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Unless otherwise defined, the following abbreviated terms are used in this book. Units are identified within specific formulas and equations.

Term	Description
bbl	Barrel
bpm	Barrels per minute
Cap	Capacity
Csg	Casing
DC	Drill collar
Disp	Displacement
DP	Drillpipe
DS	Drillstring
ECD	Equivalent circulating density
Eff	Efficiency
EMW	Equivalent mud weight
EOB	End of build
FCP	Final circulating pressure
FMDPP	Final maximum drillpipe pressure
FP	Formation pressure
ft	Foot
gal	Gallon
gpm	Gallons per minute
HP	Hydrostatic pressure
ICP	Initial circulating pressure
ID	Internal diameter
IMDPP	Initial maximum drillpipe pressure
KOP	Kick off point
KWM	Kill weight mud
MD	Measured depth
min	Minutes
MW	Mud weight
OD	Outer diameter
OMW	Original mud weight
pcf	Pounds per cubic foot
PP	Pump pressure
ppf	Pounds per foot
ppg	Pounds per gallon
psi	Pounds per square inch
PV	Plastic viscosity
Q	Flow rate
SF	Safety factor
SICP	Shut in casing pressure
SIDPP	Shut in drillpipe pressure
sk, sx	Sack, sacks
SPM	Strokes per minute
SPP	Slow pump pressure
stk	Stroke
TVD	True vertical depth
V	Velocity
Vol	Volume
YP	Yield point

Capacities & Volumes for Downhole

Capacities

$$\text{Open Hole Capacity}_{bpf}\ (OHCap) = \frac{(\text{Hole Diameter}_{inches})^2}{1{,}029.4}$$

$$\text{Casing Capacity}_{bpf}\ (CsgCap) = \frac{(\text{Casing ID}_{inches})^2}{1{,}029.4}$$

$$\text{Drill String Capacity}_{bpf}\ (DSCap) = \frac{(\text{Pipe ID}_{inches})^2}{1{,}029.4}$$

$$\text{OH x DS Annular Capacity}_{bpf}\ (OH \times DSCap) = \frac{(\text{HoleDiameter}_{inches})^2 - (\text{ODString}_{inches})^2}{1{,}029.4}$$

$$\text{Csg x DS Annular Capacity}_{bpf}\ (Csg \times DSCap) = \frac{(\text{Casing ID}_{inches})^2 - (\text{ODString}_{inches})^2}{1{,}029.4}$$

$$\text{Multiple String Annular Capacity}_{bpf}\ (MSACap) = \frac{(\text{Casing ID}_{inches})^2 - \left[(\text{ODPipe1}_{inches})^2 + (\text{ODPipe2}_{inches})^2\right]}{1{,}029.4}$$

Volumes per Section

$$\text{Open Hole Volume}_{bbl}\ (OHVol) = OHCap \times \text{Length}_{ft}$$

$$\text{Casing Volume}_{bbl}\ (CsgVol) = CsgCap \times \text{Length}_{ft}$$

$$\text{Drill String Volume}_{bbl}\ (DSVol) = DSCap \times \text{Length}_{ft}$$

$$\text{OH x DS Annular Volume}_{bbl}\ (OH \times DSVol) = (OH \times DSCap) \times \text{Length}_{ft}$$

$$\text{Csg x DS Annular Volume}_{bbl}\ (Csg \times DSVol) = (Casg \times DSCap) \times \text{Length}_{ft}$$

$$\text{Multiple String Annular Volume}_{bbl}\ (MSAVol) = MSACap \times \text{Length}_{ft}$$

Capacities & Volumes of Tanks

Vertical Cylindrical Tanks

$$\text{Capacity}_{bbl/ft} = \frac{(\text{Tank Diameter}_{ft})^2}{7.148}$$

$$\text{Capacity}_{bbl/ft} = \frac{(\text{Tank Diameter}_{inches})^2}{1{,}029.4}$$

$$\text{Capacity}_{bbl/inch} = \frac{(\text{Tank Diameter}_{ft})^2}{85.78}$$

$$\text{Capacity}_{bbl/inch} = \frac{(\text{Tank Diameter}_{inches})^2}{12{,}352.9}$$

$$\text{Volume}_{bbl} = \text{Capacity}_{bbl/ft} \times \text{Height}_{ft}$$

$$\text{Volume}_{bbl} = \text{Capacity}_{bbl/inch} \times \text{Height}_{inches}$$

Rectangular Tanks

$$\text{Capacity}_{bbl/ft} = 0.178 \times \text{Length}_{ft} \times \text{Width}_{ft}$$

$$\text{Capacity}_{bbl/inch} = 0.0148 \times \text{Length}_{ft} \times \text{Width}_{ft}$$

$$\text{Volume}_{bbl} = \text{Capacity}_{bbl/ft} \times \text{Height}_{ft}$$

$$\text{Volume}_{bbl} = \text{Capacity}_{bbl/inch} \times \text{Height}_{inches}$$

Horizontal Cylindrical Tanks

$$\text{Volume of Tank}_{bbl} = \text{Length}_{ft} \times \frac{(\text{Tank Diameter}_{inches})^2}{1{,}029.4}$$

Content from Volume (for Horizontal Tanks)

$$\text{Height Ratio} = \frac{\text{Height of Content}_{inches}}{\text{Height of Tank}_{inches}}$$

FIND VOLUME FACTOR FROM TABLE USING CALCULATED HEIGHT RATIO:

$$\text{Content in Tank}_{bbl} = \text{Vol of Tank}_{bbl} \times \text{Volume Factor}$$

Height Ratio	Volume Factor	Height Ratio	Volume Factor
0.05	0.019	0.55	0.560
0.10	0.052	0.60	0.626
0.15	0.092	0.65	0.690
0.20	0.142	0.70	0.747
0.25	0.195	0.75	0.800
0.30	0.252	0.80	0.857
0.35	0.310	0.85	0.900
0.40	0.373	0.90	0.948
0.45	0.430	0.95	0.980
0.50	0.500	1.00	1.000

Pump Output & Rate Formulas

Pump Outputs

FOR TRIPLEX PUMPS:

$$Output_{bbl/stk} = 0.000243 \times (Liner\ ID_{inches})^2 \times Stroke_{inches} \times Eff\%$$

FOR DUPLEX PUMPS (DOUBLE ACTING):

$$Output_{bbl/stk} = 0.000162 \times [2 \times (Liner\ ID_{inches})^2 - (Rod\ OD_{inches})^2] \times Stroke_{inches} \times Eff\%$$

Pump Rates

$$Rate_{bpm} = Output_{bbl/stk} \times SPM$$

$$Rate_{gpm} = 42 \times Output_{bbl/stk} \times SPM$$

Pumping/Spotting/Displacing

$$Time_{min} = \frac{BBL\ to\ Pump}{Output_{bbl/stk} \times SPM}$$

Pump Pressure Relationships

New Pump Pressure (PP) for Rate Change

$$New\ PP_{psi} = \left(\frac{New\ Rate_{bpm}}{Old\ Rate_{bpm}}\right)^2 \times Old\ PP_{psi}$$

$$New\ PP_{psi} = \left(\frac{New\ SPM}{Old\ SPM}\right)^2 \times Old\ PP_{psi}$$

New Pump Pressure (PP) for Density Change

$$New\ PP_{psi} = \frac{New\ MW_{ppg}}{Original\ MW_{ppg}} \times Original\ PP_{psi}$$

Equivalent Circulating Density (ECD)

Equivalent Circulating Density (ECD_{ppg}) using Pressure Loss

$$ECD_{ppg} = MW_{ppg} + \frac{Annular\ Friction\ Pressure\ Loss_{psi}}{0.052 \times TVD_{ft}}$$

Where:

Annular Friction Pressure Loss in psi is approximately equal to 10% of the pump pressure for normal hole geometries (i.e., no liners or tapered strings).

Equivalent Circulating Density (ECD_{ppg}) using Yield Point (YP) for MW ≤ 13 ppg

$$ECD_{ppg} = MWppg + \frac{0.1 \times YP}{HoleDiameter_{inches} - PipeOD_{inches}}$$

Where:

YP = Fann 300 reading – PV

PV = Fann 600 reading – Fann 300 reading

Equivalent Circulating Density (ECD_{ppg}) using Yield Point (YP) for MW > 13 ppg

$$ECD_{ppg} = MW_{ppg} + \frac{0.1}{HoleDiameter_{inches} - PipeOD_{inches}} \times \left(YP + \frac{PV \times V_{ft/min}}{300 \times (HoleDiameter_{inches} - PipeOD_{inches})}\right)$$

Trip Calculations

Trip $Margin_{ppg}$

$$Trip\ Margin_{ppg} = \frac{YP_{mud}}{11.7 \times (Hole\ Diameter_{inches} - Pipe\ OD_{inches})}$$

$$Trip\ Margin_{ppg} = \frac{Annular\ Pressure\ Loss_{psi}}{0.052 \times TVD_{ft}}$$

Slug Mud $Weight_{ppg}$ for a given Length of Dry Pipe

$$Slug\ Weight_{ppg} = MW_{ppg} + \frac{(MW_{ppg} \times Length\ Dry\ Pipe_{ft} \times DP\ Cap_{bbl/ft})}{Volume\ of\ Slug_{bbl}}$$

Slug $Volume_{bbl}$ for a given Length of Dry Pipe

$$Slug\ Volume_{bbl} = \frac{MW_{ppg} \times Length\ Dry\ Pipe_{ft} \times DP\ Cap_{bbl/ft}}{Slug\ MW_{bbl} - MW_{ppg}}$$

Trip Calculations, continued

Pit Gain from $Slug_{bbl}$

$$Pit\ Gain_{bbl} = Slug\ Volume_{bbl} \times \frac{Slug\ Weight_{ppg} - MW_{ppg}}{MW_{ppg}}$$

Depth Slug $Falls_{ft}$

$$Depth\ Slug\ Falls_{ft} = \frac{Pit\ Gain\ from\ Slug_{bbl}}{DP\ Cap_{bbl/ft}}$$

Hydrostatic Pressure Drop per Vertical Foot ($\Delta P_{psi/ft}$) when Pulling Dry Pipe

$$\Delta P_{psi/ft} = \frac{0.052 \times MW_{ppg} \times DP\ Displ_{bbl/ft}}{Annulus\ Cap_{bbl/ft} + DP\ Cap_{bbl/ft}}$$

Hydrostatic Pressure Drop per Vertical Foot ($\Delta P_{psi/ft}$) when Pulling Wet Pipe

$$\Delta P_{psi/ft} = 0.052 \times MW_{ppg} \times \frac{(DP\ Cap_{bbl/ft} + DP\ Displ_{bbl/ft})}{Annulus\ Cap_{bbl/ft}}$$

Length of Dry Pipe Pulled Before Fill-Up for Desired Pressure Drop ΔP

$$Length_{ft} = \frac{\Delta P_{psi} \times (Annulus\ Cap_{bbl/ft} + DP\ Capl_{bbl/ft})}{0.052 \times MW_{ppg} \times DP\ Displ_{bbl/ft}}$$

Length of Wet Pipe Pulled Before Fill-Up for Desired Pressure Drop ΔP

$$Length_{ft} = \frac{\Delta P_{psi} \times Annulus\ Cap_{bbl/ft}}{0.052 \times MW_{ppg} \times (DP\ Cap_{bbl/ft} + DP\ Displ_{bbl/ft})}$$

Pressure & Gradient Formulas

Fluid Gradient ($Gradient_{psi/ft}$)

$$Gradient_{psi/ft} = 0.052 \times Fluid\ Density_{ppg}$$

$$Gradient_{psi/ft} = 0.007 \times Fluid\ Density_{pcf}$$

$$Gradient_{psi/ft} = 0.433 \times Specific\ Gravity\ (SG)$$

Hydrostatic Pressure (HP_{psi})

$$HP_{psi} = Gradient_{psi/ft} \times TVD_{ft}$$

$$HP_{psi} = 0.052 \times MW_{ppg} \times TVD_{ft}$$

$$HP_{psi} = 0.007 \times MW_{pcf} \times TVD_{ft}$$

$$HP_{psi} = 0.433 \times SG \times TVD_{ft}$$

Kill Sheet Calculations

SEE SAMPLE KILL SHEET ON PAGE 30/31.

Kill Weight Mud (KWM_{ppg}) from Original Mud Weight (OMW_{ppg})

$$KWM_{ppg} = \frac{SIDPP_{psi}}{(0.052 \times TVD_{ft})} + OMW_{ppg}$$

Initial Circulating Pressure (ICP_{psi})

$$ICP_{psi} = SIDPP_{psi} + SPP_{psi}$$

Final Circulating Pressure (FCP_{psi})

$$FCP_{psi} = \frac{SPP_{psi} \times KWM_{ppg}}{OMW_{ppg}}$$

Strokes to Bit (STB)

$$STB = \frac{Drillstring\ Volume_{bbl}}{Output_{bbl/stk}}$$

Strokes for KWM to Shoe

$$Strokes\ to\ Shoe = \frac{Openhole\ Annular\ Volume_{bbl}}{Output_{bbl/stk}} + STB$$

Strokes for KWM to Surface

$$Strokes\ to\ Surface = \frac{Total\ Annular\ Volume_{bbl}}{Output_{bbl/stk}} + STB$$

Time for KWM to Bit

$$Time\ to\ Bit_{min} = \frac{STB}{SPM}$$

Time for KWM to Shoe

$$Time\ to\ Shoe_{min} = \frac{Strokes\ to\ Shoe}{SPM}$$

Time for KWM to Surface

$$Time\ to\ Surface = \frac{Strokes\ to\ Surface}{SPM}$$

Kick Related Formulas

Length of Influx

$$\text{Influx Length}_{ft} = \frac{\text{Influx Size}_{bbl}}{\text{Lower Annulus Cap}_{bbl/ft}}$$

Expected Pit Gain (MPG_{bbl}) with a Gas Kick in Water-Based Mud Systems

$$MPG_{bbl} = 4 \times \sqrt{\frac{FP_{psi} \times \text{Original Gain}_{bbl} \times \text{Annular Cap}_{bbl/ft}}{KWM_{ppg}}}$$

Expected Surface Pressure (MSP_{psi}) from a Gas Kick in Water-Based Mud Systems

$$MSP_{psi} = 0.20 \times \sqrt{\frac{FP_{psi} \times \text{Original Gain}_{bbl} \times KWM_{ppg}}{\text{Surface Annular Cap}_{bbl/ft}}}$$

Maximum Allowable Mud Weight ($MAMW_{ppg}$)

$$MAMW_{ppg} = \frac{\text{Applied Pressure}}{0.052 \times TVD_{shoe}} + \text{Test } MW_{ppg}$$

Note: Applied Pressure from Integrity or Leak-Off test.

Maximum Allowable Shut-In Casing Pressure ($MASP_{psi}$)

$$MASP_{psi} = 0.052 \times (MAMW_{ppg} - MW_{ppg}) \times TVD_{shoe}$$

Kick Tolerance (KT_{ppg}) with Influx

$$KT_{ppg} = \left[(MAMW_{ppg} - MW_{ppg}) \times \frac{TVD_{shoe}}{TVD_{ft}} \right] - \left[(MW_{ppg} - MWI_{ppg}) \times \frac{\text{Influx Height}_{TVDft}}{TVD_{ft}} \right]$$

Where:

MWI_{ppg} = Density of influx (ppg)

Estimated Kick Density

$$\text{Kick Density}_{ppg} = MW_{ppg} - \frac{SICP_{psi} - SIDPP_{psi}}{0.052 \times \text{Kick Length}_{TVDft}}$$

Kick Gradient$_{psi/ft}$

$$\text{Kick Gradient}_{psi/ft} = (MW_{ppg} \times 0.052) - \frac{SICP_{psi} - SIDPP_{psi}}{\text{Kick Length}_{TVDft}}$$

Gas Migration Distance

$$\text{Distance}_{TVDft} = \frac{\text{Rise in } SICP_{psi}}{MW_{ppg} \times 0.052}$$

Rate of Gas Migration

$$\text{Migration Rate}_{TVDft/min} = \frac{\text{Distance of Rise}_{TVDft}}{\text{Time for Rise}_{min}}$$

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Kick Related Engineering Calculations

Bottom Hole Pressure (BHP_{psi}) while Circulating on the Choke

BHP_{psi} = Hydrostatic Pressure$_{psi}$ Mud in Drillstring + SIDPP

Equivalent Mud Weight (EMW_{ppg}) at Bottom Hole while Circulating out a Kick

$$EMW_{ppg} = \frac{BHP_{psi}}{0.052 \times TVD_{ft}}$$

Shut-In Casing Pressure ($SICP_{psi}$)

$$SICP_{psi} = SIDPP_{psi} + [0.052 \times (MW_{ppg} - \text{Kick Density}_{ppg}) \times \text{Length of Influx}_{VDft}]$$

Formation Pressure (FP_{psi})

$$FP_{psi} = SIDPP_{psi} + [0.052 \times OMW_{ppg} \times TVD_{ft}]$$

$$FP_{psi} = SICP + 0.052 \times [(\text{Kick Length}_{VDft} \times \text{Kick Density}_{ppg}) + (\text{Mud Column}_{ft} \times OMW_{ppg})]$$

% Reduction in Hydrostatic Pressure Due to Gas-Cut Mud (GCMW) $\%\Delta P_{gcm}$ (for water-base mud)

$$\%\Delta P_{gcm} = \frac{100 \times (OMW_{ppg} - GCMW_{ppg})}{GCMW_{ppg}}$$

Leak-Off Test Pressure (LOT_{psi}) and Equivalent Mud Weight (EMW_{LOT}) at Shoe

$$LOT_{psi} = 0.052 \times \text{Test } MW_{ppg} \times TVD_{shoe} + \text{Applied Pressure to Leak-Off}_{psi}$$

$$EMW_{LOT\ ppg} = \frac{LOT_{psi}}{TVD_{shoe}}$$

Formation Integrity Test Pressure (FIT_{psi}) and Equivalent Mud Weight (EMW_{FIT}) at Shoe

$$FIT_{psi} = 0.052 \times \text{Test } MW_{ppg} \times TVD_{shoe} + \text{Applied Integrity Pressure}_{psi}$$

$$EMW_{FIT\ ppg} = \frac{FIT_{psi}}{TVD_{shoe}}$$

Maximum Formation Pressure that can be Controlled with a Well Shut-In

$$\text{Max } FP_{psi} = 0.052 \times (KT_{ppg} + MW_{ppg}) \times TVD_{ft}$$

Kick Related Engineering Calculations, continued

Maximum Kick Height Possible not to Exceed MASP

$$\text{Kick Height}_{TVDft} = \frac{\text{MASP}}{\text{Mud Gradient}_{psi/ft} - \text{Kick Gradient}_{psi/ft}}$$

Maximum Kick Volume Possible not to Exceed MASP

$$\text{Kick Volume}_{bbl} = \text{Kick Height}_{ft} \times \text{Annulus Cap}_{bbl/ft}$$

Volumetric Method Calculations

Initial Pressure Build Increment (ΔIP)

$$\Delta IP_{psi} = \text{Safety Margin}_{psi} + \text{Range}_{psi}$$

Cycle Pressure Build Increment (ΔCP)

$$\Delta CP_{psi} = \text{Range}_{psi}$$

Hydrostatic Pressure ($\Delta HPL_{psi/bbl}$) Loss per Barrel of Mud Bled in Upper Annulus

$$\Delta HPL_{psi/bbl} = \frac{\text{Gradient Mud}_{psi/ft}}{\text{Annulus Cap}_{bbl/ft} \text{ at top of hole}}$$

Bleed Volume (bbl) per Cycle

$$\text{Vol}_{bleed} = \frac{\Delta CP_{psi}}{\Delta HPL_{psi/bbl}}$$

Lubricate & Bleed Calculations

Cycle Hydrostatic Pressure Gain ($\Delta HP_{psi/bbl}$) per Barrel of Mud Pumped in Upper Annulus

$$\Delta HP_{psi/bbl} = \frac{\text{Gradient Lube Mud}_{psi/ft}}{\text{Annulus Cap}_{bbl/ft} \text{ at top of hole}}$$

Cycle Hydrostatic Pressure Increase (ΔHPI_{psi}) or Lubricated Volume (ΔVOL_{bbl}) to be Bled Off

$$\Delta HPI_{psi} = \frac{\text{Gradient Lube Mud}_{psi/ft} \times \Delta VOL_{bbl}}{\text{Annulus Cap}_{bbl/ft} \text{ at top of hole}}$$

$$\Delta VOL_{bbl} = \frac{\Delta HPI_{psi} \times \text{Annulus Cap}_{bbl/ft} \text{ at top of hole}}{\text{Gradient Lube Mud}_{psi/ft}}$$

Bullheading Calculations

Kill Weight Mud (KM_{ppg})

$$KWM_{ppg} = \frac{\text{Formation Pressure}_{psi}}{0.052 \times \text{Perfs Depth}_{TVDft}}$$

Formation Integrity Pressure (FIT_{psi}) at Perfs Depth

$$FIT_{psi} = 0.052 \times (EMW_{FIT\ ppg} \text{ at perf}) \times \text{Perfs TVD}_{ft}$$

Hydrostatic Pressure (HP_{psi}) in Drillpipe

$$HP_{psi} = \text{Formation Pressure}_{psi} - SIDPP_{psi}$$

Initial Maximum Drillpipe Pressure ($IMDPP_{psi}$)

$$IMDPP_{psi} = FIT_{psi} - HP_{psi}$$

Hydrostatic Pressure from KWM_{ppg} ($KMHP_{psi}$)

$$KMHP_{psi} = 0.052 \times KWM_{ppg} \times \text{Perfs TVD}_{ft}$$

Final Maximum Drillpipe Pressure ($FMDPP_{psi}$)

$$FMDPP_{psi} = FIT_{psi} - KMHP_{psi}$$

Stripping Calculations

Snub Force & Length of DC to Balance Pstrip

$$\text{Snub Force} = \text{Pstrip} \times OD^2_{dc} \times 0.782$$

$$\text{Length of DC}_{ft} = \frac{\text{Pstrip} \times OD^2_{dc} \times 0.785}{\text{PPF of DC}}$$

Where:

Pstrip = Stripping Pressure, psi

Influx Height Gain from Stripping Into

$$\Delta\text{Height}_{ft} = \frac{\text{Pipe Length}_{strip} \times (\text{DPCap}_{bpf} + \text{DPDispl}_{bpf})}{\text{Annulus Cap}_{bpf}}$$

Casing Pressure Increase (ΔSICP) from Stripping into an Influx

$$\Delta SICP_{psi} = \Delta\text{Height}_{ft} \times (\text{Gradient}_{mud} - \text{Gradient}_{influx})$$

Mud Volume to Bleed to Maintain Constant Bottom Hole Pressure

$$\text{BleedMud}_{bbl} = \frac{\text{Csg Pressure Increment}_{psi} \times \text{Annulus Cap}_{bbl/ft}}{\text{Mud Gradient}_{psi/ft}}$$

Subsea Formulas

Riser Differential$_{psi}$

$$\text{Riser Differential}_{psi} = 0.052 \times [(\text{Riser MW}_{ppg} - \text{Seawater Weight}_{ppg}) \times \text{Water Depth}_{ft} + \text{Riser MW}_{ppg} \times \text{Air Gap}_{ft}]$$

Riser Margin$_{ppg}$

$$\text{Riser Margin}_{ppg} = \frac{\text{Riser Differential}_{psi}}{0.052 \times (\text{TVD}_{ft} - \text{Water Depth}_{ft} - \text{Air Gap}_{ft})}$$

Pump Start-Up Pressure on Casing Side

$$\text{Pump Start-Up}_{psi} = \text{SICP}_{psi} - \text{CLFP}_{psi}$$

Where:

CLFP = Choke Line Friction Pressure (psi)

Initial Circulating Pressure (ICP$_{psi}$)

$$\text{ICP}_{psi} = \text{SIDPP}_{psi} + \text{SPP}_{psi} \text{ through the riser}$$

Final Circulating Pressure (FCP$_{psi}$)

$$\text{FCP}_{psi} = (\text{SPP}_{psi} \text{ through the riser}) \times \frac{\text{KWM}_{ppg}}{\text{OMW}_{ppg}}$$

Accumulator Sizing

API Minimum Requirements

100% (S.F.= 1) of fluid volume required to close and hold closed all preventers and open an HCR valve and have a system pressure of 200 psi above minimum recommended precharge pressure remaining on the accumulator with pumps off.

Standard Recommendation

150% (S.F.= 1.5) of fluid volume required to close and hold closed all preventers and open an HCR valve and have 1,200 psi system pressure remaining on the accumulator with pumps off.

Fluid Volume Required (Vol$_{reqd}$)

$$\text{Vol}_{req} = \text{S.F.} \times (\text{CloseVol}_{annular} + \text{CloseVol}_{bop1} + \text{CloseVol}_{bop2} + \text{CloseVol}_{bop3} + \text{CloseVol}_{bop4} + \text{OpenVol}_{hcr})$$

Accumulator Sizing, continued

Accumulator Volume Required

Usable hydraulic fluid for operation of blowout preventer equipment is affected by system pressure and nitrogen precharge. If the nitrogen precharge is at the correct (recommended) precharge, multiply the sizing factor from the table below times the fluid volume required to operate a specified number of BOP functions (Vol$_{req}$) will provide the required total accumulator volume.

Accumulator System Pressure	Minimum Recommended Precharge Pressure	Useable Fluid	Accumulator Size Factor*
1,500	750	12.5%	8
2,000	1,000	33.0%	3
3,000	1,000	50.0%	2
5,000	1,000	63.0%	1.6

* *Based on minimum system pressure of 1,200 psi.*

Accumulator Volume Example

If the total fluid required for a BOP stack is 33 gallons, including the safety factor, and the accumulator has an operating pressure of 3,000 psi with a 1,000 psi minimum precharge, the accumulator volume required is 33 gallons times the size factor of 2, or 66 gallons.

Accumulator Usable Fluid Volume

$$\text{Usable Volume} = \text{VR} \times \text{Bottle Volume}$$

$$\text{Where VR} = \frac{\text{Precharge press}}{\text{Min operating press}} - \frac{\text{Precharge press}}{\text{Max operating press}}$$

Mud & Cement Formulas

Barite (100 lb sx) Per 100 bbl Required for Weight-Up

$$\text{Sacks per 100 bbl} = 1{,}470 \times \frac{\text{KWM}_{ppg} - \text{OMW}_{ppg}}{35 - \text{KWM}_{ppg}}$$

Hematite (100 lb sx) Per 100 bbl Required for Weight-Up

$$\text{Sacks per 100 bbl} = 1{,}680 \times \frac{\text{KWM}_{ppg} - \text{OMW}_{ppg}}{40 - \text{KWM}_{ppg}}$$

Mud & Cement Formulas, continued

Pit Volume Increase per 100 bbl (ΔV_{100bbl}) due to Weight-Up with Barite

$$\Delta V_{100bbl} = 100 \times \frac{KWM_{ppg} - OMW_{ppg}}{35 - KWM_{ppg}}$$

Final Mud Weight (MW_{ppg}) when Mixing Two Densities of Mud

$$MW_{ppg} = \frac{(Vol1_{bbl} \times MW1_{ppg}) + (Vol2_{bbl} \times MW2_{ppg})}{Vol1_{bbl} + Vol2_{bbl}}$$

Initial Mud Volume Required ($IVol_{bbl}$) to Build a Final Volume of Mud with Barite

$$IVol_{bbl} = \text{Final } Vol_{bbl} \times \frac{35 - KWM_{ppg}}{35 - OMW_{ppg}}$$

Sacks of (94 lb) Cement Required

$$Sacks_{94lb} = \frac{5.615_{cf/bbl} \times Cap_{bbl/ft} \times Length_{ft} \times \%Excess}{Yield_{cf/sk}}$$

Mix Fluid Requirement

$$\text{Mix Fluid}_{bbl} = (\text{No. Sacks to Mix}) \times \frac{\text{Mix Fluid Req}_{gal/sk}}{42_{gal/bbl}}$$

Balanced Plug (Cement, Barite, etc.)

a) Calculate Volume Of Plug:

$PlugVol_{bbl} = Length_{Plug\ ft} \times \text{Hole } Cap_{bbl/ft}$

b) Calculate Length of Balanced Column :

$$Length_{Col\ Ft} = \frac{PlugVol_{bbl}}{\text{Annulus } Cap_{bbl/ft} + DP\ Cap_{bbl/ft}}$$

c) Calculate Total String Volume to Balance:

$VolBalance_{bbl} =$
$= (\text{Plug Bottom Depth}_{ft} - Length_{Col\ Ft}) \times DPCap_{bbl/ft}$

d) Calculate Ratio of Spacer Inside and Outside of String:

$$Ratio_{spacer} = \frac{\text{Annular } Cap_{bbl/ft}}{DP\ Cap_{bbl/ft}}$$

e) Calculate Displacement Volume:

$DisplVol_{bbl} = VolBalance_{bbl} - \text{Spacer Behind}_{bbl}$

Hydraulics Formulas

Annular Velocity ($AV_{ft/min}$)

$$V_{ft/min} = \frac{24.51 \times \text{Pump Rate}_{gpm}}{HoleOD^2 - PipeOD^2}$$

Hydraulic Horsepower (HHP)

$$HHP = \frac{Q_{gpm} \times \text{Pump Pressure}_{psi}}{1{,}714}$$

$$HHP = \frac{Q_{bpm} \times \text{Pump Pressure}_{psi}}{40.8}$$

Rules of Thumb

Tripping Rules of Thumb

Ideally, drillers would like to keep bottomhole hydrostatic pressure constant during the trip out (POOH) and the trip in (RIH). However, this is impossible from the operational standpoint because of swab and surge pressures. Most tripping rules-of-thumb are closely associated with maintaining a safe hydrostatic overbalance that neither causes a kick nor lost circulation.

Slug Mud Weight Rule of Thumb

Slug mud weight is generally one ppg higher than the hole mud weight, with the objective being to unbalance the DP/annulus U-tube by enough to pull dry pipe. The condition of the mud, related to drill solids, and/or the mud weight range could influence the driller to accept less than one ppg.

Stuck Pipe

The causes of stuck pipe are broadly classified as differential or mechanical, and good monitoring and operating practices will minimize both types of pipe sticking. Differential sticking is caused by mud pressure overbalance and is influenced by drilling practices, type mud solids, permeability, bottom-hole assembly clearance, coefficient of friction and the lubricating characteristics of mud. Mechanical sticking is caused by deterioration of hole stability (shale problems, hole cleaning, etc.) and/or directional (crooked-hole) problems.

Rule of Thumb for Differentially Stuck Pipe

The estimated force required to pull free is equal to the contact force per unit length, times the length of pipe in contact with permeable formation times the coefficient of friction. This estimate tends to be more accurate in a straight hole than in a directional well.

Estimating Formula for Differential Sticking

$$F_{diff} = K\ (\Delta P)\ Area$$

Where:

K = Sticking coefficient (0.2 water base mud)
(ΔP) = Differential pressure
Area = Contact area

$$Area = L \times \left(\frac{12in.}{ft}\right) \times \left(\frac{\pi \times d}{3}\right)$$

(assume ⅓ of the drill collar circumference is buried)
Circumference = π x Diameter

Conclusion: Force to pull free increases as the length of pipe in contact with permeable formation increases, and as the coefficient of friction between pipe and wall increases.

Example

Given 6 ¼" DC:

$$\frac{\pi \times d}{3} = \frac{3.1416 \times 6.25}{3} = 6.545 \quad \textit{(round to 6.5)}$$

ΔP = 200 psi *(approx. 0.5 ppg overbalance at 8,000 ft)*

L = 200 ft *(of permeable zone)*

$F_{diff} = 0.2 \times 200_{psi} \times 200_{ft} \times 12_{in./ft} \times 6.5_{in.} = 624{,}000_{lbs}$

Free Point and Stretch Estimates

When the drill string is stuck, the free point method can be used to estimate the amount of free pipe in the hole.

Begin by pulling on the pipe with an initial force (F_i) that is at least 1,000 pounds more than the hanging weight of the string, and make a reference mark on the string. Increase the pull by increments (for example, 5,000 lbs) to final force (F_f) to determine a measurable stretch. Mark the string again, measure the distance between the marks and record as the stretch (S) in inches. Record the difference between F_f and F_i as the pull increment (PI). The amount of free pipe (L) in 1,000's of feet below the rotary can then be estimated. These estimates tend to be more accurate in straight holes than in directional wells.

Estimating Formula

The formula for free pipe length L is:

$$L = 1.9635 \times S \times \frac{OD^2 - ID^2}{PI}$$

The formula for pipe stretch S is:

$$S = \frac{PI \times L}{1.9635 \times (OD^2 - ID^2)}$$

Where:

L = Length of free pipe (1,000s ft)
S = Stretch (inches)
OD = OD of the pipe (inches)
ID = ID of the pipe (inches)
PI = Pull increment (1,000s lbs) = F_f - F_i

Example

Given:

Drillpipe size = 5", 19.5 lb/ft
OD = 5"
ID = 4.276"
F_i = 5,000 lb
F_f = 35,000 lb
S = 12"

Calculate:

$$PI = 35 - 5 = 30$$

$$L = 1.9635 \times 12 \times \frac{25 - 18.284}{30} = 5.27 \text{ thousand feet}$$

Estimating Temperature Drop Across a Choke or Orifice

Rule of Thumb

The temperature drop across a choke or orifice is about one degree Fahrenheit (F) per each pressure drop of one atmosphere (rounded at 15 psi).

Estimating Formula

$$T_{drop} = \frac{(P_h - P_L)\,psi}{15\,psi} \times 1°F$$

Where:

T_{drop} = Temperature drop (degrees)
P_h = Gas pressure before the choke (psi)
P_L = Gas pressure after the choke (psi)

Example

Calculate temperature drop if the gas pressure is reduced from 1,000 psi to 500 psi across a choke.

$$T_{drop} = \frac{(1{,}000 - 500)}{15} \times 1°F$$

= 33 x 1°F = 33°F temperature drop

Estimating Gas Well Flow Rates

Rule of Thumb

The approximate flow rate (in mmscfd) of a gas well through a blowdown line choke can be estimated by multiplying 24 hours/day, times the tubing pressure plus 15, times the square of the choke size in inches and divide by 1,000.

Estimating Formula

$$Q = \frac{24 \times (PL + 15) \times (Dch)^2}{1{,}000}$$

Where:

Q = Flowrate (mmscfd)
P_L = Pressure upstream of choke (psi)
D_{ch} = Choke size (inches)

Example

Calculate the estimated flowrate of a gas well, given that tubing pressure is 3,500 psi, and choke size is 1/4.

$$Q = \frac{24 \times (3{,}500 + 15) \times (0.25)^2}{1{,}000} = 5.273 \text{ mmscfd}$$

Area of a Circle (in²)

$$0.7854 \times D^2$$
$$\text{or } \pi D^2/4$$
$$\text{or } \pi R^2$$

Where:

D = diameter in inch
R = radius in inch

Force and Pressure

$$\text{Force}_{lb} = \text{Pressure}_{psi} \times \text{Area}_{sq\ in}$$

Weight of Spiral Drill Collars

ppf for spiral DC
= 0.96 x ppf for smooth DC of same OD & ID

Buoyancy Factor (BF)

$$BF = \frac{65.4 - MW_{ppg}}{65.4}$$

Pipe Elongation Due to Temperature

Since the well has higher temperatures than the air above ground, an elongation will take place.

Rule of Thumb

Pipe will elongate about 0.83 inches, per 100 feet of length, per 100 degree F increase in temperature. Knowing the surface temperature and the average temperature of the well, the elongation can be estimated.

Note: Elongation (stretch) is also caused by the hanging weight of pipe.

Estimating Formulas

$$BHT = \left(\frac{1°F}{100ft} \times TVD\right) + ST°F$$

$$T_a = \frac{BHT + ST}{2}$$

$$\Delta T = T_a - \text{Surface Temp}$$

$$\Delta L_T = 12_{in/ft} \times 0.0000069 \frac{in/in}{°F} \times L \times \Delta T$$

$$\Delta L_T = \frac{L}{100\,ft} \times \frac{\Delta T}{100°F} \times 0.83$$

Where:

BHT	= Bottomhole temperature (°F)
Depth	= True vertical depth (ft)
ST	= Surface temperature (°F)
T_a	= Average temperature (°F)
ΔT	= Change in average temperature (°F)
ΔL_T	= Elongation (inches)
L	= Length of pipe (ft)

Surface & Bottom Hole Pressures in Full Gas Column

Method A – Approximate gas gradient is 0.1 psi/ft

$$SP = BHP - (0.1_{psi/ft} \times TVD_{ft})$$

Method B – Exact equation

$$SP = BHP \times e^{-\left(\frac{0.01875 \times SG \times D}{Z_{avg} \times T_{avg}}\right)}$$

Where:

SP	= Surface Pressure (psi)
BHP	= Bottom hole pressure (psi)
SG	= Specific gravity of the gas
D	= Depth in TVD (feet
Z_{avg}	= Average compressibility factor of the gas
T_{avg}	= Average gas temp in degrees Rankine(°F + 460)

My Rules of Thumb

Pipe Size In.	Nom. Wt. Lb/Ft	Wall Thick. In.	Pipe ID In.	Plain End Wt. Lb/Ft	Upset Wt. Lb	Pipe End Dia. ID	Pipe End Dia. OD	API Designation	Tool Joint OD In.	Tool Joint ID In.	Tool Joint Length Ft.	with Tool Joint Weight Lb	with Tool Joint Capacity Bbls/Ft	with Tool Joint Displ. Bbls/Ft	without Tool Joint Capacity Bbls/Ft	without Tool Joint Displ. Bbls/Ft
External Upset – Grade E																
2 7/8	10.40	0.362	2.151	9.72	2.40	2.151	3.219	OH	3.875	2.156	1.29	34.99	0.00451	0.00389	0.00449	0.00353
3 1/2	13.30	0.368	2.764	12.31	4.00	2.602	3.824	NC 38 (IF)	4.750	2.688	1.54	61.10	0.00741	0.00515	0.00742	0.00448
3 1/2	15.50	0.449	2.602	14.63	2.80	2.602	3.824	NC 38 (IF)	5.000	2.563	1.59	74.82	0.00658	0.00606	0.00658	0.00532
Internal External Upset – Grade X																
5	19.50	0.362	4.276	17.93	16.80	3.653	5.188	NC 50 (EH)	6.375	3.500	1.65	120.23	0.01745	0.00784	0.01776	0.00652
External Upset – Grade G																
4	14.00	0.330	3.340	12.93	14.40	3.063	4.625	NC 46 (IF)	6.000	3.250	1.70	108.76	0.01082	0.00587	0.01084	0.00471
4 1/2	16.60	0.337	3.826	14.98	17.20	3.563	5.188	NC 50 (IF)	6.375	3.750	1.67	113.10	0.01421	0.00663	0.01422	0.00545
Internal External Upset – Grade G																
4 1/2	20.00	0.430	3.640	18.69	17.60	2.813	4.250	NC 46 (EH)	6.250	2.500	1.71	142.46	0.01252	0.00830	0.01287	0.00680
5	19.50	0.362	4.276	17.93	16.80	3.563	5.188	NC 50 (IF)	6.625	2.750	1.70	157.37	0.01719	0.00827	0.01776	0.00652
5	25.60	0.500	4.000	24.03	15.40	3.313	5.188	5 1/2 FH	7.250	3.250	1.82	188.17	0.01523	0.01075	0.01554	0.00874
5	25.60	0.500	4.000	24.03	15.40	3.313	5.188	5 1/2 FH	7.250	3.500	1.82	179.97	0.01535	0.01066	0.01554	0.00874
5 1/2	21.90	0.361	4.778	19.81	21.00	3.813	5.563	5 1/2 FH	7.250	3.500	1.79	184.41	0.02162	0.00925	0.02218	0.00721
Internal External Upset – Grade S																
5 1/2	21.90	0.361	4.778	19.81	21.00	3.813	5.563	HT 55	7.000	4.000	2.33	199.19	0.02172	0.00925	0.02218	0.00721
5 1/2	24.70	0.415	4.670	22.54	18.40	3.813	5.563	HT 55	7.000	3.750	2.31	210.15	0.02067	0.01042	0.02119	0.00820
5 7/8	23.40	0.361	5.153						7.000	4.25			0.02521	0.00971	0.02579	0.00773
6 5/8	25.20	0.330	5.965	22.19	25.87	5.315	6.929	HT 65	8.000	5.000	2.35	240.81	0.03385	0.01078	0.03456	0.00807
6 5/8	27.70	0.362	5.901	24.21	24.00	5.315	6.929	HT 65	8.000	4.750	2.39	284.15	0.03297	0.01194	0.03383	0.00881

DP OD (In).	Weight (ppf)	ID Tube (In.)	DP Capacity (bbl/ft)	Displacement (bbl/ft)	Closed-End (bbl/ft)
2 3/8	4.85	1.995	0.00387	0.0016	0.0055
	6.65	1.815	0.00320	0.0023	0.0055
2 7/8	6.45	2.469	0.00592	0.0021	0.0080
	6.85	2.441	0.00579	0.0022	0.0080
	8.35	2.323	0.00524	0.0028	0.0080
	10.40	2.151	0.00449	0.0035	0.0080
3 1/2	8.50	3.063	0.00911	0.0028	0.0119
	9.50	2.992	0.00870	0.0032	0.0119
	11.20	2.900	0.00817	0.0037	0.0119
	13.30	2.764	0.00742	0.0045	0.0119
	15.50	2.602	0.00658	0.0053	0.0119
4	11.85	3.476	0.01174	0.0038	0.0155
	14.00	3.340	0.01084	0.0047	0.0155
	15.70	3.240	0.01020	0.0053	0.0155
4 1/2	12.75	4.000	0.01554	0.0041	0.0197
	13.75	3.958	0.01522	0.0045	0.0197
	16.60	3.826	0.01422	0.0055	0.0197
	20.00	3.640	0.01287	0.0068	0.0197
5	16.25	4.408	0.01888	0.0054	0.0243
	19.50	4.276	0.01776	0.0065	0.0243
	20.50	4.214	0.01725	0.0070	0.0243
5 1/2	21.90	4.778	0.02218	0.0072	0.0294
	24.70	4.670	0.02119	0.0082	0.0294
5 7/8	23.40	5.153	0.02579	0.0077	0.0335
	26.30	5.045	0.02472	0.0088	0.0335
	28.67	4.875	0.02309	0.0104	0.0335
6 5/8	22.20	6.065	0.03573	0.0069	0.0426
	25.20	5.965	0.03456	0.0081	0.0426
	31.90	5.761	0.03224	0.0104	0.0426
7 5/8	29.25	6.969	0.04718	0.0093	0.0565

Note: Capacity and displacement value are without tool joint.

Nominal Size In.	Nominal Tube Dimensions		Tool Joint			Approx. Weight Tube & Joints lb/ft	Make-up Torque (ft-lb)	Capacity bbls/ft	Displacement bbls/ft
	Inside Dia. In.	Wall Thickness In.	Connection Size In.	Outside Dia. In.	Inside Dia. In.				
3 ½	2 1/16	0.719	NC 38 (3 ½ IF)	4 ¾	2 3/16	25.3	9,900	0.0042	0.0092
3 ½	2 ¼	0.625	NC 38 (3 ½ IF)	4 ¾	2 ⅜	23.2	9,900	0.0050	0.0084
4	2 9/16	0.719	NC 40 (4 FH)	5 ¼	2 11/16	27.2	13,250	0.0073	0.0100
4 ½	2 ¾	0.875	NC 46 (4 IF)	6 ¼	2 ⅞	41.0	21,800	0.0074	0.0149
5	3	1.000	NC 50 (4 ½ IF)	6 ⅝	3 1/16	49.3	29,400	0.0088	0.0179
5 ½	3 ⅜	1.063	5 ½ FH	7	3 ½	57.0	33,200	0.0111	0.0207
6 ⅝	4 ½	1.063	6 ⅝ FH	8	4 ½	70.8	46,900	0.0196	0.0257

OD	ID Capacity	1 ½" 0.0022	1 ¾" 0.0030	2" 0.0039	2 ¼" 0.0049	2 ½" 0.0061	2 ¾" 0.0073	3" 0.0087	3 ¼" 0.0103	3 ½" 0.0119	3 ¾" 0.0137
4"	Wt lb/ft	36.7	34.5	32.0	29.2	-	-	-	-	-	-
	Disp bbl/ft	0.0133	0.0125	0.0116	0.0106	-	-	-	-	-	-
4 ¼"	Wt lb/ft	42.2	40.0	37.5	34.7	-	-	-	-	-	-
	Disp bbl/ft	0.0153	0.0145	0.0136	0.0126	-	-	-	-	-	-
4 ½"	Wt lb/ft	48.1	45.9	43.4	40.6	-	-	-	-	-	-
	Disp bbl/ft	0.0175	0.0167	0.0158	0.0148	-	-	-	-	-	-
4 ¾"	Wt lb/ft	54.3	52.1	49.6	46.8	43.6	-	-	-	-	-
	Disp bbl/ft	0.0197	0.0189	0.0181	0.0170	0.0159	-	-	-	-	-
5"	Wt lb/ft	60.8	58.6	56.1	53.3	50.1	-	-	-	-	-
	Disp bbl/ft	0.0221	0.0213	0.0204	0.0194	0.0182	-	-	-	-	-
5 ¼"	Wt lb/ft	67.6	65.4	62.9	60.1	56.9	53.4	-	-	-	-
	Disp bbl/ft	0.0246	0.0238	0.0229	0.0219	0.0207	0.0194	-	-	-	-
5 ½"	Wt lb/ft	74.8	72.6	70.1	67.3	64.1	60.6	56.8	-	-	-
	Disp bbl/ft	0.0272	0.0264	0.0255	0.0245	0.0233	0.0221	0.0207	-	-	-
5 ¾"	Wt lb/ft	82.3	80.1	77.6	74.8	71.6	68.1	64.3	-	-	-
	Disp bbl/ft	0.0299	0.0291	0.0282	0.0272	0.0261	0.0248	0.0234	-	-	-
6"	Wt lb/ft	90.1	87.9	85.4	82.6	79.4	75.9	72.1	67.9	63.4	-
	Disp bbl/ft	0.0328	0.0320	0.0311	0.0301	0.0289	0.0276	0.0262	0.0247	0.0231	-
6 ¼"	Wt lb/ft	98.0	95.8	93.3	90.5	87.3	83.8	80.0	75.8	71.3	-
	Disp bbl/ft	0.0356	0.0349	0.0339	0.0329	0.0318	0.0305	0.0291	0.0276	0.0259	-
6 ½"	Wt lb/ft	107.0	104.8	102.3	99.5	96.3	92.8	89.0	84.8	80.3	-
	Disp bbl/ft	0.0389	0.0381	0.0372	0.0362	0.0350	0.0338	0.0324	0.0308	0.0292	-

Spiral Drill Collars

Approx. Displacement of Spiral Drill Collar in bbls/ft

$$\frac{(OD^2 - ID^2) \times 2.56}{2,747}$$

OD	ID / Capacity	1 ½" 0.0022	1 ¾" 0.0030	2" 0.0039	2 ¼" 0.0049	2 ½" 0.0061	2 ¾" 0.0073	3" 0.0087	3 ¼" 0.0103	3 ½" 0.0119	3 ¾" 0.0137
6 ¾"	Wt lb/ft	116.0	113.8	111.3	108.5	105.3	101.8	98.0	93.8	89.3	-
	Disp bbl/ft	0.0422	0.0414	0.0405	0.0395	0.0383	0.0370	0.0356	0.0341	0.0325	-
7"	Wt lb/ft	125.0	122.8	120.3	117.5	114.3	110.8	107.0	102.8	98.3	93.4
	Disp bbl/ft	0.0455	0.0447	0.0438	0.0427	0.0416	0.0403	0.0389	0.0374	0.0358	0.0340
7 ¼"	Wt lb/ft	134.0	131.8	129.3	126.5	123.3	119.8	116.0	111.8	107.3	102.4
	Disp bbl/ft	0.0487	0.0479	0.0470	0.0460	0.0449	0.0436	0.0422	0.0407	0.0390	0.0372
7 ½"	Wt lb/ft	144.0	141.8	139.3	136.5	133.3	129.8	126.0	121.8	117.3	112.4
	Disp bbl/ft	0.0524	0.0516	0.0507	0.0497	0.0485	0.0472	0.0458	0.0443	0.0427	0.0409
7 ¾"	Wt lb/ft	154.0	151.8	149.3	146.5	143.3	139.8	136.0	131.8	127.3	122.4
	Disp bbl/ft	0.0560	0.0552	0.0543	0.0533	0.0521	0.0509	0.0495	0.0479	0.0463	0.0445
8"	Wt lb/ft	165.0	162.8	160.3	157.5	154.3	150.8	147.0	142.8	138.3	133.4
	Disp bbl/ft	0.0600	0.0592	0.0583	0.0573	0.0561	0.0549	0.0535	0.0520	0.0503	0.0485
8 ¼"	Wt lb/ft	176.0	173.8	171.3	168.5	165.3	161.8	158.0	153.8	149.3	144.4
	Disp bbl/ft	0.0640	0.0632	0.0623	0.0613	0.0601	0.0589	0.0575	0.0560	0.0543	0.0525
8 ½"	Wt lb/ft	187.0	184.8	182.3	179.5	176.3	172.8	169.0	164.8	160.3	155.4
	Disp bbl/ft	0.0680	0.0672	0.0663	0.0653	0.0641	0.0629	0.0615	0.0600	0.0583	0.0565
8 ¾"	Wt lb/ft	199.0	196.8	194.3	191.5	188.3	184.8	181.0	176.8	172.3	167.4
	Disp bbl/ft	0.0724	0.0716	0.0707	0.0697	0.0685	0.0672	0.0658	0.0643	0.0697	0.0609
9"	Wt lb/ft	210.2	208.0	205.6	202.7	199.6	196.0	192.2	188.0	183.5	178.7
	Disp bbl/ft	0.0765	0.0757	0.0748	0.0738	0.0726	0.0714	0.0700	0.0685	0.0668	0.0651
10"	Wt lb/ft	260.9	258.8	256.3	253.4	250.3	246.8	242.9	238.8	234.3	229.4
	Disp bbl/ft	0.0950	0.0942	0.0933	0.0923	0.0911	0.0898	0.0884	0.0869	0.0853	0.0835

Drill Collar Capacity & Displacement

DC OD (In.)	DC ID (In.)	DC Capacity (bbl/ft)	Steel Displ. (bbl/ft)	Closed-End (bbl/ft)
3 ⅛	1.250	0.00152	0.0080	0.0095
3 ¾	1.500	0.00219	0.0115	0.0137
4 ⅛	2.000	0.00389	0.0126	0.0165
4 ¾	2.000	0.00389	0.0181	0.0219
6	2.250	0.00492	0.0301	0.0350
6 ¼	2.500	0.00607	0.0318	0.0379
6 ½	2.500	0.00607	0.0350	0.0410
8	2.813	0.00768	0.0545	0.0622
8 ¼	2.875	0.00803	0.0589	0.0661
8 ½	2.875	0.00803	0.0622	0.0629
9	2.875	0.00803	0.0707	0.0787
9 ½	2.875	0.00803	0.0796	0.0877
10	2.875	0.00803	0.0891	0.0971
10 ½	2.875	0.00803	0.0991	0.1071
11	2.875	0.00803	0.1095	0.1175
11 ½	2.875	0.00803	0.1204	0.1285
12	2.875	0.00803	0.1319	0.1399

Well Data

Date _____

TD _____ | TVD _____

Mud weight _____ ppg

Slow pump _____ psi @ _____ SPM

Fast pump _____ psi @ _____ SPM

Pump output _____ bbl/stk

Drill String Capacity		Annulus Capacity	
Sec. A	_____ bbl	Sec. F	_____ bbl
Sec. B	_____ bbl	Sec. G	_____ bbl
Sec. C	_____ bbl	Sec. H	_____ bbl
Sec. D	_____ bbl		_____ bbl
Sec. E	_____ bbl		_____ bbl
Total	_____ **bbl**	**Total**	_____ **bbl**

Kick Data

SIDP _____ psi | SICP _____ psi

Volume gained _____ bbl

Old mud weight (OMW) _____ ppg

Bit at _____ ft

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Kill Data ("Wait & Weight" Method)

Kill rate (slow or fast pump) = _____ SPM

Kill weight mud (KWM) = $OMW + \frac{SIDPP}{0.052 \times TVD}$ = _____ ppg

Initial circulation pressure (ICP) = SIDP + Kill rate pressure = _____ psi

Final circulation pressure (FCP) = Kill rate pressure x $\frac{KWM}{OMW}$ = _____ psi

Surface to bit _____ strokes | Bit to surface _____ strokes

One circulation _____ strokes

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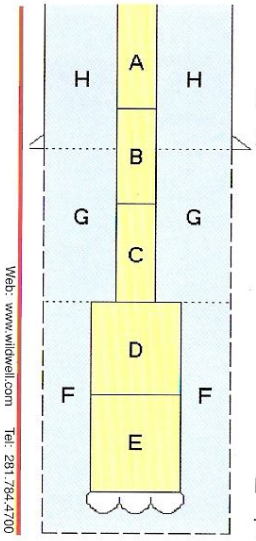


NOTE: Enlarge page by 125% to get 8½ x11" full-size worksheet.

Casing size _____

Set at _____

Bit at _____ ft

TD at _____ ft

Web: www.wildwell.com Tel: 281.784.4700

Kill Schedule ("Wait & Weight" Method)

Strokes	Volumes	Drillpipe Press	Strokes	Volume	Drillpipe Press
0	0	ICP			
			To Bit		FCP

Kill Chart

PRESSURE

STROKES

Tubing Size		Normal Weight		Grade	Wall Thick. In.	Inside Dia. In.	Threaded Coupling				Collapse Resistance PSI	Internal Yield Pressure PSI	Joint Yield Strength		Capacity bbl/ft	Displacement	
							Drift Dia In.	Coupling Outside dia.					T&C Non-Upset Lb	T&C Upset Lb		T&C Non-Upset bbl/ft	T&C Upset bbl/ft
Nominal In.	OD In.	T&C Non-Upset lb/ft	T&C Upset lb/ft					Non-Upset In.	Upset Req. In.	Upset Spec In.							
3/4	1.050	1.14	1.20	H-40	0.113	.824	.730	1.313	1.660		7,680	7,530	6,360	13,300	0.00066	0.00041	0.00044
	1.050	1.14	1.20	J-55	0.113	.824	.730	1.313	1.660		10,560	10,560	8,740	18,290	0.00066	0.00041	0.00044
	1.050	1.14	1.20	C-75	0.113	.824	.730	1.313	1.660		14,410	14,130	11,920	24,940	0.00066	0.00041	0.00044
	1.050	1.14	1.20	N-80	0.113	.824	.730	1.313	1.660		15,370	15,070	12,710	26,610	0.00066	0.00041	0.00044
1	1.315	1.70	1.80	H-40	0.133	1.049	.955	1.660	1.900		7,270	7,080	10,960	19,760	0.00107	0.00062	0.00065
	1.315	1.70	1.80	J-55	0.133	1.049	.955	1.660	1.900		10,000	9,730	15,060	27,160	0.00107	0.00062	0.00065
	1.315	1.70	1.80	C-75	0.133	1.049	.955	1.660	1.900		13,640	13,270	20,540	37,040	0.00107	0.00062	0.00065
	1.315	1.70	1.80	N-80	0.133	1.049	.955	1.660	1.900		14,550	14,160	21,910	39,510	0.00107	0.00062	0.00065
1 1/4	1.660	2.30	2.40	H-40	0.125	1.410	1.286	2.054	2.200		5,570	5,270			0.00193		
	1.660	2.30	2.40	H-40	0.140	1.380	1.286	2.054	2.200		6,180	5,900	15,530	26,740	0.00185	0.00084	0.00087
	1.660	2.30	2.40	J-55	0.140	1.410	1.286	2.054	2.200		7,660	7,250	21,360	36,770	0.00185	0.00084	0.00087
	1.660	2.30	2.40	J-55	0.140	1.380	1.286	2.054	2.200		8,490	8,120	21,360	36,770	0.00185	0.00084	0.00087
	1.660	2.30	2.40	C-75	0.140	1.380	1.286	2.054	2.200		11,580	11,070	29,120	50,140	0.00185	0.00084	0.00087
	1.660	2.30	2.40	N-80	0.140	1.380	1.286	2.054	2.200		12,360	11,810	31,060	53,480	0.00185	0.00084	0.00087

Tubing Size		Normal Weight		Grade	Wall Thick. In.	Inside Dia. In.	Threaded Coupling				Collapse Resistance PSI	Internal Yield Pressure PSI	Joint Yield Strength		Capacity bbl/ft	Displacement	
							Drift Dia In.	Coupling Outside dia.					T&C Non-Upset Lb	T&C Upset Lb		T&C Non-Upset bbl/ft	T&C Upset bbl/ft
Nominal In.	OD In.	T&C Non-Upset lb/ft	T&C Upset lb/ft					Non-Upset In.	Upset Req. In.	Upset Spec In.							
1 1/2	1.900	2.75	2.90	H-40	0.145	1.650	1.516	2.200	2.500		4,920	4,610	19,090	31,980	0.00252	0.00100	0.00106
	1.900	2.75	2.90	H-40	0.145	1.610	1.516	2.200	2.500		5,640	5,340	19,090	31,980	0.00252	0.00100	0.00106
	1.900	2.75	2.90	J-55	0.125	1.650	1.516	2.200	2.500		6,640	6,330	19550	19550	0.00264	0.00100	0.00106
	1.900	2.75	2.90	J-55	0.145	1.610	1.516	2.200	2.500		7,750	7,350	26,250	43,970	0.00252	0.00100	0.00106
	1.900	2.75	2.90	C-75	0.145	1.610	1.516	2.200	2.500		10,570	10,020	35,800	59,960	0.00252	0.00100	0.00106
	1.900	2.75	2.90	N-80	0.145	1.610	1.516	2.200	2.500		11,280	10,680	38,130	63,950	0.00252	0.00100	0.00106
2 1/16	2.063			H-40	0.156	1.751					7,770	7,630			0.00298		
	2.063			J-55	0.156	1.751					7,690	7,280			0.00298		
	2.063			C-75	0.156	1.751					10,480	9,920			0.00298		
	2.063			N-80	0.156	1.751					11,180	10,590			0.00298		

Tubing Size		Normal Weight		Grade	Wall Thick. In.	Inside Dia. In.	Threaded Coupling				Collapse Resistance PSI	Internal Yield Pressure PSI	Joint Yield Strength		Capacity bbl/ft	Displacement	
							Drift Dia In.	Coupling Outside dia.					T&C Non-Upset Lb	T&C Upset Lb		T&C Non-Upset bbl/ft	T&C Upset bbl/ft
Nominal In.	OD In.	T&C Non-Upset lb/ft	T&C Upset lb/ft					Non-Upset In.	Upset Rea. In.	Upset Spec In.							
2 3/8	2.375	4.00		H-40	0.167	2.041	1.947	2.875			5,230	4,920	30,130		0.00405	0.00146	
	2.375	4.60	4.70	H-40	0.190	1.995	1.901	2.875	3.063	2.910	5,890	5,600	35,960	52,170	0.00387	0.00167	0.00171
	2.375	4.60	4.70	J-55	0.190	1.995	2.041	2.875	3.063	2.910	7,190	6,770	49,450	71,730	0.00387	0.00167	0.00171
	2.375	4.60	4.70	J-55	0.190	1.995	2.041	2.875	3.063	2.910	8,100	7,700	49,450	71,730	0.00387	0.00167	0.00171
	2.375	4.60	4.70	C-75	0.190	2.041	1.901	2.875	3.063	2.910	9,520	9,230	67,430	97,820	0.00387	0.00167	0.00171
	2.375	4.60	4.70	C-75	0.190	1.995	1.901	2.875	3.063	2.910	11,040	10,500	67,430	97,820	0.00387	0.00167	0.00171
	2.375	5.80	5.95	C-75	0.254	1.867	1.773	2.875	3.063	2.910	14,330	14,040	96,560	126,940	0.00339	0.00211	0.00216
	2.375	4.60	4.70	N-80	0.190	2.041	1.901	2.875	3.063	2.910	9,980	9,840	71,930	104,340	0.00387	0.00167	0.00171
	2.375	4.60	4.70	N-80	0.190	1.995	1.901	2.875	3.063	2.910	11,780	11,200	71,930	104,340	0.00387	0.00167	0.00171
	2.375	5.80	5.95	N-80	0.254	1.867	1.773	2.875	3.063	2.910	15,280	14,970	102,990	135,400	0.00339	0.00211	0.00216
	2.375	4.60	4.70	P-105	0.190	1.995	1.901	2.875	3.063	2.910	15,460	14,700	94,410	136,940	0.00387	0.00167	0.00171
	2.375	5.80	5.95	P-105	0.254	1.867	1.773	2.875	3.063	2.910	20,060	19,650	135,180	177,710	0.00339	0.00211	0.00216

Tubing Size		Normal Weight		Grade	Wall Thick. In.	Inside Dia. In.	Threaded Coupling				Collapse Resistance PSI	Internal Yield Pressure PSI	Joint Yield Strength		Capacity bbl/ft	Displacement	
							Drift Dia In.	Coupling Outside dia.					T&C Non-Upset Lb	T&C Upset Lb		T&C Non-Upset bbl/ft	T&C Upset bbl/ft
Nominal In.	OD In.	T&C Non-Upset lb/ft	T&C Upset lb/ft					Non-Upset In.	Upset Rea. In.	Upset Spec In.							
2 7/8	2.875	6.40	6.50	H-40	0.217	2.441	2.347	3.500	3.668	3.460	5,580	5,280	52,780	72,480	0.00579	0.00233	0.00236
	2.875	6.40	6.50	J-55	0.217	2.441	2.347	3.500	3.668	3.460	7,680	7,260	72,580	99,660	0.00579	0.00233	0.00236
	2.875	6.40	6.50	C-75	0.217	2.441	2.347	3.500	3.668	3.460	10,470	9,910	98,970	135,900	0.00579	0.00233	0.00236
	2.875	8.60	8.70	C-75	0.308	2.259	2.165	3.500	3.668	3.460	14,350	14,060	149360	185,290	0.00496	0.00313	0.00317
	2.875	6.40	6.50	N-80	0.217	2.441	2.347	3.500	3.668	3.460	11,170	10,570	105,570	144,960	0.00579	0.00233	0.00236
	2.875	8.60	8.70	N-80	0.308	2.259	2.165	3.500	3.668	3.460	15,300	15,000	159,310	198,710	0.00496	0.00313	0.00317
	2.875	6.40	6.50	P-105	0.217	2.441	2.347	3.500	3.668	3.460	14,010	13,870	138,560	190,260	0.00579	0.00233	0.00236
	2.875	8.60	8.70	P-105	0.308	2.259	2.165	3.500	3.668	3.460	20,090	19,690	209,100	260,810	0.00496	0.00313	0.00317
3 1/2	3.500	7.70		H-40	0.216	3.068	2.943	4.250			4,630	4,320	65,070		0.00914	0.00280	
	3.500	9.20	9.30	H-40	0.254	2.992	2.867	4.250	4.500	4.180	5,380	5,080	79,540	103,810	0.00870	0.00335	0.00338
	3.500	10.20		H-40	0.289	2.922	2.797	4.250			6,060	5,780	92,550		0.00829	0.00371	
	3.500	7.70		J-55	0.215	3.068	2.943	4.250			5,970	5,940	89,470		0.00914	0.00262	

Tubing Size		Normal Weight		Grade	Wall Thick. In.	Inside Dia. In.	Threaded Coupling				Collapse Resistance PSI	Internal Yield Pressure PSI	Joint Yield Strength		Capacity bbl/ft	Displacement	
							Drift Dia In.	Coupling Outside dia.					T&C Non-Upset Lb	T&C Upset Lb		T&C Non-Upset bbl/ft	T&C Upset bbl/ft
Nominal In.	OD In.	T&C Non-Upset lb/ft	T&C Upset lb/ft					Non-Upset In.	Upset Reg. In.	Upset Spec In.							
3 1/2	3.500	9.30		J-55	0.289	2.922	2.797	4.250			7,400	6,990	127,250		0.00829	0.00371	
	3.500	10.20		J-55	0.289	2.922	2.797	4.250			8,330	7,950	127,250		0.00829	0.00371	
	3.500	7.70		C-75	0.216	3.068	2.943	4.250			7,540	8,100	122,010		0.00914	0.00280	
	3.500	10.20		C-75	0.289	2.922	2.797	4.250			11,360	10,840	173,530		0.00829	0.00371	
	3.500	12.70	12.95	C-75	0.375	2.750	2.625	4.250	4.500	4.180	14,350	14,060	230,990	276,120	0.00735	0.00462	0.00471
	3.500	7.70		N-80	0.216	3.068	2.943	4.250			7,870	8,640	130,140		0.00914	0.00280	
	3.500	10.20		N-80	0.289	2.922	2.797	4.250			12,120	11,560	185,100		0.00829	0.00371	
	3.500	12.70	12.95	N-80	0.375	2.750	2.625	4.250	4.500	4.180	15,310	15,000	246,390	294,530	0.00735	0.00462	0.00471
	3.500	9.20	9.30	P-105	0.254	2.992	2.867	4.250	4.500	4.180	13,050	13,340	208,800	271,970	0.00870	0.00335	0.00338
	3.500	12.70	12.95	P-105	0.375	2.750	2.625	4.250	4.500	4.180	20,090	19,690	323,390	386,570	0.00735	0.00462	0.00471

Tubing Size		Normal Weight		Grade	Wall Thick. In.	Inside Dia. In.	Threaded Coupling				Collapse Resistance PSI	Internal Yield Pressure PSI	Joint Yield Strength		Capacity bbl/ft	Displacement	
							Drift Dia In.	Coupling Outside dia.					T&C Non-Upset Lb	T&C Upset Lb		T&C Non-Upset bbl/ft	T&C Upset bbl/ft
Nominal In.	OD In.	T&C Non-Upset lb/ft	T&C Upset lb/ft					Non-Upset In.	Upset Reg. In.	Upset Spec In.							
4	4.000	9.50		H-40	0.226	3.548	3.423	4.750			4,050	3,960	72,000		0.01223	0.00346	
	4.000		11.00	H-40	0.262	3.476	3.351		5.000		4,900	4,590		123,070	0.01174		0.00400
	4.000	9.50		J-55	0.226	3.548	3.423	4.750			5,110	5,440	99,010		0.01223	0.00346	
	4.000		11.00	J-55	0.262	3.476	3.351		5.000		6,590	6,300		169,220	0.01174		0.00400
	4.000	9.50		C-75	0.226	3.548	3.423	4.750			6,350		135,010		0.01223	0.00346	
	4.000		11.00	C-75	0.262	3.476	3.351		5.000		8,410	8,600		230,750	0.01174		0.00400
	4.000	9.50		N-80	0.226	3.548	3.423	4.750			6,590	7,910	144,010		0.01223	0.00346	
	4.000		11.00	N-80	0.262	3.476	3.351		5.000		8,800	9,170		246,140	0.01174		0.00400
4 1/2	4.500	12.60	12.75	H-40	0.271	3.958	3.833	5.200	5.563		4,490	4,220	104,360	144,020	0.01522	0.00458	0.00464
	4.500	12.60	12.75	J-55	0.271	3.958	3.833	5.200	5.563		5,730	5,800	143,500	198,030	0.01522	0.00458	0.00464
	4.500	12.60	12.75	C-75	0.271	3.958	3.833	5.200	5.563		7,200	7,900	195,680	270,040	0.01522	0.00458	0.00464
	4.500	12.60	12.75	N-80	0.271	3.958	3.833	5.200	5.563		7,500	8,430	208,730	288,040	0.01522	0.00458	0.00464

Tubing Size	Connection Data				Tube Data																
	Outer Dia. In.	Inner Dia. In.	Make-up Torque	Grade	Outer Dia. In.	Inner Dia. In.	Drift	Wall Thick	Cross Section	100% Yield	Ult. Strength	Depth 100%	Pull 100%	PSI Burst 100%	Collapse 100%	Cap. Gals/1000 ft	Disp.	Capacity bbls/ft	Disp.
¾" CS HYDRIL 1.5# P-110	1.327	0.687	300	P-110	1.050	0.742	0.648	0.154	0.433	110,000	125,000	31,700	47,600	32,200	26,200	22.5	15.3	0.00054	0.00036
1" CS HYDRIL 2.25# C-75	1.600	0.864	400	C-75	1.315	0.957	0.848	0.179	0.639	75,000	95,000	21,300	48,000	20,400	17,600	37.4	34.4	0.00089	0.00082
1" CS HYDRIL 2.25# N-80/L-80	1.600	0.864	400	N-L-80	1.315	0.957	0.848	0.179	0.639	80,000	100,000	22,600	51,000	21,800	18,800	37.4	34.4	0.00089	0.00082
1" CS HYDRIL 2.25# T-95	1.600	0.864	400	T-95	1.315	0.957	0.848	0.179	0.639	95,000	105,000	27,000	60,700	25,900	22,300	37.4	34.4	0.00089	0.00082
1" CS HYDRIL 2.25# P-110	1.600	0.864	400	P-110	1.315	0.957	0.848	0.179	0.639	110,000	125,000	31,200	70,300	29,900	25,900	37.4	34.4	0.00089	0.00082
1" CS HYDRIL 2.25# S-135	1.600	0.864	500	S-135	1.315	0.957	0.848	0.179	0.639	135,000	145,000	38,300	86,200	36,700	31,700	37.4	34.4	0.00089	0.00082
1-¼" CS HYDRIL 3.02# C-75	1.927	1.218	600	C-75	1.660	1.278	1.184	0.191	0.881	75,000	95,000	21,800	66,000	17,200	15,200	66.6	46.2	0.00159	0.00110
1-¼" CS HYDRIL 3.02# N-80/L-80	1.927	1.218	600	N-L-80	1.660	1.278	1.184	0.191	0.881	80,000	100,000	23,500	71,000	18,400	16,200	66.6	46.2	0.00159	0.00110
1-¼" CS HYDRIL 3.02# T-95	1.927	1.218	600	T-95	1.660	1.278	1.184	0.191	0.881	95,000	105,000	27,700	83,700	21,900	19,300	66.6	46.2	0.00159	0.00110
1-¼" CS HYDRIL 3.02# P-110	1.927	1.218	600	P-110	1.660	1.278	1.184	0.191	0.881	110,000	125,000	32,000	96,600	25,300	22,400	66.6	46.2	0.00159	0.00110
1-¼" CS HYDRIL 3.02# S-135	1.927	1.218	600	S-135	1.660	1.278	1.184	0.191	0.881	135,000	145,000	39,400	119,000	31,000	27,500	66.6	46.2	0.00159	0.00110
1-½" CS HYDRIL 3.64# N-80/L-80	2.162	1.440	800	N-L-80	1.900	1.500	1.406	0.200	1.068	80,000	100,000	23,300	85,000	16,800	15,000	91.8	55.7	0.00219	0.00133
1-½" CS HYDRIL 3.64# P-110	2.162	1.440	800	P-110	1.900	1.500	1.406	0.200	1.068	110,000	125,000	32,300	117,500	23,000	20,700	91.8	55.7	0.00219	0.00133
1-½" CS HYDRIL 3.64# S-135	2.162	1.440	800	S-135	1.900	1.500	1.406	0.200	1.068	135,000	145,000	39,600	144,199	28,421	25,429	91.8	55.7	0.00219	0.00133
2-⅛" CS HYDRIL 3.25# N-80/L-80	2.330	1.700	900	N-L-80	2.063	1.751	1.657	0.156	0.935	80,000	100,000	23,000	75,000	12,100	11,200	125.0	49.7	0.00298	0.00118
2-⅜" EUE 8RD 4.7# N-80/L-80	3.063	1.995	1,500	N-L-80	2.375	1.995	1.901	0.190	1.304	80,000	100,000	22,200	104,300	12,800	11,770	162.3	71.9	0.00386	0.00171

Tubing Size	Connection Data				Tube Data																
	Outer Dia. In.	Inner Dia. In.	Make-up Torque	Grade	Outer Dia. In.	Inner Dia. In.	Drift	Wall Thick	Cross Section	100% Yield	Ult. Strength	Depth 100%	Pull 100%	PSI Burst 100%	Collapse 100%	Cap. Gals/1000 ft	Disp.	Capacity bbls/ft	Disp.
2-⅜" PH-6 HYDRIL 5.95# N-80/L-80	2.906	1.805	2,200	N-L-80	2.375	1.867	1.773	0.254	1.692	80,000	100,000	22,700	135,000	17,100	15,300	142.2	91.0	0.00339	0.00217
2-⅜" PH-6 HYDRIL 5.95# RY-85	2.906	1.805	2,200	RY-85	2.375	1.867	1.773	0.254	1.692	85,000	100,000	24,100	143,800	18,200	16,240	142.2	91.0	0.00339	0.00217
2-⅜" PH-6 HYDRIL 5.95# T-95	2.906	1.805	2,200	T-95	2.375	1.867	1.773	0.254	1.692	95,000	110,000	27,000	160,740	19,665	17,595	142.2	91.0	0.00339	0.00217
2-⅜" PH-6 HYDRIL 5.95# P-110	2.906	1.805	2,700	P-110	2.375	1.867	1.773	0.254	1.692	105,000	120,000	29,900	178,000	22,500	20,060	142.2	91.0	0.00339	0.00217
2-⅞" EUE 8RD 6.5# N-80/L-80	3.668	2.441	2,300	N-L-80	2.875	2.441	2.347	0.217	1.812	80,000	100,000	22,300	145,000	12,100	11,160	243.0	99.5	0.00579	0.00237
2-⅞" PH-6 HYDRIL 8.7# N-80/L-80	3.500	2.200	3,000	N-L-80	2.875	2.259	2.165	0.308	2.484	80,000	100,000	22,800	198,700	17,140	15,300	208.1	133.1	0.00495	0.00317
2-⅞" PH-6 HYDRIL 7.9# N-80/L-80	3.437	2.265	3,000	N-L-80	2.875	2.323	2.229	0.276	2.254	80,000	100,000	22,800	180,000	15,300	13,900	220.0	120.9	0.00524	0.00288
2-⅞" PH-6 HYDRIL 7.9# T-95	3.437	2.265	3,200	T-95	2.875	2.323	2.229	0.276	2.254	95,000	110,000	27,098	214,082	18,000	16,000	220.0	120.9	0.00524	0.00288
2-⅞" PH-6 HYDRIL 7.9# P-110	3.437	2.265	3,500	P-110	2.875	2.323	2.229	0.276	2.254	105,000	120,000	29,900	236,000	20,100	18,200	220.0	120.9	0.00524	0.00288
3-½" EUE 8RD 9.3# N-80/L-80	4.500	2.992	2,400-3,200	N-L-80	3.500	2.992	2.867	0.254	2.590	80,000	100,000	22,200	207,200	11,600	10,700	365.2	134.5	0.00870	0.00320
3-½" EUE 8RD 9.3# P-110	4.500	2.992	3,000-4,000	P-110	3.500	2.992	2.867	0.254	2.590	110,000	125,000	30,600	284,900	15,900	14,800	365.2	134.5	0.00870	0.00320
3-½" PH-6 HYDRIL 12.95# N-80/L-80	4.312	2.687	5,500	N-L-80	3.500	2.750	2.625	0.375	3.682	80,000	100,000	22,700	294,500	17,100	15,310	308.4	198.1	0.00734	0.00472
3-½" PH-6 HYDRIL 12.95# T-95	4.313	2.687	6,000	T-95	3.500	2.750	2.625	0.375	3.682	95,000	105,000	27,000	386,600	20,300	18,100	308.4	198.1	0.00734	0.00472
3-½" PH-6 HYDRIL 12.95# P-110	4.312	2.687	7,000	P-110	3.500	2.750	2.625	0.375	3.682	105,000	120,000	29,800	386,600	22,500	20,090	308.4	198.1	0.00734	0.00472
4-½" PH-6 HYDRIL 15.50# P-110	5.125	3.765	8,500	P-110	4.500	3.826	3.701	0.337	4.407	110,000	125,000	31,300	485,000	16,480	14,340	598.0	229.2	0.01424	0.00546

Casing OD (In.)	Weight (ppf)	Burst Pressure (psi)						Collapse Pressure (psi)					
		H40	J/K 55	C75	N80	C95	P110	H40	J/K 55	C75	N80	C95	P110
4 ½	9.5		4,380						3,310				
	11.6		5,350	7,290	7,780	9,240	10,690		4,960	6,100	6,350	7,030	7,580
	13.5		6,200	8,460	9,020	10,710	12,410		6,420	8,140	8,540	9,660	10,680
	15.1		7,210	9,830	10,480		14,420		7,620	10,390	11,080		14,350
5	11.5		4,240						3,060				
	13.0		4,870	6,640	7,090				4,140	4,990	5,140		
	15.0		5,700	7,770	8,290	9,840	11,400		5,500	6,970	7,250	8,090	8,830
	18.0		6,970	9,500	10,140	12,040	13,940		7,390	10,000	10,490	12,010	13,470
5 ½	14.0		4,270	5,820					3,120	3,560			
	15.5		4,810	6,560	7,000		9,620		3,860	4,860	4,990		5,620
	17.0		5,320	7,250	7,740	9,190	10,640		4,910	6,070	5,890	6,930	8,520
	20.0		6,310	8,610	9,190	10,910	12,640		6,610	8,440	8,830	10,000	11,100
	23.0		7,270	9,900	10,560	12,540	14,520		7,670	10,400	11,160	12,920	14,520
6 ⅝	20.0		4,180		6,090	7,230			3,060		3,480	3,830	
	24.0		5,110	6,970	7,440	8,830	10,230		4,560	5,550	5,550	6,310	6,730
	28.0		6,060	8,260	8,810	10,460	12,120		6,170	7,830	8,170	9,200	10,140
7	20.0	2,720	3,740	5,100				1,920	2,500	2,660			
	23.0		4,360	5,940	6,340	7,530			3,270	3,770	3,830	4,150	
	26.0		4,980	6,790	7,240	8,600	9,960		4,320	5,250	5,320	5,870	7,220
	29.0		5,610	7,650	8,160	9,690	11,220		5,400	6,760	7,020	7,820	8,510
	32.0		6,230	8,490	9,060	10,760	12,460		6,460	8,230	8,600	9,730	10,760
	35.0		6,850	9,340	9,960	11,830	13,700		7,270	9,710	10,180	11,640	13,020

Casing OD (In.)	Weight (ppf)	Burst Pressure (psi)						Collapse Pressure (psi)					
		H40	J/K 55	C75	N80	C95	P110	H40	J/K 55	C75	N80	C95	P110
7 ⅝	26.4		4,140	5,650	6,020	7,150	8,280		3,010	3,280	3,930	3,710	3,900
	29.7			6,450	6,890	8,180	9,470			4,670	4,790	5,120	6,180
	33.7		5,430	7,400	7,900	8,180	10,860		5,090	6,320	6,560	7,260	7,870
	39.0			8,610	9,180	9,380	12,620			8,430	8,820	9,980	11,060
8 ⅝	24.0		2,950						950				
	32.0	2,860	3,930	5,360	5,710	7,860		2,210	2,530	2,950	3,050		3,430
	36.0		4,460	6,090	6,490	7,710	8,930		3,450	4,020	4,470	4,360	4,700
	40.0		5,020	6,850	7,300	8,670	10,040		4,400	5,350	5,520	6,010	7,420
9 ⅝	36.0	2,560	3,520	4,800	5,120		7,040	1,710	2,220	2,320	2,370		2,470
	40.0		3,950	5,390	5,750	6,820	7,900		2,570	2,980	3,530	3,330	3,480
	43.5		4,350	5,930	6,330	7,510	8,700		3,250	3,750	3,810	4,130	4,760
	47.0		4,720	6,440	6,870	8,150	9,440		3,880	4,630	4,760	5,080	5,310
	53.5			7,430	7,930	9,410	10,900			6,380	6,620	7,330	7,930
10 ¾	40.5	2,280	3,130	4,270				1,420	1,730	1,720			
	45.5		3,580	4,880	5,210	7,160			2,090	2,410	2,480		2,610
	51.0		4,030	5,490	5,860	6,960	8,060		2,700	3,100	3,750	3,490	3,750
	55.5		4,430	6,040	6,450	7,660	8,860		3,320	3,950	4,020	4,300	4,630
	60.7		4,880	6,650	7,100	8,436	9,760		4,160	5,020	5,160	5,566	5,860
	65.7		5,330	7,260	7,750	9,200	10,650		4,920	6,080	6,300	6,950	7,490
	71.1					10,050	11,640					8,470	9,280
11 ¾	47.0		3,070	4,190					1,630	1,620			
	54.0		3,560	4,860					2,070	2,380			
	60.0		4,010	5,460	5,830	6,920	8,010		2,660	3,070	3,680	3,440	3,610

Casing OD (In.)	Weight (ppf)	Burst Pressure (psi)						Collapse Pressure (psi)						
		H40	J/K 55	C75	N80	C95	P110	H40	J/K 55	C75	N80	C95	P110
13 3/8	48.0	1,730						770					
	54.5		2,730	3,980	5,470				1,140				
	61.0		3,090	4,220	4,500				1,540	1,660	1,670		
	68.0		3,450	4,710	5,020	5,970			1,950	2,220	2,270	2,330	
	72.0		3,700	5,040	5,380	6,390	7,400		2,230	2,590	2,880	2,820	2,880
	77.0			5,400	5,760					2,990	3,100		
	85.0			5,970	6,360	8,750				3,810	3,870	4,490	
16	65.0	1,640						670					
	75.0		2,630						1,010				
	84.0		2,980						1,410				
	109.0		3,950				7,890		2,560				3,470
18 5/8	87.5	1,530	2,110					520	520				
	106.0		2,740						1,140				
20	94.0	1,530	2,110					520	520				
	106.5		2,410						770				
	133.0		3,060						1,500				
24	156.0	X-42	1,910					860					
26	202.0	X-42	2,120					1,100					
30	310.0	X-42	2,450					1,480					
36	374.0	X-42	2,040					1,010					

Casing OD (In.)	Weight (ppf)	Casing ID (In.)	Capacity (bbl/ft)	Displacement (bbl/ft)
4 1/2	9.5	4.090	0.0163	0.0035
	11.6	4.000	0.0155	0.0042
	13.5	3.920	0.0149	0.0049
	15.1	3.826	0.0142	0.0055
5	11.5	4.560	0.0202	0.0042
	13.0	4.494	0.0196	0.0047
	15.0	4.408	0.0189	0.0055
	18.0	4.276	0.0178	0.0066
5 1/2	14.0	5.012	0.0244	0.0051
	15.5	4.950	0.0238	0.0056
	17.0	4.892	0.0233	0.0062
	20.0	4.778	0.0222	0.0073
	23.0	4.670	0.0212	0.0084
6 5/8	20.0	6.049	0.0355	0.0071
	24.0	5.921	0.0341	0.0087
	28.0	5.791	0.0326	0.0102
7	20.0	6.456	0.0405	0.0073
	23.0	6.366	0.0394	0.0084
	26.0	6.276	0.0383	0.0095
	29.0	6.184	0.0372	0.0106
	32.0	6.094	0.0361	0.0116
	35.0	6.004	0.0350	0.0127
7 5/8	26.4	6.969	0.0472	0.0096
	29.7	6.875	0.0459	0.0108
	33.7	6.765	0.0445	0.0123
	39.0	6.624	0.0426	0.0142
8 5/8	24.0	8.098	0.0637	0.0086
	32.0	7.921	0.0610	0.0116
	36.0	7.825	0.0595	0.0131
	40.0	7.725	0.0580	0.0146
9 5/8	36.0	8.921	0.0773	0.0131
	40.0	8.835	0.0758	0.0146
	43.5	8.755	0.0745	0.0158
	47.0	8.681	0.0732	0.0171
	53.5	8.535	0.0708	0.0195

Casing OD (In.)	Weight (ppf)	Casing ID (In.)	Capacity (bbl/ft)	Displacement (bbl/ft)
10 ¾	40.5	10.050	0.0981	0.0147
	45.5	9.950	0.0962	0.0166
	51.0	9.850	0.0943	0.0186
	55.5	9.760	0.0925	0.0202
	60.7	9.660	0.0907	0.0216
	65.7	9.560	0.0888	0.0235
	71.1	9.450	0.0868	0.0255
	76.0	9.350	0.0849	0.0273
	81.0	9.250	0.0831	0.0291
11 ¾	47.0	11.000	0.1175	0.0171
	54.0	10.880	0.1150	0.0197
	60.0	10.772	0.1127	0.0218
13 ⅜	48.0	12.715	0.1571	0.0175
	54.5	12.615	0.1546	0.0198
	61.0	12.515	0.1522	0.0219
	68.0	12.415	0.1497	0.0247
	72.0	12.347	0.1481	0.0262
	77.0	12.275	0.1464	0.0274
	85.0	12.159	0.1436	0.0302
16	65.0	15.250	0.2259	0.0237
	75.0	15.124	0.2222	0.0273
	84.0	15.100	0.2189	0.0306
	109.0	14.688	0.2096	0.0391
	118.0	14.570	0.2062	0.0425
18 ⅝	87.5	17.755	0.3062	0.0307
	109.0	17.491	0.2972	0.0398
	122.0	17.385	0.2936	0.0434
20	94.0	19.124	0.3553	0.0342
	106.5	19.000	0.3507	0.0388
	133.0	18.730	0.3408	0.0484
24 x 5/8" t_{in}	156.0	22.750	0.5028	0.0568
30 x 1" t_{in}	310.0	28.000	0.7616	0.1127
36 x 1" t_{in}	374.0	34.000	1.1230	0.1360
48 x 1" t_{in}	502.0	46.000	2.0556	0.1826

Note: To find casing weight for other wall thicknesses:

$$\text{Weight of Casing}_{lb/ft} = 10.68 \times (Od_{in} - t_{in}) \times t_{in}$$

Where:

t_{in} = Wall thickness (inches)

Hole Diameter (In.)	Hole Capacity (bbl/ft)
3	0.0087
3 ½	0.0119
4	0.0155
4 ½	0.0197
5	0.0243
5 ½	0.0294
6	0.0350
6 ½	0.0410
7	0.0476
7 ½	0.0546
8	0.0622
8 ½	0.0702
9	0.0787
9 ½	0.0877
10	0.0971
10 ½	0.1071
11	0.1175
11 ½	0.1285
12	0.1399
12 ½	0.1518
13	0.1642
13 ½	0.1770
14	0.1904
14 ½	0.2042
15	0.2086
15 ½	0.2334
16	0.2487
16 ½	0.2645
17	0.2807
17 ½	0.2975
18	0.3147
18 ½	0.3325
19	0.3507
19 ½	0.3694
20	0.3886
20 ½	0.4082
21	0.4284
21 ½	0.4490
22	0.4702
22 ½	0.4918

Hole Diameter (In.)	Hole Capacity (bbl/ft)
23	0.5139
23 ½	0.5365
24	0.5595
24 ½	0.5831
25	0.6071
25 ½	0.6317
26	0.6567
26 ½	0.6822
27	0.7082
27 ½	0.7347
28	0.7616
28 ½	0.7891
29	0.8170
29 ½	0.8454
30	0.8743
30 ½	0.9037
31	0.9336
31 ½	0.9639
32	0.9948
32 ½	1.0261
33	1.0579
33 ½	1.0902
34	1.1230
34 ½	1.1563
35	1.1900
35 ½	1.2243
36	1.2590
36 ½	1.2942
37	1.3299
37 ½	1.3661
38	1.4028
38 ½	1.4399
39	1.4776
39 ½	1.5157
40	1.5543
40 ½	1.5934
41	1.6330
41 ½	1.6731
42	1.7136
42 ½	1.7547

Liner Diameter	STROKE LENGTH (INCHES)													Units
	2	2 ½	3	4	5	6	7	7 ½	8	8 ½	9	9 ½	10	11	12	
1"	0.0005	0.0006	0.0007	0.0010	0.0012	0.0015	0.0017	0.0018	0.0019	0.0021	0.0022	0.0023	0.0024	0.0027	0.0029	BBLS/STK
	0.0204	0.0255	0.0306	0.0408	0.0510	0.0612	0.0714	0.0765	0.0816	0.0868	0.0919	0.0970	0.1021	0.1123	0.1225	Gal/STK
1 3/8"	0.0009	0.0011	0.0014	0.0018	0.0023	0.0028	0.0032	0.0034	0.0037	0.0039	0.0041	0.0044	0.0046	0.0051	0.0055	BBLS/STK
	0.0386	0.0482	0.0579	0.0772	0.0965	0.1158	0.1351	0.1447	0.1544	0.1640	0.1737	0.1833	0.1930	0.2123	0.2315	Gal/STK
1 ½"	0.0011	0.0014	0.0016	0.0022	0.0027	0.0033	0.0038	0.0041	0.0044	0.0046	0.0049	0.0052	0.0055	0.0060	0.0066	BBLS/STK
	0.0459	0.0574	0.0689	0.0919	0.1148	0.1378	0.1607	0.1722	0.1837	0.1952	0.2067	0.2182	0.2296	0.2526	0.2756	Gal/STK
1 5/8"	0.0013	0.0016	0.0019	0.0026	0.0032	0.0039	0.0045	0.0048	0.0051	0.0055	0.0058	0.0061	0.0064	0.0071	0.0077	BBLS/STK
	0.0539	0.0674	0.0809	0.1078	0.1348	0.1617	0.1887	0.2021	0.2156	0.2291	0.2426	0.2560	0.2695	0.2965	0.3234	Gal/STK
1 ¾"	0.0015	0.0019	0.0022	0.0030	0.0037	0.0045	0.0052	0.0056	0.0060	0.0063	0.0067	0.0071	0.0074	0.0082	0.0089	BBLS/STK
	0.0625	0.0781	0.0938	0.1250	0.1563	0.1875	0.2188	0.2344	0.2500	0.2657	0.2813	0.2969	0.3126	0.3438	0.3751	Gal/STK
2"	0.0019	0.0024	0.0029	0.0039	0.0049	0.0058	0.0068	0.0073	0.0078	0.0083	0.0087	0.0092	0.0097	0.0107	0.0117	BBLS/STK
	0.0816	0.1021	0.1225	0.1633	0.2041	0.2449	0.2858	0.3062	0.3266	0.3470	0.3674	0.3878	0.4082	0.4491	0.4899	Gal/STK
2 ¼"	0.0025	0.0031	0.0037	0.0049	0.0062	0.0074	0.0086	0.0092	0.0098	0.0105	0.0111	0.0117	0.0123	0.0135	0.0148	BBLS/STK
	0.1033	0.1292	0.1550	0.2067	0.2583	0.3100	0.3617	0.3875	0.4133	0.4392	0.4650	0.4908	0.5167	0.5683	0.6200	Gal/STK
2 ½"	0.0030	0.0038	0.0046	0.0061	0.0076	0.0091	0.0106	0.0114	0.0122	0.0129	0.0137	0.0144	0.0152	0.0167	0.0182	BBLS/STK
	0.1276	0.1595	0.1914	0.2552	0.3189	0.3827	0.4465	0.4784	0.5103	0.5422	0.5741	0.6060	0.6379	0.7017	0.7655	Gal/STK
2 ¾"	0.0037	0.0046	0.0055	0.0074	0.0092	0.0110	0.0129	0.0138	0.0147	0.0156	0.0165	0.0175	0.0184	0.0202	0.0221	BBLS/STK
	0.1544	0.1930	0.2315	0.3087	0.3859	0.4631	0.5403	0.5789	0.6175	0.6561	0.6946	0.7332	0.7718	0.8490	0.9262	Gal/STK
3"	0.0044	0.0055	0.0066	0.0087	0.0109	0.0131	0.0153	0.0164	0.0175	0.0186	0.0197	0.0208	0.0219	0.0241	0.0262	BBLS/STK
	0.1837	0.2296	0.2756	0.3674	0.4593	0.5511	0.6430	0.6889	0.7348	0.7808	0.8267	0.8726	0.9185	1.0104	1.1022	Gal/STK
3 ¼"	0.0051	0.0064	0.0077	0.0103	0.0128	0.0154	0.0180	0.0193	0.0205	0.0218	0.0231	0.0244	0.0257	0.0282	0.0308	BBLS/STK
	0.2156	0.2695	0.3234	0.4312	0.5390	0.6468	0.7546	0.8085	0.8624	0.9163	0.9702	1.0241	1.0780	1.1858	1.2936	Gal/STK
3 ½"	0.0060	0.0074	0.0089	0.0119	0.0149	0.0179	0.0208	0.0223	0.0238	0.0253	0.0268	0.0283	0.0298	0.0327	0.0357	BBLS/STK
	0.2500	0.3126	0.3751	0.5001	0.6251	0.7501	0.8752	0.9377	1.0002	1.0627	1.1252	1.1877	1.2502	1.3753	1.5003	Gal/STK
3 ¾"	0.0068	0.0085	0.0103	0.0137	0.0171	0.0205	0.0239	0.0256	0.0273	0.0290	0.0308	0.0325	0.0342	0.0376	0.0410	BBLS/STK
	0.2870	0.3588	0.4306	0.5741	0.7176	0.8611	1.0047	1.0764	1.1482	1.2199	1.2917	1.3635	1.4352	1.5787	1.7223	Gal/STK

Liner Diameter	STROKE LENGTH (INCHES)													Units
	2	2 ½	3	4	5	6	7	7 ½	8	8 ½	9	9 ½	10	11	12	
4"	0.0078	0.0097	0.0117	0.0156	0.0194	0.0233	0.0272	0.0292	0.0311	0.0330	0.0350	0.0369	0.0389	0.0428	0.0467	BBLS/STK
	0.3266	0.4082	0.4899	0.6532	0.8165	0.9798	1.1431	1.2247	1.3064	1.3880	1.4697	1.5513	1.6330	1.7963	1.9596	Gal/STK
4 ¼"	0.0088	0.0110	0.0132	0.0176	0.0219	0.0263	0.0307	0.0329	0.0351	0.0373	0.0395	0.0417	0.0439	0.0483	0.0527	BBLS/STK
	0.3687	0.4609	0.5530	0.7374	0.9217	1.1061	1.2907	1.3826	1.4748	1.5669	1.6591	1.7513	1.8435	2.0278	2.2122	Gal/STK
4 ½"	0.0098	0.0123	0.0148	0.0197	0.0246	0.0295	0.0344	0.0369	0.0394	0.0418	0.0443	0.0467	0.0492	0.0541	0.0590	BBLS/STK
	0.4133	0.5167	0.6200	0.8267	1.0334	1.2400	1.4467	1.5500	1.6534	1.7567	1.8600	1.9634	2.0667	2.2734	2.4801	Gal/STK
4 ¾"	0.0110	0.0137	0.0164	0.0219	0.0274	0.0329	0.0384	0.0411	0.0439	0.0466	0.0493	0.0521	0.0548	0.0603	0.0658	BBLS/STK
	0.4605	0.5757	0.6908	0.9211	1.1514	1.3816	1.6119	1.7270	1.8422	1.9573	2.0725	2.1876	2.3027	2.5330	2.7633	Gal/STK
5"	0.0122	0.0152	0.0182	0.0243	0.0304	0.0365	0.0425	0.0456	0.0486	0.0516	0.0547	0.0577	0.0608	0.0668	0.0729	BBLS/STK
	0.5103	0.6379	0.7655	1.0206	1.2758	1.5309	1.7861	1.9136	2.0412	2.1688	2.2964	2.4239	2.5515	2.8067	3.0618	Gal/STK
5 ¼"	0.0134	0.0167	0.0201	0.0268	0.0335	0.0402	0.0469	0.0502	0.0536	0.0569	0.0603	0.0636	0.0670	0.0737	0.0804	BBLS/STK
	0.5626	0.7033	0.8439	1.1252	1.4065	1.6878	1.9691	2.1098	2.2504	2.3911	2.5317	2.6724	2.8130	3.0943	3.3756	Gal/STK
5 ½"	0.0147	0.0184	0.0221	0.0294	0.0368	0.0441	0.0515	0.0551	0.0588	0.0625	0.0662	0.0698	0.0735	0.0809	0.0882	BBLS/STK
	0.6175	0.7718	0.9262	1.2349	1.5437	1.8524	2.1611	2.3155	2.4699	2.6242	2.7786	2.9329	3.0873	3.3960	3.7048	Gal/STK
5 ¾"	0.0161	0.0201	0.0241	0.0321	0.0402	0.0482	0.0562	0.0603	0.0643	0.0683	0.0723	0.0763	0.0803	0.0884	0.0964	BBLS/STK
	0.6749	0.8436	1.0123	1.3497	1.6872	2.0246	2.3621	2.5308	2.6995	2.8682	3.0369	3.2056	3.3744	3.7118	4.0492	Gal/STK
6"	0.0175	0.0219	0.0262	0.0350	0.0437	0.0525	0.0612	0.0656	0.0700	0.0744	0.0787	0.0831	0.0875	0.0962	0.1050	BBLS/STK
	0.7348	0.9185	1.1022	1.4697	1.8372	2.2045	2.5719	2.7556	2.9393	3.1230	3.3067	3.4905	3.6742	4.0416	4.4090	Gal/STK
6 ¼"	0.0190	0.0237	0.0285	0.0380	0.0475	0.0570	0.0664	0.0712	0.0759	0.0807	0.0854	0.0902	0.0949	0.1044	0.1139	BBLS/STK
	0.7973	0.9967	1.1960	1.5947	1.9934	2.3920	2.7907	2.9900	3.1894	3.3887	3.5880	3.7874	3.9867	4.3854	4.7841	Gal/STK
6 ½"	0.0205	0.0257	0.0308	0.0411	0.0513	0.0616	0.0719	0.0770	0.0821	0.0873	0.0924	0.0975	0.1027	0.1129	0.1232	BBLS/STK
	0.8624	1.0780	1.2936	1.7248	2.1560	2.5872	3.0184	3.2340	3.4496	3.6652	3.8808	4.0964	4.3120	4.7432	5.1744	Gal/STK
6 ¾"	0.0221	0.0277	0.0332	0.0443	0.0554	0.0664	0.0775	0.0830	0.0886	0.0941	0.0996	0.1052	0.1107	0.1218	0.1329	BBLS/STK
	0.9300	1.1625	1.3950	1.8600	2.3251	2.7901	3.2551	3.4876	3.7201	3.9526	4.1851	4.4176	4.6501	5.1151	5.5801	Gal/STK
7"	0.0238	0.0298	0.0357	0.0476	0.0595	0.0714	0.0833	0.0893	0.0953	0.1012	0.1072	0.1131	0.1191	0.1310	0.1429	BBLS/STK
	1.0002	1.2502	1.5003	2.0004	2.5005	3.0006	3.5007	3.7507	4.008	4.2508	4.5008	4.7509	5.0009	5.5010	6.0011	Gal/STK

Initial Mud Wt (ppg)	DESIRED MUD WEIGHT (PPG)																		
	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5	18.0
9.0	29	59	90	123	156	192	229	268	308	350	395	442	490	542	596	653	714	778
9.5		29	60	92	125	160	196	234	273	315	359	405	452	503	557	612	672	735
10.0	43		30	61	93	128	164	201	239	280	323	368	414	464	516	571	630	691
10.5	85	30		31	62	96	131	167	205	245	287	331	376	426	479	531	588	648
11.0	128	60	23		31	64	98	134	171	210	251	294	339	387	437	490	546	605
11.5	171	90	46	19		32	66	101	137	175	215	258	301	348	397	449	504	562
12.0	214	120	69	37	16		33	67	103	140	179	221	263	310	357	408	462	518
12.5	256	150	92	56	32	14		34	68	105	144	184	226	271	318	367	420	475
13.0	299	180	115	75	48	27	12		34	70	108	147	188	232	278	327	378	432
13.5	342	210	138	94	63	41	24	11		35	72	111	150	194	238	286	336	389
14.0	385	240	161	112	76	54	36	21	10		36	74	113	155	199	245	294	345
14.5	427	270	185	131	95	68	48	32	19	9		37	75	116	159	204	252	302
15.0	470	300	208	150	110	82	60	43	29	18	8		37	77	119	163	210	259
15.5	513	330	231	169	126	95	72	54	39	26	16	8		39	79	122	168	216
16.0	556	360	254	187	142	109	84	64	48	35	24	15	7		40	81	126	172
16.5	598	390	277	206	158	123	96	75	58	44	32	23	14	7		41	84	129
17.0	641	420	300	225	174	136	108	86	68	53	40	30	21	13	6		42	86
17.5	684	450	323	244	189	150	120	96	77	62	49	38	28	20	12	6		43
18.0	726	480	346	262	205	163	132	107	87	71	57	45	35	26	18	12	5	

Dilution or Cut Back: The gray section of the chart shows the number of barrels of water which must be added to 100 bbls of mud to produce the desired weight reduction.

Mud Weight Increase: The yellow section of the chart indicates the number of 100 lb sacks of barite which must be added to 100 bbls of mud to produce desired weight increases.

lb/gal	lb/ft³	kg/m³	Specific Gravity	Gradient Depth (psi/ft)	Gradient Depth (kPa/m)
8.34	62.38	999.3	1.00	0.434	9.8
8.5	63.58	1018.5	1.02	0.442	10.0
8.6	64.32	1030.5	1.03	0.447	10.1
8.7	65.07	1042.4	1.04	0.452	10.2
8.8	65.82	1054.4	1.05	0.458	10.4
8.9	66.57	1066.4	1.07	0.463	10.5
9.0	67.31	1078.4	1.08	0.468	10.6
9.1	68.06	1090.4	1.09	0.473	10.7
9.2	68.81	1102.3	1.10	0.478	10.8
9.3	69.56	1114.3	1.12	0.484	10.9
9.4	70.31	1126.3	1.13	0.489	11.1
9.5	71.05	1138.3	1.14	0.494	11.2
9.6	71.80	1150.3	1.15	0.499	11.3
9.7	72.55	1162.3	1.16	0.504	11.4
9.8	73.30	1174.2	1.18	0.510	11.5
9.9	74.05	1186.2	1.19	0.515	11.6
10.0	74.79	1198.2	1.20	0.520	11.8
10.1	75.54	1210.2	1.21	0.525	11.9
10.2	76.29	1222.2	1.22	0.530	12.0
10.3	77.04	1234.2	1.24	0.536	12.1
10.4	77.79	1246.1	1.25	0.541	12.2
10.5	78.53	1258.1	1.26	0.546	12.4
10.6	79.28	1270.1	1.27	0.551	12.5
10.7	80.03	1282.1	1.28	0.556	12.6
10.8	80.78	1294.1	1.29	0.562	12.7
10.9	81.53	1306.0	1.31	0.567	12.8
11.0	82.27	1318.0	1.32	0.572	12.9
11.1	83.02	1330.0	1.33	0.577	13.1
11.2	83.77	1342.0	1.34	0.582	13.2
11.3	84.52	1354.0	1.36	0.588	13.3
11.4	85.27	1366.0	1.37	0.593	13.4
11.5	86.01	1377.9	1.38	0.598	13.5
11.6	86.76	1389.9	1.39	0.603	13.6
11.7	87.51	1401.9	1.40	0.608	13.8
11.8	88.26	1413.9	1.41	0.614	13.9
11.9	89.01	1425.9	1.43	0.619	14.0
12.0	89.75	1437.8	1.44	0.624	14.1
12.1	90.50	1449.8	1.45	0.629	14.2
12.2	91.25	1461.8	1.46	0.634	14.4
12.3	92.00	1473.8	1.48	0.640	14.5
12.4	92.74	1485.8	1.49	0.645	14.6
12.5	93.49	1497.8	1.50	0.650	14.7
12.6	94.24	1509.7	1.51	0.655	14.8
12.7	94.99	1521.7	1.52	0.660	14.9
12.8	95.74	1533.7	1.53	0.666	15.1
12.9	96.48	1545.7	1.55	0.671	15.2
13.0	97.23	1557.7	1.56	0.676	15.3
13.1	97.98	1569.6	1.57	0.681	15.4
13.2	98.73	1581.6	1.58	0.686	15.5

lb/gal	lb/ft³	kg/m³	Specific Gravity	Gradient Depth (psi/ft)	Gradient Depth (kPa/m)
13.3	99.48	1593.6	1.60	0.692	15.6
13.4	100.22	1605.6	1.61	0.697	15.8
13.5	100.97	1617.6	1.62	0.702	15.9
13.6	101.72	1629.6	1.63	0.707	16.0
13.7	102.47	1641.5	1.64	0.712	16.1
13.8	103.22	1653.5	1.65	0.718	16.2
13.9	103.96	1665.5	1.67	0.723	16.4
14.0	104.71	1677.5	1.68	0.728	16.5
14.1	105.46	1689.5	1.69	0.733	16.6
14.2	106.21	1701.5	1.70	0.738	16.7
14.3	106.96	1713.4	1.72	0.744	16.8
14.4	107.70	1725.4	1.73	0.749	16.9
14.5	108.45	1737.4	1.74	0.754	17.1
14.6	109.20	1749.4	1.75	0.759	17.2
14.7	109.95	1761.4	1.76	0.764	17.3
14.8	110.70	1773.3	1.78	0.770	17.4
14.9	111.44	1785.3	1.79	0.775	17.5
15.0	112.19	1797.3	1.80	0.780	17.6
15.1	112.94	1809.3	1.81	0.785	17.8
15.2	113.69	1821.3	1.82	0.790	17.9
15.3	114.44	1833.3	1.84	0.796	18.0
15.4	115.18	1845.2	1.85	0.801	18.1
15.5	115.93	1857.2	1.86	0.806	18.2
15.6	116.68	1869.2	1.87	0.811	18.3
15.7	117.43	1881.2	1.88	0.816	18.5
15.8	118.18	1893.2	1.90	0.822	18.6
15.9	118.92	1905.1	1.91	0.827	18.7
16.0	119.67	1917.1	1.92	0.832	18.8
16.1	120.42	1929.1	1.93	0.837	18.9
16.2	121.17	1941.1	1.94	0.842	19.1
16.3	121.91	1953.1	1.96	0.846	19.2
16.4	122.66	1965.1	1.97	0.853	19.3
16.5	123.41	1977.0	1.98	0.858	19.4
16.6	124.16	1989.0	2.00	0.863	19.5
16.7	124.91	2001.0	2.01	0.868	19.6
16.8	125.65	2013.0	2.02	0.874	19.8
16.9	126.40	2025.0	2.03	0.879	19.9
17.0	127.15	2036.9	2.04	0.884	20.0
17.1	127.90	2048.9	2.05	0.889	20.1
17.2	128.65	2060.9	2.06	0.894	20.2
17.3	129.39	2072.9	2.08	0.900	20.3
17.4	130.14	2084.9	2.09	0.905	20.5
17.5	130.89	2096.9	2.10	0.910	20.6
17.6	131.64	2108.8	2.11	0.915	20.7
17.7	132.39	2120.8	2.12	0.920	20.8
17.8	133.13	2132.8	2.14	0.926	20.9
17.9	133.88	2144.8	2.15	0.931	21.1
18.0	134.63	2156.8	2.16	0.936	21.2
18.1	135.38	2168.8	2.17	0.941	21.3

lb/gal	lb/ft³	kg/m³	Specific Gravity	Gradient Depth (psi/ft)	Gradient Depth (kPa/m)
18.2	136.13	2180.7	2.18	0.946	21.4
18.3	136.87	2192.7	2.20	0.952	21.5
18.4	137.62	2204.7	2.21	0.957	21.6
18.5	138.37	2216.7	2.22	0.962	21.8
18.6	139.12	2228.7	2.23	0.967	21.9
18.7	139.87	2240.6	2.24	0.972	22.0
18.8	140.61	2252.6	2.26	0.978	22.1
18.9	141.36	2264.6	2.27	0.983	22.2
19.0	142.11	2276.6	2.28	0.988	22.3
19.1	142.86	2288.6	2.29	0.993	22.5
19.2	143.61	2300.6	2.30	0.998	22.6
19.3	144.35	2312.5	2.32	1.004	22.7
19.4	145.10	2324.5	2.33	1.009	22.8
19.5	145.85	2336.5	2.34	1.014	22.9
19.6	146.60	2348.5	2.35	1.019	23.1
19.7	147.34	2360.5	2.36	1.024	23.2
19.8	148.09	2372.4	2.38	1.030	23.3
19.9	148.84	2384.4	2.39	1.035	23.4
20.0	149.59	2396.4	2.40	1.040	23.5

Specifications for BOP Flanges, Ring Gaskets, and Flange Bolts & Nuts

Stack Rating	Approved Flanges	Approved Ring Gaskets	Bolt Spec.	Nut Spec.
2000 psi and 3000 psi	API type 6B with type R flat Bottom Groove	API Type RX	ASTM Grade B-7	ASTM Grade 2-H
5000 psi	API Type 6B with Type R Flat Bottom groove or API Type 6BX with Type BX Groove	API Type RX or API Type BX with Type 6BX Flange	ASTM Grade B-7	ASTM Grade 2-H
10,000 psi	API Type 6BX with Type BX Groove	API Type BX	ASTM Grade B-7	ASTM Grade 2-H

Bolt Size (In.)	Torque (Ft-Lb)
¾ - 10 UNC	200
⅞ - 9 UNC	325
1 - 8 UNC	475
1 ⅛ - 8 UN	600
1 ½ - 8 UN	1400
1 ⅝ - 8 UN	1700
1 ¾ - 8 UN	2040
1 ⅞ - 8 UN	3220

NOTE: Acceptable flange ring gasket material for sweet oil applications is low-carbon steel and for sour oil or gas is type 316 stainless or type 304 stainless steel. ASTM A-193 Grade B/M with a maximum Rockwell Hardness of 22 may be acceptable but should be derated as per Table 1.4B of API Spec 6A. Specifications as per API Spec 6A "Wellhead Equipment".

Size, Working Pressure and Number of Turns to Operate

Cameron

*Cameron valves have a round handwheel with the name "Cameron" embossed on it. Operate Cameron Valves full open or full close, **then back off ¼ turn.***

Model	Inches	Turns
3,000/5,000 psi WP		
F, FC & FL	2 1/16	12 1/2
	2 9/16	15 1/4
	3 1/8	18 1/4
	4 1/16	23 1/2
10,000 psi WP		
FC, FL & FLS	1 13/16	12 1/2
	2 1/16	12 1/2
	2 9/16	15 1/4
	3 1/16	18 1/4
	4 1/16	23 1/2
15,000 – 20,000 psi WP		
FLS	1 13/16	12 1/2
	2 1/16	12 1/2
	2 9/16	15 3/4
	3 1/16	22 7/8
	4 1/16	29 1/2
15,000 – 20,000 psi WP		
F, FC & FL	1 13/16	12 1/2
	2 1/16	12 1/2
	2 9/16	15 3/4
	3 1/16	15 1/4
	4 1/16	29 1/2
10,000 psi WP		
J & JS	1 13/16	12
	2 1/16	12
	2 9/16	17 1/4
	3 1/16	21 1/2
	4 1/16	23
15,000 psi WP		
J &JS	1 13/16	15 3/4
	2 1/16	15 3/4
	2 9/16	19 1/2
	3 1/16	135 Torque Multiplier
20,000 psi WP		
J & JS	1 13/16	15 3/4
	2 1/16	15 3/4
	2 9/16	117 Torque Multiplier
	3 1/16	135 Torque Multiplier

W-K-M

*W-K-M valves have a unique wedge shaped handwheel. Operate W-K-M valves full open or full close, **then jam tight.***

Model	Inches	Turns
3,000/5,000 psi WP		
M	2 1/16	13
	2 9/16	16
	3 1/8	20
	4 1/16	25
10,000 - 15,000 psi WP		
M-1 & M-2	1 13/16	14
	2 1/16	12
	2 9/16	15
	3 1/16	17 1/2
	4 1/16	23
20,000 psi WP		
M-3	1 13/16	15
	2 1/16	16 1/2
	2 9/16	19 1/2
	3 1/16	23
	4 1/16	29

Size, Working Pressure and Number of Turns to Operate

Ingram Cactus

*Ingram Cactus valves have a round handwheel with three spokes and the name "Ingram Cactus" embossed on it. Operate Ingram Cactus valves Model 205 and 215 full open or full close, **then jam tight.** Operate Model 405 and 315 full open or full close, **then back off ¼ turn.***

Model	Inches	Turns
2,000/5,000 psi WP		
205	2 1/16	13
	2 9/16	16
	3 1/8	20
	4 1/16	25
2,000/5,000 psi WP		
405	2 1/16	16
	2 9/16	19
	3 1/8	23
	4 1/16	24 1/2
10,000 – 15,000 psi WP		
215	1 13/16	14
	2 1/16	12
	2 9/16	15
	3 1/16	17 1/2
	4 1/16	23
10,000 – 15,000 psi WP		
315	1 13/16	16
	2 1/16	18
	2 9/16	17
	3 1/16	24
	4 1/16	21

McEvoy

*McEvoy valves have a round handwheel with the name "McEvoy" embossed on it. Operate McEvoy valves full open or full close, **then back off ¼ turn.***

Model	Inches	Turns
2,000/3,000/5,000 psi WP		
C	2 1/16	13
	2 9/16	16
	3 1/8	18
	4 1/16	17
10,000 psi WP		
E	1 13/16	11
	2 1/16	13
	2 9/16	10 1/2
	3 1/16	12 1/2
	4 1/16	17
15,000 psi WP		
E	1 13/16	11
	2 1/16	9
	2 9/16	10 1/2
	3 1/16	26
	4 1/16	---
10,000 psi WP		
E-2	1 13/16	11
	2 1/16	9
	2 9/16	10 1/2
	3 1/16	12 3/4
	4 1/16	17 1/8
15,000 psi WP		
E-2	1 13/16	7 3/4
	2 1/16	9
	2 9/16	10 1/2
	3 1/16	12 3/4
	4 1/16	17 1/8

Nominal Flange Size (In.)	Service Rating (psi)	Standard Ring Gasket Number	Energized Ring Number	Old API Series Designation	Through Bore ID (In.)	Number of Bolts	Bolt Size (In.)	Bolt Circle (In.)	Flange Diameter (In.)	Flange Thickness (In.)
1 13/16	10M		BX151		1 13/16	8	3/4	5 3/4	7 3/8	1 21/32
	15M		BX151		1 13/16	8	7/8	6 5/16	8 3/16	1 25/32
	20M		BX151		1 13/16	8	1	8	10 1/8	2 1/2
2 1/16	2M	R23	RX23	2" 600	2 1/16	8	5/8	5	6 1/2	1 5/16
	5M	R24	RX24	2" 1,500	2 1/16	8	7/8	6 1/2	8 1/2	1 13/16
	10M		BX152		2 1/16	8	3/4	6 1/4	7 7/8	1 47/64
	15M		BX152		2 1/16	8	7/8	6 7/8	8 3/4	2
	20M		BX152		2 1/16	8	1 1/8	9 1/16	11 5/16	2 13/16
2 9/16	2M	R26	RX26	2 1/2" 600	2 9/16	8	3/4	5 7/8	7 1/2	1 7/16
	5M	R27	RX27	2 1/2" 1,500	2 9/16	8	1	7 1/2	9 5/8	1 15/16
	10M		BX153		2 9/16	8	7/8	7 1/4	9 1/8	2 1/64
	15M		BX153		2 9/16	8	1	7 7/8	10	2 1/4
	20M		BX153		2 9/16	8	1 1/4	10 5/16	12 13/16	3 1/8
3 1/16	10M		BX154		3 1/16	8	1	8 1/2	10 5/8	2 19/64
	15M		BX154		3 1/16	8	1 1/8	9 1/16	11 5/16	2 17/32
	20M		BX154		3 1/16	8	1 3/8	11 5/16	14 1/16	3 3/8
3 1/8	2M	R31	RX31	3" 600	3 1/8	8	3/4	6 5/8	8 1/4	1 9/16
	3M	R31	RX31	3" 900	3 1/8	8	7/8	7 1/2	9 1/2	1 13/16
	5M	R35	RX35	3" 1,500	3 1/8	8	1 1/8	8	10 1/2	2 3/16

Nominal Flange Size (In.)	Service Rating (psi)	Standard Ring Gasket Number	Energized Ring Number	Old API Series Designation	Through Bore ID (In.)	Number of Bolts	Bolt Size (In.)	Bolt Circle (In.)	Flange Diameter (In.)	Flange Thickness (In.)
4 1/16	2M	R37	RX37	4" 600	4 1/16	8	7/8	8 1/2	10 3/4	1 13/16
	3M	R37	RX37	4" 900	4 1/16	8	1 1/8	9 1/4	11 1/2	2 1/16
	5M	R39	RX39	4" 1,500	4 1/16	8	1 1/4	9 1/2	12 1/4	2 7/16
	10M		BX155		4 1/16	8	1 1/8	10 3/16	12 7/16	2 49/64
	15M		BX155		4 1/16	8	1 3/8	11 7/16	14 3/16	3 3/32
	20M		BX155		4 1/16	8	1 3/4	14 1/16	17 9/16	4 3/16
5 1/8	2M	R41	RX41		5 1/8	8	1	10 1/2	13	2 1/16
	3M	R41	RX41		5 1/8	8	1 1/4	11	13 3/4	2 5/16
	5M	R44	RX44		5 1/8	8	1 1/2	11 1/2	14 3/4	3 3/16
	10M		BX169		5 1/8	12	1 1/8	11 13/16	14 1/16	3 1/8
7 1/16	2M	R45	RX45	6" 600	7 1/16	12	1	11 1/2	14	2 3/16
	3M	R45	RX45	6" 900	7 1/16	12	1 1/8	12 1/2	15	2 1/2
	5M	R46	RX46	6" 1,500	7 1/16	12	1 3/8	12 1/2	15 1/2	3 5/8
	10M		BX156		7 1/16	12	1 1/2	15 7/8	18 7/8	4 1/16
	15M		BX156		7 1/16	16	1 1/2	16 7/8	19 7/8	4 11/16
	20M		BX156		7 1/16	16	2	21 13/16	25 13/16	6 1/2
9	2M	R49	RX49	8" 600	9	12	1 1/8	13 3/4	16 1/2	2 1/2
	3M	R49	RX49	8" 900	9	12	1 3/8	15 1/2	18 1/2	2 13/16
	5M	R50	RX50	8" 1,500	9	12	1 5/8	15 1/2	19	4 1/16
	10M		BX157		9	16	1 1/2	18 3/4	21 3/4	4 7/8
	15M		BX157		9	16	1 7/8	21 3/4	25 1/2	5 3/4

Nominal Flange Size (In.)	Service Rating (psi)	Standard Ring Gasket Number	Energized Ring Number	Old API Series Designation	Through Bore ID (In.)	Number of Bolts	Bolt Size (In.)	Bolt Circle (In.)	Flange Diameter (In.)	Flange Thickness (In.)
11	2M	R53	RX53	10" 600	11	16	1 1/4	17	20	2 13/16
	3M	R53	RX53	10" 900	11	16	1 3/8	18 1/2	21 1/2	3 1/16
	5M	R54	RX54	10" 1,500	11	12	1 7/8	19	23	4 11/16
	10M		BX158		11	16	1 3/4	22 1/4	25 3/4	5 9/16
	15M		BX158		11	20	2	28	32	7 3/8
13 5/8	2M	R57	RX57	12" 600	13 5/8	20	1 1/4	19 1/4	22	2 15/16
	3M	R57	RX57	12" 900	13 5/8	20	1 3/8	21	24	3 7/16
	5M		BX160		13 5/8	16	1 5/8	23 1/4	26 1/2	4 7/16
	10M		BX159		13 5/8	20	1 7/8	26 1/2	30 1/4	6 5/8
	15M		BX159		13 5/8	20	2 1/4	30 3/8	34 7/8	7 7/8
16 3/4	2M	R65	RX65	16" 600	16 3/4	20	1 1/2	23 3/4	27	3 5/16
	3M	R66	RX66	16" 900	16 3/4	20	1 5/8	24 1/4	27 3/4	3 15/16
	5M		BX162		16 3/4	16	1 7/8	26 5/8	30 3/8	5 1/8
	10M		BX162		16 3/4	24	1 7/8	30 9/16	34 5/16	6 5/8
18 3/4	5M		BX163		18 3/4	20	2	31 5/8	35 5/8	6 17/32
	10M		BX164		18 3/4	24	2 1/4	36 7/16	40 15/16	8 25/32
20 3/4	3M	R74	RX74	20" 900	20 3/4	20	2	29 1/2	33 3/4	4 3/4
21 1/4	2M	R73	RX73	20" 600	21 1/4	24	1 5/8	28 1/2	32	3 7/8
21 1/4	5M		BX165		21 1/4	24	2	34 7/8	39	7 1/8
21 1/4	10M		BX166		21 1/4	24	2 1/2	40 1/4	45	9 1/2
26 3/4	2M		BX167		26 3/4	20	1 3/4	37 1/2	41	4 31/32
	3M		BX168		26 3/4	24	2	39 3/8	43 3/8	6 11/32

Cameron BOPs

Cameron Type 'D' Annular Preventer

BOP Nom. Size (In.)	Working Pressure (psi)	Fluid to Close (gal)	Fluid to Open (gal)
7 1/16	5,000	1.69	1.39
	10,000	2.94	2.55
11	5,000	5.65	4.69
	10,000	10.15	9.06
13 5/8	5,000	12.12	10.34
	10,000	18.10	16.15

Cameron Type 'U' Ram Preventer

BOP Nom. Size (In.)	Working Pressure (psi)	Fluid to Close (gal)	Fluid to Open (gal)
6	3,000	1.33	1.28
	5,000	1.33	1.28
7 1/16	10,000	1.33	1.28
	15,000	1.33	1.28
10	3,000	3.36	3.20
	5,000	3.36	3.20
11	5,000 - 10,000	3.36	3.20
	15,000	6.2	6.1
12	3,000	5.80	5.45
13 5/8	5,000	5.80	5.45
	10,000	5.80	5.45
	15,000	11.30	11.70
16 3/4	3,000	9.80	10.60
	5,000	9.80	10.60
18 3/4	10,000	23.00	24.90
20	3,000	8.40	7.85
21 1/4	5,000	20.40	17.80
	10,000	26.50	24.10
26 3/4	2,000	10.40	9.85
	3,000	10.40	9.85

Cameron Type 'QRC' Ram Preventer

BOP Nom. Size (In.)	Working Pressure (psi)	Fluid to Close (gal)	Fluid to Open (gal)
6	3,000	0.81	0.95
	5,000	0.81	0.95
8	3,000	2.36	2.70
	5,000	2.36	2.70
10	3,000	2.77	3.18
	5,000	2.77	3.18
12	3,000	4.42	5.10
16	2,000	6.00	7.05
18	2,000	6.00	7.05

Cameron Hydraulic Gate Valves					
OEM	Type	BOP Nom. Size (In.)	Working Pressure (psi)	Fluid to Close (gal)	Fluid to Open (gal)
Cameron	HCR	4	3,000	0.52	0.61
Cameron	HCR	4	5,000	0.52	0.61
Cameron	HCR	6	3,000	1.95	2.25
Cameron	HCR	6	5,000	1.95	2.25
Cameron	F	4	3,000	0.30	0.30
Cameron	F	4	5,000	0.30	0.30
Cameron	F	4	10,000	0.59	0.59
Cameron	F	6	3,000	0.84	0.84
Cameron	F	6	5,000	0.84	0.84

Shaffer BOPs

Shaffer Spherical Annular Preventers				
BOP Nom. Size (In.)	Working Pressure (psi)	Cover Type	Fluid to Close (gal)	Fluid to Open (gal)
7 1/16	3,000	Bolted	4.57	3.21
	5,000	Bolted	4.57	3.21
	10,000	Bolted	17.11	13.95
9	3,000	Bolted	7.23	5.03
	5,000	Bolted	11.05	8.72
11	3,000	Bolted	11.00	6.78
	5,000	Bolted	18.67	14.59
	10,000	Wedge	30.58	24.67
13 5/8	3,000	Bolted	23.50	14.67
	5,000	Bolt/Wedge	23.58	17.41
	10,000	Wedge	40.16	32.64
16 3/4	5,000	Wedge	33.26	25.61
18 3/4	5,000	Wedge	48.16	37.61
21 1/4	2,000	Bolted	32.59	16.92
	5,000	Wedged	61.37	47.76

Shaffer Type 'LWS' Ram Preventers				
BOP Nom. Size (In.)	Working Pressure (psi)	Piston Size (In.)	Fluid to Close (gal)	Fluid to Open (gal)
7 1/16	5,000	6 ½	1.00	0.83
	15,000	14	4.77	4.43
9	5,000	8 ½	2.18	1.90
11	3,000	6 ½	1.55	1.29
	5,000	8 ½	2.64	2.32
20 3/4	3,000	8 ½	4.91	4.31
	3,000	10	7.80	6.86
	3,000	14	14.50	13.59
21 1/4	3,000	8 ½	5.07	4.46
	2,000	10	7.80	6.86
	2,000	14	14.50	13.50

Shaffer Type 'SL' Ram Preventers				
BOP Nom. Size (In.)	Working Pressure (psi)	Piston Size (In.)	Fluid to Close (gal)	Fluid to Open (gal)
7 1/16	15,000	10	2.72	2.34
	15,000	14	6.00	5.57
11	10,000	14	9.45	7.00
	15,000	14	2.72	2.34
13 5/8	3,000	10	5.44	4.46
	5,000	10	5.44	4.46
	5,000	14	11.00	10.52
	10,000	14	10.58	10.52
	15,000	14	11.56	10.52
16 3/4	5,000	10	11.76	5.44
	5,000	14	10.67	4.46
	10,000	14	14.47	12.5
18 3/4	10,000	14	14.55	13.21
21 1/4	10,000	14	16.05	13.86

Shaffer Hydraulic Gate Valves					
OEM	Type	BOP Nom. Size (In.)	Working Pressure (psi)	Fluid to Close (gal)	Fluid to Open (gal)
Shaffer	-	2 1/16	10,000	0.15	0.20
Shaffer	-	3 1/16	5,000	0.20	0.25
Shaffer	-	3 1/16	10,000	0.40	0.35
Shaffer	-	3 1/16	15,000	0.35	0.40
Shaffer	-	4 1/16	5,000	0.35	0.40
Shaffer	-	4 1/16	10000	0.45	0.50
Shaffer	-	4 1/16	15000	0.45	0.50

Hydril BOPs

Hydril Type 'GK' Annular Preventer			
BOP Nom. Size (In.)	Working Pressure (psi)	Fluid to Close (gal)	Fluid to Open (gal)
7 1/16	3,000	2.85	2.24
	5,000	3.86	3.30
	10,000	9.42	7.08
	15,000	11.20	7.50
	20,000	10.90	7.20
9	3,000	4.33	3.41
	5,000	6.84	5.80
11	3,000	7.43	5.54
	5,000	9.81	7.97
	10,000	25.10	18.87
	15,000	26.67	20.45
13 5/8	3,000	11.36	8.94
	5,000	17.98	14.15
	10,000	34.53	24.66
16 3/4	2,000	17.42	12.53
	3,000	21.02	15.80
	5,000	28.70	19.93

Hydril Type 'MSP' Annular Preventer			
BOP Nom. Size (In.)	Working Pressure (psi)	Fluid to Close (gal)	Fluid to Open (gal)
7 1/16	2,000	2.85	1.98
9	2,000	4.57	2.95
11	2,000	7.43	5.23
20 3/4	2,000	31.05	18.93
21 1/4	2,000	31.05	18.93
29 1/2	500	60.00	n/a
30	1,000	87.60	27.80
Hydril Type 'GX' Annular Preventer			
18 3/4	10,000	58.00	58.00
Hydril MPL (Multi Position Lock) Ram Preventers			
18 3/4	10,000	17.1	15.6
18 3/4	15,000	19.4	16.7

Hydril Type 'GL' Annular Preventer				
BOP Nom. Size (In.)	Working Pressure (psi)	Fluid to Close (gal)	Fluid to Open (gal)	Secondary Fluid (gal)
13 5/8	5,000	19.76	19.76	8.24
16 3/4	5,000	33.80	33.80	17.30
18 3/4	5,000	44.00	44.00	20.00
21 1/4	5,000	58.00	58.00	29.50

Hydril Manual Lock Ram Preventers				
BOP Nom. Size (In.)	Working Pressure (psi)	Type	Fluid to Close (gal)	Fluid to Open (gal)
7 1/16	3,000	V	1.30	1.20
	5,000	V	1.30	1.20
	10,000	X	1.90	1.80
	15,000	X	3.70	3.40
9	3,000	V	1.90	1.90
	5,000	V	1.90	1.90
11	3,000	V	3.10	3.10
	5,000	V	3.10	3.10
	10,000	X	11.80	11.80
13 5/8	3,000	V	5.40	4.90
	5,000	V	5.40	4.90
	10,000	X	11.80	11.80
16 3/4	10,000	X	15.00	14.10
18 3/4	10,000	X	16.40	15.60
20 3/4	3,000	V	8.10	7.20
21 1/4	2,000	V	8.10	7.20

Coiled Tubing Stretch Table			
Size (In) OD	Wall Thickness (In)	Cross Sectional Area (Sq In)	Free Point Constant
1.250	.087	.304	760.0
	.095	.328	820.0
	.102	.351	877.5
	.109	.374	935.0
	.125	.420	1050.0
	.134	.451	1127.5
	.156	.512	1280.0
1.500	.095	.399	997.5
	.102	.428	1070.0
	.109	.456	1140.0
	.125	.512	1280.0
	.134	.552	1380.0
	.156	.629	1572.5
1.750	.109	.538	1345.0
	.125	.605	1512.5
	.134	.652	1630.0
	.156	.745	1862.5
	.175	.831	2077.5
2.0	.109	.619	1547.5
	.125	.698	1745.0
	.134	.753	1882.5
	.156	.861	2152.5
	.175	.962	2405.0
2.375	.125	.837	2092.5
	.134	.904	2260.0
	.156	1.035	2587.5
	.175	1.158	2895.5
	.190	1.241	3102.5

OD Specified	Wall Specified	ID Calculated	Nom. Wt lbs/ft	Internal Capacity/ft		Displacement of Steel/ft		External Displacement/ft		OD Specified	Wall Specified	ID Calculated	Nom Wt lbs/ft	Internal Capacity		Displacement Of Steel		External Displacement	
				Gallons	bbls	Gallons	bbls	Gallons	bbls					Gallons	bbls	Gallons	bbls	Gallons	bbls
1.00	.080	.840	.788	.02879	.000685	.01201	.00029	.04080	.00097	1.50	.116	1.268	1.712	.06560	.001562	.02620	.00062	.09180	.00219
1.00	.087	.826	.850	.02784	.000663	.01296	.00031	.04080	.00097	1.50	.125	1.250	1.840	.06375	.001518	.02805	.00067	.09180	.00219
1.00	.095	.810	.920	.02677	.000637	.01403	.00033	.04080	.00097	1.50	.134	1.232	1.960	.06193	.001474	.02987	.00071	.09180	.00219
1.00	.102	.796	.981	.02585	.000616	.01495	.00036	.04080	.00097	1.50	.145	1.210	2.104	.05974	.001422	.03206	.00076	.09180	.00219
1.00	.109	.782	1.040	.02495	.000594	.01585	.00038	.04080	.00097	1.50	.156	1.188	2.245	.05758	.001371	.03422	.00081	.09180	.00219
1.25	.080	1.090	1.002	.04847	.001154	.01528	.00036	.06375	.00152	1.50	.175	1.150	2.483	.05396	.001285	.03784	.00090	.09180	.00219
1.25	.087	1.076	1.083	.04724	.001125	.01651	.00039	.06375	.00152	1.50	.190	1.120	2.665	.05118	.001219	.04062	.00097	.09180	.00219
1.25	.095	1.060	1.175	.04584	.001091	.01791	.00043	.06375	.00152	1.75	.109	1.532	1.915	.09576	.002280	.02919	.00070	.12495	.00298
1.25	.102	1.046	1.254	.04464	.001063	.01911	.00046	.06375	.00152	1.75	.116	1.518	2.029	.09402	.002238	.03093	.00074	.12495	.00298
1.25	.109	1.032	1.332	.04345	.001035	.02030	.00048	.06375	.00152	1.75	.125	1.500	2.175	.09180	.002186	.03315	.00079	.12495	.00298
1.25	.116	1.018	1.408	.04228	.001007	.02147	.00051	.06375	.00152	1.75	.134	1.482	2.313	.08961	.002134	.03534	.00084	.12495	.00298
1.25	.125	1.000	1.506	.04080	.000971	.02295	.00055	.06375	.00152	1.75	.145	1.460	2.492	.08697	.002071	.03798	.00090	.12495	.00298
1.25	.134	.982	1.601	.03934	.000937	.02441	.00058	.06375	.00152	1.75	.156	1.438	2.662	.08437	.002009	.04058	.00097	.12495	.00298
1.25	.145	.960	1.715	.03760	.000895	.02615	.00062	.06375	.00152	1.75	.175	1.400	2.951	.07997	.001904	.04498	.00107	.12495	.00298
1.25	.156	.938	1.827	.03590	.000855	.02785	.00066	.06375	.00152	1.75	.188	1.374	3.140	.07703	.001834	.04792	.00114	.12495	.00298
1.25	.175	.900	2.014	.03305	.000787	.03070	.00073	.06375	.00152	1.75	.190	1.370	3.173	.07658	.001823	.04837	.00115	.12495	.00298
1.50	.095	1.310	1.429	.07002	.001667	.02178	.00052	.09180	.00219	2.00	.109	1.782	2.207	.12956	.003085	.03364	.00080	.16320	.00389
1.50	.102	1.296	1.527	.06853	.001632	.02327	.00055	.09180	.00219	2.00	.116	1.768	2.340	.12753	.003037	.03567	.00085	.16320	.00389
1.50	.109	1.282	1.623	.06706	.001597	.02474	.00059	.09180	.00219	2.00	.125	1.750	2.509	.12495	.002975	.03825	.00091	.16320	.00389

OD Specified	Wall Specified	ID Calculated	Nom. Wt lbs/ft	Internal Capacity/ft		Displacement of Steel/ft		External Displacement/ft		OD Specified	Wall Specified	ID Calculated	Nom Wt lbs/ft	Internal Capacity		Displacement Of Steel		External Displacement	
				Gallons	bbls	Gallons	bbls	Gallons	bbls					Gallons	bbls	Gallons	bbls	Gallons	bbls
2.00	.134	1.732	2.677	.12239	.002914	.04081	.00097	.16320	.00389	2.875	.156	2.563	4.541	.26801	.006381	.06922	.00165	.33724	.00803
2.00	.145	1.710	2.880	.11930	.002841	.04390	.00105	.16320	.00389	2.875	.175	2.525	5.059	.26013	.006193	.07711	.00184	.33724	.00803
2.00	.156	1.688	3.080	.11625	.002768	.04695	.00112	.16320	.00389	2.875	0.188	2.499	5.400	.25480	.006067	.08244	.00196	.33724	.00803
2.00	.175	1.650	3.419	.11108	.002645	.05212	.00124	.16320	.00389	2.875	0.190	2.495	5.462	.25398	.006047	.08326	.00198	.33724	.00803
2.00	.188	1.624	3.640	.10760	.002562	.05560	.00132	.16320	.00389	2.875	0.203	2.469	5.790	.24872	.005922	.08852	.00211	.33724	.00803
2.00	.190	1.620	3.682	.10708	.002549	.05612	.00134	.16320	.00389	2.875	0.204	2.467	5.834	.24831	.005912	.08893	.00212	.33724	.00803
2.00	.203	1.594	3.900	.10367	.002468	.05953	.00142	.16320	.00389	3.500	0.134	3.232	4.820	.42619	.010147	.07361	.00175	.49980	.01190
2.00	.204	1.592	3.923	.10341	.002462	.05979	.00142	.16320	.00389	3.500	0.156	3.188	5.570	.41466	.009873	.08514	.00203	.49980	.01190
2.375	.125	2.125	3.011	.18424	.004387	.04590	.00109	.23014	.00548	3.500	0.175	3.150	6.230	.40484	.009639	.09496	.00226	.49980	.01190
2.375	.134	2.107	3.215	.18113	.004313	.04901	.00117	.23014	.00548	3.500	0.188	3.124	6.650	.39818	.009481	.10162	.00242	.49980	.01190
2.375	.145	2.085	3.462	.17737	.004223	.05277	.00126	.23014	.00548	3.500	0.190	3.120	6.733	.39716	.009456	.10264	.00244	.49980	.01190
2.375	.156	2.063	3.706	.17364	.004134	.05649	.00135	.23014	.00548	3.500	0.203	3.094	7.150	.39057	.009299	.10923	.00260	.49980	.01190
2.375	.175	2.025	4.122	.16731	.003983	.06283	.00150	.23014	.00548	3.500	0.204	3.092	7.199	.39007	.009287	.10973	.00261	.49980	.01190
2.375	.188	1.999	4.390	.16304	.003882	.06710	.00160	.23014	.00548	3.500	0.224	3.052	7.857	.38004	.009049	.11976	.00285	.49980	.01190
2.375	.190	1.995	4.445	.16239	.003866	.06775	.00161	.23014	.00548	3.500	0.250	3.000	8.699	.36720	.008743	.13260	.00316	.49980	.01190
2.375	.203	1.969	4.710	.15818	.003766	.07196	.00171	.23014	.00548	4.500	0.204	4.092	9.383	.68317	.016266	.14303	.00341	.82620	.01967
2.375	.204	1.967	4.742	.15786	.003759	.07228	.00172	.23014	.00548	4.500	0.224	4.052	10.255	.66988	.015950	.15632	.00372	.82620	.01967
2.875	.125	2.625	3.670	.28114	.006694	.05610	.00134	.33724	.00803	4.500	0.250	4.000	11.376	.65280	.015543	.17340	.00413	.82620	.01967

Cable Type	Size (In.)	Diameter (In.)	Breaking Strength (lbs)	Weight (lbs) 1000ft	Armor Wires (Out/In)	Wire BS – lbs (Out/In)	CDR Resistance (Ohms/Mft)	Maximum Temp (°F)
1-H-100-A	1/10	.101	1,000	19	18/12	41/41	25.2	300
1-H-125-A	1/8	.123	1,500	27	18/12	60/60	25.2	300
1-H-125-K	1/8	.123	1,500	28	18/12	60/60	25.2	500
1-H-181-A	3/16	.185	3,900	63	15/12	198/127	9.8	300
1-H-181-D	3/16	.185	3,900	65	15/12	198/127	9.8	420
1-H-181-K	3/16	.185	3,900	65	15/12	198/127	9.8	500
1-H-181-M	3/16	.187	3,600	68	15/12	198/132	12.5	600
4-H-181-A	3/16	.186	3,300	60	18/18	143/76	26.0	300
1-H-203-A	13/64	.203	4,500	79	16/10	212/212	6.9	300
1-H-203-D	13/64	.203	4,500	79	16/10	212/212	6.9	420
1-H-203-K	13/64	.203	4,500	80	16/10	212/212	6.9	500
1-H-220-A	7/32	.223	5,500	92	18/12	212/212	4.5	300
1-H-220-D	7/32	.223	5,500	95	18/12	212/212	4.5	420
1-H-220-K	7/32	.223	5,500	95	18/12	212/212	4.5	500
1-H-226-K	7/32	.222	5,000	99	18/12	196/196	7.7	500
1-H-281-A	9/32	.288	10,000	153	18/12	352/352	2.8	300
1-H-281-K	9/32	.288	10,000	158	18/12	352/352	2.8	500
1-H-314-A	5/16	.316	11,200	183	18/12	426/426	2.8	300
1-H-314-D	5/16	.316	11,200	187	18/12	426/426	2.8	420
1-H-314-K	5/16	.316	11,200	190	18/12	426/426	2.8	500
7-H-314-A	5/16	.323	9,600	180	18/18	426/225	16.6	300

Cable Type	Size (In.)	Diameter (In.)	Breaking Strength (lbs)	Weight (lbs) 1000ft	Armor Wires (Out/In)	Wire BS - lbs (Out/In)	CDR Resistance (Ohms/Mft)	Maximum Temp (°F)
1-H-375-A	3/8	.375	14,600	253	18/12	595/595	2.9	300
1-H-375-D	3/8	.375	14,600	260	18/12	595/595	2.9	420
1-H-375-K	3/8	.375	14,600	261	18/12	595/595	2.9	500
3-H-375-A	3/8	.372	13,500	235	20/16	486/397	7.1	300
4-H-375-A	3/8	.372	13,500	239	20/16	572/301	10.5	300
7-H-375-A	3/8	.372	12,800	243	18/18	572/301	10.5	300
1-H-422-A	7/16	.414	17,800	307	18/12	727/727	2.9	300
1-H-422-D	7/16	.414	17,800	316	18/12	727/727	2.9	420
1-H-422-K	7/16	.414	17,800	317	18/12	727/727	2.9	500
7-H-422-A	7/16	.426	18,300	314	18/18	766/397	10.9	300
7-H-422-D	7/16	.426	18,300	324	18/18	766/397	10.0	420
7-H-422-K	7/16	.426	18,300	326	18/18	766/397	10.0	500
7-H-464-A	15/32	.462	18,300	326	24/24	539/335	10.0	300
7-H-464-D	15/32	.462	18,300	333	24/24	539/335	10.0	420
7-H-464-K	15/32	.462	18,300	347	24/24	539/335	10.0	500
7-H-520-A	17/32	.522	26,000	462	20/16	958/778	10.5	300
7-H-520-D	17/32	.522	26,000	467	20/16	958/778	10.5	420
7-H-472-A	Slammer	.472	22,200	379	18/18	929/486	10.0	300
7-H-472-D	Slammer	.472	22,200	386	18/18	929/486	10.0	420
7-H-472-K	Slammer	.472	22,200	394	18/18	929/486	10.0	500

Carbon Steel – API 9A Breaking Strengths

Material (in)	.072	.082	.092	.105	.108	.125
Br. Steel API Level 3 or Improved plow (lbs)	961	1239	1547	1966	2109	2794
API Ex. Impr. Plow, Hi-Str. or Mon. AA (lbs)	1150	1460	1830	2360	2490	3300

Austenitic Stainless Steel – Breaking Strengths

Material (in)	.082	.092	.105	.108	.125
316 Stainless (lbs)	1083	1363	1732	1786	2270

Super Austenitic Stainless – Breaking Strengths

Material (in)	.092	.105	.108	.125
Sandvik Sanicro 28 (lbs)	1445	1885	1995	2675

6 Moly Stainless Steel – Breaking Strengths

Material (in)	.092	.105	.108	.125
Avesta 254 SMO (lbs)	1462	1818	1924	2454
Bridon Supa (lbs)	1550	2030	2030	2560
25-6MO (lbs)	1475	N/A	2050	2550

Cobalt Based Alloy – Breaking Strengths

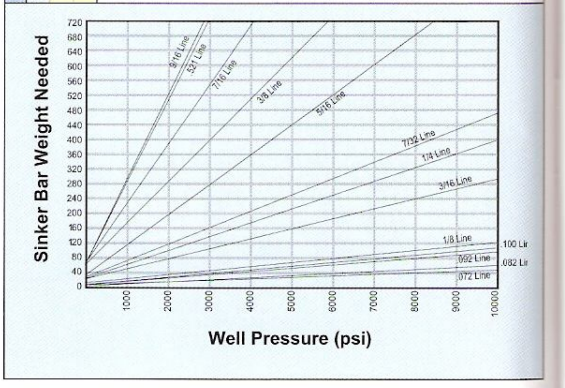
Material (in)	.092	.105	.108	.125
MP35N (lbs)	1582	2009	2080	2724

Braided Line – Breaking Strengths

Size (in)	3/16"	3/16"	7/32"	7/32"
Construction	1 x 16	1x 19 (Dyform/Dyform)	1 x 16	1x 19 (Dyform/Dyform)
Galv. Carbon Steel	4500	6170	6000	8370
15-6Mo (Supa 75)	4320	4960	5842	5990

For wireline to fall against well pressure, find desired line versus well pressure and extrapolate total sinker bar weight needed.

All "lbs" are breaking strength. These vary with the manufacturer.



Field Units to Metric Conversion

If You Have:	Multiply By:	To Get:
Feet	x 0.3048	Meters (M)
Inches	x 2.54	Centimeters (cm)
Inches	x 25.4	Millimeters (mm)
Pounds (Lbs)	x 0.0004536	Metric Tons
Pounds (Lbs)	x 0.44482	Decanewtons (daN)
Pounds	x 0.4536	Kilograms
Weight (Lbs/ft)	x 1.4882	Kg/M
Pounds per Barrel	x 2.85307	Kg/M^3
Barrels	x 158.987	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 158.987	Liters/Minute
Barrels/Minute	x 0.158987	Cubic Meters/Minute
bbl/ft. Capacity	x 521.612	Liters/Meter (L/M)
bbl/ft. Capacity	x 0.521612	Cubic Meters/Meter
Bbl Displacement	x 521.612	Liters/Meter (L/M)
Bbl 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
BWPD @ 8.9 ppg	X 0.118	Kg/Min
BOPD @ 7.74 ppg	X 0.099	Kg/Min
mmCFD @ 0.6 sp. gr.	X 14.1	Kg/Min

Metric to Field Units Conversion

If You Have:	Multiply By:	To Get:
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)
Decanewtons (daN)	x 0.22481	Pounds (Lbs)
Kilograms	x 2.2046	Pounds
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 1.917	BBL/Ft. Capacity
Liters/Meter (l/m)	x 0.0019171	BBL Displacement
Cubic Meters/Meter	x 1.9171	BBL 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 Meter	x 0.0083454	Mud Weight PPG
Specific Gravity (SG)	x 8.3454	Mud Weight PPG
Kg/m^3	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
Kg/Minute	X 8.475	BWPD @ 8.9 ppg
Kg/Minute	X 10.105	BOPD @ 7.74 ppg
Kg/Minute	X 0.071	mmCFD @ 0.6 sp.gr.