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 two decimal places (for example: round up 1.212 kg/m³ to 1.22 kg/m³; round up 1.463 kg/m³ to 1.47 kg/m³).
- When calculating Leak Off Test Equivalent Mud Weight, **ROUND DOWN** to two decimal places (for example: round down 1.408 kg/m³ to 1.40 kg/m³; round down 1.614 kg/m³ to 1.61 kg/m³).
- When calculating Pressure Reduction Schedule, **ROUND DOWN** to a whole number (for example: round down 1.33 kPa/100 stks to 1.3 kPa/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>Meters</td>
<td>X, X</td>
</tr>
<tr>
<td>Pressure</td>
<td>kPa</td>
<td>X</td>
</tr>
<tr>
<td>Pressure Gradient</td>
<td>kPa/meter</td>
<td>XX</td>
</tr>
<tr>
<td>Mud Weight</td>
<td>kg/m³</td>
<td>X.XX</td>
</tr>
<tr>
<td>Volume</td>
<td>m³</td>
<td>X.XX</td>
</tr>
<tr>
<td>Capacity and Displacement</td>
<td>m³/meter</td>
<td>X.XXX</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 meters per hour</td>
<td>meters/hour</td>
<td>X.X</td>
</tr>
<tr>
<td>Area</td>
<td>cm²</td>
<td>X.XX</td>
</tr>
<tr>
<td>Weight</td>
<td>kg</td>
<td>X</td>
</tr>
<tr>
<td>Force</td>
<td>decaNewtons (daN)</td>
<td>X</td>
</tr>
<tr>
<td>Wait and Weight Pressure Reduction Schedule</td>
<td>kPa/100 stks or kPa/10 steps*</td>
<td>X.XX</td>
</tr>
</tbody>
</table>

* 10 steps = Surface to Bit strokes divided by 10.
1. FORCE IN DECANEWTONS (daN) = Pressure kPa x Area cm² ÷ 100
2. PRESSURE (kPa) = Force daN ÷ Area cm² x 100
3. TUBULAR CAPACITY (m³/meter) = \( \frac{ID_{mm}^2}{1273236} \) \( (ID = Internal Diameter of Tubular in millimeters) \)
4. ANNULAR CAPACITY (m³/meter) = \( \frac{(D_{mm}^2 - d_{mm}^2)}{1273236} \) \( (D = Hole Diameter or Casing ID \ d = Outside Diameter of Tubular) \)
5. HEIGHT OF FLUID IN A PIPE OR ANNULUS (meters) = Kick Volume m³ ÷ Annular Capacity m³/meter or Pipe Capacity m³/meter
6. HYDROSTATIC PRESSURE (kPa) = Mud Weight kg/m³ x 0.00981 x TVD meters
7. HYDROSTATIC PRESSURE GRADIENT (kPa/meter) = Mud Weight kg/m³ x 0.00981
8. FORMATION PRESSURE (kPa) = Hydrostatic Pressure in Drill String kPa + SIDPP kPa
9. MUD WEIGHT (kg/m³) = Pressure Gradient kPa/meter ÷ 0.00981 or Pressure kPa ÷ TVD meters ÷ 0.00981
10. EQUIVALENT MUD WEIGHT (kg/m³) = Pressure kPa ÷ 0.00981 ÷ TVD meters
   or (Surface Pressure kPa ÷ TVD meters ÷ 0.00981) + Mud Weight kg/m³
11. EQUIVALENT CIRCULATING DENSITY (kg/m³) = (Annular Pressure Loss kPa ÷ 0.00981 ÷ TVD meters) + Original Mud Weight kg/m³
12. KILL WEIGHT MUD (kg/m³) = (SIDPP kPa ÷ 0.00981 ÷ TVD meters) + Original Mud Weight kg/m³
13. INITIAL CIRCULATING PRESSURE (kPa) = Slow Circulating Rate Pressure kPa + SIDPP kPa
14. FINAL CIRCULATING PRESSURE (kPa) = Slow Circulating Rate Pressure kPa x (Kill Mud Weight kg/m³ ÷ Original Mud Weight kg/m³)
15. NEW PUMP PRESSURE WITH NEW SPM (kPa) = Current Pressure kPa x (New SPM ÷ Old SPM)² \( (only \ approximate!) \)
16. NEW PUMP PRESSURE WITH NEW MUD WEIGHT \( (kPa) \) = Current Pressure \( kPa \) x (New Mud Weight ÷ Old Mud Weight) \( \) (only approximate!)

17. MAXIMUM ALLOWABLE MUD WEIGHT \( (kg/m^3) \) = (Surface Leak Off \( kPa \) ÷ 0.00981 ÷ Shoe TVD meters) + Test Mud Weight \( kg/m^3 \)

18. MAASP or MACP \( (kPa) \) = (Maximum Allowable Mud Weight \( kg/m^3 \) - Current Mud Weight \( kg/m^3 \)) x 0.00981 x Shoe TVD meters

19. NEW MAASP AFTER KILL \( (kPa) \) = (Maximum Allowable Mud Weight \( kg/m^3 \) - Kill Mud Weight \( kg/m^3 \)) x 0.00981 x Shoe TVD meters

20. ADDITIONAL MUD RETURNED BY SLUG \( (m^3) \) = [(Slug Weight \( kg/m^3 \) ÷ Mud Weight \( kg/m^3 \)) – 1] x Slug Volume \( m^3 \)

21. TOTAL MUD RETURNED BY SLUG \( (m^3) \) = (Slug Weight \( kg/m^3 \) ÷ Mud Weight \( kg/m^3 \)) x Slug Volume \( m^3 \)

22. LEVEL DROP AFTER PUMPING A SLUG \( (m^3) \) = [(Slug Weight \( kg/m^3 \) ÷ Mud Weight \( kg/m^3 \)) – 1] x Slug Volume \( m^3 \) ÷ Drill Pipe Capacity \( m^3/meter \)

23. RISER MARGIN \( (kg/m^3) \) = [(Riser Mud Hydrostatic \( kPa \) – Seawater Hydrostatic \( kPa \)) ÷ 0.00981] ÷ (Well TVD \( m \) - Water Depth \( m \) – Air Gap \( m \))

24. CASING PRESSURE AFTER SUBSEA START-UP \( (kPa) \) = Shut-In Casing Pressure \( kPa \) – Choke Line Friction Loss \( kPa \)

25. BOYLES LAW FORMULAE
\[ P_1 \times V_1 = P_2 \times V_2 \]
\[ P_2 = \frac{P_1 \times V_1}{V_2} \]
\[ V_2 = \frac{P_1 \times V_1}{P_2} \]
\[ \text{Atmospheric Pressure} = 101.3 \ kPa \]

26. GAS MIGRATION RATE \( (\text{meters/hour}) \) = Shut-In Pressure Increase \( kPa/hour \) ÷ Mud Gradient \( kPa/meter \) \( \) (can use SIDPP or SICP)

\[ \text{(Increase over last hour)} \]

27. VOLUME TO BLEED DUE TO GAS MIGRATION \( (m^3) \) = (Working Pressure to Bleed \( kPa \) ÷ Mud Gradient \( kPa/meter \)) x Annular Capacity \( m^3/meter \)

\( \) (For Volumetric Method)
WELL COMPLETION/WORKOVER FORMULA SHEET—FIELD UNITS

1. KILL FLUID WEIGHT \((kg/m^3)\)
   \[ \text{ Kill Fluid Weight } = (\text{SITP kPa} \div \text{Top Perforations TVD meters} \div 0.00981) + \text{Original Fluid Weight } \]

2. KILL FLUID WEIGHT \((kg/m^3)\)
   \[ \text{ Kill Fluid Weight } = \text{BHP kPa} \div \text{TVD meters} \div 0.00981 \]

BULLHEAD FORMULAE

3. FORMATION FRACTURE PRESSURE \((kPa)\)
   \[ \text{ Formation Fracture Pressure } = \text{Formation Fracture Gradient } \div \text{Top Perforations TVD meters} \]

4. INITIAL HYDROSTATIC PRESSURE \((kPa)\)
   \[ \text{ Initial Hydrostatic Pressure } = \text{Formation Pressure kPa} - \text{SITP kPa} \]

5. INITIAL AVERAGE FLUID DENSITY \((kg/l)\)
   \[ \text{ Initial Average Fluid Density } = \text{Initial Hydrostatic Pressure kPa} \div \text{Top Perforations TVD meters} \div 0.00981 \]

6. MAX INITIAL SURFACE PRESSURE \((kPa)\)
   \[ \text{ Max Initial Surface Pressure } = \text{Formation Fracture Pressure kPa} - \text{Initial Hydrostatic Pressure kPa} \]

7. MAX FINAL SURFACE PRESSURE \((kPa)\)
   \[ \text{ Max Final Surface Pressure } = \text{Formation Fracture Pressure kPa} - \text{(Kill Fluid Weight } \times \text{Top Perforations TVD meters}) \]

8. VOLUME TO BULLHEAD \((m^3)\)
   \[ \text{ Volume to Bullhead } = \text{Surface Lines } m^3 + \text{Surface to EOT } m^3 + \text{EOT to Top Perfs } m^3 + \text{Top Perfs to Bottom Perfs } m^3 \]
   \[ \text{ (EOT = End of Tubing \quad Perfs = Perforations)} \]

9. BULLHEAD SPM TO EXCEED GAS MIGRATION
   \[ \text{ Bullhead SPM to Exceed Gas Migration } = \text{Gas Migration Rate } m^3/hour \div 60 \times \text{Tubing Capacity } m^3/meter \div \text{Pump Output } m^3/stroke \]

TEMPERATURE CORRECTION FORMULA FOR BRINES

10. FLUID DENSITY TO MIX \((kg/m^3)\)
    \[ \text{ Fluid Density to Mix } = \text{Fluid Density at Avg. Temp } \frac{\text{[(Avg. Temp } C - \text{Surface Temp } C) \times \text{Weight Loss } kg/m^3/degree C]}{\text{AVG = Average \quad C = degrees Centigrade}} \]

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

<table>
<thead>
<tr>
<th>Brine weight (kg/m^3)</th>
<th>Weight loss (kg/m^3/°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000.0 – 1080.0</td>
<td>0.37</td>
</tr>
<tr>
<td>1090.0 – 1320.0</td>
<td>0.54</td>
</tr>
<tr>
<td>1330.0 – 1740.0</td>
<td>0.71</td>
</tr>
<tr>
<td>1750.0 – 2040.0</td>
<td>0.86</td>
</tr>
<tr>
<td>2050.0 – 2300.0</td>
<td>1.04</td>
</tr>
</tbody>
</table>