BOP Stack] Answer

10. WELL CONTROL EQUIPMENTS

10.1 BARRIERS TO FLOW
10.2 Well Control Equipments
10.3 DRILL PIPE SAFETY VALVE,FULL OPENING SAFETY VALVE (FOSV), TEXAS IRON WORKS (TIW), KELLY COCK
10.4 TOP DRIVE REMOTE & MANUAL SAFETY VALVES
10.5 Inside Blowout Preventer (IBOP)
10.6 Float Valves
10.7 HYDRIL Drop Version Safety Valve:
10.8 IBOP (Gray Valve)
10.9 BLOWOUT PREVENTERS (BOP)
10.10 ANNULAR PREVENTER
    10.10.1 Hydril Packing Elements
    10.10.2 Hydril GK operating features:
    10.10.3 Shaffer Spherical
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.10.4 Cameron type D and DL operating features</td>
<td>22</td>
</tr>
<tr>
<td>10.11 RAM PREVENTERS</td>
<td>24</td>
</tr>
<tr>
<td>10.11.1 PIPE RAM</td>
<td>26</td>
</tr>
<tr>
<td>10.11.2 Shaffer Poslock</td>
<td>28</td>
</tr>
<tr>
<td>10.11.3 Shaffer Ultra Lock</td>
<td>29</td>
</tr>
<tr>
<td>10.11.4 SHEAR BLIND RAM</td>
<td>30</td>
</tr>
<tr>
<td>10.12 BOP OPERATING PRESSURES</td>
<td>34</td>
</tr>
<tr>
<td>10.12.1 BOP Pressure Test</td>
<td>35</td>
</tr>
<tr>
<td>10.12.2 INFLOW TEST:</td>
<td>36</td>
</tr>
<tr>
<td>10.12.3 BOP SHELL PROOF TEST (New BOP body test)</td>
<td>39</td>
</tr>
<tr>
<td>10.13 Accumulator Bottle (Bladder Type)</td>
<td>42</td>
</tr>
<tr>
<td>10.13.1 Accumulator Calculation</td>
<td>43</td>
</tr>
<tr>
<td>10.14 Hydraulic BOP Control Unit (Koomey, Accumulator Closing System)</td>
<td>50</td>
</tr>
<tr>
<td>10.15 ACCUMULATORS TESTING</td>
<td>55</td>
</tr>
<tr>
<td>10.16 Pump Capacity Requirements:</td>
<td>56</td>
</tr>
<tr>
<td>10.17 Pump Power Requirements:</td>
<td>56</td>
</tr>
<tr>
<td>10.18 AIR OPERATED BOP CONTROL PANEL – SURFACE INSTALLATION</td>
<td>57</td>
</tr>
<tr>
<td>10.19 DRILLER’S ELECTRIC OPERATED CONTROL PANEL – SUBSEA INSTALLATION</td>
<td>58</td>
</tr>
<tr>
<td>10.20 GRAPHIC SYMBOL FOR 4 - WAY VALVES</td>
<td>60</td>
</tr>
<tr>
<td>10.21 Diverter systems</td>
<td>61</td>
</tr>
<tr>
<td>10.22 BOP CONNECTIONS</td>
<td>66</td>
</tr>
<tr>
<td>10.22.1 THE NOMINAL DIMENSION</td>
<td>66</td>
</tr>
<tr>
<td>10.22.2 API type of flange 6B and 6BX</td>
<td>67</td>
</tr>
<tr>
<td>10.23 POOR BOY MUD GAS SEPARATOR(MGS)</td>
<td>70</td>
</tr>
</tbody>
</table>

11. SUBSEA WELL CONTROL
<p>| 11.1 LOWER MARINE RISER PACKAGE (LMRP) | 6 |
| 11.2 HYDRIL GL | 8 |
| 11.3 SUBSEA HOOKUPS AND CONTROLS | 10 |
| 11.4 Control Pods and Control Lines | 12 |
| 11.5 HYDRAULIC FLUID MIXING SYSTEM | 12 |
| 11.5.1 SUBSURFACE BOP SYSTEM: | 12 |
| 11.5.2 Pipe ram | 13 |
| 11.5.3 SUBSEA ANNULAR PREVENTERS | 13 |
| 11.6 SUBSEA ACCUMULATORS | 14 |
| 11.7 THE RESPONSE TIME FOR CLOSING | 14 |</p>
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.8 FAILSAFE VALVES</td>
<td>15</td>
</tr>
<tr>
<td>11.9 BOP CONTROL SYSTEMS</td>
<td>16</td>
</tr>
<tr>
<td>11.10 HYDRAULIC CONTROL SYSTEM</td>
<td>16</td>
</tr>
<tr>
<td>11.10.1 Control Pods</td>
<td>16</td>
</tr>
<tr>
<td>11.10.2 Regulated Power Fluid</td>
<td>16</td>
</tr>
<tr>
<td>11.10.3 Power system and Pilot system</td>
<td>17</td>
</tr>
<tr>
<td>11.11 ELECTRO-HYDRAULIC CONTROL SYSTEMS</td>
<td>17</td>
</tr>
<tr>
<td>11.12 ACOUSTIC CONTROL SYSTEMS</td>
<td>17</td>
</tr>
<tr>
<td>11.13 GENERAL SUBSEA BOP STACK</td>
<td>18</td>
</tr>
<tr>
<td>11.14 DIVERTER SYSTEM</td>
<td>18</td>
</tr>
<tr>
<td>11.15 TELESCOPIC (SLIP) JOINT</td>
<td>18</td>
</tr>
<tr>
<td>11.16 BOOSTER LINE</td>
<td>19</td>
</tr>
<tr>
<td>11.17 FILL UP VALVE (DUMP VALVE)</td>
<td>19</td>
</tr>
<tr>
<td>11.18 RISER MARGIN</td>
<td>21</td>
</tr>
<tr>
<td>11.19 MANIPULATOR VALVE AND SELECTOR VALVES</td>
<td>24</td>
</tr>
<tr>
<td>11.20 SUBSEA STACK - CONTROL OPERATION</td>
<td>29</td>
</tr>
<tr>
<td>11.21 KILLING RISER AND TRAPPED GAS IN THE BOP STACK</td>
<td>34</td>
</tr>
</tbody>
</table>

Appendixes:

- SURFACE BOP VERTICAL WELL KILL SHEET (API UNITS)
- SUBSEA BOP VERTICAL WELL KILL SHEET (API UNITS)
- FORMULA SHEET (API UNITS)