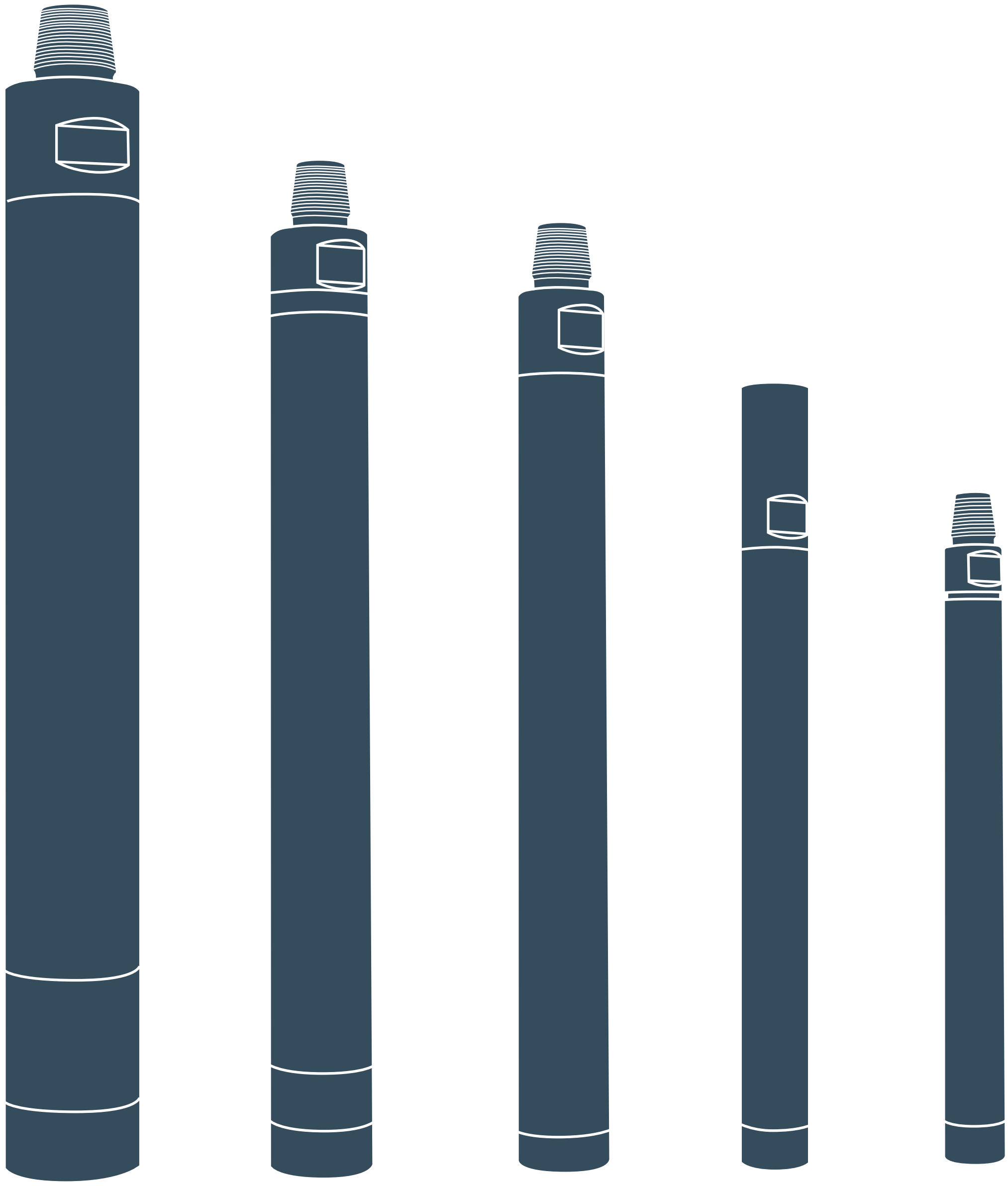
TerraRoc

Geotechnical Terranox DTH hammers

Terranox 3, 4, 5, 6, 8

Safety, operating instructions and spare parts list



Contents

Introduction

These instructions are intended for operators of the TerraRoc equipment. The aim of the instructions is to provide you with knowledge of how to use the equipment in an efficient and safe way. These instructions also give you advice and tell you how to perform regular maintenance on the equipment. It does not replace thorough training of operator, it is a complement. For further information concerning service measures, please contact your nearest TerraRoc representative.

Always read these instructions carefully and make sure that you understand all of them before starting for the first time. Read this manual carefully to learn how to operate and service your down-the-hole (DTH) hammer correctly. Failure to do so could result in personal injury or equipment damage. Consult your TerraRoc Dealer if you do not understand the instructions in this manual or need additional information. This manual should be considered a permanent part of the DTH hammer, and should remain with the DTH hammer and available for reference at all times.

The owner of the equipment is granted the permission to take copies of this publication solely for internal use. It is recommended, however, to order additional copies from TerraRoc representative in order to benefit from the latest revision. We reserve the right to make changes in its products in order to improve design or performance characteristics without notice. The information in this publication is assumed to be accurate at the time of publication, but is subject to changes in order to remedy detected deficiencies or to follow changes in the product. The instructions, illustrations, and specifications in this manual are based on the latest information available at time of publication. Your DTH hammer may have improvements and options not yet contained in this manual.

Any user of this publication is requested to inform us about deficiencies found, particularly in matters concerning product safety.

Measurements

Measurements in this manual are given in both metric and English/imperial units and are used to provide additional worldwide understanding. English/imperial units are shown between parentheses "( )".

Abbreviations

Abbreviations used throughout this manual.

acfm	Actual Cubic Feet per Minute
C	Centigrade
dia.	Diameter
deg.	Degree
F	Farenheit
ft.	Feet
ft.-lb	Foot Pounds
gpm	Gallons per Minute
in.	Inches
kg	Kilogram
l	Liter
lbs.	Pounds
lpm	Liters per Minute
m	Meter
mm	Millimeter
mm Hg	Milimeters of Mercury
m3/min	Cubic Meters per Minute
psi	ounds per Square Inch
psig	Pounds per Square Inch Gauge Pressure
rpm	Revolutions per Minute
scfm	Standard Cubic Feet per Minute
⚠	Safety Alert Symbol

Safety regulations

To reduce risk of serious injury or death to yourself or others, read these safety instructions before operating the machine. Post these safety instructions at work locations, provide copies to employees, and make sure that everyone reads the safety instructions before operating or servicing the machine. Comply with all safety regulations.

All possible hazards cannot be covered here, but we highlight some of the most important. For additional safety information consult other documents and information packed with this machine.

⚠ DANGER

Indicates immediate hazards which WILL result in serious or fatal injury if the warning is not observed.

⚠ WARNING

Indicates hazards or hazardous procedures which COULD result in injury or damage to equipment if the warning is not observed.

⚠ CAUTION

Indicates hazards or hazardous procedures which COULD result in injury or damage to equipment if the warning is not observed.

Personal precautions and qualifications

Only qualified and trained persons may operate or maintain the equipment. Always use your common sense and good judgement.

Operating equipment requires the full attention of the operator. Do not wear radio or music headphones while operating the hammer.

Hoisting and transport

Hoisting and transport of the equipment may only be undertaken by persons who:

• are authorized to operate a crane or fork-lift truck in conformity with the applicable national directives,

• are aware of all the relevant national safety instructions and accident prevention instructions

• and have read and understood the safety and hoisting and transport chapters of this manual.

Storage, repair, maintenance and disposal

Storage, repair, maintenance and disposal of the equipment may only be undertaken by persons who:

• are aware of all the relevant national safety instructions and accident prevention instructions

• and have read and understood the Safety and operating instructions.

Operation

Operation of the equipment may only be undertaken by qualified drill rig operators. Operators are qualified if they:

• have undergone theoretical and practical training on the equipment in conformity with the national directives

• are aware of all the relevant national safety instructions and accident prevention instructions

• and have read and understood the Safety and operating instructions.

Personal protective equipment

Entanglement hazard

⚠ WARNING

Loose fitting clothing and jewelry can get caught in the moving parts of the machinery and cause serious injury or death.

• Do not wear jewelry and loose fitting clothes.

• Confine long hair

Always use approved protective equipment. Operators and all other persons in the working area must wear protective equipment, including at a minimum:

• Protective helmet

• Hearing protection in accordance with occupational health and safety regulation

• Impact resistant eye protection with side protection

• Respiratory protection when appropriate

• Protective gloves

• Proper protective boots

Drugs, alcohol or medication

⚠ WARNING

Drugs, alcohol or medication may impair your judgment and powers of concentration. Poor reactions and incorrect assessments can lead to severe accidents or death.

• Never use the machine when you are tired or under the influence of drugs, alcohol or medication.

• Prevent other people from using the machine if they are under the influence of drugs, alcohol or medication.

Safety area

Falling objects can cause serious injury or death

⚠ WARNING

During operation, falling objects from great heights can cause bodily injury and extensive damage.

• Close off the working area.

• Before starting always make sure no unauthorized persons are within the working area of the drill rig in use.

• Immediately stop operation when persons are present in the danger area.

Hoisting and transport

Heavy equipment can cause serious injury

⚠ **WARNING**

- Use a sling dimensioned for the load it is to carry.
- Use only straps that are whole and intended for the load in question.
- Never use a damaged rope/sling.
- Fasten straps in lifting eyes when present.
- Always lift at the centre of gravity.
- Always make sure that nobody is under or anywhere near a suspended load or within the swing radius of the rope/sling.
- Observe great care when strapping and lifting heavy objects.

NOTICE Sling can damage components

When lifting, make sure that the sling will not damage the hydraulic hoses, mechanical components etc.

Operation, precautions

Hydraulic oil at high pressure

⚠ **WARNING**

- Thin jets of hydraulic oil under high pressure can penetrate the skin and cause permanent damage.
- Immediately consult a doctor if hydraulic oil has penetrated the skin.
- Never use your fingers to check for hydraulic fluid leaks.
- Keep your face away from any possible leaks.

Underground utility lines

⚠ **WARNING**

- Check for underground utility lines. Before starting work, remember that contact with buried utilities may cause serious injury or death. Electric line contact may cause electric shock or electrocution. Gas line contact may rupture pipe causing explosion or fire.

Fiber optic cables can blind you if you look into the laser light in them. Water line rupture may cause a flood and possible ground collapse. Before drilling, check with qualified sources to properly locate all buried utilities in and around drill path. Select a drill path that will not intersect buried utilities. Never launch a drill bit on a path toward electric, gas, or water lines until their location is known. If there is any doubt as to the location of the underground placement, have the utility company shut it off before starting any underground work and excavate to confirm its exact location.

Dust hazard

⚠ **WARNING**

When drilling with compressed air, the rock cuttings are carried out of the bore in the form of small cuttings, and dust, which can cause serious injury.

Some dusts, fumes or other airborne material created during use of the machine may contain chemicals known to the State of California to cause cancer and birth defects or other reproductive harm. Some examples of such chemicals are:

- Crystalline silica, cement and other masonry products.
- Arsenic and chromium from chemically-treated rubber.
- Lead from lead-based paints.
- To reduce your exposure to these chemicals, work in a well ventilated area and work with approved safety equipment, such as dust masks that are specially designed to filter out microscopic particles.
- Use a dust collector, or spray water with a water/ foam pump.

Unexpected movement can cause serious injury

⚠ **WARNING**

If control levers and switches are not set to neutral position, start of the machine can lead to unexpected movements and can therefore cause injury.

- ISet control levers and switches to the neutral positions prior to starting up.

Noise hazard

⚠ **WARNING**

High sound levels may cause permanent hearing loss.

- Use hearing protection in accordance with occupational health and safety regulations.

Emergency situation

⚠ **WARNING**

An emergency situation can occur due to material failure or incorrect handling.

- Stop the operation by pushing the emergency stop button or if available pull the trip wire.
- Check proper function of the rig safety equipment at least once beginning of each shift.

Gas line pressurized, Explosion hazard

⚠ WARNING

If the equipment comes in contact with gas lines and explosives, an explosion could occur. Explosions will lead to severe injuries or death.

• Never operate the machine in any explosive environment.

• Never use the machine near flammable materials, fumes or dust.

• Make sure that there are no undetected sources of gas or explosives.

• When working in areas where gas lines are buried, make sure that your equipment is placed on the windward side.

Shut down all combustion engines, like hydraulic power pack, generators etc.

• Leave the machine immediately.

• Warn people to evacuate the area.

• Contact emergency personnel.

• Contact the gas company to shut the gas off.

• Stay out of the area until the gas company declares the area to be safe.

Maintenance, precautions

Hydraulic oil

⚠ WARNING

Spilled hydraulic oil can cause burns, accidents by slippery conditions and will also harm the environment.

• Take care of all spilled oil and handle it according to your safety and environment regulations.

• Never dismount the hydraulic components when the hydraulic oil is hot.

Hydraulic system under high pressure

⚠ WARNING

Maintenance and repair on the machine and the hydraulic equipment under pressure can lead to severe injuries. Connections can loosen suddenly, parts can suddenly move and hydraulic oil can be ejected.

• Depressurize the hydraulic system before performing maintenance on the hydraulic equipment.

• Never replace high pressure hoses with hoses of lower quality than the original or with hoses that have removable couplings

Pressure settings are always performed on a pressurized system.

• Always exercise the greatest caution.

• Pressure settings must only be performed by trained personnel.

Rotating parts can cause serious injury and damage

⚠ WARNING

• Always turn off the engine before performing any maintenance or service on the equipment.

Machine modification

⚠ WARNING

Any machine modification may result in bodily injuries to yourself or others.

• Always contact your TerraRoc Customer Center before you modify the machine.

• Always use original parts and accessories approved by TerraRoc.

Heavy machine can cause serious injury

⚠ WARNING

• During service and maintenance work, all components that may be brought into motion or fall must be supported or tied secure.

Thermal cracks may arise when welding

⚠ WARNING

• Do not do any welding on the equipment without consulting TerraRoc.

Hot engine parts can cause burn

⚠ WARNING

• Make sure the engine is turned off before all maintenance work and before refueling

• Be careful when draining hot oil and fluids

• Do not handle flammable fluids in the vicinity of hot surfaces, sparks or naked flames

Electric shock

> ⚠ **WARNING**
>
> • Do not touch live electrical lines
>
> • Only authorized electricians may carry out work on the electrical system.
>
> • Only qualified electricians should perform any electrical troubleshooting or maintenance. Remove all watches and rings that could contact live electric circuits.
>
> • Make sure all power to the system has been cut before carrying out any maintenance work.
>
> • All electric cabinets should remain locked when not under direct control of qualified electrician.
>
> • Do not use the cabinets as a toolbox or spare parts storage container. The inherent vibration and magnetism associated with transformer and motor starters can cause inadvertent contact of foreign objects with live circuits.
>
> • Some electrical components may have power when the main circuit breaker is open, verify that power is disconnected before servicing.
>
> • Do not tamper with safety interlock circuits, safety guards or other safety devices, except as required during normal maintenance and troubleshooting.
>
> • Confirm that all safety devices and circuits are replaced and functioning before operation is resumed.

Electrocution

> ⚠ **WARNING**
>
> Serious injury or death may result if the machine strikes an energized powerline. Take the following precautions to prevent electrocution. Also refer to the operating instructions.
>
> • Always contact your local utility company when working in the vicinity of utilities.
>
> • Locate underground utilities by qualified persons.
>
> • Do not raise, lower, or move drill guide or boom near power lines.
>
> • Always wear proper electrically insulated lineman´s gloves and boots.
>
> • Never touch metal parts on machine while standing on bare ground if machine comes in contact with a powerline.
>
> • Never step onto or off of a machine if an electric strike occurs.

Additional safety instructions for the Terranox DTH hammer

Follow instructions

Carefully read all safety messages in this manual and on your machine´s safety labels. Keep safety labels in good condition. Replace all missing or damaged safety labels.

Learn how to operate the DTH hammer and how to use the controls on the machine properly. Do not let anyone operate this DTH hammer without proper instruction.

If you do not understand any part of this manual and need assistance, contact your local TerraRoc dealer.

Keep DTH hammer in good working condition

Unauthorized modifications to the DTH hammer may impair the function and/or safety and effect the DTH hammers life.

Make sure all safety devices, including shields are installed and functioning properly.

Visually inspect the DTH hammer daily before using. Do not operate the DTH hammer with loose, worn, or broken parts.

Loose parts

Make sure the drill rod to rotary head spindle joint is securely tightened before running the rotary head in reverse rotation. A loose connection could result in the drill rod unscrewing completely; a falling drill rod could strike personnel.

Live air

Never get under a downhole drill to examine the exhaust air; live air is dangerous. Also, part failure could cause the bit to fall out of the downhole drill which could result in bodily injury. A piece of cardboard can be inserted under the bit to check for the lubrication being carried through the downhole drill.

Air pressure

Make certain that the air line lubricator (or lubrication system) is capable of handling the higher air pressures associated with the downhole drill (up to 25 bar (350 psi) air pressure). When pressurized, an unsuitable lubricator could burst and possibly cause injury to personnel in the area.

Do not work in trench

Do not work in trench with unstable sides which could cave in. Check local laws and regulations for working in trenches.

Check laws and regulations

Know and obey all laws and regulations that apply to your work situation.

Observe environmental protection regulations

Be mindful of the environment and ecology.

Before draining any fluids, find the correct way of disposing them.

Observe the relevant environmental protection regulations when disposing of oil, fuel, coolant, brake fluid, filters and batteries.

When using any solvent to clean parts, make sure that it is nonflammable, that it will not harm the skin, that it meets current standards, laws, regualations and that it is used in an area that is adequately ventilated.

> ⚠ **WARNING**
>
> • Failure to follow any of the above safety instructions or those that follow within this manual, could result in serious injury or death. This DTH hammer is to be used only for those purposes for which it was intended as explained in this safety and operating instructions.

Installation and operation

General information

Description

The Terranox line of down-the-hole hammers is designed for use on drilling machines in conjunction with a top head or kelly drive mounting. The mounting must be capable of supplying sufficient feed force, hold back, rpm, torque, hammer lubrication, air pressure and air volume.

DTH hammers are recommended for practically any rock application. Depending on the size downhole drill being used, they are suitable for drilling water wells, primary blast holes in quarries, open pit mining, coal stripping operations, oil and gas exploration, and construction jobs where large volume rock excavation is required.

DTH hammers operate by using the position of a piston to direct supply and exhaust air to and from drive and return volumes. The drive volume "drives" the piston toward impact and the return volume "returns" the piston in preparation for another impact stroke.

The DTH hammer cycle utilizes a stepped piston design that provides air pressure throughout the piston cycle. This results in a constant down force on the piston that increases the striking power of the piston over conventional drills with a non-stepped piston. The constant down force on the piston also provides fast, positive shut off when the bit is lifted off the hole bottom, limiting damage caused by "dry firing".

Setting up the DTH hammer

Before the DTH hammer is used to drill it should be set up for proper air consumption and the joints should be tightened. The selection of choke size will be dependent on the hole cleaning requirements and the capacity (pressure and flow) of the compressor being used. Hammer air consumption should be set up for the best balance of power and hole cleaning. Other factors which need to be considered are depth of hole, water to be encountered and water to be injected. In some cases, where such factors are unpredictable, the proper choke size can only be selected after experience is developed.

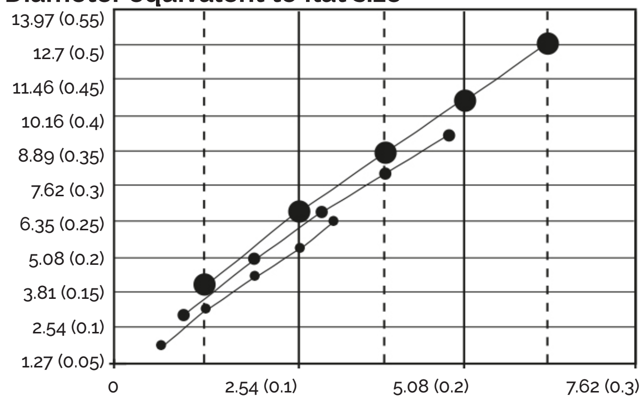
Choke selection setup

The best performance of any DTH hammer will be achieved when a maximum volume of air can be passed through the drill with a solid choke. Under ideal conditions the pressure required to drive this volume through the drill will be within the capabilities of the compressor. When more air volume delivery is available than that required to operate the hammer at the rated compressor pressure, an alternative way of utilizing the excess volume is required. If this excess flow is not used the compressor´s unloader will cycle, resulting in a loss of hammer performance.

TerraRoc DTH hammers can be modified for additional hole cleaning capacity by replacing the solid choke plug installed at the factory with a bypass choke plug (Refer to chart below). If additional hole cleaning air is needed and compressor capacity is sufficient flow can be determined from the following expression:

Q=9.71 * D^2 * P, where D= hole diameter (in.);
Q= flow (scfm); P= pressure (psig).

Diameter equivalent to flat size



Flat Height, mm (inch)

- 1/4 dia plug (Terranox 3 and Terrranox 4)
- 3/8 dia plug (Terranox 5 and Terranox 6)
- 1/2 dia plug (Terranox 8)

1. Diameter is based on flow entering from both sides of the flat (ie. two flats make up hole equivalent).

2. Flat height is thickness removed from round choke plug.

3. Flow can be determined from the expression following where:

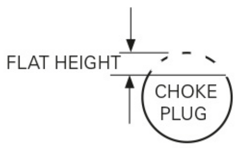
D is equivalent hole diameter

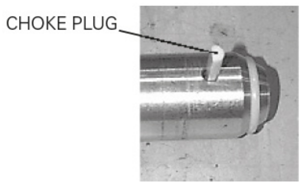
Q is flow in scfm

P is pressure in psig

Q = 9.71 x D^2 x P

Assumptions: Flow coefficient is 0.7 temperture is 120F gas is air.





Air pressure Bar (psig)	Hole diameter mm (in)				
	1.6 (1/16)	3.2 (1/8)	4.8 (3/16)	6.4 (1/4)	7.9 (5/16)
	Bypass air (m3/min (scfm)				
14 (200)	0.23 (8)	0.85 (30)	1.93 (68)	3.43 (121)	5.38 (190)
17 (250)	0.25 (9)	1.08 (38)	2.41 (85)	4.30 (152)	6.71 (237)
21 (300)	0.31 (11)	1.30 (46)	2.89 (102)	5.15 (182)	8.04 (284)
25 (350)	0.37 (13)	1.50 (53)	3.37 (119)	6.0 (212)	9.40 (332)

Bailing velocity requirements

The need for adequate hole cleaning cannot be over emphasized. A hole that is not cleaned properly can result in poor performance, rapid wear of bits and accessories and in some cases loss of the drill and pipe down the hole. Hole cleaning is usually directly related to what is called bailing velocity or the speed of the air which is lifting cuttings from the hole.

Bailing velocity is defined as the velocity of the air in the hole annulus at atmospheric pressure. In other words, the effect of bottom hole pressure is not taken into account when computing bailing velocity. For conventional hole cleaning (no soaps or foams) bailing velocity should exceed 15 m/s (3000 ft./min.).

However, if possible, bailing velocity should not exceed 35 m/s (7000 ft./min.).

Bailing velocity can be computed by dividing the air consumption of the DTH by the annulus area. The equation following may be used:

$$\text{Velocity [m/min.] (ft./min.)} = \frac{\text{Air consumption [m3/min.] (scfm)}}{\text{Annulus area [sq. m] (sq. ft.)}}$$

where:

• Air consumption is the rated delivery of the compressor or the air consumption of the drill at maximum pressure, whichever is less.

• Annulus area is the area between the hole bore and the drill rod. It can be computed as follows:

• Annulus area

[sq. m] =.785 x (hole dia. [m]2 - rod dia. [m]2)
sq. ft.) =.0055 x (hole dia. [inches]2 - rod dia. [inches]2)

Bit installation

Bit splines should be well lubricated with rock drill oil or thread grease before the chuck is installed over the splines. Additionally, the threads on the chuck should also be well coated with thread grease before threading the chuck into the DTH. Remember to install the bit retaining ring halves before threading the chuck into the DTH.

Used bit and chuck

Caution must be used when installing a new bit on a used chuck or vice-versa. Some applications, usually soft rock where there is excessive bit travel within the splines, can develop uneven wear on the bit and chuck splines. When a new bit is installed in a used chuck the mating surfaces are likely to be poor. Check the condition of the chuck or bit splines when using a new bit or chuck if your application is prone to this form of spline wear.

It is also suggested that the chuck be rotated relative to the bit splines from time to time to even out the gouging and grooving which takes place due to erosive wear. This practice will extend your chuck and casing life.

Makeup torque and backhead closure

DTH series drills use a ''solid clamping'' arrangement for locking internal components whereby parts are held in place under very high load. This system is highly effective in preventing motion (and subsequent damage) of internal parts.

Rotary head torque is not sufficient to close the backhead on DTH Series hammers. Because of the high load used to clamp the parts in place a high level of torque is needed to close the backhead gap. A supplementary wrench is needed to properly tighten the joint. The hydraulic wrench and wraparound tong supplied on most drilling rigs is usually sufficient. It is extremely important that the backhead gap be closed in these drills.

The presence of a gap between the casing and the backhead while drilling will increase the chances for loosening the backhead in the hole and possibly losing the drill In addition to at least closing the backhead gap, it is also recommended that the backhead and chuck be torqued to approximately 40 - 55 N-m per mm (750 - 1000 ft.-lb per inch) of hammer diameter. This makeup torque insures against loosening joints in the hole and also preloads the threads sufficiently. Makeup torque for each hammer is presented in the General specifications table.

Drill Lubrication

Lubrication guidelines and specifications

All DTH´s require oil lubrication to resist wear, galling and corrosion. Additionally, the film of oil coating all internal parts seals internal clearance paths to reduce power-robbing leakage across sealing clearances. As a general rule of thumb the oil required is proportional to the volume of air being used.

Oil also needs to be of sufficiently high quality. It is recommended that TerraRoc rock drill oils are used.

For dry drilling (less than 7.6 lpm (2 gpm) of water injection) it is generally recommended that oil be injected into the drill air stream at the rate of .16 l (1/3 pint) of oil per hour for every 2.8 m3/min. (100 scfm) of air. For example a 25.5 m3/min. (900 scfm) compressor delivering full flow to a DTH would require 25.5 ÷ 2.8 x .16 = 1.6 l per hour (900 ÷ 100 x 1/3 = 3 pints per hour). For wet drilling (more than 7.6 lpm (2 gpm) it is suggested that the lubrication rate be doubled to .32 l (2/3 pint) of oil per hour for every 2.8 m3/min. (100 scfm) of air.

The additional oil compensates for the wash-out caused by water and the oil losses. Additional lubrication is also required when drilling with soap or foam. See the ''Drilling With Foam'' section for more details.

	Oil Injection Rate Oil Injection Rate l/hr (pints/hr)	
Air Flow m3/min (scfm)	Dry Drilling	Wet or Hydrocyclone
4.25 (150)	0.2 (0.5)	0.5 (1.0)
7.08 (250)	0.4 (0.8)	0.8 (1.7)
9.91 (350)	0.6 (1.2)	1.1 (2.3)
14.2 (500)	0.8 (1.7)	1.6 (3.3)
17 (600)	1.0 (2.0)	1.9 (4.0)
21.2 (750)	1.2 (2.5)	2.4 (5.0)
22.7 (800)	1.3 (2.7)	2.5 (5.3)
25.5 (900)	1.4 (3.0)	2.8 (6.0)
29.7 (1050)	1.7 (3.5)	3.3 (7.0)
35.4 (1250)	2.0 (4.2)	3.9 (8.3)
42.5 (1500)	2.4 (5.0)	4.7 (10.0)
56.6 (2000)	3.2 (6.7)	6.3 (13.3)
84.9 (3000)	4.7 (10.0)	9.5 (20.0)

Lubricators

There are two primary types of lubricators; a plunger oiler and a venturi oiler:

A plunger oiler normally operates from a timed plunger system which delivers a fixed ''slug'' of oil into the line in timed intervals. These systems are beneficial in that the oil reservoir does not need to contain a high pressure. Plunger lubricators are also insensitive to oil viscosity and temperature. However, because of their complexity, the reliability of plunger lubricators is not as good as the venturi type. Also, because oil is delivered as ''slugs'' it is not atomized and delivered to the drill internals as evenly as a venturi.

Venturi type lubricators (sometimes referred to as pig oilers) operate in a similar fashion to a gasoline carburetor. A necked down area in the venturi creates a pressure drop which draws oil into the air stream. The oil is atomized and mixed very efficiently with the air providing maximum coverage and cohesion to internal drill components. A needle valve is usually used to adjust the oil volume delivered. Disadvantages of the venturi oiler are that it requires a pressurized reservoir, which is generally small in volume. Also, the lubrication rate is dependent on oil viscosity which varies with temperature.

Lubrication check

When oil is injected into an air stream with dry piping or hoses it takes a considerable amount of time to coat the walls of the piping so that the oil is actually delivered to the DTH. Until these surfaces are coated with an oil film very little is actually delivered to the DTH. It´s important to insure that an oil film is established before starting the DTH. It´s recommended that the drill be allowed to blow until a visible film of oil is developed on the bit blow holes.

Placing a piece of cardboard or wood beneath the blow holes gives a good indication when oil is passing through the drill. The cardboard or wood will become wet with oil when an adequate film of oil has been developed. If a drill string has not been used for some time and the oil has dried out it is suggested that a cup of oil be poured into each rod to assist in developing an oil film. After drilling with high levels of water injection it is important to note that any oil film has probably been washed off. For operators that switch from wet to dry drilling (i.e. waterwell and quarry) its important to redevelop the oil film.

Water injection

Water injection can cause a DTH to either consume more air (hold a lower pressure) or less air (hold a higher pressure) depending on the volume of fluids injected. For example, if a DTH is lubricated with oil and water is then injected at a low rate (less than 3.8 lpm (1 gpm)), the oil film which is sealing the internal leak paths is washed out and air consumption will increase (pressure will fall).

Conversely, if water is injected at a high rate (more than 11.4 lpm (3 gpm)) the fluid level will be sufficient to seal the leak paths and restrict the flow of air through the DTH. In this case the air consumption will decrease (pressure will increase).

The use of water, while required in most cases, does reduce component life. The following lists some of the problems that water injection can cause:

• Poor quality water can either be corrosive or can carry contamination into the drill. Premature wear or corrosion related failures can result. All water injected into a DTH should be neutral in pH and free from particulate contamination.

• Water injection reduces drill performance considerably. Water restricts the flow and resultant pressure in working chambers of the drill and reduces face cleaning which causes regrinding of cuttings.

• Water present at the impact face causes cavitation of the bit and piston and jetting or cutting of the exhaust tube. In both cases component life is reduced.

A DTH that has been operated with water injection and will be idle for more than a few days should be dried out and lubricated with oil. This can be accomplished by blowing lubricated air through the tool when drilling is finished.

Drill operation

Drilling with foam

In certain drilling situations, it may be advantageous to use foam to improve hole cleaning and control backpressure. Use of a heavy (shaving cream consistency) foam can suspend drilled cuttings and allow them to be removed from the bore hole at bailing velocities much lower than when depending on air flow alone. Foam can also entrain and suspend formation water in instances of high water inflows, reducing backpressure on the drill.

TerraRoc DTH´s are compatible with all commonly available foaming compounds. Modern drilling foams are non-corrosive, but their effects create an environment suited to rapid corrosion of drill parts. The use of foam with a DTH requires extra care to maximize drill performance and life.

• Foam, being basically soap, breaks down rock drill oil, which can cause lubrication problems in the drill. Increase oil injection rates when drilling with foam.

• As foam passes through the drill, bubbles are created and destroyed. This action polishes the steel parts, making them more susceptible to corrosion.

• When drilling activity stops, the oil film normally present has been removed. This leaves the internal parts of the hammer without corrosion protection.

When drilling with foam is completed, all foam residues must be removed from the inside of the drill, and the parts must be coated with oil. Failure to do so will result in rapid corrosion of the internal parts and rapid wear when drilling resumes. The following procedure is is recommended when drilling with foam is completed:

• With the drill in blow position, shut off foam delivery and blow air with a large quantity of water through the hammer for several minutes.

• Shut off the water and continue to blow lubricated air through the hammer until a good flow of oil is seen at the bit.

• For best results, clean the hammer at the end of each day. If the hammer is to remain unused for an extended period, it is recommended that the DTH be disassembled, cleaned, oiled and reassembled before storage.

Collaring

Collaring a drilled hole is a critical stage of the drilling process. In blast holes it can determine the quality of the top of the hole and the ability to load a charge. In foundation and well drilling it can determine the overall straightness of the completed hole. It is suggested that a drill be collared with low pressure and feed until the hole has stabilized. Just as a twist drill needs to be controlled carefully when drilling with an electric hand drill, a DTH needs to be started with care.

Rotation speed

Recomended rotation speed for each Terranox hammer is presented in the Operational specifications chart on page 27.

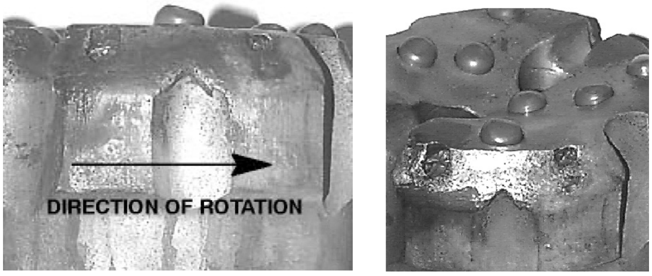
Rotation speed directly affects the amount of angular index the bit inserts go through from one impact to the next. The optimum amount of index is dependent on variables such as blow energy (pressure), rock hardness, bit diameter, etc. The ideal rotation speed produces the best overall balance of penetration rate, bit life and smoothness of operation. It generally occurs when cuttings are their largest.

Determining the optimum rotation speed needs to be carried out in the actual application. A good rule-ofthumb is to divide 300 by the bit diameter in inches to determine RPM. This will get the rotation to an acceptable speed. However, a fine-tuned rotation speed also needs to be correlated with penetration rate. It has been found that a proper rotation speed usually results in a 9.5 mm - 19 mm (3/8 in.- 3/4 in.) advance of the bit per revolution of the DTH. This measurement can normally be taken by using chalk or soapstone to scribe a spiral on the drill pipe while the drill is operating. The distance between the spirals (thread pitch) can be measured to determine if rotation speed should be increased or decreased. If the pitch is less than 9.5 mm (3/8 in.) the drill RPM should be decreased, if it is more than 19 mm (3/4 in.) the drill RPM should be increased.

The picture following shows an example of the marks left on a drill pipe when using chalk to mark the advance of the drill.

Adjust RPM to give
9.5 to 19 mm.
(3/8 to 3/4 in)

Another method for setting rotation speed involves observing the wear flat developed on the gage (outer) carbide. The wear flat on the should be directly on the top of the inserts. A flat which is on the leading edge of carbide (side facing the direction of rotation) indicates rotation speed is too slow. Conversely, rotating too fast will cause rapid wear of the bit and the wear flat will be on the trailing edge of the carbide.



View showing wear flat on leading edge - indicates rotation too slow. Note that carbide failure was caused by the leading edge wear flat.

Rotation Torque

As a general rule of thumb, you should apply roughly 27 newton/ meter (500 foot/pounds) of torque for each inch of bit diameter.

Example: 6 inch diameter bit x 27 newton/meter (500 ft/pounds) = 162 newton/meter (3000 ft/pounds) of rotation torque

Feed force (hold down and hold back)

Recomended feed force for each Terranox hammer is presented in the Operational specifications chart on page 27.

The force required to feed a percussive tool properly is directly proportional to the level of output power.

As a rule of thumb, DTH´s need to be fed with a force of roughly 9 kg per mm (500 lb per inch) of hammer diameter when operating at maximum power.

In many cases operators will simply adjust the feed pressure until rotation pressure starts to pulse and then back off slightly until rotation pressure becomes smooth. When a hole is first started, if the weight of the starter rod or collars is not sufficient to feed the drill then pull down will be needed. As the hole is advanced and more weight is added to the drill string, the level of pull down will need to be decreased. Eventually, the weight of the string may exceed the proper feed force and the feed system will need to be shifted to a pull-back mode.

When drilling through varying conditions such as hard and soft or voided material, every effort should be made to keep the drill fed properly. A loose running DTH can cause damage to the tool and bit in a short period of time. The feed system of a drilling rig should have a sufficiently fast response so the DTH can ''catch up'' with the bit when a void or soft seam is encountered.

It´s equally important to avoid feeding too hard through voided and fractured material. The piston in a DTH operates within the casing with a clearance of about .076 mm (.003 in.) on each side. While the casing appears very strong and stiff, it does not take much sideways pressure to distort the casing enough to cause interference with the piston as it reciprocates. If the casing is overfed through voided ground it is likely that deflection of the casing will occur. Frictional cracks will develop on the surface of the piston if the piston rubs hard enough against the wall of the casing while being distorted. These small frictional cracks can eventually grow and break the piston.

Feed force should be reduced when drilling through voided, unconsolidated or fractured ground to avoid twisting or distorting the hammer casing.

Hole cleaning, flushing and dust suppression

As stated previously, the importance of good hole cleaning cannot be over emphasized. A hole which is not cleaned effectively will cause reduced production (penetration rate), decreased bit and accessory life and could ultimately increase the risk of losing the drill and string in the hole.

Dry drilling

The most effective means for hole cleaning is drilling dry. Cuttings are normally lifted and cleaned from the hole very efficiently. Imagine blowing or sweeping dust or dirt from a floor when the floor is dry and wet: which is more effective? The same principle holds true for cleaning cuttings from a hole.

Wet drilling

Water injection is required in many applications for dust suppression or hole cleaning. Water injection rates for dust suppression only are usually less than 3.785 lpm (1 gpm) and just sufficient to moisten fine dust. It is usually common to use minimal water injection for dust suppression in shallow blasthole applications where water intrusion into the hole is not a problem.

Larger volumes of water injection are usually required in water well and deep-hole applications where a number of factors come into play;

• Water intrusion into the hole can develop mud rings where dry cuttings meet a seam of water entering the hole. Mud rings develop where dry cuttings stick to the wall of the hole when they hit the moist area. Water injection is needed to keep the hole wet enough to prevent these mud rings from developing. Fluid injection rates can vary from 3,785 - 30,28 lpm (1 - 8 gpm) depending of the hole size, rate of penetration and the type of material being drilled.

• Some materials such as those which drill fast or contain clay can sometimes require very heavy levels of water injection. These applications are unique in that they can either be drilled totally dry or totally wet, not in between. Marginal fluid injection results in making a tacky mud which sticks to the drill rods and hole wall and hinders hole cleaning. The correct level of fluid injection thins the paste so it will be cleared from the hole.

Bit changing

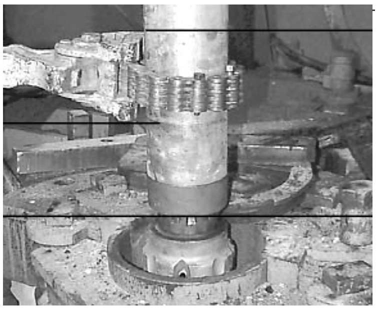
Removing the drill bit

Bit removal can be one of the most dangerous and frustrating tasks associated with the drilling operation. However, with the proper tools and techniques it should require no more than a few minutes and few expletives to remove a bit. The following lists pointers which will be beneficial in helping you remove a bit quickly, safely and with reduced risk to damaging DTH parts and components:

1. Use sharp tong jaws. Worn or rolled over tong jaws increase the jaw pressure and make the wrench more prone to damaging the hammer case.

Many TerraRoc hammer cases are case hardened which means sharp jaws are needed to grip through the hardened case.

2. Grip the casing in the proper location. Gripping over the threads can make thread loosening extremely difficult. Example; as the wrench tightens it exerts an inward force which can pinch the threads if they are under the wrench jaw. This only increases the torque needed to uncouple the thread. Also, do not grip the casing in an area where the bore is not supported by either the piston or bearing. Gripping over an unsupported area can distort the bore. The figure and table below shows the recommended locations for wrenches.



	Chain Wrench Positions	
from DTH model	Min. distance from chuck to lower jaw	Max. distance chuck to upper jaw
Terranox 3	85 mm (3.3 in.)	312 mm (12.3 in.)
Terranox 4	165 mm (6.5 in.)	355 mm (14 in.)
Terranox 5	165 mm (6.5 in.)	432 mm (17 in.)
Terranox 6	165 mm (6.5 in.)	432 mm (17 in.)
Terranox 8	165 mm (6.5 in.)	432 mm (17 in.)

3. Insure the bit fits properly within the bit basket. An improper fit may result in the bit slipping from the basket.

4. Never weld or hammer on the casing to loosen it. All casings are case hardened for extended service life. The hard casing surface can be cracked by welding or impacting with a sledge hammer. If a chuck or backhead is difficult to loosen, repeatedly tapping the casing at the thread location with a brass bar or hammer while torque is applied may help loosen the joint.

⚠ WARNING

• Insure chain wrenches or tongs are rated for the torque applied. The flying parts of chain wrenches can cause injury or death when they break!

Warranty will be voided by: n Welding on casing will destroy heat treatment of casing causing cracks.

• Heating casing with a torch will distort bore and ruin heat treatment.

• Gripping with wrench across threads can distort bore and start cracks.

• Hammering on casing can form cracks on outside of casing. Use sharp tong jaws to avoid problems

Removing the bit with percussion only

If a chuck is difficult to loosen it´s sometimes helpful to use low-pressure percussion assisted with reverse rotation to free the thread.
The following lists the process and cautionary notes:

⚠ CAUTION

• Wear eye protection as the hammer will be cycling above ground.

• Insure that all drill string joints are tight. Watch other string joints to insure they do not loosen before the chuck. If they do loosen, stop the process.

Process instructions

1. Place a piece of relatively hard polyurethane or conveyor belting in the bit break-out basket to absorb shock.

2. Remove all drill pipe so only the DTH and required adapters are attached to the rotary head.

3. Bring the drill in contact with the bit basket with a relatively light feed.

4. Bring the hammer pressure up to roughly 10 bar (150 psig).

5. See if the joint has loosened on its own after about 10 seconds of cycling.

6. If the joint has not loosened, "Bump" the rotation in reverse at a slow speed while the drill cycles until the joint has loosened.

7. Stop as soon as the chuck loosens, grease and air will be noticed coming from the loosened joint.

Maintenance and repair

Follow instructions

Along with correct operational technique; proper and timely service and repair of a DTH can extent component life and reduce operational expenses considerably. The sections following describe how to disassemble, inspect, repair and reassemble all DTH´s.

Depending on the degree to which you plan on servicing a DTH, a number of tools are required. The following lists the tools needed for a complete overhaul of all DTH´s. Obviously a stand is required for holding the DTH and it is presumed that backhead and chuck threads have been loosened. Complete overhaul includes measuring and inspecting all clearances at seal locations and other wear points.

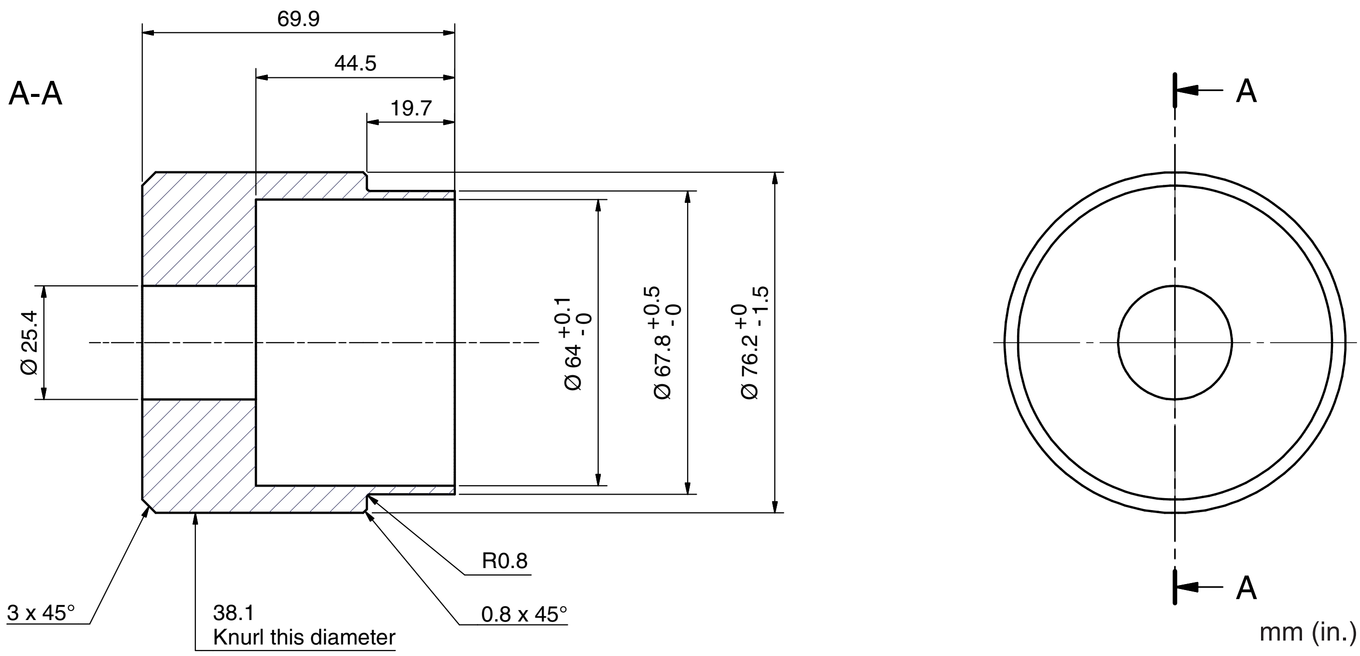
Tools required for DTH service and repair

Tool	Terranox 3	Terranox 4	Terranox 5	Terranox 6	Terranox 8
Outside Micrometer	3-4", 2-3", 1-2"	3-4", 2-3", 1-2"	4-5", 3-4", 2-3", 1-2"	5-6", 4-5", 3-4", 2-3", 1-2"	7-8", 5-6", 4-5", 7-8", 2-3"
Feeler Gauges	One set	One set	One set	One set	One set
Telescopic Bore gauges	Set up to 3"	Set up to 3"	Set up to 4"	Set up to 5"	Set up to 6"
Vernier Caliper	0-6"	0-6"	0-6"	0-6"	0-6"
Brass, or other soft metal, bar	3/4" dia. by 48" length	1" dia. by 48" length	1-1/4" dia. by 48" length	1-3/4" dia. by 48" length	2" dia. by 48" length
"J" Wrench	2-1/2"	2-1/2"	3-1/2"	4"	6"
Breakout bench Product no. 90514057 Product code 9178	Applicable	Applicable	Applicable	Applicable	Applicable

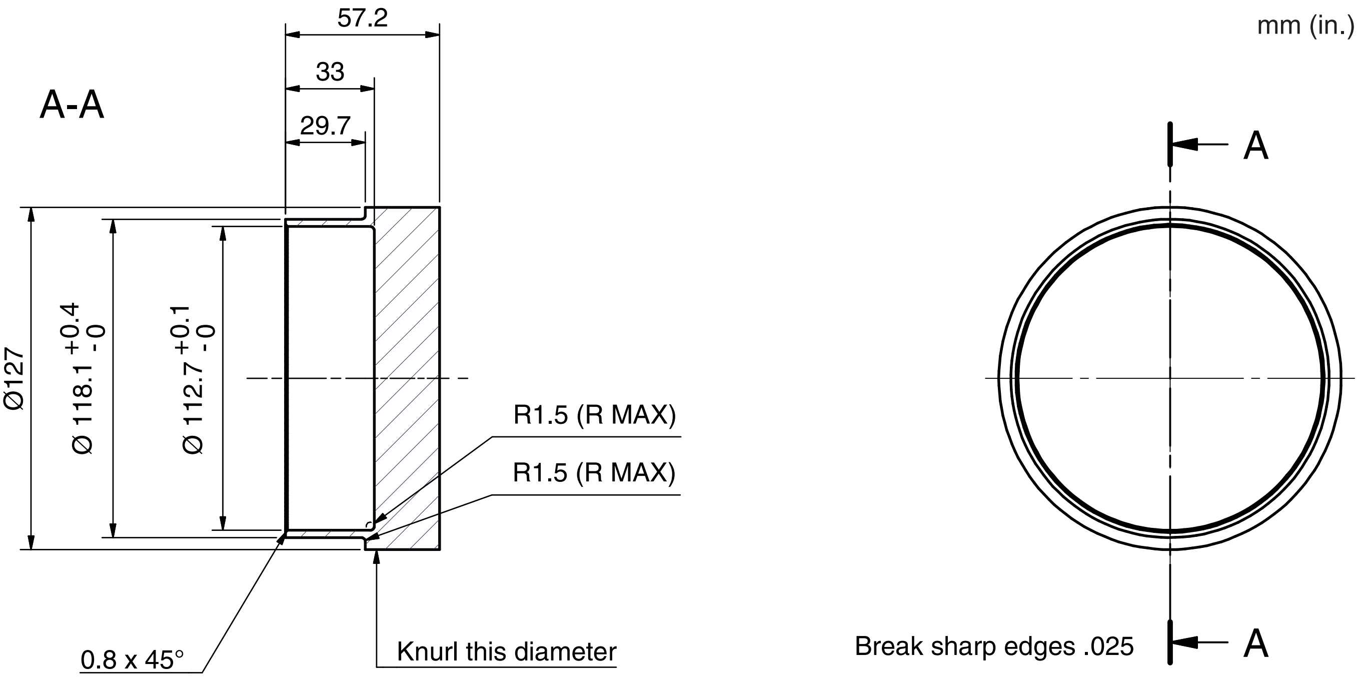
Assembly tools

An optional tool can be used to simplify the assembly of Terranox 3 and Terranox 6.

Terranox 3 assembly tool



Terranox 6 assembly tool



DTH service

In most cases a DTH will only require servicing when the casing wears out or when performance deteriorates due to internal parts wear. The level of inspection can obviously be much less if the casing only needs replacement. If the DTH has lost performance a more detailed inspection will be required.

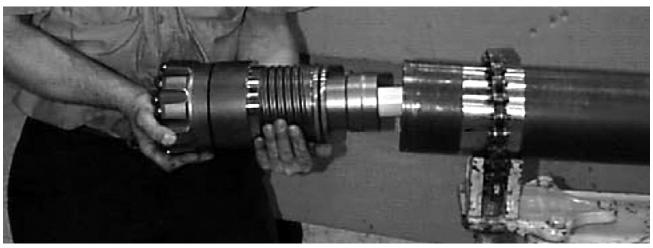
Terranox disassembly

The following disassembly procedure starts with the presumption that the chuck and backhead threads have been loosened. While the disassembly process is similar for all DTH´s there are slight distinctions from one model to another that will be noted.

It´s important to note that the piston can only be removed from the chuck end of the drill

1. Mark the casing so you can note which end is the backhead side and which is the chuck end. Once the hammer has been disassembled it´s hard to tell which end is which.

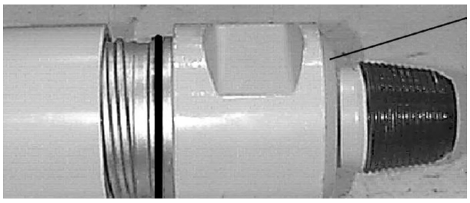
2. Loosen the chuck along with bit and retaining rings and remove from casing.



3. Remove retaining rings and o-ring from bit shank.

4. Remove the chuck from the bit.

5. Remove the backhead from the other end of the casing.



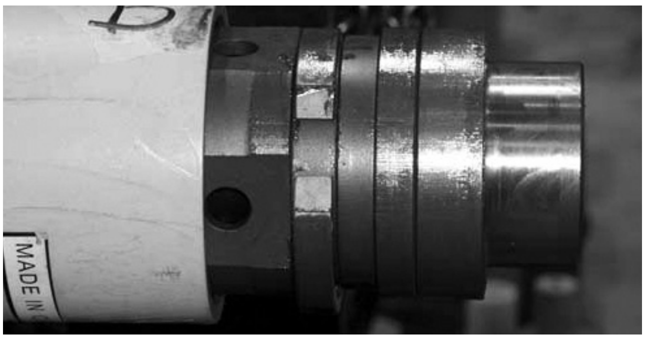
Backhead

6. Remove the check valve, and check valve spring.

7. Remove the check valve and check valve spring from the top of the air distributor. It is not necessary to remove the choke plug unless it is damaged or a bypass plug is required.

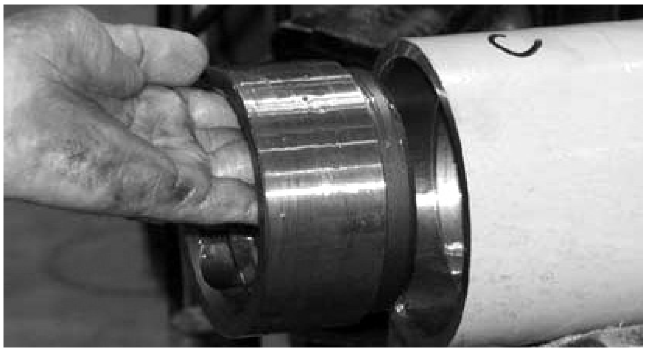
8. Remove the bit bearing (if your Terranox model is furnished with one) from the hammer. The bearing can sometimes be removed by hand, but often will require the use of a bearing puller. When using a bearing puller, be sure it is in contact with the bearing and not the bearing retainer.

For Terranox 6: The bit bearing is held in place with a C-shaped retainer ring. Use heavy duty retainer ring pliers to remove the retainer ring. Remove the belleville springs and wear spacer (if used). The bearing can now be removed as described above.



9. Insert a brass rod through the piston bore until it makes contact with the air distributor. Push the air distributor and cylinder out of the casing.

To remove the air distributor and cylinder from Terronox 3 and Terranox 6 models push the piston toward the cylinder until it makes contact, then strike the piston struck end with a brass bar to unseat the cylinder retaining ring. The assembly can then be pushed out ot the casing.



10. The cylinders for Terranox 8 are held inplace by a cylinder stop ring located in a groove near the center of the casing. These rings can be removed by hand. The cylinder must first be removed from the backhead end of the casing and the piston must be removed from the chuck end of the casing before the cylinder stop ring can be removed.

11. Insert the brass rod in the opposite side of the casing and push the piston down until it contacts the piston retainer ring. Strike the piston with the brass rod to unseat the ring and remove it from the casing. These can be removed by hand. It may be helpful to use a flat-bladed screwdriver to move the ring from its groove.

12. Remove the piston from the chuck end of the casing.

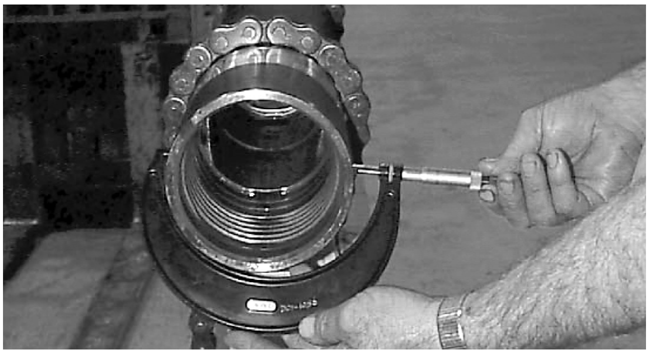
Terranox inspection

The following lists critical measurements which are required to determine what parts, if any, require replacement, repair or reversal. Refer to the specifications for finding the appropriate discard point clearances. Bear in mind that discard point clearances represent an increase in clearance of 50% over the maximum as-new clearance. In some applications this clearance increase may represent too much performance loss and in other applications the opposite may be true.

Note that deterioration in drill performance is caused by the increase in clearance between two parts. It is obviously more cost effective to replace the part which decreases clearance the most at the lowest cost. The specifactions chapter in the end of this manual tabulates all the "minimum material condition" diameters as new from which the wear on each part can be judged. This data should be used to determine which part(s) should be replaced when the net clearance is beyond the discard point.

1. Casing outside diameter should be measured roughly 50 - 75 mm (2 - 3 in.) from the end of the chuck end. Refer to the casing reverse and discard dimensions to determine if the casing should be replaced or reversed. If the casing is to be reversed refer to instructions in the assembly procedures.

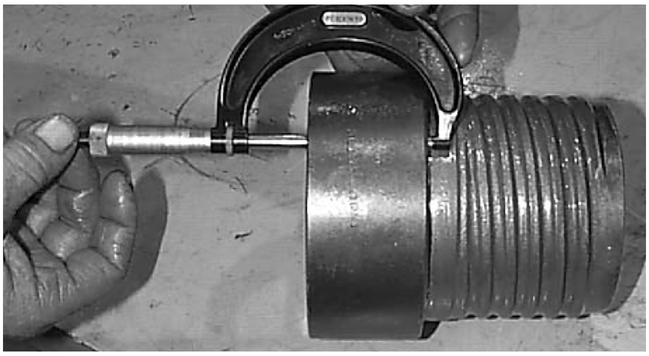
• It´s suggested that the chuck be replaced when the casing is reversed.



2. The chuck should be inspected from a few perspectives:

• The overall length of the chuck should be checked against specification. A short chuck can cause cycling problems, difficulty handling water and a rough drill operation.

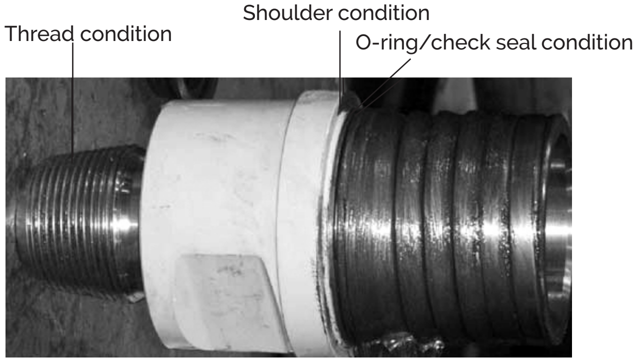
• The chuck should be replaced if spline wear is heavy or uneven. The chuck should be replaced if its minimum outside diameter is less than the casing discard point.



3.The backhead should be inspected from a few perspectives:

• The condition of the connection thread should be checked. A backhead should be replaced if the threads are torn, galled or damaged. The condition of the connection shoulder should also be inspected for a depression which means the thread will not make-up properly.

4. The backhead o-ring or check seal should be replaced if damaged in any way.



5. Inspect the check valve and spring. Replace if cracked, torn, or if the seal is brittle.

6. Inspect the air distributor guide and the air distributors guide stem for wear, scoring, or galling. Replace if worn beyond tabulated limits. A wear pattern on one side of the guide can indicate misalignment in the drill. If this condition is observed, check other parts carefully to identify the source of the misalignment.

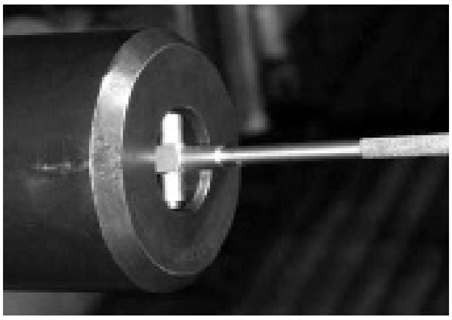
7. Inspect the air distributor guide stem or separate guide stem (Terranox 3 and Terranox 4).

8. Inspect the bearing bore just above the internal flutes for wear using a telescopic bore gage and a micrometer. Replace the bearing if the net clearance with a new bit has worn beyond the discard point. Replace the bearing o-ring if it has been worn or damaged.

9. Inspect the piston for wear using micrometers in the four locations noted below. The piston usually wears more than its mating parts so it´s likely that it will affect clearance the most. Record the dimensions for comparison to mating parts (cylinder, distributor and casing) to determine which part offers the most economical replacement cost.

• Measure the tail outside diameter in the location shown.

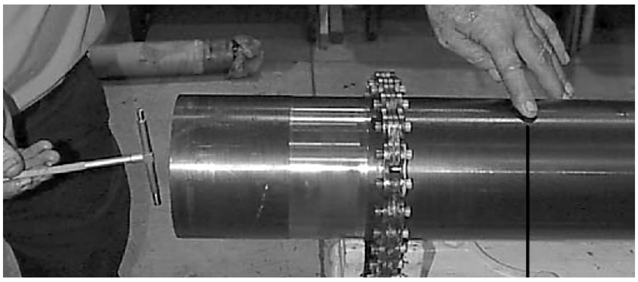
• Measure the tail bore and inspect for damage.



• Measure the large piston diameter in the location shown. NOTE: This is the most critical wear point on the drill, as it has the greatest influence on performance.

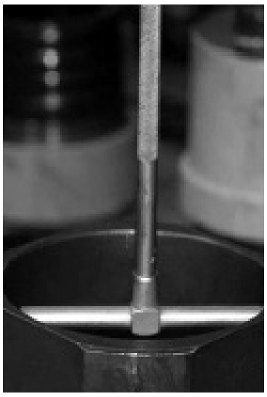
10. Carefully remove any sharp edges, burrs or nicks which have developed on the piston using a hand grinder. Do not overheat the piston...it will crack if overheated! If the piston face is heavily cavitated or pitted either use a ceramic facing tool to dress the face of the piston or use a well cooled grinder. In either case, a maximum of 1.52 mm (.060 in.) can be removed from the piston face.

11. If the casing does not require replacement due to outside diameter wear, measure the bore diameter using a telescopic bore gage and micrometer as shown. Record the measurement for later reference. Polish any rough or galled spots in the casing bore with emery cloth. Larger areas of damage can be smoothed out using a hand grinder with flap wheel. Be careful not to remove too much material from the bore to avoid degradation of hammer performance.



MEASURE AT THIS LOCATION (1/2'' past long undercut)

12. Inspect the cylinder for cracks or damage. Measure the diameter of the bore and record for later reference. Scored or galled areas of the bore can be polished with emery cloth.



13. Measure and record the following clearances from the dimesnions recorded.

• Bit to bit bearing. n Piston to casing.

• Piston to cylinder. n Piston to guide.

14. Determine which parts have suffered the most wear. Replace the part(s) needed to bring the clearances back to specification. The Clearence chart together with The Service Specifications chart, located in the end of this manual, may be useful for recording and determining which clearances require service.

Terranox assembly

The DTH assembly process is identical to the disassembly process yet in reverse. The following guidelines should be used:

• All parts should be clean and free of grit dirt and other foreign material.

• All nicks and burrs on parts should have been removed.

• All parts should be coated with rockdrill oil and preferably the same type to be used on the drilling rig

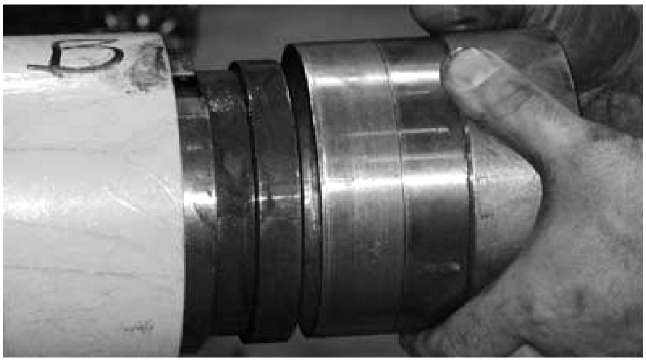
• All damaged o-rings should have been replaced if. All seals should be oiled or greased to avoid cutting or tearing.

• If corrosion is common it may be useful to spray the threads on the casing with a corrosion protector. Make sure the threads are clean and dry and sufficient drying time is allowed.

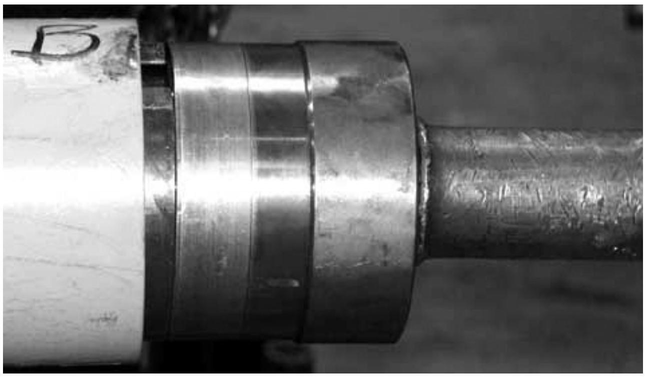
1. Install the backhead o-ring.

2. Install the cylinder into the backhead end of the casing.

For Terranox 3 and Terranox 6 models, compress the cylinder retainer in the deeper groove and push it into the casing. An optional installation tool may be helpful for this process. The assembly tools are described in the begining of this chapter.

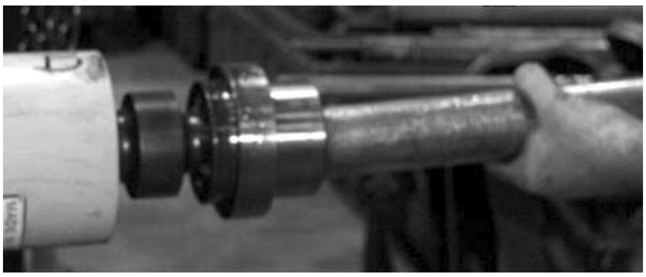


Use the assembly tool to insert the cylinder retainer into the casing.



Tap the assembly tool, cylinder with a brass bar to bring it to its proper position.

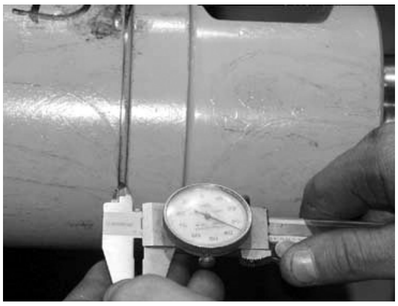
3. Install the air distributor o-ring (if removed) and install the air distributor into the cylinder. Tap the air distributor with a brass bar to seat it in place.



4. Install the check valve and spring insuring the valve cycles freely.

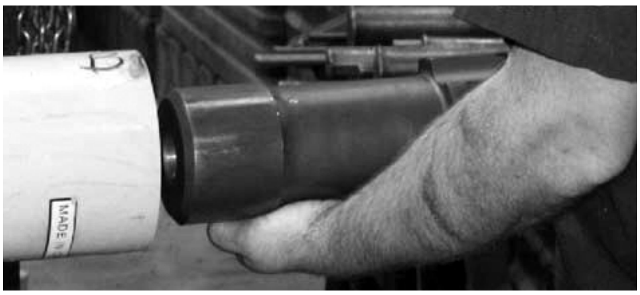
5. Arranging the belleville springs as shown, install the belleville stack and wear spacer (if used) on the air distributor.

6. Coat the backhead threads with thread lubricant and install in the casing. When made up hand tight, there will be a gap between the backhead and casing shoulders. If there is no gap, install a wear spacer above the belleville springs. this gap must be closed by torqueing the threaded joint before drilling commences.



8. Install the piston (small end first) in the casing from the chuck end. Push the piston by hand well past the bearing retainer ring groove. If the piston does not slide freely in the bore under hand pressure, check for dirt, debris, or distorted parts that are interfering with piston action.

Required gap size, the difference between minimum and maximum backhead standoff, for each hammer is presented in the Service specifications chart.



9. Install the piston retainer ring into the casing by starting it sideways, turning it to its proper orientation near the groove until it snaps into place. A brass rod will be needed to tap the ring into its place. Be sure to wear safety glasses as oil and grease in the groove may be expelled when the ring snaps in place.

Terranox 8 use a polymer piston retaining ring. These are installed by hand. A screwdriver may be helpful to insure the ring is evenly seated in its groove.

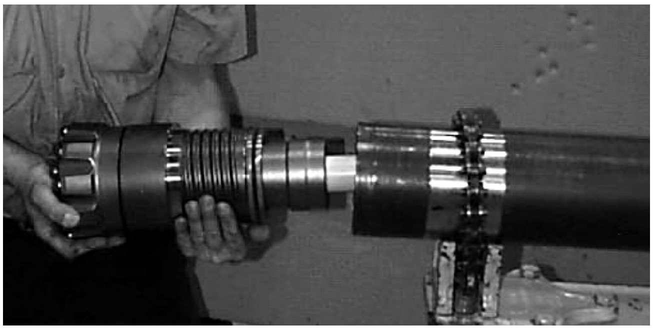
10. If your hammer is furnished with a bit bearing insure the bit bearing o-ring is in good condition. Slide the bearing (stepped end first) into the casing until it seats against the bearing retainer ring. The bearing may require tapping with a brass rod to keep it from binding in the casing bore. The piston may be used to seat the bearing by inserting it into the casing, large end first, and tapping the bearing in place. Heavy impact is not normally required. If the bearing is very tight, it may indicate damage to the bearing and/or casing.

11. If your hammer is furnished with a bearing retainer and/or belleville springs on the chuck end, assemble them as shown. A retaining ring pliers is required to install the retainer on the Terranox 6 model.

12. Coat the bit splines liberally with copper or zinc based thread compound and install the chuck on the bit.

13. Install the bit retaining ring and o-ring onto the bit and chuck.

14. Coat the chuck threads with copper or zinc based thread compound and thread the bit, chuck, and retainer ring assembly into the casing. Be sure to torque the chuck to specifications before drilling.



Exhaust tube replacement and installation

Exhaust tubes (footvalves) can become damaged during handling or physically eroded while in service, the net result is that they need to be serviced from time to time.

Tube failures will generally occur due to erosion caused by the jetting of water, oil and grit which is displaced as the piston strikes the bit. This form of failure is common in waterwell applications where injection rates are high. This high velocity jet of material actually erodes away the base of the tube and can eventually cause the tube to fail. Tube erosion can be reduced by insuring water is clean and free from particulate matter and that excessive fluid injection is avoided. It´s a good idea to monitor tube erosion and make replacements as needed before a hole is started to avoid a costly trip out of the hole.

Exhaust tubes can be removed by cutting off the remaining portion of the tube and prying the remaining piece out with a screwdriver. It may be useful to use a small rotary file to relieve the bore of the tube which remains in the bit. However, be careful not to touch the bit tube bore with the rotary file or a heat check followed by bit failure may result. The tube can also be heated slightly to soften the plastic. Avoid breathing fumes which may come from the heated plastic and also be careful not to overheat the bit.

A new exhaust tube can be installed by driving the tube into the bit with a rubber faced mallet or with a block of wood between the hammer and tube. Do not hit the tube directly with a metal hammer or the tube may be damaged. Alternatively, the tube can be pressed into the bore using a press or even the table and feed on a drilling rig. Be careful not to over-press the tube. Correct exhaust tube extension for each hammer is presented in the Service specifications chart.

Correct exhaust tube extension

Bits

Selecting the right bit

TerraRoc has a comprehensive range of DTH drill bits to match all conceivable applications. Each bit is made from quality alloy steel, and has been precision machined to produce a perfect body, heat treated to the required hardness, given surface compression for fatigue resistance, and fitted with precision buttons manufactured in-house.

Five basic designs are available: Convex, Flat front, SpeedBit, Concave, and Rocket bit. These are designed for specific applications for all rock types, hardness's and conditions.

Bit life and rate of penetration are the most important criteria in selecting the right bit for a particular application. In most cases, the focus is on productivity, so the fast cuttings removal features of the SpeedBit and Convex/Ballistic designs are preferable, to ensure the buttons are cutting clean, with the minimum of recrushing.

In hard and abrasive formations, however, the flat front design offers best bit life, having strong gauge rows with large spherical buttons which are easy to regrind and maintain. The SpeedBit offers improved productivity with the same gauge as the Flat front, but with ballistic buttons in the front for faster penetration. An alternative is the Concave design with spherical buttons.

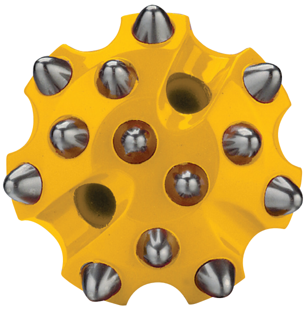
The Rocket bit can be dressed with ballistic buttons for use in soft to medium hard formations where fractured rock can be expected, or can be supplied with spherical buttons for hard and abrasive formations.

Bits are manufactured to match all diameters of Terranox hammers.

Drill bits – standard assortment

Convex front

Convex front, ballistic



General characteristics

All-round bit designed for hard and abrasive rock, but can be used in almost any formation. Preferred use is broken and unconsolidated formation. The DGR (double gauge row) design results in two overlapping outer rows. Available for bits > 203 mm (8").

Typical formations

• Granite (220 Mpa/32000 psi)

• Hard Limestone (200 Mpa/29000 psi)

• Basalt (300 Mpa/43500 psi)

Features – benefits

• Ballistic buttons – Improved protrusion. Better cuttings removal. Cutting ripping action in clay for faster penetration.

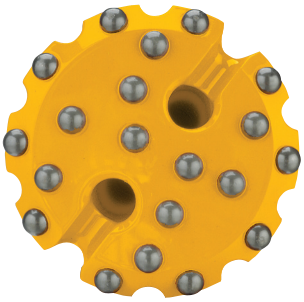
• Larger front flushing grooves– Improved cuttings removal. Faster penetration.

• Waist design for better flushing – Improved flow pattern for cuttings which results in less hammer wear.

• Increased clearance angle – Less sensitive for antitaper wear. Smoother run in the hole.

Flat front

Flat front HD



General characteristics

All round bit that is designed for hard and abrasive rock but can be use in almost any formation. Preferably used in abrasive formation with high silica content.

Typical formations

• Granite (220 Mpa/32000 psi)

• Hard Limestone (200 Mpa/29000 psi)

• Basalt (300 Mpa/43500 psi)

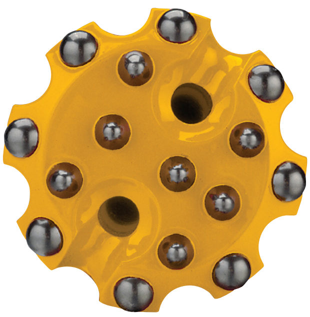
Features – benefits

• Spherical buttons optimized for abrasive rock – Maximum life in abrasive formation.

• Large front flushing grooves – Improved cuttings removal. Faster penetration. Less steel wear.

• Waist design for better flushing– Improve flow pattern for cutting. Cuttings deflected for less hammer wear.

SpeedBit



General characteristics

All round bit that is designed for medium to hard and abrasive rock, but can be use in almost any formation where high productivity is requested.

Typical formations

• Granite (220 Mpa/32000 psi)

• Hard Limestone (200 Mpa/29000 psi)

• Basalt (300 Mpa/43500 psi)

Features – benefits

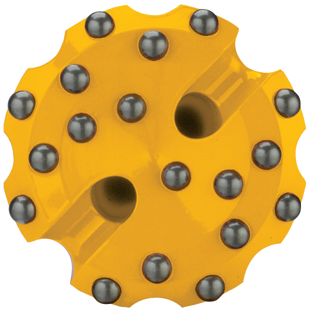
• Spherical buttons in gauge and ballistic buttons in front –Improved cuttings removal due to ballistic buttons. High penetration.

• Large front flushing grooves– Improved cuttings removal. Faster penetration. Less steel wear.

• Waist design for better flushing – Improved flow pattern for cutting. Cuttings deflected for less hammer wear.

Concave front

Concave front/Concave front DGR



General characteristics

All-round bit designed for hard and abrasive rock, but can be used in almost any formation. Preferred use is broken and unconsolidated formation. The DGR (double gauge row) design results in two overlapping outer rows. Available for bits > 203 mm (8").

Typical formations

• Granite (220 Mpa/32000 psi)

• Hard Limestone (200 Mpa/29000 psi)

• Basalt (300 Mpa/43500 psi)

Features – benefits

• Concave front – Excellent hole deviation control.

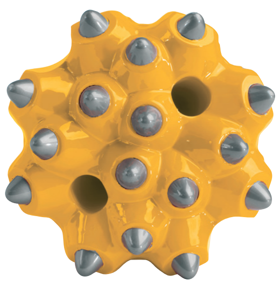
• Spherical buttons optimized for abrasive rock – Max life in abrasive formation.

• Large front flushing grooves – Improved cuttings removal. Faster penetration. Less steel wear.

• Waist design for better flushing – Improved flow pattern for cutting. Cuttings deflected for less hammer wear.

• Double gauge row of overlapping large spherical buttons – Strong wear resistant gauge.

Rocket bit



Convex front, ballistic

General characteristics

Super high penetration in soft to medium hard formations with low silica content. Can also handle difficult formation with clay intrusions where other bit designs will not work. Also available with spherical buttons for medium and abrasive formations.

Typical formations

• Limestone (100 Mpa/14500 psi)

• Hard Limestone (200 Mpa/29000 psi)

• Shale (5-100 Mpa/725-14500 psi)

Features – benefits

• Forged front where the ballistic buttons are imbedded into raised platforms on the bit – Improved protrusion. Better cuttings removal. Cutting ripping action in clay. Faster penetration.

• Waist design for better flushing – Improved flow pattern for cutting. Cuttings deflected for less hammer wear.

• Increased clearance angle – Less sensitive for antitaper wear. Smoother run in the hole.

Bit service

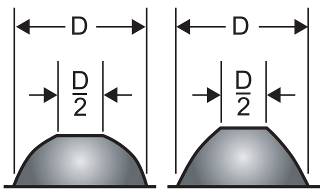
Bits need to be sharpened and serviced just like any other cutting tool would. The following provides tips and suggestions for proper bit maintenance.

The sharper a bit insert is the faster you will penetrate and the longer your bit will last. The objective is to penetrate the insert into the rock so that chips can be created. A sharper insert will penetrate deeper and generate larger cuttings. Also, the stresses on a sharp insert are lower those on a dull insert. Lower stresses mean longer insert life and reduced risk of socket bottom failures.

Keep those inserts sharp!

Grinding instructions for button bits

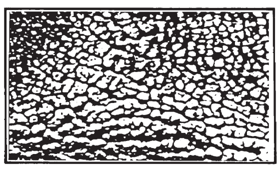
When to regrind



Button bits should be reground when the penetration rate drops, or if any of the cemented carbide buttons are damaged (fractured buttons should be ground flat). It is both practical and economical to redress the buttons when the wear flat reaches about ½ of the diameter of the button.

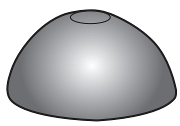
Note: This is a general recommendation.

Look out for “snake skin”



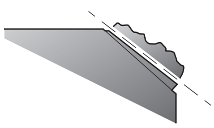
If microscopic fatigue cracks – so-called “snake skin” – begin to appear on the cemented carbide buttons, they must be ground away. In any event, bits should be reground after 300 metres of drilling at the most. This should be done even if there are no visible signs of wear and the penetration rate continues to be good. If snakeskin is not removed, the cracks will deepen and ultimately result in button fracture.

Do not grind away too much cemented carbide



Do not grind too much on the top of the buttons. Let a few millimetres of the wear flat remain on top of the button.

Always grind broken buttons flat



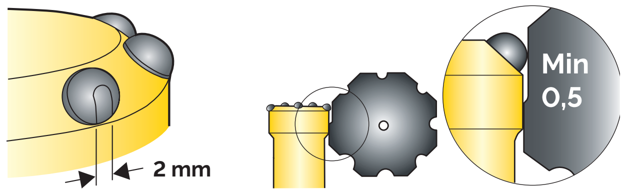
A drill bit can remain in service as long as the gauge buttons maintain the diameter of the bit. Fractured buttons must always be ground flat to prevent chips of cemented carbide from damaging the other buttons.

Avoid grinding the perimeter

Gauge-button anti-taper has to be removed by grinding, although excessive reduction of the bit diameter should be avoided. Leave about 2 mm of the wear flat.

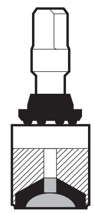
If necessary, remove some of the bit-body steel below the gauge buttons, so that a clearance (taper) of 0,5 mm is maintained.

If the flushing holes start to deform, open them up with the aid of a rotary burr or steel file.

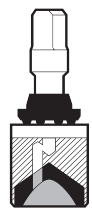


Diamond grinding wheels and cups

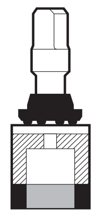
Diamond grinding wheels and diamond grinding cups are used to redress cemented carbide buttons. Boron nitride grinding cups and wheels are used to remove body steel around the buttons.



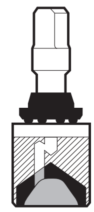
Grinding cups for spherical buttons



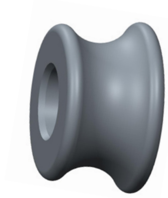
Grinding cups for ballistic buttons



Grinding cups for removing body steel



Grinding cups for Trubbnos buttons



Grinding cups for spherical buttons

Grinding cups for ballistic buttons

Grinding cups for Trubbnos buttons

General and safety rules for grinding

• Always use grinding wheels and gridning cups with correct form and dimension for the buttons you will regrind.

• Always use water flushing with grinding wheels. Use water also when grinding indoors and underground with grinding cups.

• Be sure that the bit is securely fixed in position.

• Make sure there is no explosive in the flushing holes of the bit.

• Use protective goggles and other safety equipment when grinding.

Troubleshooting guide

The majority of DTH operating problems can be traced to improper operation. These troubleshooting charts will help you by suggesting a probable cause and a recommended remedy.

Problem	Cause(s)	Remedy(s)
Rough-erratic operation	1. Too much water injection	1. Reduce level of water injection.
	2. Chuck has worn too much	2. Inspect chuck length for correct body length. A short chuck will restrict air needed to return piston. Note that body length is the distance from the shoulder which contacts the casing to the shoulder that contacts the bit.
	3. Rotation speed too slow	3. Increase rotation speed to get no more than 13 mm (1/2 in.) advance per revolution. Watch flat on carbide; if it´s on the leading edge of the insert rotation´s too slow.
	4. Feed too hard	4. Set feed pressure (decrease holddown orincrease holdback) just until pulsation in rotation pressure falls and pressure is steady.
	5. Worn bit bearing	5. Replace bit bearing. Leakage past bit bearing may cause piston to lack upstroke force making cycle erratic.
	6. Worn piston exhaust tube	6. Inspect piston bore and exhaust tube vs. bore or exhaust tube. specification. Replace if needed. Leakage past this clearance can reduce piston upstroke force making cycle erratic.
Low penetration/high pressure	1. Chuck has worn too much	1. Inspect chuck length for correct body length. A short chuck will restrict air needed to return piston.
	2. Too much water injection	2. Reduce level of water injection
	3. Contamination (rubber hose, etc.) jammed in hammer	3. Remove obstruction which may be restricting the air flow.
	4. Exhaust tube projection	4. Check projection vs. specifications repair tube.
Low penetration/low pressure	1. Lack of oil	1. Insure lubricator is working and hammer is pressure. getting coated with oil. Check bit blow ports for oil film.
	2. Worn drill clearances	2a. Inspect piston for wear particularly on large diameter just beneath scallops. This is the most sensitive diameter. Check other diameters; for wear. Compare all to specification. 2b. Inspect guide diameter for wear. Compare with specification and replace if necessary. 2c. Check cylinder bore for wear. Compare to specification and replace if necessary. 2d. Check casing bore for wear. Compare tospecification and reverse or replace if necessary. 2e. Check bearing bore for wear. Compare to specification and replace if necessary.
Drill running off bottom	1. Worn piston	1. Inspect large diameter of piston for wear. Leakage past the large diameter can cause the piston to cycle when off bottom.
	2. Excessive water injection	2. Try reducing water injection level. Water inhibits the air venting process which is needed to shut the hammer off.
	3. Debris (cuttings, mud) between chuck & bit spline	3. Clear debris.

Problem	Cause(s)	Remedy(s)
Chuck hard to loosen	1. Poor gripping	1a. Don´t grip over threads. 1b. Insure tong jaws are sharp.
	2. Conditions	2a. Try using breakout washer. 2b. Tighten chuck completely before drilling.
Compressor unloading	1. Excessive water injection	1. Reduce water injection rate.
	2. Mud Rings	2. Clear mud ring. Increase water injection. Consider adding foam.
Hammer won´t start	1. Mud or dirt in hammer	1. Disassemble, clean, inspect & repair hammer. Check for proper function of check valve.
	2. Broken exhaust tube	2. Replace tube. Inspect Bearing and Chuck.
	3. Broken internal parts	3. Replace broken parts.
Component failures	1. Piston cracked through	1a. Lack of lubrication could cause frictional cracks. large diameter. Check lubricator and insure oil film is developed on bit blow holes. 1b. Wrenching over wrong location distorts casing and causes frictional rubbing with piston. Apply tong wrench pressure in correct location. 1c. Fighting or getting stuck in hole heats and distorts casing bore causing frictional heat and cracks on piston. Flood tool with water when stuck. 1d. Collaring on an angle or feeding hard through voided, faulted or broken ground can cause casing to distort and rub piston causing cracks. Use light feed when going through tough conditions.
	2. Piston struck end cupping	2a. Usually a sign of underfeeding. Increase feed or breaking. until rotation pressure pulses and then back down till smooth. 2b. Cavitation from excess water injection can cause small pits in piston face. These pits turn into cracks. Avoid excessive water injection.
	3. Cracked casing	3a. Hammering, welding and wrenching in wrong location can fail casings; avoid these practices & use sharp tong jaws to loosen connections. 3b. Corrosion from internal undercuts and threads; use good quality (neutral pH) water and flush with oil when finished drilling. If possible, coat threaded areas undercuts and bore of casing with corrosion protector such as LPS Hardcoat. 3c. Look for beat in chuck which could allow the piston to stroke far enough to contact air distributor and overstress the casing. Replace chuck if worn more than specification. 3d. Casing has worn beyond discard point. Measure casing OD about 51 mm (2 in.) from chuck end. Compare to specification and replace if needed. 3e. Backhead or chuck thread loose. Be sure threaded joints are tight. Do not reverse otate or allow hammer to cycle without rotation.

Problem	Cause(s)	Remedy(s)
Component failures cont.	4. Rolled over chuck	4. Underfeeding can cause the bit to rebound into shoulder of the chuck and generate a rolled up edge. Increase feed force.
	5. Cracked backhead-body	5. Fighting from hole and pulling backhead through caved-in materials creates frictional heat. Rotate slowly and/or flood with water when stuck.
	6. Cracked backhead	6. Look for evidence of connection moving on threaded connection. contact shoulder. Connection shoulder may be worn allowing movement. Replace/ repair adapter sub or rod.
Breaking exhaust tubes	1. Erosion	1a. Water jetting erodes base of bit tube at striking surface. Reduce level of water injection. 1b. Contaminants in water mix and cause abrasive blast at base of exhaust tube. Use clean water.
	2. Damage	2a. Damaging tubes when changing bits. Be careful to thread casing onto chuck while vertical and in alignment. 2b. Use care when transporting bits to avoid damage to tube. Keep bit in box until needed.
	3. Bit tube bore small	3. The tube bore of a bit can become deformed and pinch the tube. Look for a rolled over edge or deformation at the top of the bit bore. Remove by grinding away lip.
Chuck loosening	1. Running loose	1a. Refer to proper feed settings. 1b. Avoid feathering feed in loose ground or at end of rod.
	2. Improper make up torque	2. Tong chuck tight before drilling.

Specifications

Physical and maintenance specifications

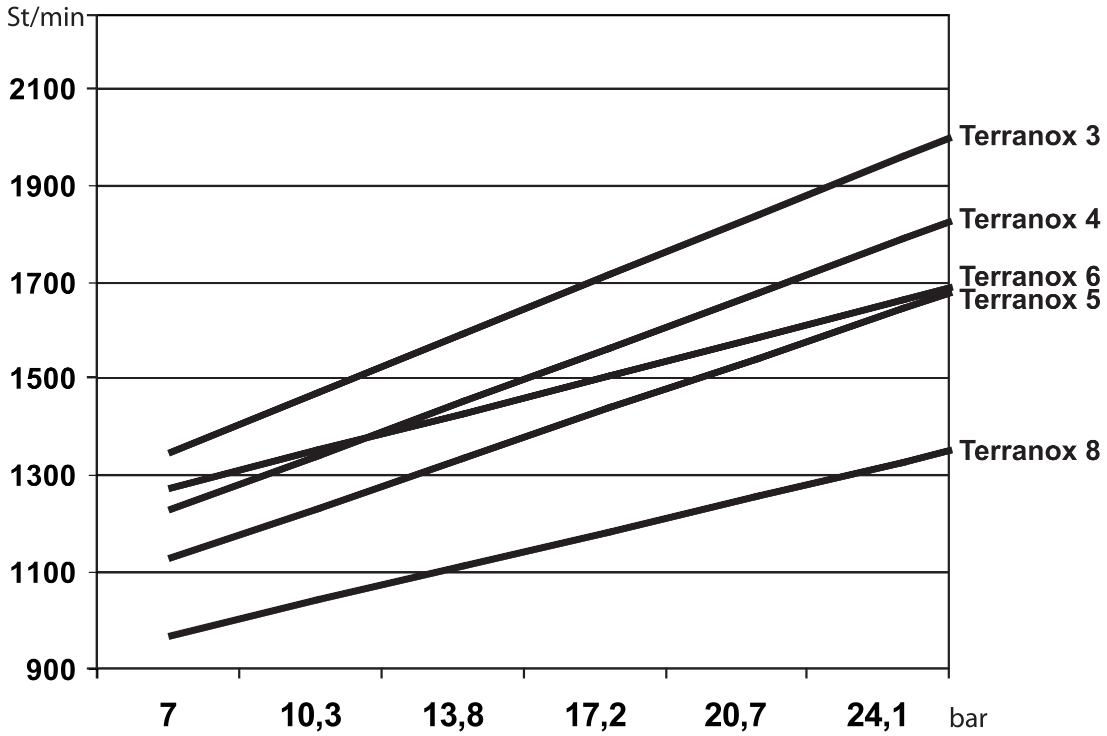
General specifications

	Terranox 3	Terranox 4	Terranox 5	Terranox 6	Terranox 8
Connection	2-3/8 API reg pin	2-3/8 API reg box	3-1/2 API reg pin	3-1/2 API reg pin	4-1/2 API reg pin
Outside diameter, mm (in.)	79.4 (3.13)	92.2 (3.63)	115.1 (4.53)	136.7 (5.38)	181.1 (7.13)
Length w/o bit shoulder to shoulder, mm (in)	901.7 (35.5)	1049.0 (41.3)	1168.4 (46.0)	1254.8 (49.4)	1442.7 (56.8)
Length with bit extended, mm (in.)	1000.8 (39.4)	1158.2 (45.6)	1295.4 (51.0)	1404.6 (55.3)	1612.9 (63.5)
Length with bit retracted, mm (in.)	970.3 (36.1)	1130.3 (44.5)	1295.4 (51.0)	1404.6 (55.3)	1559.6 (61.4)
Weight w/o bit, kg (lb)	29.5 (65)	38.6 (85)	68.6 (151)	102.7 (226)	177.3 (390)
Backhead across flats, (in.)	1-3/4 X 2-1/2 AF	1-3/4 X 2-1/2 AF	2 X 3-1/2 AF	2 X 4 AF	2-1/2 X 5-7/8 AF
Minimum bit size, mm (in.)	89.9 (3.54)	104.9 (4.13)	130.3 (5.13)	152.4 (6.00)	200.2 (7.88)
Maximum bit size, mm (in.)	99.8 (3.93)	127.0 (5.00)	152.4 (6.00)	215.9 (8.50)	270.0 (10.63)
Bore, mm (in.)	64.03 (2.521)	74.88 (2.948)	91.97 (3.621)	112.57 (4.432)	147.85 (5.821)
Piston weight, kg (lb)	5.5 (12)	7.8 (17.1)	15.5 (34)	20.5 (45)	37.3 (82)
Stroke, mm (in.)	101.6 (4.00)	101.6 (4.00)	101.6 (4.00)	101.6 (4.00)	101.6 (4.00)
Maximum pressure differential, bar (psig)	24.1 (350.0)	24.1 (350.0)	24.1 (350.0)	24.1 (350.0)	24.1 (350.0)
Maximum choke diameter, mm (in.)	8.89 (0.35)	8.89 (0.35)	9.65 (0.38)	12.70 (0.50)	13.46 (0.53)
Make-up torque, N-m (ft-lb)	4062 (3000)	5416 (4000)	6770 (5000)	8124 (6000)	10832 (8000)

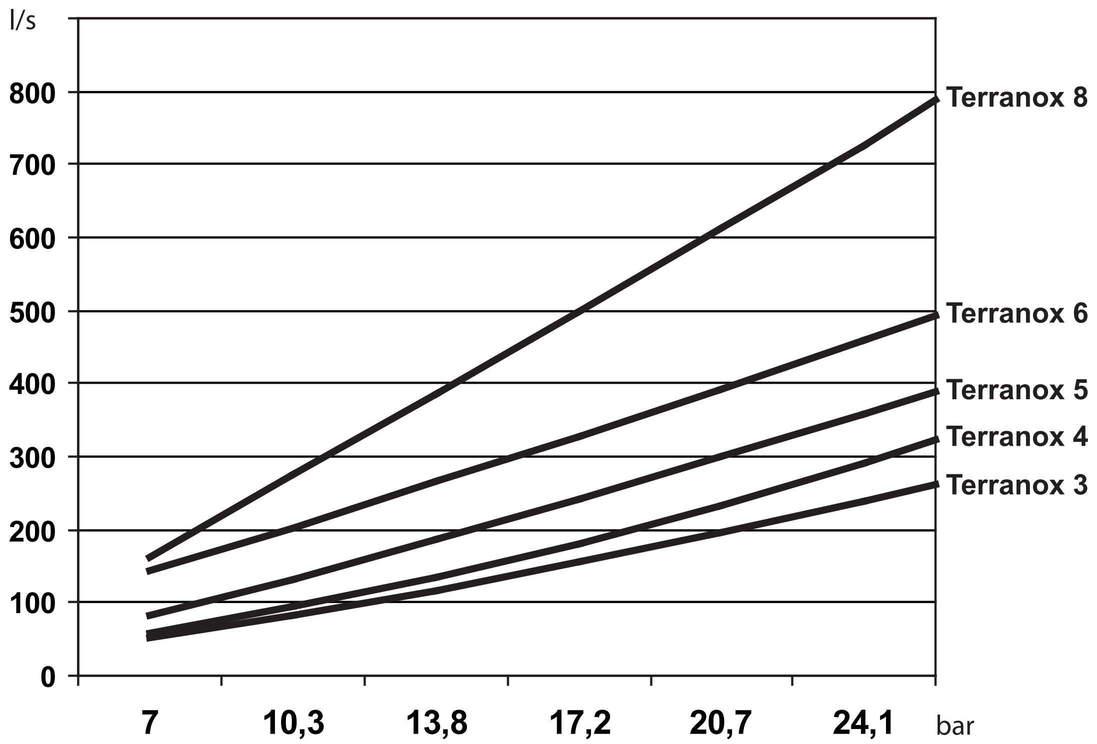
Operational specifications

	Terranox 3	Terranox 4	Terranox 5	Terranox 6	Terranox 8
Feed force, lbs	1500 - 2000	1500 - 2000	1500 - 2000	1500 - 2000	2000 - 3000
Rotation speed, rpm	50 - 70	50 - 70	50 - 70	40 - 60	30 - 50

Hammer frequence at different working pressures



Air consumption at different working pressures



Air consumption and hammer frequence

	Terranox 3	Terranox 4	Terranox 5	Terranox 6	Terranox 8
100 psi / 6,9 bar, m3/min (scfm)	3.1 (111)	3.5 (125)	79.4 (175)	5.5 (194)	9.7 (345)
100 psi (bpm)	1347	1145	1269	1122	1000
150 psi / 10,3 bar, m3/min (scfm)	5.0 (176)	5.6 (199)	8.0 (283)	9.2 (327)	16.5 (583)
150 psi (bpm)	1486	1335	1380	1301	1100
200 psi / 13,8 bar, m3/min (scfm)	7.0 (248)	8.1 (285)	11.2 (396)	13.2 (467)	23.2 (821)
200 psi (bpm)	1625	1505	1489	1453	1200
250 psi / 17,2 bar, m3/min (scfm)	9.3 (328)	10.9 (384)	14.5 (513)	17.3 (611)	29.9 (1060)
250 psi (bpm)	1764	1656	1596	1576	1300
300 psi / 20,7 bar, m3/min (scfm)	11.7 (414)	14.0 (495)	17.9 (634)	21.5 (762)	36.7 (1299)
300 psi (bpm)	1904	1787	1701	1671	1400
350 psi / 24,1 bar, m3/min (scfm)	14.3 (506)	17.5 (618)	21.5 (760)	25.9 (917)	43.4 (1538)
350 psi (bpm)	2043	1898	1804	1738	1500

Calculating feed force

How much feed force is needed can be calculated by multiplying the effective bit section area with the working air pressure.

f = Feed pressure, p = Air pressure, a = Effective shank area (~ piston area)

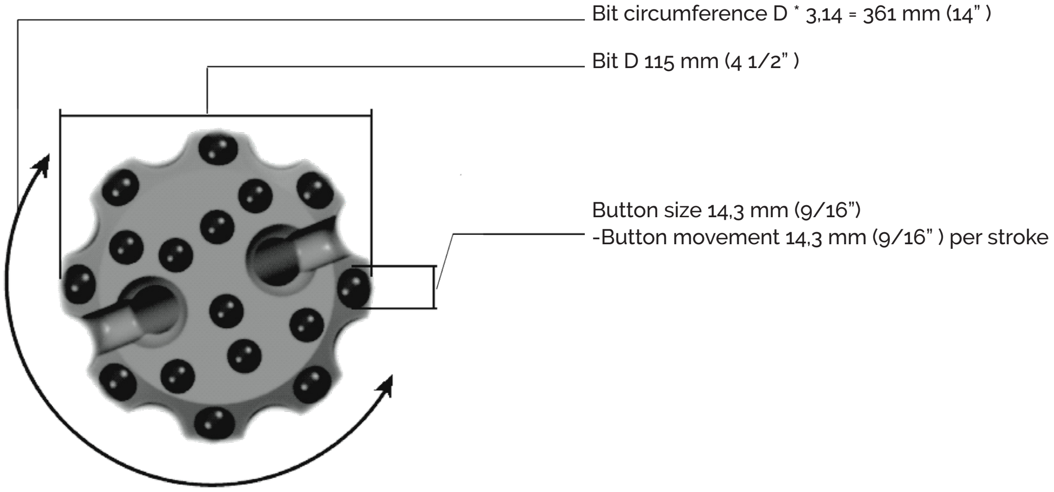
f = p * a

Example: Terranox 6; p = 25 bar, a ~ 100 cm2. f = 25*100 = 2 500 kp (25 kN)

Calculating recomended rotation speed

A hammers recomended rotation speed can be calculated by dividing the hammers stroke frequency by the hammers strokes by turn. Stroke by turn is calculated by dividing the bit circumference by the button size/ movement.

Example: Terranox 4 with a stroke frequency at 24,1 bar (350 psi) of 1898 strokes per minute is beeing operated with a 115 mm (4 1/2 in.) bit with 14,3 mm (9/16 in.) buttons.



Bit circumference D * 3,14 = 361 mm (14 in.)

Strokes per turn = 361 mm (14 in.) / 14,3 mm (9/16 in.) = 25

Recomended rotation = 1898 / 25 = 76 rpm

Service specifications

	Terranox 3	Terranox 4	Terranox 5	Terranox 6	Terranox 8
Casing discard diameter, mm (in.)	73.7 (2.90)	86.1 (3.39)	106.4 (4.19)	127.0 (5.00)	169.4 (6.67)
Casing reverse diameter, mm (in.)	n/a	n/a (3.46)	108.0 (4.25)	130.0 (5.12)	172.7 (6.80)
Minimum chuck length, mm (in.)	47.0 (1.85)	47.5 (1.87)	44.5 (1.75)	54.6 (2.15)	84.1 (3.31)
Max. worn piston to casing clearence, mm (in.)	0.27 (0.010)	38.33 (1.509)	0.19 (0.007)	0.23 (0.009)	0.27 (0.011)
Min new piston large OD	63.68 (2.515)	74.88 (2.948)	91.97 (3.621)	112.57 (4.432)	147.85 (5.821)
Max new casing ID	64.06 (2.522)	100.43 (3.954)	92.10 (3.626)	112.73 (4.438)	148.03 (5.828)
Max. worn piston to cylinder clearence, mm (in.)	0.23 (0.009)	0.27 (0.011)	0.23 (0.009)	0.27 (0.011)	0.34 (0.014)
Min new piston tail OD	51.38 (2.023)	60.86 (2.396)	76.07 (2.995)	93.52 (3.682)	121.79 (4.795)
Max new cylinder ID	51.54 (2.029)	61.04 (2.403)	76.23 (3.001)	93.70 (3.689)	122.02 (4.804)
Max. worn piston to guide clearence, mm (in.)	0.53 (0.021)	0.27 (0.011)	0.34 (0.013)	0.38 (0.015)	0.34 (0.013)
Min new piston tail ID	21.03 (0.828)	24.51 (0.965)	30.99 (1.220)	33.93 (1.336)	46.56 (1.833)
New guide OD	20.68 (0.814)	24.33 (0.958)	30.76 (1.211)	33.68 (1.326)	46.33 (1.824)
Max. worn bit to bearing clearence, mm (in.)	0.46 (0.018)	n/a (n/a)	n/a (n/a)	0.30 (0.012)	n/a (n/a)
Max new bearing ID	52.53 (2.068)	n/a (n/a)	n/a (n/a)	87.33 (3.438)	n/a (n/a)
Min new bit shank OD	52.22 (2.056)	63.78 (2.511)	80.77 (3.180)	0.38 (0.015)	n/a (n/a)
Max. worn bit to chuck clearence, mm (in.)	0.50 (0.019)	0.46 (0.018)	0.46 (0.018)	0.38 (0.015)	0.57 (0.022)
Max new chuck ID	55.02 (2.166)	65.07 (2.562)	84.46 (3.325)	101.70 (4.004)	129.13 (5.084)
Min new bit shank OD	54.69 (2.153)	67.77 (2.550)	84.15 (3.313)	101.45 (3.994)	128.75 (5.069)
Exhaust tube extension, mm (in.)	58.93 (2.32)	56.63 (2.19)	63.50 (2.5)	50.80 (2.00)	50.80 (2)
Maximum backhead standoff	3.10 (0.122)	n/a (n/a)	7.52 (0.296)	4.22 (0.166)	7.62 (0.3)
Minimum backhead standoff	1.47 (0.058)	n/a (n/a)	1.93 (0.076)	2.57 (0.101)	5.99 (0.236)

Terranox clearance worksheet

Dimensions		Measured dimension	As new diameter from table	Actual wear	Measured clearance	Discard clearance from table
	ID	A	B	C	D	E
Piston to casing					2A-1A	
Large piston OD	1			1B-1A		
Casing ID	2			2A-2B		
Piston to cylinder					4A-3A	
Small piston OD	3			3B-3A		
Cylinder ID	4			4A-4B		
Piston to guide					5A-6A	
Piston tail ID	5					
Guide OD	6					
Bit to bearing						
Bit bearing ID	7			7A-7B		
New bit tail OD	8			8B-8A		

DTH requirements

Minimum guidelines for mounting specifications

Rotation torque: Roughly 27 N-m per mm (500 ft-lb per inch) maximum of bit.

Rotation speed: 10 to 90 rpm.

Feed force: 9 kg per mm (500 lb per inch) of hammer maximum

(i.e. Terranox 6 needs 1360.8 kg (3000lb)).

Hold back force: Dependent on hole depth and string weight. Must be capable of maintaining 226.8 kg per mm (500 lb per inch) at depth.

Operating pressure: 25 bar (350 psig) maximum.

Volume:.165 - .22 m3/min per mm (150 - 200 scfm per inch) of hammer diameter.

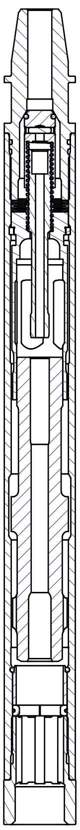
Lubrication: .16 l (1/3 pint) per hour per 2.8 m3/min (100 scfm).

Minimum requirements for compressor capacity and pressure

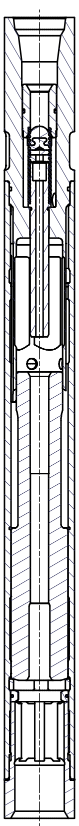
The pressure and production developed by a DTH will be related to the air flow passing through the drill. The pressure and performance of a DTH is related to the SCFM delivered by the compressor. To determine what pressure a DTH will carry (without fluid injection and well oiled) you need to take into account the actual SCFM (or mass flow) of air delivered by the compressor. Compressors are rated in ACFM which only equals SCFM at standard conditions of sea level and 16˚ C (60˚ F) inlet temperature. As the inlet air density either increases or decreases due to temperature and altitude changes, the SCFM delivery of a compressor will change.

Cross sections of the Terranox hammers

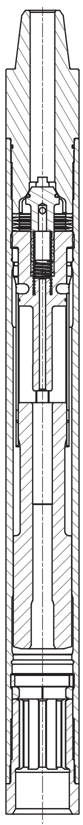
Terranox 3



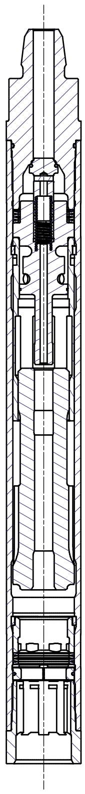
Terranox 4



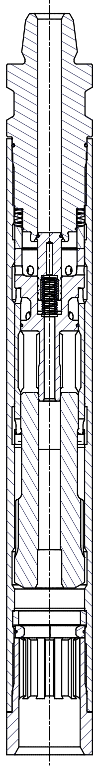
Terranox 5



Terranox 6



Terranox 8



Disposal and environmental instructions

Always follow the local regulations in force for the handling and disposal of waste.

Oil and Grease

Leaking hydraulic connections and lubrication grease are environmentally hazardous. Changing oils, replacing hydraulic hoses and different types of filter can be environmentally hazardous.

• Always collect oil residue, oil spillage, waste with oil content, and lubrication grease residue and spillage. Treat in accordance with local regulations.

• Use biodegradable hydraulic fluids and lubrication oils for TerraRoc products wherever possible. Contact your local TerraRoc office for further information.

Chemicals

Chemicals such as flushing additives, other additives and coolants can be environmentally hazardous.

• Dispose of chemicals such as drilling additives, other additives, glycol etc. according to the manufacturer's instructions.

• Treat in accordance with local regulations for both handling and waste disposal.

• Avoid the use of leaning agents containing solvents like carbon tetrachloride. There are environmentally better alternatives now available on the market.

Dust

Rock dust can pose a health danger.

• Use dust binding oil.

Metals (steel, aluminum, etc.)

• These products are recyclable and should be taken care of according to national regulations.

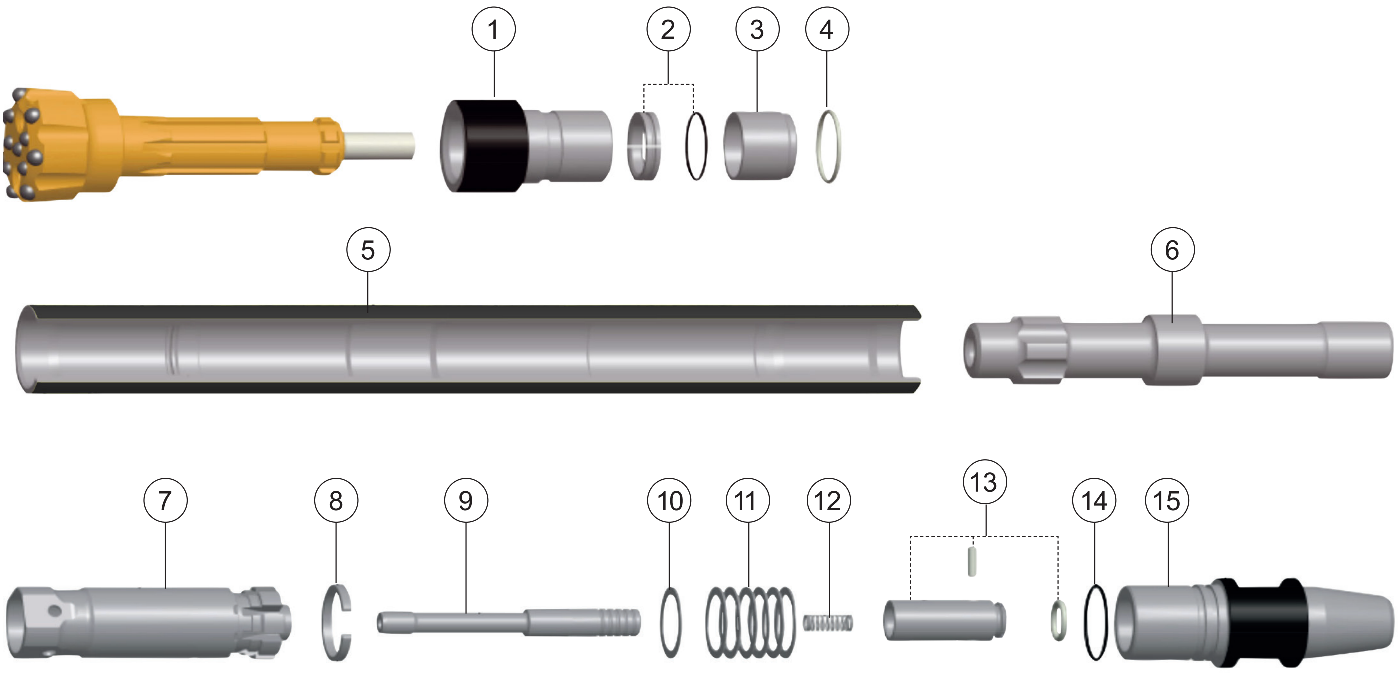
Plastics and rubber

• These products are often labeled according to different classes. In those cases they are recyclable and should be taken care of according to national regulations.

Spare parts list

Terranox 3

Down-the-hole hammer



Ref.	Description	Qty	Part number
	Terranox 3 DTH hammer 2 3/8" API Reg Pin		**8393 0826 35**
1	Terranox 3 chuck DHD 3.5	1	8393 0826 53
2	Retainer rings T3 incl o-ring	1	8393 0826 52
3	Bit bearing T3	1	8393 0826 48
4	O-Ring, bit bearing T3	1	8393 0826 47
5	Hammer casing T3	1	8393 0826 46
6	Piston T3	1	8393 0826 45
7	Inner cylinder T3	1	8393 0826 43
8	Surclip T3	1	8393 0826 39
9	Guide T3	1	8393 0826 44
10	Retainer ring T3	1	8393 0826 42
11	Belleville spring T3 (6 pcs)	1	8393 0826 38
12	Check valve spring T4 & T3	1	8393 0826 37
13	Check valve body assembly T3	1	8393 0826 31
14	O-Ring, backhead T3	1	8393 0826 36
15	Backhead T3 2 3/8 API REG PIN	1	8393 0826 30

Ref.	Description	Qty	Part number
	Service kit for Terranox 3		**8393 0827 23**
1	Terranox 3 chuck DHD 3.5	1	8393 0826 53
2	Retainer rings T3 incl o-ring	1	8393 0826 52

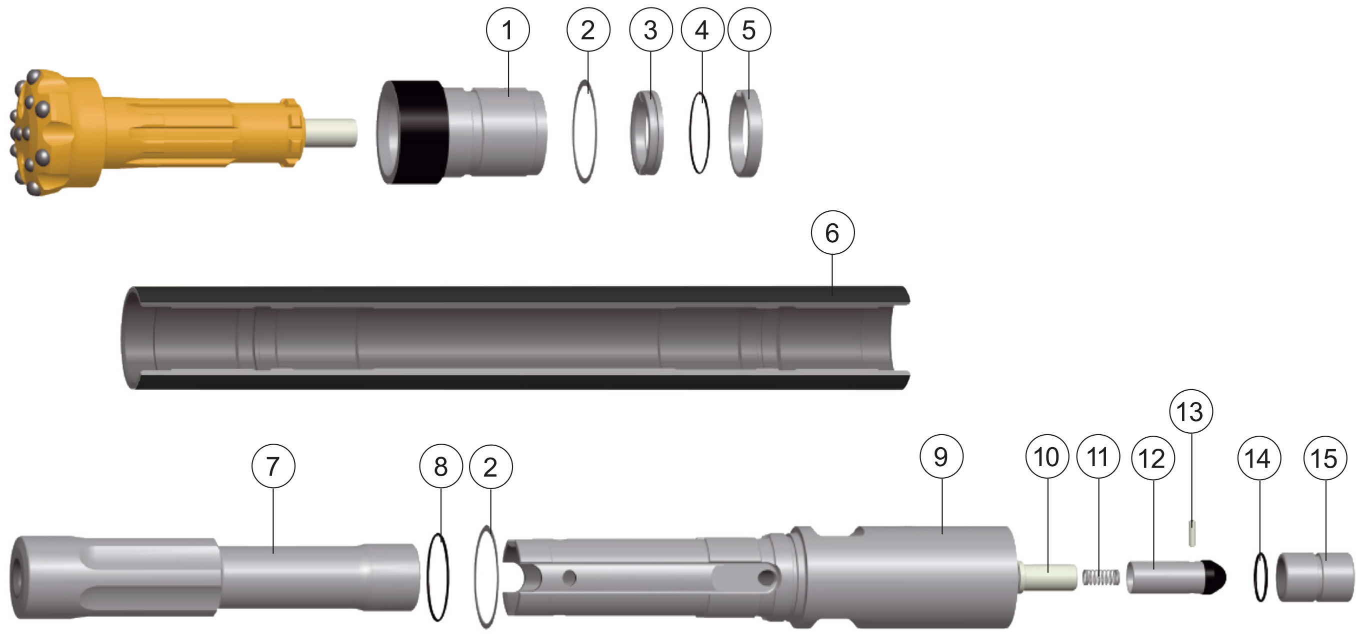
Ref.	Description	Qty	Part number
	Tuning kit for Terranox 3		**8393 0827 28**
4	O-Ring, bit bearing T3	1	8393 0826 47
11	Belleville spring T3	6	8393 0826 38
13	Check valve body assembly T3	1	8393 0826 31
14	O-Ring, backhead T3	1	8393 0826 36
	O-Ring, retainer ring T3	1	8393 0826 49

Wear limits	mm	inch
Casing min. OD	73.7	2.90
Min. chuck length	47.0	1.80
Max. worn piston to casing clearance	0.27	0.010
Max. worn piston to guide clearance	0.53	0.021
Exhaust tube extension	58.93	2.32

Spare parts list

Terranox 4

Down-the-hole hammer



Ref.	Description	Qty	Part number
	Terranox 4 DTH hammer 2 3/8" API Reg Box		**8393 0826 40**
1	Terranox 4 chuck DHD 340	1	8393 0826 64
2	Spacer T4	1	8393 0826 65
3	Retainer ring T4	1	8393 0826 63
4	O-Ring, retainer ring T4	1	8393 0826 66
5	Surclip T4	1	8393 0826 62
6	Hammer casing T4	1	8393 0826 59
7	Piston T4	1	8393 0826 61
8	O-ring for backhead	1	8393 0826 57
9	Cylinder T4 with backhead 2 3/8" API REG BOX	1	8393 0826 54
10	Guide T4	1	8393 0826 58
11	Check valve spring T4 & T3	1	8393 0826 37
12	Check valve body assembly T4	1	8393 0827 33
13	Check valve plug package T3 & T4	1	8393 0826 34
14	O-Ring, check valve T4	1	8393 0826 56
15	Body seat T4	1	8393 0826 55

Ref.	Description	Qty	Part number
	Service kit for Terranox 4		**8393 0827 24**
1	Terranox 4 chuck DHD 340	1	8393 0826 64
2	Spacer T4	2	8393 0826 65
3	Retainer ring T4	1	8393 0826 63
4	O-Ring, retainer ring T4	1	8393 0826 66
10	Guide T4	1	8393 0826 58

Ref.	Description	Qty	Part number
	Conversion from standard top sub thread 2-3/8 API reg box to pin	1	3702 0070 00
	Pin adapter	1	3702 0070 00

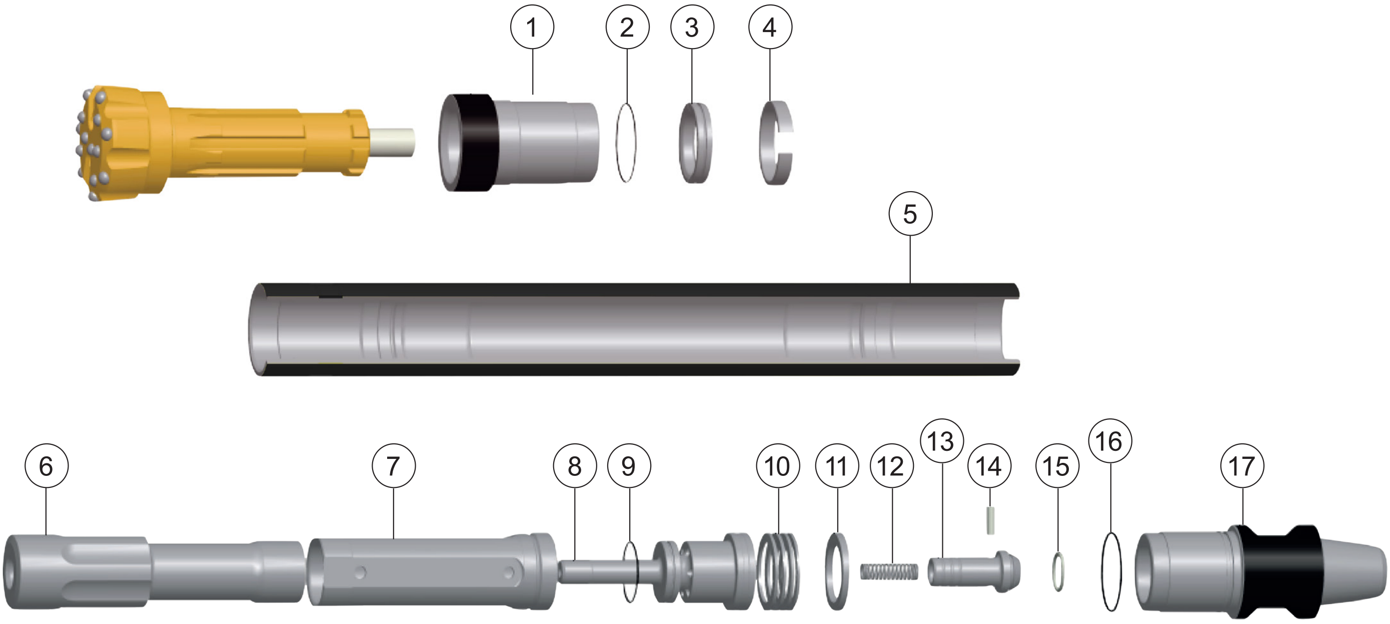
Ref.	Description	Qty	Part number
	Tuning kit for Terranox 4		**8393 0827 29**
4	O-Ring, retainer ring T4	1	8393 0826 66
8	O-Ring, backhead T4	1	8393 0826 57
12	Check valve body assembly T4	1	8393 0827 33
13	Check valve plug package T3 & T4	2	8393 0826 34
14	O-Ring, check valve T4	1	8393 0826 56

Wear limits	mm	inch
Casing min. OD	86.10	3.39
Max. worn piston to casing clearance	0.18	0.007
Max. worn cylinder to guide clearance	0.28	0.011
Max. worn piston to guide clearance	0.28	0.011

Spare parts list

Terranox 5

Down-the-hole hammer



Ref.	Description	Qty	Part number
	Terranox 5 DTH hammer 3 1/2" API Reg Pin		8393 0826 50
1	Terranox 5 chuck DHD 350	1	8393 0826 84
2	O-ring, retainer ring T5	1	95086351
3	Retainer ring T5	1	8393 0826 83
4	Piston retainer ring T5	1	8393 0826 81
5	Hammer casing T5	1	8393 0826 79
6	Piston T5	1	8393 0826 78
7	Inner hammer cylinder T5	1	8393 0826 77
8	Air distributor T5	1	8393 0826 76
9	O-Ring, air distributor T5	1	8393 0826 75
10	Bellville spring T5 (4 pcs)	1	8393 0826 73
11	Wear washer T5	1	8393 0826 72
12	Check valve spring T5 +T6	1	8393 0826 74
13	Check valve body assembly T5 & T6	1	8393 0826 69
14	Check valve plug package T5, T6 & T8	1	8393 0826 71
15	O-Ring, check valve T5 & T6	1	8393 0826 70
16	O-Ring, backhead T5	1	8393 0826 68
17	Backhead T5 3 1/2" API REG PIN	1	8393 0826 67

Ref.	Description	Qty	Part number
	Service kit for Terranox 5		8393 0827 25
1	Terranox 5 chuck DHD 350		8393 0826 84
3	Retainer ring T5	1	8393 0826 83

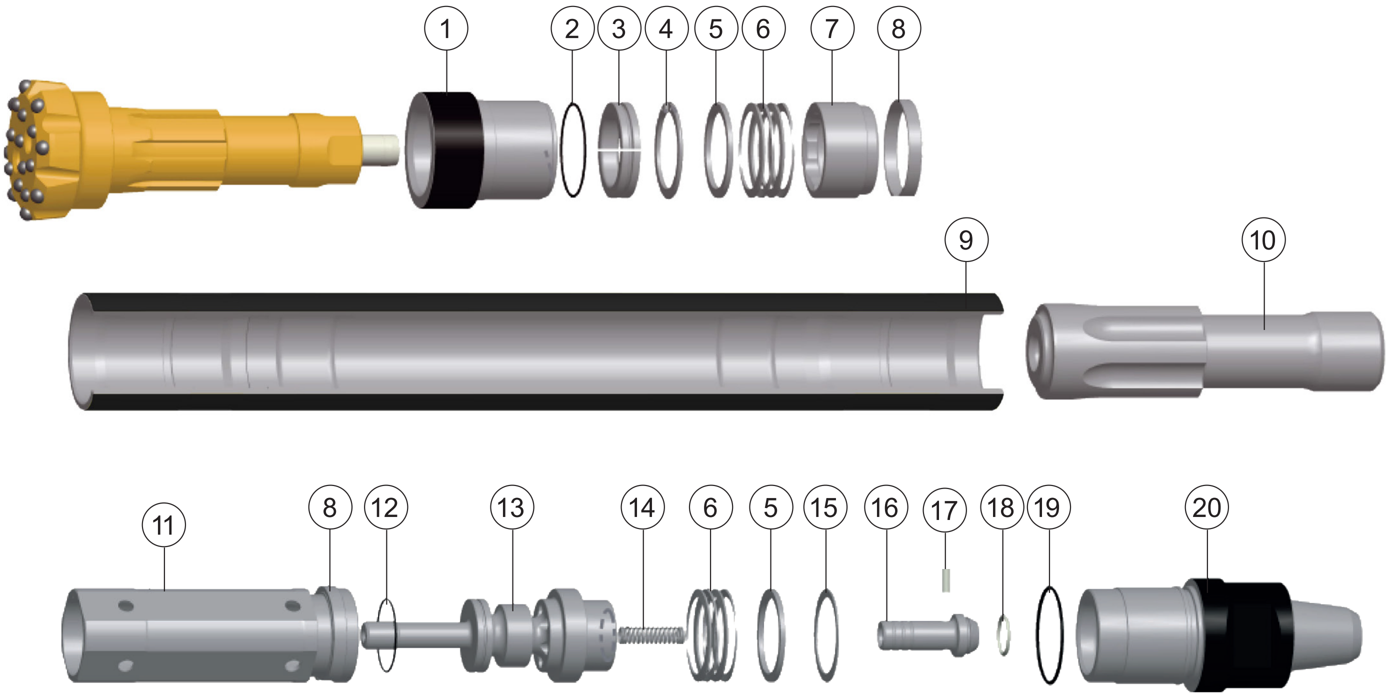
Ref.	Description	Qty	Part number
	Tuning kit for Terranox 5		8393 0827 30
9	O-Ring, air distributor T5	1	8393 0826 75
10	Bellville spring T5	4	8393 0826 73
11	Wear washer T5	1	8393 0826 72
13	Check valve body assembly T5 & T6	1	8393 0826 69
14	O-Ring, check valve T5 & T6	1	8393 0826 71
15	Check valve plug package T5, T6 & T8	1	8393 0826 70
16	O-Ring, backhead T5	1	8393 0826 68

Wear limits	mm	inch
Casing min. OD	106.40	4.19
Max. worn piston to casing clearance	0.18	0.07
Max. worn piston to cylinder clearance	0.23	0.09
Max. worn piston to guide clearance	0.33	0.13

Spare parts list

Terranox 6

Down-the-hole hammer



Ref.	Description	Qty	Part number
	Terranox 6 DTH hammer 3 1/2" API Reg Pin		**8393 0826 60**
1	Terranox 6 chuck DHD 360	1	8393 0827 01
2	O-Ring, retainer ring T6	1	8393 0827 00
3	Retainer ring T6	1	8393 0826 99
4	Bearing surclip T6	1	8393 0826 98
5	Washer retaining	1	50757574
6	Belleville spring T6 (4 pcs)	1	8393 0826 96
7	Bit bearing T6	1	8393 0826 94
8	Cylinder surclip T6	1	8393 0826 95
9	Hammer casing T6	1	8393 0826 86
10	Piston T6	1	8393 0826 93
11	Inner hammer cylinder T6 incl cylinder retainer ring	1	8393 0826 88
12	O-Ring, air distributor T6	1	8393 0826 90
13	Air distributor T6	1	8393 0826 89
14	Check valve spring T5+T6	1	8393 0826 74
15	Spacer washer	1	8393 0826 97
16	Check valve body assembly T5 & T6	1	8393 0826 69
17	Check valve plug package T5, T6 & T8	1	8393 0826 71
18	O-Ring, check valve T5 & T6	1	8393 0826 70
19	O-Ring, backhead T6	1	8393 0826 92
20	Backhead T6 3 1/2" API REG PIN	1	8393 0826 91

Ref.	Description	Qty	Part number
	Service kit for Terranox 6		**8393 0827 26**
1	Terranox 6 chuck DHD 360	1	8393 0827 01
2	O-Ring, retainer ring T6	1	8393 0827 00
3	Retainer ring T6	1	8393 0826 99

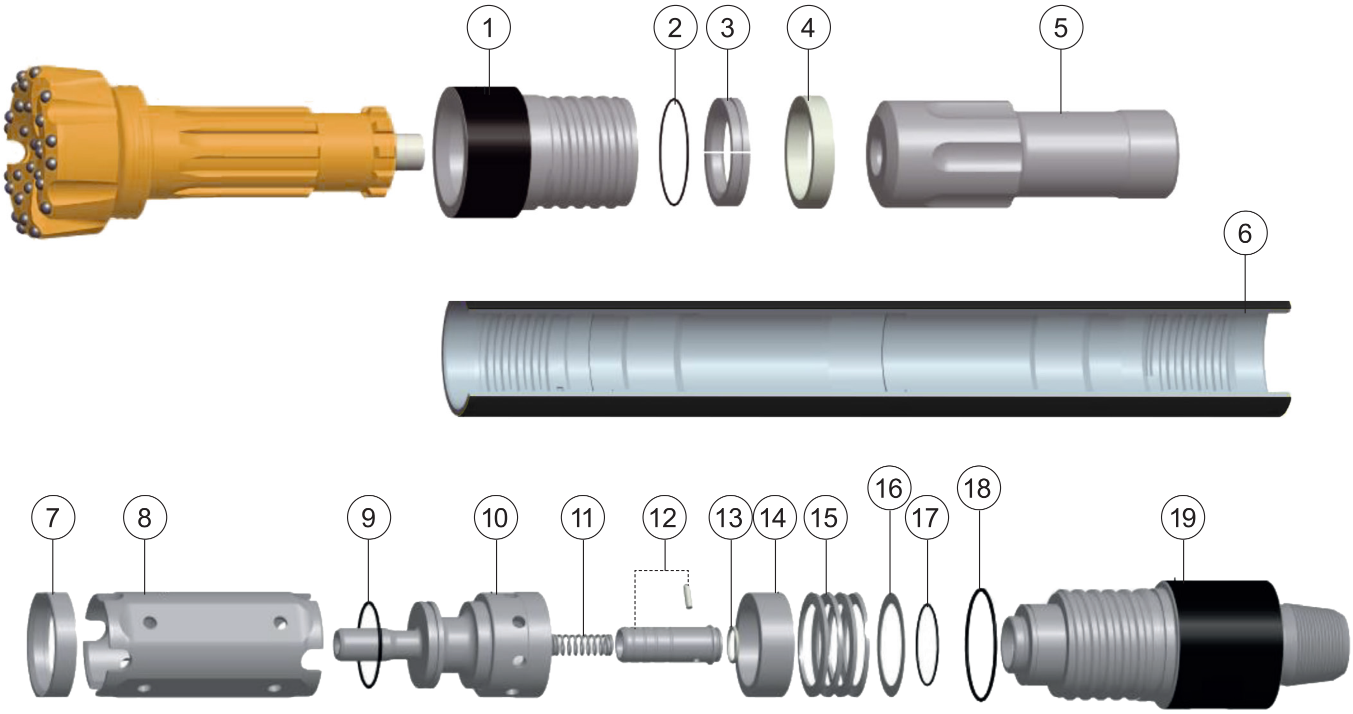
Ref.	Description	Qty	Part number
	Tuning kit for Terranox 6		**8393 0827 31**
2	O-Ring, retainer ring T6	1	8393 0827 00
6	Belleville spring T6	4	8393 0826 96
12	O-Ring, air distributor T6	1	8393 0826 90
16	Check valve spring T5+T6	1	8393 0826 69
17	Check valve plug package T5, T6 & T8	1	8393 0826 71
18	O-Ring, check valve T5 & T6	1	8393 0826 70
19	O-Ring, backhead T6	1	8393 0826 92
	Breakout washer T6	1	8393 0827 43

Wear limits	mm	inch
Casing min. OD	127	5
Max. worn piston to casing clearance	0.23	0.009
Max. worn piston to cylinder clearance	0.28	0.011
Max. worn piston to guide clearance	0.38	0.015

Spare parts list

Terranox 8

Down-the-hole hammer



Ref.	Description	Qty	Part number
	Terranox 8 DTH hammer 4 1/2" API Reg Pin		**8393 0826 80**
1	Terranox 8 chuck DHD 380	1	8393 0827 21
2	O-Ring, retainer ring T8	1	8393 0827 19
3	Retainer ring T8	1	8393 0827 20
4	Retaining ring piston T8	1	8393 0827 18
5	Piston T8	1	8393 0827 14
6	Hammer casing T8	1	8393 0827 05
7	Cylinder retaining ring T8	1	8393 0827 17
8	Inner Hammer Cylinder T8	1	8393 0827 13
9	O-Ring, air distributor T8	1	8393 0827 12
10	Air distributor T8	1	8393 0827 11
11	Check valve spring T8	1	8393 0827 09
12	Check valve body assembly T8	1	8393 0827 07
13	O-Ring, check valve T8	1	8393 0827 36
14	Belleville spacer	1	8393 0827 10
15	Bellville spring T8	4	8393 0827 16
16	Wear spacer T8	1	8393 0827 22
17	O-Ring for washer	1	8393 0827 15
18	O-Ring, backhead T8	1	8393 0827 06
19	Backhead T8, 4 1/2" API REG PIN	1	8393 0826 85

Ref.	Description	Qty	Part number
	Service kit for Terranox 8		**8393 0827 27**
1	Terranox 8 chuck DHD 380	1	8393 0827 21
2	O-Ring, retainer ring T8	1	8393 0827 19
3	Retainer ring T8	1	8393 0827 20
17	Wear spacer T8	1	8393 0827 22

Ref.	Description	Qty	Part number
	Tuning kit for Terranox 8		**8393 0827 32**
2	O-Ring, retainer ring T8	1	8393 0827 19
9	O-Ring, air distributor T8	1	8393 0827 12
12	Check valve body assembly T8	1	8393 0827 07
14	O-Ring, check valve T8	1	8393 0827 36
16	Bellville spring T8	4	8393 0827 16
18	O-Ring for washer	1	8393 0827 15
19	O-Ring, backhead T8	1	8393 0827 06
	Check valve plug package T5, T6 & T8	1	8393 0827 04

Wear limits	mm	inch
Casing min. OD	169.4	6.67
Max. worn piston to casing clearance	0.28	0.011
Max. worn piston to cylinder clearance	0.36	0.014
Max. worn piston to guide clearance	0.33	0.013

Notes

Notes

Notes

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