IBEX
DRILLING SOLUTIONS

MOTOR HANDBOOK

RAM PERFORMANCE MOTOR

First Edition - 2025

ABOUT IBEX

IBEX Drilling Solutions is a privately owned Midland, Texas based company that offers the RAM mud lubricated-style downhole motor for rental or purchase options and are available for straight, directional, or horizontal drilling applications. IBEX's main goal is to provide the highest quality equipment to our customers so that we may support their needs to drill as efficiently and economically as possible in various applications.

MOTOR HANDBOOK

This motor handbook contains technical information including specification sheets, diagrams, tables, and charts for the various sizes and configurations that IBEX offers. This handbook is to be used for reference purposes only.

DISCLAIMER

The interpretation of the information and how it is used by the customer is the sole responsibility of the customer or end user and is subject to change at any time. IBEX is not responsible for the end result of work based on the information given in this motor handbook. Please contact any of IBEX's locations if there are questions not answered in this handbook.

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IBEX DRILLING SOLUTIONS

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INTRODUCTION

Mud Motor Design

IBEX offers the RAM mud lubricated-style downhole motor which are available in multiple diameters for straight, directional, horizontal or RSS assist drilling applications. The RAM is a fully redesigned tough and versatile mud motor that offers the performance necessary for a variety of drilling applications.

These motors feature a sleeve on sleeve upper and lower radial bearings that provide radial support plus controlling the flow of the fluid through the bearing stack. The motors also feature multiple tiers of hardened thrust-bearing races and rock bit balls that provide the endurance to withstand long continuous run times in any drilling environment.

The power sections provided by IBEX offer several ranges of bit speeds and torques which can be set up to function in both low or hot hole temperatures and inverted mud systems. IBEX motors are available in multiple speed and torque ranges for various downhole applications. Also, IBEX mud motors are designed to meet very high criteria with the primary focus on reliability and simplicity. This produces an extremely tough and versatile mud motor, which provides the end user with the performance necessary for a variety of drilling applications.

Mud Motor Features

- The RAM bearing assembly features a typical stack up of thrust bearing races and rock bit balls along with upper and lower radial bearings providing increased axial and radial load capabilities that reduces the stresses on individual components within the bearing assembly providing extended run times and reduced operating costs.
- The RAM offers multiple driveshaft assemblies including a Hybrid Flex Shaft, Jaw Clutch, and our patent protected Lobe Coupling. All the driveshaft assembly designs convert the eccentric rotation of the rotor into concentric rotation for input into the bearing assembly. The driveshaft transfers the thrust load from the rotor caused by the pressure drop across it. All driveshaft assemblies are re-buildable and re-useable, which can be easily assembled or disassembled.
- The RAM motors are assembled with fixed bend or straight housings. Fixed bend housings can be manufactured from 0° to 3° to achieve the desired build rates during the run. The straight housings are primarily used for Rotary Steerable Assist applications when additional output of the RSS tool is needed.
- The RAM mud motors are assembled with multiple power section models that produce various speed and torque outputs to accommodate customer needs. All stators are lined with high durometer hard rubber elastomers which produces maximum power section output.

- The RAM mud motors are assembled with a top sub/rotor catch assembly that will allow for the entire motor to be retrieved should any housing connection including the top stator connection fracture or backoff.

SERVICE QUALITY PLAN (SQP)

The IBEX Service Quality Program (SQP) policy establishes our commitment to continuous improvement and providing first class services to our customers. By doing so, IBEX will provide the highest quality equipment to our customers so they can operate with the confidence that their operation will run successfully. IBEX's goal is to:

- Provide the highest-quality services to our customers.
- Expand, improve, and add value to the services that we provide.
- Continuously focus on service quality to improve IBEX's Quality Management System that ensures the company is run at the highest level to support our customers' needs.
- Challenge our employees to be responsive to the customer's expectations and "do it right the first time."
- Provide services that exceed our customer's expectations every time.
- Evaluate the effectiveness of the SQP system which allows IBEX to continuously develop and improve.
- Involve employees so they may take pride in their workmanship and commitment to quality.

MOTOR COMPONENTS

Bearing Assembly

The bearing assembly transfers the rotation of the rotor, through the driveshaft, to the drill bit. It carries the compression thrust load created by weight on bit, and the radial and bending loads created while directional or steerable drilling. The assembly also carries the tension created when off bottom thrust loads are produced by the pressure drop across the rotor and the drill bit, as well as any load caused by back reaming. The bearing mandrel bit box is the lower most connection of the mud motor and is manufactured with an API tool joint box thread.

Maximum Bearing Assembly Life

Maintaining the proper flow rate and WOB will significantly increase bearing assembly life. Refer to the motor specification sheets given in Section 4 “Motor Specifications”.

Exceeding maximum flow rate can cause the radial bearings to wash. Exceeding maximum WOB can cause the thrust bearings to wear prematurely.

Driveshaft

IBEX offers Single and Double Articulated driveshaft designs capable of withstanding the high torque of extended power sections and can be run with bend settings up to 3° depending on the driveshaft design used.

The driveshaft assembly converts the eccentric rotation of the rotor into concentric rotation for input into the bearing assembly. The driveshaft transfers the thrust load from the rotor caused by the pressure drop across it. The driveshaft assembly is also re-buildable and re-useable which can be easily assembled or disassembled.

The Single Articulated driveshaft consists of a single universal joint connecting to the bearing assembly and lower rotor connections. The Single Articulated assembly is lubricated, sealed, and pressure balanced. The Double Articulated driveshaft assembly consists of upper and lower universal joints along with a center driveshaft. The upper universal joint connects to the lower rotor connection and the lower universal joint connects to the bearing assembly connection. The Double Articulated assembly is not sealed and can run at any temperature.

Fixed Bend Housing

IBEX motors can be assembled with a fixed bend housing which also are manufactured in various bend angles ranging from 0° - 3°.

Power Section

IBEX offers multi-lobe power section configurations. The power section is a Moineau pump operated in reverse when drilling fluid pressure is applied. It transforms the hydraulic energy from the drilling fluid pressure to mechanical energy which rotates the driveshaft in turn rotating the bit.

The power section consists of a helical shaped rotor with a multi-lobe cross section that forms a helix which runs inside the stator.

The stator tube has an elastomer liner that is bonded to the ID of the tube. The stator elastomer liner is similar to the shape of the rotor. However, it has one additional lobe than the rotor which creates adequate clearance allowing the rotor to rotate within the stator. The rotor forms a continuous seal lengthwise with the stator at their contact points creating wedge shaped cavities. When drilling fluid pressure is applied to these cavities, the rotor is forced to rotate within the stator.

The stator, having one more lobe than the rotor, has a pitch length which is longer than the rotor's. The stator pitch length can be calculated by dividing the number of stator lobes by the number of rotor lobes. The power section configurations are designated by the ratio of their lobes. Generally, as the number of lobes increases so does the torque. Then the speed decreases. Another factor affecting torque is the number of spirals each lobe translates over the length of the rotor. One complete spiral is referred to as one stage.

Extended power sections offer increased torque without reducing speed by increasing the overall length and number of stages.

Power Section Fit

The power section fit is established by obtaining the rotor and stator interference or clearance fit. This is the difference between the stator minor diameter (lobe peak to lobe peak) and the rotor mean diameter (lobe peak to lobe valley).

The power section fit is determined by the bottom hole temperature (BHT), mud type, etc. Generally, where the BHT is low, the rotor is sized slightly larger than the stator creating an interference fit of the power section. Increasing the rotor and stator interference increases the sealing surfaces thereby producing larger pressure drops but decreases stator life as the elevated frictional forces can cause elastomer wear and/or premature chunking.

In applications where the BHT is high the power section fit is decreased. Elevated temperatures require that the power section fit be reduced to achieve clearance (negative) fits. Clearance fits and/or flush fits (rotor mean diameter and stator minor diameter are the same size) are generally used when downhole circulating temperatures are expected to be above 200°F. To achieve fit accuracy, the stator should be measured at 75°F. If the temperature exceeds 75°F, the measurements can be calculated to ensure accuracy of the stator and subsequent power section fit.

Increasing Power

Increasing the power output is achieved by increasing the length and number of stages of the power section. Since rotor/stator power is proportional to the number of stages of a power section, increasing the number of stages increases power. This can be accomplished by using an extended length power section. Extended power sections are used to produce more torque or to produce an equivalent amount of torque at a lower pressure drop, increasing power section life.

Factors Affecting Power Section Life

The most common mode of failure in power sections is damage to the stator elastomer. This is commonly known as chunking. “Chunks” or pieces of stator elastomer are torn or pulled away. This is caused when the frictional forces between the rotor and stator exceed the tensile strength of the elastomer.

Power section life can be lengthened by following the recommendations outlined below:

- Never exceed the recommended maximum operating differential pressures shown on the motor specification sheets given in Section 4 “Motor Specifications”.
- Never exceed the recommended maximum flow rate shown on the motor specification sheets given in Section 4 “Motor Specifications”.
- Be certain that the correct power section fit is chosen for the mud type and temperature.

- When using oil-based drilling mud, consider the downhole operating temperatures as well as the aniline point (AP). The AP (i.e. temperature) of an oil is an indication of its tendency to cause swelling of the stator elastomer and is a measure of the oil's aromatic content. The lower the AP, the greater the swelling tendency. Generally, stator elastomer or bond degradation increases when the AP is lower than 160. The aniline point gives a measure of the solvent power of a petroleum product for aniline, which is related to its solvent power for many materials.
- Running a motor in oil based fluids at temperatures above the oil's AP allows the aromatic portion of the oil to penetrate and swell the elastomer which will reduce the strength and hardness. As the swelling increases the interference fit between the rotor and stator also increases. This will result in additional heat build-up which will lead to rapid destruction of the elastomer.
- Larger power section fits will minimize the potential for premature chunking.
- Avoid or minimize motor stalls.
- Minimize the amount of trash (metal filings, etc.) in the drilling mud system.
- Monitor the age and condition of stator elastomer. Doing so can help reduce failures and assist in determining when to reline stators. Consult the power section manufacturer for their recommended "shelf life" criteria.

Rotor Jetting

Higher flow rates can be achieved by jetting the rotor using tungsten-carbide nozzles. Rotor nozzles allow higher drilling fluid circulation rates by diverting a portion of the drilling fluid through the center of the rotor. They can also be used to reduce bit speed at high flow rates. **NOTE:** The rotor must be gun drilled to allow for the fluid to bypass.

When the drilling requirements are within the operating criteria, either a solid rotor is used, or the rotor is fitted with a plug to prevent fluid bypass.

The following hydraulic equation may be used to determine jet size.

$$A = \sqrt{(Q^2 \times W) / (P \times 10{,}858)}$$

Where: A = Total cross sectional flow area of jet (in.^{2})

Q = Circulation rate (gpm)
W = Drilling fluid weight (ppg)
P = Differential pressure (psi)

Refer to Table 2-1 for the flow area of a particular jet size or Table 2-2 for the bypass flow for a particular jet size at a given differential pressure.

Refer to Section 5 “Formulas” for other hydraulic calculations.

Table 2-1 Jet Size

Table 2-1 Rotor Jet Size and Flow Area			
Jet Size (in)	**Flow Area (in2)**	**Jet Size (in)**	**Flow Area (in2)**
6/32	0.028	15/32	0.172
7/32	0.038	16/32	0.196
8/32	0.049	18/32	0.249
9/32	0.062	20/32	0.306
10/32	0.077	22/32	0.371
11/32	0.093	24/32	0.442
12/32	0.110	26/32	0.518
13/32	0.130	28/32	0.601
14/32	0.150	30/32	0.690

Table 2-2 Rotor Jet Bypass Flow at Various Motor Differential Pressures

Jet (in)	Mud Weight (ppg)	Bypass Flow Rates (gpm) at Various Differential Pressures (psi)								
		100 psi	200 psi	300 psi	400 psi	500 psi	600 psi	700 psi	800 psi	900 psi
7/32	water	14	19	23	27	30	33	36	38	41
	10	12	18	21	25	28	30	33	35	37
	12	11	16	20	23	25	28	30	32	34
	14	10	15	18	21	23	26	28	30	32
8/32	water	17	25	31	35	40	43	47	50	53
	10	15	23	28	32	36	40	43	46	48
	12	14	21	26	29	33	36	39	42	44
	14	13	19	24	27	30	33	36	39	41
10/32	water	28	39	48	55	62	68	72	78	83
	10	25	36	44	50	57	62	67	71	75
	12	23	33	40	46	52	56	61	65	69
	14	21	30	37	42	48	52	56	60	64
12/32	water	40	56	69	80	89	98	105	113	119
	10	36	51	63	73	81	89	96	103	109
	12	33	47	58	66	74	81	88	94	99
	14	31	43	53	62	69	75	81	87	91
14/32	water	54	77	94	108	121	133	144	153	162
	10	50	70	86	99	111	121	131	140	147
	12	45	64	78	90	101	111	120	128	135
	14	42	59	73	84	94	103	111	118	124
16/32	water	71	100	123	142	158	174	187	200	212
	10	65	91	112	129	145	158	171	183	193
	12	59	84	102	118	132	145	156	167	175
	14	55	77	95	109	122	134	145	155	162
18/32	water	90	127	155	179	200	220	237	254	268
	10	82	116	142	164	183	201	217	232	245
	12	75	106	129	150	167	183	198	211	221
	14	69	98	120	138	155	170	183	196	202

Top Sub

The top sub is the upper most portion of the mud motor with an API tool joint box thread. The lower end of the top sub is an IBEX designed thread form that connects to the upper box thread of the stator. All top subs are bored for a float valve.

Rotor Catch

The rotor catch is a standard motor component which is inserted into the top of the rotor and runs inside the top sub. Its main function is to "catch" the entire motor in the event of a fractured or backed off housing connection including if this occurs at the upper stator/top sub connection.

Job Preparation

Motor Selection

Fluid type, rotary speed, bitt speed, hydraulics, circulating fluid data, formation characteristics, and motor diameter are some of the requirements needed to specify the proper motor.

Power Section Selection

The power section selected must provide the proper performance for the drilling application and is selected based on the power section's output vs. the bit that is used and formation both are being run in.

Motor Bend Angle

The bend angle is determined by the required build rates in degrees/100 ft. and can be found on the motor specification sheets given in Section 4 "Motor Specifications" to determine the proper build rates.

Rotor Jet Sizing

A rotor nozzle jet can be used to bypass flow should the flow rate exceed the recommended maximum. The nozzle is fitted in the rotor catch which allows a portion of the fluid to bypass through the ID of the rotor. This option must be selected prior to shipping to the rig. (Refer to Table 2-1 and Table 2-2 for jet sizing.)

Top Sub and Bit Box Connections

It is necessary that the proper top and bottom connections of the motor be requested prior to the motor being assembled to match those being run at the rig site.

Stabilizers

It is recommended that the stabilizer be under gage by no less than ⅛" and not exceed ¼." A ring gage should always be used to ensure that the stabilizer is within specification. If a screw on stabilizer is not required and either a screw on thread protector must be threaded to the bearing housing or a true slick bearing housing must be used.

Pre – Run Motor Evaluation and Set Up

Visual Inspection

A visual inspection of the motor is recommended to check for any signs of external damage to the motor.

Stabilizers

If the bearing housing is threaded for a stabilizer, be sure that a stabilizer or screw on thread protector is used (Refer to Table 4-2 in Section 4 for recommended sleeve torque values).

Bearing Assembly Wear Measurements (Push / Pull)

Follow the steps below to determine if a motor is within acceptable wear limits for new or continued operation before or after a motor is run.

1. Measure the off bottom or tension gap between the lower housing and bit box when the motor is hanging above the rig floor (Refer to L2 in Figure 1).
2. Measure the on bottom or compression gap when the motor is standing on the rig floor (See L1 in Figure 3-1).
3. For new or used motors subtract the hanging gap minus the standing gap (L2 - L1).
4. Lay the motor down if the difference between the hanging or standing gap exceeds the push/pull measurements in Table 3-1.

Figure 3-1 Push / Pull Measurements

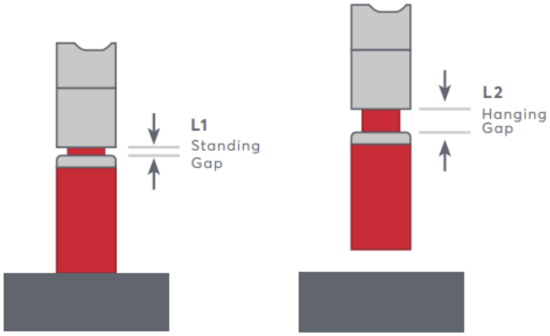


Table 3-1 Push / Pull Measurements

RAM Push-Pull Measurements	
Motor Size	Max On Rig Floor
5"	.130"
5 3/8"	.135"
5 1/2"	.135"
6 5/8"	.145"
6 3/4"	.145"
7 1/8"	.145"
8 1/4"	.170"

Running IBEX Mud Motors

Running In

When the motor is set at a non-zero bend angle it is recommended to run in the hole at a controlled rate and should be done when running the drill string through the blow out preventers, casing shoes, liner hangers, ledges, or key seats to ensure that the motor or drill bit does not hang up. Do not run into bottom or "bottom fill," as it could plug the bit or damage the motor.

A straight motor can be run in the hole normally.

Starting the Motor

1. Begin circulating the motor "off bottom" allowing the bit to turn freely.
2. Continue circulating until the desired flow rate is achieved.
3. Maintain flow rates within the recommended min/max range. Doing so will reduce the potential for motor damage.
4. Record the off-bottom pressure.

Drilling

1. Slowly lower the motor to bottom. Once on bottom and weight is applied, the standpipe pressure will increase producing differential pressure.
2. Slowly increase the weight on bit (WOB) until the desired rate of penetration (ROP) has been achieved. The WOB will likely need to be adjusted to maintain the optimal ROP.

The standpipe pressure will gradually increase after hole cleaning due to the hydraulic energy required to lift the cuttings. Therefore, it may become necessary to periodically recheck the off-bottom pressure.

Bit torque is produced while the motor is on bottom. The torque is directly proportional to the difference between the on bottom and off bottom pressure.

- As the WOB is increased so does the bit torque.
- As the bit drills off, the WOB, pressure, and torque decrease. Therefore, the standpipe pressure gage can be used as a torque indicator.

Rotary RPM

Fatigue loading on the motor can be produced when the bend settings are within recommended values. Therefore, it is recommended that the rotary speed not exceed the values in Table 3-2. Doing so will reduce the rotational bending fatigue loads across the motor which will reduce the potential for a motor failure.

Table 3-2 Rotary Speed Guidelines

Maximum Recommended FBH Bend Angle For Rotary Speeds Up To 80 RPM													
Motor Bend Angle		0.00	1.25	1.50	1.75	1.83	2.00	2.12	2.25	2.38	2.50	2.75	3.00
Maximum RPM For Vertical / Lateral Section	Max RPM	80	80	80	80	70	60	50	40	0	0	0	0
Maximum RPM For Curve / Transition Section	Max RPM	80	80	80	80	60	50	40	30	20	0	0	0

Stalling

When a stall occurs the drill bit becomes overloaded causing the differential pressure to increase and the ROP to decrease to zero. When this occurs, the drilling fluid distorts the stator elastomer and flows through the motor without the rotor turning.

The steps below are recommended to immediately be followed should a stall occur.

1. Immediately shut down the rotary table.
2. If needed, shut the pumps off.
3. Slowly release the trapped torque using the rotary table break.
4. Lift the bit off bottom.

If the above stall procedures are not followed, the following may occur."

- The trapped torque in the drill string will be released which can cause motor connections to backoff or cause damage to other components in the BHA.
- If continuous circulation through a stalled motor or repeated stalling occurs, the stator elastomer can become damaged causing chunking to occur along with the potential for internal motor component damage.

Bit Pressure Drop

The bit pressure drop should not exceed 1500 PSI. Exceeding this value increases the chance of bearing failure.

Tripping Out of the Hole and Surface Checking

- No special procedures are required when tripping out of the hole.
- When the motor reaches the rig floor, a visual inspection is recommended to check for any signs of external damage to the motor. Also check for the bit push/pull measurements and record.
- Prior to laying down or racking back the motor for an extended period of time, it is recommended to pump fresh water through the motor, so it is flowing out of the bit box or bit jets. Doing so will flush out any oil base or elevated brine content drilling fluids that can cause damages to the motors internal components in general or should it be rerun.

Drilling Fluid Selection

Selecting the proper drilling fluid is important to extending motor life and performance as well as aiding in drilling operations. Various fluid additives can be detrimental to the rotor and/or stator elastomer.

Chlorides

Drilling fluids containing chlorides, especially at elevated temperatures, can considerably reduce rotor and stator life due to corrosion.

Although some motor companies offer tungsten carbide rotors for high chloride content applications, the majority offer chrome coated rotors. The effects of chlorides can be detrimental to rotor's chrome coating. Therefore, if chrome rotors are used, the chloride concentration should not exceed 30,000 PPM.

Oil Based Mud

IBEX mud motors can be run in oil base mud (OBM) provided the operating temperature is less than the aniline point (AP) of the oil. The AP is an estimated value of the oil's aromatic content.

If a motor is run in oil base fluids at a temperature above the oil's AP the aromatic portion of the oil will penetrate the stator elastomer causing it to swell, reduce the hardness, strength and require reline after each run – To minimize the potential for chunking, a looser fit power section with less interference or clearance can be used to limit the effects of swelling. However, the risk is greater at the beginning of the run for the potential to stall the motor due to the looser fit.

Mud Density

Drilling mud with a density greater than 16.0 lbs/gal can cause irregular erosion of internal motor components including stator elastomer due to suspended materials in the mud.

Recommended mud density in drilling fluids:

- Sand content should not exceed 2%.
- Corrected solid content should not exceed 18%.
- Low gravity solid content should not exceed 6%.

Air or 2 Phase Drilling Types

- **Mist** – Occurs when the liquid fraction is greater than 2.5% at the downhole operating conditions ensuring the liquid remains as droplets within the gas.
- **Foam** – Occurs when the liquid fraction is between 2.5% - 25% at downhole operating conditions. Foam is specified as “% foam quality”. This is the volume fraction of the gas. Therefore, 60% foam quality is 60% gas and 40% liquid by volume.
- **Aerated Mud** – Occurs when the liquid fraction is greater than 25% at downhole operating conditions. In this circumstance, gas stays as bubbles in the liquid.

Recommended Operations Requirement

- **Air Volume** – 3 to 4 standard cubic feet per minute (scfm) = 1 gallon per minute (gpm) of drilling fluid.
  Example – 400 gpm = 1,200 -1,600 scfm.
- **Foam Volume** – 3 ½ - 4 ½ scfm of air plus a range of 10-100 gpm of foam injection is recommended.
- **Pressure** – Approximately 2 times the amount required with normal fluids.

Lubricants

Running with dry air can cause frictional heat build up between the rotor and stator causing the stator to chunk resulting in shorter than expected run times. Therefore, it is necessary to make sure the elastomer is lubricated.

A lubricant created from a mixture of soap/gel and water that is injected at approximately 5% rate by volume is sufficient for most applications.

Standard Lubricants

Liquid Soap ....½ to 1 gal per barrel of water
Graphite...................4 to 6 lbs per barrel of water
Gel..........................½ to 1 lbs per barrel of water
Oil .... 0.1 to 0.6 gal per hour

CFM/GPM Calculation

Equivalent GPM for Gas Without Temp Change Used

$$\text{Equivalent GPM} = \frac{\text{Total CFM}}{\text{Compression Ratio}} \times \text{Unit Conversion Factor}$$

$$\text{Compression Ratio} = \frac{\text{Operation Pressure}}{\text{Atmospheric Pressure}}$$

Atmospheric Pressure at sea level = 14.7psi

Unit Conversion Factor = 7.48 gallons/ft^3

Example: 625psi operating pressure for 4250cfm, 3800cfm

Equivalent GPM = 4250*7.48/(625/14.7) = 748gpm

Equivalent GPM = 3800*7.48/(625/14.7) = 669gpm

Total GPM = Fluid GPM + Equivalent Gas GPM

Example: 750gpm mud + 1500cfm air@600psi

GPM = 750gpm + 1500/(600/14.7)*7.48

GPM = 1025gpm equivalent at injection point

Operating pressure at depth (total compression pressure)

Total compression pressure = injection pressure + hydrostatic column pressure

Example: 2000ft depth – pressure column – 0.35psi/ft(?)

Hydrostatic pressure = 2000*0.35 = 700psi

Gas GPM equivalent = 1500/((600+700)/14.7)*7.48 = 127gpm

Example: 6000ft depth @ 0.35psi/ft = 2100psi with gas injection pressure of 600psi

Gas GPM equivalent = 1500/((600+2100)/14.7)*7.48 = 61gpm

Motor Operation With Air or 2 Phase

When drilling with air, the motor will:

- Require less weight on bit to drill.
- Be more weight sensitive the with fluids.
- Stall at lower pressure

It is recommended to let the motor drill off as the compressors and boosters are being shut down after drilling is completed. Then, prior to picking up the motor from bottom, it is recommended to allow for the pressure to equalize. If the motor is picked up prior to the pressure equalizing, the air within the drill string can expand which will cause high motor speeds that can cause damage to the motor up to causing internal motor connections to back off.

Motor Selection for Air or 2 Phase Application

Sealed bearing assemblies are generally preferred for drilling in air or 2-phase drilling applications as air does not conduct heat as well as fluids. Mud lubricated bearing assemblies are susceptible to seizing due to overheating. However, this may not be an issue in aerated mud systems. Being able to minimize the temperature generated within the stator elastomer is critical when selecting a motor to rerun in an air or 2-phase application.

The following is recommended:

- Select a stator that ensures a loose power section fit compared to a fit that would be run in fluid at the same temperature range.
- Use the lowest foam amount and highest amount of liquid possible.
- Run the lowest rev/gal power section possible.
- Circulate for as much time as possible through the motor.

Drilling with Nitrogen

78% of air consists of nitrogen. The density of nitrogen is approximately 3% less than that of air at standard temperature and pressure. Therefore, a drilling motor will operate the same on air as nitrogen.

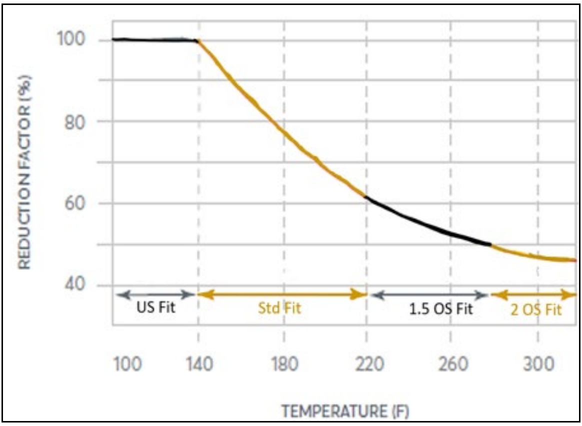
NOTE: Stator elastomer, o-rings, seals, etc. are normally not affected by nitrogen. However, they will absorb nitrogen and other gases under pressure for an extended period. If the pressure is released too soon and the gases do not have time to exit from the seals, explosive decompression can occur which will cause blistering of the seals and chunking of the elastomer. Typically, this will occur if the pressure drop exceeds 400 psi across the motor.

Downhole Temperature

A reduction of stator elastomer strength can be caused by an increase of the downhole circulating temperature. When this occurs a reduction of the maximum recommended differential pressure drop across the power section should be made to reduce the probability of stator elastomer failure.

As shown in Figure 3-2, when the temperature is at or below 140° F it is not required to reduce the differential pressure. However, if the temperature is over 140° F, the maximum rated differential pressure obtained from the performance curves should be multiplied by the differential pressure reduction factor below.

Figure 3-2 - Maximum Differential Pressure Derating for Power Sections



The fit sections at the bottom of the chart - indicated as “Std Fit”, “OS Fit” and “2xOS Fit”- indicate the recommended stator sizes to be used at temperature.

While a standard fit stator can be used at temperatures higher than 220°F, it is susceptible to premature failure due to excessive interference fit, resulting in additional frictional heat increasing the potential for chunking.

Likewise, an oversized fit can be used at temperatures below 220°F. However, it may not perform as expected due to the looser fit. This enables fluid leakage at the seal lines of the rotor and stator, resulting in stalling and a weak motor.

EXAMPLE

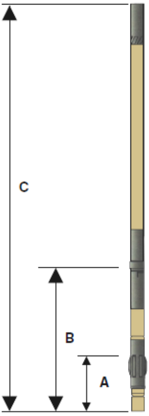
If the maximum differential pressure is 900 psi and the downhole circulating temperature is 180° F, the operating full load pressure is calculated by multiplying 900 psi by a differential reduction factor of 77%, yielding 693 psi.

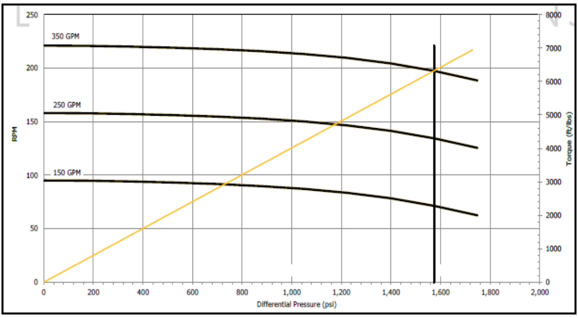
NOTE: IBEX assembles power sections based on actual fits vs. the proposed downhole circulating temperature range and mud type. Therefore, power sections or not sized by using a designated standard size stator for a low temperature application or an oversized stator for a hot temperature application. Therefore, IBEX recommends assembling power sections by actual fit vs the maximum circulating temperature of the proposed run. This is recommended due to the tolerance range of the stators elastomer which can range from +/- .010” to +/- .015” depending on the stator vendor which can result in a +/- .020” to .030” measurement swing. This large variance can result in a power section fit that is either too tight or too loose resulting in the potential for elastomer failure or stalling causing the motor to be weak.

5” 5/6 Lobe 6.7 Stage

5.00” 5/6 6.7 Stage Flex CV	
Motor OD	5.00 inch
Lobe Configuration Bit	5 - 6 Lobe 6.7 Stage
Size Range	6 - 7 7/8 inches
Bit Box Connection	3 1/2 REG or NC40
A = Bit to Stabalizer (Center)	NA
B = Bit to Bend - Flex Shaft	52.40 inches
B = Bit to Bend - Fixed	52.40 inches
B = Bit to Bend - Adjustable	NA
C = Overall - Flex Shaft (w/Top Sub)	373.92 inches
C = Overall (with Top Sub)	373.92inches
Adjustable Makeup Torque	NA
Weight	1700
Max WOB - w/Flow	57,970 lbs
Optimum WOB - w/Flow	28,985 lbs
Max WOB - w/o Flow	144,925 lbs
Max Bit Pull - w/Damage	252,000 lbs

Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	*GPM*	*RPM*	*Ft. Lbs*	*PSI*
0.630	150 - 350	90 - 220	6,330	1,580





5.00” 5/6 6.7 STAGE HR								
CALCULATED BUILD UP RATES - DEGREES / 100ft. * (Flex Shaft Fixed)								
Angle (Deg)	Hole Size (in) – Slick Sleeve				Hole Size (in) - Stabilized			
	6”	6 1/8"	6 3/4"	7 7/8"	6”	6 1/8"	6 3/4"	7 7/8"
0.25	1.0	0.8			1.0	1.0	1.3	1.8
0.50	2.4	2.2	1.1		2.3	2.3	2.6	3.1
0.75	3.8	3.6	2.5	0.5	3.6	3.7	3.9	4.4
1.00	5.2	5.0	3.9	1.9	4.9	5.0	5.3	5.7
1.25	6.6	6.4	5.3	3.3	6.3	6.3	6.6	7.1
1.50	8.0	7.8	6.7	4.7	7.6	7.6	7.9	8.4
1.75	9.5	9.2	8.1	6.1	8.9	9.0	9.2	9.7
2.00	10.9	10.6	9.5	7.5	10.2	10.3	10.6	11.0
2.25	12.3	12.0	10.9	8.9	11.6	11.6	11.9	12.4
2.50	13.7	13.4	12.3	10.3	12.9	13.0	13.2	13.7
2.75	15.1	14.8	13.7	11.7	14.2	14.3	14.5	15.0

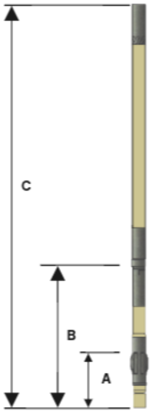
Actual build rates are subject to varying factors including formation, weight on bit, etc.

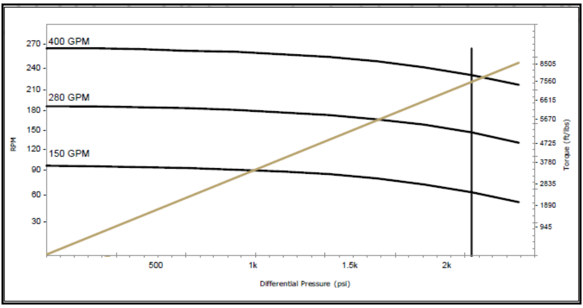
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

5” 6/7 Lobe 8.8 Stage

5.00” 6/7 8.8 Stage Flex CV	
Motor OD	5.00 inch
Lobe Configuration Bit	6 - 7 Lobe 8.8 Stage
Size Range	6 - 7 7/8 inches
Bit Box Connection	3 1/2 REGULAR
A = Bit to Stabalizer (Center)	24.50 inches
B = Bit to Bend - Flex Shaft	52.44 inches
B = Bit to Bend - Fixed	52.44 inches
B = Bit to Bend - Adjustable	NA
C = Overall - Flex Shaft (w/Top Sub)	399.53inches
C = Overall (with Top Sub)	399.53 inches
Adjustable Makeup Torque	NA
Weight	1700
Max WOB - w/Flow	57,970 lbs
Optimum WOB - w/Flow	28,985 lbs
Max WOB - w/o Flow	144,925 lbs
Max Bit Pull - w/Damage	252,000 lbs

Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	*GPM*	*RPM*	*Ft. Lbs*	*PSI*
0.66	150 - 400	100 - 260	7,660	2,070





5.00” 6/7 8.8 STAGE HR								
CALCULATED BUILD UP RATES - DEGREES / 100ft. * (Flex Shaft Fixed)								
Angle (Deg)	Hole Size (in) – Slick Sleeve				Hole Size (in) - Stabilized			
	6"	6 1/8"	6 3/4"	7 7/8"	6"	6 1/8"	6 3/4"	7 7/8"
0.25	1.0	0.8			1.0	1.0	1.3	1.8
0.50	2.4	2.2	1.1		2.3	2.3	2.6	3.1
0.75	3.8	3.6	2.5	0.5	3.6	3.7	3.9	4.4
1.00	5.2	5.0	3.9	1.9	4.9	5.0	5.3	5.7
1.25	6.6	6.4	5.3	3.3	6.3	6.3	6.6	7.1
1.50	8.0	7.8	6.7	4.7	7.6	7.6	7.9	8.4
1.75	9.5	9.2	8.1	6.1	8.9	9.0	9.2	9.7
2.00	10.9	10.6	9.5	7.5	10.2	10.3	10.6	11.0
2.25	12.3	12.0	10.9	8.9	11.6	11.6	11.9	12.4
2.50	13.7	13.4	12.3	10.3	12.9	13.0	13.2	13.7
2.75	15.1	14.8	13.7	11.7	14.2	14.3	14.5	15.0

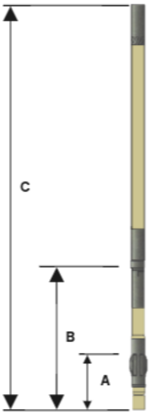
Actual build rates are subject to varying factors including formation, weight on bit, etc.

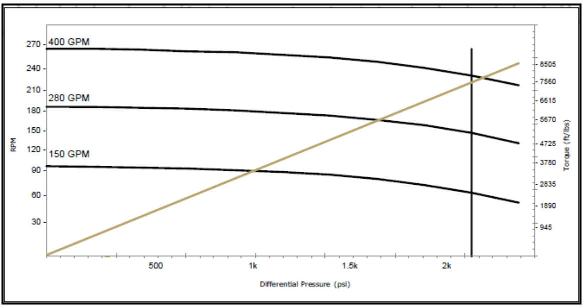
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

5” 6/7 Lobe 8.8 Stage RSS Assist

5.15” 6/7 8.8 Stage Flex CV	
Motor OD	5.15 inch
Lobe Configuration	6 - 7 Lobe 8.8 Stage
Bit Size Range	6 - 7 7/8 inches
Bit Box Connection	XT39
A = Bit to Stabalizer (Center)	24.7 inches
B = Bit to Bend - Flex Shaft	NA
B = Bit to Bend - Fixed	NA
B = Bit to Bend - Adjustable	NA
C = Overall - Flex Shaft (w/Top Sub)	384.86 inches
C = Overall (with Top Sub)	384.86 inches
Adjustable Makeup Torque	NA
Weight	1700
Max WOB - w/Flow	57,970 lbs
Optimum WOB - w/Flow	28,985 lbs
Max WOB - w/o Flow	144,925 lbs
Max Bit Pull - w/Damage	252,000 lbs

Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	*GPM*	*RPM*	*Ft. Lbs*	*PSI*
0.66	150 - 400	100 - 260	7,660	2,070



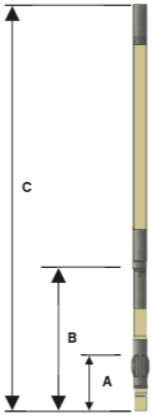


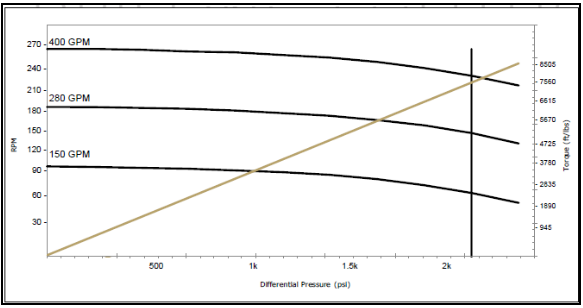
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

5” 7/8 Lobe 8.3 Stage

5.15” 7/8 8.3 Stage Flex CV	
Motor OD	5.13 inch
Lobe Configuration	7 - 8 Lobe 8.3 Stage
Bit Size Range	6 - 7 7/8 inches
Bit Box Connection	3 1/2 REGULAR
A = Bit to Stabalizer (Center)	NA
B = Bit to Bend - Flex Shaft	52.40 inches
B = Bit to Bend - Fixed	52.40 inches
B = Bit to Bend - Adjustable	NA
C = Overall - Flex Shaft (w/Top Sub)	384.90 inches
C = Overall (with Top Sub)	384.90 inches
Adjustable Makeup Torque	NA
Weight	1700
Max WOB - w/Flow	57,970 lbs
Optimum WOB - w/Flow	28,985 lbs
Max WOB - w/o Flow	144,925 lbs
Max Bit Pull - w/Damage	252,000 lbs

Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	*GPM*	*RPM*	*Ft. Lbs*	*PSI*
0.66	150 - 400	100 - 260	7,660	2,070





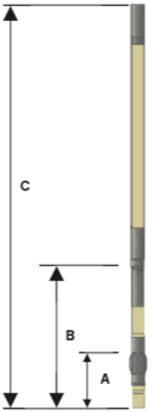
5.15” 7/8 8.3 STAGE				
CALCULATED BUILD UP RATES - DEGREES / 100ft. * (Flex Shaft Fixed)				
Angle (Deg)	**Hole Size (in) – True Slick**			
	6"	**6 1/8"**	**6 3/4"**	**7 7/8"**
0.25				
0.50	0.3	0.7		
0.75	1.3	0.8		
1.00	2.8	2.4	0.3	
1.25	4.4	3.9	1.8	
1.50	5.9	5.5	3.4	0.5
1.75	7.5	7.1	5.0	1.1
2.00	9.1	8.6	6.5	2.7
2.25	10.6	10.2	8.1	4.2
2.50	12.2	11.7	9.6	10.3
2.75	13.7	13.3	11.2	11.7

Actual build rates are subject to varying factors including formation, weight on bit, etc.

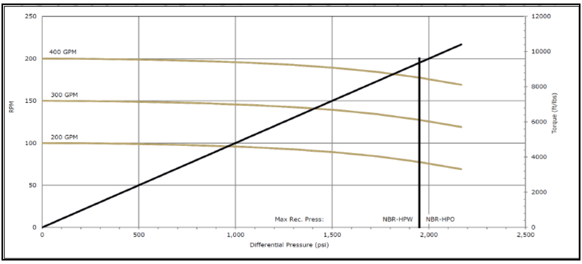
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

5” 7/8 Lobe 8.3 Stage – RSS Assist

5.00" 7/8 8.3 Stage HR Flex-SHAFT	
Motor OD	5.00 inch
Lobe Configuration	7 - 8 Lobe 8.3 Stage
Bit Size Range	6 - 7 7/8 inches
Bit Box Connection	3 1/2 REGULAR
A = Bit to Stabalizer (Center)	24.50 inches
B = Bit to Bend - Flex Shaft	NA
C = Overall - Flex Shaft (w/Top Sub)	384.96 inches
Weight	1,700 lbs
Max WOB - w/Flow	57,970 lbs
Optimum WOB - w/Flow	28,985 lbs
Max WOB - w/o Flow	144,925 lbs
Max Bit Pull - w/Damage	252,000 lbs



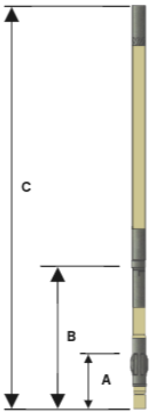
Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	*GPM*	*RPM*	*Ft. Lbs*	*PSI*
0.50	200 - 400	200 - 400	9,370	1,960



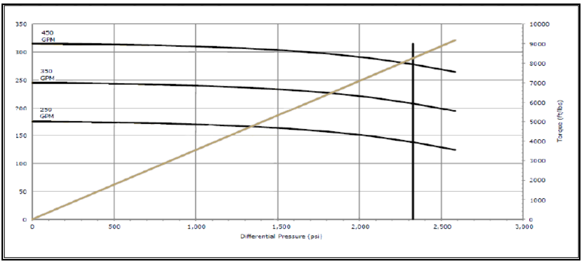
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

5 3/8” 5/6 Lobe 9.9 Stage

5.38” 5/6 9.9 Stage HR	
Motor OD	5.38 inch
Lobe Configuration	5 - 6 Lobe 9.9 Stage
Bit Size Range	6 1/2 - 7 7/8 inches
Bit Box Connection	NC 40
A = Bit to Stabalizer (Center)	21.00 inches
B = Bit to Bend - Flex Shaft	54.53 inches
C = Overall - Flex Shaft (w/Top Sub)	402.38 inches
Weight	1,700 lbs
Max WOB - w/Flow	43,500 lbs
Optimum WOB - w/Flow	21,750 lbs
Max WOB - w/o Flow	210,000 lbs
Max Bit Pull - w/Damage	210,000 lbs



Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	*GPM*	*RPM*	*Ft. Lbs*	*PSI*
0.70	250 - 450	180 - 320	8,260	2,330



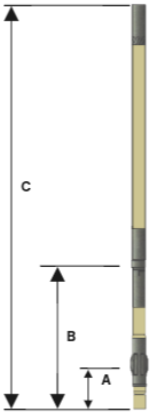
5.38” 5/6 9.9 STAGE HR								
CALCULATED BUILD UP RATES - DEGREES / 100ft. *								
Angle (Deg)	**Hole Size (in) - Slick Sleeve**				**Hole Size (in) - Stabalized**			
	6"	**6 1/8"**	**6 3/4"**	**7 7/8"**	**6"**	**6 1/8"**	**6 3/4"**	**7 7/8"**
0.25	1.3	0.7	0.3		0.9	1.1	1.2	1.6
0.50	2.6	2.0	1.7		2.2	2.3	2.4	2.9
0.75	4.0	3.4	3.0	1.3	3.5	3.6	3.7	4.1
1.00	5.4	4.8	4.4	2.7	4.7	4.9	5.0	5.4
1.25	6.7	6.2	5.8	4.0	6.0	6.2	6.2	6.7
1.50	8.1	7.5	7.1	5.4	7.3	7.4	7.5	8.0
1.75	9.5	8.9	8.5	6.8	8.5	8.7	8.8	9.2
2.00	10.8	10.3	9.9	8.1	9.8	10.0	10.1	10.5
2.25	12.2	11.6	11.3	9.5	11.1	11.2	11.3	11.8

Actual build rates are subject to varying factors including formation, weight on bit, etc.

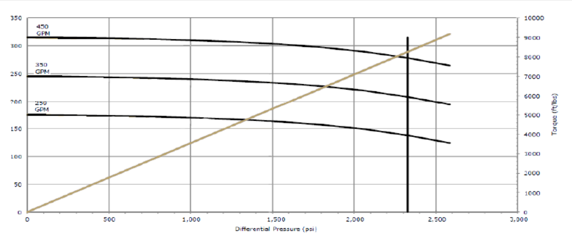
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

5 1/2” 5/6 Lobe 9.9 Stage

5.50” 5/6 9.9 Stage HR Flex-Shaft	
Motor OD	5.50 inch
Lobe Configuration	5 - 6 Lobe 9.9 Stage
Bit Size Range	6 1/2 - 7 7/8 inches
Bit Box Connection	NC-40 / 3 1/2 reg
A = Bit to Stabalizer (Center)	N/A inches
B = Bit to Bend	54.53 inches
C = Overall - Flex Shaft (w/Top Sub)	402.00 inches
Weight	1,950 lbs
Max WOB - w/Flow	57,970 lbs
Optimum WOB - w/Flow	23,2500 lbs
Max WOB - w/o Flow	146,750 lbs
Max Bit Pull - w/Damage	220,000 lbs



Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	*GPM*	*RPM*	*Ft. Lbs*	*PSI*
0.70	250 - 450	180 - 320	8,260	2,330



5.50” 5/6 9.9 STAGE HR Flex-Shaft								
CALCULATED BUILD UP RATES - DEGREES / 100ft. *								
Angle (Deg)	Hole Size (in) - Slick Sleeve				Hole Size (in) - Stabalized			
	6"	6 1/8"	6 3/4"	7 7/8"	6"	6 1/8"	6 3/4"	7 7/8"
0.25	1.3	0.7	0.3		0.9	1.1	1.2	1.6
0.50	2.6	2.0	1.7		2.2	2.3	2.4	2.9
0.75	4.0	3.4	3.0	1.3	3.5	3.6	3.7	4.1
1.00	5.4	4.8	4.4	2.7	4.7	4.9	5.0	5.4
1.25	6.7	6.2	5.8	4.0	6.0	6.2	6.2	6.7
1.50	8.1	7.5	7.1	5.4	7.3	7.4	7.5	8.0
1.75	9.5	8.9	8.5	6.8	8.5	8.7	8.8	9.2
2.00	10.8	10.3	9.9	8.1	9.8	10.0	10.1	10.5
2.25	12.2	11.6	11.3	9.5	11.1	11.2	11.3	11.8

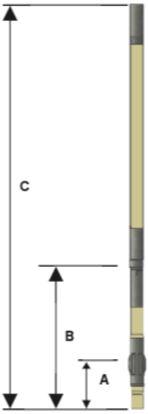
Actual build rates are subject to varying factors including formation, weight on bit, etc.

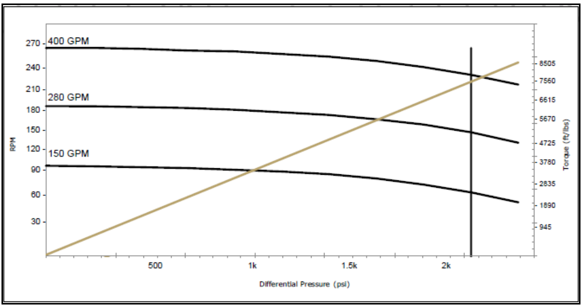
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

5 1/2" 6/7 Lobe 8.8 Stage

5.50" 6/7 8.8 Stage HR	
Motor OD	5.50 inch
Lobe Configuration	6 - 7 Lobe 8.8 Stage
Bit Size Range	6 1/2 - 7 7/8 inches
Bit Box Connection	3 1/2 REG or NC 40
A = Bit to Stabalizer (Center)	N/A
B = Bit to Bend - Flex Shaft - Fixed	54.53 inches
C = Overall - Flex Shaft - Fixed (w/Top Sub)	398.02 inches
Weight	1,700 lbs
Max WOB - w/Flow	46,500 lbs
Optimum WOB - w/Flow	23,250 lbs
Max WOB - w/o Flow	146,750 lbs
Max Bit Pull - w/Damage	220,000 lbs

Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	GPM	RPM	Ft. Lbs	PSI
0.66	150 - 400	100 - 260	7,660	2,070





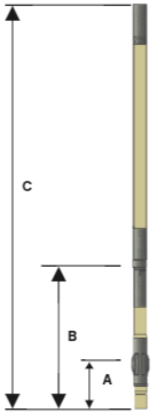
5.50" RAM 6/7 8.8 STAGE HR CALCULATED BUILD UP RATES - DEGREES / 100ft. * (FIXED)						
Angle (Deg)	Hole Size (in) - Slick Sleeve			Hole Size (in) - Stabalized		
	6 1/2"	6 3/4"	7 7/8"	6 1/2"	6 3/4"	7 7/8"
0.25	1.5	0.6	-	0.7	0.9	1.3
0.50	2.7	1.8	-	1.9	2.1	2.5
0.75	4.0	3.0	1.4	3.0	3.2	3.6
1.00	5.2	4.3	2.6	4.2	4.4	4.7
1.25	6.5	5.6	3.9	5.3	5.6	5.9
1.50	7.7	6.8	5.2	6.5	6.7	7.1
1.75	9.0	8.0	6.4	7.6	7.8	8.2
2.00	10.2	9.3	7.6	8.8	9.0	9.4
2.25	11.5	10.6	8.9	10.0	10.2	10.6
2.50	12.7	11.8	10.2	11.2	11.4	11.8
2.75	14.0	13.0	11.4	12.3	12.5	12.9
3.00	15.2	14.3	12.6	13.4	13.7	14.0

Actual build rates are subject to varying factors including formation, weight on bit, etc.

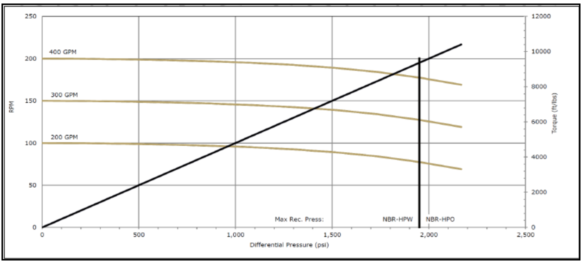
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

5 1/2" 7/8 Lobe 8.3 Stage

5.50" 7/8 8.3 Stage HR	
Motor OD	5.50 inch
Lobe Configuration	7 - 8 Lobe 8.3 Stage
Bit Size Range	6 1/2 - 7 7/8 inches
Bit Box Connection	3 1/2 REG or NC 40
A = Bit to Stabalizer (Center)	N/A
B = Bit to Bend - Flex Shaft - Fixed	54.5 inches
C = Overall - Flex Shaft - Fixed (w/Top Sub)	385.02 inches
Weight	1,750 lbs
Max WOB - w/Flow	43,500 lbs
Optimum WOB - w/Flow	21,750 lbs
Max WOB - w/o Flow	210,000 lbs
Max Bit Pull - w/Damage	210,000 lbs



Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	GPM	RPM	Ft. Lbs	PSI
0.48	200 - 400	100 - 190	9,370	1,960



5.50" RAM 7/8 8.3 STAGE HR CALCULATED BUILD UP RATES - DEGREES / 100ft. * (FIXED)						
Angle (Deg)	Hole Size (in) - Slick Sleeve			Hole Size (in) - Stabalized		
	6 1/2"	6 3/4"	7 7/8"	6 1/2"	6 3/4"	7 7/8"
0.25	0.8	0.5	-	1.0	1.1	1.5
0.50	1.9	1.6	-	2.3	2.4	2.8
0.75	3.0	2.7	1.4	3.5	3.6	4.1
1.00	4.1	3.8	2.4	4.8	4.9	5.3
1.25	5.1	4.9	3.5	6.0	6.1	6.5
1.50	6.2	5.9	4.6	7.3	7.4	7.8
1.75	7.3	7.0	5.6	8.5	8.6	9.1
2.00	8.4	8.1	6.7	9.8	9.9	10.4
2.25	9.5	9.2	7.8	11.1	11.2	11.6
2.50	10.6	10.3	8.9	12.3	12.4	12.8
2.75	11.7	11.4	10.0	13.5	13.6	14.0
3.00	12.8	12.5	11.1	14.7	14.8	15.2

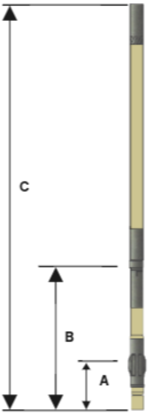
Actual build rates are subject to varying factors including formation, weight on bit, etc.

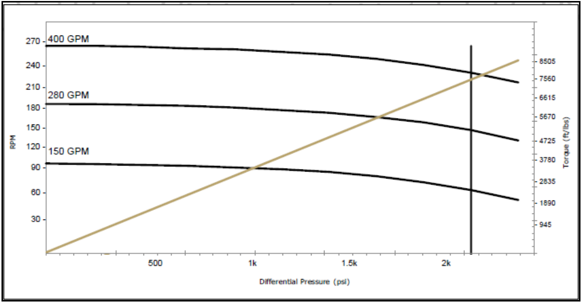
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

5 3/4” x 5 1/2” Combo 6/7 Lobe 8.8 Stage

5.50" - 5.75" 6/7 8.8 Stage HR	
Motor OD	5.50 inch - 5.75 inch
Lobe Configuration	6 - 7 Lobe 8.8 Stage
Bit Size Range	6 1/2 - 7 7/8 inches
Bit Box Connection	3 1/2 REG or NC 40
A = Bit to Stabalizer (Center)	N/A
B = Bit to Bend - Flex Shaft - Fixed	54.50 inches
C = Overall - Flex Shaft - Fixed (w/Top Sub)	398.03 inches
Weight	1,700 lbs
Max WOB - w/Flow	43,500 lbs
Optimum WOB - w/Flow	21,750 lbs
Max WOB - w/o Flow	N/A
Max Bit Pull - w/Damage	210,000 lbs

Rev. Per Gallon	Flow Rate Range	Bit Speed	Torque Output	Max Diff Pressure
RPG	*GPM*	*RPM*	*Ft. Lbs*	*PSI*
0.66	150 - 400	100 - 260	7,660	2,070





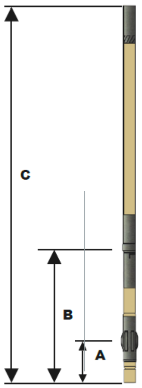
5.50" - 5.75" RAM 6/7 8.8 STAGE HR CALCULATED BUILD UP RATES - DEGREES / 100ft. * (FIXED)						
Angle (Deg)	Hole Size (in) - Slick Sleeve			Hole Size (in) - Stabalized		
	6 1/2"	6 3/4"	7 7/8"	6 1/2"	6 3/4"	7 7/8"
0.25	1.6	0.6	-	NA	NA	NA
0.50	2.8	1.9	-	NA	NA	NA
0.75	4.2	3.1	1.5	NA	NA	NA
1.00	5.4	4.5	2.7	NA	NA	NA
1.25	6.8	5.8	4.1	NA	NA	NA
1.50	8.0	7.1	5.4	NA	NA	NA
1.75	9.4	8.3	6.7	NA	NA	NA
2.00	10.6	9.7	7.9	NA	NA	NA
2.25	12.0	11.1	9.3	NA	NA	NA
2.50	13.3	12.3	10.6	NA	NA	NA
2.75	14.6	13.6	11.9	NA	NA	NA
3.00	15.9	14.9	13.1	NA	NA	NA

Actual build rates are subject to varying factors including formation, weight on bit, etc.

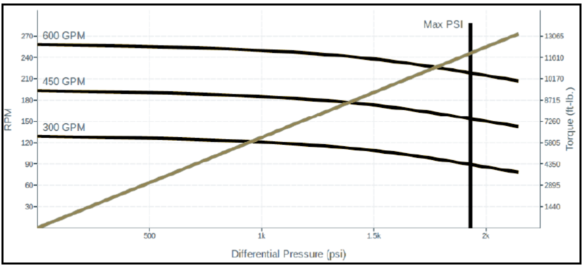
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

6 5/8” 5/6 Lobe 8.2 Stage

6.63" 5/6 8.2 Stage HR	
Motor OD	6.63 inch
Lobe Configuration	5 - 6 Lobe 8.2 Stage
Bit Size Range	7 7/8 - 9 7/8 inches
Bit Box Connection	4 1/2 REGULAR
A = Bit to Stabalizer (Center)	N/A inches
B = Bit to Bend - Fixed	60.63 inches
B = Bit to Bend - Adjustable	N/A inches
C = Overall (with Top Sub)	394.5 inches
Adjustable Makeup Torque	N/A ft. lbs
Weight	2,325 lbs
Max WOB - w/Flow	110,000 lbs
Optimum WOB - w/Flow	55,000 lbs
Max WOB - w/o Flow	275,000 lbs
Max Bit Pull - w/Damage	380,000 lbs



Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
	GPM	RPM	Ft. Lbs	PSI
0.430	300- 600	130 - 260	11,760	1,930



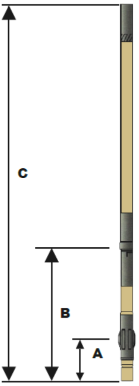
6.63" 5/6 8.2 STAGE HR								
CALCULATED BUILD UP RATES - DEGREES / 100ft. * (FIXED)								
Angle (Deg)	Hole Size (in) - Slick Sleeve				Hole Size (in) - Stabalized			
	7 7/8"	8 1/2"	8 3/4"	9 7/8"	7 7/8"	8 1/2"	8 3/4"	9 7/8"
0.25	2.2	1.6	1.4		1.5	1.9	2.0	2.7
0.50	3.5	3.0	2.7		3.0	3.4	3.5	4.1
0.75	4.8	4.2	4.0	3.0	4.5	4.9	5.0	5.6
1.00	6.1	5.5	5.3	4.2	6.0	6.4	6.5	7.1
1.25	7.4	6.9	6.7	5.6	7.5	7.8	8.0	8.6
1.50	8.7	8.2	8.0	6.9	9.0	9.3	9.4	10.1
1.75	10.1	9.4	9.2	8.3	10.5	10.8	10.9	11.6
2.00	11.3	10.8	10.4	9.5	12.0	12.3	12.4	13.0
2.25	12.7	12.1	11.9	10.8	13.5	13.8	13.9	14.5
2.50	14.0	13.5	13.1	12.2	14.9	15.3	15.4	16.0
2.75	15.3	16.0	14.5	13.5	16.4	16.7	16.9	17.5

Actual build rates are subject to varying factors including formation, weight on bit, etc.

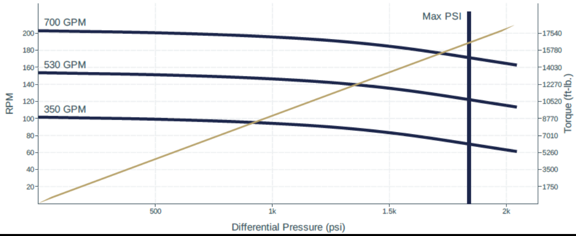
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

6 5/8” 6/7 Lobe 7.8 Stage

6.63" 6/7 7.8 Stage HR	
Motor OD	6.63 inch
Lobe Configuration	6 - 7 Lobe 7.8 Stage
Bit Size Range	7 7/8 - 9 7/8 inches
Bit Box Connection	4 1/2 REGULAR
A = Bit to Stabalizer (Center)	28.7 inches
B = Bit to Bend - Fixed	60.63 inches
B = Bit to Bend - Adjustable	N/A inches
C = Overall (with Top Sub)	424 inches
Adjustable Makeup Torque	N/A ft. lbs
Weight	2,325 lbs
Max WOB - w/Flow	110,000 lbs
Optimum WOB - w/Flow	55,000 lbs
Max WOB - w/o Flow	275,000 lbs
Max Bit Pull - w/Damage	380,000 lbs



Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	*GPM*	*RPM*	*Ft. Lbs*	*PSI*
0.29	350 - 700	100 - 200	15,730	1,840



6.63" 6/7 7.8 STAGE HR								
CALCULATED BUILD UP RATES - DEGREES / 100ft. * (FIXED)								
Angle (Deg)	**Hole Size (in) - Slick Sleeve**				**Hole Size (in) - Stabalized**			
	7 7/8"	**8 1/2"**	**8 3/4"**	**9 7/8"**	**7 7/8"**	**8 1/2"**	**8 3/4"**	**9 7/8"**
0.25	2.8	2.3	2.0		1.6	2.1	2.3	3.1
0.50	4.2	3.7	3.5		3.3	3.7	3.9	4.8
0.75	5.7	5.2	5.0	4.1	5.0	5.4	5.6	6.5
1.00	7.2	6.7	6.5	5.6	6.6	7.1	7.2	8.1
1.25	8.7	8.2	8.0	7.1	8.3	8.7	8.9	9.8
1.50	10.2	9.6	9.4	8.6	10.0	10.4	10.6	11.3
1.75	11.7	11.1	10.9	10.1	11.6	12.0	12.2	13.0
2.00	13.1	12.6	12.4	11.6	13.3	13.7	13.9	14.7
2.25	14.6	14.1	13.9	13.0	14.8	15.4	15.5	16.3
2.50	16.1	15.6	15.4	14.5	16.5	16.7	17.2	18.0
2.75	17.6	17.1	16.9	16.0	18.2	18.7	18.9	19.7

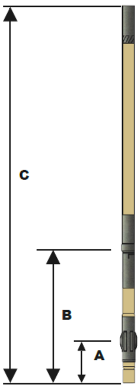
Actual build rates are subject to varying factors including formation, weight on bit, etc.

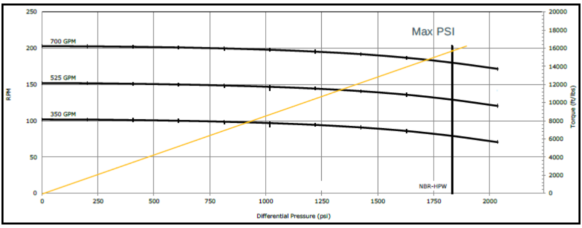
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

6 5/8” 6/7 Lobe 7.8 Stage 55” SBTB

6.63" 6/7 7.8 Stage SBTB HR	
Motor OD	6.63 inch
Lobe Configuration	6 - 7 Lobe 7.8 Stage
Bit Size Range	7 7/8 - 9 7/8 inches
Bit Box Connection	4 1/2 REGULAR
A = Bit to Stabilizer (Center)	NA
B = Bit to Bend - Fixed	55.13 inches
B = Bit to Bend - Adjustable	NA
C = Overall (with Top Sub)	422.78 inches
Adjustable Makeup Torque	N/A ft. lbs
Weight	2,850 lbs
Max WOB - w/Flow	110,000 lbs
Optimum WOB - w/Flow	55,000 lbs
Max WOB - w/o Flow	275,000 lbs
Max Bit Pull - w/Damage	380,000 lbs

Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	*GPM*	*RPM*	*Ft. Lbs*	*PSI*
0.29	350 - 700	100 - 200	15,730	1,840





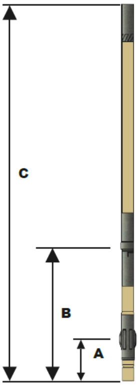
6.63" 6/7 7.8 STAGE SBTB HR								
CALCULATED BUILD UP RATES - DEGREES / 100ft. * (FIXED)								
Angle (Deg)	**Hole Size (in) - Slick Sleeve**				**Hole Size (in) - Stabalized**			
	7 7/8"	**8 1/2"**	**8 3/4"**	**9 7/8"**	**7 7/8"**	**8 1/2"**	**8 3/4"**	**9 7/8"**
0.25	2.9	2.4	2.1		1.7	2.2	2.4	3.2
0.50	4.4	3.8	3.6		3.4	3.8	4.0	5.0
0.75	5.9	5.4	5.2	4.3	5.2	5.6	5.8	6.8
1.00	7.5	7.0	6.8	5.8	6.9	7.4	7.5	8.5
1.25	9.1	8.6	8.4	7.4	8.7	9.1	9.3	10.2
1.50	10.7	10.0	9.8	9.0	10.5	10.9	11.1	11.8
1.75	12.3	11.6	11.4	10.6	12.1	12.6	12.8	13.6
2.00	13.7	13.2	13.0	12.1	13.9	14.3	14.5	15.4
2.25	15.3	14.8	14.5	13.6	15.5	16.1	16.2	17.1
2.50	16.9	16.3	16.1	15.2	17.3	17.5	18.0	18.9
2.75	18.4	17.9	17.7	16.8	19.1	19.6	19.8	20.6

Actual build rates are subject to varying factors including formation, weight on bit, etc.

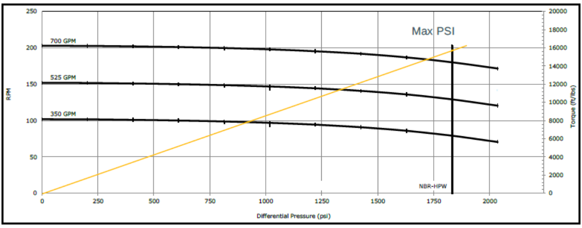
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

6 5/8” 6/7 Lobe 7.8 Stage RSS Assist

6.63" 6/7 7.8 Stage HR RSS	
Motor OD	6.63 inch
Lobe Configuration	6 - 7 Lobe 7.8 Stage
Bit Size Range	7 7/8 - 9 7/8 inches
Bit Box Connection	4 1/2 IF
A = Bit to Stabalizer (Center)	N/A inches
B = Bit to Bend - Fixed	N/A inches
B = Bit to Bend - Adjustable	N/A inches
C = Overall (with Top Sub)	424. 03 inches
Adjustable Makeup Torque	N/A ft. lbs
Weight	2,325 lbs
Max WOB - w/Flow	110,000 lbs
Optimum WOB - w/Flow	55,000 lbs
Max WOB - w/o Flow	275,000 lbs
Max Bit Pull - w/Damage	380,000 lbs



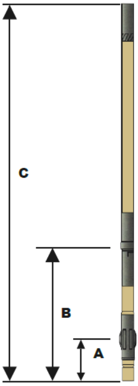
Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	*GPM*	*RPM*	*Ft. Lbs*	*PSI*
0.290	350 - 700	100 - 200	15,730	1,840



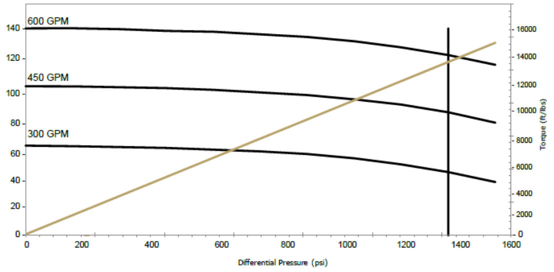
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

6 5/8" 7/8 Lobe 5.7 Stage

6.63" 7/8 5.7 Stage HR	
Motor OD	6.63 inch
Lobe Configuration	7 - 8 Lobe 5.7 Stage
Bit Size Range	7 7/8 - 9 7/8 inches
Bit Box Connection	4 1/2 REGULAR
A = Bit to Stabalizer (Center)	28.7 inches
B = Bit to Bend - Fixed	60.63 inches
B = Bit to Bend - Adjustable	N/A inches
C = Overall (with Top Sub)	408.03 inches
Adjustable Makeup Torque	N/A ft. lbs
Weight	2,850 lbs
Max WOB - w/Flow	110,000 lbs
Optimum WOB - w/Flow	55,000 lbs
Max WOB - w/o Flow	275,000 lbs
Max Bit Pull - w/Damage	380,000 lbs



Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	*GPM*	*RPM*	*Ft. Lbs*	*PSI*
0.23	300 - 600	70 - 140	14,200	1,340



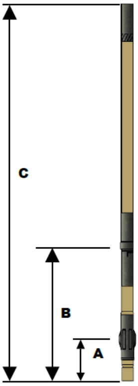
6.63" 7/8 5.7 STAGE HR								
CALCULATED BUILD UP RATES - DEGREES / 100ft. * (FIXED)								
Angle (Deg)	Hole Size (in) - Slick Sleeve				Hole Size (in) - Stabalized			
	7 7/8"	8 1/2"	8 3/4"	9 7/8"	7 7/8"	8 1/2"	8 3/4"	9 7/8"
0.25	2.9	2.4	2.1		1.7	2.2	2.4	3.2
0.50	4.4	3.8	3.6		3.4	3.8	4.0	5.0
0.75	5.9	5.4	5.2	4.3	5.2	5.6	5.8	6.8
1.00	7.5	7.0	6.8	5.8	6.9	7.4	7.5	8.5
1.25	9.1	8.6	8.4	7.4	8.7	9.1	9.3	10.2
1.50	10.7	10.0	9.8	9.0	10.5	10.9	11.1	11.8
1.75	12.3	11.6	11.4	10.6	12.1	12.6	12.8	13.6
2.00	13.7	13.2	13.0	12.1	13.9	14.3	14.5	15.4
2.25	15.3	14.8	14.5	13.6	15.5	16.1	16.2	17.1
2.50	16.9	16.3	16.1	15.2	17.3	17.5	18.0	18.9
2.75	18.4	17.9	17.7	16.8	19.1	19.6	19.8	20.6

Actual build rates are subject to varying factors including formation, weight on bit, etc.

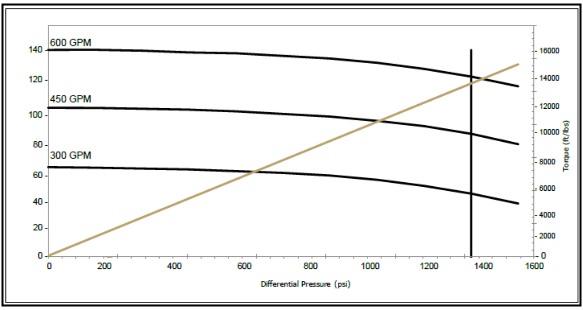
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

6 5/8” 7/8 Lobe 5.7 Stage 55” SBTB

6.63" 7/8 5.7 Stage SBTB HR	
Motor OD	6.63 inch
Lobe Configuration	7 - 8 Lobe 5.7 Stage
Bit Size Range	7 7/8 - 9 7/8 inches
Bit Box Connection	4 1/2 REGULAR
A = Bit to Stabalizer (Center)	NA
B = Bit to Bend - Fixed	55.13 inches
B = Bit to Bend - Adjustable	NA
C = Overall (with Top Sub)	406.78 inches
Adjustable Makeup Torque	N/A ft. lbs
Weight	2,850 lbs
Max WOB - w/Flow	110,000 lbs
Optimum WOB - w/Flow	55,000 lbs
Max WOB - w/o Flow	275,000 lbs
Max Bit Pull - w/Damage	380,000 lbs



Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	*GPM*	*RPM*	*Ft. Lbs*	*PSI*
0.23	300 - 600	70 - 140	14,200	1,340



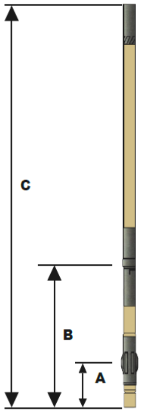
6.63" 7/8 5.7 STAGE SBTB HR								
CALCULATED BUILD UP RATES - DEGREES / 100ft. * (FIXED)								
Angle (Deg)	Hole Size (in) - Slick Sleeve				Hole Size (in) - Stabalized			
	7 7/8"	8 1/2"	8 3/4"	9 7/8"	7 7/8"	8 1/2"	8 3/4"	9 7/8"
0.25	2.9	2.4	2.1		1.7	2.2	2.4	3.2
0.50	4.4	3.8	3.6		3.4	3.8	4.0	5.0
0.75	5.9	5.4	5.2	4.3	5.2	5.6	5.8	6.8
1.00	7.5	7.0	6.8	5.8	6.9	7.4	7.5	8.5
1.25	9.1	8.6	8.4	7.4	8.7	9.1	9.3	10.2
1.50	10.7	10.0	9.8	9.0	10.5	10.9	11.1	11.8
1.75	12.3	11.6	11.4	10.6	12.1	12.6	12.8	13.6
2.00	13.7	13.2	13.0	12.1	13.9	14.3	14.5	15.4
2.25	15.3	14.8	14.5	13.6	15.5	16.1	16.2	17.1
2.50	16.9	16.3	16.1	15.2	17.3	17.5	18.0	18.9
2.75	18.4	17.9	17.7	16.8	19.1	19.6	19.8	20.6

Actual build rates are subject to varying factors including formation, weight on bit, etc.

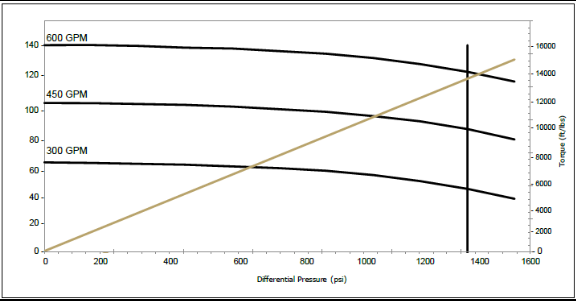
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

6 5/8" 7/8 Lobe 5.7 Stage 51" SSBTB – IB Stabilized

6.63" 7/8 5.7 Stage SBTB HR	
Motor OD	6.63 inch
Lobe Configuration	7 - 8 Lobe 5.7 Stage
Bit Size Range	7 7/8 - 9 7/8 inches
Bit Box Connection	4 1/2 REGULAR
A = Bit to Stabalizer (Center)	26.6 inches
B = Bit to Bend - Fixed	51.0 inches
B = Bit to Bend - Adjustable	NA
C = Overall (with Top Sub)	402.38 inches
Adjustable Makeup Torque	N/A ft. lbs
Weight	2,850 lbs
Max WOB - w/Flow	110,000 lbs
Optimum WOB - w/Flow	55,000 lbs
Max WOB - w/o Flow	275,000 lbs
Max Bit Pull - w/Damage	380,000 lbs



Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	*GPM*	*RPM*	*Ft. Lbs*	*PSI*
0.23	300 - 650	70 - 150	14,200	1,340



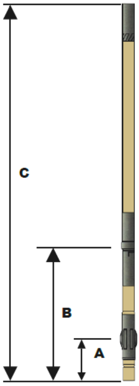
6.63" 7/8 5.7 STAGE SBTB HR			
CALCULATED BUILD UP RATES - DEGREES / 100ft. * (FIXED)			
Angle (Deg)	**7 7/8"**	**8 1/2"**	**8 3/4"**
0.25	0.9	1.2	1.3
0.50	2.3	2.6	2.7
0.75	3.7	4.0	4.1
1.00	5.1	5.4	5.5
1.25	6.5	6.8	6.9
1.50	7.9	8.2	8.3
1.75	9.3	9.6	9.7
1.83	9.8	10.0	10.1
2.00	10.7	11.0	11.1
2.12	11.3	11.7	11.8
2.25	12.1	12.4	12.5
2.50	13.5	13.8	13.9
2.75	14.9	15.2	15.3
3.00	16.3	16.6	16.7

Actual build rates are subject to varying factors including formation, weight on bit, etc.

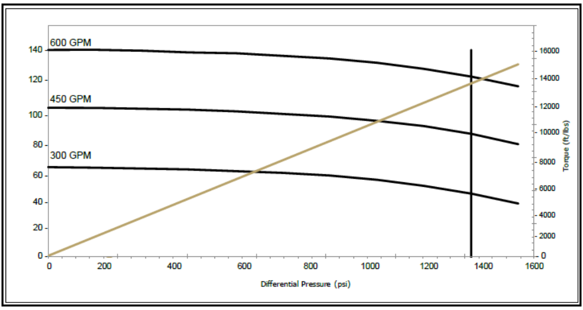
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

6 5/8" 7/8 Lobe 5.7 Stage 51" SSBTB

6.63" 7/8 5.7 Stage HR SSBTB	
Motor OD	6.63 inch
Lobe Configuration	7 - 8 Lobe 5.7 Stage
Bit Size Range	7 7/8 - 9 7/8 inches
Bit Box Connection	4 1/2 REGULAR
A = Bit to Stabalizer (Center)	NA
B = Bit to Bend - Fixed	51.00 inches
B = Bit to Bend - Adjustable	NA
C = Overall (with Top Sub)	408.03 inches
Adjustable Makeup Torque	NA
Weight	2,850 lbs
Max WOB - w/Flow	110,000 lbs
Optimum WOB - w/Flow	55,000 lbs
Max WOB - w/o Flow	275,000 lbs
Max Bit Pull - w/Damage	380,000 lbs



Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	*GPM*	*RPM*	*Ft. Lbs*	*PSI*
0.23	300 - 650	70 - 150	14,200	1,340



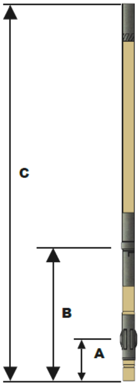
6.63" 7/8 5.7 STAGE HR SSBTB				
CALCULATED BUILD UP RATES - DEGREES / 100ft. * (FIXED)				
Angle (Deg)	Hole Size (in) - Slick Sleeve			
	7 7/8"	8 1/2"	8 3/4"	9 7/8"
0.25	2.8	2.4	2.1	
0.50	4.3	3.8	3.6	
0.75	5.7	5.4	5.2	4.3
1.00	7.3	7.0	6.8	5.8
1.25	9.1	8.6	8.4	7.4
1.50	10.7	10.0	9.8	9.0
1.75	12.3	11.6	11.4	10.6
2.00	13.7	13.2	13.0	12.1
2.25	15.3	14.8	14.5	13.6
2.50	16.9	16.3	16.1	15.2
2.75	18.4	17.9	17.7	16.8

Actual build rates are subject to varying factors including formation, weight on bit, etc.

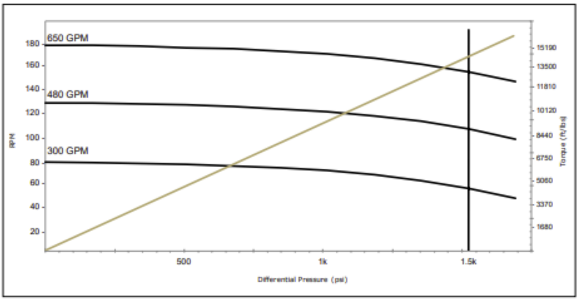
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

6 5/8” 7/8 Lobe 6.4 Stage

6.63" 6/7 7.8 Stage HR	
Motor OD	6.63 inch
Lobe Configuration	7 - 8 Lobe 6.4 Stage
Bit Size Range	7 7/8 - 9 7/8 inches
Bit Box Connection	4 1/2 REGULAR
A = Bit to Stabalizer (Center)	28.7 inches
B = Bit to Bend - Fixed	60.63 inches
B = Bit to Bend - Adjustable	N/A inches
C = Overall (with Top Sub)	394.5 inches
Adjustable Makeup Torque	N/A ft. lbs
Weight	2,325 lbs
Max WOB - w/Flow	110,000 lbs
Optimum WOB - w/Flow	55,000 lbs
Max WOB - w/o Flow	275,000 lbs
Max Bit Pull - w/Damage	380,000 lbs



Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	*GPM*	*RPM*	*Ft. Lbs*	*PSI*
0.27	300 - 650	80 - 180	13,630	1,510



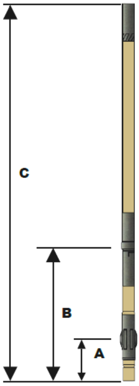
6.50” 7/8 6.4 STAGE HR								
CALCULATED BUILD UP RATES - DEGREES / 100ft. * (FIXED)								
Angle (Deg)	**Hole Size (in) - Slick Sleeve**				**Hole Size (in) - Stabalized**			
	7 7/8”	**8 1/2”**	**8 3/4”**	**9 7/8”**	**7 7/8”**	**8 1/2”**	**8 3/4”**	**9 7/8”**
0.25	2.1	1.5	1.3		1.3	1.6	1.7	2.3
0.50	3.3	2.7	2.5		2.7	3.0	3.1	3.6
0.75	4.4	3.9	3.7	2.7	4.0	4.3	4.4	5.0
1.00	5.6	5.1	4.9	3.9	5.4	5.7	5.8	6.4
1.25	6.8	6.3	6.1	5.1	6.7	7.0	7.2	7.7
1.50	8.0	7.5	7.3	6.3	8.1	8.4	8.5	9.1
1.75	9.2	8.7	8.5	7.5	9.4	9.8	9.9	10.4
2.00	10.4	9.9	9.6	8.7	10.8	11.1	11.2	11.8
2.25	11.6	11.1	10.8	9.9	12.2	12.5	12.6	13.1
2.50	12.8	12.2	12.0	11.0	13.5	13.8	14.0	14.5
2.75	14.0	13.4	13.2	12.2	14.9	15.2	15.3	15.9
3.00	15.2	14.6	14.4	13.4	16.2	16.5	16.7	17.2

Actual build rates are subject to varying factors including formation, weight on bit, etc.

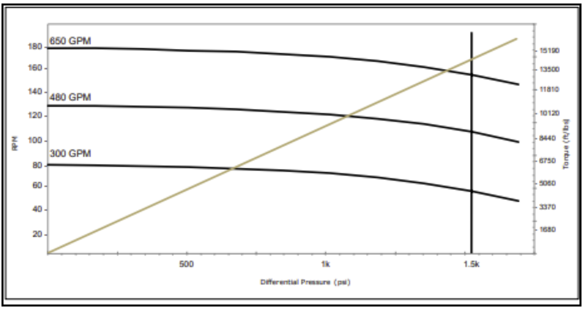
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

6 5/8” 7/8 Lobe 6.4 Stage 55” SBTB

6.63" 7/8 6.4 Stage SBTB HR	
Motor OD	6.63 inch
Lobe Configuration	7 - 8 Lobe 6.4 Stage
Bit Size Range	7 7/8 - 9 7/8 inches
Bit Box Connection	4 1/2 REGULAR
A = Bit to Stabalizer (Center)	NA
B = Bit to Bend - Fixed	55.13 inches
B = Bit to Bend - Adjustable	NA
C = Overall (with Top Sub)	393.23 inches
Adjustable Makeup Torque	N/A ft. lbs
Weight	2,850 lbs
Max WOB - w/Flow	110,000 lbs
Optimum WOB - w/Flow	55,000 lbs
Max WOB - w/o Flow	275,000 lbs
Max Bit Pull - w/Damage	380,000 lbs



Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	*GPM*	*RPM*	*Ft. Lbs*	*PSI*
0.23	300 - 600	70 - 140	14,200	1,340



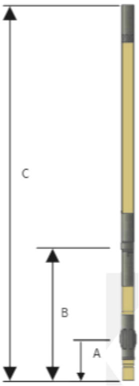
6.63" 7/8 6.4 STAGE SBTB HR								
CALCULATED BUILD UP RATES - DEGREES / 100ft. * (FIXED)								
Angle (Deg)	**Hole Size (in) - Slick Sleeve**				**Hole Size (in) - Stabalized**			
	7 7/8"	**8 1/2"**	**8 3/4"**	**9 7/8"**	**7 7/8"**	**8 1/2"**	**8 3/4"**	**9 7/8"**
0.25	2.9	2.4	2.1		1.7	2.2	2.4	3.2
0.50	4.4	3.8	3.6		3.4	3.8	4.0	5.0
0.75	5.9	5.4	5.2	4.3	5.2	5.6	5.8	6.8
1.00	7.5	7.0	6.8	5.8	6.9	7.4	7.5	8.5
1.25	9.1	8.6	8.4	7.4	8.7	9.1	9.3	10.2
1.50	10.7	10.0	9.8	9.0	10.5	10.9	11.1	11.8
1.75	12.3	11.6	11.4	10.6	12.1	12.6	12.8	13.6
2.00	13.7	13.2	13.0	12.1	13.9	14.3	14.5	15.4
2.25	15.3	14.8	14.5	13.6	15.5	16.1	16.2	17.1
2.50	16.9	16.3	16.1	15.2	17.3	17.5	18.0	18.9
2.75	18.4	17.9	17.7	16.8	19.1	19.6	19.8	20.6

Actual build rates are subject to varying factors including formation, weight on bit, etc.

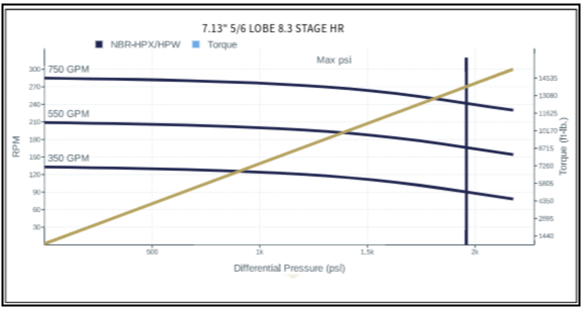
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

7 1/8” 5/6 Lobe 8.3 Stage

Motor OD	7.13inch
Lobe Configuration	7 - 8 Lobe 8.5 Stage
Bit Size Range	8 1/2 - 9 7/8 inches 4
Bit Box Connection	1/2 REGULAR inches
A = Bit to Stabilizer (Center)	22.68 inches
B = Bit to Bend - Fixed	54.75 inches
B = Bit to Bend - Adjustable	N/A
C = Overall (with Top Sub)	408.05 inches
Adjustable Makeup Torque	N/A
Weight	3,300 lbs
Max WOB - w/Flow	124,000 lbs
Optimum WOB - w/Flow	67,000 lbs
Max WOB - w/o Flow	300,000 lbs
Max Bit Pull - w/Damage	400,000 lbs



Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	GPM	RPM	Ft. Lbs	PSI
0. 38	350 - 750	130-290	13,030	1,960



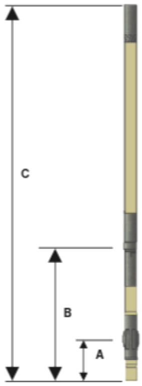
7.13” 5/6 8.3 STAGE HR								
CALCULATED BUILD UP RATES - DEGREES / 100ft. * (FIXED)								
Angle (Deg)	Hole Size (in) - Slick Sleeve				Hole Size (in) - Stabilized			
	7 7/8”	8 1/2”	8 3/4”	9 7/8”	7 7/8”	8 1/2”	8 3/4”	9 7/8”
0.25	2.4	1.8	1.4		1.1	1.3	1.4	2.0
0.50	3.6	3.0	2.6		2.4	2.8	2.9	3.3
0.75	4.7	4.1	3.9	2.6	3.9	4.1	4.2	4.7
1.00	5.9	5.3	5.1	3.9	5.3	5.5	5.6	6.1
1.25	7.2	6.5	6.2	5.1	6.6	6.8	6.9	7.5
1.50	8.4	7.7	7.4	6.3	8.0	8.3	8.4	8.8
1.75	9.5	8.8	8.6	7.4	9.4	9.7	9.8	10.2
2.00	10.8	10.0	9.8	8.6	10.8	11.0	11.1	11.6
2.25	12.0	11.2	10.9	9.8	12.1	12.4	12.5	13.0
2.50	13.0	12.4	12.1	11.0	13.5	13.8	13.9	14.3
2.75	14.3	13.5	13.3	12.1	14.9	15.2	15.3	15.7

Actual build rates are subject to varying factors including formation, weight on bit, etc.

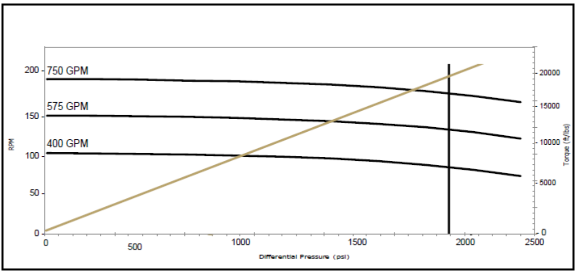
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

7 1/8" 7/8 Lobe 8.5 Stage

7.13" 7/8 8.5 Stage HR	
Motor OD	7.13 inch
Lobe Configuration	7 - 8 Lobe 8.5 Stage
Bit Size Range	8 1/2 - 9 7/8 inches
Bit Box Connection	4 1/2 REGULAR
A = Bit to Stabilizer (Center)	22.68 inches
B = Bit to Bend - Fixed	54.88 inches
B = Bit to Bend - Adjustable	N/A
C = Overall (with Top Sub)	426.13 inches
Adjustable Makeup Torque	N/A
Weight	3,400 lbs
Max WOB - w/Flow	124,000 lbs
Optimum WOB - w/Flow	67,000 lbs
Max WOB - w/o Flow	300,000 lbs
Max Bit Pull - w/Damage	400,000 lbs



Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	*GPM*	*RPM*	*Ft. Lbs*	*PSI*
0.26	400 - 750	100 - 200	19,540	2,000



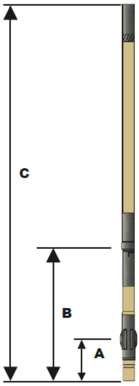
7.13" 7/8 8.5 STAGE HR								
CALCULATED BUILD UP RATES - DEGREES / 100ft. * (FIXED)								
Angle (Deg)	Hole Size (in) - Slick Sleeve				Hole Size (in) - Stabilized			
	7 7/8"	8 1/2"	8 3/4"	9 7/8"	7 7/8"	8 1/2"	8 3/4"	9 7/8"
0.25	2.4	1.8	1.4		1.1	1.3	1.4	2.0
0.50	3.6	3.0	2.6		2.4	2.8	2.9	3.3
0.75	4.7	4.1	3.9	2.6	3.9	4.1	4.2	4.7
1.00	5.9	5.3	5.1	3.9	5.3	5.5	5.6	6.1
1.25	7.2	6.5	6.2	5.1	6.6	6.8	6.9	7.5
1.50	8.4	7.7	7.4	6.3	8.0	8.3	8.4	8.8
1.75	9.5	8.8	8.6	7.4	9.4	9.7	9.8	10.2
2.00	10.8	10.0	9.8	8.6	10.8	11.0	11.1	11.6
2.25	12.0	11.2	10.9	9.8	12.1	12.4	12.5	13.0
2.50	13.0	12.4	12.1	11.0	13.5	13.8	13.9	14.3
2.75	14.3	13.5	13.3	12.1	14.9	15.2	15.3	15.7

Actual build rates are subject to varying factors including formation, weight on bit, etc.

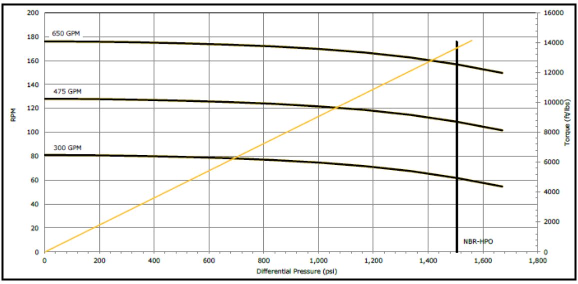
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

7 1/8" x 6 5/8" 7/8 Lobe 6.4 Stage Combo

7.13" - 6.63" 7/8 6.4 Stage Combo HR	
Motor OD	7.13 & 6.63 inch
Lobe Configuration	7 - 8 Lobe 6.4 Stage
Bit Size Range	7 7/8 - 9 7/8 inches
Bit Box Connection	4 1/2 REGULAR
A = Bit to Stabalizer (Center)	NA
B = Bit to Bend - Fixed	54.75 inches
B = Bit to Bend - Adjustable	NA
C = Overall (with Top Sub)	394.52 inches
Adjustable Makeup Torque	N/A ft. lbs
Weight	2,850 lbs
Max WOB - w/Flow	110,000 lbs
Optimum WOB - w/Flow	55,000 lbs
Max WOB - w/o Flow	275,000 lbs
Max Bit Pull - w/Damage	380,000 lbs



Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	*GPM*	*RPM*	*Ft. Lbs*	*PSI*
0.27	300 - 650	80 - 180	13,630	1,510



Angle (Deg)	Hole Size (in) - Slick Sleeve				Hole Size (in) - Stabilized			
7.13" - 6.63" 7/8 8.5 STAGE COMBO HR — CALCULATED BUILD UP RATES - DEGREES / 100ft. * (FIXED)								
	7 7/8"	8 1/2"	8 3/4"	9 7/8"	7 7/8"	8 1/2"	8 3/4"	9 7/8"
0.25	2.4	1.8	1.4		1.1	1.3	1.4	2.0
0.50	3.6	3.0	2.6		2.4	2.8	2.9	3.3
0.75	4.7	4.1	3.9	2.6	3.9	4.1	4.2	4.7
1.00	5.9	5.3	5.1	3.9	5.3	5.5	5.6	6.1
1.25	7.2	6.5	6.2	5.1	6.6	6.8	6.9	7.5
1.50	8.4	7.7	7.4	6.3	8.0	8.3	8.4	8.8
1.75	9.5	8.8	8.6	7.4	9.4	9.7	9.8	10.2
2.00	10.8	10.0	9.8	8.6	10.8	11.0	11.1	11.6
2.25	12.0	11.2	10.9	9.8	12.1	12.4	12.5	13.0
2.50	13.0	12.4	12.1	11.0	13.5	13.8	13.9	14.3
2.75	14.3	13.5	13.3	12.1	14.9	15.2	15.3	15.7

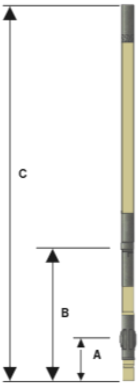
Actual build rates are subject to varying factors including formation, weight on bit, etc.

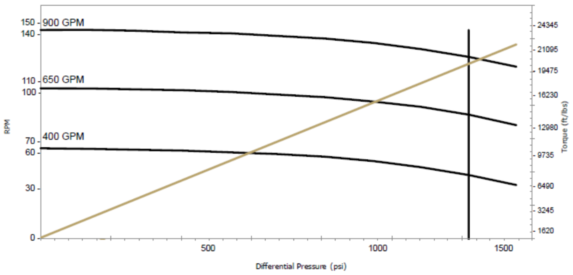
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

8 ¼" 7/8 Lobe 5.9 Stage

8.25" 7/8 5.9 Stage RAM	
Motor OD	8.25 inch
Lobe Configuration	7 - 8 Lobe 5.9 Stage
Bit Size Range	9 7/8 - 12 1/4 inches
Bit Box Connection	6 5/8 REGULAR
A = Bit to Stabalizer (Center)	24.50 inches
B = Bit to Bend - Fixed	69.0 inches
B = Bit to Bend - Adjustable	N/A
C = Overall (with Top Sub)	466.4 inches
Adjustable Makeup Torque	N/A
Weight	4,750 lbs
Max WOB - w/Flow	146,4900 lbs
Optimum WOB - w/Flow	73,245 lbs
Max WOB - w/o Flow	366,225 lbs
Max Bit Pull - w/Damage	732,880 lbs

Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	GPM	RPM	Ft. Lbs	PSI
0.16	400 - 900	60 - 140	21,870	1,390





8.25" 7/8 5.9 STAGE RAM CALCULATED BUILD UP RATES - DEGREES / 100ft. * (FIXED)						
Angle (Deg)	Hole Size (in) - Slick Sleeve			Hole Size (in) - Stabalized		
	9 7/8"	10 5/8"	12 1/4"	9 7/8"	10 5/8"	12 1/4"
0.25	0.3			1.3	1.6	2.2
0.50	1.3	0.7		2.5	2.8	3.4
0.75	2.3	1.7	0.5	3.7	4.0	4.6
1.00	3.4	2.8	1.5	4.9	5.2	5.8
1.25	4.4	3.8	2.5	6.1	6.3	6.9
1.50	5.5	4.9	3.6	7.2	7.5	8.1
1.75	6.4	5.9	4.6	8.4	8.7	9.3
2.00	7.4	6.8	5.7	9.6	9.9	10.5
2.25	8.5	8.0	6.6	10.7	11.1	11.7
2.50	9.5	9.0	7.6	12.0	12.3	12.9
2.75	10.6	10.0	8.7	13.2	13.5	14.1

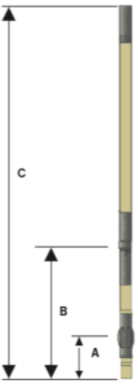
Actual build rates are subject to varying factors including formation, weight on bit, etc.

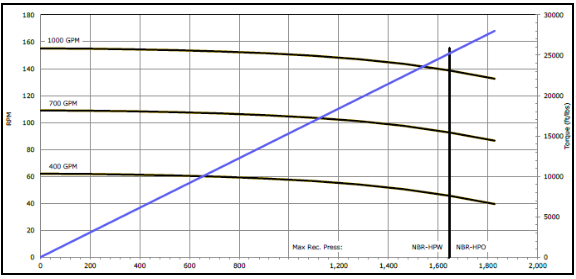
Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

8 ¼” 7/8 Lobe 7.0 Stage

8.25" 7/8 7.0 Stage RAM	
Motor OD	8.25 inch
Lobe Configuration	7 - 8 Lobe 7.0 Stage
Bit Size Range	9 7/8 - 12 1/4 inches
Bit Box Connection	6 5/8 REGULAR
A = Bit to Stabalizer (Center)	24.40 inches
B = Bit to Bend - Fixed	69.0 inches
B = Bit to Bend - Adjustable	N/A
C = Overall (with Top Sub)	470.2 inches
Adjustable Makeup Torque	N/A
Weight	4,750 lbs
Max WOB - w/Flow	146,4900 lbs
Optimum WOB - w/Flow	73,245 lbs
Max WOB - w/o Flow	366,225 lbs
Max Bit Pull - w/Damage	732,880 lbs

Rev. Per Gallon	Flow Rate Range	Bit Speed Range	Torque Output	Max Diff Pressure
RPG	GPM	RPM	Ft. Lbs	PSI
0.155	400 - 1000	60 - 160	25,210	1,650





8.25" 7/8 7.0 STAGE RAM CALCULATED BUILD UP RATES - DEGREES / 100ft. * (FIXED)						
Angle (Deg)	Hole Size (in) - Slick Sleeve			Hole Size (in) - Stabalized		
	9 7/8"	10 5/8"	12 1/4"	9 7/8"	10 5/8"	12 1/4"
0.25	0.3			1.3	1.6	2.2
0.50	1.3	0.7		2.5	2.8	3.4
0.75	2.3	1.7	0.5	3.7	4.0	4.6
1.00	3.4	2.8	1.5	4.9	5.2	5.8
1.25	4.4	3.8	2.5	6.1	6.3	6.9
1.50	5.5	4.9	3.6	7.2	7.5	8.1
1.75	6.4	5.9	4.6	8.4	8.7	9.3
2.00	7.4	6.8	5.7	9.6	9.9	10.5
2.25	8.5	8.0	6.6	10.7	11.1	11.7
2.50	9.5	9.0	7.6	12.0	12.3	12.9
2.75	10.6	10.0	8.7	13.2	13.5	14.1

Actual build rates are subject to varying factors including formation, weight on bit, etc.

Should the circulating temperature exceed 140° Fahrenheit, it is recommended to derate the differential pressure as shown in Figure 3-2.

Table 4-1 Motor Specifications

Motor Size (in)	Model	Lobe	Stages	Bit to Bend	Rotor	Stator	Flow	Speed Rev/Gal	Torque Slope ft-lb/psi	Max RPM	Pressure Diff psi	Torque ft-lb	Power HP
5"	500566.7	5/6	6.7	47.63"	241"	250"	150-350	0.63	4.02	220	1580	6330	265
	500678.8	6/7	8.8	47.63"	265"	275"	150-400	0.66	3.70	260	1760	6520	323
	515788.3	7/8	8.3	47.63"	253"	275"	200-400	0.48	4.80	190	1960	9370	339
5.38"	538569.9	5/6	9.9	54.53"	269"	292"	250-450	0.70	3.55	320	2330	8260	503
5.50"	550569.9	5/6	9.9	54.53"	269"	292"	250-450	0.70	3.55	320	2330	8260	503
	550678.8	6/7	8.8	53.88"	265"	275"	150-400	0.66	3.70	260	1760	6520	323
	550788.3	7/8	8.3	53.88"	253"	275"	200-400	0.48	4.80	190	1960	9370	339
5.75" x 5.50" Combo	500678.8	6/7	8.8	47.63"	265"	275"	150-400	0.66	3.70	260	1760	6520	323
6.63"	663568.2	5/6	8.2	60.63"	239"	257"	300-600	0.43	6.10	260	1930	11760	582
	663677.8	6/7	7.8	60.63"	268"	275"	350-700	0.29	8.58	200	1840	15730	599
	663785.7	7/8	5.7	64.25"	252"	260"	300-600	0.23	10.6	140	1340	14200	380
	663786.4	7/8	6.4	60.63"	238"	246"	300-650	0.27	9.06	180	1510	13630	467
6.75"	675785.0	7/8	5.0	64.25"	188"	194"	300-650	0.27	9.06	180	1180	10650	370
	675785.7	7/8	5.7	64.25"	252"	260"	300-600	0.23	10.6	140	1340	14200	380
7.13"	700568.3	5/6	8.3	54.88"	252"	270"	400-750	0.38	6.68	290	1960	13030	719
	700788.5	7/8	8.5	54.88"	291"	309"	400-750	0.26	9.78	200	2000	19540	740
7.13" x 6.63" Combo	663786.4	7/8	6.4	60.63"	238"	246"	300-650	0.27	9.06	180	1510	13630	467
8.25"	800785.9	7/8	5.9	69.00"	284"	300"	400-900	0.16	15.77	140	1390	21870	580
	800787.0	7/8	7.0	69.00"	292"	309"	400-1000	0.16	15.32	160	1650	25210	768

Table 4-2 Bearing Stabilizer Make Up Torques

Motor Size (in)	Make Up Torque (lb-ft)
7.13"	29,070
7.13" x 6.63" Combo	29,070
8.25"	40,000

Engineering Data

Formulas

Horsepower

Mechanical (hp)

$$HP_m = \frac{T \times N}{5252}$$

HP_m=motor mech. horsepower

T = torque (ft-lbs)
N = speed (rpm)

Hydraulic

$$HP_h = \frac{P \times Q}{1714}$$

HP_h = hydraulic at bit
P = pressure drop (psi)
Q = flow rate (gpm)

Pressure

Bit Pressure Drop

$$P = \frac{Q^2 \times W}{10858 \times A^2}$$

P = pressure drop (psi)
Q = flow rate (gpm)
W = fluid/mud wt. (ppg)
A = total flow area (in^2)

Hydrostatic

$$P = .052 \times D \times W$$

D = vertical depth (ft)

Velocity

Jet

$$V = \frac{.32086 \times Q}{A}$$

V = velocity (ft/s)
Q = flow rate (gpm)
A = jet flow area (in^2)

Annular

$$V = \frac{.4085 \times Q}{D_h^2 - D_p^2}$$

D_h = hole diameter (in)
D_p = drill string OD (in)

Motor Efficiency

Motor Efficiency

$$\% = \frac{32.64 \times T \times N}{Q \times P}$$

T = torque (ft-lbs)
N = speed (rpm)
Q = flow rate (gpm)
P = pressure drop (psi)

Total Flow Area (TFA) to Obtain a Required Bit Pressure Loss

$$A = \sqrt{(Q^2 \times W) / (Pb \times 10{,}858)}$$

Where: A = Total cross sectional flow area of jet ($in.^2$)
Q = Circulation rate (gpm)
W = Drilling fluid weight (ppg)
Pb = Differential pressure (psi)

Conversion Tables

CONVERSION TABLES			
	Units	Multiply By	To Obtain
Acceleration (Acc. of gravity)	ft/sec^2	0.3048	m/sec^2
	32.2 ft/sec^2	0.3048	9.81 m/sec^2
	m/sec^2	3.2808	ft/sec^2
Angle	deg (angle)	60	min
	deg (angle)	0.01745	rad
	deg (angle)	3600	sec
Area	in^2	6.944×10^{-3}	ft^2
	in^2	6.4516	cm^2
	in^2	645.16	mm^2
	ft^2	0.0929	m^2
	ft^2	144	in^2
	cm^2	0.155	in^2
	mm^2	0.00155	in^2
	m^2	10.764	ft^2
Density	lb/gal	119.82	kg/m^3
	lb/gal	0.11982	g/cm^3
	lb/gal	7.48	lb/ft^2
	lb/ft^3	5.787×10^{-4}	lbs/in^3
	lb/ft^3	16.02	kg/m^3
	lb/in^3	27679.7	kg/m^3
	lb/in^3	27.6797	g/cm^3
	kg/m^3	8.346×10^{-3}	lb/gal
	g/cm^3	8.346	lb/gal
	kg/m^3	$3.61\ x^{-5}$	lb/in^3
	kg/m^3	0.006243	lb/ft^3
	g/cm^3	0.03613	lb/in^3
Energy	joule	0.737557	ft-lb
	ft-lb	1.35583	joule
	ft-lb	1.286×10^{-3}	Btu
	Btu	777.6	ft-lb

CONVERSION TABLES - Continued			
	Units	Multiply By	To Obtain
Flow Rate	bbl/min	42	gpm
	bbl/day	0.02917	gpm
	gpm	0.02381	bbl/min
	gpm	34.286	bbl/day
	gpm	3.785	lpm
	gpm	3.785×10^{-3}	m^3/min
	bbl/min	0.158899	m^3/min
	ft^3/min	$4.72 \times {}^{-4}$	m^3/sec
	ft^3/min	0.1247	gal/sec
	ft^3/min	0.472	liters/sec
	ft^3/sec	448.83	gpm
	lpm	0.2642	gpm
	m^3/min	264.2	gpm
	m^3/min	6.2933	bbl/min
	m^3/sec	2118.6	ft^3/min
	gal/sec	8.0515	ft^3/min
	liters/sec	2.1186	ft^3/min
	gpm	0.002228	ft^3/sec
Force	lbf	4.448	N
	lbf	4.448×10^{-3}	kN
	lbf	0.4536	kgf
	N	0.22481	lbf
	kN	224.82	lbf
	kgf	2.20459	lbf
Length	in	25.4	mm
	in	2.54	cm
	ft	0.30479	m
	ft	5280	mi
	mi	1.609	km
	mm	0.03937	in
	cm	0.3937	in
	m	3.2808	ft
	km	0.6215	mi

CONVERSION TABLES - Continued			
	Units	Multiply By	To Obtain
Mass	lb	0.453597	kg
	lb	4.535×10^{-4}	ton (metric)
	kgf	2.2046	lbf
Nozzles	1/32 in	0.79375	mm
	mm	1.2598	1/32 in
Power	hp	0.7457	kw
	ft-lb/min	2.259×10^{-5}	kw
	ft-lb/s	1.6557	w
	kw	1.34102	hp
	kw	44250	ft-lb/min
	w	0.7376	ft-lb/s
Pressure	psi	6.8948	kPa
	psi	0.0068948	Mpa
	psi	0.0680462	atm
	psi	0.068948	bar
	atm	14.6959	psi
	bar	14.50326	psi
	kPa	0.14504	psi
	Mpa	145.03684	psi
Stress	psi	0.0068948	Mpa
	psi	0.0680462	bar
	psi	14.6959	N/mm²
	bar	14.50326	psi
	Mpa	0.14504	psi
	n/mm²	145.03684	psi
Temperature	°F	(°F - 32) / 1.8	°C
	°C	(°C x 1.8) + 32	°F
	°F	°F + 459.69	°R
	°C	°C + 273.16	°K
Torque	ft-lb	1.35582	Nm
	ft-lb	0.00135582	kNm
	ft-lb	0.1382	kgm
	Nm	0.737561	ft-lb
	kNm	737.561	ft-lb
	kgm	7.23589	ft-lb
Velocity	ft/min	0.508	cm/s
	ft/min	0.01667	ft/sec
	ft/min	0.01829	km/hr
	ft/min	0.3048	m/min
	ft/min	0.01136	mi/hr
	cm/s	1.9685	ft/min
	ft/sec	59.988	ft/min
	km/hr	54.67	ft/min
	m/min	3.281	ft/min
	mi/hr	88.028	ft/min
Volume	gal (US)	3.785	lbf
	gal (US)	0.003785	m³
	ft³	0.02831	m³
	bbl	0.1589	m³

Buoyancy Factors for Steel Drill Collars

Mud Weight (lbs/gal)	Mud Weight (kgf/l)	Buoyancy Factor
8.5	1.02	0.870
9.0	1.08	0.862
9.5	1.14	0.855
10.0	1.20	0.847
10.5	1.26	0.839
11.0	1.32	0.832
11.5	1.38	0.824
12.0	1.44	0.816
12.5	1.50	0.809
13.0	1.56	0.801
13.5	1.62	0.793
14.0	1.68	0.786
14.5	1.74	0.778
15.0	1.80	0.771
15.5	1.86	0.763
16.0	1.92	0.755
16.5	1.98	0.748
17.0	2.04	0.740
17.5	2.10	0.732
18.0	2.16	0.725

Example:

$$BF = 1 - \frac{MW\_1}{65.37}$$

BF = Buoyancy Factor
MW1 = Mud Weight (lbs/gal)

$$BF = 1 - \frac{MW\_2}{7.83}$$

BF = Buoyancy Factor
MW2 = Mud Weight (kgf/l)

Note: lb/gal x .11983 = kgf/l

Collar Weights in Pounds Per Foot

OD of Drill Collar (in)	Bore of Drill Collar (in)												
	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 13/16	3	3 1/4	3 1/2	3 3/4	4
2 7/8	19	18	16										
3	21	20	18										
3 1/8	22	22	20										
3 1/4	26	24	22										
3 1/2	30	29	27										
3 3/4	35	33	32										
4	40	39	37	35	32	29							
4 1/8	43	41	39	37	35	32							
4 1/4	46	44	42	40	38	35							
4 1/2	51	50	48	46	43	41							
4 3/4			54	52	50	47	44						
5			61	59	56	53	50						
5 1/4			68	6	63	60	57						
5 1/2			75	73	70	67	64	60					
5 3/4			82	80	78	75	72	67	64	60			
6			90	88	85	83	79	75	72	68			
6 1/4			98	96	94	91	88	83	80	76	72		
6 1/2			107	105	102	99	96	91	89	85	80		
6 3/4			116	114	111	108	105	100	98	93	89		
7			125	123	120	117	114	110	107	103	98	93	84
7 1/4			134	132	130	127	124	119	116	112	108	103	93
7 1/2			144	142	139	137	133	129	126	122	117	113	102
7 3/4			154	152	150	147	144	139	136	132	128	123	112
8			165	163	160	157	154	150	147	143	138	133	122
8 1/4			176	174	171	168	165	160	158	154	149	144	133
8 1/2			187	185	182	179	176	172	169	165	160	155	150
9			210	208	206	203	200	195	192	188	184	179	174
9 1/2			234	232	230	227	224	220	216	212	209	206	198
9 3/4			248	245	243	240	237	232	229	225	221	216	211
10			261	259	257	254	251	246	243	239	235	230	225
11			317	315	313	310	307	302	299	295	291	286	281
12			379	377	374	371	368	364	361	357	352	347	342

Drill Collar Connection Make-Up Torque †

Connection Type			Minimum Make-up Torque² ft/lb. Bore of Drill Collar, (in)							
Size	Type	OD (in)	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 13/16
API	NC23	3	*2,508	*2,508	*2,508					
		3 1/8	*3,330	*3,330	2,647					
		3 1/4	4,000	3,387	2,647					
2 3/8	Regular	3		*2,241	*2,241	1,749				
		3 1/8		*3,028	2,574	1,749				
		3 1/4		3,285	2,574	1,749				
2 7/8	PAC³	3		*3,797	*3,797	2,926				
		3 1/8		*4,966	4,151	2,926				
		3 1/4		5,206	4,151	2,926				
2 3/8	API IF	3 1/2		*4,606	*4,606	3,697				
		3 3/4		5,501	4,668	3,697				

Drill Collar Connection Make-Up Torque †

Connection Type			Minimum Make-up Torque² ft/lb. Bore of Drill Collar, (in)							
Size	Type	OD (in)	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 13/16
2 7/8	Regular	3 1/2		*3,838	*3,383	*3,383				
		3 3/4		5,766	4,951	4,002				
		3 7/8		5,766	4,951	4,002				
2 7/8	X-Hole	3 3/4		*4,089	*4,089	*4,089				
3 1/2	Dbl. Streamline	3 7/8		*5,352	*5,352	*5,352				
2 7/8	Mod. Open	4 1/8		*8,059	*8,059	7,433				
2 7/8	API IF	3 7/8		*4,640	*4,640	*4,640	*4,640			
API	NC31	4 1/8		*7,390	*7,390	*7,390	6,853			
3 1/2	Regular	4 1/8		*6,466	*6,466	*6,466	*6,466	5,685		
		4 1/4		*7,886	*7,886	*7,886	7,115	5,685		
		4 1/2		10,471	9,307	8,161	7,115	5,685		

Drill Collar Connection Make-Up Torque †

Connection Type			Minimum Make-up Torque[2] ft/lb. Bore of Drill Collar, (in)							
Size	Type	OD (in)	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 13/16
3 1/2	Slim Hole	4 1/4		*8,858	*8,858	8,161	6,853	5,391		
		4 1/2		10,286	9,307	8,161	6,853	5,391		
API	NC35	4 1/2				*9,038	*9,038	*9,038	7,411	
		4 3/4				*9,038	*9,038	*9,038	7,411	
		5				*9,038	*9,038	*9,038	7,411	
3 1/2	X-Hole	4 1/4				*5,161	*5,161	*5,161	*5,161	
4	Slim Hole	4 1/2				*8,497	*8,497	*8,497	8,311	
3 1/2	Mod. Open	4 3/4				*12,074	11,803	10,144	8,311	
		5				13,283	11,803	10,144	8,311	
		5 1/4				13,283	11,803	10,144	8,311	

Drill Collar Connection Make-Up Torque †

Connection Type			Minimum Make-up Torque[2] ft/lb. Bore of Drill Collar, (in)							
Size	Type	OD (in)	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 13/16
3 1/2	API IF	4 3/4				*9,986	*9,986	*9,986	*9,986	8,315
API	NC 38	5				*13,949	*13,949	12,907	10,997	8,315
		5 1/4				16,207	14,643	12,907	10,997	8,315
		5 1/2				16,207	14,643	12,907	10,997	8,315
3 1/2	H-90[4]	4 3/4		*8,786	*12,794	*12,794	*12,794	*8,786		
		5		*12,794	*12,794	*12,794	*12,794	10,408		
		5 1/4		*17,094	16,929	15,137	13,151	10,408		
		5 1/2		*17,094	16,929	15,137	13,151	10,408		
4	Full Hole	5		*10,910	*10,910	*10,910	*10,910	*10,910		
API	NC40	5 1/4		*15,290	*15,290	*15,290	14,969	12,125		
4	Mod. Open	5 1/2		*19,985	18,886	17,028	14,969	12,125		
4 1/2	Dbl. Streamline	5 3/4		20,539	18,886	17,028	14,969	12,125		
		6		20,539	18,886	17,028	14,969	12,125		

Drill Collar Connection Make-Up Torque †

Connection Type			Minimum Make-up Torque² ft/lb. Bore of Drill Collar, (in)							
Size	Type	OD (in)	1 1/2	1 3/4	2	2 1/4	2 1/2	2 13/16	3	3 1/4
4	H-90[4]	5 1/4		*12,590	*12,590	*12,590	*12,590	*12,590		
		5 1/2		*17,401	*17,401	*17,401	*17,401	16,536		
		5 3/4		*22,531	*22,531	21,714	19,543	16,536		
		6		25,408	23,671	21,714	19,543	16,536		
		6 1/4		25,408	23,671	21,714	19,543	16,536		
4 1/2	API Regular	5 1/2		*15,576	*15,576	*15,576	*15,576	*15,576		
		5 3/4		*20,609	*20,609	*20,609	19,601	16,629		
		6		25,407	23,686	21,749	19,601	16,629		
		6 1/4		25,407	23,686	21,749	19,601	16,629		
API	NC44	5 3/4		*20,895	*20,895	*20,895	*20,895	18,161		
		6		*26,453	25,510	23,493	21,257	18,161		
				27,300	25,510	23,493	21,257	18,161		
				27,300	25,510	23,493	21,257	18,161		

Drill Collar Connection Make-Up Torque †

Connection Type			Minimum Make-up Torque[2] ft/lb. Bore of Drill Collar, (in)							
Size	Type	OD (in)	2	2 1/4	2 1/2	2 13/16	3	3 1/4	3 1/2	3 3/4
4 1/2	API Full Hole	5 1/2			*12,973	*12,973	*12,973	*12,973	*12,973	
		5 3/4			*18,119	*18,119	*18,119	*18,119	17,900	
		6			*23,605	*23,605	22,028	19,921	17,900	
		6 1/4			27,294	25,272	22,028	19,921	17,900	
		6 1/2			27,294	25,272	22,028	19,921	17,900	
4 1/2	X-Hole	5 3/4				*17,738	*17,738	*17,738	*17,738	
API	NC46	6				*23,422	*23,422	22,426	20,311	
4	API IF	6 1/4				28,021	25,676	22,426	20,311	
4 1/2	Semi IF	6 1/2				28,021	25,676	22,426	20,311	
5	Dbl. Streamline	6 3/4				28,021	25,676	22,426	20,311	
4 1/2	H-90[4]	5 3/4				*18,019	*18,019	*18,019	*18,019	
		6				*23,681	*23,681	23,159	21,051	
		6 1/4				28,732	26,397	23,159	21,051	
		6 1/2				28,732	26,397	23,159	21,051	
		6 3/4				28,732	26,397	23,159	21,051	

Drill Collar Connection Make-Up Torque †

Connection Type			Minimum Make-up Torque[2] ft/lb. Bore of Drill Collar, (in)							
Size	Type	OD (in)	2	2 1/4	2 1/2	2 13/16	3	3 1/4	3 1/2	3 3/4
5	H-90[4]	6 1/4				*25,360	*25,360	*25,360	*25,360	23,988
		6 1/2				*31,895	*31,895	29,400	27,167	23,988
		6 3/4				35,292	32,825	29,400	27,167	23,988
						35,292	32,825	29,400	27,167	23,988
4 1/2	API IF	6 1/4		*23,004	*23,004	*23,004	*23,004	*23,004		
API	NC50	6 1/2		*29,679	*29,679	*29,679	*29,679	26,675		
5	X-Hole	6 3/4		*36,742	35,824	32,277	29,966	26,675		
5	Mod. Open	7		38,397	35,824	32,277	29,966	26,675		
5 1/2	Dbl. Streamline	7 1/4		38,397	35,824	32,277	29,966	26,675		
5	Semi IF	7 1/2		38,397	35,824	32,277	29,966	26,675		
5 1/2	H-90[4]	6 3/4		*31,941	*31,941	*31,941	*31,941	*31,941		
		7		*41,993	40,117	36,501	34,142	30,781		
		7 1/4		42,719	40,117	36,501	34,142	30,781		
		7 1/2		42,719	40,117	36,501	34,142	30,781		

Drill Collar Connection Make-Up Torque †

Connection Type			Minimum Make-up Torque² ft/lb. Bore of Drill Collar, (in)							
Size	Type	OD (in)	2	2 1/4	2 1/2	2 13/16	3	3 1/4	3 1/2	3 3/4
5 1/2	API Regular	6 3/4		*31,941	*31,941	*31,941	*31,941	30,495		
		7		*39,419	*39,419	36,235	33,868	30,495		
		7 1/4		42,481	39,866	36,235	33,868	30,495		
		7 1/2		42,481	39,866	36,235	33,868	30,495		
5 1/2	API Full Hole	7		*32,762	*32,762	*32,762	*32,762	*32,762		
		7 1/4		*40,998	*40,998	*40,998	*40,998	*40,998		
		7 1/2		*49,661	*49,661	47,756	45,190	41,533		
		7 3/4		54,515	51,687	47,756	45,190	41,533		
API	NC56	7 1/4			*40,498	*40,498	*40,498	*40,498		
		7 1/2			*49,060	48,221	45,680	42,058		
		7 3/4			52,115	48,221	45,680	42,058		
		8			52,115	48,221	45,680	42,058		

Drill Collar Connection Make-Up Torque †

Connection Type			Minimum Make-up Torque² ft/lb. Bore of Drill Collar, (in)							
Size	Type	OD (in)	2	2 1/4	2 1/2	2 13/16	3	3 1/4	3 1/2	3 3/4
6 5/8	API Regular	7 1/2			*46,399	*46,399	*46,399	*46,399		
		7 3/4			*55,627	53,346	50,704	46,936		
		8			57,393	53,346	50,704	46,936		
		8 1/4			57,393	53,346	50,704	46,936		
6 5/8	H-90[4]	7 1/2			*45,509	*45,509	*45,509	*45,509		
		7 3/4			*55,708	*55,708	53,629	49,855		
		8			60,321	56,273	53,629	49,855		
		8 1/4			60,321	56,273	53,629	49,855		
API	NC61	8			*55,131	*55,131	*55,131	*55,131		
		8 1/4			*65,438	*65,438	*65,438	61,624		
		8 1/2			72,670	68,398	65,607	61,624		
		8 3/4			72,670	68,398	65,607	61,624		
		9			72,670	68,398	65,607	61,624		

Drill Collar Connection Make-Up Torque †

Connection Type			Minimum Make-up Torque[2] ft/lb. Bore of Drill Collar, (in)							
Size	Type	OD (in)	2	2 1/4	2 1/2	2 13/16	3	3 1/4	3 1/2	3 3/4
5 1/2	API IF	8			*56,641	*56,641	*56,641	*56,641	*56,641	
		8 1/4			*67,133	*67,133	*67,133	63,381	63,381	
		8 1/2			74,626	70,277	67,436	63,381	59,027	
		8 3/4			74,626	70,277	67,436	63,381	59,027	
		9			74,626	70,277	67,436	63,381	59,027	
		9 1/4			74,626	70,277	67,436	63,381	59,027	
6 5/8	API Full Hole	8 1/2			*67,789	*67,789	*67,789	*67,789	*67,789	67,184
		8 3/4			*79,544	*79,544	*79,544	76,706	72,102	67,184
		9			88,852	83,992	80,991	76,706	72,102	67,184
		9 1/4			88,852	83,992	80,991	76,706	72,102	67,184
		9 1/2			88,852	83,992	80,991	76,706	72,102	67,184
API NC70		9			*78,781	*78,781	*78,781	*78,781	*78,781	*78,781
		9 1/4			*88,802	*88,802	*88,802	*88,802	*88,802	*88,802
		9 1/2			*102,354	*102,354	*102,354	101,107	92,214	90,984
		9 3/4			113,710	108,841	105,657	101,107	92,214	90,984
		10			113,710	108,841	105,657	101,107	92,214	90,984
		10 1/4			113,710	108,841	105,657	101,107	92,214	90,984

Drill Collar Connection Make-Up Torque †

Connection Type			Minimum Make-up Torque[2] ft/lb. Bore of Drill Collar, (in)							
Size	Type	OD (in)	2	2 1/4	2 1/2	2 13/16	3	3 1/4	3 1/2	3 3/4
7	H-90[4]	8			*53,454	*53,454	*53,454	*53,454	*53,454	*53,454
		8 1/14			*63,738	*63,738	*63,738	*63,738	60,971	56,382
		8 1/2			*74,478	72,066	69,265	65,267	60,971	56,382
7 5/8	API Regular	8 1/2			*60,402	*60,402	*60,402	*60,402	*60,402	*60,402
		8 3/4			*72,169	*72,169	*72,169	*72,169	*72,169	*72,169
		9			*84,442	*84,442	*84,442	84,221	79,536	74,529
		9 1/4			96,301	91,633	85,580	84,221	79,536	74,529
		9 1/2			96,301	91,633	85,580	84,221	79,536	74,529
7 5/8	H-90[4]	9			*73,017	*73,017	*73,017	*73,017	*73,017	*73,017
		9 1/4			*86,006	*86,006	*86,006	*86,006	*86,006	*86,006
		9 1/2			*99,508	*99,508	*99,508	*99,508	*99,508	96,285

Drill Collar Connection Make-Up Torque †

Connection Type			Minimum Make-up Torque² ft/lb. Bore of Drill Collar, (in)							
Size	Type	OD (in)	2	2 1/4	2 1/2	2 13/16	3	3 1/4	3 1/2	3 3/4
8 5/8	API Regular	10			*109,345	*109,345	*109,345	*109,345	*109,345	*109,345
		10 1/4			*125,263	*125,263	*125,263	*125,263	*125,263	125,034
		10 1/2			*141,767	*141,767	141,134	136,146	130,777	125,034
8 5/8	H-90[4]	10 1/4			*113,482	*113,482	*113,482	*113,482	*113,482	*113,482
		10 1/2			*130,063	*130,063	*130,063	*130,063	*130,063	*130,063
7	H-90[4]	8 3/4				*68,061	*68,061	67,257	62,845	58,131
	(with low torque face)	9				74,235	71,361	67,257	62,845	58,131

Drill Collar Connection Make-Up Torque †

Connection Type			Minimum Make-up Torque² ft/lb. Bore of Drill Collar, (in)							
Size	Type	OD (in)	2	2 1/4	2 1/2	2 13/16	3	3 1/4	3 1/2	3 3/4
7 5/8	API Regular	9 1/4					*73,099	*73,099	*73,099	*73,099
	(with low torque face)	9 1/2					*84,463	*84,463	82,457	77,289
		9 3/4					91,789	87,292	82,457	77,289
		10					91,789	87,292	82,457	77,289
7 5/8	H-90⁴	9 3/4				*91,667	*91,667	*91,667	*91,667	*91,667
	(with low torque face)	10				*106,260	*106,260	*106,260	104,171	98,804
		10 1/4				117,112	113,851	109,188	104,171	98,804
		10 1/2				117,112	113,851	109,188	104,171	98,804
8 5/8	API Regular	10 3/4					*112,883	*112,883	*112,883	*112,883
	(with low torque face)	11					*130,672	*130,672	*130,672	*130,672
		11 1/4					14,616	142,430	136,846	130,871
8 5/8	H-90⁴	10 3/4					*92,960	*92,960	*92,960	*92,960
	(with low torque face)	11					*110,781	*110,781	*110,781	*110,781
		11 1/4					*129,203	*129,203	*129,203	*129,203

Drill Collar Connection Make-Up Torque †

† Recommended Make-Up Torque[1] for Rotary Shouldered Drill Collar Connections.

Notes:

- Torque figures preceded by an asterisk (*) indicate that the weaker member for corresponding outside diameter (OD) and bore is the box thread. For all other torque values the weaker connection is the pin thread.
- In each connection size and type group, torque values apply to all connection types in the group, when used with the same drill collar outside diameter and bore. i.e. 2 3/8 API IF, API NC26, and 2 7/8 Slim Hole connections used with 3 ½ x 1 ¼ drill collars all have the same minimum bake-up torque of 4,600 ft/lb and the box is the weakest connection.
- Stress-relief features are disregarded for make-up torque.

Footnotes:

- Basis of calculations for recommended make-up torque assumed the use of a thread compound containing 40-60% by weight of finely powdered metallic zinc or 60% by weight of finely powdered metallic lead with not more than 0.3% total active sulfur applied thoroughly to all threads and shoulders and using the modified screw jack formula in API RP7G (16th edition) Appendix A, paragraph A.8 and a unit stress of 62,500 psi in the box or pin, whichever is weaker.
- Normal torque range is tabulated value plus 10%. Higher torque values may be used under extreme conditions.
- Make-up torque for 2 7/8 PAC connection is based on 87,500 psi stress and other factors listed in footnote 1.
- Make-up torque for H-90 connection is based on 56,200 psi stress and other factors listed in footnote 1.

The information in the above table is taken from API Recommended Practice 7G, Sixteenth Edition, December 1, 1998.

Properties of Drill Pipes and Tool Joints †

Drill Pipe			New Tool Joint Data				Premium Class			Class 2		
Nom Size (in)	Nom Weight (ft/lb)	Type Upset and Grade	Connection	New OD (in)	New ID (in)	Make-up Torque[6] (ft/lb)	Min OD Tool Joint (in)	Min Box Shoulder With Eccentric Wear (in)	Make-up Torque for Min OD Tool Joint (ft/lb)	Min OD Tool Joint (in)	Min Box Shoulder With Eccentric Wear (in)	Make-up Torque for Min OD Tool Joint (ft/lb)
3 1/2	15.50	EU-E75	NC38	5	2 9/16	12,196 P	4 17/32	3/16	7,785	4 15/32	5/32	6,769
3 1/2	15.50	EU-X95	NC38	5	2 7/16	13,328 P	4 21/32	1/4	9,879	4 19/32	7/32	8,822
3 1/2	15.50	EU-G105	NC38	5	2 1/8	15,909 P	4 23/32	9/32	10,957	4 5/8	15/64	9,348
	15.50	EU-G105	NC40	5 1/4	2 9/16	16,656 P	4 15/16	1/4	11,363	4 27/32	13/64	9,595
3 1/2	15.50	EU-S135	NC40	5 1/2	2 1/4	19,766 P	5 3/32	21/64	14,419	4 31/32	17/64	11,963
4	11.85	EU-E75	NC46	6	3 1/4	20,175 P	5 7/32	7/64	7,843	5 5/32	5/64	6,476
	11.85	EU-E75	4 WO	5 3/4	3 7/16	17,285 P	5 7/32	7/64	7,843	5 5/32	5/64	6,476
	11.85	EU-E75	4 OHLW	5 1/4	3 15/32	13,186 P	5	9/64	7,866	4 15/16	7/64	6,593
	11.85	IU-E75	4 H90	5 1/2	2 13/16	21,224 P	4 7/8	7/64	7,630	4 27/32	3/32	6,962

Properties of Drill Pipes and Tool Joints †

Drill Pipe			New Tool Joint Data				Premium Class			Class 2		
Nom Size (in)	Nom Weight (ft/lb)	Type Upset and Grade	Connection	New OD (in)	New ID (in)	Make-up Torque[6] (ft/lb)	Min OD Tool Joint (in)	Min Box Shoulder With Eccentric Wear (in)	Make-up Torque for Min OD Tool Joint (ft/lb)	Min OD Tool Joint (in)	Min Box Shoulder With Eccentric Wear (in)	Make-up Torque for Min OD Tool Joint (ft/lb)
4	14.00	IU-E75	NC40	5 1/4	2 13/16	14,092 P	4 13/16	3/16	9,017	4 3/4	5/32	7,877
	14.00	EU-E75	NC46	6	3 1/4	20,175 P	5 9/32	9/64	9,233	5 7/32	7/64	7,843
	14.00	IU-E75	4 SH[2]	4 5/8	2 9/16	9,102 P	4 7/16	15/64	8,782	4 3/8	1/4	7,817
	14.00	EU-E75	4 OHSW	5 1/2	3 1/4	16,320 P	5 1/16	11/64	9,131	5	9/64	7,839
	14.00	IU-E75	4 H90	5 1/2	2 13/16	21,224 P	4 15/16	9/64	8,986	4 7/8	7/64	7,630
4	14.00	IU-X95	NC40	5 1/4	2 11/16	15,404 P	4 15/16	1/4	11,363	4 27/32	13/64	9,595
	14.00	EU-X95	NC46	6	3 1/4	20,175 P	5 3/8	3/16	11,363	5 5/16	5/32	9,937
	14.00	IU-X95	4 H90	5 1/2	2 13/16	21,224 P	5 1/32	3/16	11,065	4 31/32	5/32	9,673
4	14.00	IU-G105	NC40	5 1/2	2 7/16	18,068 P	5	9/32	12,569	4 29/32	15/64	10,768
	14.00	EU-G105	NC46	6	3 1/4	20,175 P	5 7/16	7/32	12,813	5 11/32	11/64	10,647
	14.00	IU-G105	4 H90	5 1/2	2 13/16	21.224 P	5 3/32	7/32	12.481	5 1/32	3/16	11.065

Properties of Drill Pipes and Tool Joints †

Drill Pipe			New Tool Joint Data				Premium Class			Class 2		
Nom Size (in)	Nom Weight (ft/lb)	Type Upset and Grade	Connection	New OD (in)	New ID (in)	Make-up Torque[6] (ft/lb)	Min OD Tool Joint (in)	Min Box Shoulder With Eccentric Wear (in)	Make-up Torque for Min OD Tool Joint (ft/lb)	Min OD Tool Joint (in)	Min Box Shoulder With Eccentric Wear (in)	Make-up Torque for Min OD Tool Joint (ft/lb)
4	14.00	EU-S135	NC46	6	3	23,538 P	5 9/16	9/32	15,787	5 1/2	1/4	14,288
4	15.70	IU-E75	NC40	5 1/4	2 11/16	15,404 P	4 7/8	7/32	10,179	4 25/32	11/64	8,444
	15.70	EU-E75	NC46	6	3 1/4	20,175 P	5 5/16	5/32	9,937	5 1/4	1/8	8,535
	15.70	IU-E75	4 H90	5 1/2	2 13/16	21,224 P	4 31/32	5/32	9,673	4 29/32	1/8	8,305
4	15.70	IU-X95	NC40	5 1/2	2 7/16	18,068 P	5	9/32	12,569	4 29/32	15/64	10,768
	15.70	EU-X95	NC46	6	3	23,538 P	5 7/16	7/32	12,813	5 11/32	11/64	10,647
	15.70	IU-X95	4 H90	5 1/2	2 13/16	21,224 P	5 3/32	7/32	12,481	5 1/32	3/16	11,065
4	15.70	EU-G105	NC46	6	3	23,538 P	5 15/32	15/64	13,547	5 13/32	13/64	12,085
	15.70	IU-G105	4 H90	5 1/2	1 13/16	21,224 P	5 5/32	1/4	13,922	5 1/16	13/64	11,770

Properties of Drill Pipes and Tool Joints †

Drill Pipe			New Tool Joint Data				Premium Class			Class 2		
Nom Size (in)	Nom Weight (ft/lb)	Type Upset and Grade	Connection	New OD (in)	New ID (in)	Make-up Torque[6] (ft/lb)	Min OD Tool Joint (in)	Min Box Shoulder With Eccentric Wear (in)	Make-up Torque for Min OD Tool Joint (ft/lb)	Min OD Tool Joint (in)	Min Box Shoulder With Eccentric Wear (in)	Make-up Torque for Min OD Tool Joint (ft/lb)
4	15.70	IU-S135	NC46	6	2 5/8	26,982 B	5 21/32	21/64	18,083	5 17/32	17/64	15,035
	15.00	EU-S135	CN46	6	2 7/8	25,118 P	5 21/32	21/64	18,083	5 17/32	17/64	15,035
4 1/2	16.60	IEU-E75	4 1/2 FH	6	3	20,868 P	5 3/8	13/64	12,125	5 9/32	5/32	10,072
	16.60	IEU-E75	NC46	6 1/4	3 1/4	20,396 P	5 13/32	13/64	12,085	5 11/32	11/64	10,647
	16.60	IEU-E75	4 1/2 OHSW	5 7/8	3 3/4	16,346 P	5 7/16	13/64	11,862	5 3/8	11/64	10,375
	16.60	IEU-E75	NC50	6 5/8	3 3/4	22,836 P	5 23/32	5/32	11,590	5 11/16	9/64	10,773
	16.60	IEU-E75	4 1/2 H90	6	3 1/4	23,355 P	5 11/32	3/16	12,215	5 9/32	5/32	10,642
4 1/2	16.60	IEU-X95	4 1/2 FH	6	2 3/4	23,843 P	5 1/2	17/64	14,945	5 13/32	7/32	12,821
	16.60	IEU-X95	NC46	6 1/4	3 1/4	20,396 P	5 17/32	17/64	15,035	5 7/16	7/32	12,813
	16.60	EU-X95	NC50	6 5/8	3 3/4	22,836 P	5 27/32	7/32	14,926	5 25/32	3/16	13,245
	16.60	IEU-X95	4 1/2 H90	6	3	27,091 P	5 15/32	1/4	15,441	5 3/8	13/64	13,102

Properties of Drill Pipes and Tool Joints †

Drill Pipe			New Tool Joint Data				Premium Class			Class 2		
Nom Size (in)	Nom Weight (ft/lb)	Type Upset and Grade	Connection	New OD (in)	New ID (in)	Make-up Torque[6] (ft/lb)	Min OD Tool Joint (in)	Min Box Shoulder With Eccentric Wear (in)	Make-up Torque for Min OD Tool Joint (ft/lb)	Min OD Tool Joint (in)	Min Box Shoulder With Eccentric Wear (in)	Make-up Torque for Min OD Tool Joint (ft/lb)
4 1/2	16.60	IEU-G105	4 1/2 FH	6	2 3/4	23,843 P	5 9/16	19/64	16,391	5 15/32	1/4	14,231
	16.60	IEU-G105	NC46	6 1/4	3	23,795 P	5 19/32	19/64	16,546	5 1/2	1/4	14,288
	16.60	EU-G105	NC50	6 5/8	3 3/4	22,836 P	5 29/32	1/4	16,633	5 13/16	13/64	14,082
	16.60	IEU-G105	4 1/2 H90	6	3	27,091 P	5 1/2	17/64	16,264	5 7/16	15/64	14,625
4 1/2	16.60	IEU-S135	NC46	6 1/4	2 3/4	26,923 P	5 25/32	25/64	21,230	5 21/32	21/64	18,083
	16.60	EU-S135	NC50	6 5/8	3 1/2	27,076 P	6 1/16	21/64	21,017	5 31/32	9/32	18,367
4 1/2	20.00	IEU-G105	4 1/2 FH	6	3	20,868 P	5 15/32	1/4	14,231	5 3/8	13/64	12,125
	20.00	IEU-G105	NC46	6 1/4	3	23,795 P	5 1/2	1/4	14,288	5 13/32	13/64	12,085
	20.00	EU-G105	NC50	6 5/8	3 5/8	24,993 P	5 13/16	13/64	14,082	5 3/4	3/16	12,415
	20.00	IEU-G105	4 1/2 H90	6	3	27,091 P	5 13/32	7/32	13,815	5 11/32	3/16	12,215

Properties of Drill Pipes and Tool Joints †

Drill Pipe			New Tool Joint Data				Premium Class			Class 2		
Nom Size (in)	Nom Weight (ft/lb)	Type Upset and Grade	Connection	New OD (in)	New ID (in)	Make-up Torque[6] (ft/lb)	Min OD Tool Joint (in)	Min Box Shoulder With Eccentric Wear (in)	Make-up Torque for Min OD Tool Joint (ft/lb)	Min OD Tool Joint (in)	Min Box Shoulder With Eccentric Wear (in)	Make-up Torque for Min OD Tool Joint (ft/lb)
4 1/2	20.00	IEU-X95	4 1/2 FH	6	2 1/2	29,778 P	5 5/8	21/64	17,861	5 17/32	9/32	15,665
	20.00	IEU-X95	NC46	6 1/4	2 3/4	26,923 P	5 21/32	21/64	18,083	5 9/16	9/32	15,787
	20.00	EU-X95	NC50	6 5/8	3 1/2	27,076 P	5 15/16	17/64	17,497	5 7/8	15/64	15,776
	20.00	IEU-X95	4 1/2 H90	6	3	27,091 P	5 9/16	19/64	17,929	5 15/32	1/4	15,441
4 1/2	20.00	IEU-G105	NC46	6 1/4	2 1/2	29,778 P	5 23/32	23/64	19,644	5 5/8	5/16	17,311
	20.00	EU-G105	NC50	6 5/8	3 1/2	27,076 P	6 1/32	5/16	20,127	5 29/32	1/4	16,633
4 1/2	20.00	EU-S135	NC50	6 5/8	2 7/8	36,398 P	6 7/32	13/32	25,569	6 3/32	11/32	21,914
5	19.50	IEU-E75	NC50	6 5/8	3 3/4	22,836 P	5 7/8	15/64	15,776	5 13/16	13/64	14,082
5	19.50	IEU-X95	NC50	6 5/8	3 1/2	27,076 P	6 1/32	5/16	20,127	5 15/16	17/64	17,497
	19.50	IEU-X95	5 H90	6 1/2	3 1/4	31,084 P	5 27/32	19/64	19,862	5 3/4	1/4	17,116

Properties of Drill Pipes and Tool Joints †

Drill Pipe			New Tool Joint Data				Premium Class			Class 2		
Nom Size (in)	Nom Weight (ft/lb)	Type Upset and Grade	Connection	New OD (in)	New ID (in)	Make-up Torque[6] (ft/lb)	Min OD Tool Joint (in)	Min Box Shoulder With Eccentric Wear (in)	Make-up Torque for Min OD Tool Joint (ft/lb)	Min OD Tool Joint (in)	Min Box Shoulder With Eccentric Wear (in)	Make-up Torque for Min OD Tool Joint (ft/lb)
5	19.50	IEU-G105	NC50	6 5/8	3 1/4	31,025 P	6 3/32	11/32	21,914	6	19/64	19,244
	19.50	IEU-G105	5 H90	6 1/2	3 1/2	35,039 P	5 29/32	21/64	21,727	5 13/16	9/32	18,940
5	19.50	IEU-S135	NC50	6 5/8	2 3/4	38,044 P	6 5/16	29/64	28,381	6 3/16	25/64	24,645
	19.50	IEU-S135	5 1/2 FH	7 1/4	3 1/2	43,490 P	6 3/4	3/8	28,737	6 5/8	5/16	24,412
5	25.60	IEU-E75	NC 50	6 5/8	3 1/2	27,076 P	6 1/32	5/16	20,127	5 15/16	17/64	17,497
	25.60	IEU-E75	5 1/2 FH	7	3 1/2	37,742 B	6 1/2	1/4	20,205	6 13/32	13/64	17,127
5	25.60	IEU-X95	NC50	6 5/8	3	34,680 P	6 7/32	13/32	25,569	6 3/32	11/32	21,914
	25.60	IEU-X95	5 1/2 FH	7	3 1/2	37,742 B	6 21/32	21/64	25,483	6 9/16	9/32	22,294
5	25.60	IEU-G105	NC50	6 5/8	2 3/4	38,044 P	6 9/32	7/16	27,437	6 5/32	3/8	23,728
	25.60	IEU-G105	5 1/2 FH	7 1/4	3 1/2	43,490 P	6 23/32	23/64	27,645	6 5/8	5/16	24,412

Properties of Drill Pipes and Tool Joints †

Drill Pipe			New Tool Joint Data				Premium Class			Class 2		
Nom Size (in)	Nom Weight (ft/lb)	Type Upset and Grade	Connection	New OD (in)	New ID (in)	Make-up Torque[5] (ft/lb)	Min OD Tool Joint (in)	Min Box Shoulder With Eccentric Wear (in)	Make-up Torque for Min OD Tool Joint (ft/lb)	Min OD Tool Joint (in)	Min Box Shoulder With Eccentric Wear (in)	Make-up Torque for Min OD Tool Joint (ft/lb)
5	25.60	IEU-S135	5 1/2 FH	7 1/4	3 1/4	47,230 B	6 15/16	15/32	35,446	6 13/16	13/32	30,943
5 1/2	21.90	IEU-E75	5 1/2 FH	7	4	33,560 P	6 15/32	15/64	19,172	6 13/32	13/64	17,127
5 1/2	21.90	IEU-X95	5 1/2 FH	7	3 3/4	34,742 B	6 5/8	5/16	24,412	6 17/32	17/64	21,246
	21.90	IEU-X95	5 1/2 H90	7	3 1/2	35,454 P	6 13/16	21/64	24,414	6 3/32	9/32	21,349
5 1/2	21.90	IEU-G105	5 1/2 FH	7 1/4	3 1/2	43,490 P	6 23/32	23/64	27,645	6 19/32	19/64	23,350
5 1/2	21.90	IEU-S135	5 1/2 FH	71/2	3	53,302 P	6 15/16	15/32	35,446	6 13/16	13/32	30,943
5 1/2	24.70	IEU-E75	5 1/2 FH	7	4	33,560 P	6 9/16	9/32	22,294	6 15/32	15/64	19,172
5 1/2	24.70	IEU-X95	5 1/2 FH	7 1/4	3 1/2	43,490 P	6 23/32	23/64	27,645	6 19/32	19/64	23,350

Properties of Drill Pipes and Tool Joints †

Drill Pipe			New Tool Joint Data				Premium Class			Class 2		
Nom Size (in)	Nom Weight (ft/lb)	Type Upset and Grade	Connection	New OD (in)	New ID (in)	Make-up Torque[6] (ft/lb)	Min OD Tool Joint (in)	Min Box Shoulder With Eccentric Wear (in)	Make-up Torque for Min OD Tool Joint (ft/lb)	Min OD Tool Joint (in)	Min Box Shoulder With Eccentric Wear (in)	Make-up Torque for Min OD Tool Joint (ft/lb)
5 1/2	24.70	IEU-G105	5 1/2 FH	7 1/4	3 1/2	43,490 P	6 25/32	25/64	29,836	6 11/16	11/32	26,560
5 1/2	24.70	IEU-S135	5 1/2 FH	7 1/2	3	52,302 P	7 1/32	33/64	38,901	6 7/8	7/16	33,180
6 5/8	25.20	IEU-E75	6 5/8 FH	8	5	44,196 P	7 7/16	1/4	26,810	7 3/8	7/32	24,100
	25.20	IEU-X95	6 5/8 FH	8	5	44,196 P	7 5/8	11/32	35,139	7 1/2	9/32	29,552
	25.20	IEU-G105	6 5/8 FH	8 1/4	4 3/4	51,742 P	7 11/16	5/8	37,983	7 19/32	21/64	33,730
	25.20	IEU-S135	6 5/8 FH	8 1/2	4 1/4	65,535 P	7 29/32	31/64	48,204	7 25/32	27/64	42,312
6 5/8	27.70	IEU-E75	6 5/8 FH	8	5	44,196 P	7 1/2	9/32	29,552	7 13/32	15/64	25,451
	27.70	IEU-X95	6 5/8 FH	8 1/4	4 3/4	51,742 P	7 11/16	3/8	37,983	7 9/16	5/16	32,329
	27.70	IEU-G105	6 5/8 FH	8 1/4	4 3/4	51,742 P	7 3/4	13/32	40,860	7 21/32	23/64	36,556
	27.70	IEU-S135	6 5/8 FH	8 1/2	4 1/4	65,535 P	8	17/32	52,714	7 27/64	29/64	45,241

Properties of Drill Pipes and Tool Joints †

† Recommended minimum OD and make-up torque of weld-on type tool joints based on torsional strength of box and drill pipe.
Tool joint diameters specified are required to retain torsional strength in the tool joint comparable to the torsional strength of the attached drill pipe. These should be adequate for all service. Tool joints with torsional strengths considerably below that of the drill pipe may be adequate for much drilling service.

Footnotes:

- The use of outside diameters (OD) smaller than those listed in the table may be acceptable due to special service requirements.
- Tool joint with dimensions shown has lower torsional yield ration than the 0.80 which is generally used.
- Recommended make-up torque is based on 72,000 psi stress.
- In calculation of torsional strengths of tool joints, both new and worn, the bevels of the tool joint shoulders are disregarded. This thickness measurement should be made in the plane of the face from the ID of the counter bore to the outside diameter of the box, disregarding the bevels.
- Any tool joint with an outside diameter less than API bevel diameter should be provided with a minimum 1/32" depth x 45° bevel on the outside and inside diameter fo the box shoulder and outside diameter of the pin shoulder.
- P = Pin limit. B = Box limit

The information in the above table is taken from API Recommended Practice 7G, Sixteenth Edition, December 1, 1998.

Mechanical Properties of Drill Pipe †

Size OD (in)	[1]Nominal Weight New (ft/lb)	Class	[2]Torsional Data Torsional Yield Strength (ft/lb) E75	X95	G105	S135	[3]Tensile Data Minimum Yield Strength Load at (lb) E75	X95	G105	S135
2 3/8	4.85	New	4,763	6,033	6,668	8,574	97,817	123,902	136,944	176,071
		Premium	3,725	4,719	5,215	6,705	76,893	97,398	107,650	138,407
		Class 2	3,224	4,083	4,513	5,802	66,686	84,469	93,360	120,035
	6.65	New	6,250	7,917	8,751	11,251	138,214	175,072	193,500	248,786
		Premium	4,811	6,093	6,735	8,659	107,616	136,313	150,662	193,709
		Class 2	4,130	5,232	5,782	7,434	92,871	117,636	130,019	167,167
2 7/8	6.85	New	8,083	10,238	11,316	14,549	135,902	172,143	190,263	244,624
		Premium	6,332	8,020	8,865	11,397	106,946	135,465	149,725	192,503
		Class 2	5,484	6,946	7,677	9,871	92,801	117,549	129,922	167,043

Mechanical Properties of Drill Pipe †

Size OD (in)	[1]Nominal Weight New (ft/lb)	Class	[2]Torsional Data Torsional Yield Strength (ft/lb) E75	X95	G105	S135	[3]Tensile Data Minimum Yield Strength Load at (lb) E75	X95	G105	S135
	10.40	New	11,554	14,635	16,176	20,798	214,344	271,503	300,082	385,820
		Premium	8,858	11,220	12,401	15,945	166,535	210,945	233,149	299,764
		Class 2	7,591	9,615	10,627	13,663	143,557	181,839	200,980	258,403
3 1/2	9.50	New	14,146	17,918	19,805	25,463	194,264	246,068	271,970	349,676
		Premium	11,094	14,052	15,531	19,968	152,979	193,774	214,171	275,363
		Class 2	9,612	12,176	13,457	17,302	132,793	168,204	185,910	239,027
	13.30	New	18,551	23,498	25,972	33,392	271,569	343,988	380,197	477,825
		Premium	14,361	18,191	20,106	25,850	212,150	268,723	297,010	381,870
		Class 2	12,365	15,663	17,312	22,258	183,398	232,304	256,757	330,116

Mechanical Properties of Drill Pipe †

Size OD (in)	[1]Nominal Weight New (ft/lb)	Class	[2]Torsional Data Torsional Yield Strength (ft/lb) E75	X95	G105	S135	[3]Tensile Data Minimum Yield Strength Load at (lb) E75	X95	G105	S135
	15.50	New	21,086	26,708	29,520	37,954	322,775	408,848	451,885	580,995
		Premium	16,146	20,452	22,605	29,063	250,620	317,452	350,868	451,115
		Class 2	13,828	17,515	19,359	24,890	215,967	273,558	302,354	388,741
4	11.85	New	19,474	24,668	27,264	35,054	230,755	292,290	323,057	415,360
		Premium	15,310	19,392	21,433	27,557	182,016	230,554	254,823	327,630
		Class 2	13,281	16,823	18,594	23,907	158,132	200,301	221,385	284,638
	14.00	New	23,288	29,498	32,603	41,918	285,359	361,454	399,502	513,646
		Premium	18,196	23,048	25,474	32,752	224,182	283,963	313,854	403,527
		Class 2	15,738	19,935	22,034	28,329	194,363	246,193	272,108	349,852

Mechanical Properties of Drill Pipe †

Size OD (in)	[1]Nominal Weight New (ft/lb)	Class	[2]Torsional Data Torsional Yield Strength			(ft/lb)	[3]Tensile Data Minimum Yield Strength			Load at (lb)
			E75	X95	G105	S135	E75	X95	G105	S135
	15.70	New	25,810	32,692	36,134	46,458	324,118	410,550	453,765	583,413
		Premium	20,067	25,418	28,094	36,120	253,851	321,544	355,391	456,931
		Class 2	17,315	21,932	24,241	31,166	219,738	278,335	307,633	395,528
4 1/2	13.75	New	25,907	32,816	36,270	46,633	270,034	342,043	378,047	486,061
		Premium	20,403	25,844	28,564	36,725	213,258	270,127	298,561	383,864
		Class 2	17,715	22,439	24,801	31,887	185,389	234,827	259,545	333,701
	16.60	New	30,807	39,022	43,130	55,453	330,558	418,707	462,781	595,004
		Premium	24,139	30,576	33,795	43,450	260,165	329,542	364,231	468,297
		Class 2	20,908	26,483	29,271	37,634	225,771	285,977	316,080	406,388

Mechanical Properties of Drill Pipe †

Size OD (in)	[1]Nominal Weight New (ft/lb)	Class	[2]Torsional Data Torsional Yield Strength (ft/lb) E75	X95	G105	S135	[3]Tensile Data Minimum Yield Strength Load at (lb) E75	X95	G105	S135
	15.70	New	25,810	32,692	36,134	46,458	324,118	410,550	453,765	583,413
		Premium	20,067	25,418	28,094	36,120	253,851	321,544	355,391	456,931
		Class 2	17,315	21,932	24,241	31,166	219,738	278,335	307,633	395,528
4 1/2	13.75	New	25,907	32,816	36,270	46,633	270,034	342,043	378,047	486,061
		Premium	20,403	25,844	28,564	36,725	213,258	270,127	298,561	383,864
		Class 2	17,715	22,439	24,801	31,887	185,389	234,827	259,545	333,701
	16.60	New	30,807	39,022	43,130	55,453	330,558	418,707	462,781	595,004
		Premium	24,139	30,576	33,795	43,450	260,165	329,542	364,231	468,297
		Class 2	20,908	26,483	29,271	37,634	225,771	285,977	316,080	406,388

Mechanical Properties of Drill Pipe †

Size OD (in)	[1]Nominal Weight New (ft/lb)	Class	[2]Torsional Data Torsional Yield Strength (ft/lb)				[3]Tensile Data Minimum Yield Strength Load at (lb)			
			E75	X95	G105	S135	E75	X95	G105	S135
	19.50	New	41,167	52,144	57,633	74,100	395,595	501,087	553,833	712,070
		Premium	32,285	40,895	45,199	58,113	311,535	394,612	436,150	560,764
		Class 2	27,976	35,436	39,166	50,356	270,432	342,548	378,605	486,778
	25.60	New	52,257	66,192	73,159	94,062	530,144	671,515	742,201	954,259
		Premium	40,544	51,356	56,762	72,979	414,690	525,274	580,566	746,443
		Class 2	34,947	44,267	48,926	62,905	358,731	454,392	502,223	645,715
5 1/2	19.20	New	44,074	55,826	61,703	79,332	372,181	471,429	521,053	669,925
		Premium	34,764	44,035	48,670	62,575	294,260	372,730	411,965	529,669
		Class 2	30,208	28,263	42,291	54,374	255,954	324,208	358,335	460,717

Mechanical Properties of Drill Pipe †

Size OD (in)	[1]Nominal Weight New (ft/lb)	Class	[2]Torsional Data Torsional Yield Strength (ft/lb) E75	X95	G105	S135	[3]Tensile Data Minimum Yield Strength Load at (lb) E75	X95	G105	S135
	21.90	New	50,710	64,233	70,994	91,278	437,116	553,681	611,963	786,809
		Premium	39,863	50,494	55,809	71,754	344,780	436,721	482,692	620,604
		Class 2	34,582	43,804	48,414	62,247	299,533	379,409	419,346	539,160
	24.70	New	56,574	71,660	79,204	101,833	497,222	629,814	696,111	894,999
		Premium	44,320	56,139	62,048	79,776	391,285	495,627	547,799	704,413
		Class 2	38,383	48,619	53,737	69,090	339,533	430,076	475,347	611,160
6 5/8	25.20	New	70,580	89,402	98,812	127,044	489,464	619,988	685,250	881,035
		Premium	55,766	71,522	79,050	101,635	387,466	490,790	542,452	697,438
		Class 2	48,497	61,430	67,896	87,295	337,236	427,166	472,131	607,026

Mechanical Properties of Drill Pipe †

Size OD (in)	[1]Nominal Weight New (ft/lb)	Class	[2]Torsional Data Torsional Yield Strength (ft/lb)				[3]Tensile Data Minimum Yield Strength Load at (lb)			
			E75	X95	G105	S135	E75	X95	G105	S135
	27.70	New	76,295	96,640	106,813	137,330	534,199	676,651	747,877	961,556
		Premium	60,192	77,312	85,450	109,864	422,419	535,064	591,387	760,354
		Class 2	52,308	66,257	73,231	94,155	367,455	465,443	514,437	661,419

Mechanical Properties of Drill Pipe †

† New Drill Pipe Torsional and Tensile Data, Used Drill Pipe Torsional and Tensile Data API Premium Class, and Used Drill Pipe Torsional and Tensile Data API Class 2.

Footnotes:

- New weight, nominal with threads and couplings

New Drill Pipe

- Based on the shear strength equal to 57.7% of minimum yield strength and nominal wall thickness Minimum torsional yield strength calculated from equation RP7G, (16th edition) Appendix A, paragraph A.15.
- Tensile data based on minimum values. Minimum tensile strength calculated from equation in API RP7G, (16th edition) Appendix A, paragraph A.13.

Premium Class

- Based on the shear strength equal to 57.7% of minimum yield strength.
  Torsional data based on 20% uniform wear on outside diameter.
- Tensile data based on 20% uniform wear on outside diameter.

Class 2

- Based on the shear strength equal to 57.7% of minimum yield strength.
  Torsional data based on 30% uniform wear on outside diameter.
- Tensile data based on 30% uniform wear on outside diameter.

The information in the above table is taken from API Recommended Practice 7G, Sixteenth Edition, December 1, 1998.

Heavy Walled Drill Pipe

Nominal Size (in)	Tube	
	ID (in)	Wall Thickness (in)
3 1/2	2 1/16	0.719
3 1/2	2 1/4	0.625
4	2 9/16	0.719
4 1/2	2 3/4	0.875
5	3	1.000
5 1/2	3 3/8	1.063
6 5/8	4 1/2	1.063

Nominal Size (in)	Tool Joint		
	Connection Size	OD (in)	ID (in)
3 1/2	NC38 (3 1/2 IF)	4 3/4	2 13/16
3 1/2	NC38 (3 1/2 IF)	4 3/4	2 3/8
4	NC40 (4FH)	5 1/4	2 11/16
4 1/2	NC46 (4 IF)	6 1/4	2 7/8
5	NC50 (4 1/2 IF)	6 5/8	3 1/16
5 1/2	5 1/2 FH	7	3 1/2
6 5/8	6 5/8 FH	8	4 1/2

Nominal Size (in)	Approximate Weight (Including tube & joints)	
	Wt/ft (lb)	Wt/Jt 30 ft (in)
3 1/2	2 1/16	760
3 1/2	2 1/4	695
4	2 9/16	815
4 1/2	2 3/4	1,230
5	3	1,480
5 1/2	3 3/8	1,880
6 5/8	4 1/2	2,290

Drill Bit Sizes

Rotary Pin Connection	Size of Bit (in)
2 3/8 REG	3 3/4
	3 7/8
	4 1/8
	4 1/4
	4 3/8
	4 1/2
2 7/8 REG	4 5/8
	4 3/4
	4 7/8
	5
3 1/2 REG	5 1/8
	5 3/8
	5 5/8
	5 3/4
	5 7/8
	6
	6 1/8
	6 1/4
	6 3/8
	6 1/2
	6 5/8
	6 3/4
	7
	7 3/8
4 1/2 REG	7 1/2
	7 5/8
	7 3/4
	7 7/8
	8 1/8
	8 3/8
	8 1/2
	8 5/8
	8 3/4
	9
	9 3/8

Rotary Pin Connection	Size of Bit (in)
6 5/8 REG	9 1/2
	9 5/8
	9 3/4
	9 7/8
	10 5/8
	11
	11 1/2
	11 5/8
	11 3/4
	12
	12 1/4
	13 1/2
	13 3/4
	14 3/4
	15
	16
	17
	17 1/2
	18 1/2
7 5/8 REG	14 1/2
	14 3/4
	15
	16
	17
	17 1/2
	18 1/2
	20
	22
	23
	24
	26
8 5/8 REG	18 5/8
	20
	22
	23
	24
	26
	27
	and larger

Hole Curvature

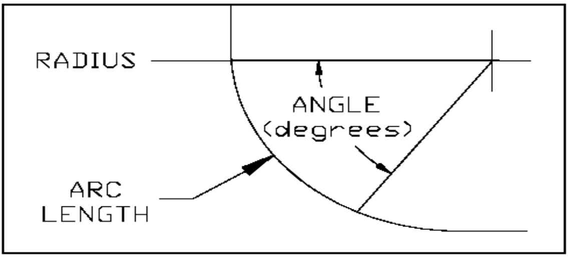
Build Rate	Hole Radius	
Degrees per 100 ft (30m)	R1 FEET	R2 Meters
2	2865	859
4	1432	430
6	955	286
8	716	215
10	573	172
12	477	143
14	409	123
16	358	107
18	318	95
20	286	86
22	260	78
24	239	72
26	220	66
28	205	61
30	191	57
32	179	54
34	169	51
36	159	48
38	151	45
40	143	43
42	136	41
44	130	39
46	125	37
48	119	36
50	115	34
52	110	33
54	106	32
56	102	31
58	99	30
60	95	29
62	92	28
64	90	27
66	87	26
68	84	25
70	82	25
72	80	24
74	77	23
76	75	23
78	73	22
80	72	21

Build Rate	Hole Radius	
Degrees per 100 ft (30m)	R1 FEET	R2 Meters
82	70	21
84	68	20
86	67	20
88	65	20
90	64	19
92	62	19
94	61	18
96	60	18
98	58	18
100	57	17
105	55	16
110	52	16
115	50	15
120	48	14
125	46	14
130	44	13
135	42	13
140	41	12
145	40	12
150	38	11
155	37	11
160	36	11
165	35	10
170	34	10
175	33	10
180	32	10
185	31	9
190	30	9
195	29	9
200	29	9
210	27	8
220	26	8
230	25	7
240	24	7
250	23	7
260	22	7
270	21	6
280	20	6
290	20	6
300	19	6

FORMULA:

$$R1 = \frac{\text{Arc Length (ft)}}{.017453 \times \text{Angle } (^\circ)}$$

$$R1 = \frac{\text{Arc Length (m)}}{.017453 \times \text{Angle } (^\circ)}$$



NOZZLE SELECTION

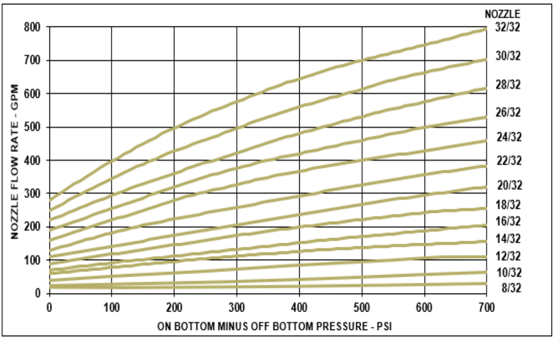
The formula below illustrates the procedure used to properly select the nozzle size.

- From the Motor Specifications, Section 4 of the Motor Handbook, specify the flow rate through the motor (Qm) for the required motor RPM and differential pressure.
- Subtract this flow rate from the total required flow rate (Qt) to obtain the required flow rate through the nozzle (Qn).

Qe = Qn x .35 x Square Root (Mud Weight.)
(gpm) (qpm) (lb/gal)

Using this comparable nozzle flow rate (Qe) and the optimal motor differential pressure, obtain the required nozzle from the chart in Table 6-1.

Table 6-1 Nozzle Selection



Example:

A total flow of 700 GPM at 300 PSI differential pressure is required to run the motor. The required speed is 125 RPM and the mud weight is 9 PPG.

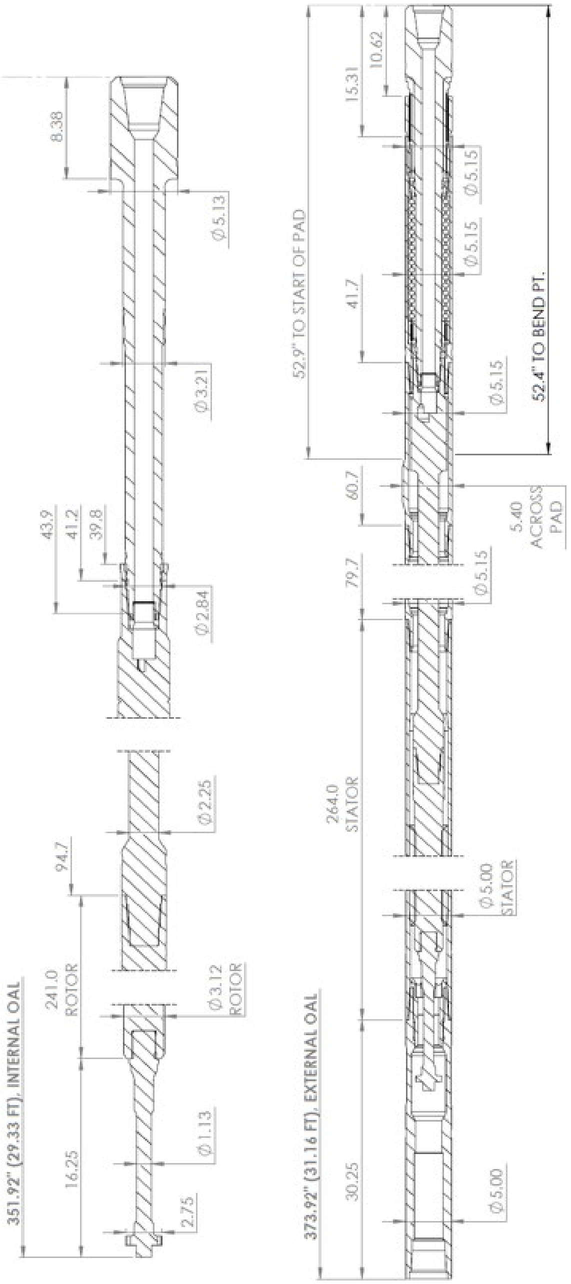
The motor spec sheet shows 430 GPM is required to turn the motor at 125 RPM. Subtracting 430 GPM motor flow rate from 700 GPM total flow rate will give the needed nozzle flow rate of 270 GPM.

Adjusting the nozzle flow rate for 9 PPG mud weight will give a nozzle flow rate (Qe) of:

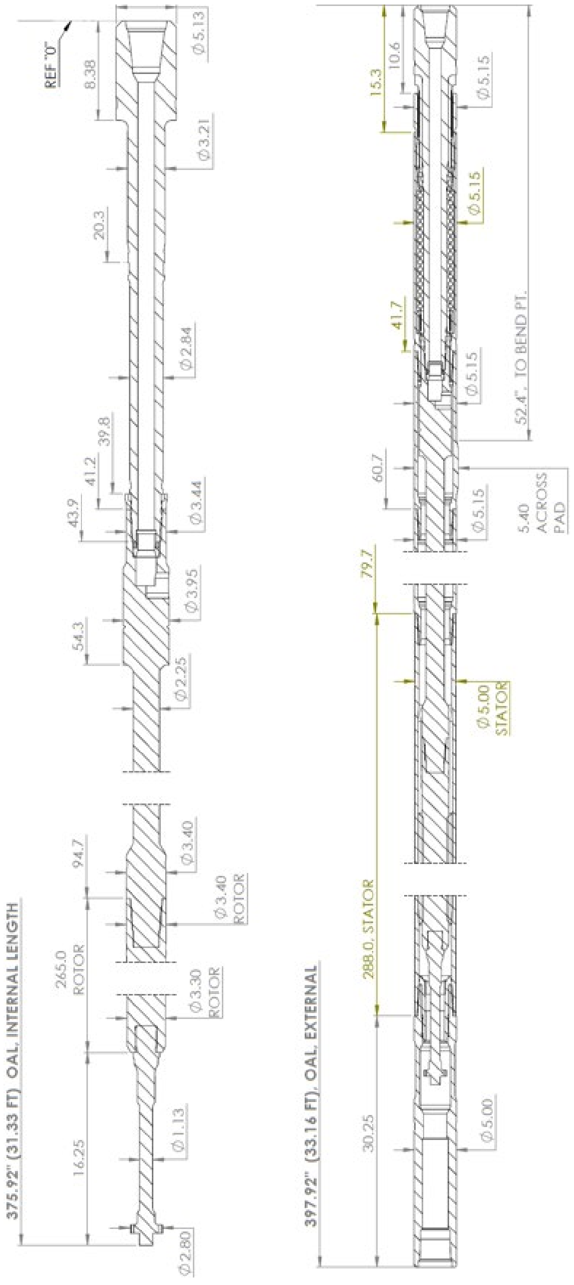
Qe = Qn x .35 x SQRT(PPG)
Qe = 270 GPM x .35 x SQRT (9)
Qe = 284 GPM

The above chart indicates that a 22/32 nozzle is required to bypass 284 GPM at 300 PSI.

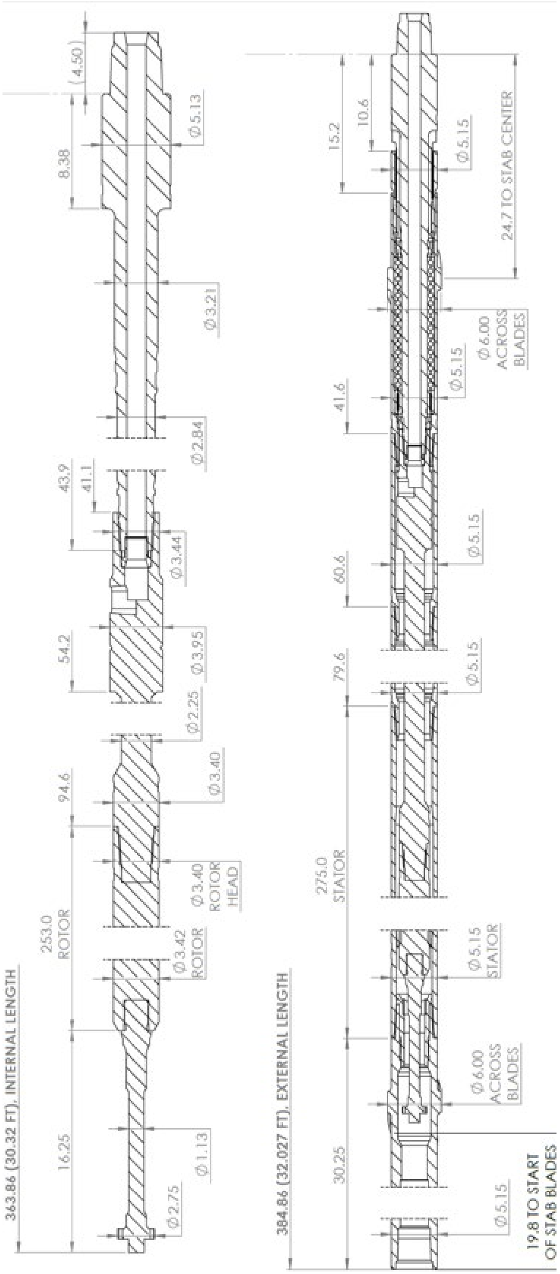
5” 5/6 Lobe 6.7 Stage



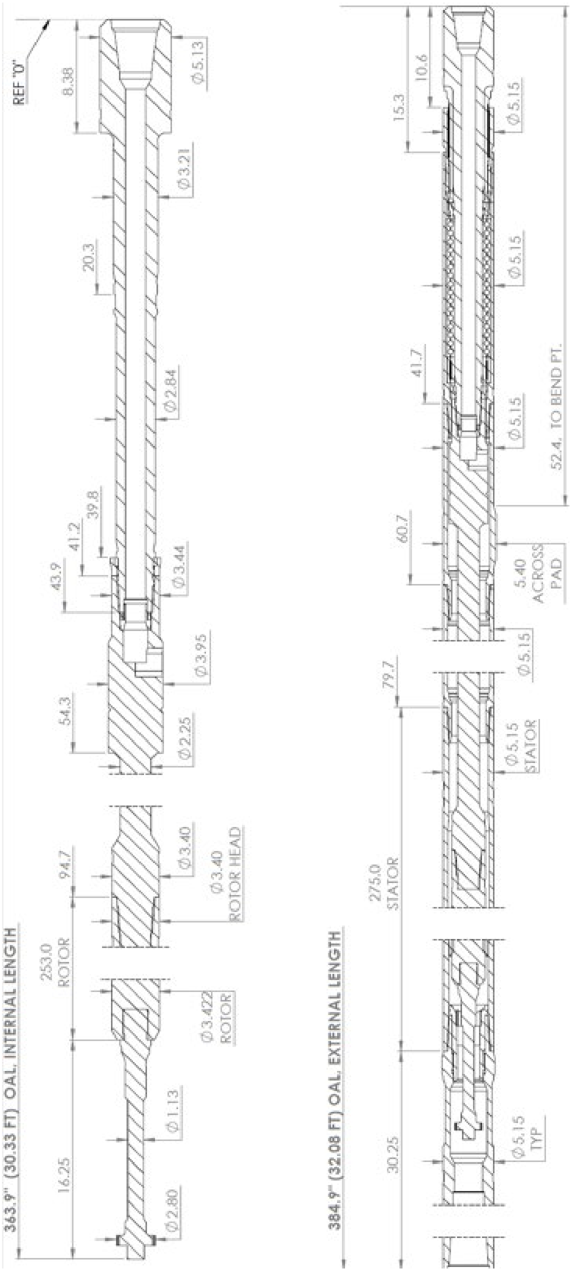
5” 6/7 Lobe 8.8 Stage



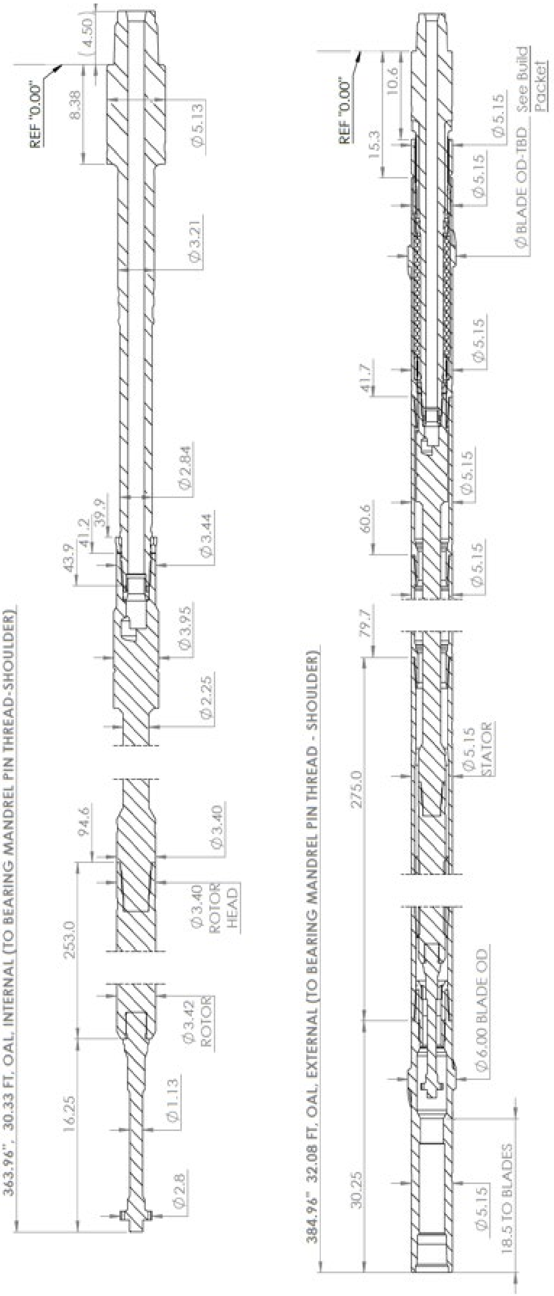
5” 6/7 Lobe 8.8 Stage RSS Assist



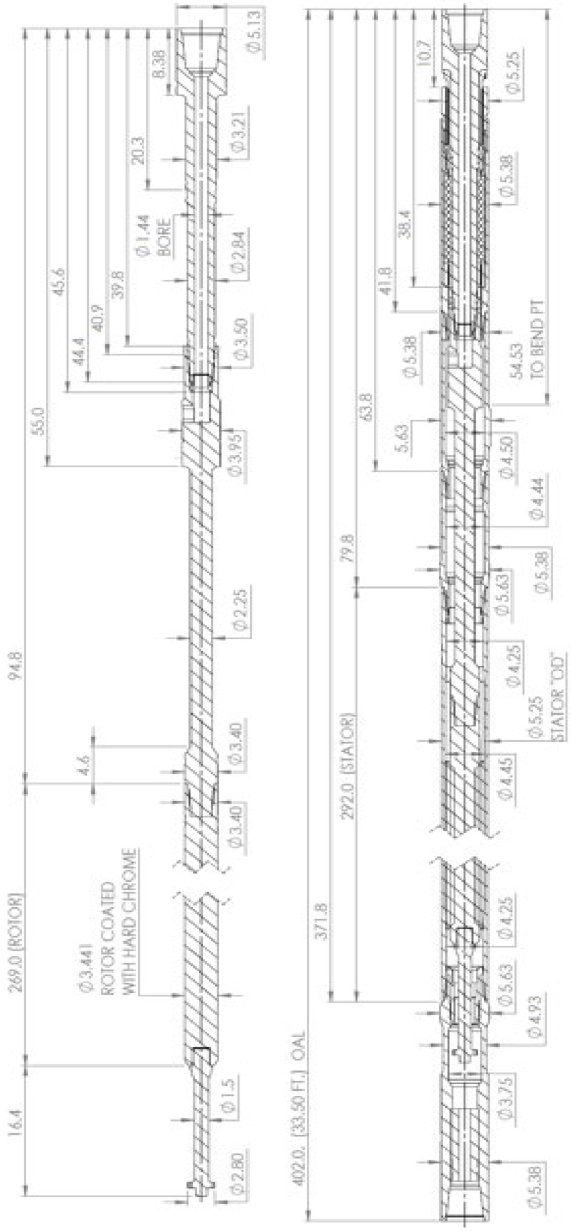
5” 7/8 Lobe 8.3 Stage



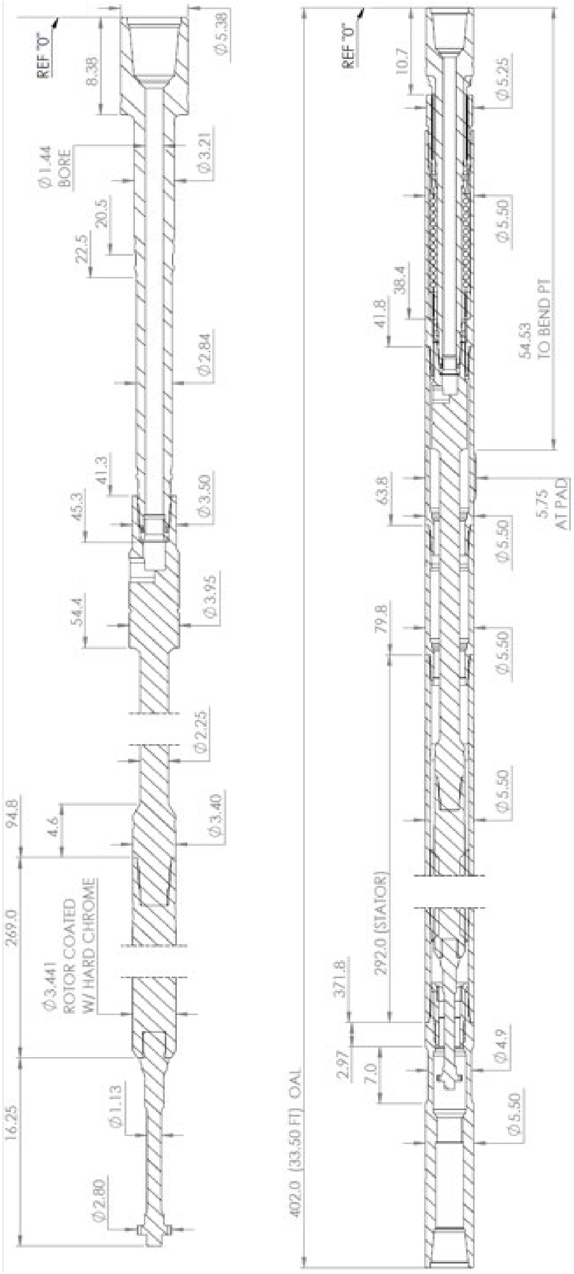
5” 7/8 Lobe 8.3 Stage – RSS Assist



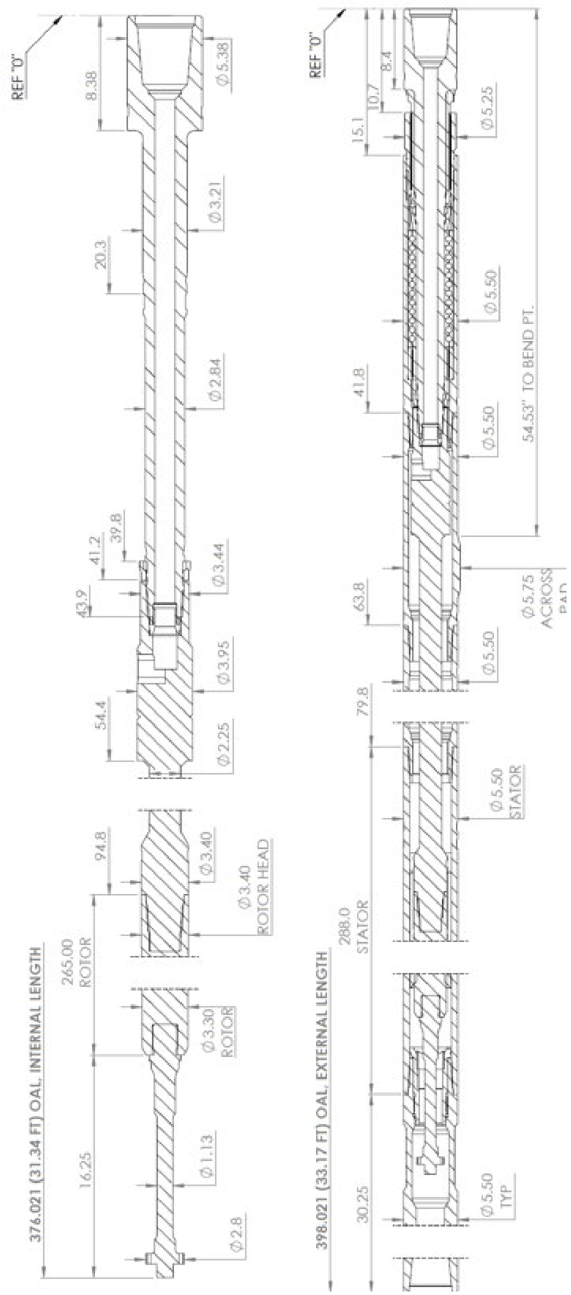
5 3/8” 5/6 Lobe 9.9 Stage



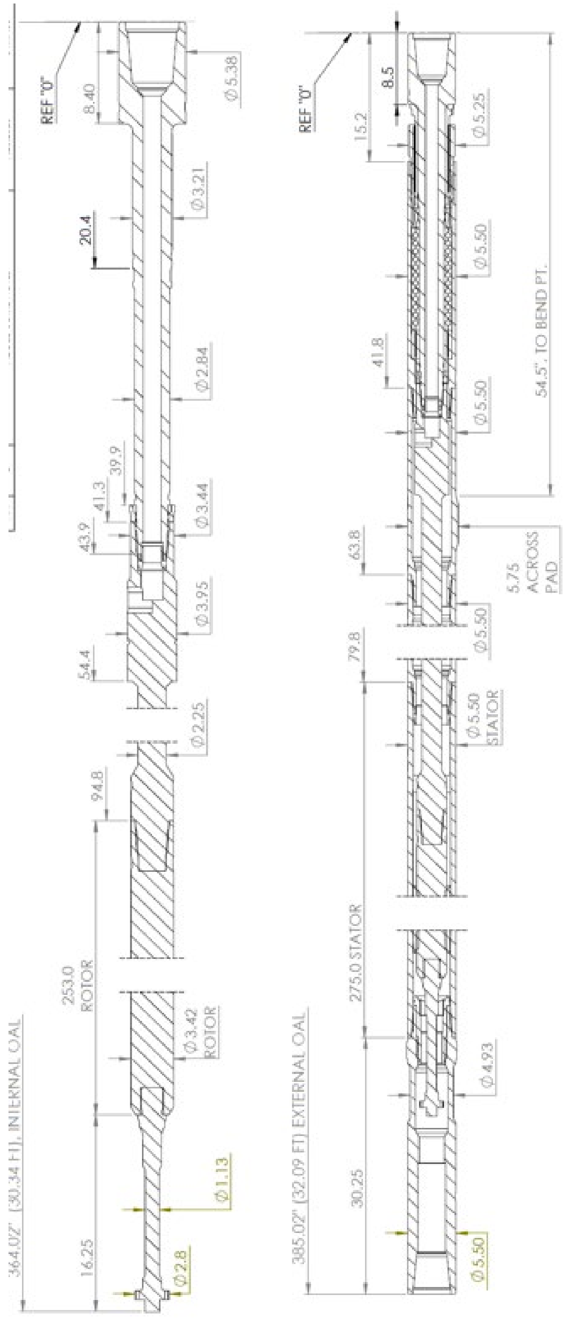
5 1/2” 5/6 Lobe 9.9 Stage



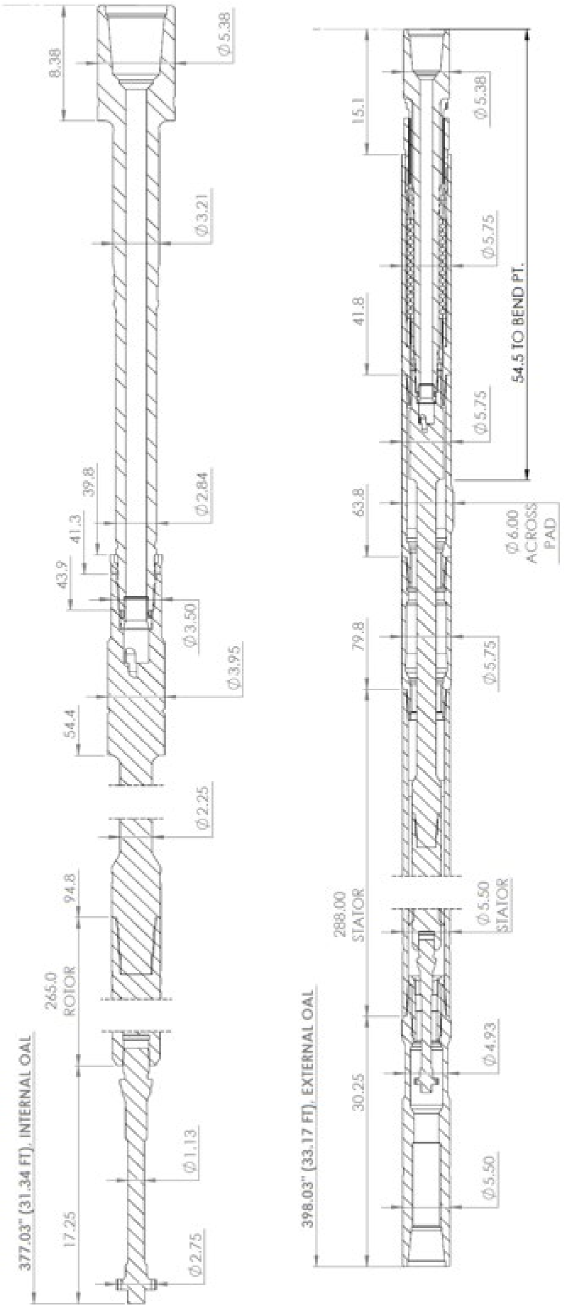
5 1/2” 6/7 Lobe 8.8 Stage



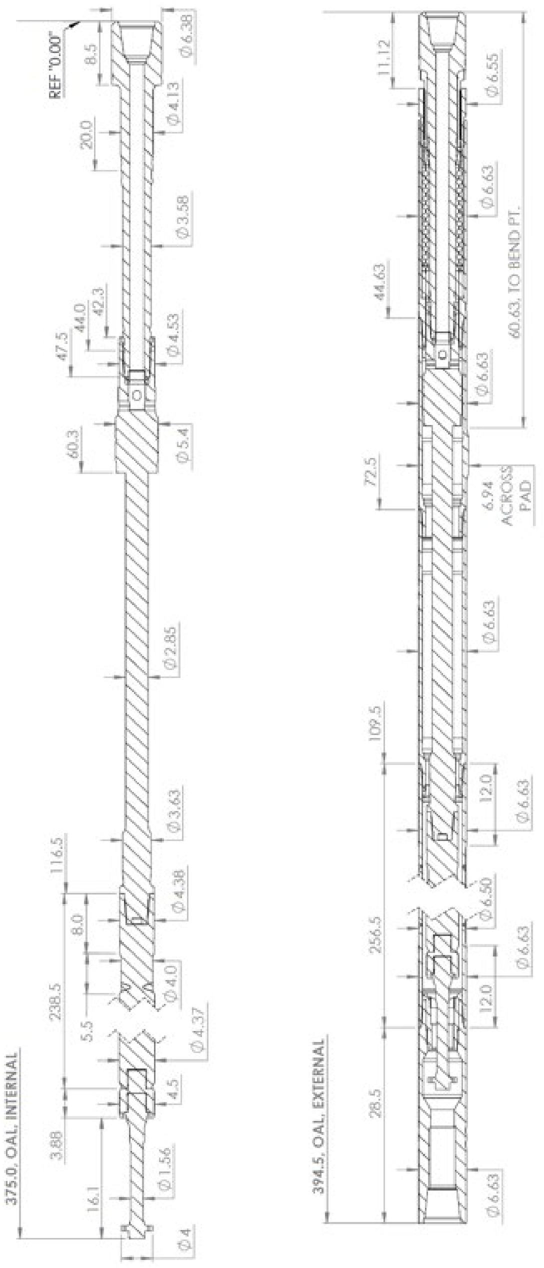
5 1/2” 7/8 Lobe 8.3 Stage



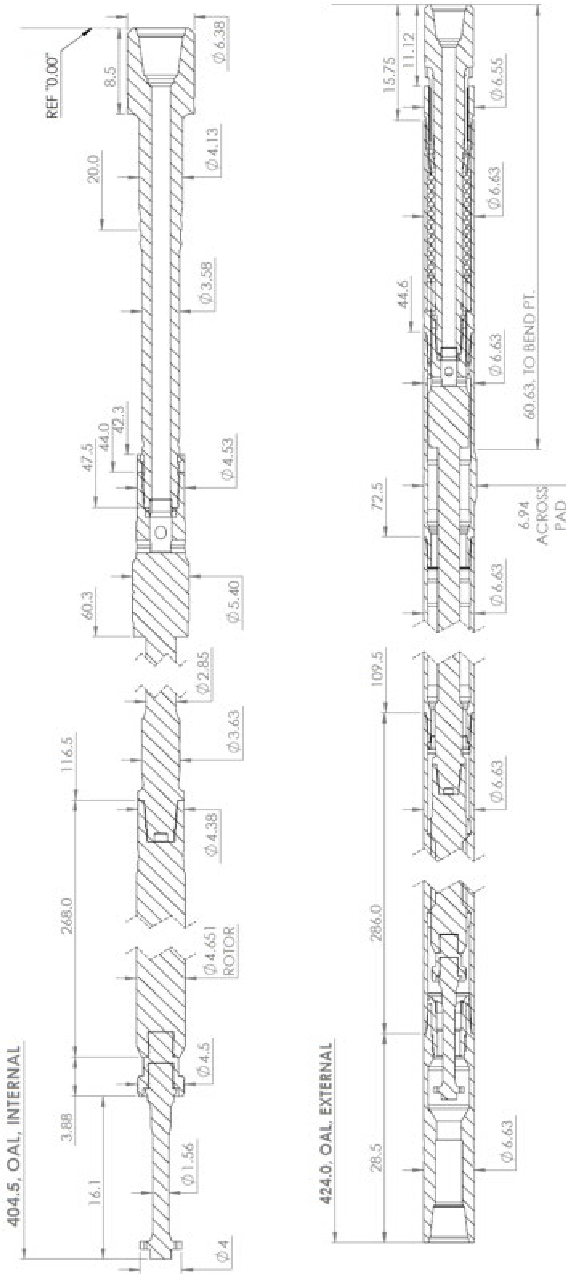
5 3/4” x 5 1/2” Combo 6/7 Lobe 8.8 Stage



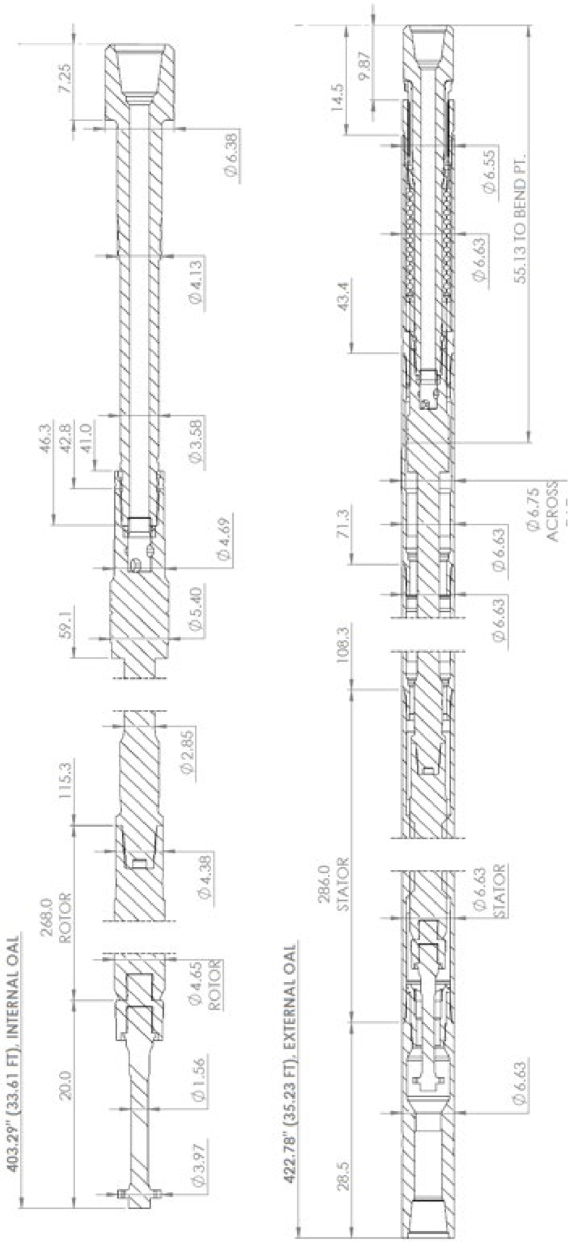
6 5/8” 5/6 Lobe 8.2 Stage



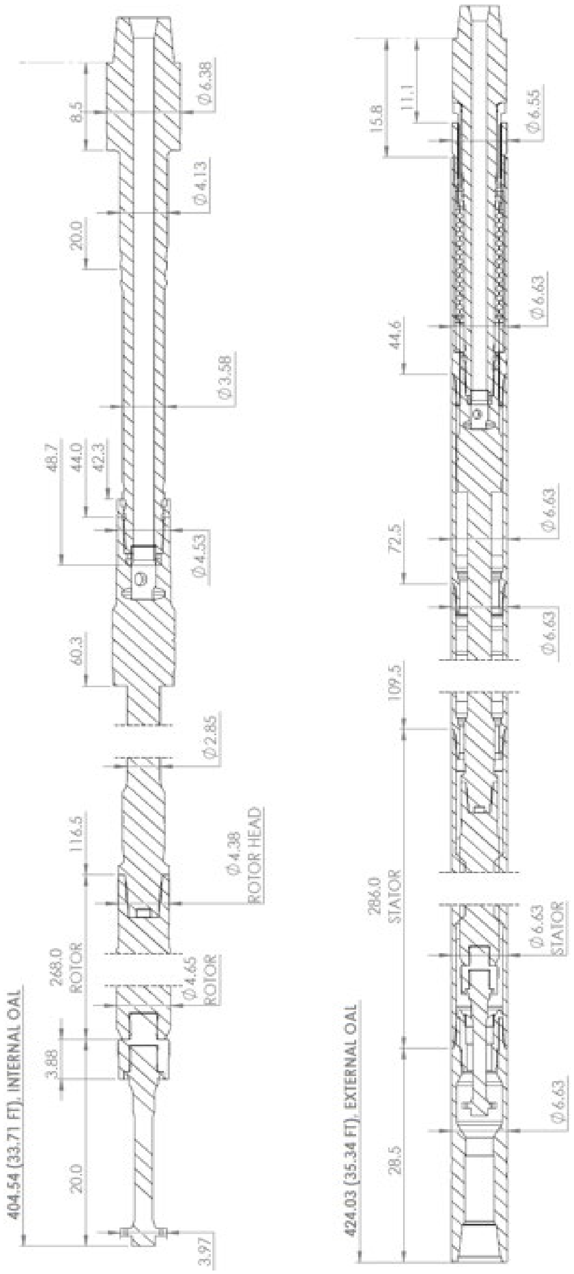
6 5/8” 6/7 Lobe 7.8 Stage



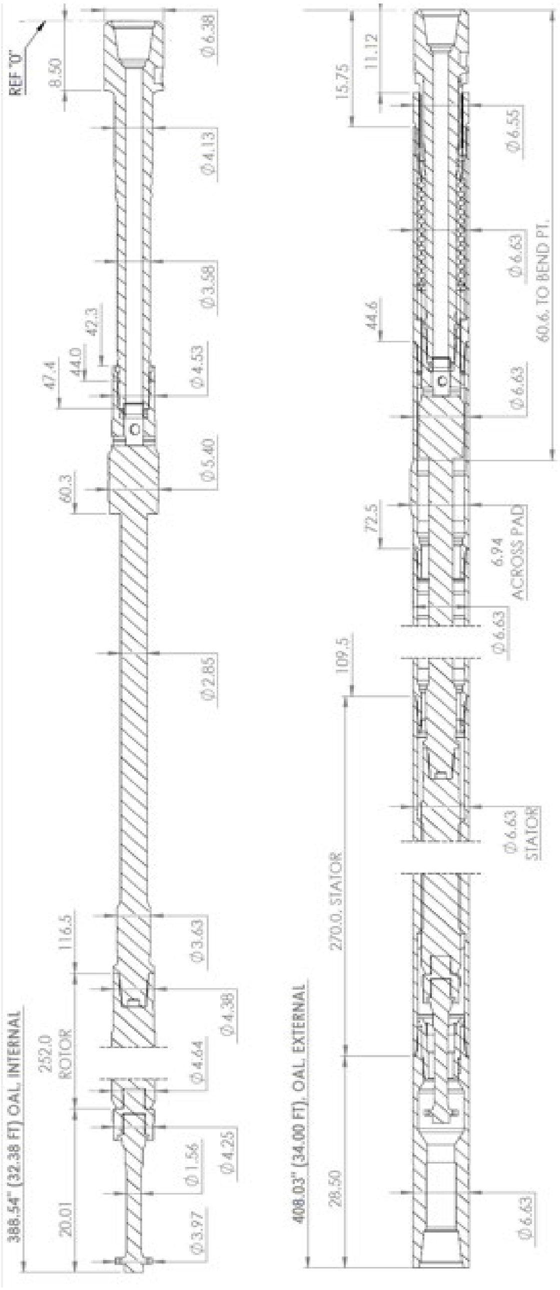
6 5/8” 6/7 Lobe 7.8 Stage 55” SBTB



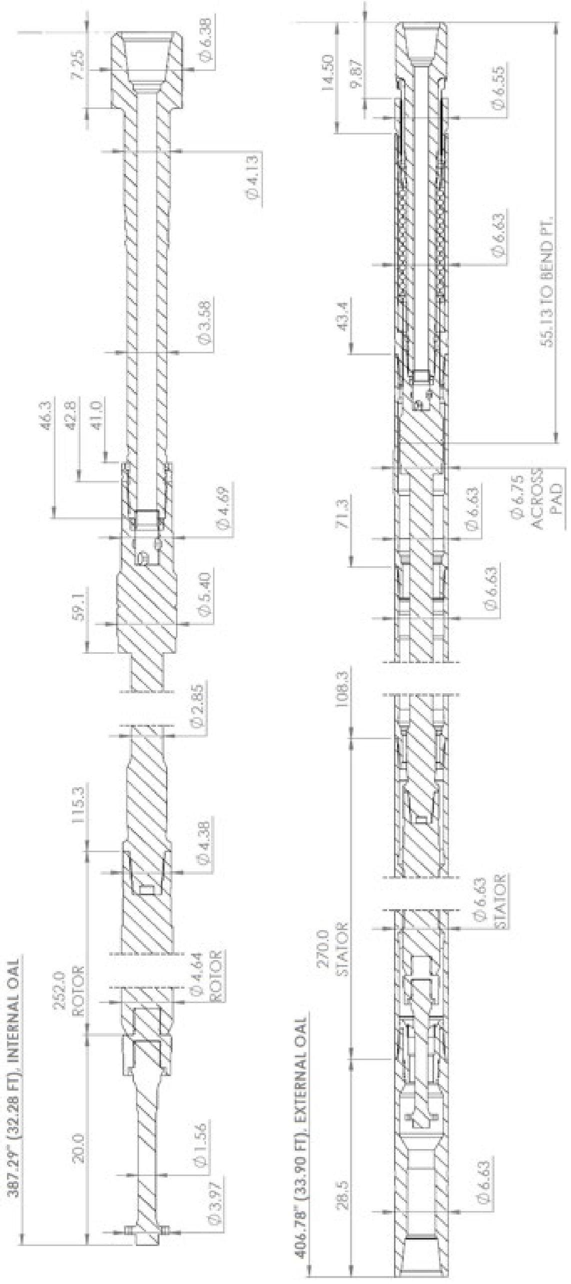
6 5/8” 6/7 Lobe 7.8 Stage RSS Assist



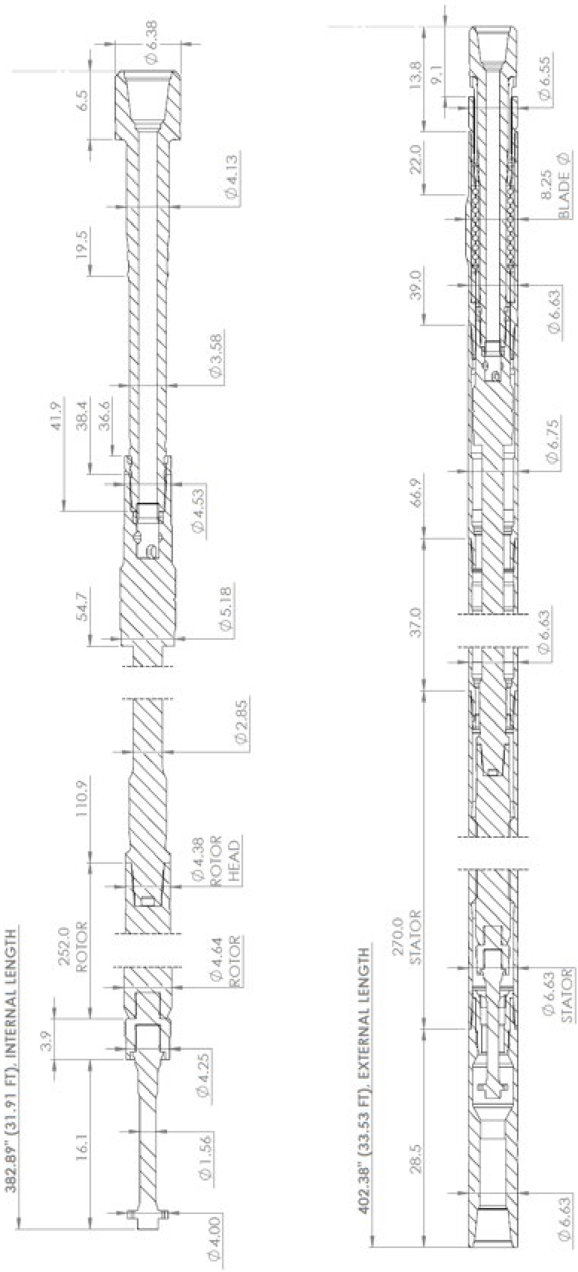
6 5/8” 7/8 Lobe 5.7 Stage



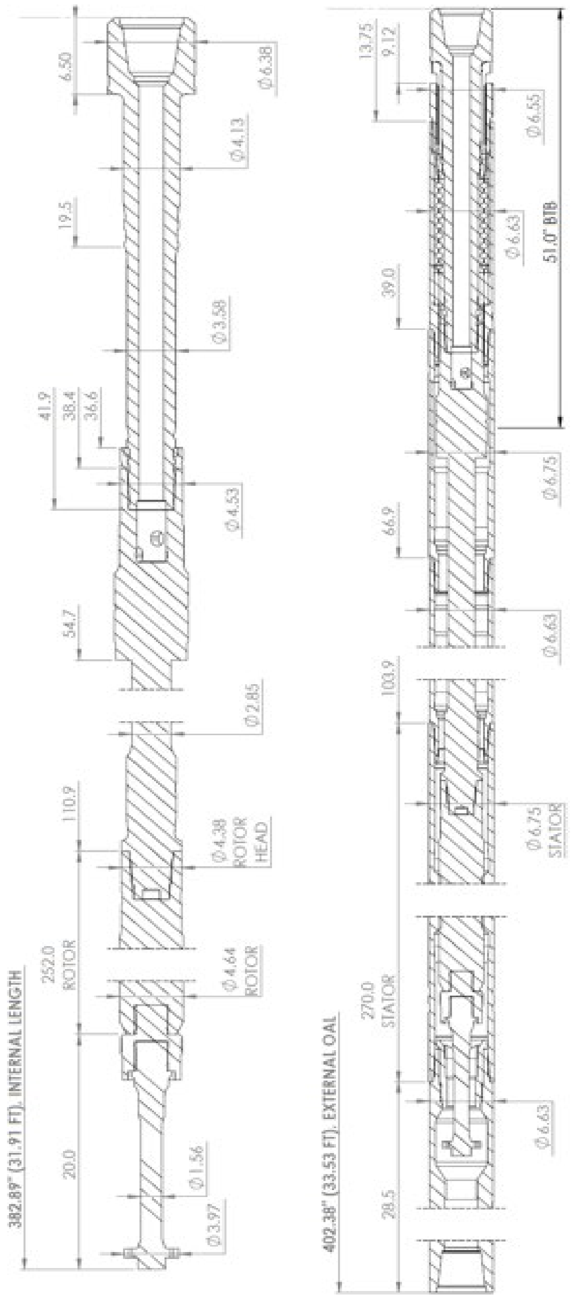
6 5/8” 7/8 Lobe 5.7 Stage 55” SBTB



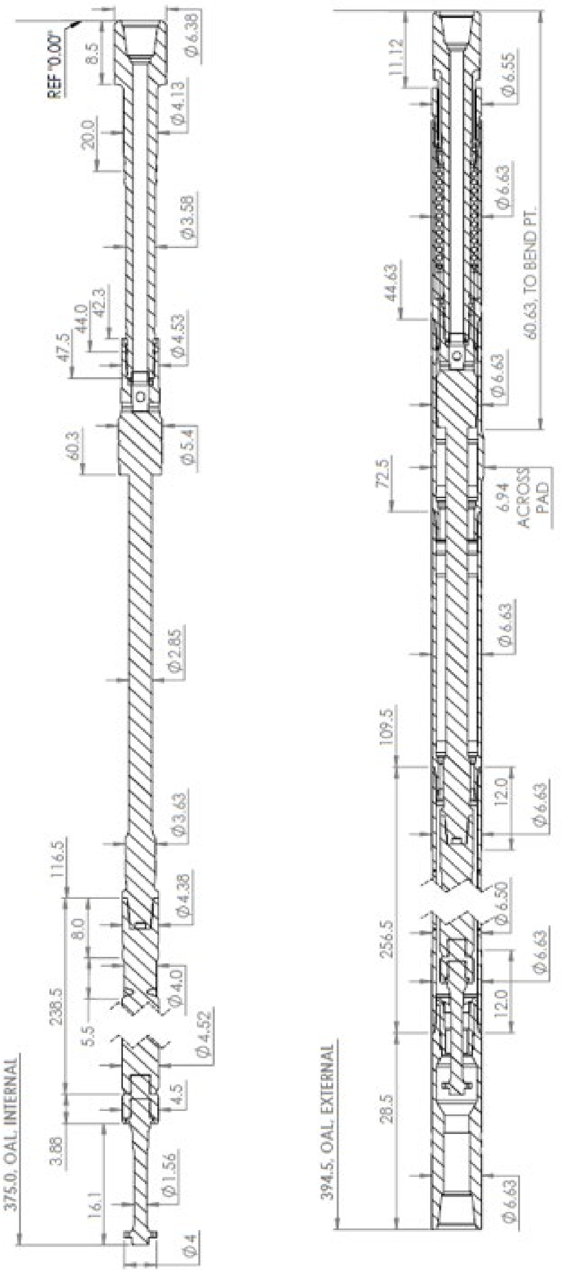
6 5/8” 7/8 Lobe 5.7 Stage 51” SSBTB – IB Stabilized



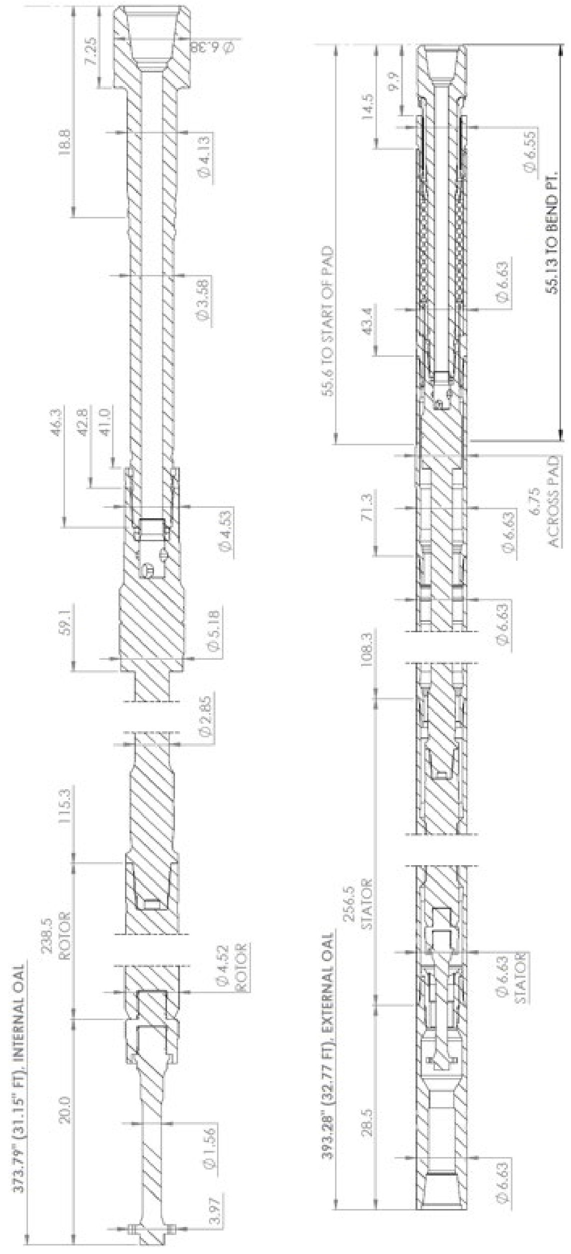
6 5/8” 7/8 Lobe 5.7 Stage 51” SSBTB



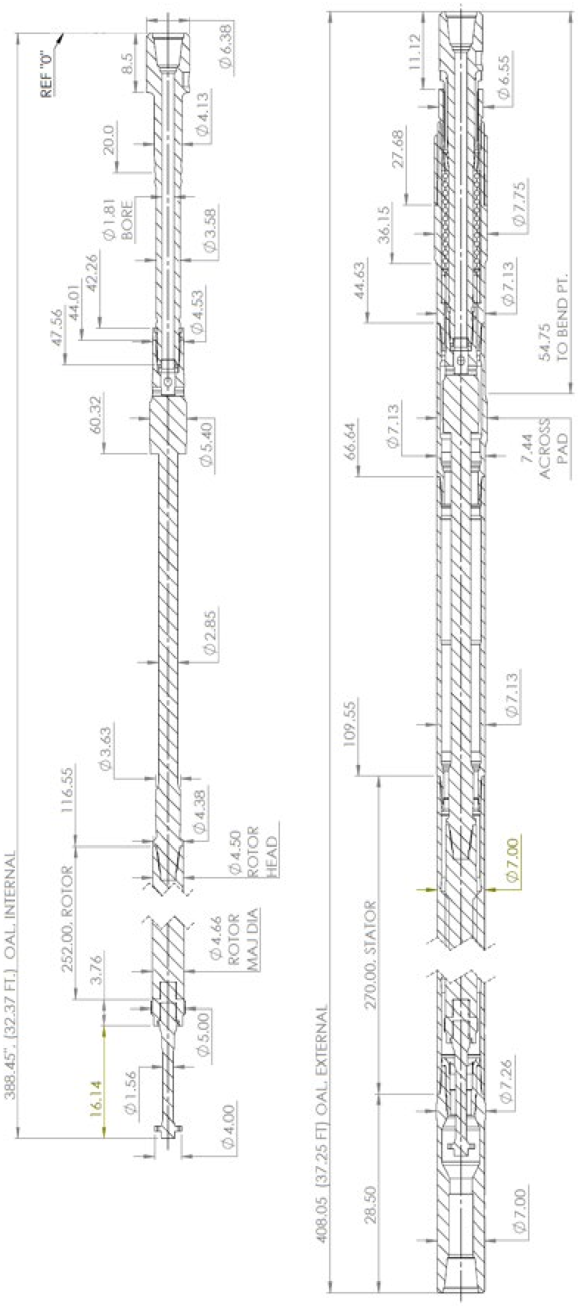
6 5/8” 7/8 Lobe 6.4 Stage



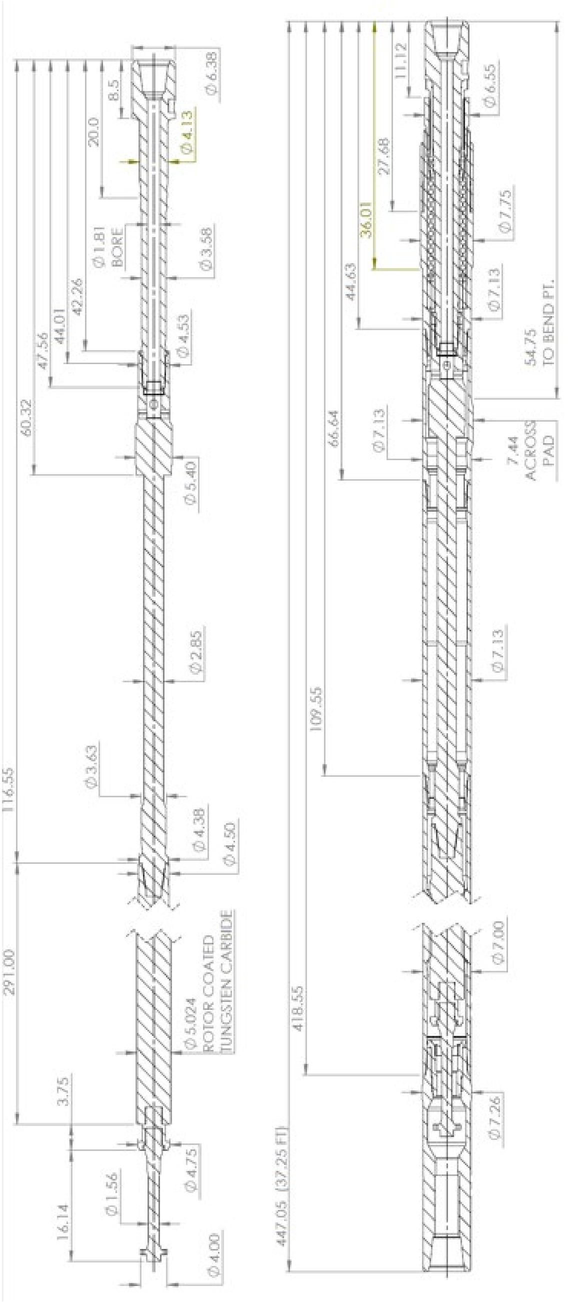
6 5/8” 7/8 Lobe 6.4 Stage 55” SBTB



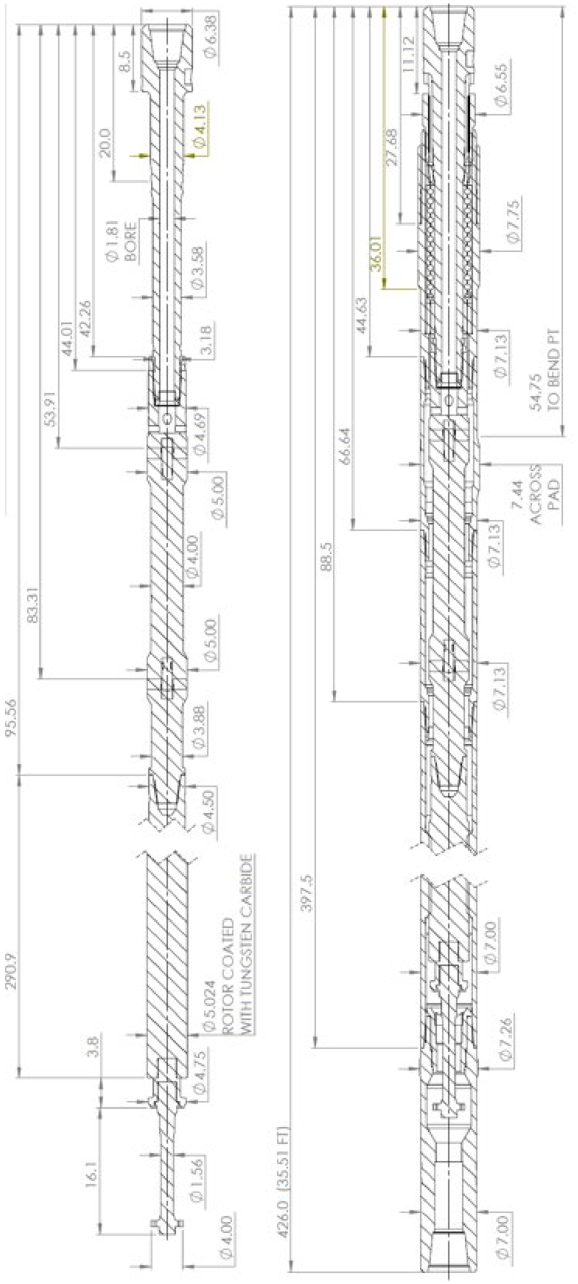
7 1/8” 5/6 Lobe 8.3 Stage



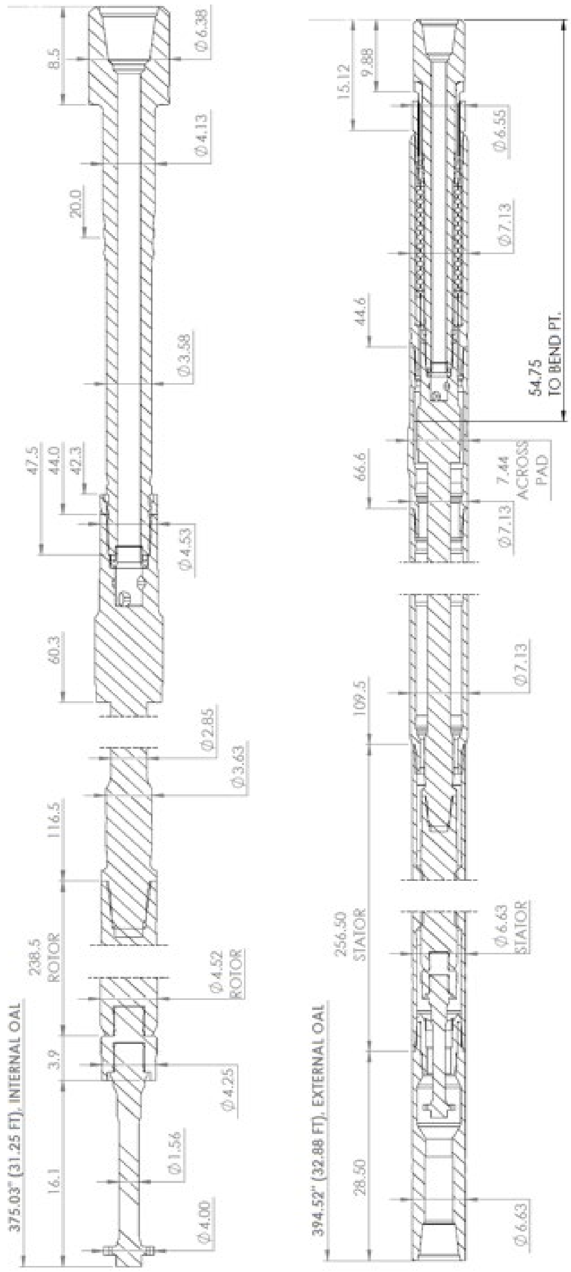
7 1/8” 7/8 Lobe 8.5 Stage



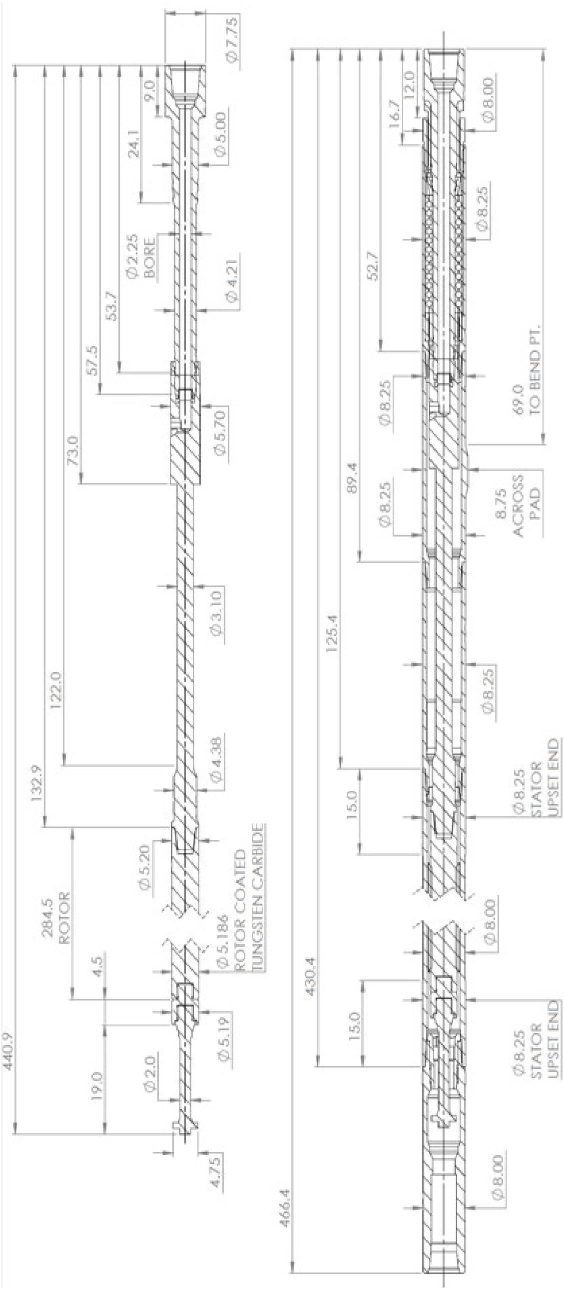
7 1/8" 7/8 Lobe 8.5 Stage Jaw Clutch



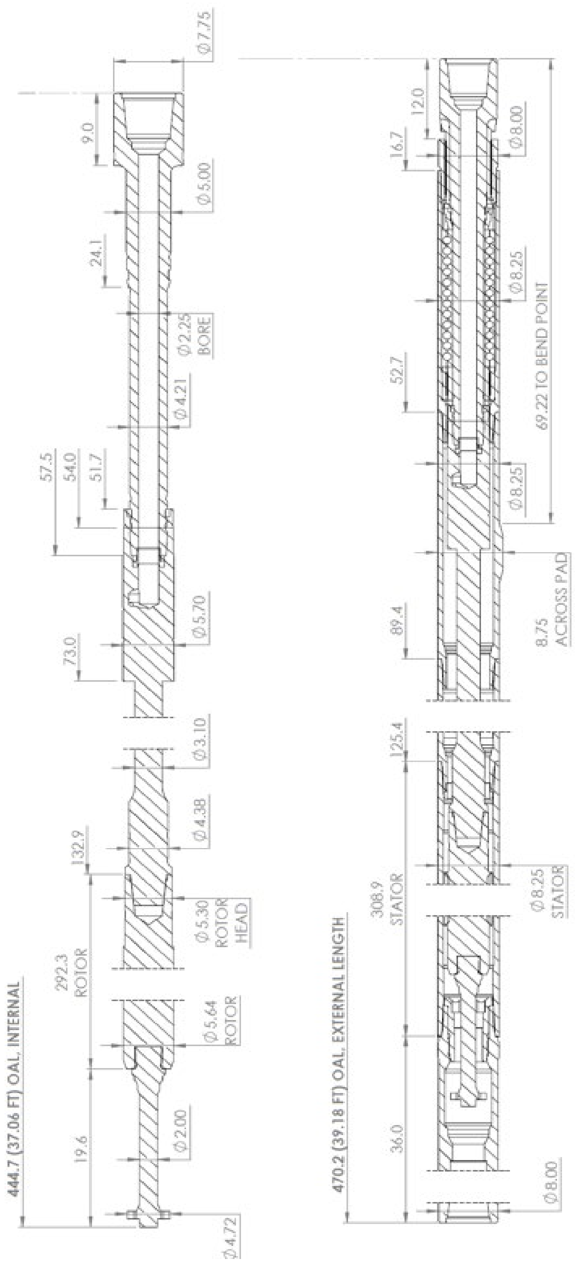
7 1/8” x 6 5/8” 7/8 Lobe 6.4 Stage Combo



8 ¼” 7/8 Lobe 5.9 Stage



8 ¼” 7/8 Lobe 7.0 Stage



8 ¼” 7/8 Lobe 7.0 Stage Jaw Clutch