



FORMULA SHEET—METRIC UNITS
WELL CONTROL FOR DRILLING OPERATIONS

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.XXXX = Number with 4 decimal places

MEASUREMENT	UNITS	ROUNDING and ANSWER FORMAT
Depth	meters	X.X
Pressure	bar	X.X
Pressure Gradient	bars/meter	X.XXX
Mud Weight	kg/liter	X.XX
Volume	liters	X
Capacity and Displacement	litres/meter	X.XX
Pump Speed in strokes per minute	SPM	X
Strokes	stk or stks	X
Speed in meters per hour	meters/hour	X.X
Area	cm ²	X.XX
Weight	kg	X
Force	decaNewtons (daN)	X
Wait and Weight Pressure Reduction Schedule	bar/100 stks or bar/10 steps*	X.XX

* 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*) = $ID_{mm}^2 \div 1273.236$ (*ID = Internal Diameter of Tubular in millimeters*)
4. ANNULAR CAPACITY (*litres/meter*) = $(D_{mm}^2 - d_{mm}^2) \div 1273.236$ (*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 (*bar*) = Current Pressure _{bar} x (New Mud Weight ÷ Old Mud Weight) **(only approximate!)**
17. MAXIMUM ALLOWABLE MUD WEIGHT (*kg/l*)
(*Fracture Mud Weight*) = (Surface Leak Off _{bar} ÷ 0.0981 ÷ Shoe TVD _{meters}) + Test Mud Weight _{kg/l}
18. MAASP or MACP (*bar*) = (Maximum Allowable Mud Weight _{kg/l} - Current Mud Weight _{kg/l}) x 0.0981 x Shoe TVD _{meters}
19. NEW MAASP AFTER KILL (*bar*) = (Maximum Allowable Mud Weight _{kg/l} - Kill Mud Weight _{kg/l}) x 0.0981 x Shoe TVD _{meters}
20. ADDITIONAL MUD RETURNED BY SLUG (*litres*) = [(Slug Weight _{kg/l} ÷ Mud Weight _{kg/l}) - 1] x Slug Volume _{litres}
21. TOTAL MUD RETURNED BY SLUG (*litres*) = (Slug Weight _{kg/l} ÷ Mud Weight _{kg/l}) x Slug Volume _{litres}
22. LEVEL DROP AFTER PUMPING A SLUG (*meters*) = [(Slug Weight _{kg/l} ÷ Mud Weight _{kg/l}) - 1] x Slug Volume _{litres} ÷ Drill Pipe Capacity _{litres/meter}
23. RISER MARGIN (*kg/l*) = [(Riser Mud Hydrostatic _{bar} - Seawater Hydrostatic _{bar}) ÷ 0.0981] ÷ (Well TVD _m - Water Depth _m - Air Gap _m)
24. CASING PRESSURE AFTER SUBSEA START-UP (*bar*) = Shut-In Casing Pressure _{bar} - Choke Line Friction Loss _{bar}
25. BOYLES LAW FORMULAES
P = Pressure: V = Volume $P_1 \times V_1 = P_2 \times V_2$ $P_2 = \frac{P_1 \times V_1}{V_2}$ $V_2 = \frac{P_1 \times V_1}{P_2}$ *Atmospheric Pressure = 1 bar*
26. GAS MIGRATION RATE (*meters/hour*) = Shut-In Pressure Increase _{bar/hour} ÷ Mud Gradient _{bar/meter} *(can use SIDPP or SICP)*
(Increase over last hour)
27. VOLUME TO BLEED DUE TO GAS MIGRATION (*litres*)
(*For Volumetric Method*) = (Working Pressure to Bleed _{bar} ÷ Mud Gradient _{bar/meter}) x Annular Capacity _{litres/meter}

WELL COMPLETION/WORKOVER FORMULA SHEET—FIELD UNITS

1. KILL FLUID WEIGHT (kg/l) = $(SITP_{bars} \div Top\ Perforations\ TVD_{meters} \div 0.0981) + Original\ Fluid_{kg/l}$
2. KILL FLUID WEIGHT (kg/l) = $BHP_{bars} \div TVD_{meters} \div 0.0981$

BULLHEADING FORMULAE

3. FORMATION FRACTURE PRESSURE (bars) = Formation Fracture Gradient $_{bars/meter} \times Top\ Perforations\ TVD_{meters}$
4. INITIAL HYDROSTATIC PRESSURE (bars) = Formation Pressure $_{bars} - SITP_{bars}$
5. INITIAL AVERAGE FLUID DENSITY (kg/l) = Initial Hydrostatic Pressure $_{bars} \div Top\ Perforations\ TVD_{meters} \div 0.0981$
6. MAX INITIAL SURFACE PRESSURE (bars) = Formation Fracture Pressure $_{bars} - Initial\ Hydrostatic\ Pressure_{bars}$
7. MAX FINAL SURFACE PRESSURE (bars) = Formation Fracture Pressure $_{bars} - (Kill\ Fluid\ Weight_{kg/l} \times 0.0981 \times Top\ Perforations\ TVD_{meters})$
8. VOLUME TO BULLHEAD (liters) = Surface Lines $_{liters} + Surface\ to\ EOT_{liters} + EOT\ to\ Top\ Perfs_{liters} + Top\ Perfs\ to\ Bottom\ Perfs_{liters}$
{EOT = End of Tubing Perfs = Perforations}
9. BULLHEAD SPM TO EXCEED GAS MIGRATION = Gas Migration Rate $_{meters/hour} \div 60 \times Tubing\ Capacity_{liters/meter} \div Pump\ output_{liters/stroke}$

TEMPERATURE CORRECTION FORMULA FOR BRINES

10. FLUID DENSITY TO MIX (kg/l) = Fluid Density at Avg. Temp $_{kg/l} + [(Avg.\ Temp_{C} - Surface\ Temp_{C}) \times Weight\ Loss_{kg/l/degree\ C}]$
{AVG = Average C = degrees Centigrade}

Example Weight Loss Chart

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

Brine weight (kg/l)	Weight loss (kg/l/°C)
1.0 – 1.08	0.00037
1.09 – 1.32	0.00054
1.33 – 1.74	0.00071
1.75 – 2.04	0.00086
2.05 – 2.3	0.00104

