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/l to 1.22 kg/l; round up 1.463 kg/l to 1.47 kg/l).
- When calculating Leak Off Test Equivalent Mud Weight, **ROUND DOWN** to two decimal places (for example, round down 1.408 kg/l to 1.40 kg/l; round down 1.614 kg/l to 1.61 kg/l).
- When calculating Pressure Reduction Schedule, **ROUND DOWN** to two decimal places (for example, round down 1.334 bar/100 stks to 1.33 bar/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.XXX = 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>bar</td>
<td>X.X</td>
</tr>
<tr>
<td>Pressure Gradient</td>
<td>bars/meter</td>
<td>X.XXX</td>
</tr>
<tr>
<td>Mud Weight</td>
<td>kg/liter</td>
<td>X.XX</td>
</tr>
<tr>
<td>Volume</td>
<td>liters</td>
<td>X</td>
</tr>
<tr>
<td>Capacity and Displacement</td>
<td>litres/meter</td>
<td>X.XX</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>bar/100 stks or bar/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 bar x Area cm²

2. PRESSURE (bar) = Force daN ÷ Area cm²

3. TUBULAR CAPACITY (litres/meter) = ID² mm ÷ 1273.236 (ID = Internal Diameter of Tubular in millimeters)

4. ANNULAR CAPACITY (litres/meter) = (D² mm - d² mm) ÷ 1273.236 (D = Hole Diameter or Casing ID, d = Outside Diameter of Tubular)

5. HEIGHT OF FLUID IN A PIPE OR ANNULUS (meters) = Kick Volume liters ÷ Annular Capacity liters/meter or Pipe Capacity liters/meter

6. HYDROSTATIC PRESSURE (bars) = Mud Weight kg/l x 0.0981 x TVD meters

7. HYDROSTATIC PRESSURE GRADIENT (bar/meter) = Mud Weight kg/l x 0.0981

8. FORMATION PRESSURE (bar) = Hydrostatic Pressure in Drill String bar + SIDPP bar

9. MUD WEIGHT (kg/l) = Pressure Gradient bar/meter ÷ 0.0981 or Pressure bar ÷ TVD meters ÷ 0.0981

10. EQUIVALENT MUD WEIGHT (kg/l) = Pressure bar ÷ 0.0981 ÷ TVD meters

   or (Surface Pressure bar ÷ TVD meters ÷ 0.0981) + Mud Weight kg/l

11. EQUIVALENT CIRCULATING DENSITY (kg/l) = (Annular Pressure Loss bar ÷ 0.0981 ÷ TVD meters) + Original Mud Weight kg/l

12. KILL MUD WEIGHT (kg/l) = (SIDPP bar ÷ 0.0981 ÷ TVD meters) + Original Mud Weight kg/l

13. INITIAL CIRCULATING PRESSURE (bar) = Slow Circulating Rate Pressure bar + SIDPP bar

14. FINAL CIRCULATING PRESSURE (bar) = Slow Circulating Rate Pressure bar x (Kill Mud Weight kg/l ÷ Original Mud Weight kg/l)

15. NEW PUMP PRESSURE WITH NEW SPM (bar) = Current Pressure bar x (New SPM ÷ Old SPM)² (only approximate!)
16. NEW PUMP PRESSURE WITH NEW MUD WEIGHT \((\text{bar})\) = Current Pressure \(\text{bar}\) \(\times\) (New Mud Weight \(\div\) Old Mud Weight) \(\text{(only approximate!)}\)

17. MAXIMUM ALLOWABLE MUD WEIGHT \((\text{kg/l})\)
   \((\text{Fracture Mud Weight})\)
   = (Surface Leak Off \(\text{bar} \div 0.0981 \div \text{Shoe TVD}_\text{metres}\)) + Test Mud Weight \(\text{kg/l}\)

18. MAASP or MACP \((\text{bar})\)
    = (Maximum Allowable Mud Weight \(\text{kg/l}\) - Current Mud Weight \(\text{kg/l}\)) \(\times\) 0.0981 \(\times\) Shoe TVD \(\text{metres}\)

19. NEW MAASP AFTER KILL \((\text{bar})\)
    = (Maximum Allowable Mud Weight \(\text{kg/l}\) - Kill Mud Weight \(\text{kg/l}\)) \(\times\) 0.0981 \(\times\) Shoe TVD \(\text{metres}\)

20. ADDITIONAL MUD RETURNED BY SLUG \((\text{litres})\)
    = [(Slug Weight \(\text{kg/l} \div\) Mud Weight \(\text{kg/l}\)) \(-\) 1] \(\times\) Slug Volume \(\text{litres}\)

21. TOTAL MUD RETURNED BY SLUG \((\text{litres})\)
    = (Slug Weight \(\text{kg/l} \div\) Mud Weight \(\text{kg/l}\)) \(\times\) Slug Volume \(\text{litres}\)

22. LEVEL DROP AFTER PUMPING A SLUG \((\text{meters})\)
    = [(Slug Weight \(\text{kg/l} \div\) Mud Weight \(\text{kg/l}\)) \(-\) 1] \(\times\) Slug Volume \(\text{litres}\) \(\div\) Drill Pipe Capacity \(\text{litres/meter}\)

23. RISER MARGIN \((\text{kg/l})\)
    = [(Riser Mud Hydrostatic \(\text{bar}\) - Seawater Hydrostatic \(\text{bar}\)) \(\div\) 0.0981] \(\div\) (Well TVD \(\text{m}\) - Water Depth \(\text{m}\) - Air Gap \(\text{m}\))

24. CASING PRESSURE AFTER SUBSEA START-UP \((\text{bar})\)
    = Shut-In Casing Pressure \(\text{bar}\) \(-\) Choke Line Friction Loss \(\text{bar}\)

25. BOYLES LAW FORMULAE
    \(P_1 \times V_1 = P_2 \times V_2\)
    \(P_2 = P_1 \times V_1 \div V_2\)
    \(V_2 = P_2 \div V_1\)
    \(\text{Atmospheric Pressure} = 1 \text{ bar}\)

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

27. VOLUME TO BLEED DUE TO GAS MIGRATION \((\text{litres})\)
    = (Working Pressure to Bleed \(\text{bar} \div\) Mud Gradient \(\text{bar/meter}\)) \(\times\) Annular Capacity \(\text{litres/meter}\)
    \(\text{(For Volumetric Method)}\)
WELL COMPLETION/WORKOVER FORMULA SHEET—FIELD UNITS

1. KILL FLUID WEIGHT (kg/l) = (SITP bars ÷ Top Perforations TVD meters ÷ 0.0981) + Original Fluid kg/l

2. KILL FLUID WEIGHT (kg/l) = BHP bars ÷ TVD meters ÷ 0.0981

BULLHEADING FORMULAE

3. FORMATION FRACTURE PRESSURE (bars) = Formation Fracture Gradient bars/meter × Top Perforations TVD meters

4. INITIAL HYDROSTATIC PRESSURE (bars) = Formation Pressure bars - SITP bars

5. INITIAL AVERAGE FLUID DENSITY (kg/l) = Initial Hydrostatic Pressure bars ÷ Top Perforations TVD meters ÷ 0.0981

6. MAX INITIAL SURFACE PRESSURE (bars) = Formation Fracture Pressure bars - Initial Hydrostatic Pressure bars

7. MAX FINAL SURFACE PRESSURE (bars) = Formation Fracture Pressure bars - (Kill Fluid Weight kg/l × 0.0981 × Top Perforations TVD meters)

8. VOLUME TO BULLHEAD (liters) = Surface Lines liters + Surface to EOT liters + EOT to Top Perfs liters + Top Perfs to Bottom Perfs liters

9. BULLHEAD SPM TO EXCEED GAS MIGRATION = Gas Migration Rate meters/hour ÷ 60 × Tubing Capacity liters/meter ÷ Pump output liters/stroke

TEMPERATURE CORRECTION FORMULA FOR BRINES

10. FLUID DENSITY TO MIX (kg/l) = Fluid Density at Avg. Temp kg/l × [(Avg. Temp °C - Surface Temp °C) × Weight Loss kg/l/°C]

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

<table>
<thead>
<tr>
<th>Brine weight (kg/l)</th>
<th>Weight loss (kg/l/°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 – 1.08</td>
<td>0.00037</td>
</tr>
<tr>
<td>1.09 – 1.32</td>
<td>0.00054</td>
</tr>
<tr>
<td>1.33 – 1.74</td>
<td>0.00071</td>
</tr>
<tr>
<td>1.75 – 2.04</td>
<td>0.00086</td>
</tr>
<tr>
<td>2.05 – 2.3</td>
<td>0.00104</td>
</tr>
</tbody>
</table>