FORMULA SHEET—FIELD UNITS

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

MEASUREMENT	UNITS	ROUNDING and ANSWER FORMAT
Depth	feet	X
Pressure	psi	X
Pressure Gradient	psi/foot	X.XXXX
Mud Weight	ppg	X.X
Volume	bbls	X.X
Capacity and Displacement	bbls/foot	X.XXXX
Pump Speed in strokes per minute	SPM	X
Strokes	stk or stks	X
Speed in feet per hour	feet/hour	X
Area	in^2	X.XXXX
Force	lbs	X
Buoyancy Factor	Unitless	X.XXXX
Wait and Weight Pressure Reduction Schedule	psi/100 stks or psi/10 steps*	X

* 10 steps = Surface to Bit strokes divided by 10.

1. FORCE *(lbs)* = $Pressure_{psi} \times Diameter^2 \times 0.7854$ (*Diameter in inches)*

2. PRESSURE *(psi)* = $Force_{lbs} \div Diameter^2 \div 0.7854$

3. RECTANGULAR TANK VOLUME *(bbls)* = $(Length_{ft} \times Width_{ft} \times Height_{ft}) \div 5.615$

4. RECTANGULAR TANK CAPACITY *(bbls/ft)* = $Length_{ft} \times Width_{ft} \times 0.178$

5. RECTANGULAR TANK CAPACITY *(bbls/in)* = $Length_{ft} \times Width_{ft} \times 0.0148$

6. VERTICAL CYINDRICAL TANK VOLUME *(bbls)* = $Capacity_{bbls/ft} \times Height_{ft}$

7. VERTICAL CYINDRICAL TANK CAPACITY*(bbls/ft)* = Tank $diameter_{ft}^2 \div 7.148$

8. TUBULAR CAPACITY *(bbls/ft)* = $ID^2 \div 1029.4$ *(ID = Internal Diameter of Tubular)*

9. ANNULAR CAPACITY *(bbls/ft)* = $(D^2 - d^2) \div 1029.4$ *(D = Hole Diameter or Casing ID, d = Outside Diameter of Tubular)*

10. HEIGHT OF FLUID IN A PIPE OR ANNULUS *(ft)* = $Kick\ Volume_{bbls} \div Annular\ Capacity_{bbls/ft}$ or $Pipe\ Capacity_{bbls/ft}$

11. HYDROSTATIC PRESSURE *(psi)* = $Mud\ Weight_{ppg} \times 0.052 \times TVD_{ft}$

12. HYDROSTATIC PRESSURE GRADIENT *(psi/ft)* = $Mud\ Weight_{ppg} \times 0.052$

13. FORMATION PRESSURE *(psi)* = $Hydrostatic\ Pressure\ in\ Drill\ String_{psi} + SIDPP_{psi}$
(also referred to as Bottomhole Pressure at Shut In)

14. MUD WEIGHT *(ppg)* = $Pressure\ Gradient_{psi/ft} \div 0.052$ or $Pressure_{psi} \div TVD_{ft} \div 0.052$

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 $Pressure_{psi}$ x [Kill $Mud\ Weight_{ppg} \div$ Original $Mud\ Weight_{ppg}$]

20. NEW PUMP PRESSURE WITH NEW SPM *(psi)* = Current $Pressure_{psi}$ x $[New\ SPM \div Old\ SPM]^2$ ***(only approximate!)***

21. NEW PUMP PRESSURE WITH NEW MUD WEIGHT *(psi)* = Current $Pressure_{psi}$ x [New Mud Weight ÷ Old Mud Weight] ***(only approximate!)***

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

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

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

25. ADDITIONAL MUD RETURNED BY SLUG *(bbls)* = [($Slug\ Weight_{ppg} \div Mud\ Weight_{ppg}$) – 1] x $Slug\ Volume_{bbls}$

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

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

28. RISER MARGIN (*ppg*) = [(Riser Mud $Hydrostatic_{psi}$ – Seawater $Hydrostatic_{psi}$) ÷ 0.052] ÷ (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 = Pressure: V = Volume

31. GAS MIGRATION RATE *(ft/hr)* = Shut-In Pressure Increase$_{psi/hr}$ ÷ 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$_{psi}$ ÷ Mud Gradient$_{psi/ft}$) x Annular Capacity$_{bbls/ft}$

(For Volumetric Method)

33. LENGTH OF WET PIPE PULLED BEFORE FILL-UP FOR DESIRED PRESSURE DROP ΔP (*Length$_{ft}$*)

= (ΔP_{psi} x Annulus Cap$_{bbl/ft}$) ÷ [0.052 x MW$_{ppg}$ x (DP Cap$_{bbl/ft}$ + DP Displ$_{bbl/ft}$)]

34. LENGTH OF DRY PIPE PULLED BEFORE FILL-UP FOR DESIRED PRESSURE DROP ΔP (*Length$_{ft}$*)

= [ΔP_{psi} x (Annulus Cap$_{bbl/ft}$ + DP Cap$_{bbl/ft}$)] ÷ 0.052 x MW$_{ppg}$ x DP Displ$_{bbl/ft}$

35. HYDROSTATIC PRESSURE DROP PER FOOT ($\Delta P_{psi/ft}$) WHEN PULLING WET PIPE

= 0.052 x MW$_{ppg}$ x [(DP Cap$_{bbl/ft}$ + DP Displ$_{bbl/ft}$) ÷ Annulus Cap$_{bbl/ft}$]

36. USABLE FLUID VOLUME PER BOTTLE

= (Precharge Pressure ÷ Minimum Operating Press) - (Precharge Pressure ÷ Maximum Operating pressure) x Bottle Volume

37. CONVERSION OF API GRAVITY (^{o}API) TO SPECIFIC GRAVITY (SG) = 141.5 ÷ (^{o}API + 131.5)

38. CONVERSION OF SPECIFIC GRAVITY (SG) TO PPG = 8.33 x SG

WELL COMPLETION/WORKOVER FORMULA SHEET—FIELD UNITS

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

2. KILL FLUID WEIGHT *(ppg)* = $BHP_{psi} \div 0.052 \div TVD_{ft}$

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

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

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

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

BULLHEADING FORMULAE

7. FORMATION FRACTURE PRESSURE *(psi)* = Formation Fracture $\text{Gradient}_{psi/ft}$ x Top Perforations TVD_{ft}

8. INITIAL HYDROSTATIC PRESSURE *(psi)* = Formation Pressure_{psi} - $SITP_{psi}$

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

10. MAX INITIAL SURFACE PRESSURE *(psi)* = Formation Fracture Pressure_{psi} - Initial Hydrostatic Pressure_{psi}

11. MAX FINAL SURFACE PRESSURE *(psi)* = Formation Fracture $\text{Pressure}_{psi} - (\text{Kill Fluid Weight}_{ppg} \text{ x } 0.052 \text{ x Top Perforations } TVD_{ft})$

12. VOLUME TO BULLHEAD *(bbls)* = Surface Lines_{bbls} + Surface to EOT_{bbls} + EOT to Top Perfs_{bbls} + Top Perfs to Bottom Perfs_{bbls}

    {EOT = End of Tubing Perfs = Perforations}

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

TEMPERATURE CORRECTION FORMULA FOR BRINES

14. FLUID DENSITY TO *MIX (ppg)* = Fluid Density at Avg. $Temp_{ppg}$ + [(Avg. $Temp_F$ - Surface $Temp_F$) x Weight $Loss_{ppg/^OF}$]

{Avg = Average F = degrees Fahrenheit}

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

Brine weight (ppg)	Weight loss (ppg/°F)
8.4 – 9.0	0.0017
9.1 – 11.0	0.0025
11.1 – 14.5	0.0033
14.6 – 17.0	0.0040
17.1 – 19.2	0.0048