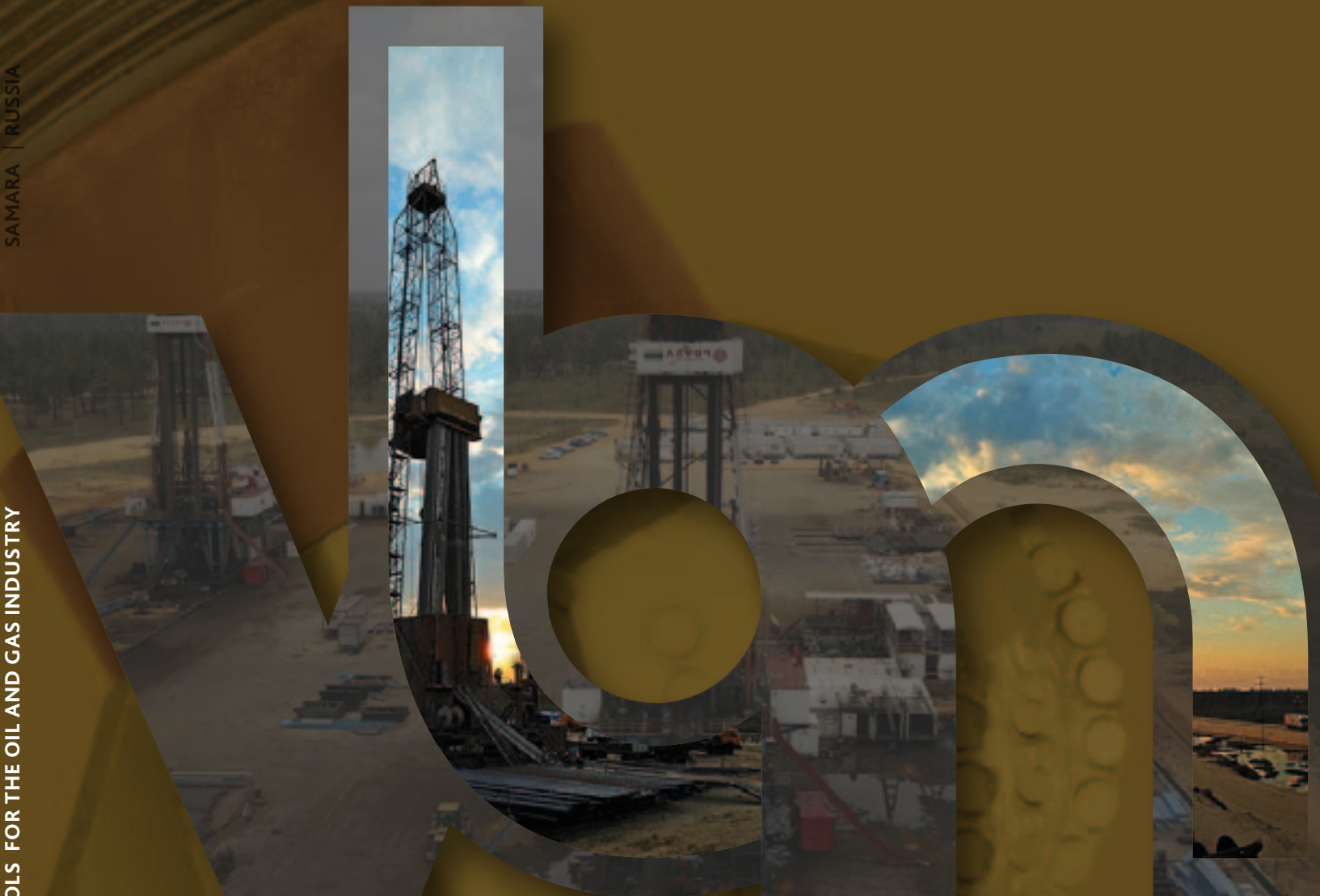


DRILLING TOOLS FOR THE OIL AND GAS INDUSTRY



OUR MISSION

WE ENGINEER QUALITY COST-EFFECTIVE PRODUCTS AND PROVIDE INDUSTRY LEADING RELIABILITY OF SUPPLY.

OUR VISION

WE AIM TO PROVIDE OUR PARTNERS **ALL OVER THE WORLD** WITH SUPERIOR **INNOVATIONS** — RELIABLE PRODUCTS AND ENGINEERING COMPETENCE, MEETING SPECIFIC REQUIREMENTS FOR **GREAT RESULTS**.

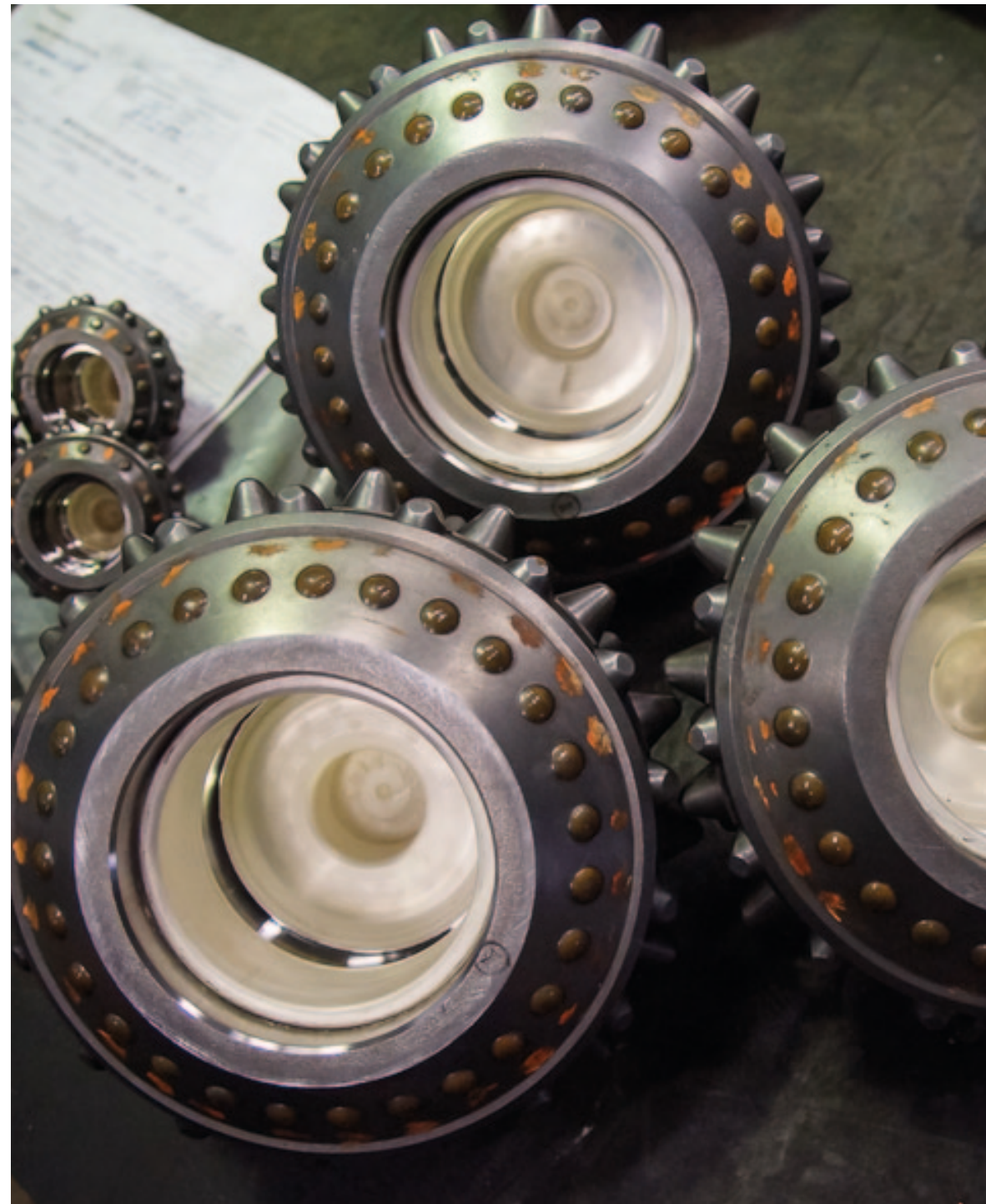
We successfully transform our expertise, manufacturing capacities and skills into your achievements:

- VBM drill bits are used in 75+ countries and across continents;
- VBM is ranked among the TOP-10 of world producers of drilling tools in terms of production quality and turnover;
- VBM factory produces drill bits for the oil and gas, mining, water well and construction industries;
- VBM offers customized bit design and manufacturing;
- VBM's highly qualified personnel and the most up to date production digitization techniques enable continuously improving drill bit development and ensure production quality compliance with the highest world standards.

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ABOUT THE COMPANY



Volgaburmash JSC (VBM) is the largest manufacturer in Russia of high-quality rock cutting tools for the oil and gas, mining, water well and construction industries.

ABOUT THE COMPANY

VBM specializes in the production of an extensive range of drill bits which are successfully exported and utilized in over 75 countries, and that number is constantly increasing.



ABOUT THE COMPANY



VBM PRODUCES:

- over 500 roller cone bit designs from 6 3/4" up to 26" (171.4 - 660.4 mm) in diameter with milled tooth and tungsten carbide inserts (TCI) for drilling boreholes in different geological conditions;
- over 350 PDC bit designs from 3" to 17 1/2" (76 - 444.5 mm) in diameter with matrix or steel bodies;
- DTH bits and other rock cutting tools.



ABOUT THE COMPANY



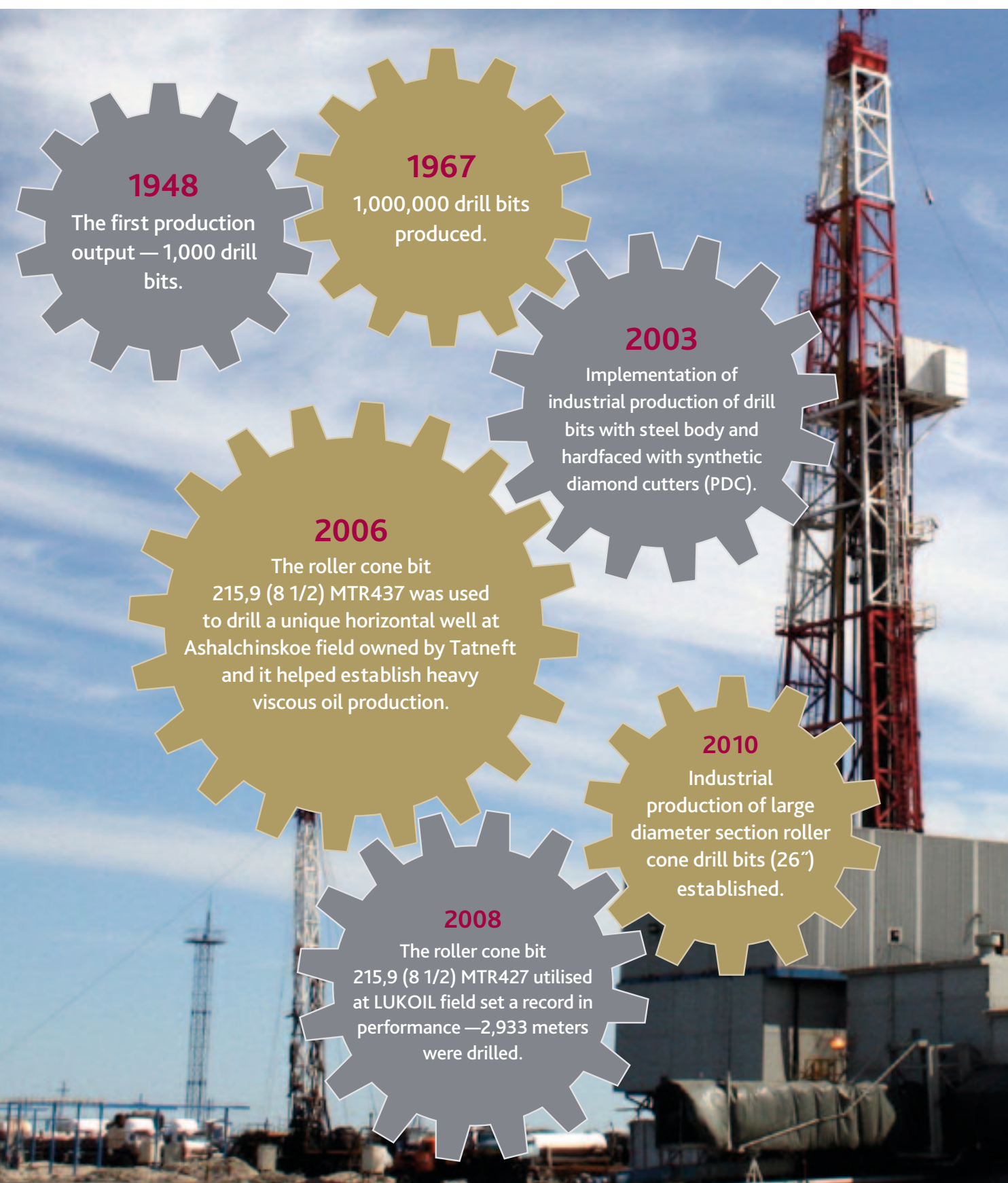
VBM was established in the industrial, but picturesque Volga region, where all seasons are full of colors and natural beauty.

We actively encourage visits to our factory to inspect the industry leading manufacturing practices and of course to take advantage of the local Samara countryside.

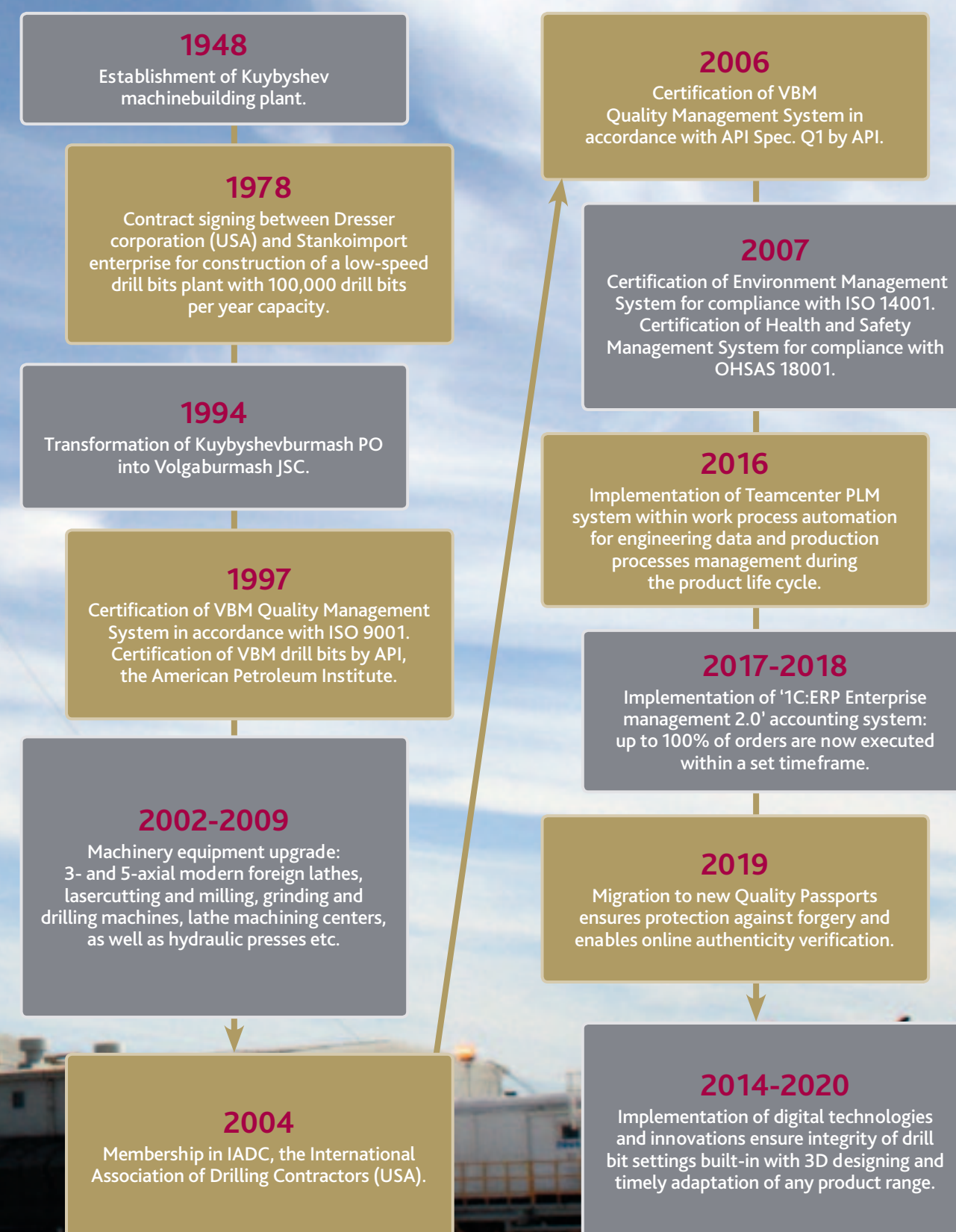
WELCOME TO SAMARA AND VBM!



SIGNIFICANT MILESTONES



OUR HISTORY



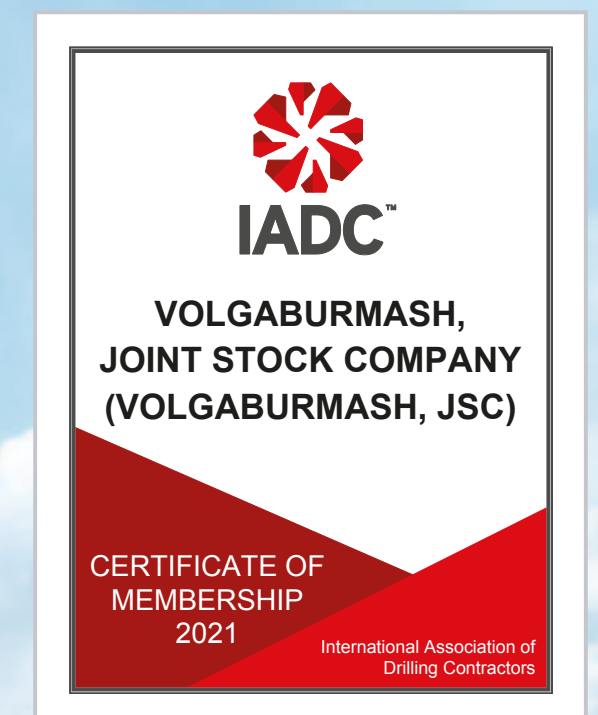
QUALITY



In 1997 VBM's Quality Management System (QMS) was implemented and certified in accordance with ISO 9001. In the same year Volgaburmash, JSC was licensed to apply the official API monogram as per API Spec. 7-1. Along with that our QMS compliance with the API Spec. Q1 has been annually audited and confirmed by the American Petroleum Institute (API).

According to the Quality Policy, our organization's priority is to 'Meet customer's requirements and expectations'. Key aspects of the Policy implementation are:

- maintaining an advanced communication system as well as establishing long-term and mutually beneficial cooperation with our business-partners;
- improving the design solutions;
- monitoring the quality of manufacturing processes;
- ensuring a high level of competence of employees;
- continuous improvement of the quality management system effectiveness;
- compliance with legal requirements, the requirements of national and international standards and specifications, customer requirements, as well as the internal requirements of the organization.



QUALITY

VBM drill tools are certified in compliance with the Technical Regulations of the Customs Union, and meet the State Standards GOST 20692 and GOST 26474.

VBM's certified Quality Management System regulates all aspects from contracts analysis to shipment of finished goods to the Customer. Special attention is paid to Customer's satisfaction evaluation and continuous improvement.

Quality control is deeply embedded into processes throughout the entire manufacturing cycle to guarantee uncompromised output quality.

All raw materials and components are subject to thorough incoming inspection in the Central Plant Laboratory. Conformance to all the requirements is mandatory for release into production.

Prior to the final assembly a multistage inspection is performed with respect to the relevant design and engineering specifications requirements.

Finished goods are admitted to the warehouse upon successful completion of special control performed by highly qualified inspectors.

Measuring and control instruments are calibrated initially and periodically to ensure the uniformity and required accuracy of measurements.

Due to the integrated approach to quality, VBM drilling equipment fully complies with international and local standards as well as customer's requirements and expectations.



TECHNOLOGICAL AND RESEARCH CAPACITIES

PRODUCTION INSTRUMENTATION

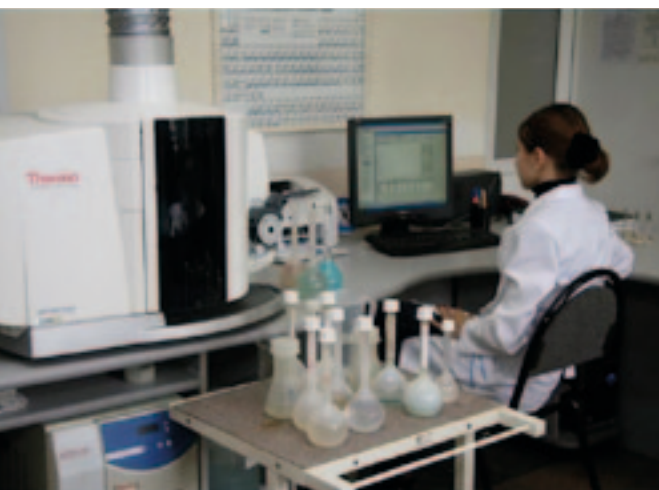
Mechanical and complex treatment of roller cone bits components are both done on different machines including 3- and 5-axial milling and lathe machines, machining centers and with fluid-actuated presses. Treatment is performed at equipment produced by Danobat, Trevisan, EMAG, Heynumat, Intermato, ARC Specialties and other companies.

PDC bits production is fitted with the most up-to-date precision measurement equipment: CNC lathes and machining centers made by leading world manufacturers. Thus, while turning operations nipples and PDC bit bodies depending on their sizes are machined in SPU 40 and MNC 1000 lathe centers, and then milled and drilled at 5-axis machine DMU 80 P (Deckel Maho, Germany).

Chemical and thermal treatment (CTT) is one of the stages of bit manufacturing and the key method of strengthening the surface of bit components. VBM uses unique vacuum and chamber furnaces to carry out heat treatment operations automatically and according to the pre-set program. CTT enables control the main parameters for achieving the maximum strength of components and bit performance reliability.



TECHNOLOGICAL AND RESEARCH CAPACITIES



VBM'S CENTRAL LABORATORY

Unique knowledge and skills of personnel along with the contemporary analytical equipment provide a solid foundation for VBM's Central Laboratory to conduct in-depth inspection of several hundreds of types of materials as well as semi-finished products and finished goods.

Among other devices, our laboratory is equipped with:

- inductively coupled plasma atomic emission spectrometer for chemical composition study;
- atomic absorption spectrometer;
- spectrophotometer;
- carbon analyzers;
- viscometers;
- penetrometers;
- devices for determining the flash point and dropping point;
- devices for determining particle size distribution;
- wide range of hardness testing machines;
- optical microscopes;
- image analyzer;
- laboratory furnaces;
- analytical balances;
- mechanical properties testing machines, etc.



Not only does the laboratory provide precise evidence of quality compliance at each stage of the manufacturing process, one of its routine yet crucially important functions is analysis of used drill tools, this allows our engineering team and manufacturing subdivision to receive comprehensive feedback thus enabling continuous improvement.

INVESTIGATIONS AND MEASUREMENTS

CHEMICAL COMPOSITION ANALYSIS

Spectro-chemical analysis at all production stages helps to compare the actual content of any material with the required values, and to prevent low quality materials application that may affect strength characteristics of the finished products.

METALLOGRAPHIC SURVEY

Bit bearing durability is one of the key factors that affects drill bit performance. Chemical and heat treatment are both applied to enhance bit bearing performance followed by 50-1500-power microscope-assisted metallurgical survey. Silver-plated parts of the bearing are checked with an image analyzer IA-32, which defines a grain size (10-200 μm) and coating thickness (20-30 μm) with visualization eliminating the risk of personal assessment. Such studies ensure that only high quality components are used for manufacturing.



MICRO AND HARDNESS MEASUREMENT

One of the tests applied to tungsten carbide inserts (TCI) and hard-facing materials used for protection of bit legs and milled teeth is the measure of hardness and micro-hardness. Hardness gradient of bit bearings and cones is also measured.



TECHNOLOGICAL AND RESEARCH CAPACITIES

SOFTWARE

Modern high accuracy equipment and advanced software are used for designing and manufacturing reliable VBM bits.

BIT PERFORMANCE MODELLING

In the bit design process we use software for automated drafting of well profile and bottom-hole coverage, evaluation of dulling characteristics, selection of optimal parameters of bit hydraulics, load balancing to improve bit steerability as well as analysis of field test results using advanced statistical processing methods. Moreover, we also use benchmark tests, which enable physical modelling of a drill bit bottom-hole performance to check and improve software math algorithms.

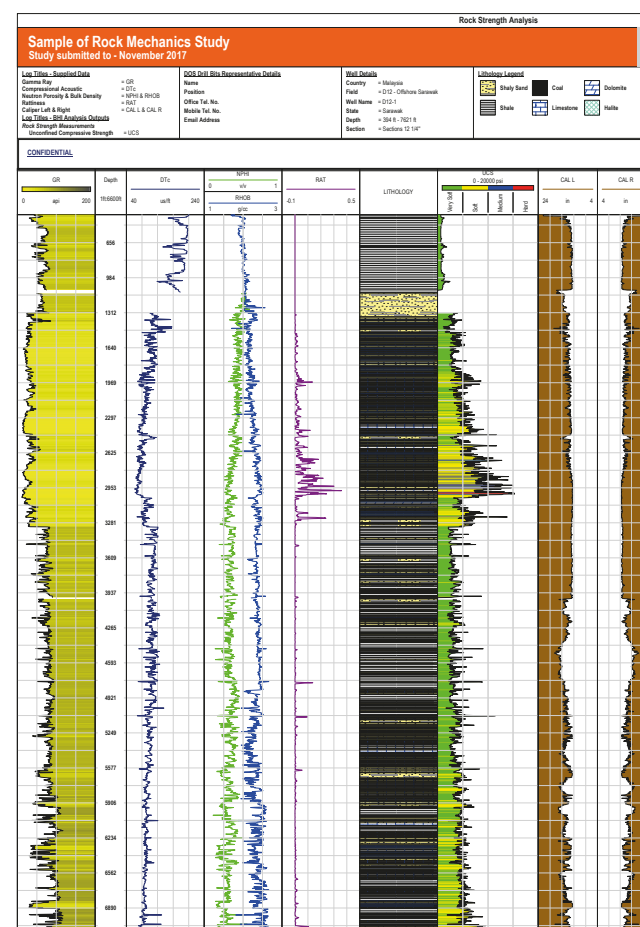
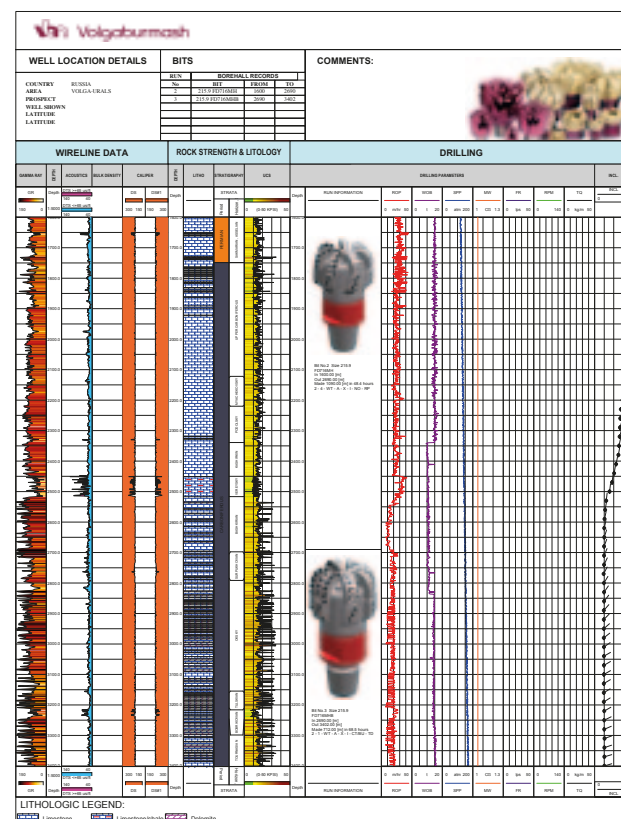
Application of these methods enables the reduction of lead-time for new bit designs, improves their efficiency and reliability due to optimizing development and technology parameters at the

design stage, as well as providing an opportunity for manufacturing bits suitable for specific applications according to drilling environment and lithology.

WellCad is a software which provides processing and visualization of log data, drilling modes, well trajectory and design.

Basic module delivers data input and output, visualization of logs, data interpretation, strip logs and statistics processing. Additional modules provide quick well data correlation and simultaneous 2D and 3D visualization of several wellbores.

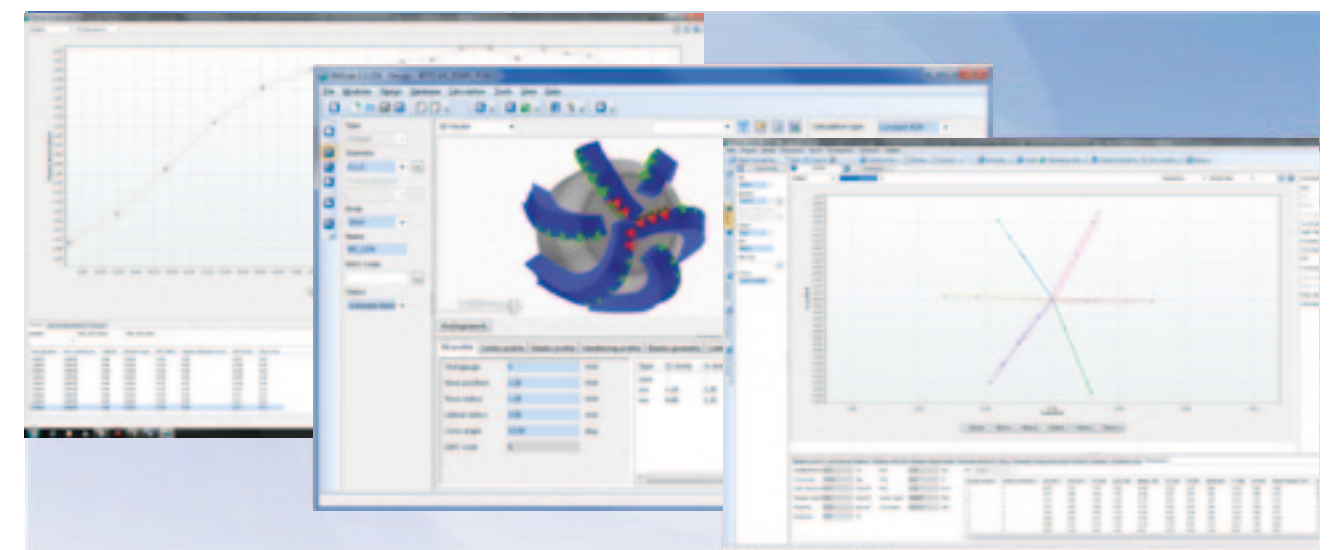
WellCad application allows to reveal the relation between the numerous forces influencing the performance results and use them for selection and optimization of rock cutting tools and drilling parameters.



For bit design, selection and optimization, **BitScan** software developed by DrillScan is used.

The software complex incorporates:

- **design and simulation module**, which enables to make a forecast of bit performance characteristics in actual well applications (including ROP, MSE, wear, torque, steerability);
- **sensitivity module**, in which bit design is analyzed, and some designs are compared to make the best choice for the specific applications (it also enables to review both bit behavior in general and each individual cutter);
- **post-analysis module**, in which detailed drilling analysis is carried out based on log data, bit performance results versus lithology, MSE calculation and finding correlations.



Using **BitScan** software helps to select the optimum bit design to meet customer's tasks and make performance forecast with high accuracy.

TOOLS FOR THE OIL AND GAS INDUSTRY

For oil and gas wells drilling VBM designs and manufactures roller cone bits and PDC bits, jet nozzles, wrenches and bit breakers.



Roller cone bits

- Grand (GRD)
- GrandPro (GRDP)
- GrandXtreme (GRDX)
- Motor (MTR)
- MotorPro (MTRP)
- SlimHolePro (SLHP)

PDC bits

- FastDrill (FD)
- FastDrillMatrix (FDM)
- WiperTrip (WT)
- SideTrack (ST)
- BicentricDrill (BD)
- CoreBits (CB)

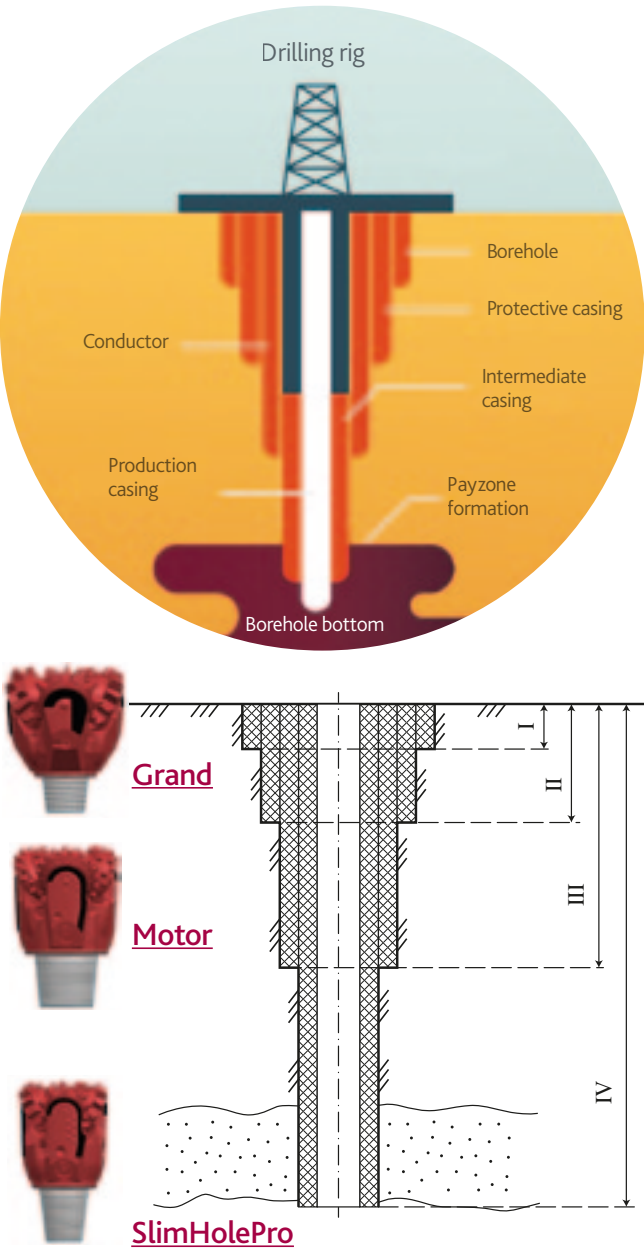
Auxiliaries for roller cone and PDC bits

- Nozzles
- Wrenches
- Bit breakers

ROLLER CONE BITS

Optimal size and product line of suitable roller cone bit for oil and gas wells are chosen depending upon drilling stages and casing types.

- Drill bit family **Grand (Grand, GrandPro, GrandXtreme)** features great sizes (over 12 14") and is intended for drilling, including multistage drilling and drilling the top sections such as protective casing and conductor.
- Drill bit family **Motor (Motor and MotorPro)** as of 7 1/2-12 1/4 inches is intended for drilling with intermediate or production strings, and can be also used for operations with downhole motors at high speed, as they features high wear-resistance.
- **SlimHolePro** bits with small sizes less than 6 3/4" are suitable for well completion and slimhole drilling, sidetracking and re-entry operations.



Size, inch	Over 12 1/4"	7 1/2" - 12 1/4"	Up to 6 3/4"
Product Line	Grand	Motor	SlimHolePro
	GrandPro	MotorPro	
	GrandXtreme		

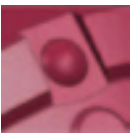
I – protective casing
II – conductor
III – Intermediate casing
IV – production casing

FEATURES

Main features of VBM roller cone bits used for the oil and gas industry are presented in the tables below.

GRAND	GRANDPRO		GRANDXTREME	MOTORPRO	MOTOR	SLIMHOLEPRO
	Up to 17 1/2"	over 17 1/2"				
OPEN BEARING	SEALED ROLLER BEARING		SEALED JOURNAL BEARING			
						
Open roller bearing with rollers in large and small roller race.	Sealed roller bearing with O-ring, rollers in large and small roller race.	Sealed roller bearing with two seals, rollers in large and small roller race.	Journal sealed bearing with O-ring, two floating bushings and thrust washer made of wear-resistant material and silver plated.	Journal sealed bearing with two seals, floating bushing, thrust washer and cap made of wear-resistant material and silver plated.	Journal sealed bearing with O-ring, floating bushing and thrust washer made of wear-resistant material and silver plated.	
COMBINED JET				• SIDE JET • COMBINED JET: Motor, MotorPro (11 5/8"-12 1/4") — standard; Motor, MotorPro (7 1/2"-11") — option		SIDE JET
						

Features	Appearance	Description	Product lines
PLASMA HARDFACING		Plasma hardfacing of cones designed to protect erosion wear of cone body are used to extend bit performance in highly abrasive formations.	SLIMHOLEPRO
DIAMOND CUTTERS ON THE CONE GAGE		Diamond-enhanced TCI on the cone gage are designed to calibrate the wellbore, protect cone body against erosion wear in tough geological conditions.	MOTORPRO
STABILIZED PAD EQUIPPED WITH TCI		Additional protected pad on the leg decreases lateral vibrations during bit rotation, improves borehole quality.	

Features	Appearance	Description
CHISEL-SHAPED AND CONICAL TUNGSTEN CARBIDE INSERTS (TCI)		Chisel-shaped TCI are applied for cutting and chipping action and assure high ROP. Conical and sphero-conical shaped TCI are applied for cutting and chipping action, have higher wear-resistance when used in medium-hard, hard and extra hard brittle formations.
BULK SURFACING		Tungsten carbide hard-facing aims to increase wear-resistance of steel teeth bits. Both bulk and partial surfacing is used.
INSERT ON THE CONE GAGE DOUBLE ROW OF TCI ON THE CONE GAGE		TCI on the cone gage are applied to calibrate the wellbore, protect cone body against erosion wear. Double row of TCI on the cone gage are designed to increase contact area between the borehole and bit, improve borehole quality and protect cone body against erosion wear.
ADDITIONAL GAGE ROW		Additional heel row of TCI is designed to protect cone body against erosion wear, increase contact area between the borehole and bit and improve borehole quality.

Depending on the applications and according to the customer's requests shirttail and leading edge of VBM roller cone bit can be protected to avoid bit wear.



Shirttail and leading edge are reinforced with TCI, leading edge is additionally hardfaced



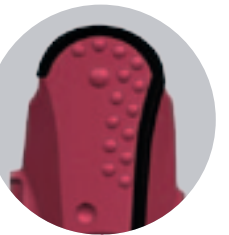
Shirttail is hardfaced



Shirttail and leading edge are hardfaced



Shirttail and leading edge are hardfaced and shirttail is protected with TCI



Shirttail and leading edge are reinforced with TCI and additionally hardfaced

GRAND (GRD) BITS



Grand roller cone bits are designed for drilling upper well sections, or surface hole drilling. Without sealing elements in the bearing, it is possible to maximize the journal and achieve full circulation in the bearing which is highly important for torque reduction, rapid cooling and bearing life extension. Grand bits can be also used for forced drilling with different types of turbines. They feature low cost and acceptable resource while drilling with protective casing and conductor and it helps a customer to save money when drilling a small number of wells.

444,5

(17 1/2)

GRD

111

Bit size, mm

Bit size, inch

Product line

IADC code

Bit identification	Bit size		IADC code	Connecting thread	Gross weight, kg	Shipping dimensions, mm
	mm	inch		API		
1	2	3	4	5	6	7
444,5 (17 1/2) GRD111	444.5	17 1/2	111	Pin 7 5/8 Reg	210.3	475x475x702
444,5 (17 1/2) GRD211	444.5	17 1/2	211	Pin 7 5/8 Reg	226.3	475x475x702
444,5 (17 1/2) GRD311	444.5	17 1/2	311	Pin 7 5/8 Reg	216.3	475x475x702
444,5 (17 1/2) GRD423	444.5	17 1/2	423X	Pin 7 5/8 Reg	224.3	475x475x702
444,5 (17 1/2) GRD523	444.5	17 1/2	523X	Pin 7 5/8 Reg	230.3	475x475x702
444,5 (17 1/2) GRD623	444.5	17 1/2	623X	Pin 7 5/8 Reg	230.3	475x475x702
444,5 (17 1/2) GRD713	444.5	17 1/2	713X	Pin 7 5/8 Reg	220.3	475x475x702
490,0 (19 19/64) GRD111	490.0	19 19/64	111	Pin 7 5/8 Reg	269.7	690x690x807
490,0 (19 19/64) GRD213	490.0	19 19/64	213	Pin 7 5/8 Reg	295.7	690x690x807
490,0 (19 19/64) GRD311	490.0	19 19/64	311	Pin 7 5/8 Reg	275.7	690x690x807
490,0 (19 19/64) GRD423	490.0	19 19/64	423X	Pin 7 5/8 Reg	283.7	690x690x807
490,0 (19 19/64) GRD523	490.0	19 19/64	523X	Pin 7 5/8 Reg	295.7	690x690x807
490,0 (19 19/64) GRD623	490.0	19 19/64	623Y	Pin 7 5/8 Reg	294.7	690x690x807
490,0 (19 19/64) GRD713	490.0	19 19/64	713Y	Pin 7 5/8 Reg	289.7	690x690x807
660,4 (26) GRD111	660.4	26	111	Pin 7 5/8 Reg	604.7	690x690x807
660,4 (26) GRD211	660.4	26	211	Pin 7 5/8 Reg	605.7	690x690x807

GRANDPRO (GRDP) BITS



GrandPro roller cone bits are designed for multiple drilling of upper well sections. Thanks to sealed roller bearing these bits feature enhanced resources and can be safely stored for a long time between work intervals without the danger of jamming and corrosion damage to the support elements. GrandPro bits are cost effective when drilling several wells or reduce the number of trips when drilling long intervals.

339,7

(13 3/8)

GRDP

535

Bit size, mm

Bit size, inch

Product line

IADC code

Bit identification	Bit size		IADC code	Connecting thread	Gross weight, kg	Shipping dimensions, mm
	mm	inch		API		
1	2	3	4	5	6	7
339,7 (13 3/8) GRDP635	339.7	13 3/8	635Y	Pin 6 5/8 Reg	124.6	430x430x676
349,2 (13 3/4) GRDP525	349.2	13 3/4	525X	Pin 6 5/8 Reg	129.6	430x430x676
374,6 (14 3/4) GRDP115	374.6	14 3/4	115	Pin 7 5/8 Reg	155.6	430x430x676
374,6 (14 3/4) GRDP215	374.6	14 3/4	215	Pin 7 5/8 Reg	161.6	430x430x676
374,6 (14 3/4) GRDP315	374.6	14 3/4	315	Pin 7 5/8 Reg	158.6	430x430x676
374,6 (14 3/4) GRDP425	374.6	14 3/4	425X	Pin 7 5/8 Reg	165.6	430x430x676
374,6 (14 3/4) GRDP535	374.6	14 3/4	535X	Pin 7 5/8 Reg	161.6	430x430x676
374,6 (14 3/4) GRDP635	374.6	14 3/4	635Y	Pin 7 5/8 Reg	169.6	430x430x676
374,6 (14 3/4) GRDP715	374.6	14 3/4	715Y	Pin 7 5/8 Reg	163,1	430x430x676
381,0 (15) GRDP535	381.0	15	535X	Pin 7 5/8 Reg	165.6	430x430x676
381,0 (15) GRDP615	381.0	15	615Y	Pin 7 5/8 Reg	173.6	430x430x676
393,7 (15 1/2) GRDP115	393.7	15 1/2	115	Pin 7 5/8 Reg	180.6	430x430x676
393,7 (15 1/2) GRDP135	393.7	15 1/2	135	Pin 7 5/8 Reg	187.6	430x430x676
393,7 (15 1/2) GRDP215	393.7	15 1/2	215	Pin 7 5/8 Reg	194.6	430x430x676
393,7 (15 1/2) GRDP235	393.7	15 1/2	235	Pin 7 5/8 Reg	192.6	430x430x676
393,7 (15 1/2) GRDP315	393.7	15 1/2	315	Pin 7 5/8 Reg	184.6	430x430x676

1	2	3	4	5	6	7
393,7 (15 1/2) GRDP425	393.7	15 1/2	425X	Pin 7 5/8 Reg	186.6	430x430x676
393,7 (15 1/2) GRDP545	393.7	15 1/2	545X	Pin 7 5/8 Reg	189.6	430x430x676
393,7 (15 1/2) GRDP625	393.7	15 1/2	625Y	Pin 7 5/8 Reg	191.6	430x430x676
393,7 (15 1/2) GRDP635	393.7	15 1/2	635Y	Pin 7 5/8 Reg	192.6	430x430x676
393,7 (15 1/2) GRDP715	393.7	15 1/2	715Y	Pin 7 5/8 Reg	190.6	430x430x676
406,4 (16) GRDP115	406.4	16	115	Pin 7 5/8 Reg	183.6	430x430x676
406,4 (16) GRDP215	406.4	16	215	Pin 7 5/8 Reg	200.6	430x430x676
406,4 (16) GRDP315	406.4	16	315	Pin 7 5/8 Reg	191.6	430x430x676
406,4 (16) GRDP435	406.4	16	435X	Pin 7 5/8 Reg	193.6	430x430x676
406,4 (16) GRDP535	406.4	16	535X	Pin 7 5/8 Reg	198.6	430x430x676
406,4 (16) GRDP635	406.4	16	635Y	Pin 7 5/8 Reg	203.6	430x430x676
406,4 (16) GRDP715	406.4	16	715Y	Pin 7 5/8 Reg	198.6	430x430x676
431,8 (17) GRDP115	431.8	17	115	Pin 7 5/8 Reg	203.3	475x475x702
444,5 (17 1/2) GRDP115	444.5	17 1/2	115	Pin 7 5/8 Reg	209.3	475x475x702
444,5 (17 1/2) GRDP135	444.5	17 1/2	135	Pin 7 5/8 Reg	225.3	475x475x702
444,5 (17 1/2) GRDP215	444.5	17 1/2	215	Pin 7 5/8 Reg	228.3	475x475x702
444,5 (17 1/2) GRDP315	444.5	17 1/2	315	Pin 7 5/8 Reg	213.3	475x475x702
444,5 (17 1/2) GRDP425	444.5	17 1/2	425X	Pin 7 5/8 Reg	218.3	475x475x702
444,5 (17 1/2) GRDP535	444.5	17 1/2	535X	Pin 7 5/8 Reg	224.3	475x475x702
444,5 (17 1/2) GRDP625	444.5	17 1/2	625Y	Pin 7 5/8 Reg	226.3	475x475x702
444,5 (17 1/2) GRDP715	444.5	17 1/2	715Y	Pin 7 5/8 Reg	226.3	475x475x702
490,0 (19 19/64) GRDP115	490.0	19 19/64	115	Pin 7 5/8 Reg	269.7	690x690x807
490,0 (19 19/64) GRDP215	490.0	19 19/64	215	Pin 7 5/8 Reg	292.7	690x690x807
490,0 (19 19/64) GRDP315	490.0	19 19/64	315	Pin 7 5/8 Reg	276.7	690x690x807
490,0 (19 19/64) GRDP425	490.0	19 19/64	425X	Pin 7 5/8 Reg	278.7	690x690x807
490,0 (19 19/64) GRDP545	490.0	19 19/64	545Z	Pin 7 5/8 Reg	288.7	690x690x807
490,0 (19 19/64) GRDP625	490.0	19 19/64	625Y	Pin 7 5/8 Reg	294.7	690x690x807
490,0 (19 19/64) GRDP715	490.0	19 19/64	715Y	Pin 7 5/8 Reg	290.7	690x690x807
508,0 (20) GRDP115	508.0	20	115	Pin 7 5/8 Reg	277.7	690x690x807
508,0 (20) GRDP215	508.0	20	215	Pin 7 5/8 Reg	295.7	690x690x807
508,0 (20) GRDP425	508.8	20	425X	Pin 7 5/8 Reg	286.7	690x690x807
508,0 (20) GRDP535	508.0	20	535X	Pin 7 5/8 Reg	307.7	690x690x807
508,0 (20) GRDP625	508.0	20	625Y	Pin 7 5/8 Reg	302.7	690x690x807
508,0 (20) GRDP715	508.8	20	715Y	Pin 7 5/8 Reg	298.7	690x690x807
558,8 (22) GRDP515	558.8	22	515X	Pin 7 5/8 Reg	391.7	690x690x807
558,8 (22) GRDP535	558.8	22	535Y	Pin 7 5/8 Reg	409.7	690x690x807
558,8 (22) GRDP635	558.8	22	635Y	Pin 7 5/8 Reg	406.7	690x690x807
584,2 (23) GRDP115	584.2	23	115	Pin 7 5/8 Reg	417.7	690x690x807
609,6 (24) GRDP115	609.6	24	115	Pin 7 5/8 Reg	509.7	690x690x807
609,6 (24) GRDP525	609.6	24	525X	Pin 7 5/8 Reg	500.7	690x690x807
609,6 (24) GRDP615	609.6	24	615Y	Pin 7 5/8 Reg	512.7	690x690x807
660,4 (26) GRDP115	660.4	26	115	Pin 7 5/8 Reg	600.7	690x690x807
660,4 (26) GRDP135	660.4	26	135	Pin 7 5/8 Reg	600.7	690x690x807
660,4 (26) GRDP515	660.4	26	515X	Pin 7 5/8 Reg	586.7	690x690x807
660,4 (26) GRDP535	660.4	26	535X	Pin 7 5/8 Reg	587.7	690x690x807

GRANDXTREME (GRDX) BITS



GrandXtreme roller cone bits are designed for the most severe drilling conditions in the upper sections of wells, where the integrity of the bit and its ability to withstand extreme loads from the drill string are of paramount importance. The use of a sealed premium-class journal bearing and innovative solutions for the sealing assembly and protection of the bit bearing ensure a high bearing life and the optimum technical and economic bit performance.

444,5

(17 1/2)

GRDX

837

Bit size, mm

Bit size, inch

Product line

IADC code

Bit identification	Bit size		IADC code	Connecting thread	Gross weight, kg	Shipping dimensions, mm
	mm	inch		API		
1	2	3	4	5	6	7
349,2 (13 3/4) GRDX837	349.2	13 3/4	837Y	Pin 6 5/8 Reg	139.6	430x430x676
381,0 (15) GRDX837	381.0	15	837Y	Pin 7 5/8 Reg	175.6	430x430x676
444,5 (17 1/2) GRDX117	444.5	17 1/2	117	Pin 7 5/8 Reg	219.3	475x475x702
444,5 (17 1/2) GRDX217	444.5	17 1/2	217	Pin 7 5/8 Reg	236.3	475x475x702
444,5 (17 1/2) GRDX317	444.5	17 1/2	317	Pin 7 5/8 Reg	221.3	475x475x702
444,5 (17 1/2) GRDX437	444.5	17 1/2	437X	Pin 7 5/8 Reg	227.3	475x475x702
444,5 (17 1/2) GRDX517	444.5	17 1/2	517X	Pin 7 5/8 Reg	233.3	475x475x702
444,5 (17 1/2) GRDX537	444.5	17 1/2	537X	Pin 7 5/8 Reg	233.3	475x475x702
444,5 (17 1/2) GRDX627	444.5	17 1/2	627Y	Pin 7 5/8 Reg	234.3	475x475x702
444,5 (17 1/2) GRDX837	444.5	17 1/2	837Y	Pin 7 5/8 Reg	232.3	475x475x702

MOTOR (MTR) BITS



Motor roller cone bits are suitable for a wide range of applications. The design of the sealed journal bearing allows to use them both in combination with a rotor drive at high loads, and with a hydraulic downhole motor at high rotation speeds. Application of various protection designs for bit pads and a large number of additional options helps customizing Motor bits for specific conditions and achieving high technical and economic bit performance.

215,9

Bit size, mm

(8 1/2)

Bit size, inch

MTR

Product line

117

IADC code

Bit identification	Bit size		IADC code	Connecting thread	Gross weight, kg	Shipping dimensions, mm
	mm	inch		API		
1	2	3	4	5	6	7
190,5 (7 1/2) MTR117	190.5	7 1/2	117	Pin 4 1/2 Reg	30.7	255x255x389
190,5 (7 1/2) MTR127	190.5	7 1/2	127	Pin 4 1/2 Reg	31.7	255x255x389
190,5 (7 1/2) MTR137	190.5	7 1/2	137	Pin 4 1/2 Reg	31.7	255x255x389
190,5 (7 1/2) MTR547	190.5	7 1/2	547X	Pin 4 1/2 Reg	31.7	255x255x389
190,5 (7 1/2) MTR627	190.5	7 1/2	627Y	Pin 4 1/2 Reg	31.7	255x255x389
200,0 (7 7/8) MTR117	200.0	7 7/8	117	Pin 4 1/2 Reg	31.7	255x255x389
200,0 (7 7/8) MTR517	200.0	7 7/8	517X	Pin 4 1/2 Reg	33.7	255x255x389
200,0 (7 7/8) MTR527	200.0	7 7/8	527X	Pin 4 1/2 Reg	33.7	255x255x389
200,0 (7 7/8) MTR537	200.0	7 7/8	537X	Pin 4 1/2 Reg	33.7	255x255x389
200,0 (7 7/8) MTR627	200.0	7 7/8	627Y	Pin 4 1/2 Reg	32.7	255x255x389
200,0 (7 7/8) MTR637	200.0	7 7/8	637Y	Pin 4 1/2 Reg	32.7	255x255x389
212,7 (8 3/8) MTR217	212.7	8 3/8	217	Pin 4 1/2 Reg	36.7	255x255x389
212,7 (8 3/8) MTR547	212.7	8 3/8	547X	Pin 4 1/2 Reg	37.7	255x255x389

1	2	3	4	5	6	7
215,9 (8 1/2) MTR117	215.9	8 1/2	117	Pin 4 1/2 Reg	37.7	255x255x389
215,9 (8 1/2) MTR217	215.9	8 1/2	217	Pin 4 1/2 Reg	38.7	255x255x389
215,9 (8 1/2) MTR337	215.9	8 1/2	337	Pin 4 1/2 Reg	38.7	255x255x389
215,9 (8 1/2) MTR437	215.9	8 1/2	437X	Pin 4 1/2 Reg	38.7	255x255x389
215,9 (8 1/2) MTR517	215.9	8 1/2	517X	Pin 4 1/2 Reg	38.7	255x255x389
215,9 (8 1/2) MTR547	215.9	8 1/2	547X	Pin 4 1/2 Reg	38.7	255x255x389
222,3 (8 3/4) MTR117	222.3	8 3/4	117	Pin 4 1/2 Reg	38.7	255x255x389
222,3 (8 3/4) MTR527	222.3	8 3/4	527X	Pin 4 1/2 Reg	39.7	255x255x389
222,3 (8 3/4) MTR617	222.3	8 3/4	617Y	Pin 4 1/2 Reg	40.7	255x255x389
228,6 (9) MTR837	228.6	9	837Y	Pin 4 1/2 Reg	41.7	255x255x389
241,3 (9 1/2) MTR537	241.3	9 1/2	537X	Pin 6 5/8 Reg	60.2	295x295x439
241,3 (9 1/2) MTR637	241.3	9 1/2	637Y	Pin 6 5/8 Reg	60.2	295x295x439
244,5 (9 5/8) MTR437	244.5	9 5/8	437X	Pin 6 5/8 Reg	60.2	295x295x439
244,5 (9 5/8) MTR547	244.5	9 5/8	547X	Pin 6 5/8 Reg	61.2	295x295x439
244,5 (9 5/8) MTR637	244.5	9 5/8	637X	Pin 6 5/8 Reg	60.2	295x295x439
250,8 (9 7/8) MTR117	250.8	9 7/8	117	Pin 6 5/8 Reg	61.2	295x295x439
250,8 (9 7/8) MTR537	250.8	9 7/8	537X	Pin 6 5/8 Reg	63.2	295x295x439
250,8 (9 7/8) MTR617	250.8	9 7/8	617Y	Pin 6 5/8 Reg	63.2	295x295x439
250,8 (9 7/8) MTR637	250.8	9 7/8	637Y	Pin 6 5/8 Reg	63.2	295x295x439
250,8 (9 7/8) MTR837	250.8	9 7/8	837Y	Pin 6 5/8 Reg	62.2	295x295x439
269,9 (10 5/8) MTR137	269.9	10 5/8	137	Pin 6 5/8 Reg	71.2	295x295x439
269,9 (10 5/8) MTR217	269.9	10 5/8	217	Pin 6 5/8 Reg	70.2	295x295x439
269,9 (10 5/8) MTR237	269.9	10 5/8	237	Pin 6 5/8 Reg	70.2	295x295x439
269,9 (10 5/8) MTR547	269.9	10 5/8	547X	Pin 6 5/8 Reg	71.2	295x295x439
269,9 (10 5/8) MTR637	269.9	10 5/8	637Y	Pin 6 5/8 Reg	72.2	295x295x439
279,4 (11) MTR837	279.4	11	837Y	Pin 6 5/8 Reg	79.1	340x340x524
295,3 (11 5/8) MTR217	295.3	11 5/8	217	Pin 6 5/8 Reg	92.1	340x340x524
295,3 (11 5/8) MTR237	295.3	11 5/8	237	Pin 6 5/8 Reg	89.1	340x340x524
295,3 (11 5/8) MTR337	295.3	11 5/8	337	Pin 6 5/8 Reg	90.1	340x340x524
295,3 (11 5/8) MTR537	295.3	11 5/8	537X	Pin 6 5/8 Reg	90.1	340x340x524
311,1 (12 1/4) MTR117	311.1	12 1/4	117	Pin 6 5/8 Reg	95.1	340x340x524
311,1 (12 1/4) MTR137	311.1	12 1/4	137	Pin 6 5/8 Reg	96.1	340x340x524
311,1 (12 1/4) MTR217	311.1	12 1/4	217	Pin 6 5/8 Reg	98.1	340x340x524
311,1 (12 1/4) MTR317	311.1	12 1/4	317	Pin 6 5/8 Reg	96.1	340x340x524
311,1 (12 1/4) MTR427	311.1	12 1/4	427X	Pin 6 5/8 Reg	95.1	340x340x524
311,1 (12 1/4) MTR527	311.1	12 1/4	527X	Pin 6 5/8 Reg	97.1	340x340x524
311,1 (12 1/4) MTR547	311.1	12 1/4	547X	Pin 6 5/8 Reg	97.1	340x340x524
311,1 (12 1/4) MTR617	311.1	12 1/4	617Y	Pin 6 5/8 Reg	97.1	340x340x524
311,1 (12 1/4) MTR837	311.1	12 1/4	837Y	Pin 6 5/8 Reg	101.1	340x340x524

MOTORPRO (MTRP) BITS



MotorPro premium sealed bearing roller cone bits are specially designed for high load and RPM drilling with a downhole motor. The design of bits and the use of special features provide excellent protection of the bit body while drilling directional and horizontal wells. The use of a premium sealed journal bearing and innovative design solutions for the sealing assembly and protection of the bit bearing ensure a long bearing life and the optimum technical and economic bit performance.

215,9

(8 1/2)

MTRP

627

Bit size, mm

Bit size, inch

Product line

IADC code

Bit identification	Bit size		IADC code	Connecting thread	Gross weight, kg	Shipping dimensions, mm
	mm	inch		API		
1	2	3	4	5	6	7
215,9 (8 1/2) MTRP117	215.9	8 1/2	117	Pin 4 1/2 Reg	40.7	255x255x389
215,9 (8 1/2) MTRP137	215.9	8 1/2	137	Pin 4 1/2 Reg	41.7	255x255x389
215,9 (8 1/2) MTRP437	215.9	8 1/2	437X	Pin 4 1/2 Reg	40.7	255x255x389
215,9 (8 1/2) MTRP517	215.9	8 1/2	517X	Pin 4 1/2 Reg	42.7	255x255x389
215,9 (8 1/2) MTRP527	215.9	8 1/2	527X	Pin 4 1/2 Reg	43.7	255x255x389
215,9 (8 1/2) MTRP537	215.9	8 1/2	537X	Pin 4 1/2 Reg	42.7	255x255x389
215,9 (8 1/2) MTRP617	215.9	8 1/2	617X	Pin 4 1/2 Reg	41.7	255x255x389
215,9 (8 1/2) MTRP627	215.9	8 1/2	627Y	Pin 4 1/2 Reg	41.7	255x255x389
215,9 (8 1/2) MTRP637	215.9	8 1/2	637Y	Pin 4 1/2 Reg	41.7	255x255x389
295,3 (11 5/8) MTRP117	295.3	11 5/8	117	Pin 6 5/8 Reg	88.1	340x340x524
295,3 (11 5/8) MTRP127	295.3	11 5/8	127	Pin 6 5/8 Reg	88.1	340x340x524
295,3 (11 5/8) MTRP137	295.3	11 5/8	137	Pin 6 5/8 Reg	88.1	340x340x524
295,3 (11 5/8) MTRP547	295.3	11 5/8	547X	Pin 6 5/8 Reg	91.1	340x340x524
295,3 (11 5/8) MTRP627	295.3	11 5/8	627Y	Pin 6 5/8 Reg	93.1	340x340x524
311,1 (12 1/4) MTRP117	311.1	12 1/4	117	Pin 6 5/8 Reg	94.1	340x340x524
311,1 (12 1/4) MTRP217	311.1	12 1/4	217	Pin 6 5/8 Reg	97.1	340x340x524
311,1 (12 1/4) MTRP317	311.1	12 1/4	317	Pin 6 5/8 Reg	95.1	340x340x524
311,1 (12 1/4) MTRP437	311.1	12 1/4	437X	Pin 6 5/8 Reg	95.1	340x340x524
311,1 (12 1/4) MTRP517	311.1	12 1/4	517X	Pin 6 5/8 Reg	97.1	340x340x524
311,1 (12 1/4) MTRP537	311.1	12 1/4	537X	Pin 6 5/8 Reg	97.1	340x340x524
311,1 (12 1/4) MTRP627	311.1	12 1/4	627Y	Pin 6 5/8 Reg	97.1	340x340x524
311,1 (12 1/4) MTRP717	311.1	12 1/4	717Y	Pin 6 5/8 Reg	98.1	340x340x524

SLIMHOLEPRO (SLHP) BITS



SlimHolePro small-sized roller cone bits with sealed journal bearings are ideal for horizontal drilling, sidetracking, re-entry jobs and drilling final well sections. The bit design and the use of reinforced shirrtail provide excellent protection for the bit body while drilling horizontal wells. Sealed journal bearing application ensures a long bearing life and the optimum technical and economic bit performance.

104,8

(4 1/8)

SLHP

117

Bit size, mm

Bit size, inch

Product line

IADC code

Bit identification	Bit size		IADC code	Connecting thread	Gross weight, kg	Shipping dimensions, mm
	mm	inch		API		
1	2	3	4	5	6	7
104,8 (4 1/8) SLHP117	104.8	4 1/8	117	Pin 2 3/8 Reg	7.4	150x150x254
108,0 (4 1/4) SLHP517	108.0	4 1/4	517X	Pin 2 3/8 Reg	7.4	150x150x254
114,3 (4 1/2) SLHP117	114.3	4 1/2	117	Pin 2 3/8 Reg	7.4	150x150x254
114,3 (4 1/2) SLHP437	114.3	4 1/2	437X	Pin 2 3/8 Reg	7.4	150x150x254
114,3 (4 1/2) SLHP537	114.3	4 1/2	537X	Pin 2 3/8 Reg	7.4	150x150x254
114,3 (4 1/2) SLHP627	114.3	4 1/2	627Y	Pin 2 3/8 Reg	7.4	150x150x254
114,3 (4 1/2) SLHP737	114.3	4 1/2	737Y	Pin 2 3/8 Reg	7.4	150x150x254
120,6 (4 3/4) SLHP117	120.6	4 3/4	117	Pin 2 7/8 Reg	9.4	150x150x254
120,6 (4 3/4) SLHP437	120.6	4 3/4	437X	Pin 2 7/8 Reg	10.4	150x150x254
120,6 (4 3/4) SLHP547	120.6	4 3/4	547X	Pin 2 7/8 Reg	10.4	150x150x254
124,0 (4 7/8) SLHP117	124.0	4 7/8	117	Pin 2 7/8 Reg	10.4	150x150x254
124,0 (4 7/8) SLHP517	124.0	4 7/8	517X	Pin 2 7/8 Reg	10.4	150x150x254
124,0 (4 7/8) SLHP547	124.0	4 7/8	547X	Pin 2 7/8 Reg	10.4	150x150x254
124,0 (4 7/8) SLHP627	124.0	4 7/8	627Y	Pin 2 7/8 Reg	10.8	150x150x254
124,0 (4 7/8) SLHP717	124.0	4 7/8	717Y	Pin 2 7/8 Reg	10.4	150x150x254
126,0 (4 31/32) SLHP527	126.0	4 31/32	527X	Pin 2 7/8 Reg	10.4	150x150x254
127,0 (5) SLHP117	127.0	5	117	Pin 2 7/8 Reg	10.4	150x150x254
127,0 (5) SLHP527	127.0	5	527X	Pin 2 7/8 Reg	10.4	150x150x254
139,7 (5 1/2) SLHP216	139.7	5 1/2	216	Pin 3 1/2 Reg	15.3	220x220x334
139,7 (5 1/2) SLH527K*	139.7	5 1/2	527X	Pin 2 7/8 Reg	15.3	220x220x334

1	2	3	4	5	6	7
139,7 (5 1/2) SLH547K*	139.7	5 1/2	547X	Pin 2 7/8 Reg	15.8	220x220x334
139,7 (5 1/2) SLHP547	139.7	5 1/2	547X	Pin 3 1/2 Reg	15.8	220x220x334
142,9 (5 5/8) SLHP117	142.9	5 5/8	117	Pin 3 1/2 Reg	16.3	220x220x334
142,9 (5 5/8) SLHP517	142.9	5 5/8	517X	Pin 3 1/2 Reg	16.3	220x220x334
142,9 (5 5/8) SLHP547	142.9	5 5/8	547X	Pin 3 1/2 Reg	15.3	220x220x334
142,9 (5 5/8) SLHP627	142.9	5 5/8	627X	Pin 3 1/2 Reg	16.3	220x220x334
143,9 (5 43/64) SLHP547	143.9	5 43/61	547X	Pin 3 1/2 Reg	15.3	220x220x334
146,0 (5 3/4) SLHP137	146.0	5 3/4	117	Pin 3 1/2 Reg	15.3	220x220x334
146,0 (5 3/4) SLHP547	146.0	5 3/4	547Y	Pin 3 1/2 Reg	17.3	220x220x334
146,0 (5 3/4) SLHP627	146.0	5 3/4	627X	Pin 3 1/2 Reg	15.3	220x220x334
149,2 (5 7/8) SLHP137	149.2	5 7/8	137	Pin 3 1/2 Reg	17.3	220x220x334
149,2 (5 7/8) SLHP337	149.2	5 7/8	337	Pin 3 1/2 Reg	15.3	220x220x334
149,2 (5 7/8) SLHP437	149.2	5 7/8	437X	Pin 3 1/2 Reg	15.3	220x220x334
149,2 (5 7/8) SLHP517	149.2	5 7/8	517X	Pin 3 1/2 Reg	17,3	220x220x334
149,2 (5 7/8) SLHP527	149,2	5 7/8	527X	Pin 3 1/2 Reg	15.3	220x220x334
149,2 (5 7/8) SLHP537	149.2	5 7/8	537X	Pin 3 1/2 Reg	17.3	220x220x334
149,2 (5 7/8) SLHP547	149.2	5 7/8	547X	Pin 3 1/2 Reg	17.3	220x220x334
149,2 (5 7/8) SLHP617	149.2	5 7/8	617X	Pin 3 1/2 Reg	15.3	220x220x334
152,4 (6) SLHP117	152.4	6	117	Pin 3 1/2 Reg	16.3	220x220x334
152,4 (6) SLHP127	152.4	6	127	Pin 3 1/2 Reg	16	220x220x334
152,4 (6) SLHP217	152.4	6	217	Pin 3 1/2 Reg	16.3	220x220x334
152,4 (6) SLHP337	152.4	6	337	Pin 3 1/2 Reg	15.3	220x220x334
152,4 (6) SLHP517	152.4	6	517X	Pin 3 1/2 Reg	16.3	220x220x334
152,4 (6) SLHP537	152.4	6	537X	Pin 3 1/2 Reg	16.3	220x220x334
152,4 (6) SLHP647	152.4	6	647Y	Pin 3 1/2 Reg	16.3	220x220x334
155,6 (6 1/8) SLHP117	155.6	6 1/8	117	Pin 3 1/2 Reg	17.3	220x220x334
155,6 (6 1/8) SLHP437	155.6	6 1/8	437X	Pin 3 1/2 Reg	20.3	220x220x334
155,6 (6 1/8) SLHP517	155.6	6 1/8	517X	Pin 3 1/2 Reg	19.3	220x220x334
155,6 (6 1/8) SLHP527	155.6	6 1/8	527X	Pin 3 1/2 Reg	18.3	220x220x334
155,6 (6 1/8) SLHP537	155.6	6 1/8	537X	Pin 3 1/2 Reg	18.3	220x220x334
155,6 (6 1/8) SLHP547	155.6	6 1/8	547X	Pin 3 1/2 Reg	18.3	220x220x334
155,6 (6 1/8) SLHP617	155.6	6 1/8	617X	Pin 3 1/2 Reg	18.3	220x220x334
155,6 (6 1/8) SLHP627	155.6	6 1/8	627X	Pin 3 1/2 Reg	19.3	220x220x334
158,7 (6 1/4) SLHP127	158.7	6 1/4	127	Pin 3 1/2 Reg	18.3	220x220x334
158,7 (6 1/4) SLHP517	158.7	6 1/4	517X	Pin 3 1/2 Reg	19.3	220x220x334
165,1 (6 1/2) SLHP217	165.1	6 1/2	217	Pin 3 1/2 Reg	20.3	220x220x334
165,1 (6 1/2) SLHP237	165.1	6 1/2	237	Pin 3 1/2 Reg	19.3	220x220x334
165,1 (6 1/2) SLHP517	165.1	6 1/2	517X	Pin 3 1/2 Reg	19.3	220x220x334
165,1 (6 1/2) SLHP547	165.1	6 1/2	547X	Pin 3 1/2 Reg	20.3	220x220x334
165,1 (6 1/2) SLHP637	165.1	6 1/2	637Y	Pin 3 1/2 Reg	20.3	220x220x334
165,1 (6 1/2) SLHP837	165.1	6 1/2	837Y	Pin 3 1/2 Reg	20.3	220x220x334
171,4 (6 3/4) SLHP117	171.4	6 3/4	117	Pin 3 1/2 Reg	20.3	220x220x334

*K is an additional suffix used in case of nonstandard thread.

AUXILIARIES FOR ROLLER CONE BITS



- Nozzle
- Nail
- Snap ring
- O-ring
- Calliper for nozzle size measurement
- Hammer for nail injection/extraction
- Forceps for snap ring installation/removal
- Wrench for central jet

Nozzles for roller cone bits

Size, mm	Size, inch	Side jet	Central jet
104.8 - 114.3	4 1/8 - 4 1/2	R9531	-
120.6 - 127.0	4 3/4 - 5	R6738	-
139.7 - 152.4	5 1/2 - 6	R3401	-
155.6 - 171.4	6 1/8 - 6 3/4	R1804	-
190.5 - 228.6	7 1/2 - 9	R0030	R1804*
241.3 - 660.4	9 1/2 - 26	R0101	R0030

*They are installed optionally.

	Orifice size, inch																					
Nozzle	7/32	8/32	9/32	10/32	11/32	12/32	13/32	14/32	15/32	16/32	17/32	18/32	19/32	20/32	21/32	22/32	23/32	24/32	25/32	26/32	28/32	
R9531	●	●	●	●	●	●	●	●														
R6738	●	●	●	●	●	●	●	●	●	●		●		●								
R3401	●	●	●	●	●	●	●	●	●	●		●		●								
R1804			●	●	●	●	●	●	●	●		●		●								
R0030		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	
R0101		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	

PDC BITS

For oil and gas production VBM also offers bits with steel or matrix bodies and polycrystalline diamond cutters (PDC).

- All-purpose **FastDrill (FD) bits** are designed for the oil and gas industry and used for full-hole drilling of vertical, directional and horizontal wells.
- Due to high abrasion and erosion wear resistance **FastDrillMatrix (FDM) bits** are applied for drilling extended intervals and wells in severe geological conditions.
- **SideTrak (ST) bits** are designed for open-hole side-tracking.
- **WiperTrip (WT) bits** are used for hole reaming and gaging.
- **BicentricDrill (BD) bits** are suitable for underreaming while oil and gas wells drilling.
- **CoreBits (CB) bits** are utilized for oil and gas wells core drilling.



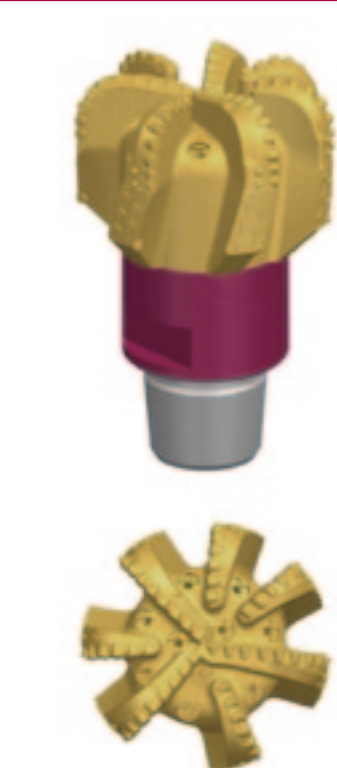
FEATURES

VBM bits feature special designs depending on their applications and geological environments.

Bit body	FD	BD	CB	FDM
Steel	*	*	*	
Matrix				*

Appearance	Description
	SECOND ROW OF CUTTERS increases density of cutting structure and improves bit performance in different types of formations without effecting ROP.
	SHOCK STUDS limit vibrations and increase bit stability.
	THE UP DRILL CUTTERS are designed for hole cleaning during back-reaming and caliper operations reducing bit seizure, dogleg severity, and hole wall sloughing.
	SUPPORT INSERTS are used for restriction of cutting depth and enhancement of bit steering response.
	THE INCREASED NUMBER OF FLUSHING HOLES is used to improve the hydraulic pattern of bit flushing and cuttings removal and to avoid bit balling.
	Depending on the geological environment bits can be equipped with STANDARD , OPTIMAL (of high performance) or PREMIUM cutters (for tougher conditions).

FASTDRILL (FD) BITS



FastDrill PDC bits with a steel body are all-purpose bits used for full-hole drilling of vertical, directional and horizontal oil and gas wells depending on the design features required.

These bits are designed using BitScan software to optimally position the cutters in the bit and predict controllability, ROP and bit life. Application of various PDC cutters can extend the design integrity and bit performance. Flushing through open channels at the bottom provides efficient bottomhole cleaning and tool cooling. FD bits feature high performance and provide optimal penetration rate at high ROP and minimal cost of drilling.

295,3	(11 5/8)	FD	6	16	SM	F
Bit size, mm	Bit size, inch	Product line	Number of blades	Insert size, mm	Formation category *	Additional suffix **

* Formation category

- S — soft
- SM — soft with medium interlayers
- M — medium
- MH — medium with hard interlayers

** Additional suffix

- B — the second row of cutters
- F — reinforcement of the central part

Bit identification	Bit size		Connecting thread	Gross weight, kg	Shipping dimensions, mm
	mm	inch	API		
1	2	3	4	5	6
83,0 (3 9/32) FD409M	83	3 9/32	Pin 2 3/8 Reg	39.5	355x355x359
85,0 (3 11/32) FD608SM	85	3 11/32	Pin 2 3/8 Reg	38.8	355x355x359
85,0 (3 11/32) FD409S	85	3 11/32	Pin 2 3/8 Reg	39.4	355x355x359
86,0 (3 3/8) FD409SM	86	3 3/8	Pin 2 3/8 Reg	39.6	355x355x359
92,0 (3 5/8) FD409M	92	3 5/8	Pin 2 3/8 Reg	40.7	355x355x359
95,0 (3 47/64) FD608SM	95	3 47/64	Pin 2 3/8 Reg	39.5	355x355x359
95,3 (3 3/4) FD509SMF	95.3	3 3/4	Pin 2 3/8 Reg	39.3	355x355x359

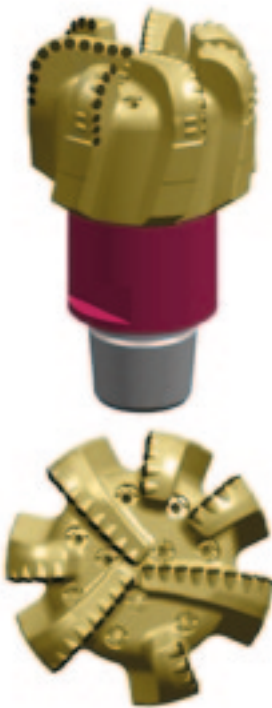
1	2	3	4	5	6
98,4 (3 7/8) FD413SM	98.4	3 7/8	Pin 2 3/8 Reg	39.5	355x355x359
114,0 (4 31/64) FD609M	114	4 31/64	Pin 2 3/8 Reg	40.5	355x355x359
114,3 (4 1/2) FD513MH	114.3	4 1/2	Pin 2 7/8 Reg	45.5	355x355x359
118,0 (4 21/32) FD313S	118	4 21/32	-	45.9	150x150x254
120,6 (4 3/4) FD613MH	120,6	4 3/4	Pin 2 7/8 Reg	46.3	355x355x359
120,6 (4 3/4) FD413SM	120.6	4 3/4	Pin 2 7/8 Reg	46.0	355x355x359
120,6 (4 3/4) FD313S	120.6	4 3/4	Pin 2 7/8 Reg	45.5	355x355x359
120,6 (4 3/4) FD613SMF	120.6	4 3/4	Pin 2 7/8 Reg	47.0	355x355x359
123,8 (4 7/8) FD413SM	123.8	4 7/8	Pin 2 7/8 Reg	46.5	355x355x359
123,8 (4 7/8) FD613M	123.8	4 7/8	Pin 2 7/8 Reg	47.0	355x355x359
123,8 (4 7/8) FD513SMF	123.8	4 7/8	Pin 2 7/8 Reg	46.0	355x355x359
123,8 (4 7/8) FD610SM	123.8	4 7/8	Pin 2 7/8 Reg	45.7	355x355x359
123,8 (4 7/8) FD513SMF	123.8	4 7/8	Pin 2 7/8 Reg	46.0	355x355x359
123,8 (4 7/8) FD613SM	123.8	4 7/8	Pin 2 7/8 Reg	46.5	355x355x359
124,0 (4 7/8) FD513MH	124	4 7/8	Pin 2 7/8 Reg	47.0	355x355x359
124,0 (4 7/8) FD613M	124	4 7/8	Pin 2 7/8 Reg	47.5	355x355x359
124,0 (4 7/8) FD613MH	124	4 7/8	Pin 2 7/8 Reg	46.5	355x355x359
124,0 (4 7/8) FD613SM	124	4 7/8	Pin 2 7/8 Reg	46.5	355x355x359
126,0 (4 31/32) FD513SMF	126	4 31/32	Pin 2 7/8 Reg	46.5	355x355x359
126,0 (4 31/32) FD613MH	126	4 31/32	Pin 2 7/8 Reg	46.9	355x355x359
126,0 (4 31/32) FD413SM	126	4 31/32	Pin 2 7/8 Reg	46.5	355x355x359
126,0 (4 31/32) FD512SMF	126	4 31/32	Pin 2 7/8 Reg	46.2	355x355x359
126,0 (4 31/32) FD613SM	126	4 31/32	Pin 2 7/8 Reg	46.0	355x355x359
127,0 (5) FD610SM	127	5	Pin 2 7/8 Reg	46.5	355x355x359
132,0 (5 3/16) FD313S	132	5 3/16	-	45.9	355x355x359
132,0 (5 3/16) FD313S	132	5 3/16	-	45.9	355x355x359
139,7 (5 1/2) FD613M	139.7	5 1/2	Pin 3 1/2 Reg	49.0	355x355x359
139,7 (5 1/2) FD413SM	139.7	5 1/2	Pin 3 1/2 Reg	48.5	355x355x359
139,7 (5 1/2) FD513SMF	139.7	5 1/2	Pin 3 1/2 Reg	47.0	355x355x359
139,7 (5 1/2) FD813MH	139.7	5 1/2	Pin 3 1/2 Reg	49.5	355x355x359
141,0 (5 35/64) FD313S	141	5 35/64	Pin 2 7/8 Reg	48.6	355x355x359
142,9 (5 5/8) FD413SM	142,9	5 5/8	Pin 3 1/2 Reg	48.7	355x355x359
142,9 (5 5/8) FD613M	142.9	5 5/8	Pin 3 1/2 Reg	49.0	355x355x359
142,9 (5 5/8) FD713M	142.9	5 5/8	Pin 3 1/2 Reg	49.0	355x355x359
142,9 (5 5/8) FD613SM	142.9	5 5/8	Pin 3 1/2 Reg	48.0	355x355x359
142,9 (5 5/8) FD713M	142.9	5 5/8	Pin 3 1/2 Reg	49.6	355x355x359
142,9 (5 5/8) FD713MH	142.9	5 5/8	Pin 3 1/2 Reg	49.5	355x355x359
144,4 (5 11/16) FD613MH	144.4	5 11/16	Pin 3 1/2 Reg	49.4	355x355x359
146,0 (5 3/4) FD613SMF	146	5 3/4	Pin 3 1/2 Reg	49.5	355x355x359
146,0 (5 3/4) FD513SM	146	5 3/4	Pin 3 1/2 Reg	48.2	355x355x359
146,0 (5 3/4) FD713M	146	5 3/4	Pin 3 1/2 Reg	49.5	355x355x359
146,0 (5 3/4) FD413SM	146	5 3/4	Pin 3 1/2 Reg	50.4	355x355x359

1	2	3	4	5	6
146,0 (5 3/4) FD613SM	146	5 3/4	Pin 3 1/2 Reg	48.5	355x355x359
149,2 (5 7/8) FD713MH	149.2	5 7/8	Pin 3 1/2 Reg	50.0	355x355x359
149,2 (5 7/8) FD813MH	149.2	5 7/8	Pin 3 1/2 Reg	50.2	355x355x359
149,2 (5 7/8) FD513SMF	149.2	5 7/8	Pin 3 1/2 Reg	51.9	355x355x359
152,4 (6) FD513SMF	152.4	6	Pin 3 1/2 Reg	52.4	355x355x359
152,4 (6) FD613SM	152.4	6	Pin 3 1/2 Reg	50.0	355x355x359
152,4 (6) FD713MH	152.4	6	Pin 3 1/2 Reg	50.2	355x355x359
152,4 (6) FD413SM	152.4	6	Pin 3 1/2 Reg	44.3	355x355x359
155,6 (6 1/8) FD713MH	155.6	6 1/8	Pin 3 1/2 Reg	50.0	355x355x359
155,6 (6 1/8) FD613SMF	155.6	6 1/8	Pin 3 1/2 Reg	42.0	355x355x359
155,6 (6 1/8) FD416S	155.6	6 1/8	Pin 3 1/2 Reg	51.4	355x355x359
155,6 (6 1/8) FD613SM	155.6	6 1/8	Pin 3 1/2 Reg	50.2	355x355x359
161,0 (6 11/32) FD313S	161	6 11/32	Pin 2 7/8 Reg	51.9	355x355x359
165,1 (6 1/2) FD513SMF	165.1	6 1/2	Pin 3 1/2 Reg	52.5	355x355x359
165,1 (6 1/2) FD613MH	165.1	6 1/2	Pin 3 1/2 Reg	52.5	355x355x359
165,1 (6 1/2) FD613SMF	165.1	6 1/2	Pin 3 1/2 Reg	57.5	355x355x359
165,1 (6 1/2) FD713MH	165.1	6 1/2	Pin 3 1/2 Reg	50.8	355x355x359
190,5 (7 1/2) FD419SM	190.5	7 1/2	Pin 4 1/2 Reg	76.9	355x355x474
190,5 (7 1/2) FD516SMF	190.5	7 1/2	Pin 4 1/2 Reg	77.9	355x355x474
190,5 (7 1/2) FD313S	190.5	7 1/2	Pin 4 1/2 Reg	75.9	355x355x474
190,5 (7 1/2) FD416S	190.5	7 1/2	Pin 4 1/2 Reg	79.4	355x355x474
190,5 (7 1/2) FD613SM	190.5	7 1/2	Pin 4 1/2 Reg	79.2	355x355x474
190,5 (7 1/2) FD713MH	190.5	7 1/2	Pin 4 1/2 Reg	77.8	355x355x474
190,5 (7 1/2) FD813MH	190.5	7 1/2	Pin 4 1/2 Reg	79.9	355x355x474
195,0 (7 11/16) FD613SM	195	7 11/16	Pin 4 1/2 Reg	78.4	355x355x474
212,7 (8 3/8) FD716MHB	212.7	8 3/8	Pin 4 1/2 Reg	87.9	355x355x474
212,7 (8 3/8) FD913MH	212.7	8 3/8	Pin 4 1/2 Reg	91.9	355x355x474
214,3 (8 7/16) FD613SM	214.3	8 7/16	Pin 4 1/2 Reg	83.9	355x355x474
215,9 (8 1/2) FD913MH	215.9	8 1/2	Pin 4 1/2 Reg	89.6	355x355x474
215,9 (8 1/2) FD519SM	215.9	8 1/2	Pin 4 1/2 Reg	84.6	355x355x474
215,9 (8 1/2) FD619SM	215.9	8 1/2	Pin 4 1/2 Reg	83.8	355x355x474
215,9 (8 1/2) FD616SM	215.9	8 1/2	Pin 4 1/2 Reg	83.9	355x355x474
215,9 (8 1/2) FD716MH	215.9	8 1/2	Pin 4 1/2 Reg	86.1	355x355x474
215,9 (8 1/2) FD613MHB	215.9	8 1/2	Pin 4 1/2 Reg	86.9	355x355x474
215,9 (8 1/2) FD616MHB	215.9	8 1/2	Pin 4 1/2 Reg	91.9	355x355x474
215,9 (8 1/2) FD419S	215.9	8 1/2	Pin 4 1/2 Reg	84.9	355x355x474
215,9 (8 1/2) FD513MHB	215.9	8 1/2	Pin 4 1/2 Reg	88.3	355x355x474
215,9 (8 1/2) FD613SMF	215.9	8 1/2	Pin 4 1/2 Reg	83.9	355x355x474
215,9 (8 1/2) FD516MHB	215.9	8 1/2	Pin 4 1/2 Reg	84.9	355x355x474
215,9 (8 1/2) FD613SM	215.9	8 1/2	Pin 4 1/2 Reg	85.9	355x355x474
215,9 (8 1/2) FD416SM	215.9	8 1/2	Pin 4 1/2 Reg	84.4	355x355x474
215,9 (8 1/2) FD516SM	215.9	8 1/2	Pin 4 1/2 Reg	83.9	355x355x474

1	2	3	4	5	6
215,9 (8 1/2) FD716MHB	215.9	8 1/2	Pin 4 1/2 Reg	86.5	355x355x474
215,9 (8 1/2) FD513SMF	215.9	8 1/2	Pin 4 1/2 Reg	85.9	355x355x474
215,9 (8 1/2) FD516SMF	215.9	8 1/2	Pin 4 1/2 Reg	85.6	355x355x474
215,9 (8 1/2) FD313S	215.9	8 1/2	Pin 4 1/2 Reg	82.9	355x355x474
215,9 (8 1/2) FD416S	215.9	8 1/2	Pin 4 1/2 Reg	84.9	355x355x474
215,9 (8 1/2) FD713MH	215.9	8 1/2	Pin 4 1/2 Reg	88.4	355x355x474
215,9 (8 1/2) FD716MHB	215.9	8 1/2	Pin 4 1/2 Reg	91.8	355x355x474
215,9 (8 1/2) FD813MH	215.9	8 1/2	Pin 4 1/2 Reg	92.9	355x355x474
215,9 (8 1/2) FD816MH	215.9	8 1/2	Pin 4 1/2 Reg	93.4	355x355x474
215,9 (8 1/2) FD913MH	215.9	8 1/2	Pin 4 1/2 Reg	91.4	355x355x474
219,1 (8 5/8) FD416SM	219.1	8 5/8	Pin 4 1/2 Reg	86.9	355x355x474
219,1 (8 5/8) FD613SM	219.1	8 5/8	Pin 4 1/2 Reg	82.9	355x355x474
219,1 (8 5/8) FD613SMF	219.1	8 5/8	Pin 4 1/2 Reg	82.9	355x355x474
219,1 (8 5/8) FD616MHB	219.1	8 5/8	Pin 4 1/2 Reg	86.9	355x355x474
219,1 (8 5/8) FD716MHB	219.1	8 5/8	Pin 4 1/2 Reg	87.9	355x355x474
220,7 (8 11/16) FD516SM	220.7	8 11/16	Pin 4 1/2 Reg	89.9	355x355x474
220,7 (8 11/16) FD613SMF	220.7	8 11/16	Pin 4 1/2 Reg	83.9	355x355x474
220,7 (8 11/16) FD513SMF	220.7	8 11/16	Pin 4 1/2 Reg	86.9	355x355x474
220,7 (8 11/16) FD416S	220.7	8 11/16	Pin 4 1/2 Reg	84.9	355x355x474
220,7 (8 11/16) FD416SM	220.7	8 11/16	Pin 4 1/2 Reg	82.0	355x355x474
220,7 (8 11/16) FD419S	220.7	8 11/16	Pin 4 1/2 Reg	85.9	355x355x474
220,7 (8 11/16) FD519SM	220.7	8 11/16	Pin 4 1/2 Reg	85.9	355x355x474
220,7 (8 11/16) FD613MHB	220.7	8 11/16	Pin 4 1/2 Reg	90.4	355x355x474
220,7 (8 11/16) FD613SM	220.7	8 11/16	Pin 4 1/2 Reg	83.9	355x355x474
220,7 (8 11/16) FD616SMF	220.7	8 11/16	Pin 4 1/2 Reg	87.5	355x355x474
220,7 (8 11/16) FD713MH	220.7	8 11/16	Pin 4 1/2 Reg	93.2	355x355x474
220,7 (8 11/16) FD716MH	220.7	8 11/16	Pin 4 1/2 Reg	88.6	355x355x474
220,7 (8 11/16) FD813MH	220.7	8 11/16	Pin 4 1/2 Reg	91.9	355x355x474
222,3 (8 3/4) FD613SMF	222.3	8 3/4	Pin 4 1/2 Reg	86.0	355x355x474
222,3 (8 3/4) FD516SM	222.3	8 3/4	Pin 4 1/2 Reg	85.7	355x355x474
222,3 (8 3/4) FD616SMF	222.3	8 3/4	Pin 4 1/2 Reg	86.4	355x355x474
222,3 (8 3/4) FD516SM	222.3	8 3/4	Pin 4 1/2 Reg	85.7	355x355x474
250,8 (9 7/8) FD519S	250.8	9 7/8	Pin 6 5/8 Reg	131.9	475x475x594
250,8 (9 7/8) FD616SM	250.8	9 7/8	Pin 6 5/8 Reg	132.4	475x475x594
269,9 (10 5/8) FD519S	269.9	10 5/8	Pin 6 5/8 Reg	149.2	475x475x594
269,9 (10 5/8) FD516MHB	269.9	10 5/8	Pin 6 5/8 Reg	152.9	475x475x594
269,9 (10 5/8) FD419SM	269.9	10 5/8	Pin 6 5/8 Reg	148.9	475x475x594
269,9 (10 5/8) FD516SM	269.9	10 5/8	Pin 6 5/8 Reg	146.9	475x475x594
269,9 (10 5/8) FD416SM	269.9	10 5/8	Pin 6 5/8 Reg	138.9	475x475x594
269,9 (10 5/8) FD616SM	269.9	10 5/8	Pin 6 5/8 Reg	136.3	475x475x594
269,9 (10 5/8) FD716SMF	269.9	10 5/8	Pin 6 5/8 Reg	144.9	475x475x594
295,3 (11 5/8) FD716M	295.3	11 5/8	Pin 6 5/8 Reg	152.3	475x475x594

1	2	3	4	5	6
295,3 (11 5/8) FD419SM	295.3	11 5/8	Pin 6 5/8 Reg	153.3	475x475x594
295,3 (11 5/8) FD816MH	295.3	11 5/8	Pin 6 5/8 Reg	164.1	475x475x594
295,3 (11 5/8) FD519SM	295.3	11 5/8	Pin 6 5/8 Reg	144.2	475x475x594
295,3 (11 5/8) FD516M	295.3	11 5/8	Pin 6 5/8 Reg	156.9	475x475x594
295,3 (11 5/8) FD616SMF	295.3	11 5/8	Pin 6 5/8 Reg	148.9	475x475x594
295,3 (11 5/8) FD813MHB	295.3	11 5/8	Pin 6 5/8 Reg	162.9	475x475x594
295,3 (11 5/8) FD419S	295.3	11 5/8	Pin 6 5/8 Reg	151.0	475x475x594
295,3 (11 5/8) FD516MHB	295.3	11 5/8	Pin 6 5/8 Reg	162.0	475x475x594
295,3 (11 5/8) FD519M	295.3	11 5/8	Pin 6 5/8 Reg	157.0	475x475x594
295,3 (11 5/8) FD519SM	295.3	11 5/8	Pin 6 5/8 Reg	148.0	475x475x594
295,3 (11 5/8) FD613MHB	295.3	11 5/8	Pin 6 5/8 Reg	155.4	475x475x594
295,3 (11 5/8) FD616MHB	295.3	11 5/8	Pin 6 5/8 Reg	163.9	475x475x594
295,3 (11 5/8) FD619SM	295.3	11 5/8	Pin 6 5/8 Reg	152.0	475x475x594
295,3 (11 5/8) FD619SMF	295.3	11 5/8	Pin 6 5/8 Reg	152.0	475x475x594
295,3 (11 5/8) FD619SMF	295.3	11 5/8	Pin 6 5/8 Reg	154.9	475x475x594
295,3 (11 5/8) FD716MH	295.3	11 5/8	Pin 6 5/8 Reg	159.9	475x475x594
300,0 (11 13/16) FD616SMF	300	11 13/16	Pin 6 5/8 Reg	160.9	475x475x594
300,0 (11 13/16) FD419S	300	11 13/16	Pin 6 5/8 Reg	151.2	475x475x594
300,0 (11 13/16) FD519SM	300	11 13/16	Pin 6 5/8 Reg	149.0	475x475x594
300,0 (11 13/16) FD519SM	300	11 13/16	Pin 6 5/8 Reg	145.7	475x475x594
311,1 (12 1/4) FD716SMF	311.1	12 1/4	Pin 6 5/8 Reg	159.0	475x475x594
311,1 (12 1/4) FD519SM	311.1	12 1/4	Pin 6 5/8 Reg	152.9	475x475x594
311,1 (12 1/4) FD616SMF	311.1	12 1/4	Pin 6 5/8 Reg	160.4	475x475x594
311,1 (12 1/4) FD716MH	311.1	12 1/4	Pin 6 5/8 Reg	162.9	475x475x594
311,1 (12 1/4) FD419S	311.1	12 1/4	Pin 6 5/8 Reg	156.0	475x475x594
311,1 (12 1/4) FD613MHB	311.1	12 1/4	Pin 6 5/8 Reg	160.9	475x475x594
311,1 (12 1/4) FD616SM	311.1	12 1/4	Pin 6 5/8 Reg	149.9	475x475x594
311,1 (12 1/4) FD619SM	311.1	12 1/4	Pin 6 5/8 Reg	160.0	475x475x594
311,1 (12 1/4) FD619SMF	311.1	12 1/4	Pin 6 5/8 Reg	152.7	475x475x594
311,1 (12 1/4) FD713SMF	311.1	12 1/4	Pin 6 5/8 Reg	152.9	475x475x594
393,7 (15 1/2) FD419SM	393.7	15 1/2	Pin 7 5/8 Reg	231.3	475x475x694
393,7 (15 1/2) FD816MH	393.7	15 1/2	Pin 7 5/8 Reg	241.0	475x475x694
393,7 (15 1/2) FD619SM	393.7	15 1/2	Pin 7 5/8 Reg	247.5	475x475x694
393,7 (15 1/2) FD519SM	393.7	15 1/2	Pin 7 5/8 Reg	219.0	475x475x694
406,4 (16) FD516MHB	406.4	16	Pin 7 5/8 Reg	238.9	475x475x694
406,4 (16) FD616SM	406.4	16	Pin 7 5/8 Reg	244.0	475x475x694
406,4 (16) FD619SM	406.4	16	Pin 7 5/8 Reg	240.0	475x475x694
431,8 (17) FD619SM	431.8	17	Pin 7 5/8 Reg	246.0	736x736x714
431,8 (17) FD816MH	431.8	17	Pin 7 5/8 Reg	314.0	736x736x714
444,5 (17 1/2) FD519SM	444.5	17 1/2	Pin 7 5/8 Reg	354.9	736x736x714
444,5 (17 1/2) FD419SM	444.5	17 1/2	Pin 7 5/8 Reg	426.9	736x736x714
444,5 (17 1/2) FD619SM	444.5	17 1/2	Pin 7 5/8 Reg	379.0	736x736x714

FASTDRILLMATRIX (FDM) BITS



FastDrillMatrix PDC bits with a matrix body are used for the oil and gas industry. They feature high abrasion and erosion wear resistance. These bits are designed using BitScan software to optimally position the cutters in the bit and predict controllability, ROP and bit life. Application of various cutters can extend the design integrity and bit performance. Flushing through open channels at the bottom provides efficient bottomhole cleaning and tool cooling. FDM bits feature high performance and provide optimal penetration rate at high ROP and minimal cost of drilling.

215,9	(8 1/2)	FDM	5	19	MH	B
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Bit size, mm

Bit size, inch

Product line

Number of blades

Insert size, mm

Formation category *

Additional suffix **

* Formation category

- M — medium
- MH — medium with hard interlayers

** Additional suffix

- B — the second row of cutters
- F — reinforcement of the central part

Bit identification	Bit size		Connecting thread	Gross weight, kg	Shipping dimensions, mm
	mm	inch	API		
1	2	3	4	5	6
149,2 (5 7/8) FDM613MHB	149.2	5 7/8	Pin 3 1/2 Reg	61.1	355x355x359
215,9 (8 1/2) FDM519MHB	215.9	8 1/2	Pin 4 1/2 Reg	133.9	355x355x474
215,9 (8 1/2) FDM619MHB	215.9	8 1/2	Pin 4 1/2 Reg	140.9	355x355x474
311,1 (12 1/4) FDM519M	311.1	12 1/4	Pin 6 5/8 Reg	259.9	475x475x594
311,1 (12 1/4) FDM619MHB	311.1	12 1/4	Pin 6 5/8 Reg	275.9	475x475x594
311,1 (12 1/4) FDM716MH	311.1	12 1/4	Pin 6 5/8 Reg	268.9	475x475x594

SIDETRACK (ST) BITS



SideTrak PDC bits are designed for open-hole sidetracking. They feature high performance and provide fast execution of operations.

142,9	(5 5/8)	ST	9	10	MH
Bit size, mm	Bit size, inch	Product line	Number of blades	Insert size, mm	Formation category *

* Formation category
MH — medium with hard interlayers

Bit identification	Bit size		Connecting thread	Gross weight, kg	Shipping dimensions, mm
	mm	inch	API		
1	2	3	4	5	6
126,0 (4 31/32) ST613MH	126	4 31/32	Pin 2 7/8 Reg	45.4	355x355x359
142,9 (5 5/8) ST613MH	142.9	5 5/8	Pin 3 1/2 Reg	47.0	355x355x359
142,9 (5 5/8) ST910MH	142.9	5 5/8	Pin 3 1/2 Reg	42.8	355x355x359

WIPERTRIP (WT) BITS



WiperTrip PDC bits with a steel body are applied for hole reaming and gaging. The design uses a parabolic profile, which prevents spontaneous sidetracking.

120,6	(4 3/4)	WT	6	13	S
Bit size, mm	Bit size, inch	Product line	Number of blades	Insert size, mm	Formation category *

* Formation category
S — soft
SM — soft with medium interlayers

Bit identification	Bit size		Connecting thread	Gross weight, kg	Shipping dimensions, mm
	mm	inch	API		
1	2	3	4	5	6
120,6 (4 3/4) WT613SM	120.6	4 3/4	-	9.4	150x150x254
123,8 (4 7/8) WT613SM	123.8	4 7/8	Box NC31	13.8	150x150x254
127,0 (5) WT613SM	127	5	Box NC31	14.3	220x220x334
142,9 (5 5/8) WT613S	142.9	5 5/8	Box NC31	20.7	255x255x389
215,9 (8 1/2) WT413SM	215.9	8 1/2	Box NC50	46.2	255x255x389
215,9 (8 1/2) WT613SM	215.9	8 1/2	Box 4 1/2 Reg	84.4	355x355x474
220,7 (8 11/16) WT613SM	220.7	8 11/16	Box 4 1/2 Reg	86	355x355x474

BICENTRICDRILL (BD) BITS



BicentricDrill PDC bits with a steel body are designed for underreaming while drilling. These bits feature high performance and provide stress free penetration at high ROP and minimum cost of drilling.

152,4	x175,0	(6x	7 7/8)	BD	6	13	SM
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Drift bit size, mm

Opening bit size, mm

Drift bit size, inch

Opening bit size, inch

Product line

Number of blades

Insert size, mm

Formation category *

* Formation category

■ S — soft

■ SM — soft with medium interlayers

■ M — medium

■ MH — medium with hard interlayers

Bit identification	Bit size		Connecting thread	Gross weight, kg	Shipping dimensions, mm
	mm	inch	API		
1	2	3	4	5	6
120,6x142,9 (4 3/4x5 5/8) BD613M	120.6x142.9	4 3/4x5 5/8	Pin 2 7/8 Reg	52.5	355x355x474
139,7x165,1 (5 1/2x6 1/2) BD513SM	139.7x165.1	5 1/2x6 1/2	Pin 3 1/2 Reg	58.0	355x355x474
139,7x165,1 (5 1/2x6 1/2) BD613MH	139.7x165.1	5 1/2x6 1/2	Pin 3 1/2 Reg	57.0	355x355x474
152,4x175,0 (6x6 14/16) BD613SM	152.4x175.0	6x6 14/16	Pin 3 1/2 Reg	61.9	355x355x474
165,1x190,5 (6 1/2x7 1/2) BD713MH	165.1x190.5	6 1/2x7 1/2	Pin 3 1/2 Reg	66.9	355x355x474
215,9x238,2 (8 1/2x9 3/8) BD713SM	215.9x238.2	8 1/2x9 3/8	Pin 4 1/2 Reg	120.9	475x475x694
215,9x250,8 (8 1/2x9 7/8) BD613SM	215.9x250.8	8 1/2x9 7/8	Pin 4 1/2 Reg	113.9	475x475x694
215,9x266,7 (8 1/2x10 1/2) BD713SM	215.9x266.7	8 1/2x10 1/2	Pin 4 1/2 Reg	120.9	475x475x694
241,2x269,9 (9 1/2x10 5/8) BD713MH	241.2x269.9	9 1/2x10 5/8	Pin 6 5/8 Reg	154.9	475x475x694
311,1x342,9 (12 1/4x13 1/2) BD716MH	311.1x342.9	12 1/4x13 1/2	Pin 6 5/8 Reg	227.9	736x736x714

COREBITS (CB) BITS



CoreBits PDC bits with a steel body feature high performance and are used for core drilling.

142,9	/80	CB	6	13	SM
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Bit size, mm

Core size, mm

Product line

Blades number

Insert size, mm

Formation category *

* Formation category

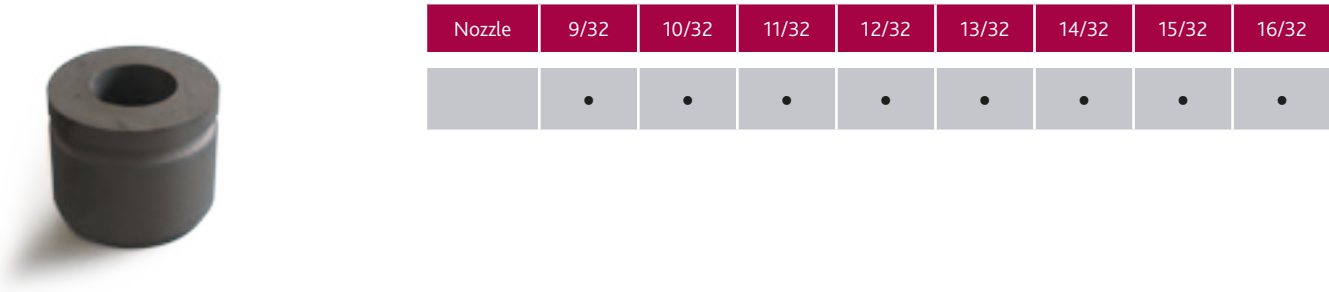
■ SM — soft with medium interlayers

■ MH — medium with hard interlayers

Bit identification	Bit size		Connecting thread	Gross weight, kg	Shipping dimensions, mm
	mm	inch	API		
1	2	3	4	5	6
139,7/52 CB613SM	139.7/52.0	5 1/2x 2 1/16	-	12.3	220x220x334
139,7/67 CB613SM	139.7/67.0	5 1/2x 2 5/8	-	13.3	220x220x334
142,9/80 CB809MH	142.9/80.0	5 5/8x3 5/32	-	9.5	220x220x334
142,9/80 CB613SM	142.9/80.0	5 5/8x3 5/32	-	17.2	255x255x389
146/80 CB613SM	146.0/80.0	5 3/4x3 5/32	-	10.3	220x220x334
158,7/67 CB613SM	158.7/67.0	6 1/4x2 5/8	Box NC50	15.3	220x220x334
163,5/67 CB809MH	163.5/67.0	6 7/16x2 5/8	Box NC50	19.1	220x220x334
187,3/80 CB613SM	187.3/80.0	7 3/8x3 5/32	-	21.3	220x220x334
195,0/80 CB913MH	195.0/80.0	7 11/16x3 5/32	-	22.7	255x255x389
212,7/100 CB1013MH	212.7/100.0	8 3/8x3 15/16	-	28.2	255x255x389
212,7/100 CB613SM	212.7/100.0	8 3/8x3 15/16	-	26.7	255x255x389
212,7/80 CB1009MH	212.7/80.0	8 3/8x3 5/32	-	32.3	255x255x389
212,7/80 CB613SM	212.7/80.0	8 3/8x3 5/32	-	23.7	255x255x389
212,7/80 CB613SM	212.7/80.0	8 3/8x3 5/32	-	25.7	255x255x389
212,7/80 CB613SM	212./80.0	8 3/8x3 5/32	-	21.2	255x255x389
215,9/100 CB1009MH	215.9/100.0	8 1/2x3 15/16	Box 6 5/8 FH	26.7	255x255x389
215,9/100 CB613SM	215.9/100.0	8 1/2x3 15/16	Box 6 5/8 FH	34.2	255x255x389
215,9/100 CB813SM	215.9/100.0	8 1/2x3 15/16	-	28.7	255x255x389
215,9/100 CB813SM	215.9/100.0	8 1/2x3 15/16	Box 6 5/8 FH	28.7	255x255x389
215,9/100 CB913MH	215.9/100.0	8 1/2x3 15/16	Box 6 5/8 FH	36.7	255x255x389
215,9/80 CB613SM	215.9/80.0	8 1/2x3 5/32	-	23.7	255x255x389
215,9/80 CB813SM	215.9/80.0	8 1/2x3 5/32	-	26.7	255x255x389
295,3/100 CB913SM	295.3/100.0	11 5/8x3 15/16	Box 6 5/8 FH	74.1	340x340x524

AUXILIARIES FOR PDC BITS

Port (unchangeable nozzle)



Nozzle	9/32	10/32	11/32	12/32	13/32	14/32	15/32	16/32
	•	•	•	•	•	•	•	•

Replaceable threaded nozzles

Nozzle (type)	Orifice size, inch																		Wrench
	7/32	8/32	9/32	10/32	11/32	12/32	13/32	14/32	15/32	16/32	17/32	18/32	19/32	20/32	21/32	22/32	23/32	24/32	
MJP-CSA-201			•	•		•	•	•	•	•									R22561
AH22-3			•	•		•	•	•	•										A22K
AH27-4	•	•	•	•		•	•	•	•	•	•	•							A22K
AH39-3		•	•	•		•	•	•	•	•	•	•	•	•	•				A39K



Bit breaker

Bit breaker identification	BB A63,5P-1	BB A66P-1	BB A76P-1	BB A88P-1	BB A117.85P-1	BB A152-177P-1	BB A177P-7
Shipping dimensions, mm	330 x 330	330 x 330	330 x 330	330 x 330	330 x 330	450 x 450	711 x 711
Weight, kg	29	28	29	26	33	52	175



OIL AND GAS BIT OPERATION MANUAL

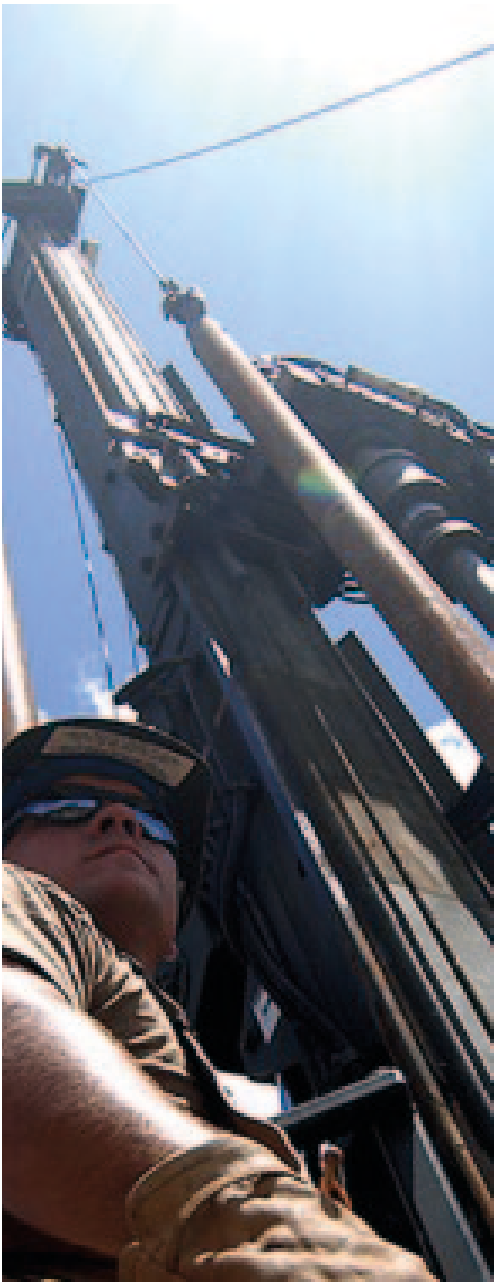
A full version of **Bit Operation Manual** can be downloaded from the corporate site, or ask for its delivery by e-mail or through the official dealers or VBM representatives.



BIT OPERATION RECOMMENDATIONS

BIT PREPARATIONS FOR OPERATIONS

- Before running a new bit, analyze and assess efficiency of the old one: wear, RPM, drilling modes, penetration rate etc.
- Inspect the bit condition and its configuration: nozzles mounting security, nozzles availability and their sizes (if necessary), thread condition. Ensure that the thread of connecting drill rod (stabilizer, sub etc) is non-defective, not damaged and complies with bit thread.
- Inspect the rotary table condition, rotary brake availability and its correct operation. Ensure that the rotary inserts size and configurations complies with bit breaker.
- Check mud pumps functionality, and test mud manifold to working pressure. Ensure that the mud pumps are capable of delivering the recommended mud pump flow for the bit type - too low mud flow can reduce cuttings flow while drilling, causing a drop in drilling speed and bit balling-up. Thermal destruction of the cuttings is also possible due to insufficient bit cooling.
- Do not make any unauthorized changes to the bit design.



BIT MAKE-UP OPERATIONS

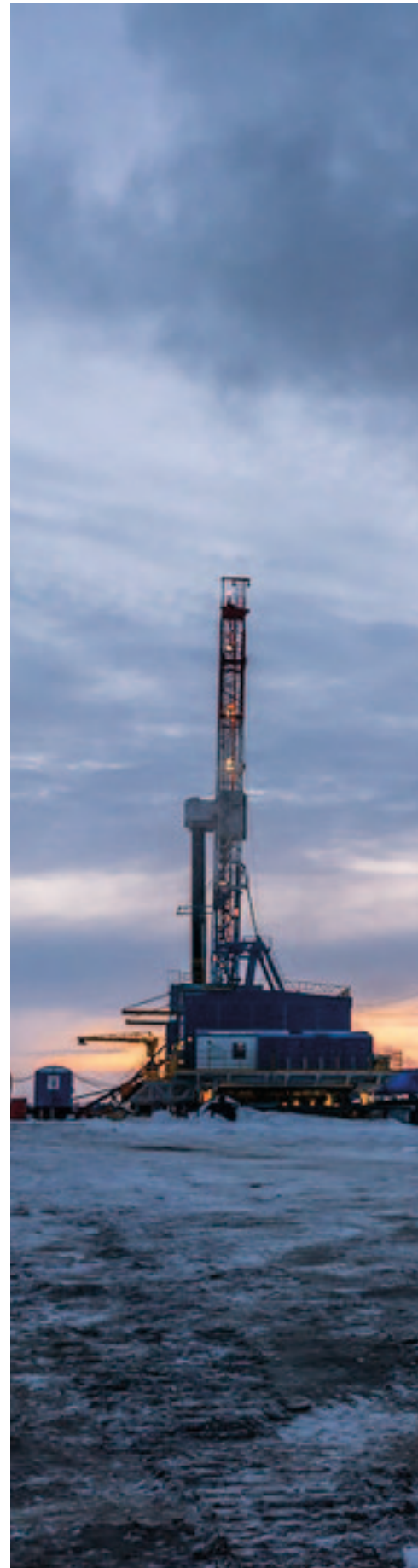
1. Clean and lubricate bit pin thread and drill tools' box thread.
2. Use a bit breaker and rotary tongs/automatic drilling tongs for make-up/break-out operations. Never apply a sledge hammer to a bit and avoid manual handling of the bit. Perform make-up operations without impact and distortions.
3. Set the torque limit value according to the Bit Operation Manual. The make-up control while bit bracing should be carried out with the tong torque gauge. A bit should be tightened mechanically first, then repeated visual inspection of bit fitting should be performed.

BIT RUNNING

1. During bit running it is required to control the bit passage through the BOP assembly. It is important to avoid impacts, snagging, or unloading on the BOP rams as this can damage the bit cutting structure (PDC bits) or bearings (roller cone bits).
2. Running and wiper tripping operations should be carried out with the pumps turned off, at a speed not exceeding 15-20 m/s in a cased hole and not exceeding 5 m/s in an open wellbore. With a downhole motor in the bottom hole assembly, activation of the mud pump should be avoided when the bit is in the cased hole to avoid damage to the cutting structure against the casing wall.
3. Pulling operations must be carried out with constant weight control. If there are "landings" during the running trips or "torque" while lifting over 5 tons in excess of the weight of the drill string, then stop running operations, activate the mud flush and perform 1-2 flushing cycles. Then, deactivating the circulation, resume the trip, starting at the lowest speed.

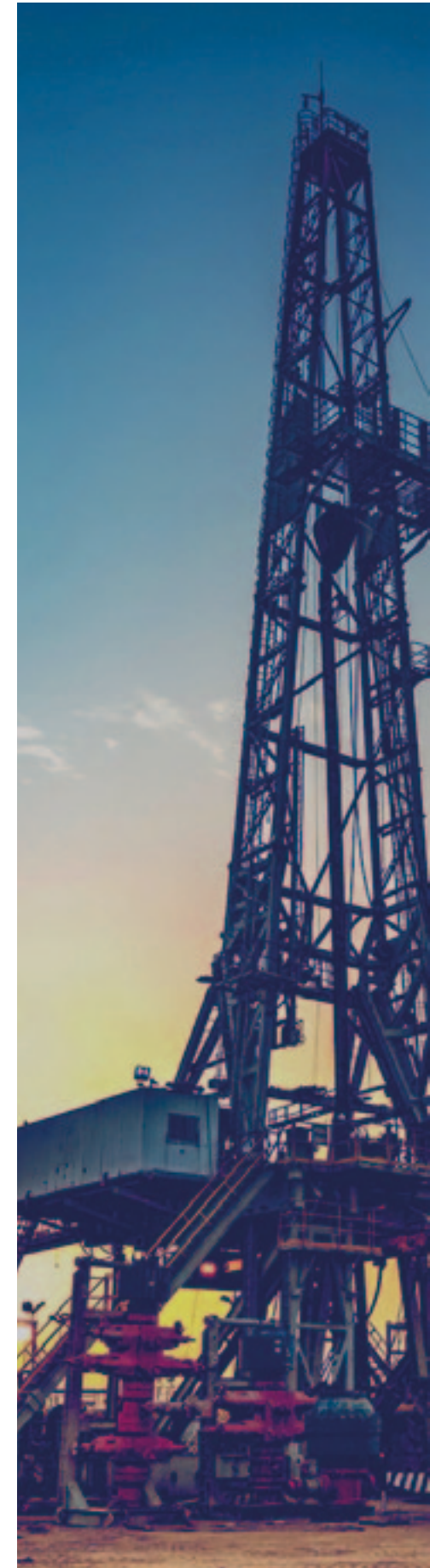
A NEW BIT DRILLING

1. A new bit should be run for 30-40 minutes with rotor or TDA RPM not exceeding 40 rpm and WOB not exceeding 10-15% of the manufacturer's recommended rate applicable for this bit size.
2. Increase bit load smoothly (according to manufacturers' recommendations) up to maximum RPM to avoid excessive vibration.
3. While directional and horizontal well drilling a new bit run operation should be reduced to 10-15 minutes to avoid wellbore trajectory error.



DRILLING

1. Select parameters, rheology and mud flush to ensure maximum cuttings removal during drilling, bit cooling, as well as prevention of debris /borehole collapsing during drilling and tripping operations.
2. Select optimal drilling mode according to the current geological conditions, wellbore trajectory and possible complications of the wellbore while drilling each well section.
3. The drilling mode is considered acceptable when the highest indicator of bit resistance, bit and drill rig performance for given specific mining and geological conditions are achieved.
4. Drill only with mud circulation on.
5. Do not load the bit without rotating.
6. Control vibration while drilling. If the vibration approaches critical values, frequency rotation and bit load should be reduced.
7. A mud circulation pressure spike while drilling can mean blockage of one or more nozzles on the bit. With indirect signs of plugging of over 40% of the nozzles/flushing ports (PDC), pull bit to clean the nozzles.
8. Rotation should be engaged BEFORE contacting the bit on hole bottom. The bottom should be approached at low speed with the mud circulation activated.
9. In case of an extended delay while drilling (accident, repair, power outage, etc.), raise the bit above the bottom by 3-4 meters. Do not leave the bit at the bottom, as this can cause «sticking» of the drill string or bit sludge, which can subsequently lead to sticking. It is necessary to periodically raise and lower the assembly in the well. If there is no such possibility, then pull the bit into the cased part of the wellbore. Before resuming drilling it is necessary to flush the well within 1-2 cycles. It is also recommended after the bit landing (in case of a long stop), re-run bit as for new bit for 10-20 minutes.
10. It is not recommended to drill in case of metal objects at the bottom..



SIGNS OF BIT WEAR

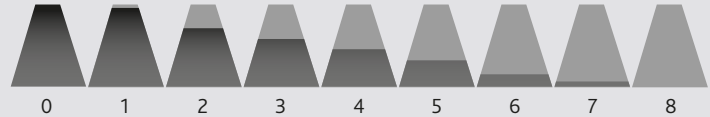
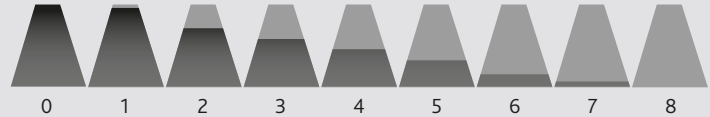
- ROP falling. With drilling control parameter changes, the ROP does not change.
- A sharp increase in vibration while drilling.
- A sharp spike in pressure with a subsequent drop in mechanical speed.
- Sharp pressure drop, no differential pressure drop while drilling.
- Lack of gradual «development» of the load on the bit while drilling.
- Increase in torque while drilling.

STORAGE AND TRANSPORTATION

- Bits should be properly stored in a dry area. Direct contact with moisture should be avoided. Relative humidity and temperature should be monitored in indoor storage areas.
- Storage of sealed bearing bits at low temperatures is not recommended; sudden changes in temperature should be avoided as seal life may be affected.
- Bit storage and transportation should be made in original manufacturer boxes oriented vertically (a bit should be stored with pin face upward). Handling and stowage while transporting should ensure bit box stability.
- Bits should be stored on the drill rigs in the manufacturer's package, if without the original packaging bit should be stored with pin up to protect thread from mechanical damage, moisture and atmospheric precipitations, and cutting structure (especially of the PDC bits) from contact with metal.



DULL GRADING

Roller cone and PDC bit dull evaluation parameters							
1. CUTTING STRUCTURE				2. BEARING	3. OUTER BIT SIZE	4. NOTES	
Inner rows	Outer rows	Dull features	Location	Bearing seal condition	Gauge wear (1/16")	Other dull types	Reason for bit pulling
Milled teeth bits		TCI bits		PDC bits			
Measurement of the remaining tooth height due to abrasive wear or chipping.		Measurement of the total height of the teeth, reduced due to lost, wear or fracture; calculation of lost insert.		Counting of lost, worn or chipped inserts. Note. Normal wear reaches maximum 4. 5 - 8 values are assigned with cracked/chipped inserts.			
							
0 – cutter is not worn, there is no loss, wear or chip; 8 – wear-out, all inserts/cutters are worn out, chipped or lost							

Cutting structure: to describe the wear of the cutters, the bit is conventionally divided into two parts — **inner rows** (2/3 radius) and **outer rows** (1/3 radius).

DULL FEATURES

- Ab – abrasion

BB – broken blade

BC – broken cone

BF – bond failure (PDC bits)

BL – broken leg

BM – broken bit matrix

BT – broken teeth/cutters/inserts

BU – balled up

CB – clearance bearing

CC – cracked cone

CD – cone dragged

CI – cone interference

CR – cored

CT – chipped teeth/cutters

ER – erosion

FC – flat crested wear

HC – heat checking

JD – junk damage

LBP – lost ball plug
- LC – lost cone

LN – lost nozzle

LT – lost teeth/cutters/inserts

NO – no wear/no other major dull characteristics

NR – not re-runnable

OC – off-center wear

PB – pinched bit

PL – plugged bit

PN – plugged nozzle/flow area

RG – rounded gauge

RO – ring out

RR – re-runnable

SD – shirttail damage

SF – seal failure

SS – self-sharpening

TR – tracking

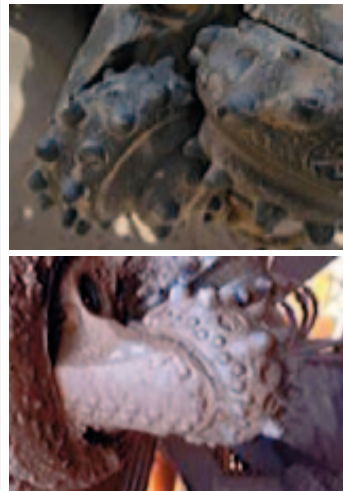
WO – washed out

WT – worn teeth/cutters

XT – cross-threaded

DULL FEATURES

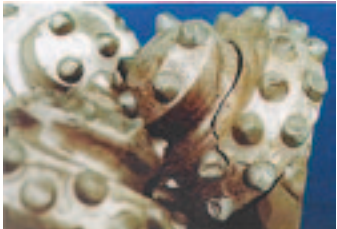
Ab	ABRASION	
	NON-EROSIVE WEAR OF THE BIT BODY OR ITS PARTS RESULTING FROM CUTTING OR SCRAPING BY COLLAPSED DRILLING FORMATIONS.	
	CAUSES	RECOMMENDATIONS
	• Drilling out of collapsing holes. • High-abrasive formations with ineffective wellbore cleaning from debris due to insufficient mud volume.	• The composition of the drilling fluid must ensure the stability of the borehole walls / use the bit able to reverse the rotation of the bit. • Provide sufficient mud flow and sufficient viscosity to remove cuttings to the surface / use a BHA to ensure minimum cuttings retention.
BB	BROKEN BLADE	
	BLADE OR ITS PART IS BROKEN (NO OFFICIAL IADC CODE).	
	CAUSES	RECOMMENDATIONS
	• Junk/loose iron in the well. • High torsional or lateral vibration (uneven blade loading). • Manufacturing defects or manufacturing errors (unlikely).	• Avoid foreign objects dropping in the hole. • Reduce RPM / WOB to reduce vibration. Modify the BHA to reduce its stiffness. • Carry out a bit body non-destructive testing (NDT) before starting work with a used bit.
BC	BROKEN CONE	
	PART OF ONE OR SOME CONES ARE BROKEN IN THE AXIAL OR RADIAL DIRECTIONS, BUT MOST OF THEM ARE STILL IN PLACE ON THE BIT.	
	CAUSES	RECOMMENDATIONS
	• Junk/loose iron in the well. • Cone shell thinning due to erosive wear / cone metal fatigue. • Shock loads due to hitting ledges while running operations. • Dropped bit / BHA in the hole. • Cone external toothings results in overheat with further cracking in case of axial overloading on a bit.	• Clean the borehole / avoid foreign objects dropping in the hole. • Use drilling modes corresponding to the current drilling conditions, or replace a bit with a more aggressive one. • Move slowly in case of ledges / follow drilling procedure. • Avoid BHA dropping in the hole / control wear of thread connections. • Analyze drilling conditions and reduce WOB if necessary.

BL	BROKEN LEG	
	ONE OF SOME BIT LEGS ARE MISSING.	
	CAUSES	RECOMMENDATIONS
	• Dropped bit / BHA in the hole. • Bit hitting a ledge or bottom of borehole. • Excessive erosion on leg.	• Timely replace worn thread connections. • Follow correct drilling procedure. • Replace bit.
BM	BROKEN MATRIX	
	COMPLETE OR PARTIAL DESTRUCTION OF THE BIT MATRIX (NO OFFICIAL IADC CODE).	
	CAUSES	RECOMMENDATIONS
	• Critical radial bit wear. • Loss of cutting structure and, as a result, direct contact of the bit matrix with the rock. • Metal at the bottom of hole.	• Avoid foreign objects dropping in the hole. • Reduce RPM / WOB to avoid vibration. Modify the BHA to reduce its stiffness. • Make NDT of the bit body before drilling with a used bit.
BT	BROKEN TEETH	
	A CONE TOOTH IS BROKEN (LOWER SECTION REMAINS IN PLACE).	
	CAUSES	RECOMMENDATIONS
	• A bit run on junk left in the hole. • Bit hitting ledges/bottom. • Excessive RPM results in broken teeth on gage row. • Too hard formation, fractured, decayed rocks, alternation of strata with extra hard formations / incorrect selection of a bit type for the current conditions. • Cone interference.	• Avoid foreign objects dropping in the hole. • Follow drilling procedure. • Reduce RPM. • Replace a bit with a more suitable one for the current drilling conditions. • Reduce WOB after confirming bit bearing is operable and has no play.

BT	BROKEN CUTTER	
 	COMPLETE OR PARTIAL DESTRUCTION OF THE PDC CUTTER.	
	CAUSES	RECOMMENDATIONS
	• Shock loads. • Destruction of the tungsten carbide substrate of the cutter. • Damage during transportation, storage, bit twisting - e.g. fastening bit using power tongs but without a bit breaker.	• Reduce RPM / WOB to cut vibration. Modify the BHA to reduce its stiffness. • Monitor weight and ride comfort during trips. • Observe the conditions of storage, transportation, and bit mounting.

BU	BALLED UP	
 	PLUGGED SPACE BETWEEN CONES AND BIT BODY RESULTING IN SERIOUS DECLINE IN RATE OF PENETRATION.	
	CAUSES	RECOMMENDATIONS
	• Insufficient cleaning of the hole bottom (inconsistency between flushing modes or drilling fluid parameters with the drilling program). • Incorrect drilling process. • Viscous, sticky and plastic type strata. • Incorrect selection of a bit type for the current drilling conditions.	• Test mud pump output, check the parameters of the drilling fluid. • Use central nozzles for better cleaning of the cones. • Select a more aggressive bit (e.g. with longer milled teeth). • Replace bit with a new one with the other body and cutters geometry.

CB	CLEARANCE BEARING	
 	CLEARANCE BEARING (OPEN BEARING BITS).	
	CAUSES	RECOMMENDATIONS
	• Bearing wear due to bearing overheating (insufficient well flushing, improper nozzle selection). • Bearing wear due to excessive drill string vibration.	• Provide drilling fluid flow in accordance with the drilling program. • Take a set of measures to reduce vibration to an acceptable level in accordance with the drilling program.

CC	CRACKED CONE	
 	CRACKS APPEARS ON SHELL OF ONE OR SOME CONES (CONES ARE HELD AT THE BIT LEG JOURNAL)	
	CAUSES	RECOMMENDATIONS
	• Bit hitting ledges or bottom. • BHA dropping due to twist-off. • Overload, additional cyclic loads due to bit over-time in the hole. • Loose iron in the well (including lost bit cutting elements).	• Follow correct drilling process. • Timely replace worn BHAs and monitor thread wear. • Adjust optimal load for bit type or reduce bit time in the hole / select another bit. • Avoid foreign objects dropping in the hole. Inspect a bit at least 5 times per shift.

CD	CONE DRAGGED	
  	ONE OR SOME CONES STOP ROTATING. PLAIN WEAR PATTERNS ARE SEEN ON SHELL AND CUTTING STRUCTURE OF NON-ROTATING CONES.	
	CAUSES	RECOMMENDATIONS
	• Bearing damage of one or more cones. • Junk lodging between the cones (or bit balling including plugged flushing ports). • Pinched bit causes cone interference and drag. • Insufficient/low mud flush volume, oil leakage (for sealed bearings), bearing wear.	• Replace bit / select a bit with durable bearing (if bit life is within acceptable parameters, then it's considered as a normal bit wear). • Inspect a bit periodically, especially while sticky and plastic rock drilling. Clean bit, in particular during long drilling breaks. • Before running, perform a thorough visual inspection of the bit for deformation of the body and legs. • Monitor the operating hours / revolutions per bit, if the guaranteed values are exceeded, replace bit with a new one.

CI	CONE INTERFERENC	
 	INTERFERENCE OF ONE CONE WITH THE OTHERS.	
	CAUSES	RECOMMENDATIONS
	• Pinched bit (possibly while applying a large bit for smaller-sized borehole drilling, or re-entry operations, or drilling ahead up to the target depth with a new bit). • Bearing failure results in cone rotation out of revolution axis. • Bending of the drilling tool / wear of the rotary bushings. • Critical values of radial vibrations while drilling.	• Timely check / replace drill-stem bushings. • Select a bit with premium bearing / in some cases, when acceptable results are achieved it's considered a normal bit wear. • Make non-destructive testing of the instrument. • Add stabilizer to the BHA if needed.

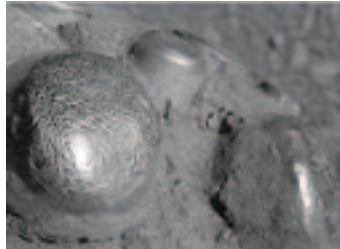
CR	CORED	
  	ABNORMAL WEAR OF THE CONE'S CENTRE ACCOMPANIED WITH CONE INSERTS AND NOSES LOST.	
	CAUSES	RECOMMENDATIONS
	• Low mud volume causes inadequate removal of cuttings from bottom of hole. • With excessive axial load on a bit with central jet while abrasive formation drilling due to sand blasting. • Prolonged cone interference (CI). • Drilling foreign objects in the hole. • Formation abrasiveness exceeds wear properties of cutting elements of the cone noses.	• Monitor mud pump operation, drill rod size and nozzle selection. • Replace bit with central jet with a bit with a side jet / reduce WOB. • Follow recommendations presented in the chapter 'Cone interference CI'. • Avoid debris dropping in the hole. • To drill hard formations, select a bit with cone axis side misalignment, as well as equipped with more teeth, hard-alloyed and hard-structured.

CR	CORED (PDC bits)	
 	CIRCULAR WEAR OF THE BIT CENTER.	
	CAUSES	RECOMMENDATIONS
	• Such a wear is uncommon for PDC bits and is quite rare. • Looks like a ring out (RO) wear. • Incorrect running-in of the bit. • Like RO it can occur with critical destruction or complete loss of cutters in the bit nose.	• Run in the bit strictly in accordance with the manufacturer recommendations. • Minimize vibration while drilling to avoid cutter loss. • Check the compliance of the wear resistance of the cutting structure with the indicators of drillability and abrasiveness of rocks. • Avoid hitting the bottom, sharp unloading during tripping, damage to the cutters while bit mounting.

CT	CHIPPED TEETH	
 	A TOOTH IS CHIPPED BY AT LEAST 1/2 OF ITS LENGTH (FOR WHATEVER REASON).	
	CAUSES	RECOMMENDATIONS
	• Excessive axial / impact load on a bit. • Excessive RPM for the current drilling conditions. • Fractured decayed formations while drilling or collaring. • Incorrect running-in of a new bit. • Incorrect selection of TCI / bit type / formation hardness exceeds the expected one. • Alternation of layers with well-defined boundaries.	• Use shock sub in case of layers alteration / reduce axial load on bit up to recommended rates. • Follow drilling procedure. • Adjust RPM smoothly to prevent vibration and drill string bouncing in the borehole. • Perform part-load running-in of a new bit. • Select a bit with coated hard-alloy teeth / select a correct bit type. • Select an optimal WOB and RPM for the current drilling conditions.

ER	EROSION (ROLLER CONE BITS)	
  	WEAR OF THE CUTTER BODY DUE TO LOW MUD FLUSH VOLUME AND INEFFECIENT MUD CLEANING. OFTEN LEADS TO LOSS OF INSERTS.	
	CAUSES	RECOMMENDATIONS
	• Abrasive formation contacts cone shell (an insert full-length penetration into the rock) due to excessive WOB, and debris damages cone shell due to insufficient mud flushing (drilling cuttings). • Excessive pressure spikes caused by incorrect nozzle size selection. • Heavy, sticky, abrasive formations.	• Reduce WOB / check mud pump performance (make leak check in the circulation system) and provide optimal WOB for the current drilling conditions. Select a bit with more aggressive cutting structure and additional abrasive wear protection for the specific geological environment. • Select nozzles size according to the geological conditions. • Regularly inspect efficiency of cuttings lifting / select an abrasion-resistant bit / proceed with operations (without any changes) in case of high RPM.

ER	EROSION (PDC BITS)	
  	WEAR OF THE CUTTER BODY DUE TO LOW MUD FLUSH VOLUME AND INEFFECIENT MUD CLEANING. OFTEN LEADS TO LOSS OF INSERTS.	
	CAUSES	RECOMMENDATIONS
	• Highly abrasive formations that form a sandblasting effect at high flow rate of the drilling mud. • High solids content in the drilling fluid. • Highly aggressive environment of use (presence of hydrogen sulfide and other aggressive components).	• Use additional means of cleaning the drilling fluid from the solid phase (centrifuges, sand separators). • Use bits reinforced with a harder alloy material designed to reduce erosion from highly abrasive or highly corrosive environments.

HC	HEAT CHECKING	
 	OVERHEATING OF INSERT MATERIAL. TINY SHEARS AND A NETWORK OF FINE CRACKS ON THE SURFACE OF INSERT (SNAKE SKIN), CAUSED BY CYCLIC HEATING WITH THE FURTHER COOLING.	
	CAUSES	RECOMMENDATIONS
	• Teeth/inserts overheating due to sliding along the rock and then cooling them with flushing medium during many flushing cycles. • Insert alloy properties do not correspond to categories of drilling formations. • Tight hole reaming with high RPM. • A typical cause while carbonate drilling.	• Reduce RPM. • Replace bit. • For tight hole reaming use an old stand-by bit and apply part-load drilling modes according to working conditions. • Use diamond impact-resistant inserts with increased temperature stability.

JD	JUNK DAMAGE	
	BIT BODY OR ITS CUTTING STRUCTURE ARE DAMAGED BY JUNK (NOT ROCKS).	
	CAUSES	RECOMMENDATIONS
	- Loose iron dropped into borehole from the surface or from drilling equipment. - Drill string junk on the bottom (rods, reamers, stabilizers, subs elements and parts left in the hole). - Bit fragments in the hole (TCI, rollers etc). - Borehole crossed old casing or drill rods, or air shafts left or lost while previous exploration or subsurface mining operations.	- Avoid foreign objects dropping in the hole. - Run the «magnet» to extract metal from the bottom of the well. - Run and trip with an end mill to drill out or use 'pasting' technique (after running with a magnet). - Request a detailed geological map of the field, change the trajectory of the well.

LBP	LOST BALL PLUG	
	THE BALL PLUG IS MISSING FROM A LUG.	
	CAUSES	RECOMMENDATIONS
	- Permanently caving and collapsing holes drilling. - Off center wear. - Back-reaming operations.	- Check mud composition to prevent hole collapse. Use a bit with a extra shirttail protection. - Do not drill with a bent drill rod or worn deck bushing. - Use a special back reamer.

LC	LOST CONE	
	A CONE IS LOST FROM A BIT LEG JOURNAL.	
	CAUSES	RECOMMENDATIONS
	- Bit overrun caused by issues with a bearing (drilling with a bit with a damaged bearing results in uncontrolled cone movement across bearing and finally loss). - Bit bouncing on hole bottom while tripping or stabbing jobs. - Bit dropping. - Work in aggressive environment (H₂S exposure).	- Closely monitor the change in torque according to the readings of the instruments (usually 2-3 times exceeding the torque indicates problems with the bearings). - Follow acceptable drilling procedure. Avoid drill bit dropping in the borehole. - Check the brake pads of the winch and drill line's slipping and cutting in timely manner. - Test the drilling fluid for corrosive components.

LN	LOST NOZZLE	
	LOSS OF NOZZLES.	
	CAUSES	RECOMMENDATIONS
	- Nozzle dissembling before bit running. - Incorrect nozzle installation/mounting in bit bore. - Installation of inappropriate nozzle types (other manufacturers' nozzles) for the current bit type. - Nozzles or fitting mechanically damaged.	- Investigate the reasons of nozzle dissembling. - Follow rules for nozzle installation/mounting. - Use original VBM nozzles only. - Be careful working with all nozzle types including extended ones and follow rules for nozzle installation/ mounting.

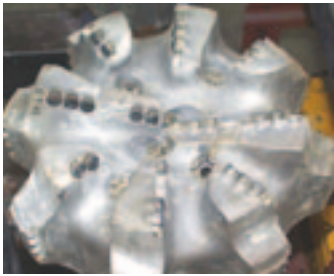
LT	LOST TEETH	
	TCI REMOVAL FROM THE CONE SHELL.	
	CAUSES	RECOMMENDATIONS
	- Cone shell erosion. - Loose iron in the hole. - Excessive WOB (especially in intensively fractured formations with heavy vibration while drilling). - A crack in the cone that loosens the grip of the inserts.	- Analyze and compare geological/mining conditions and drilling modes. If there are no deviations, select a bit with more aggressive cutting structure. - Ensure proper borehole cleanout / avoid dropping metal in the hole. - Reduce WOB / follow drilling procedure. - Replace bit.

OC	OFF CENTER WEAR	
	MISALIGNMENT IN BIT ROTATION IN THE HOLE (BIT ROTATES AROUND ITS GEOMETRIC CENTER WHICH DOES NOT MATCH BOREHOLE CENTER). REAMING SIZE EXCEEDS NOMINAL WELLBORE SIZE.	
	CAUSES	RECOMMENDATIONS
	- Bent drill rods. - Different manufacturers' or different geometry's rods are used in one drill string. - Often observed when shaft is worn or with the steering angle of the downhole motor while drilling directional or horizontal wells. - Mismatch between the geometric centers of the bit and the borehole (spontaneous increase in the borehole diameter). - Impact of rock on the cutter body between the rows of cloves.	- Replace the drill rod. - Include only drill rods of the same manufacturer and the same geometry. - Change the downhole motor within BHA according to the product passport. The use of the downhole motor with too large axial and radial play is not allowed. - Check rig alignment. - Use a more aggressive bit.

PL	PLUGGED BIT	
 	BIT INTERNAL CHAMBER INCLUDING FLUSHING PORTS ARE BLOCKED BY UNCIRCULATED CUTTINGS OR OTHER DEBRIS, ACCOMPANIED BY PRESSURE BUILDUP IN THE MANIFOLD.	
	CAUSES	RECOMMENDATIONS
	• Low flow of drilling fluid. • Sliming. • Junk/foreign objects entering a bit. • A bit left in the hole for a long time (e.g. during shift change or repair operations).	• Follow the recommended parameters of the fluid supply when drilling. • Follow correct drilling procedure. • Avoid junk/foreign objects in the manifold. While BHA assembling be sure that no foreign objects are inside the equipment. • Always raise a bit from the hole bottom (at least 3 m upward) during extended down time.

PN	PLUGGED NOZZLE	
 	NOZZLES PLUGGED.	
	CAUSES	RECOMMENDATIONS
	• Junk/foreign objects in manifold (drill strings and air hoses components, etc). • Nozzle is obstructed with cuttings.	• Avoid foreign objects in manifold. • Select the optimal well flushing mode while drilling and reaming. When trips from deep depths, make stops for intermediate flushes.

RG	ROUNDED GAGE	
 	CONE GAGE TEETH WEAR IS ROUNDED TOWARDS THE BIT CENTER RESULTING IN DRILLING SPEED DROP, TORQUE SPIKE AND BOREHOLE NARROWING.	
	CAUSES	RECOMMENDATIONS
	• Excessive RPM. • Tight borehole reaming. • Rocks abrasiveness exceeds insert wear-resistance.	• Adjust RPM. • If possible avoid borehole reaming. If necessary use partial load drilling modes. • Select a bit with hard-wearing inserts, rugged structure and with more cone gage teeth.

RO	RING OUT	
 	CIRCULAR WEAR OF THE BIT BLADES.	
	CAUSES	RECOMMENDATIONS
	• Critical destruction or complete loss of cutting structure in a certain part of the bit, as a result of which the metal of the blades comes into direct contact with the rock. • Loss of cutters is possible due to critical vibration while drilling.	• Replace bit with a new one. • Reduce RPM / WOB to acceptable vibration level, add stabilizing elements to the BHA.

SD	SHIRTTAIL DAMAGE	
 	DAMAGE OF SHIRTTAIL (RESULTING IN BEARING WEAR).	
	CAUSES	RECOMMENDATIONS
	• Axial load is such that shirrtail bears part of this load (in soft rocks). • Junk damage in the hole. • Tight hole reaming. • Directional drilling in abrasive rock formations.	• Reduce axial load or select a bit with lower inclination between bit leg journal axis and bit axis. • Avoid foreign objects dropping in the borehole. If a bit part is left in the hole, then use strong magnet to extract it, or if it's not possible, then stop drilling and drill a new borehole. • Avoid tight hole reaming. If necessary, use part-load drilling modes or an old used bit. • Select a bit with hardfaced shirrtail.

SF	SEAL FAILURE	
 	SEAL OF ONE OR ALL CONES ARE WORN OR MISSING RESULTED IN BEARING FAILURE (SEALED BEARING BITS).	
	CAUSES	RECOMMENDATIONS
	• Operational life of such bearing type is limited. • Excessive WOB. • Vibration while drilling. • Damage is caused if bits are stored under extreme low temperatures.	• Select a bit with another bearing type. • Follow drilling procedure and Bit Operation Manual. • Avoid heavy vibration while drilling. • Sealed bearing bits should not be stored under extreme low temperatures.

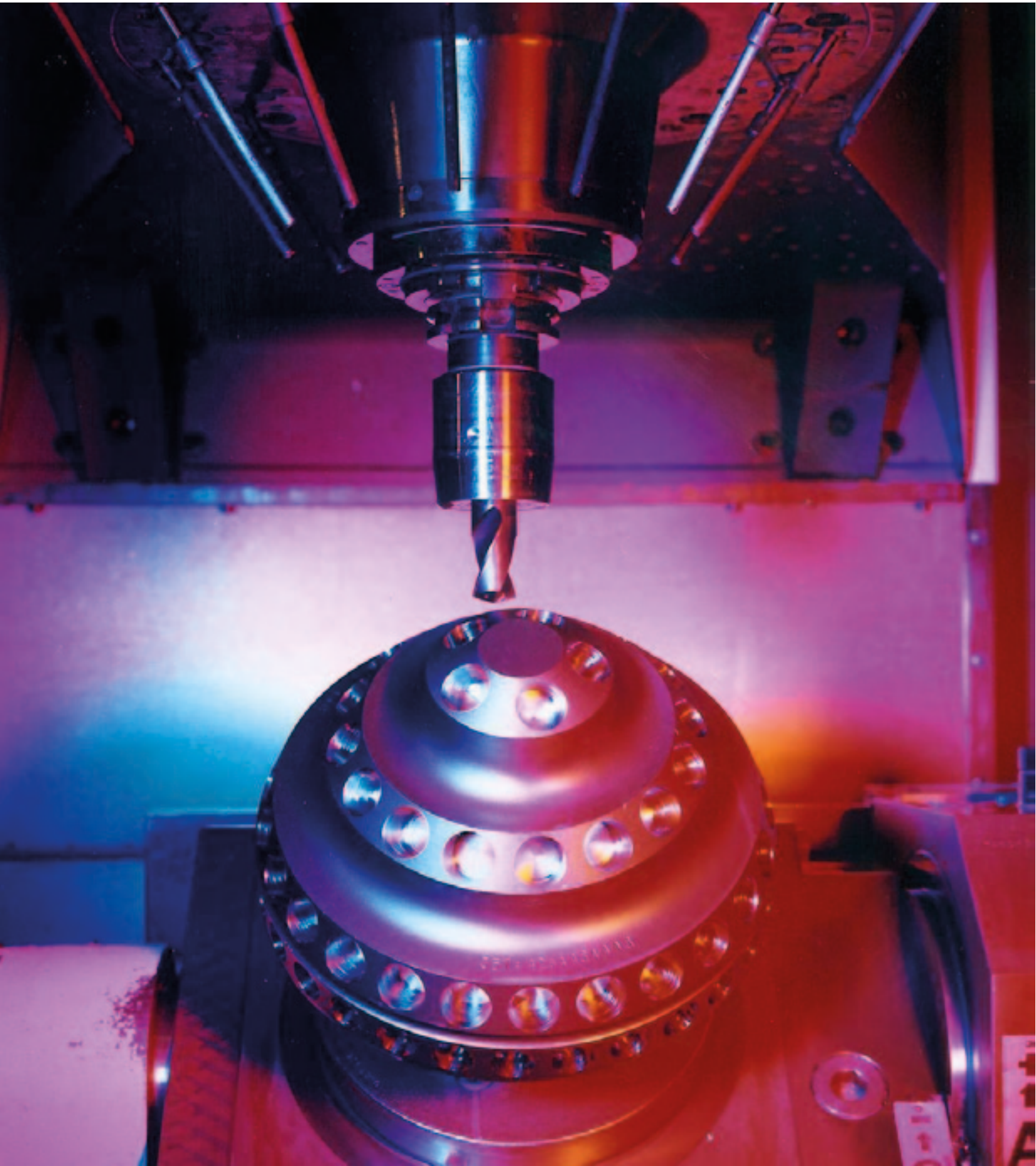
SS	SELF-SHARPENING WEAR	
	SUCH A FEATURE IS REFERRED ONLY TO BITS WITH MILLED TEETH, WHEN A TOOTH KEEPS SHORT SHARP CUTTERS FOR WEAR.	
	CAUSES	RECOMMENDATIONS
	Such a wear is an indicator of the optimal bit selection for the current drilling conditions.	No need to correct.

TR	TRACKING	
	TOOTH WEAR IS MAINLY ONE-SIDED RESULTING IN THE PREVIOUS CONE'S TEETH PENETRATION OR PREVIOUS BIT REVOLUTION (LIKE A WHEEL). CONE SHELL CONTACTS THE BOREHOLE BOTTOM.	
	CAUSES	RECOMMENDATIONS
	- Often caused while unconsolidated rock formation drilling and accompanied with dramatic decline in ROP. - WOB exceeds the requirement for drilling in the specific geological conditions. Commonly referred to as "overdrilling".	Select a more aggressive bit and drilling modes required for the specific conditions.

WT	WORN TEETH (ROLLER CONE BITS)	
	A TOOTH IS EVENLY WORN. MAIN WEAR FEATURES ARE HIGH ABRASION DUE TO CONTACT WITH ROCKS, SMALL FRACTURES AND CRACKING.	
	CAUSES	RECOMMENDATIONS
	- While hard formations drilling such a wear is considered normal if required results are achieved. - Abrasiveness of formations exceeds cutting elements wear hardness. - Low WOB together with high rotation speed while drilling hard formations and insufficient cleaning of the bottomhole from cuttings (drilling on a sludge bed).	- Replace bit. - Select a bit design with more abrasion-resistant cutting structure. - Use test approach to find an optimal WOB and rotation speed to achieve the best ROP. If WOB can't be physically increased or it's not recommended, apply a hard formation bit.

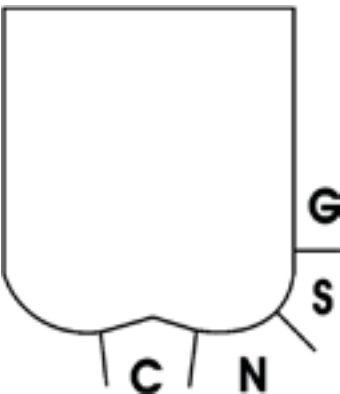
WT	WORN TEETH (PDC BITS)	
	UNIFORM WEAR ALONG THE CUTTER HEIGHT, POSSIBLY WITH SMALL CRACKING FEATURES OF THE PDC INSERT.	
	CAUSES	RECOMMENDATIONS
	- Normal wear of the PDC bit. - In some cases, premature occurrence of such wear may indicate an incorrect selection of bits for the given mining and geological conditions (low wear resistance of the cutters compared to rocks.)	- With critical wear of the cutting structure, replace the bit with a new one of the same type. - Select a bit with more abrasion-resistant cutting elements. - Try testing to find the optimal WOB and RPM that will produce the best ROP. If it is physically impossible to increase the load on the bit or it is undesirable, use a more wear-resistant and aggressive bit.

XT	CROSS-THREADED	
	CROSS-THREADING OF A BIT ON A DRILLING STRING.	
	CAUSES	RECOMMENDATIONS
	- Misalignment of drill string (sub) to a new bit. - Bit sub thread damaged.	- Avoid misalignment while threading. - Check for thread integrity before mounting bit to sub.



1. CUTTING STRUCTURE

Location	
Roller cone bits	PDC bits
N – nose, or central rows	C – cone
M – middle rows	N - nose
G – gauge rows	S - shoulder
A – all rows	G - gauge
1 2 3 – cone's numbers	A - all rows



2. BEARING / SEALS



Open bearing	Sealed bearing
For unsealed bits the specific scale* is used, where: • 0 – bearing life is full, not used at all • 8 – bearing life is over, fully utilized <i>* It's used for bit service life.</i>	A letter code describing seal state is used for sealed bits: • E – working state, seals are not damaged • F – seals damaged • N – impossible to evaluate wear (cone lost, damaged etc) • X – PDC bit (without any bearing)

3. OUTER BIT SIZE

1. in gauge
2. up to 1/16 out of gauge
3. 1/16 – 1/8" out of gauge
4. 1/8 – 3/16" out of gauge
5. 3/16 – 1/4" out of gauge

Roller cone bits	PDC bits
■ The two-thirds rule requires the template to touch the two cones at the maximum bit size. ■ The distance between the template and the end point of the third cutter is multiplied by 2/3 and rounded up to 1/16 inch to obtain the diameter wear value.	■ Bit size is measured at the location of the outer sector calibrating tools. ■ The plane of the outer sector can be of a smaller diameter. ■ When measuring the bit size with high imbalance, it is necessary to control the low friction zone with an offset to the center of the bit.

4. NOTES

REASONS FOR BIT PULLING

- BHA – bottomhole assembly replacement
- DMF – downhole motor failure
- DP – drill-out of cement plugs
- DSF – drilling string elements failure/broken tools
- DST – drill stem test /tool pressure test
- DTF – other downhole equipment failure
- CM – mismatch of mud parameters
- CP – core point
- FM – formation change
- HP – hole problems
- LIN – left BHA elements in the hole
- HR – exceeding quantity of critical hours on bit
- LOG – running logging operations
- PP – pump pressure in manifold/casing annulus
- PR – penetration rate drop
- RIG – rig maintenance
- TD – target depth achievement
- TQ – torque jump
- TW – tool's twist off
- WC – weather conditions
- WO – tool washout

IADC CLASSIFICATION SYSTEM FOR ROLLER CONE BITS

1st IADC numeric character refers to **bit type**. Series 1-3 refer to milled teeth bits for drilling formations from soft to hard. Series 4-8 refer to tungsten carbide insert bits for drilling formations from soft to extra hard.

2nd IADC numeric character refers to the **formation subcategories** (from soft to the hardest).

3rd IADC numeric character means **bearing design features**.

- | | | |
|--|--|--|
| ■ Standard open roller bearing | ■ Sealed roller bearing | ■ Sealed journal bearing with gauge protection |
| ■ Standard open roller bearing, air-cooled | ■ Sealed roller bearing with gauge protection | ■ For directional drilling |
| ■ Standard open roller bearing with gauge protection | ■ Sealed journal bearing with gauge protection | ■ Special |

4th IADC alphabetic character — refers to **additional features**. 16 alphabetic characters are used to indicate special cutting structures, bearings, nozzle configurations and bit body protection. Some bit designs may have more than one of optional features, then the most critical feature is indicated.

IADC CLASSIFICATION SYSTEM FOR PDC BITS

IADC classification is applied for optimal PDC bits selection. IADC code for PDC bits consists of 4 symbols:

1st symbol code features **bit body material**:

- S – steel
- M – matrix

2nd symbol code features **cutter density**:

- 25%-50%
- 50%-75%
- 75%-90%
- over 90%

3rd symbol code features **cutter size**:

- PDC cutters > 24 mm in diameter
- PDC cutters < 24 mm, but > 14 mm
- PDC cutters < 14 mm, but > 8 mm
- PDC cutters < 8 mm



4th symbol code features bit profile:

- Short fishtail
- Short
- Medium
- Long

RECOMMENDED TORQUE FOR THREAD CONNECTIONS

Thread connections	Torque, kN/m
API	
-	2.1 – 2.4
2 3/8	4.0 – 4.8
2 7/8	6.0 – 7.5
NC 31	9.6 – 11.6
3 1/2	9.5 – 12.0
4 1/2	16.0 – 22.0
NC 50	15.0 – 17.0
6 5/8	38.0 – 43.0
7 5/8	46.0 – 54.0



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