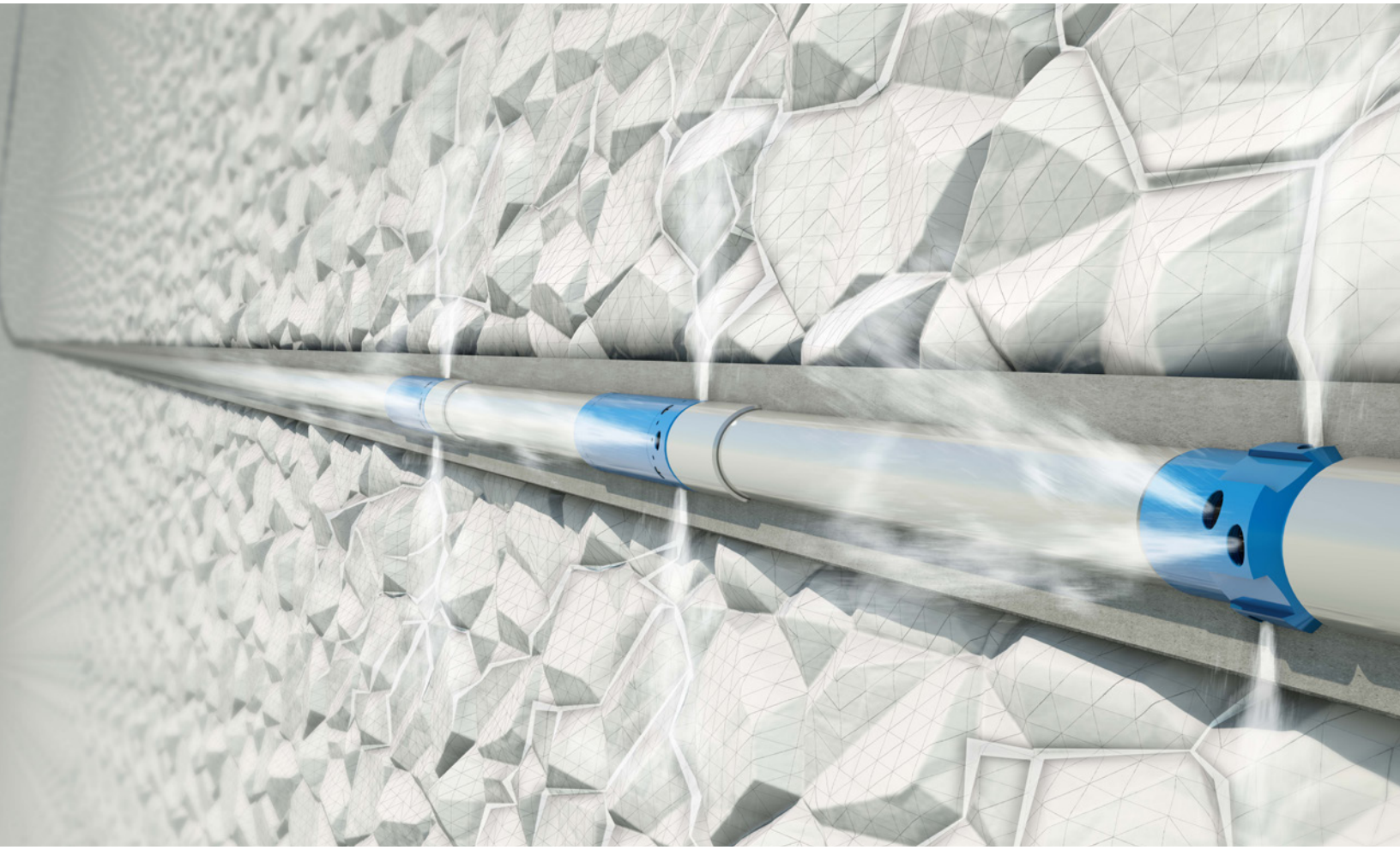

DRILLING MOTOR HANDBOOK

April 2018

Tartan
energy group

About Tartan

Tartan Energy Group (Tartan) is a multifaceted energy services company that engineers and manufactures innovative, customized multistage stimulation solutions and provides completions milling services in Canada and the USA. For 20 years, Tartan has followed the philosophy of engineering our products with simplicity, reliability, flexibility and performance in mind, providing outstanding field service and value to our customers. From design to installation, we continue to meet the high expectations of our customers.

Tartan is a recognized leader in the design and manufacture of reliable and robust downhole drilling motors used in the oil and gas industry and has provided improved designs and increased motor offerings to suit many different applications. With our experienced Field Supervisors, Tartan is able to provide a full supply and service operation for the most difficult of completions drilling operations.

Locations

Canada			
Edmonton Head Office – Canadian Operations Engineering and Manufacturing Centre 4003 – 53 Avenue Edmonton, AB • T6B 3R5 780-463-3366	**Calgary** Sales Office 350, 1201 – 5 Street SW, Calgary, AB • T2R 0Y6 403-232-1490	**Grande Prairie** District Office 4-11456 96 Avenue Grande Prairie, AB • T8V 5M4 780-882-6627	**Fort St. John** District Office 11119 Tahltan Road Fort St John, BC • V1J 4M6 250-785-9223
USA			
Casper Head Office – US Operations 2327 Colman Circle Casper, WY • 82601 307-265-6895	**Denver** Sales Office 600 – 17 Street 2800 South Denver, CO • 80202 720-359-1565	**Williamsport** District Office 333 Rose Street Williamsport, PA • 17701 570-326-1004	**Tioga** District Office 409 – 5th Street SE Tioga, ND • 58852 701-664-6650
Houston Sales Office	**San Antonio** District Office 18235 W Loop 1604 Von Ormy, TX • 78023		
China			
Shanghai Head Office 23 Yi Xian Lu, Room 302 WuJiaoChang, Yangpu Qu, Shanghai Shi, China • 200434	**Sichuan** District Office 250 Ming Xing Da Dao Chuanshan Qu, Suining Shi, Sichuan Sheng, China • 629000		
United Arab Emirates			
Quwain Middle East Operations Free Zone, Umm Al Quwain, United Arab Emirates			

Tartan energy group

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SECTION 1 – Drilling Motor Introduction

Tartan maintains a complete lineup of motors customized to various speeds, sizes and torques to meet the needs of coiled tubing and jointed pipe operations. Tartan also designs and supplies innovative bottom hole assembly (BHA) equipment including vibration packages, compact motor head assemblies (MHAs), rotating scrapers and brushes, venturi baskets, and an assortment of drill mills.

Typical motor drilling operations include composite bridge plugs, frac ball/seats, retainers, permanent bridge plugs, cement, stage tools, debris subs, open hole, vertical extensions, fish dressing, washovers, cleanouts, high plug back, performance drilling, coiled tubing drilling and any other drilling that may be required.

Tartan provides drilling motors for the following oil and gas operations.

1. Cased Hole Drilling
2. Coiled Tubing Drilling
3. Underbalanced Drilling
4. Directional Drilling
5. Horizontal Drilling
6. Vertical Extensions

Benefits of using Tartan drilling motors.

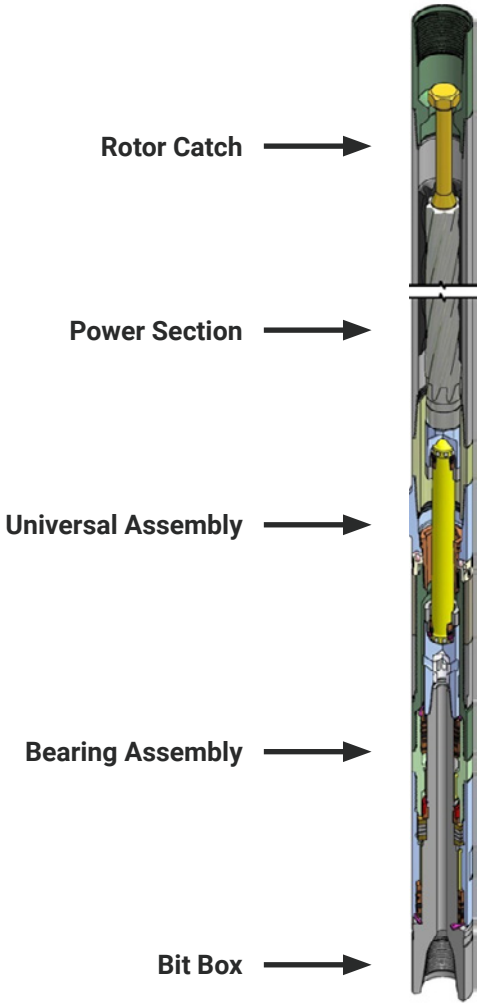
1. Higher rates of penetration in most applications
2. Much safer than power swivels because there is no rotating equipment on floor
3. Less wear and tear on tubing and casing because tubing is not rotated
4. Excellent application for horizontal and directional applications
5. Motors are superior to power swivels in deviated wellbores
6. No transportation issues as they are carried on Tartan trucks

Typical BHA

The positive displacement drilling motor (PDM) is a hydraulically actuated device that converts drilling fluids hydraulic energy into mechanical energy. The purpose of the motor is to generate rotational speed and torque needed to perform drilling operations.

Tartan's drilling motors comprise 5 individual components that when installed together form a PDM.

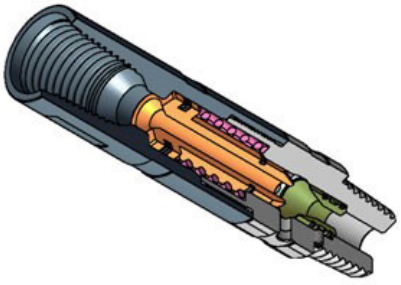
1. Rotor Catch
2. Power Section
3. Universal Drive Shaft Assembly
4. Sealed Bearing Assembly
5. Bit Box



Dump Sub

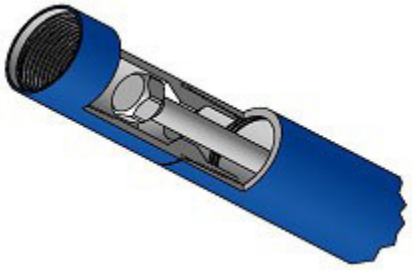
The Dump Sub is a hydraulically actuated valve located at the top of the drilling motor that allows the drill string to fill with fluid when running in the hole and drain when tripping out of the hole. The dump sub prevents wet tripping.

The Dump Sub can be removed in cases where it is not required or desired, such as in underbalanced drilling using nitrogen or air.



Rotor Catch

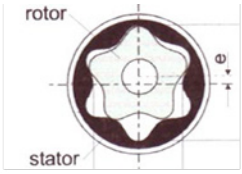
The Rotor Catch provides the capability to recover the drilling motor in the unlikely event of a connector separation or mechanical failure. The Rotor Catch is used extensively in extreme drilling events that produce excessive loading to minimize the risk of fishing operations.



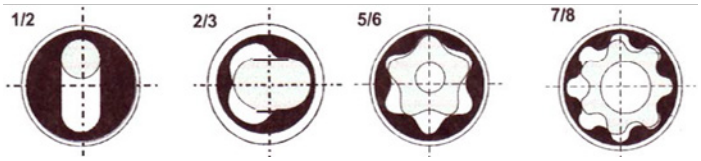
Power Section

The Power Section converts hydraulic energy from drilling fluids into mechanical energy, which rotates the bit. The Power Section consists of two parts: the Stator and the Rotor.

The Stator is a length of tubular steel that is lined with an elastomer formed in a helical manner similar in design to the Rotor. The Stator will always have one more lobe than the rotor as designated by ratio of Rotor = x and the Stator x + 1. For example, 4/5 or 7/8.



The Rotor is a steel bar which is machined to produce a multi-lobe pattern. It is then chromed to improve chemical and wear protection. The Rotor can be bored to allow an increase of fluid pump rate that bypasses the Stator/Rotor for improved lift velocity to ensure cutting removal and prevent stuck conditions.



When the Rotor is installed into the Stator, the combination of the spiral shapes and lobes form sealed cavities between the two components. When drilling fluid is forced through the power section, the pressure drop across the cavities will cause the Rotor to turn.

Another output characteristic of the Power Section is the length. A stage is defined as one complete 360° spiral rotation of the Stator. As stages are added to a power section, the differential pressure increases, as does the torque output.

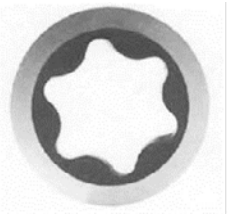
The rate at which fluid is pumped into the motor directly impacts its rotational speed. Fluid rates in excess of what the motor was designed for will cause premature failure of the Stator.

With increased temperatures, or certain drilling fluids, the Stator elastomer will expand and cause a tighter seal with the Rotor and will create a more interference fit than allowed in the design. This will also cause damage to the Stator with subsequent failure.

High Performance Power Section

A relatively new development in drilling motors is the introduction of High Performance Power Sections that incorporate an even thickness of rubber applied to a helical manufactured Stator. This design has several advantages over standard Stators.

1. Higher power/torque outputs due to the increased interference fit between the Stator and Rotor
2. Higher temperature operation due to the consistent elastomer thickness, which decreases expansion rates found in standard lobe designs
3. Improved chemical resistance due to uniform elastomer thickness, which reduces swelling
4. Longer life due to the higher temperature ability because hysteresis heat generated with a standard lobe is eliminated

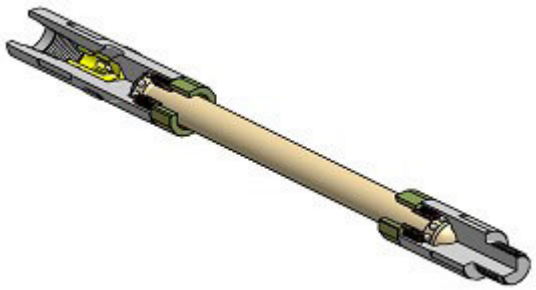


High Performance Hard Rubber

High Performance Even Wall

Universal Drive Shaft Assembly

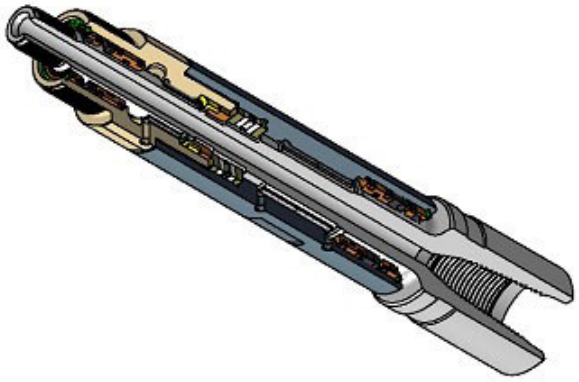
The Tartan patented Universal Drive Shaft Assembly consists of an external housing and internal drive shaft that connects the Rotor at the top end and the mandrel of the Bearing Assembly at the bottom end. The drive shaft transmits the rotational speed and torque generated from the Power Section to the bit. In addition, the Universal Connecting Assembly converts the eccentric (side-to-side) rotation of the Rotor to a concentric (in-line) rotation.



Sealed Bearing Assembly

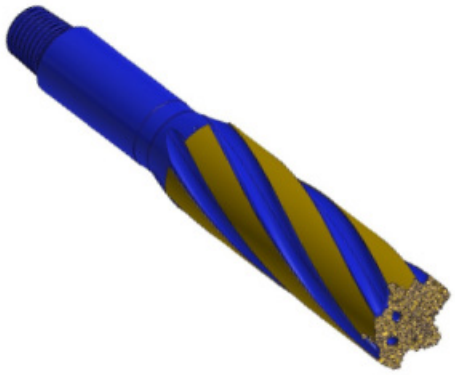
Tartan's patented Sealed Bearing Assembly contains radial and axial bearings and bushing. They transmit the axial and radial loads from the bit to the tool string while providing a drive line that allows the Power Section to rotate the bit. Tartan's bearing design is completely sealed and pressure compensated to ensure reliable operation and long bearing life.

Nitrogen (N_2) and air pose no additional risk to Tartan's Sealed Bearing Assembly housing, unlike open bearing assemblies. Since no drilling fluid is used to lubricate the Sealed Bearing Assembly housing, all fluid can be directed to the bit for maximum hydraulic efficiency. This improves bottom hole cleaning and increases bit life.



Drill Mills

Tartan manufactures various sizes of Drill Mills for specific applications in the oil and gas industry. Tartan mills are engineered to provide superior milling capabilities for all completions drilling. Whether multi-bladed, fluted, concave or convex, Tartan Drill Mills ensure excellent durability and penetration rates when drilling. Standard milling operations include composite frac/bridge plugs, ball drop systems, steel, rubber, cement and many other materials encountered downhole. Specialty mills can be provided upon request.

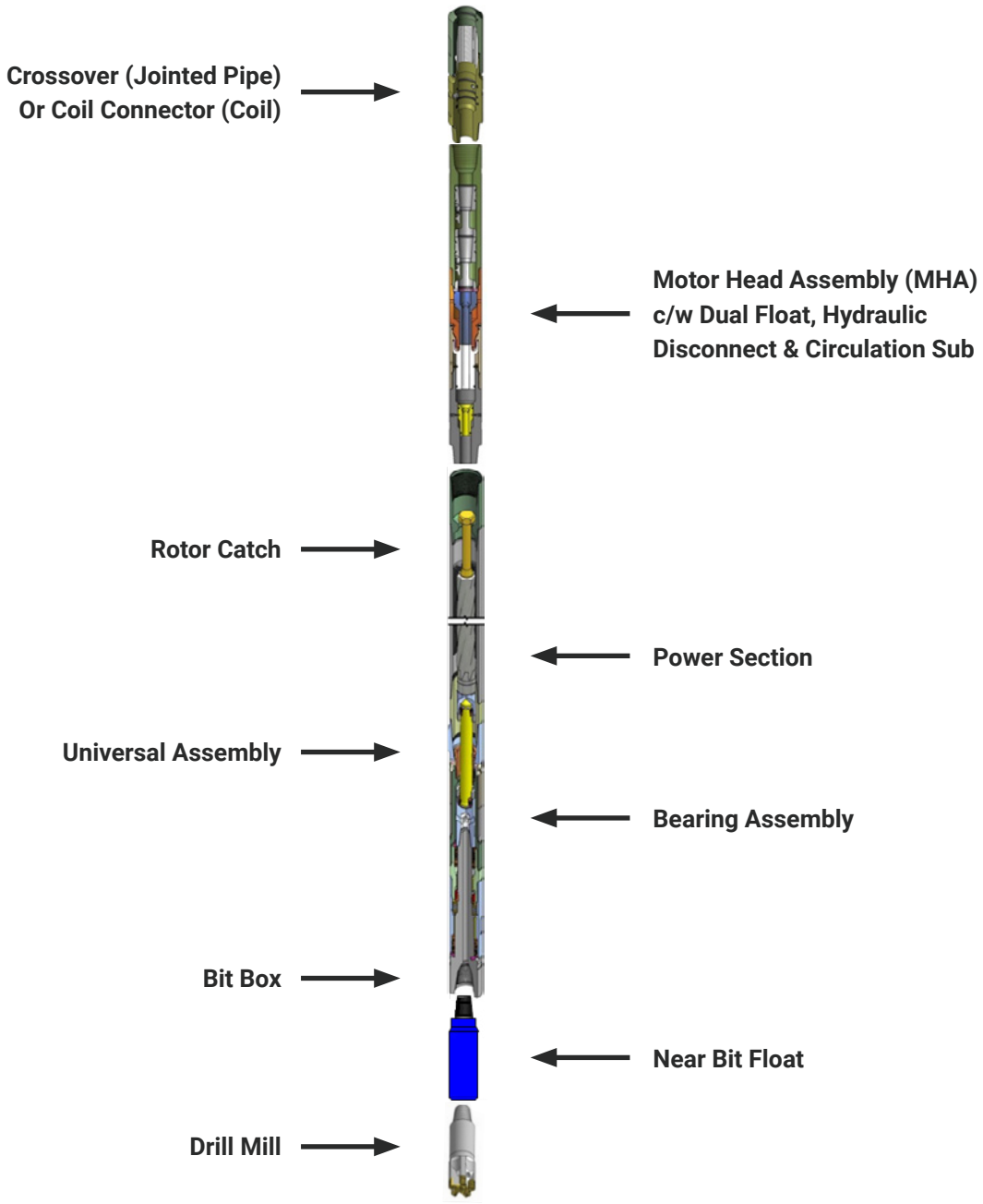


SECTION 2 – Jointed Pipe and Coiled Tubing Drilling

Tartan Energy Group has provided full service operations for coiled tubing drilling and coiled tubing fishing since 2000. During this time, Tartan has designed many tools that complement the wide array of operations available to coiled tubing.

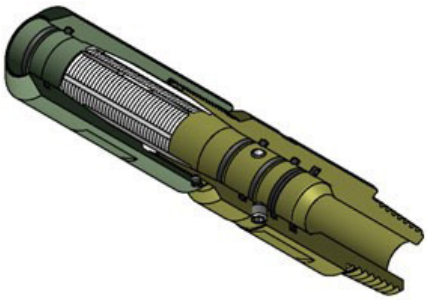
From standard drill out of cement and equipment to extended reach drill out of open hole multistage systems, Tartan continues to lead the way in service, value and performance.

Typical BHA



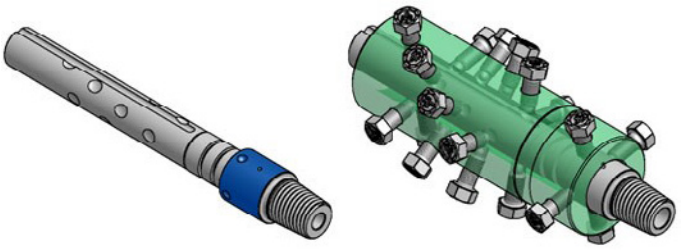
Coil Connector – External

Tartan's External Coil Connector provides a means of connecting coiled tubing to the BHA by attaching to the outside diameter (OD) of coiled tubing. Tartan's design incorporates multiple slips with dimpling screws to set the connector.

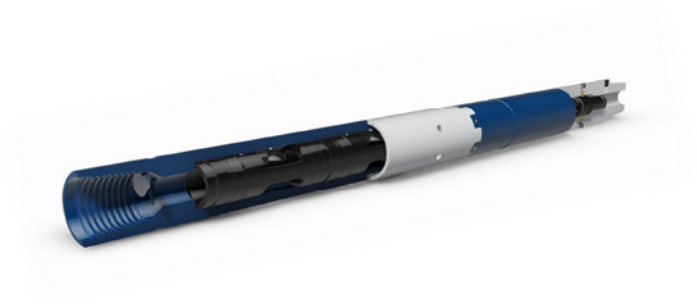


Coil Connector – Internal

Tartan's Internal Coil Connector provides a means of connecting coiled tubing to the BHA by attaching to the inside diameter (ID) of coiled tubing. The connector is secured by multiple dimples. This tool is especially common on smaller OD drilling BHAs. The connector assembly ensures a positive connection to the coiled tubing.



Motor Head Assembly



APPLICATIONS

- ✓ Operates as a Hydraulic Disconnect
- ✓ Cleans the wellbore after drilling operations are completed

OVERVIEW

Tartan's patented motor head assembly (MHA) is designed and constructed to provide the convenience of a single motor head tool for connecting to coiled tubing or jointed pipe. The MHA comes complete with a dual float sub, hydraulic disconnect and circulation sub.

The Tartan hydraulic disconnect is designed to release tubing from the tools below it via a steel ball, which is pumped or dropped to the internal seat. Hydraulic pressure is then applied to shear the shear pins and push a piston down to release the lock.

FEATURES AND BENEFITS

- Prevents back flow of fluid or gas into the tubing
- Allows the tool string to detach from the tubing via a drop ball
- Withstands harmonics of drilling with nitrogen (N_2) or air
- Allows fluid communication with the annulus

SPECIFICATIONS

		Sheer Pressure		Disconnect Pressure	
Outside Diameter (OD) in. (mm)	**Tensile Strength** lb (kg)	**No Ball** psi (MPa)	**Ball** psi (MPa)	**Sheer** psi (MPa)	**With Circ. Sub** psi (MPa)
1.6875 (42.863)	**33,860 (15, 359)**	**5,200 (35.85)**	**2,500 (17.23)**	**3,800 (26.20)**	**2,500 (17.23)**
2.125 (53.975)	**60,000 (27,216)**	**5,200 (35.85)**	**1,600 (11.03)**	**3,000 (20.68)**	**1,600 (11.03)**
2.875 (73.025)	**103,104 (46,767)**	**6,600 (45.50)**	**2,800 (19.31)**	**2,700 (18.61)**	**2,800 (19.31)**

Rotating Scraper

APPLICATIONS

- ✓ Clean casing ID to specifications while drilling out obstructions

OVERVIEW

Tartan's patented Rotating Scraper (RS) cleans the casing wall inside diameter (ID) while drilling out obstructions using Tartan's downhole motors. The RS is connected directly to the bit box with a mill/bit installed at the opposite end.

Incorporating the Rotating Scraper with the downhole motor saves an additional tubing run, since casing wall cleaning is accomplished while drilling.

FEATURES AND BENEFITS

- One run accomplishes casing cleaning and drilling out obstructions
- Thoroughly cleans casing wall due to rotation
- Reduces rig time by eliminating a separate cleaning run
- Decreases operational costs
- Nine adjustable floating blades for multiple casing weights/IDs
- Improves completions drilling efficiency
- Operational in a push/pull scenario

SPECIFICATIONS

Outside Diameter (OD) in. (mm)	Length in. (cm)	Min. Casing ID in. (mm)	Max. Casing ID in. (mm)
3.750 (95.25)	30.750 (78.105)	3.158 (80.21)	3.898 (99.01)
4.500 (114.30)	30.750 (78.105)	3.490 (88.65)	4.191 (106.45)
5.000 (127.00)	30.750 (78.105)	4.000 (101.60)	4.756 (120.80)
5.500 (139.70)	34.000 (86.360)	4.534 (115.16)	5.474 (139.04)
7.000 (177.80)	30.000 (76.200)	5.943 (150.95)	6.644 (168.76)

Venturi Basket

APPLICATIONS

- ✓ Cleans wellbore of junk and debris
- ✓ Retains debris from falling back into wellbore
- ✓ Catches large sized debris that is difficult to circulate out

OVERVIEW

Tartan's Venturi Junk Basket is designed to remove debris from the wellbore. Fluid is pumped down the tool string and out through nozzles, creating a vacuum within the tool. Wellbore debris is then sucked into the tool and remains trapped between the filter screen and catchers.

The tool nozzles are adjustable and easily changed to alter the flow rate and pressure to suit individual applications. The Venturi Junk Basket can be run with a motor and washover shoe for specific operations where rotation is required.

FEATURES AND BENEFITS

- One run accomplishes debris cleaning
- Reduces rig time by eliminating a separate cleaning run
- Debris chamber may be enlarged by adding debris chambers
- Optional internal magnet to collect metallic debris
- Tool may be used with a mud motor
- Decreases operational costs
- Improves completions drilling efficiency

SPECIFICATIONS

Outside Diameter (OD) in. (mm)	**Length** in. (cm)	**Number of Nozzles**
2.125 (53.975)	**34.25 (87)**	**1**
2.875 (73.000)	**36.6875 (93.18)**	**3**
3.125 (79.375)	**41.875 (106.36)**	**3**

Nozzle Inside Diameter (ID) Sizes

in.	**0.062**	**0.078**	**0.094**	**0.109**	**0.125**	**0.140**	**0.156**	**0.171**	**0.187**
mm	**1.575**	**1.981**	**2.388**	**2.769**	**3.175**	**3.556**	**3.962**	**4.343**	**4.750**

Anti-Rotation Device (ARD) and Circulating Head

APPLICATIONS

- ✓ Controls reactive torque when completions drilling with service and workover rigs

OVERVIEW

Tartan's patented Anti-Rotation Device (ARD) controls and releases reactive torque generated from the use of downhole drilling motors. The ARD mechanically removes the reactive torque from the tool string at the rig floor.

To increase worker safety, Tartan has designed the ARD so that it does not have any external moving parts exposed to the service rig personnel. The ARD also acts as the circulating head with flow passages and screens, which allows fluid to be circulated to operate the motor.

FEATURES AND BENEFITS

- Mechanically removes reactive torque at surface
- No external moving parts
- Extremely safe for rig personnel
- Very reliable in all working conditions
- Includes a circulating head for fluid delivery
- Equipped with flow passages and screen
- Provides costs savings
  - No power swivel is required
  - Short rig up/down time – 20 min vs. 60+ min
  - No minimum rental charges
  - No casing damage by rotating tubing
  - Improved efficiency
  - No collars required
- Minimizes pinch points
- No connection over-torque issue

SPECIFICATIONS

Size in. (mm)	**Tubing Outside Diameter (OD)** in. (mm)	**Connection API EUE** in. (mm)	**Pressure Test** psi (MPa)	**Load Test** ton (tonne)
2.875 (73.025)	**2.375 (60.325)** **2.875 (73.025)**	**2.875 (73.025)**	**6,000 (41.37)**	**75 (68.039)**
3.500 (88.900)	**2.875 (73.025)** **3.500 (88.900)**	**3.500 (88.900)**	**6,000 (41.37)**	**100 (90.718)**

**Premium threads available.*

Pulse Generator and Intensifier

APPLICATIONS

- ✓ Extended reach horizontal completions drill outs
- ✓ Deviated wellbores
- ✓ Where weight on bit (WOB) is difficult to attain

OVERVIEW

Tartan's patented Pulse Generator (PG) is designed to vibrate the downhole motor bottom hole assembly (BHA) to decrease tubular friction (wall contact forces), which improves rate of penetration (ROP) through better transfer of weight to the bit, and increases the reach in horizontal and deviated wells using coiled tubing or jointed pipe.

Tartan's Intensifier tool is designed to operate in conjunction with the Pulse Generator. The Intensifier creates addition axial and lateral forces to help facilitate improved reach in horizontal and deviated wellbores.

SPECIFICATIONS

PG and Intensifier Outside Diameter (OD) in. (mm)	**Length** in. (cm)	**Tubing OD** in. (mm)
2.875 (73.025)	**51.3 (130.2)**	**1.750 (44.450)** **2.000 (50.800)** **2.375 (60.325)** **2.875 (73.025)**

FEATURES AND BENEFITS

- Generates vibration both axially and laterally
- Enables true WOB readings at surface
- Eliminates or significantly reduces the use of costly friction reducers
- Increases ROP with improved transfer of weight to the bit
- Increases reach of BHA in deviated and horizontal wells
- Vibration frequency and amplitude are adjustable
- Improves completions drilling efficiency
- Attaches directly to the top of the downhole motor
- Decreases operational costs
- No shock sub required on jointed pipe

Dynamometer

OVERVIEW

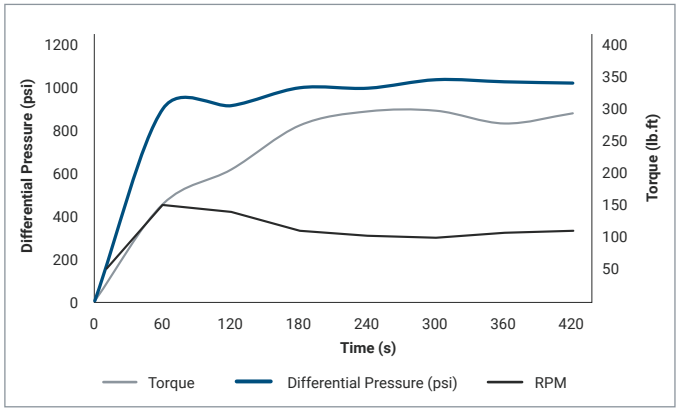
Tartan's Dynamometers provide verification of our downhole drilling motor performance prior to running in hole. Tartan tests every motor after each job to ensure the motor meets operational specifications. Each test includes the relationship between flow rate, differential pressure, speed and torque.

FEATURES AND BENEFITS

- Confirms operation of motors within specific operating ranges including inputs/outputs prior to every job
- With the addition of surface testing, provides a reliable confirmation of motor operation
- Provides confidence that the drilling motor will operate within specifications
- Provides time and costs savings by:
  - Reducing failure opportunities
  - Increasing rate of penetration (ROP)
  - Reducing lost time

APPLICATIONS

- ✓ Testing drilling motor operation within specifications
- ✓ Motor sizes from 1-11/16 in. (43 mm) to 6-1/2 in. (165 mm) outside diameter (OD)
- ✓ Measurement of flow rates, differential pressure, speed and torque

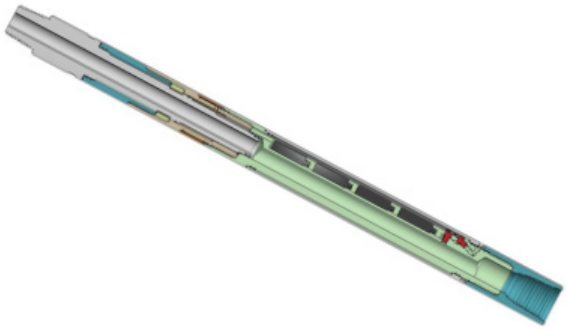


Rotating Brush

Tartan designed the Rotating Brush to run in tandem with Tartan drilling motors. The rotating brush removes residual cement after cementing operations.

Data Logger with Memory

Tartan's Data Logger assembly provides the ability to capture and record several downhole parameters when drilling with Tartan positive displacement motors. The Tartan Data Logger measures axial forces, torque and pressures, both internal and external to the BHA. This data provides important surface information to understand downhole conditions and offers a means of improving rate of penetration (ROP) if required.



SECTION 3 – Drilling Motor Applications

The requirement for motors to be offered in many different design configurations has been driven by the drilling motor's ability to perform well in many applications. Typical drilling motor applications are described in the following section.

Composite Bridge Plug Drilling – Sacrificial Motor

Tartan Energy Group has completed numerous multi-zone drilling projects to date using jointed pipe or coiled tubing. On many of these projects, Tartan has released and abandoned the BHA (MHA or separation sub with dual floats, crossover, motor, bit-end float sub and drill mill) downhole, so snubbing out of the hole is not required. Many different procedures are employed by energy companies for multi-zone drilling.

Typical BHA

1. MHA or separation sub equipped with dual floats
2. Crossover to motor connection
3. Positive displacement motor (sizes 2 ⅛-in. to 4 ¾-in.)
4. Bit end float sub
5. Drill mill / Bit

Benefits

1. Using Tartan's patented Anti-Rotation Device (ARD) increases safety by controlling reactive torque mechanically at surface. The Tartan ARD is the only mechanically locking tool in the oil and gas industry. Unlike hydraulic locking tools, mechanically operated locking tools are not adversely affected by cold weather applications.
2. By turning the mill/bit with a motor, no rotating equipment is used at surface.
3. The BHA can be deployed downhole with either coiled tubing units, service rigs or stand-alone snubbing units.
4. Little torque is transferred through the work string (production string) when using motors, especially in deviated and deep wells.
5. Cost savings can be significant especially since there is no need to snub the BHA out of the hole, and the production string back in the hole when drilling multiple composite bridge plugs.
6. Tartan can supply high temperature, high torque motors for specialty applications.

Comingled Nitrogen (N_2) / Air / Fluids

Downhole drilling motors were initially designed to be used with standard drilling fluids. The fluid acts as a hydraulic power source, and provides heat dissipation and lubrication. When air, N_2 and foams are introduced, drilling motors are limited in their original performance designs.

Because N_2 and air are compressible media, the performance of the motor is considerably affected in the following ways:

- Torque is reduced
- Motor will run at higher RPM
- Weight on bit capability is reduced
- Stall conditions happen at a lower weight on bit
- Higher pressures are required to operate motor
- Motor temperature will drastically increase with little or no lubrication

Life of the power section stator is reduced by the presence of N_2. The elastomer of the stator initially absorbs the N_2 causing no damage when the motor is operating downhole. As the motor is brought to surface, the N_2 expands causing the stator to tear. This is known as explosive decompression, which cannot be controlled.

Vibration through the BHA is increased largely from the compressible gases causing compression and expansion waves when exiting the power section. The pressure drop across the power section is also reduced, causing less horsepower output of the motor.

Misting occurs when the liquid fraction is less than 2.5% of overall media rate. The liquid forms as droplets within the gas or air being used downhole. Foam is generated between 2.5% and 25% liquid fraction of overall media rate. Foam quality is given as a fraction of the gas; so, a 70% foam quality is equal to 70% gas and 30% fluid.

Failure of the stator elastomer is accelerated by the internal heat generated by reduced lubrication. As the stator heats it expands causing the interference fit between the stator and rotor to increase. Hard spots on the stator then occur, causing the stator to fail prematurely.

Frac Seat / Ball Drilling

Open-hole packer systems that allow multiple fracturing locations without tripping have proven themselves within the oil and gas industry. Since their introduction, Tartan has been at the forefront in their ability, both in experience and proven tools, to successfully drill out frac balls and/or frac seats. Extended reach horizontal wells increase the difficulty of reaching the farthest frac seat to drill out. Some of the situations that may occur are:

- No weight on the bit indication at surface
- Lost circulation to wellbore
- Potential of BHA getting stuck with sand accumulation in horizontal
- Inadequate cutting removal
- Whether drilling the frac seats or frac balls, jointed pipe or coiled tubing can be used in this drilling application.

Fluids Compatibility

Many types of fluids and mud compositions are used to power drilling motors. Water- and oil-based systems both pose problems with regards to corrosion cracking, chrome pitting and elastomer failures.

The interaction between the stator elastomer and drilling fluid can lead to swelling and changes to the physical properties of the motor. Swelling will cause the interference fit to increase resulting in heat build-up. In turn, this generated heat will cause the stator to "chunk" and fail.

One key measurement that can be used to predict elastomer swell is the aniline point of the oil-based fluid. The main rules of thumb are:

- Fluids with an aniline point higher than the bottom hole circulating temperature will ***minimize*** the amount of swelling in the stator rubber.
- Fluids with an aniline point lower than the bottom hole circulating temperature will result in ***greater*** amounts of stator swell.

While aniline point is a useful measure, some oil-based drilling fluids can cause damage even with a high aniline point.

Drilling Fluid Additives

Some amine-based additives, such as corrosion inhibitors and emulsifiers can cause damage to the drilling motor. It is recommended that amine-based additives are not used.

Fresh Water

Fresh water offers little issues and is most frequently used in coiled tubing and service rig drilling operations.

Brine

Brine is heavily saturated salt water commonly used for additional weighting and flow control. Brine can be mildly corrosive due to the salt content but is generally rated acceptable at all temperatures.

Diesel

Diesel is a common medium when used in a lower temperature environment. However, as temperatures increase, this fluid can seriously impact the stator elastomer. Bottom hole temperatures must be below 80°C (176°F) for diesel operations.

Lost Circulating Material (LCM)

Care must be taken when introducing LCM into the motor. LCM can lead to plugging of the motor if they are not sized properly. Generally speaking, as long as the LCM fluid can be pumped by a centrifugal pump, no issues should occur to cause motor problems.

Frac Oils

Frac oils contain many hydrocarbon ingredients that cause severe damage to the elastomers of drilling motor stators; therefore, the use of frac oils when drilling is not recommended. Frac oils can be used after drilling operations when a tubing drain is installed above the motor. Isolation of the motor can take place after a steel ball is dropped to shift a piston down within the diversion sub.

Methanol

Methanol and nitrile rubber have similar solubility parameters and when immersed together, swelling and softening of the elastomer will occur. When the nitrile rubber is immersed in a fluid that is polar, the fluids' atoms are attracted to the polar atoms of the nitrile and slip into the space between the rubbers' molecular chains. Today's rubber compounds are acrylonitrile (ACN) polymers which dictate at what rate the methanol is absorbed. Care must be taken to ensure stator failure is avoided.

Chlorides

Chloride content of the mud system is an important factor in determining the life of the rotor. Chrome coated rotors are generally acceptable up to 30,000 ppm (mg/l). Beyond that limit, the chrome will deteriorate and cause the rotor to fail. Stator failure is usually seen in these cases caused by the pieces of chrome cutting the elastomer of the stator. Generally in these situations, a carbide coated rotor will provide a greater resistance than chrome.

Carbon Dioxide (CO_2)

The nitrile rubber in the stator will absorb CO_2 resulting in elastomer swelling and loss of mechanical properties. This is typical of any gas when under pressure in the drilling medium. If pressure is reduced slowly, the CO_2 will diffuse out of the nitrile rubber and return to its original dimensions and mechanical properties. If pressure is released too quickly, explosive decompression will occur causing the nitrile rubber to blister, split and possibly rupture.

Sand Content

High sand content in the fluid system will lead to premature failure due to abrasive wear on the stator and motor components. The abrasiveness of sand is dependent on the grain form, size and sharpness. API sand content up to 1% is acceptable. With a sand content higher than 1%, reduced motor life can be expected. Scale and other abrasive particles must be avoided due to their highly damaging effects on motors.

High Flow Rate

Most drilling motor applications require that a certain annular velocity be maintained in order to facilitate sufficient cutting removal. Tartan operates several different power section configurations to accomplish this. Tartan also uses a gun barrel style of rotor. This allows a predetermined amount of fluid to enter the power section while the remaining fluid flows through the rotor. This style of power section is very useful when drilling in a liner that is much smaller than the casing above. Care must be taken to ensure that the service or coil rigs have a large enough pump to operate the motor and provide additional fluid rates required in these instances.

High Temperature

Most drilling motor applications have downhole temperatures less than 120°C (248°F). Tartan standard elastomer stators are designed to operate up to this temperature. Our high performance motors operate up to 150°C (302°F) and, in certain situations, even higher temperatures can be reached. To protect motors from temperature failure, refer to the following:

- Operate power section at below maximum rated pressures
- Do not introduce over-speed conditions
- Use a rotor/stator with a correct interference fit
- Know the downhole temperatures
- Keep cyclic loading to a minimum
- Choose the correct amount and type of lubrication
- Correct elastomer compound selection is required
- Circulate fluids through motor whenever possible
- Do no “park” motor downhole in higher temperature locations for an extended period of time

SECTION 4 – Drilling Motor Specifications

Tartan offers a range of motors customized to various speeds, sizes and torques to meet the industry's wide range of needs in coiled tubing, service rigs and directional applications.

In addition to engineering motors to handle all types of drilling applications, Tartan designs, builds and stocks all types of drilling accessories for virtually any rig operation.

To see more details about a particular motor please refer to the part number data sheet.

P/N	OD (in.)	Lobe	Stage	Overall Length (in.)	Flow (gpm)	Speed (RPM)	Torque (lbf.ft)	Connection Top Box	Connection Bottom Box
1695644	1.690	5/6	4.4	116	25-45	50-500	50-160	1 1/4 MT	1 AW ROD
2135650	2.125	5/6	5.0	123	20-50	110-378	150-325	1 1/2 MT	1 1/2 MT
2135660	2.125	5/6	6.0	125	20-50	80-600	150-412	1 1/2 MT	1 1/2 MT
2875633	2.875	5/6	3.3	114	50-125	167-530	750-1147	2 3/8 PAC	2 3/8 PAC
2875635	2.875	5/6	3.5	145	60-120	150-400	400-810	2 3/8 PAC	2 3/8 PAC
2875647	2.875	5/6	4.7	147	50-147	176-519	400-890	2 3/8 PAC	2 3/8 PAC
2875670	2.875	5/6	7.0	150	30-90	110-520	200-800	2 3/8 PAC	2 3/8 PAC
2877830	2.875	7/8	3.0	130	50-100	40-250	175-450	2 3/8 PAC	2 3/8 PAC
2877836	2.875	7/8	3.6	147	50-120	152-364	400-890	2 3/8 PAC	2 3/8 PAC
3137825	3.125	7/8	2.5	169	110-210	110-240	1000-1960	2 3/8 REG	2 3/8 REG
3137830	3.125	7/8	3.0	163	40-190	110-240	300-660	2 3/8 REG	2 3/8 REG
3137840	3.125	7/8	4.0	133	40-120	80-440	200-440	2 3/8 REG	2 3/8 REG
3504550	3.500	4/5	5.0	179	30-110	50-340	100-590	2 3/8 IF	2 7/8 REG
3507830	3.500	7/8	3.0	175	30-110	25-152	150-760	2 3/8 IF	2 7/8 REG
3754522	3.750	4/5	2.2	161	80-180	110-275	400-1020	2 3/8 IF	2 7/8 REG
3754535	3.750	4/5	3.5	175	100-160	110-230	250-760	2 3/8 IF	2 7/8 REG
4754535	4.750	4/5	3.5	188	100-275	75-275	400-1160	3 1/2 IF	3 1/2 REG
4754560	4.750	4/5	6.0	259	100-275	75-275	800-2100	3 1/2 IF	3 1/2 REG
4757830	4.750	7/8	3.0	192	100-275	45-165	600-1750	3 1/2 IF	3 1/2 REG
4757829	4.750	7/8	2.9	297	150-250	32-69	2000-6214	3 1/2 IF	3 1/2 REG
4757838	4.750	7/8	3.8	259	150-250	78-130	2000-4450	3 1/2 IF	3 1/2 REG
6507829	6.500	7/8	2.9	336	350-600	45-95	4000-8000	4 1/2 XF	4 1/2 REG
6507850	6.500	7/8	5.0	305	300-600	80-160	3000-6750	4 1/2 XF	4 1/2 REG

Drilling Motor – Standard Series

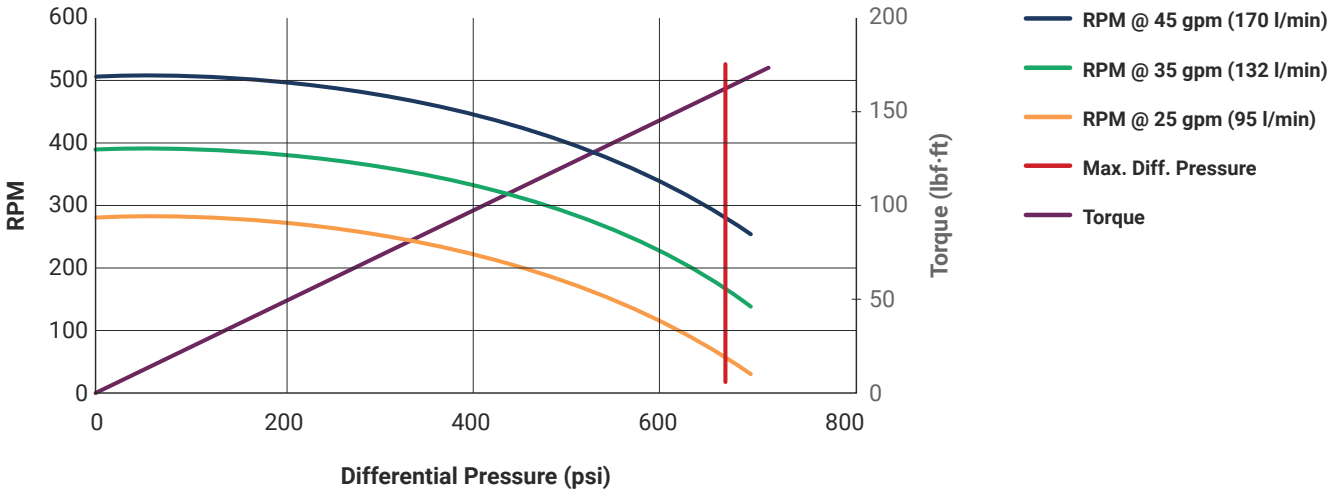
1-11/16 in. OD 5/6 4.4

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**1.6875 (43)**
Power Section Configuration	**5/6 lobe 4.4 stage**
Overall Length in. (cm)	**116 (296)**
Connection – Top Box	**1 1/4 MT**
Connection – Bottom Box	**1 AW ROD**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**25 - 45 (95 -170)**
Speed Range RPM	**50 - 500**
Displacement rev/gal (rev/l)	**9.38 (2.48)**
Torque – Max. Operating lbf·ft (Nm)	**160 (217)**
Torque – Max. Stall lbf·ft (Nm)	**352 (477)**
Differential Pressure – Max. Operating psi (MPa)	**675 (4.7)**
Temperature – Max.* °F (°C)	**248 (120)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – Standard Series

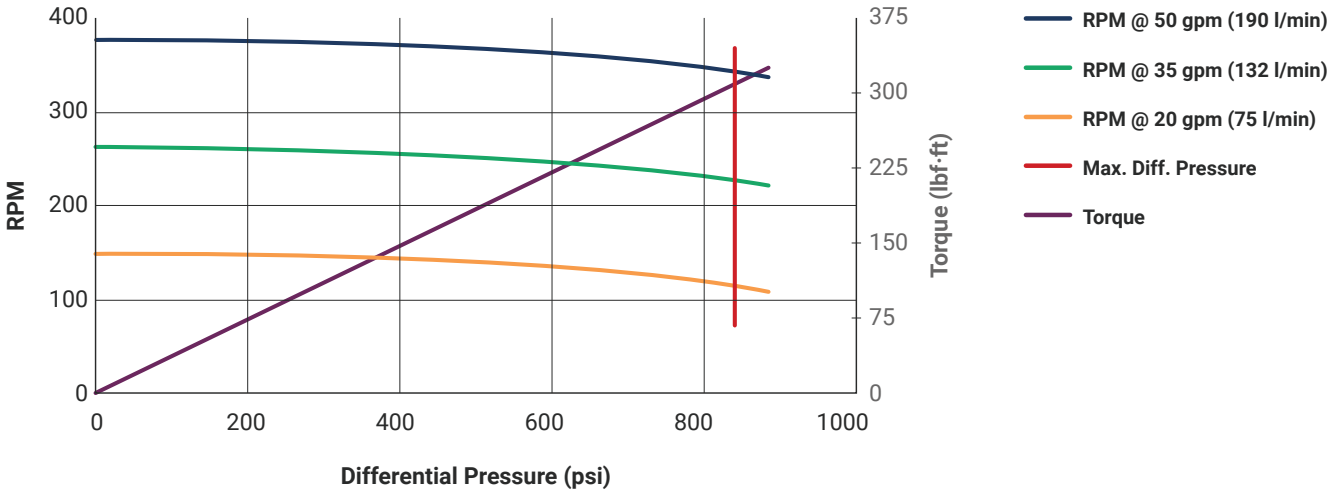
2-⅛ in. OD 5/6 5.0

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**2.125 (54)**
Power Section Configuration	**5/6 lobe 5.0 stage**
Overall Length in. (cm)	**123 (313)**
Connection – Top Box	**1 1/2 MT**
Connection – Bottom Box	**1 1/2 MT**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**20 - 50 (76 - 189)**
Speed Range RPM	**110 - 378**
Displacement rev/gal (rev/l)	**7.61 (2.01)**
Torque – Max. Operating lbf·ft (Nm)	**325 (441)**
Torque – Max. Stall lbf·ft (Nm)	**715 (969)**
Differential Pressure – Max. Operating psi (MPa)	**850 (5.9)**
Temperature – Max.* °F (°C)	**248 (120)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – High Performance Series

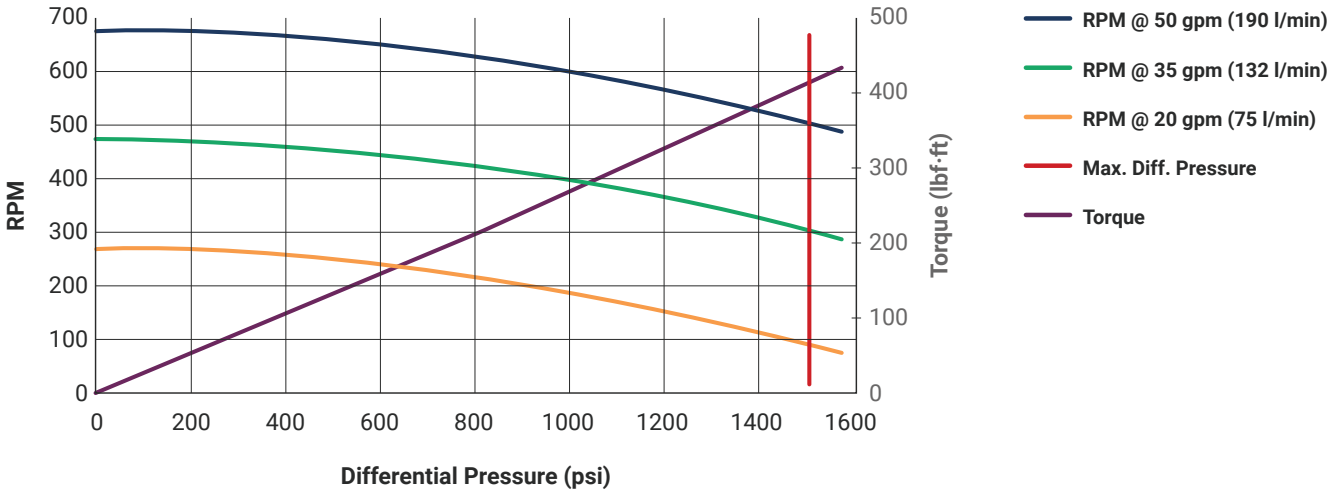
2-⅛ in. OD 5/6 6.0

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**2.125 (54)**
Power Section Configuration	**5/6 lobe 6.0 stage**
Overall Length in. (cm)	**125 (318)**
Connection – Top Box	**1 1/2 MT**
Connection – Bottom Box	**1 1/2 MT**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**20 - 50 (76 - 189)**
Speed Range RPM	**80 - 600**
Displacement rev/gal (rev/l)	**13.6 (3.60)**
Torque – Max. Operating lbf·ft (Nm)	**412 (559)**
Torque – Max. Stall lbf·ft (Nm)	**906 (1228)**
Differential Pressure – Max. Operating psi (MPa)	**1500 (10.3)**
Temperature – Max.* °F (°C)	**302 (150)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – High Performance Series

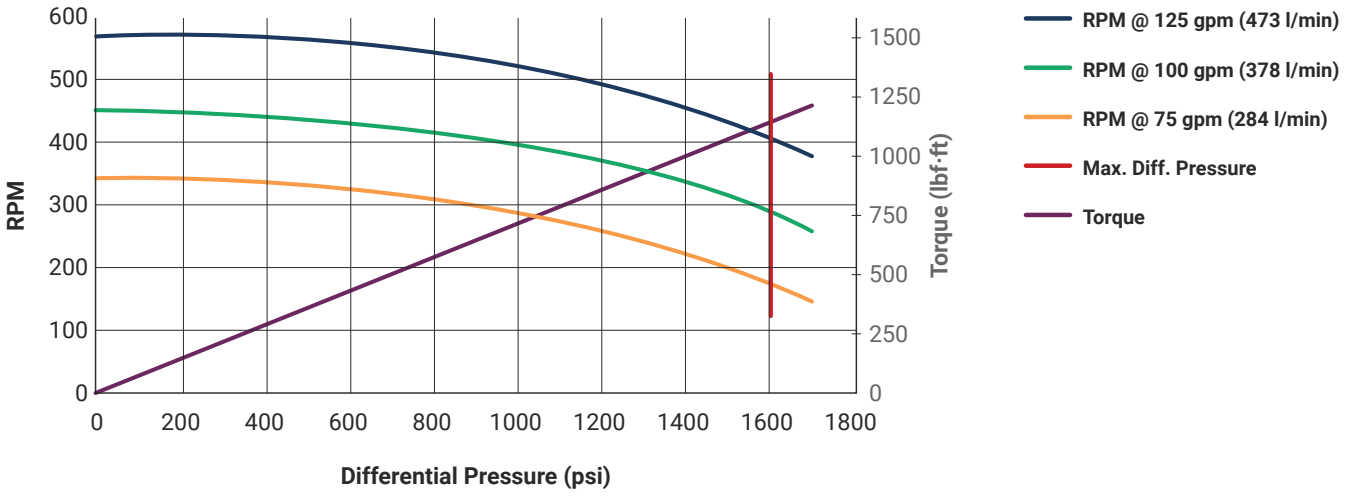
2-7/8 in. OD 5/6 3.3

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**2.875 (73)**
Power Section Configuration	**5/6 lobe 3.3 stage**
Overall Length in. (cm)	**114 (289)**
Connection – Top Box	**2 3/8 PAC**
Connection – Bottom Box	**2 3/8 PAC**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**50 - 125 (189 - 473)**
Speed Range RPM	**167 - 530**
Displacement rev/gal (rev/l)	**4.52 (1.19)**
Torque – Max. Operating lbf·ft (Nm)	**1147 (1555)**
Torque – Max. Stall lbf·ft (Nm)	**1793 (2431)**
Differential Pressure – Max. Operating psi (MPa)	**1600 (11.0)**
Temperature – Max.* °F (°C)	**302 (150)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – High Performance Series

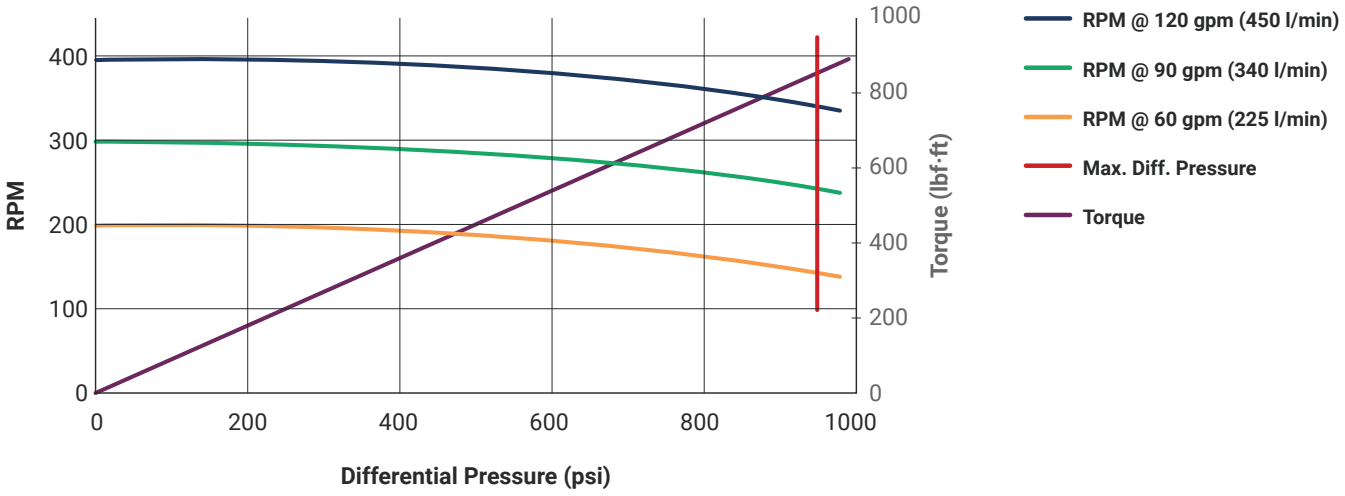
2-⅞ in. OD 5/6 3.5

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**2.875 (73)**
Power Section Configuration	**5/6 lobe 3.5 stage**
Overall Length in. (cm)	**145 (368)**
Connection – Top Box	**2 3/8 PAC**
Connection – Bottom Box	**2 3/8 PAC**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**60 - 120 (227 - 454)**
Speed Range RPM	**150 - 400**
Displacement rev/gal (rev/l)	**3.19 (0.84)**
Torque – Max. Operating lbf·ft (Nm)	**810 (1098)**
Torque – Max. Stall lbf·ft (Nm)	**1782 (2416)**
Differential Pressure – Max. Operating psi (MPa)	**950 (6.6)**
Temperature – Max.* °F (°C)	**302 (150)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – High Performance Series

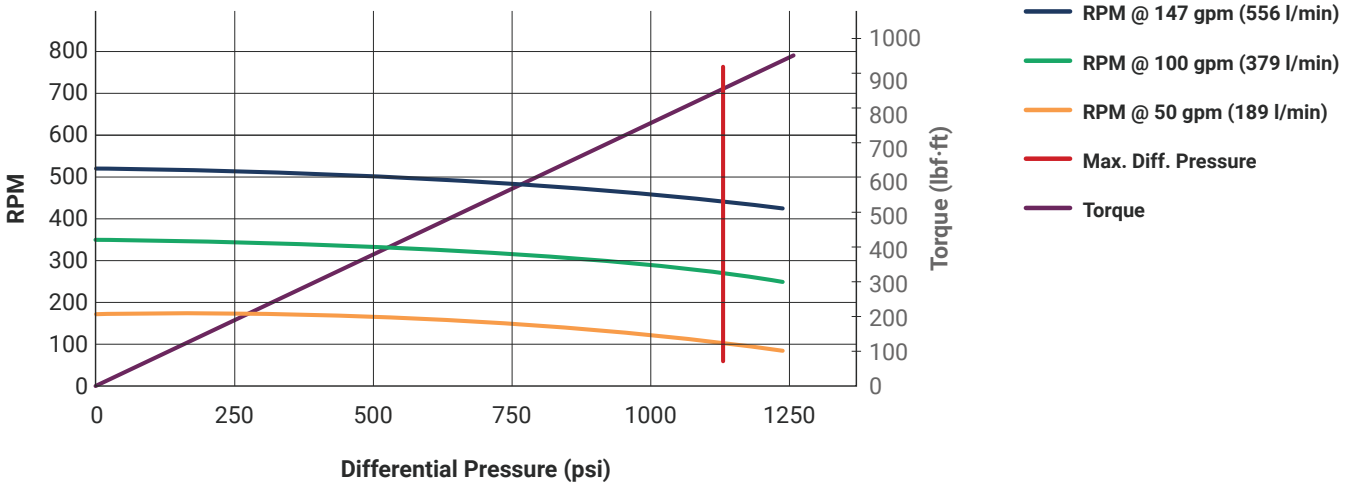
2-7/8 in. OD 5/6 4.7

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**2.875 (73)**
Power Section Configuration	**5/6 lobe 4.7 stage**
Overall Length in. (cm)	**147 (374)**
Connection – Top Box	**2 3/8 PAC**
Connection – Bottom Box	**2 3/8 PAC**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**50 - 147 (189 - 556)**
Speed Range RPM	**176 - 519**
Displacement rev/gal (rev/l)	**3.76 (1.00)**
Torque – Max. Operating lbf·ft (Nm)	**890 (1207)**
Torque – Max. Stall lbf·ft (Nm)	**1710 (2318)**
Differential Pressure – Max. Operating psi (MPa)	**1140 (7.9)**
Temperature – Max.* °F (°C)	**302 (150)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – High Performance Series

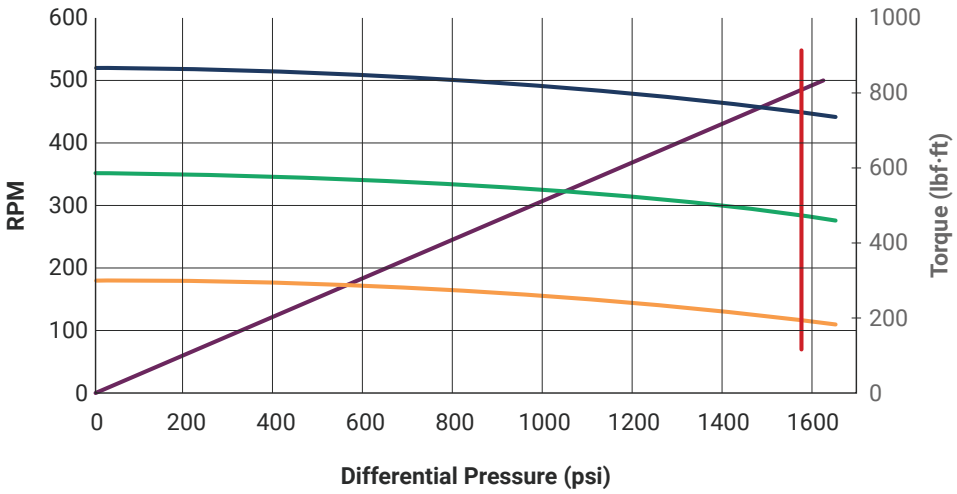
2-7/8 in. OD 5/6 7.0

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**2.875 (73)**
Power Section Configuration	**5/6 lobe 7.0 stage**
Overall Length in. (cm)	**150 (381)**
Connection – Top Box	**2 3/8 PAC**
Connection – Bottom Box	**2 3/8 REG**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**30 - 90 (114 - 341)**
Speed Range RPM	**110 - 520**
Displacement rev/gal (rev/l)	**5.74 (1.52)**
Torque – Max. Operating lbf·ft (Nm)	**800 (1085)**
Torque – Max. Stall lbf·ft (Nm)	**1760 (2386)**
Differential Pressure – Max. Operating psi (MPa)	**1580 (10.9)**
Temperature – Max.* °F (°C)	**302 (150)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – Standard Series

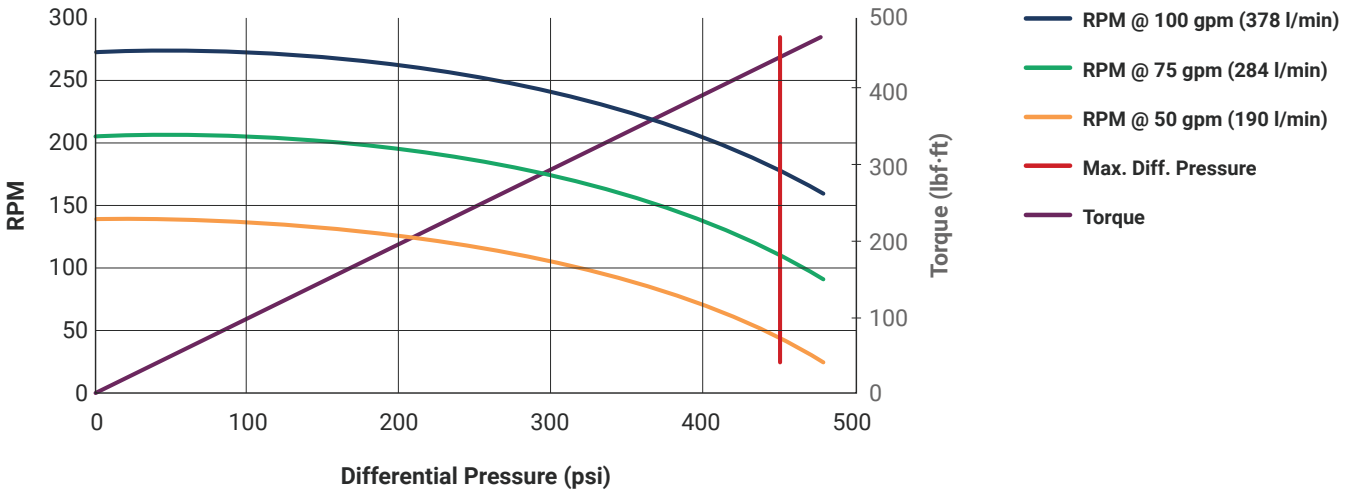
2-7/8 in. OD 7/8 3.0

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**2.875 (73)**
Power Section Configuration	**7/8 lobe 3.0 stage**
Overall Length in. (cm)	**130 (330)**
Connection – Top Box	**2 3/8 PAC**
Connection – Bottom Box	**2 3/8 PAC**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**50 - 100 (189 - 379)**
Speed Range RPM	**40 - 250**
Displacement rev/gal (rev/l)	**2.70 (0.71)**
Torque – Max. Operating lbf·ft (Nm)	**450 (610)**
Torque – Max. Stall lbf·ft (Nm)	**990 (1342)**
Differential Pressure – Max. Operating psi (MPa)	**450 (3.1)**
Temperature – Max.* °F (°C)	**248 (120)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – High Performance Series

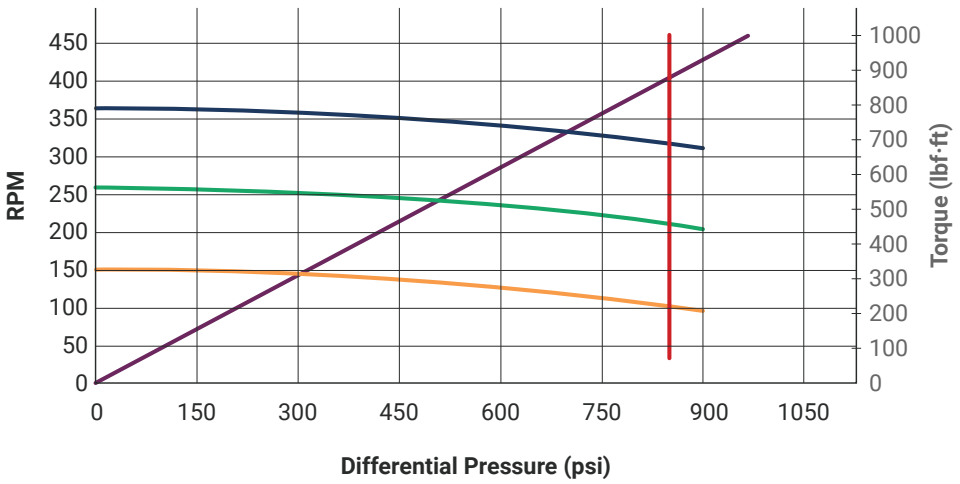
2-7/8 in. OD 7/8 3.6

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**2.875 (73)**
Power Section Configuration	**7/8 lobe 3.6 stage**
Overall Length in. (cm)	**147 (374)**
Connection – Top Box	**2 3/8 PAC**
Connection – Bottom Box	**2 3/8 PAC**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**50 - 120 (189 - 454)**
Speed Range RPM	**152 - 364**
Displacement rev/gal (rev/l)	**3.04 (0.80)**
Torque – Max. Operating lbf·ft (Nm)	**890 (1207)**
Torque – Max. Stall lbf·ft (Nm)	**1110 (1505)**
Differential Pressure – Max. Operating psi (MPa)	**850 (5.9)**
Temperature – Max.* °F (°C)	**302 (150)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – High Performance Series

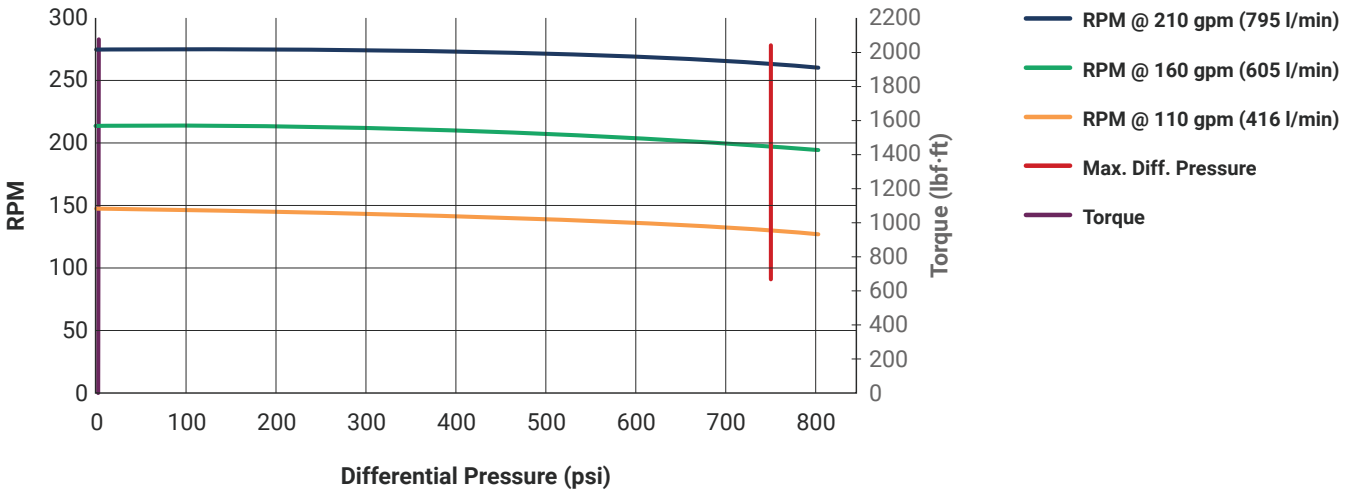
3-⅛ in. OD 7/8 2.5

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**3.125 (79.3)**
Power Section Configuration	**7/8 lobe 2.5 stage**
Overall Length in. (cm)	**169 (430)**
Connection – Top Box	**2 3/8 REG**
Connection – Bottom Box	**2 3/8 REG**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**110 - 210 (416 - 795)**
Speed Range RPM	**110 - 240**
Displacement rev/gal (rev/l)	**1.34 (0.35)**
Torque – Max. Operating lbf·ft (Nm)	**1960 (2657)**
Torque – Max. Stall lbf·ft (Nm)	**3528 (4783)**
Differential Pressure – Max. Operating psi (MPa)	**750 (5.2)**
Temperature – Max.* °F (°C)	**302 (150)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – Standard Series

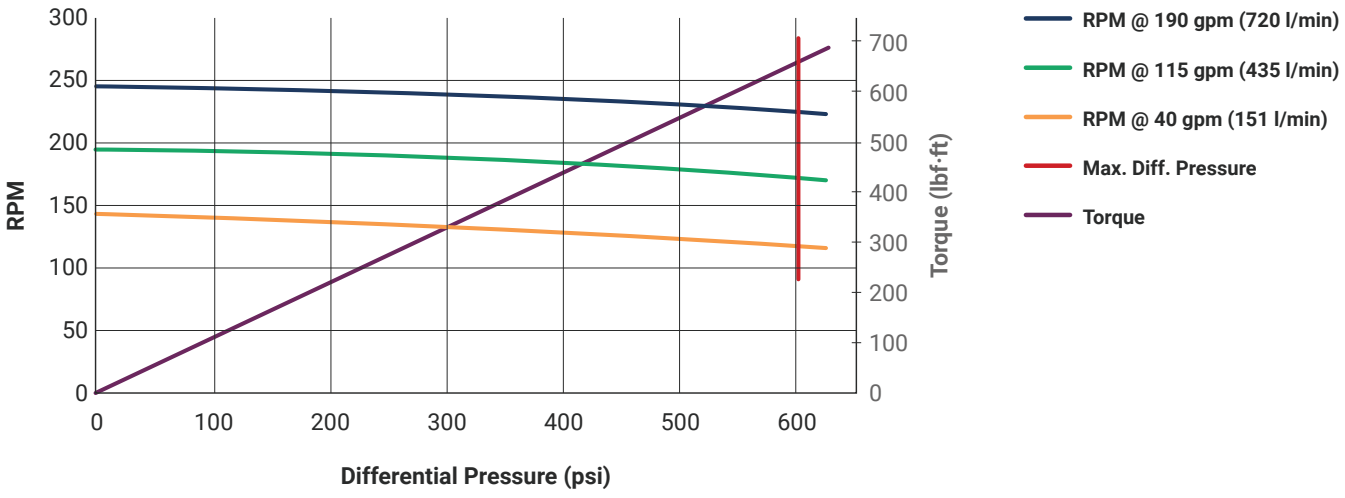
3-⅛ in. OD 7/8 3.0

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**3.125 (79.3)**
Power Section Configuration	**7/8 lobe 3.0 stage**
Overall Length in. (cm)	**163 (414)**
Connection – Top Box	**2 3/8 REG**
Connection – Bottom Box	**2 3/8 REG**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**40 - 190 (151 - 719)**
Speed Range RPM	**110 - 240**
Displacement rev/gal (rev/l)	**1.29 (0.34)**
Torque – Max. Operating lbf·ft (Nm)	**660 (895)**
Torque – Max. Stall lbf·ft (Nm)	**1452 (1969)**
Differential Pressure – Max. Operating psi (MPa)	**600 (4.1)**
Temperature – Max.* °F (°C)	**248 (120)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – Standard Series

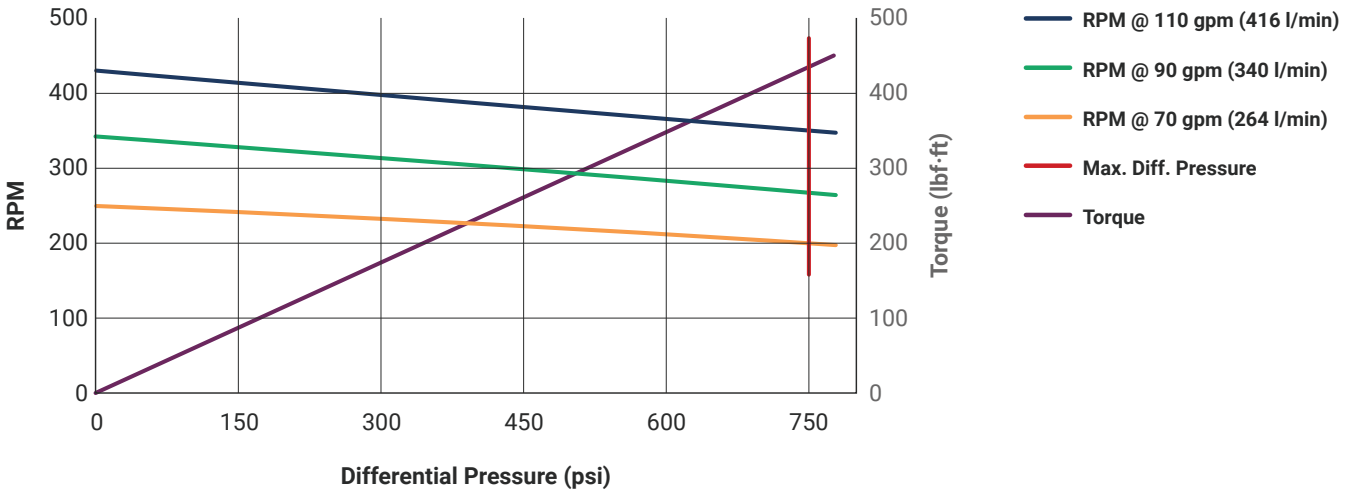
3-⅛ in. OD 7/8 4.0

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**3.125 (79.3)**
Power Section Configuration	**7/8 lobe 4.0 stage**
Overall Length in. (cm)	**133 (340)**
Connection – Top Box	**2 3/8 REG**
Connection – Bottom Box	**2 3/8 REG**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**40 - 120 (151 - 454)**
Speed Range RPM	**80 - 440**
Displacement rev/gal (rev/l)	**3.66 (0.97)**
Torque – Max. Operating lbf·ft (Nm)	**440 (397)**
Torque – Max. Stall lbf·ft (Nm)	**968 (1312)**
Differential Pressure – Max. Operating psi (MPa)	**750 (5.2)**
Temperature – Max.* °F (°C)	**248 (120)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – Standard Series

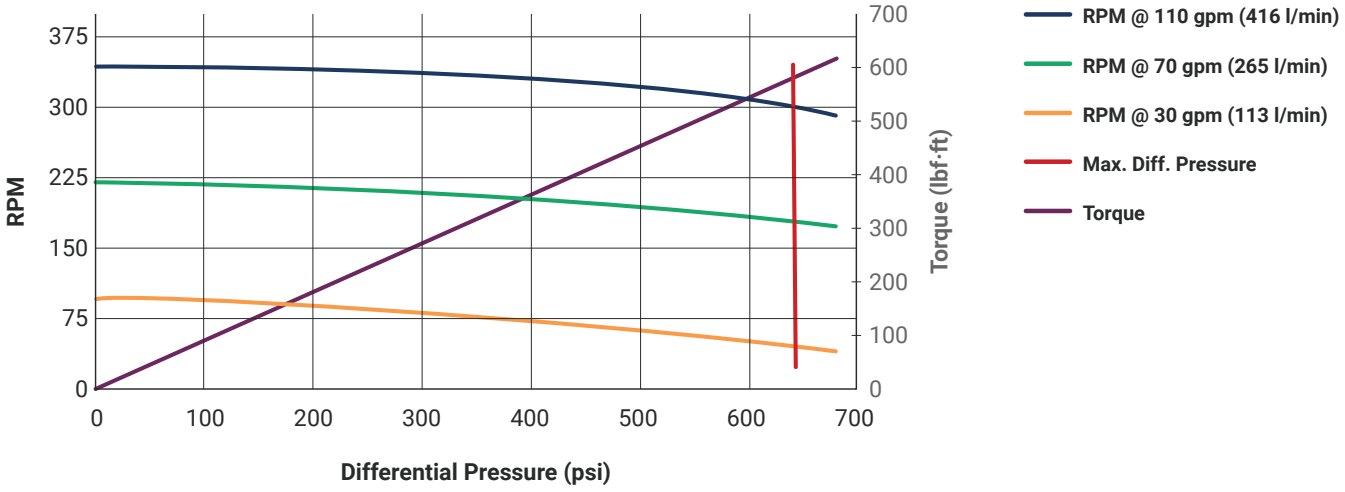
3-½ in. OD 4/5 5.0

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**3.5 (88.9)**
Power Section Configuration	**4/5 lobe 5.0 stage**
Overall Length in. (cm)	**179 (455)**
Connection – Top Box	**2 3/8 IF**
Connection – Bottom Box	**2 7/8 REG**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**30 - 110 (114 - 416)**
Speed Range RPM	**50 - 340**
Displacement rev/gal (rev/l)	**3.16 (0.83)**
Torque – Max. Operating lbf·ft (Nm)	**590 (800)**
Torque – Max. Stall lbf·ft (Nm)	**1298 (1760)**
Differential Pressure – Max. Operating psi (MPa)	**640 (4.4)**
Temperature – Max.* °F (°C)	**248 (120)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – Standard Series

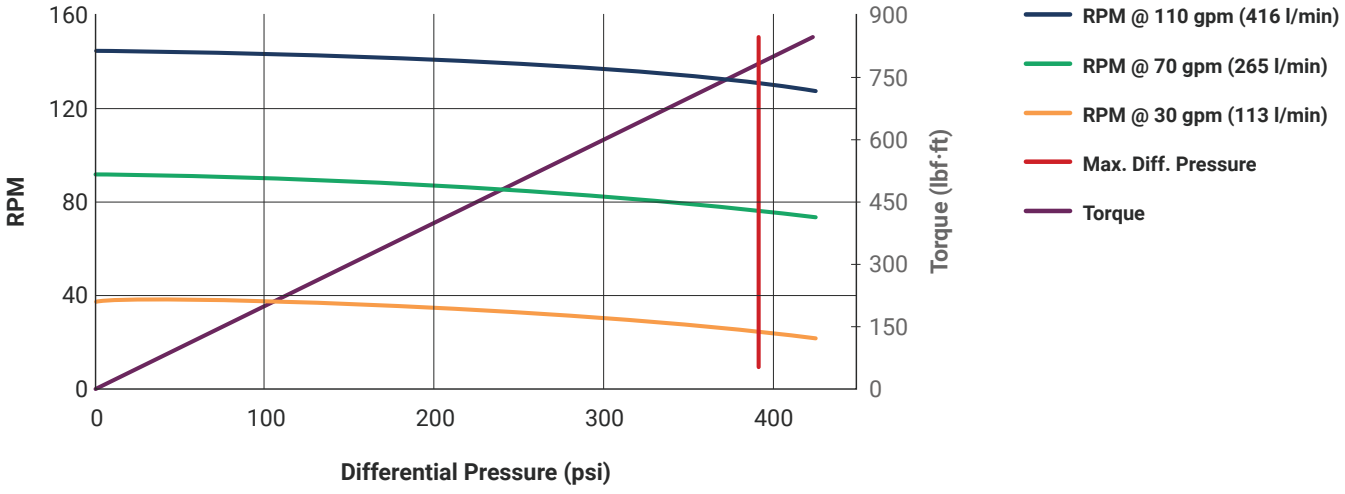
3-½ in. OD 7/8 3.0

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**3.5 (88.9)**
Power Section Configuration	**7/8 lobe 3.0 stage**
Overall Length in. (cm)	**175 (445)**
Connection – Top Box	**2 3/8 IF**
Connection – Bottom Box	**2 7/8 REG**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**30 - 110 (114 - 416)**
Speed Range RPM	**25 - 152**
Displacement rev/gal (rev/l)	**1.39 (0.37)**
Torque – Max. Operating lbf·ft (Nm)	**760 (1030)**
Torque – Max. Stall lbf·ft (Nm)	**1672 (2267)**
Differential Pressure – Max. Operating psi (MPa)	**390 (2.7)**
Temperature – Max.* °F (°C)	**248 (120)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – High Performance Series

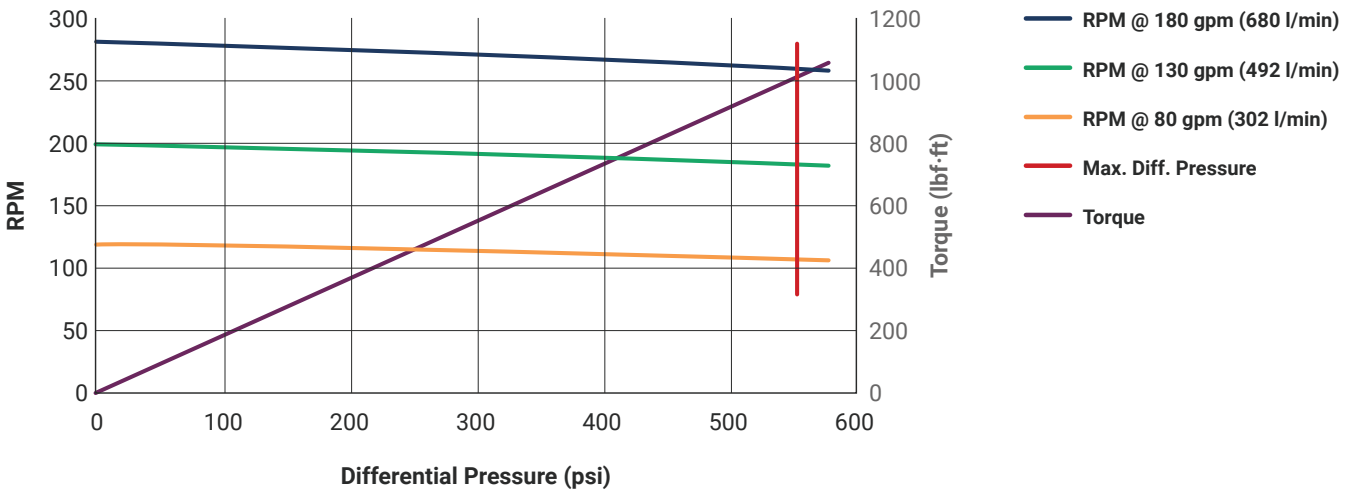
3-¾ in. OD 4/5 2.2

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**3.75 (95.3)**
Power Section Configuration	**4/5 lobe 2.2 stage**
Overall Length in. (cm)	**161 (410)**
Connection – Top Box	**2 3/8 IF**
Connection – Bottom Box	**2 7/8 REG**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**80 - 180 (303 - 681)**
Speed Range RPM	**110 - 275**
Displacement rev/gal (rev/l)	**1.56 (0.41)**
Torque – Max. Operating lbf·ft (Nm)	**1020 (1383)**
Torque – Max. Stall lbf·ft (Nm)	**2244 (3043)**
Differential Pressure – Max. Operating psi (MPa)	**550 (3.8)**
Temperature – Max.* °F (°C)	**302 (150)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – Standard Series

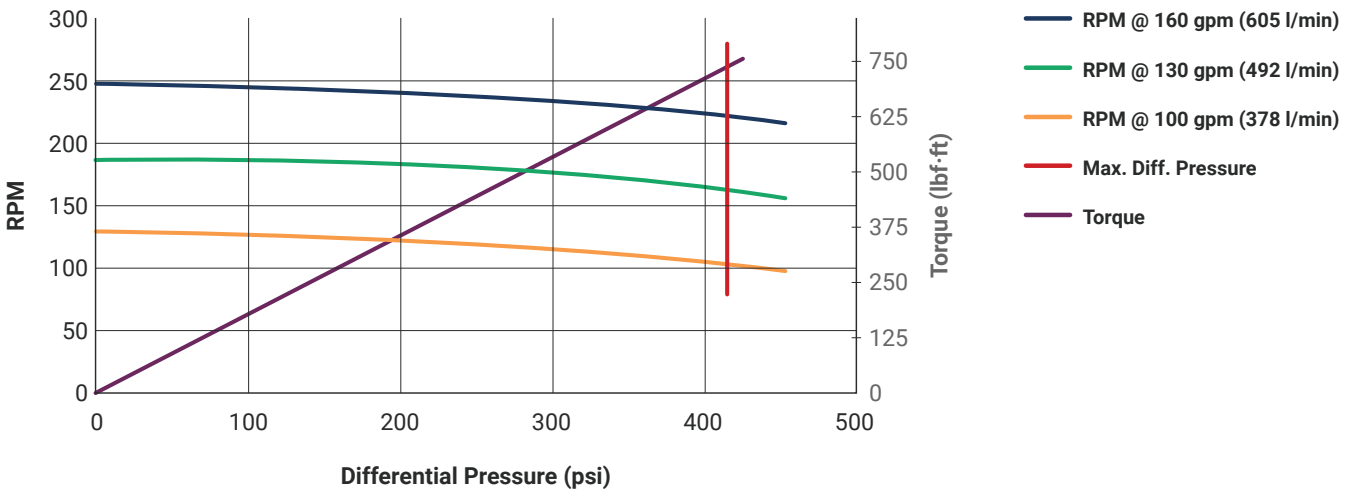
3-¾ in. OD 4/5 3.5

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**3.75 (95.3)**
Power Section Configuration	**4/5 lobe 3.5 stage**
Overall Length in. (cm)	**175 (445)**
Connection – Top Box	**2 3/8 IF**
Connection – Bottom Box	**2 7/8 REG**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**100 - 160 (379 - 606)**
Speed Range RPM	**110 - 230**
Displacement rev/gal (rev/l)	**1.56 (0.41)**
Torque – Max. Operating lbf·ft (Nm)	**760 (1030)**
Torque – Max. Stall lbf·ft (Nm)	**1672 (2267)**
Differential Pressure – Max. Operating psi (MPa)	**415 (2.9)**
Temperature – Max.* °F (°C)	**248 (120)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – Standard Series

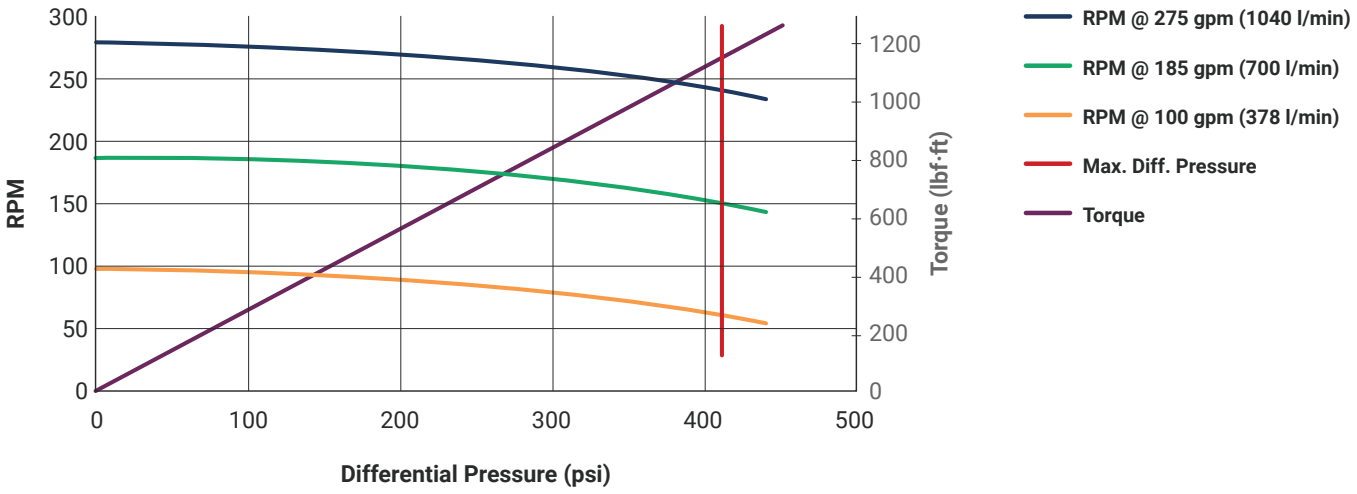
4-¾ in. OD 4/5 3.5

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**4.75 (120.6)**
Power Section Configuration	**4/5 lobe 3.5 stage**
Overall Length in. (cm)	**188 (478)**
Connection – Top Box	**3 1/2 IF**
Connection – Bottom Box	**3 1/2 REG**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**100 - 275 (379 - 1041)**
Speed Range RPM	**75 - 275**
Displacement rev/gal (rev/l)	**1.01 (0.27)**
Torque – Max. Operating lbf·ft (Nm)	**1160 (1573)**
Torque – Max. Stall lbf·ft (Nm)	**2288 (3102)**
Differential Pressure – Max. Operating psi (MPa)	**410 (2.8)**
Temperature – Max.* °F (°C)	**248 (120)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – Standard Series

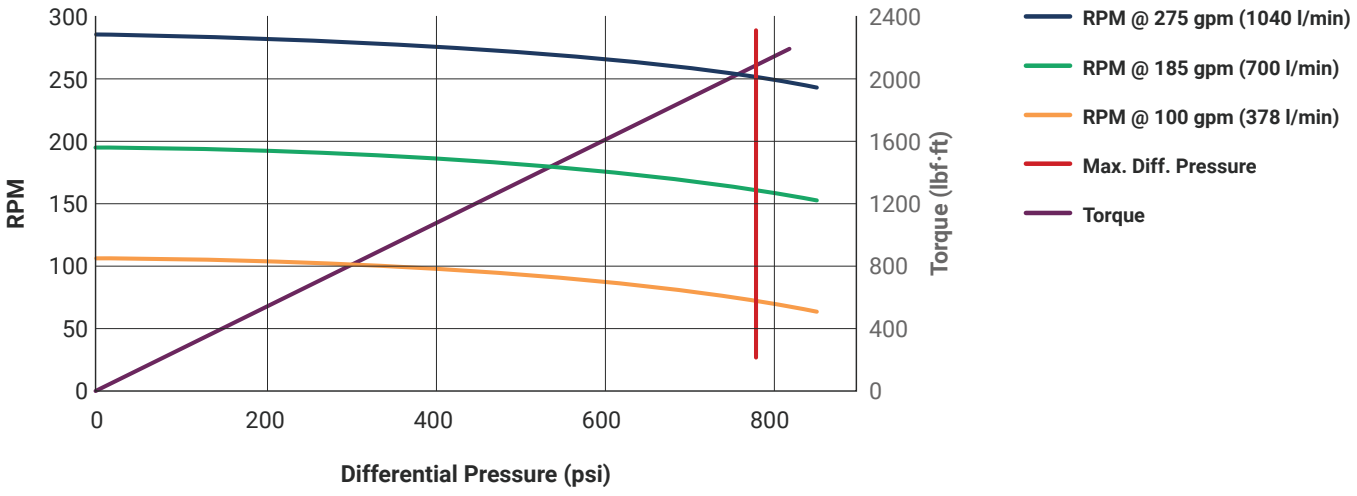
4-¾ in. OD 4/5 6.0

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**4.75 (120.6)**
Power Section Configuration	**4/5 lobe 6.0 stage**
Overall Length in. (cm)	**259 (658)**
Connection – Top Box	**3 1/2 IF**
Connection – Bottom Box	**3 1/2 REG**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**100 - 275 (379 - 1041)**
Speed Range RPM	**75 - 275**
Displacement rev/gal (rev/l)	**1.01 (0.27)**
Torque – Max. Operating lbf·ft (Nm)	**2100 (2847)**
Torque – Max. Stall lbf·ft (Nm)	**4620 (6264)**
Differential Pressure – Max. Operating psi (MPa)	**780 (5.4)**
Temperature – Max.* °F (°C)	**248 (120)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – Standard Series

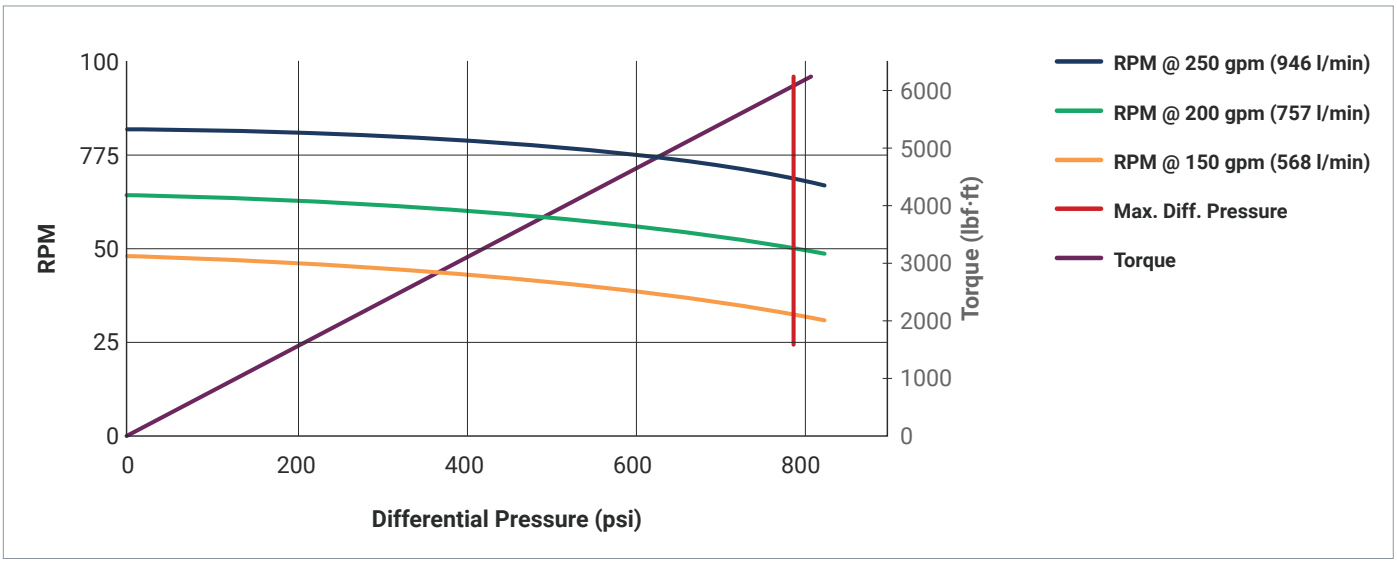
4-¾ in. OD 7/8 2.9

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**4.75 (120.6)**
Power Section Configuration	**7/8 lobe 2.9 stage**
Overall Length in. (cm)	**297 (754)**
Connection – Top Box	**3 1/2 IF**
Connection – Bottom Box	**3 1/2 REG**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**150 - 250 (568 - 946)**
Speed Range RPM	**32 - 69**
Displacement rev/gal (rev/l)	**0.30 (0.08)**
Torque – Max. Operating lbf·ft (Nm)	**6214 (8425)**
Torque – Max. Stall lbf·ft (Nm)	**15592 (21140)**
Differential Pressure – Max. Operating psi (MPa)	**788 (5.4)**
Temperature – Max.* °F (°C)	**302 (150)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – Standard Series

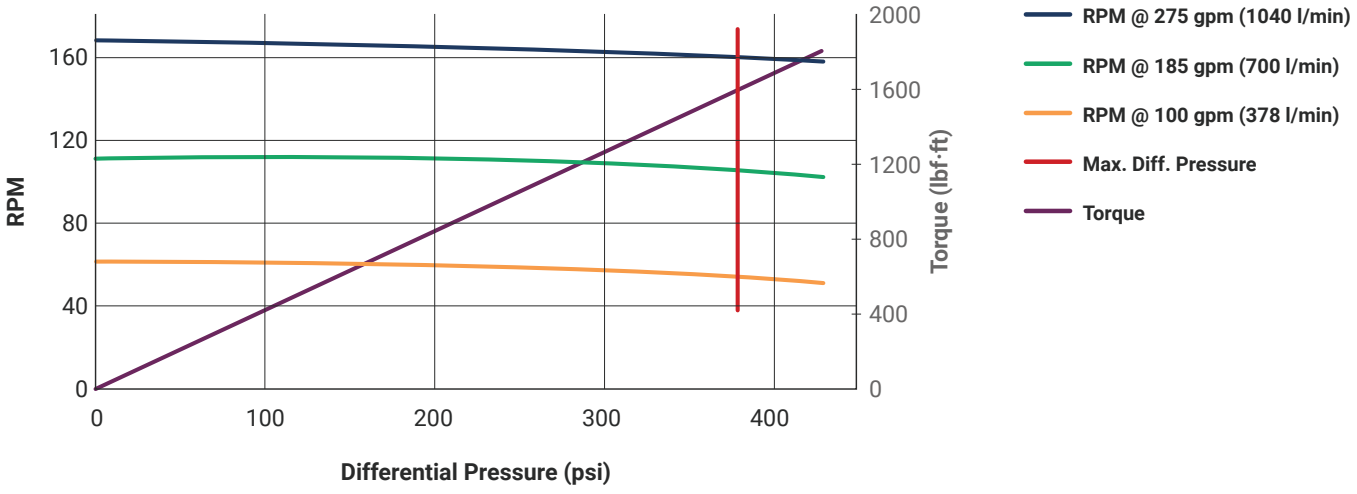
4-¾ in. OD 7/8 3.0

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**4.75 (120.6)**
Power Section Configuration	**7/8 lobe 3.0 stage**
Overall Length in. (cm)	**192 (488)**
Connection – Top Box	**3 1/2 IF**
Connection – Bottom Box	**3 1/2 REG**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**100 - 275 (379 - 1041)**
Speed Range RPM	**45 - 165**
Displacement rev/gal (rev/l)	**0.61 (0.16)**
Torque – Max. Operating lbf·ft (Nm)	**1750 (2373)**
Torque – Max. Stall lbf·ft (Nm)	**3850 (5220)**
Differential Pressure – Max. Operating psi (MPa)	**380 (2.6)**
Temperature – Max.* °F (°C)	**248 (120)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – High Performance Series

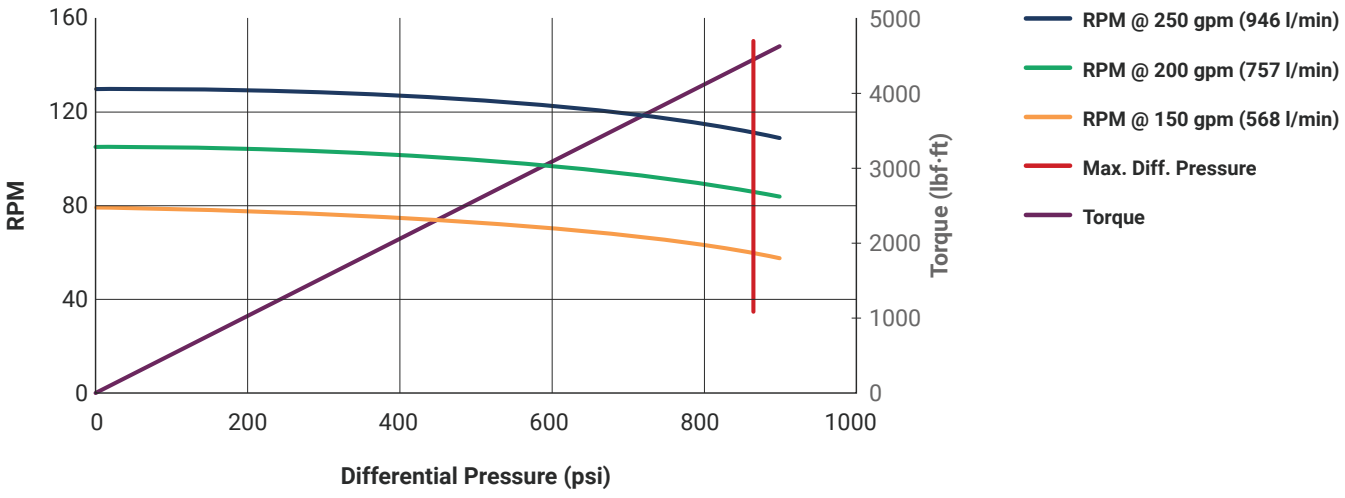
4-¾ in. OD 7/8 3.8

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**4.75 (120.6)**
Power Section Configuration	**7/8 lobe 3.8 stage**
Overall Length in. (cm)	**259 (658)**
Connection – Top Box	**3 1/2 IF**
Connection – Bottom Box	**3 1/2 REG**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**150 - 250 (568 - 946)**
Speed Range RPM	**78 - 130**
Displacement rev/gal (rev/l)	**0.52 (0.14)**
Torque – Max. Operating lbf·ft (Nm)	**4450 (6033)**
Torque – Max. Stall lbf·ft (Nm)	**6670 (9043)**
Differential Pressure – Max. Operating psi (MPa)	**860 (5.9)**
Temperature – Max.* °F (°C)	**302 (150)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – Standard Series

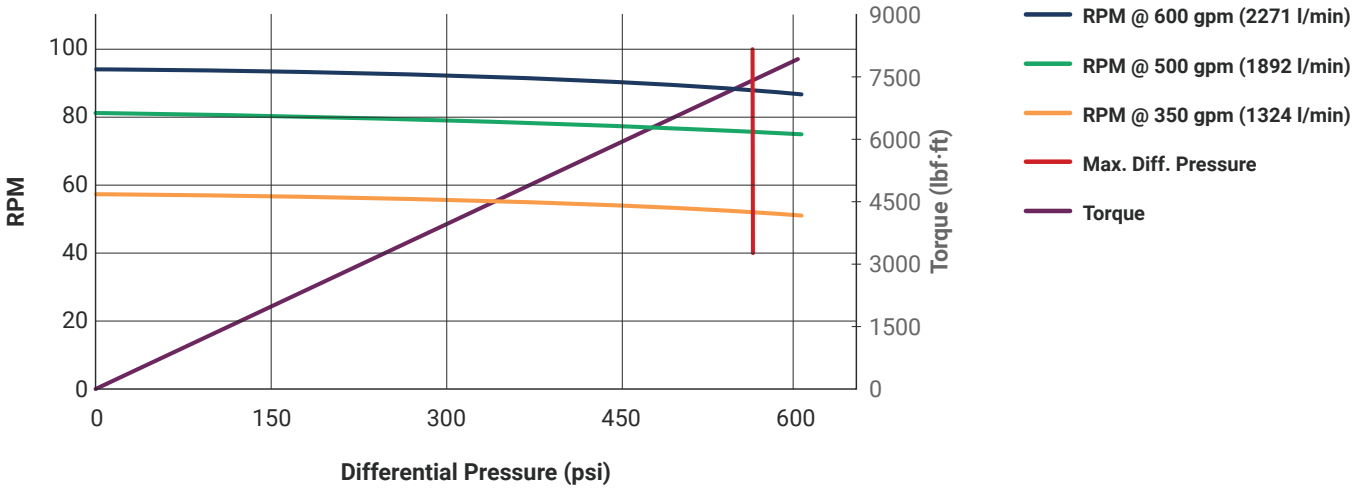
6-½ in. OD 7/8 2.9

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**6.5 (165)**
Power Section Configuration	**7/8 lobe 2.9 stage**
Overall Length in. (cm)	**336 (853)**
Connection – Top Box	**4 1/2 XF**
Connection – Bottom Box	**4 1/2 REG**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**350 - 600 (1325 - 2271)**
Speed Range RPM	**45 - 95**
Displacement rev/gal (rev/l)	**0.15 (0.04)**
Torque – Max. Operating lbf·ft (Nm)	**8000 (10847)**
Torque – Max. Stall lbf·ft (Nm)	**17600 (23862)**
Differential Pressure – Max. Operating psi (MPa)	**550 (3.8)**
Temperature – Max.* °F (°C)	**248 (120)**

** Dependant on wellbore conditions.*

PERFORMANCE PARAMETERS



Drilling Motor – Standard Series

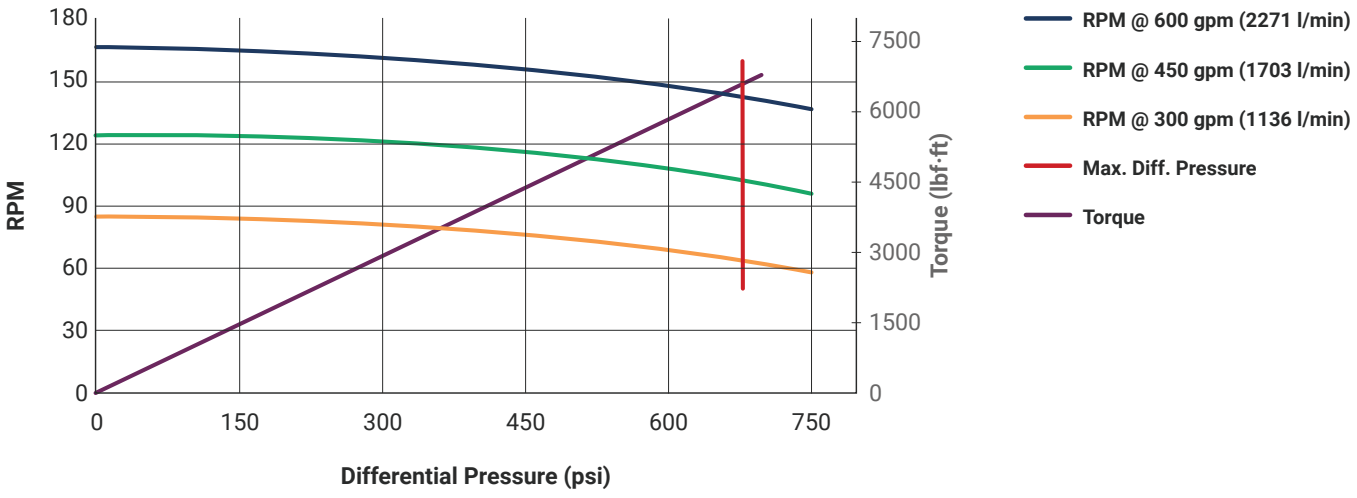
6-½ in. OD 7/8 5.0

SPECIFICATIONS

Physical Dimensions	
Motor Outside Diameter (OD) in. (mm)	**6.5 (165)**
Power Section Configuration	**7/8 lobe 5.0 stage**
Overall Length in. (cm)	**305 (823)**
Connection – Top Box	**4 1/2 XF**
Connection – Bottom Box	**4 1/2 REG**
Bearing Type	**Sealed**
Operational Data	
Flow Rate gpm (l/min)	**300 - 600 (1136 - 2271)**
Speed Range RPM	**80 - 160**
Displacement rev/gal (rev/l)	**0.28 (0.07)**
Torque – Max. Operating lbf·ft (Nm)	**6750 (9152)**
Torque – Max. Stall lbf·ft (Nm)	**14850 (20134)**
Differential Pressure – Max. Operating psi (MPa)	**680 (4.7)**
Temperature – Max.* °F (°C)	**248 (120)**

** Dependant on wellbore conditions.*

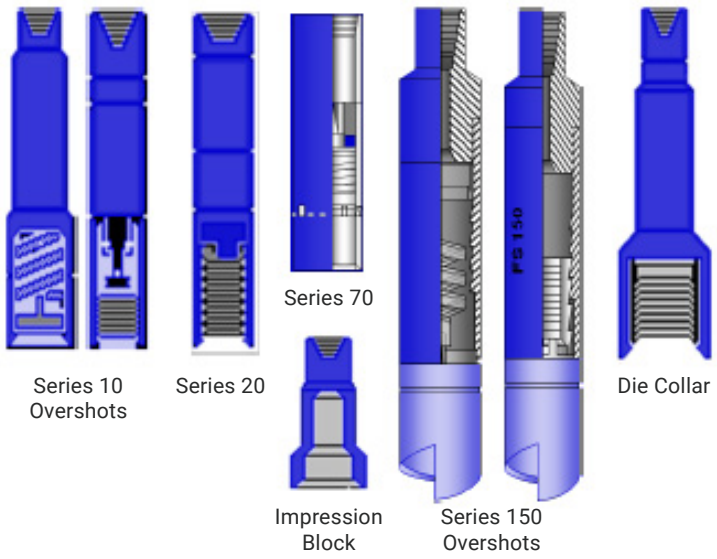
PERFORMANCE PARAMETERS



SECTION 5 – Fishing Services and Rentals

External Catch Fishing Tools

- Series 10 Sucker Rod Overshots
- Series 20 Sucker Rod Overshots
- Series 70 Short Catch Releasing Overshots
- Series 150 Releasing & Circulating Overshots
- Lead Impression Blocks
- Rotary Die Collars



Series 10 Sucker Rod Overshots

The best tools to engage and retrieve sucker rods, couplings and similar items from inside tubing strings. Series 10 overshots are available up to 2 5/16" OD inside 2 7/8" tubing and up to 1 29/32" OD inside 2 3/8" tubing.

Overshot OD	1 29/32	2 5/16	2 27/32
Maximum Catch Spiral	1 5/8	2	2 3/8
Maximum Catch Basket	1 7/16	1 13/16	2 3/16
Grapple Part No.	9343	9403	9872

Series 20 Short Catch Sucker Rod Overshots

Designed to engage and retrieve sucker rods, couplings and exposed portions of other items that are too short to be engaged with standard overshots.

Overshot OD	1 29/32	2 5/16	2 27/32
Maximum Catch Basket	1 1/2	2	2 3/8
Grapple Part No.	11557	1 13/16	2 3/16

Series 70 Short Catch Sucker Rod Overshots

Designed to engage, packoff and retrieve tubular fish and are specifically designed to use when the top of the fish is too short to be engaged with a Series 150 overshot.

Standard OD	3 5/8	3 3/4	4 11/16	5 7/8
Maximum Catch	2 1/2	2 5/8	3 21/32	4 3/4
Grapple Part No.	17618	13538	10546	10563

Series 150 Releasing and Circulating Overshots

Designed to engage, packoff and retrieve tubular fish and are especially suited to retrieve parted tubing and other items from the wellbore.

Overshot OD	2 5/8	3 5/8	3 7/8	3 7/8	4 3/8	4 5/8	4 11/16	5 3/4	5 7/8	5 7/8
Max. Catch Size (Spiral)	2 1/8	2 7/8	3 1/8	3 1/8	3 3/8	3 1/2	3 7/8	3 21/32	4 3/4	5
Max. Catch Size (Basket)	1 3/4	2 1/2	2 5/8	2 5/8	2 7/8	2 7/8	3 3/8	3.22	4 1/4	4 1/2
Spiral Grapple Part No.	B-10204	9272	B-1837	B-1837	21305	B-3607	B-6234	6662	6112	B-4369
Basket Grapple Part No.	B-10204	9272	B-1837	B-1837	21305	B-3607	B-6234	6662	6112	B-4369

Impression Blocks

Designed to determine the position and condition of the top of the fish or junk in the wellbore.

Internal Catch Fishing Tools

- Rotary Taper Taps
- Itco-Type Releasing Spear

Rotary Taper Taps

Provide a simple, dependable and inexpensive means to retrieve a tubular fish that is restrained from rotation. The one-piece taper taps are constructed with a fine thread form that allows the tap to work as a threading tool.

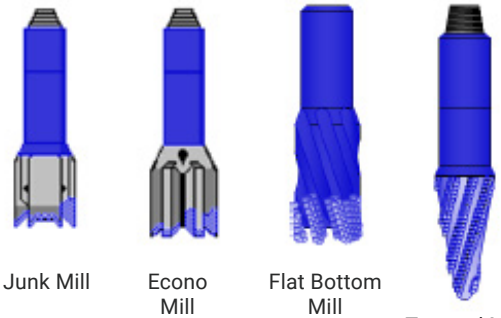
Bowen Itco Type Releasing Spears

A superior fishing spear which is designed to ensure positive engagement with the fish. The Itco-Type Releasing Spear internally engages and retrieves tubing and other obstructions with an inside diameter (ID) up to 9 5/8".

Nominal Catch Size OD	1.660	1.900	2 3/8	2 7/8	3 1/2	4 1/2	5
Spear OD (H")	1 1/8	1 3/8	1 7/8	2 5/16	2 13/16	3 5/8	4 1/32
Complete Assembly Part No.	11195	9915	1344	1227	9410	17475	9680
Grapple Part No.	11197	9917	1348	1230	9412	17477	9682

Drilling Mills

- Junk Mills
- Econo Mills
- Flat Bottom Mills
- Tapered Mills
- Insert Mills



Junk Mills

Designed with high quality tungsten carbide to ensure optimum performance in every application. Junk mills are suitable for all types of general junk milling as well as the removal of packers and retainers.

Econo Mills

Used for drilling cement, metal or other objects from the wellbore.

Flat Bottom Mills

Used for dressing the top of the fish to make retrieving easier.

Tapered Mills

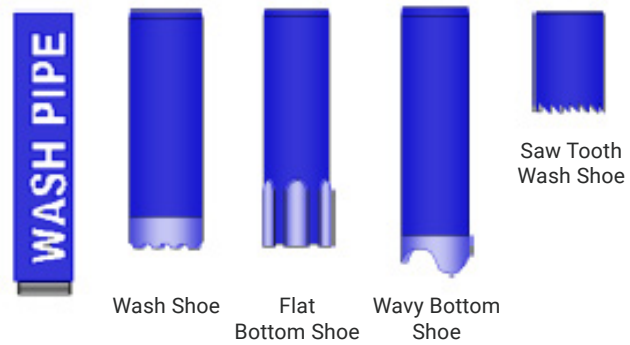
Designed specifically for milling through tight spots in tubulars. Tapered mills are recommended for cleaning out liners, tubing and other collapsed or deformed tubulars.

Insert Mills

Have tungsten carbide inserts for milling specialty applications.

Washovers / Rotary Shoes

- Wash pipe
- Flat Bottom Rotary Shoes
- Wavy Bottom Rotary Shoes
- Saw Tooth Rotary Shoe
- Specialty Rotary Shoes



Washovers / Rotary Shoe

Washing over is an effective method of freeing stuck pipe in a wellbore by cutting away and circulating obstructions hindering the pipe's movement. Tartan offers a wide variety of washover shoes in various configurations to suit a wide range of downhole conditions.

Flat Bottom Rotary Shoe

Used to cut metal on the fish where clearances are small.

Wavy Bottom Rotary Shoe

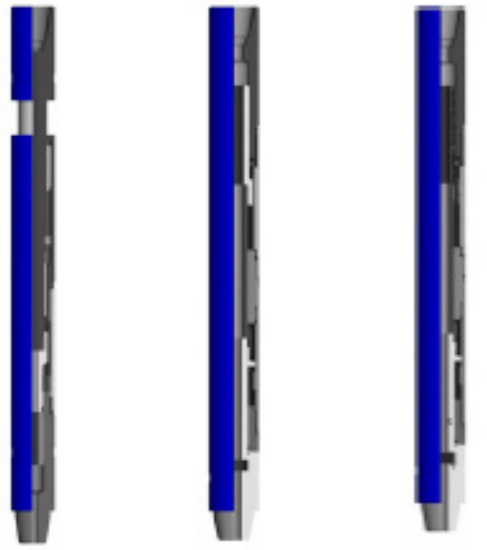
Used to cut on the ID, the OD and the bottom face to increase clearances.

Saw Tooth Rotary Shoe

Used for washing over and cutting. Cuts on outside and bottom only.

Intensifiers, Jars and Bumper Subs

- Intensifiers
- Hydraulic Fishing Jars
- Mechanical Bumper Subs
- Lubricated Bumper Subs



Intensifier | Hydraulic Jar | Bumper Sub

Intensifiers

Run in conjunction with Lee or Bowen fishing jars. The Intensifier's function is to accelerate the upper end of the Jar and the lower portion of the work string during the jarring stroke.

Hydraulic Fishing Jars

A straight pull operated jar that can be deployed in any fishing operation, including stuck pipe, packer retrieval, tubing removal, milling and debris recovery.

Mechanical Bumper Subs

Provide durable and economical upward and downward bumping action. Full torque transmission and circulation can be maintained through the tool at all times in any stroke position. They also aid in latching onto a fish and removal of the fish at surface.

Miscellaneous / Rental Equipment

- RS100 Stripping Head
- Gate Valve
- Magnets
- Junk Baskets
- Indexing Tools

RS100

Gate Valve

Magnet

RS100 Stripping Heads

A blowout prevention device consisting of a gland and packing arrangement bolted to the wellhead. It is often used to seal the annular space between tubing and casing in shallow or low-pressure completions and workovers.

Junk Basket

Indexing Tool

Gate Valves

API 6A 19th ED is an expanding gate valve that is available in various sizes including 7 1/16” 2000 #, 3000 # and 5000 # FE, RTJ or FE.

Junk Baskets

A tool that is used to retrieve junk and debris out of the wellbore. A mill shoe or flat bottom type shoe are available. Reverse Circulation Junk Baskets are also available.

Indexing Tools

Designed for use when controlled rotation of the lower tool string is required. One application is for rotating an overshot onto the fish using coiled tubing.

Notes

Notes

SECTION 6 – Casing Chart

Imperial			
Casing OD (in.)	Weight (lb/ft)	Drift (in.)	ID (in.)
4 1/2	9.5	3.965	4.090
4 1/2	10.5	3.927	4.052
4 1/2	11.6	3.875	4.000
4 1/2	12.6	3.833	3.958
4 1/2	13.5	3.795	3.920
5	11.5	4.435	4.560
5	13.0	4.369	4.494
5	15.0	4.283	4.408
5 1/2	14.0	4.887	5.012
5 1/2	15.5	4.825	4.950
5 1/2	17.0	4.767	4.892
5 1/2	20.0	4.653	4.778
5 1/2	23.0	4.545	4.670
6	18.0	5.299	5.424
6	20.0	5.227	5.352
6	23.0	5.115	5.240
6	26.0	5.007	5.132
6 5/8	20.0	5.924	6.049
6 5/8	24.0	5.796	5.921
6 5/8	28.0	5.666	5.791
6 5/8	32.0	5.550	5.675
7	17.0	6.413	6.538
7	20.0	6.331	6.456
7	23.0	6.241	6.366
7	26.0	6.151	6.276
7	29.0	6.059	6.184
7	32.0	5.969	6.094
7	35.0	5.879	6.004
7	38.0	5.795	5.920
7 5/8	24.0	6.900	7.025
7 5/8	26.4	6.844	6.969
7 5/8	29.7	6.750	6.875
7 5/8	33.7	6.640	6.765
7 5/8	39.0	6.500	6.625
8 5/8	24.0	7.972	8.097
8 5/8	28.0	7.892	8.017
8 5/8	32.0	7.796	7.921
8 5/8	36.0	7.700	7.825
8 5/8	40.0	7.600	7.725
8 5/8	44.0	7.500	7.625
8 5/8	49.0	7.386	7.511
9 5/8	32.3	8.845	9.001
9 5/8	36.0	8.765	8.921
9 5/8	40.0	8.679	8.835

Metric			
Casing OD (mm)	Weight (kg/m)	Drift (mm)	ID (mm)
114.3	14.14	100.7	103.9
114.3	15.63	99.7	102.9
114.3	17.26	98.4	101.6
114.3	18.75	97.4	100.5
114.3	20.09	96.4	99.6
127.0	17.11	112.6	115.8
127.0	19.35	111.0	114.1
127.0	22.32	108.8	112.0
139.7	20.83	124.1	127.3
139.7	23.07	122.6	125.7
139.7	25.30	121.1	124.3
139.7	29.76	118.2	121.4
139.7	34.23	115.4	118.6
152.4	26.79	134.6	137.8
152.4	29.76	132.8	135.9
152.4	34.23	129.9	133.1
152.4	38.69	127.2	130.4
168.3	29.76	150.5	153.6
168.3	35.72	147.2	150.4
168.3	41.67	143.9	147.1
168.3	47.62	141.0	144.1
177.8	25.30	162.9	166.1
177.8	29.76	160.8	164.0
177.8	34.23	158.5	161.7
177.8	38.69	156.2	159.4
177.8	43.16	153.9	157.1
177.8	47.62	151.6	154.8
177.8	52.09	149.3	152.5
177.8	56.55	147.2	150.4
193.7	35.72	175.3	178.4
193.7	39.29	173.8	177.0
193.7	44.20	171.5	174.6
193.7	50.15	168.7	171.8
193.7	58.04	165.1	168.3
219.1	35.72	202.5	205.7
219.1	41.67	200.5	203.6
219.1	47.62	198.0	201.2
219.1	53.57	195.6	198.8
219.1	59.53	193.0	196.2
219.1	65.48	190.5	193.7
219.1	72.92	187.6	190.8
244.5	48.07	224.7	228.6
244.5	53.57	222.6	226.6
244.5	59.53	220.4	224.4

Tartan energy group

Drilling Motor Specifications

P/N	OD (in.)	Lobe	Stage	Overall Length (in.)	Flow (gpm)	Speed (RPM)	Torque (lbf.ft)	Connection Top Box	Connection Bottom Box
1695644	1.690	5/6	4.4	116	25-45	50-500	50-160	1 1/4 MT	1 AW ROD
2135650	2.125	5/6	5.0	123	20-50	110-378	150-325	1 1/2 MT	1 1/2 MT
2135660	2.125	5/6	6.0	125	20-50	80-600	150-412	1 1/2 MT	1 1/2 MT
2875633	2.875	5/6	3.3	114	50-125	167-530	750-1147	2 3/8 PAC	2 3/8 PAC
2875635	2.875	5/6	3.5	145	60-120	150-400	400-810	2 3/8 PAC	2 3/8 PAC
2875647	2.875	5/6	4.7	147	50-147	176-519	400-890	2 3/8 PAC	2 3/8 PAC
2875670	2.875	5/6	7.0	150	30-90	110-520	200-800	2 3/8 PAC	2 3/8 PAC
2877830	2.875	7/8	3.0	130	50-100	40-250	175-450	2 3/8 PAC	2 3/8 PAC
2877836	2.875	7/8	3.6	147	50-120	152-364	400-890	2 3/8 PAC	2 3/8 PAC
3137825	3.125	7/8	2.5	169	110-210	110-240	1000-1960	2 3/8 REG	2 3/8 REG
3137830	3.125	7/8	3.0	163	40-190	110-240	300-660	2 3/8 REG	2 3/8 REG
3137840	3.125	7/8	4.0	133	40-120	80-440	200-440	2 3/8 REG	2 3/8 REG
3504550	3.500	4/5	5.0	179	30-110	50-340	100-590	2 3/8 IF	2 7/8 REG
3507830	3.500	7/8	3.0	175	30-110	25-152	150-760	2 3/8 IF	2 7/8 REG
3754522	3.750	4/5	2.2	161	80-180	110-275	400-1020	2 3/8 IF	2 7/8 REG
3754535	3.750	4/5	3.5	175	100-160	110-230	250-760	2 3/8 IF	2 7/8 REG
4754535	4.750	4/5	3.5	188	100-275	75-275	400-1160	3 1/2 IF	3 1/2 REG
4754560	4.750	4/5	6.0	259	100-275	75-275	800-2100	3 1/2 IF	3 1/2 REG
4757830	4.750	7/8	3.0	192	100-275	45-165	600-1750	3 1/2 IF	3 1/2 REG
4757829	4.750	7/8	2.9	297	150-250	32-69	2000-6214	3 1/2 IF	3 1/2 REG
4757838	4.750	7/8	3.8	259	150-250	78-130	2000-4450	3 1/2 IF	3 1/2 REG
6507829	6.500	7/8	2.9	336	350-600	45-95	4000-8000	4 1/2 XF	4 1/2 REG
6507850	6.500	7/8	5.0	305	300-600	80-160	3000-6750	4 1/2 XF	4 1/2 REG