BAKER HUGHES

Hughes Christensen

Drill Bit Catalog

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Hughes Christensen

We are Hughes Christensen, the most innovative and technically advanced drill bit manufacturer in the world. Since we introduced the first rotary rock bit in 1909, our research and development programs have been responsible for the systematic advancement of drill bit technology that accounts for our products being recognized around the world as the industry standard. Our products and services have played a major role in helping the petroleum industry find and produce energy worldwide.

Today our culture is based on a philosophy of continuous improvement. We are constantly searching for more effective ways to provide our customers the highest quality products and value added service to enhance their drilling programs. For example, our new BETA field research facility provides real world testing and state-of-the-art data acquisition. This $2.5 million dollar investment will bring new, more reliable technology to the market faster. In the field, our OASIS drilling optimization service utilizes proprietary analytical tools to lower client drilling costs worldwide. Down hole, we are revolutionizing drill bit design with SPECTRUM application-specific technology. New Tricone and PDC drill bit designs are tailored for the drilling applications you encounter.

World Headquarters, The Woodlands, Texas

We value you as a customer and hope to be your key resource for drilling solutions regardless of where you are drilling or the formations you will encounter.

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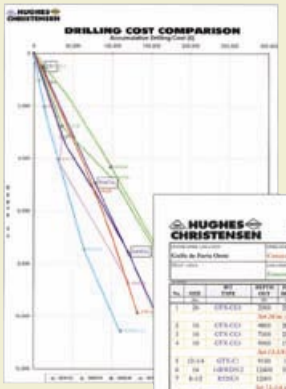
Customer Services

Hughes Christensen is committed to providing the industry's foremost value-added services to optimize your drilling efficiency and lower drilling costs. Services like advance log and rock strength analysis are used to monitor on-site performance and boaster the accuracy of our bit programs. Our drilling optimization service, OASIS, is lowering clients drilling costs worldwide. We have the most knowledgeable technical sales force operating within a network that stretches into every mature and emerging drilling theater in the world. All this adds up to a company committed to providing state-of-the-art products and services. Our goal is 100% customer satisfaction.

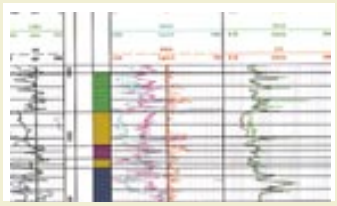
Bit Records / Bit Programs

When you do business with Hughes Christensen, you automatically gain access to the world's most comprehensive database of drilling information. Whether you're planning an exploratory well in an unproven area or wanting to improve performance in a mature field, our stockpile of run information can help you make the right decision. With our Windows-based Bit Record Database Query System, Hughes Christensen's field personnel can quickly access a full range of offset well data.

Another benefit you derive from our extensive database is engineered bit programs specifically designed to meet the objectives of your proposed well. These expertly engineered programs help your HCC representative identify potential problem areas prior to spudding.



Log & Rock Mechanics Analysis



Our engineers have recently designed a new bit application program that converts data from offset wells into a digital format for predicting drilling conditions. This state-of-the-art analytical tool takes into account rock mechanics and operating parameters.

Hughes Christensen uses this rock mechanics application software to calculate unconfined compressive strength from offset wireline logs. We can incorporate data from sonic, gamma ray, caliper and long resistivity logs into our system. Our software can also utilize specific energy, ROP, WOB, RPM, HSI, flow rate of drilling fluids and stand pipe pressure. Any number of these operating parameters can be used depending upon what problems need to be resolved.

We are currently utilizing real-time data acquisition systems to obtain operating parameters on a consistent footage or time basis. This unique combination of offset data used in conjunction with real time information gives us a better understanding of the downhole environment so we can more accurately determine the bit type that delivers the most value.

OASIS Engineering Services

Oasis is Hughes Christensen's drilling optimization service designed to lower a client's drilling costs

while maintaining wellbore quality. Using proprietary tools and engineering services within Hughes Christensen, solutions are provided that improve overall drilling efficiency. The Oasis approach is a three step process; planning, drilling, and post well analysis.

Every Oasis project starts with a detailed study of offset wells to benchmark current performance and determine areas of possible improvement.

As the well is being drilled, the Oasis engineer follows daily progress, attends drilling team meetings, updates the well prognosis and helps devise strategies to overcome problems that might be occurring.

After completion of the well, a complete analysis is made documenting the achievements, as well as the failures. Finally, a report is produced comparing actual to forecasted performance to carry the lessons learned forward to the planning of the next well.

Dull Bit Grading

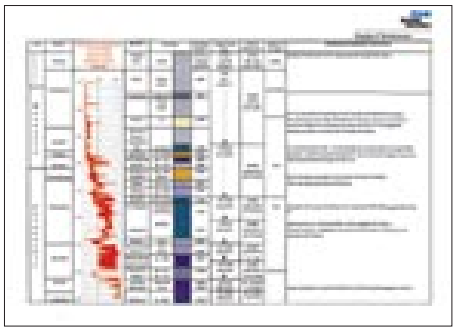
Another integral part of Hughes Christensen's valuable customer service is the evaluating and grading of dull bits. This service is extremely useful for selecting the most cost-effective bit for a subsequent well in a specific area. Examining a dull bit provides you and Hughes Christensen's representatives an accurate look at what occurred during the drilling process and what adjustments in the bit selection process should be made for future wells. An analysis of dull bits also gives us insights into how operating parameters can be adjusted for improving performance and lowering costs in upcoming wells.

Hydraulic Software

Hughes Christensen's Windows based Hydraulics software program allows you to develop an inclusive hydraulics plan for each bit of an entire drilling program. An important feature of our software is the ability to alter some of the design data on any single bit run such as pump pressure and downhole tools. The resulting hydraulics program incorporates this modified information into a detailed comprehensive report for each single bit run.

The capacity to alter operating parameters is what sets our software apart from other Hydraulics programs on the market. Our bit specific application software takes into account the significant changes in operating conditions that occur with increased depth, including changes in mud weight and viscosities as well as increased drill pipe friction.

Well Recaping



Like dull grading, the practice of recapping wells is a very useful barometer for selecting the proper bit for a specific application. With our inclusive well recaps, we look at the entire well to document the performance of the bit as it compares to the well program. In a well recap, the actual drilling time, day versus depth, drilling costs, hydraulics, rate of penetration and other factors influencing drilling efficiencies are compared against the program estimates. Recapping well performance helps document achievements as well as the failures and helps when planning your next well.

Customer Training

Since its inception in 1968, the Hughes Christensen Customer Drilling Seminar has become the industry standard for the timely sharing of oilfield technology. Held regularly at The Woodlands, TX headquarters, the three-day seminar covers a specialized, yet broad range of information. Variations of the seminar also can be held in customer locations worldwide.

Complementing the Drilling Seminar is an expanded technical training program with modules on such subjects as rock mechanics, drill string vibration, hydraulics, dull grading, and bit design. All of these programs are designed to help our customers lower their drilling costs.

Spectrum Technology

SPECTRUM
Application Engineered Technology

At Hughes Christensen we're revolutionizing drill bit design. Instead of engineering a single bit for many applications, we're now engineering each bit for its specific application. We call it SPECTRUM application-specific technology.

SPECTRUM includes Tricone and PDC designs tailored to the drilling applications that you encounter. Under the SPECTRUM umbrella you will find our newest technology and product lines.

UltraMax

High Performance Bits For Motor and High Speed Applications

ULTRA MAX

HydraBoss

Hydraulically Enhanced Bits Designed To Drill Bit Balling Formations

HydraBoss

HardRok

Bits Designed For Hard And Abrasive Formations

ChipMaster

Enhanced Chip Management For Optimized Bit Cleaning

STAR

Slim Hole Technology

BlackTrax

Premium PDC Bits For Steerable Applications

RWD

Ream While Drilling Technology

Black Diamond

Premium PDC Bits Engineered For Specific Applications

TRICONE
DRILL BITS

SERIES	FORMATIONS	TYPE	1	2	4	5		6		7		
			STANDARD ROLLER BEARING	ROLLER BEARING AIR COOLED	SEALED ROLLER BEARING	SEALED ROLLER BEARING GAUGE PROTECTED		SEALED FRICTION BEARING		SEALED FRICTION BEARING GAUGE PROTECTED		
						ELASTOMER	METAL	ELASTOMER		ELASTOMER		METAL
					GT	GT	GT		GT/STR		GT/STR	MX
MILLED TOOTH	1 SOFT	1	R1		GTX-1	GTX-G1	MAX-GT1		GT-1		GT-G1, GT-G1H STR-1	MX-1
		2										
		3				GTX-G3	MAX-GT3					
		4										
	2 MEDIUM	1						ATJ-4		ATJ-G4		
		2	DR5									
		3										
		4										
	3 HARD	1										
		2	R7									
		3										
		4								ATJ-G8		
INSERT	4 SOFT	1				GTX-00 GTX-03	MAXGT-00 MAXGT-03				GT-03 STR-03 H-03	MX-03
		2									GT-09C, STR-05C H-09C	MX-09C MX-09CG
		3				GTX-09	MAXGT-09				GT-09, STR-09 H-09	MX-09 MX-09G
		4					MAXGT-18				GT-18, GT-18C H-18, H-18C	MX-18
	5 SOFT TO MEDIUM	1				GTX-20	MAXGT-20				GT-20, GT-20S STR-20, H-20	MX-20 MX-20G
		2				GTX-20C	MAXGT-20CG				GT-20C, GT-28 GT-28C H-28, H-28C	MX-28
		3								ATJ-33A	STR-30 GT-30 H-30	MX-30 MX-30G
		4				GTX-30C	MAXGT-30CG				GT-30C STR-30C STR-35C	MX-35C MX-35CG
	6 MEDIUM	1		G44						ATJ-44, ATJ-44A ATJ-44G	STR-40 HR-40	
		2					MAX-44C			ATJ-44C ATJ-44CA	STR-40C, STR-44C HR-40C	MX-40CG
		3		G55			MAX-55			ATJ-55R, ATJ-55RG ATJ-55, ATJ-55A	STR-50, STR-50R HR-50	
		4								ATJ-66	HR-60	
	7 HARD	1										
		2										
		3								ATJ-77	STR-70, HR-70	
		4								ATJ-88	STR-80, HR-80	
	8 EXTRA HARD	1										
		2										
		3								ATJ-99		
		4										

ROCK BIT SIZES & TYPES

Tungsten Carbide Insert Bits

Bit Size in. / mm.	API PIN	G	ATJ	ATX	MAX	GT	GTX	MAXGT	STR	H	MX	HR	Approx Wt lb./ kg.
3 3/4 95.3	2 3/8								STR-20				11.5/ 5.21
3 7/8 98.4	2 3/8								STR-30, STR-50				11.5/ 5.21
4 1/8 104.8	2 3/8								STR-30 STR-70				12.5/ 5.6
4 1/2 114.3	2 7/8								STR-35C STR-70				14.5/ 6.56 14.5/ 6.56
4 5/8 117.5	2 7/8								STR-40, STR-40C				17/ 7.7
4 3/4 120.6	2 7/8								STR-05C STR-20, STR-30C STR-30, STR-44C STR-70				17/ 7.7
5 5/8 142.9	2 7/8								STR-09				31/ 14.04
5 3/4 146.1	2 7/8								STR-09				35/ 15.85
5 7/8 149.2	3 1/2								STR-09 STR-20, STR-30 STR-44C, STR-50 STR-70				39/ 17.7
6 152.4	3 1/2								STR-09 STR-20, STR-30 STR-40, STR-40C STR-50, STR-70				39/ 17.7
6 1/8 155.6	3 1/2								STR-03 STR-09, STR-09C STR-20, STR-30 STR-30C, STR-40 STR-44C, STR-50 STR-70				39/ 17.7
6 1/4 158.8	3 1/2		ATJ-33A ATJ-55A						STR-09 STR-20, STR-30 STR-40, STR-40C STR-50, STR-70				41/ 18.6
6 1/2 165.1	3 1/2		ATJ-55A						STR-09 STR-20, STR-30 STR-30C, STR-44C STR-50, STR-50R STR-70				47/ 21.3
6 3/4 171.4	3 1/2								STR-09 STR-20, STR-30C STR-40, STR-44C				49/ 22.2
7 7/8 200.0	4 1/2		ATJ-33A, ATJ-35C, ATJ-44 ATJ-44A, ATJ-44C, ATJ-44CA, ATJ-55 ATJ-55A, ATJ-55R, ATJ-55RG, ATJ-66 ATJ-77, ATJ-88, ATJ-99			GT-03, GT-09 GT-09C, GT-18 GT-18C, GT-20S GT-20, GT-20C GT-28, GT28C GT-30, GT-30C				H-03 H-09 H-09C H-18 H-18C H-20 H-20C H-30	MX-09 MX-18	HR-50 HR-60 HR-80	76/ 34.5
8 3/8 212.7	4 1/2										MX-18, MX-20G MX-30G, MX35CG		86/ 39.0
8 1/2 215.9	4 1/2	G44 G77	ATJ-44, ATJ-44C ATJ-55, ATJ-55R, ATJ-55RG ATJ-55A, ATJ-77, ATJ-88, ATJ-99			GT-03 GT-09 GT-18, GT20 GT-20C, GT-30C	GTX-30C			H-03 H-09 H-20	MX03 MX-09, MX-09C MX-09G, MX-18 MX-20, MX-20G MX-30, MX-35CG MX-40CG		90/ 40.8
8 3/4 222.2	4 1/2		ATJ-05C, ATJ-33S, ATJ-33, ATJ-33C ATJ-35, ATJ-35C, ATJ-44, ATJ-44A ATJ-44C, ATJ-FF4, ATJ-55, ATJ55A ATJ-55R, ATJ-55RG, ATJ-66 ATJ-77, ATJ-88, ATJ-99			GT-00, GT-03 GT-09, GT-09C GT-18, GT-20 GT-20C, GT-30				H-03 H-09 H-09C H-18 H-20 H-28	MX-20	HR-40C HR-50	90/ 40.8
9 1/2 241.3	6 5/8		ATJ-44C			GT-30					MX-20		137/ 62.1
9 7/8 250.8	6 5/8		ATJ-35, ATJ-44, ATJ-44C ATJ-55R, ATJ-55RG, ATJ-66 ATJ-77, ATJ-88, ATJ-99			GT-03, GT-09 GT-18, GT-20					MX-09, MX-20 MX-30		140/ 63.5
10 5/8 269.9	6 5/8		ATJ-33A, ATJ-44, ATJ-44A										158/ 71.7
11 279.4	6 5/8		ATJ-33A, ATJ-44A ATJ-55A			GT-28C							170/ 77.1
12 304.8											MX-28, MX35C		207/ 93.8
12 1/4 311.1	6 5/8	G44	ATJ-33C, AJT-44, ATJ-44A ATJ-44C, ATJ-55, ATJ-55R, ATJ-77	X33C X44C	MAX-44C	GT-00, GT-03 GT-09C, GT-09C GT-18, GT-20 GT-20C, GT28 GT-28C		MAXGT-00, MAXGT-03 MAXGT-09, MAXGT-18		H-03 H-09 H-30	MX-03 MX-09, MX-09CG MX-18, MX-20 MX-20G, MX-28 MX-30G		224/ 101.6
14 1/2 368.3	7 5/8							MAXGT-09					314/142.24
14 3/4 374.6	7 5/8							MAXGT-09, MAXGT-18			MX-03*, MX-09*		346/ 156.0
16 406.4	7 5/8				MAX-55		GTX-03 GTX-09 GTX-20C	MAXGT-00, MAXGT-03 MAXGT-09, MAXGT-18 MAXGT-20CG			MX-05*, MX-09*		485/ 220
17 1/2 444.5	7 5/8				MAX-44C, MAX-55		GTX-03 GTX-09 GTX-20 GTX-40C	MAXGT-00, MAXGT-03 MAXGT-09, MAXGT-18 MAXGT-20			MX-03*, MX-09*		569/ 258.1
22 558.8	7 5/8						GTX-03 GTX-09						1195/ 542
23 584.2	7 5/8						GTX-20G						1199/ 542
24 609.6	7 5/8						GTX-00 GTX-03 GTX-20						1375/ 624
26 660.4	7 5/8						GTX-03 GTX-20						1477/ 670

*Coming in 1999

ROCK BIT SIZES & TYPES

Steel Tooth Bits

in.	mm	API PIN	DR/R	ATJ	GT	GTX	ATMGT	MAXGT	STR	MX	LB.	KG.
3 3/4	95.2	2 3/8	DR5								10	4.5
3 7/8	98.4	2 3/8	DR5								10	4.5
4 1/8	104.8	2 3/8	DR5						STR-1		11	5.0
4 5/8	117.5	2 7/8	DR5						STR-1		16	7.3
4 3/4	120.6	2 7/8	DR5	ATJ-4					STR-1		16	7.3
5 7/8	149.2	3 1/2		ATJ-4					STR-1		29	13.2
6	152.4	3 1/2		ATJ-4	GT-1				STR-1		30	13.6
6 1/8	155.6	3 1/2	R7	ATJ-4	GT-1				STR-1		30	13.6
6 1/4	158.7	3 1/2			GT-1				STR-1		30	13.6
6 1/2	165.1	3 1/2			GT-1				STR-1		31	14.1
6 3/4	171.4	3 1/2			GT-1				STR-1		45	20.4
7 7/8	200	4 1/2		ATJ-G4	GT-1 GT-G1H					MX-1	73	33.1
8 3/8	212.7	4 1/2				GTX-G3					86	39.0
8 1/2	215.9	4 1/2	R7	ATJ-G8	GT-1 GT-G1	GTX-G3				MX-1	86	39.0
8 3/4	222.2	4 1/2		ATJ-G4	GT-1 GT-G1					MX-1	90	40.8
9 1/2	241.3	6 5/8			GT-1		ATM-GT3				130	58.9
9 7/8	250.8	6 5/8			GT-1 GT-G1					MX-1	137	62.1
10 5/8	269.9	6 5/8			GT-1						159	72.1
11	279.4	6 5/8	R1		GT-1						165.	74.8
12 1/4	311.1	6 5/8	R1 R7	ATJ-G8	GT-1 GT-G1	GTX-1 GTX-G1 GTX-G3		MAX-GT1 MAX-GT3		MX-1	211	95.7
13 1/2	342.9	6 5/8	R1			GTX-1					231	104.8
13 3/4	349.3	6 5/8	R1			GTX-1					269	122.0
14 1/2	368.3	7 5/8				GTX-1					296	134.08
14 3/4	374.6	7 5/8	R1			GTX-1 GTX-G1 GTX-G3		MAX-GT1			305	138.3
16	406.4	7 5/8				GTX-1 GTX-G1		MAX-GT1 MAX-GT3			485	220.0
17 1/2	444.5	7 5/8	R1			GTX-1 GTX-G1 GTX-3		MAX-GT1 MAX-GT3			568	257.6
20	508.0	7 5/8	R1								685	310.7
22	558.8	7 5/8	R1			GTX-G1					1133	514.0
23	584.2	7 5/8	R1								1155	524.0
24	609.6	7 5/8	R1			GTX-G1					1245	564.7
26	660.4	7 5/8	R1 R3			GTX-G1					1280	580.6

TRICONE PRODUCT NOMENCLATURE

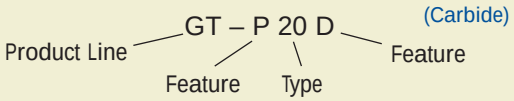
Hughes Christensen offers the industry's most comprehensive line of roller cone bits. We are committed to providing solutions to your most challenging projects, regardless of where you are drilling or the formations you will encounter.

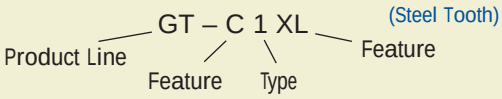
Applications

BIT APPLICATIONS	Ultra Max (MX)	MAXGT	HydraBoss (H)	GT	HardRok (HR)	STAR (STR)	ATJ	GTX	G
Motor	■	■							
High RPM	■	■							
High Temperature	■	■							
Highly Abrasive	■	■			■				
Prone to Bit Balling	■		■						
Slim Hole						■			
Conventional Rotary Speed				■			■		
Higher Weight				■			■		
Economical – Short Sections & Hours				■				■	
Ultra Hot / Geothermal								■	■
Hard Formation					■				

Bearing & Performance Packages

PRODUCT LINES	Ultra Max (MX)	MAXGT	HydraBoss (H)	GT	HardRok (HR)	STAR (STR)	ATJ	GTX	G
Journal Bearing	■		■	■	■	■	■		
Ball & Roller Bearing	■	■						■	■
Metal Seal	■	■							
Elastomer Seal			■	■	■	■	■	■	
GT Performance Package	■	■	■	■	■	■		■	
Enhanced Hydraulics	■		■						





Product Features

	EXAMPLE			EXAMPLE	
A	Air Journal Bearing, Air Nozzles	ATJ-33**A**	DX	DSE Diamond Gauge Compacts (33%)	STR-09**DX**
C (prefix)	Center Jet	GT-**C**18	G	Enhanced Gauge	MX-20**G**
C (suffix)	Conical Shape Inserts	H-18**C**	L	Leg Bullets	GT-**L**09
D	Diamond Gauge Compacts (33%)	MX-20**D**	M	Motor Hardfacing	GT-**M**1
D1	Diamond Gauge Compacts (66%)	MX-20**D1**	P	Leg Stabilization Wear Pad	GT-**P**18
D2	Diamond Gauge Compacts (100%)	MX-20**D2**	R	Spray Coated Cones	GT-**R**09
DT	Diamond Gauge Trimmers	MX-18**DT**	S	Shirttail Compacts	GT-**S**20
DDT	DX Diamond Gauge/Diamond Trimmers	MX-09**DDT**	T	High Flow Nozzles	MAXGT-**T**03
DP	Diamond Enhanced Wear Pad	ATJ-**DP**55	XL	Tooth Extenders (Steel tooth)	GT-1**XL**
DS	Diamond Shirttail Compacts	GT-**DS**09C			

NOZZLE SELECTION

Nozzles				
Bit Size	Standard Nozzle	Mini-Extended	Vortex 3 Port	Vortex 6 Port
3 1/2 – 3 3/4	FA			
3 7/8 – 4 3/4	FA			
4 1/2 – 4 3/4	FB			
5 5/8 – 6 3/4	FF			
7 3/8 – 7 7/8	FH	LH		
8 3/8 – 14	FK	LK	EW265	EY334
14 1/2 – 26	FL	LL	XRC592	

Center Jets		
Bit Size	Assembly	Nozzle
7 7/8	CJ7	FF
8 3/8 & larger	CJF	FF
10 5/8 & larger	CJK	FK

Notes:
Vortex 3 port EW265 has equivalent nozzle size of 8
Vortex 6 port EY334 has equivalent nozzle size of 14
Vortex 3 port XRC592 had equivalent nozzle size of 13

Nozzle Availability

Size	Standard FA	FB	FF	FH	FK	FL	Mini EXT. LH	LK	LL
00									
06									
08									
09									
10									
11									
12									
13									

Size	Standard FA	FB	FF	FH	FK	FL	Mini EXT. LH	LK	LL
14									
15									
16									
18									
20									
22									
24									
28									

TECHNICAL INFORMATION

Make-Up Torque Recommended for Rock Bit Shanks					
Shank Size	Recommended Torque		Shank Size	Recommended Torque	
in.	ft-lb	m-kg	in.	ft-lb	m-kg
2 3/8	3,000-3,500	410-480	6 5/8	28,000-32,000	3870-4420
2 7/8	4,500-5,500	620-760	7 5/8	34,000-40,000	4700-5530
3 1/2	7,000-9,000	970-1420	8 5/8	40,000-60,000	5530-8300
4 1/2	12,000-16,000	1660-2210			

API Roller Cone Bit Tolerances		
NOMINAL BIT SIZE O.D.	O.D. TOLERANCE	
inches	inches	mm*
3 3/8" – 13 3/4", incl.	-0. +.0313 (1/32)	-0. + .794
14" – 17 1/2", incl.	-0. +.0625 (1/16)	-0. +1.588
17 5/8" and larger	-0. +.0938 (3/32)	-0. +2.381

*Converted from inches

TRICONE BIT OPTIONAL FEATURES

Center Jet (C prefix)

A fourth jet may be positioned in the center of the bit. Center jets primarily are used to prevent bit balling and the associated reduction in penetration rate. Center jets are available in bit sizes 7 7/8" and larger. Vortex nozzles are recommended for most center jet applications. Their unique design increases inner bit turbulence, essentially eliminating stagnant areas on bottom.

DX Gauge Enhancement Package

For directional and highly abrasive applications, Hughes Christensen offers the DX diamond gauge protection package as an option. Every third gauge compact utilizes new DSE compact technology with a thicker diamond table and generous chamfer for increased resistance to breakage.

D Gauge Enhancement Package (33% diamond gauge)

For extremely abrasive applications, a diamond gauge enhancement package is recommended. These premium gauge protection packages feature Hughes Christensen's patented shear cutting diamond gauge inserts. These inserts are strategically located on the gauge surface of the cone and are designed to cut and trim the borehole wall to maintain a full gauge hole.

D1 Gauge Enhancement Package (66 % diamond gauge)

D2 Gauge Enhancement Package (100% diamond gauge)

Diamond Gauge / Diamond Trimmers (DDT)

For maximum protection to the gauge and heel area. Every Gauge Trimmer is diamond and every third gauge compact is DX diamond.

Diamond Enhanced Wear Pad (DP)

For additional leg protection in abrasive applications, flat-diamond compacts can be added to the leading edge of the leg pad.

Diamond Gauge Trimmers (DT)

For abrasive applications where gauge rounding is a problem. Every Gauge Trimmer is diamond.

Diamond Shirttail Compacts (DS)

For additional leg protection in abrasive applications, flat diamond compacts can be inserted on the leg of the bit.

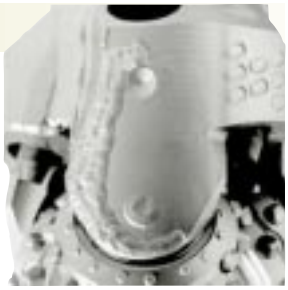
G Gauge Enhancement Package (G)

One of the gauge enhancement packages available for directional and highly abrasive applications. The G-Bit package utilizes tough ovoid shaped inserts on the heel row and generous amounts of carbide inserts on the gauge. Steel tooth bits are designed with a full compliment of carbide inserts on gauge.

Leg Bullets (L)

Elongated tungsten carbide compacts are added to the shirttail to reduce leg wear in abrasive formations and deviated or horizontal well bores.

Motor Hardfacing (M)



For additional protection in high speed, directional or abrasive environment applications, motor hardfacing can be applied to essentially all of the Hughes Tricone line. Tungsten carbide particle hardfacing is liberally applied along the shirttail, and extended up the leading edge of the bit leg.

Spray Coated Cones (R)

For additional wear resistance when drilling directional or abrasive applications, Hughes Christensen offers a tungsten carbide coating for its cones.

Wear / Stabilization Pad (P)

Wear/stabilization pads are steel blocks containing flush mounted carbide inserts. This extra protection is added to the outer diameter of a rolling cutter bit to minimize wear on the bit leg or body.

Shirttail Compacts (S)

Tungsten carbide compacts are added to the shirttail to reduce leg wear in abrasive formations and deviated or horizontal well bores.

High-Flow Extended Nozzles (T)

High Flow Extended Nozzles are added to maximize penetration rates in both hard and soft formations. Used in both single and twin arrangements, these nozzles are much sturdier and possess greater flow capacity than conventional extended nozzles.

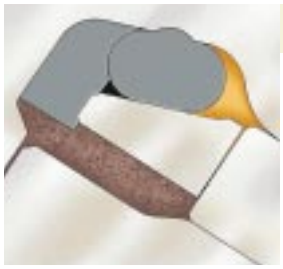
XL Feature

XL is a patent pending tooth geometry that allows an additional application of hardfacing in the areas susceptible to abrasive wear.

UltraMax Bits

UltraMax is a line of bits designed specifically for the rigors of motor and high-speed drilling and other demanding applications. New technologies to protect the bearing seal have been integrated into a more robust metal sealed bearing package with tighter tolerances and built-in reliability. A new grease and lubrication system is protected by the BOSS six point stabilization system. Cuttings are removed with Clean Sweep hydraulics. UltraMax offers you the perfect balance of high speed performance and reliability.

UltraMax Bit Availability	
7 7/8”	MX-1, MX-09, MX-18
8 3/8”	MX-18, MX-20G, MX-30G, MX-35CG
8 1/2”	MX-1, MX-03, MX-09, MX-09G, MX-09C, MX-18, MX-20, MX-20G, MX-30, MX-35CG, MX-40CG
8 3/4”	MX-1, MX-20
9 1/2”	MX-1, MX-20
9 7/8”	MX-1, MX-09, MX-20, MX-30
12 1/4”	MX-1, MX-03, MX-09, MX-09CG, MX-18, MX-20, MX-20G, MX-28, MX-30G



SEM Bearing Package

UltraMax utilizes a patented single energizer metal sealing system (SEM) which is far simpler, yet more robust than earlier technology. Fewer sealing components and tighter tolerances ensure fewer avenues for leakage and greater reliability in the tough applications. Additional bearing refinements like a silver plated insert and new bearing geometry add up to a tougher bearing ready to provide long hours under the most strenuous operating conditions.

Excluder Package

The Excluder Package is comprised of new technology targeted specifically at preventing the detrimental effects of mud packing. The cornerstone of the package is an elastomer backup ring. Strategically positioned to occupy a space where particles once invaded, the ring acts as a static seal between the mud and seal package. Also working against the effects of mud packing is the Mud Wiper and Cone Backface Groove which work in tandem to wipe away packed-in mud.

Equalizer Lubrication Package

A new modified grease formulation provides lower torque, less heat and reduced wear in the sealing area. Also included in the Equalizer Package is an improved compensation system. The compensator is made with HSN elastomer material for improved heat and chemical resistance. Its spring energized compensator cap reduces vibration and fretting.

Clean Sweep Hydraulics

All UltraMax bits utilize the Clean Sweep hydraulic system designed to directly clean areas of the cutting structure prone to bit balling and mudpacking. Clean Sweep's unique design allows aggressive cleaning of the heel row, the gauge trimmers and gauge compacts. The nozzle position minimizes flow recirculation and turbulence, providing superior chip removal.

BOSS Stabilization

The BOSS Stabilization System features unique integrated stabilizers which provide near six point contact with the borehole wall. This new technology provides unequaled bit stability while protecting the cutting structure from damaging blows.

HydraBoss Bits

HydraBoss is a new line of hydraulically enhanced bits designed to drill bit balling formations. Nozzles have been shifted closer to the cones with their flow directed toward the heel and gauge area. A new BOSS Stabilization System provides unequaled bit stability. A new Anti-Balling Heel and tougher carbide tooth shapes further enhance this new product line designed to help you drill faster in formations that ball up the cutting structure.

HydraBoss Bit Availability	
7 7/8”	H-03, H-09, H-09C, H-18, H-18C, H-20, H-20C, H-30
8 1/2”	H-03, H-09, H-20, H-30
8 3/4”	H-03, H-09, H-09C, H-18, H-20, H-28
12 1/4”	H-03, H-09, H-30

Clean Sweep Hydraulics

Nozzles are positioned closer to the cones with their fluid streams directed toward areas where bit balling occurs. Clean Sweep's high velocity core strikes heel and adjacent heel teeth and sweeps the critical bit offset space on the backside of the cutter. With most of the flow core confined to this critical area, undesirable recirculation and turbulence are minimized and return flow is unobstructed.

Anti-Balling Heel

HydraBoss bits utilize a patented Anti-Balling Heel which contains a non-traditional heel row. The conventional staggered row has been eliminated leaving room for additional teeth on the adjacent heel row. For more durability, large additional gauge trimmers are added as well.

BOSS Stabilization

HydraBoss bits incorporate a unique integrated BOSS Stabilization System which provides near six point contact with the borehole wall. Positioned directly opposite the gauge point, these patented stabilizers accept contact with the wall of the hole, cushioning the bit against vibrating forces.

Harder Carbide Grade & New Tooth Shapes

A new harder carbide grade resists deformation and ensures a more durable tooth. In addition, a new tooth geometry reduces damaging tensile stresses ensuring longer hours on bottom.

STAR Bits

STAR drill bits are a premium line of Tricone bits designed specifically for slim hole wells. Both steel tooth and tungsten carbide insert bits employ many of the features found in Hughes Christensen's widely accepted GT line. In addition, improvements in bearing geometry / metallurgy, compensator design and shirttail protection have combined to make these the most reliable, high performance slimhole tricone bits available.

Star Bit Availability	
3 3/4"	STR-20
3 7/8"	STR-30, STR-50
4 1/8"	STR-1, STR-30, STR-70
4 1/2"	STR-1, STR-35C, STR-70
4 5/8"	STR-40, STR-40C
4 3/4"	STR-1, STR-05C, STR-20, STR-30, STR-30C, STR-44C, STR-70
5 5/8"	STR-09
5 3/4"	STR-1, STR-09
5 7/8"	STR-1, STR-09, STR-20, STR-30, STR-44C, STR-50, STR-70
6"	STR-1, STR-09, STR-20, STR-30, STR-40, STR-40C, STR-50, STR-70
6 1/8"	STR-1, STR-03, STR-09, STR-09C, STR-20, STR-30, STR-30C, STR-40, STR-44C, STR-50, STR-70
6 1/4"	STR-1, STR-09, STR-20, STR-30, STR-40, STR-40C, STR-50, STR-70
6 1/2"	STR-1, STR-09, STR-20, STR-30, STR-30C, STR-44C, STR-50, STR-50R, STR-70
6 3/4"	STR-1, STR-09, STR-20, STR-30C, STR-40, STR-44C

Gauge Trimmers

Patented, self-sharpening carbide inserts efficiently remove uncut rock ribs between the heel teeth. Gauge Trimmers enhance ROP and improve steering responsiveness.

Active Gauge Compacts

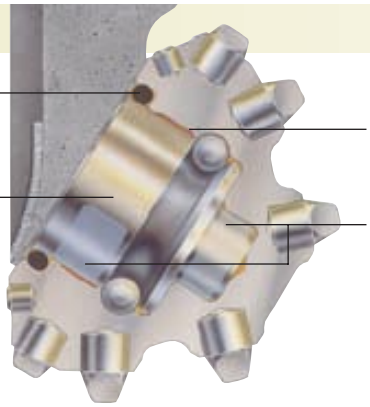
Gauge compacts are extended out from the cone steel to assist the heel row and gauge trimmers in cutting hole wall to full gauge.

Shirttail Compacts

Tungsten carbide compacts have been added to the shirttail to reduce leg wear in abrasive formations and deviated or horizontal well bores.

Updrill Feature

A standard feature which provides additional protection to the bit and assists the drilling operation when tight hole conditions are encountered or backreaming is required.



G2 Bearing

STAR bits utilize the very reliable G2 bearing package. Breakthroughs in elastomer research, metallurgy, and bearing design have been incorporated into a package that is consistently coming out of the hole seal effective.

STEEL TOOTH BITS

Bi-Metallic Gauge

Two hardfacing alloys are applied to the gauge surface to reduce gauge wear and rounding.

Trimmer Pads

Hardmetal pads, placed between the heel teeth, minimize cone shell erosion, inhibit rounded gauge, and cut the borehole wall more efficiently.

Inverted Radius Tooth Geometry

A patented tooth geometry that allows thicker application of hardfacing in the areas susceptible to abrasive wear.

Endura Hardfacing

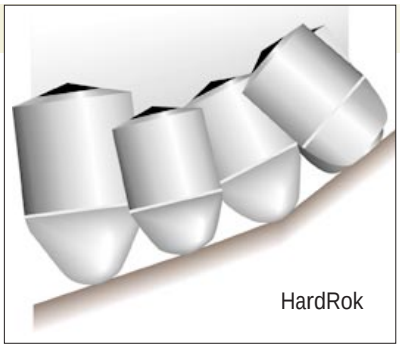
A unique, extremely wear resistant coating that is very tough and resistant to flaking and chipping.

HardRok Bits

HardRok is a family of bits designed specifically for hard and abrasive formations. Advancements in nose design and compact technology give these bits an aggressive yet more durable cutting structure for drilling hard West Texas carbonates. For bits drilling the hard and abrasive sands of East Texas, Hughes Christensen engineers have developed a double gauge row which is aggressively positioned to reinforce the heel row and keep the bit in gauge. Other advancements such as new aggressive tooth shapes, a new stabilization system and tucked shirttails allow HardRok bits to drill longer and faster.

HardRok Availability	
7 7/8”	HR-40C, HR-50, HR-60, HR-80
8 1/2”	HR-50R
8 3/4”	HR-40C, HR-50
9 7/8”	HR-50

Standard

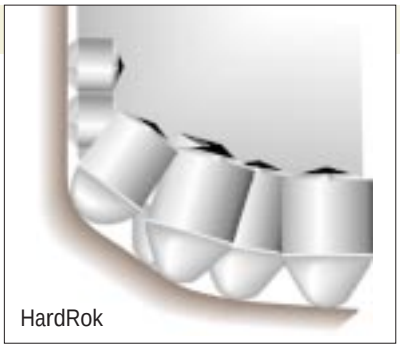


HardRok

More Efficient Nose Area

HardRok bits employ a new cutter orientation for better bottom hole coverage. New, sharper compacts with increased projection have been added to the nose area to increase the bit's aggressiveness without giving up durability.

Standard



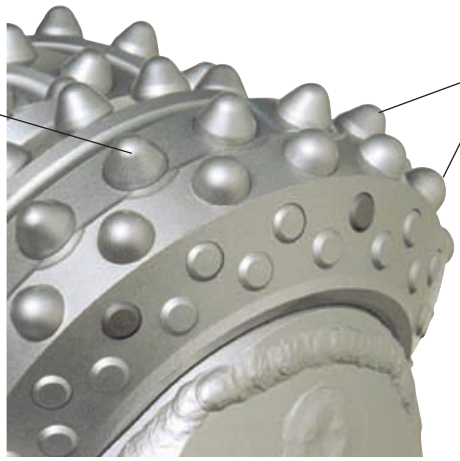
HardRok

Tougher Heel and Gauge

HardRok incorporates up to 100% more carbide in a double gauge row configuration. Gauge compacts are now positioned closer to the edge of the heel. In this position they hold gauge, assist the heel row drilling formation and maintain drilling effectiveness as the bit wears.

More Durable Compact Shape

Many HardRok bits utilize a new double angle conical compact. This new geometry provides a sharper nose radius and better load distribution.



New Wear Resistant Carbide

HardRok bits use compacts made with a new wear resistant carbide that resists crack propagation, lowering the probability for tooth fracture.

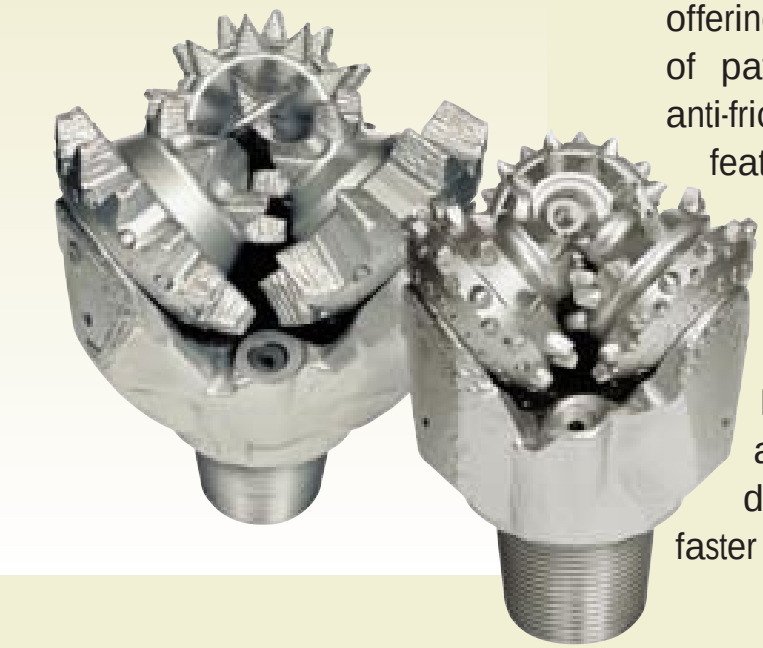
BOSS Stabilization

With six-point contact with the borehole wall, HardRok bits are cushioned against vibrating forces, protecting the cutting structure from damaging blows.

Tucked Shirttails

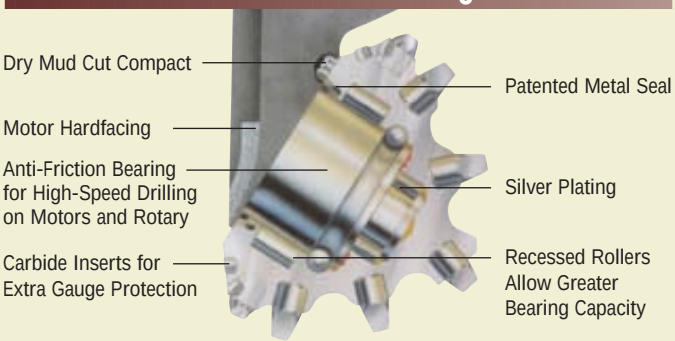
Shirttails have been pulled away from the hole wall, providing more room for cuttings removal while reducing friction generated heat.

MAXGT / MAX Bits



The MAX rock bit line is the only bit offering the ideal high-speed combination of patented high RPM metal seals and anti-friction roller bearings. MAX bits feature compensating metal-to-metal bearing seals which provide long lasting protection for bearings under the demands of directional and downhole motor drilling. MAXGT bits utilize Gauge Trimmers and active gauge inserts to improve drilling efficiency which results in faster ROP and longer bit life.

Metal Sealed Anti-Friction Bearing



Gauge Trimmers

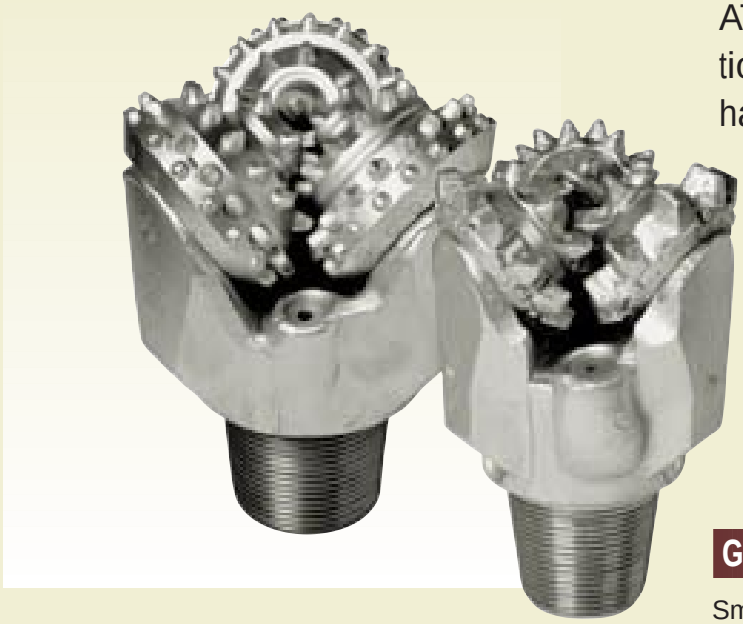
Small self-sharpening inserts have been strategically placed between the heel row teeth. Gauge Trimmers minimize cone shell erosion and rounded gauge, allowing a bit's cutting structure to retain its drilling effectiveness as it wears.

Motor Hardfacing

Tungsten carbide particle hardfacing has been liberally applied from the shirttail up the leg of the bit. This extra protection allows MAX bits to hold gauge better and resist the wear that comes with high speed, directional drilling.

MAXGT / MAX Availability	
12 1/4"	MAXGT-00, MAXGT-03, MAXGT-09, MAXGT-18, MAX-11CG, MAX-44C
14 1/2"	MAXGT-09
14 3/4"	MAXGT-09, MAXGT-18
16"	MAXGT-00, MAXGT-03, MAXGT-09, MAXGT-18, MAXGT-20CG, MAX-11HG, MAX-22, MAX-55
17 1/2"	MAXGT-00, MAXGT-03, MAXGT-09, MAXGT-18, MAXGT-20, MAX-11H, MAX-11HG, MAX-22, MAX-22G MAX-44C, MAX-55

ATMGT / ATM Bits

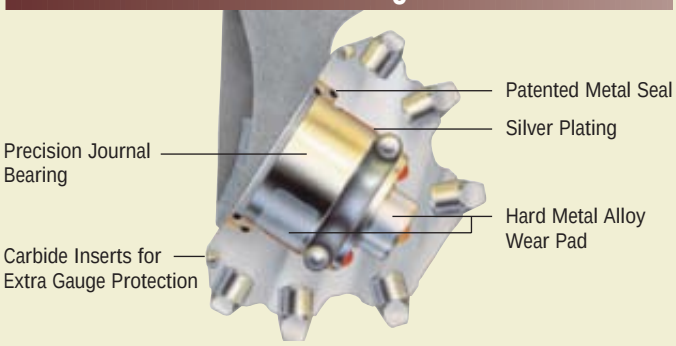


ATM bits are ideally suited to applications requiring high rotary speeds, having high bottom hole temperatures, drilling in excessive abrasives or a combination of these conditions which limit the life of O-ring sealed bits.

Gauge Trimmers

Small self-sharpening inserts have been strategically placed between the heel row teeth. Gauge Trimmers minimize cone shell erosion and rounded gauge, allowing a bit's cutting structure to retain its drilling effectiveness as it wears.

Metal Sealed Journal Bearing



Active Gauge Compacts

Gauge compacts are extended out from the cone steel to assist the heel row and gauge trimmers in cutting hole wall to full gauge.

ATMGT / ATM Availability	
8 3/8"	ATMGT-09, ATMGT-18, ATMGT-20G, ATM-18, ATM-22G, ATM-33G
8 1/2"	ATMGT-03, ATMGT-09, ATMGT-09C, ATMGT-18, ATMGT-20, ATM-11HG, ATM-22G, ATM-22, ATM-22C ATM-33, ATM-35CG
8 3/4"	ATMGT-18, ATMGT-20
9 1/2"	ATMGT-18, ATMGT-20, ATMGT-30
10 5/8"	ATMGT-20
12 1/4"	ATM-18, ATM-20, ATMGT-20G, ATM-11H, ATM-11HG, ATM-11CG, ATM-22, ATM-22C, ATM-22G, ATM-28 ATM-33, ATM-33G, ATM-33C, ATM-35CG
14 3/4"	ATM-33CG

GT Bits

GT stands for cutting edge technology. These premium elastomer sealed bits incorporate advances in cutter geometry, hardfacing and tooth design. GT bits utilize a cutting structure which cuts the borehole wall easily and efficiently, allowing more energy to be directed at drilling the hole bottom and improving penetration rate.

G2 Bearing

The very reliable G2 bearing incorporates breakthroughs in elastomer research, metallurgy, and bearing design.

Gauge Trimmers

Small self-sharpening inserts placed between the heel row teeth minimize cone shell erosion and rounded gauge, allowing a bit's cutting structure to retain its drilling effectiveness as it wears.

Active Gauge Compacts

Gauge compacts are extended out from the cone steel to assist the heel row and gauge trimmers in cutting hole wall to full gauge.

Endura Hardfacing

Endura is an extremely wear resistant coating that is tough and very resistant to flaking and chipping.

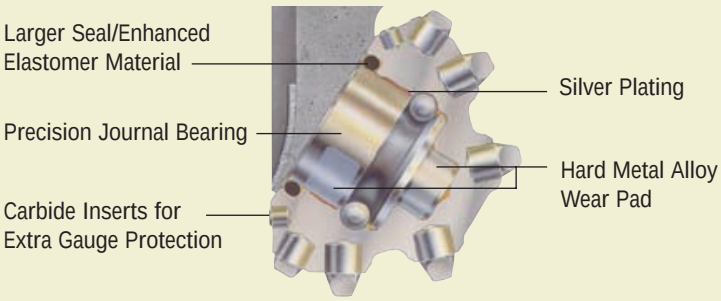
Bi-Metallic Gauge

To improve their gauge holding ability, GT bits utilize the superior impact resistance of Endura hardfacing in combination with wear resistant macro crystalline tungsten carbide on gauge for superior protection.

GT Availability	
7 7/8”	GT-03, GT-09, GT-09C, GT-18, GT-18C, GT-20S, GT-20, GT-20C, GT-28, GT-28C, GT-30, GT-30C
8 1/2”	GT-03, GT-09, GT-18, GT-20, GT-20C, GT-30C
8 3/4”	GT-00, GT-03, GT-09, GT-09C, GT-18, GT-20, GT-20C, GT-30
9 1/2”	GT-30
9 7/8”	GT-03, GT-09, GT-18, GT-20, GT-30
11”	GT-28C
12 1/4”	GT-00, GT-03, GT-09, GT-09C, GT-18, GT-20, GT-20C, GT-28, GT-28C

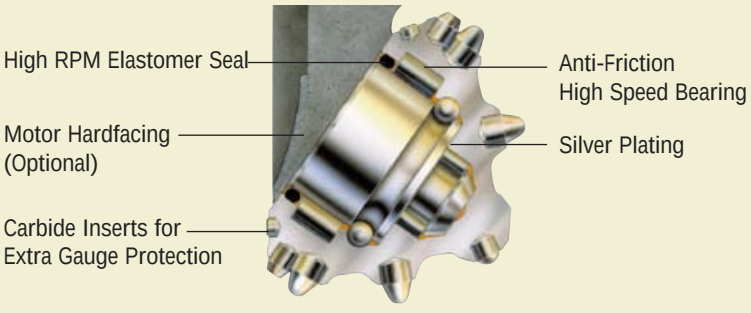
ATJ Bits

For applications requiring higher weight on bit while turning at conventional rotary speed, Hughes Christensen recommends the ATJ line of bits. These elastomer sealed bits utilize the G2 bearing package which consistently comes out of the hole seal effective.



GTX / ATX Bits

The GTX / ATX line features an O-ring sealed ball and roller bearing. These bits are recommended for high rpm drilling and directional applications where hole sections and hours on bit are reduced. Advanced Technology features make GTX / ATX an economical alternative in these applications.



DIAMOND DRILL BITS

ABD, BD (Black Diamond) Series Diamond Compact Bits

Black Diamond is a premium line of multi-purpose bits, custom designed for specific applications. Utilizing "Application Engineered Black Ice Cutters" and "Engineered Cutter Layouts", Black Diamond bits can be tailored to meet the unique requirements of specific formations and operating parameters. Designs also utilize new hydraulics, gauge design and streamlined geometry. ABD bits utilize Anti-Whirl Technology.

BX (Black Trax) Series Diamond Compact Bits

BlackTrax is a revolutionary line of PDC bits designed specifically for steerable applications. BlackTrax bits feature a long tandem gauge. This less aggressive gauge with limited side cutting action, has improved steerability and delivers a quality wellbore. BlackTrax bits with Black Ice Cutters take advantage of Engineered Cutter Technology. Each bit's cutter configuration is tailored for a specific application. Like BD bits, BX bits incorporate new hydraulics, gauge design and streamlined geometry.

AG/G (Gold) Series Diamond Compact Bits

Designed for conventional drilling, the AG/G bits feature Stress Engineered Cutters, Engineered Cutter Placement, Carbide Supported Edge, and Black Ice polished Cutters. AG Series bits incorporate Anti-Whirl technology to extend their life and application range.

STR (STAR) Series Diamond Compact Bits

STAR is a premium line of small diameter PDC bits. Gold Series features like Stress Engineered Cutters, Carbide Supported Edge geometry and Black Ice polished cutters make these the right choice for the challenges of slim hole† and directional applications. Where steerability is a concern, STAR bits are available with increased cutter back rake, and wearknots to limit torque variability.

S-Series BallaSet Bits

S series bits utilize thermally-stable polycrystalline diamond cutters to drill medium to hard formations, or diamond impregnated segments to drill hard, abrasive formations.

D-Series Natural Diamond Bits

The D Series bits are surface set with natural diamonds of various grades and concentrations to drill a variety of harder, more abrasive formations.

†Rotary and Coiled Tubing

Diamond Drill Bit Series

	PDC*	BallaSet	Natural Diamond
Spectrum Technology			
Black Diamond	BD		
Anti-Whirl Black Diamond	ABD		
BlackTrax	BX		
Auto Trak**	TX**		
Conventional PDC			
Gold Series	G		
Anti-Whirl Gold Series	AG		
Impregnated PDC			
BallaSet		S	
Natural Diamond			D, T

*PDC Cutter Size is identified by the first digit of the bit nomenclature
3 = 3/8" cutter 4 = 1/2" cutter 5 = 3/4" cutter i.e. BD554 has 3/4" cutters

**Designed for use in conjunction with Baker Hughes INTEQ's AutoTrak Rotary Steerable Tool

DIAMOND BIT OPTIONAL FEATURES*

C1 – Carbide Supported Edge (CSE)

The Carbide Supported Edge feature is a special configuration of the edge geometry that improves durability and modifies damaging stresses in a critical area of the cutter.

C2 – Polished Cutter / Carbide Supported Edge Combination

Cutter option where the Polished Cutters are combined with Carbide Supported Edge geometry.

C3 – "Black Ice" Polished Cutters

"Black" Ice cutters have highly polished surfaces, whose extremely low friction coefficient reduce shear forces, improving cuttings removal and drilling efficiency.

D – Directional Option

Bits with the Directional option incorporate a 30 degree back rake on all cutters (face and gauge). A PDC cutter with a higher backrake reduces the aggressiveness of the cutter. The "D" option can provide a smoother torque response and better control of the toolface angle in some steerable motor applications.

EB – Extended B Profile

This option describes an extended B profile on natural diamond bits that normally use an RB profile. The EB profile uses a smooth transition between the nose and the gauge creating a rounded shoulder instead of a straight flank.

G1 – Undercut Gauge

The G1 option is designed specifically for AR and AG Series bits. The gauge pads are set at 0.025" under the full hole diameter as defined by the PDC gauge trimmers. The G1 option is designed to provide better side cutting ability and therefore improve angle build capability and steerability.

G2 – Shorter Gauge Than Standard

The G2 gauge option is defined as any gauge length shorter than the standard for a given bit size.

G3 – Step Gauge

The G3 gauge option, also known as the step gauge, consists of two equal length gauge pad sections, a primary pad and a secondary pad. This feature is designed to provide the steerability and build rate benefits of the G2 option while minimizing the disadvantages of reduced durability and stabilization.

G5 – In-Gauge PDC Trimmers

Additional PDC cutters are flush mounted on the leading edge of the gauge pads.

G8 – Longer Gauge Than Standard

The G8 option is any gauge length that is longer than the standard gauge length for a given bit size.

G9 – Turbine Sleeve

For greater bit stability when drilling with high rotational speeds, an optional gauge sleeve may be added.

J – Chipbreaker Feature

The "J" option is a face volume/junk slot enhancement that is more commonly known as the chipbreaker feature. The chipbreaker assists bit cleaning by creating a sharp deflection of the cuttings after moving off the face of the cutter causing them to break off in discrete elements before forming long contiguous chips.

K – Wear Knot

Matrix pads located behind the PDCs restrict the depth of cut. Used almost exclusively in horizontal or high angle drilling, Wear Knots help minimize large torque variations that could cause the toolface angle to swing erratically.

M – Multiport Hydraulics

Due to room constraints, effectively adding nozzles to bits smaller than 8 3/4" can pose design problems. This option indicates fixed ports or a combination of fixed ports and nozzles have been designed into the bit.

P – Block Segments

This option describes parallel-piped segments (also called block segments, interrupted segments, or Porcupine) on impregnated bits. The "P" option improves cleaning of the segments by providing cross-flow paths in the segment profile.

U1 – Natural Diamond Updrill

The Updrill feature drills the formation when the bit is rotated while tripping out of the hole. This reduces the risk of problems in tight holes, unstable formations or salt sections.

X – Extra Cutters

This option provides additional cutters on each blade in the shoulder area.

Y – Box-Up Connection

Some directional drilling applications utilizing turbines have required the smallest possible distance between the bit face and the lower bearing stabilizer. This has been achieved by using a pin-down connection on the turbine.

**Features may only be available on certain styles.*

TFA Values Of Common Nozzle Sizes

Size	NUMBER OF NOZZLES									
	1	2	3	4	5	6	7	8	9	10
7	.0376	.0752	.1127	.1503	.1877	.2255	.2631	.3007	.3382	.3758
8	.0491	.0982	.1473	.1963	.2454	.2945	.3436	.3927	.4418	.4909
9	.0621	.1242	.1864	.2485	.3106	.3728	.4349	.4970	.5591	.6213
10	.0767	.1534	.2301	.3060	.3835	.4602	.5369	.6136	.6903	.7670
11	.0928	.1856	.2784	.3712	.4640	.5568	.6496	.7424	.8353	.9281
12	.1104	.2209	.3313	.4418	.5522	.6627	.7731	.8836	.9940	1.1045
13	.1296	.2592	.3889	.5185	.6481	.7777	.9073	1.0370	1.1666	1.2962
14	.1503	.3007	.4510	.6013	.7517	.9020	1.0523	1.2026	1.3530	1.5033
15	.1726	.3451	.5177	.6903	.8629	1.0356	1.2080	1.3806	1.5532	1.7258
16	.1963	.3927	.5890	.7854	.9817	1.1781	1.3744	1.5708	1.7671	1.9634
17	.2217	.4433	.6650	.8866	1.1083	1.3300	1.5516	1.7733	1.9949	2.2166
18	.2485	.4970	.7455	.9940	1.2425	1.4910	1.7395	1.9880	2.2365	2.4850
19	.2769	.5538	.8307	1.1076	1.3845	1.6614	1.9383	2.2152	2.4921	2.7690
20	.3068	.6136	.9204	1.2272	1.5340	1.8408	2.1476	2.4544	2.7612	3.0680
22	.3712	.7424	1.1137	1.4849	1.8561	2.2273	2.5985	2.9698	3.3410	3.7122

Diamond Drill Bit Recommended Make-up Torque

API Reg. Pin Conn.	Recommended Make-up Torque Range		Bit O.D.
inches	kNm*	1000 ft-lbs	inches
2 3/8	2.4 – 2.7 3.3 – 3.7 4.2 – 4.6	1.8 – 2.0 2.4 – 2.7 3.1 – 3.4	3 3 1/8 3 1/4
2 7/8	4.2 – 4.6 6.2 – 6.9	3.1 – 3.4 4.6 – 5.1	3 1/2 3 3/4 & larger
3 1/2	7.1 – 7.7 8.5 – 9.4 10.4 – 11.4	5.2 – 5.8 6.4 – 7.1 7.7 – 8.6	4 1/8 4 1/4 4 1/2 & larger
4 1/2	16.9 – 18.6 22.4 – 24.5 23.9 – 26.3	12.5 – 13.7 16.5 – 18.1 17.6 – 19.4	5 1/2 5 3/4 6 & larger
6 5/8	50.3 – 55.3 51.5 – 56.7	37.1 – 40.8 38.0 – 41.8	7 1/2 7 3/4 & larger
7 5/8	65.5 – 72.0 78.2 – 86.1 81.3 – 89.5	48.3 – 53.1 57.7 – 63.5 60.0 – 66.0	8 1/2 8 3/4 9 & larger

API Diamond Bit Tolerances

NOMINAL BIT SIZE O.D.	O.D. TOLERANCE	
inches	inches	mm*
up to 6 1/4", incl.	+0. -0.015	+0. -0.38
6 25/32" to 9", incl.	+0. -0.020	+0. -0.51
9 1/32" to 13 1/4"	+0. -0.030	+0. -0.76
13 25/32" and larger	+0. -0.045	+0. -1.14

*Converted from inches

Black Diamond Bits

Black Diamond is a premium line of multi-purpose bits, custom designed for your applications. Utilizing Application Engineered Cutters and Engineered Cutter Layouts, Black Diamond bits can be tailored to meet the unique requirements of specific formations and operating parameters. In addition to new cutter technology, Black Diamond bits feature a "total balance" concept. The volume of rock removed is proportional to the volume of fluid flow. Other features like Duraset Gauge and streamlined geometry make the Black Diamond line the standard for PDC technology.

Black Diamond Availability

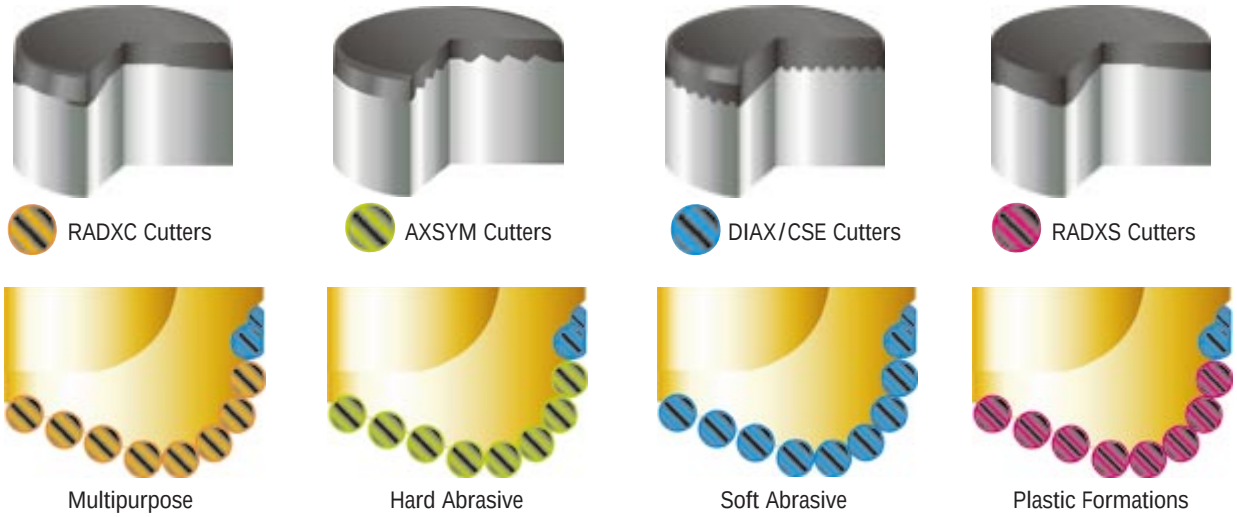
IADC	BD444 M133			BD426 M133			BD445 M233			BD447 M333			BD449 M433			BD554 M123			BD535 M123			BD536 M223			BD547 M323			BD549 M423		
Size	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Blades	4			5			6			8			10			4			5			6			8			10		
Nozzles	4	4	*	5	5	*	6	6	6	4	6	8	*	4-5	8	4	4	4-6	5	5	5	6	6	6	*	*	8	*	*	5-8
IADC	ABD444** M133			ABD426** M133			ABD445** M233			ABD447** M333			ABD449** M443			ABD554** M123			ABD535** M123			ABD536** M223			ABD547** M323			ABD549** M423		
Size	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Blades	4			5			6			8			10			4			5			6			8			10		
Nozzles	4	4	*	5	5	*	6	6	6	4	6	8	*	4-5	8	4	4	4-6	5	5	5	6	6	6	*	*	8	*	*	5-8

Size Range 1 6 3/4" — 8 1/2"
Size Range 2 8 1/2" — 10 5/8"
Size Range 3 10 5/8" — 12 1/4"

*Not recommended in this size range
**Antiwhirl Bits

Application Specific Cutter Technology

Whether you need to drill with good impact resistance in carbonates; withstand wear in abrasive formations; or retard formation build-up in plastic shales, there's a cutter to address each application. Years of research into cutter features like cutter interfaces, chamfer geometry, and polished surfaces has enabled Hughes Christensen to develop specific cutter types that demonstrate superior characteristics for given drilling environments.



Designed for Specific Applications

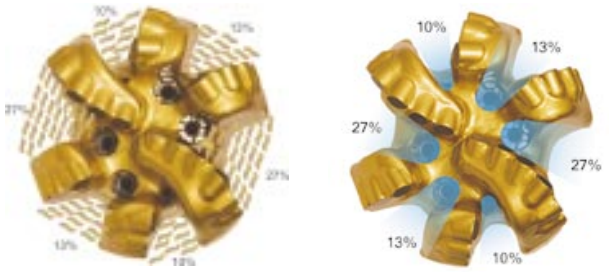
Engineered Cutter Placement

From an examination of dulls, it's obvious certain areas of a bit undergo more wear than others. Some areas must withstand impact while other areas must be abrasion resistant. Black Diamond bits utilize Engineered Cutter Placement where Application Specific Cutters are strategically positioned on the bit body so that their design characteristics match-up well with the loads encountered downhole.

Balanced Flow Hydraulics

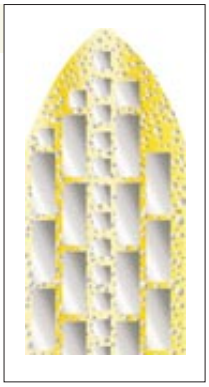
Each blade of a given type cuts about an equal volume of rock. The junk slots are then sized and balanced according to the cuttings generated. Flow volume is then apportioned across the face of the bit* proportional to the volume of rock cut.

This balanced chip management process dramatically reduces the tendency for bit balling.



Using engineered nozzle selection

Duraset Gauge



The Black Diamond Duraset Gauge provides the highest abrasion resistance available. Two leading rows of tungsten carbide bricks are followed by a row of natural cube diamonds. These alternating rows are embedded into a highly wear resistant matrix with impregnated diamonds.

Streamlined Geometry

Fluid movement is enhanced by the use of aerodynamic geometric shapes on the blades, junk slots and gauge.

BlackTrax Bits

BlackTrax is a revolutionary line of PDC bits designed specifically for steerable applications. Contrary to traditional beliefs, BlackTrax bits feature a less aggressive gauge, designed to improve stability. Research has shown, BlackTrax bits with their long tandem gauge and limited side cutting action, have improved steerability and deliver a quality wellbore. BlackTrax bits take advantage of Engineered Cutter Technology. Each bit's cutter configuration is tailored for a specific application.

Additional features like Balanced Hydraulics, streamlined blades and junk slots, and a tough Duraset gauge make BlackTrax bits the perfect choice for all of your steerable applications.

BlackTrax Availability

IADC	BX444 M133			BX426 M133			BX445 M233			BX447 M333			BX449 M433		
Size	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Blades	4			5			6			8			10		
Nozzles	4	4	*	5	5	*	6	6	6	4	6	8	*	4–5	8
Gauge	7'–10"	11"–12"	*	7'–10"	11"–12"	*	7'–10"	11"–12"	12"–14"	7'–10"	11"–12"	12"–14"	*	11"–12"	12"–14"
IADC	BX554 M123			BX535 M123			BX536 M233			BX547 M323			BX549 M423		
Size	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Blades	4			5			6			8			10		
Nozzles	4	4	4-6	5	5	5	6	6	6	4	6	8	*	*	5-8
Gauge	7'–10"	11"–12"	12"–14"	7'–10"	11"–12"	12"–14"	7'–10"	11"–12"	12"–14"	*	*	12"–14"	*	*	12"–14"

Size Range 1 6-3/4" — 8-1/2"
Size Range 2 8-1/2" — 10-5/8"
Size Range 3 10-5/8" — 12-1/4"

*Not recommended in this size range

Application Specific Cutter Technology

Cutters designed for specific applications are strategically positioned on the bit body to match downhole loads the bit is likely to encounter. All cutters employ the Black Ice polished cutter feature.

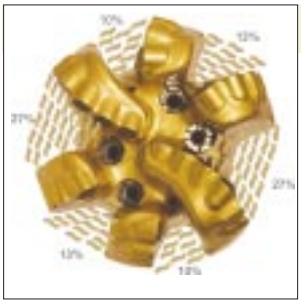
DIAX 45 Cutters | RADXC Cutters | DIAX 60 Cutters | AXSYM Cutters | DIAX/CSE Cutters

Multipurpose | Hard Abrasive | Soft Abrasive

Designed for Specific Applications

Engineered Cutter Placement

From an examination of dulls, it's obvious certain areas of a bit undergo more wear than others. Some areas must withstand impact while other areas must be abrasion resistant. BlackTrax bits utilize Engineered Cutter Placement where Application Specific Cutters are strategically positioned on the bit body so that their design characteristics match-up well with the loads encountered downhole.



Balanced Hydraulics

Balanced cuttings are achieved through like blades generating equal cuttings volume. Cuttings generation is then balanced to hydraulic flow and junk slot area.

Duraset Gauge

Duraset Gauge provides the highest abrasion resistance available. Two leading rows of tungsten carbide bricks are followed by a row of natural cube diamonds. These alternating rows are embedded into a highly wear resistant matrix with impregnated diamonds.

Streamlined Geometric Shapes

Fluid movement is enhanced by streamlined blades, junk slots and gauge. Streamlining bit features greatly reduces areas of flow stagnation.

STAR Bits

STAR PDC bits are small diameter bits with big bit features designed for the rigors of slimhole* and directional applications. Gold Series features like Stress Engineered Cutters and Carbide Supported Edge cutter geometry prevent premature fracturing and accelerated cutter wear. Black Ice polished cutters improve cuttings removal and penetrations rates. And, where steerability is a concern, STAR bits are available with increased cutter back rake and wear knots, thereby lessening their aggressiveness and reducing torque variability.

**Rotary and Coiled Tubing*

Star Availability

IADC	STR324 M142	STR382/386 M342	STR443 M132	STR444 M132	STR426 M132	STR445 M342
Blades	4	6	3	4	5	6
Nozzles	4	4	3	4	4 – 6	4 – 6

IADC	STR482/STR486 M342	STR438 M442	STR447 M442	STR554 M122	STR535 M122
Blades	6	7	8	4	5
Nozzles	4 – 6	4 – 7	4	4	5

Size Range is 6 3/4” and less.

Carbide Supported Edge

CSE cutters feature an extended chamfer edge which reinforces the diamond table against detrimental blows. CSE cutters delay the onset of fracturing and cutter wear, dramatically extending cutter life.

Polished Cutters

Patented “Black Ice” polished cutters reduce shear forces, significantly improving cuttings removal, thus reducing torque and increasing overall penetration rates.

STAR Gauge

STAR bits utilize a more durable gauge pad with a tighter diamond setting for enhanced gauge holding capabilities in directional and abrasive applications.

Updrill Feature

A standard feature which assists the drilling operation when tight hole conditions are encountered or backreaming is required.

Wear Knots (optional)*

Matrix pads, located behind the cutters restrict the depth of cut, reducing torque fluctuations.

**Only on certain styles*

Directional Feature (optional)

The cutter’s backrake has been increased, reducing torque variations.

ChipMaster Bits

Chipmaster PDC bits are designed to drill soft, sticky formations where bit balling has traditionally limited performance. Through its unique geometry and hydraulic flow, Chipmaster bits utilize Enhanced Chip Management for optimized bit cleaning. With the addition of Gold Series features, we've extended the operating envelope for a soft formation bit to increasingly harder formations. The combination of highly efficient, durable cutters and patented Rear Impact Hydraulics offers high penetration rates and highly efficient chip management over a wide range of cuttings and chip sizes.

ChipMaster Availability

IADC	G573 M123			AG574 M123		
Size	1	2	3	8.5	12.25	16
Blades	3			4		
Nozzles – BL	3	3	3	4	4	6
Nozzles – JS	3	3	3	4	4	4

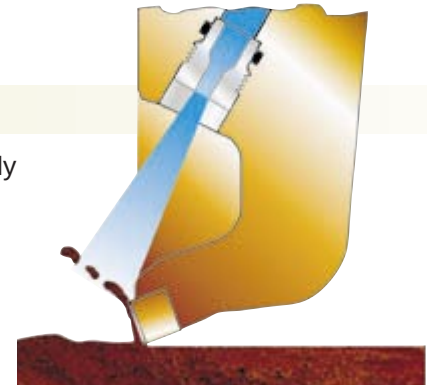
Size Range 1 0" – 8 1/2"
Size Range 2 8 1/2" – 10 5/8"
Size Range 3 10 5/8" – 12 1/4"

Unique Geometry

Each Chipmaster is designed with a discontinuity at the transition between the cutters and bit body. This limits contact between the bit face and cuttings, encouraging cuttings to move quickly into the junk slot and up the annulus. The combination of Black Ice ultra-low friction cutters and the unique blade design create a natural chip flow path that is not impeded by the bit body.

Rear Impact Hydraulics

As cuttings slide up the face of the polished cutters, they move directly into the stream of two powerful nozzles. The first nozzle impacts the cuttings from behind, breaking them into small manageable pieces. Fluid from the second nozzle carries the debris up the junk slot.

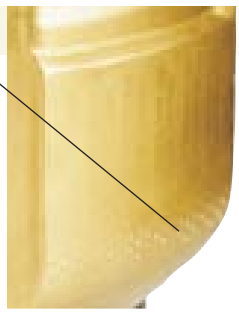


Gold Series Features

Chipmaster bits take advantage of many Gold Series features to increase durability and provide high penetration rates. Fracture resistant Stress Engineered Cutters provide longer bit life and high ROP. Engineered Cutter Placement maximizes bit life by matching cutter load to bore hole stress distribution. Black Ice/CSE cutters inhibit fracture initiation while lowering friction between the cutter and the formation. The results are lower torque and higher ROP.

Diamond Updrill

Natural diamond stones protect the bit in highly inclined well bores and reduced the incidence of ledges.



DuraSet Gauge

Two rows of tungsten carbide blocks and one row of cubic diamond lowers gauge erosion and wear in soft abrasive formations.

AG / G Bits

Gold Series bits are a premium line of PDC bits with features that optimize both bit durability and rate of penetration. After years of studying rock and cutter mechanics, and the stresses built into a cutter during the manufacturing process, Hughes Christensen engineers developed new concepts in diamond cutter technology. The results of their efforts are Stress Engineered Cutters, Engineered Cutter Placement, Carbide Supported Edge and Polished Cutters. Collectively, these concepts are the foundation for Gold Series PDC bits.

Gold Series Availability

IADC	G426 M133			G436 / G445 M233			G447 M333			G449 M433			G554 M123			G526 M123			G536 / G545 M223			G547 M323			G549 M423		
Size	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Blades	5			6			8			10			4			5			6			8			10		
Nozzles	5	5	5	4	4	6-8	4	4	8	*	6	10	4	4	6	5	5	5	6	6	10	*	*	6-8	*	*	8

IADC	AG454 M133			AG426 M133			AG445 / AG435 M233			AG437 M333			AG449 M443			AG554 M123			AG526 M123			AG545 M223			AG548 / AG547 M323			AG549 M423		
Size	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Blades	4			5			6	6	8	8	8	5	9	10	10	4			5			6	6	8	*	8	8	*	*	9
Nozzles	4	4	*	5	5	*	4	4-6	6	4	4	10	4	4	10	4	4	8	5	5	5	4	6	6	*	8	8	*	*	7

Size Range 1 6 3/4" — 8 1/2"
Size Range 2 8 1/2" — 10 5/8"
Size Range 3 10 5/8" — 12 1/4"

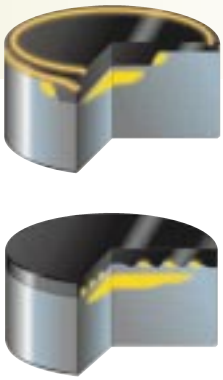
*Not recommended in this size range

Black Ice Polished Cutters

Black Ice cutters lower the frictional forces that cause chips to adhere to the cutter face. Their highly polished surfaces improve cuttings removal, reduce torque and increase overall penetration rates.

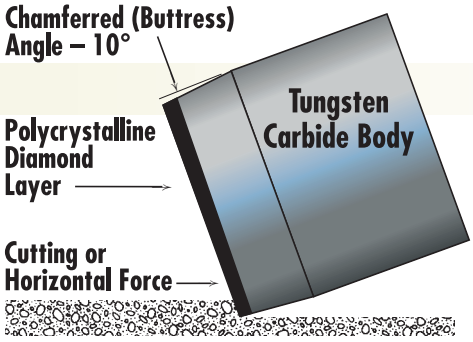
Stress Engineered Cutters

Detrimental stresses built into a PDC cutter have been engineered away from the cutting edge to areas better able to absorb high loads. By reducing the chance for fracture at the cutting edge, cutters stay sharper longer and penetration rates are sustained.



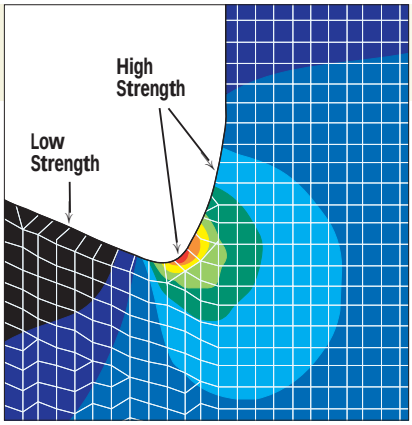
Carbide Supported Edge (CSE)

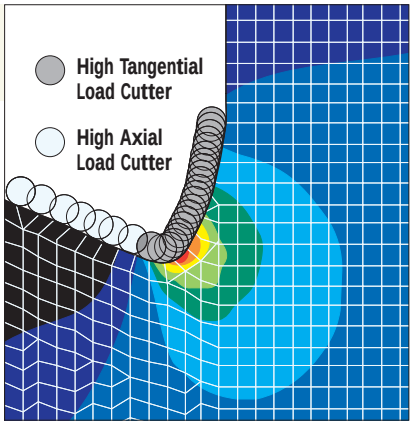
Patented CSE cutters feature an extended chamfer edge which reinforces the diamond table against detrimental blows experienced during drilling. This unique cutter design delays the onset of fracturing and cutter wear, dramatically extending cutter life.



Engineered Cutter Placement

Cutters, designed for specific loads, are strategically positioned on the bit body to match borehole rock strengths.





Impregnated Diamond Bits

Impregnated Diamond Bits

Hughes Christensen offers a wide selection of impregnated bits for drilling medium to hard formations. For hard and abrasive formations, the S279 utilizes hot pressed segments, which are proven features for high ROP and excellent durability. When drilling mudstones and carbonates or formations where hydraulics can be challenging, the advanced S280 impregnated bit is the solution. The S280 utilizes a balanced mixture of diamond sizes to increase the space between rock and bit. This extra "standoff" results in better cuttings removal and higher ROP. All Hughes Christensen impregnated bits utilize "Super Cone" technology for enhanced durability and balanced wear.

Natural Diamond / BallaSet Diamond Bits

Hughes Christensen offers natural and BallaSet diamond bits in a variety of styles for both motor and rotary drilling. Various sizes, shapes and concentrations of cutters are used in these bits to match the requirements of your specific application.

Impregnated Diamond Availability

IADC	S279 M841			S279P M841			S280 M841		
Size	1	2	3	1	2	3	1	2	3
Application	Hard Formation with High Abrasives			Hard Formation Interbedded with Moderately Abrasive Rock			Hard Formation Interbedded with Softer Rock		

Size Range 1	0" – 8 1/2"
Size Range 2	8 1/2" – 10 5/8"
Size Range 3	10 5/8" – 12 1/4"

Sidetrack / Speedmill

Sidetrack Bits

Our sidetracking bits feature shallow cone profiles that produce minimal resistance to directional changes. The short shoulder radius enhances the lateral cut when side forces are applied for successful kickoffs. Hughes Christensen sidetracking bits are available with PDC, BallaSet and natural diamond cutters to meet all of your applications. All sidetracking designs feature tungsten carbide matrix body construction for erosion resistance and all have natural diamond protection at the gauge.

Speedmill Bits

Diamond speed mills utilize a flat profile with short shoulder radius. This profile provides the greatest surface area in direct contact with the casing. The short shoulder radius is designed to combine durability with an aggressive edge to begin the casing window. Our speed mills commonly utilize small 10 – 12 SPC stones evenly distributed in a grid pattern. The smaller, less exposed diamonds have high impact resistance to prevent breakage while drilling steel casing. The gauge, designed with abrasion resistant natural diamonds, are flush set to provide the greatest protection when drilling through steel casing.

RWD Technology

No matter the size or shape of your next well, Hughes Christensen has a tool that enables you to drill and ream in one continuous operation. Together, our Ream While Drilling (RWD) tool, Steerable Ream While Drilling (SRWD) tool and the Slimhole Technology Ream While Drilling (STRWD) tool comprise a system designed for specific hole opening applications at a fraction of the costs and none of the risks associated with bi-center bits and conventional underreamers.

RWD Availability						
Drill Size	12.25	14	15	17	18	20
Blades	5	5	4	5	5	5
Pass Through	10.625	12	12	14.5	15.75	17
Pilot Size	8.5	8.5	8.5	10.625	12.25	12.25

SRWD Availability												
Drill Size	7	7.5	8	9.875	12.25	13.75	14	14.75	15	17	18	20
Blades	4	4	4	4	5	4	5	4	4	5	5	5
Pass Through	6	6.3	6.625	8.375	10.625	12.25	12	12.25	12	14.5	15.7	17
Pilot Size	4.75	4.75	4.75	6.5	8.5	9.87	8.5	8.5	8.5	10.625	12.25	12.25

STRWD Availability					
Drill Size	4.125	5.125	6	6.5	6.7
Blades	2	3	3	2	3
Pass Through	3.75	4.75	5.4	5.75	5.95
Pilot Size	3.125	3.125	4.5	4.75	4.75

RWD

Designed specifically for rotary applications, the RWD tool features a two-piece design, consisting of the RWD tool and pilot bit. This configuration provides flexibility when choosing the BHA configuration.

Hole Opening Blade

Creates a smooth transition from pass thru size to drill size.

Interchangeable Nozzles

Maximize cleaning and minimize hole erosion.

Pilot Stabilization Pad

Forces rotation around the pilot hole center, ensuring a full-size hole is drilled.

Black Ice / CSE Cutters

Reduce shear forces, improve cutting removal, and enhance drilling efficiency.

Depth Adjusted Cutters

Adjust the height of each cutter to ensure all cutters are loaded evenly.

SRWD

For high-angle environments, the SRWD is the ideal two-piece tool uniquely engineered to run on steerable systems, comprising either a rotary or motor BHA. Field tests have validated the ability of these tools to provide more consistent build rates, easier tool face orientation and a quality wellbore.

STRWD

The STRWD is the bit of choice for hole opening in slimhole applications. Its one-piece matrix design, incorporating a pilot bit and stabilized reamer, provides maximum hole clearance, greatly reducing the risk of mechanical failure in tight well bores.

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