Common Symbols and Abbreviations

Inches	=	ins or “
Feet	=	ft or ‘
Cubic inches	=	cu ins or ins^3
Cubic feet	=	cu ft or ft^3
Square inches	=	sq. ins or ins^2
Square feet	=	sq. ft or ft^2
Pounds	=	lbs
Ounces	=	oz
Pounds per cubic foot	=	pcf or lbs/ft^3
Pounds per gallon	=	ppg or lbs/gall
Pounds per square inch	=	P.S.I.
Millimetres	=	mm
Centimetres	=	cm
Metres	=	m
Square metres	=	m^2
Cubic centimetres	=	cc or cms^3
Kilometre	=	km
Grams	=	gm
Kilograms per sq centimetre	=	kg/cm^2
Barrel	=	bbl

Basic Rig Math Calculations

.052 converts PPG to PSI/ft

Example:

10.0 PPG x .052 = .52 PSI/ft

1029.4 used to find capacity bbls/ft

Example:

$8.5^2 \div 1029.4 = .0702$ bbls/ft

.7854 finds sq. in. in a circle

Example:

$8.5^2 \times .7854 = 56.75$ sq.in.

.0003638 reciprocal of 2748

2748 weight of a oilfield bbl of steel

Example:

465 ft of 5" 19.5 D.P.

465 ft x 19.5 x .0003638 = 3.3 bbls

OR

465ft x 19.5 ÷ 2748 = 3.3 bbls

.000243 used to find output of a triplex pump bbls/strk 100%

Example:

7 x 10 triplex = $7^2 \times 10 \times .000243 = .1191$ bbls/strk

65.4 used to figure up the buoyancy of the pipe

Example:

$$\frac{(65.4 - \text{mud weight})}{65.4} = \frac{(65.4 - 12.6)}{65.4}$$

Basic Rig Math Calculations

1. Converting a fraction to a decimal.

Divide the numerator by the denominator

Example:

7 ÷ 8 = .875

2. Squaring a number.

Number then keystroke X followed by =

Example:

5^2

5X = equals 25

3. Capacity

ID^2 ÷ 1029.4

Example:

ID is 4.276

4.276 X = ÷ 1029.4 = .01776 bbls/ft

4. Displacement

Pipe WT or Adj Pipe WT X .0003638

Example:

5”0D 4.276 ID Adj. P.WT. 23.07 X .0003638 = .00839

5. Annular Volume bbls/ft

$ID^2 – OD^2$ ÷ 1029.4

Example:

Hole Size 8.5” DP size 5.0 OD

$8.5^2 – 5^2$ ÷ 1029.4 = bbls/ ft

Key Strokes:

8.5 X = m+

5X = m-

M R/C ÷ 1029.4 = .046 bbls/ft

OR

8.5X = **m +** 5x = **m - mR/C** ÷ 1029.4 = .046 bbls/ft

To clear all numbers from memory push the **M r/c** key twice

6. Remember when you see an equation that is using parenthesis you must work the problem within the parenthesis ***first.***

Example:

$$\frac{(1500 \times (12.0 - 10.0))}{35 - 12.0}$$

$$\frac{(1500 \times 2)}{23}$$

$$\frac{3000}{23} = 130.4 \text{ lbs per bbl}$$

Well Control Kill Sheets

(A) WELL INFO:

Original Mud Weight

ppg

Total Vertical Depth (TVD)

ft

Slow Pump Pressure

psi

Slow Pump Speed

spm

Surface to Bit Strokes

stks

(B) KICK DATA:

Shut-In Drillpipe Pressure (SIDP)

psi

Shut-In Casing Pressure (SICP)

psi

Pit Gain

bbls

(C) CALCULATIONS:

Kill Weight Mud (KWM) *ppg*

KWM = (SIDP ÷ TVD ÷ .052) + Original Mud Weight

KWM = (_____ ÷ _____ ÷ .052) + _____

Initial Circulation Pressure (ICP) *psi*

ICP = Slow Pump Pressure + SIDP

ICP = _____ + _____

Final Circulating Pressure (FCP) *psi*

FCP = Slow Pump Pressure X KWM ÷ OMW

FCP = _____ x _____ ÷ _____

(D) WAIT & WEIGHT PROCEDURE

1. Raise mud weight in suction pit to Kill Weight Mud Value.
2. Monitor Shut-In Pressures for possible Gas Migration. Maintain drillpipe pressure constant at original Shut-In Value if necessary.
3. When KWM is ready, bring pump on line according to Pump Start Up Procedure.
4. Maintain constant pump speed during kill and adjust choke as needed to control drillpipe pressure as shown on Schedule.
5. Follow Drillpipe Pressure Circulating Schedule until Kill Weight Mud reaches bit.
6. Continue pumping, holding drillpipe pressure at final circulating press until KWM returns to surface.

(E) DRILLPIPE PRESSURE CIRCULATING SCHEDULE

STROKES	PRESSURE	
0		◀ ICP
(1)		
(2)		
(3)		
(4)		
(5)		
(6)		
(7)		
(8)		
(9)		
(10)		◀ FCP

Stks to Bit ▶

INSTRUCTIONS:

Write in ICP, FCP, and Stks to Bit in spaces indicated by schedule.

1. Calculate strokes per increment:

Stks to Bit ÷ 10 = _____stks

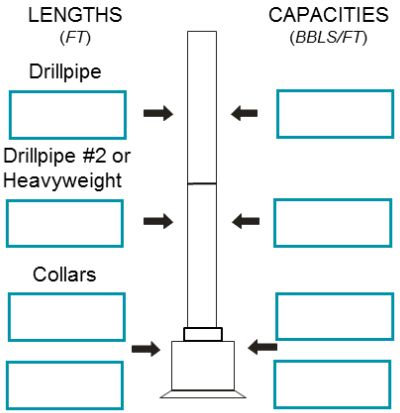
Add these stks to each increment until Stks to Bit is reached.

2. Calculate Drillpipe pressure reduction per increment:

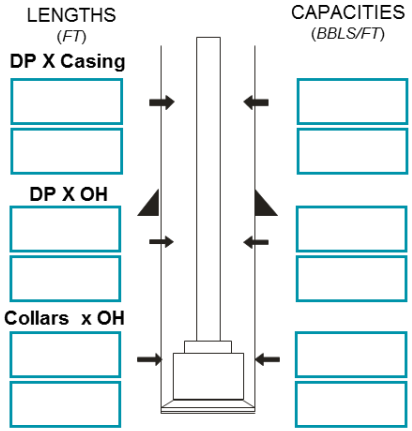
(ICP - FCP) ÷ 10 = _____ *psi*

From ICP subtract this pressure reduction from each increment until FCP is reached.

PRE-RECORDED DRILLSTRING INFO



PRE-RECORDED ANNULUS INFO



DRILLSTRING VOLUME (*BBLS*)

Length (*ft*) x Capacity (*bbl/ft*) = Vol. (*bbls*)

(1)		X		=		
(2)		X		=		
(3)		X		=		
(4)		X		=		

Add 1+2+3+4 for Total Drillstring Volume =

ANNULAR VOLUME (*BBLS*)

Length (*ft*) x Capacity (*bbl/ft*) = Vol. (*bbls*)

(1) Casing by Drillstring

	X		=	
	X		=	
	X		=	
	X		=	

(2) Open Hole by Drillstring

	X		=	
	X		=	
	X		=	
	X		=	

(3) Choke Line Volume (subsea only)

	X		=	

Add 1 + 2 + 3 for Total Annular Volume =

PUMP OUTPUT AND TOTAL STROKES TO KILL WELL

Pump Output (*bbls/stk*) =

1) Surface to bit strokes: Drillstring Volume ÷ Pump Output = Drillstring Strokes

2) Bottoms Up Strokes: Annular Volume ÷ Pump Output = Annulus Strokes

Add 1 + 2 for Total Circulation for Well Kill = **Total Strokes**

PUMP START-UP PROCEDURES

SURFACE STACKS:

1. As Driller brings pump on line; adjust choke as necessary to maintain casing pressure constant at SICP value until kill speed is reached.
2. Driller should take at least a full minute to bring pump up to kill speed.
3. When pressure gages stabilize, read correct ICP from drillpipe gage, If necessary, correct Drillpipe Pressure Circulating Schedule.

SUBSEA STACKS:

CHOKE LINE FRICTION = ____ *psi*

1. As Driller brings pump on line; adjust choke as necessary to maintain kill line pressure constant at shut-in value until kill speed is reached.

   If kill line pressure not available, reduce casing pressure by the choke line friction as the pump is coming up to kill speed.

2. Continue with steps (2) & (3) above.

Well Control Formulas

1. Pressure = $\frac{\text{Force}}{\text{Area}}$ Force = Pressure x Area

2. Area of a Circle = 0.7854 ÷ Diameter^2

3. Capacity = $\frac{ID^2}{1029.4}$

4. Volume = Capacity X Length

5. Displacement = Weight per Foot x 0.000367

6. Hydrostatic Pressure = MW X TVD .052

7. Mud Gradient = MW X .052

8. Pit Gain from Slug = Volume of Slug x $\left(\frac{\text{Weight of Slug - Mud Weight}}{\text{Mud Weight}}\right)$

9. Depth Slug Falls = Length of Slug x $\left(\frac{\text{Weight of Slug - Mud Weight}}{\text{Mud Weight}}\right)$

10. Pump Output (TPX) = (Liner^2) x Stroke Length x .000243 x Efficiency

11. Pump Output (DPX) = [2 x (Liner Dia)^2 – (Rod Dia)^2] x Stroke Length x .000162 x Efficiency

12. Pump Strokes = $\frac{\text{Volume}}{\text{Pump Output}}$

13. Time = $\frac{\text{Total Pump Strokes}}{\text{Stroke Rate}}$

14. Annular Velocity = $\frac{\text{Pump Output x Pump Rate}}{\text{Annular Capacity}}$

15. Buoyancy Factor = $\frac{(65.5 - \text{Mud Weight})}{65.5}$

16. Kill Weight Mud = $\left(\frac{\text{Shut in Drillpipe Pressure}}{0.052 \times \text{TVD}}\right)$ + Original Mud Weight

17. Initial Circulating Pressure = Slow Pump Pressure + Shut In Drillpipe Pressure

18. Final Circulating Pressure = $\frac{\text{Kill Mud Weight}}{\text{Original MW}}$ X Slow Pump Pressure

19. Formation "Pore" Pressure = Hydrostatic Pressure + Shut in Drillpipe Pressure

20. Maximum Allowable Casing Pressure for Leak – Off = (FRACMW – Mud Weight) x TVD of shoe x .052

21. Height of Influx = $\frac{\text{Pit Gain}}{\text{Annular Capacity}}$

22. Vertical Height of Influx = Height of Influx x Cosine <

Note:
For straight holes the vertical height of influx is the same as the height of influx (cosine $0^0 = 1$).

Well Control Formulas

23. $$\text{Gradient of Influx} = \text{Mud Gradient} - \left(\frac{\text{Shut in Casing Pressure} - \text{Shut in Drillpipe Pressure}}{\text{Vertical Height of Influx}}\right)$$

24. $$\text{Shut in Casing Pressure} = \text{SIDP} + (\text{Mud Gradient} - \text{Influx Gradient}) \times \text{Vertical Height of Influx}$$

25. $$\text{Mud Tank Capacity (bbls / inch)} = \frac{\text{Length (ft)} \times \text{Width (ft)}}{67.3}$$

26. $$\text{Mud Tank Capacity (bbls / foot)} = \frac{\text{Length (ft)} \times \text{Width (ft)}}{5.61}$$

27. $$\text{Volume Delivered} = \text{Bottle Volume} \times \left(\frac{\text{Precharge Pressure}}{\text{Final Pressure}} - \frac{\text{Precharge Pressure}}{\text{System Pressure}}\right)$$

28. $$\text{Initial Pressure} \times \text{Initial Volume} = \text{Final Pressure} \times \text{Final Volume} \text{ or } P_1 \times V_1 = P_2 V_2$$

29. $$\text{Gas Rise (ft)} = \frac{\text{Increase in Casing Pressure}}{\text{Mud Gradient}}$$

30. $$\text{Migration Rate (ft/hr)} = \frac{\text{Increase in Casing Pressure per Hour}}{\text{Mud Gradient}}$$

31. $$\text{Barite Required to Weight Up (lbs/bbl)} = \frac{1500 \times (MW_2 - MW_1)}{(35 - MW_2)}$$

32. $$\text{Sacks per Minute} = \frac{15 \times (MW_2 - MW_1) \times \text{Pump Rate}}{(35 - MW_2)}$$ **bbls per minute**

33. $$\text{Volume Increase} = \frac{\text{Pit Volume} \times (MW_2 - MW_1)}{35 - MW_2}$$

34. $$\text{Frac Gradient} = (\text{Overburden Gradient} - \text{Pore Pressure Gradient}) \times \text{Lithology Factor} + \text{Pore Pressure}$$

35. $$\text{Riser Margin} = \left(\frac{HP_{\text{riser}} - HP_{\text{sea water}}}{(\text{TVD} - \text{Air Gap} - \text{Sea Water Depth})}\right)$$

36. $$\text{Riser Collapse} = \frac{46,950,000}{(D/t) \times (D/t - 1)^2}$$

Where:
Riser Collapse - psi
D - Riser OD (inches)
t - Wall thickness (inches)

37. **Below Mud Line**

$$\text{Max MW} = \frac{(\text{Water Depth} \times \text{Water Grad.} + \text{Depth BML} \times \text{Overburden Grad.}) - \text{Annular Friction Loss}}{0.052 \times TVD_{RKB}}$$

38. $$\text{Minimum Penetration} = \frac{(\text{Mud Grad.} - \text{Water Grad.}) \times \text{Water Depth} + \text{Air Gap} \times \text{Mud Grad.} + \text{AFL}}{(\text{Overburden Grad.} - \text{Mud Grad.})}$$

Conversion Factors

Feet	x 0.3048	Meters (M)
Inches	x 2.54	Centimeters (cm)
Inches	x 25.4	Millimeters (mm)
Wt Indicators (lbs)	x 0.0004536	Metric Tons
Pounds	x 0.4536	Kilograms
Weight (Lbs/ft)	x 1.4882	Kg/M
Pounds per Barrel	x 2.85307	Kg/M^3
Barrels	x 158987	Liters
Barrels	x 0.15898	Cubic Meters
Gallons	x 3.7854	Liters
Gallons	x 0.0037854	Cubic Meters
Barrels/Stroke	x 158.987	Liters/Stroke
Barrels/Stroke	x 0.158987	Cubic Meters/Stroke
Gallons/Minute	x 3.7854	Liters/Minute
Barrels/Minute	x 158987	Liters/Minute
Barrels/Minute	x 0.158987	Cubic Meters/Minute
bbl/ft Capacity	x 521.612	Liters/Meter (1/M)
bbl/ft Capacity	x 0.521612	Cubic Meters/Meter
Bbl/ft Displacement	x 521.612	Liters/Meter (1/M)
Bbl/ft Displacement	x 0.521612	Cubic Meters/Meter
Gradient psi/ft	x 22.6206	KPa/M
Gradient psi/ft	x 0.226206	Bar/M
Mud Weight PPG	x 0.119826	Kilograms/Liter (Kg/L)
Mud Weight PPG	x 119.826	Kilograms/Cubic Meter
Mud Weight PPG	x 0.119826	Specific Gravity (SG)
Mud Weight (Lb/Ft^3)	x 1.60185	Kg/M^3
Fahrenheit Degrees	x 0.56 – 17.8	Celsius Degrees
PSI	x 6894.8	Pascals (Pa)
PSI	x 6.8948	Kilopascals (KPa)
PSI	x 0.06895	Bar

Conversion Factors

Meters (m)	x 3.2808	Feet
Centimeters (cm)	x 0.3937	Inches
Millimeters (mm)	x 0.03937	Inches
Metric Tons	x 2204.6	Pounds (Lbs)
Kilograms (KG)	x 22046	Pounds (Lbs)
Kg/m	x 0.67196	Weight (Lbs/Ft)
Kg/m^3	x 0.3505	Pounds per Barrel
Liters	x 0.00629	Barrels
Cubic Meters	x 6.2898	Barrels
Liters	x 0.2642	Gallons
Cubic Meters	x 264.173	Gallons
Liters/Stroke	x 0.00629	Barrels/Stroke
Cubic Meters/Stroke	x 6.2898	Barrels/Stroke
Liters/Minute	x 0.2642	Gallons/Minute
Liters/Minute	x 0.00629	Barrels/Minute
Cubic Meters/Minute	x 6.2898	Barrels/Minute
Liters/Meter (l/m)	x 0.0019171	BBL/ft Capacity
Cubic Meters/Meter	x 1.9171	BBL/ft Capacity
Liters/Meter (l/m)	x 0.0019171	BBL/ft Displacement
Cubic Meters/Meter	x 1.9171	BBL/ft Displacement
KPa/m	x 0.044207	Gradient PSI/Ft
Bar/m	x 4.4207	Gradient PSI/Ft
Kilograms/Liter (Kg/L)	x 8.3454	Mud Weight PPG
Kilograms/Cubic Meters	x 0.0083454	Mud Weight PPG
Specific Gravity (SG)	x 8.3454	Mud Weight PPG
Kg/m3	x 6.24279	Mud Weight (Lb/Ft^3)
Celsius Degrees	x 1.8 + 32	Fahrenheit Degrees
Pascals (Pa)	x 0.000145	PSI
Kilopascals (KPa)	x 0.14504	PSI
Bar	x 14.50377	PSI

Abbreviations

Ann Cap	Annular Capacity
API	American Petroleum Institute
bbls	Barrels
bbls/ft	Barrels per foot
bbls/stk	Barrels per stroke
BF	Buoyancy Factor
BHP	Bottom Hole Pressure
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
BOP	Blowout Preventer
bpm	Barrels per minute
Cap	Capacity
CFR	Code of Federal Regulations
CLF	Choke Line Friction
Csg	Casing
D	Diameter
DC	Drill Collar
DC Cap	Drill Collar Capacity
DP Cap	Drill Pipe Capacity
Disp	Displacement
DP	Drillpipe
DS	Drillstring
ECD	Equivalent Circulating Density
Eff	Efficiency
EMW	Equivalent Mud Weight
EOB	End of Build
FCP	Final Circulating Pressure
FIT	Formation Integrity Test
FG	Fluid Gradient
FLOP	Formation Leak Off Pressure
FOSV	Full Open Safety Valve
FP	Formation Pressure
ft	Foot
FW	Fluid Weight
gal	Gallon
gpm	Gallons per minute
HCR Valve	High Closing Ration Valve
HP	Hydrostatic Pressure
HPP	Hydraulic Horsepower
HWDP	Heavy Weight Drill Pipe
IBOP	Inside Blowout Preventer
ICP	Initial Circulating Pressure
ID	Internal Diameter
KFW	Kill Fluid Weight
KOP	Kick Off Point

Abbreviations

KWM	Kill Weight Mud
LOT	Leak Off Test
MAMW	Maximum Allowable Mud Weight
MAFW	Maximum Allowable Fluid Weight
MASP	Maximum Allowable Surface Pressure
MAASP	Maximum Allowable Annulus Surface Pressure
MD	Measured Depth
MDR	Minimum Drilling Rate
MMS	Minerals Management Service
min	Minutes
MW	Mud Weight
OD	Outer Diameter
OH Cap	Open Hole Capacity
OMW	Original Mud Weight
P	Pressure
pcf	Pounds per cubic foot
PIT	Pressure Integrity Test
POOH	Pull Out of Hole
ppf	Pounds per foot
ppg (lbs/gal)	Pounds per gallon
psi	Pounds per square inch
psi/ft	Pounds per square inch per foot
PVT	Pit Volume Totalizer
RIH	Run In Hole
RKB	Rotary Kelly Bushing
ROP	Rate of Penetration
SCRP	Slow Circulating Rate Pressure
SG	Specified Gravity
SICP	Shut In Casing Pressure
SIDPP	Shut In Drillpipe Pressure
spm	Strokes per minute
$SPM_{Valve(subsea)}$	Sub Plate Mounted Valve
SPP	Slow Pump Pressure
STB	Strokes to Bit
stk	Stroke
TD	Total Depth
TVD	True Vertical Depth
V	Volume