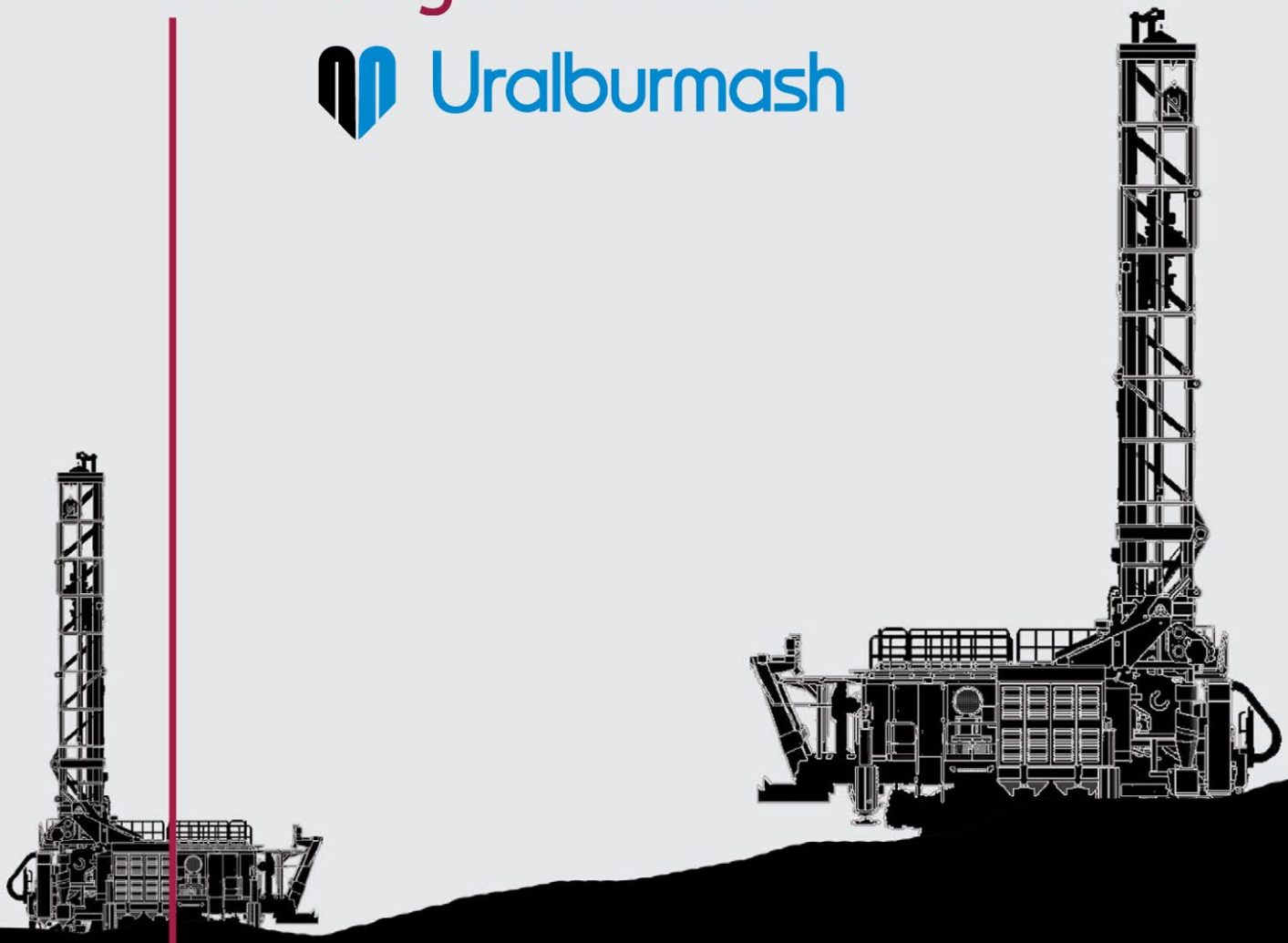
Volgaburmash

Uralburmash



PRODUCT CATALOGUE FOR MINING INDUSTRY

vbm.ru

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Volgaburmash

Contents

ABOUT COMPANY

Companies

Volgaburmash, JSC and Uralburmash, JSC are Russian largest manufacturers of advanced high quality rock-cutting tools for oil&gas, mining and construction industries.

The Companies manufacture over 250 standard sizes of mining roller cone bits ranging from 75.0 mm (2-61/64") to 393.7 mm (15-½") for compressed-air drilling in various mining and geological conditions and over 1000 roller cone bit designs for oil and gas industry ranging from 95.3 mm (3-3/4") to 660.4 mm (26") with milled teeth and tungsten carbide inserts. Also, Volgaburmash, JSC manufactures over 350 designs of PDC bits with matrix or steel bodies for various drilling applications ranging from 83 mm (3-1/4") to 444.5 mm (17-1/2"), PDC core bits for core drilling and near-bit stabilizers.

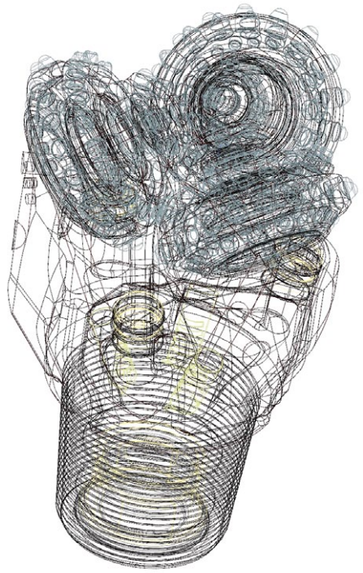
Besides, Volgaburmash, JSC and Uralburmash, JSC manufacture components for rock-cutting tools production: forgings and sections of roller cone bits, bodies of PDC bits, tungsten carbide inserts. The Companies carry out continuous technical modernization of production.

Currently, production facilities are equipped with the most advanced multi-axis machining centers, furnaces, heat-treatment machines, welding and hard-facing units purchased from the world's leading producers.

State of the art equipment enables us to master new bit designs in the shortest time and provides products quality conformance with the international standards.

All products undergo quality control at each manufacturing stage. Since 1997, Volgaburmash, JSC has implemented certified Quality Management System according to ISO standards and API Q1 specification.

Volgaburmash, JSC also has implemented and certified environment management



« OVER 250 STANDARD SIZES OF DRILL BITS FOR MINING INDUSTRY »

Companies

system and health and safety management system according to the requirements of ISO 14001:2004 and OHSAS 18001:2007.

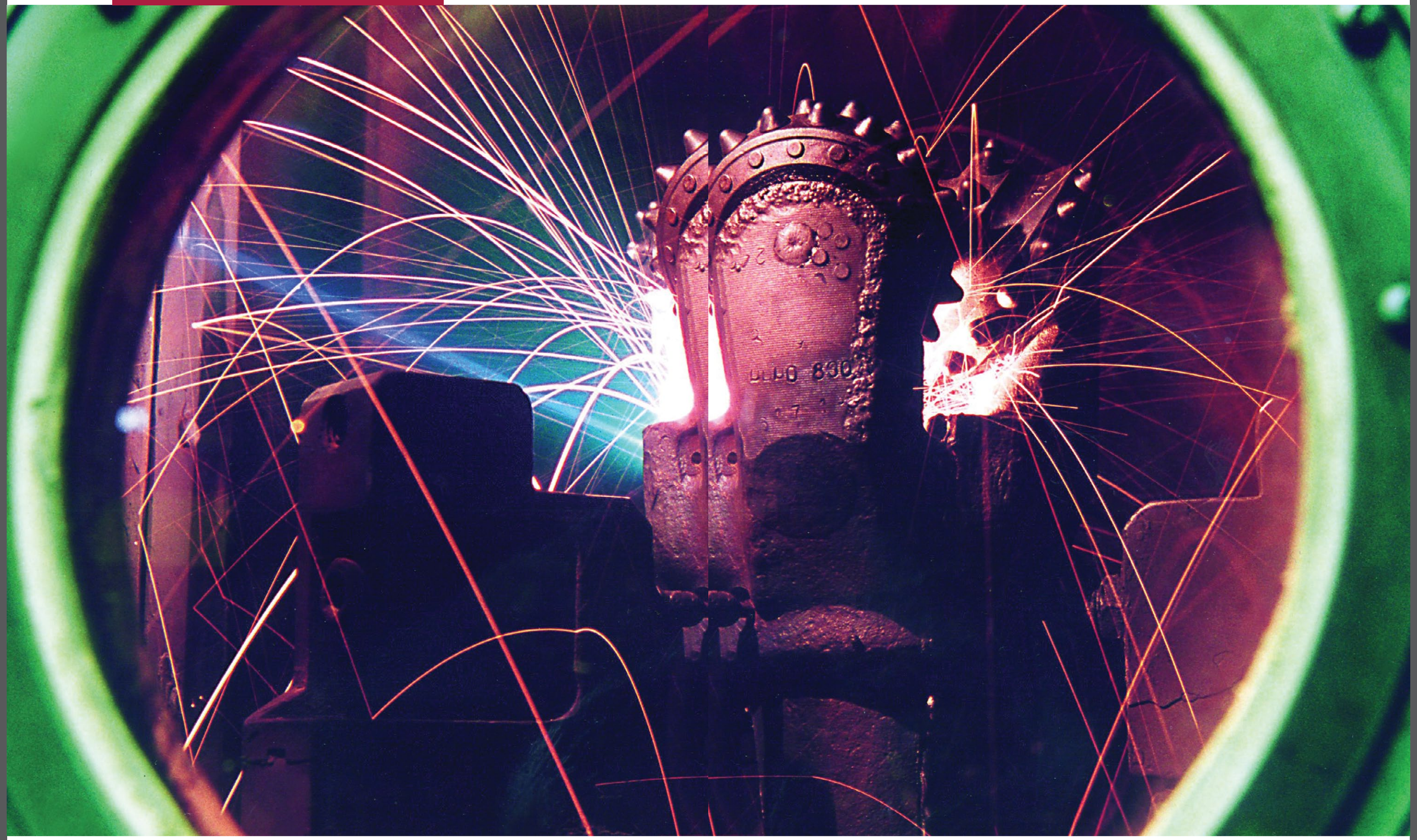
Over the years, the Companies' specialists have developed over 2000 drill bit designs. Many of these design solutions are of international novelty. Their authors and the Companies have obtained more than 300 inventor's certificates and patents for inventions in Russia and 17 other countries. Over fifteen hundred innovations have been put into production.

Since their foundation, Volgaburmash, JSC and Uralburmash, JSC have produced more than 20 million drill bits for oil and gas and mining industries. The quality of the products and the sales volume make the Companies world's leading rock-cutting tools manufacturers.

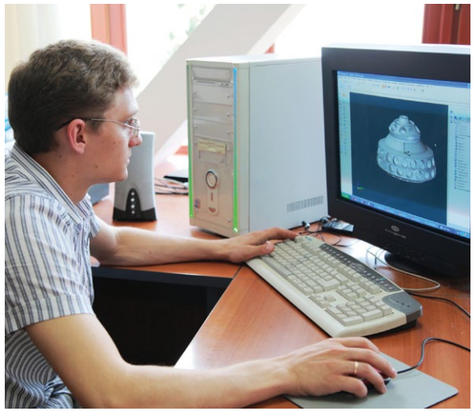
Rock-cutting tools produced by Volgaburmash, JSC and Uralburmash, JSC are used in the main Russian fields and in more than 40 other countries. Our background of experience, high scientific engineering potential and the team of professionals give

the Companies an excellent opportunity of creating an individual approach to each customer and developing unique drill bit designs for any drilling applications in the shortest time possible.

INNOVATIONS



Innovations

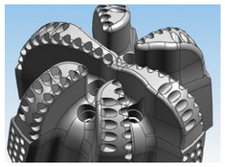


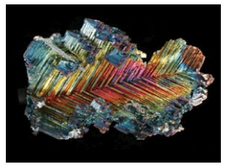
The base of the Companies' development is working out and introducing innovation technologies in all aspects of their activities providing high product quality level: in design engineering, manufacturing technology and after-sales service.

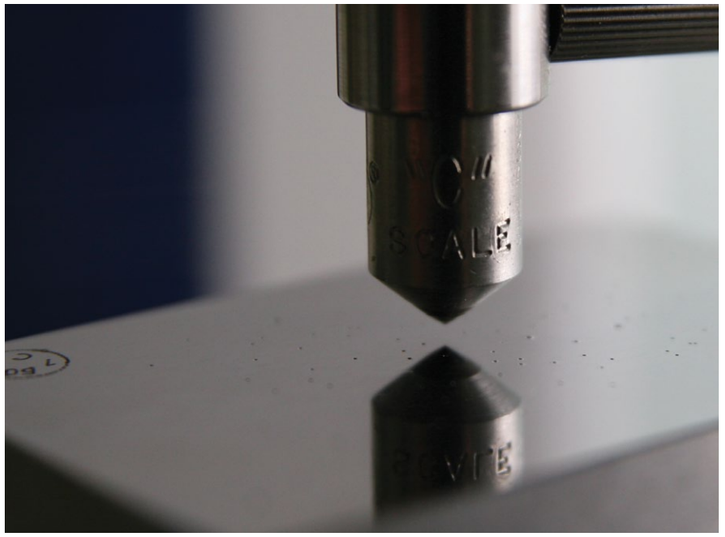
Volgaburmash, JSC and Uralburmash, JSC have worked out a successful thorough system of automated design engineering, technology process planning and engineering evaluation (CAD/CAM/CAE-system) based on the unified environment of Siemens UG NX software system that is widely used by the world's leading companies.

Design engineering system incorporates patented research results, math model simulation, selecting the optimal drill bit design parameters and multifactor analysis of bit test results.

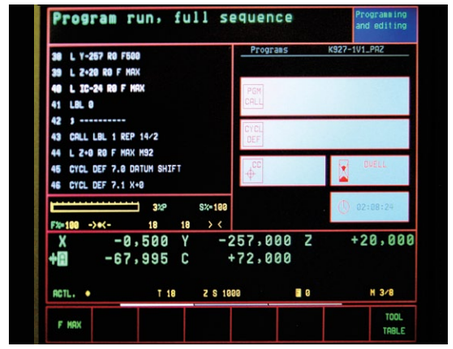
Design engineers have at their disposal a software for automated drawing of a bit profile and bottom-hole coverage pattern, dull bit grading, selection of optimal hydraulics, load balancing for improving bit steerability, as well as field test performance analysis by means of advanced statistical data processing methods.

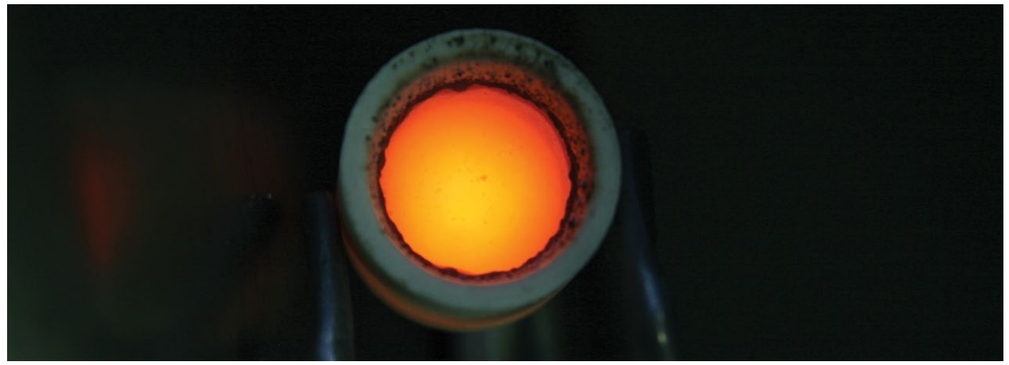






This enables us to shorten lead time for new bit designs, improve their efficiency and reliability due to optimizing design and technology parameters at the design stage, as well as provide an opportunity for creating drill bits for specific applications taking into account technological environment and lithology.





« INTRODUCING INNOVATION TECHNOLOGIES IN ALL ASPECTS »

Innovations

One of the key objectives of drill bit design is improving bottom-hole cleaning. For this purpose, specialists of design bureau and research department analyze and select optimum quantity and location of nozzles for timely removal of cuttings from bottom-hole, prevention of their re-cutting with the cutting structure, ensuring cuttings evacuation from the hole through the annulus, preventing bit balling and providing cooling of the work areas of the cutting structure. Having our proprietary patented technical research and software developments enables us to manufacture highly competitive drill bits modified for customer specific applications.

Continuous monitoring products quality at all stages of their life facilitates operational decision-making related to improvement of design parameters and manufacturing technology.

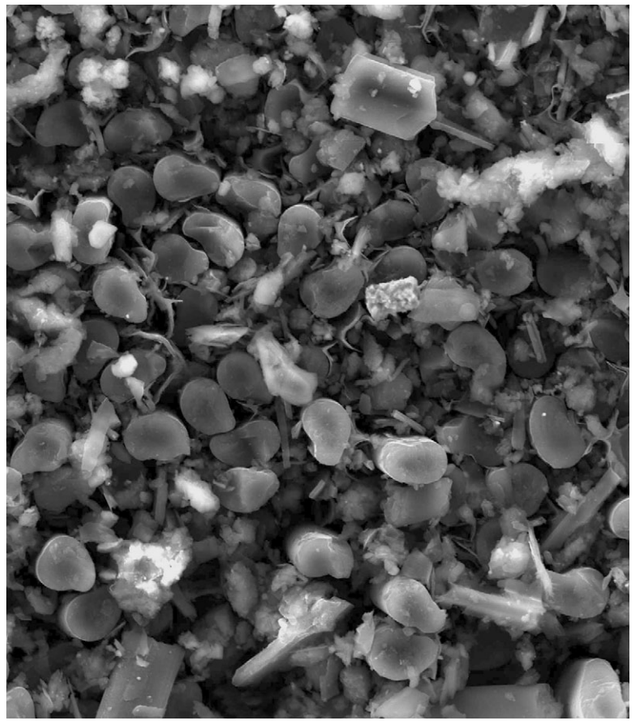
A team of highly skilled specialists develops and implements innovations in cooperation with scientific and research organizations.

Improvement of manufacturing technology includes selecting optimum equipment, optimizing technological processes, the production modes as well as selecting new materials with improved characteristics.

Design engineering and product manufacturing are fulfilled according to an individual arrangement for a particular customer, taking into account customer equipment and field lithology.

Currently, Volgaburmash, JSC and Uralburmash, JSC specialists can design and manufacture drilling tools of any complexity and modify bit design depending on the drilling application.

All innovations are targeted at fulfillment of Quality Policy, which means maximum satisfaction of customer's requirements and expectations and creating their confidence in the Companies' products.



QUALITY MANAGEMENT SYSTEM

Certificate of Authority to use the Official API Monogram
License Number: 7-1-0268 ORIGINAL

The American Petroleum Institute hereby grants to

VOLGABURMASH, JSC
1, Groznenskaya Street
Samara, Samara Region
Russian Federation

the right to use the Official API Monogram® on manufactured products under the conditions in the official publications of the American Petroleum Institute entitled API Spec Q1® and API Spec 7-1 and in accordance with the provisions of the License Agreement.

In all cases where the Official API Monogram is applied, the API Monogram should be used in conjunction with this certificate number: 7-1-0268

The American Petroleum Institute reserves the right to revoke this authorization to use the Official API Monogram for any reason satisfactory to the Board of Directors of the American Petroleum Institute.

The scope of this license includes the following products: Roller Bits; PDC Bits

QMS Exclusions: Section 7.5.4. Customer Property

American Petroleum Institute

QMS REGISTERED

Certificate of Registration

APIQR® REGISTRATION NUMBER
0451

This certifies that the quality management system of

VOLGABURMASH, JSC
1, Groznenskaya Street
Samara, Samara Region
Russian Federation

has been assessed by the American Petroleum Institute Quality Registrar (APIQR®) and found it to be in conformance with the following standard:

ISO 9001:2008

The scope of this registration and the approved quality management system applies to the

Design, Develop and Manufacture of Drilling Tools, Coring Tools, Milling Tools and Other Related Downhole Tools for the Oil and Gas Industry

APIQR® approves the organization's justification for excluding:

7.5.4 Customer Property

Effective Date: NOVEMBER 17, 2014
Expiration Date: NOVEMBER 17, 2017
Registered Since: APRIL 26, 2004

Vice President, API Global Industry Services

Accredited by Members of the International Accreditation Forum Multilateral Recognition Arrangement for Quality Management System

This certificate is valid for the period specified herein. The registered organization must continually meet all requirements of APIQR's Registration Program and the requirements of the Registration Agreement. Registration is maintained and regularly monitored through annual full system audits. Further clarifications regarding the scope of this certificate and the applicability of ISO 9001 standard requirements may be obtained by consulting the registered organization. This certificate has been issued from APIQR offices located at 1220 L Street, N.W., Washington, D.C. 20005-4070, U.S.A., it is the property of APIQR, and must be returned upon request. To verify the authenticity of this certificate, go to www.api.org/compositelist.

QUALITY REGISTRAR

energy API AMERICAN PETROLEUM INSTITUTE

REGISTRATION NO. Q1-0349

Certificate of Registration

The American Petroleum Institute certifies that the quality management system of

VOLGABURMASH, JSC
1, Groznenskaya Street
Samara, Samara Region
Russian Federation

has been assessed by the American Petroleum Institute and found to be in conformance with the following:

API Specification Q1

The scope of this registration and the approved quality management system applies to the:

Design, Develop and Manufacture of Drilling Tools, Coring Tools, Milling Tools and Other Related Downhole Tools for the Oil and Gas Industry

API approves the organization's justification for excluding:

Customer Property

Effective Date: NOVEMBER 17, 2014
Expiration Date: NOVEMBER 17, 2017
Registered Since: MARCH 13, 2006

Vice President, API Global Industry Services

This certificate is valid for the period specified herein. The registered organization must continually meet all requirements of API Spec Q1, *Specification for Quality Programs for the Petroleum, Petrochemical and Natural Gas Industry*, and the requirements of the Registration Agreement. Registration is maintained and regularly monitored through annual full system audits. This certificate has been issued from API offices located at 1220 L Street, N.W., Washington, D.C. 20005-4070, U.S.A. It is the property of API, and must be returned upon request. To verify the authenticity of this certificate, go to www.api.org/compositelist.

API Spec Q1 Registered

2014-162 | 05.14

Goodwill Certification System

EUROPEAN STANDARDS OF QUALITY

CERTIFICATION BODY
"ISO CONSULTING"
36/4, BOLSHEVIKOV PROSPECT, MOSCOW, RUSSIA, 121170

CERTIFICATE OF CONFORMITY

Issue 2. EMS is certified since October 2014

№ РОСС RU.С.04ФАЛ.СЭМ.0078

Is given to: Volgaburmash, Joint-Stock Company (Volgaburmash, JSC)
TIN 6314041126

1, Groznenskaya Str., Samara, Russia, 443004

THIS CERTIFICATE CERTIFIES THAT:

ENVIRONMENTAL MANAGEMENT SYSTEM AS APPLIED TO DESIGN, DEVELOPMENT, AND PRODUCTION OF DRILLING TOOLS, CORING TOOLS, MILLING TOOLS IN THE WELL BOREHOLE, AND OTHER RELATED EQUIPMENT AND TOOLS FOR THE OIL AND GAS INDUSTRY

COMPLIES WITH THE REQUIREMENTS OF ISO 14001:2004

By virtue of: Decision of the Certification Body № 0078 dated 14 January 2016

Issued: 15 January 2016 *Expiry date: 15 January 2019*
(If the inspection control is passed)

Terms for the first inspection: Not later than 15 January 2017
Terms for the second inspection: Not later than 15 January 2018

T.V. GRICHANAYA S.I. BUTKINA

Deputy Head of the Certification Body

№ 001585

FEDERAL AGENCY OF TECHNICAL REGULATION AND METROLOGY
Goodwill Certification System «European Standards of Quality». Registration № РОСС RU.5805.04ФА70
Certification parent body «EuroStandard-certifica» OGRN 1097746581488
Address: 36/3, Kolusonskiy Prospect, Moscow, RUSSIA, 121170. Tel: 8-800-100-0037

Goodwill Certification System

EUROPEAN STANDARDS OF QUALITY

CERTIFICATION BODY
"ISO CONSULTING"
36/4, BOLSHEVIKOV PROSPECT, MOSCOW, RUSSIA, 121170

CERTIFICATE OF CONFORMITY

Issue 2. OHSMS is certified since October 2014

№ РОСС RU.С.04ФАЛ.СМБТиОЗ.0076

Is given to: Volgaburmash, Joint-Stock Company (Volgaburmash, JSC)
TIN 6314041126

1, Groznenskaya Str., Samara, Russia, 443004

THIS CERTIFICATE CERTIFIES THAT:

OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT SYSTEM AS APPLIED TO DESIGN, DEVELOPMENT, AND PRODUCTION OF DRILLING TOOLS, CORING TOOLS, MILLING TOOLS IN THE WELL BOREHOLE, AND OTHER RELATED EQUIPMENT AND TOOLS FOR THE OIL AND GAS INDUSTRY

COMPLIES WITH THE REQUIREMENTS OF OHSAS 18001:2007

By virtue of: Decision of the Certification Body № 0076 dated 14 January 2016

Issued: 15 January 2016 *Expiry date: 15 January 2019*
(If the inspection control is passed)

Terms for the first inspection: Not later than 15 January 2017
Terms for the second inspection: Not later than 15 January 2018

T.V. GRICHANAYA S.I. BUTKINA

Deputy Head of the Certification Body

№ 001584

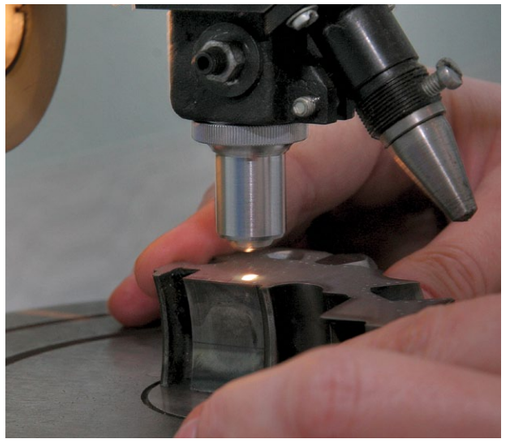
FEDERAL AGENCY OF TECHNICAL REGULATION AND METROLOGY
Goodwill Certification System «European Standards of Quality». Registration № РОСС RU.5805.04ФА70
Certification parent body «EuroStandard-certifica» OGRN 1097746581488
Address: 36/3, Kolusonskiy Prospect, Moscow, RUSSIA, 121170. Tel: 8-800-100-0037

Quality management system

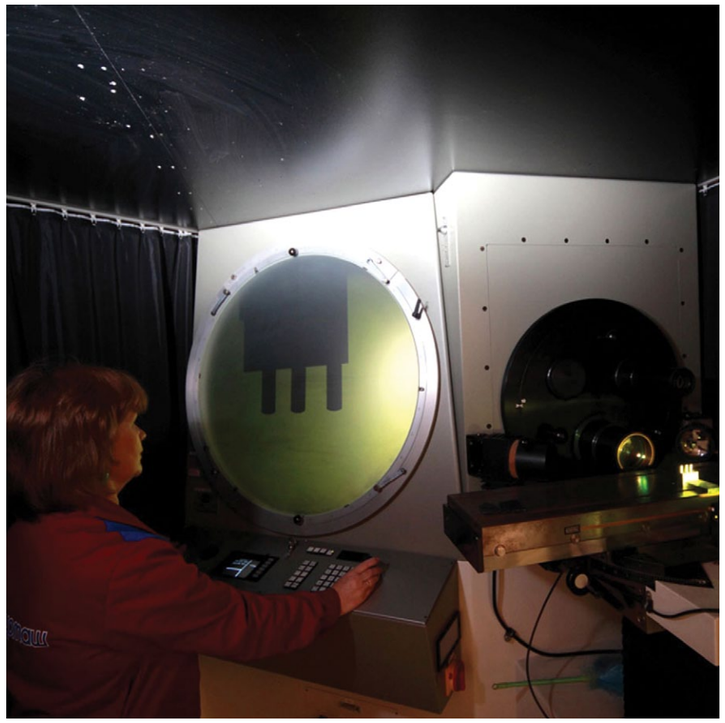
Volgaburmash, JSC and Uralburmash, JSC have implemented, certified and maintain Quality Management System (QMS) that meets the requirements of the International Standards ISO 9001. Besides, for more than 15 years Volgaburmash, JSC has been certified according to API Spec.Q1 standard. Also, the Company has implemented ISO 14001 standards (Environment Management System) and British National Standard BS-OHSAS 18001 (Health and Safety Management System).

The main strategic target of Volgaburmash, JSC and Uralburmash, JSC – the quality – regulates all Companies' processes: management, production and marketing, starting with developing new designs meeting customer requirements and finishing with shipment of manufactured products to customer.

A special place in Quality Management System is traditionally and justly held by the quality control of the released products. Highly qualified personnel of Manufacturing Engineering Support and Technical Control Departments, a number of high technology laboratories and services ensure undeviating filling product requirements that have been set before Volgaburmash, JSC and Uralburmash, JSC for many decades.



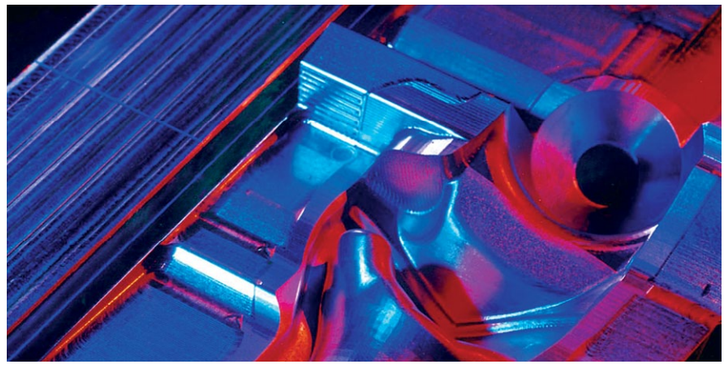
« QUALITY GUARANTEE IN ALL ASPECTS OF COMPANIES' ACTIVITY »



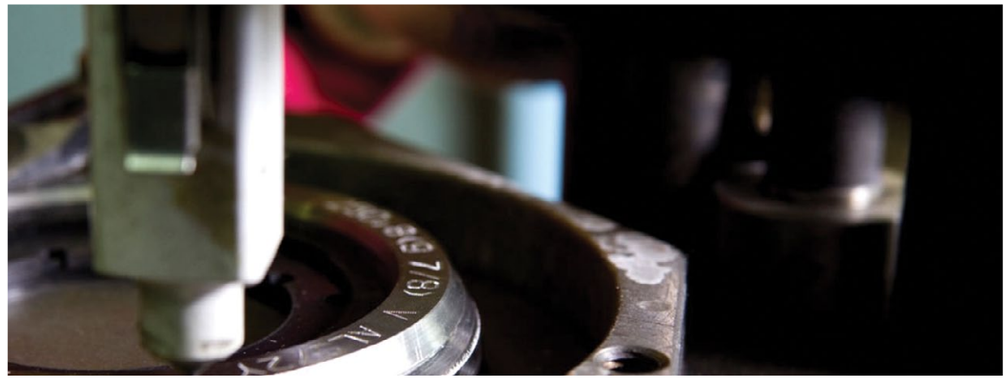
Quality management system

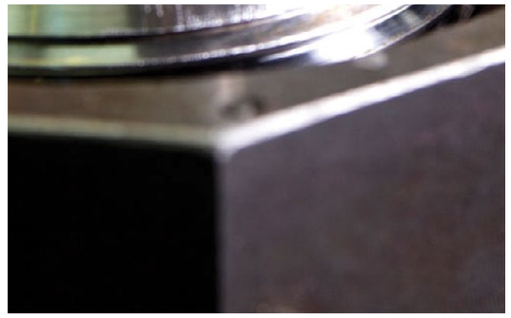
Advanced and constantly brought up to date equipment of the Companies' laboratories and services guarantees quality control and assessment level meeting the International Standards as far as design solutions, materials, component parts and manufacturing processes are concerned.

From chemical analysis of highly complex materials, structural study, identification of grade, grain size, plating thickness – to operational control in express laboratories and modification of technology processes of powder metallurgy, industrial rubber articles, chemical and heat treatment of bit component parts – this is by no means the complete list of methods and processes that are successfully carried out for the purposes of product quality control.



« DRILLING TOOLS OF ANY COMPLEXITY LEVEL, BIT DESIGNS UPGRADING »





PARTNERSHIP

Partnership

Volgaburmash and Uralburmash specialists pay special attention to technological development of drilling operations of Russian and foreign mining industry.

We timely offer our customers new design solutions without which production and technological capacity of the most advanced drilling equipment cannot be used efficiently and to the full extent.

Mining companies allocate substantial funds for drilling wells. The possibility of reducing these costs directly depends on the drill bits technical level and performance results. It is very important for us to provide the customers with the most complete range of tools that enable them to make their drilling processes as efficient and economically viable as possible.

Analysis of the customer information on bit performance enables Volgaburmash and Uralburmash specialists to timely modify designs of serial bits to considerably improve the bits performance, as well as develop new innovation designs.

When developing bit designs, our specialists lay emphasis on improvement of technical and economic indices of their performance. First of all, it means the increase of ROP and meterage per run due to optimal cutting structure layout and improved durability of the bearing assemblies.

« HIGH QUALITY, ACCIDENT-FREE AND STEADY OPERATION »

Partnership

As the customers mention in their feedback, the rock bits produced by the Companies feature high quality, accident-free and steady operation when drilling in highly water-flooded rocks. That is why they are used for a long time. The Companies constantly improve their technical characteristics and implements new designs that helps achieve higher performance results. Volgaburmash, JSC and Uralburmash, JSC keep in touch with their customers.

Working in a close contact with the customer enables us to better understand the unique features of the production processes at each field in particular mining and geological applications, identify the “bottleneck” and jointly arrive at a decision for any issue.

NORILSK NICKEL
Severstal
Russian Railways
УГМК UMMC
EVRAZ
ALROSA
MECHEL
RUSAL
KOKS GROUP
METINVEST
Metalloinvest
EuroChem
GPM GeoProMining
POLYMETAL
FERREXPO
URGA
RASPADSKAYA
RUSSIAN COAL
SUEK

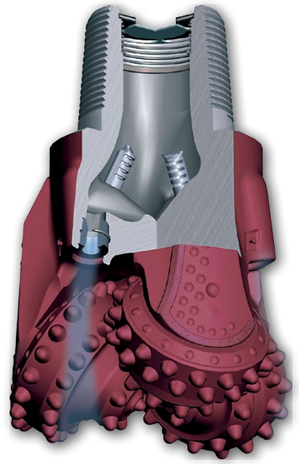
PRODUCTS FOR MINING INDUSTRY

Roller-cone bits

Designation

250,8	(9 7/8)	AIRP	727
Diameter, mm	Diameter, in	Product line	IADC code

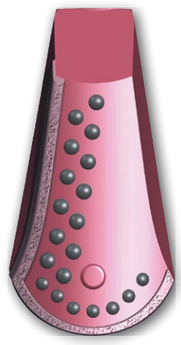
Design features



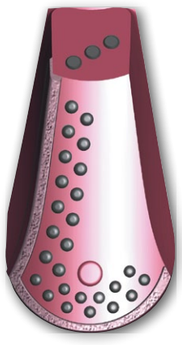
Side air-flushing

Single gauge

Leg protection with TCI.
AirStandart Line.



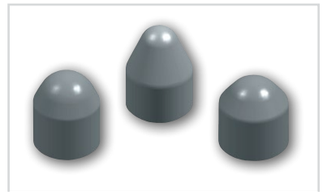
Leg protection with TCI.
AirPro, AirJet Lines.



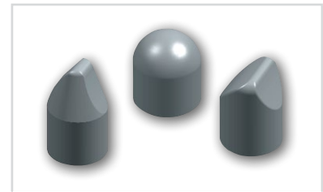
Leg protection with TCI.
AirPro, AirJet Lines.

Design features

Chisel inserts



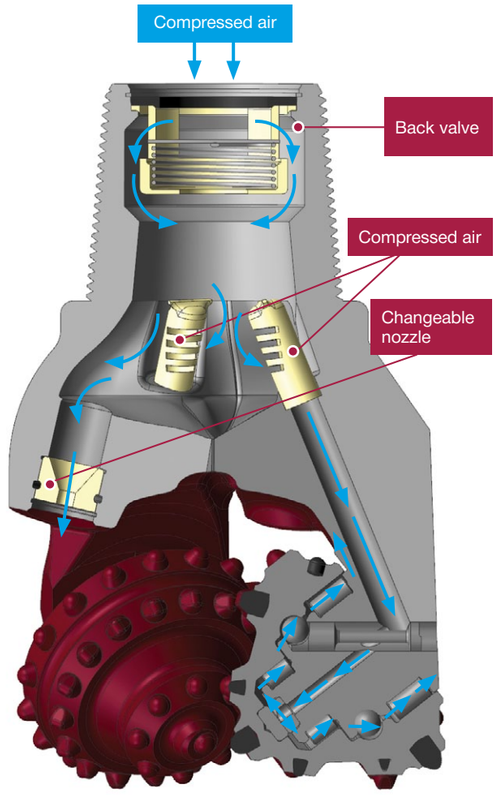
Conical inserts



Other shape inserts

Cuttings protection system in bit bearings

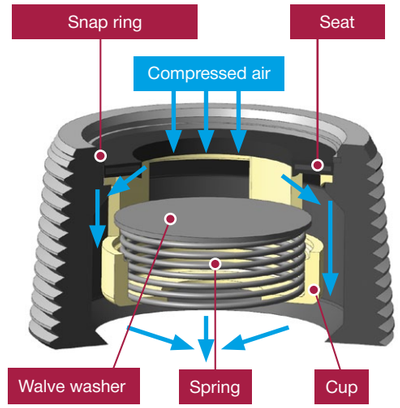
In a mining roller cone bit, the air flow passes through the bearing for cooling and cleaning the bearings.



Cooling and cleaning

There is a valve unit inside the bit shank. It consists of a seat with elastic circular ledge, a valve washer, a cup and a spring. To fix the valve unit, a snap ring is mounted inside the pin. To prevent cuttings getting into bit bearings, filters are located at the inlet of the cooling system.

The valve unit of a drill bit functions as follows. While drilling the air flows into the bit shank, the valve washer is moved down by the air inside the shank cavity allowing the air to flow downhole through the slots in the cup and through nozzles and bearing air passages.



Open valve

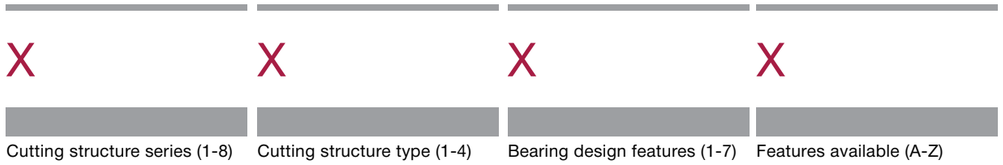
Products

Roller cone bits

IADC CLASSIFICATION

The classification system of International Association of Drilling Contractors (IADC) is based on the 4-character code describing bit design and rock type for drilling which the bit is designed.

The first three characters are numeric and the fourth character is alphabetic. The sequence of numeric characters means "series – type – bearing / gauge". The fourth alphabetic character stands for "features available".



Cutting structure series
[first numeric character]

Eight categories of cutting structure series correspond to general formation characteristics.

Series 1-3 refer to milled teeth bits. **Series 4-8** refer to tungsten carbide insert bits.

Within steel teeth and insert bit groups formations become harder and more abrasive as the series numbers increase.

Cutting structure type
[second numeric character]

Each series is divided into 4 types depending on formation hardness.

Type 1 refers to bits designed for the softest formation within the series.

Type 4 refers to the hardest formation within the series.

Bearing design
[third numeric character]

1	open (non-sealed) bearing
2	open bearing for drilling with air flushing
3	open bearing + tungsten carbide compacts on the cone gauge
4	sealed roller bearing
5	sealed roller bearing + tungsten carbide compacts on the cone gauge
6	sealed journal bearing
7	sealed journal bearing + tungsten carbide compacts on the cone gauge
8,9	standby for future use

Features available **[fourth alphabetic character]**

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. In such a case the most critical feature is indicated.

A	air flushing
B	sealed bearing, special seal design for higher RPM
C	central nozzle
D	special cutting structure minimizing borehole deviation
E	extended nozzles
G	enhanced shirttail protection with hard-facing or TCI
H	bits for horizontal or directional drilling
J	jet bits for drilling tangent sections
L	leg pads with TCI
M	motor application
S	standard steel teeth bits
T	two-cone bits
W	improved cutting structure
X	mostly chisel inserts
Y	conical inserts
Z	other shape inserts

Examples of IADC code:

212G is a milled teeth bit for drilling medium formations **(21)**, it has an open bearing for drilling with air flushing **(2)**, enhanced leg and shirttail protection with hard-facing and TCI **(G)**.

742X is a TCI bit for drilling hard formations **(74)**, it has an open bearing for drilling with air flushing **(2)**, the inserts are mostly chisel-shaped **(X)**.

Products

AirPro

These premium bits with sealed bearings are designed for drilling blast holes, flushing with air or water-air mixture. The bits of this line use journal bearing. They show high performance due to the seal, high-reliability bearing elements, cutting structure and bit body protection; this allows to achieve high performance results, especially in water-flooded wells.

TCI bit
250,8 (9 7/8) AIRP727

Cutting structure

The bits of this line have TCI as their cutting structure. To improve the protection against gauge loss, there are TCI on the gauge.

Lubrication system

Bit lubrication system is designed to compensate grease consumption and pressure during long-term operation. It consists of a grease reservoir with a rigidly mounted cap, a flexible diaphragm, a metal canister protecting the diaphragm from breakage, and channels to connect the grease reservoir with friction areas in bearings.

Shirttail and leg protection

Shirttail and leg are hardfaced along the leading edge and protected with tungsten carbide inserts.

AirPro

Bit diameter		Standard size
mm	in	
215,9	8 1/2	AIRP635
228,6	9	AIRP635
233	9 1/5	AIRP727
244,5	9 5/8	AIRP627, AIRP637
250,8	9 7/8	AIRP637, AIRP637, AIRP727, AIRP727
258,0	10 1/6	AIRP637, AIRP727, AIRP727
269,9	10 5/8	AIRP427, AIRP727
311,1	12 1/4	AIRP625, AIRP627, AIRP715, AIRP635

AirJet

TCI bit
152,4 (6) AIRJ512

These bits with open bearings and side flushing with air or water-air mixture are designed for drilling blast holes. The bits of this line can have either journal bearings (the bits ranging from 5 1/8” to 6 1/4») or roller bearings (the bits ranging from 6 1/4” to 15 1/2”). They show high performance due to high-reliability bearing elements, cutting structure and bit body protection.

Cutting structure

The bits of this line have TCI or milled teeth as their cutting structure. The gauge is protected with TCI.

Shirttail and leg protection

Depending on the formations abrasiveness shirttail and leg are hardfaced along the leading edge and protected with TCI.

AirJet

Bit diameter		Standard size
mm	in	
75,0	2 61/64	AIRJ542
130,2	5 1/8	AIRJ612
136,5	5 3/8	AIRJ512
149,2	5 7/8	AIRJ512, AIRJ612
152,4	6	AIRJ512, AIRJ612
158,7	6 1/4	AIRJ212, AIRJ612

Products

Product lines

AirJet		
Bit diameter		Standard size
mm	in	
171,4	6 3/4	AIRJ122, AIRJ222, AIRJ412, AIRJ512, AIRJ542, AIRJ622, AIRJ632, AIRJ722, AIRJ732, AIRJ832
187,3	7 3/8	AIRJ522
200,0	7 7/8	AIRJ412, AIRJ512, AIRJ532, AIRJ622, AIRJ632, AIRJ722
215,9	8 1/2	AIRJ122, AIRJ321, AIRJ522, AIRJ542, AIRJ612, AIRJ622, AIRJ632
228,6	9	AIRJ412, AIRJ422, AIRJ522, AIRJ612, AIRJ632
233,0	9 1/5	AIRJ522, AIRJ632
244,5	9 5/8	AIRJ422, AIRJ632, AIRJ742, AIRJ832
250,8	9 7/8	AIRJ212, AIRJ412, AIRJ422, AIRJ522, AIRJ622, AIRJ632, AIRJ722, AIRJ742
269,9	10 5/8	AIRJ422, AIRJ432, AIRJ522, AIRJ612, AIRJ622, AIRJ632, AIRJ722
279,4	11	AIRJ622, AIRJ632, AIRJ732
311,1	12 1/4	AIRJ522, AIRJ622, AIRJ632, AIRJ722, AIRJ742
320,0	12 5/8	AIRJ312
349,2	13 3/4	AIRJ522, AIRJ622, AIRJ722
393,7	15 1/2	AIRJ632

AirStandart

These bits with open bearings and central flushing with air or water-air mixture are designed for drilling blast holes. The bits of this line can have either journal bearings (the bits ranging from 5 1/8” to 6 1/4”) or roller bearings (the bits ranging from 6 1/4” to 15 1/2”). They show high performance due to high-reliability bearing elements, cutting structure and bit body protection.

TCI bit
273,0 (10 3/4) AIRS632

Cutting structure

The bits of this line have TCI or milled teeth as their cutting structure. The gauge is protected with TCI.

Shirttail and leg protection

Depending on the formations abrasiveness shirttail and leg are hardfaced along the leading edge and protected with TCI.

AirStandart		
Bit diameter		Standard size
mm	in	
98,4	3 7/8	AIRS332, AIRS522, AIRS542
101,6	4	AIRS332, AIRS522, AIRS542
104,8	4 1/8	AIRS332, AIRS522, AIRS542
114,3	4 1/2	AIRS112, AIRS122, AIRS222, AIRS322, AIRS332, AIRS522
120,6	4 3/4	AIRS122, AIRS222, AIRS332, AIRS522, AIRS542
127,0	5	AIRS122, AIRS222, AIRS522, AIRS542
130,2	5 1/8	AIRS122, AIRS222, AIRS522, AIRS542, AIRS612
133,4	5 1/4	AIRS122, AIRS222, AIRS512, AIRS522, AIRS542

Product lines

AirStandart

Bit diameter		Standard size
mm	in	
136,5	5 3/8	AIRS512, AIRS513
142,9	5 5/8	AIRS542
146,0	5 3/4	AIRS332, AIRS622, AIRS832
149,2	5 7/8	AIRS122, AIRS142, AIRS332, AIRS522, AIRS622
151,0	5 15/16	AIRS322
152,4	6	AIRS142, AIRS332, AIRS522
155,6	6 1/8	AIRS322, AIRS332, AIRS522
158,7	6 1/4	AIRS122, AIRS222, AIRS322
161,0	6 11/32	AIRS322, AIRS742
165,1	6 1/2	AIRS122, AIRS222, AIRS322, AIRS522, AIRS622
190,5	7 1/2	AIRS832
215,9	8 1/2	AIRS122, AIRS322, AIRS522, AIRS622, AIRS632, AIRS742, AIRS832
233,0	9 3/16	AIRS642, AIRS832
244,5	9 5/8	AIRS322, AIRS632, AIRS632, AIRS732, AIRS742, AIRS822, AIRS832
250,8	9 7/8	AIRS542, AIRS542, AIRS632, AIRS632, AIRS642
258,0	10 3/16	AIRS632, AIRS632
269,9	10 5/8	AIRS642, AIRS742, AIRS832
273,0	10 3/4	AIRS622, AIRS632
295,3	11 3/5	AIRS632

Technical information

Table K-1

TCI Bits

Bit diameter		Bit designation		IADC	Recommended drilling modes		Connecting thread		Weight, kg	Manufac-turer
mm	in	Volgaburmash / Uralburmash	GOST 20692-2003		RPM	WOB, kN	GOST 50864-96	API 7-2		
75,0	2 61/64	AIRJ542	С3-ПА	542X	115-60	10-50		N-Rod	2,8	Uralburmash
98,4	3 7/8	AIRS522	М3-ПА	522X	115-60	10-70	3-66	2 3/8 Reg	3,9	Uralburmash
		AIRS542	С3-ПА	542X	115-60	10-70	3-66	2 3/8 Reg	4,0	Uralburmash
101,6	4	AIRS522	М3-ПА	522	115-60	20-70	3-66	2 3/8 Reg	4,0	Uralburmash
		AIRS542	С3-ПА	542X	115-60	20-70	3-66	2 3/8 Reg	4,0	Uralburmash
104,8	4 1/8	AIRS522	М3-ПА	522X	115-60	20-70	3-66	2 3/8 Reg	4,1	Uralburmash
		AIRS542	С3-ПА	542X	115-60	20-70	3-66	2 3/8 Reg	4,3	Uralburmash
114,3	4 1/2	AIRS522	М3-ПВ	522X	115-60	20-80	3-66	2 3/8 Reg	5,0	Uralburmash
120,6	4 3/4	AIRS522	М3-ПВ	522X	115-60	20-80	3-76	2 7/8 Reg	8,5	Uralburmash
		AIRS542	С3-ПВ	542X	115-60	20-90	3-76	2 7/8 Reg	8,5	Uralburmash
127,0	5	AIRS522	М3-ПН	522X	115-60	20-90	3-76	2 7/8 Reg	7,0	Uralburmash
		AIRS542	С3-ПН	542X	115-60	20-90	3-76	2 7/8 Reg	7,0	Uralburmash
130,2	5 1/8	AIRJ612	Т3-ПГН	612X	115 - 60	40-110	3-76	2 7/8 Reg	9,7	Volgaburmash
		AIRS522	М3-ПН	522X	115-60	40-100	3-76	2 7/8 Reg	7,4	Uralburmash
		AIRS542	С3-ПН	542X	115-60	20-90	3-76	2 7/8 Reg	7,4	Uralburmash
		AIRS612	Т3-ПН	612X	115 - 60	40-110	3-76	2 7/8 Reg	6,4	Volgaburmash
133,4	5 1/4	AIRS512	М3-ПН	512Y	115 - 60	40-110	3-76	2 7/8 Reg	6,6	Volgaburmash
		AIRS522	М3-ПН	522X	115-60	20-90	3-76	2 7/8 Reg	7,6	Uralburmash
		AIRS542	С3-ПН	542X	115-60	20-90	3-76	2 7/8 Reg	7,6	Uralburmash
136,5	5 3/8	AIRJ512	М3-ПГН	512Y	115 - 60	20-90	3-76	2 7/8 Reg	10,1	Volgaburmash
		AIRS512	М3-ПН	512Y	115 - 60	20-90	3-76	2 7/8 Reg	7,1	Volgaburmash
		AIRS513	М3-ЦН	513CY	115 - 60	20-90	3-76	2 7/8 Reg	7,0	Volgaburmash
142,9	5 5/8	AIRS542	С3-ПН	542X	115 - 60	20-100	3-88	3 1/2 Reg	8,2	Volgaburmash
146,0	5 3/4	AIRS622	Т3-ПВ	622X	115-60	40-120	3-88УК	3 1/2 Reg	10,6	Uralburmash
		AIRS832	ОК-ПВ	832Z	115-60	70-150	3-88УК	3 1/2 Reg	13,8	Uralburmash
149,2	5 7/8	AIRJ512	М3-ПГН	512Y	115 - 60	20-100	3-88	3 1/2 Reg	14,2	Volgaburmash
		AIRJ612	Т3-ПГН	612Y	115 - 60	40-120	3-88	3 1/2 Reg	14,5	Volgaburmash
		AIRS522	М3-ПВ	522X	115-60	20-100	3-88	3 1/2 Reg	11,8	Uralburmash
		AIRS622	Т3-ПН	622X	115 - 60	40-120	3-88	3 1/2 Reg	11,7	Volgaburmash
152,4	6	AIRJ512	М3-ПГН	512Y	115 - 60	20-100	3-88	3 1/2 Reg	16,0	Volgaburmash
		AIRJ612	Т3-ПГН	612Y	115 - 60	50-130	3-88	3 1/2 Reg	16,2	Volgaburmash
		AIRS522	М3-ПВ	522X	115-60	20-100	3-88	3 1/2 Reg	12,4	Uralburmash

Technical information

TCI Bits

Bit diameter		Bit designation		IADC	Recommended drilling modes		Connecting thread		Weight, kg	Manufac-turer
mm	in	Volgaburmash / Uralburmash	GOST 20692-2003		RPM	WOB, kN	GOST 50864-96	API 7-2		
155,6	6 1/8	AIRS522	М3-ПВ	522X	115-60	20-110	3-88	3 1/2 Reg	12,8	Uralburmash
158,7	6 1/4	AIRJ612	Т3-ПГВ	612Y	115 - 60	20-110	3-88	3 1/2 Reg	18,4	Volgaburmash
161,0	6 11/32	AIRS742	К-ПВ	742Z	115-60	70-140	3-88	3 1/2 Reg	13,7	Uralburmash
165,1	6 1/2	AIRS522	М3-ПВ	522X	115-60	20-110	3-88	3 1/2 Reg	14,5	Uralburmash
		AIRS622	Т3-ПВ	622X	115-60	40-120	3-88	3 1/2 Reg	17,5	Uralburmash
171,4	6 3/4	AIRJ412	М3-ПГВ	412Y	115 - 60	30-120	3-88	3 1/2 Reg	20,8	Volgaburmash
		AIRJ512	М3-ПГВ	512XY	115 - 60	30-120	3-88	3 1/2 Reg	18,7	Volgaburmash
		AIRJ542	С3-ПГВ	542X	115-60	80-150	3-88	3 1/2 Reg	24,0	Uralburmash
		AIRJ622	Т3-ПГВ	622Y	115 - 60	50-140	3-88	3 1/2 Reg	19,0	Volgaburmash
		AIRJ632	ТК3-ПГВ	632Y	115 - 60	50-140	3-88	3 1/2 Reg	19,0	Volgaburmash
		AIRJ722	К-ПГВ	722Y	115 - 60	80-150	3-88	3 1/2 Reg	19,3	Volgaburmash
		AIRJ732	К-ПГВ	732Y	115-60	80-150	3-88	3 1/2 Reg	25,0	Uralburmash
		AIRJ832	ОК-ПГВ	832Z	115-60	90-170	3-88	3 1/2 Reg	25,5	Uralburmash
187,3	7 3/8	AIRJ522	М3-ПГВ	522Y	115 - 60	30-130	3-88	3 1/2 Reg	22,8	Volgaburmash
190,5	7 1/2	AIRS832	ОК-ПВ	832Z	115-60	100-190	3-117	4 1/2 Reg	18,0	Uralburmash
200,0	7 7/8	AIRJ412	М3-ПГВ	412Y	115 - 60	30-140	3-117	4 1/2 Reg	31,4	Volgaburmash
		AIRJ512	М3-ПГВ	512Y	115 - 60	30-140	3-117	4 1/2 Reg	31,5	Volgaburmash
		AIRJ532	М3-ПГВ	532Y	115 - 60	30-140	3-117	4 1/2 Reg	35,0	Volgaburmash
		AIRJ622	Т3-ПГВ	622Y	115 - 60	60-170	3-117	4 1/2 Reg	33,0	Volgaburmash
		AIRJ632	ТК3-ПГВ	632Y	115 - 60	60-170	3-117	4 1/2 Reg	32,4	Volgaburmash
		AIRJ722	К-ПГВ	722Y	115 - 60	90-180	3-117	4 1/2 Reg	31,8	Volgaburmash
215,9	8 1/2	AIRJ522	М3-ПГВ	522X	115-60	60-180	3-117	4 1/2 Reg	32,5	Uralburmash
		AIRJ542	Т3-ПГВ	542Y	115 - 60	60-180	3-117	4 1/2 Reg	33,0	Volgaburmash
		AIRJ612	Т3-ПГВ	612X	115 - 60	60-180	3-117	4 1/2 Reg	34,5	Volgaburmash
		AIRJ622	Т3-ПГВ	622Y	115 - 60	60-180	3-117	4 1/2 Reg	38,0	Volgaburmash
		AIRJ632	ТК3-ПГВ	632Y	115 - 60	60-180	3-117	4 1/2 Reg	35,0	Volgaburmash
		AIRP635	ТК3-ПГВУ	635Y	115 - 60	60-180	3-117	4 1/2 Reg	34,5	Volgaburmash
		AIRS522	М3-ПВ	522X	115-60	100-190	3-117УК	4 1/2 Reg	27,2	Uralburmash
		AIRS622	Т3-ПВ	622X	115-60	100-200	3-117УК	4 1/2 Reg	29,3	Uralburmash
		AIRS632	ТК3-ПВ	632Y	115-60	60-180	3-117УК	4 1/2 Reg	29,3	Uralburmash
		AIRS742	К-ПВ	742Y	115-60	100-190	3-117УК	4 1/2 Reg	29,3	Uralburmash
		AIRS832	ОК-ПВ	832Z	115-60	110-220	3-117УК	4 1/2 Reg	30,0	Uralburmash
228,6	9	AIRJ412	М3-ПГВ	412YP	115 - 60	30-150	3-117	4 1/2 Reg	38,0	Volgaburmash
		AIRJ422	М3-ПГВ	422Y	115 - 60	60-180	3-117	4 1/2 Reg	38,0	Volgaburmash
		AIRJ522	М3-ПГВ	522Y	115 - 60	70-190	3-117	4 1/2 Reg	38,0	Volgaburmash

TCI Bits

Bit diameter		Bit designation		IADC	Recommended drilling modes		Connecting thread		Weight, kg	Manufac-turer
mm	in	Volgaburmash / Uralburmash	GOST 20692-2003		RPM	WOB, kN	GOST 50864-96	API 7-2		
228,6	9	AIRJ612	Т3-ПГВ	612Y	115 - 60	70-190	3-117	4 1/2 Reg	39,6	Volgaburmash
		AIRJ632	ТК3-ПГВ	632Y	115 - 60	70-190	3-117	4 1/2 Reg	40,3	Volgaburmash
		AIRP635	ТК3-ПГВУ	635Y	115 - 60	70-190	3-117	4 1/2 Reg	40,0	Volgaburmash
233,0	9 3/16	AIRJ522	М3-ПГВ	522Y	115 - 60	70-190	3-117	4 1/2 Reg	40,5	Volgaburmash
		AIRJ632	ТК3-ПГВ	632Y	115 - 60	70-190	3-117	4 1/2 Reg	40,5	Volgaburmash
		AIRP727	К-ПГАУ	727Y	115 - 60	90-210	3-121УК	4 1/2 Reg	40,0	Volgaburmash
		AIRS642	ТК3-ПВ	642Y	115-60	70-190	3-121УК	4 1/2 FH	40,0	Uralburmash
		AIRS832	ОК-ПВ	832Z	115-60	120-230	3-121УК	4 1/2 FH	40,0	Uralburmash
244,5	9 5/8	AIRJ422	М3-ПГВ	422Y	115 - 60	40-150	3-121УК	4 1/2 FH	49,0	Volgaburmash
		AIRP627	Т3-ПГАУ	627Y	115 - 60	120-220	3-121УК	4 1/2 FH	41,0	Volgaburmash
		AIRJ632	ТК3-ПГВ	632Y	115 - 60	120-220	3-121УК	4 1/2 FH	41,0	Volgaburmash
		AIRP637	ТК3-ПГАУ	637Y	115 - 60	120-220	3-121УК	4 1/2 FH	41,0	Volgaburmash
		AIRJ742	К-ПГВ	742Y	115 - 60	110-220	3-121УК	4 1/2 FH	43,0	Volgaburmash
		AIRJ832	ОК-ПГВ	832Z	115-60	120-240	3-121УК	4 1/2 FH	49,0	Uralburmash
		AIRS632	ТК3-ПВ	632Y	115-60	70-200	3-121УК	4 1/2 FH	38,6	Uralburmash
		AIRS632	ТК3-ПВ	632Y	115-60	70-200	3-121УК	4 1/2 FH	38,6	Uralburmash
		AIRS732	К-ПВ	732Y	115-60	120-220	3-121УК	4 1/2 FH	39,0	Uralburmash
		AIRS742	К-ПВ	742Z	115-60	120-220	3-121УК	4 1/2 FH	45,0	Uralburmash
		AIRS822	ОК-ПВ	822Z	115-60	120-240	3-121УК	4 1/2 FH	42,0	Uralburmash
		AIRS832	ОК-ПВ	832Z	115-60	120-240	3-121УК	4 1/2 FH	42,0	Uralburmash
250,8	9 7/8	AIRJ412	М3-ПГВ	412Y	115 - 60	40-170	3-152	6 5/8 Reg	60,8	Volgaburmash
		AIRJ422	М3-ПГВ	422Y	115 - 60	40-170	3-152	6 5/8 Reg	58,0	Volgaburmash
		AIRJ522	М3-ПГВ	522Y	115 - 60	110-230	3-152	6 5/8 Reg	60,8	Volgaburmash
		AIRJ622	Т3-ПГВ	622Y	115 - 60	80-210	3-152	6 5/8 Reg	62,0	Volgaburmash
		AIRJ632	ТК3-ПГВ	632Y	115 - 60	80-210	3-152	6 5/8 Reg	63,0	Volgaburmash
		AIRP637	ТК3-ПГАУ	637Y	115 - 60	150-280	3-121УК	4 1/2 FH	44,0	Volgaburmash
		AIRP637	ТК3-ПГАУ	637Y	115 - 60	150-280	3-152	6 5/8 Reg	62,0	Volgaburmash
		AIRJ722	К-ПГВ	722Y	115 - 60	110-230	3-152	6 5/8 Reg	62,5	Volgaburmash
		AIRP727	К-ПГВ	727Y	115 - 60	150-280	3-152	6 5/8 Reg	62,0	Volgaburmash
		AIRP727	К-ПГАУ	727Y	115 - 60	150-280	3-121УК	4 1/2 FH	44,0	Volgaburmash
		AIRJ742	К-ПГВ	742Y	115 - 60	110-230	3-152	6 5/8 Reg	62,5	Volgaburmash
		AIRS542	С3-ПВ	542X	115-60	70-200	3-121УК	4 1/2 FH	48,3	Uralburmash
		AIRS542	Т3-ПВ	542X	115-60	70-200	3-121УК	4 1/2 FH	45,0	Uralburmash
		AIRS632	ТК3-ПВ	632Y	115-60	80-210	3-152УК	6 5/8 Reg	50,0	Uralburmash
		AIRS632	ТК3-ПВ	632Y	115-60	80-210	3-121УК	4 1/2 FH	49,0	Uralburmash
		AIRS642	ТК3-ПВ	642Y	115-60	80-210	3-121УК	4 1/2 FH	49,0	Uralburmash

Technical information

TCI Bits

Bit diameter		Bit designation		IADC	Recommended drilling modes		Connecting thread		Weight, kg	Manufac-turer
mm	in	Volgaburmash / Uralburmash	GOST 20692-2003		RPM	WOB, kN	GOST 50864-96	API 7-2		
258,0	10 3/16	AIRP637	ТК3-ПГАУ	637Y	115 - 60	150-280	3-152	6 5/8 Reg	62,0	Volgaburmash
		AIRP727	К-ПГАУ	727Y	115 - 60	150-280	3-152	6 5/8 Reg	63,0	Volgaburmash
		AIRP727	К-ПГАУ	727Y	115 - 60	150-280	3-121УК	4 1/2 FH	45,0	Volgaburmash
		AIRS632	ТК3-ПВ	632Y	115-60	80-210	3-121УК	4 1/2 FH	47,0	Uralburmash
		AIRS632	ТК3-ПВ	632Y	115-60	80-210	3-152	6 5/8 Reg	52,0	Uralburmash
269,9	10 5/8	AIRJ422	М3-ПГВ	422YGG	115 - 60	40-180	3-152	6 5/8 Reg	71,2	Volgaburmash
		AIRP427	М3-ПГАУ	427Y	115 - 60	40-180	3-152	6 5/8 Reg	71,0	Volgaburmash
		AIRJ432	М3-ПГВ	432Y	115 - 60	40-180	3-152	6 5/8 Reg	65,5	Volgaburmash
		AIRJ522	М3-ПГВ	522Y	115 - 60	40-180	3-152	6 5/8 Reg	78,0	Volgaburmash
		AIRJ612	Т3-ПГВ	612Y	115 - 60	80-220	3-152	6 5/8 Reg	71,1	Volgaburmash
		AIRJ622	Т3-ПГВ	622Y	115 - 60	80-220	3-152	6 5/8 Reg	71,1	Volgaburmash
		AIRJ632	ТК3-ПГВ	632Y	115 - 60	80-22	3-152	6 5/8 Reg	70,0	Volgaburmash
		AIRJ722	К-ПГВ	722Y	115 - 60	120-240	3-152	6 5/8 Reg	72,5	Volgaburmash
		AIRP727	К-ПГАУ	727Y	115 - 60	120-240	3-152	6 5/8 Reg	72,5	Volgaburmash
		AIRS642	ТК3-ПВ	642Z	115-60	80-220	3-152УК	6 5/8 Reg	52,4	Uralburmash
		AIRS742	К-ПВ	742Y	115-60	120-240	3-152УК	6 5/8 Reg	54,2	Uralburmash
		AIRS832	ОК-ПВ	832Z	115-60	130-270	3-152УК	6 5/8 Reg	55,6	Uralburmash
273,0	10 3/4	AIRS622	Т3-ПВ	622X	115-60	120-240	3-152УК	6 5/8 Reg	58,0	Uralburmash
		AIRS632	ТК3-ПВ	632Y	115-60	120-240	3-152УК	6 5/8 Reg	62,0	Uralburmash
279,4	11	AIRJ622	Т3-ПГВ	622Y	115 - 60	80-230	3-152	6 5/8 Reg	73,0	Volgaburmash
		AIRJ632	ТК3-ПГВ	632YGG	115 - 60	80-230	3-152	6 5/8 Reg	73,0	Volgaburmash
		AIRJ732	К-ПГВ	732Y	115 - 60	130-250	3-152	6 5/8 Reg	75,6	Volgaburmash
295,3	11 3/5	AIRS632	ТК3-ПВ	632Y	115-60	150-300	3-152УК	6 5/8 Reg	86,0	Uralburmash
311,1	12 1/4	AIRJ522	М3-ПГВ	522Y	115 - 60	50-210	3-152	6 5/8 Reg	95,3	Volgaburmash
		AIRJ622	Т3-ПГВ	622Y	115 - 60	90-260	3-152	6 5/8 Reg	97,3	Volgaburmash
		AIRP625	Т3-ПГВУ	625Y	115 - 60	5-210	3-152	6 5/8 Reg	100,0	Volgaburmash
		AIRP627	Т3-ПГАУ	627Y	115 - 60	5-210	3-152	6 5/8 Reg	100,0	Volgaburmash
		AIRJ632	ТК3-ПГВ	632Y	115 - 60	90-260	3-152	6 5/8 Reg	98,3	Volgaburmash
		AIRP715	К-ПГВУ	715Y	115 - 60	140-280	3-152	6 5/8 Reg	100,0	Volgaburmash
		AIRP635	ТК3-ПГВУ	635Y	115 - 60	90-260	3-152	6 5/8 Reg	100,0	Volgaburmash
		AIRJ722	К-ПГВ	722Y	115 - 60	140-280	3-152	6 5/8 Reg	100,3	Volgaburmash
		AIRJ742	К-ПГВ	742YGG	115 - 60	140-280	3-152	6 5/8 Reg	100,3	Volgaburmash
349,2	13 3/4	AIRJ522	М3-ПГВ	522Y	115 - 60	50-240	3-152	6 5/8 Reg	154,0	Volgaburmash
		AIRJ622	Т3-ПГВ	622Y	115 - 60	100-290	3-152	6 5/8 Reg	154,0	Volgaburmash
		AIRJ722	К-ПГВ	722Y	115 - 60	160-310	3-152	6 5/8 Reg	154,0	Volgaburmash
393,7	15 1/2	AIRJ632	ТК3-ПГВ	632Y	115 - 60	120-320	3-152	6 5/8 Reg	190,0	Volgaburmash

Table K-2

Steel Teeth Bits

Bit diameter		Bit designation		IADC	Recommended drilling modes		Connecting thread		Weight, kg	Manufac-turer
mm	in	Volgaburmash / Uralburmash	GOST 20692-2003		RPM	WOB, kN	ГОСТ 50864-96	API 7-2		
98,4	3 7/8	AIRS332	Т-ПА	332	115-60	40-90	3-66	2 3/8 Reg	3,9	Uralburmash
101,6	4	AIRS332	Т-ПА	332	115-60	50-90	3-66	2 3/8 Reg	4,0	Uralburmash
104,8	4 1/8	AIRS332	Т-ПА	332	115-60	50-90	3-66	2 3/8 Reg	4,2	Uralburmash
114,3	4 1/2	AIRS112	М-ПВ	112	115-60	50-90	3-66	2 3/8 Reg	4,9	Uralburmash
		AIRS122	М-ПВ	122	115-60	50-90	3-66	2 3/8 Reg	4,9	Uralburmash
		AIRS222	С-ПВ	222	115-60	30-90	3-66	2 3/8 Reg	5,0	Uralburmash
		AIRS322	Т-ПВ	322	115-60	50-90	3-66	2 3/8 Reg	5,0	Uralburmash
		AIRS332	Т-ПВ	332	115-60	50-120	3-66	2 3/8 Reg	5,0	Uralburmash
120,6	4 3/4	AIRS122	М-ПВ	122	115-60	50-90	3-76	2 7/8 Reg	6,6	Uralburmash
		AIRS222	С-ПВ	222	115-60	40-90	3-76	2 7/8 Reg	6,6	Uralburmash
		AIRS332	Т-ПВ	332	115-60	50-110	3-76	2 7/8 Reg	6,6	Uralburmash
127,0	5	AIRS122	М-ПН	122	115-60	20-80	3-76	2 7/8 Reg	10,0	Uralburmash
		AIRS222	С-ПН	222	115-60	40-100	3-76	2 7/8 Reg	10,0	Uralburmash
130,2	5 1/8	AIRS122	М-ПН	122Т	115 - 60	40-110	3-76	2 7/8 Reg	5,6	Volgaburmash
		AIRS222	С-ПН	222	115-60	40-100	3-76	2 7/8 Reg	10,2	Uralburmash
133,4	5 1/4	AIRS122	М-ПН	122	115-60	20-80	3-76	2 7/8 Reg	10,4	Uralburmash
		AIRS222	С-ПН	222	115-60	40-100	3-76	2 7/8 Reg	10,4	Uralburmash
146,0	5 3/4	AIRS332	Т-ПВ	332	115-60	70-120	3-88УК	3 1/2 Reg	10,0	Uralburmash
149,2	5 7/8	AIRS122	М-ПВ	122	115-60	20-90	3-88УК	3 1/2 Reg	11,5	Uralburmash
		AIRS142	МС-ПВ	142	115-60	20-110	3-88	3 1/2 Reg	11,5	Uralburmash
		AIRS332	Т-ПВ	332	115-60	70-130	3-88	3 1/2 Reg	11,8	Uralburmash
151,0	5 15/16	AIRS322	Т-ПВ	322	115-60	70-130	3-88	3 1/2 Reg	11,3	Uralburmash
152,4	6	AIRS142	МС-ПВ	142	115-60	20-110	3-88	3 1/2 Reg	12,0	Uralburmash
		AIRS332	Т-ПВ	332	115-60	70-140	3-88	3 1/2 Reg	12,0	Uralburmash
155,6	6 1/8	AIRS322	Т-ПВ	322	115-60	70-140	3-88	3 1/2 Reg	12,2	Uralburmash
		AIRS332	Т-ПВ	332	115-60	70-140	3-88	3 1/2 Reg	12,2	Uralburmash
158,7	6 1/4	AIRJ212	С-ПГН	212	115 - 60	20-110	3-88	3 1/2 Reg	12,7	Volgaburmash
		AIRS122	М-ПВ	122	115-60	20-100	3-88	3 1/2 Reg	13,4	Uralburmash
		AIRS222	С-ПВ	222	115-60	50-120	3-88	3 1/2 Reg	13,4	Uralburmash
		AIRS322	Т-ПВ	322	115-60	70-130	3-88	3 1/2 Reg	13,4	Uralburmash
161,0	6 11/32	AIRS322	Т-ПВ	322	115-60	70-140	3-88	3 1/2 Reg	12,5	Uralburmash
165,1	6 1/2	AIRS122	М-ПВ	122	115-60	20-100	3-88	3 1/2 Reg	14,0	Uralburmash
		AIRS222	С-ПВ	222	115-60	50-120	3-88	3 1/2 Reg	12,6	Uralburmash
		AIRS322	Т-ПВ	322	115-60	70-150	3-88	3 1/2 Reg	14,0	Uralburmash
171,4	6 3/4	AIRJ122	М-ПГВ	122	115-60	30-100	3-88	3 1/2 Reg	16,5	Uralburmash
		AIRJ222	С-ПГВ	222	115-60	30-120	3-88	3 1/2 Reg	16,5	Uralburmash
215,9	8 1/2	AIRJ122	М-ПГВ	122	115 - 60	30-130	3-117	4 1/2 Reg	33,0	Volgaburmash
		AIRJ321	Т-ПН	312	115 - 60	60-180	3-117	4 1/2 Reg	34,0	Volgaburmash
		AIRS122	М-ПВ	122	115-60	30-130	3-117	4 1/2 Reg	27,2	Uralburmash
		AIRS322	Т-ПВ	322	115-60	100-180	3-117	4 1/2 Reg	28,0	Uralburmash
244,5	9 5/8	AIRS322	Т-ПВ	322	115-60	110-200	3-121	4 1/2 FH	39,0	Uralburmash
250,8	9 7/8	AIRJ212	М-ПГВ	212	115 - 60	150-280	3-152	6 5/8 Reg	59,0	Volgaburmash
320,0	12 5/8	AIRJ312	М-ПГВ	312	115 - 60	50-210	3-152	6 5/8 Reg	89,0	Volgaburmash

Products

Technical information

Table K-3

Standard Nozzle List

Bit diameter, in	Nozzle inner diameter, mm																				
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	22	24	25	26	28	30	32
130,2 - 149,2	*	*	*	*	*	*	*	*	*		*											
152,4 - 171,4	*		*	*	*	*	*	*	*		*	*		*								
187,3 - 233,0			*	*	*	*	*	*	*	*	*	*	*	*	*	*						
244,5 - 393,7 *			*	*	*	*	*	*	*		*	*		*	*	*		*				
349,2								*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

* *Made of plastic*

Table K-4

Torque recommended for thread connections

Bit diameter		Connecting thread		Recommended torque	
mm	in	API, in	GOST, mm	Ft-lbs	kNm
76,0	3	-	3-42	900 - 1800	1,2 - 2,5
93,0	3 21/32	-	3-50	1500 - 1800	2,1 - 2,4
96,0 -98,0	3 25/32 - 3 55/64	-	3-66	3000 - 3500	4,0 - 4,8
130,2 – 136,5	5 1/8 – 5 3/8	2 7/8 Reg	3-76	4500 - 5500	6,0 – 7,5
142,9 – 190,5	5 5/8 – 7 1/2	3 1/2 Reg	3-88	7000 - 9000	9,5 – 12,0
200,0 – 233,0	7 7/8 – 9 3/16	4 1/2 Reg	3-117	12000 - 16000	16,0 – 22,0
244,5 - 258,0	9 5/8 - 10 5/32	4 1/2 FH	3-121	16600 - 21000	22,5 – 28,0
250,8 - 349,2	9 7/8 - 13 3/4	6 5/8 Reg	3-152	28000 - 32000	38,0 – 43,0
393,7	15 1/2	7 5/8 Reg	3-177	34000 - 40000	46,0 – 54,0

DTH Bits

DTH

DTH bits are designed for drilling blast holes with downhole hammers. Splined joint of the shank increases reliability and joint efficiency, provides quick tool change. The bits cutting structure consists of tungsten carbide spherical or ballistic buttons. Flushing grooves are designed for the most efficient bottom-hole cleaning.

165,1 (6 1/2) DTH-QL6 F2S

165,1 (6 1/2) DTH- QL6 C3S

- Bit diameter, mm (in)
- Product line
- Shank type
- Face geometry
- Number of ports
- Button shape

Face geometry:
F — flat
C — concave
X — convex

Button shape:
S — spherical
B — ballistic

DTH							
Bit diameter		Designation	Shank		Flushing grooves, pcs. x mm	Weight, kg	Manufacturer
mm	in		Compatible type	Height, mm			
152,4	6	DTH-M5 F3S	M50	259	3x20	16,1	Volgaburmash
152,4	6	DTH-QL5 C3S	QL50	240	3x20	17,9	Volgaburmash
165,1	6 1/2	DTH-QL6C3S	QL60	245,9	3x24	23,4	Volgaburmash
165,1	6 1/2	DTH-QL6 F2S	QL60	245,9	2x24	23,6	Volgaburmash
171,4	6 3/4	DTH-QL6 F2S	QL60	245,9	2x24	24,3	Volgaburmash
203,2	8	DTH-QL6 F2S	QL60	245,9	2x24	27,5	Volgaburmash

PDC Bits

FastDrillConstruction

FastDrillConstruction bits are used for full diameter drilling of vertical and directional wells and are designed specifically for mining industry. Using wear-resistant PDC cutters multiplies bit life and performance. Flushing through channels directed towards the bottom-hole efficiently cleans the bottom-hole and cools the tool.

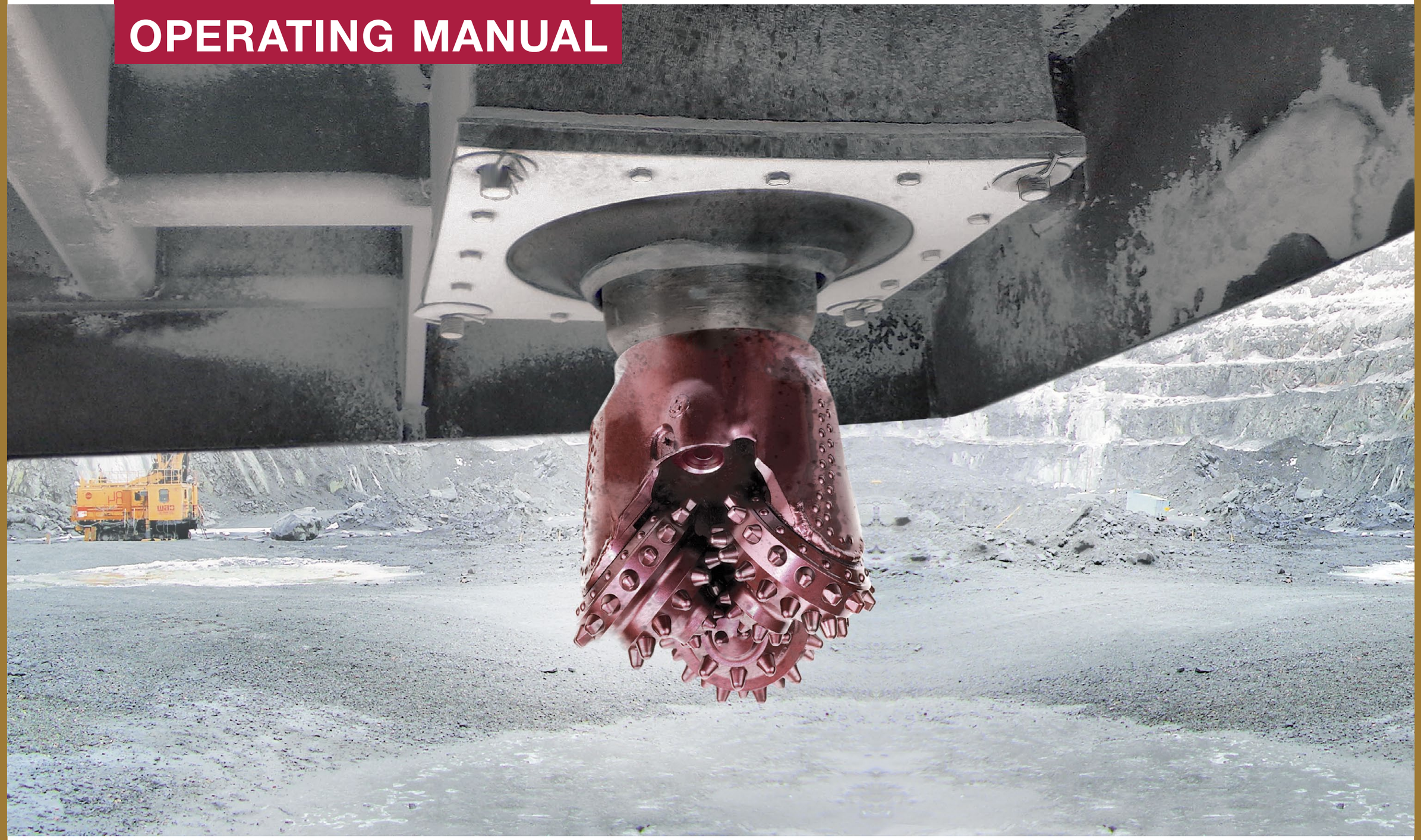
76 (3) FDC 3 13 S

- 76 — Bit diameter, mm (in)
- (3) — Product line
- FDC — Product line
- 3 — Number of gauge pads
- 13 — Cutter size
- S — Formation hardness

76.0 (3) FDC313S

FDC						
Bit diameter		Designation	Connecting thread		Weight, kg	Manufacturer
mm	in		GOST	API		
76	3	FDC313S	3-42	-	2	Volgaburmash
93	3 21/32	FDC313S	3-50	-	2,8	Volgaburmash
96	3 25/32	FDC313S	3-66	2 3/8 Reg	2,8	Volgaburmash
98	3 55/64	FDC313S	3-66	2 3/8 Reg	2,9	Volgaburmash

ROLLER CONE BITS OPERATING MANUAL



Section 1 – Rock Failure

1.1 Rock failure mechanics

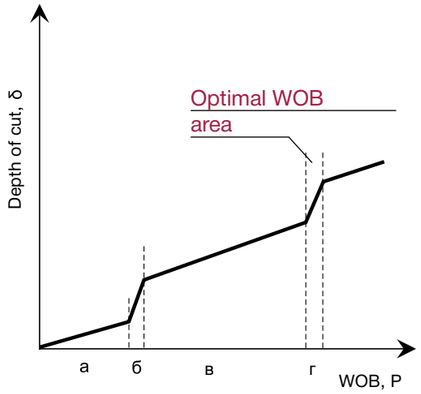


Figure. 1

Efficient rock drilling requires an optimum combination of many factors, one of which is dynamic load or an impact energy applied to the bit cutting structure.

Experiments proved that the depth of cut depends on the load applied to the insert. Figure 1 shows this regularity in a form of a polygonal line with 4 main areas of rock failure (a, b, c, d) under it. Figure 2 illustrates the rock failure patterns in the process of penetration of one insert.

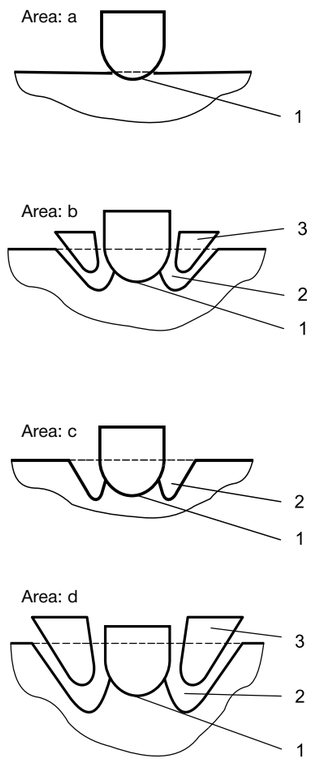


Figure. 2

When only a minor impact energy is applied there is only minor fragmentation made by the insert on the rock surface (residual deformation). This results in the rock cracking around the insert contour.

With further increase in impact energy the rock starts chipping away from the insert contour. This is the first stage of rock failure. The force resulting in chipping around the insert contour is called the load of the first stage of rock failure.

The further increase in the impact energy up to the load of the second phase of rock failure results only in an insignificant increase in the volume of failure.

When maximum load is applied the volume of destruction increases proportionately. This type of failure is called the second stage of rock failure.

Figure 2 illustrates: 1 Insert-rock contact surface; 2 Rock failure crater; 3 Cutting cross section.

1.2 Selecting drilling modes

Conditions for b, d stage in rock failure (Figure 1) depend on the properties of the rock, WOB, RPM and bottom hole cleaning conditions.

Optimization of drilling parameters is achieved through experimental selection of WOB and RPM. Specifications shown for WOP and RPM of the bit type should not be exceeded. In order to facilitate the most suitable cutting structure selection, please refer to Table R-1 “Rock Classification”. The Table shows a variety of formations and their classification according to IADC code, GOST 20692-2003, strength coefficient as per the scale of professor M. Protodyakonov, drillability category, uniaxial compressive strength, etc.

Experiments proved the relation between the bottom hole penetration δ per one rotation and WOB while drilling with a rock bit. Figure 3 illustrates the relation as a curve. Three main areas of rock failure are shown under it.

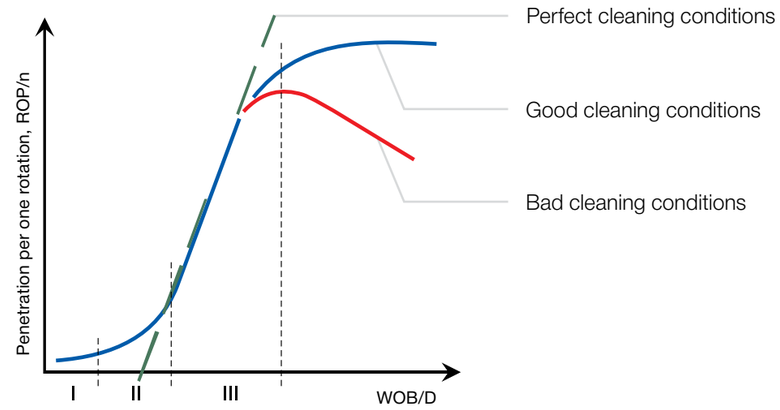


Figure. 3

Area I

The rock is cut by abrasive wear, micro chipping, crushing and movement of some bottom hole irregularities. This area demonstrates insufficient WOB. ROP is not more than 3m/h.

Area II

Fatigue failure, voluminous chipping after several impacts on the same bottom hole area. Very hard formations are mostly drilled in this area. ROP is not more than 10m/h.

Area III

This is a bulk failure area where specific power inputs per unit of rock volume are considerably lower than in the first two areas but ROP is higher.

Operating Manual

Rock classification

Table R-1

Rocks	Bit type: IADC	Bit type: GOST 20692-2003	Hardness as per professor Protodyakonov's scale, f	Standard rock drillability classification	Building specifications and acts	Uniaxial compressive strength, δ: Kg/cm²	Uniaxial compressive strength, δ: MPa	Uniaxial compressive strength, δ: 1000psi	International Bureau of Rock Mechanics	Ministry of Geology (mining and tunneling)	Ministry of Geology (drilling)
Filled-up ground. Sand. Vegetable layer. Peat with no admixture. Loose cinder.	112 122 132 142 412 422 432 442	M OM3	0,2 0,3 0,4 0,5 0,6 0,7 0,8 0,9 1,0 1,2 1,5 2,0 3,0 4,0	I II III IV V VI VII VIII IX X XI XII XIII XIV XV XVI XVII XVIII XIX XX	I II III IV V VI VII VIII IX X XI	less than 50	less than 7	less than 1	1 2 3 4 5 6 7 8 9 10 11 12	I II III IV V VI VII VIII IX X XI	I II III IV V VI VII VIII IX X XI XII
Fine sandy gravel (up to 15 cm). Ice. Dry and dense loess. Sand and vegetable layer with rubble and rock debris. Dense vegetable layer. Light loess-like loam. Peat with gravel. Very soft coke coal. Black soil.						40-120	7-14	1-2			
Light and sandy ground. Medium plastic clay, moraine, coarse gravel. Very soft marl. Rock fill and monton. Sand with coarse rock debris. Heavy loam. Peat with roots. Soft coal. Rock debris up to 50mm.						80-300	14-21	2-3			
Heavy, dry and boulder moraine clay. Clay interbedded with sandstone and marl. Silty rock debris and sand. Packed sand and clay ground. Earthy gypsum. Soft marl. Weakly cemented coquina.Construction waste. Medium coal (Donetsk type).							21-28	3-4			
Coaly argillite. Weakly cemented rubble and gravel. Porous gypsum. Shaly clay. Wet sand and shingle interbedded with clay and marl. Destructed schist. Medium coal (Kuznetsk type).							28-41	4-6			
Anthracite. Coaly-clay argillite. Crystallized gypsum. Rock debris and detritus ground Porous limestone						200-450					
Compact shingle. Soft dolomite. Stone soil. Chalk. Marl. Frozen ground.g Opoka. Loose sandstone. Iron ore. Serpentinite. Clay slate. Rock salt. Compact alkaline soil. Hard coal.	212 222 232 242 412 422 432 442	C M3					41-48	6-7			
Hard anthracite. Clay siltstone. Barite. Fine grained gypsum. Porous dolomite. Soft limestone. Rock salt. Compact frozen sand. Iron ore. Tuff.							48-62	7-9			
Siltstone with siliceous and argillaceous cement. Anhydrite. Apatite ore. Siliceous and argillaceous argillite. Compact bauxite. Soft dolomite. Brown hematite, porous and weathered ironstone. Marly and soft limestone. Hard marl. Sandstone with argillaceous and gypseous cement. Weathered serpentinite. Conglomerate of sedimentary rock with argillaceous cement. Very hard clay shale and mica schist and sericitic schist. Slate. Very hard coal.						350-700	62-76	9-11			
Siltstone with siliceous and sericitic cement. Apatite-nepheline ore. Stone and jasperoid bauxite. Soft gneiss. Weathered dunite. Run-of-mine limestone. Conglomerate of sedimentary rock with carbonate cement. Iron ore. Striate magnetite and weathered massive magnetite. Coarse grained mineralized marble. Sandstone with clay-argillaceous porous carbonate cement. Serpentinite. Siderite. Silicificated, micacerous, hard, coaly and sandstone shale. Phosphorite with phosphoric acid and carbonate cement.	312 322 332 342 512 522 532 542	T C3					76-90	11-13			
Laminated siltstone with siliceous cement. Solid brown hematite. Dolomite. Compact and dolomitic limestone. Coarse grained granite, granodiorite, gabbro, dunite, pegmatite. Basaltic lava. Massive magnetite. Medium grained mineralized marble. Sandstone with mixed clay carbonate cement. Mica-quartz shale. Weathered porphyrite. Chalcopyrite ore. Kimberlite.	312 322 332 342 612 622 632 642	T T3 TK3				550-950	90-103	13-15			
Gneiss, granite-gneiss, weathered diabase, conglomerates with limestone gravel. Basaltic-andesite lava. Medium-hard martite and hematite-martite ore. Massive siltstone with siliceous cement. Metamorphic granite rock. Silicificated sandstone with calcareous cement. Medium grained anisomerous porphyraceous granite, granodiorite, gabbro, peridotite, pyroxenite, pegmatite. Acid tuff. Magnesite.							103-117	15-17			
Amphibole. Fine, normal and medium grained gabbro. Massive limestone. Conglomerated with igneous rock pebble with mixed cement. Porous acid and medium lava. Fine grained granite, granite diorite. Gabbro. Oxidated ferruginous quartzite. Massive sandstone with siliceous cement. Alkaline dike rock. Silicificated magnesite.	612 622 632 642 712 722 732 742	T3 TK3 K				750-1350	117-131	17-19			
Granite – porphyry. Fine grained sandstone. Siliceous limestone. Hard magnetite and hematite-magnetite ore. Fine grained granite. Onezhsky type. Ferruginous quartzite. Sandstone with siliceous cement. Medium size grained diorite. Compact garnet skarn.							131-152	19-22			
Olivinic basalt and andesite. Medium and fine grained granite. Dacite and dacite porphyrite. Diabase. Massive diorite. Magnetite ferruginous quartzite, very compact. Quartz porphyry. Martite ore. Micro granite and micro diorite. Quartzitic sandstone. Silicificated shale. Very fine grained skarn. Quartz, biotite, pyroxene gneiss. Soft pegmatite.	612 622 632 642 712 722 732 742 812 822 832 842	T3 TK3 K OK				1100-1700	152-166	22-24			
Jasperite. Fine grained gabbro-diorite. Solid diabase and basalt. Martite ferruginous quartzite. Fine grained solid quartzite. Solid quartzite. Emery chlorite ore. Metabasalt of basalt group. Massive porphyrite. Chert and jasperoid shale.							166-186	24-27			
Basalt, diabase and very dense porphyrite. Solid jasperite, quartzite and jasper. Corundum ore. Nephrite. Massive pyretic hornfels. Titanium magnetite ore. Jasper. Micro quartzite.							186-193	27-28			
							200-221	29-31			
							221-241	31-35			
						1500-2100	241-262	35-38			
							262-283	38-41			
							283-303	41-44			
							303-324	44-47			
							324-345	47-50			
						1850-2700	345-359	50-53			
						more than 2500	more than 366	more than 53			

When RPM is modified, the quantity of insert impacts against the bottom hole per time unit changes. The penetration per one rotation (δ) can be expressed by ROP:

$$ROP = n \cdot \delta$$

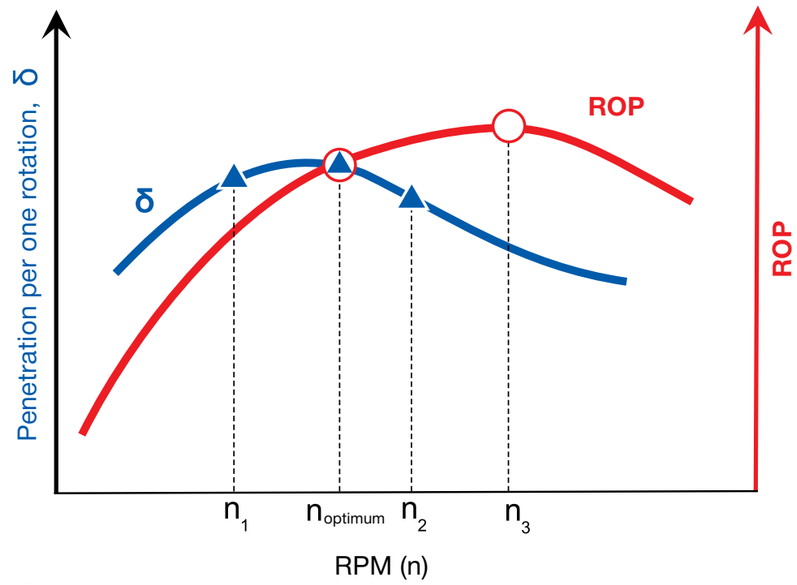


Figure. 4

Figure 4 shows how bit penetration per one rotation (δ) and ROP depend on RPM. With increased RPM in n < n1 section, the values of ROP and δ increase. With increased RPM in n1≤n≤n2 section, δ decreases but ROP keeps growing. With further increase in RPM in n>n3 section, the values of δ and ROP decrease considerably. ROP decreases after the point n3 due to:

- Reduced insert-rock interaction time;
- Decreased impact energy applied to an insert;
- Increased dynamic resistance of the rock drilled due to its plastic properties with little bit penetration per one rotation;
- Increased drilling rod vibrations;
- Changed mode of the air flow at the bottom hole;
- Increased power consumption.

Continuous air flushing while drilling ensures bottom hole clearing, the bit cooling and contributes to the efficient penetration into rock.

An optimum ratio of the value of a bit penetration per one rotation δ and ROP on Figure 4 corresponds to bit RPM n opt. A further increase of RPM will result in erosion of the bit cutting structure and bearing with little further increase of ROP.

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1.3 Practical use of test results

The maximum ROP is determined experimentally for each bit type and size in given mining and geological applications. Therefore an optimum ratio of WOP and RPM is theoretically achieved when the depth of cut is about 80% of insert protrusion. 20% remain for efficient cuttings removal. In practice the recommended drilling parameters for a particular bit type and size shall be determined using Tables K-1 and K-2. The target is to determine the maximum ROP with the given WOP and RPM. The maximum ROP value will correspond to the optimal WOP and RPM values.

Excessive WOB which makes depth of cut more than 80% results in the following:

- Cuttings will not be completely removed from rock cutting area;
- Rock is milled repeatedly;
- ROP decreases;
- Bit cutting structure and bearing wear intensively;
- Load on the drilling rig rotary head increases.

Section 2. Air Circulation System

2.1 Bottom hole cleaning

An optimum air circulation in up-to-date drilling with mining bits comes down to the following tasks:

1. To ensure efficient cuttings removal from bottom hole to the surface;
2. To reduce the erosive wear of cutting structure and bearings by means of efficient bottom hole cleaning.
3. To cool the bearing and to keep the bearing clean.

An efficient bottom hole cleaning objective comes down to obtaining the required annular return velocity.

The annular return velocity produces a lifting force that ensures cuttings removal. It can be controlled by:

- Selection of a compressor and its adjustment to the optimum air capacity;
- Selection of the rock bit diameter and drilling rod OD
- Selection of replaceable nozzles with optimum flow area and setting them in the bit.

Actual compressor capacity changes depending on the throttle flap position, wear of the screw pair and the compressor body, altitude above the sea level and manifold leakage. Factors that affect the value of the annular velocity for cuttings removal:

- Correlation between the bit diameter and the drill pipe OD;
- Drilling rod gauge loss as a result of the wear;
- Rock specific strength;
- Sizes and shapes of cuttings;
- Water in the hole.

They can be expressed by the following formula:

$$Q = 47 \bullet V \bullet (D^2_b - D^2_p)$$

Where **Q** is – air flow, m3/min;
V – is desired air velocity, m/sec;
It should be noted that:

- The air velocity for drilling light weight rock is to be more than 25 m/sec;
- The air velocity for drilling heavy weight rock is to be more than 35 m/sec;
- The air velocity for drilling heavy weight rock with high water content is to be more than 50 m/sec;

Db — is Bit diameter, m;
Dp — is Pipe Diameter, m;

2.2 Required drilling rig compressor capacity

The required value of compressor capacity versus air velocity, rock bit diameter and drill rod diameter is shown in Table R-2.

Table R-2

Bit diameter		Drilling rod diameter		Compressor capacity, m³/min for desired air velocity		
mm	in	mm	in	25 m/sec	35 m/sec	50 m/sec
76,0	3	60	2 23/64	3	4	5
93,0	3 2/3	60	2 23/64	6	9	12
		65	2 9/16	6	8	11
98,4	3 7/8	60	2 23/64	7	10	14
		65	2 9/16	6	9	13
		73	2 7/8	5	7	10
114,3	4 1/2	65	2 9/16	10	15	21
		73	2 7/8	9	13	18
		89	3 1/2	6	8	12
120,6	4 3/4	60	2 23/64	13	18	26
		65	2 9/16	12	17	24
		73	2 7/8	11	15	22
		89	3 1/2	8	11	6
		102	4	5	7	10
130,2	5 1/8	73	2 7/8	14	19	27
		89	3 1/2	11	15	21
		102	4	8	11	15
136,5	5 3/8	73	2 7/8	16	22	31
		89	3 1/2	13	18	25
		102	4 1/64	10	14	19
139,7	5 1/2	89	3 1/2	14	19	27
		102	4 1/64	11	15	21
		114	4 31/64	8	12	17
142,9	5 5/8	73	2 7/8	18	25	35
		89	3 1/2	15	21	29
		102	4 1/64	12	17	24
		114	4 31/64	9	13	19
149,2	5 7/8	102	4 1/64	14	19	28
		114	4 31/64	11	15	22
		127	5	7	10	14
152,4	6	102	4 1/64	15	21	30
		114	4 31/64	12	17	24
		127	5	8	12	17
158,7	6 1/4	89	3 1/2	20	28	41
		102	4 1/64	17	24	35
		114	4 31/64	14	20	29
		127	5	11	15	21
171,4	6 3/4	102	4 1/64	22	31	45
		114	4 31/64	19	27	38
		127	5	16	22	31
		140	5 33/64	12	16	23
187,3	7 3/8	114	4 31/64	26	36	52
		127	5	22	31	45
		140	5 33/64	18	26	37
		152	5 63/64	14	20	28
		159	6 17/64	12	16	23
200,0	7 7/8	140	5 33/64	24	34	48
		152	5 63/64	20	28	39
		159	6 17/64	17	24	35
		168	6 39/64	14	19	27
215,9	8 1/2	140	5 33/64	32	44	63
		152	5 63/64	27	38	55
		159	6 17/64	25	35	50
		168	6 39/64	21	30	43
228,6	9	168	6 39/64	28	39	56
		178	7	24	34	48
		180	7 3/32	23	33	47
		191	7 33/64	19	26	38
		197	7 3/4	16	22	32
233,0	9 3/16	168	6 39/64	31	43	61
		178	7	27	37	53
		180	7 3/32	26	36	51
		191	7 33/64	21	29	42
		197	7 3/4	18	25	36
244,5	9 5/8	178	7	33	46	49
		180	7 3/32	32	44	48
		191	7 33/64	27	38	41
		197	7 3/4	25	34	37
		203	8	22	30	33
250,8	9 7/8	178	7	37	51	74
		180	7 3/32	36	50	72
		191	7 33/64	31	44	62
		197	7 3/4	28	40	57
		203	8	25	36	51
		219	8 5/8	18	25	35
269,9	10 5/8	203	8	37	52	74
		219	8 5/8	29	41	58
		229	9	24	34	48
279,4	11	203	8	43	61	86
		219	8 5/8	35	50	71
		229	9 1/64	30	42	60
295,3	11 3/5	203	8	54	76	108
		219	8 5/8	46	65	92
		229	9 1/64	41	57	82
		235	9 1/4	38	53	75
311,1	12 1/4	219	8 5/8	57	80	115
		229	9	52	73	105
		235	9 1/4	49	68	98
		254	10	38	53	76
		273	10 3/4	26	37	52
320,0	12 5/8	229	9 1/64	59	82	118
		235	9 1/4	55	78	111
		254	10	45	62	89
349,2	13 3/4	254	10	67	94	135
		273	10 3/4	56	78	111
		305	12	34	48	68
393,7	15 1/2	305	12	73	102	145
		311	12 1/4	68	96	137
		330	13	54	76	108

The above calculation gives a preliminary estimate of required compressor capacity. The final data can be obtained only after a test drilling.

2.3 Nozzles selection

Optimum combination of drilling equipment on a drilling rig (bit diameter, drilling rod diameter, actual compressor capacity) for given mining and geological applications makes it possible to achieve the required annular velocity and satisfactory bottom hole cleaning and cuttings removal.

The better are the bottom hole cleaning and cuttings removal, the less is the erosive wear of the cutting structure and the bearing at maximum ROP. However, it is very important to realize that air circulation system is to ensure not only the required annular return velocity but to provide conditions for the best cooling and cleaning the bearing.

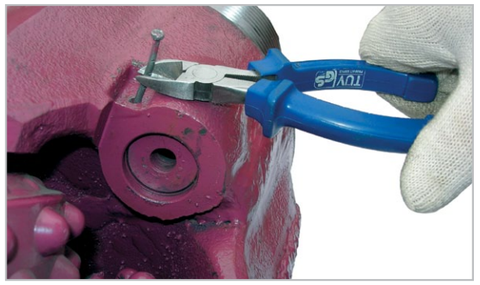
This problem is solved solely by the choice of bit nozzles diameter, because only nozzles selection makes it possible to gain an air pressure drop in a bit which is required for successful drilling.

Recommended air pressure in a bit is determined in each case experimentally by making measurements with a special pressure gauge. The long-term experience in drilling blast holes reveals that the air pressure in a bit has to be within the range of not less than 0.20 – 0.22 MPa (29.7 – 32.6 psi) and has to match physical and mechanical properties of formations and drilling applications.

Failure to observe the recommended values of air pressure in a bit will inevitably result in premature bearing failure.

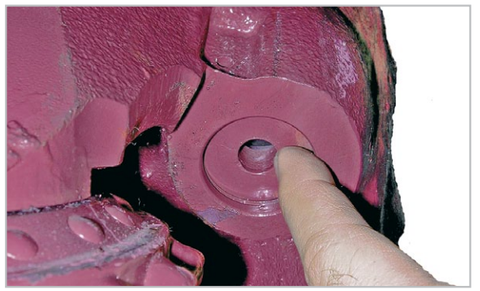
2.4 Nozzles replacement

Nozzles are fixed with a nail. The nail is installed through a hole in the leg and fills in the ring groove made in the nozzle recess of the leg and in the nozzle. Such method is the most reliable and facilitates nozzles replacement. Nozzles replacement procedure:

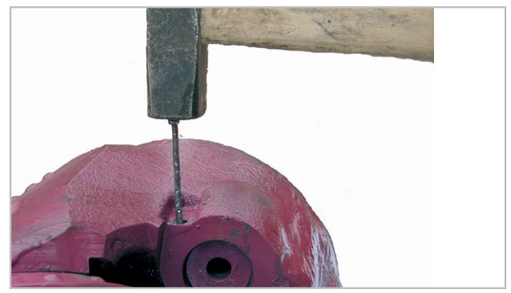


1. Remove the nail to remove the nozzle

2. Remove the nozzle



3. Install a new nozzle



4. Fix the nozzle with a nail using a hammer

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2.5 On-site measurement of compressor capacity

The subject method makes it possible to measure an actual drilling rig compressor capacity on-site taking into account its wear, air circulation system leakage and other factors.

Values obtained with this method are true only for Volgaburmash bits when their air passages are free from cuttings. It is recommended to measure compressor capacity in the following order:

1. Determine bit type and size and its condition. Only new bits or bits in good condition can be used.
2. Determine the flow area of the nozzles. Be sure that all three nozzles are the same.
3. When the compressor is switched on, check the air flow under the cones to make sure that all air passages are empty. The compressor should run with a nominal working temperature and with water supply switched off.
4. Determine air temperature with the tools in the operator's booth.
5. Install a pressure gauge into one of the nozzles and measure the pressure.
6. Basing on the corresponding bit and nozzle diameter find compressor capacity in the table.
7. For your calculation use correction factors in Tables R-4, R-5, R-6: working level altitude above the sea level, temperature of air supplied into the bit, ambient temperature.

Table R-3

Compressor capacity (m^3/min) for 244,5 - 269,9 mm (9 5/8" - 10 5/8") bits

MPa	Nozzles diameter, mm							
	11	12	14	16	17	19	22	24
0,1	10	12	14	16	19	21	28	31
0,11	11	12	14	17	20	22	29	32
0,12	11	13	15	18	20	23	30	34
0,13	12	14	16	19	21	24	32	35
0,14	12	14	16	20	22	25	33	37
0,15	13	15	17	20	23	26	34	38
0,16	13	15	18	21	24	27	36	40
0,17	14	16	18	22	25	28	37	41
0,18	14	17	19	23	26	29	39	43
0,19	15	17	20	24	27	31	40	45
0,20	15	18	20	24	28	32	41	46
0,21	16	18	21	25	29	33	43	48

Table R-4

Altitude above sea level correction factor

MPa	Altitude above sea level correction factor									
	0	500	1000	1500	2000	2500	3000	3500	4000	4500
0,1	1	1,03	1,06	1,09	1,13	1,17	1,21	1,27	1,33	1,41
0,11	1	1,03	1,06	1,09	1,13	1,17	1,22	1,28	1,35	1,43
0,12	1	1,03	1,06	1,10	1,14	1,18	1,23	1,29	1,36	1,45
0,13	1	1,03	1,06	1,10	1,14	1,19	1,24	1,30	1,38	1,46
0,14	1	1,03	1,06	1,10	1,15	1,19	1,25	1,31	1,39	1,48
0,15	1	1,03	1,07	1,11	1,15	1,20	1,26	1,32	1,40	1,49
0,16	1	1,03	1,07	1,11	1,15	1,21	1,26	1,33	1,41	1,50
0,17	1	1,03	1,07	1,11	1,16	1,21	1,27	1,34	1,42	1,52
0,18	1	1,03	1,07	1,11	1,16	1,21	1,28	1,35	1,43	1,53
0,19	1	1,03	1,07	1,12	1,16	1,22	1,28	1,35	1,44	1,54
0,20	1	1,04	1,07	1,12	1,17	1,22	1,29	1,36	1,44	1,55
0,21	1	1,04	1,08	1,12	1,17	1,23	1,29	1,36	1,45	1,55

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Table R-5

Bit temperature (°C) correction factor	
Temperature in a bit, °C	Factor
- 20	1,08
-10	1,06
0	1,04
10	1,02
20	1,00
30	0,98
40	0,97
50	0,95
60	0,94
70	0,92
80	0,91
90	0,90
100	0,89
110	0,87
120	0,86
130	0,85
140	0,84

Table R-6

Ambient temperature (°C) correction factor	
Ambient temperature, °C	Factor
- 40	0,80
- 30	0,83
- 20	0,86
- 10	0,90
0	0,93
10	0,97
20	1,00
30	1,03
40	1,07
50	1,10
60	1,14
70	1,17
80	1,20

Example 1:

Selection of air circulation parameters for efficient rock bit operation on СБШ-250МНА-32 drilling rig..

Basic data:

- 250.8AIRJ742 rock bit;
- Bit nozzles: ø19mm x 3 nozzles;
- Altitude above sea level: 500m;
- Air temperature in bit: +30°C
- Ambient temperature: -10 °C
- Drill rod diameter: 203mm;
- Formations: ferruginous quartzite;
- Holes contain no water.

1.	Measure the pressure with the pressure gauge included in the set.	0.18 MPa
2.	Table R-3: “244.5 – 269.9”. find the matching compressor capacity based on the changed pressure (0.18 MPa) and nozzles sizes (Ø19mm x 3 nozzles)	29 m^3/min
3.	Table R-4: Find correction factor for the altitude above sea level (500m)	29 x 1,03 = 29,87 m^3/min
4.	Table R-5: Find correction factor for the air temperature in the bit (+30°C)	29,87 x 0,98 = 29,27 m^3/min
5.	Table R-6: Find correction factor for the ambient temperature (-10 °C)	29,27 x 0,90 = 26,34 m^3/min
6.	Actual compressor capacity on СБШ-250МНА-32 drilling rig is 26.34 m^3/min.	
7.	Based on the Table R-2, we determine that the required air velocity (35 m/sec) is not ensured (with Ø 203 mm drilling rod, the actual compressor capacity of 26.34 m^3/min when drilling in heavy formations without water content). However, when the drilling rod is replaced by a 219 mm one, the compressor with 26.34 m^3/min capacity supplies the required air velocity (35 m/sec).	
8.	To extend the bit bearing life, it is required to have pressure in the bit more than 0.2 MPa. Replace the three nozzles by 17.5 mm ones.	
9.	The second measurement of the pressure in the bit	0.21 MPa

Thus, we have selected nozzles and air velocity required for an efficient bit run.

Operating Manual

Section 3. Guidelines to rock bit operation

Our recommendations will allow you to obtain good bit performance

Before drilling

3.1 Inspect the thread condition of the drill pipe drive rod. If the thread condition is unsatisfactory, the drive rod should be replaced.

3.2 Inspect the drilling rod condition. Do not use curved rods or a worn thread.

3.3 Inspect the bushings condition. Do not use worn bushings.

3.4 Inspect compressor based on the pressure gauge reading on the outlet as compared to its specification data. Adjust the flap position if necessary.

3.5 Inspect the air ducts and hoses for leakage. Fix the leakage found in the system.

3.6 Inspect the control equipment. Replace faulty equipment.

3.7 Inspect hoisting jacks. Do not allow loosing the drilling rig horizontal position while drilling

3.8 Inspect the bit condition and completeness, reliability of the fixture and state of the relieve valve, availability and size of nozzles, thread connection

3.9 Do not make unauthorized changes to the bit design by means of cutting or welding additional parts or removing relieve valve and nozzles.

3.10 Flush the drilling assembly with air before screwing on the bit

3.11 Avoid impacts or shifts when screwing on the bit

3.12 Set the air pressure in the bit not less than 0.2 MPa by means of selecting the nozzles.

While drilling

3.13 Fill in the Bit Record Sheet for each bit (Appendix 1).

3.14 Break in a new bit for 15 minutes with the drilling rod rotation at 30 RPM and WOB of 10% of the upper limit recommended in the bit specification. Break in a new bit in a new hole (except for the first row holes) with the compressor on.

3.15 Smoothly apply the operation parameters recommended in the bit specification. Do not exceed the WOB and RPM indicated in the specification.

3.15.1 If with sequential increase in WOB the ROP does not increase or decreases, then the WOB shall be reduced to the earlier registered level at which the maximum ROP was obtained.

3.15.2 If the drilling rod starts vibrating, then the bit RPM or WOB shall be reduced to the level at which the vibration stops.

3.16 Optimum drilling parameters shall be determined only by experiment. The most critical factor is the maximum ROP

3.17 Drill only with the compressor switched on.

3.18 Do not apply weight on bit when it does not rotate.

3.19 Do not drill when the bit cones are balled up and do not rotate.

3.20 Do not drill when the bit air passages are blocked.

3.21 Do not complete an old hole with a new bit. It can result in shirttail and hill row inserts cracking and cones jamming.

3.22 Carry out tripping and hole conditioning only with the drilling assembly rotating and the compressor on.

3.23 Do not use new or test bits to clean out collapsed holes. Always apply a used bit for this purpose.

3.24 Emergency stop and leaving a bit at the bottom hole with the compressor off may result in plugged bearing and cones jamming. To prevent its early failure, conduct the following control measures:

3.24.1 Lift the bit above the bottom hole by 1.5-2 meters with no rotation. Turn on the compressor and flush the bit. While doing so, control the pressure increase in the drilling rig air line with a pressure gauge.

3.24.2 Pull the bit out of the hole, clean the bit, check cones rotations manually, turn the compressor on, and visually check flushing air through the cones.

3.24.3 You can continue drilling with the bit if the bit examination results are satisfactory for the drilling rig operator.

3.24.4 If the bit examination results are not satisfactory for the drilling rig operator, then the bit shall be removed for repair.

After drilling

3.27 Used bits intended for repair and drilling in the wells or for cleaning of choked wells shall be flushed and cleaned from mud, their bearing and thread shall be lubricated. It is not recommended to use new bits in repair operations.

3.28 Dull bits intended for scrapping shall be:

3.28.1 Examined by the drilling rig operator and registered in the bit registry.

3.28.2 Disassembled in order to have a stock of replaceable parts, i.e. relieve valves and nozzles on site.

3.29 Drilling report is forwarded to the engineer for registering the bits and analyzing Bit Performance Statistics (Appendix 2)

3.25 B Before the bit a new hole it should be cleaned and examined.

3.26 Use bits till they have obvious failure symptoms:

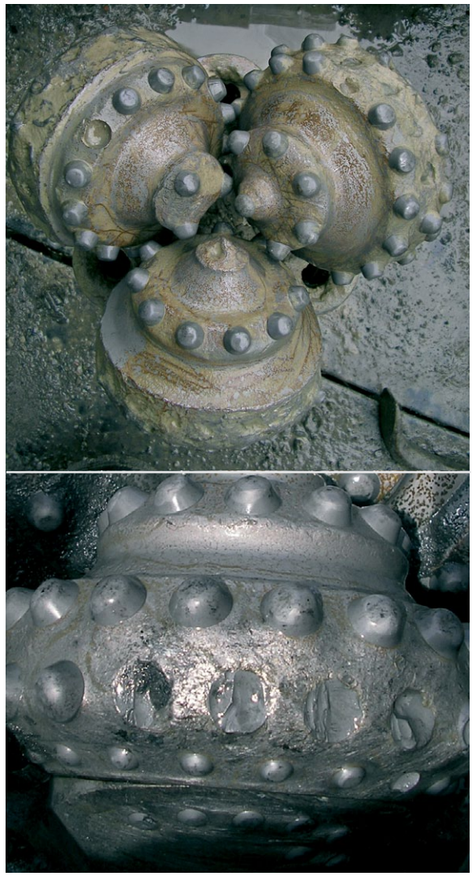
- Locking of bearing at least in one cone;
- Big play resulting in cones jamming and interference;
- Rollers and balls falling out of at least one of the bearings;
- Teeth (inserts) from one cone interfere with other cones;
- Excessive wear of the cones cutting structure;
- Bit failure (bearing failure, welding seams cracking, cones cracking, etc)

3.30 A rate of bit performance is determined based on “Bit Performance Statistics” for a specific mine by an average performance of not less than 50 bits of the similar size and type and designation with a Report issued.

3.31 A report on dull bit performance statistics including meters drilled, hours and ROP is recommended to be delivered to the manufacturer.

Section 4. Dull bit analysis

Broken teeth (BT)



Examination

Teeth break flush to cone body.

Causes

- Too high RPM.
- Broken, disintegrated formation while drilling or spudding a well.
- Improper bit.
- Alteration of formations including very hard ones.

Recommendation

- Reduce the RPM.
- Drill sections interbedded with very hard formations with reduced WOB and RPM.
- Select a bit with the cutting structure features fitting the drilling conditions.

Chipped teeth (CT)

Examination

Chipped tungsten carbide inserts.

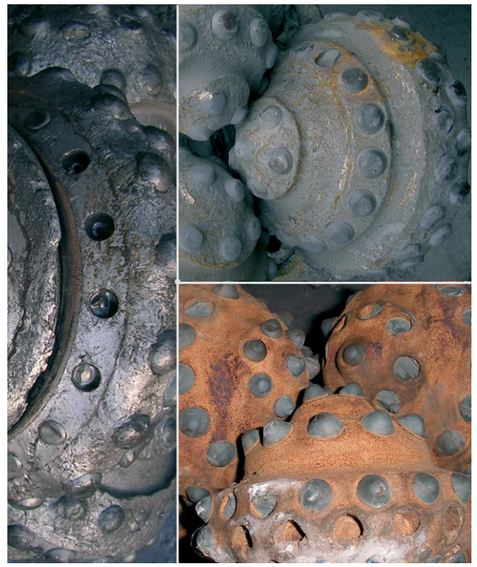
Causes

- Excessive WOB.
- Broken, disintegrated formation while drilling or spudding a well.
- Wrong TCI grade.
- Cone interference.

Recommendation

- Revise the drilling applications and WOB.
- Reduce WOB and gradually reduce RPM.
- Select a bit with more wear resistant TCI.

Lost teeth (LT)



Examination

TCI fall out of the cone body.

Causes

- Metal on the bottom hole.
- Cone erosion.
- A crack in the cone that loosens the grip on the insert.
- Excessive WOB.

Recommendation

- Reduce WOB and RPM –as an option you can use both actions.
- Select a bit that is more suitable for the application.

Worn teeth (WT)

Examination

Inserts wear blunt. Slow penetration rates.

Causes

- Excessive WOB.
- Carbide grade does not match the rock properties.
- Formations changed and are interbedded with hard abrasive stringers.
- Excessive RPM.
- This dull characteristic can be considered as a norm if the meterage and durability values are high.

Operating Manual

Dull bit analysis

Recommendation

- Reduce WOB and RPM – as an option you can use both actions.
- Select a bit with another shape of inserts and with a more wear resistant carbide grade.
- Select a bit that is more suitable for the application.

Heat checking (HC)

Examination

Inserts surface is worn and looks like a “snake skin”. It often results in inserts breakage.

Causes

- Carbide grade does not match the formations drilled.
- Inserts are heated by drilling process and at the same time are cooled with water, injected into the well with air and by underground water.

Recommendation

- Select a bit with carbide grade less prone to heat checking (higher cobalt content or bigger grain size).
- Reduce RPM and water supply.

Rounded gauge (RG)

Examination

The gauge inserts are rounded towards the center of the bit. Slow penetration rates.

Causes

- Excessive RPM.
- Carbide grade does not match the formation hardness.

Recommendation

- Reduce RPM.
- Use a bit with a more wear resistant carbide grade.
- Use a bit with less offset and a bigger journal angle.

Tracking (TR)

Examination

Inserts are worn mainly on one side. This is a dull characteristic that occurs when the inserts mesh like a gear into the bottom hole formation.

Causes

- Improper WOB and RPM
- Improper bit selection
- Changes of the formation.

Recommendation

- Adjust WOB and RPM so that the proper rock cutting within a certain period of time is achieved.
- Select a bit better suited for the application or a bit with an irregular skip pitch.

Self-sharpening wear (SS)

Examination

This is a dull characteristic that occurs when inserts wear in such a way that they retain a sharp crest shape. This proves proper selection of bit and operating parameters.

Operating Manual

Dull bit analysis

Erosion (ER)

Examination

Cone steel erodes away round the inserts and results in loss of inserts. Also, excessive leg erosion can result in loss of inserts on the legs and in shirttail wear, air passage opening and loss of cone.

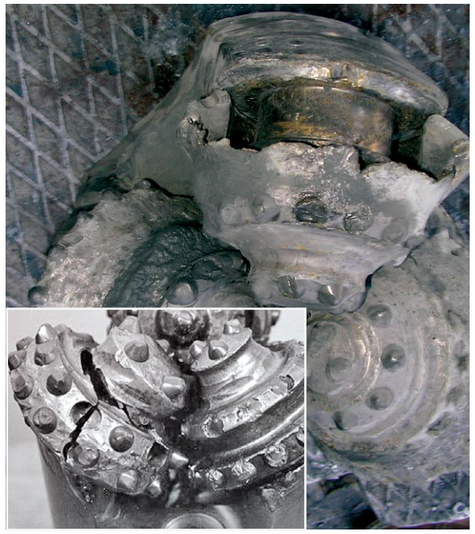
Causes

- High abrasiveness of the formations drilled.
- Inadequate air volume flowing through the nozzles.
- Wet (from either ground water or excessive water injection) sticky and abrasive formations.

Recommendation

- Select WOB and RPM to achieve maximum ROP.
- Inspect air supply system for leakage.
- If water dust control is used, reduce water supply. Make sure that the nozzles are not plugged.
- Inspect cuttings removal efficiency.
- Increase nozzle size to reduce air pressure.

Cracked cone (CC)



Examination

The cone cracks either axially or circumferentially.

Causes

- Cone steel fatigue.
- Cone interference making the cone heat and generate cracks.
- Excessive WOB.
- Dropped drilling rod.

Recommendation

- This dull characteristics can be allowed if the bit is run for a long time.
- Reduce WOB.
- Review the drilling applications and make sure that the bit drills the bottom hole smoothly with no impacts.
- Monitor and control the wear of drilling rod threaded joints.

Lost cone (LC)

Examination

Cones are left at the bottom hole.

Causes

- The bit overdrilled the bottom hole.
- Bit shock problem.
- Bearing failure (all rollers and balls fell out).

Recommendation

- Observe instructions in the bit manual.
- Monitor and control wear of the drilling rod threaded joints.

Cone interference (CI)

Examination

Bearing wear results in the teeth (inserts) of one cone interfering with another cone. It often results in intermittent cone jamming and inserts deterioration and radial cone breakage.

Causes

- Excessive WOB resulting in exaggerated bending moment of journals.
- Plugged air passages, as a result bearings are not properly cooled.
- Insufficient air volume supplied to the bearing.
- Running a bit in an under-gauge well.
- Rollers and balls fall out of one cone.

Recommendation

- Reduce WOB.
- Inspect drilling rods condition, their wear and deviation.
- Inspect drilling assembly bushings for wear.
- Check the back pressure valve availability as well as nozzles availability and proper selection.

Dull bit analysis

Cone dragged (CD)

Examination

All three cones are jammed. The cones have typical tracks (flats) caused by inserts sliding at the bottom hole.

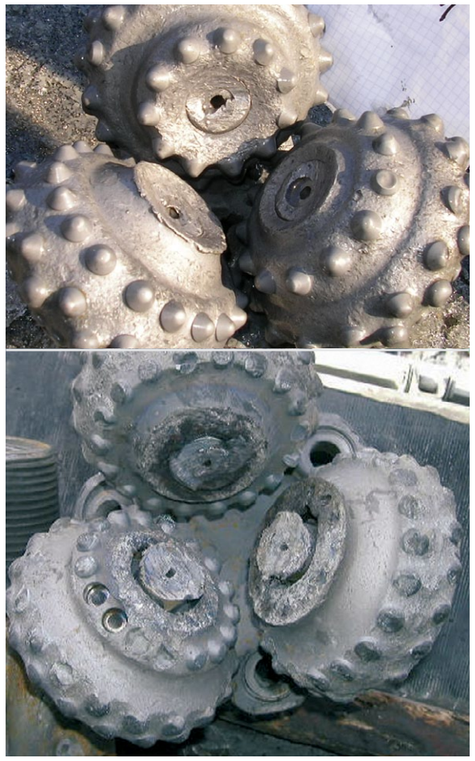
Causes

- Drilling with an air compressor switched off or failed.
- Air supply stopped or is insufficient due to air hose tear or air leakage in the circulation system.
- A foreign object jammed between the cones.
- Bit balling up.

Recommendation

- Repair and adjust the compressor.
- Eliminate air leakage.
- Follow the instructions in the bit manual.

Cored bit (CR) (Loss of cone noses)



Examination

Nose parts of the cones are missing or worn.

Causes

- Excessive WOB resulting in the cone body coming in contact and hitting against the bottom hole.
- Inadequate hole cleaning causing cone erosion.
- Cone noses of the bits with central nozzle wear badly while drilling abrasive formations due to sand blasting effect resulting in lost inserts and worn noses.
- Junk on the bottom hole.

Recommendation

- Reduce WOB.
- Select inserts projection, shape, diameter and quantity so that the cone body would not contact or hit against the bottom hole.
- Measure the actual compressor capacity, drilling rod diameter and check the nozzles selection.
- Replace the bit with a central nozzle by a bit with side nozzles only.

Balled-up bit (BU)

Examination

Formation is packed between the cones. It can be erroneously considered as the bearing being jammed.

Causes

- Inadequate cleaning of the bottom hole.
- Running the bit in hole with the compressor being off.
- Drilling a sticky formation.

Recommendation

- Increase the air flow rate by nozzles selection.
- When you plan a blackout, inform the drilling rig operator in advance.
- Examine the bit after each drilled well.

Broken leg (BL)

Examination

One or all three legs are missing. It often happens as a result of the operator's error or equipment failure.

Causes

- The drilling rod lost in the hole while tripping or repair.
- High abrasiveness of the formations drilled.

Recommendation

- Periodically check the thread of the drilling rod. In case of a wear or thread damage replace the thread connection.
- Select the optimal nozzle diameter (Section 2, page 52).

Dull bit analysis

Pinched bit (PB) (mechanically damaged bit)

Examination

Inserts of inner rows are chipped. Between the rows of one cone there are traces of the adjacent cone.

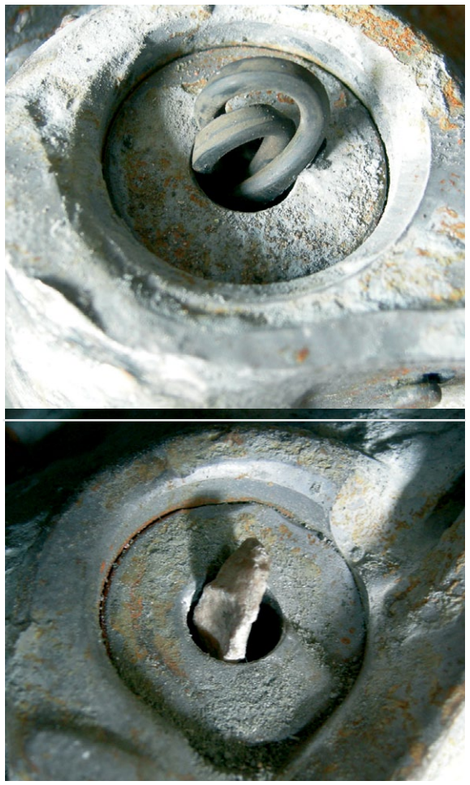
Causes

- Well re-drilling with a new bit.
- Cleaning out the wells with a new bit.

Recommendation

- Use a worn bit to clean out or re-drill a well.
- If there are no worn bits, drill a new well adjacent to old one.
- Order undersized bits for hole cleaning.
- Have a stock of dull bits for well re-drilling or cleaning.

Plugged nozzle (PN)



Examination

A nozzle is plugged with cuttings or rubber hose scraps. The compressor discharges air through the valve. There is a significant erosion of the bit shirttails and legs.

Causes

- The bit was left at the bottom hole with air off for work-over and for power transmission line switching.
- The bit valve protecting from cuttings failed or is missing.
- The compressor failed, the hose fell off.

Recommendation

- Use a dull bit for work-over.
- When you plan a blackout, inform the drilling rig operator in advance.
- Periodically check the relieve valve of the bit, its operability and fixture reliability. Replace the valve if necessary.
- Do not use bits that have no valve protection from cuttings.

- Adjust the compressor, eliminate air leakage, clean the bit from cuttings (nozzles and air passages in the legs).
- Flush the drilling rod with air before screwing the bit on.

Lost nozzle (LN)

Examination

A lost nozzle usually results in a sharp pressure drop and requires an immediate bit pulling out.

Causes

- Breaking the rules of nozzle installation.
- Mechanical damage of nozzles or their retention system.
- Nozzles or their fixture erosion.
- Bit balling up.

Recommendation

- Examine the bit after each drilled well.

Off-center wear (OC)

Examination

Excessive wear of one or two legs (legs, shirttails); of one or two cones (gauge and hill rows), along with bearings failure; cones jammed and balls and rollers lost.

Causes

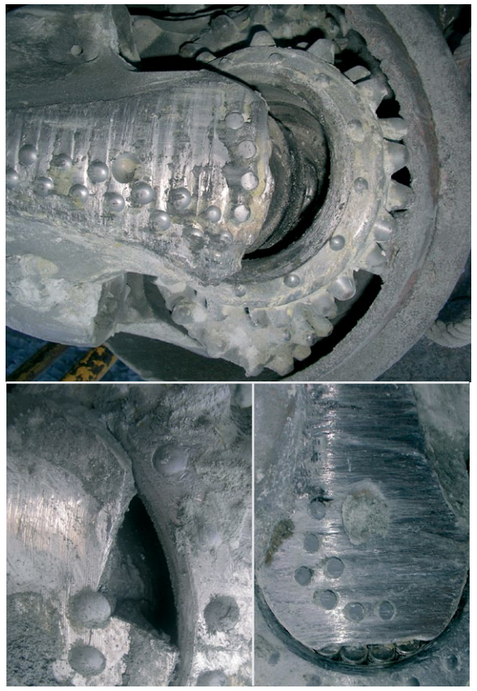
- The drilling rod is bent which results in off-center bit rotation (radial runout).
- Hoisting jack has failed.
- The bit is screwed to the above bit sub with a warp, the bit thread is damaged.
- The thread of the sub (box) is not cut properly, the thrust face of the sub does not thrust against that of the bit.

Recommendation

- Check the drilling rod rotation for eccentricity.
- Check the bit for damaged thread.
- Check and replace the above-bit sub if its thread is damaged.

Dull bit analysis

Shirttail damage (SD)



Examination

Leg shirttail protecting the bearing is broken.

Causes

- Axial part of the load on the bearing results in the shirttail bearing a part of the load.
- Axial runout when the bit rotates.
- Erosion weakens the shirttail structure.

Recommendation

- Reduce WOB and select a bit with a smaller journal angle and bit axis.
- Check the bit for off-center wear and the drilling rod for a bent.
- Check the bit thread and the sub thread for damage.
- Check the drilling rod, compressor and the air line for leakage.

Bearing sludging (BS)

Examination

Sludge in the bit bearing (it can be erroneously considered as jammed bearing).

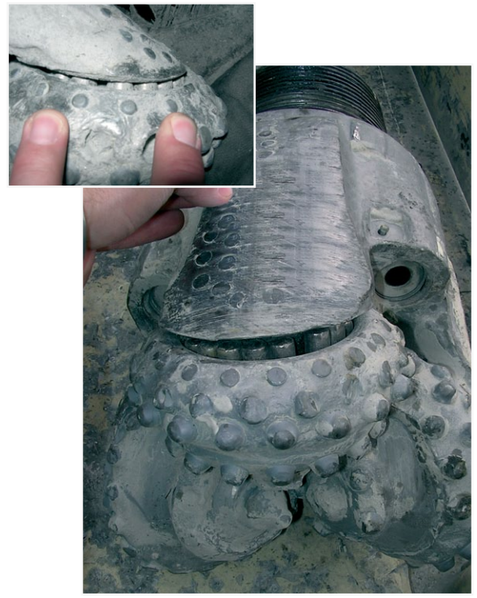
Causes

- Insufficient compressor capacity.
- Improper nozzles selection.
- Drilling without the relieve valve.
- The bit was left at the bottom hole for a long time with the compressor off.

Recommendation

- Select the nozzles according to recommendations.
- When you plan a blackout, inform the drilling rig operator in advance.
- Run the bit with a relieve valve in place.

Play (PL)



Examination

Play.

Causes

- Insufficient compressor capacity.
- Improper nozzles selection.
- Roll and ball bearings wear, bearing. overheating resulting in journal bearing failure.

Recommendation

- Repair the compressor or replace it to a more efficient one.
- Select nozzles according to recommendations.
- Examine the bit after each drilled well.

Section 5. Selection of efficient bit designs

More than 250 bit types and sizes have been developed and can be manufactured for mining companies. It is important to select efficient bit designs for specific mining and geological applications to ensure the best performance (reduced expenses for drilling equipment and drilling operations, increased drilling rigs productivity, reduced time for blast blocks preparation). Our specialists give all recommendations on the optimum bit types and sizes selection and analyze the efficiency of bit runs. Efficient bit selection at each mining company is made based on a complex assessment of:

- Mining, geological and technological drilling applications
- Rock bit statistics
- Dull bit analysis
- Cutting structure and design features
- Technical and economic indices of bits performance based on test results.

If necessary, we can design and manufacture rock bits based on our customer's specific requirements.

5.1 Mining and geological applications analysis

A critical factor that affects bit performance is the mining and geological applications analysis. Rock properties, namely uniaxial compression strength δ, average formation hardness factor F as per professor Protodyakonov's scale, alteration, stringers, attitude of beds, water cut, abrasiveness, broken formations, etc. determine rock bit specification and design features. Since geology may alter with a mine deepening and widening, it is important to consider the drilling volume as per "Long Term Drilling Operation Plan" (Appendix 3).

5.2 Technological applications analysis

Intensive mining complex development is directly related to technical re-equipment and replacement of drilling rigs. Such technical characteristics of drilling rigs as drilling performance, drilling assembly, connecting thread, compressor capacity should match the design features of bits.

It is obvious, that it is impossible to achieve a considerable economic effect in drilling using the state-of-the-art bits with old and worn drilling rig. At the same time, it is well possible to reduce drilling expenses by selection of bits efficiency of which would match actual drilling rig technical parameters.

5.3 Bit performance statistics analysis

The evaluation database for an efficient bit design selection is Rock Bit Performance Statistics Analysis ***(Appendix 2)****. Modern drilling companies usually use a few bit types of different manufacturers and it is important to make a comparative assessment of their efficiency disregarding the bits cost.*

Example 2

A and **B** rock bits comparison assessment with the following statistics:

- **A** rock bit, meterage $(H_a)=60$ meters drilled, hours $(t_a)=10hrs$;
- **B** rock bit, meterage $(H_b)=40$ meters drilled, hours $(t_b)=8$ hrs

Let's determine the average ROP of **A** and **B** bits performance:

$$ROP_a = \frac{H_a}{t_a} = \frac{60_m}{10hrs} = 6m/hr$$

$$ROP_b = \frac{H_b}{t_b} = \frac{40_m}{8hrs} = 5m/hr$$

Conclusion

Bit **A** is more efficient than bit **B**, because $H_a > H_b$ and $ROP_a > ROP_b$

Example 3

C and **D** rock bits comparison assessment with the following statistics

- **C** rock bit, meterage $(H_c)=60$ meters drilled, hours $(t_c)=10hrs$
- **D** rock bit, meterage $(H_d)=60$ meters drilled, hours **(td)=12hrs**

Let's determine the average **ROP** of **C** and **D** bits performance:

$$ROP_c = \frac{H_c}{t_c} = \frac{60_m}{10hrs} = 6m/hr$$

$$ROP_d = \frac{H_d}{t_d} = \frac{60_m}{12hrs} = 5m/hr$$

Conclusion

Bit **C** is more efficient than bit **D**, because $H_c > H_d$ and $ROP_c > ROP_d$

If the meterage and ROP of two bits are equal then the bits are equal in their efficiency.

Operating Manual

Selection of efficient bit designs

5.4 Dull bit analysis and reasons bit failed

After assessment of bits efficiency based on statistics, it is necessary to make a comparative analysis of each bit type dulling and reasons. The analysis results are important because it is critical to very precisely identify what bit design features are required for the application.

5.5 Bit cutting structure and bearing design features analysis

As a rule, to select bits for optimization of their design features, drilling specialists in mining companies use bits identification method based on the data provided by manufacturers. It is a list of products at web-sites and in catalogues with bits specifications. The information contains alphabetic characters as per GOST 20692-2003 and the designation as per IADC code.

5.6 Analysis of technical and economic indices of bits performance based on field test results

A bit design efficiency is determined based on comparative test results in equal mining and geological conditions. An efficient bit design should be considered the one that ensures the minimum value of operational expenses for drilling one running meter of a hole which is determined by the formula:

$$C = \frac{C_{bit}}{H} + \frac{C_{rig}}{ROP_{av}}, \text{ Where :}$$

C – cost of one running meter of hole;
C_{bit} – bit cost;
H – average meterage per bit, m;
C_{rig} – rig cost per one hour of drilling;
ROP_{av} – average ROP

Example 4: Calculation of A and B bits efficiency: **A** и **B**:

Indices	A bit	B bit
Bit cost, RUR	40 000	45 000
Annual scope of drilling, m	300 000	
Meterage, m	2 000	2 100
Bit durability, hrs	90	80
ROP, m/h	22,2	26,2
Rig cost/hr, RUR	1 500	1 500
Rig cost/m, RUR	87,56	78,67
Saving per 1 running meter, RUR	-	8,89
Annual benefit	-	2 667 000

Conclusion

Using bit **B** gives the company an annual benefit of 2 667 000 RUR as compared with bit **A**

Section 6. Bits storage and transportation

6.1 Bits should be stored in a dry and enclosed facility.

6.2 Bits should be stored in cardboard or wooden boxes placed on pallets.

6.3 The transportation should be made either on pallets or in boxes (without pallets).

6.4 The transportation should be made by all modes of transport according to cargo transportation rules for each transportation type provided the cargo is protected from atmospheric precipitations and mechanical damage.

6.5 Storage and transportation of bits in bulks is forbidden.

6.6 Bits shall not hit each other or other solid objects while handling.

6.7 Gloves should be used when handling the bits. 8 1/2» and larger bits shall be handled using mechanic equipment.

6.8 Bits should be stored at drilling rigs in the manufacturer's package or with their shanks upward and the thread and the relief valve protected by a cap.

APPENDICES

Formation Hardness

Formation Hardness			
S	Soft formations	H	Hard formations
SM	Soft formations with medium interlayers	HA	Hard abrasive formations
SMA	Soft abrasive formations with medium interlayers	HE	Hard formations with extra-hard interlayers
M	Medium formations	HEA	Hard abrasive formations with extra-hard interlayers
MA	Medium abrasive formations	E	Extra-hard formations
MH	Medium formations with hard interlayers		

Conversion Tables

Length		mm	m	inch	foot
mm	1 mm	1v	0,001	0,03937	0,003281
m	1 m	1000	1	39,3701	3,2808
inch (in)	1 inch	25,4	0,0254	1	0,08333
foot (ft)	1 foot	304,8	0,3048	12	1

Weight		kg	tn	lb
kg	1 kg	1	1000	2,2046
t	1 tn	1000	1	2204,6
lb	1 lb	0,45359	$4,5359*10^{-4}$	1

Pressure		bar	atm	MПa	kg/cm^2	psi (lb/in^2)
bar	1 bar	1	0,98692	0,1	1,01972	14,504
atm	1 atm	1,01325	1	0,10132	1,03323	14,696
MPa	1 MPa (N/m^2)	10	9,8692	1	10,197	145,0377
kg/cm^2	1 kg/cm^2	0,98067	0,96784	0,09806	1	14,2233
psi (lb/in^2)	1 psi (lb/in^2)	0,06895	0,06805	0,00689	0,07031	1

Volume		l	m^3	cf
l	1 l (dm^3)	1	0,001	0,03531
m^3	1 m^3	1000	1	35,3146
cf (ft^3)	1 cf (ft^3)	28,3168	0,02831	1

Circulation Rate		l/min	m^3/min	cfm
l/min	1 l/min 1	1	0,001	0,03531
m^3 /min	1 m^3/min	1000	1	35,3146
cfm (ft^3/min)	1 cfm (ft^3/min)	28,3168	0,02831	1

Velocity		m/s	km/h	m/h	ft/min
m/s	1 m/s	1	3,6	3600	196,85
km/h	1 km/h	0,2778	1	1000	54,68
m/h	1 m/h	$2,778*10^{-4}$	0,001	1	0,05468
ft/min	1 ft/min	$2,778*10^{-4}$	0,01828	18,2879	1

Appendix 1

BIT RUN REPORT

Weighted average _____ Date removed _____

Serial number _____ Date installed _____

Bit design _____ Rig # _____

Open pit mining _____ Drilling rig _____ Lithology _____

№	Level	Block #	Well number as per project	f=	Well depth, m	Net drilling time			Drilling modes			Name of Operator. Signature. Date/shift
									Bottom hole pressure, atm.	RPM	Air pressure, atm.	
						Rod 1	m					
							min					
						Rod 2	m					
							min					
						Rod 3	m					
							min					
						Total	m					
							min					

Drill Rig Manager _____

Volgaburmash, JSC Representative _____

Bit Performance Statistics for _____year

№	Bit type	Bit serial number	Drilling assembly	Open cast	Level	Block	Hardness coefficient, f=	Date installed	Drilling mode			Meterage, m	Drilling hours, h	ROP, m/h	Date removed	Reason removed
									WOB, kN	RPM	Air pressure, atm					

Position (of the person in charge)_____ Name (of the person in charge)_____Signature, date (of the person in charge)_____

Приложение 2

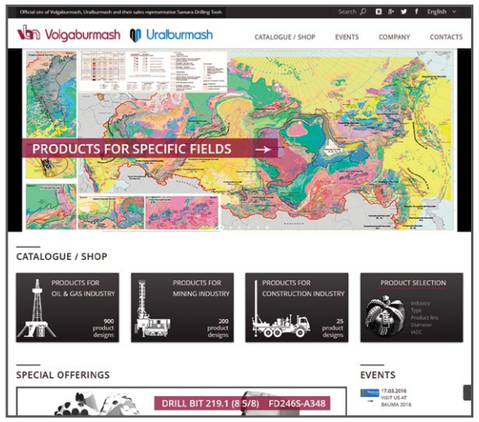
Long Term Drilling Operations Plan for _____ year

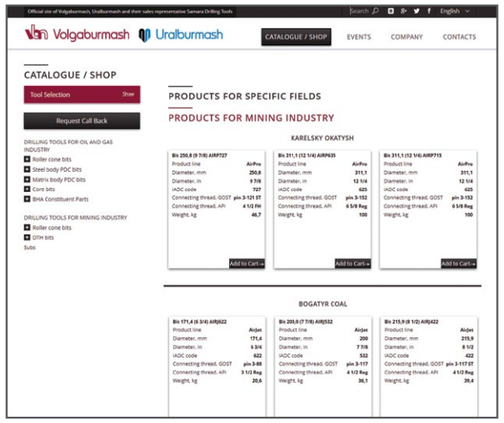
Meterage drilled, km				Meterage drilled split by hardness, km			
Open cast	Level	Block	Total	f=	f=	f=	f= .....

Position (of the person in charge) _____ Name (of the person in charge) _____ Signature, date (of the person in charge) _____

Приложение 3

Site





At our web-site you will find more detailed information about our range of products, drilling modes and operating conditions.

In the section “Products for Specific Fields” you can find optimal designs, make selection using filter and then send your request for the necessary products to our specialists.

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