# In-The-Hole Tools Product Manual

# Boart Longyear Coring Systems Operations and Service Manual



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## **Section 2 - Core Barrels**

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# Introduction

This manual shows how to get the best performance from your Q<sup>®</sup> Wireline Core Barrel Assembly or 'V' Conventional Core Barrel Assembly and explains preventative maintenance and how to make minor adjustments.

Boart Longyear is backed by over 100 years of experience in the design, manufacture and operation of core drilling equipment. Many of the accepted practices in use today were pioneered by Boart Longyear.

#### To obtain the utmost in performance and wear life:

- Read this manual carefully before attempting to use the tools.
- Use as instructed.
- Perform regular maintenance.
- Keep this manual handy for reference.

#### NOTE:

Throughout this manual, the use of grease is mentioned. It is important to note that the use of petroleum-based grease in some areas of the world is prohibited.

Contact your Boart Longyear representative for recommended lubrication alternatives.

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# **Ordering and Returning Parts**

#### **Ordering Parts**

The following procedure results in timely deliveries; eliminates delays; and ensures the correct replacement parts are received.

- 1 Note the size of the wireline system.
- 2 State the exact quantity required.
- 3 Specify the description and part number as shown in catalogue.
- 4 Specify the method of shipment, ie: Parcel Post, Express, Freight; for Overseas shipment, Air Freight, Air Parcel Post, or Ocean Freight.

All parts are priced F.O.B., our factory, and separate charges will be made for transportation and export packing.

#### **Returning Parts**

1 If you wish to return parts for repairs, replacement, or warranty, first send a letter to your Boart Longyear representative:

Specify the quantity, part numbers, wireline system and reason for requesting the return.

- 2 DO NOT ship parts until authorization and shipping instructions are received.
- 3 All parts returned must be prepaid.

# **Safety Identification and Safeguards**



Practice EXTREME CAUTION when operating in or near inclined holes or UP HOLES. Always leave the retainer sub attached to the rod string unless removal is absolutely required.

Do NOT remove the retainer sub until the inner tube assembly is in the collar. Always maintain a column of fluid in the drill rods to reduce the chance of uncontrolled descent of wireline tools or core.



Head assemblies with a pump-in seal connected to the retracting case (such as the former QU style heads) are not recommended for drilling ground with pressurized fluid or gas zones. Boart Longyear recommends the Next Q<sup>™</sup> Fast Pump-In head assembly which incorporates pump-in seals below the retracting case. Carefully read and understand all safety and operational instructions before operating this equipment. Failure to follow these instructions could result in serious personal injury or death.

#### Causes of unlatched tools or falling core include:

- worn parts
- broken core
- rock movement (e.g. mine blast)
- high in-ground water pressure
- operator error

# **A**WARNING

Keep hands and body clear of open rods while operating. Failure to do so could result in serious injury or death.



#### **Always Follow These Rules:**

- 1 Keep clear of rotating equipment. Never wear any loose clothing, which could become entangled in the rods.
- 2 Never stand or walk with any part of your body in front of the rod string. Never look up the rod string. When working, always stand to the side of the open rod.
- 3 When attaching or removing water swivels or loading chambers on **UP HOLES** always keep the retainer sub attached. Do not open the rod string unless absolutely necessary, and then do so with extreme caution. Keep open rod string as close to the floor as possible and stand to the side.
- 4 When the rods remain in an UP HOLE:
  - Remove the inner tube assembly. Plug the rod string by attaching the retainer sub and water swivel or loading chamber;
  - Move the rods as close to the floor as possible.
  - If it is not possible to remove the inner tube, pump the rods full of water with the retainer sub and water swivel still attached. Attach a visible **WARNING TAG** to alert the next shift or anyone approaching the drill that there is a Safety Hazard.

- 5 Never use air pressure to pump the inner tube assembly or overshot into a rod string.
- 6 Use only Boart Longyear replacement parts. Failure to do so could cause severe damage to the equipment or operator and may void your warranty.
- 7 Read and understand the **Operations and Service Manual**. Complete all checks and adjustments as stated in Manual before starting the drill.
- 8 Do not alter the core barrel assembly, its components, optional equipment or accessories without prior approval from Boart Longyear.

Unauthorized alteration may void the warranty, render the equipment unsafe, or result in decreased performance.

- 9 DO NOT attempt to stop the core with your hand when emptying the inner tube. The core can be sharp or heavy and cause severe injury. If it is necessary to look in an inner tube, always look down, never look up the tube.
- 10 Never rotate the rod string with a joint between the drill chuck and the water swivel. The joint may become loose and unscrew the rod that is not held by the chuck jaws.
- 11 If you do not fully understand the equipment and how it operates, **DO NOT** attempt to make adjustments or repairs.
- 12 When the core barrel is transported on an angle where the head assembly is lower than the bit and shell, the inner tube assembly will unlatch and slide out of the outer tube. To prevent the inner tube assembly from sliding out, it is good practice to thread a sub into the locking coupling, or remove the inner tube assembly from the outer tube.

For additional information on training or start-up, contact your Boart Longyear representative.

# **Standard Warranty**

Boart Longyear Inc. makes no warranty that the products sold hereunder shall be merchantable or that such products shall be fit for any particular purpose and there are no warranties expressed or implied made by Boart Longyear Inc. except its following standard warranty.

Boart Longyear Inc. warrants each product, and accessory equipment sold by it (except items not manufactured by Boart Longyear Inc. such as power units, pumps, and other trade accessories sold with, attached to, or operated with Boart Longyear drills or other products) to be free from defects in material and workmanship under normal use and service for 90 days from date of use, but not to exceed 6 months from the date of shipment from a Boart Longyear Inc. factory, the obligation of this warranty being limited to the replacement or repair at a Boart Longyear Inc. facility in Ontario, Canada, or at a point designated by it, of such parts as shall appear to it upon inspection at such point to have been defective in material or workmanship at the time sold, providing that the part or parts claimed defective are returned to inspection point, transportation charges prepaid.

This warranty applies only to new and unused products and accessory equipment, which after shipment from the Boart Longyear factory, have not been altered, changed or repaired in any manner.

#### Exclusion of Liability for Consequential Damage

It is further agreed by the purchaser that in no event shall Boart Longyear be liable for increased costs, loss of profits or goodwill or any special, indirect, incidental, or consequential damages whatsoever.

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## **Standards**

Boart Longyear Coring Systems are available for conventional core drilling (including systems conforming to portions of ISO3551/BS4019 Rotary Core Drilling Equipment - System A) or wireline core drilling (including systems conforming to ISO10097/BS4019 Wireline Core Drilling Equipment - System A).

These coring systems consist of a 'double-tube' format wherein a stationary inner tube accepts and protects the core sample while an outer tube rotates with the drill string and drives the drill bit. Larger size systems are also available in a 'triple-tube' format. A 'triple-tube' system includes a liner to receive a slightly smaller core sample inside the standard inner tube for improved sample protection in poor ground conditions.

Boart Longyear introduced wireline core drilling in 1958 and released the  $Q^{\otimes}$  Wireline System in 1966. The ' $Q^{\otimes}$ ' wireline and 'V' conventional systems are based on the conventional systems nomenclature and hole sizes taken from the DCDMA 'W' series and still include the 'W' casing sizes. Thin Kerf Wireline  $Q^{\otimes}$ TK systems were introduced in 1989 offering larger core sizes and greater productivity, similar to the 'LTK' conventional thin kerf systems. In 1998, Boart Longyear's Wireline Systems were upgraded to 'Next  $Q^{\otimes}$ ' with the incorporation of the patented 'link-latch' mechanism and other improvements.

#### **Conventional Coring System Sizes**

Size	Core Diameter	Hole Diameter	
	mm (in)	mm (in)	
LTK 48	35.3 (1-3/8)	48.0 (1-7/8)	
LTK 60	43.9 (1-3/4)	60.0 (2-23/64)	
NV	47.6 (1-7/8)	75.7 (3)	
NV2"	50.6 (2)	75.7 (3)	
NV-3	45.0 (1-3/8)	75.7 (3)	
HV	63.5 (2-1/2)	96.0 (3-3/8)	
HV-3	61.1 (2-3/8)	96.0 (3-3/8)	

#### Next Q<sup>®</sup> Wireline Coring System Sizes

Size	Core Diameter	Hole Diameter	
	mm (in)	mm (in)	
AQTK	35.3 (1-3/8)	48.0 (1-7/8)	
BQ	36.4 (1-7/16)	60.0 (2-3/8)	
BQTK	40.7 (1-5/8)	60.0 (2-3/8)	
NQ	47.6 (1-7/8)	75.7 (3)	
NQ2"	50.6 (2)	75.7 (3)	
NQ-3	45.0 (1-3/8)	75.7 (3)	
HQ	63.5 (2-1/2)	96.0 (3-3/8)	
HQ-3	61.1 (2-3/8)	96.0 (3-3/8)	
PQ	85.0 (3-3/8)	122.6 (4-7/8)	
PQ-3	83.0 (3-1/4)	122.6 (4-7/8)	

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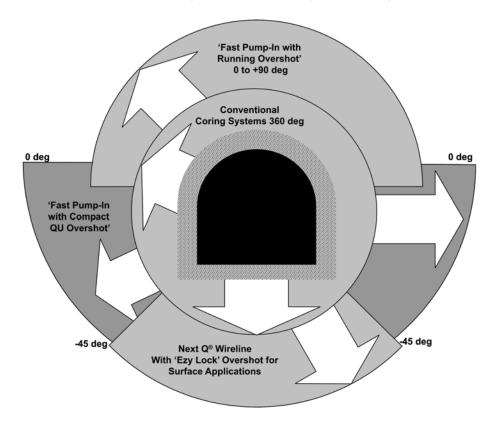
#### NOTE:

Diamond Core Drilling Manufacturers Association (DCDMA) specifications were adopted into ISO3551/ BS4019 Rotary Drilling Equipment, 1992/1993.

# Guidelines

#### **Coring Systems Application**

Conventional 'V' and 'LTK' coring systems are recommended for all hole angles but are limited to shallow hole depths only. Next Q<sup>®</sup> Wireline Coring Systems are recommended for productive drilling at depth, but in different configurations depending on hole angle.



#### Thin Kerf Coring Systems

The LTK Conventional Coring Systems and the Q<sup>®</sup>TK Wireline Coring Systems offer a larger core diameter and reduced drilling torque and power by virtue of the thinner kerf of rock cut. While greater penetration rates may be achieved, the performance of thin kerf systems in general is limited by the reduced strength and stiffness of the thin wall tubular components and the greater pressures generated by the reduced annular fluid passages.

#### 'Full-Hole' Coring Systems

Optional 'full-hole' style outer tubes and locking couplings are available in all systems. The outer diameter is increased to maximize stabilization of the core barrel in the hole and stiffness of the outer tube. Four fluid passage 'flats' are provided to compensate for the loss of annulus between these components and the hole. 'Full-Hole' systems are not recommended for broken ground conditions due to the tight fit and higher fluid pressures.

#### **Coring System Selection**

As ground conditions degrade, a larger size system is required for productive core recovery. A thin kerf system may be desired to reduce power requirements. However, in a given hole size an increase in core size translates into a loss in strength, higher sensitivity to core blocks, and a loss of directional control. However, this may be addressed with a 'Full-Hole' format system.

The strength and directional control of each system can be correlated to outer tube cross section as demonstrated below in comparing to standard system sizes by percentage:

System Size	Hole Diameter mm (in)	Q <sup>®</sup> & V Section mm <sup>2</sup> (in <sup>2</sup> )	Q <sup>®</sup> TK Section mm <sup>2</sup> (in <sup>2</sup> )		Q <sup>®</sup> TK Full-Hole Section	Q <sup>®</sup> Full-Hole Section
A	48.0 (1.890)	n/a	478 (0.742)	70%	124%	n/a
В	60.0 (2.360)	905 (1.403)	73%	63%	96%	123%
N	75.7 (2.980)	1,330 (2.062)	n/a	n/a	n/a	119%
Н	96.0 (3.782)	1,905 (2.952)	n/a	n/a	n/a	129%
Р	122.6 (4.827)	2,474 (3.835)	n/a	n/a	n/a	n/a

#### **Coring System Selection**

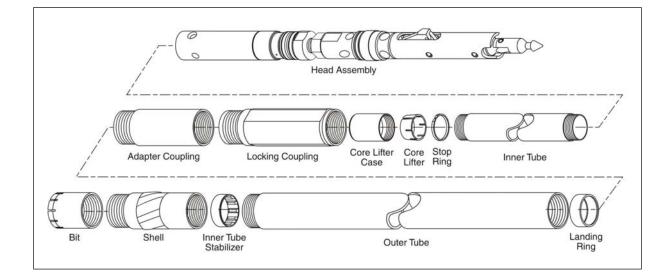
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# **Core Barrel Assembly**

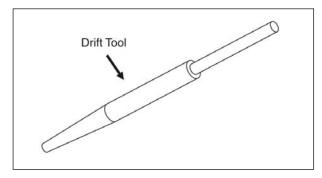


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# **Head Assembly**

#### NOTE:

In order to replace worn components and reassemble, the assembly drift tool is required to align links and latches for spring pin insertion (see 'Inspection & Maintenance'). The head assembly is carefully assembled at the factory. It is unnecessary to make any adjustments.



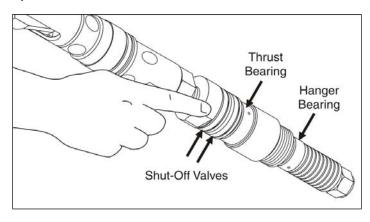
#### Fluid Control Features for Different Drilling Conditions

Next Q<sup>®</sup> wireline head assemblies include internal fluid bypass porting around the landing shoulder. This allows drilling fluid to easily pass through the head to the bit when the landing shoulder is seated and sealed against the landing ring in the drilling position. Also, this allows fluid to easily bypass the restriction between the landing shoulder and the drill rods when tripping the inner tube assembly through the rod string.

The following features control the fluid passing through the head assembly and may require reconfiguration of the head assembly.

#### 'Shut-Off' Valves'

The two shut-off valves and two steel washers in the head assembly can be repositioned to account for different drilling conditions. When a core block occurs, the blocked core resists the downward drilling force. This exerts a force up through the inner tube assembly, which expands the shut-off valves and restricts the downward flow of fluid. This restriction increases the fluid pump pressure, warning the operator that a core block has occurred.

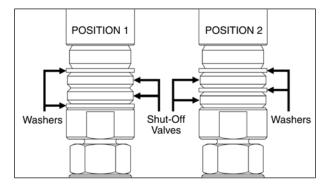


**POSITION 1:** When coring soft or friable rock, reposition the steel washers so that the valves contact each other. The table below shows the approximate core block forces necessary to close the shut-off valves in this position.

AQTK	
BQ/BQTK	
NQ/NQ2"	1750 lb (7.7 kN or 770 kg weight)
HQ	3000 lb (13.3 kN or 1300 kg weight)
PQ	

**POSITION 2:** When coring in harder formations, reposition the steel washers to separate the two shut-off valves. The table below shows the approximate core block forces necessary to close the shut-off valves in this position.

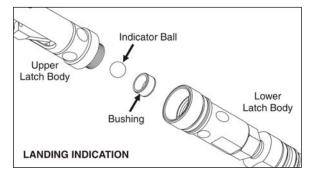
AQTK	700 lb (3.1 kN or 310 kg weight)
BQ/BQTK	1000 lb (4.4 kN or 440 kg weight)
Q/NQ2"	2500 lb (11.1 kN or 1100 kg weight)
HQ	5000 lb (22.2 kN or 2200 kg weight)
PQ	5000 lb (22.2 kN or 2200 kg weight)





#### Landing Indicator

In declined or 'down hole' operations, the landing indicator indicates to the operator that the inner tube assembly has landed. Note that the optional fluid control or dry hole valve feature provides a more reliable indication that the latches have deployed.



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#### Installation

The landing indicator can be installed or removed without pulling the entire inner tube assembly out of the hole or changing the inner tube assembly length adjustment.

- Unthread the upper and lower latch bodies.
- Drop the indicator bushing into the seat in the lower latch body (If the bushing is not fully seated, tapping the ball will seat it).
- Drop in the indicator ball.
- Thread the upper and lower latch bodies together.

#### Operation

When the inner tube assembly lands in the outer tube, fluid pressure forces the indicator ball through the indicator bushing which causes a pressure spike up to 2000 kPa (300 psi) higher than normal drilling fluid pressure. This indicates to the operator that the inner tube assembly has landed.

#### **Fluid Retention Valve**

See Chapter 6 "Dry and/or Deep Hole Operations"

#### **'Dry Hole' Valve** See Chapter 6 "Dry and/or Deep Hole Operations"

#### 'Fast Pump-In' Valve & Pump-In 'Lip' Seals

See Chapter 8 "Inclined or Up-Hole Wireline Operations"

#### NOTE:

The pressure spike degrades in deep holes. A false signal will be produced if the inner tube assembly becomes hung up in the rod string.

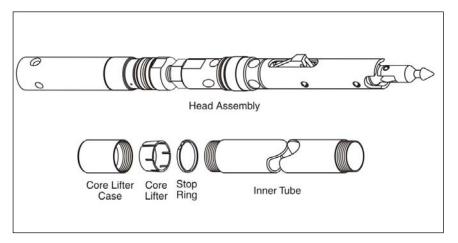






# **Inner Tube Assembly**

Consists of the head assembly, inner tube, stop ring, core lifter, and core lifter case.



- Apply a light coating of lithium grease to the inside of the core 1 lifter case.
- 2 Slide the core lifter into the threaded end of the core case, tapered end first. The tapered surfaces of the core lifter and core lifter case act against one another to tighten the grip on the core when the core barrel is pulled back.
- 3 Snap the stop ring into the core lifter case. The stop ring provides a hardened surface for the core lifter to bear against during coring.
- 4 Thread the core lifter case onto one end of the inner tube.
- 5 Thread the head assembly on to the other end of the inner tube.
- 6 An optional inner tube liner or 'split tube' (split length-wise) with a pump-out system is available. Commonly selected when drilling coal, clay bearing or highly fractured formations, a core ejection piston protects the core from pressurized drilling fluid when the split tube, containing the core sample, is pumped out of the inner tube.

#### NOTE:

Tighten all joints with an inner tube wrench.

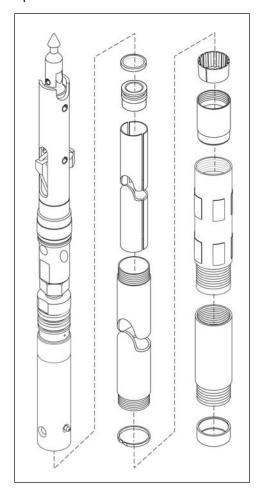
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NOTE:

These items are required to pump the core out of the inner tube. Remove the head assembly from the inner tube, insert the piston plug and thread the pump out adapter on to the inner tube. Fluid pressure supplied by optional hand pump group or pump out group. Upon removal, one half of the split tube is lifted off to reveal the undisturbed core sample. See **Core Removal** section for operation.

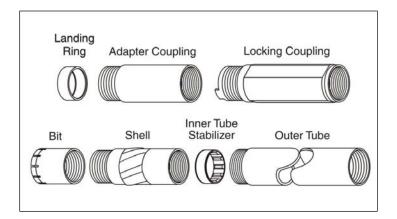


# **Outer Tube Assembly**

#### NOTE:

Boart Longyear core barrels include a feature to drive the head assembly in rotation with the outer tube, eliminating undue wear between the latches and couplings.

Surface core barrels include a locking coupling 'Tang' (also available without), while underground core barrels include a drive key in the adapter coupling or 'drive coupling'. In Conventional Coring Systems, the outer tube threads to the head assembly, which threads directly to the rod string. In Wireline Coring Systems, the outer tube assembly consists of:



#### NOTE:

Assembly is easier if the bit end of the core barrel is lower. To pass the box thread of the locking coupling, retract the latches.

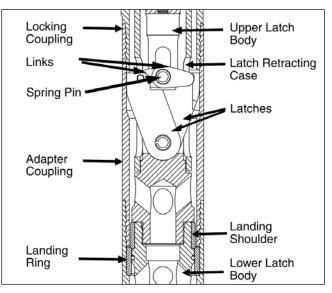
- 1 Apply a light coating of lithium grease to the outside of the landing ring and the counter bore of the outer tube, and insert into the outer tube.
- 2 Thread the adapter coupling onto the outer tube.
- 3 Thread the locking coupling to the adapter coupling.
- 4 Install the inner tube stabilizer into the bore of a new reaming shell, then thread it onto the outer tube. The stabilizer centers the inner tube. See 'Installing Bits and Shells' below.
- 5 Tighten all joints with an outer tube wrench or pipe wrench.

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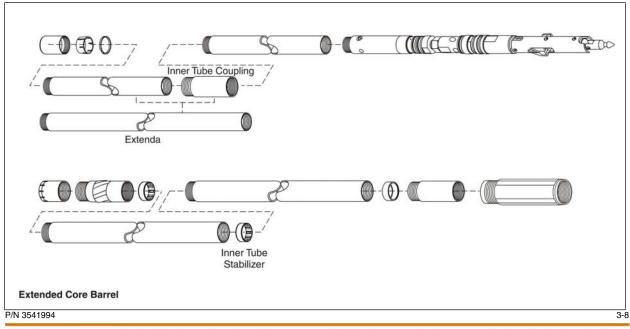
#### **Installing Bits and Shells**

#### NOTE:

In the PQ and PV systems, the inner tube stabilizer is inserted into the bore of the bit. 1 Install the inner tube stabilizer into the counter bore of a new reaming shell. This stabilizer centers the inner tube.



- 2 If assembling an extended core barrel, insert an inner tube stabilizer into the box of the second length of outer tube and thread it to the first. To extend the inner tube, insert an inner tube coupler and a second inner tube between the first inner tube and the core lifter case. Alternatively, an 'extenda' inner tube is available in certain sizes which combines a coupler and an inner tube into one length.
- 3 Thread both the reaming shell and the diamond bit to the outer tube.

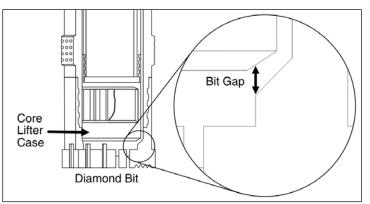


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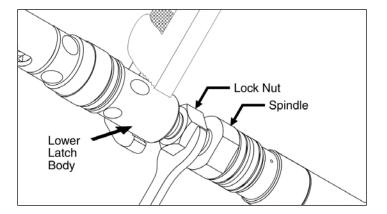
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- 4 If using a stabilized reaming shell, add the appropriate inner tube extension between the inner tube and the core lifter case. If using a stabilized reaming shell with an extended core barrel, use the appropriate extended inner tube coupling.
- 5 Wipe the inner tube assembly clean and lightly oil the outside surface. Insert the inner tube assembly into the outer tube. For Wireline Coring Systems, ensure the landing shoulder is firmly seated on the landing ring.
- 6 Check the bit gap, the space between the beveled shoulder inside of the bit and lower end of the core lifter case. The gap should measure 3–5 mm (1/8"–3/16").



If the gap setting is not within the limits specified above:

- Extract the inner tube assembly.
- Loosen the lock nut.
- Adjust the spindle to attain the proper gap.
- Insert the inner tube.
- Check the gap again.



#### NOTE:

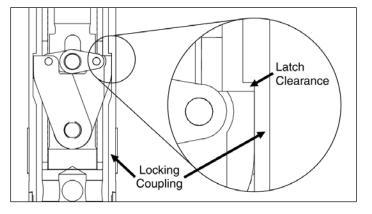
When pumping in the inner tube assembly, too small a bit gap will cause the core lifter case to seal against the bit upon landing. This may over-ride the latch indication signal from the pump-in valve or fluid retention valve or may cause a mis-latch.

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A bit gap that exceeds 4.8 mm (3/16") may cause poor recovery or short core runs. If it is less than 3.2 mm (1/8") then high fluid pressure, reduced flow to the bit, and mis-latching of the inner tube assembly may result.

Whenever a new bit or reaming shell is first installed, or if the inner tube or a core lifter case is replaced, check the bit gap between the core lifter case and the bit to assure proper adjustment.

7 Latch Clearance Check (Wireline Systems)



Suspend the entire assembly and recheck the bit gap. Remove the bit and push upward on the core lifter case to check latch clearance. Movement should be slight, approximately 1.5-3 mm (1/16"-1/8").

When using more than one inner tube assembly, check the bit gap and latch clearance in all the assemblies used with the same outer tube assembly.

8 Tighten all thread joints using Boart Longyear inner tube and outer tube wrenches.

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# **Storage and Transporting**

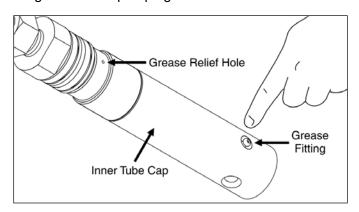
When transporting or storing the core barrel, insert the inner tube assembly into the outer tube assembly. Incline the assembly to prevent accidental release of the inner tube. Knuckle-over the spearpoint to reduce injury in the case of accidental release.

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# **Final Check and Lubrication**

1 Before drilling and before every run, pump grease into the inner tube cap until it flows through the grease relief hole in the thrust bearing. Rotate the inner tube cap assembly slowly to distribute the grease while pumping.



- 2 Grease the wireline cable swivel bearing in the overshot.
- 3 Apply grease between the core lifter and core lifter case.
- 4 The thrust and hanger bearings accept thrust loads during drilling and core breaking. The bearings allow the inner tube to remain stationary with the core while the outer tube rotates. If the bearings do not spin freely, expect rapid wear of the core lifter and core lifter case (see 'After Service Maintenance' for correct bearing installation).
- 5 If the landing indicator feature is installed in the wireline head assembly, ensure the indicator ball is in the proper position above the indicator bushing prior to each run. If an inner tube assembly is dropped with the indicator ball below the bushing, the bypass porting is blocked and the descent rate is drastically reduced.

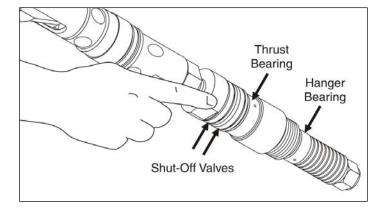
# **Core Barrel Initial Run**

- 1 Coring system performance is dictated by ground conditions. Solid, competent ground or 'bedrock' may be drilled without interruption, filling the core barrel each run. Alternatively, fractured, broken rock can wedge (or 'block') in the core barrel and prevent penetration. Each time a core block occurs the core barrel must be emptied, reducing productivity. As a result, holes from surface are often pre-bored through overburden and cased prior to coring system application. However, an experienced coring crew may outperform an expensive rotary drill rig in overburden drilling.
- 2 In the tight confines of an underground application, a 'starting barrel' is often required to start a hole from the mine face. This typically consists of a standard 1.5 m / 5 ft core barrel assembly connected to a short drill rod sufficient to allow drilling the first meter. Once the hole is of sufficient depth, or 'collared', a standard conventional or wireline core barrel assembly may replace the starting barrel.
- 3 After the core barrel is in the hole, complete the drill string by connecting the rod string to the locking coupling and the water swivel to the rod string.
- 4 Lower the drill string to within a few inches of the bottom of the hole.
- 5 Start the water pump and the drill, but do not advance the rod string into the hole until the water pressure rise is indicated on the pressure gauge or until water is returning from the hole. Water must be circulating around the diamond bit before core cutting begins.
- 6 Water pressure of 350–700 kPa (50–100 psi) is sufficient to start advancing the rotating rod string into the hole and to start coring. As the hole progresses, the water pressure will gradually increase.
- 7 Select a suitable rotation speed and penetration rate for the drilling conditions encountered. Refer to the **Boart Longyear Diamond Products Field Manual**.
- 8 Continue drilling until a core block occurs or the inner tube becomes full of core.

# **Fluid Pressure and Core Blocks**

- 1 Whenever the fluid pressure rises rapidly above normal operating pressure, or if the pressure relief valve opens, stop drilling and prepare to retrieve the inner tube assembly.
- 2 Occasionally during the drilling operation, the bit will 'mud' or 'block', which causes a sharp rise in fluid pressure. When this happens, retract the drill string so the bit is pulled back 1/2–1 in (2–3 cm). Allow the bit to clear itself, and allow the fluid pressure to return to normal. Begin drilling, but if high fluid pressure returns, it may indicate a core block.
- 3 In most cases, an above normal water pressure reading indicates that either the core barrel is full of core, that a core block has occurred in the bit, or that the inner tube or bit has been consumed (Refer to the **Boart Longyear Diamond Products Field Manual**).

Regardless, the inner tube must be removed from the hole and inspected to avoid unnecessary damage to the bit or barrel.



- 4 When a core block occurs, the blocked core resists the downward drilling force. This exerts a force up through the inner tube assembly, which compresses the shut-off valves causing them to spread outward and restrict the flow of water. This restriction increases the supply fluid pressure indicating to the operator that a core block has occurred.
- 5 Wash the hole for several minutes before retrieving the inner tube.

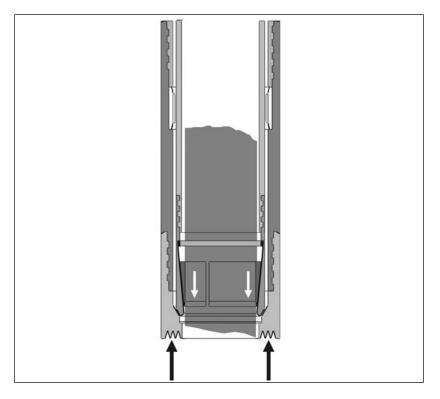
4-4

# **Core Breaking**

#### NOTE:

Core lifters require the toughness of heat-treated steel to withstand core breaking pressures. However, the grip pattern or teeth machined onto the inner diameter is subject to wear as the core lifter drags across core during normal operations. This results in frequent replacement to avoid core slippage or drops. New micro-diamond coated core lifters provide superior wear life and gripping, virtually eliminating slippage and drops.

- 1 As the rod string and core barrel are pulled back, the core lifter grasps the core and wedges against the core lifter case halting movement of the inner tube.
- 2 A compression spring acting between the spindle and inner tube cap assembly compresses. This allows the head assembly to move with the outer tube until the bit contacts the stationary core-lifter case.
- 3 The core breaking load is then transferred through the bit and outer tube, protecting the inner tube assembly from overload.
- 4 The core breaks below the core lifter allowing the core sample retained in the inner tube to be retrieved.

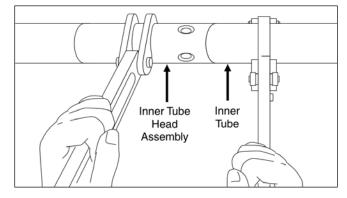


4-5

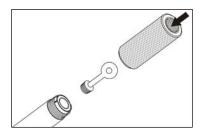
# **Removing Core from the Inner Tube**

# **A**CAUTION

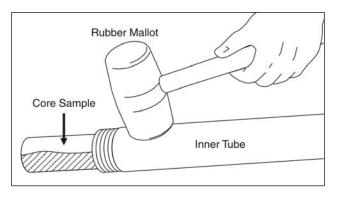
When emptying the inner tube, do not attempt to stop the core by hand. Core can be sharp or heavy and cause severe injury. If it's necessary to look into an inner tube, always look down into the tube. 1 Unthread the inner tube from the head assembly using Boart Longyear inner tube wrenches. When using two inner tube assemblies, inspect and service one between core runs while the other is running.



2 If running a triple-tube assembly, insert the piston plug into the split tube piston. Thread the pump-out adapter onto the inner tube. Pump out the split tube and core sample. Proceed to step 4.



3 Empty core from the inner tube. Jar the core loose from the inner tube by tapping with a rubber mallet. Place the core carefully in a box and mark as instructed by the geologist on site.



4 Between each core run, check the inside of the inner tube to be sure all of the core has been removed. Flush out the inner tube with clear water to remove all chips and grit.

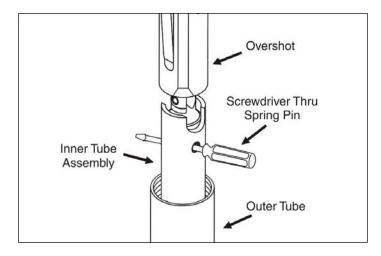
# Loading the Inner Tube Assembly (Surface)

(The Following Applies To Wireline Systems Only)

### **CAUTION**

Do not drop the inner tube assembly into the rod string. The latch links are spring-driven into an overcentre position preventing retraction. The latches will hit the box thread damaging the rod, latches, or links. Even a short drop may cause damage.

- 1 In order to insert the inner tube assembly into the rod string, the retracting case must be pulled back to retract the latches. This is achieved by lowering the inner tube assembly using the overshot and releasing the spearpoint only after the latches are fully inserted into the rod string past the box thread. Alternatively, an optional loading sleeve is available to hold the latches retracted until the inner tube assembly is inserted into the rod string.
- 2 If there is more than 9 m (30 ft) of water in the hole, release the inner tube assembly by squeezing the back ends of the overshot lifting dogs. If the load of the inner tube assembly makes release difficult, insert a screwdriver or similar suitable tool through the spring pin in the top of the latch retracting case.
- 3 Lower the inner tube assembly until the tool rests on the top of the rod string, taking the weight off the overshot. Release the overshot. Pull the tool out to allow descent of the inner tube assembly.



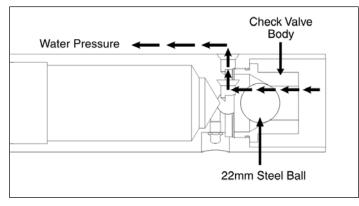
4 If there is insufficient water in the hole to control the descent of the inner tube assembly, attach the locking sleeve to the overshot above the lifting dogs and lower keeping the wireline cable taught. When the inner tube assembly hits the water table, the overshot advances opening the lifting dogs and allowing the locking sleeve to drop. The inner tube assembly is released. To lower the inner tube assembly in dry holes, see Chapter 6 'Dry Hole Operation'.

#### Inner Tube Tripping (Surface)

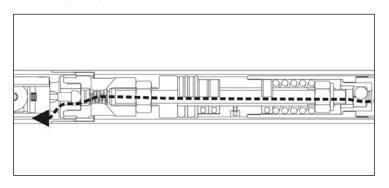
In deep-hole drilling, the tripping of the inner tube consumes the largest portion of time in the drilling cycle. As a result, the following practices and features are effective in improving productivity.

The landing shoulder has very little clearance to the drill rod, which limits the descent rate of the inner tube through standing fluid. To remedy this, fluid bypass porting is provided through the latch bodies allowing the inner tube assembly to descend guickly through standing ground water (To lower in dry holes, refer to Chapter 6 'Dry Hole Operation'):

- 1 The use of internally-upset rods (mid-body has larger inner diameter than joints), allows for greater fluid bypass and significantly reduces descent time.
- If the landing indicator is installed, the indicator ball must be 2 above the indicator bushing to allow bypass flow.
- If a fluid control valve is installed, the valve ball will lift to an open 3 position to allow fluid bypass.
- The ball check valve located in the inner tube cap assembly, 4 speeds descent by allowing fluid to pass through the inner tube. During drilling and core retrieval, the ball stops fluid from entering the inner tube.



A recent improvement featured in 'Fast Descent' heads, is the 5 incorporation of a hollow spindle. This allows fluid to bypass directly from the inner tube and through the head assembly providing a significant additional descent time reduction.



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### CAUTION

Do not start the circulation pump until the inner tube assembly is near the landing shoulder. The pressure change induced by the pump will close the bypass and check valves and decrease or limit the descent rate of the inner tube assembly.

#### NOTE:

The landing indicator pressure increase can be up to 2500 kPa (400 psi) but this will degrade with hole depth and as the bushing wears.

#### NOTE:

Boart Longyear recommends its 3/16 in (4 mm) swaged wireline cable for maximum strength and durability. Regular galvanized or armoured cables suffer from unravelling, kinking, and bird-nesting problems. Maintain a minimum drum to cable diameter ratio of 20:1 for maximum life and do not operate with ratios below 15:1.

The inner tube assembly should travel between 30 - 50 m/min (100 -150 ft/min). Fast Descent heads will travel up to twice this rate. especially if tripping through internally upset drill rods.

As the inner tube assembly approaches the landing ring, attach the water swivel. Start the drilling fluid supply pump adjusted for flow and pressure adequate for the hole being drilled. Rotate the rod string slowly.

#### Inner Tube Latching (Surface)

The impact of the inner tube assembly against the landing ring will generate a noise that is audible up to approximately 300 m (1000 ft). To aid in detecting this, place a wrench against the rod string to amplify the sound.

A rise in supply fluid pressure will also occur...

- If the landing indicator is installed, a significant pressure spike will occur. However, this does not confirm that the latches have deployed, only that the inner tube is halted. Fluid pressure will drop to drilling pressure which is strictly due to the resistance of circulation.
- If a fluid control valve is installed, pressure will rise to the drilling • pressure which is determined by the strength of the fluid retention spring installed in addition to the resistance of circulation.
- If pressure remains well above normal or increases to the point • where the supply pump pressure relief valve vents, this indicates that the fluid control valve is not open. The valve cannot open unless the latches have deployed. On the rare case where the latches have opened on the locking coupling tang, rotate the rod string with a sharp partial turn to 'jump' the latches off the tang. Alternatively, stop the pump and then rapidly raise and drop the rod string a short distance to cause the inner tube assembly to reseat itself.

#### **Overshot Operation (Surface)**

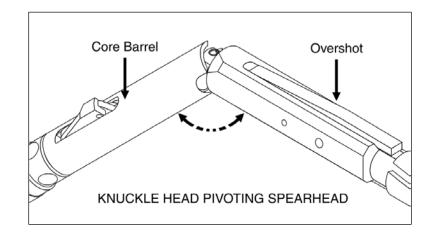
- Mark or paint a 2 m (6 ft) section of the wireline cable about 10 m 1 (30 ft) above the overshot. This marker will signal the approach of the overshot when it is being retrieved from the hole.
- Starting with the drill head at its lowest point, pull the rod string 2 until the first joint appears. Disconnect the drill rod with the water swivel attached.
- 3 Lower the overshot into the rod string, keeping a slight tension on the cable. As the overshot approaches the spearhead, reduce the descent rate. When the overshot connects to the spearhead, put a moveable marker (e.g. piece of string) about one meter above the point of contact on the cable to use as a warning for the next core retrieval. Move the marker upward with each run.

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- 4 To check that the overshot has latched, reel in the slack in the cable. With experience, the operator can detect the extra weight of the inner tube assembly.
- 5 Begin spooling the wireline onto the hoist drum to retrieve the inner tube assembly. As the overshot pulls on the spearpoint, the retracting case retracts the latches and the inner tube assembly is released.
- 6 Slowly hoist the inner tube assembly. As the overshot approaches, the painted marker will appear. Carefully move the core-laden inner tube to the side once the core lifter clears the rod.
- 7 Lower the inner tube assembly to the floor. Disconnect the overshot from the inner tube assembly, and connect it to an empty tube that has been checked and serviced.



#### NOTE:

The Next Q<sup>®</sup> head assembly is equipped with a 'knucklehead' pivoting spearpoint. This feature makes removing the inner tube assembly from the rod string or outer tube safer and easier by allowing the overshot to pivot 90 degrees on the spearpoint.

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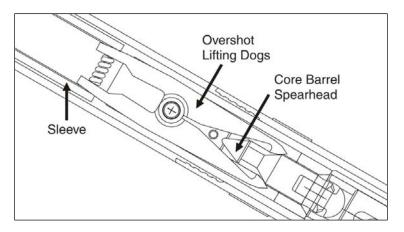
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#### NOTE:

The optional locking sleeve is also used for Dry Hole Lowering, see Chapter 6.

## **Inner Tube Fails to Release**

- 1 The inner tube assembly may not release (un-latch) as a result of a severe core block or due to oversized core, etc.
- 2 Pull the cable tight and release it to cause a jarring action of the overshot body, which may free the tube. If the inner tube assembly does not release, use the locking sleeve. Slip the sleeve over the wireline cable and drop it down the hole.
- 3 The sleeve slips over the upper ends of the lifting dogs which are drawn in when the lower ends are spread over the spearhead. If the overshot fails to release, pull the cable tight and release it so the jarring action of the overshot body forces the locking sleeve onto the lifting dogs.



4 Retrieve the overshot and pull the rods.

## Loading the Inner Tube Assembly (Underground)

## **CAUTION**

Head assemblies with a pump-in seal connected to the retracting case (such as the former QU style heads) are not recommended for drilling ground with pressurized fluid or gas zones. Boart Longyear recommends the Next Q<sup>®</sup> 'fast pump-in' head assembly which incorporates pump-in seals below the retracting case.

## **A**CAUTION

Do not force the inner tube assembly into the rod string without pulling back the retracting case. The latch links are spring-driven into an over-centre position, preventing retraction. The latches will hit the box thread damaging the rod, latches, or links.

#### NOTE:

Refer to Chapter 8, 'Inclined 'Up-Hole' Operations', for recommended operations when drilling an inclined hole (fluid drains from rod string).

- 1 Clean out any grease or debris from the pump-in lip seals to ensure they expand under fluid pressure. Also, ensure the lip is free to expand by checking that the seals freely rotate on the assembly (they are not over-tightened).
- 2 As the inner tube assembly is inserted into the rod string, the retracting case must be pulled back to retract the latches. The 'Fast Pump-In' core barrel heads have an 'Ezy-Loading' feature: While inserting the inner tube assembly up into the rod string, the retracting case can be held back while pushing the assembly in by the spearpoint (the spearpoint bottoms out on the upper latch body to lift the assembly). Alternatively, an optional loading sleeve is available to hold the latches retracted until the inner tube assembly is inserted into the rod string.

## Inner Tube Tripping (Underground)

The tripping of the inner tube consumes a large portion of time in the drilling cycle. A seal between the rod string and the inner tube assembly allows it to be pumped into the hole by the drilling fluid supply pump. A high quality seal is required to maximize inner tube speed and maintain productivity above that of a conventional coring system.

As the retracting case is pulled back, this also retracts the pump-in valve into a closed position, sealing on the latch indicator bushing. In addition to the double pump-in lip seals, this creates a hermetic (100%) seal, which translates into significantly faster tripping as all of the supply pump flow and pressure goes into propelling the inner tube assembly (compared to previous Q-U head assemblies).

Attach the water swivel. Quick coupler connections are recommended to quickly switch the fluid supply line from the loading chamber to the water swivel. Start the drilling fluid supply pump adjusted for high flow and pressure.

## Inner Tube Latching (Underground)

Only upon reaching the drive coupling can the latches deploy, allowing the retracting case to drop and the valve to advance into the latch indicator bushing. Pump pressure will then spike, approximately 1500kPa (250psi) over the pump-in pressure, as the pump-in valve is forced through the latch indicator bushing into an open position (latch indication).

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#### NOTE:

If the pump is set to maximum there will not be any capacity remaining to generate a latch pressurespike indication. The magnitude of the latch indication pressure will decrease as the bushing wears.

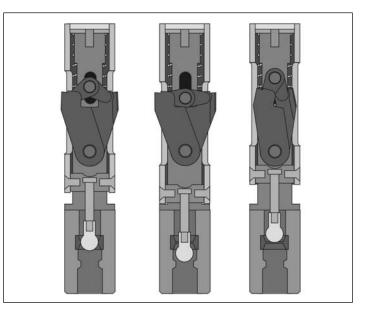
#### NOTE:

In a flat or slight down-hole where fluid does not drain from the rod string, if the Inner Tube Assembly is hung up or cannot latch the Pump-In Valve will remain closed. As a result, the overshot cannot be pumped in and the rod string will have to be pulled to retrieve the inner tube (as with all pump-in wireline systems).



Suction is created when removing a Water Saver Sub and the retained column of drilling fluid drains. Do not use a Head assembly with a pump-in seal connected to the retracting case (such as the former QU style heads) as they may unlatch. If a spike does not occur and the pressure remains well above normal or increases to the point where the supply pump Pressure Relief Valve vents, this indicates that the Pump-In Valve is not open. The valve cannot open unless the latches have deployed. On the rare case where the latches have opened on the Drive Coupling key, rotate the rod string with a sharp partial turn to 'jump' the latches off the key.

If the indication is not evident or is missed, the operator can detect that the head is not latched if pressure does not drop from that during pump-in or if the pump's PRV setting is continually exceeded (vents). Also, pressure gauges are available with maximum pressure indicators which will show the indication spike until reset. The pumpin valve will not open on a false landing (e.g. a hung-up Inner Tube Assembly) or if the latches are on the drive key.



## Water Saver Subs (Underground)

When drilling with extended core barrels, a special 'water saver' adapter sub may be utilized to increase productivity by eliminating drainage and refilling of the rod string when adding drill rods to the rod string. The adapter has an internal check valve to retain drilling fluid in the rod string.

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## **CAUTION**

In inclined holes, drain all fluid from the rod string with a control valve before removing the water swivel. If this is not done, the suction created by the draining fluid will act on the head assembly. Head assemblies with a pump-in seal connected to the retracting case (such as the former QU style heads) are not recommended as they may unlatch.

#### NOTE:

Boart Longyear recommends its 3/16"(4mm) swaged wireline cable for maximum strength and durability. Regular galvanized or armoured cables suffer from unravelling, kinking, and bird-nesting problems. Also, armoured cables cause rapid wear of loading chamber packings. Maintain a minimum drum to cable diameter ratio of 20:1 for maximum life and do not operate with ratios below 15:1.

## **Overshot Operation (Underground)**

Underground wireline overshots are significantly different than surface overshots in that they are driven into the hole by drilling fluid pressure. Boart Longyear underground overshots utilize the unique pump-in lip seal for this purpose.

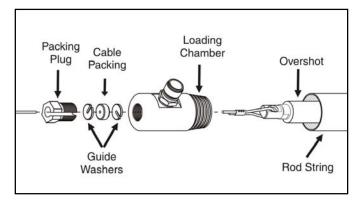
Underground overshots are compact for use in constricted areas and offer features to handle drilling fluid in shallow angle hole and inclined hole applications.

The 'running overshot' is specifically designed for inclined holes providing improved productivity and controls over the raised column of fluid and inner tube assembly.

## Loading Chamber

Loading chambers allow passage of the wireline attached to the overshot, into a fluid pressurized rod string.

- 1 Run the wireline cable through the appropriate sized cable packing (the packing may be cut with a utility knife to slip over the cable) and the loading chamber body.
- 2 Slide guide washers, of appropriate size, over the cable both in front and behind the cable packing. Slide these components along the cable to bottom out in the loading chamber body.
- 3 Thread the packing plug into the chamber body and tighten to form a seal around the wireline. The packing should be compressed and continually adjusted by the packing nut to account for wear.
- 4 Thread the wireline cable through the overshot eyebolt and terminate the cable (e.g. with appropriate sleeves and swaging or compression tool).
- 5 Align the wireline sheaves and cable with the packing plug to minimize wear.
- 6 Thread the loading chamber onto the rod string and attach the fluid pressure line. Quick coupler connections are recommended to quickly switch the fluid supply line from the water swivel to the loading chamber. Loading chamber bodies feature a drill rod thread connection to eliminate adapter subs.



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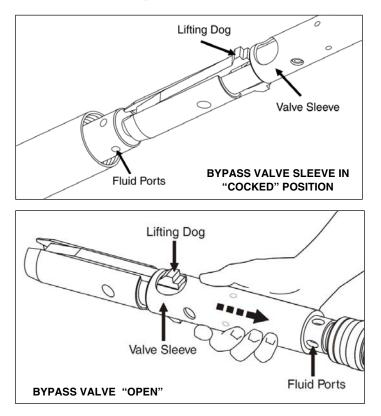
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#### NOTE:

A short rod extension is required to allow connection to the rod string and accommodate the running overshot body.

## Loading the Overshot

- 1 In order to retrieve the inner tube assembly from holes with a shallow decline, a compact QU overshot is loaded into the rod string. In order to retrieve from holes with an incline, the running overshot is loaded into the rod string (see Chapter 8, Inclined 'Up-Hole' Operation).
- 2 These 'pump-in' overshots are equipped with the same pump-in lip seals that are installed on the 'fast pump-in' head assembly. The lip seal forms to the inner diameter of the rod string and allows the fluid supply pump to build pressure behind it and drive the overshot into the hole.
- 3 Clean out any grease or debris from the pump-in lip seals to ensure they expand under fluid pressure. Also, ensure the lip is free to expand by checking that the seals freely rotate on the assembly (they are not over-tightened).
- 4 The Compact QU Overshot requires a bypass valve sleeve to be manually retracted to close bypass porting prior to loading. The lifting dogs will hold the valve sleeve in this 'cocked' position (Note that the running overshot does not have bypass porting).



5 Mark or paint a 2m (6 ft) section of the wireline cable about 10 m (30 ft) above the overshot. This marker will signal the approach of the overshot when it is being retrieved from the hole.

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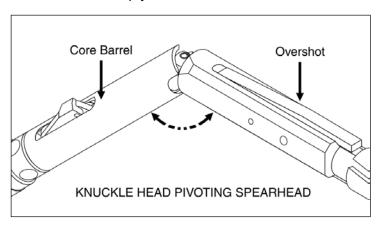
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#### NOTE:

The Next Q<sup>®</sup> fast pump-in head assembly is equipped with a 'knuckle-head' pivoting spearpoint. This feature makes removing the inner tube assembly from the rod string or outer tube safer and easier by allowing the overshot to pivot 90 degrees on the spearpoint.

## Inner Tube Retrieval

- 1 The fluid supply pump should be set at maximum flow and pressure to attain maximum overshot velocity.
- 2 When the lifting dogs hit the inner tube spearhead, they open and attach themselves to the spearhead point. On the QU overshot, this action releases the valve sleeve allowing it to slide downward opening the fluid bypass porting (Note that the running overshot does not have bypass porting).
- 3 Watch for the wireline to stop feeding into the loading chamber. Divert or close the supply fluid pressure valve and tie a string or similar marker to the wireline about one metre above the point of contact. On successive runs this marker will warn the operator when the overshot is approaching the spearpoint. Move the marker upward with each run.
- 4 Begin spooling the wireline onto the hoist drum to retrieve the inner tube assembly. As the overshot pulls on the spearpoint, the retracting case retracts the latches and the inner tube assembly is released.
- 5 The bypass porting in the overshot allows it to move through standing fluid. (In inclined holes, control the speed of the cable by reducing the fluid drainage flow to prevent the inner tube assembly coming out faster than the cable, refer to Chapter 8).
- 6 When the wireline marker comes into view, slow down the wireline hoist. Continue slowly until the overshot contacts the loading chamber. Remove the loading chamber. Grasp the overshot and gauge the weight to ensure the inner tube assembly is attached.
- 7 Remove the inner tube assembly and lower to the floor. Disconnect the overshot from the inner tube assembly, and connect it to an empty tube that has been checked and serviced.



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8 If the inner tube assembly is not attached, the inner tube assembly may be hung up in the rod string. If it can be determined that the inner tube assembly is still in a latched position, repeat the retrieval procedure.



## Inner Tube Fails to Release

- 1 The inner tube assembly may not release (un-latch) as a result of a severe core block or due to oversized core, etc.
- 2 The compact QU overshot and the running overshot include shear failure pins that are designed to fail under a pullback load slightly less than the strength of the wireline cable. This allows retrieval of the wireline prior to pulling the rod string.

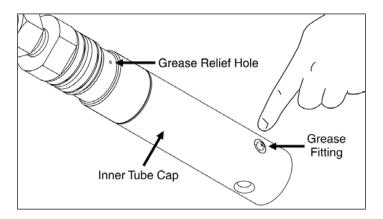


In inclined hole operations, do not remove the retainer sub unless the inner tube assembly is attached to the running overshot. Use of a retainer sub is recommended for all inclined hole operations. If the retainer sub is removed, stand clear of the rod string as close as possible to the floor as the inner tube assembly may be descending uncontrolled.

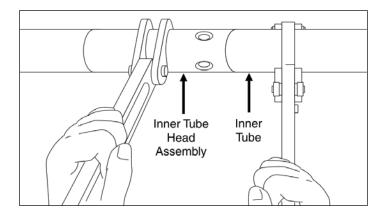
## **Maintenance Between Core Runs**

## **Head Assembly**

- 1 Wash the head assembly in clear water to remove drilling mud and debris.
- 2 Inspect the action of the latches and the latch retracting case. Check the spindle for straightness.
- 3 Check the movement of the spindle bushings. They should spin freely and there should be no vertical endplay. If endplay exists, the head assembly needs further repairs.
- 4 Check the shut-off valves for wear.
- 5 If the bearings are in good condition, apply grease to the latches and the latch retraction case. Pump grease into the grease fitting until clean grease flows out of the grease relief hole in the thrust bearing. Rotate the inner tube cap slowly to distribute the grease while pumping.



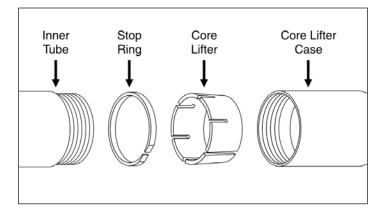
6 Rejoin the head assembly to the inner tube.



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### **Inner Tube Assembly**

1 Check the core lifter case, stop ring, and core lifter. The core lifter should rotate freely. If the inside surface of the core lifter is smooth, check the grip action by inserting a short section of core into the core lifter and pull it out to see if it will firmly grip the core. If the core slips, the core lifter or core lifter case should be replaced.



- 2 Before you can extract a worn core lifter, you must remove the stop ring. To remove the stop ring:
- Insert a screwdriver blade under the split in the ring and pry loose.
- Rotate the stop ring so that the ring hoop is at 90° with the diameter of the core lifter case and pull it out.
- Replace the worn core lifter.
- Replace the stop ring by sliding it in the 90° position, rotate the hoop 90° and snap it into the recess.
- Grease the inside of the core lifter case.
- 3 Check the inner tube for wear. Reverse the inner tube, if necessary (NQ2" inner tubes are not reversible).

### Overshot

- Check that the lifting dogs latch onto the head assembly spearpoint.
- Check the head assembly spearpoint by comparing to a spare spearpoint and replace if visibly worn.
- Check the 'hooked' ends of overshot lifting dogs by comparing to a spare lifting dog and replace if visibly worn (The 'Ezy-Lock' overshot includes inspection windows to allow visual inspection of the lifting dogs mated to the spearpoint).

NOTE:

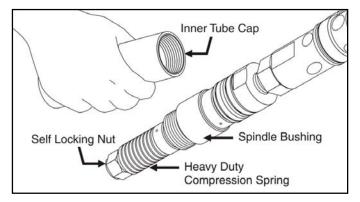
New micro-diamond coated core lifters are available with superior gripping action and longer wear life.

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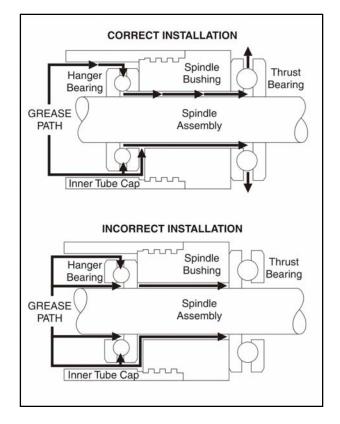
## **After Service Maintenance**

## **Inner Tube Assembly**

1 Using Boart Longyear inner tube wrenches, remove the inner tube cap from the spindle bushing and wash out the grease from within the cap.



- 2 Clean the grease from the compression spring and from the bearings on the spindle shaft.
- 3 Check both the thrust and hanger bearings to see that the cages are not broken and that the races are spinning freely. If replacement is required, it is very important to ensure that the bearings are installed correctly.



#### NOTE:

Thrust type ball bearings have two different inner diameters. For correct installation, the largest inner diameter must contact the spindle bushing. Incorrect bearing installation can reduce the head life and cause excessive core lifter wear.

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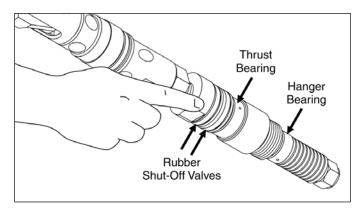
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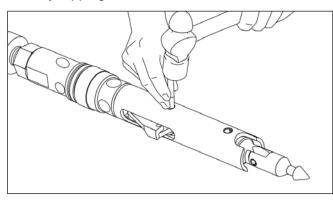
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The larger inside diameter must always face the spindle bushing to allow proper grease flow. After installation, pump grease into the inner tube cap assembly, until grease squirts out of the grease relief hole in the thrust bearing.

4 If the shut-off valves or any of the bearings need replacing, remove the Stover nut and strip the spindle shaft of all parts, keeping the bearings together as a group. Inspect the ball check spring and steel ball for caked debris or water.

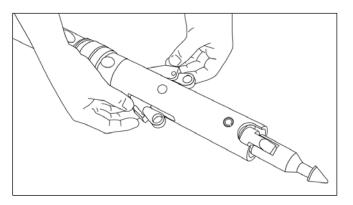


- 5 Check the spindle shaft for wear and shaft straightness. Although some shaft wear is permissible, replace the shaft if galls or grooves are visible.
- 6 Thread the stover nut to the spindle and tighten so that the compression spring is only lightly pre-loaded. There should be no up and down bearing endplay, however the bearings must spin freely.
- 7 If there is visible wear or deformation on the landing shoulder or landing ring, reverse or replace as necessary.
- 8 Rapid wear of the core lifter, latch faces, or locking coupling pin end shoulder face, may indicate poor lubrication or poor condition of the thrust and hanger bearings.
- 9 If the latches or links show excessive wear, remove worn latches by driving out the spring pin and removing latch retraction case.
  - a) Remove the spring pin that connects the links to the retraction case by tapping it out.

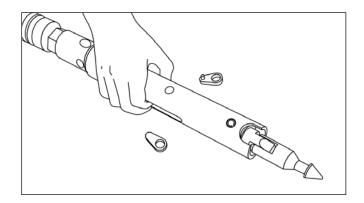


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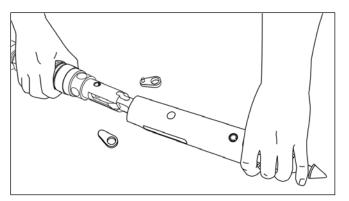
b) Swing the link latches outward and remove the two links.



c) Swing the latches back inward.

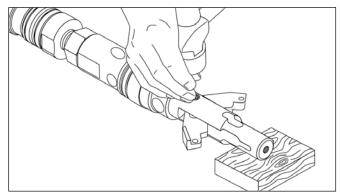


d) Remove the latch retracting case.

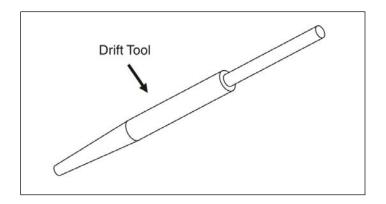


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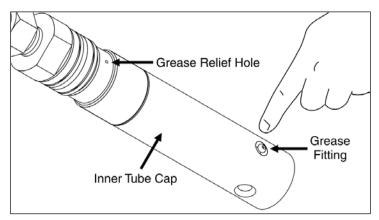
e) Remove the spring pin that connects the latches to the upper body by tapping it out.



f) To assemble the latches and retraction case reverse the procedure above utilizing the assembly drift tool to align the links and latches allowing spring pin insertion.

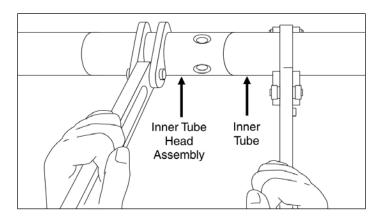


- 10 Lubricate the head assembly with a light oil or grease coating to ensure internal components do not seize up due to corrosion while in storage, especially in underground conditions.
- 11 Pump grease until it flows up through the thrust bearings.



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- 12 Check the spearhead assembly for wear. Replace as necessary.
- 13 Attach the inner tube to the head assembly.



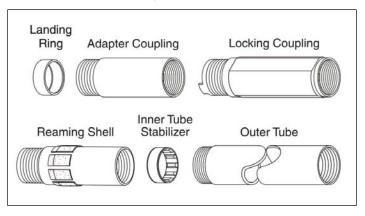
14 Set the inner tube assembly aside and service the outer tube assembly.

### **Outer Tube Assembly**

1 Check the general condition of the outer tube assembly each time it is pulled from the hole. A dented or bent outer tube causes premature core blocking and vibration.

#### NOTE:

For PQ and PV systems, the inner tube stabilizer is inserted into the bit, not the shell.



- 2 Remove the locking coupling. Drilling through heavy core blocks may cause latch dents on the locking coupling. When this damage occurs, the locking coupling needs to be replaced.
- 3 Remove the adapter coupling / drive coupling from the outer tube and inspect the condition of the shoulders above the threads for wear.
- 4 Remove the landing ring from the counterbore of the outer tube. If it is tight, insert the inner tube assembly from the bit end of the outer tube. Grasp the inner tube and use the assembly as a slide hammer to jar the landing ring loose.
- 5 Clean both the landing ring and the outer tube counterbore.
- 6 Check the landing ring for wear. If the landing ring is worn or chipped, reverse it and reinstall. Replace if both sides are worn. Apply grease between the ring and the counterbore before reinstalling.
- 7 Remove the reaming shell from the outer tube. The inner tube stabilizer is located in the counterbore of the reaming shell.
- 8 Remove the inner tube stabilizer by carefully tapping it out of the reaming shell using a screwdriver and hammer. Clean the inner tube stabilizer and the reaming shell counterbore.
- 9 Examine the inner tube stabilizer for wear by fitting it over the inner tube O.D. If there is more than 0.7mm (.030") clearance, the ring is worn and should be replaced.
- 10 Reassemble the outer tube, replacing all worn parts. Clean each threaded connection and apply thread compound to each joint.

## **Core Barrel Assembly**

- 1 After the inner tube assembly and the outer tube have been serviced, clean and lightly oil the surface of the inner tube.
- 2 Install the inner tube assembly into the outer tube so that the landing shoulder is firmly seated on the landing ring (*required for wireline systems only*).
- 3 Check the latching action of the head assembly in the outer tube assembly. The latches should snap out quickly and latch in firmly. In order to check the 'Fast Pump-In' head, temporarily remove the latch indication bushing (*required for wireline systems only*).

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**SECTION 2** 

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## Introduction

A 'dry hole' or 'lost circulation' occurs when the partial or total volume of drilling fluids pumped down the hole is lost to voids in the formation.

An internal fluid control valve is required to retain a column of fluid above the head assembly and control the flow of fluid to the bit or limit the flow lost to the ground. Where the hole is sufficiently deep, an internal fluid control valve can also provide reliable latch indication and a method to allow drainage of the retained column of fluid upon retrieval.

A method is required to lower the inner tube into a dry hole and then release into a low water table or in totally dry holes, prevent release until the inner tube assembly is in the latch position.

## **Lost Circulation Guide**

Lost circulation is also referred to as lost return, low water table, or dry hole drilling. After attempts are made to case off, plug with lost circulation material, or cement the lost circulation zone, it is often necessary to continue drilling. Typically there are varying degrees of lost circulation.

## **Total Loss Conditions**

- no water table
- fluid escapes at or ahead of the bit
- no indication on fluid pressure gauge while drilling
- vibration

### Intermittent Circulation Conditions

- intermittent conditions are the most difficult, as the water table can change rapidly
- circulation may vary from full return to total loss of fluids as the water table fluctuates
- water table may drop when drilling is interrupted during shutdowns or shift changes
- fluid supply pressure gauge reading will vary

#### **Potential Results**

- rod string vibration
- excessive consumption of water and additives
- core blocks (no signal possible from shut-off valves)
- poor bit life
- stuck or sanded-in inner tubes or rod string
- damage to in-hole tools from debris, lack of flushing
- damaged bit and core barrel from dropped inner tube assembly

## **Optional Fluid Control Valves and Dry Hole Lowering**

A fluid control valve ensures a positive supply pressure reading and core block signals (shut-off valve signals). Two optional valves are available: the fluid retention valve or the dry hole valve.

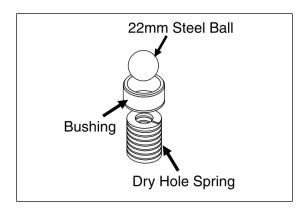
Both valves utilize a spring-loaded ball or piston moving through a flow control bushing to retain a column of fluid in the rod string. The valve can be adjusted without losing the inner tube adjustment (bit gap adjustment).

When lowering with the overshot it is possible to accidentally release the inner tube assembly, especially in angled holes, which can cause extensive damage in dry holes. A locking sleeve is available for the overshot which allows wireline lowering and release into low water tables.

Also, the **Dry Hole Lowering Kit** is available to modify the Next Q<sup>™</sup> overshot and head assembly and eliminate accidental drops by locking the overshot to the spearhead until the latches have deployed.

## **Fluid Retention Valve Option**





## Form and Function

- Consists of a spring, steel bushing, and ball installed in the lower latch body.
- As the inner tube assembly descends, the ball floats above the bushing.
- Upon landing the ball drops into the bushing, closing the valve. Note that the valve may close even if the latches have not deployed.
- As supply fluid pressure builds it acts against the ball and compresses the spring.
- As the spring compresses, the ball moves through the bushing which allows fluid to pass around the ball and through the bushing. A steady fluid pressure will develop.
- In this fashion, the strength of the spring determines the fluid pressure in the rods.
- Because the steel ball is slightly smaller in diameter than the stainless steel bushing, some fluid drains between the bushing and the ball. With clean drilling fluids, this flow is sufficient to slowly drain the retained column of fluid and reduce the pullback load when pulling the inner tube off bottom.

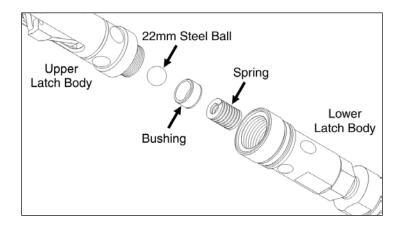
**SECTION 2** 

## Installing the Valve

- 1 Unscrew the upper and lower latch body.
- 2 Drop the spring into the seat in the lower latch body.
- 3 Slip fit the steel bushing into the seat in the lower latch body.
- 4 Drop in the steel ball.

#### NOTE:

Examine bushing wear and replace regularly. To remove the bushing, tap the bushing out from behind the bushing seat.



- 5 Thread the upper and lower latch bodies together.
- 6 Before lowering the core barrel, check that the valve produces the desired pressure and measure the output flow from the pump.

## Limitations

- Difficult to pull the inner tube off the bottom of deep holes against and through the retained column of fluid due to valve ball in bushing.
- The fluid retention valve does not allow for full bypass when pulling the inner tube assembly.
- Lost circulation material (LCM) can plug the valve bushing and ball.

## **Dry Hole Valve Option**



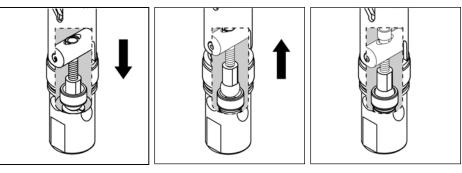
Similar to the fluid retention valve, the dry hole valve consists of a valve member passing through a flow control bushing against a spring. However, the dry hole valve addresses the limitations of the fluid retention valve by controlling the position of the valve member with the retracting case.

The dry hole valve helps avoid problems with pulling the inner tube due to the weight of the drilling fluid and/or suction from aquifers.

## Form and Function

- Consists of a spring, steel bushing, threaded ball, shoulder bolt, and valve holder. The threaded ball and shoulder bolt are controlled by the retracting case through the valve holder.
- As the inner tube assembly descends, the threaded ball floats above the bushing.
- Upon landing the latches must be deployed to drop the retracting case and allow the threaded ball to move into the bushing, closing the valve. This provides a latch indication pressure signal.
- As supply fluid pressure builds it acts against the ball and compresses the spring.
- As the spring compresses, the ball moves through the bushing which allows fluid to pass around the ball and through the bushing. A steady fluid pressure will develop.
- In this fashion, the strength of the spring determines the fluid pressure in the rods.
- As the overshot pulls on the spearpoint during retrieval, the retracting case retracts the valve out of the bushing. This drains the retained column of fluid and allows full fluid bypass as the inner tube trips out of the hole.

#### **Dry Hole Valve Movement**



While Drilling

While Pulling

At Rest

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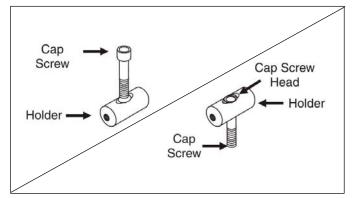
#### NOTE:

Keep the Head Assembly clean and free of debris at all times and replace worn parts to maintain full travel of the threaded ball.

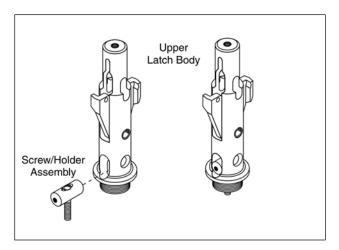
## Installing the Valve

(Tools required: 3/16" Allen Wrench and a 5/8" Open End Wrench)

- 1 Remove the retraction case from head assembly by driving out the spring pin and removing the links. Remove the lower latch body.
- 2 Start the shoulder bolt through the holder. Ensure correct direction of cap screw entry, as shown below.



3 Install the bolt/holder assembly into the large slot of upper latch body. When properly installed, the threaded portion of the bolt will be inside the latch body and protrude beyond the threaded end of the upper latch body. The head of the bolt will lie inside the countersunk portion of the holder.

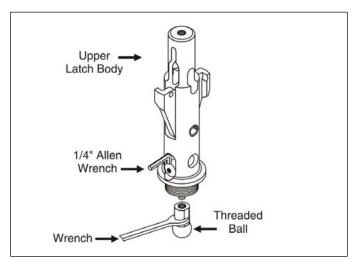


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**SECTION 2** 

#### NOTE:

This bolt should be replaced with each disassembly for a fresh nylon insert. 4 Thread the valve ball onto the shoulder bolt. Tighten, using the Allen wrench on the screw, and the open-end wrench on the threaded ball until the ball shoulders. The shoulder bolt thread has a nylon ball insert to lock the threaded ball in place.

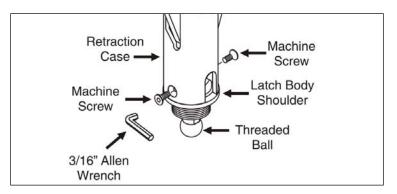


#### NOTE:

These screws should be replaced with each disassembly for a fresh nylon insert.

5 Slide the retracting case over the latch body such that it bottoms out on the upper latch body shoulder. Align the two countersunk holes at the end of the retracting case with the two tapped holes at each end of the holder, which is now installed into the upper latch body. Fasten the retracting case to the holder with the two machine screws as shown below. These screws have a nylon ball thread insert to lock them in place.

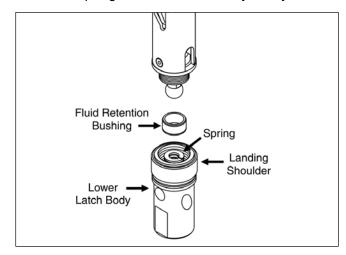
Slide the fluid retention ball/screw assembly up and down in the upper latch to ensure free movement. Tighten the machine screws.



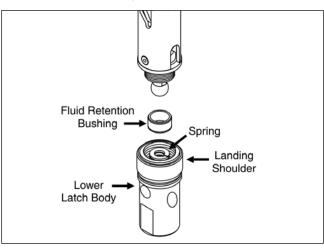
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- Spring -
- 6 Install the links and spearhead assembly components.

7 Install the spring into lower latch body cavity.



8 Install the fluid retention bushing into its seat in the lower latch body above the spring.



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### Chapter 6 - Dry Hole or Lost Circulation

**SECTION 2** 

- 9 Thread the upper latch body to the lower latch body and tighten. Ensure the landing shoulder is fixed in place between the upper and lower latch bodies.
- 10 Before lowering the core barrel, check that the valve produces the desired pressure and measure the output flow from the pump.

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## **Fluid Retention Springs**

#### NOTE:

Pressure signal drops as the hole depth and hydrostatic pressure increases. The pressure signal can be increased by dropping in adjusting washers below the spring to create a valve preload (p/n 44611 WASHER, FLAT 3/8 USS). Consideration must be given to the choice of spring installed into the lower latch body. The table below is provided for reference however, site conditions, worn parts, and driller preferences will affect the choice of spring. Test the core barrel before lowering to check that the valve produces the desired pressure and measure the output flow from the pump.

Hole Depth	Spring	Pressure Rise @ 38-57 L/min (10-15 gpm)	Type (Colour)
m (ft)		MPa (psi)	
0 - 61 (0 - 200)	104966 (BQ/BQTK 306443)	1.0 – 1.4 (150 - 200)	Light (green or brown)
61 - 152 (200 - 500)	104971 (BQ/BQTK 306444)	2.1 – 2.8 (300 – 400)	Medium (blue)
152 - 305 (500 – 1000)	104972	5.5 – 6.9 (800 - 1000)	Heavy (red)
305+ (1000+)	103116		Extra Heavy (yellow)

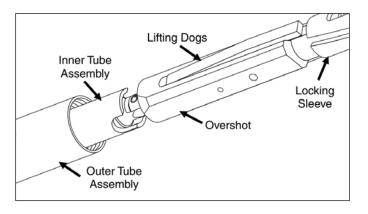
## **Overshot Lowering With The Locking Sleeve**

#### NOTE:

Slack in the wireline cable may cause the overshot to release prematurely.

Where a low water table exists that fluctuates or is insufficient to allow dropping the inner tube from surface, utilize the overshot locking sleeve to lower and delay release until the inner tube hits the water table.

1 Check the action of the lifting dogs when attached to the spearhead. To keep the locking sleeve from sliding off the overshot, attach it to the overshot with the self-locking set screw.



#### NOTE:

An experienced operator can detect the weight difference between the overshot and the combined overshot and inner tube.

#### NOTE:

Only use the Locking Sleeve for lowering or for releasing the overshot from a stuck inner tube. Remove the Locking Sleeve from the overshot for inner tube retrieval.



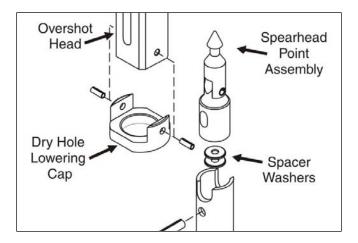
The overshot and the head assembly should not be worn or altered. Inspect the lifting dogs.

- 2 Lower the inner tube assembly into the open rods, making sure that the locking sleeve rests on the lifting dog ends. Keep the wireline cable tight by controlling the speed of the hoist.
- 3 When the inner tube and overshot assembly hit the water table or land in the outer tube, the overshot drops further onto the spearpoint. The taper on the spearhead body spreads the lower ends of the lifting dogs. This brings the opposite end of the lifting dogs inward allowing the locking sleeve to drop, locking the lifting dogs open to release the inner tube.
- 4 If the overshot did not release, pull the cable tight and release it quickly. If the hole is not deep, this can be done by hand. The jarring action of the overshot will force the locking sleeve down over the lifting dogs.
- 5 Retrieve the overshot and remove the locking sleeve.

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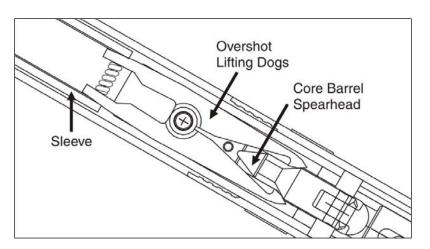
## **Dry Hole Lowering Kit**

As the Inner Tube Assembly is lowered with a wireline overshot, it is possible for the inner tube to catch on a rod joint or hit an unexpected water table. This forces the overshot lifting dogs over the spearpoint base into an open position creating potential for accidental release. The Dry Hole Lowering kit eliminates this potential.



### Form and Function

With the overshot head spacer installed and washers inserted under the spearhead base, the lifting dogs cannot advance over the spearhead base to allow release. When the latches open in the adapter coupling, the latch retraction case drops allowing the lifting dogs to advance down the taper of the spearhead body. This brings the opposite end of the lifting dogs inward allowing the locking sleeve to drop, locking the lifting dogs open to release the inner tube.



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**SECTION 2** 



Slack in the cable may cause the overshot to release causing damage to the core barrel.

#### NOTE:

An experienced operator can detect the weight difference between the overshot and the combined overshot and inner tube.



The overshot and the head assembly should not be worn or altered. Inspect the lifting dogs.

#### NOTE:

Only use the Locking Sleeve for lowering or for releasing the overshot from a stuck inner tube. Remove the Locking Sleeve from the overshot for inner tube retrieval.

## Using the Dry Hole Lowering Kit

- 1 Check the operation of the overshot and locking sleeve on the surface, making sure the overshot only releases when the latches are fully deployed.
- 2 Lower the overshot and inner tube assembly into the rods. Stop when the latches are inside the rod, and ensure the locking sleeve is resting on the top of the lifting dogs.
- 3 To keep the locking sleeve from sliding up the cable, especially on an angle hole, install the self-locking set-screw.
- 4 Keep the cable tight by controlling the speed of the hoist.
- 5 When the inner tube assembly lands on the landing ring, the lifting dogs down the taper of the spearhead body. This brings the opposite end of the lifting dogs inward allowing the Locking Sleeve to drop, locking the lifting dogs open to release the inner tube.
- 6 If the overshot did not release, pull the cable tight and release it quickly. If the hole is not deep, this can be done by hand. The jarring action of the overshot will force the Locking Sleeve down over the lifting dogs.
- 7 Retrieve the overshot and remove the locking sleeve.

## **Troubleshooting Guide**

## 1 Problem: Fluid Pressure Too High

### Causes:

- Latches may not have deployed preventing Dry Hole Valve from opening
- May have selected too strong a spring
- core lifter case adjusted too close to bit
- drilling fluid/mud too thick
- lost circulation material too coarse
- swelling ground (clay-like)
- reaming shell gauge below minimum
- bit impregnation consumed
- pumping excessive volume of drilling fluid
- Mud build-up in lower latch body, holder, or fluid retention bushing.
- Threaded ball may have come unthreaded from shoulder bolt.

#### Action:

• With the rods off the bottom, circulate drill fluids at the normal rate to determine the cause and address.

## 2 Problem: Fluid Pressure Too Low

#### Causes:

- Inner Tube Assembly may be hung up in rod string or in 'mud rings'
- Water table may have dropped, thus too weak a spring may have been selected
- Fluid retention bushing or threaded ball may be worn
- Fluid retention spring may be badly worn or broken
- Valve Holder may be misaligned with the latch body
- Inefficient pump
- Suction hose leaking
- Rod joints leaking, unscrewed, or broken
- flat area worn on landing shoulder allowing fluid to leak past landing ring

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#### Action:

- Replace worn parts.
- Check pump performance and rod joints at normal drilling pressures.
- If damaged rods are suspected, do not lower the overshot. Pull the rods.

## 3 Problem: Difficult to Pull Inner Tube Assembly Off Bottom

### Causes:

- Threaded ball may have come unthreaded from shoulder bolt.
- core lifter case sitting on throat of bit
- inner tube "mudded" or sanded-in
- wireline hoist not adequate

### Action:

- Wait longer for fluid to drain from rods.
- Check inner tube adjustment.
- Circulate for a few minutes to flush core barrel before descending overshot.
- Replace valve shoulder bolt for fresh nylon insert or apply medium strength thread locking solution to the valve assembly.

## 4 Problem: Very Slow Descent

#### Causes:

- Threaded ball may be 'mudded in' to the fluid retention bushing.
- Threaded ball may have come unthreaded from shoulder bolt.

### Action:

- Unthread upper and lower latch body and clean the bushing.
- Replace valve shoulder bolt for fresh nylon insert or apply medium strength thread locking solution to the valve assembly.

**SECTION 2** 

## Introduction

## **WARNING**

Wear PPE and handle suspended wireline tools carefully and remain clear! 'Q<sup>®</sup>' and 'NextQ<sup>®</sup>' wireline inner tube assemblies cannot withstand side loads, bending loads, or impact loads as a result of improper handling.

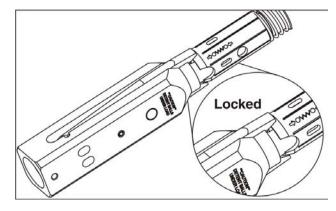
#### NOTE:

The socket-head set screw, used to retain the optional locking sleeve, must be removed or threaded completely into the overshot head to allow operation of the 'Ezy-Lock' Sleeve. When handling an inner tube assembly above ground level suspended at any height, it becomes a raised load representing a potential safety hazard. The 'Ezy-Lock' overshot incorporates safety devices to act as a back-up should excessively worn or dirty components cause the overshot lifting dogs or core barrel spearpoint to malfunction or fail.

## 'Ezy-Lock' Sleeve Operation

The 'Ezy-Lock' sleeve is an integral, one-hand operated safety mechanism to easily lock the lifting dogs to the spearpoint and is recommended for all wireline operations.

- 1 As the 'Ezy-Lock' overshot is raised out of the rod string, stop the wireline and twist the sleeve 90 degrees (the sleeve has spring-loaded detent positioning in 90 degree intervals) from the 'open' position to the 'locked' position. The sleeve is spring loaded against the back of the overshot head. As the sleeve rotates into the locked position, tapered extensions of the sleeve are forced underneath the back ends of the lifting dogs. This forces the hooked ends of the lifting dogs from releasing the spearpoint.
- 2 In order to release an inner tube assembly, the 'Ezy-Lock' sleeve must be returned to the 'open' position. Slots in the tapered extension of the sleeve align with the lifting dogs allowing them to function normally.



3 Alternatively, when tripping expensive survey tools in the hole utilize the 'Ezy-Lock' sleeve to ensure the lifting dogs remain engaged to the tool spearpoint.

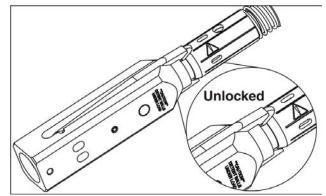
#### NOTE:

The overshot cannot retrieve an inner tube assembly unless the 'Ezy-Lock' sleeve is in the open position.

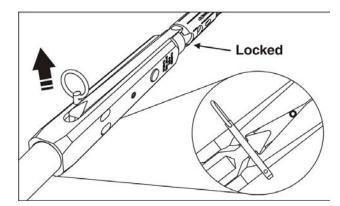
**SECTION 2** 

## **Ezy-Lock Safety Pin Operation**

1 The safety pin is a two-hand operated safety device which acts as a back-up to the lifting dogs and may be used in addition to the 'Ezy-Lock' sleeve.



- 2 Use of the safety pin is recommended in operations where additives are used in the drilling fluid, or where heavy drilling muds are utilized such that debris may build up under the spearpoint or under the hooked ends of the lifting dogs.
- 3 The safety pin should be used when hoisting extended inner tube assemblies in large size wireline systems which may overload the lifting dogs under accidental impact load or sudden movement.
- 4 As the 'Ezy-Lock' overshot is raised out of the rod string, stop the wireline and insert the safety pin into the hole in the overshot head immediately adjacent the hooked end of the lifting dogs and under the spearpoint. The safety pin has a spring-loaded detent ball which retains the pin in the head. Should the lifting dogs move into a release position or fail due to overload, the safety pin will retain the spearpoint.
- 5 In order to release an inner tube assembly, remove the safety pin.



**NOTE:** The Safety Pin must be removed in order to retrieve an inner tube assembly.

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The 'Ezy-Lock' sleeve detent balls are spring loaded and will eject at significant speed creating a safety hazard. Wear proper PPE and contain the balls as the 'Ezy-Lock' sleeve is removed to prevent ejection.

## Ezy Lock Maintenance / Assembly

Regular maintenance is required for the lifting dog mechanism to ensure proper grasping of the head assembly spearpoint. Also, the 'Ezy-Lock' sleeve must be replaced if any wear is visible on the tapered end.

- A. Unscrew the jar staff from the overshot head sub assembly.
- B. Slowly remove the 'Ezy-Lock' sleeve, spring, and cap, being careful to retain the spring loaded detent balls inside.
- C. Disassemble the head and lifting dogs.
- D. Inspect all components for corrosion and wear and replace as required to ensure proper function of both the lifting dog and 'Ezy-Lock' sleeve.
- E. To reassemble the detent balls, hold the head oriented with the detent hole horizontal. Compress the balls and spring into the detent hole with one hand and slowly advance the 'Ezy- Lock' sleeve over the balls with the other hand.

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## Introduction

## **WARNING**

In inclined holes, all wireline systems must be operated with an incompressible drilling fluid. The column of fluid in a closed rod string will prevent a runaway inner tube. A fluid filled rod string allows control of the inner tube descent rate during retrieval, through a valve which adjusts the fluid flow draining from the rod string.

#### NOTE:

While the Next Q<sup>®</sup> 'Fast-Pump-In' head assembly includes features to address some of these issues, use of the running overshot eliminates this hazard risk.



Never use a head assembly with a pump-in seal attached to the retracting case (e.g. the former 'QU' style of head assembly) when drilling into pressurized ground. When drilling in "up-holes", a hazardous situation is created when the inner tube assembly is raised or pumped into an up-angled hole. Gravity acts on the mass of the inner tube and may accelerate it down the rod string should it become free (un-latch).

## Potential Causes of an Un-latched Inner Tube

- a) Broken core prevents the inner tube from reaching the latched position.
- b) Sudden rock movement (e.g. blasting) either prevents latching or causes inner tube latch mechanism to release.
- c) High ground water pressure either prevents latching or causes inner tube latch mechanism to release.
- d) Negative water pressure causes inner tube latch mechanism to release (e.g. The suction created by draining rod string fluid after removal of the water swivel).
- e) Sudden movement of the rod string causes inner tube latch mechanism to release (e.g. pulling rods or attempting to free a stuck inner tube).
- f) Worn or loose components, or mis-matched components from multiple manufacturers or system variations.

# 

Keep hands and body clear of open rods while operating. Failure to do so could result in serious injury or death.



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**SECTION 2** 

#### NOTE:

Both styles of underground overshot are designed to work with 3/16" (4 mm) wireline. 1/4" (6 mm) wireline creates too large a loop through the overshot eyebolt, preventing passage through the retainer sub.

## **WARNING**

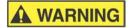
If the retainer sub is removed and the running overshot has accidentally released into the rod string, stand clear of the rod string as close as possible to the floor. Very carefully remove each length of rod from the rod string until the overshot is located.

#### NOTE:

The dog nut is extended between the lifting dogs preventing them from connecting with the inner tube spearhead.

#### NOTE:

If operating in a flat or declined hole, the retainer key will not be protruding from the retainer sub. Insert the retrieval tool through the retainer sub and rotate into the slot in the rear of the retainer key. Pull the overshot out until the retainer key can be removed.



Do not remove the retainer sub unless the inner tube assembly is attached to the running overshot. If the retainer sub is removed, stand clear of the rod string and lower the rod string as close as possible to the floor as the inner tube assembly may be descending uncontrolled.

## **Running Overshot**

While the standard 'QU' compact overshot is recommended for flat and slightly declined holes, it's integral pump-in seal bypass valve is of no benefit in inclined holes.

The running overshot is recommended for inclined holes as it provides valving to control the raised column of fluid and provides a method to monitor the position of the raised inner tube assembly.

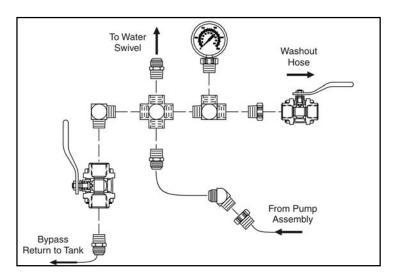
### **Running Overshot Operation**

- 1 Insert the overshot body into the male end (pin end) of the retainer sub.
- 2 Attach the retainer key (longer key with internal check valve installed) by inserting it into the slot in the end of the overshot body, displacing the circulation tube/rod inside and extending the dog nut. The key should be flush with the overshot body when inserted (i.e. the 'tooth' of the key protrudes into the slot). Slide the locking sleeve back and thread to the retainer key.
- 3 Thread the retainer sub, assembled with the overshot, to the female end (box end) of the next rod to be added to the rod string.
- 4 Attach the water swivel to the female end (box end) of the retainer sub.
- 5 Insert the inner tube assembly into the rod string. Raise the rod and overshot assembly to the rod string. Hold and lower the inner tube out of the rod string and into the rod and overshot assembly.
- 6 Attach the rod to the rod string and pump the inner tube into the rod string to the core barrel.
- 7 Drill a "run" (fill inner tube), attaching extra rods behind the retainer sub for an extended core barrel, and break the core.
- 8 Remove the water swivel (the overshot will retain the drilling fluid in the rod string; water saver subs are eliminated). Remove any extra rods behind the retainer sub.
- 9 Remove the retainer key and attach the wireline key and wireline. Again, the top of the key should be flush with the overshot body when installed. Note that the dog nut retracts, allowing the lifting dogs to connect to the inner tube spearpoint.
- 10 Attach the loading chamber with the extension attached or a 0.5 m (1 ft) rod (to clear the overshot body which will be protruding out of the retainer sub due to fluid weight).
- 11 Pump the overshot into the rod string until it has latched onto the inner tube.

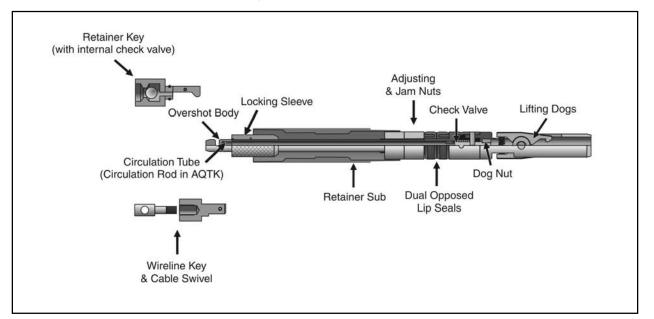
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12 Retract the inner tube and overshot with the wireline hoist until they seat on the retainer sub. Control the rate of descent by adjusting a valve controlling drainage flow through the loading chamber.



- 13 Remove the loading chamber (and short rod extension). Manually lift the overshot to confirm that the inner tube has been successfully retrieved by feel of weight.
- 14 Upon confirmation, remove the retainer sub, inner tube, and overshot.
- 15 Have a previously assembled overshot, retainer sub, and rod ready to load for the next run to minimize downtime between runs.
- 16 This method eliminates draining of the rod string, required for a traditional overshot, and the re-filling and re-draining of the rod string for inner tube retrieval.



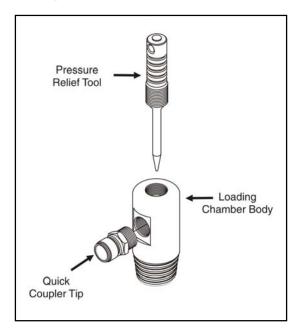
## Running Overshot Operation in Near-Vertical Holes or In-Ground Pressure

In near vertical holes, the load on the supply pump is greatly increased due to the column of fluid maintained above the running overshot. As a result tripping speed is reduced.

In holes where pressurized zones of fluid or gas may be intercepted, the retainer key check valve will hold the pressure.

Follow the steps below to drain the column of fluid or to relieve inground pressure in a controlled manner:

- 1 Lower the rod string as close to the floor as possible.
- 2 Remove the water swivel to expose the retainer sub and retainer key.
- 3 The pressure relief assembly consists of a standard loading chamber body fitted with a short rod extension, a quick coupler fitting, and a check valve spear. Thread the pressure relief assembly to the retainer sub and tighten, with the check valve spear fully retracted. Connect the quick coupler to a suitable drainage hose or circuit.



4 Slowly thread the check valve spear towards the retainer key check valve ball and force the ball off it's seat to relieve pressure in the rod string.

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