

BOART LONGYEAR®
DRILLING PRODUCTS

DRILLING EQUIPMENT

CORING RODS AND CASING CATALOG

2026.14 EDITION

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IMPORTANT SAFETY INFORMATION

Use appropriate eye protection, gloves, masks, and ventilation when using our tools.



Warning and Caution indicators are located throughout the manual at specific points of interest and are intended to alert the reader to the existence and relative degree of a hazard. These notices are given to prevent personal injury, death, and/or equipment damage. These indicators must be followed to reduce the risk of personal injury, equipment damage, or improper service. Always heed these notices, and practice common sense when performing any maintenance or repair procedure.



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury and death.



“Danger” indicates an imminently hazardous situation which, if not avoided, could result in death.



“Warning” indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury or property damage.



“Caution” indicates a potentially hazardous situation which, if not avoided, MAY result in minor or moderate injury and property damage. It may also be used to alert against unsafe practices.



"Notice” is used to draw attention to detailed instructions. These notes are intended to give further important information regarding the machine and/or a step in a procedure.

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IMPORTANT SAFETY INFORMATION (CONT.)

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 UN-LATCHED TOOLS OR FALLING CORE INCLUDE:

- worn parts
- broken core
- rock movement (e.`g. mine blast)
- pressurized fluid or gas reservoirs
- operator error

ALWAYS FOLLOW THESE RULES:

- Keep clear of rotating equipment. **NEVER** wear any loose clothing, which could become entangled in the rods.
- **NEVER** stand or walk with any part of your body in front of the rod string. Never look into the rod string. When working, always stand to the side of an open rod string.
- **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.

WHEN A ROD STRING IS IN AN INCLINED OR 'UP' HOLE:

- Plug the rod string when not in operation by attaching a water saver sub, a water swivel, or loading chamber.
- Move the rods as close to the floor as possible.
- If it is not possible to retrieve the inner tube or overshot, pump the rods full of water prior to plugging the rod string. If leaving the rod string unattended, attach a visible warning tag to alert the next shift or anyone approaching the drill to a safety hazard.
- **NEVER** use air pressure to pump the inner tube assembly into a rod string unless the head assembly incorporates a hold-back braking device that has been inspected or tested prior to use.
- Use only Boart Longyear replacement parts. Failure to do so could cause severe damage to the equipment or operator and may void your warranty.
- Read and understand the Operations and Service Manuals for all drilling equipment in use. Complete all checks and adjustments as stated before starting the drill.
- **DO NOT** alter or modify 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.
- **DO NOT** attempt to stop the core with your hand when emptying the inner tube. The core can be sharp or heavy, causing severe injury. If it is necessary to look in an inner tube, always look down, never look up the tube.
- **NEVER** rotate the rod string with a joint between the drill chuck and the water swivel. The joint may become loose, causing the rod to unscrew if it is not held by the chuck jaws.
- If you do not fully understand the equipment and how it operates, **DO NOT** attempt to make adjustments or repairs.

When the core barrel is transported on an angle where the head assembly is lower than the bit and shell, the inner tube assembly may 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 Board Longyear representative.

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IMPORTANT SAFETY INFORMATION (CONT.)

WARNING

OVERSHOTS & ELEVATED LOAD HAZARDS

Inner tubes are an elevated load hazard when hoisting overhead with a surface wireline overshot, or when retracting from elevated positions in inclined drill strings with an underground wireline overshot. Regularly inspect and confirm the safe working condition of wireline hoist, cable, and fittings. Always use recommended overshot safety features and safety devices. Always use Boart Longyear components and hardware. Do not interchange components or hardware from other manufacturers. A fluid bypass valve is required in underground pump-in overshots to release the hold-back brake. Do not block porting or otherwise disable the bypass valve.

INCLINED DRILLING HAZARD

Inclined, up-hole drilling presents a risk that wireline tools or other in-hole components may fall back towards the operator at high speed, under gravity or in-hole fluid or gas pressure. Operators must always stand clear of rod string openings to prevent serious injury or death. Do not remove the Water Swivel or Loading Chamber until the inner tube assembly is at 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 ASSEMBLY HOLDBACK BRAKE

The head assembly hold-back brake feature is designed to improve the safety of up-hole drilling operations. The hold-back brake is not designed nor intended to be used as a fail-safe device. Failure of the hold-back brake can occur due to improper maintenance or wireline overload. A fluid bypass valve is required in underground pump-in overshots to release the hold-back brake. Do not block porting or otherwise disable the bypass valve.

ADAPTER COUPLING HAZARD

Roller Latch™ head assemblies are not compatible with core barrel adapter couplings. Verify that adapter couplings have been removed from pre-existing core barrel assemblies and drill strings. Failure to do so will prevent latch deployment and may result in product failure or injury.

PRESSURIZED INNER TUBE LINER HAZARD

Q™3 triple-tube core barrels may require a pump-out piston to remove the core sample under fluid pressure. There is a risk of sudden expulsion of core samples under excessive fluid pressure due to stuck core samples or worn components. Always stand to the side of a pressurized inner tube. Never look into an inclined or pressurized inner tube. Always inspect for and replace a worn pump-out piston or worn split tubes. Failure to do so may result in product failure or injury.

PUMP-IN SEAL HAZARD

Head assemblies with a pump-in seal connected to the latch-retracting case are not recommended for inclined holes or ground in pressurized fluid or gas zones. Boart Longyear recommends Quick Pump-In™ head assemblies that incorporate pump-in seals separate from the retracting case.

RETAINED FLUID COLUMN HAZARD

Do not remove loading chambers or water-saver subs without first draining any retained fluid from the column. Inclined or up-hole drilling can include retention of a column of fluid by a wireline-loading chamber or a water-saver sub. As the hole depth increases, this fluid column rapidly accumulates hazardous weight and hydrostatic pressure until it is safely drained. If drainage tooling and adapters are not available, use the drill rig to partially break the joint at the loading chamber or water saver sub to allow drainage, while standing clear.

PETROLEUM-BASED GREASE

Throughout this manual, the use of grease is mentioned. It is important to note that the use of petroleum-based grease is prohibited in some parts of the world. Contact your Boart Longyear representative for recommended lubrication alternatives.

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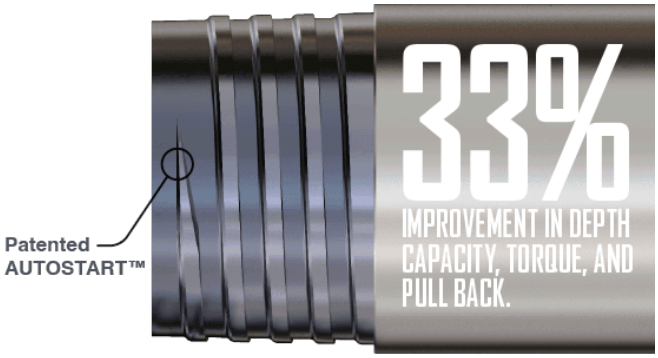
WIRELINE CORING ROD TECHNOLOGY

SUPERQ TECHNOLOGY OVERVIEW

PERFORMANCE-FOCUSED TECHNOLOGY

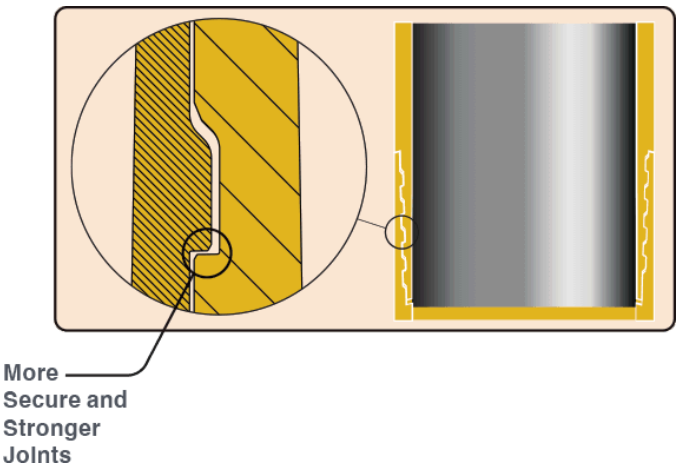
SuperQ™ Coring Rods have been developed as a smarter version of the Q® system, trusted for decades. Engineered as a drop-in replacement, SuperQ delivers enhanced joint strength, smoother threading, and improved operator safety, while remaining 100% compatible with existing Q and MQ tooling and drill rigs.

No system changes, no new accessories, no downtime. With SuperQ, you reduce complexity, gain premium performance, and keep your operations running at their best, all at the same price as standard Q rods.



WITH SUPERQ, DRILLERS AND MINE OPERATORS GAIN A NEW FEATURE SET THAT SETS THE BENCHMARK FOR ROD PERFORMANCE:

- 100% Q/MQ-Compatible – Seamlessly integrates with your existing Q tooling and rigs.
- Stronger Joints – Engineered for durability and reliability in demanding conditions. Up to 2500m (N).
- AUTOSTART for Easier Threading – Faster makeup and breakout, reducing operator strain and downtime.
- Ultimate Life - case hardened pin threads provide the longest thread life
- Improved Safety – Designed to minimize handling risks and improve crew confidence.
- Simplified Inventory – One rod replaces Q and MQ streamlining your supply chain.
- Rapid Delivery – Local stock in key markets ensures tooling is available when you need it.



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RQ TECHNOLOGY OVERVIEW

Invented by Boart Longyear in 1996 and launched in 1999, RQ™ rods introduced engineered interlocking joints to the industry, and quickly became renowned for strength and reliability. RQ drill rods expand your drilling capabilities and lower your total drill rod cost per meter/foot in deep, deviated and demanding wireline coring applications.





WARNING

Due to the significant safety risk, Boart Longyear drill rods should never be mixed with another manufacturers' rods. Doing so may cause catastrophic equipment failure, leading to bodily injury or death. In addition, mixing rods voids the Boart Longyear warranty.

RQ™ is a Boart Longyear proprietary product and as such retains all of the quality, features and fit associated with Boart Longyear global manufacturing standards.

TUBING

- High-quality low-alloy steel tubing, optimized to resist fatigue and environmentally-assisted-cracking (EAC).
- 100% inspection ensures consistent concentricity, straightness and heat treatment.

THRU-WALL HEAT TREATMENT

- Q&T heat-treated ends for optimal balance of strength and toughness
- Heat treated box threads significantly increase thread life.

CASE HARDENING

- Boart Longyear is the only major manufacturer in the industry to case-harden threads.
- Pin thread crest is case-hardened to maximum hardness to eliminate damaging 'adhesion wear' against the mating box thread.
- Eliminates the transfer of wear material back and forth as seen between threads of equal hardness, leading to large scale galling and joint seizing.
- Many years of process development and proven field performance, globally, has resulted in unmatched thread wear life and rod joint reliability.

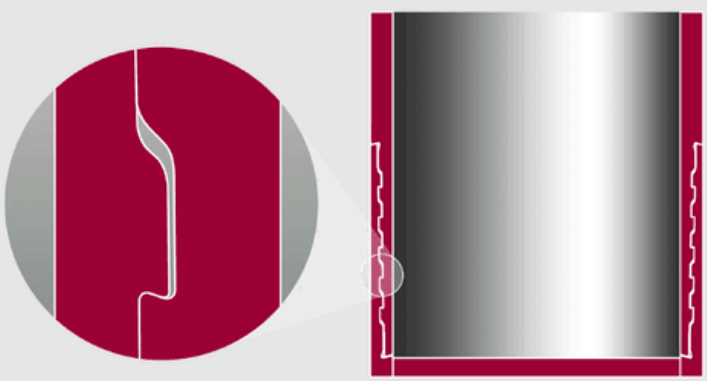
THREAD

- Coarse RQ™ threads (3 threads per inch) with a 10 degree reverse angle load-flank provides an interlocking joint with increased strength and increased taper provides easier make-up.
- Finer RQ™TK threads provide high performance for Thin Kerf wireline systems.
- Load efficiency of 50% provides high strength for demanding applications.
- RQ™ is a Boart Longyear™ proprietary product and as such contains all of the quality, features and fit associated with Boart Longyear manufacturing standards.

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XQ TECHNOLOGY OVERVIEW

Patented XQ™ wireline coring rods feature a combination of exclusive heat treatments and innovative engineering to provide the ultimate in performance and longevity. XQ drill rods are stronger, last longer, and offer easier make and break. Featuring innovative self-aligning, double-start threads, rod joints engage smoothly without wedging or jamming. XQ threads significantly improve depth capacity, productivity, and life.



WARNING

Due to the significant safety risk, Boart Longyear drill rods should never be mixed with another manufacturers' rods. Doing so may cause catastrophic equipment failure, leading to bodily injury or death. In addition, mixing rods voids the Boart Longyear warranty.

XQ™ is a Boart Longyear proprietary product and as such retains all of the quality, features and fit associated with Boart Longyear global manufacturing standards.

TUBING

- High-quality low-alloy steel tubing, optimized to resist fatigue and environmentally-assisted-cracking (EAC).
- 100% inspection ensures consistent concentricity, straightness and heat treatment.

THRU-WALL HEAT TREATMENT

- Q&T heat-treated ends for optimal balance of strength and toughness.
- Heat treated box threads significantly increase thread life.
- XQ™ is a Boart Longyear™ proprietary product and as such contains all of the quality, features and fit associated with Boart Longyear manufacturing standards.

CASE HARDENING

- Boart Longyear is the only major manufacturer in the industry to case-harden threads.
- Pin thread crest is case-hardened to maximum hardness to eliminate damaging 'adhesion wear' against the mating box thread.
- Eliminates the transfer of wear material back and forth as seen between threads of equal hardness, leading to large scale galling and joint seizing.
- Many years of process development and proven field performance, globally, has resulted in unmatched thread wear life and rod joint reliability.

THREAD

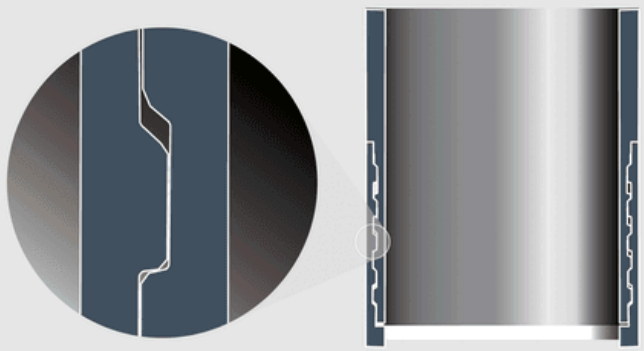
- Patented double-start, tapered, coarse threads (2 threads per inch) with 20-degree reversed-angle load flanks balance load stresses across the joint, providing the ultimate in strength and life.
- Patented self-aligning thread start geometry eliminates wedging and jamming, enabling automated equipment and smooth make-up for maximum productivity.
- Load efficiency of up to 60% provides the ultimate in strength for demanding applications and maximum reliability and productivity in all applications.

Patents AU2012209354; AU2013315186; CA2884798; CA2825533; CN201280010513; RU2607560; US9810029; US9850723; ZA2013/06418; Patents Pending.

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HD TECHNOLOGY OVERVIEW

HD Rods are designed for reliability in large size core drilling, featuring a robust, coarse thread profile for heavy duty wireline applications.



WARNING

Due to the significant safety risk, Boart Longyear drill rods should never be mixed with another manufacturers' rods. Doing so may cause catastrophic equipment failure, leading to bodily injury or death. In addition, mixing rods voids the Boart Longyear warranty.

TUBING

- High-quality low-alloy steel tubing, optimized to resist fatigue and environmentally-assisted-cracking (EAC).
- 100% inspection ensures consistent concentricity, straightness and heat treatment.

CASE HARDENING

- Boart Longyear is the only major manufacturer in the industry to case-harden threads.
- Pin thread crest is hardened to eliminate damaging ‘adhesion’ wear.
- Eliminates the transfer of wear material back and forth as seen between threads of equal hardness, leading to large-scale galling and joint seizing.
- Many years of process development and proven field performance, globally, have resulted in unmatched thread wear life and rod joint reliability.

THREAD

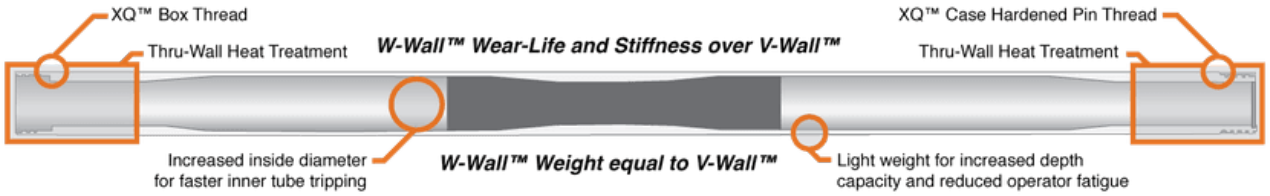
- Larger, deeper threads (2.5 threads per inch) provide maximum durability.
- Load efficiency of 40% provides sufficient strength for large hole sizes.
- HD is a Boart Longyear™ proprietary product and as such contains all of the quality, features and fit associated with Boart Longyear manufacturing standards.

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W-WALL OVERVIEW

W-WALL FOR INCREASED PRODUCTIVITY & REDUCED COSTS

W-Wall™ is a unique patented internal-upset rod tubing, available with RQ™, XQ™, and HD threads. W-Wall tubing undergoes the same unique processing and heat treatment as our standard wall tubing for performance in demanding applications. With up to 30% less weight in the drill string, productivity will increase while overall operation costs will be reduced.

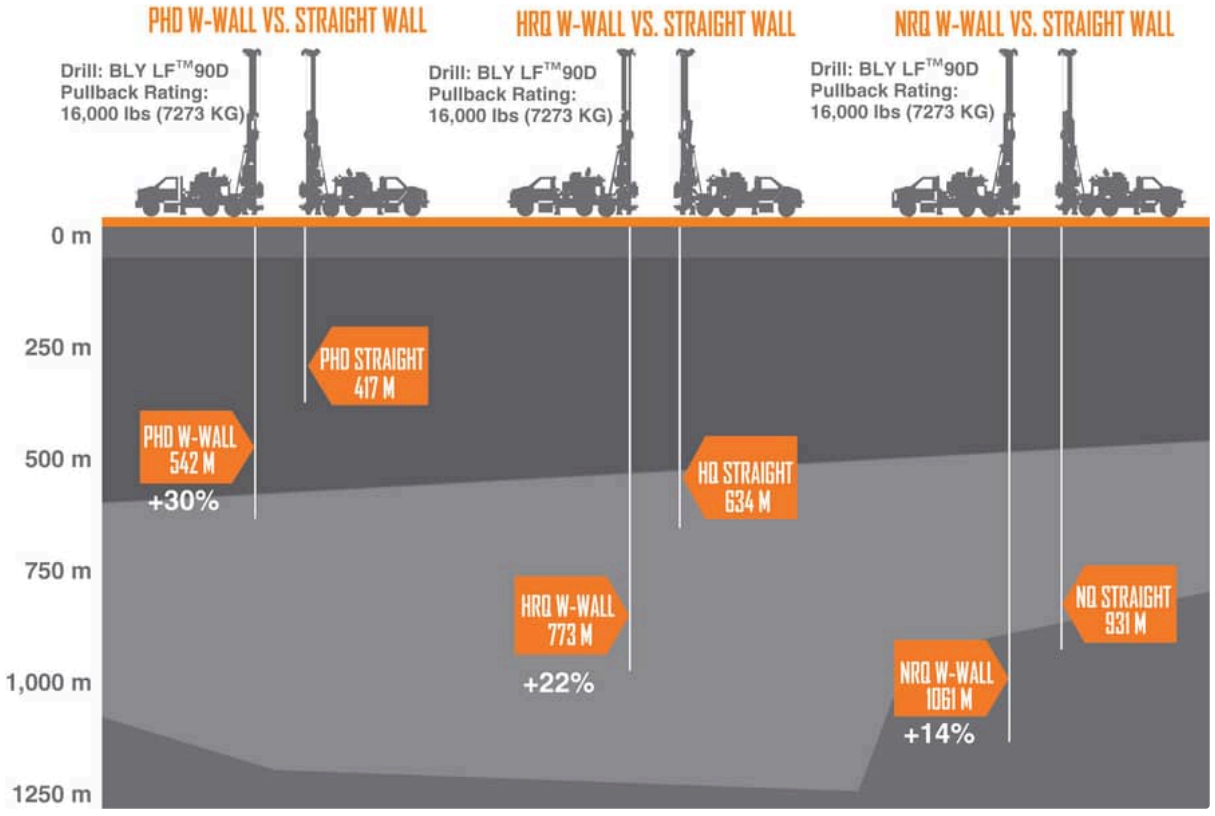


W-WALL RODS

- Decrease operator fatigue in rod handing — increasing safety and productivity.
- Decrease fuel costs in rod transportation, and increase the fuel efficiency of each rig on the site.
- Increase drill's rated depth capacity. For example, a LF™90D PHD Straight Wall can drill 417 m, while the PDH W-Wall can drill 542 m, increasing by 30%.
- Increase mid-body flexibility, which is advantageous in wedging or steering applications, but does not reduce drill string stiffness during coring operations.

W-WALL™ FOR FASTER INNER TUBE TRIPPING

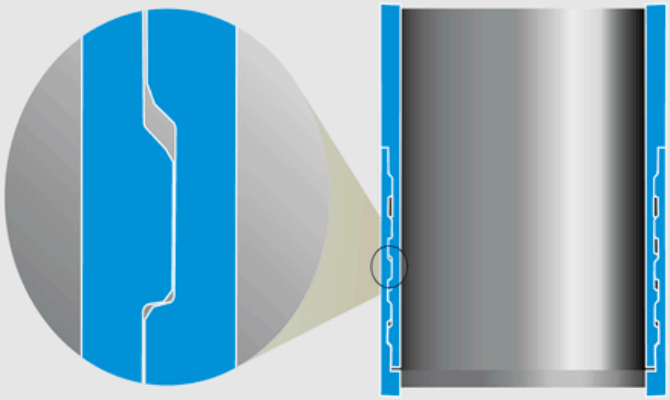
- The annular clearance between the core barrel and the rod's interior wall is larger, enabling faster core barrel tripping speeds.
- When combined with Quick Descent™ core barrel technology, tripping speed increases up to 50%.



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WT TECHNOLOGY OVERVIEW

The WT casing is designed to surpass expectations for a casing and features a tapered HD thread allowing for multiple make and break cycles. The WT casing is made with DCDMA C80 compliant tubing and the tapered HD thread provides increased strength and easier make and break-out.



WARNING

Due to the significant safety risk, Boart Longyear drill rods should never be mixed with another manufacturers' rods. Doing so may cause catastrophic equipment failure, leading to bodily injury or death. In addition, mixing rods voids the Boart Longyear warranty.

TUBING

- Parallel wall tubing compatible with Q™ wireline drilling systems (tooling and rods).
- Standard DCDMA sizing allows nesting between WT casing sizes.

THREAD

- Larger deeper threads (2.5 threads per inch) provide maximum durability.
- Tapered joint and fewer threads per inch result in easier and faster make and break for multiple casing uses.
- Threads are easier to clean due to wider spacing of the threads for situations where casing is reused.
- Compatible with HD rod threads.

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SUPERQ™ WIRELINE CORING RODS



B SUPERQ CORING RODS

PART #	LENGTH	VARIANT	O.D.	I.D.	WEIGHT	THREAD PITCH	PIN LENGTH	VOLUME
METRIC								
3548206S	1.5M	—	55.6 mm	46.0 mm	18.8 kg/3m	8.5 mm	44.5 mm	167.0 L/100m
3548208S	3.0M	—	55.6 mm	46.0 mm	18.8 kg/3m	8.5 mm	44.5 mm	167.0 L/100m
US CUSTOMARY								
51554S	1FT	—	2.19 in	1.81 in	42.00 lb/10ft	3.00 TPI	1.75 in	13.20 USgal/100ft
51555S	2FT	—	2.19 in	1.81 in	42.00 lb/10ft	3.00 TPI	1.75 in	13.20 USgal/100ft
3548207S	5FT	—	2.19 in	1.81 in	42.00 lb/10ft	3.00 TPI	1.75 in	13.20 USgal/100ft
3548209S	10FT	—	2.19 in	1.81 in	42.00 lb/10ft	3.00 TPI	1.75 in	13.20 USgal/100ft

B SUPERQ BUNDLE SPECIFICATIONS

▲ Do not use rods shorter than 1.5m at the top of the hole as a drive sub or Kelly rod, because they lack Q&T heat treatment; they have only pin-thread case hardening for wear. Subs made from Q&T material should be used for these applications.

3.0 m/10 ft ROD BUNDLE (19 RODS)

- Dimensions (L x W x H): 3.2 × 0.3 × 0.3 m (10.3 × 1.0 x 0.8 ft)
- Volume: 0.2 m3 (8 ft3)
- Gross Weight: 355 kg (780 lb)

1.5 m/5 ft ROD BUNDLE (19 RODS)

- Dimensions (L x W x H): 1.6 × 0.3 × 0.3 m (5.3 × 1.0 x 0.8 ft)
- Volume: 0.1 m3 (4 ft3)
- Gross Weight: 180 kg (400 lb)

CONTAINER SHIPMENTS:

- 20 ft container load of 3.0 m/10 ft rods holds 42 bundles (798 rods)
- 40 ft container load of 3.0 m/10 ft rods holds 56 bundles (1,064 rods)

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N SUPERQ CORING RODS

PART #	LENGTH	VARIANT	O.D.	I.D.	WEIGHT	THREAD PITCH	PIN LENGTH	VOLUME
METRIC								
5011042	0.5M	—	69.9 mm	60.5 mm	23.4 kg/3m	8.5 mm	44.4 mm	286.0 L/100m
3548210S	1.5M	—	69.9 mm	60.5 mm	23.4 kg/3m	8.5 mm	44.4 mm	286.0 L/100m
3548212S	3.0M	—	69.9 mm	60.5 mm	23.4 kg/3m	8.5 mm	44.4 mm	286.0 L/100m
US CUSTOMARY								
51562S	1FT	—	2.75 in	2.38 in	52.40 lb/10ft	3.00 TPI	1.75 in	23.00 USgal/100ft
51563S	2FT	—	2.75 in	2.38 in	52.40 lb/10ft	3.00 TPI	1.75 in	23.00 USgal/100ft
3548211S	5FT	—	2.75 in	2.38 in	52.40 lb/10ft	3.00 TPI	1.75 in	23.00 USgal/100ft
3548213S	10FT	—	2.75 in	2.38 in	52.40 lb/10ft	3.00 TPI	1.75 in	23.00 USgal/100ft

N SUPERQ BUNDLE SPECIFICATIONS

▲ Do not use rods shorter than 1.5m at the top of the hole as a drive sub or Kelly rod, because they lack Q&T heat treatment; they have only pin-thread case hardening for wear. Subs made from Q&T material should be used for these applications.

3.0 m/10 ft ROD BUNDLE (19 RODS)

- Dimensions (L x W x H): 3.2 × 0.4 × 0.3 m (10.3 × 1.2 × 1.1 ft)
- Volume: 0.4 m3 (13 ft3)
- Gross Weight: 453 kg (1,000 lb)

1.5 m/5 ft ROD BUNDLE (19 RODS)

- Dimensions (L x W x H): 1.6 × 0.4 × 0.3 m (5.3 × 1.2 × 1.1 ft)
- Volume: 0.2 m3 (7 ft3)
- Gross Weight: 239 kg (526 lb)

CONTAINER SHIPMENTS:

- 20 ft container load of 3.0 m/10 ft rods holds 30 bundles (570 rods)
- 40 ft container load of 3.0 m/10 ft rods holds 45 bundles (855 rods)

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H SUPERQ CORING RODS

PART #	LENGTH	VARIANT	O.D.	I.D.	WEIGHT	THREAD PITCH	PIN LENGTH	VOLUME
METRIC								
5011043	0.15M	—	88.9 mm	77.7 mm	34.5 kg/3m	8.5 mm	44.4 mm	475.0 L/100m
5011044	0.2M	—	88.9 mm	77.7 mm	34.5 kg/3m	8.5 mm	44.4 mm	475.0 L/100m
5011045	0.3M	—	88.9 mm	77.7 mm	34.5 kg/3m	8.5 mm	44.4 mm	475.0 L/100m
5011046	0.5M	—	88.9 mm	77.7 mm	34.5 kg/3m	8.5 mm	44.4 mm	475.0 L/100m
5011047	1.0M	—	88.9 mm	77.7 mm	34.5 kg/3m	8.5 mm	44.4 mm	475.0 L/100m
3548214S	1.5M	—	88.9 mm	77.7 mm	34.5 kg/3m	8.5 mm	44.4 mm	475.0 L/100m
3548216S	3.0M	—	88.9 mm	77.7 mm	34.5 kg/3m	8.5 mm	44.4 mm	475.0 L/100m
5011012	3.0M	W-Wall	88.9 mm	81.0 - 77.7 mm	27.3 (km/3m)	8.5 mm	44.4 mm	506.0 L/100m
US CUSTOMARY								
51568S	1FT	—	3.50 in	3.06 in	77.00 lb/10ft	3.00 TPI	1.75 in	38.20 USgal/100ft
51569S	2FT	—	3.50 in	3.06 in	77.00 lb/10ft	3.00 TPI	1.75 in	38.20 USgal/100ft
3548215S	5FT	—	3.50 in	3.06 in	77.00 lb/10ft	3.00 TPI	1.75 in	38.20 USgal/100ft
3548217S	10FT	—	3.50 in	3.06 in	77.00 lb/10ft	3.00 TPI	1.75 in	38.20 USgal/100ft
5011011	10FT	W-Wall	3.50 in	3.19 - 3.06 in	60.0 (lb/10ft)	3.00 TPI	1.75 in	40.70 USgal/100ft

H SUPERQ BUNDLE SPECIFICATIONS

▲ Do not use rods shorter than 1.5m at the top of the hole as a drive sub or Kelly rod, because they lack Q&T heat treatment; they have only pin-thread case hardening for wear. Subs made from Q&T material should be used for these applications.

3.0 m/10 ft ROD BUNDLE (19 RODS)

- Dimensions (L x W x H): 3.2 × 0.5 × 0.4 m (10.3 × 1.5 × 1.3 ft)
- Volume: 0.6 m3 (21 ft3)
- Gross Weight: 682 kg (1,505 lb)

1.5 m/5 ft ROD BUNDLE (19 RODS)

- Dimensions (L x W x H): 1.6 × 0.5 × 0.4 m (5.3 × 1.5 × 1.3 ft)
- Volume: 0.3 m3 (11 ft3)
- Gross Weight: 346 kg (764 lb)

CONTAINER SHIPMENTS:

- 20 ft container load of 3.0 m/10 ft rods holds 20 bundles (380 rods)
- 40 ft container load of 3.0 m/10 ft rods holds 30 bundles (570 rods)

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RQ™ WIRELINE CORING RODS



BRQ CORING RODS

PART #	LENGTH	VARIANT	O.D.	I.D.	WEIGHT	THREAD PITCH	PIN LENGTH	VOLUME
METRIC								
5010612	0.9M	TK	55.6 mm	48.5	14.3 kg/3m	7.3 mm	40.6 mm	184 L/100m
3540867	1.5M	TK	55.6 mm	48.5 mm	14.3 kg/3m	7.3 mm	40.6 mm	184.0 L/100m
3541308	1.5M	—	55.6 mm	46.0 mm	18.8 kg/3m	8.5 mm	41.9 mm	167.0 L/100m
306227	3.0M	TK	55.6 mm	48.5 mm	14.3 kg/3m	7.3 mm	40.6 mm	184.0 L/100m
306238	3.0M	—	55.6 mm	46.0 mm	18.8 kg/3m	8.5 mm	41.9 mm	167.0 L/100m
US CUSTOMARY								
3545301	1FT	—	2.19 in	1.81 in	42.00 lb/10ft	3.00 TPI	1.65 in	13.20 USgal/100ft
3545303	1FT	TK	2.19 in	1.91 in	32.00 lb/10ft	3.50 TPI	1.60 in	14.80 USgal/100ft
3541340	2FT	—	2.19 in	1.81 in	42.00 lb/10ft	3.00 TPI	1.65 in	13.20 USgal/100ft
3541343	2FT	TK	2.19 in	1.91 in	32.00 lb/10ft	3.50 TPI	1.60 in	14.80 USgal/100ft
3541378	5FT	—	2.19 in	1.81 in	42.00 lb/10ft	3.00 TPI	1.65 in	13.20 USgal/100ft
3541379	5FT	TK	2.19 in	1.91 in	32.00 lb/10ft	3.50 TPI	1.60 in	14.80 USgal/100ft
3541555	10FT	—	2.19 in	1.81 in	42.00 lb/10ft	3.00 TPI	1.65 in	13.20 USgal/100ft

BRQ BUNDLE SPECIFICATIONS

▲ Do not use rods shorter than 1.5m at the top of the hole as a drive sub or Kelly rod, because they lack Q&T heat treatment; they have only pin-thread case hardening for wear. Subs made from Q&T material should be used for these applications.

3.0 m/10 ft ROD BUNDLE (19 RODS)

- Dimensions (L x W x H): 3.2 × 0.3 × 0.3 m (10.3 × 1.0 x 0.8 ft)
- Volume: 0.2 m3 (8.1 ft3)
- Gross Weight: 355 kg (780 lb)

1.5 m/5 ft ROD BUNDLE (19 RODS)

- Dimensions (L x W x H): 1.6 × 0.3 × 0.3 m (5.3 × 1.0 x 0.8 ft)
- Volume: 0.1 m3 (3.5 ft3)
- Gross Weight: 180 kg (400 lb)

CONTAINER SHIPMENTS:

- 20 ft container load of 3.0 m/10 ft rods holds 42 bundles (798 rods)
- 40 ft container load of 3.0 m/10 ft rods holds 56 bundles (1,064 rods)

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NRQ CORING RODS

PART #	LENGTH	VARIANT	O.D.	I.D.	WEIGHT	THREAD PITCH	PIN LENGTH	VOLUME
METRIC								
5011003	1.0M	—	69.9 mm	60.5 mm	23.4 kg/3m	8.5 mm	41.9 mm	286.0 L/100m
3541309	1.5M	—	69.9 mm	60.5 mm	23.4 kg/3m	8.5 mm	41.9 mm	286.0 L/100m
104741	3.0M	—	69.9 mm	60.5 mm	23.4 kg/3m	8.5 mm	41.9 mm	286.0 L/100m
5008543	3.0M	W-Wall	69.9 mm	62 - 60.5 mm	20.7 kg/3m	8.5 mm	41.9 mm	297.0 L/100m
US CUSTOMARY								
3542459	1FT	—	2.75 in	2.38 in	52.40 lb/10ft	3.00 TPI	1.65 in	23.00 USgal/100ft
3541341	2FT	—	2.75 in	2.38 in	52.40 lb/10ft	3.00 TPI	1.65 in	23.00 USgal/100ft
3541380	5FT	—	2.75 in	2.38 in	52.40 lb/10ft	3.00 TPI	1.65 in	23.00 USgal/100ft
3541556	10FT	—	2.75 in	2.38 in	52.40 lb/10ft	3.00 TPI	1.65 in	23.00 USgal/100ft
5008542	10FT	W-Wall	2.75 in	2.44 - 2.38 in	45.00 lb/10ft	3.00 TPI	1.65 in	23.90 USgal/100ft

NRQ BUNDLE SPECIFICATIONS

▲ Do not use rods shorter than 1.5m at the top of the hole as a drive sub or Kelly rod, because they lack Q&T heat treatment; they have only pin-thread case hardening for wear. Subs made from Q&T material should be used for these applications.

3.0 m/10 ft ROD BUNDLE (19 RODS)

- Dimensions (L x W x H): 3.2 × 0.4 × 0.3 m (10.3 × 1.2 × 1.1 ft)
- Volume: 0.4 m3 (13 ft3)
- Gross Weight: 453 kg (1,000 lb)

1.5 m/5 ft ROD BUNDLE (19 RODS)

- Dimensions (L x W x H): 1.6 × 0.4 × 0.3 m (5.3 × 1.2 × 1.1 ft)
- Volume: 0.2 m3 (7 ft3)
- Gross Weight: 239 kg (526 lb)

CONTAINER SHIPMENTS:

- 20 ft container load of 3.0 m/10 ft rods holds 30 bundles (570 rods)
- 40 ft container load of 3.0 m/10 ft rods holds 45 bundles (855 rods)

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HRQ CORING RODS

PART #	LENGTH	VARIANT	O.D.	I.D.	WEIGHT	THREAD PITCH	PIN LENGTH	VOLUME
METRIC								
3541310	1.5M	—	88.9 mm	77.7 mm	34.5 kg/3m	8.5 mm	41.9 mm	475.0 L/100m
306243	3.0M	—	88.9 mm	77.7 mm	34.5 kg/3m	8.5 mm	41.9 mm	475.0 L/100m
5009612	3.0M	W-Wall	88.9 mm	81.0 - 77.7 mm	27.3 kg/3m	8.5 mm	41.9 mm	506.0 L/100m
US CUSTOMARY								
3545071	1FT	—	3.50 in	3.06 in	77.00 lb/10ft	3.00 TPI	1.65 in	38.20 USgal/100ft
3541342	2FT	—	3.50 in	3.06 in	77.00 lb/10ft	3.00 TPI	1.65 in	38.20 USgal/100ft
3541381	5FT	—	3.50 in	3.06 in	77.00 lb/10ft	3.00 TPI	1.65 in	38.20 USgal/100ft
3541558	10FT	—	3.50 in	3.06 in	77.00 lb/10ft	3.00 TPI	1.65 in	38.20 USgal/100ft
5009611	10FT	W-Wall	3.50 in	3.19 - 3.06 in	60.00 lb/10ft	3.00 TPI	1.65 in	40.70 USgal/100ft

HRQ BUNDLE SPECIFICATIONS

▲ Do not use rods shorter than 1.5m at the top of the hole as a drive sub or Kelly rod, because they lack Q&T heat treatment; they have only pin-thread case hardening for wear. Subs made from Q&T material should be used for these applications.

3.0 m/10 ft ROD BUNDLE (19 RODS)

- Dimensions (L x W x H): 3.2 × 0.5 × 0.4 m (10.3 × 1.5 × 1.3 ft)
- Volume: 0.6 m3 (21.2 ft3)
- Gross Weight: 682 kg (1,505 lb)

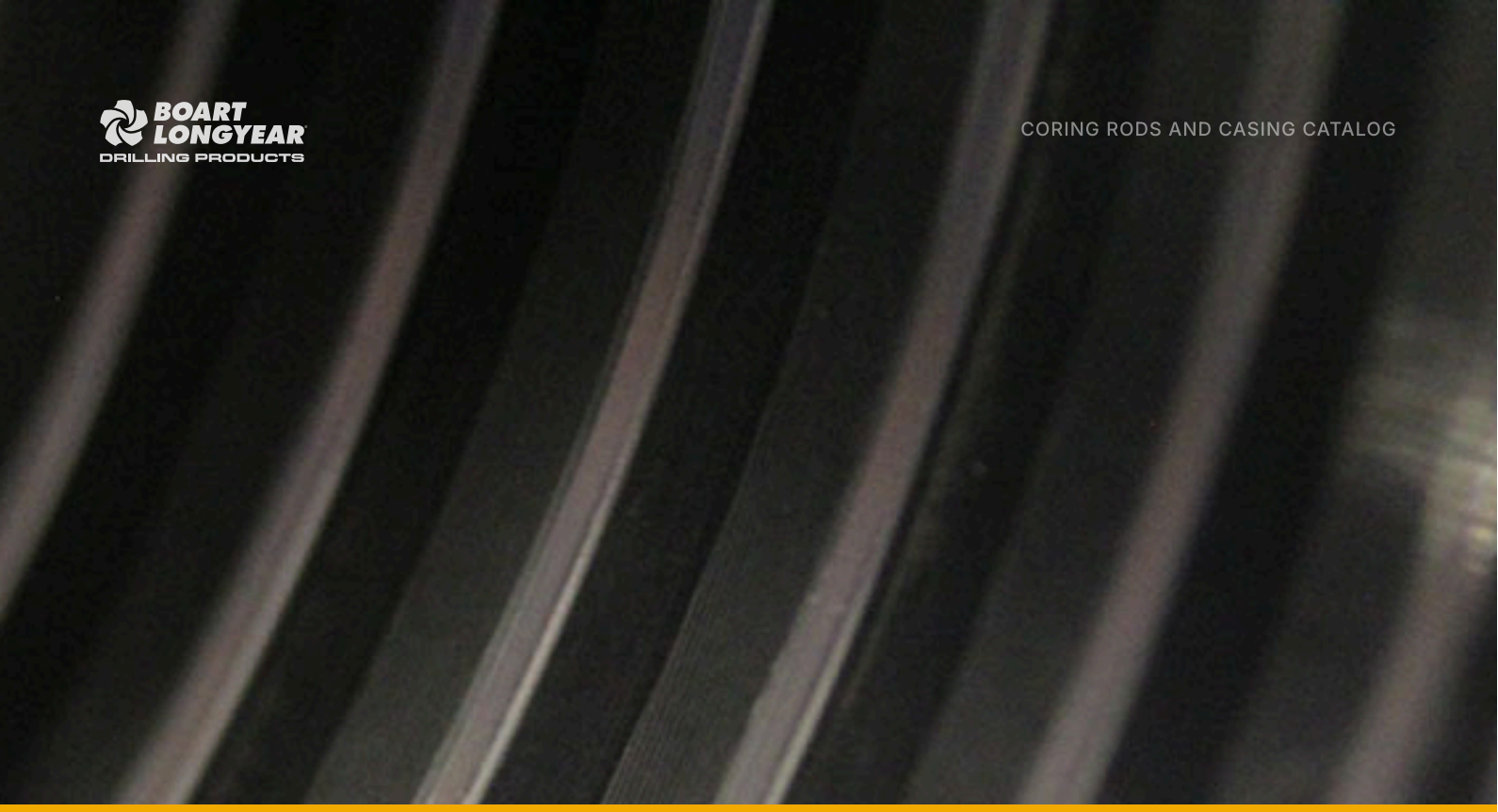
1.5 m/5 ft ROD BUNDLE (19 RODS)

- Dimensions (L x W x H): 1.6 × 0.5 × 0.4 m (5.3 × 1.5 × 1.3 ft)
- Volume: 0.3 m3 (10.9 ft3)
- Gross Weight: 346 kg (764 lb)

CONTAINER SHIPMENTS:

- 20 ft container load of 3.0 m/10 ft rods holds 20 bundles (380 rods)
- 40 ft container load of 3.0 m/10 ft rods holds 30 bundles (570 rods)

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XQ™ WIRELINE CORING RODS



BXQ CORING RODS

PART #	LENGTH	VARIANT	O.D.	I.D.	WEIGHT	THREAD PITCH	PIN LENGTH	VOLUME
METRIC								
5009229	1.5M	—	55.6 mm	46.0 mm	18.8 kg/3m	12.7 mm	44.5 mm	167.0 L/100m
5008505	3.0M	—	55.6 mm	46.0 mm	18.8 kg/3m	12.7 mm	44.5 mm	167.0 L/100m
US CUSTOMARY								
5009143	1FT	—	2.19 in	1.81 in	42.00 lb/10ft	2.00 TPI	1.75 in	13.20 USgal/100ft
5009144	2FT	—	2.19 in	1.81 in	42.00 lb/10ft	2.00 TPI	1.75 in	13.20 USgal/100ft
5009228	5FT	—	2.19 in	1.81 in	42.00 lb/10ft	2.00 TPI	1.75 in	13.20 USgal/100ft
5008504	10FT	—	2.19 in	1.81 in	42.00 lb/10ft	2.00 TPI	1.75 in	13.20 USgal/100ft

BXQ BUNDLE SPECIFICATIONS

▲ Do not use rods shorter than 1.5m at the top of the hole as a drive sub or Kelly rod, because they lack Q&T heat treatment; they have only pin-thread case hardening for wear. Subs made from Q&T material should be used for these applications.

3.0 m/10 ft ROD BUNDLE (19 RODS)

- Dimensions (L x W x H): 3.2 × 0.3 × 0.3 m (10.3 × 1.0 x 0.8 ft)
- Volume: 0.2 m3 (8.1 ft3)
- Gross Weight: 355 kg (780 lb)

1.5 m/5 ft ROD BUNDLE (19 RODS)

- Dimensions (L x W x H): 1.6 × 0.3 × 0.3 m (5.3 × 1.0 x 0.8 ft)
- Volume: 0.1 m3 (3.5 ft3)
- Gross Weight: 180 kg (400 lb)

CONTAINER SHIPMENTS:

- 20 ft container load of 3.0 m/10 ft rods holds 42 bundles (798 rods)
- 40 ft container load of 3.0 m/10 ft rods holds 56 bundles (1,064 rods)

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NXQ CORING RODS

PART #	LENGTH	VARIANT	O.D.	I.D.	WEIGHT	THREAD PITCH	PIN LENGTH	VOLUME
METRIC								
5010549	0.9M	—	69.9 mm	60.5 mm	23.4 kg/3m	12.7 mm	44.5 mm	286.0 L/100m
5010910	1.2M	—	69.9 mm	60.5 mm	23.4 kg/3m	12.7 mm	44.5 mm	286.0 L/100m
5009231	1.5M	—	69.9 mm	60.5 mm	23.4 kg/3m	12.7 mm	44.5 mm	286.0 L/100m
5008502	3.0M	—	69.9 mm	60.5 mm	23.4 kg/3m	12.7 mm	44.5 mm	286.0 L/100m
5008807	3.0M	W-Wall	69.9 mm	62 - 60.5 mm	20.7 kg/3m	12.7 mm	44.5 mm	297.0 L/100m
US CUSTOMARY								
5009142	1FT	—	2.75 in	2.38 in	52.40 lb/10ft	2.00 TPI	1.75 in	23.00 USgal/100ft
5008944	2FT	—	2.75 in	2.38 in	52.40 lb/10ft	2.00 TPI	1.75 in	23.00 USgal/100ft
5009230	5FT	—	2.75 in	2.38 in	52.40 lb/10ft	2.00 TPI	1.75 in	23.00 USgal/100ft
5008501	10FT	—	2.75 in	2.38 in	52.40 lb/10ft	2.00 TPI	1.75 in	23.00 USgal/100ft
5008806	10FT	W-Wall	2.75 in	2.44 - 2.38 in	45.00 lb/10ft	2.00 TPI	1.75 in	23.90 USgal/100ft

NXQ BUNDLE SPECIFICATIONS

▲ Do not use rods shorter than 1.5m at the top of the hole as a drive sub or Kelly rod, because they lack Q&T heat treatment; they have only pin-thread case hardening for wear. Subs made from Q&T material should be used for these applications.

3.0 m/10 ft ROD BUNDLE (19 RODS)

- Dimensions (L x W x H): 3.2 × 0.4 × 0.3 m (10.3 × 1.2 × 1.1 ft)
- Volume: 0.4 m3 (13 ft3)
- Gross Weight: 453 kg (1,000 lb)

1.5 m/5 ft ROD BUNDLE (19 RODS)

- Dimensions (L x W x H): 1.6 × 0.4 × 0.3 m (5.3 × 1.2 × 1.1 ft)
- Volume: 0.2 m3 (7 ft3)
- Gross Weight: 239 kg (526 lb)

CONTAINER SHIPMENTS:

- 20 ft container load of 3.0 m/10 ft rods holds 30 bundles (570 rods)
- 40 ft container load of 3.0 m/10 ft rods holds 45 bundles (855 rods)

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HXQ CORING RODS

PART #	LENGTH	VARIANT	O.D.	I.D.	WEIGHT	THREAD PITCH	PIN LENGTH	VOLUME
METRIC								
5010911	1.2M	—	88.9 mm	77.7 mm	34.5 kg/3m	12.7 mm	44.5 mm	475.0 L/100m
5009233	1.5M	—	88.9 mm	77.7 mm	34.5 kg/3m	12.7 mm	44.5 mm	475.0 L/100m
5008508	3.0M	—	88.9 mm	77.7 mm	34.5 kg/3m	12.7 mm	44.5 mm	475.0 L/100m
5008811	3.0M	W-Wall	88.9 mm	81.0 - 77.7 mm	27.3 kg/3m	12.7 mm	44.5 mm	506.0 L/100m
US CUSTOMARY								
5009145	1FT	—	3.50 in	3.06 in	77.00 lb/10ft	2.00 TPI	1.75 in	38.20 USgal/100ft
5009146	2FT	—	3.50 in	3.06 in	77.00 lb/10ft	2.00 TPI	1.75 in	38.20 USgal/100ft
5009232	5FT	—	3.50 in	3.06 in	77.00 lb/10ft	2.00 TPI	1.75 in	38.20 USgal/100ft
5008507	10FT	—	3.50 in	3.06 in	77.00 lb/10ft	2.00 TPI	1.75 in	38.20 USgal/100ft
5008810	10FT	W-Wall	3.50 in	3.19 - 3.06 in	60.00 lb/10ft	2.00 TPI	1.75 in	40.70 USgal/100ft

HXQ BUNDLE SPECIFICATIONS

▲ Do not use rods shorter than 1.5m at the top of the hole as a drive sub or Kelly rod, because they lack Q&T heat treatment; they have only pin-thread case hardening for wear. Subs made from Q&T material should be used for these applications.

3.0 m/10 ft ROD BUNDLE (19 RODS)

- Dimensions (L x W x H): 3.2 × 0.5 × 0.4 m (10.3 × 1.5 × 1.3 ft)
- Volume: 0.6 m3 (21.2 ft3)
- Gross Weight: 682 kg (1,505 lb)

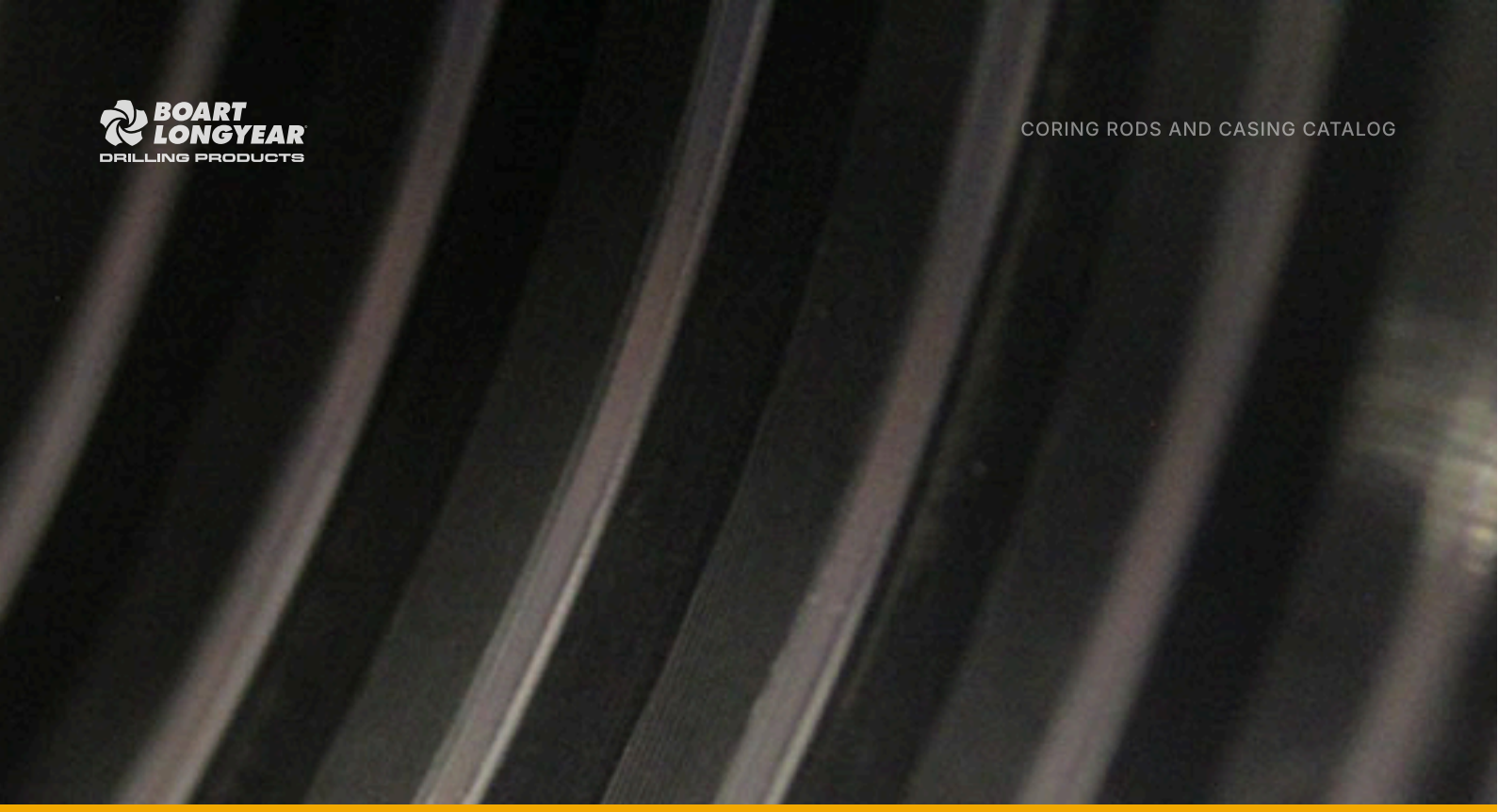
1.5 m/5 ft ROD BUNDLE (19 RODS)

- Dimensions (L x W x H): 1.6 × 0.5 × 0.4 m (5.3 × 1.5 × 1.3 ft)
- Volume: 0.3 m3 (10.9 ft3)
- Gross Weight: 346 kg (764 lb)

CONTAINER SHIPMENTS:

- 20 ft container load of 3.0 m/10 ft rods holds 20 bundles (380 rods)
- 40 ft container load of 3.0 m/10 ft rods holds 30 bundles (570 rods)

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HD™ WIRELINE CORING RODS



PHD CORING RODS

PART #	LENGTH	VARIANT	O.D.	I.D.	WEIGHT	THREAD PITCH	PIN LENGTH	VOLUME
METRIC								
3541743	1.5M	—	114.3 mm	101.6 mm	52.2 kg/3m	10.2 mm	62.7 mm	811.0 L/100m
3542314	3.0M	—	114.3 mm	101.6 mm	52.2 kg/3m	10.2 mm	62.7 mm	811.0 L/100m
5008537	3.0M	W-Wall	114.3 mm	106.4 - 101.8 m	39 kg/3m	10.2 mm	62.7 mm	869.3 L/100m
US CUSTOMARY								
3542519	2FT	—	4.50 in	4.00 in	117.00 lb/10ft	2.50 TPI	2.47 in	65.30 USgal/100ft
3540844	5FT	—	4.50 in	4.00 in	117.00 lb/10ft	2.50 TPI	2.47 in	65.30 USgal/100ft
3540845	10FT	—	4.50 in	4.00 in	117.00 lb/10ft	2.50 TPI	2.47 in	65.30 USgal/100ft
5008536	10FT	W-Wall	4.50 in	4.19 - 4.00 in	82.50 lb/10ft	2.50 TPI	2.47 in	71.00 USgal/100ft

PHD BUNDLE SPECIFICATIONS

▲ Do not use rods shorter than 1.5m at the top of the hole as a drive sub or Kelly rod, because they lack Q&T heat treatment; they have only pin-thread case hardening for wear. Subs made from Q&T material should be used for these applications.

3.0 m/10 ft CASING BUNDLE (7 PIECES)

- Dimensions (L x W x H): 3.2 × 0.4 × 0.3 m (10.3 × 1.2 × 1.1 ft)
- Volume: 0.4 m3 (14.1 ft3)
- Gross Weight: 373 kg (823 lb)

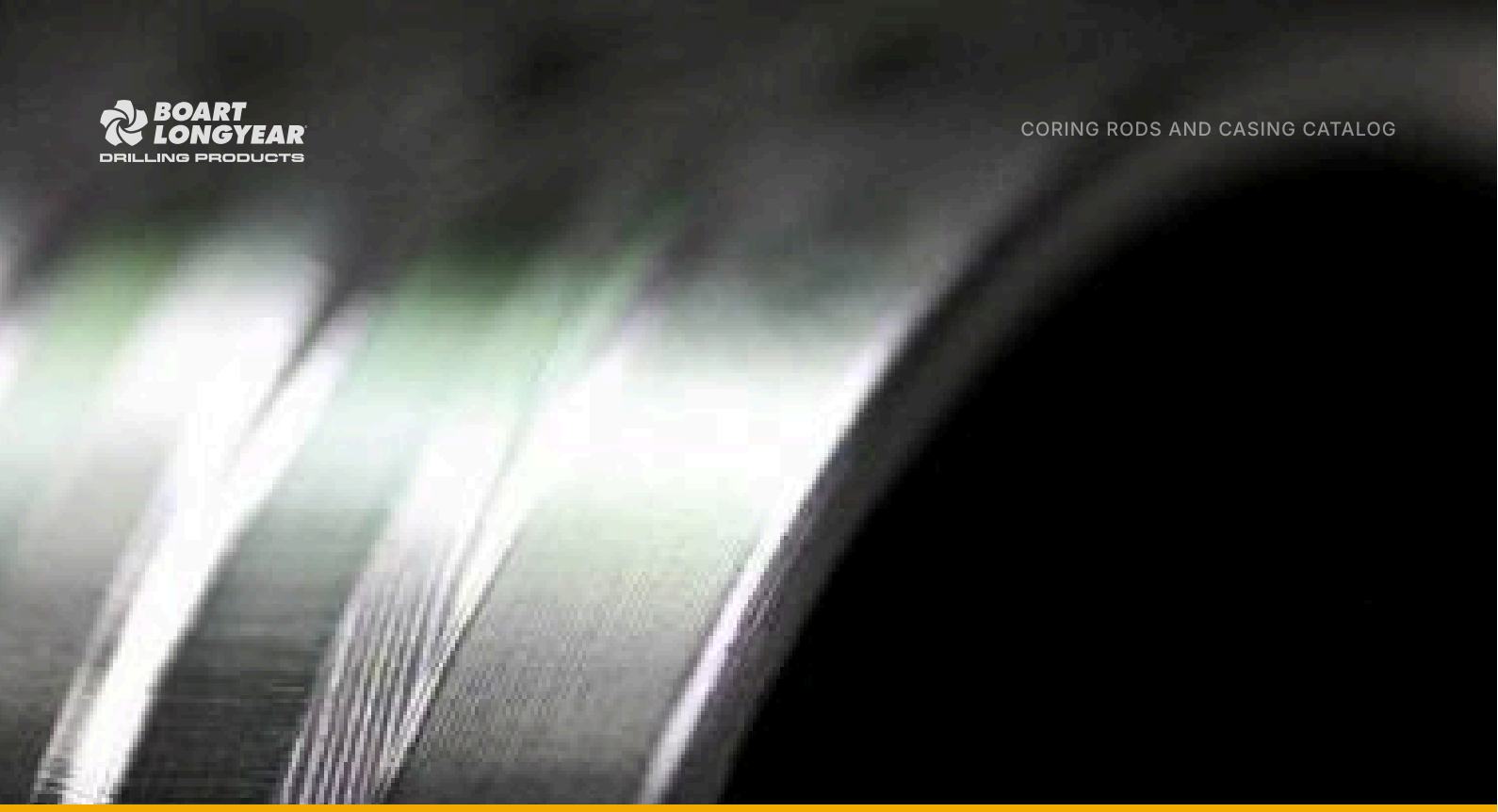
1.5 m/5 ft ROD BUNDLE (7 PIECES)

- Dimensions (L x W x H): 1.6 × 0.4 × 0.3 m (5.3 × 1.2 × 1.1 ft)
- Volume: 0.2 m3 (7.1 ft3)
- Gross Weight: 194.1 kg (428 lb)

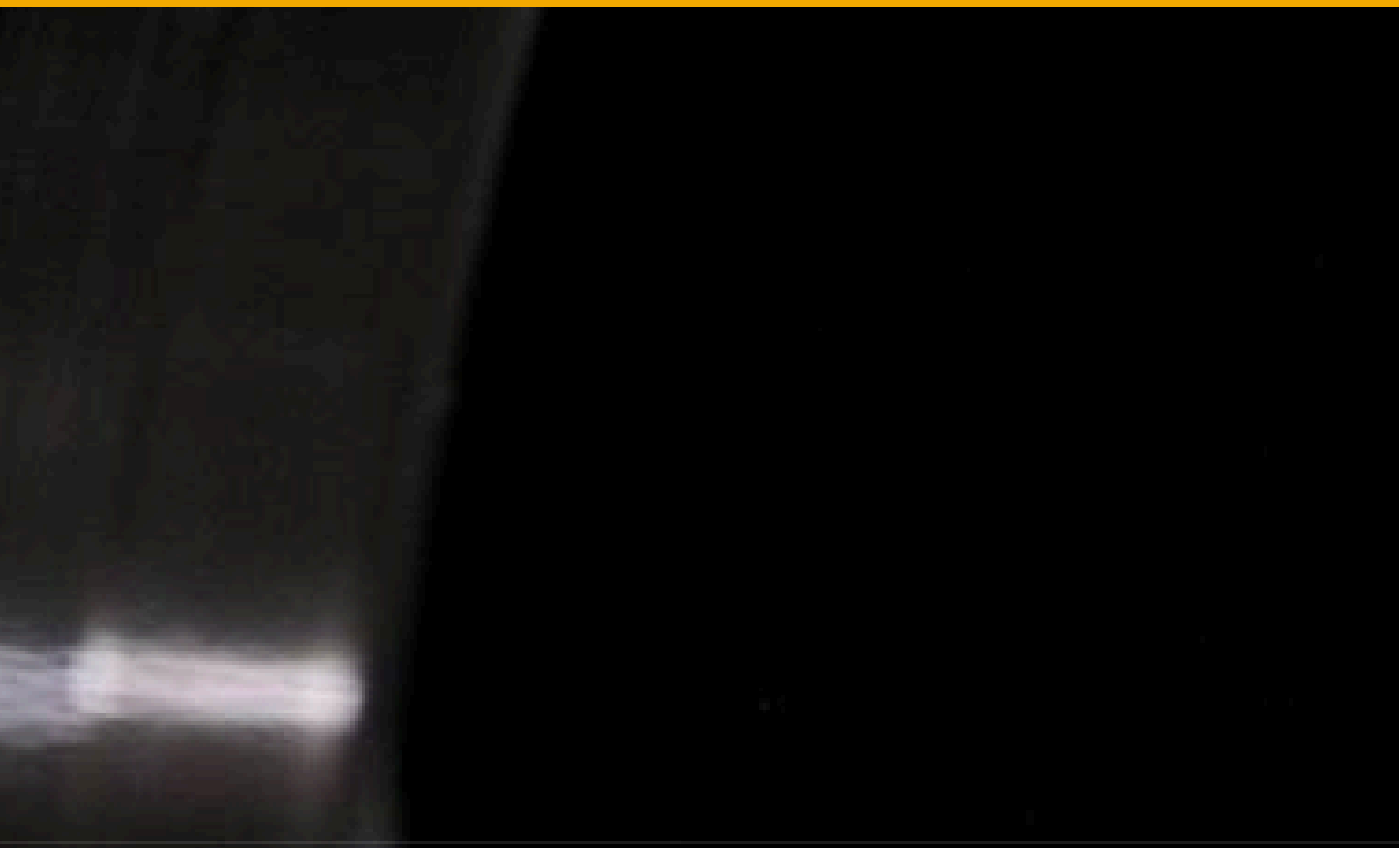
CONTAINER SHIPMENTS:

- 20 ft container load of 3.0 m/10 ft rods holds 30 bundles (210 rods)
- 40 ft container load of 3.0 m/10 ft rods holds 54 bundles (378 rods)

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WIRELINE CASING



NWT CASING

PART #	LENGTH	VARIANT	O.D.	I.D.	WEIGHT	THREAD PITCH	PIN LENGTH	VOLUME
METRIC								
5008787	1.5M	—	88.9 mm	76.2 mm	38.4 kg/3m	10.2 mm	62.7 mm	455.7 L/100m
5008513	3.0M	—	88.9 mm	76.2 mm	38.4 kg/3m	10.2 mm	62.7 mm	455.7 L/100m
US CUSTOMARY								
5008816	2FT	—	3.50 in	3.00 in	86.00 lb/10ft	2.50 TPI	2.47 in	36.70 USgal/100ft

NWT BUNDLE SPECIFICATIONS

3.0 m/10 ft CASING BUNDLE (19 PIECES)

- Dimensions (L x W x H): 3.2 × 0.5 × 0.4 m (10.3 × 1.5 × 1.3 ft)
- Volume: 0.6 m3 (21.0 ft3)
- Gross Weight: 760 kg (1,676 lb)

1.5 m/5 ft ROD BUNDLE (19 PIECES)

- Dimensions (L x W x H): 1.6 × 0.5 × 0.4 m (5.3 × 1.5 × 1.3 ft)
- Volume: 0.3 m3 (11.0 ft3)
- Gross Weight: 390 kg (860 lb)

CONTAINER SHIPMENTS:

- 20 ft container load of 3.0 m/10 ft rods holds 20 bundles (380 rods)
- 40 ft container load of 3.0 m/10 ft rods holds 26 bundles (494 rods)

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HWT CASING

PART #	LENGTH	VARIANT	O.D.	I.D.	WEIGHT	THREAD PITCH	PIN LENGTH	VOLUME
METRIC								
101339	1.5M	—	114.3 mm	101.6 mm	52.2 (kg/3m)	10.2 mm	44.4 mm	810.8 (L/100m)
101338	3.0M	—	114.3 mm	101.6 mm	52.2 (kg/3m)	10.2 mm	44.4 mm	810.8 (L/100m)
US CUSTOMARY								
55055	2FT	—	4.50 in	4.00 in	117.00 lb/10ft	2.50 TPI	2.47 in	65.30 USgal/100ft

HWT BUNDLE SPECIFICATIONS

3.0 m/10 ft CASING BUNDLE (7 PIECES)

- Dimensions (L x W x H): 3.2 × 0.4 × 0.3 m (10.3 × 1.2 × 1.1 ft)
- Volume: 0.4 m3 (14.1 ft3)
- Gross Weight: 373 kg (823 lb)

1.5 m/5 ft ROD BUNDLE (7 PIECES)

- Dimensions (L x W x H): 1.6 × 0.4 × 0.3 m (5.3 × 1.2 × 1.1 ft)
- Volume: 0.2 m3 (7.1 ft3)
- Gross Weight: 194.1 kg (428 lb)

CONTAINER SHIPMENTS:

- 20 ft container load of 3.0 m/10 ft rods holds 30 bundles (210 rods)
- 40 ft container load of 3.0 m/10 ft rods holds 54 bundles (378 rods)

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PWT CASING

PART #	LENGTH	VARIANT	O.D.	I.D.	WEIGHT	THREAD PITCH	PIN LENGTH	VOLUME
METRIC								
3543976	1.5M	—	139.7 mm	127.0 mm	64.3 kg/3m	10.2 mm	44.4 mm	1266.6 L/100m
3543977	3.0M	—	139.7 mm	127.0 mm	64.3 kg/3m	10.2 mm	44.4 mm	1266.6 L/100m
US CUSTOMARY								
3543973	2FT	—	5.50 in	5.00 in	144.00 lb/10ft	2.50 TPI	2.47 in	102.00 USgal/100ft

PWT BUNDLE SPECIFICATIONS

3.0 m/10 ft CASING BUNDLE (7 PIECES)

- Dimensions (L x W x H): 3.2 × 0.5 × 0.4 m (10.3 × 1.5 × 1.3 ft)
- Volume: 0.6 m3 (21.2 ft3)
- Gross Weight: 463 kg (1,022 lb)

1.5 m/5 ft ROD BUNDLE (7 PIECES)

- Dimensions (L x W x H): 1.6 × 0.5 × 0.4 m (5.3 × 1.5 × 1.3 ft)
- Volume: 0.3 m3 (10.6 ft3)
- Gross Weight: 254 kg (560 lb)

CONTAINER SHIPMENTS:

- 20 ft container load of 3.0 m/10 ft rods holds 20 bundles (140 rods)
- 40 ft container load of 3.0 m/10 ft rods holds 44 bundles (308 rods)

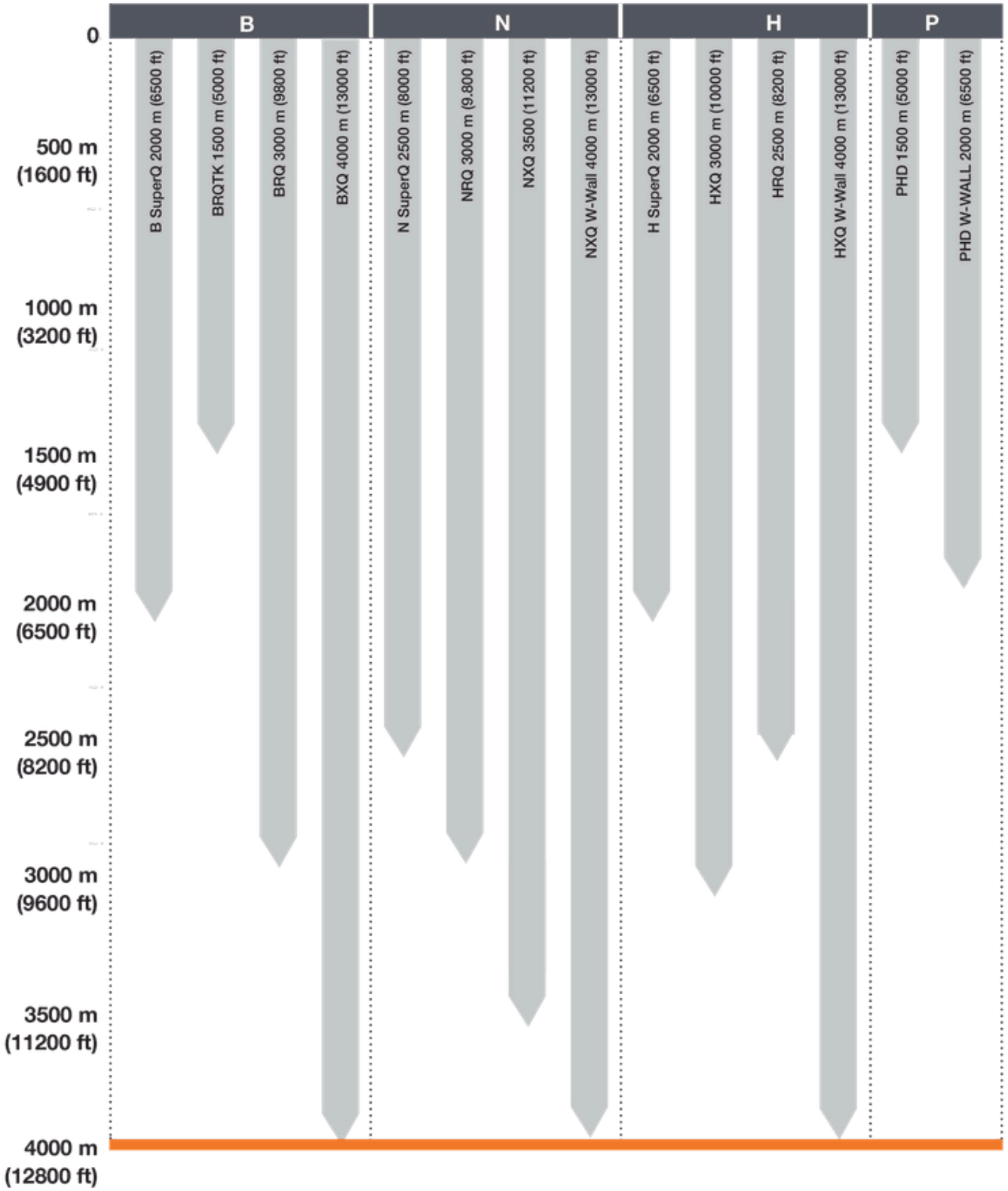
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TECHNICAL SPECIFICATIONS



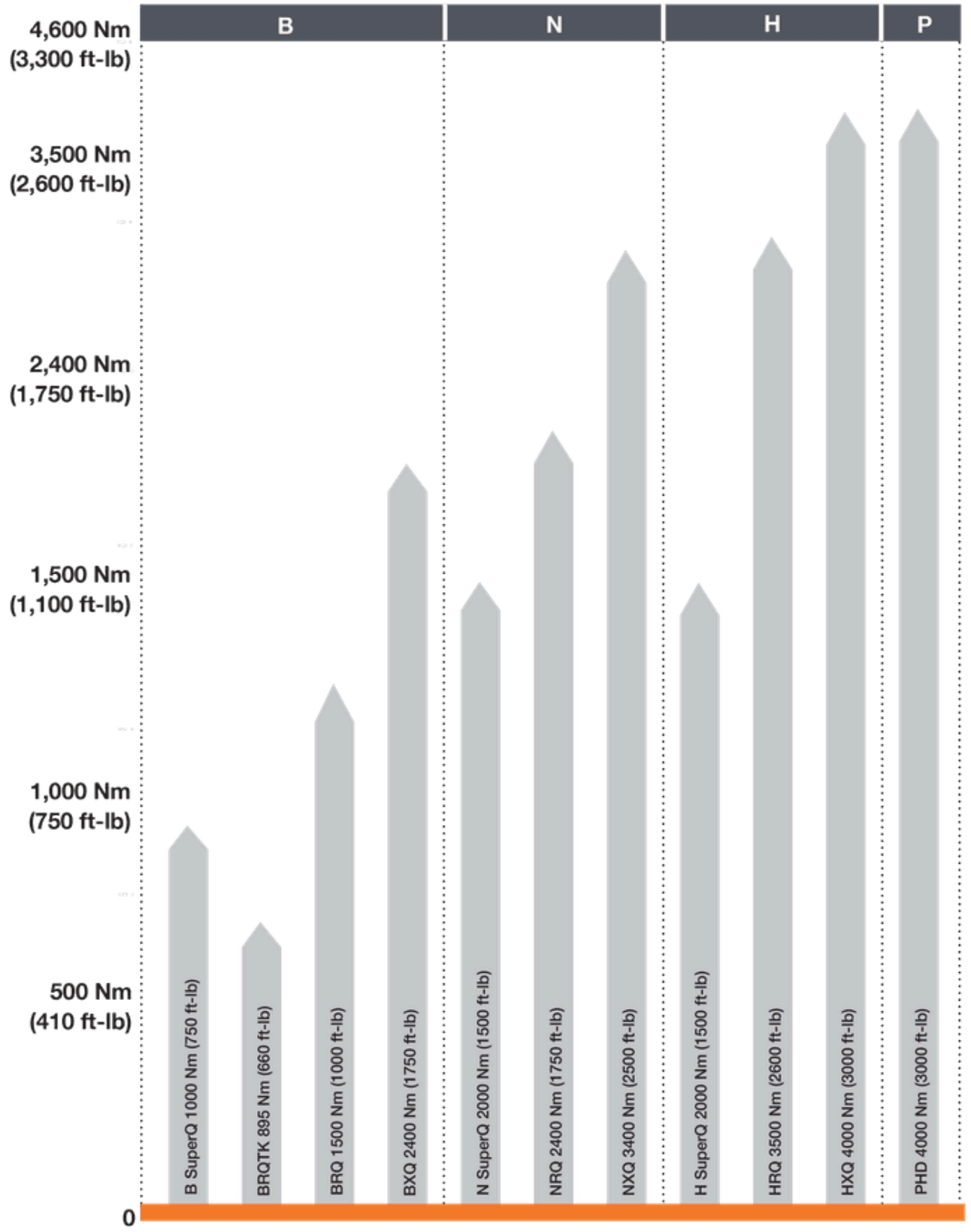
CORING ROD DEPTH RATING



- All ratings and recommendations are based on torque and tension load testing by an independent party.
- Depth and load capacities decrease with wear. For example, de-rate at least 50% for box shoulder thickness worn to 50% of original.
- Actual performance may vary depending on operating conditions and drilling practices.
- Increase make-up torque to match operating torque as depth increases. Operating torque should not exceed make-up torque.

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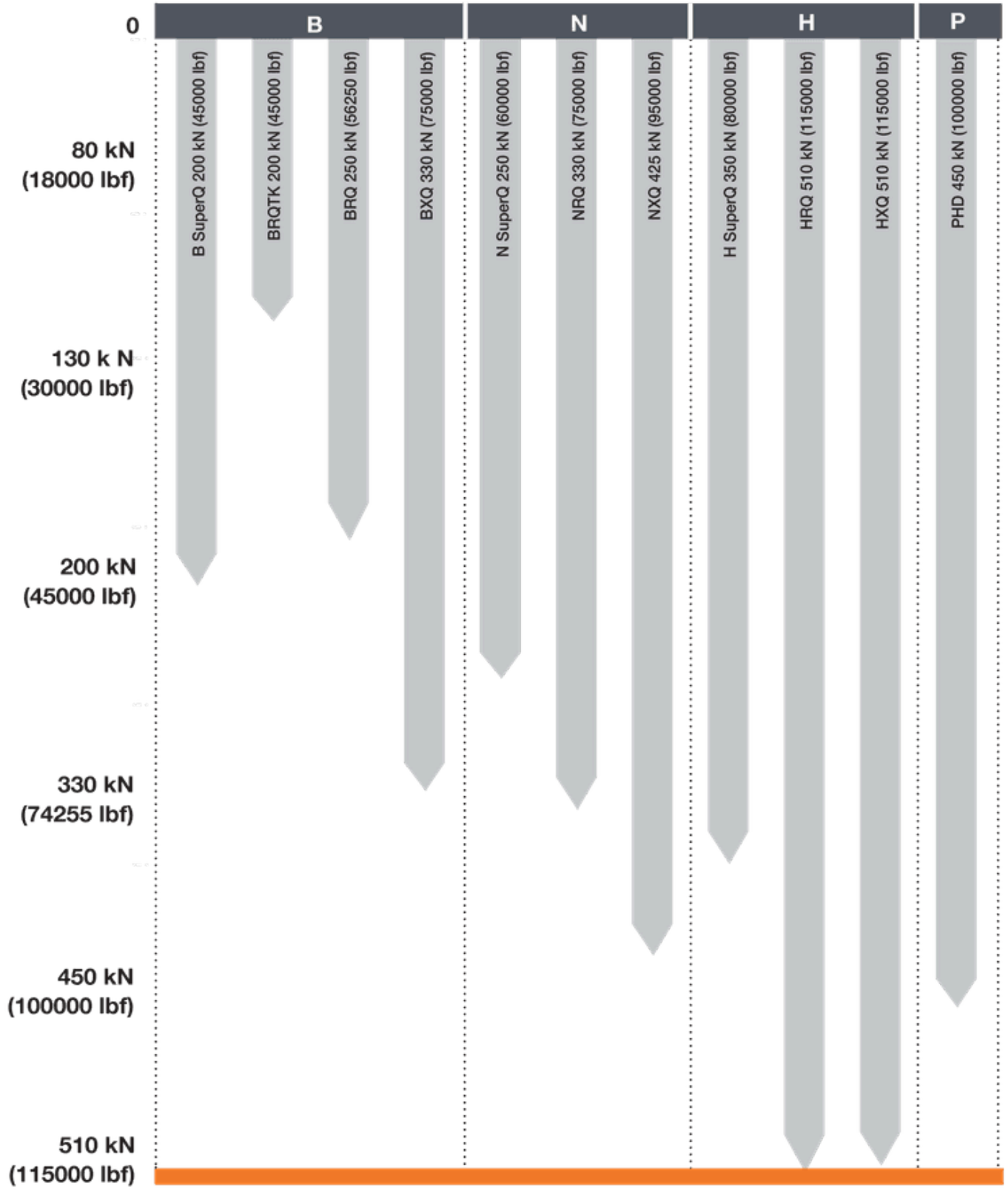
DRILL ROD JOINT MAX TORQUE RATING



- All ratings and recommendations are based on torque and tension load testing by an independent party.
- Depth and load capacities decrease with wear. For example, de-rate at least 50% for box shoulder thickness worn to 50% of original.
- Actual performance may vary depending on operating conditions and drilling practices.
- Increase make-up torque to match operating torque as depth increases. Operating torque should not exceed make-up torque.

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DRILL ROD JOINT MAX PULLBACK RATING



- All ratings and recommendations are based on torque and tension load testing by an independent party.
- Depth and load capacities decrease with wear. For example, de-rate at least 50% for box shoulder thickness worn to 50% of original.
- Actual performance may vary depending on operating conditions and drilling practices.
- Increase make-up torque to match operating torque as depth increases. Operating torque should not exceed make-up torque.

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B SUPERQ TECHNICAL INFORMATION

PERFORMANCE RATING	METRIC	US CUSTOMARY
Rated Drilling Depth by Joint Strength	2000 m	6500 ft
Rated Maximum Pullback	200 kN	45000 lb
Rated Maximum Torque (Operating or Make-Up)	1000 Nm	750 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 2000m	1000 Nm	750 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 1000m	700 Nm	500 ft-lb
Recommended Minimum Make-Up Torque	400 Nm	300 ft-lb
API Theoretical Burst Pressure at Box Shoulder (per API bulletin 5C3)	59250 kPa	8500 psi
API Theoretical Burst Pressure at Midbody (per API bulletin 5C3)	93200 kPa	13511 psi
API Theoretical Collapse Pressure at Midbody (per API bulletin 5C3)	97300 kPa	14117 psi

RATING CRITERIA	METRIC	US CUSTOMARY
Rod Midbody Outer Diameter	55.9 mm	2.19 in
Rod Midbody Inner Diameter	46.1 mm	1.81 in
Rod Joint Inner Diameter	46.1 mm	1.81 in
Rod Resistance to Deviation (Stiffness)	6183 mm	9.60 in
Rod Weight per Unit Length	6.3 kg/m	4.20 lb/ft
Rod Content Weight (Water) per Unit Length	1.7 L/m	0.13 gal/ft
Rod Displacement (Water) per Unit Length	0.8 L/m	0.07 gal/ft

*API burst and collapse ratings are intended for drilling and hydrostatic fluid pressure considerations only. For rod handling considerations, wrench or automated clamping jaws or roller gripping pressures must be limited to significantly lower values depending on the number of jaws or rollers and the gripping surface area and gripper tooth penetration, i.e. Always choose maximum number of jaws and maximum gripping area to minimize damage due to gripping pressure and to avoid crushing and fatigue failure.

NOTE: All rod capacities and failure loads were determined through simultaneous torque and tension load testing by an independent party. An appropriate safety factor has been applied in determining the ratings above. These ratings apply to new, unused rods of Boart Longyear manufacture, in a straight vertical down-hole, assuming compliance to Boart Longyear Care and Handling or Product Literature and standard core drilling practices. Actual performance may vary depending on operating conditions and drilling practices. Actual Burst and collapse pressure ratings will be reduced under drilling loads. Increase make-up torque to match operating torque in deep down-holes. Operating torque should not exceed make-up torque.

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BRQ TECHNICAL INFORMATION

PERFORMANCE RATING	METRIC	US CUSTOMARY
Rated Drilling Depth by Joint Strength	3000 m	9843 ft
Rated Maximum Pullback	250 kN	56250 lb
Rated Maximum Torque (Operating or Make-Up)	1500 Nm	1100 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 2000m	1000 Nm	750 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 1000m	700 Nm	500 ft-lb
Recommended Minimum Make-Up Torque	400 Nm	300 ft-lb
API Theoretical Burst Pressure at Box Shoulder (per API bulletin 5C3)	61300 kPa	8890 psi
API Theoretical Burst Pressure at Midbody (per API bulletin 5C3)	93200 kPa	13511 psi
API Theoretical Collapse Pressure at Midbody (per API bulletin 5C3)	97300 kPa	14117 psi

RATING CRITERIA	METRIC	US CUSTOMARY
Rod Midbody Outer Diameter	55.9 mm	2.19 in
Rod Midbody Inner Diameter	46.1 mm	1.81 in
Rod Joint Inner Diameter	46.1 mm	1.81 in
Rod Resistance to Deviation (Stiffness)	6183 mm	9.60 in
Rod Weight per Unit Length	6.3 kg/m	4.20 lb/ft
Rod Content Weight (Water) per Unit Length	1.7 L/m	0.13 gal/ft
Rod Displacement (Water) per Unit Length	0.8 L/m	0.07 gal/ft

*API burst and collapse ratings are intended for drilling and hydrostatic fluid pressure considerations only. For rod handling considerations, wrench or automated clamping jaws or roller gripping pressures must be limited to significantly lower values depending on the number of jaws or rollers and the gripping surface area and gripper tooth penetration, i.e. Always choose maximum number of jaws and maximum gripping area to minimize damage due to gripping pressure and to avoid crushing and fatigue failure.

NOTE: All rod capacities and failure loads were determined through simultaneous torque and tension load testing by an independent party. An appropriate safety factor has been applied in determining the ratings above. These ratings apply to new, unused rods of Boart Longyear manufacture, in a straight vertical down-hole, assuming compliance to Boart Longyear Care and Handling or Product Literature and standard core drilling practices. Actual performance may vary depending on operating conditions and drilling practices. Actual Burst and collapse pressure ratings will be reduced under drilling loads. Increase make-up torque to match operating torque in deep down-holes. Operating torque should not exceed make-up torque.

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BRQ TK TECHNICAL INFORMATION

PERFORMANCE RATING	METRIC	US CUSTOMARY
Rated Drilling Depth by Joint Strength	1500 m	4900 ft
Rated Maximum Pullback	200 kN	45000 lb
Rated Maximum Torque (Operating or Make-Up)	895 Nm	660 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 2000m	N/A	N/A
Recommended Minimum Make-Up Torque for Deep Holes over 1000m	700 Nm	500 ft-lb
Recommended Minimum Make-Up Torque	400 Nm	300 ft-lb
API Theoretical Burst Pressure at Box Shoulder (per API bulletin 5C3)	56418 kPa	8182 psi
API Theoretical Burst Pressure at Midbody (per API bulletin 5C3)	74703 kPa	10834 psi
API Theoretical Collapse Pressure at Midbody (per API bulletin 5C3)	72506 kPa	10516 psi

RATING CRITERIA	METRIC	US CUSTOMARY
Rod Midbody Outer Diameter	56.03 mm	2.20 in
Rod Midbody Inner Diameter	48.32 mm	1.90 in
Rod Joint Inner Diameter	48.32 mm	1.90 in
Rod Resistance to Deviation (Stiffness)	5362 mm	8.30 in
Rod Weight per Unit Length	4.95 kg/m	3.30 lb/ft
Rod Content Weight (Water) per Unit Length	1.83L/m	0.15 gal/ft
Rod Displacement (Water) per Unit Length	0.76 L/m	0.06 gal/ft

*API burst and collapse ratings are intended for drilling and hydrostatic fluid pressure considerations only. For rod handling considerations, wrench or automated clamping jaws or roller gripping pressures must be limited to significantly lower values depending on the number of jaws or rollers and the gripping surface area and gripper tooth penetration, i.e. Always choose maximum number of jaws and maximum gripping area to minimize damage due to gripping pressure and to avoid crushing and fatigue failure.

NOTE: All rod capacities and failure loads were determined through simultaneous torque and tension load testing by an independent party. An appropriate safety factor has been applied in determining the ratings above. These ratings apply to new, unused rods of Boart Longyear manufacture, in a straight vertical down-hole, assuming compliance to Boart Longyear Care and Handling or Product Literature and standard core drilling practices. Actual performance may vary depending on operating conditions and drilling practices. Actual Burst and collapse pressure ratings will be reduced under drilling loads. Increase make-up torque to match operating torque in deep down-holes. Operating torque should not exceed make-up torque.

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BXQ TECHNICAL INFORMATION

PERFORMANCE RATING	METRIC	US CUSTOMARY
Rated Drilling Depth by Joint Strength	3000 m	9843 ft
Rated Maximum Pullback	250 kN	56250 lb
Rated Maximum Torque (Operating or Make-Up)	1500 Nm	1100 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 2000m	1000 Nm	750 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 1000m	700 Nm	500 ft-lb
Recommended Minimum Make-Up Torque	400 Nm	300 ft-lb
API Theoretical Burst Pressure at Box Shoulder (per API bulletin 5C3)	61300 kPa	8891 psi
API Theoretical Burst Pressure at Midbody (per API bulletin 5C3)	93200 kPa	13511 psi
API Theoretical Collapse Pressure at Midbody (per API bulletin 5C3)	97300 kPa	14117 psi

RATING CRITERIA	METRIC	US CUSTOMARY
Rod Midbody Outer Diameter	55.9 mm	2.19 in
Rod Midbody Inner Diameter	46.1 mm	1.81 in
Rod Joint Inner Diameter	46.1 mm	1.81 in
Rod Resistance to Deviation (Stiffness)	6183 mm	9.60 in
Rod Weight per Unit Length	6.3 kg/m	4.20 lb/ft
Rod Content Weight (Water) per Unit Length	1.7 L/m	0.13 gal/ft
Rod Displacement (Water) per Unit Length	0.8 L/m	0.07 gal/ft

*API burst and collapse ratings are intended for drilling and hydrostatic fluid pressure considerations only. For rod handling considerations, wrench or automated clamping jaws or roller gripping pressures must be limited to significantly lower values depending on the number of jaws or rollers and the gripping surface area and gripper tooth penetration, i.e. Always choose maximum number of jaws and maximum gripping area to minimize damage due to gripping pressure and to avoid crushing and fatigue failure.

NOTE: All rod capacities and failure loads were determined through simultaneous torque and tension load testing by an independent party. An appropriate safety factor has been applied in determining the ratings above. These ratings apply to new, unused rods of Boart Longyear manufacture, in a straight vertical down-hole, assuming compliance to Boart Longyear Care and Handling or Product Literature and standard core drilling practices. Actual performance may vary depending on operating conditions and drilling practices. Actual Burst and collapse pressure ratings will be reduced under drilling loads. Increase make-up torque to match operating torque in deep down-holes. Operating torque should not exceed make-up torque.

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N SUPERQ TECHNICAL INFORMATION

PERFORMANCE RATING	METRIC	US CUSTOMARY
Rated Drilling Depth by Joint Strength	2500 m	8000 ft
Rated Maximum Pullback	250 kN	60000 lb
Rated Maximum Torque (Operating or Make-Up)	2000 Nm	1500 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 2000m	1500 Nm	1000 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 1000m	1000 Nm	750 ft-lb
Recommended Minimum Make-Up Torque	700 Nm	500 ft-lb
API Theoretical Burst Pressure at Box Shoulder (per API bulletin 5C3)	47000 kPa	6800 psi
API Theoretical Burst Pressure at Midbody (per API bulletin 5C3)	75500 kPa	10952 psi
API Theoretical Collapse Pressure at Midbody (per API bulletin 5C3)	73900 kPa	10724 psi

RATING CRITERIA	METRIC	US CUSTOMARY
Rod Midbody Outer Diameter	69.9 mm	2.75 in
Rod Midbody Inner Diameter	60.3 mm	2.38 in
Rod Joint Inner Diameter	60.3 mm	2.38 in
Rod Resistance to Deviation (Stiffness)	13135 mm	20.40 in
Rod Weight per Unit Length	7.8 kg/m	5.20 lb/ft
Rod Content Weight (Water) per Unit Length	2.9 L/m	0.23 gal/ft
Rod Displacement (Water) per Unit Length	0.9 L/m	0.07 gal/ft

*API burst and collapse ratings are intended for drilling and hydrostatic fluid pressure considerations only. For rod handling considerations, wrench or automated clamping jaws or roller gripping pressures must be limited to significantly lower values depending on the number of jaws or rollers and the gripping surface area and gripper tooth penetration, i.e. Always choose maximum number of jaws and maximum gripping area to minimize damage due to gripping pressure and to avoid crushing and fatigue failure.

NOTE: All rod capacities and failure loads were determined through simultaneous torque and tension load testing by an independent party. An appropriate safety factor has been applied in determining the ratings above. These ratings apply to new, unused rods of Boart Longyear manufacture, in a straight vertical down-hole, assuming compliance to Boart Longyear Care and Handling or Product Literature and standard core drilling practices. Actual performance may vary depending on operating conditions and drilling practices. Actual Burst and collapse pressure ratings will be reduced under drilling loads. Increase make-up torque to match operating torque in deep down-holes. Operating torque should not exceed make-up torque.

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NRQ TECHNICAL INFORMATION

PERFORMANCE RATING	METRIC	US CUSTOMARY
Rated Drilling Depth by Joint Strength	3000 m	9800 ft
Rated Maximum Pullback	330 kN	74255 lb
Rated Maximum Torque (Operating or Make-Up)	2400 Nm	1750 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 2000m	1400 Nm	1000 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 1000m	1000 Nm	750 ft-lb
Recommended Minimum Make-Up Torque	700 Nm	500 ft-lb
API Theoretical Burst Pressure at Box Shoulder (per API bulletin 5C3)	49700 kPa	7215 psi
API Theoretical Burst Pressure at Midbody (per API bulletin 5C3)	75513 kPa	10952 psi
API Theoretical Collapse Pressure at Midbody (per API bulletin 5C3)	73943 kPa	10724 psi

RATING CRITERIA	METRIC	US CUSTOMARY
Rod Midbody Outer Diameter	69.9 mm	2.75 in
Rod Midbody Inner Diameter	60.3 mm	2.38 in
Rod Joint Inner Diameter	60.3 mm	2.38 in
Rod Resistance to Deviation (Stiffness)	13135 mm	20.40 in
Rod Weight per Unit Length	7.8 kg/m	5.20 lb/ft
Rod Content Weight (Water) per Unit Length	2.9 L/m	0.23 gal/ft
Rod Displacement (Water) per Unit Length	0.9 L/m	0.07 gal/ft

*API burst and collapse ratings are intended for drilling and hydrostatic fluid pressure considerations only. For rod handling considerations, wrench or automated clamping jaws or roller gripping pressures must be limited to significantly lower values depending on the number of jaws or rollers and the gripping surface area and gripper tooth penetration, i.e. Always choose maximum number of jaws and maximum gripping area to minimize damage due to gripping pressure and to avoid crushing and fatigue failure.

NOTE: All rod capacities and failure loads were determined through simultaneous torque and tension load testing by an independent party. An appropriate safety factor has been applied in determining the ratings above. These ratings apply to new, unused rods of Boart Longyear manufacture, in a straight vertical down-hole, assuming compliance to Boart Longyear Care and Handling or Product Literature and standard core drilling practices. Actual performance may vary depending on operating conditions and drilling practices. Actual Burst and collapse pressure ratings will be reduced under drilling loads. Increase make-up torque to match operating torque in deep down-holes. Operating torque should not exceed make-up torque.

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NXQ TECHNICAL INFORMATION

PERFORMANCE RATING	METRIC	US CUSTOMARY
Rated Drilling Depth by Joint Strength	3350 m	11000 ft
Rated Maximum Pullback	425 kN	95000 lb
Rated Maximum Torque (Operating or Make-Up)	3400 Nm	2500 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 2000m	1400 Nm	1000 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 1000m	1000 Nm	750 ft-lb
Recommended Minimum Make-Up Torque	700 Nm	500 ft-lb
API Theoretical Burst Pressure at Box Shoulder (per API bulletin 5C3)	49700 kPa	7215 psi
API Theoretical Burst Pressure at Midbody (per API bulletin 5C3)	75513 kPa	10952 psi
API Theoretical Collapse Pressure at Midbody (per API bulletin 5C3)	73943 kPa	10724 psi

RATING CRITERIA	METRIC	US CUSTOMARY
Rod Midbody Outer Diameter	69.9 mm	2.75 in
Rod Midbody Inner Diameter	60.3 mm	2.38 in
Rod Joint Inner Diameter	60.3 mm	2.38 in
Rod Resistance to Deviation (Stiffness)	13135 mm	20.40 in
Rod Weight per Unit Length	7.8 kg/m	5.20 lb/ft
Rod Content Weight (Water) per Unit Length	2.9 L/m	0.23 gal/ft
Rod Displacement (Water) per Unit Length	0.9 L/m	0.07 gal/ft

*API burst and collapse ratings are intended for drilling and hydrostatic fluid pressure considerations only. For rod handling considerations, wrench or automated clamping jaws or roller gripping pressures must be limited to significantly lower values depending on the number of jaws or rollers and the gripping surface area and gripper tooth penetration, i.e. Always choose maximum number of jaws and maximum gripping area to minimize damage due to gripping pressure and to avoid crushing and fatigue failure.

NOTE: All rod capacities and failure loads were determined through simultaneous torque and tension load testing by an independent party. An appropriate safety factor has been applied in determining the ratings above. These ratings apply to new, unused rods of Boart Longyear manufacture, in a straight vertical down-hole, assuming compliance to Boart Longyear Care and Handling or Product Literature and standard core drilling practices. Actual performance may vary depending on operating conditions and drilling practices. Actual Burst and collapse pressure ratings will be reduced under drilling loads. Increase make-up torque to match operating torque in deep down-holes. Operating torque should not exceed make-up torque.

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NXQ W-WALL TECHNICAL INFORMATION

PERFORMANCE RATING	METRIC	US CUSTOMARY
Rated Drilling Depth by Joint Strength	4000 m	13000 ft
Rated Maximum Pullback	425 kN	95000 lb
Rated Maximum Torque (Operating or Make-Up)	3400 Nm	2500 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 2000m	1400 Nm	1000 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 1000m	1000 Nm	750 ft-lb
Recommended Minimum Make-Up Torque	700 Nm	500 ft-lb
API Theoretical Burst Pressure at Box Shoulder (per API bulletin 5C3)	49700 kPa	7215 psi
API Theoretical Burst Pressure at Midbody (per API bulletin 5C3)	63387 kPa	9193 psi
API Theoretical Collapse Pressure at Midbody (per API bulletin 5C3)	52421 kPa	7603 psi

RATING CRITERIA	METRIC	US CUSTOMARY
Rod Midbody Outer Diameter	70.0 mm	2.75 in
Rod Midbody Inner Diameter	62.0 mm	2.44 in
Rod Joint Inner Diameter	60.3 mm	2.38 in
Rod Resistance to Deviation (Stiffness)	11408 mm	17.70 in
Rod Weight per Unit Length	6.8 kg/m	4.50 lb/ft
Rod Content Weight (Water) per Unit Length	2.9 L/m	0.24 gal/ft
Rod Displacement (Water) per Unit Length	0.8 L/m	0.07 gal/ft

*API burst and collapse ratings are intended for drilling and hydrostatic fluid pressure considerations only. For rod handling considerations, wrench or automated clamping jaws or roller gripping pressures must be limited to significantly lower values depending on the number of jaws or rollers and the gripping surface area and gripper tooth penetration, i.e. Always choose maximum number of jaws and maximum gripping area to minimize damage due to gripping pressure and to avoid crushing and fatigue failure.

NOTE: All rod capacities and failure loads were determined through simultaneous torque and tension load testing by an independent party. An appropriate safety factor has been applied in determining the ratings above. These ratings apply to new, unused rods of Boart Longyear manufacture, in a straight vertical down-hole, assuming compliance to Boart Longyear Care and Handling or Product Literature and standard core drilling practices. Actual performance may vary depending on operating conditions and drilling practices. Actual Burst and collapse pressure ratings will be reduced under drilling loads. Increase make-up torque to match operating torque in deep down-holes. Operating torque should not exceed make-up torque.

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H SUPERQ TECHNICAL INFORMATION

PERFORMANCE RATING	METRIC	US CUSTOMARY
Rated Drilling Depth by Joint Strength	2000 m	6500 ft
Rated Maximum Pullback	350 kN	80000 lb
Rated Maximum Torque (Operating or Make-Up)	2000 Nm	1500 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 2000m	1750 Nm	1250 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 1000m	1500 Nm	1000 ft-lb
Recommended Minimum Make-Up Torque	1000 Nm	750 ft-lb
API Theoretical Burst Pressure at Box Shoulder (per API bulletin 5C3)	45000 kPa	6500 psi
API Theoretical Burst Pressure at Midbody (per API bulletin 5C3)	64000 kPa	9850 psi
API Theoretical Collapse Pressure at Midbody (per API bulletin 5C3)	60000 kPa	8770 psi

RATING CRITERIA	METRIC	US CUSTOMARY
Rod Midbody Outer Diameter	89.0 mm	3.50 in
Rod Midbody Inner Diameter	77.8 mm	3.06 in
Rod Joint Inner Diameter	77.8 mm	3.06 in
Rod Resistance to Deviation (Stiffness)	31668 mm	49.10 in
Rod Weight per Unit Length	11.4 kg/m	7.70 lb/ft
Rod Content Weight (Water) per Unit Length	4.8 L/m	0.38 gal/ft
Rod Displacement (Water) per Unit Length	1.5 L/m	0.12 gal/ft

*API burst and collapse ratings are intended for drilling and hydrostatic fluid pressure considerations only. For rod handling considerations, wrench or automated clamping jaws or roller gripping pressures must be limited to significantly lower values depending on the number of jaws or rollers and the gripping surface area and gripper tooth penetration, i.e. Always choose maximum number of jaws and maximum gripping area to minimize damage due to gripping pressure and to avoid crushing and fatigue failure.

NOTE: All rod capacities and failure loads were determined through simultaneous torque and tension load testing by an independent party. An appropriate safety factor has been applied in determining the ratings above. These ratings apply to new, unused rods of Boart Longyear manufacture, in a straight vertical down-hole, assuming compliance to Boart Longyear Care and Handling or Product Literature and standard core drilling practices. Actual performance may vary depending on operating conditions and drilling practices. Actual Burst and collapse pressure ratings will be reduced under drilling loads. Increase make-up torque to match operating torque in deep down-holes. Operating torque should not exceed make-up torque.

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HRQ TECHNICAL INFORMATION

PERFORMANCE RATING	METRIC	US CUSTOMARY
Rated Drilling Depth by Joint Strength	2500 m	8200 ft
Rated Maximum Pullback	510 kN	115000 lb
Rated Maximum Torque (Operating or Make-Up)	3500 Nm	2600 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 2000m	2750 Nm	2000 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 1000m	2000 Nm	1500 ft-lb
Recommended Minimum Make-Up Torque	1000 Nm	750 ft-lb
API Theoretical Burst Pressure at Box Shoulder (per API bulletin 5C3)	45000 kPa	6561 psi
API Theoretical Burst Pressure at Midbody (per API bulletin 5C3)	64000 kPa	9850 psi
API Theoretical Collapse Pressure at Midbody (per API bulletin 5C3)	60000 kPa	8770 psi

RATING CRITERIA	METRIC	US CUSTOMARY
Rod Midbody Outer Diameter	89.0 mm	3.50 in
Rod Midbody Inner Diameter	77.9 mm	3.06 in
Rod Joint Inner Diameter	77.9 mm	3.06 in
Rod Resistance to Deviation (Stiffness)	31668 mm	49.10 in
Rod Weight per Unit Length	11.4 kg/m	7.70 lb/ft
Rod Content Weight (Water) per Unit Length	5.1 L/m	0.38 gal/ft
Rod Displacement (Water) per Unit Length	1.5 L/m	0.12 gal/ft

*API burst and collapse ratings are intended for drilling and hydrostatic fluid pressure considerations only. For rod handling considerations, wrench or automated clamping jaws or roller gripping pressures must be limited to significantly lower values depending on the number of jaws or rollers and the gripping surface area and gripper tooth penetration, i.e. Always choose maximum number of jaws and maximum gripping area to minimize damage due to gripping pressure and to avoid crushing and fatigue failure.

NOTE: All rod capacities and failure loads were determined through simultaneous torque and tension load testing by an independent party. An appropriate safety factor has been applied in determining the ratings above. These ratings apply to new, unused rods of Boart Longyear manufacture, in a straight vertical down-hole, assuming compliance to Boart Longyear Care and Handling or Product Literature and standard core drilling practices. Actual performance may vary depending on operating conditions and drilling practices. Actual Burst and collapse pressure ratings will be reduced under drilling loads. Increase make-up torque to match operating torque in deep down-holes. Operating torque should not exceed make-up torque.

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HXQ TECHNICAL INFORMATION

PERFORMANCE RATING	METRIC	US CUSTOMARY
Rated Drilling Depth by Joint Strength	3050 m	10000 ft
Rated Maximum Pullback	510 kN	115000 lb
Rated Maximum Torque (Operating or Make-Up)	4000 Nm	3000 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 2000m	2750 Nm	2000 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 1000m	2000 Nm	1475 ft-lb
Recommended Minimum Make-Up Torque	1000 Nm	750 ft-lb
API Theoretical Burst Pressure at Box Shoulder (per API bulletin 5C3)	45000 kPa	6561 psi
API Theoretical Burst Pressure at Midbody (per API bulletin 5C3)	64000 kPa	9850 psi
API Theoretical Collapse Pressure at Midbody (per API bulletin 5C3)	60000 kPa	8770 psi

RATING CRITERIA	METRIC	US CUSTOMARY
Rod Midbody Outer Diameter	89.0 mm	3.50 in
Rod Midbody Inner Diameter	77.9 mm	3.06 in
Rod Joint Inner Diameter	77.9 mm	3.06 in
Rod Resistance to Deviation (Stiffness)	31668 mm	49.10 in
Rod Weight per Unit Length	11.4 kg/m	7.70 lb/ft
Rod Content Weight (Water) per Unit Length	5.1 L/m	0.38 gal/ft
Rod Displacement (Water) per Unit Length	1.5 L/m	0.12 gal/ft

*API burst and collapse ratings are intended for drilling and hydrostatic fluid pressure considerations only. For rod handling considerations, wrench or automated clamping jaws or roller gripping pressures must be limited to significantly lower values depending on the number of jaws or rollers and the gripping surface area and gripper tooth penetration, i.e. Always choose maximum number of jaws and maximum gripping area to minimize damage due to gripping pressure and to avoid crushing and fatigue failure.

NOTE: All rod capacities and failure loads were determined through simultaneous torque and tension load testing by an independent party. An appropriate safety factor has been applied in determining the ratings above. These ratings apply to new, unused rods of Boart Longyear manufacture, in a straight vertical down-hole, assuming compliance to Boart Longyear Care and Handling or Product Literature and standard core drilling practices. Actual performance may vary depending on operating conditions and drilling practices. Actual Burst and collapse pressure ratings will be reduced under drilling loads. Increase make-up torque to match operating torque in deep down-holes. Operating torque should not exceed make-up torque.

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HXQ W-WALL TECHNICAL INFORMATION

PERFORMANCE RATING	METRIC	US CUSTOMARY
Rated Drilling Depth by Joint Strength	4000 m	13000 ft
Rated Maximum Pullback	510 kN	115000 lb
Rated Maximum Torque (Operating or Make-Up)	4000 Nm	3000 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 2000m	2750 Nm	2000 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 1000m	2000 Nm	1500 ft-lb
Recommended Minimum Make-Up Torque	1000 Nm	750 ft-lb
API Theoretical Burst Pressure at Box Shoulder (per API bulletin 5C3)	45500 kPa	6561 psi
API Theoretical Burst Pressure at Midbody (per API bulletin 5C3)	50200 kPa	7280 psi
API Theoretical Collapse Pressure at Midbody (per API bulletin 5C3)	29000 kPa	4206 psi

RATING CRITERIA	METRIC	US CUSTOMARY
Rod Midbody Outer Diameter	89.0 mm	3.50 in
Rod Midbody Inner Diameter	81.0 mm	3.19 in
Rod Joint Inner Diameter	77.9 mm	3.06 in
Rod Resistance to Deviation (Stiffness)	24592 mm	38.10 in
Rod Weight per Unit Length	9.1 kg/m	6.00 lb/ft
Rod Content Weight (Water) per Unit Length	5.1 L/m	0.38 gal/ft
Rod Displacement (Water) per Unit Length	1.1 L/m	0.09 gal/ft

*API burst and collapse ratings are intended for drilling and hydrostatic fluid pressure considerations only. For rod handling considerations, wrench or automated clamping jaws or roller gripping pressures must be limited to significantly lower values depending on the number of jaws or rollers and the gripping surface area and gripper tooth penetration, i.e. Always choose maximum number of jaws and maximum gripping area to minimize damage due to gripping pressure and to avoid crushing and fatigue failure.

NOTE: All rod capacities and failure loads were determined through simultaneous torque and tension load testing by an independent party. An appropriate safety factor has been applied in determining the ratings above. These ratings apply to new, unused rods of Boart Longyear manufacture, in a straight vertical down-hole, assuming compliance to Boart Longyear Care and Handling or Product Literature and standard core drilling practices. Actual performance may vary depending on operating conditions and drilling practices. Actual Burst and collapse pressure ratings will be reduced under drilling loads. Increase make-up torque to match operating torque in deep down-holes. Operating torque should not exceed make-up torque.

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PHD TECHNICAL INFORMATION

PERFORMANCE RATING	METRIC	US CUSTOMARY
Rated Drilling Depth by Joint Strength	1500 m	4900 ft
Rated Maximum Pullback	450 kN	100000 lb
Rated Maximum Torque (Operating or Make-Up)	4000 Nm	3000 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 2000m	N/A	N/A
Recommended Minimum Make-Up Torque for Deep Holes over 1000m	2200 Nm	1600 ft-lb
Recommended Minimum Make-Up Torque	1000 Nm	750 ft-lb
API Theoretical Burst Pressure at Box Shoulder (per API bulletin 5C3)	21614 kPa	3135 psi
API Theoretical Burst Pressure at Midbody (per API bulletin 5C3)	62038 kPa	8998 psi
API Theoretical Collapse Pressure at Midbody (per API bulletin 5C3)	50026 kPa	7255 psi

RATING CRITERIA	METRIC	US CUSTOMARY
Rod Midbody Outer Diameter	114.4 mm	4.50 in
Rod Midbody Inner Diameter	101.4 mm	4.00 in
Rod Joint Inner Diameter	101.4 mm	4.00 in
Rod Resistance to Deviation (Stiffness)	80423 mm	124.70 in
Rod Weight per Unit Length	17.4 kg/m	11.70 lb/ft
Rod Content Weight (Water) per Unit Length	8.1 L/m	0.65 gal/ft
Rod Displacement (Water) per Unit Length	2.2 L/m	0.17 gal/ft

*API burst and collapse ratings are intended for drilling and hydrostatic fluid pressure considerations only. For rod handling considerations, wrench or automated clamping jaws or roller gripping pressures must be limited to significantly lower values depending on the number of jaws or rollers and the gripping surface area and gripper tooth penetration, i.e. Always choose maximum number of jaws and maximum gripping area to minimize damage due to gripping pressure and to avoid crushing and fatigue failure.

NOTE: All rod capacities and failure loads were determined through simultaneous torque and tension load testing by an independent party. An appropriate safety factor has been applied in determining the ratings above. These ratings apply to new, unused rods of Boart Longyear manufacture, in a straight vertical down-hole, assuming compliance to Boart Longyear Care and Handling or Product Literature and standard core drilling practices. Actual performance may vary depending on operating conditions and drilling practices. Actual Burst and collapse pressure ratings will be reduced under drilling loads. Increase make-up torque to match operating torque in deep down-holes. Operating torque should not exceed make-up torque.

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PHD W-WALL TECHNICAL INFORMATION

PERFORMANCE RATING	METRIC	US CUSTOMARY
Rated Drilling Depth by Joint Strength	2000 m	6500 ft
Rated Maximum Pullback	450 kN	100000 lb
Rated Maximum Torque (Operating or Make-Up)	4000 Nm	3000 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 2000m	3500 Nm	2500 ft-lb
Recommended Minimum Make-Up Torque for Deep Holes over 1000m	2200 Nm	1600 ft-lb
Recommended Minimum Make-Up Torque	1000 Nm	750 ft-lb
API Theoretical Burst Pressure at Box Shoulder (per API bulletin 5C3)	21700 kPa	3145 psi
API Theoretical Burst Pressure at Midbody (per API bulletin 5C3)	38849 kPa	5634 psi
API Theoretical Collapse Pressure at Midbody (per API bulletin 5C3)	15852 kPa	2299 psi

RATING CRITERIA	METRIC	US CUSTOMARY
Rod Midbody Outer Diameter	114.4 mm	4.50 in
Rod Midbody Inner Diameter	106.0 mm	4.19 in
Rod Joint Inner Diameter	101.4 mm	4.00 in
Rod Resistance to Deviation (Stiffness)	53739 mm	83.30 in
Rod Weight per Unit Length	37.3 kg/m	25 lb/ft
Rod Content Weight (Water) per Unit Length	8.8 L/m	0.70 gal/ft
Rod Displacement (Water) per Unit Length	2.2 L/m	0.17 gal/ft

*API burst and collapse ratings are intended for drilling and hydrostatic fluid pressure considerations only. For rod handling considerations, wrench or automated clamping jaws or roller gripping pressures must be limited to significantly lower values depending on the number of jaws or rollers and the gripping surface area and gripper tooth penetration, i.e. Always choose maximum number of jaws and maximum gripping area to minimize damage due to gripping pressure and to avoid crushing and fatigue failure.

NOTE: All rod capacities and failure loads were determined through simultaneous torque and tension load testing by an independent party. An appropriate safety factor has been applied in determining the ratings above. These ratings apply to new, unused rods of Boart Longyear manufacture, in a straight vertical down-hole, assuming compliance to Boart Longyear Care and Handling or Product Literature and standard core drilling practices. Actual performance may vary depending on operating conditions and drilling practices. Actual Burst and collapse pressure ratings will be reduced under drilling loads. Increase make-up torque to match operating torque in deep down-holes. Operating torque should not exceed make-up torque.

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NWT CASING TECHNICAL INFORMATION

PERFORMANCE RATING	METRIC	US CUSTOMARY
Rated Drilling Depth by Joint Strength	832.3 m	2731.4 ft
Rated Maximum Pullback	184.0 kN	41405.7 lb
Rated Maximum Torque (Operating or Make-Up)	1626 Nm	1200 ft-lb
Recommended Minimum Make-Up Torque for drilling to depth	813 Nm	600 ft-lb
Recommended Minimum Make-Up Torque	406 Nm	300 ft-lb
API Theoretical Burst Pressure at Box Shoulder (per API bulletin 5C3)	23452 kPa	3401 psi
API Theoretical Burst Pressure at Midbody (per API bulletin 5C3)	65353 kPa	9978 psi
API Theoretical Collapse Pressure at Midbody (per API bulletin 5C3)	67607 kPa	9805 psi

RATING CRITERIA	METRIC	US CUSTOMARY
Rod Midbody Outer Diameter	89.1 mm	3.51 in
Rod Midbody Inner Diameter	76.4 mm	3.01 in
Rod Joint Inner Diameter	76.4 mm	3.01 in
Rod Resistance to Deviation (Stiffness)	35253 mm	54.6 in
Rod Weight per Unit Length	12.9 kg/m	8.7 lb/ft
Rod Content Weight (Water) per Unit Length	4.6 L/m	0.37 gal/ft
Rod Displacement (Water) per Unit Length	6.2 L/m	0.50 gal/ft

*API burst and collapse ratings are intended for drilling and hydrostatic fluid pressure considerations only. For rod handling considerations, wrench or automated clamping jaws or roller gripping pressures must be limited to significantly lower values depending on the number of jaws or rollers and the gripping surface area and gripper tooth penetration, i.e. Always choose maximum number of jaws and maximum gripping area to minimize damage due to gripping pressure and to avoid crushing and fatigue failure.

NOTE: All rod capacities and failure loads were determined through simultaneous torque and tension load testing by an independent party. An appropriate safety factor has been applied in determining the ratings above. These ratings apply to new, unused rods of Boart Longyear manufacture, in a straight vertical down-hole, assuming compliance to Boart Longyear Care and Handling or Product Literature and standard core drilling practices. Actual performance may vary depending on operating conditions and drilling practices. Actual Burst and collapse pressure ratings will be reduced under drilling loads. Increase make-up torque to match operating torque in deep down-holes. Operating torque should not exceed make-up torque.

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HWT CASING TECHNICAL INFORMATION

PERFORMANCE RATING	METRIC	US CUSTOMARY
Rated Drilling Depth by Joint Strength	730.1 m	2395.4 ft
Rated Maximum Pullback	249.3 kN	56035.0 lb
Rated Maximum Torque (Operating or Make-Up)	1626 Nm	1200 ft-lb
Recommended Minimum Make-Up Torque for drilling to depth	1016 Nm	750 ft-lb
Recommended Minimum Make-Up Torque	508 Nm	375 ft-lb
API Theoretical Burst Pressure at Box Shoulder (per API bulletin 5C3)	18252 kPa	2647 psi
API Theoretical Burst Pressure at Midbody (per API bulletin 5C3)	52387kPa	7598 psi
API Theoretical Collapse Pressure at Midbody (per API bulletin 5C3)	44957 kPa	6520 psi

RATING CRITERIA	METRIC	US CUSTOMARY
Rod Midbody Outer Diameter	114.5 mm	4.51 in
Rod Midbody Inner Diameter	101.4 mm	3.99 in
Rod Joint Inner Diameter	101.4 mm	3.99 in
Rod Resistance to Deviation (Stiffness)	80423 mm	124.7 in
Rod Weight per Unit Length	17.4 kg/m	11.7 lb/ft
Rod Content Weight (Water) per Unit Length	8.1 L/m	0.65 gal/ft
Rod Displacement (Water) per Unit Length	10.3 L/m	0.83 gal/ft

*API burst and collapse ratings are intended for drilling and hydrostatic fluid pressure considerations only. For rod handling considerations, wrench or automated clamping jaws or roller gripping pressures must be limited to significantly lower values depending on the number of jaws or rollers and the gripping surface area and gripper tooth penetration, i.e. Always choose maximum number of jaws and maximum gripping area to minimize damage due to gripping pressure and to avoid crushing and fatigue failure.

NOTE: All rod capacities and failure loads were determined through simultaneous torque and tension load testing by an independent party. An appropriate safety factor has been applied in determining the ratings above. These ratings apply to new, unused rods of Boart Longyear manufacture, in a straight vertical down-hole, assuming compliance to Boart Longyear Care and Handling or Product Literature and standard core drilling practices. Actual performance may vary depending on operating conditions and drilling practices. Actual Burst and collapse pressure ratings will be reduced under drilling loads. Increase make-up torque to match operating torque in deep down-holes. Operating torque should not exceed make-up torque.

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PWT CASING TECHNICAL INFORMATION

PERFORMANCE RATING	METRIC	US CUSTOMARY
Rated Drilling Depth by Joint Strength	402.3 m	1320.2 ft
Rated Maximum Pullback	174.7 kN	39277.0 lb
Rated Maximum Torque (Operating or Make-Up)	1626 Nm	1200 ft-lb
Recommended Minimum Make-Up Torque for drilling to depth	1220 Nm	900 ft-lb
Recommended Minimum Make-Up Torque	610 Nm	450 ft-lb
API Theoretical Burst Pressure at Box Shoulder (per API bulletin 5C3)	14938 kPa	2166 psi
API Theoretical Burst Pressure at Midbody (per API bulletin 5C3)	42875 kPa	6218 psi
API Theoretical Collapse Pressure at Midbody (per API bulletin 5C3)	28340 kPa	4110 psi

RATING CRITERIA	METRIC	US CUSTOMARY
Rod Midbody Outer Diameter	139.9 mm	5.51 in
Rod Midbody Inner Diameter	126.8 mm	4.99 in
Rod Joint Inner Diameter	126.8 mm	4.99 in
Rod Resistance to Deviation (Stiffness)	151407 mm	234.7 in
Rod Weight per Unit Length	21.5 kg/m	14.4 lb/ft
Rod Content Weight (Water) per Unit Length	12.6 L/m	1.01 gal/ft
Rod Displacement (Water) per Unit Length	15.4 L/m	1.24 gal/ft

*API burst and collapse ratings are intended for drilling and hydrostatic fluid pressure considerations only. For rod handling considerations, wrench or automated clamping jaws or roller gripping pressures must be limited to significantly lower values depending on the number of jaws or rollers and the gripping surface area and gripper tooth penetration, i.e. Always choose maximum number of jaws and maximum gripping area to minimize damage due to gripping pressure and to avoid crushing and fatigue failure.

NOTE: All rod capacities and failure loads were determined through simultaneous torque and tension load testing by an independent party. An appropriate safety factor has been applied in determining the ratings above. These ratings apply to new, unused rods of Boart Longyear manufacture, in a straight vertical down-hole, assuming compliance to Boart Longyear Care and Handling or Product Literature and standard core drilling practices. Actual performance may vary depending on operating conditions and drilling practices. Actual Burst and collapse pressure ratings will be reduced under drilling loads. Increase make-up torque to match operating torque in deep down-holes. Operating torque should not exceed make-up torque.

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GUIDELINES FOR USE, CARE AND HANDLING



PACKAGING AND APPEARANCE

PACKAGING FEATURES

- Drill rods and casing are packaged and sold in ‘bundles’ which offer product protection during shipping and handling.
- Protective caps cover box and pin threads sealing in thread compound. A generous layer of fresh thread compound is recommended before making-up rod joint.
- Heavy duty galvanized hexagon bundle end caps protect the drill rod ends.
- Drill rods are coated with rust inhibitor to reduce surface oxidation during shipping. When storing rods for long periods of time, it is recommended you reapply a rust inhibitor to protect the rods from oxidation. Avoid extended outdoor exposure to precipitation or high humidity to prevent ingress of moisture into rod mid-bodies which lack internal corrosion protection.

Steel strapping is under tension and will recoil suddenly when cut, with risk of laceration from sharp edges. Stand clear of recoil and always wear appropriate PPE!

DRILL ROD APPEARANCE

The color of the incoming tube depends on a combination of the following factors at the tubing mill:

- Formulation of their cold draw lubricant which gets pressed into the outer skin, e.g. zinc particulate, etc.
- The furnace atmosphere (gas) and temperature used in the annealing furnaces which reacts with the tubing surface and lubricant, e.g. nitrogen, argon, etc.
- Formulation of the rust preventative applied prior to shipment.

COLOR

- Color Q&T: Darker and bluish due to oxide formed from cooling in air. Color is a function of the temperature.
- Color Pin Case: Darker and bluish due to oxide formed from cooling in air. Color is a function of the temperature.
- Color Due to RP: Adds gloss or refraction color may appear slightly more yellow or amber.
- Color due to Thread Compound: Adds a light grey color to threads.

FINAL APPEARANCE:



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LUBRICATION AND CLEANING

Boart Longyear™ drill rod threads are coated with thread compound (anti-galling lubricant) for shipment from the factory. **Prior to initial make-up, apply a fresh coating of thread compound.** Thereafter, clean and re-lubricate the threads with a Boart Longyear recommended compound (50% zinc particulate) after each use. Use enough compound to cover both thread and shoulder surfaces. A 40 to 50 mm (1.5 to 2 inch) brush is excellent for applying thread compound.



Keep the compound and brush clean.

While occasional mixing of the compound is recommended to avoid settling, dilution of any kind (e.g. diesel, gasoline or oil) will render the compound ineffective.

This thread compound is critical to the life of the joint. To prevent wear, metallic particulates in the compound form an interface layer that can withstand contact pressure and prevent galling. A poor choice of compound or diluted compound will allow the mating surfaces to interact, resulting in adhesion or abrasion wear.

The thread compound is also critical to the strength of the joint. The interaction of the metallic particulate and the surface determines the frictional resistance to torque loads. This in turn determines how much torque is transferred through the joint versus how much is absorbed by the joint. A poor choice of compound or diluted compound will provide insufficient friction, leading to overload failure.

Compounds containing 50% zinc particulate generally provide a higher friction factor (higher torque capacity) and better resistance than those containing similar amounts of copper, lead, or graphite particulate. Environmentally friendly compounds must contain non-toxic, bio-stable, solid particles of similar properties and performance characteristics to those of typical zinc particles in order to perform.



Use of grease without solid particulates will void the warranty. Thread compounds with sacrificial zinc-particulate help protect against stress-corrosion-cracking in corrosive drilling fluids containing chlorides or sulfides. Monitor and control drilling fluid corrosivity with inhibiting additives. Control and monitor drilling fluid acidity level. Never use low friction lubricants on rod joints.

In addition, lubricating the rod body with grease is recommended to reduce hole friction, drilling torque and mid-body wear.

NOTICE - PETROLEUM-BASED GREASE: THROUGHOUT THIS MANUAL, THE USE OF GREASE OR THREAD COMPOUNDS IS MENTIONED. IT IS IMPORTANT TO NOTE THAT THE USE OF PETROLEUM-BASED OR METAL BEARING LUBRICANT PRODUCTS IN SOME AREAS OF THE WORLD IS PROHIBITED. CONTACT YOUR BOART LONGYEAR REPRESENTATIVE FOR RECOMMENDED ALTERNATIVES.

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PREPARATION FOR TRANSIT

Always provide proper protection for thread ends. If available, reuse protective caps cover box and pin threads sealing in thread lubrication. If available, heavy duty galvanized hexagon bundle end caps can protect the drill rod ends during transit. Reapply a rust inhibitor to protect the rods from corrosion if the rods will be exposed to significant moisture. Load rods on at least three cross members and tie down with suitable chain or strap at end cross members. For long rods, an additional chain or strap should be provided in the middle.



Always provide proper protection for threaded ends.

STORAGE OF DRILL RODS

Always clean and grease the pin and box end threads of the rods before storing. Reuse protective caps cover box and pin threads sealing in thread lubrication. Heavy duty galvanized hexagon bundle end caps protect the drill rod ends. Store rods horizontally on a minimum of three cross supports on less than 30 cm (12 in) from the ground to keep moisture and dirt away from the rods.

When rods are temporarily stacked in the mast or rod rack, always provide a wooden or rubber base to protect the pin ends. This is especially important when handling multiple length stands of 6 m (20 ft) or more.

Inspect used rods for bent mid-bodies and worn box shoulders regularly. Straighten or discard bent rods immediately as these cause vibration and can hamper drilling performance.

In addition to thread compound, a corrosion inhibitor on the body is recommended for long term storage (see packaging).



Due to the significant safety risk, Boart Longyear drill rods should never be mixed with another manufacturers' rods. Doing so may cause catastrophic equipment failure, leading to bodily injury or death. In addition, mixing rods voids the Boart Longyear warranty.

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MAKING AND BREAKING (STABBING & MAKE-UP)



Note: See Coring Rod Operations checklist for recommended inspections prior to and during drilling operations.

STABBING

Wireline drill rods and casing provide very little radial clearance when first inserting a pin end into a box end (stabbing). If the pin end is misaligned, it will stab into the box-end shoulder, causing permanent damage regardless of design or heat treatment. This damage will create leakage ranging from negligible to significant, depending on the degree of damage. Severe stabs can compromise the fit of the joint and potentially cause fatigue failures.

Once the face of the pin end shoulder is even with the face of the box end shoulder, the pin end should be lowered slowly into the box until the stab flank of the pin thread mates against the stab flank of the box thread. If the pin is not in true vertical alignment over the box or if the joint has insufficient taper to allow the first turn of pin thread to clear the first turn of box thread, the pin thread crest may wedge or 'jam' against the box thread crest or begin to cross-thread. Rotating the connection counter-clockwise will correct the misalignment.

Once successfully lowered, rotate the stabbing rod by hand to ensure proper thread engagement. Use a stabbing guide (e.g., Boart Longyear™ hoist plug and water swivel adapter subs have a bull nose lead-in feature to prevent stabbing damage).

STAND-OFF

In coring applications, apply right-hand make-up torque when adding drill rod to maintain a closed joint and a fluid seal at the outside shoulder while drilling. All drill-rod threaded connections are designed to be “self-locking”, so that the loads cannot unmake or unload the connection. Diamond coring requires high rotational speeds to maintain the cutting performance of diamond bits, with speeds ranging up to 1700 rpm. Like any moving or rotating body, rotating drill strings develop inertia as the square of rotational speed, so the high rpm of coring means high inertia. The faster a rotating drill string is stopped, the greater the inertial break-out torque. For example, a 1000m(3000ft) long NQ™ drill string rotating at 1,000rpm can generate 500ft-lb of break-out torque if stopped in one second, or over 1,000ft-lb if stopped in half a second, or an extreme amount of break-out torque if stopped instantaneously. While the frictional resistance at the mating thread load-flanks depends on the make-up torque and opposing drilling loads, the frictional resistance created by the interference fit remains constant. For example, the NQ™ joint includes a nominal interference fit that generates about 200 ft-lb of resistance against breakout; without it, drill rod strings would constantly unthread when rotation slows or stops. The interference fit creates a standoff gap when rods are tightened by hand. Rods with a low or no standoff gap are very likely to unthread in operation.

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MAKING AND BREAKING (CONT.)



STAND-OFF (Cont.)

To allow for manufacturing variance and get consistent readings, measure the standoff gap in the wrench-snug condition. Using wrench-snug torque of about 30ft-lb (roughly equal to a one-arm load on a 12" wrench handle), a gap should remain at the external torque shoulder, which indicates the amount of interference in the connection

Wrench Snug Standoff Gap:
Q/SuperQ: 0.031 to 0.072
RQ: 0.030 to 0.060
XQ: 0.040 to 0.080

Note: Subs due to their construction will have half the standoff gap listed above when brand new. For used subs, use the finger gauges to assess thread wear, as stand-off gap is not a predictable measure of wear.

If the stand-off gap is outside specification (see table above) or if the joint does not close after applying a small amount of make-up torque, break out the joint and clean and inspect both threads. This indicates excessive wear, excessive foreign material, or thread deformation due to overloading during making or breaking. It may also indicate that the product is from a different manufacturer.

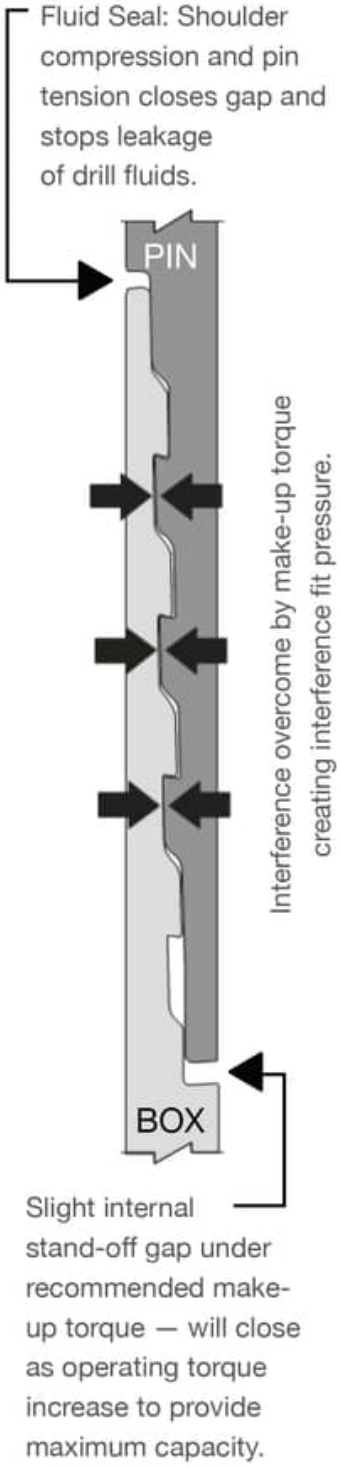
MAKE-UP

Wireline rods and casing make-up by slowly rotating the pin clockwise into the box (right-hand threads). On most drills, this must be done at a very low rotation (e.g. 10 RPM or less) to avoid applying extraneous torque due to the inertia of the drill head. Adjust the feed rate to match the rod thread (e.g. 3 threads per inch for Q rods versus 2 threads per inch for XQ) while maintaining light compression on the joint to minimize thread wear. Do not allow tension or excessive rotation speed, as this wears the thread load flanks.

If the stand-off gap, 0.8-2.0 mm (1/32" - 5/64"), is outside specification or if the joint does not close after applying a small amount of make-up torque, break out the joint and clean and inspect both threads. This indicates excessive wear, excessive foreign material, or thread deformation due to overloading during making or breaking. It may also indicate that the product is from a different manufacturer.

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MAKING AND BREAKING (MAKE-UP TORQUE)



MAKE-UP TORQUE (PRE-LOADING)

After the stand-off gap is closed, additional make-up is required to sufficiently pre-load the joint. While a large wrench may be sufficient on smaller-sized rod strings or less demanding applications, make-up applied with the drill head or other power make-up devices is often required. This ensures the box shoulder does not become unloaded during drilling, allowing leakage, fretting, or premature fatigue failures. Joints will not self-make-up sufficiently during drilling alone, as the joint has additional frictional resistance to make-up under drilling loads.

Joints with insufficient make-up will begin to leak as the pullback load increases and the box shoulder relaxes. Another visual sign of insufficient make-up is pitting-wear in the joints due to fretting and, in extreme cases, fatigue failures.

As a rule of thumb, the make-up torque on each joint should be adjusted to match the drilling torque it is expected to see. Additional make-up is required to maintain box shoulder compression under excessive pullback or twisting loads. However, note that excessive make-up reduces the available load capacity and fatigue strength.

ROD TYPE	METRIC	US CUSTOMARY
BQ	400 Nm	300 FT-LBS
BRQ/BXQ	400 Nm	300 FT-LBS
BRQTK	400 Nm	300 FT-LBS
NQ	700 Nm	500 FT-LBS
NRQ/NXQ	700 Nm	500 FT-LBS
HQ	1000 Nm	750 FT-LBS
HRQ/HXQ	1000 Nm	750 FT-LBS
PHD	1000 Nm	750 FT-LBS

Note: A common practice, in standard applications, is to apply 20% more make-up than drilling torque, however this takes away from the remaining load capacity and is not recommended for demanding applications.

The pin end is engineered to be slightly shorter than the box end to allow pre-loading of the box shoulder and elastic response to drilling loads. This is evident by a gap at the internal torque shoulder. Under extraordinary make-up or drilling torque, the pin and box will be sufficiently loaded to close this gap and engage the internal torque shoulder, providing additional torque capacity.

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MAKING AND BREAKING (SUBS, WEAR GAUGING)

TOP DRIVE SUBS

Special Considerations: top-drive subs are subject to repeated make-and-break events during tripping, while each drill rod only sees a single make-and-break. Additionally, thick-wall adapter subs use heat-treated alloy-steel bar; however, this bar is somewhat softer than mating drill rods. As a result, the torque shoulders are subject to wear after repeated makes against harder drill rods. Thus, top-drive adapters wear significantly faster than drill rods.

Adapter subs made with thick wall sections are significantly stiffer than the mating drill rods, causing higher stress and strain in the rods. The precisely engineered fit between the adapter and drill rod is lost as the adapter wears. In combination with the difference in stiffness, the mating drill rod box can suffer premature fatigue failure when mated to a worn top-drive adapter.

Every effort has been made to reduce top-drive sub wear. Adapters intended for top-drive applications include the following features:

- Increased shoulder depths to resist wear and deformation from repeated makes & breaks.
- Bullnose guides to eliminate ‘stabbing’ shoulder damage during make-up.
- All thick-wall adapters will continue to feature male drill rod threads with case-hardening.

MANAGING TOP DRIVE SUB WEAR

Since they wear faster, plan to replace top-drive adapters regularly. The number of makes and breaks achieved will depend on drill rig make-up settings and the type and replenishment of thread compound. Consider using separate adapters for drilling (lower wear rate) from adapters used for tripping rods (higher wear rate).

HOW TO GAUGE SUB FIT WEAR

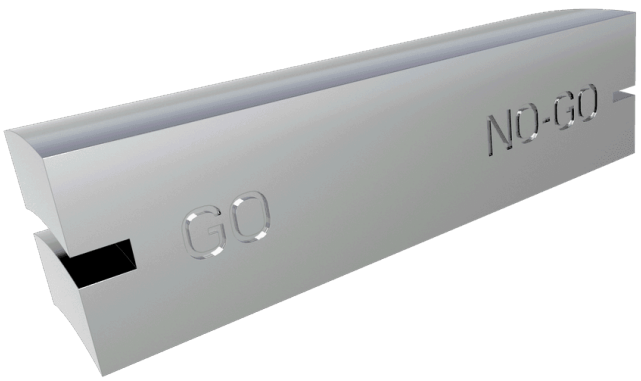
Manually make up a spare locking coupling (or similar unused rod box, coupling, or adapter, made by Boart Longyear) to the top-drive adapter, wrench-snug condition with thread compound applied, and measure or visually confirm that a ‘stand-off’ gap exists at the outer shoulder, approximately 0.4-1.0 mm (0.015" to 0.040"). If no gap, or if the joint feels loose, then replace the adapter. If uncertain, compare to the fit on a spare unused adapter sub, and reassess.

HOW TO GAUGE ADAPTER SHOULDER WEAR

After passing the wrench-snug fit test above, manually wrench the joint to a fully closed position. If the outer shoulder is not fully closed (visible gap) or has significantly worn or deformed (visible change in profile), then replace the adapter. If uncertain, compare to a spare unused adapter sub and reassess.

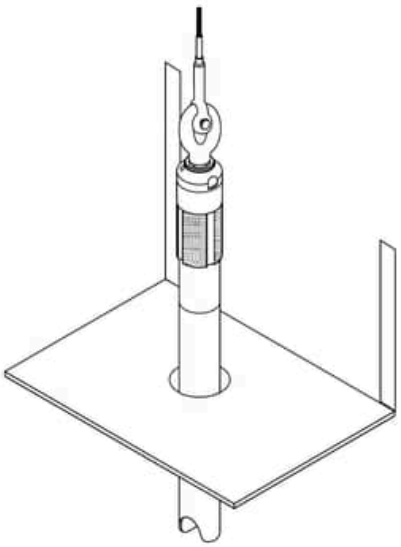
HOW TO GAUGE ADAPTER THREAD WEAR

RQ™ and XQ™ threaded adapters, use the new thread-profile go/no-go gauges to confirm the thread profile is providing performance benefits:



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MAKING AND BREAKING (LOWERING, BREAK-OUT)



LOWERING/INSERTING

The drill drive and hoist sheave must be aligned with the center line of the hole to prevent undue twisting and drag. The drill must also be well secured to the casing, ground or work face to ensure it does not load the rod string or become misaligned.

Adjust hollow spindle drive chucks and rod handling feed rollers to ensure that contact pressure is not permanently deforming or twisting mid-bodies, especially in the case of lightweight rod strings. In order to avoid fracture failures, do not use feed rollers with carbide teeth, do not chuck on rod joints, and do not feed rod joints through feed rollers.

In down-holes, always lower the rod string with the inner tube assembly latched in position. The inner tube assembly will act as a check valve in case the rod string is accidentally dropped.



BREAK-OUT

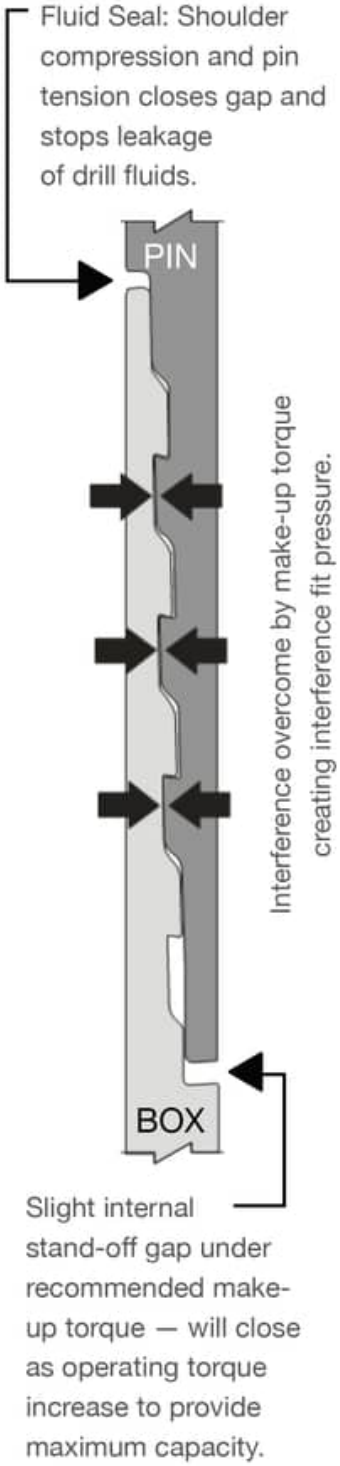
Theory and laboratory tests show that break-out torque should be 70-80% of the greater of make-up or drilling torque applied to each joint. Despite this, breakout may be problematic, as some drill rigs do not have the same load capacity in breakout as they do in make-up or drilling. Additionally, during drilling, the joints may be subject to vibration, allowing incremental make-up. Note that a poor choice of thread compound will contribute to this effect as well. This may result in a break-out torque requirement that exceeds the original make-up applied. This can be overcome by utilizing the same effect by applying a slight percussive blow to the side of the box with a rubber mallet or similar non-damaging tool. Do not use a metal hammer or similarly hard objects. They will affect material properties in the impacted area, potentially cause fatigue failures, and may void the Boart Longyear warranty.

On down-hole applications of significant depth, prior to breaking-out, ensure that the drill rig foot-clamp is holding the rod string weight and that any tension across the joint (between the drill head and foot clamp) has been relieved. This eliminates undue thread wear and a potential safety hazard on deep holes; the pin should not 'jump' out of the box on break-out.

Once the threads have disengaged, the pin can be slowly lifted. Cleaning and re-lubricating is recommended to minimize wear.

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MAKING AND BREAKING (FLUID SEALS)



FLUID SEAL

Conventional and wireline drill rods and casing utilize steel-on-steel interfaces as a fluid seal. Make-up torque is required to load the box end shoulder face against the pin external shoulder face to develop the necessary contact pressure at the mated interface. Given the high elastic modulus of steel, the performance of these seals is very limited regardless of face geometry or heat treatment. As a result, the fluid seal is very sensitive to damage on either shoulder face.

All BLY rods are made with the same material grade, heat treatment (except PHD, which does not have Q&T), and nominal shoulder thicknesses (except PHD, which is thicker). All BLY threads also have modified thread profiles to minimize bulging. As a result of identical material properties and minimum bulging, all BLY have the same damage resistance and fluid sealing capability.

NOTE: Chucking on or applying wrenches to either shoulder will cause leakage.

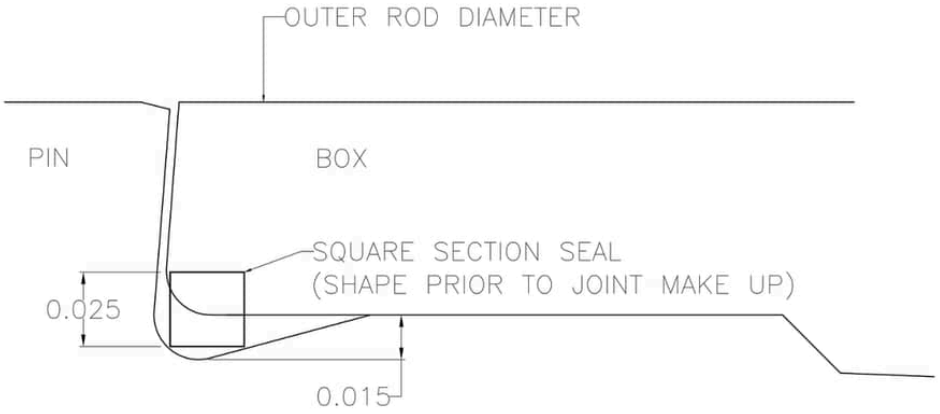
Sealing performance of a rod string in a downhole can be evaluated with a pressure test:

- Drop an inner tube assembly adjusted to zero-bit-gap such that the weight of the column of fluid above the inner tube will create a seal between the core lifter case and the bit.
- Run the fluid supply pump until maximum pressure is achieved and then close the valve between the rod string and pump.
- Monitor the fluid pressure gauge and record any drop in pressure over a time interval. The amount of flow loss can be calculated using standard pressure vessel formula.
- While no drop in pressure should occur on a new string, only a complete loss of pressure in less than one minute is significant.

EXAMPLE:

An 1,800 m (5,900 ft) string of NQ™ rod that loses 14 MPa (200 psi) in one minute is only losing 7 lpm (1.6 gpm), where the minimum recommended flow for an NQ bit is 30 lpm (8 gpm).

ROD SEAL INSTALLATION



Rod Joint Seals

PART #	DESCRIPTION
5008777	SEAL, BRQ/BXQ R/P
3545024	SEAL, NRQ/NXQ R/P
3545025	SEAL, HRQ/HXQ R/P

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CARE AND HANDLING (ROD WEAR)

THREAD WEAR

Wear on sliding steel-on-steel surfaces, such as in a rod or casing joint, commonly referred to as galling, mainly consists of adhesion and abrasion wear resulting from making and breaking contact. While some wear can be tolerated without compromising performance, worn surfaces are prone to further wear. If unattended, the degree of wear can worsen to the point where it can cause premature failure or, in the case of mating surfaces or similar hardness, seize the joint. Additionally, a worn thread can damage a good thread.

The rate of wear to be expected in a sliding metal-to-metal system can only be determined by considering all of the following variables:

- Lubrication
- The hardness of the softer surface
- The distance of contact slide
- The contact load or pressure

Less wear can be achieved by:

- Cleaning and lubricating joints regularly; preferably after every break. Dry lubrication coatings are available but these wear off and must also be cleaned and lubricated.
- Choosing joints with mating surfaces of dissimilar hardness. Published data shows that given equal contact pressures and equal hardness on the softer surfaces, a system with a harder mating surface (dissimilar hardness) can provide several times the wear life.
- Choosing joints with dissimilar hardness and with greater hardness on the softer thread such as on RQ and XQ rod joints.
- Reduce the sliding contact distance by choosing joints with greater taper.
- Reduce the contact pressure by choosing an XQ™ joint with double-start threads.
- Minimize the contact pressure by adjusting the feed rate and rotation speed during make and break to match the thread pitch and compensate for rod and drill head weight.
- Ensure there is light compression during joint make-up. Do not allow tension or excessive rotation speed, as this wears the thread load flank. Tension while partially mated under incorrect make-up or breakout settings will cause a visible burr on the box-thread and will drastically reduce wear life if not corrected. The burr can also create extra stress in the thread, leading to box failure, and insufficient shoulder pre-load, leading to leakage.

Another source of rod joint wear is worn accessories. All threaded accessory equipment, such as Kelly (drive) rods, drive head adapter subs, hoist plugs, water swivels and cross-over adapter subs should be inspected prior to use to ensure they are in good condition. Use only genuine Boart Longyear™ accessories to ensure proper fits and maximum wear life. Boart Longyear tooling and gauging adhere to a high global standard.

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CARE AND HANDLING (ROD WEAR) CONT.

BOX WEAR

In many applications, a drill rod retires due to localized wear resulting from the box deforming out of a 'flush' position.

In Q joints, it is inherent for the box and box end shoulder to elastically deform radially or 'bulge'. This is due to radial and hoop stresses imposed by conventional thread forms, which add to drilling load stresses. This is evident by a thin section in the box shoulder and/or a small polished area on the side of the joint where thread engagement begins. As the wear progresses, the box becomes weaker and the deformation more pronounced, increasing the wear rate. Given sufficient contact pressure and speed, the heat generated between the rod string and casing or hole can cause heat-check cracking, which ultimately appears as an axial crack, typically on the box end.

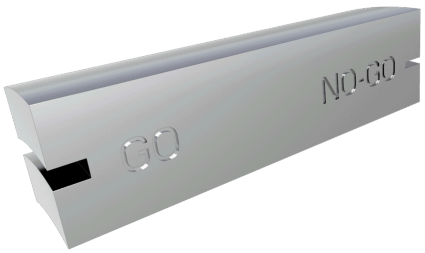
- Check make-up torque to ensure it is at least minimum, but not more than required. Higher make-up torque increase bulging in Q rods.
- Move to RQ joints which mimic the load response of a solid tube in that radial and hoop stresses imposed by the thread subtract from drill load stresses, reducing 'bulging'.
- If already on RQ threads move to XQ threads, whose dual start threads and increased torque capacity reduce box wear even further.

MIDBODY WEAR

All rod strings are unstable and, in response to drilling loads, elastically buckle into a three-dimensional helical shape, a phenomenon first identified and defined by Boart Longyear as 'helical whirling'. As loads or rotation increase, and in deviated drilling applications, the lateral contact pressure between the string and the casing or hole increases, contributing to an increased mid-body wear rate. Do not exceed rod deviation ratings.

The use of 'rod grease' and drilling fluid additives to reduce friction and wear between the rod string and the casing or hole is common; however, the only effective solution to reduce mid-body abrasion wear is to reduce lateral loads, either by changing RPM, reducing weight on bit, or re-cutting hole deviations.

BOX OUTER DIAMETER SHOULDER WEAR GAUGE ORDERING INFORMATION



PART #	DESCRIPTION
3547010	GAUGE, BQ/BRQ/BXQ R/B OD WEAR
3547027	GAUGE, NQ/NRQ/NXQ R/B OD WEAR
3547011	GAUGE, HQ/HRQ/HXQ R/B OD WEAR
5003593	GAUGE, PHD R/B OD WEAR

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CARE AND HANDLING (WEAR GAUGES)

BOX OUTER DIAMETER SHOULDER WEAR GAUGE

The 'box' or female end of the drill rod joint is subject to abrasive wear against the wall of the drill hole. As the shoulder decreases in thickness, the load capacity of the joint is reduced. This 'go/no-go' gauge determines whether a particular portion of the shoulder has retained 60% of its original thickness. The ends of the wear gauge are labeled 'GO' or 'NO-GO'. A curved groove is cut into each end of the gauge with a radius that matches that of the drill rod joint.

Ascertain the portion of the box with the least thickness by visual inspection. A thin section will become pronounced as joints respond to large torque or pullback loads and wear against the hole.

Attempt to insert the thinnest portion of the box shoulder into the 'NO-GO' end of the gauge.

If the box will insert into the gauge, there is less than 60% of the original shoulder thickness remaining. This means that the joint's load capacity has been significantly compromised. The rod should be considered for retirement, and the remainder of the rod string should be inspected.

If the box will not insert into the gauge, there is more than 60% of the shoulder thickness remaining, and the majority of the joint's load capacity is available.

Insert the thinnest portion of the box shoulder into the 'GO' end of the gauge. The amount of radial movement or 'play' will allow the operator to estimate the amount of wear that has taken place or the amount of wear life remaining. If the box shoulder will not insert into the gauge, the box is in a 'new' condition and has greater than nominal thickness due to tubing mill tolerance.

Reverse Flank Thread Wear Gauge



PART #	DESCRIPTION
5008766	GAUGE, BRQ R/B THREAD WEAR
5008852	GAUGE, BXQ R/B THREAD WEAR
5008768	GAUGE, NRQ R/B THREAD WEAR
5008857	GAUGE, NXQ R/B THREAD WEAR
5008770	GAUGE, HRQ R/B THREAD WEAR
5008862	GAUGE, HXQ R/B THREAD WEAR

REVERSE FLANK THREAD WEAR GAUGE

Due to its lesser hardness, the box thread accepts virtually all of the wear when made and broken against the pin thread. During make and break, the box thread should only have contact on the 'root' or minor diameter and on the 'stab' or 'clearance' flank. If the 'load' flank has deformed or worn in error, it may lead to failures. This 'go/no-go' gauge determines whether the load flank portion of the thread form has retained its original shape sufficient to provide its 'RQ™' and 'XQ™' low-stress & anti-bulge features.

- Mate the gauge with the box threads such that the outer diameter shoulders are not in contact.
- Slide the gauge along the threads until the shoulders mate and apply hand pressure to ensure it stays in place.
- Try to pry the gauge off of the threads. If the gauge cannot be removed (without 'unthreading'), the box thread form is intact. This means that the make-and-break setup on the rig is good and the joint has retained full load capacity. If the gauge is removable (without 'unthreading'), the box thread load flank has been deformed. This means the make-and-break setup is incorrect, the joint's load capacity has been reduced, and reverse-flank thread benefits are lost. Correct make and break settings. Consider retirement and inspect the remainder of the rod string.

Checking Size Or Fit

If any concerns arise during make-up either with subs or used rods, the best practice is to use a new rod end to check fit.

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FATIGUE LOADS AND DEVIATED HOLES

FATIGUE LOADS AND DEVIATED HOLES

Fatigue failures are brittle cracks that occur at load levels that are significantly below static ratings; however, the loads are applied or cycled a large number of times. An example everyone can relate to is flexing a paper clip back and forth until it breaks. Due to the reduced cross-sections of material in the threaded ends, the joints between mated rods in the string are significantly weaker than the rod mid-bodies and is the typical location of failure under an excessive cyclic load. Fatigue failures always occur perpendicular to the cyclic load or stress. Therefore the most common failure is a circumferentially oriented crack which indicates that the cyclic load or stress was axially oriented, caused by twisting.

This type of load occurs when drilling in a deviated hole, where the surface of the rod undergoes both tension and compression in each revolution. In steel materials, there is a well defined stress limit below which it should not fail. Deviation guidelines are developed to keep the rods below this limit, though they do not consider depth and torque. Fatigue failures can be avoided by limiting the level of cyclic loads in consideration of the pullback load. As stiffness varies with rod size follow the deviation guidelines in the table below. If Dog Leg Severity (DLS) is not provided with survey results, it can be calculated using formula in the illustration below. It is not the dip and azimuth added together.

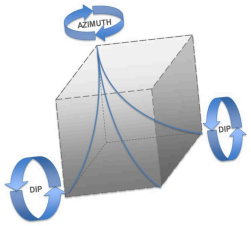
DEVIATION GUIDELINES

Maximum Degrees Per Rod Length*

SIZE	DEGREE
B SuperQ / BXQ / BRQ / BRQTK	1.5 deg
N SuperQ / NXQ W-WALL / NRQ	1.0 deg
H SuperQ / HXQ W-WALL / HRQ	0.8 deg
HQ / PHD / PHD W-WALL	Not Recommended

***Reduce deviation for excessive pullback applications, i.e. deep-holes**

- Limit the build angle or rate of hole deviations, checking that the deviation rating per rod length is not exceeded, rather than the deviation per 30 m (100 ft).
- Deviation should be further limited with increasing hole depth.
- Re-cut or ream out any sections that exceed deviation or add significant torque.
- Place bends as close to bottom as possible to limit stress.
- Lubricate rods to minimize friction and torque.
- Check rods for polishing; retire any rods worn thin or showing fine cracks (heat-check cracking).



The twisting of the rod string in 3D space, or the angle between two survey points. More precisely, it is the angle between the two tangent vectors at those points. The formula below provides reasonable results:

Dogleg angle = cos-1 [cos(azimuth change) sin(final dip) sin(initial dip) + cos(final dip) cos(initial dip)]

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ROD MID-BODY TWISTING

Mid-body twisting (aka bending) has occurred since the development of the coring rod and is not a quality defect. Modeling, testing, and experience have shown that all rod strings are unstable and elastically buckle into a helical shape under normal loading. Whether the rod returns to straight or permanently twists depends on several variables that are difficult to predict.

Work done in the early 2000's sought to improve resistance to rod twisting. Benchmarking tests, confirmed by neutron diffraction, showed that residual stress induced by roll-rod straightening during tube manufacture reduced twisting resistance. As a result, we developed new annealing processes and validation test equipment to minimize residual stress. Once the optimal annealing process was developed, twisting resistance improved significantly.

Twisted mid-bodies result from complex dynamic loading, at least in part due to natural harmonics, similar to breaking wine glasses with sound. A driller will not directly observe the twisted helical shape; instead, he will notice increased vibration and torque (the helical shape can sometimes be revealed in video recordings).

Note: excessive rod handling using universal V-shaped rollers has been shown to reduce mid-body strength, leading to permanent deformation of the rod-string into a “corkscrew” or “augur”, known as “twisting”. Twisted rods increase drilling torque, borehole friction, and wear rates, leading to heat-check cracking. W-Wall & V-Wall rods are not recommended for rod-handlers with straight or ‘V’ profile feed rollers, due to their thinner walls.

We used both computer modeling and field tests to identify the factors influencing rod twisting. As part of these tests, we tested special super high-strength prototypes alongside normal rods and rods without annealing to see whether they could withstand a twisting event. Under dynamic loading, all the rods twisted, and poorly annealed rods twisted more. Rod string dynamics are severe enough that it will always be possible to twist drill rod. The important variables are as follows:

- **RPM:** Higher rotation speed (higher energy) makes it easier to twist rods, but rods can still twist at lower speed. Speed adjustments can have a significant influence by avoiding harmonic resonance of the rod string, which changes the hole depth. In one example, adjusting rod rotation only 50 RPM has been shown to reduce torsional vibration by a factor of five.
- **Drilling Fluid:** Drilling fluids dampen vibration. Instances of lost circulation increase vibration and sidewall friction, both of which increase the likelihood of a twisting event.
- **Hole Angle:** Increases in hole angle generate more side wall friction, increasing the likelihood of a twisting event.
- **Hole Clearance:** Running oversize bits or using large-diameter casing allows space for a larger corkscrew to form and increases the likelihood of a twisting event.
- **Trajectory:** Changes in dip and azimuth ('dog legs') greatly contribute to rod friction and stress.
  For example, deviations exceeding 1 degree per rod length (10 degrees in 30 m) can produce side wall friction sufficient to trigger a twisting event and fatigue loading sufficient to cause fatigue failure. Do not exceed guidelines.

Minor improvements to drilling methods can reduce likelihood of mid-body twisting:

- Minimize drill rod friction, e.g. fluid circulation with additives, greased rod string, etc.
- Monitor and minimize vibration by adjusting speed up or down when encountering harmonic resonance (very important).
- Minimize and monitor deviation, in both dip and azimuth, and correct when necessary.

While it is common to accurately control dip as the primary way to stay on target, azimuth change also plays an important role in deviation. Directional stability can be increased by adopting use of full-hole outer tubes, free-cutting bit formulas, taller crown bits such as Stage™ bits, and dual length shells. Once a severe dog leg is cut, there may not be any prevention of twisting without corrective reaming or changing hole direction.

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ROD MID-BODY TWISTING (CONT.)

ROD MID-BODY TWISTING

When increasing torque and vibration is observed, and does not go away with changes in parameters, it is likely some rods are permanently bent. The string needs to be checked and any twisted rods removed to prevent further twisting and getting stuck in the hole. Assuming there is no other damage, like fatigue cracks, twisted rods can be returned to original performance by straightening.

Drill Rod Straightening Procedure Equipment Requirements: Hydraulic Press, 1 Set Of Rollers; Dial Indicator With Magnetic Base.

- Mark the mid-point of a 3m drill rod with a marking pen and position the rod into the hydraulic press so that the mid-point is directly below the hydraulic ram. The rod should be supported by the rollers, which should be spaced so that they are close to the either side of the hydraulic
  press frame.
- Locate the dial indicator so that the measuring probe is on the middle of the drill rod adjacent to the marking.
- Rotate the rod by hand to locate the high spot. Typically one revolution of the needle on the dial gauge is 1mm. The high spot is then marked and positioned directly below the hydraulic ram.
- Down on the center of the rod to deflect the rod downwards and in the opposite direction of the bend. Some trial and error is necessary to determine how much reverse bending is necessary to straighten the rod. Try bending in increments of approximately 5mm to begin with. After straightening a few rods, a pattern will develop showing how much force is necessary to straighten.
- After one deflection, release the hydraulic pressure and rotate the rod, using the dial indicator to see how much of the bend has been removed. Aim for a run-out of 1 mm in a 2m span or less, which is approximately the allowable tolerance of a new rod. If the run-out is still higher, repeat the pressing procedure whilst applying additional downwards force.

This procedure straightens the middle section of the drill rod only, which is usually where the majority of bending occurs and which is the easiest to remove. Rods can normally be returned to satisfactory use after performing this straightening procedure.



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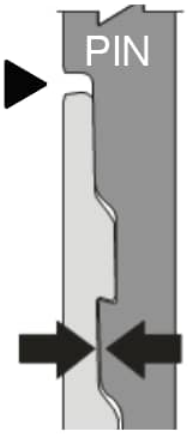
TROUBLESHOOTING



STAND-OFF GAP

Proper use and handling of coring rods in the field leads to lower rod and operational costs in the long run. Rods are typically only 3% of total drilling costs, whereas fishing a dropped string for one week would represent a 2% increase in operating costs. Re-drilling a hole for one month would result in a 9% increase of operating costs.

STAND-OFF GAP EXCESSIVE OR DOES NOT CLOSE UPON MINIMAL MAKE-UP OR DIFFICULTY BREAKING OUT.



Potential Causes and Corrective Actions

- Clean and inspect threads for excessive foreign or wear debris. Accelerated wear may be due to damaged accessories; inspect accessories (e.g. adapter subs).
- Rods are of different manufacture. Separate all rods by manufacturer and do not interchange RQ™ style joints, Boart Longyear's exacting design and fit of wirelines rod joints is held proprietary. Also, patented XQ™ rod joints are only offered by Boart Longyear.
- Hand tools should be sufficient to close the stand-off gap. Use hydraulic tools, such as a drill chuck or head to apply the minimum make-up torque required.
- Threads are excessively worn or deformed from poor set-up for make or break, or from overload. Inspect string for damage and discard rods with deformed threads. Overload or difficult breaking may be due to poor choice of thread compound (see lubrication and cleaning and break-out).
- Deformation due to hammering damage (see break-out) or stabbing damage (see stabbing). Inspect string and discard damaged rods.

Check the stand-off gap by tightening the joint to 30 ft-lbs. The gap should fall within the measurements listed in the table below.

Wrench Standoff Gap table:
- Q/SuperQ: 0.031 to 0.072
- RQ: 0.030 to 0.060
- XQ: 0.040 to 0.080

Note: Subs, due to their thick-wall construction and high stiffness, will have half the standoff gap listed above when brand new. For used subs, use the finger gauges to assess thread wear, as standoff gap is not a predictable measure of wear.

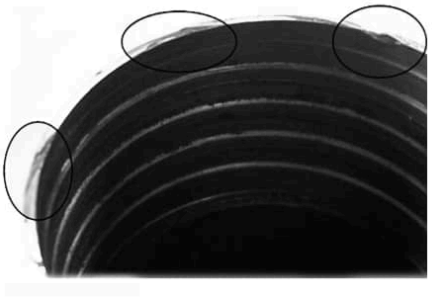
If no stand-off gap can be observed and no interference fit noted then rods will be prone to inertial separation during drilling operations. This "auto-breaking" or rod joint separation during drill string deceleration can lead dropped strings and catastrophic rod failures at the top of the hole.

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LEAKAGE

LEAKAGE





Potential Causes and Corrective Actions

- Rods run in loose (joints not closed) due to insufficient make-up or to excessive stand-off gap (see causes of excessive stand-off above).
- The pin or box outer diameter shoulder face has stabbing or handling damage.
- Outer shoulder contact pressure distribution is uneven due to poor fit. Threads are significantly worn or deformed from overload or excessive load during make and break or shoulders are deformed from overload. Overload may be due to poor choice of thread compound.
- Box wear life exceeded. Inspect string for excessive wear. Consider upgrading to XQ™ rods.
- Rods are of different manufacture. Separate all rods by manufacturer and do not interchange. RQ™ style joints, Boart Longyear's exacting design and fit of wireline rod joints is held proprietary. Also, patented XQ™ rod joints are only offered by Boart Longyear.

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FATIGUE FAILURES OR CRACKED PINS OR BOXES

FATIGUE FAILURES OR CRACKED PINS OR BOXES

Potential Causes and Corrective Actions

- Bend stresses have exceeded the fatigue strength of the joint. Bend stresses are caused by excessive steering, excessive hole deviations, caves, or helical whirling. Do not exceed deviation ratings. This may have been compounded by high pullback loads at depth or excessive make-up. Plan deviations to occur at portions of the string that are under low pullback (e.g. avoid the upper portion of a deep hole string). Fatigue strength may have been exceeded in previous application and joint cumulative fatigue damage has reached limit. Consider upgrading to XQ™ joints for higher load capacity or consider lightweight rods for reduced stiffness.
- Extraneous hoop stresses caused by deformation due to hammering damage, stabbing damage, excessive foreign debris, or wear debris in the joint.
- Box shoulder deformed due to overload leaving pin or box unsupported. Overload may be due to poor choice of thread compound. Consider upgrading to XQ™ rods.
- Top drive adapter sub pin shoulder and thread deformed leading to cracked boxes. Replace sub and inspect rod for water leakage and box cracks.
- Rod string has suffered stress corrosion cracking, or hydrogen embrittlement. Replace suspect rods, correct excessive hole deviations, and address corrosive agents in drilling fluid.
- Rods are of different manufacture. Separate all rods by manufacturer and do not interchange. RQ™ style joints are Boart Longyear's exacting design and fit of wireline rod joints is help proprietary. Also, patented XQ™ rods are only offered by Boart Longyear.



PIN FATIGUE



BOX FATIGUE

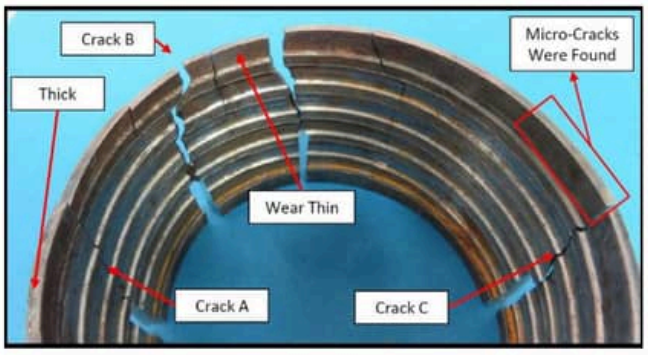
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PREMATURE BOX END CRACKING/HEAT-CHECKING CRACKING

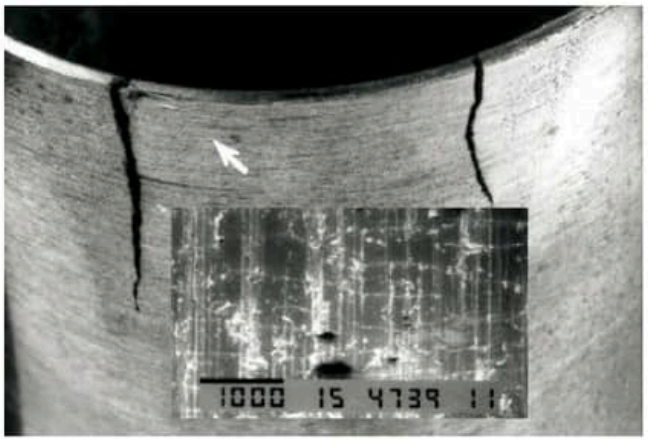
PREMATURE BOX END CRACKING/HEAT-CHECKING CRACKING

Potential Causes and Corrective Actions

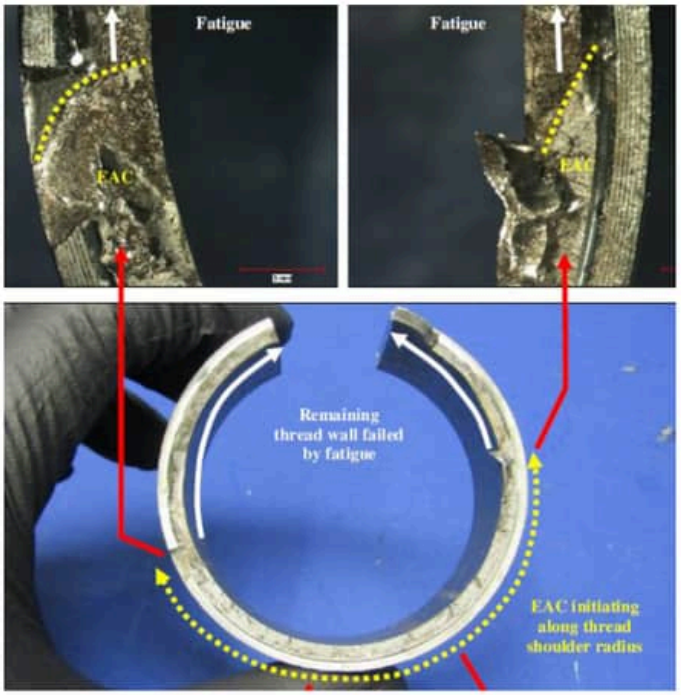
- Axial cracks at the box end due to a hardened, brittle surface layer formed while drilling. This thin surface layer is caused by cyclic friction. Microstructural changes are caused by cyclic friction between the rotating string and the case or hole wall and are independent of tubing type, steel grade, and/or applied heat treatments. Often associated with a bright, polished area and thin cross-section on the box end. Reduce drilling loads and/or pullback, or improve lubrication of the string to compensate. Inspect box end with the shoulder wear gauge and cull out worn rods before heat-check cracking occurs. If helical polishing is present along the rod, take steps to reduce twisting, such as adjusting RPM (see rod twisting).
- Stress corrosion, either by itself or combined with heat-check cracking, can cause rods to fail early in life. Corrosion can be caused by fluid pH (acidic or basic), salt content (brine), high temperature, chlorine, fluorine, or sulfides. Contact chemical/mud supplier to manage corrosive conditions.
- Box shoulder deformed due to overload leaving pin or box unsupported. Overload may be due to poor choice of thread compound. Consider upgrading to XQ™ rods.
- Top drive adapter sub pin shoulder and thread deformed leading to cracked boxes. Replace sub and inspect rod for water leakage and box cracks.
- Rod string has suffered stress corrosion cracking, or hydrogen embrittlement. Replace suspect rods, correct excessive hole deviations, and address corrosive agents in drilling fluid.
- Rods are of different manufacture. Separate all rods by manufacturer and do not interchange. RQ™ style joints are Boart Longyear's exacting design and fit of wireline rod joints is help proprietary. Also, patented XQ™ rods are only offered by Boart Longyear.



HEAT CHECK CRACKING - WORN THIN



HEAT CHECK CRACKING



STRESS CORROSION

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THREAD WEAR OR GALLING

THREAD WEAR OR GALLING

Thread galling occurs when material adheres to the mating surface and is pulled away. This is a function of the material, the hardness, and the same material creates the worst condition for galling. To help prevent galling and wear, Boart Longyear case-hardens all of its rod pins, making them much harder than the box threads.

Potential Causes and Corrective Actions

- The thread compound has failed to prevent mating thread surfaces from interacting. This is due to either a poor or diluted compound or poor lubrication practice. Upgrade the thread compound or increase the frequency of cleaning and re-lubing joints.
- Thread contact pressure during make or break is excessive. To address thread stab flank wear, reduce feed rate/pressure and/or increase rotation during make and break. To address thread load flank wear, increase feed rate and/or reduce rotation during make and break. Rods with significant load flank wear should be discarded.
- Thread sliding contact is excessive (e.g., too much drag during make/break turns), or frequent jamming or cross-threading. Consider upgrading to XQ™ style joints.
- Accelerated wear may be due to damaged accessories; inspect accessories for damage or wear (e.g. adapter subs).
- Thread wear life exceeded. Accelerated wear may be due to damaged accessories; inspect accessories (e.g. adapter subs). Inspect string for excessive wear.
- Consider upgrading to XQ™ rods. XQ™ joints have double-start threads with patented self-starting, self-aligning geometry for easy, automatic make-up. XQ™ joints balance loads and wear across the joint for maximum wear life and load strength. XQ™ threads typically last for 2x RQ™ and 3x Q™ thread make-and-breaks.



BOX THREAD GALLING



PIN THREAD GALLING

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EXTERNAL SHOULDER WEAR, MID-BODY WEAR, MID-BODY FATIGUE FAILURES



PIN SHOULDER AND PIN END FLARED DUE TO OVERLOAD



MID-BODY WEAR





FATIGUE



FATIGUE - SPIRAL DUE TO TORQUE



FATIGUE - T SHAPE DUE TO EXCESS CLAMP LOAD

EXTERNAL SHOULDER WEAR OR EXTERNAL SHOULDER FLARED/ROLLED OVER

Potential Causes and Corrective Actions

- Box shoulder flared and/or pin outer shoulder rolled over due to overload. Overload may be due to poor choice of thread compound. Consider upgrading to XQ™joints.
- Box shoulder wear life exceeded. Inspect string for excessive wear. Consider upgrading to XQ rods.

MID-BODY WEAR

Potential Causes and Corrective Actions

- Hole deviations (e.g. rotary drilled holes, wedging, or down-hole monitoring) induce increased contact pressure and friction between string and hole or casing wall. Improve lubrication of string to compensate.
- Hole has oversized or 'cave' sections allowing the string to elastically twist or buckle under load increasing contact pressure and friction. Reduce drilling loads or rotation speed to compensate or repair hole.
- High pullback or thrust load combined with high rotation speed has caused the string to elastically or permanently twist, increasing contact pressure and friction against the hole or casing wall. Evident by polished or heavy wear on one side of string in a slow spiral patter (e.g. spiral has a multiple length pitch). Reduce drilling loads and/or pullback.

MID-BODY FATIGUE FAILURES

Potential Causes and Corrective Actions

- Accumulated surface damage from rod handling with excessive gripping pressure, combined with cyclic loading leads to fatigue cracking. Care should be taken when handling rods to prevent damage. Rods with gripper tooth damage deeper than 1/32" or 0.8 mm should be retired.
- Loads are highest on devices with a single pair of opposed actuators. If a characteristic T shaped crack occurs, check rod handlers, foot clamps and chucks for excess clamping pressure.

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ROD TWISTING (AKA BENDING) OR HIGH TORQUE AND VIBRATION

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The drill string has permanently bent or twisted into a spiral shape, increasing contact pressure and friction against the hole or casing wall. Evident by increased vibration and torque in the hole. Rods show polishing or heavy wear on one side of string in a slow spiral pattern (e.g. spiral pattern completes a full revolution over typically four rod lengths).

The following factors can contribute to rod twisting:

- Higher RPM increase likelihood to twist, reduce speed to reduce energy.
- A lack of lubrication since fluid dampens vibration and reduces friction to prevent twisting. Grout hole to recover circulation and/or grease rods.
- Increasing hole angle increases friction in the hole.
- Larger Annulus, larger size casing or oversize bits create more space for rods to twist.
- Dog leg severity or rapid change in direction. Even 10 degrees in 20 m approaches rod strength limit. Stay within deviation guidelines and place cuts towards bottom of hole if possible.
- Rod twisting is a resonance or dynamic event, so minimizing vibration by adjusting speed up or down by as little as 50 RPM can reduce the chance of rod twisting. Note vibration level and change speed to minimize vibration by avoiding natural frequency.



TWISTED RODS

WARNING If using a kelly rod, start rotation slowly. Any bend or twist in the rod will be observed as wobble. If rob wobbles or rotates unevenly, stop, chuck lower on rod and if necessary replace kelly rod. Drilling at full speed with wobbling rod will lead to catastrophic bending, rod failure and potential injury.

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GLOSSARY



GLOSSARY OF TERMS

Adhesion Wear

This type of wear involves the adhesion (micro-bonding or micro-welding) of very small areas between the contacting surfaces of mating threads with similar hardness. The bonded areas can fracture off, generating wear particles, or transfer to the mating surface. Wear particles can then bond together and grow in size, producing larger scale wear. In the extreme case, adhesion wear can seize a joint. The rate of adhesion wear decreases as the surface hardness and hardness difference between contacting surfaces increases. Adhesion wear will not occur if the thread compound prevents contact of the surfaces.

Abrasion Wear

This type of wear involves gouging and polishing of a surface by wear particles or foreign debris. Wear particles are either repelled or embedded into the subject surface but do not build or micro-weld avoiding joint seizure. The rate of abrasion wear is directly proportional to the contact pressure and the sliding distance between the mating surfaces. The rate of abrasion wear decreases as the surface hardness increases. Also, the rate of wear is less between mating thread surfaces of differing hardness. Abrasion wear will not occur if the thread compound prevents contact of the surfaces.

Dog Leg

A dog leg refers to the total deviation along a length of the hole that includes both the change in azimuth or direction, and inclination or dip. Excessive deviations produce high lateral loads and fatigue loads which can result in fatigue failure, heat-check cracking, or twisting rod mid-bodies. Furthermore, multiple oblique or corrective dog legs increase these loads. It is recommended that deviations are limited (less than one degree per rod length) and oblique dog legs eliminated. Calculate Dog leg as follows: Dog leg angle = cos-1 [cos(azimuth change) sin(final dip) sin(initial dip) + cos(final dip) cos(initial dip)]

Fatigue

Fatigue damage is cumulative. All steels have a limit to the number of applications or reversals of an excessive repeating load which is commonly referred to as memory. For example, a rod may successfully complete one demanding application and then fail in a future, less demanding application when the limit is finally exceeded with only a few more cycles of excessive load. The generally accepted limit for steels to an excessive repeating or alternating load is three million cycles. At 500 RPM, this is 100 hours of drilling which could easily traverse more than one job where the excessive loading is not continuous (larger sizes are more prone to fatigue failures as they have inherently higher twisting stresses). Fatigue failures can be caused by an excessive load that fluctuates due to rotation (e.g. a twisting load, a hoop stress due to large foreign debris particles, stabbing damage, etc).

Fretting

Small relative cyclic movement between two surfaces in contact. Fretting produces pitting wear (a form of adhesion wear) which can lead to fatigue failures. The wear rate increases with amplitude but not with frequency.

Galling

Large scale (visual) damage to both mating thread surfaces in a joint caused by small areas of plastic deformation (adhesions or transfers, see adhesion wear) that interfere with sliding which can lead to seizure. Galling resistance is a function of the mating surfaces, not of a single surface, and is typically not seen on Boart Longyear™ drill rods.

Heat Check Cracking

This is axial cracking (crack works from the outside surface in) resulting from the rapid expansion of a thin layer of brittle surface material that was hardened by the heat of friction (e.g. rods rubbing on casing or hold) and then rapidly quenched by drilling fluid and the cooler material underneath. Axial cracks typically form on box ends that bulge, due to drilling loads, and suffer accelerated abrasion wear. It is recommended to inspect rod strings for visibly polished box ends as this indicates excessive torque and lateral loading due to hole deviations or similar application extremes.

Inertia

The force developed by the momentum of a moving or rotating mass (such as rotating rod string or a drill head) which resists acceleration or deceleration.

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GLOSSARY OF TERMS (CONT.)

Inertial Torque

Inertial torque is make-up induced when the joint of an added rod is fully made up and stops abruptly against the inertia of the rotating drill head.

Joint Load Efficiency

This is a measure of how much load a joint can carry, as compared to the mid-body. Inversely, this is a measure of how much more stress is created in the joint by a load, as compared to the mid-body. Consider that about half of the rod tubing wall thickness or section is removed when cutting a threaded joint, which means a loss of half the strength. Also, all traditional threads create additional stress (less strength) due to poor choice of geometry. For example, the Q™ joints are 30% load efficient which means there is only a third of the load capacity of the full section of tube, or 3x the stress than that created in a full section of tube. The HD threads have a better choice of geometry improving load efficiency to 40%, producing only 2.5x the stress under load. Ultimately, the engineered RQ™ and XQ™ joints actually mimic the load response of a solid tube and provide 50% load efficiency which is half the strength of a solid tube, or only 2x the stress under load.

Joint Seizure

Mating thread surfaces are not able to move relative to each other as a result of increased friction due to galling or adhesion wear (local solid-state welding, 'micro-welding') potentially preventing break-out of a joint. Typically not seen on Boart Longyear joints with differing mating surface hardness.

Spin Outs

Sudden break-out of joints due to the inertia of a rotating rod string under deceleration.

Stress

Stress is the material response to a load. Stress causes steel to deform elastically (strain) up to the yield strength, beyond which deformation is permanent. In a drill rod, there are three components or directions of stress:

- Axial Stress
- Hoop Stress
- Radial Stress

These components add together according to vector addition to a total stress value known as the principle or Von-Mises stress.

The axial stress is directed parallel to the rod longitudinal axis and is a direct result of drilling or twist loads.

The hoop stress is directed circumferentially around the tube and perpendicular to the rod axis. In a rod joint, hoop stress is induced by the thread form and adds to the total stress - except to RQ™and XQ™style joints which reduce the total stress - mimicking the mid-body.

The radial stress is directed radially inwards or outwards from the rod longitudinal axis and is typically not significant, except under extraordinarily high fluid pressures.

Stress Corrosion & Hydrogen Embrittlement

Given a stress level due to normal drilling loads, corrosive agents in the drilling fluid will chemically reduce material resistance to crack propagation dramatically. Underground operations exposed to mine water are often subject to stress corrosion in addition to generally accelerated corrosion. Stress Corrosion processes often involve hydrogen. Hydrogen has damaging effects on all metals, including reduction of fatigue strength, enhancement of crack propagation and corrosion cracking. Hydrogen may be encountered in the hole, or may be created by reactions with acidic fluids in the hole or generated by corrosion. The absorption of hydrogen in metals is enhanced by sulphide-bearing waters (H2S) and by drilling fluid acidity. Regular monitoring of drilling fluid pH levels is recommended.

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Warranty

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