Acronyms used in the following formulas are defined in the WellSharp Acronyms document, available on the secure Provider Resources webpage. For instructions on rounding numbers when making calculations, refer to the following rounding rules and recommendations. Carry the rounded values forward into subsequent calculations.

**ROUNDING RULES**

- When calculating Kill Mud Weight, **ROUND UP** to one decimal place (for example: round up 10.73 ppg to 10.8 ppg; round up 11.03 ppg to 11.1 ppg).
- When calculating Leak Off Test Equivalent Mud Weight, **ROUND DOWN** to one decimal place (for example: round down 11.76 ppg to 11.7 ppg; round down 13.89 ppg to 13.8 ppg).
- When calculating Pressure Reduction Schedule, **ROUND DOWN** to a whole number (for example: round down 21.6 psi/100 stks to 21 psi/100 stks).
- If the Kill Mud Weight or Leak Off values are to be used in subsequent calculations, use the rounded value in the future calculation. Do not use the unrounded calculated value.

**ROUNDING RECOMMENDATIONS**

See Table to right where:

- X = Whole number
- X.XXXX = Number with 4 decimal places

<table>
<thead>
<tr>
<th>MEASUREMENT</th>
<th>UNITS</th>
<th>ROUNDING and ANSWER FORMAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
<td>feet</td>
<td>X</td>
</tr>
<tr>
<td>Pressure</td>
<td>psi</td>
<td>X</td>
</tr>
<tr>
<td>Pressure Gradient</td>
<td>psi/foot</td>
<td>X.XXXX</td>
</tr>
<tr>
<td>Mud Weight</td>
<td>ppg</td>
<td>X.X</td>
</tr>
<tr>
<td>Volume</td>
<td>bbls</td>
<td>X.X</td>
</tr>
<tr>
<td>Capacity and Displacement</td>
<td>bbls/foot</td>
<td>X.XXXX</td>
</tr>
<tr>
<td>Pump Speed in strokes per minute</td>
<td>SPM</td>
<td>X</td>
</tr>
<tr>
<td>Strokes</td>
<td>stk or stks</td>
<td>X</td>
</tr>
<tr>
<td>Speed in feet per hour</td>
<td>feet/hour</td>
<td>X</td>
</tr>
<tr>
<td>Area</td>
<td>in²</td>
<td>X.XXXX</td>
</tr>
<tr>
<td>Force</td>
<td>lbs</td>
<td>X</td>
</tr>
<tr>
<td>Buoyancy Factor</td>
<td>Unitless</td>
<td>X.XXXX</td>
</tr>
<tr>
<td>Wait and Weight Pressure Reduction Schedule</td>
<td>psi/100 stks or psi/10 steps*</td>
<td>X</td>
</tr>
</tbody>
</table>

* 10 steps = Surface to Bit strokes divided by 10.
1. FORCE (lbs) \[= \text{Pressure}_{\text{psi}} \times \text{Diameter}^2 \times 0.7854\] (Diameter in inches)

2. PRESSURE (psi) \[= \frac{\text{Force}_{\text{lbs}}}{\text{Diameter}^2} \div 0.7854\]

3. RECTANGULAR TANK VOLUME (bbls) \[= (\text{Length}_\text{ft} \times \text{Width}_\text{ft} \times \text{Height}_\text{ft}) \div 5.615\]

4. RECTANGULAR TANK CAPACITY (bbls/ft) \[= \text{Length}_\text{ft} \times \text{Width}_\text{ft} \times 0.178\]

5. RECTANGULAR TANK CAPACITY (bbls/in) \[= \text{Length}_\text{ft} \times \text{Width}_\text{ft} \times 0.0148\]

6. VERTICAL CYINDRICAL TANK VOLUME (bbls) \[= \text{Capacity}_{\text{bbls/ft}} \times \text{Height}_\text{ft}\]

7. VERTICAL CYINDRICAL TANK CAPACITY (bbls/ft) \[= \text{Tank diameter}_\text{ft}^2 \div 7.148\]

8. TUBULAR CAPACITY (bbls/ft) \[= \text{ID}^2 \div 1029.4\] (ID = Internal Diameter of Tubular)

9. ANNULAR CAPACITY (bbls/ft) \[= (\text{D}^2 - \text{d}^2) \div 1029.4\] (D = Hole Diameter or Casing ID, d = Outside Diameter of Tubular)

10. HEIGHT OF FLUID IN A PIPE OR ANNULUS (ft) \[= \text{Kick Volume}_{\text{bbls}} \div \text{Annular Capacity}_{\text{bbls/ft}} \text{ or Pipe Capacity}_{\text{bbls/ft}}\]

11. HYDROSTATIC PRESSURE (psi) \[= \text{Mud Weight}_{\text{ppg}} \times 0.052 \times \text{TVD}_\text{ft}\]

12. HYDROSTATIC PRESSURE GRADIENT (psi/ft) \[= \text{Mud Weight}_{\text{ppg}} \times 0.052\]

13. FORMATION PRESSURE (psi) \[= \text{Hydrostatic Pressure in Drill String}_{\text{psi}} + \text{SIDPP}_{\text{psi}}\] (also referred to as Bottomhole Pressure at Shut In)

14. MUD WEIGHT (ppg) \[= \frac{\text{Pressure Gradient}_{\text{psi/ft}} \div 0.052}{\text{Pressure}_{\text{psi}} \div \text{TVD}_\text{ft} \div 0.052}\]
15. EQUIVALENT MUD WEIGHT (ppg) = Pressure_{psi} \div 0.052 \div TVD_{ft} or (Surface Pressure_{psi} \div TVD_{ft} \div 0.052) + Mud Weight_{ppg}

16. EQUIVALENT CIRCULATING DENSITY (ppg) = [Annular Pressure Loss_{psi} \div 0.052 \div TVD_{ft}] + Original Mud Weight_{ppg}

17. KILL MUD WEIGHT (ppg) = [SIDPP_{psi} \div 0.052 \div TVD_{ft}] + Original Mud Weight_{ppg}

18. INITIAL CIRCULATING PRESSURE (psi) = Slow Circulating Rate Pressure_{psi} + SIDPP_{psi}

19. FINAL CIRCULATING PRESSURE (psi) = Slow Circulating Rate Pressure_{psi} \times [Kill Mud Weight_{ppg} \div Original Mud Weight_{ppg}]

20. NEW PUMP PRESSURE WITH NEW SPM (psi) = Current Pressure_{psi} \times [New SPM \div Old SPM]^2 \hspace{1cm} \text{(only approximate!)}

21. NEW PUMP PRESSURE WITH NEW MUD WEIGHT (psi) = Current Pressure_{psi} \times [New Mud Weight \div Old Mud Weight] \hspace{1cm} \text{(only approximate!)}

22. MAXIMUM ALLOWABLE MUD WEIGHT (ppg) = [Surface Leak Off_{psi} \div 0.052 \div Shoe TVD_{ft}] + Test Mud Weight_{ppg}

23. MAASP or MACP (psi) = [Maximum Allowable Mud Weight_{ppg} - Current Mud Weight_{ppg}] \times 0.052 \times Shoe TVD_{ft}

24. NEW MAASP AFTER KILL (psi) = [Maximum Allowable Mud Weight_{ppg} - Kill Mud Weight_{ppg}] \times 0.052 \times Shoe TVD_{ft}

25. ADDITIONAL MUD RETURNED BY SLUG (bbls) = [(Slug Weight_{ppg} \div Mud Weight_{ppg}) - 1] \times Slug Volume_{bbls}

26. TOTAL MUD RETURNED BY SLUG (bbls) = (Slug Weight_{ppg} \div Mud Weight_{ppg}) \times Slug Volume_{bbls}

27. LEVEL DROP AFTER PUMPING A SLUG (ft) = [(Slug Weight_{ppg} \div Mud Weight_{ppg}) - 1] \times Slug Volume_{bbls} \div Drill Pipe Capacity_{bbls/ft}

28. RISER MARGIN (ppg) = [(Riser Mud Hydrostatic_{psi} - Seawater Hydrostatic_{psi}) \div 0.052] \div (Well TVD_{ft} - Water Depth_{ft} - Air Gap_{ft})
29. CASING (or CHoke) PRESSURE AFTER SUBSEA START-UP \((psi)\) = Shut In Casing Pressure \(_{psi} - \) Choke Line Friction Loss \(_{psi} \)

30. BOYLES LAW FORMULAE 
\[P_1 \times V_1 = P_2 \times V_2\] 
\[P_2 = \frac{P_1 \times V_1}{V_2}\] 
\[V_2 = \frac{P_1 \times V_1}{P_2}\] 

Atmospheric Pressure = 14.7 psi

\[P = \text{Pressure}; V = \text{Volume}\]

31. GAS MIGRATION RATE \((ft/hr)\) = Shut-In Pressure Increase \(_{psi/hr} \div\) Mud Gradient \(_{psi/ft}\) (can use SIDPP or SICP) 

(Increase over last hour)

32. VOLUME TO BLEED DUE TO GAS MIGRATION \((bbls)\) = (Working Pressure to Bleed \(_{psi} \div\) Mud Gradient \(_{psi/ft}\) \(\times\) Annular Capacity \(_{bbls/ft}\) (For Volumetric Method)

33. LENGTH OF WET PIPE PULLED BEFORE FILL-UP FOR DESIRED PRESSURE DROP \(\Delta P\) \((Length ft)\) 
\[= (\Delta P_{psi} \times \text{Annulus Cap}_{bbl/ft}) \div [0.052 \times MW_{ppg} \times (DP \text{ Cap}_{bbl/ft} + DP \text{ Displ}_{bbl/ft})]\]

34. LENGTH OF DRY PIPE PULLED BEFORE FILL-UP FOR DESIRED PRESSURE DROP \(\Delta P\) \((Length ft)\) 
\[= [\Delta P_{psi} \times (\text{Annulus Cap}_{bbl/ft} + DP \text{ Cap}_{bbl/ft})] \div 0.052 \times MW_{ppg} \times DP \text{ Displ}_{bbl/ft}\]

35. HYDROSTATIC PRESSURE DROP PER FOOT \(\Delta P_{psi/ft}\) WHEN PULLING WET PIPE 
\[= 0.052 \times MW_{ppg} \times [(DP \text{ Cap}_{bbl/ft} + DP \text{ Displ}_{bbl/ft}) \div \text{Annulus Cap}_{bbl/ft}]\]

36. USABLE FLUID VOLUME PER BOTTLE 
\[= (\text{Precharge Pressure} \div \text{Minimum Operating Press}) - (\text{Precharge Pressure} \div \text{Maximum Operating pressure}) \times \text{Bottle Volume}\]

37. CONVERSION OF API GRAVITY \((^\circ\text{API})\) TO SPECIFIC GRAVITY \((\text{SG})\) 
\[= 141.5 \div (^\circ\text{API} + 131.5)\]

38. CONVERSION OF SPECIFIC GRAVITY \((\text{SG})\) TO PPG 
\[= 8.33 \times \text{SG}\]
 WELL COMPLETION/WORKOVER FORMULA SHEET—FIELD UNITS

1. KILL FLUID WEIGHT (ppg) = [SITP\(_{\text{psi}}\) \(\div\) 0.052 \(\div\) Top Perfs TVD\(_{\text{ft}}\)] + Original Fluid Weight\(_{\text{ppg}}\)

2. KILL FLUID WEIGHT (ppg) = BHP\(_{\text{psi}}\) \(\div\) 0.052 \(\div\) TVD\(_{\text{ft}}\)

3. BUOYANCY FACTOR (BF) = (65.4 – Fluid weight\(_{\text{ppg}}\)) \(\div\) 65.4

4. PIPE WEIGHT BUOYED–OPEN ENDED PIPE (lbs/ft) = Weight\(_{\text{air, (lbs - ft)}}\) \(\times\) Buoyancy Factor

5. BUOYED WEIGHT OF TUBULARS (CLOSED ENDED & NO FLUID IN PIPE) (lbs/ft) = Weight\(_{\text{air, (lbs - ft)}}\) – [(Pipe OD\(_{\text{in}}^2\) \(\times\) Fluid weight\(_{\text{ppg}}\)) \(\div\) 24.5]

6. BUOYED WEIGHT OF TUBULARS (DIFFERENT FLUID IN PIPE AND ANNULUS) (lbs/ft) = Weight\(_{\text{air, (lbs - ft)}}\) + [(Pipe ID\(_{\text{in}}^2\) \(\times\) Fluid weight\(_{\text{ppg}}\)) \(\div\) 24.5] - [(Pipe OD\(_{\text{in}}^2\) \(\times\) Fluid weight\(_{\text{Annulus}}\)) \(\div\) 24.5]

**BULLHEADING FORMULAE**

7. FORMATION FRACTURE PRESSURE (psi) = Formation Fracture Gradient\(_{\text{psi/ft}}\) \(\times\) Top Perforations TVD\(_{\text{ft}}\)

8. INITIAL HYDROSTATIC PRESSURE (psi) = Formation Pressure\(_{\text{psi}}\) – SITP\(_{\text{psi}}\)

9. INITIAL AVERAGE FLUID DENSITY (ppg) = Initial Hydrostatic Pressure\(_{\text{psi}}\) \(\div\) Top Perforations TVD\(_{\text{ft}}\) \(\div\) 0.052

10. MAX INITIAL SURFACE PRESSURE (psi) = Formation Fracture Pressure\(_{\text{psi}}\) – (Kill Fluid Weight\(_{\text{ppg}}\) \(\times\) 0.052 \(\times\) Top Perforations TVD\(_{\text{ft}}\))

11. MAX FINAL SURFACE PRESSURE (psi) = Formation Fracture Pressure\(_{\text{psi}}\) – (Kill Fluid Weight\(_{\text{ppg}}\) \(\times\) 0.052 \(\times\) Top Perforations TVD\(_{\text{ft}}\))

12. VOLUME TO BULLHEAD (bbls) = Surface Lines\(_{\text{bbls}}\) + Surface to EOT\(_{\text{bbls}}\) + EOT to Top Perfs\(_{\text{bbls}}\) + Top Perfs to Bottom Perfs\(_{\text{bbls}}\)

   \(\{\text{EOT} = \text{End of Tubing} \quad \text{Perfs = Perforations}\}\)

13. BULLHEAD SPM TO EXCEED GAS MIGRATION = (Gas Migration Rate\(_{\text{ft/hr}}\) \(\div\) 60) \(\times\) Tubing Capacity\(_{\text{bbls/ft}}\) \(\div\) Pump Output\(_{\text{bbls/stroke}}\)

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TEMPERATURE CORRECTION FORMULA FOR BRINES

14. FLUID DENSITY TO MIX (ppg)

\[ \text{Fluid Density at Avg Temp}_{\text{ppg}} = \text{Fluid Density at Avg Temp}_{\text{ppg}} + ((\text{Avg Temp}_F - \text{Surface Temp}_F) \times \text{Weight Loss}_{\text{ppg}/^\circ F}) \]

\{ Avg = Average F = degrees Fahrenheit \}

Example Weight Loss Chart
(Note: Values will vary based on type of fluid and other factors.)

<table>
<thead>
<tr>
<th>Brine weight (ppg)</th>
<th>Weight loss (ppg/°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.4 – 9.0</td>
<td>0.0017</td>
</tr>
<tr>
<td>9.1 – 11.0</td>
<td>0.0025</td>
</tr>
<tr>
<td>11.1 – 14.5</td>
<td>0.0033</td>
</tr>
<tr>
<td>14.6 – 17.0</td>
<td>0.0040</td>
</tr>
<tr>
<td>17.1 – 19.2</td>
<td>0.0048</td>
</tr>
</tbody>
</table>