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As a public company with nearly 70,000 employees in approximately 80 countries, Halliburton's number one priority is to offer safe and superior products and services. We promote safety and environmental principles by working together to protect our employees, stakeholders, communities, and environment from harm.

Halliburton believes safety is everyone's business. That is why every person at every worldwide Halliburton location makes safety awareness the number one priority. Every member of every Halliburton team is tasked with taking personal ownership of his or her own safety and the safety of others.

Our goal is to keep our people (and the environments in which they work) safe and healthy. For this reason, we put policies and procedures in place to make sure that adherence to proper safety practices is a 24/7 commitment on everyone's part.

**OSHA VPP Star Worksite**

The Halliburton Drill Bits & Services manufacturing and technology facility in Conroe, Texas takes Halliburton safety fundamentals to another level by being recognized as a Star Worksite by the U.S. Occupational Safety Health Administration (OSHA). OSHA's Voluntary Protection Programs (VPP) recognize and partner with businesses and worksites that show excellence in occupational safety and health. While all U.S. companies must comply with OSHA regulations, the Star Program is designed for exemplary worksites with comprehensive, successful safety and health management systems. Our facility was recertified as a VPP Star Worksite in 2012, an honor the facility has held since its first certification in 2004.

Becoming an OSHA Star Worksite is not an easy accomplishment. It takes much more than a single audit or visit by OSHA personnel. Less than 1% of companies have been certified as OSHA VPP Star Worksites, and Halliburton is the only drill bit manufacturer in the United States to receive this award. This repeated recognition demonstrates that safety is top priority for Halliburton Drill Bits & Services.
Design at the Customer Interface (DatCI™) Process

Customized Drill Bits and Services Engineered for Optimal Efficiency and Performance

With different applications around the world, there is no one-size-fits-all solution. Our unique DatCI™ process takes that into account. Rather than centralizing design for drill bits, coring services, or downhole tools, Halliburton Drill Bits & Services has highly trained Application Design Evaluation (ADE™) service specialists in locations around the globe. This enables us to work directly with customers to design application-specific solutions.

These deployed specialists integrate local knowledge with some of the industry’s most powerful software, working with customers to design drill bits and tools. When designs are complete, they are sent directly to manufacturing, where drill bits are rapidly produced with industry-best cycle times. DatCI process has helped Halliburton become the North American market leader in drill bits.
**Powerful Software-Application Specific Solutions**

The DatCI™ process is a continuous improvement loop employed by our on-location ADE™ (Application Design Evaluation) service specialists to define application-specific drill bit solutions via well planning. This bit optimization process uses the industry’s most powerful proprietary software tools and enables our specialists to predict bit performance and design the optimal bit for your specific objectives. We analyze formation properties to precisely define the application and then match the design to that application.

Customer Challenge

Evaluate Geology Refine Geo-model SPARTA™

Capture Lessons Learned Case History

Identify Drilling Parameters PBR | MaxBHA™ Direction by Design™

Post Well Evaluation Performance Reports

Evaluate Offset Data Performance Database

Run Drilling Roadmap

Optimize Design IBitSTM | CFD
**SPARTA™ Software**

Scientific Planning and Real Time Applications

SPARTA software delivers advanced rock-strength analysis and modeling, providing clear and concise information to optimize drill bit selection and drilling parameters. SPARTA software helps to generate a map of anticipated geology including hard stringers, abrasive zones, and shales. This map can assist in optimizing drilling parameters to predict and evaluate run performance when plotted against offset wells. It can also be utilized for post-run evaluation to identify future bit selection and operating parameters. In a multi-well drilling program, SPARTA software enhances the DatCl process through reducing cycle times and overall drilling costs.
Direction by Design® Software
Halliburton’s Direction by Design® software provides advanced bit design engineering to optimize directional performance. Evaluating directional drill bit behavior depends greatly on understanding both the drive/steer mechanism and bit/formation interaction. Application Design Evaluation (ADESM) specialists use a wide variety of inputs such as applicable BHA configuration, operating parameters, hole geometry, and formation characteristics to model bits for customer-specific applications. Direction by Design software also enables Halliburton designers to define the connection between specific bit design features and their full impact on directional deliverables, enabling them to provide the ideal combination of steerability, stability, and aggressiveness for the application. Either used as an application-specific bit selection tool or in conjunction with the DatCI process, this software is a powerful means to optimize matched bit design for the specific directional application and drive system. The result is fast, responsive directional drilling.

Outputs
For a given bit under given drilling conditions, Direction by Design software determines the effects of bit geometry on steerability and walk rate, and calculates bit torque variance during directional drilling to account for different bit behaviors during kick-off, build, and hold drilling modes.

Direction by Design® Software
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**Precise Bit Reamer (PBR)**

PBR software accurately simulates the interactions of bits, reamers, BHA, and formation combinations. PBR produces a simulation of drilling efficiency for each bit and reamer configuration, showing the optimal combination. This capability supports both well planning and real-time decision making while drilling. PBR helps operators reduce non-productive time (NPT) and increase overall rate of penetration (ROP) when reaming while drilling.

Application Design Evaluation (ADE) service specialists run MaxBHA software with drill bit and reamer designs to gain insight on bending forces and to pinpoint critical rotary speeds for the BHA. The simulation software extends bit and reamer life by providing ADE service specialists with optimal run parameters that will minimize vibration and increase tool reliability.

**Performance Database**

The Performance Database is a global software system used to capture and analyze bit performance data. It provides accurate, valuable, and fast information to aid sales, product development, and product management. The application enables Halliburton DBS field personnel to quickly and efficiently analyze bit performance data and provide our customers with tailored reports. As the system is constantly updated with new runs, Halliburton has the ability to understand the unique challenges presented by each play and see the trends of successful products. This gives our technology and product development teams the real-time feedback from the field required to be successful in developing our constantly evolving and improving product portfolio.

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**MaxBHA™ Design Software**

MaxBHA™ integrated BHA modeling and drilling optimization software offers a wide range of applications including directional drilling, vibration reduction, survey improvement, and tool design optimization. It can also be used for well planning, real-time optimization, and post-run analysis.
**IBitSTM Software**

**Interactive Bit Solutions**

IBitSTM software tool is used by ADE service specialists to optimize bit selection or design a new bit for specific applications. It enables Halliburton DBS to design the highest performing bits by simulating the forces that the bit will be exposed to under specific drilling parameters. IBitS software calculates the torsional, axial, and lateral forces of each cutting element depending on the cutting structure, geometry, and space position on the bit face. The sum of these forces (total bit force imbalance) is displayed as an output to indicate how the bit will perform in the application.

IBitS software can be used to rapidly design a drill bit in 3D. The ADE service specialists can collaborate in a customer’s office or at the rig site. Both the bit design and the manufacturing processes are generated simultaneously. This process enables Halliburton DBS to achieve industry-best cycle times and manufacturing precision, which leads to best-in-class performance.

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**Fixed Cutter Application Outputs**

**Cutter Layout**
A cutter tip profile shows a two dimensional representation of cutter spacing. Also, profile zones, attached to the cutter tip profile, depict how spacing, back rake, side rake, and degree of spiral are applied to the cutters along the profile.

**Force/Energy Balancing**
On the left, force balancing with radial and drag vectors. On the right, wear analysis factoring volume and footage drilled.

**Hydraulics**
Optimal hydraulic configurations determined through unique modeling techniques in conjunction with Computational Fluid Dynamics (CFD).

**Manufacturing**
IBitS software is used to create the manufacturing components and machining programs as well as the bit design.

**Roller Cone Application Outputs**

**Tooth Angles**
Tooth angles are designed for roller cone bits with Energy Balanced® bit technology.

**Energy Balanced® Bits**
IBitS Software shows orientation of compacts for Energy Balanced® roller cone bit.

**Insert Placement**
The IBitS Software roller cone design shows bottom hole pattern (left), clearances between inserts (center) and insert spacing (right three).

**Side Wall Protection**
IBitS Software can be used to design arms and side wall protection for particular applications for roller cone bits.
Computational Fluid Dynamics (CFD) Analysis
CFD analysis enables the designer to optimize nozzle placement and blade design for effective removal of cuttings. This reduces bit balling and erosion—thus maximizing bit life and ROP.

Drilling Roadmap
As part of the DatCI process, the drilling roadmap displays expected formations and provides bit and parameter recommendations as formations change. This translates into optimized ROP and extended life.
Fixed Cutter Drill Bits

Premium Line
  GeoTech™ Drill Bits
  MegaForce™ Drill Bits
  SteelForce™ Drill Bits
  TurboForce™ Drill Bits

Performance Line
  FX Series™ Drill Bits
Fixed Cutter Drill Bits

**Premium Technologies**

Featured in our premium line of fixed cutter drill bits, our premium technologies incorporate all of the latest engineering advancements from our research and development labs.

**SelectCutter™ PDC Technology**

Proprietary technology development has produced the new thermally stable and highly abrasion-resistant SelectCutter™ PDC technology, available exclusively in the premium drill bit product line from Halliburton. SelectCutter PDC technology is suited to drill the most challenging formations by providing the highest level of abrasion resistance, impact resistance, and Thermal Mechanical Integrity (TMI) available.

**Abrasion Resistance** measures the capability of a cutter to shear formation and minimize the loss of diamond. Improvements in diamond abrasion resistance maintains the sharp cutting edge longer.

**Impact Resistance** measures the ability of a cutter to withstand a dynamic force without chipping or breaking, enabling the cutter to retain a sharp drilling edge for maximum rate of penetration.

TMI is the performance measure of a cutter’s capacity to endure frictional heat generated during the drilling process. Improving TMI means the cutters will wear slower because the diamond-to-diamond bonds can survive elevated temperatures prior to separating.

**Multi-Level Force Balancing**

By optimizing cutter placement through Multi-Level Force Balancing, Halliburton premium bits provide the maximum bit stability and cutting structure efficiency during transitional drilling.

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**Abrasion Resistance vs. Impact Resistance**

- **High Imbalance Force**: created by uneven distribution of cutting force as bit enters formation transition
- **Low Imbalance Force**: created by even distribution of cutting force as bit enters formation transition
**Premium Tungsten Carbide Matrix Material**

Halliburton’s premium tungsten carbide matrix material offers a 20% improvement in erosion and wear resistance over our performance matrix material. This translates into maximum ROP by reducing the amount of cutting structure loss and enabling longer intervals to be drilled by preventing bit body damage.

**Enhanced Hydraulics**

The use of targeted, directional micro nozzles in our premium line of drill bits optimizes fluid flow across the bit face. Micro nozzles permit significant increases in junk slot volume to improve cleaning at high ROP, reduce chances of bit balling, and offer additional design flexibility for minimizing erosion and optimizing total flow area (TFA).

**Hydro-Dynamic Bridges**

With the new hydro-dynamic bridges, not only is the strength and durability of the bit increased, but fluid flow is improved as well. TurboForce™ hydro-dynamic bridges improve fluid flow across bottom hole and results in better cleaning and cooling.
MegaForce™ Drill Bit

**Industry's Most Robust Matrix Body**

The Halliburton MegaForce™ bit features advanced SelectCutter™ PDC technology, ultra-efficient cutter layout force balancing, improved erosion resistant material, and enhanced hydraulics. Designed for an operator’s specific application by one of our Application Design Evaluation (ADE™) service specialists using our industry-unique Design at the Customer Interface (DatCISM™) process, the result is a matrix bit with a combination of higher ROP and longer intervals drilled than any other bit.

SelectCutter™ PDC Technology
Enables the bit to stay sharper longer producing more footage at higher ROPs

Premium Hydraulics
Micro nozzles optimize fluid flow across the bit face

Multi-Level Force Balancing
Provides maximum bit stability and cutting structure efficiency during transitional drilling

Premium Tungsten Carbide Material
Helps to reduce erosion and wear on PDC bit bodies

Optimal Shank Length
Reduces bit length for directional control

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Rockies: 20% Faster ROP and increased interval drilled

- Halliburton DBS 7 7/8” MM65H vs FX65
- Unitah County, Utah
- Drilled 31% more footage at a 20% increase in ROP over the same section
<table>
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<tr>
<th>FAMILY</th>
<th>CLASS</th>
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<th>BACKUP CUTTER (OPTIONAL)</th>
<th>CUTTER SIZE</th>
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<td>MM</td>
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<td>5</td>
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<td>M</td>
<td>H</td>
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**FAMILY | CLASS**

MegaForce™ Drill Bits

**APPLICATION PLATFORM (OPTIONAL)**

D = Directional (all other directional systems)
G = Geo-Pilot® Rotary Steerable
E = Geo-Pilot® EDL Rotary Steerable
T = Turbine High Rotational Speed

**BLADE COUNT**

The blade count indicates the number of blades on the bit.
3 = Three Blades
4 = Four Blades
5 = Five Blades
6 = Six Blades
7 = Seven Blades
8 = Eight Blades
9 = Nine Blades

**CUTTER SIZE**

The cutter size digit describes the size of the PDC cutters on the bit. On bits with multiple cutter sizes, the predominant size is indicated.
2 = 8 mm (3/8 in.)
3 = 10.5 mm (13/32 in.)
4 = 13 mm (1/2 in.)
5 = 16 mm (5/8 in.)
6 = 19 mm (3/4 in.)
8 = 25 mm (1 in.)

**BACKUP CUTTER (OPTIONAL)**

D = Dual Row Backup
M = Modified Diamond Round
R = R1™ Backup Cutters
I = Impreg Backup Discs
C = Carbide Impact Arrestor

**ADDITIONAL CUTTER OPTIONS**

H = Highly abrasive wear

**OPTIONAL FEATURES**

Not listed in nomenclature but found on marketing spec sheet. For more information, please contact your local Halliburton Drill Bits representative.
b = Back Reaming
c = Carbide Reinforcement
e = SE - Highly Spiraled
f = Full PDC Gauge Trimmers
k = Kerfing - Scribe Cutters
p = PDC Gauge Reinforcement
u = Updrill
DatCl℠ Process

GeoTech℠ Drill Bit

Industry’s Most Robust Matrix Body
Halliburton’s new GeoTech℠ series of fixed cutter PDC bits blends design theory with practical application-specific knowledge to produce custom-engineered matrix and steel body bits for optimal efficiency and performance—delivering you a truly optimized bit design.

Each GeoTech bit incorporates specific application experience with expert design science, including:

- Our rock-interaction analysis tool for predicting load and motion of a drill bit for multiple scenarios including rock chipping, bent motor, whirl, and more.

- Depth of cut control optimally positions cutting structure elements to smooth torque fluctuations, while a two-step cutter layout position improves performance when primary cutters wear or when drilling parameters change.

- GeoTech PDC cutter technology can significantly increase the amount of rock removed with less wear for higher average ROP and up to four times the footage of previous products.

- Improved hydraulics simulation leads to optimum hydraulic design, directing flow with little recirculation and eliminating stagnant zones to optimize bit cleaning and minimize erosion.

- Advanced materials include new matrix/binder materials, which increase durability and erosion resistance, enabling innovative steel-blade geometries and aggressive matrix body design.

DatCl℠ Process: The Most Effective Drill Bit Optimization Solution
Combining powerful design and simulation tools, and a global network of technical resources, the DatCl service platform uses direct customer input to rapidly optimize each GeoTech bit. Our global network of application design and evaluation (ADE) service specialists work directly with the customer to define specific bit solutions, drawing from a toolbox of the industry’s most sophisticated software systems for comprehensive planning, modeling and engineering—with real-time performance optimization capabilities.

That toolbox includes:

- IBit℠ patented and proprietary system for creating 3D bit designs anywhere using the latest bit dynamics modeling, including upgrades that better simulate cutting structures for specific applications.

- Enhanced hydraulics modeling that provides a more accurate bottom-hole pattern and allows quantitative analysis on cutter faces and through junk slots to minimize erosion.

- SPARTA℠ drilling optimization software with an advanced rock mechanics module to analyze formation properties and precisely define the drilling application.

- DrillingXpert simulation model that allows application and evaluation service specialist to quantify the impact of changes, recommend the best drill bit for the application and optimize bottom-hole assembly parameters to minimize vibration and enhance performance.
GeoTech™ Drill Bits

**APPLICATION PLATFORM (OPTIONAL)**
- D = Directional (all other directional systems)
- G = Geo-Pilot® Rotary Steerable
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- T = Turbine High Rotational Speed

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**OPTIONAL FEATURES**
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- k = Kerfing - Scribe Cutters
- p = PDC Gauge Reinforcement
- u = Updrill

**ADDITIONAL CUTTER OPTIONS**
- H = Highly abrasive wear
SteelForce™ Drill Bit

**Industry’s Most Advanced Steel Body Drill Bit**

Highest penetration rates. Lowest cost per foot. Application-specific designs. With the Halliburton SteelForce™ bit, slow ROP due to bit cleaning is history. Taking drill bit design to a higher level, the SteelForce bit features a large flow area, anti-balling treatment, premium hardfacing, and micro nozzles to get the right flow to the right place on the bit face. Coupled with our industry-unique DatCISM process performed by one of our ADESM service specialists, our application-specific SteelForce bits are the best performing steel body bits to overcome your specific drilling challenges.

**Premium Hardfacing**

K1 hardfacing is 100% more abrasion resistant, 30% more erosion resistant and includes tough carbide pellets making it virtually fracture proof

**Higher Blade Standoff**

Increases face volume for improved cuttings evacuation and higher rate of penetration

**SelectCutter™ PDC Technology**

Provides the highest level of abrasion resistance, impact resistance, and Thermal Mechanical Integrity available

**Anti-Balling Coating**

Helps keep shale cuttings from balling and sticking to the bit by producing an electronegative charge, which repels the negative ions in shale cuttings

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Oman: 87% Faster ROP Over Field Average

- Halliburton Drill Bits and Services 12 1/4” SF56
- Drilled entire section with 87% faster ROP over the field average
- Dull Condition 1-1-WT
### FAMILY | CLASS

SteelForce™ Drill Bits

### APPLICATION PLATFORM (OPTIONAL)

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- **9** = Nine Blades

### CUTTER SIZE

The cutter size digit describes the size of the PDC cutters on the bit. On bits with multiple cutter sizes, the predominant size is indicated.

- **2** = 8 mm (3/8 in.)
- **3** = 10.5 mm (13/32 in.)
- **4** = 13 mm (1/2 in.)
- **5** = 16 mm (5/8 in.)
- **6** = 19 mm (3/4 in.)
- **8** = 25 mm (1 in.)

### BACKUP CUTTER (OPTIONAL)

- **D** = Dual Row Backup
- **M** = Modified Diamond Round
- **R** = R1™ Backup Cutters
- **C** = Carbide Impact Arrestor

### ADDITIONAL CUTTER OPTIONS

- **H** = Highly abrasive wear

### OPTIONAL FEATURES

Not listed in nomenclature but found on marketing spec sheet. For more information, please contact your local Halliburton Drill Bits representative.

- **b** = Back Reaming
- **c** = Carbide Reinforcement
- **e** = SE - Highly Spiraled
- **f** = Full PDC Gauge Trimmers
- **k** = Kerfing - Scribe Cutters
- **p** = PDC Gauge Reinforcement
- **u** = Updrill
TurboForce™ Drill Bit

When applications become too abrasive for PDCs, TurboForce™ bits take over. TurboForce diamond-impregnated drill bits feature an improved bit stability through mass distribution, a new bridge design, increased diamond volume, and a proprietary wear indicator. These advanced features result in longer intervals drilled, enhanced versatility and reliability, plus a lower cost per foot. Using our industry-unique DatCISE™ process performed by one of our ADE™ service specialists, our application-specific TurboForce diamond-impregnated bits are the best to overcome your specific drilling challenges.

Mid-Con: First bit to complete the Bromide interval
- DBS 8 1/2” TF610D
- Saved 31.1% per foot
- Dull Condition 2-4WT-A-X-I-NO-TD

---

**Wear Indicator**
Precisely determines the bit condition, optimizing decisions for product usage

**Hydro-Dynamic Bridges**
Redirects fluid and boosts the cleaning and cooling of the cutting structure

**Mass Balancing**
Mass distribution calculation and balancing methods improve bit stability and negate underbalanced centrifugal forces

**Continuous Shoulder**
Increased diamond content further promotes bit stability and enables greater run length

**Advanced Active Gauge Geometry**
Reduces differential sticking, improving overall drilling efficiency
<table>
<thead>
<tr>
<th>FAMILY</th>
<th>CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TurboForce™ Drill Bits</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>APPLICATION PLATFORM (OPTIONAL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TF</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BLADE COUNT</th>
</tr>
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<tbody>
<tr>
<td>4</td>
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</table>

<table>
<thead>
<tr>
<th>ADDITIONAL CUTTER OPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
</tr>
</tbody>
</table>

The blade count describes the number of blades on the bit.

- 06 = Six Blades
- 08 = Eight Blades
- 09 = Nine Blades
- 10 = Ten Blades
- 11 = Eleven Blades
- 12 = Twelve Blades
- 14 = Fourteen Blades
- 15 = Fifteen Blades

S = Scribe Blocks
D = Drill Out Feature
Performance Technologies

Featured in our performance line of fixed cutter drill bits, our performance technologies deliver proven value worldwide.

X³ Series™ PDC Technology
Since 2008, X³ Series™ cutters have proven themselves over and over again as being high-performing, long-lasting cutters with high abrasion and impact resistance. Manufactured with new press technology, the X³ Series cutters have a high TMI value and can withstand the frictional heat generated during the drilling process while limiting heat build-up.

Refined Blade Geometry
To design the right bit for your application, our specialists utilize the DatCIS™ process and Halliburton's proprietary software to optimize cutter placement and hydraulic nozzles, and define blade geometry. The FX Series bits are more efficient at removing cuttings from underneath the bit through advances in manufacturing and design technology. These bits are created from a milled mold, enabling the FX Series Bits to have improved consistency and smoother drilling over hand formed molds used in previous generations of drill bits.
Performance Tungsten Carbide Matrix Material
With reduced bit body erosion, tungsten carbide matrix material increases the life of the bit.

Transverse Rupture Strength (TRS) is 18% higher in the current material as compared to the previous material.

The current carbide matrix material offers 50% more erosion resistance as compared to the previous material.

Premium Tungsten Carbide Matrix Material
Halliburton’s premium tungsten carbide matrix material offers a 20% improvement in erosion and wear resistance over our performance matrix material. This translates into maximum ROP by reducing the amount of cutting structure loss and enabling longer intervals to be drilled by preventing bit body damage.

Anti-Balling Technology
The SteelForce™ premium line features anti-balling technology, enabling for efficient drilling by maximizing the amount of cuttings removal. This patented anti-balling nitriding treatment creates a lubricating water barrier between the bit body and the drilling mud.

The nitriding treatment creates a negative electrical potential in the surface of the steel, repelling the negative ions in the mud and creating a lubricating water barrier.
FX Series™ Drill Bits

Proven Performers with over 100 Million Feet Drilled Worldwide

FX Series™ drill bits are custom designed to overcome tough drilling challenges in even the harshest environments. If reducing trip time is important to you, then an FX Series drill bit is the answer. Halliburton’s X³ Series™ cutter technology delivers a cutter that stays sharper, longer on a more erosion-resistant bit body. Ultimately, this means more footage drilled per bit and fewer trips for the operator.

X³ Series™ Cutter Technology
Enables the bit to drill farther and faster, because the cutters stay sharper, longer and are more durable under extreme drilling conditions

Refined Blade Geometry
Provides added stability

Performance Hydraulics
Improves cuttings removal and enables more efficient cooling

Superior Bit Body Hydraulics
Reduces bit body erosion, increasing the life of the bit

Brazil: Interbedded hard rock in Carauari formation

- Halliburton DBS 8 1/2” FXD74D drill bit
- Single Run on 740 m (2,828 ft)
- Average ROP of 5.8 m/hr (19 ft/hr)
- Outperformed all offsets in terms of both footage drilled and penetration rate
## Drill Bits and Services Solutions Catalog

### FAMILY | CLASS

**SteelForce™ Drill Bits**

### APPLICATION PLATFORM (OPTIONAL)

- **D** = Directional (all other directional systems)
- **G** = Geo-Pilot® Rotary Steerable
- **E** = Geo-Pilot® EDL Rotary Steerable
- **T** = Turbine High Rotational Speed

### BLADE COUNT

The blade count indicates the number of blades on the bit.

- **3** = Three Blades
- **4** = Four Blades
- **5** = Five Blades
- **6** = Six Blades
- **7** = Seven Blades
- **8** = Eight Blades
- **9** = Nine Blades

### CUTTER SIZE

The cutter size digit describes the size of the PDC cutters on the bit. On bits with multiple cutter sizes, the predominant size is indicated.

- **2** = 8 mm (3/8 in.)
- **3** = 10.5 mm (13/32 in.)
- **4** = 13 mm (1/2 in.)
- **5** = 16 mm (5/8 in.)
- **6** = 19 mm (3/4 in.)
- **8** = 25 mm (1 in.)

### BACKUP CUTTER (OPTIONAL)

- **D** = Dual Row Backup
- **M** = Modified Diamond Round
- **R** = R1™ Backup Cutters
- **C** = Carbide Impact Arrestor

### STEEL BODIED BITS

- **s** = Steel Bodied

### OPTIONAL FEATURES

- **b** = Back Reaming
- **c** = Carbide Reinforcement
- **e** = SE - Highly Spiraled
- **f** = Full PDC Gauge Trimmers
- **k** = Kerfing - Scribe Cutters
- **p** = PDC Gauge Reinforcement
- **u** = Updrill

---

Not listed in nomenclature but found on marketing spec sheet. For more information, please contact your local Halliburton Drill Bits representative.
**Fixed Cutter Bit Features**

Combining sophisticated design capabilities with the most advanced cutter technology, Halliburton Drill Bits & Services has created a series of PDC bit features to capture the benefits of durability and stability that are needed for any challenging application.

### APPLICATION PLATFORM

<table>
<thead>
<tr>
<th>Geo-Pilot® PDC Bit Design (G)</th>
<th>Turbine PDC Bit Design (T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Geo-Pilot® PDC bit uses a Modified Extended Gauge (MEG) sleeve to give the box connection and fulcrum point necessary for the Geo-Pilot® rotary steerable tool. The MEG sleeve gives consistent fulcrum point locations while maintaining a flow area from bit face to sleeve.</td>
<td>The Turbine PDC bit uses special cutter layouts and optimized Depth of Cut to give maximum ROP in high RPM applications. Bits can utilize sleeves and extended gauges for stability or specialized gauge designs for directional application.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Directional PDC Bit Design (D)</th>
<th>Geo-Pilot® EDL Bit Design (E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Directional PDC bit uses different gauge and cutting structure geometries calculated from Direction by Design® software to help ensure that adequate DLS and tool face can be achieved without sacrificing bit performance or life.</td>
<td>The Geo-Pilot® EDL PDC bit uses a standard point-the-bit cutting structure with a unique gauge design to enable high doglegs to be achieved.</td>
</tr>
</tbody>
</table>
BACKUP CUTTER

Dual Row Backup Cutters (D)
Use dual row SelectCutter™ or X³ Series™ cutters in highly abrasive conditions. Shows even wear.

Modified Diamond Reinforcement (M)
Modified diamond reinforcement (MDR) cutters can be used as a diamond “wear resistant” axial arrestor or to replace the R1 backup cutter to minimize cutter pocket wear and mitigate the progression of ring out.

Backup R1™ Cutters (R)
Use backup R1™ cutters when the application is highly interbedded with formations of significantly different rock strengths. Dull condition shows signs of cutter chippage in the nose and shoulder with surrounding cutters often having little to no wear.

Impreg Backup discs (i)
Use the “i” (synthetic diamond) backup cutter as a secondary cutter, enabling a dual-cutting action with PDC and as a reinforcement to extend bit life. Typical applications are intermediate hard/abrasive formations (interbedded or not), high RPM applications, and exploration wells.

ADDITIONAL CUTTER OPTIONS

Highly Abrasive Wear (H)
Use this feature to help ensure that highly abrasive formations can be delivered at the maximum ROP and can achieve the longest run.

Available on MegaForce™ and SteelForce™ bits only.
### Optional Features

<table>
<thead>
<tr>
<th><strong>Impact Arrestor and Carbide Impact Arrester (C)</strong></th>
<th><strong>Gauge Reinforcement (p)</strong> (Hex TSP, TSP, Dome PDC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use Impact arrestors and Carbide Impact Arrestors (CIA) when little wear is expected but impact damage is observed. Ensure DOC guidelines are used.</td>
<td>Use TSP gauge elements in all applications except where gauge pad wear is observed. When extreme wear is observed, use Hex TSP or Dome PDCs.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Back Reaming Feature (Updrill, Back Reaming, Hybrid)</strong></th>
<th><strong>Directional Gauge Features (Drop-In, Full PDC Round, Stepped)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Use back reaming cutters when hole conditioning is needed and the top of the gauge pad has wear. When key seats or cave-ins are observed then, use updrill cutters. When a combination of these events take place then, use a hybrid set of back reaming and updrill cutters.</td>
<td>The standard is one drop-in cutter per gauge pad. Based on Direction by Design® software, a more aggressive gauge might be required to achieve the DLS. In this case, increasingly use more drop-in cutters per gauge pad, full PDC round cutters along the gauge pad, or go to a stepped or undercut gauge pad as needed.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Kerfing – Scribe Cutters (k)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The scribe cutter is a unique shaped PDC cutter that puts a maximum energy point load into the formation where crushing and fracturing the formation is more advantageous than shearing. This shape ensures that maximum ROP and rock removal can be achieved.</td>
</tr>
</tbody>
</table>
Roller Cone Drill Bits
QuadPack® Plus Drill Bits
X Series™ Drill Bits
Roller Cone Technologies

Whether offshore drilling a 28-in. section or a slim hole application on land to reach TD, roller cone drill bits from Halliburton Drill Bits & Services provide solutions to customers globally. Whatever the drilling challenge: hard rock, highly interbedded, high chert content, high abrasion or high build rates, Halliburton DBS roller cone bits are designed to offer the best performance in the industry through coupling of the DatCIS™ process.

**Premium Bearing System**

8 1/2 to 28 in.
Available in sizes 8 1/2 to 28 in., the premium bearing uses two primary seals with a patented dual compensation system to extend bearing life. This dual system is a superior method for extending the life of the inner primary seal and reducing wear by preventing the intrusion of formation cuttings. Each primary seal has a dedicated reservoir to equalize pressure between them for maximum performance and life.

**Performance Bearings**

14 1/4 to 28 in.
Available in two configurations for 14 1/4 to 28 in. The performance bearing uses a primary seal along with an axial secondary seal as its bearing sealing system. The secondary seal works to protect the primary inner seal from cuttings debris and enables for pressure relief between the inner and axial seals. The premium bearing functions with a dedicated pressure compensation system.

4 3/8 to 13 3/4 in.
For bit sizes 4 3/8 to 13 3/4 in. the performance bearing uses a primary seal that exhibits greater thermal properties and wear resistance over its predecessor. The seal makes the performance bearing more effective in preventing contamination which extends bit life, resulting in better performance. A dedicated pressure compensation system which helps achieve pressure equalization across the bit is also used.
**Optimized Contact Pressure Seal**

By re-engineering the seal shape, we were able to deliver a 53% increase in seal reliability, a 24% reduction in torque friction, and a 16% decrease in temperature endured by the seal over the previous design. These achievements were accomplished by moving the highest contact pressures to the edge of the sealing interface where it is needed most. In turn, the lower contact pressures at the center of the sealing face reduce wear and frictional torque.

**Mechanical Pressure Compensator (MPC)**

The patented MPC is now available on all roller cone drill bits. The rubber diaphragm quickly equalizes the pressure on the inside and outside of the seals. This equalization greatly enhances the durability of the bearing and seal system by all reducing the seal stress.

**Energy Balanced® Bit Technology**

Only Halliburton DBS offers this patented feature, a cutting structure, which is balanced to equalized load and rock removal among all three cones. This is accomplished by optimizing cutter placement and analyzing the depth of cut on adjacent cutters. The result minimizes vibration which enhances the service life of sensitive instrumentation and equipment while increasing ROP and durability.

**SupremeTech™ Hardfacing**

Our patented SupremeTech™ Hardfacing treatment produces a material that is 73% more abrasion resistant compared to conventional hardfacing treatments. This abrasion resistance is achieved by using a novel low-binder, sintered-hipped tungsten carbide pellets. This helps maintain their super dense microstructure and superior roundness when compared to conventional hardfacing using high-binder, sintered tungsten carbide pellets.
QuadPack® Plus Engineered Hydraulic Bits

With the complexities and challenges of drilling in today’s environment, Halliburton Drill Bits & Services has developed a line of roller cone bits well suited for these applications. Through better durability and performance QuadPack® Plus drill bits are lowering operators cost per foot globally through increased durability and performance.

The QuadPack Plus design profile is focused on removing cuttings from crucial areas of the cutting structure and wellbore, accomplished by changing the arm geometry and directing the nozzles towards the leading edge of the cutting structure. This geometry change produces higher ROP and extends the bit life when compared to traditional arm profiles. QuadPack Plus bits are available in sizes 4 1/2 to 13 3/4 in.

- Increased Bearing Capacity
  An increase in main bearing length results in optimized load distribution over the main bearing extending bit life

- Forging Design
  The larger, more robust arm results in greater durability, improved protection and larger reservoir for increased grease capacity

- Greater Seal Reliability
  53% increase in seal reliability, a 24% reduction in torque friction, and a 16% decrease in temperature endured by the seal over the previous design

- More Responsive Pressure Compensation System
  Significantly reduces differential pressure variation on the seal

Ohio: Fastest ROP and lowest cost per foot
- Halliburton DBS 12 1/4 in. EQH26R drill bit
- Drilled 2,610 ft (795 m) in 26.5 hr
- ROP of 98.5 ft/hr (30 m/hr)
- Outdrilled the competitor on the same pad (20 ft away) in both footage and ROP

![Graph showing Ohio: Fastest ROP and lowest cost per foot data]
Energy Balanced® Bits

E = Energy Balanced® Bits

Family | Class

QH = QuadPack® Plus Engineered Hydraulics Bits (4 1/2 through 13-1/2 in.)

Cutting Structure (Prefix)

C = After Class Alpha for Claw Tooth on Steel Tooth Model
D = For Gauge/Face Diamond Insert on Insert Model

Cutting Structure

For Tooth Bits Single Numeric Variant From 1 to 7
For Insert Bits Dual Numeric Variant From 00 to 99

For more information, please contact your local Halliburton Drill Bits representative.

Optional Features

A = Air Application
C = Center Jet
D = Diamond Surf Row (33%)
D2 = Diamond Surf Row (50%)
D3 = Diamond Surf Row (100%)
G = Non-Standard Gauge Row
L = Lug Pads
LD = Diamond Insert Lug Pads

P = Protective Carbide Coating
R = Raised Enhanced Shirrtail / Arm Protection
S = Enhanced Shirrtail Protection
SD = Shirrtail Diamond – Enhanced Protection
RD = Shirrtail Diamond – Raised Protection
X Series™ Drill Bits

Our line of X Series™ roller cone bits include non-sealed and sealed roller bearing bits, typically in sizes larger than 13 1/2 in. Featuring greater seal reliability, these bits ensure maximum performance to meet challenging applications.

Increased Bearing Capacity
New bearing has increased load capacity with larger cross section seals for increased compression while maintaining similar contact pressure

Greater Seal Reliability
53% increase in seal reliability, a 24% reduction in torque friction, and a 16% decrease in temperature endured by the seal over the previous design

More Responsive Pressure Compensation System
Significantly reduces differential pressure variation on the seal

Saudi Arabia: Record ROP and Cost Per Foot

- Halliburton DBS 22” EBXT02S
- Drilled 1,855 ft (795 m) in 33 hr
- ROP of 53.2 ft/hr (30 m/hr)
- 25.4% improvement in ROP and reduction in cost per foot of 8% over the best competitor offset in the Shedgum field

![Graph showing ROP comparison]
**ENERGY BALANCED® BITS**

EB = Energy Balanced® Bits

**FAMILY | CLASS**

XN = Non Sealed Bearing
XT = Sealed Roller Bearing

**CUTTING STRUCTURE (PREFIX)**

C = After Class Alpha for Claw Tooth on Steel Tooth Model
D = For Gauge/Face Diamond Insert on Insert Model

**CUTTING STRUCTURE**

For Tooth Bits Single Numeric Variant From 1 to 7
For Insert Bits Dual Numeric Variant From 00 to 99

**OPTIONAL FEATURES**

For more information, please contact your local Halliburton Drill Bits representative.

- A = Air Application
- C = Center Jet
- D = Diamond Surf Row (33%)
- D2 = Diamond Surf Row (50%)
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- LD = Diamond Insert Lug Pads
- P = Protective Carbide Coating
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- S = Enhanced Shirrtail Protection
- SD = Shirrtail Diamond – Enhanced Protection
- RD = Shirrtail Diamond – Raised Protection
Roller Cone Bit Features

**CUTTING STRUCTURE**

*After Class Alpha for Claw Tooth on Steel Tooth Bits (C)*

The patented claw feature delays the typical wear pattern of the tooth, leaving a longer, sharper tooth for improved ROP and cutting structure life. Utilization of the “claw” increases the aggressiveness of the bit as the teeth wear.

*For Gauge/Face Diamond Insert on Insert Bits (D)*

Diamond enhanced gauge row insert protection for reduced gauge wear, high-quality wellbore and improved cutting structure performance.

**OPTIONAL FEATURES**

*Air Application (A)*

Center bore in bit for air drilling applications, which helps minimize the volume of drilling fluids needed for the full well and reduces the time that fluids are held in reserve pits.

*Center Jet (C)*

Center jet feature to enhance cone cleaning and hydraulic flow patterns, which helps prevent bit balling.
<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diamond Surf Row 33% (D)</strong></td>
<td>33% diamond surf protection improves resistance to impact damage and abrasive wear, which results in more protection for the bearing seal, extending bit life.</td>
</tr>
<tr>
<td><strong>Diamond Surf Row 50% (D2)</strong></td>
<td>50% diamond surf protection improves resistance to impact damage and abrasive wear, which results in more protection for the bearing seal, extending bit life.</td>
</tr>
<tr>
<td><strong>Diamond Surf Row 100% (D3)</strong></td>
<td>100% diamond surf protection improves resistance to impact damage and abrasive wear, which results in more protection for the bearing seal, extending bit life.</td>
</tr>
<tr>
<td><strong>Non-Standard Gauge Row (G)</strong></td>
<td>Tungsten carbide “surf” inserts in gauge teeth for added gauge protection.</td>
</tr>
<tr>
<td><strong>Lug Pads (L)</strong></td>
<td>Integral stabilizer pads for improved directional performance on steerable assemblies.</td>
</tr>
<tr>
<td><strong>Diamond Insert Lug Pads (LD)</strong></td>
<td>Diamond integral stabilizer pads for improved directional performance on steerable assemblies.</td>
</tr>
</tbody>
</table>
Protective Carbide Coating (P)
Thermal spray process (HVOF), using the X-Gun® sprayer, produces hard, dense tungsten carbide coatings for cutting structures that are resistant to abrasive wear and erosion.

Raised Enhanced Shirttail/Arm Protection (R)
Raised tungsten carbide inserts and proprietary hardfacing provides maximum arm protection in abrasive and directional applications.

Enhanced Shirttail/Arm Protection (S)
Shirttails protected with proprietary hardfacing and tungsten carbide inserts for maximum abrasion resistance.

Shirttail Diamond – Enhanced Protection (SD)
Diamond-enhanced inserts and tungsten carbide inserts protect shirttail for maximum abrasion resistance.

Shirttail Diamond – Raised Protection (RD)
Raised diamond-enhanced inserts and tungsten carbide inserts protect shirttail for maximum abrasion resistance.

X-Gun® is a registered trademark of GS Manufacturing
Coring Services
RockSwift™ System
Core Barrel Features
Preservation and Stabilization Services
Coring Technologies

Halliburton offers a full range of coring services from unconsolidated to ultrahard abrasive formations. With proven global performance of over 400 jobs performed each year, we have a 94% core recovery rate. We offer best-in-class core bit technology to maximize ROP and extend bit life.

Our on-site Design at the Customer Interface (DatCISM) process provides custom solutions to maximize core recovery. MaxBHA™ software analysis is performed for the coring BHA to provide additional information on drilling performance. We provide superior coring service quality to more than 170 customers in 47 countries to meet your coring objectives.

### Applications

| Tendency to Jam from Fractured Reservoir | RockStrong™ Coring System, Full Closure System, MaxBHA |
| Soft Friable or Unconsolidated, Expensive Rig Time | RockStrong, RockSwift™ Coring System, MaxBHA |
| Horizontal or High Angle | RockStrong, MaxBHA |
| High Pressure/High Temperature | RockStrong, RockSwift, MaxBHA |

### Solutions

| PDC Core Head | For Soft Formations |
| TSP Core Head | For Medium to Hard Formations |
| Diamond Impregnated Core Head | For Hard/Abrasive Formations |

---

## RockStrong™ Coring System

Designed specifically for high pressure, high temperature (HPHT) environments and hard, abrasive rock, the RockStrong™ coring system incorporates best-in-class corehead technology, anti-jamming design, and engineered vibration mitigation.

The RockStrong coring system features a unique swivel assembly, making it the most robust coring tool on the market. To date, it is the only system specifically designed for extreme wellbore environments. It is field proven to deliver high-quality core samples in the harshest conditions. The system was built to overcome ultra-deepwater coring issues and high vibration levels encountered in tight multi-layer formations.

### Tool Size

| Hole Size Compatibility | 5-7/8 in. x 7 in. | 6 in. x 8-1/2 in. | 8 in. x 9 in. | 10 7/8 in. x 12 1/4 in. |
| Core Barrel Size | 4-3/4 in. | 5-1/2 in. | 6-3/4 in. | 6-3/4 in. |
| Core Size | 2-5/8 in. | 3-1/4 in. | 4 in. | 4 in. |

---

### Ultra Stable Double Bearing Assembly

Ensures smooth core entry and reduces risk of damage to the core

### Anti-Jamming Features

Included a top spacer assembly which acts like a preloaded spring to absorb axial vibrations along the inner assembly

### Increased Space-Out Capacity

Withstands HPHT conditions

### Pre-Loaded Adjustment System

Reduces fatigue effects and extends the vibration level that can be sustained by the core barrel
**Heavy Duty Core Catcher**
Designed for coring medium-hard, hard-fractured, or interbedded formations. The spring catcher (*shown at right*) opens as the core enters. When the core barrel is lifted off the bottom, the spring catcher closes to break off the formation and retains it within the inner tube.

**Heavy Duty Threadform (patented)**
The Heavy Duty Threadform reduces thread damage and costly delays. It adds reliability in horizontal applications and enables longer core barrels to save trips and valuable rig time. The heavy duty buttress threads are double shouldered and flush internally and externally. They greatly increase tensile strength, flex capacity, torsional strength, and fatigue life compared with conventional threads. Its fatigue life is ten times greater than conventional types.

**The Hydro-Seat Barrel (HSB™) System**
The Hydro-Seat Barrel (HSB™) System, an optional feature, provides a clear and instantaneous indication on the rig floor if core jamming occurs. The floating, flexible barrel (*shown below*) is hydraulically seated, which means much less stress on the core at entry. Jamming lifts the inner barrel restricting mud flow, and increases the pressure reading at the surface.
RockSwift™ Coring System

The RockSwift™ wireline coring system enables operations to pull the core out of the hole by a wire while the core barrel remains downhole. The inner assembly containing the core is pulled, and as soon as the core is retrieved, an empty tube is dropped in and hydraulically kept inside the bore barrel, ready to complete the next core cut.

A drill plug can alternatively replace the removable tube to fill the corehead with a cutting structure to drill towards the next core point.

RockSwift™ coring system comes in a variety of tool sizes with different hole size capabilities to.

<table>
<thead>
<tr>
<th></th>
<th>Latch Les™ 4-3/4 in. x 1.713 in.</th>
<th>Latch Les™ Triple Tube 6-3/4 in. x 2.02 in.</th>
<th>RockSwift 6-3/4 in. x 3 in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hole Size Capabilities</td>
<td>5-7/8 in. - 7 in.</td>
<td>8 in. - 9 in.</td>
<td>8 in. - 9 in.</td>
</tr>
<tr>
<td>Core Size</td>
<td>1.713 in.</td>
<td>2.02 in.</td>
<td>3 in.</td>
</tr>
<tr>
<td>Recommended Drill String Drift Diameter</td>
<td>2-1/4 in.</td>
<td>2-13/16 in.</td>
<td>4-1/8 in.</td>
</tr>
</tbody>
</table>

Poland: Fast Recovery for Accurate Gas-in-Place Measurement

- Halliburton DBS 3-in. RockSwift™ wireline coring system with 8-1/2 in. x 3 in. FC3643 PDC core head
- Cut 820 ft (250 m) in 29 runs with a single core head
- 100% core recovery
Core Barrel Features

**FCS™ (Full Closure System)**
FCS™ system is ideal for soft, unconsolidated formations. A hydraulic collapsing sleeve minimizes mechanical parts and increases reliability.

Full Closure System is a parallel concept of core catcher that enables an efficient recovery of soft to highly unconsolidated cores. The FCS system is available as a conversion kit to the Conventional Barrel and consists of two main assemblies: the FCS Inner Tube Plug that is assembled to the Conventional Swivel and the FCS Collapsing Shoe that is fitted located at the top of the conventional lower half shoe containing the core catcher. An additional Activation Sub is finally fitted around the FCS Collapsing Shoe to create a TFA restriction upon request which will bring the latter to collapse around the core foot.

The FCS is hydraulically activated by a drop ball and is fully compatible with Halliburton DBS Conventional Coring equipment.

**Glider™ System**
The Glider™ system provides a layer of lubricating non-reactive fluid between the core and inner tube to prevent jamming and protect the core from the drilling mud.

**PosiClose™ System**
The PosiClose™ system also maximizes core recovery in soft formations. Unrestricted entry eliminates jamming from premature catcher/core contact.

The catcher system fully closes to ensure complete retention throughout retrieval.
Preservation and Stabilization Services

**Inner Tube Alignment Device** prevents core damage from rotating and flexing of inner tubes, while separating the inner tubes prior to laydown.

**Plug Taker** cuts core samples to aid on-site operating decisions or to ship them to the laboratory for further analysis. Operators can also take plugs at the surface to prevent further diffusion, and with trimming, provide the laboratory an inner plug untouched by drilling fluids, which prevents alternation.

**Foam Coring Preservation** provides complete core stabilization in a fast and reliable system that ensures sample integrity while facilitating ease of handling. Cores are immediately protected and preserved in-situ, eliminating potential damage and ensuring quality analysis.

**Special Shipping Baskets** can be spring-loaded to protect cores during transport. The basket can ship full length cores, the preference of some laboratories.

**Power Saw** cuts fiberglass or aluminum inner tubes into three foot sections, if requested by the customer. The blade is normally diamond tipped, and the saw pneumatic depending on the rig location. The box’s safety housing offers an open top for access.

**Lay-down Cradle** protects against bending and impact damage. The cradle is equipped with rollers.

**Core Gamma Logger (CGL)** provides on-site analysis for gamma ray logs. It enables real-time decisions on further coring, testing, or completions by correlating cored sections with anticipated lithology, delineating shale from non-shale sections. The CGL is portable and works vertically on the rig floor or horizontally on the catwalk.
Hole Enlargement Tools

XR™ Reamer
TDReam™ Tool
NBR® Near Bit Reamer
UR™ UnderReamer
Single Piece Hole Opener
Hole Enlargement Tools

Halliburton DBS offers high-performance downhole tools for hole enlargement, torque reduction, and drag resistance improvement needs.

Halliburton’s hole enlargement solutions can help solve your challenges whether you are using a rotary steerable BHA, a steerable motor BHA, or a conventional rotary drilling system. We offer innovative drilling technologies to mitigate drillstring vibration during hole enlargement.

Hole enlargement technologies

<table>
<thead>
<tr>
<th>Cutting Structures</th>
<th>Solutions</th>
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<tr>
<td><strong>TDReam™ and NBR® Pistons</strong></td>
<td>XR™, TDReam™, SPHO</td>
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<tr>
<td>The NBR® tool features dome PDC cutters, which help prevent cutters from damaging the casing if pistons are released inadvertently within the casing shoe.</td>
<td>XR™, NBR®, UR™, SPHO</td>
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Standard arms for soft applications have a single row of PDC cutters on our hole enlargement tools.

Two rows of PDC cutters are used for medium to hard applications.

Three rows of PDC cutters are for hard/abrasive applications, made with reinforced hardfacing.

XR™ Reamer Arms

With dedicated cutter arm sets for each hole opening size, the XR™ Reamer can increase hole size up to 1.5 times the pilot hole diameter.

Drilling loads are broadly distributed across the body and arm geometries so that vibrations are greatly reduced. The XR Reamer autoblocking technology assures the arms are open at all times while WOB is applied.
**UR™ Tool Arms**
The largest in the market in terms of enlargement capability, the tool is specifically designed for gravel packing, and coalbed methane and gas storage applications where enlarged hole size is critical for optimizing well production.

For medium to hard formations, interbedded with hard layers, the cutter structure is comprised of PDC cutters backed up with diamond impregnated disks.

For hard/abrasive formations, a fully diamond impregnated cutting structure is used.

**Operating Principles**

**XR™ Reamer**
XR Reamer is ball-drop activated. When the ball seats, a pressure differential is seen at the shear pin, and the arms are activated. This pressure differential can be seen at surface, indicating that the tool has moved into the active state. A second ball is then dropped to deactivate the arms.

**NBR® Tool**
The NBR® tool operates solely on hydraulic bore pressure (*shown below, top*). A minimal increase in internal pressure acts on the flanges, breaks the shear pin, and then forces the pistons to move radially. Return springs close the pistons when flow decreases.

**UR™ Tool Arms**
Hydraulic force activates the cutter arms on the UR™ tool (*shown right, bottom*). With the pumps off, a return spring closes the arms. There is no locking device. A rack-and-pinion mechanism transmits the drive rod motion to open the arms, and then stop blocks enable two different arm opening angles, 90° and 35°.

**Single Piece Hole Opener (SPHO)**
The SPHO cutting structure is designed, using force and torque balancing technology.

The cutting structure can be customized as needed to fit the application.
XR™ Reamer Hole Enlargement Tool

Quality Hole Enlargement While Drilling
The XR™ Reamer is the only tool capable of enlargement up to 1.5 times the pilot hole or drift diameter. The tool provides dependable hole enlargement while minimizing BHA vibration. The XR Reamer is proven in high-angle, extended-reach applications where it minimizes downhole vibration resulting in reliable performance, even in challenging environments.

A self-stabilized body is one of many technological features embedded in the XR Reamer. Besides minimizing BHA whirl, the technology produces a quality enlarged wellbore and extends drill string component life.

The XR Reamer autoblocking technology uses the dynamic and fully automated blocking to assure the arms are open at all times while WOB is applied. This mechanism has been chosen, because in expandable enlargement applications any physical locking open feature may expose the customer to the risk of losing the entire BHA due to the mechanical lock’s failure to disengage. This feature provides improved service quality for the customer.

Norway: World Record in Reservoir Section
- Halliburton XR800 tool with 9-in. arms
- Successful reaming to a total depth of 6353 m (20,876 ft)
- The 4297-m (14,098-ft) long section was opened in one run
- The XR800 set a world record for the longest expandable hole enlargement run in a reservoir section.
**TDReam™ Tool**

In a traditional reaming-while-drilling BHA, the reamer is placed above the RSS and LWD tools, creating a long rathole and requiring an extra trip to enlarge the hole to total depth (TD). Challenged to design a tool to increase efficiency, Halliburton has responded with a solution that has the added benefits of reducing operational risk in addition to saving time and money. Run in conjunction with the XR™ Reamer, the TDReam™ tool is Halliburton’s newest downhole innovation designed to significantly reduce rathole length and reach TD in one run.

- **No Locking Devices**
  To prevent pistons from inadvertently locking in the open position, the return springs close the arms when the flow decreases.

- **Selectable Activation**
  Selectable hydraulic activation or ball assisted hydraulic activation module – the latter for pump pressure or ECD restricted applications.

- **Shear Pin**
  Prevents tool activation while drilling out shoe track.

- **Balanced Concentric Design**
  Substantially reduces BHA vibration compared with eccentric tools of bi-center bits, improving steerability and stability.

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**Norway: Successfully enlarged wellbore from 12 1/4 in. to 13 1/2 in.**

- Halliburton TDR1200 tool in combination with the XR™ Reamer delivers a one-trip solution for borehole enlargement to TD.
- Successfully enlarged the rathole to enable the running of a 10 3/4-in. casing to TD
- Estimated cost savings of $300,000 in rig time alone for the operator
NBR® (Near Bit Reamer) Tool

The NBR® tool has borehole enlargement capabilities up to 1.2 times the pilot hole diameter. The tool is a concentric expandable reamer, which is engineered to run between the downhole motor and above the drill bit. Due to its robustness and limited moving parts, the NBR tool is the most reliable tool on the market.

The NBR tool's concentric technology substantially reduces BHA vibration compared to eccentric tools or bi-center bits, improving steerability and stability. The greater stability of the NBR tool helps ensure a gauged hole.

Gulf of Mexico: Outstanding Product Performance

- Halliburton NBR 800 tool
- Successfully enlarged the entire section of the well in a single run with excellent directional control
- Estimated cost savings of $59,000 in rig time alone for the customer, by eliminating a trip to pick up a second enlargement tool
**UR™ (UnderReamer) Tool**

The UR™ tool is a heavy-duty tool for enlarging the borehole up to two times the pilot hole diameter. It offers a variety of completion options, since it can be selectively activated or deactivated downhole.

The UR tool can be used for production enhancement applications, expanding the hole for gravel packing, scraping filter cake, plus underground gas storage applications.

**Australia: Successful under reaming of 450 m (1,476 ft) of coal**

- Halliburton UR 800 tool
- Reaming of the 8 3/4-in. pilot hole to 12 1/4 in. was successfully conducted to 1100 m
- Rate of penetration of 40 m/hr
- The UR 800 tool successfully under reams 450 m (1,476 ft) of coal in a Coal Seam Gas well.
Single Piece Hole Opener (SPHO)

The SPHO is an enhanced version of a PDC concentric hole opener. During or after drilling, the SPHO enlarges the pilot hole. The SPHO features an optimized cutting structure, single piece construction, a self-stabilized body, and interchangeable nozzles.

- **Optimized Cutting Structure**: Designed using force and torque balancing technology.
- **Self-Body Stabilization**: Is integrated with the tool so that no extra stabilization is required when the SPHO is added to the BHA.
- **Interchangeable Nozzles at Arm Level**: Provide cooling and cleaning of cutter arms.
- **Single Piece Structure**: Milled from a single steel bar; heat treatment is used to make sure the material has proper hardness and structural integrity.
Resources

API Casing Dimensions

Recommended Make-Up Torque

API Tolerances and TFA Values

IADC Dull Grading

Roller Cone Ring Gauging

Local Representatives
### API Casing Dimensions

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<th>CASING SIZE</th>
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# API Casing Dimensions

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### RECOMMENDED MAKE-UP TORQUE–FIXED CUTTER BITS

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<td>3</td>
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<td>4-1/2 (I.F. Box)</td>
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<td>7-3/4</td>
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<td>9-1/2</td>
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<td>7-5/8 (API Reg.)</td>
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<td>8-1/2</td>
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<td>8-3/4</td>
<td>48,321*</td>
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<td>9</td>
<td>57,735*</td>
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<tr>
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<td>9-1/4</td>
<td>63,824</td>
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<td></td>
<td>9-1/2</td>
<td>64,318</td>
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</tr>
<tr>
<td>8-5/8 (API Reg.)</td>
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<td>9-3/4</td>
<td>64,813</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>97,229</td>
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<td>10-1/4</td>
<td>98,012</td>
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<td>10-1/2</td>
<td>98,725</td>
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<td>99,437</td>
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</table>

### RECOMMEND MAKE-UP TORQUE–ROLLER CONE BITS*

<table>
<thead>
<tr>
<th>BIT SIZE IN.</th>
<th>TOOL-JOINT TYPE IN.</th>
<th>RECOMMENDED TORQUE FT/LBS</th>
<th>Joules</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-3/4</td>
<td>2-7/8</td>
<td>4500/5500</td>
<td>6102/7458</td>
</tr>
<tr>
<td>5-7/8 to 7-3/8</td>
<td>3-1/2</td>
<td>7000/9000</td>
<td>9492/12204</td>
</tr>
<tr>
<td>7-5/8 to 8-3/4</td>
<td>4-1/2</td>
<td>12000/16000</td>
<td>16272/21696</td>
</tr>
<tr>
<td>9-1/2 to 13-3/4</td>
<td>6-5/8</td>
<td>28000/32000</td>
<td>37968/43392</td>
</tr>
<tr>
<td>14-3/4 to 28</td>
<td>7-5/8</td>
<td>34000/40000</td>
<td>48104/54240</td>
</tr>
</tbody>
</table>

*Calculations based on recommendations from API and tool joint manufacturers.

NOTE: The tool joint type for the 14-3/4 to 17-1/2 in. rock bit range is either 6-5/8 or 7-5/8 in. per API Reg.
## API Tolerances and TFA Values

### API Standard Roller Cone Bit Tolerances

<table>
<thead>
<tr>
<th>BIT SIZE (IN.)</th>
<th>O.D. TOLERANCE (IN.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-3/4 and smaller</td>
<td>-0.0 to +1/32</td>
</tr>
<tr>
<td>6-25/32 to 9</td>
<td>-0.0 to +1/32</td>
</tr>
<tr>
<td>9-1/32 to 13-3/4</td>
<td>-0.0 to +1/32</td>
</tr>
<tr>
<td>13-25/32 to 17-1/2</td>
<td>-0.0 to +1/16</td>
</tr>
<tr>
<td>17-17/32 and larger</td>
<td>-0.0 to +3/32</td>
</tr>
</tbody>
</table>

### API Standard Fixed Cutter Bit Tolerances

<table>
<thead>
<tr>
<th>BIT SIZE (IN.)</th>
<th>O.D. TOLERANCE (IN.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-3/4 and smaller</td>
<td>-0.015 to +0.00</td>
</tr>
<tr>
<td>6-25/32 to 9</td>
<td>-0.020 to +0.00</td>
</tr>
<tr>
<td>9-1/32 to 13-3/4</td>
<td>-0.030 to +0.00</td>
</tr>
<tr>
<td>13-25/32 to 17-1/2</td>
<td>-0.045 to +0.00</td>
</tr>
<tr>
<td>17-17/32 and larger</td>
<td>-0.063 to +0.00</td>
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</table>

### TFA Values of Common Nozzle Sizes

<table>
<thead>
<tr>
<th>NOZZLE SIZE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>IN.</td>
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<td>0.0752</td>
<td>0.1128</td>
<td>0.1504</td>
<td>0.1880</td>
<td>0.2256</td>
<td>0.2632</td>
<td>0.3007</td>
<td>0.3382</td>
<td>0.3758</td>
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<tr>
<td>7/32</td>
<td>0.0491</td>
<td>0.0982</td>
<td>0.1473</td>
<td>1.1964</td>
<td>0.2455</td>
<td>0.2946</td>
<td>0.3437</td>
<td>0.3927</td>
<td>0.4418</td>
<td>0.4909</td>
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<tr>
<td>8/32</td>
<td>0.0621</td>
<td>0.1242</td>
<td>0.1863</td>
<td>0.2484</td>
<td>0.3105</td>
<td>0.3728</td>
<td>0.4349</td>
<td>0.4970</td>
<td>0.6591</td>
<td>0.6213</td>
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<tr>
<td>9/32</td>
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<td>0.2301</td>
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<td>0.3835</td>
<td>0.4602</td>
<td>0.5369</td>
<td>0.6136</td>
<td>0.6903</td>
<td>0.7670</td>
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<td>0.4640</td>
<td>0.5668</td>
<td>0.6496</td>
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<td>0.8353</td>
<td>0.9281</td>
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<tr>
<td>11/32</td>
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<td>0.5522</td>
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<td>0.9940</td>
<td>1.1045</td>
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<tr>
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<td>0.7776</td>
<td>0.9072</td>
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<td>0.9020</td>
<td>1.0523</td>
<td>1.2026</td>
<td>1.3530</td>
<td>1.5033</td>
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<td>0.8630</td>
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<tr>
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<td>0.6650</td>
<td>0.8866</td>
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<td>1.3300</td>
<td>1.5516</td>
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<td>18/32</td>
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<td>1.3845</td>
<td>1.6614</td>
<td>1.9382</td>
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<td>3.3824</td>
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<td>4.8106</td>
<td>5.4119</td>
<td>6.0132</td>
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</table>
IADC Dull Grading

### Cutting Structure

<table>
<thead>
<tr>
<th>INNER ROWS</th>
<th>OUTER ROWS</th>
<th>DULL CHAR.</th>
<th>LOCATION</th>
<th>BEARINGS/ SEALS</th>
<th>GAUGE</th>
<th>OTHER DULL CHAR.</th>
<th>REASON PULLED</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>X</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

#### 1 Inner Cutting Structure

#### 2 Outer Cutting Structure

A measure of lost, worn, and/or broken cutting structure.
Linear Scale: 0-8
- **0** - No lost, worn and/or broken cutting structure
- **8** - All of cutting structure lost, worn and/or broken

#### 3 Dull Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BF</td>
<td>Bond Failure</td>
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<tr>
<td>BT</td>
<td>Broken Cutters</td>
</tr>
<tr>
<td>BU</td>
<td>Ballsed Up</td>
</tr>
<tr>
<td>CR</td>
<td>Cored</td>
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<tr>
<td>CT</td>
<td>Chipped Cutters</td>
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<tr>
<td>DL</td>
<td>Delaminated Cutters</td>
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<td>ER</td>
<td>Erosion</td>
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<tr>
<td>HC</td>
<td>Heat Checking</td>
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<td>JD</td>
<td>Junk Damage</td>
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<tr>
<td>LM</td>
<td>Lost Matrix</td>
</tr>
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<td>LN</td>
<td>Lost Nozzle</td>
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<tr>
<td>LT</td>
<td>Lost Cutters</td>
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<tr>
<td>NO</td>
<td>No Dull Characteristics</td>
</tr>
<tr>
<td>NR</td>
<td>Not Rerunnable</td>
</tr>
<tr>
<td>PN</td>
<td>Plugged Nozzle/Flow Passage</td>
</tr>
<tr>
<td>RO</td>
<td>Ring Out</td>
</tr>
<tr>
<td>RR</td>
<td>Rerunnable</td>
</tr>
<tr>
<td>WO</td>
<td>Washed Out</td>
</tr>
<tr>
<td>WT</td>
<td>Worn Cutters</td>
</tr>
</tbody>
</table>

#### 4 Location

- **C** - Cone
- **S** - Shoulder
- **N** - Nose
- **G** - Gauge
- **T** - Taper
- **A** - All Areas

#### 5 Bearings/Seals

- N/A

#### 6 Gauge

- **I** - In Gauge
- **1** - 1/16” Out of Gauge
- **2** - 1/8” Out of Gauge
- **4** - 1/4” Out of Gauge

#### 7 Other Dull Characteristics

(Refer to column 3 codes)

#### 8 Reason Pulled or Run Terminated

- **BHA** - Change Bottom Hole Assembly
- **CM** - Condition Mud
- **CP** - Core Point
- **DMF** - Downhole Motor Failure
- **DP** - Drill Plug
- **DSF** - Drill String Failure
- **DST** - Drill Stem Test
- **DTF** - Down Hole Tool Failure
- **FM** - Formation Change
- **HP** - Hole Problems
- **HR** - Hours on Bit
- **LH** - Left in Hole
- **LOG** - Run Logs
- **PP** - Pump Pressure
- **PR** - Penetration Rate
- **RIG** - Rig Repair
- **TD** - Total Depth/Casing Depth
- **TQ** - Torque
- **TW** - Twist Off
- **WC** - Weather Conditions
- **WO** - Washout in Drill String

Halliburton's fixed cutter bits are tip ground to exacting tolerances at gauge O.D. per API spec 7. Depending on the specific design and application, as much as .080 of an inch of the cutter diameter may be ground flat. This can be mistaken for gauge wear if unfamiliar with our products. Please ensure that the dull bits are in gauge with a calibrated No Go ring gauge.
# IADC Dull Grading

## Cutting Structure

<table>
<thead>
<tr>
<th>Inner Rows</th>
<th>Outer Rows</th>
<th>Dull Char.</th>
<th>Location</th>
<th>Bearings/Seals</th>
<th>Gauge</th>
<th>Other Dull Char.</th>
<th>Reason Pulled</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>X</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

### Inner Cutting Structure
- All inner rows

### Outer Cutting Structure
- (Gauge row only)
- In columns 1 and 2, a linear scale from 0 to 8 is used to describe the condition of the cutting structure according to the following:

#### Steel Tooth Bits
- A measure of lost tooth height due to abrasion and/or damage.
- 0 - No loss of tooth height
- 8 - Total loss of tooth height

#### Insert Bits
- A measure of total cutting structure reduction due to lost, worn and/or broken inserts.
- 0 - No lost, worn and/or broken inserts
- 8 - All inserts lost, worn and/or broken

### Dull Characteristics
- (Use only cutting structure related codes)

<table>
<thead>
<tr>
<th>BC - Broken Cone*</th>
<th>LT - Lost Teeth</th>
<th>NO - No Dull Characteristic</th>
<th>NR - Not Rerunnable</th>
<th>OC - Off Center Wear</th>
<th>PB - Pinched Bit</th>
<th>PN - Plugged Nozzle/Flow Passage</th>
<th>RG - Rounded Gauge</th>
<th>RO - Ring Out</th>
<th>RR - Rerunnable</th>
<th>SD - Shirkil Damage</th>
<th>SS - Self-Sharpening Wear</th>
<th>TR -Tracking</th>
<th>TD - Total Depth/Casing Depth</th>
<th>TQ - Torque</th>
<th>WC - Weather Conditions</th>
<th>WT - Worn Teeth</th>
</tr>
</thead>
<tbody>
<tr>
<td>BT - Broken Teeth</td>
<td></td>
<td></td>
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<tr>
<td>BU - Balled Up</td>
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<tr>
<td>CC - Cracked Cone*</td>
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<td>CD - Cone Dragged*</td>
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<td>CI - Cone Interference</td>
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<td>CR - Cored</td>
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<td>CT - Chipped Teeth</td>
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<td>ER - Erosion</td>
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<td>FC - Flat Crested Wear</td>
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<tr>
<td>HC - Heat Checking</td>
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<tr>
<td>JD - Junk Damage</td>
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<tr>
<td>LC - Lost Cone*</td>
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<td>LN - Lost Nozzle</td>
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</tbody>
</table>

### Location
- C - Cone
- S - Shoulder
- N - Nose
- G - Gauge
- T - Taper
- A - All Areas

### Bearings/Seals
- Non-Sealed Bearings
- A linear scale estimating bearing life used.
- 0 - No life used
- 8 - All life used, i.e. no bearing life remaining

#### Sealed Bearings
- E - Seals Effective
- F - Seals Failed
- N - Not Able To Grade

### Gauge
- (Measure in fractions of an inch)
- I - In Gauge
- 0 - 1/16” Out of Gauge
- 2 - 1/8” Out of Gauge
- 4 - 1/4” Out of Gauge

### Other Dull Characteristics
- (Refer to Column 3 codes)

### Reason Pulled or Run Terminated
- BHA - Change Bottom Hole Assembly
- CM - Condition Mud
- CP - Core Point
- DMF - Downhole Motor Failure
- DP - Drill Plug
- DSF - Drill String Failure
- DST - Drill Stem Test
- DTF - Downhole Tool Failure
- FM - Formation Change
- HP - Hole Problems
- HR - Hours on Bit
- LIH - Left In Hole
- LOG - Run Logs
- PP - Pump Pressure
- PR - Penetration Rate
- RIG - Rig Repair
- TD - Total Depth/Casing Depth
- TQ - Torque
- TW - Twist Off
- WC - Weather Conditions
- WO - Washout in Drill String

### Cutting Structure Wear

* Show cone # or #’s under location 4.

- Cone numbers are identified as follows:
  - The number one cone contains the center most cutting element.
  - Cones two and three follow in a clockwise orientation as viewed looking down at the cutting structure with the bit sitting on the pin.
Roller Cone Ring Gauging

**Dull Three Cone Bits**

1. Obtain a nominal size ring gauge. A nominal ring gauge is one that is exact in size. For example, a 12-1/4-in. ring gauge is 12-1/4-in. exactly.

2. Rotate all cones so that one of the gauge teeth on each cone is at the maximum gauge point.* (Remember, soft formation bits with large offsets have the maximum gauge points on each cone located towards the leading side of the cone).

3. Place the ring gauge over the bit and locate it at the maximum gauge point.

4. Pull the ring gauge tight against the gauge points of two cones as shown.

5. Measure the gap between the third cone's gauge point and the ring gauge.**

6. Multiply this measurement by 2/3 for accuracy. This result is the amount the bit is under gauge. In the illustration, for example, measurement shows 3/8-in., while the bit is actually 1/4-in. out of gauge.

7. Report this amount to the nearest 1/16th of an inch.

**Sharp Bits**

1. When ring gauging a sharp (new) roller cone bit, a nominal ring gauge might not fit over the cones due to the “plus” tolerances. Obtain the appropriate Go and No Go gauges for each bit size.

2. The Go gauge is manufactured to the maximum roller cone bit tolerance (see API Standard Roller Cone Rock Bit Tolerances) plus its own tolerance +.003 to -0 in. for clearance.

3. The No Go gauge is manufactured to the minimum roller cone bit tolerance, which is nominal bit diameter, plus its own tolerance +0- to -.003-in.
# Local Representatives

## North America

<table>
<thead>
<tr>
<th>United States</th>
<th>Oklahoma City, OK</th>
<th>TEL: +405-231-1800</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bakersfield, CA</td>
<td>TEL: +1-661-391-5311</td>
</tr>
<tr>
<td></td>
<td>Bossier, LA</td>
<td>TEL: +1-318-459-2863</td>
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<td>Broussard, LA</td>
<td>TEL: +1-337-837-1892</td>
</tr>
<tr>
<td></td>
<td>Canonsburg, PA</td>
<td>TEL: +1-724-743-8100</td>
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<tr>
<td></td>
<td>Carmichaels, PA</td>
<td>TEL: +1-724-743-8100</td>
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<tr>
<td></td>
<td>Denver, CO</td>
<td>TEL: +1-303-308-4200</td>
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<tr>
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<td>Fort Worth, TX</td>
<td>TEL: +1-817-333-1143</td>
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<tr>
<td></td>
<td>Grand Junction, CO</td>
<td>TEL: +1-970-523-3900</td>
</tr>
<tr>
<td></td>
<td>Houston, TX</td>
<td>TEL: +1-281-871-6170</td>
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<tr>
<td></td>
<td>Lafayette, LA</td>
<td>TEL: +1-337-572-4774</td>
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<tr>
<td></td>
<td>Midland, TX</td>
<td>TEL: +1-432-682-4305</td>
</tr>
<tr>
<td></td>
<td>Muncy, PA</td>
<td>TEL: +1-724-743-8100</td>
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## Latin America

<table>
<thead>
<tr>
<th>Argentina</th>
<th>Buenos Aires</th>
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<tbody>
<tr>
<td>Bolivia</td>
<td>Santa Cruz</td>
<td>TEL: +591 3 3127700</td>
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<tr>
<td>Brazil</td>
<td>Centro Rio de Janeiro</td>
<td>TEL: +55 21 39740000</td>
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<tr>
<td>Colombia</td>
<td>Bogota</td>
<td>TEL: +57 1 32640000</td>
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<tr>
<td>Ecuador</td>
<td>Quito</td>
<td>TEL: +593 2 3971700</td>
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<tr>
<td>Mexico</td>
<td>Cuidad del Carmen</td>
<td>TEL: +52 93838111800</td>
</tr>
<tr>
<td>Peru</td>
<td>Lima</td>
<td>TEL: +51 1 6277722</td>
</tr>
<tr>
<td>Trinidad/Suriname</td>
<td>San Fernando, Trinidad</td>
<td>TEL: +868 2990985</td>
</tr>
<tr>
<td>Venezuela</td>
<td>Maturin</td>
<td>TEL: +58 291 3002000</td>
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## Europe

<table>
<thead>
<tr>
<th>Belgium</th>
<th>Brussels</th>
<th>TEL: +32 2 333 3522</th>
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<tbody>
<tr>
<td>Denmark</td>
<td>Esbjerg</td>
<td>TEL: +45 7914 54000</td>
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<tr>
<td>England</td>
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<tr>
<td>Germany</td>
<td>Celle</td>
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<tr>
<td>Holland</td>
<td>Ijmuiden</td>
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<tr>
<td>Italy</td>
<td>Ortona</td>
<td>TEL: +39085903361</td>
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<tr>
<td>Norway</td>
<td>Bergen</td>
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## Africa

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<tr>
<th>Algeria</th>
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<tr>
<td>Angola</td>
<td>Luanda</td>
<td>TEL: +244 935148974</td>
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<tr>
<td>Egypt</td>
<td>Cairo</td>
<td>TEL: +202 2759 1000</td>
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<tr>
<td>Gabon</td>
<td>Port Gentil</td>
<td>TEL: +244 222695200</td>
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<td>Ghana</td>
<td>Accra</td>
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<tr>
<td>Mozambique</td>
<td>Pemba</td>
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<td>Tanzania</td>
<td>Dar Es Salaam</td>
<td>TEL: +244 1224 756910</td>
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<tr>
<td>Uganda</td>
<td>Kampala</td>
<td>TEL: +244 1224 756910</td>
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</tbody>
</table>
## Local Representatives

### Middle East
- **BAHRAIN**
  - Manama
  - TEL: +966 3 8389999
- **IRAQ**
  - Basra
  - TEL: +971 42374562
- **ISRAEL**
  - Herzliya
  - TEL: +971 42374562
- **KUWAIT**
  - Ahmadi
  - TEL: +965 25458000
- **oman**
  - Muscat
  - TEL: +968 24623401
- **PAKISTAN**
  - Islamabad
  - TEL: +925 18461000
- **QATAR**
  - Doha
  - TEL: +971 44234777
- **SAUDI ARABIA**
  - Al Khobar
  - TEL: +966 3 8389999
- **UNITED ARAB EMIRATES**
  - Abu Dhabi
  - TEL: +971 26942222
  - Dubai
  - TEL: +971 4 3310666
- **YEMEN**
  - Sana’a
  - TEL: +971 26942222

### Eurasia
- **AZERBAIJAN**
  - Baku
  - TEL: +994 12 5980914
- **RUSSIA**
  - Moscow
  - TEL: +7 495 7558300
  - Nizhnevartovsk
  - TEL: +7 3466 292400

### Asia
- **CHINA**
  - Beijing
  - TEL: +86 10 59247000
  - Karamay
  - TEL: +86 990 6881745
- **INDIA**
  - Mumbai
  - TEL: +91 2267809500
- **INDONESIA**
  - Jakarta
  - TEL: +62 21 7801100
- **MALAYSIA**
  - Kuala Lumpur
  - TEL: +60 3 9206 6888
- **SINGAPORE**
  - Tuas
  - TEL: +86 10 5924708
- **THAILAND**
  - Bangkok
  - TEL: +66 2 2788100

### Australia
- **Perth WA**
  - TEL: +61 8 6424 4600

### Manufacturing and Technology Centers
- The Woodlands, Texas
- Brussels, Belgium
- Karamay, China
- Al Khobar, Saudi Arabia

### Repair and Maintenance
- Broussard, Louisiana
- Grand Junction, Colorado
- Nisku, Canada
- Villahermosa, Mexico
- Ciudad del Carmen, Mexico
- Macae, Brazil
- Aberdeen, United Kingdom
- Stavanger, Norway
- Alexandria, Egypt
- Al Khobar, Saudi Arabia
- Baku, Azerbaijan
- Tuas, Singapore
- Karamay, China
- Odessa, Texas
- Oklahoma City, Oklahoma
- Nizhnevartovsk, Russia
- The Woodlands, Texas
- Brussels, Belgium
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