



SONIC TOOLING

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Full Face Sonic Core Barrel Bit

TABLE OF CONTENTS

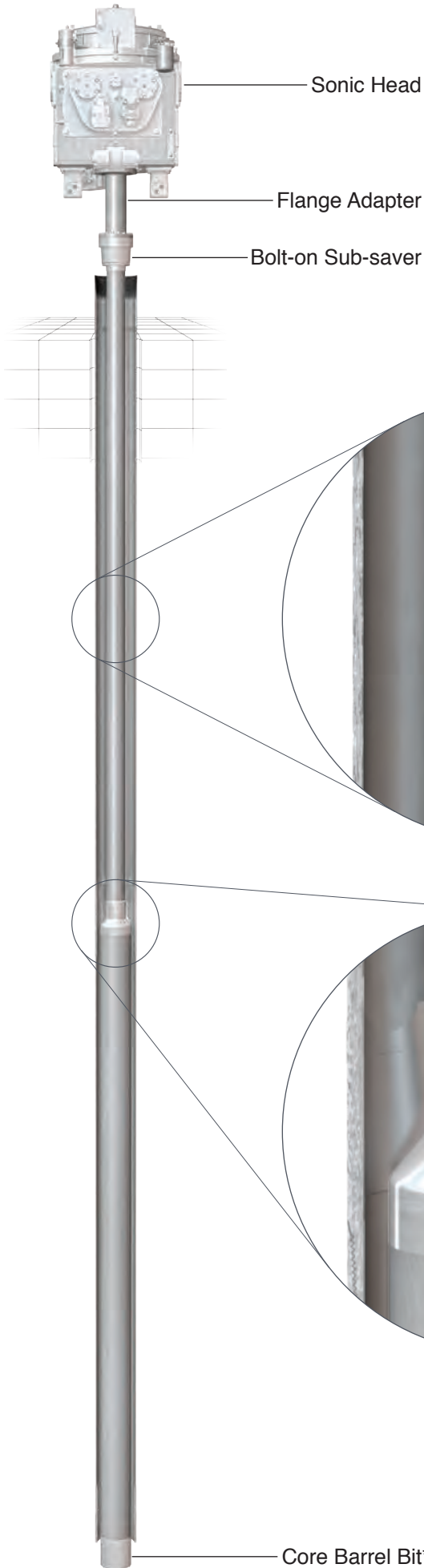
| | |
|-------------------------------------|-----------|
| Sonic System | 3 |
| Sonic System Diagrams | 4 |
| How Sonic Works | 6 |
| Sonic Drilling Procedure | 6 |
| Benefits of Sonic | 7 |
| Bits and Casing Shoes | 9 |
| Core Size Selection Guide | 10 |
| Dimensions | 12 |
| Core Barrel Bits | 14 |
| Casing Shoes | 16 |
| Rods, Core Barrel and Casing | 19 |
| Drill rod | 20 |
| Core Barrel | 22 |
| Casing | 24 |
| Accessories | 27 |
| Flange Assemblies | 28 |
| Casing Plug/Ring | 30 |
| Cross-over Subs | 30 |
| Adapters | 31 |
| Sub-savers | 32 |
| Retrieving Tools | 33 |
| Miscellaneous | 35 |
| Lexan Soil Sampler | 36 |
| Rod/Casing Handling Systems | 37 |
| Discrete Point Samplers | 39 |
| Miscellaneous Tooling | 40 |
| Consumables | 40 |
| Applications | 41 |
| Stabbing | 42 |
| Make-up | 42 |
| Pre-loading | 42 |
| Thread Break-In | 43 |
| Break-out/Fluid Seal | 44 |
| Wear and Care | 47 |
| Lubrication & Cleaning | 48 |
| Transit and Storage | 48 |
| Thread Wear | 49 |
| Loads and Deviated Holes | 50 |
| Serialization/Lot Code | 50 |
| Warranty | 52 |
| Contact Information | 54 |

| | |
|------------------------------|----|
| Sonic System | 3 |
| Bits and Casing Shoes | 9 |
| Rods, Core Barrel and Casing | 19 |
| Accessories | 27 |
| Miscellaneous | 35 |
| Applications | 41 |
| Wear and Care | 47 |
| Warranty | 52 |
| Contact Information | 54 |



SONIC SYSTEM

| | |
|--------------------------|---|
| Sonic System Diagrams | 4 |
| How Sonic Works | 6 |
| Sonic Drilling Procedure | 6 |
| Benefits of Sonic | 7 |



TOOLING (CORE BARREL ADVANCEMENT)

During typical core barrel advancement, the core barrel is advanced 10 ft (3.05 m) using sonic frequencies. After the core barrel is in place, casing is sonically advanced over the core barrel. The core barrel is retrieved, producing a relatively undisturbed sample.

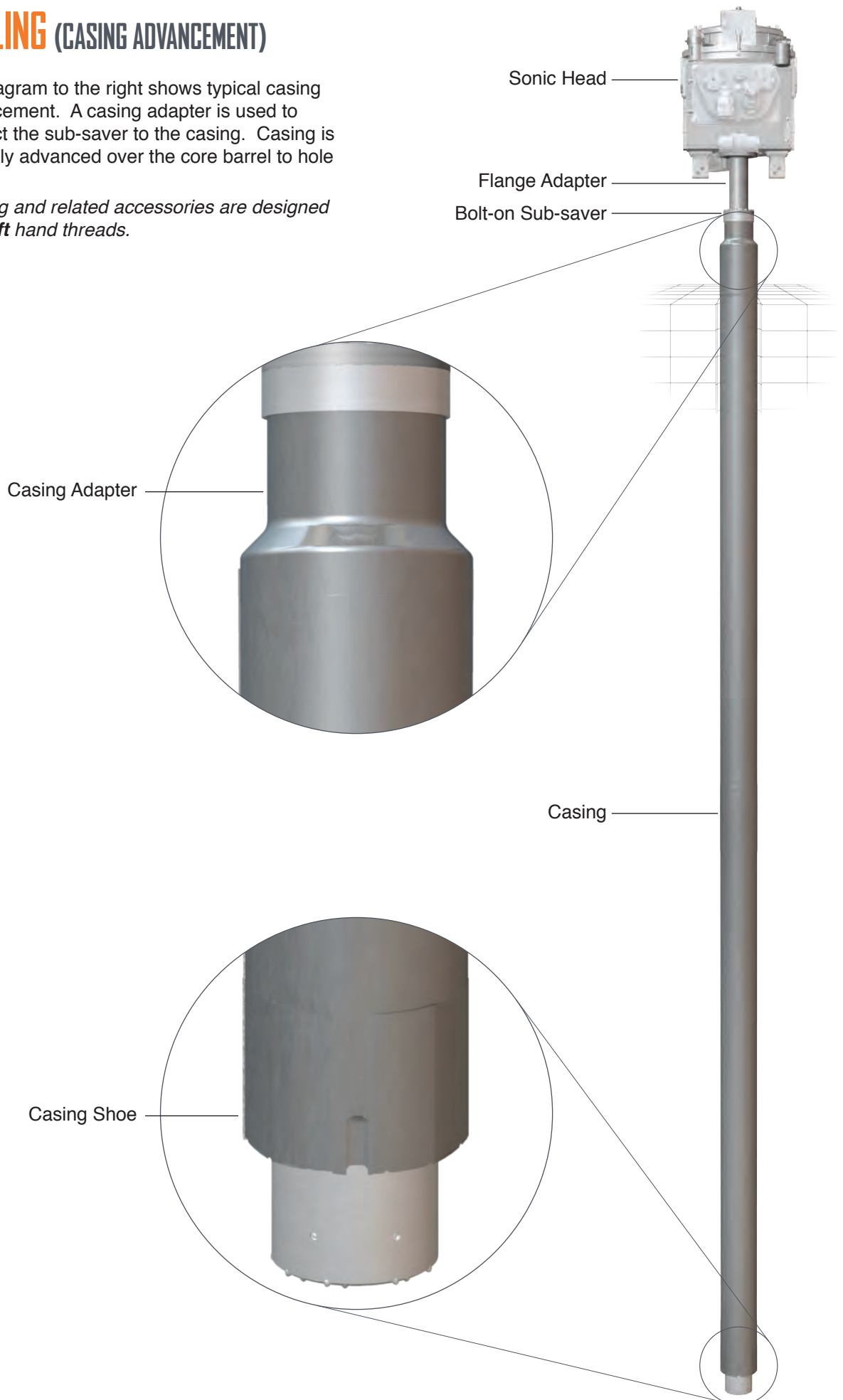
Drill rod, core barrels and related accessories are designed with **right hand threads.*

***Core Size is determined by inner diameter of bit.*

TOOLING (CASING ADVANCEMENT)

The diagram to the right shows typical casing advancement. A casing adapter is used to connect the sub-saver to the casing. Casing is sonically advanced over the core barrel to hole depth.

Casing and related accessories are designed with **left hand threads.*



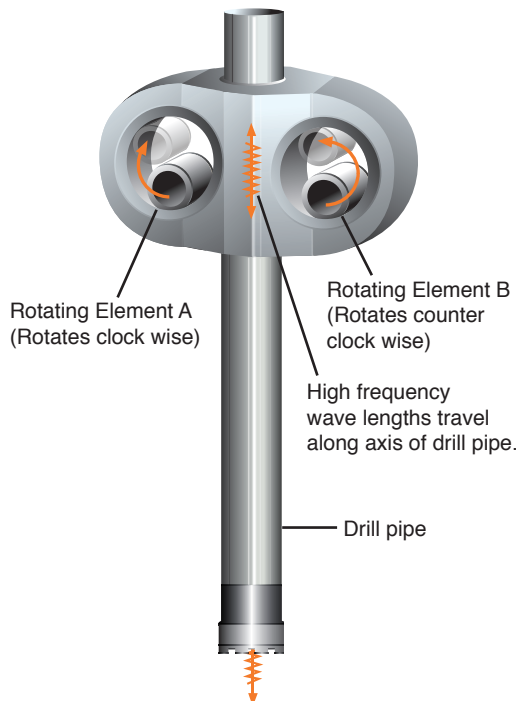
HOW SONIC DRILLING WORKS

Sonic is an advanced form of drilling which employs the use of high-frequency, resonant energy generated inside the Sonic head to advance a core barrel or casing into subsurface formations. During drilling, the resonant energy is transferred down the drill string to the bit face at various Sonic frequencies. Simultaneously rotating the drill string evenly distributes the energy and impact at the bit face.

The resonant energy is generated inside the Sonic head by two counter-rotating weights. A pneumatic isolation system inside the Sonic head prevents the resonant energy from transmitting to the drill rig and preferentially directs the energy down the drill string.

The driller controls the resonant energy generated by the Sonic head's oscillator to match the formation being encountered to achieve maximum drilling productivity. When the resonant Sonic energy coincides with the natural frequency of the drill string, resonance occurs. This results in the maximum amount of energy being delivered to the face. At the same time, friction of the soil immediately adjacent to the entire drill string is substantially minimized, resulting in fast penetration rates.

SONIC OSCILLATOR DIAGRAM

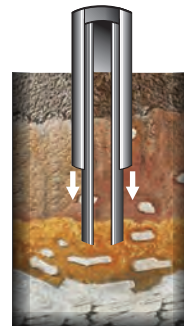


SONIC DRILLING PROCEDURE

While there are several ways to drill using Sonic (depending upon site-specific conditions and project objectives), the most common means involves advancing a core barrel, which is overridden by a larger diameter drill string that cases the open bore hole and prevents collapse.

STEP 1 - CORE BARREL ADVANCEMENT

The core barrel is advanced using sonic frequencies. When necessary this step can be performed using no fluids, air, or mud.



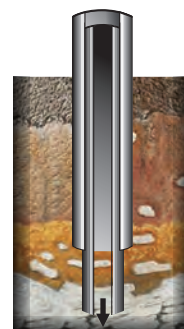
STEP 2 - CASING OVERRIDE

After the core barrel is in place, casing is sonically advanced over the core barrel, protecting the bore hole's integrity in loose unconsolidated ground.



STEP 3 - CORE RETRIEVAL

The core barrel is retrieved, producing a relatively undisturbed sample with near 100% core recovery.



STEP 4 - REPEAT CORE ADVANCEMENT

Steps 1 - 3 are repeated to depth, producing a continuous core sample through unconsolidated formations with less than 1% deviation.



BENEFITS OF SONIC

< 1%
DRILL
DEVIATION

Superior Information

Sonic drilling provides a continuous, relatively undisturbed core sample of unparalleled quality and accuracy through any type of formation. With less than 1% drilling deviation, drillers know exactly where a sample is coming from.

80%
REDUCED
WASTE

Waste Reduction

Sonic drilling reduces waste by up to 80% relative to conventional methods, reducing the expensive disposal of contaminated waste.

UP TO 2x
FASTER

Performance

Sonic drilling is up to twice as fast as conventional overburden sampling methods.

Superior Well Construction

Sonic drilling causes minimal disturbance to the surrounding bore hole wall, resulting in more efficient well development and performance.

Flexibility

Sonic drilling advances a temporary outer casing as the bore hole is drilled, allowing more to be achieved within a single bore hole.

Risk Minimization

Sonic drilling greatly reduces the risk of project failure due to unknown or difficult subsurface conditions.



BITS AND SHOES

Boart Longyear's core barrel bits and casing shoes use high-grade tungsten carbide inserts and premium steel for increased strength and toughness. Boart Longyear's state-of-the-art manufacturing techniques and facilities, coupled with its stringent quality control ensure each product produced meets the highest standard of quality.

| | |
|---------------------------|----|
| Core Size Selection Guide | 10 |
| Dimensions | 12 |
| Core Barrel Bits | 14 |
| Casing Shoes | 16 |

CORE SIZE SELECTION GUIDE

How Core Size is Determined

Core sample size is determined by the inner diameter of the core barrel bit. The bit diameter subsequently determines the core barrel diameter. Outer-hole diameter is determined by casing size.

Core Size Selection Guide

| Core Size | Core Barrel Bit Size | | | | | | | |
|---------------------|----------------------|----------------------|-----------------------|--------------------|--------------------|--------------------|--------------------|-----------------------|
| | 3.75 in (95.3 mm) | 4.5 in (114.3 mm) | 4.75 in (120.7 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) | 9 in (228.6 mm) | 10.5 in (266.7 mm) |
| 3 in (76.4 mm) | ● | | | | | | | |
| 3.5 in (90.2 mm) | | ● | | | | | | |
| 4 in (97.9 mm) | | | ● | | | | | |
| 5 in (125.5 mm) | | | | ● | | | | |
| 6 in (152.2 mm) | | | | | ● | | | |
| 7 in (177.2 mm) | | | | | | ● | | |
| 8.5 in (213 mm) | | | | | | | ● | |
| 9.5 in (240 mm) | | | | | | | | ● |



CORE BARREL BIT AND CASING SHOE DIMENSIONS

Bit and Shoe Selector

| Core Barrel Bit Size* | Core Size Size** | Casing Shoes | | | | | | |
|--------------------------|---------------------|-----------------------|--------------------|--------------------|--------------------|---------------------|-----------------------|---------------------|
| | | 4.75 in (120.7 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) | 9.25 in (235 mm) | 10.5 in (266.7 mm) | 12 in (304.8 mm) |
| 3.75 in (95.25 mm) | 3 in (76.4 mm) | ● | — | — | — | — | — | — |
| 4.5 in (114.3 mm) | 3.5 in (90.2 mm) | — | ● | — | — | — | — | — |
| 4.75 in (120.65 mm) | 4 in (97.9 mm) | — | ● | — | — | — | — | — |
| 6 in (152.4 mm) | 5 in (125.5 mm) | — | — | ● | — | — | — | — |
| 7 in (177.8 mm) | 6 in (152.2 mm) | — | — | — | ● | — | — | — |
| 8 in (203.2 mm) | 7 in (177.2 mm) | — | — | — | — | ● | — | — |
| 9 in (228.6 mm) | 8.5 in (213 mm) | — | — | — | — | — | ● | — |
| 10.5 in (266.7 mm) | 9.5 in (240 mm) | — | — | — | — | — | — | ● |

● = Ideal combination — = Optional combinations

Core Barrel Bit Dimensions

| Size* | Inner Diameter (Core Size) | | Outer Diameter | |
|---------------------|----------------------------|---------|----------------|----------|
| | Metric | U.S. | Metric | U.S. |
| 3.75 in (95.25 mm) | 76.4 mm | 3.01 in | 98.86 mm | 3.89 in |
| 4.5 in (114.3 mm) | 90.17 mm | 3.55 in | 116.33 mm | 4.58 in |
| 4.75 in (120.65 mm) | 97.87 mm | 3.85 in | 124.77 mm | 4.91 in |
| 6 in (152.4 mm) | 125.48 mm | 4.94 in | 154.94 mm | 6.1 in |
| 7 in (177.8 mm) | 152.15 mm | 5.99 in | 181.15 mm | 7.13 in |
| 8 in (203.2 mm) | 177.19 mm | 6.98 in | 208 mm | 8.19 in |
| 9 in (228.6 mm) | 213 mm | 8.39 in | 238.79 mm | 9.4 in |
| 10.5 in (266.7 mm) | 240.03 mm | 9.45 in | 271.02 mm | 10.67 in |

Casing Shoe dimensions

| Size* | Inner Diameter | | Outer Diameter | |
|---------------------|----------------|----------|----------------|----------|
| | Metric | U.S. | Metric | U.S. |
| 4.75 in (120.65 mm) | 99.77 mm | 3.93 in | 124.38 mm | 4.9 in |
| 6 in (152.4 mm) | 126.75 mm | 4.99 in | 156.64 mm | 6.17 in |
| 7 in (177.8 mm) | 158.19 mm | 6.23 in | 183.69 mm | 7.23 in |
| 8 in (203.2 mm) | 184.86 mm | 7.28 in | 210.87 mm | 8.3 in |
| 9.25 in (234.95 mm) | 213.31 mm | 8.4 in | 240.08 mm | 9.45 in |
| 10.5 in (266.7 mm) | 245.06 mm | 9.65 in | 273.1 mm | 10.75 in |
| 12 in (304.8 mm) | 276.17 mm | 10.87 in | 311.2 mm | 12.25 in |



CORE BARREL BITS



Standard Core Barrel Bits

Usage: Normal multipurpose operating conditions

| | | | | | |
|-------------|-----------------------|------------------------|--------------------|--------------------|--------------------|
| Size | 3.75 in (95.25 mm) | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) |
| Part Number | 22010819 | 22010807 | 22010818 | 22010806 | 22010890 |

| | | |
|-------------|--------------------|-----------------------|
| Size | 9 in (228.6 mm) | 10.5 in (266.7 mm) |
| Part Number | 22011251 | 22011222 |



Crowd-out Core Barrel Bits

Usage: Dry formations

| | | | |
|-------------|-----------------------|------------------------|--------------------|
| Size | 3.75 in (95.25 mm) | 4.75 in (120.65 mm) | 6 in (152.4 mm) |
| Part Number | 22011178 | 22011160 | 22011163 |



Crowd-in Core Barrel Bits

Usage: Loose, wet conditions

| | | | |
|-------------|-----------------------|------------------------|--------------------|
| Size | 3.75 in (95.25 mm) | 4.75 in (120.65 mm) | 6 in (152.4 mm) |
| Part Number | 22011179 | 22011161 | 22011164 |



Flapper Core Barrel Bits

Usage: Hole clean-out in slurry conditions (rotation not recommended)

| | | | | | |
|-------------|-----------------------|------------------------|--------------------|--------------------|--------------------|
| Size | 3.75 in (95.25 mm) | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) |
| Part Number | 22010863 | 22010821 | 22010824 | 22010827 | 22010892 |



Auger Core Barrel Bits

Usage: Hard, dry, layered conditions (helps prevents sample refusal)

| | | | | | |
|-------------|-----------------------|------------------------|--------------------|--------------------|--------------------|
| Size | 3.75 in (95.25 mm) | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) |
| Part Number | 22010862 | 22010822 | 22010825 | 22010828 | 22010891 |



HD Core Barrel Bit

Usage: Moderately abrasive formations

| | | | | | |
|-------------|-----------------------|------------------------|--------------------|--------------------|--------------------|
| Size | 3.75 in (95.25 mm) | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) |
| Part Number | 22011176 | 22010866 | 22010867 | 22010878 | 22011177 |

CORE BARREL BITS (CONTINUED)



HD Core Barrel Bit with Wear Plates

Usage: Severly abrasive formations

| | | | | | |
|-------------|-----------------------|------------------------|--------------------|--------------------|--------------------|
| Size | 3.75 in (95.25 mm) | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) |
| Part Number | 22011450 | 22011451 | 22011452 | 22011453 | 22011454 |



Steel Basket Core Barrel Bits

Usage: Loose, soft formations - use in conjunction with steel core basket

| | | | | |
|-------------|-----------------------|------------------------|--------------------|--------------------|
| Size* | 3.75 in (95.25 mm) | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) |
| Part Number | 22010861 | 22010823 | 22010826 | 22011180 |



Steel Core Basket

Usage: Retains loose, soft sample - use in conjunction with steel basket core barrel bit

| | | | | |
|-------------|-----------------------|------------------------|--------------------|--------------------|
| Size* | 3.75 in (95.25 mm) | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) |
| Part Number | 24690139 | 24690134 | 24690135 | 24690140 |



Plastic Basket Core Barrel Bits

Usage: Loose, soft formations - use in conjunction with plastic core basket

| | | |
|-------------|------------------------|--------------------|
| Size* | 4.75 in (120.65 mm) | 6 in (152.4 mm) |
| Part Number | 22011162 | 22011184 |



Plastic Core Basket

Usage: Retains loose, soft sample - use in conjunction with plastic basket core barrel bit

| | | |
|-------------|------------------------|--------------------|
| Size* | 4.75 in (120.65 mm) | 6 in (152.4 mm) |
| Part Number | 4031159 | 4032758 |



4.5 Lexan Liner Core Barrel Bits

Usage: Environmentally contaminated soils, when sample structure visibility and storage is required (Dry-drilled hole). Use in conjunction with 4.5 in solid lexan core barrel.

| | | |
|-------------|------------------------------|-----------------------------------|
| Size* | 4.5 in (114.3 mm) Std. Lexan | 4.5 in (114.3 mm) w/Flapper Lexan |
| Part Number | 22010820 | 22011173 |



Full Face Core Barrel Bits

Usage: Drill bore holes when no sample is required.
(can also be used in conjunction with the sandstone casing shoe)

| | | | |
|-------------|-----------------------|------------------------|--------------------|
| Size* | 3.75 in (95.25 mm) | 4.75 in (120.65 mm) | 6 in (152.4 mm) |
| Part Number | 22130594 | 22130568 | 22130578 |

CASING SHOES



Steel Casing Shoes

Usage: Normal multipurpose operating conditions

| | | | | | |
|-------------|------------------------|--------------------|--------------------|--------------------|------------------------|
| Size* | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) | 9.25 in (234.95 mm) |
| Part Number | 22010848 | 22010855 | 22010854 | 22010808 | 22010849 |

| | | |
|-------------|-----------------------|---------------------|
| Size* | 10.5 in (266.7 mm) | 12 in (304.8 mm) |
| Part Number | 22010850 | 22010851 |



Heavy Duty Casing Shoes with Wear Pad

Usage: Contains tungsten carbide wear pads for severely abrasive formations

| | | | | |
|-------------|--------------------|--------------------|--------------------|------------------------|
| Size* | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) | 9.25 in (234.95 mm) |
| Part Number | 22010856 | 22010876 | 22010877 | 22011181 |

| | | |
|-------------|-----------------------|---------------------|
| Size* | 10.5 in (266.7 mm) | 12 in (304.8 mm) |
| Part Number | 22011182 | 22011183 |

Dimensions

| Size* | Inner Diameter | | Outer Diameter | |
|---------------------|----------------|-----------|----------------|-----------|
| | Metric | U.S. | Metric | U.S. |
| 6 in (152.4 mm) | 127 mm | 5 in | 156.7 mm | 6.169 in |
| 7 in (177.8 mm) | 158 mm | 6.22 in | 183.7 mm | 7.232 in |
| 8 in (203.2 mm) | 185 mm | 7.283 in | 211 mm | 8.307 in |
| 9.25 in (234.95 mm) | 213.5 mm | 8.406 in | 241 mm | 9.488 in |
| 10.5 in (266.7 mm) | 245 mm | 9.646 in | 273 mm | 10.748 in |
| 12 in (304.8 mm) | 276 mm | 10.866 in | 312 mm | 12.283 in |



Sandstone Casing Shoes

Usage: Abrasive or in swelling ground conditions
(can also be used in conjunction with the full face core barrel bit)

| | | |
|-------------|------------------------|--------------------|
| Size* | 4.75 in (120.65 mm) | 6 in (152.4 mm) |
| Part Number | 22011212 | 22011211 |

Dimensions

| Size* | Inner Diameter | | Outer Diameter | |
|---------------------|----------------|---------|----------------|---------|
| | Metric | U.S. | Metric | U.S. |
| 4.75 in (120.65 mm) | 99.5 mm | 3.92 in | 143 mm | 5.63 in |
| 6 in (152.4 mm) | 127 mm | 5 in | 176 mm | 6.93 in |



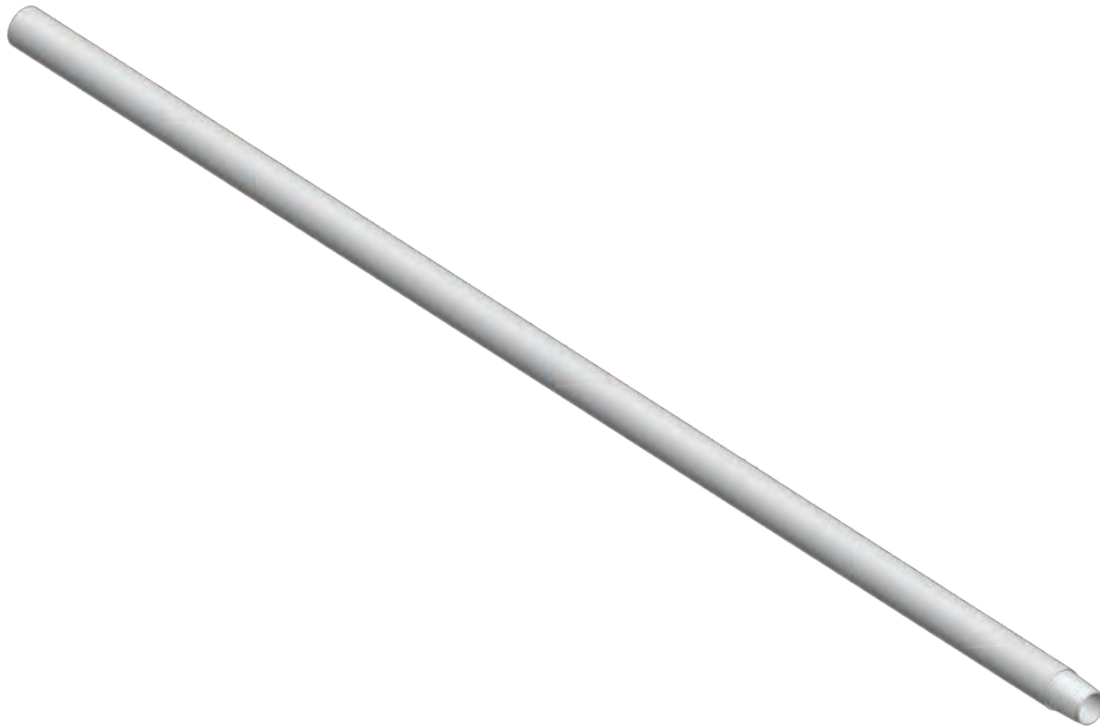


RODS, CORE BARREL AND CASING

Boart Longyear's sonic drill rods, core barrels and casing feature a heat-treated pin and box, dramatically increasing wear-resistance and the life of rods. By using high carbon alloys and advanced engineering, it increases fatigue resistance and maximizes productivity. Additionally, joint strength is increased by friction-welding the tool joints to the midbody of each rod.

| | |
|-------------|----|
| Drill rod | 20 |
| Core Barrel | 22 |
| Casing | 24 |

DRILL ROD



Drill Rod Mid-body Dimensions

| Size | Inner Diameter | | Outer Diameter | |
|-----------------|----------------|------|----------------|--------|
| | Metric | U.S. | Metric | U.S. |
| 3.5 in Standard | 76.2 mm | 3 in | 88.9 mm | 3.5 in |

Drill Rod Thread-ends Dimensions

| Size | Inner Diameter | | Outer Diameter | |
|-----------------|----------------|--------|----------------|--------|
| | Metric | U.S. | Metric | U.S. |
| 3.5 in Standard | 63.5 mm | 2.5 in | 88.9 mm | 3.5 in |

Standard Drill Rod - Imperial Length

| Description | 10 ft | 5 ft | 2 ft | 1 ft |
|-------------|---------|----------|----------|----------|
| Part Number | 8400360 | 21011187 | 21011375 | 21020530 |

Standard Drill Rod - Metric Length

| Description | 3 m | 1.5 m |
|-------------|---------|----------|
| Part Number | 8400714 | 21011238 |

Drill rod, core barrels and related accessories are designed with **right hand threads.*



CORE BARREL

Core Barrel Selector

| Casing | Core Barrel | | | | | | | |
|--|-----------------------|----------------------|------------------------|--------------------|--------------------|--------------------|------------------------|-----------------------|
| Size | 3.75 in (95.25 mm) | 4.5 in (114.3 mm) | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) | 9.25 in (234.95 mm) | 10.5 in (266.7 mm) |
| 4.75 in (120.65 mm) | ● | | | | | | | |
| 6 in (152.4 mm) | — | | | ● | | | | |
| 7 in (177.8 mm) | — | | | | ● | | | |
| 8 in (203.2 mm) | — | | | | | ● | | |
| 9.25 in (234.95 mm) | — | | | | | | ● | |
| 10.5 in (266.7 mm) | — | | | | | | | ● |
| 12 in (304.8 mm) | — | | | | | | | |
| Core Size (determined by inner-diameter of bit) | | | | | | | | |
| | 3 in (76.4 mm) | 3.5 in (90.17 mm) | 4 in (97.87 mm) | 5 in (125.5 mm) | 6 in (152.2 mm) | 7 in (177.2 mm) | 8.5 in (213 mm) | 9.5 in (240 mm) |

● = Ideal combination

— = Optional combinations

Core Barrel Mid-body Dimensions

| Size | Inner Diameter | | Outer Diameter | |
|---------------------|----------------|---------|----------------|---------|
| | Metric | U.S. | Metric | U.S. |
| 3.75 in (95.25 mm) | 82.55 mm | 3.25 in | 95.25 mm | 3.75 in |
| 4.5 in (114.3 mm) | 102.98 mm | 4.06 in | 114.3 mm | 4.5 in |
| 4.75 in (120.65 mm) | 107.95 mm | 4.25 in | 120.65 mm | 4.75 in |
| 6 in (152.4 mm) | 139.7 mm | 5.5 in | 152.4 mm | 6 in |
| 7 in (177.8 mm) | 165.1 mm | 6.5 in | 177.8 mm | 7 in |
| 8 in (203.2 mm) | 190.5 mm | 7.5 in | 203.2 mm | 8 in |
| 9.25 in (234.95 mm) | 222.25 mm | 8.75 in | 234.95 mm | 9.25 in |
| 10.5 in (266.7 mm) | 254 mm | 10 in | 266.7 mm | 10.5 in |

Core Barrel Thread-ends Dimensions

| Size | Inner Diameter | | Outer Diameter | |
|---------------------|----------------|---------|----------------|----------|
| | Metric | U.S. | Metric | U.S. |
| 3.75 in (95.25 mm) | 81.79 mm | 3.22 in | 97.03 mm | 3.82 in |
| 4.5 in (114.3 mm) | 102.99 mm | 4.06 in | 114.30 mm | 4.50 in |
| 4.75 in (120.65 mm) | 106.43 mm | 4.19 in | 123.83 mm | 4.87 in |
| 6 in (152.4 mm) | 137.16 mm | 5.4 in | 152.40 mm | 6 in |
| 7 in (177.8 mm) | 163.07 mm | 6.42 in | 179.07 mm | 7.05 in |
| 8 in (203.2 mm) | 188.01 mm | 7.4 in | 204.5 mm | 8.051 in |
| 9.25 in (234.95 mm) | 213.51 mm | 8.41 in | 235 mm | 9.25 in |
| 10.5 in (266.7 mm) | 245 mm | 9.65 in | 267 mm | 10.51 in |



Sonic Core Barrel

CORE BARREL

2 Feet

| | | | | | |
|-------------|-----------------------|------------------------|--------------------|--------------------|--------------------|
| Size | 3.75 in (95.25 mm) | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) |
| Part Number | 21011398 | 21011399 | 21011402 | 21011400 | 21011401 |

5 Feet

| | | | | | | | |
|-------------|-----------------------|------------------------|--------------------|--------------------|--------------------|------------------------|-----------------------|
| Size | 3.75 in (95.25 mm) | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) | 9.25 in (234.95 mm) | 10.5 in (266.7 mm) |
| Part Number | 21011194 | 21011198 | 21011201 | 21011203 | 21011310 | 21011464 | 21011445 |

10 Feet

| | | | | | |
|-------------|-----------------------|------------------------|--------------------|--------------------|--------------------|
| Size | 3.75 in (95.25 mm) | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) |
| Part Number | 21011193 | 21011197 | 21011200 | 21011202 | 21011304 |

0.5 Meters

| | | | | | |
|-------------|-----------------------|------------------------|--------------------|--------------------|--------------------|
| Size | 3.75 in (95.25 mm) | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) |
| Part Number | 21011403 | 21020538 | 21020539 | 21020540 | 21011405 |

1.5 Meters

| | | | | | |
|-------------|-----------------------|------------------------|--------------------|--------------------|--------------------|
| Size | 3.75 in (95.25 mm) | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) |
| Part Number | 21011195 | 21011199 | 21011270 | 21011273 | 21011406 |

3 Meters

| | | | | | |
|-------------|-----------------------|------------------------|--------------------|--------------------|--------------------|
| Size | 3.75 in (95.25 mm) | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) |
| Part Number | 21011274 | 21011267 | 21011269 | 21011272 | 21011404 |

*Drill rod, core barrels and related accessories are designed with **right** hand threads.

CASING

Casing Selector

| Core Barrel | Casing | | | | | | |
|------------------------|------------------------|--------------------|--------------------|--------------------|------------------------|-----------------------|---------------------|
| | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) | 9.25 in (234.95 mm) | 10.5 in (266.7 mm) | 12 in (304.8 mm) |
| 3.75 in (95.25 mm) | ● | — | — | — | — | — | — |
| 4.5 in (114.3 mm) | | ● | — | — | — | — | — |
| 4.75 in (120.65 mm) | | ● | — | — | — | — | — |
| 6 in (152.4 mm) | | | ● | — | — | — | — |
| 7 in (177.8 mm) | | | | ● | — | — | — |
| 8 in (203.2 mm) | | | | | ● | — | — |
| 9 in (228.6 mm) | | | | | | ● | — |
| 10 in (254 mm) | | | | | | | ● |

● = Ideal combination — = Optional combinations

Casing Mid-body Dimensions

| Size | Inner Diameter | | Outer Diameter | |
|---------------------|----------------|---------|----------------|---------|
| | Metric | U.S. | Metric | U.S. |
| 4.75 in (120.65 mm) | 107.95 mm | 4.25 in | 120.65 mm | 4.75 in |
| 6 in (152.4 mm) | 139.7 mm | 5.5 in | 152.4 mm | 6 in |
| 7 in (177.8 mm) | 165.1 mm | 6.5 in | 177.8 mm | 7 in |
| 8 in (203.2 mm) | 190.5 mm | 7.5 in | 203.2 mm | 8 in |
| 9.25 in (234.95 mm) | 222.25 mm | 8.75 in | 234.95 mm | 9.25 in |
| 10.5 in (266.7 mm) | 254 mm | 10 in | 266.7 mm | 10.5 in |
| 12 in (304.8 mm) | 292.1 mm | 11.5 in | 304.8 mm | 12 in |

Casing Thread-ends Dimensions

| Size | Inner Diameter | | Outer Diameter | |
|---------------------|----------------|----------|----------------|---------|
| | Metric | U.S. | Metric | U.S. |
| 4.75 in (120.65 mm) | 100.08 mm | 3.94 in | 122.68 mm | 4.83 in |
| 6 in (152.4 mm) | 127 mm | 5 in | 152.4 mm | 6 in |
| 7 in (177.8 mm) | 158.24 mm | 6.23 in | 179.07 mm | 7.05 in |
| 8 in (203.2 mm) | 184.91 mm | 7.28 in | 205.74 mm | 8.1 in |
| 9.25 in (234.95 mm) | 213.36 mm | 8.4 in | 234.95 mm | 9.25 in |
| 10.5 in (266.7 mm) | 245.11 mm | 9.65 in | 266.7 mm | 10.5 in |
| 12 in (304.8 mm) | 276.35 mm | 10.88 in | 304.8 mm | 12 in |

*Casing and related accessories are designed with **left** hand threads.



Sonic Casing

CASING

2 Feet

| | | | | | | | |
|-------------|------------------------|--------------------|--------------------|--------------------|------------------------|-----------------------|---------------------|
| Size | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) | 9.25 in (234.95 mm) | 10.5 in (266.7 mm) | 12 in (304.8 mm) |
| Part Number | 21011189 | 21011256 | 21011185 | 21011192 | 21011219 | 21011225 | 21011228 |

5 Feet

| | | | | | | | |
|-------------|------------------------|--------------------|--------------------|--------------------|------------------------|-----------------------|---------------------|
| Size | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) | 9.25 in (234.95 mm) | 10.5 in (266.7 mm) | 12 in (304.8 mm) |
| Part Number | 21011180 | 21011182 | 21011184 | 21011191 | 21011220 | 21011226 | 21011229 |

10 Feet

| | | | | | | | |
|-------------|------------------------|--------------------|--------------------|--------------------|------------------------|-----------------------|---------------------|
| Size | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) | 9.25 in (234.95 mm) | 10.5 in (266.7 mm) | 12 in (304.8 mm) |
| Part Number | 21011179 | 21011181 | 21011183 | 21011190 | 21011221 | 21011224 | 21011227 |

0.5 Meters

| | | | | | | | |
|-------------|------------------------|--------------------|--------------------|--------------------|------------------------|-----------------------|---------------------|
| Size | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) | 9.25 in (234.95 mm) | 10.5 in (266.7 mm) | 12 in (304.8 mm) |
| Part Number | 21011397 | 21011396 | 21011395 | 21011394 | 21011393 | 21011388 | 21011390 |

1.5 Meters

| | | | | | | | |
|-------------|------------------------|--------------------|--------------------|--------------------|------------------------|-----------------------|---------------------|
| Size | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) | 9.25 in (234.95 mm) | 10.5 in (266.7 mm) | 12 in (304.8 mm) |
| Part Number | 21011236 | 21011258 | 21011245 | 21011246 | 21011266 | 21011389 | 21011391 |

3 Meters

| | | | | | | | |
|-------------|------------------------|--------------------|--------------------|--------------------|------------------------|-----------------------|---------------------|
| Size | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) | 9.25 in (234.95 mm) | 10.5 in (266.7 mm) | 12 in (304.8 mm) |
| Part Number | 21011235 | 21011239 | 21011240 | 21011241 | 21011242 | 21011378 | 21011392 |

*Casing and related accessories are designed with **left** hand threads.



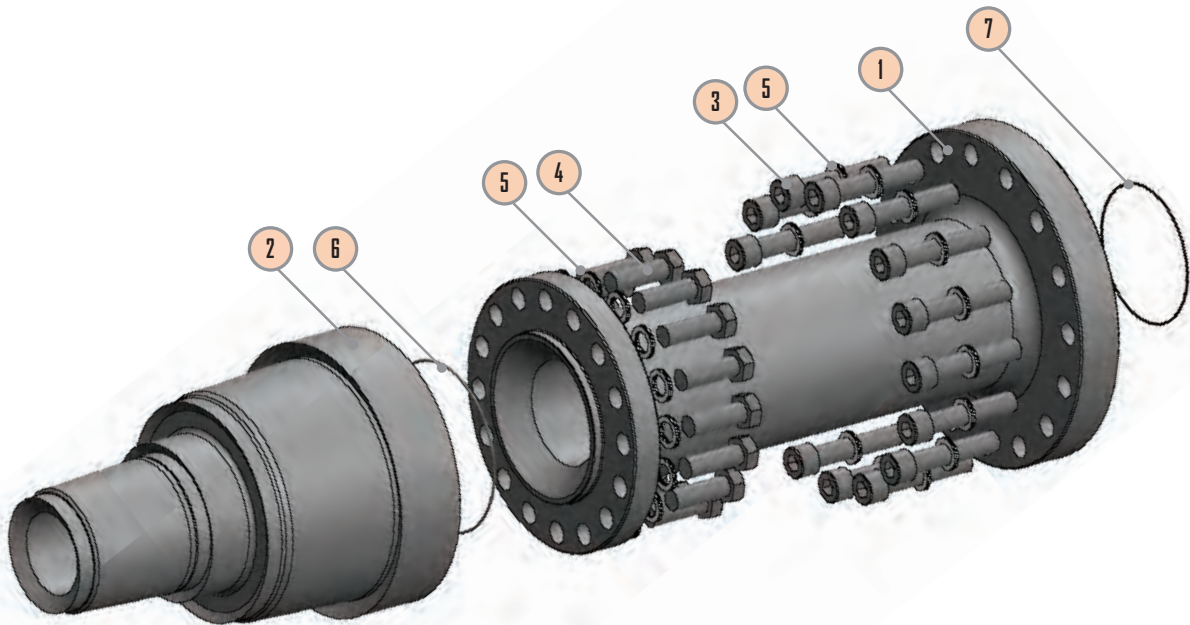
ACCESSORIES

| | |
|-------------------|----|
| Flange Assemblies | 28 |
| Casing Plug/Ring | 30 |
| Cross-over Subs | 30 |
| Adapters | 31 |
| Sub-savers | 32 |
| Retrieving Tools | 33 |

FLANGE ASSEMBLIES

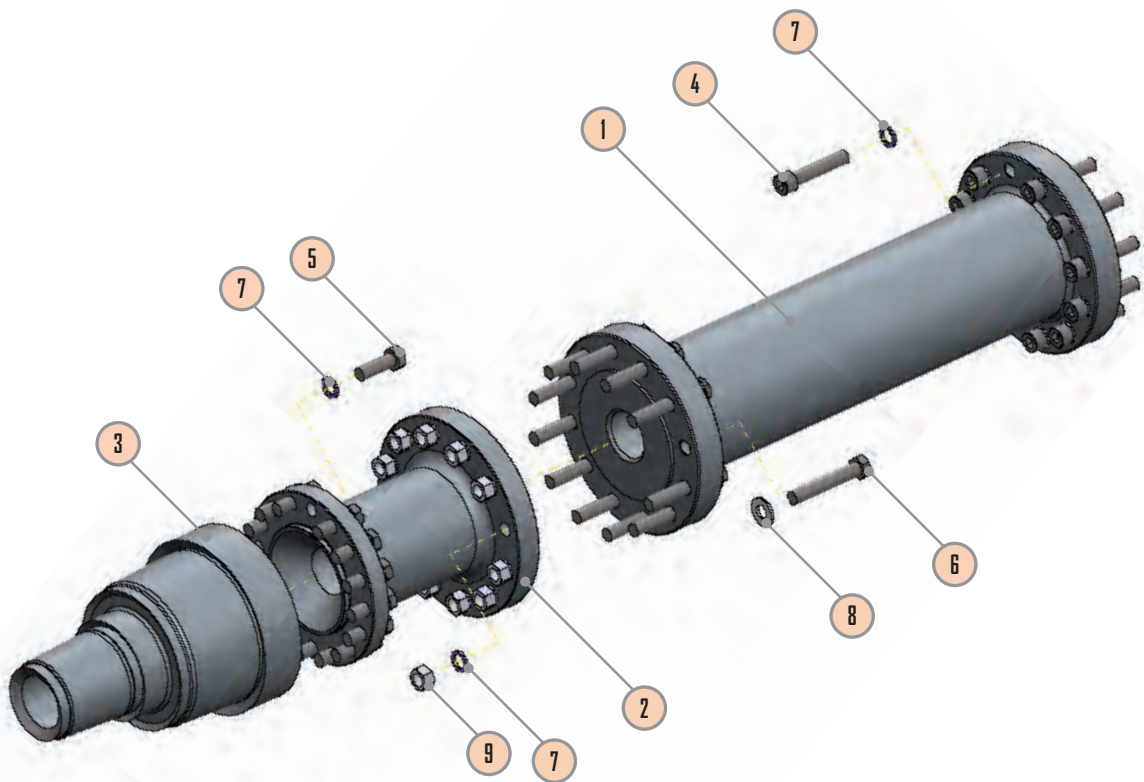
LS600 Drill Head, Flange Assembly (Part Number 6002003)

| Item | Name | Part Number | Quantity |
|------|---|-------------|----------|
| 1 | Flange Adapter, 343 mm | 24030361 | 1 |
| 2 | Flange Sonic Head, PST 3-1/2 in RH, PST 6 in LH | 24030362 | 1 |
| 3 | Socket Head Bolg 1/2 UNF x 2-1/2 in | 6002214 | 16 |
| 4 | Bot, 1/2 UNF x 1-1/2 in | 44921 | 16 |
| 5 | Lock Washer, M12 | K12553 | 32 |
| 6 | ORing, .070 in x 2-1/4 in | P03-R033 | 1 |
| 7 | ORing, .070 in x 4 in | P03-R019 | 1 |



LS250 Drill Head Flange Assembly (Part Number 8402192)

| Item | Name | Part Number | Quantity |
|------|--|-------------|----------|
| 1 | Flange Adapter, Intermediate, 500 mm (standard) | 24030275 | 1 |
| | Flange Adapter, Intermediate, 280 mm (optional) | 24030429 | 1 |
| | Flange Adapter, Intermediate, 381 mm (optional) | 24030430 | 1 |
| 2 | Head Adapter Mini | 24030391 | 1 |
| 3 | Flange Socket Head, PST 3-1/2 in RH, PST 6 in LH | 24030362 | 1 |
| 4 | Socket Head Bolt, 1/2 UNF x 2-1/2 in | 6002214 | 12 |
| 5 | Bolt, 1/2 UNF x 1-1/2 in | 44921 | 16 |
| 6 | Bolt, 1/2 UNF x 3 in | 52503 | 12 |
| 7 | Lock Washer, 1/2 in | 3544766 | 40 |
| 8 | Flat Washer, 1/2 in | 44621 | 12 |
| 9 | Nut, 1/2-20 UNF | 5004238 | 12 |



Optional Adapter Flanges

| Adapts From | Adapts To | Description | Part Number |
|---------------------------|------------------------------|---|-------------|
| Rousey (Sonicor 50K Head) | Boart Longyear Sonic Tooling | Adapts Rousey head to Boart Longyear Bolt on threaded flange | 24030562 |
| Geoprobe (GV4 Sonic Head) | Boart Longyear Sonic Tooling | Adpats Geoprobe head to Boart Longyear tooling. Threaded Flange included | 8402363 |

CASING PLUG / RING



Casing Plugs

Used to seal casing

| | | | | | |
|-------------|-----------------------|------------------------|--------------------|--------------------|--------------------|
| Size | 3.75 in (95.25 mm) | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) |
| Part Number | 24070042 | 24070043 | 24070044 | 24070045 | 24070046 |

| | | | |
|-------------|--------------------|-----------------------|---------------------|
| Size | 9 in (228.6 mm) | 10.5 in (266.7 mm) | 12 in (304.8 mm) |
| Part Number | 24070047 | 24070048 | 24070049 |



Casing Rings

Prevents casing from falling down the hole

| | | | | | |
|-------------|------------------------|--------------------|--------------------|--------------------|--------------------|
| Size | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) | 9 in (228.6 mm) |
| Part Number | 21190166 | 21190167 | 21190168 | 21190169 | 21190170 |

| | | |
|-------------|-----------------------|---------------------|
| Size | 10.5 in (266.7 mm) | 12 in (304.8 mm) |
| Part Number | 21190171 | 21190172 |

CROSS-OVER SUBS



Cross-over Subs

Connects dissimilar threaded tooling

| | | | | | |
|-------------|-------------------------|-------------------------|-------------------------|-------------------------|---------------------------------|
| Size | NWJ Pin x 3.5 in Box | NWJ Pin x 3.5 in Pin | AWJ Pin x 3.5 in Box | AWJ Pin x 3.5 in Pin | 2 in NPT Box x 3.5 in Box |
| Part Number | 350-2624 | 350-2622 | 350-2623 | 350-2625 | 350-2621 |

| | |
|-------------|-------------------------------------|
| Size | 3.5 in RH Pin x 2-3/8 in API-IF Box |
| Part Number | 4033894 |

ADAPTERS



Drill Rod Adapters - 2-3/8 in Reg API

Connects API drill rod to varying sized core barrels

| | | | |
|-------------|--|---|---|
| Size | 3 in OD / 2-3/8 in API Reg Box x 4.75 in Core Barrel RH Pin Thread | 3 in OD / 2-3/8 in API Reg Box x 6 in Core Barrel RH Pin Thread | 3 in OD / 2-3/8 in API Reg Box x 7 in Core Barrel RH Pin Thread |
| Part Number | 24021355 | 24021356 | 24021357 |

Core Barrel Adapters

Connects drill rod to varying sized core barrels

| | | | | |
|-------------|--------------------------|-----------------------------|-----------------------------|--------------------------|
| Size | 3.5 in Box x 3.75 CB Pin | 3.5 in Box x 4.75 in CB Pin | 3.5 in Box x 6.0 in CB Pin | 3.5 in Box x 7 in CB Pin |
| Part Number | 24021311 | 24021310 | 24021307 | 24021277 |
| Diameter | 3.5 in Box x 8 in CB Pin | 3.5 in Box x 9.25 in CB Pin | 3.5 in Box x 10.5 in CB Pin | |
| Part Number | 24021416 | 24021574 | 24021515 | |

Casing Adapters

Connects dissimilar sized casing

| | | | | |
|-------------|------------------------|----------------------|-----------------------|--|
| Size | 6 in Box x 4.75 in Pin | 6 in Box x 6 in Pin | 6 in Box x 7 in Pin | 6 in Box x 8 in Pin |
| Part Number | 24021309 | 24021276 | 24021303 | 24021304 |
| Size | 6 in Box x 9 in Pin | 6 in Box x 10 in Pin | 10 in Box x 12 in Pin | 6 in Box x 12 in Pin - 1 Piece Adapter |
| Part Number | 24021305 | 24021306 | 24021313 | 24021480 |



Thread Sub-saver

SUB-SAVERS

3.5 in Thread Sub-Savers (Drill Rod)

Varies drill rod string length



| | | | |
|-------------|------------------------------|-----------------------------|--|
| Size | 3.5 in RH Box x Pin x 9.5 in | 3.5 in RH Pin x Pin x 18 in | 3.5 in RH Pin x Pin x 15 in - 1 Piece Flange |
| Part Number | 24021314 | 24021354 | 24021365 |

| | | |
|-------------|-----------------------------|---------------------------------------|
| Size | 3.5 in RH Box x Pin x 18 in | Rod 3.5 in RH Box x Pin x 12 in (ACE) |
| Part Number | 24021464 | 21020530 |

6 in Thread Sub-Savers (Casing)

Varies casing string length



| | | | |
|-------------|----------------------------------|-----------------------------------|-----------------------------------|
| Size | 6 in LH Box x 6 in LH Pin x 8 in | 6 in LH Box x 6 in LH Pin x 18 in | 6 in LH Box x 6 in LH Pin x 14 in |
| Part Number | 24021302 | 21020564 | 21020572 |

| | | |
|-------------|--|---------------------------------------|
| Size | 6 LH Box x 6 in LH Pin x 24 in S/S (Deuce) | 6 in LH Box x 6 in LH Pin x 24 in S/S |
| Part Number | 21011256 | 21020529 |

RETRIEVING TOOLS



Overshot - Drill Rod

Retrieves broken drill rod

| | | |
|-------------|----------|------------------|
| Diameter | 3.5 in | 2-3/8 in API Reg |
| Part Number | 24720186 | 24720202 |



Taper Tap - Drill Rod

Retrieves broken drill rod

| | | |
|-------------|-----------------------|--------------------------------|
| Diameter | 3.5 in (120.65 mm) | 2-3/8 in API Reg (152.4 mm) |
| Part Number | 24720179 | 24720177 |



Taper Tap - Core Barrel

Retrieves broken core barrel

| | | | | | |
|-------------|-----------------------|------------------------|--------------------|--------------------|--------------------|
| Diameter | 3.75 in (95.25 mm) | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) |
| Part Number | 24720187 | 24720184 | 24720178 | 24720185 | 24720203 |

| | | |
|-------------|------------------------|-----------------------|
| Diameter | 9.25 in (234.95 mm) | 10.5 in (266.7 mm) |
| Part Number | 24720219 | 24720220 |



Taper Tap - Casing

Retrieves broken casing

| | | | | | | |
|-------------|------------------------|--------------------|--------------------|--------------------|------------------------|-----------------------|
| Diameter | 4.75 in (120.65 mm) | 6 in (152.4 mm) | 7 in (177.8 mm) | 8 in (203.2 mm) | 9.25 in (234.95 mm) | 10.5 in (266.7 mm) |
| Part Number | 24720183 | 24720175 | 24720176 | 24720181 | 24720182 | 24720180 |



MISCELLANEOUS

| | |
|-----------------------------|----|
| Lexan Soil Sampler | 36 |
| Rod/Casing Handling Systems | 37 |
| Discrete Point Samplers | 39 |
| Miscellaneous Tooling | 40 |
| Consumables | 40 |

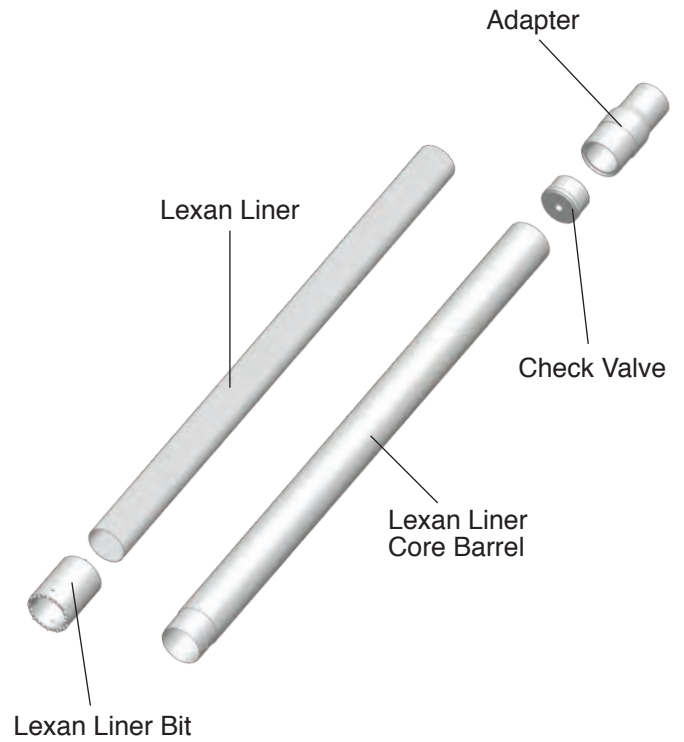
LEXAN LINER SAMPLE SYSTEMS

Shows sample structure and improves storage quality. Used when drilling dry without the use of fluids. Ideal for environmentally contaminated soils.

4.5 in Lexan Solid Core Barrel

Used when rotation is required.

| Description | Part Number |
|--|-------------|
| Core Barrel for Lexan Liner 4.5 in x 5 ft | 21011196 |
| Adapter, 4.5 in Core Barrel | 24021329 |
| Poly End Cap for Lexan Liner - 4 in OD x 1.13 in deep | P18-0056 |
| 4.5 in Lexan Check Valve - seals inside of liner and creates a vacuum to retain "mucky" sample | 450-2625 |
| Lexan Liner 4.5 in (4 in x 59.75 in x .125 in) | P18-0035 |



4.75 in Lexan Split Barrel*

Not designed for rotation.

| Description | Part Number |
|---|-------------|
| Split Core Barrel for Lexan Liner 4.75 in x 5 ft | 21011407 |
| Adapter, 4.75 in Split Core Barrel | 24021468 |
| Poly End Cap for Lexan Liner - 4.25 in OD x 2 in deep | P18-0064 |
| Lexan Liner 4.75 in (4.25 in x 59.9 in x .125 in) | 8400613 |



Lexan-lined Sonic Core Sample

*Use in conjunction with standard 4.75 in core barrel bit

ROD/CASING HANDLING SYSTEMS

Pipe Tongs

Used for handling pipe/casing



| Description | Part Number |
|---------------------|-------------|
| 3.5 in (88.9 mm) | 350-4000 |
| 3.75 in (95.25 mm) | 375-4000 |
| 4.75 in (120.65 mm) | 475-4000 |
| 6 in (152.4 mm) | 600-4000 |
| 7 in (177.8 mm) | 700-4000 |

| Description | Part Number |
|--------------------|-------------|
| 8 in (203.2 mm) | 800-4000 |
| 9 in (228.6 mm) | 900-4000 |
| 10.5 in (266.7 mm) | 1050-4000 |
| 12 in (304.8 mm) | 1200-4000 |
| 12.5 in (317.5 mm) | 1250-4000 |

Drill Rod Grapple

Used for tripping drill rod into finger board



| Description | Part Number |
|---------------------|-------------|
| 3.5 in Pipe Grapple | 8400030 |
| Pipe Grapple Tackle | 8400004 |
| 3.5 in OD Rod Cup | 350-0100 |

Grapple

Grapple Tackle

Lifting Bale

Used for tripping drill rod



| Description | Part Number | Load Capacity |
|----------------------|-------------|---------------|
| 3.5 in Drill Rod Pin | 350-2400 | 3.5 tons |
| 3 in API Regular Pin | 300-2400 | 3.5 tons |

*Custom sizes available upon request

Sonic Deck Lift Assembly

Used to lift deck prior to transport



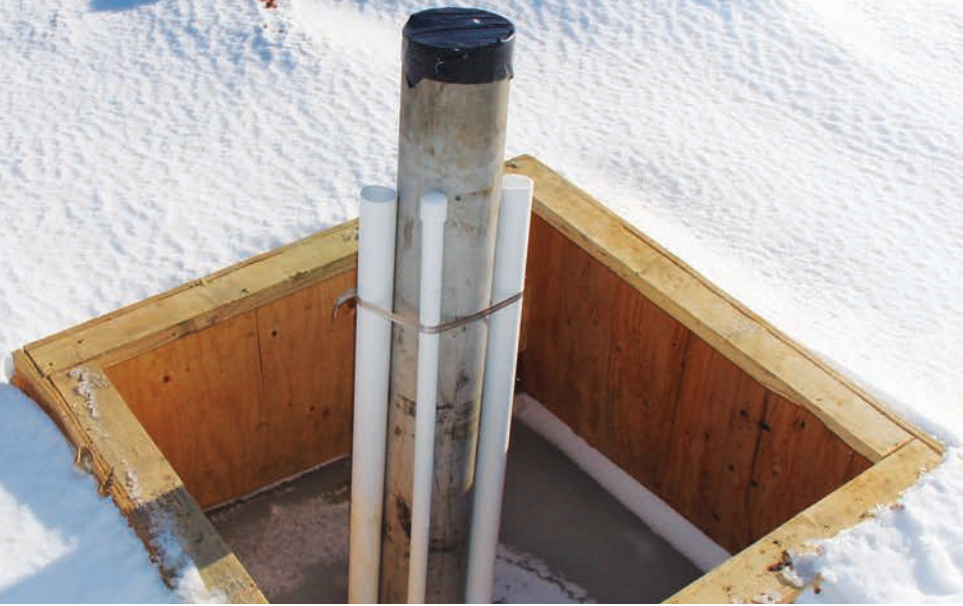
| Description | Part Number |
|--------------------------|-------------|
| Sonic Deck Lift Assembly | 8400476 |

Rod Cup





Monitoring Well



DISCRETE POINT SAMPLERS

Used with drill rod for down hole water sampling



| | |
|-------------|---|
| Description | 3.5 in Discrete Point Water Sampler Water Sample on Point Pin Opening Size 1/15 in 16 Ports |
| Part Number | 8400385 |



| | | |
|-------------|------------------------------|---|
| Description | Discrete Water Sampler Point | Discrete Water Sampler Rod Body Water Sample on Rod Pin Opening Size: .375 in 4 Ports |
| Part Number | 350-3010 | 350-3020 |



| | |
|-------------|--|
| Description | 3.5 in Discrete Water Sampler O-Ring Water Sample Laser Cut Screen Slot Size: 1 in x .020 in 324 Slots |
| Part Number | 8400715 |



Poly Core Bag

MISCELLANEOUS TOOLING



| Description | Part Number |
|-------------------------|-------------|
| Core Sample Tray | P19-0151 |
| 3.5 in Thread Protector | 350-3001 |

CONSUMABLES

Poly Core Bags

| Core Size | 4.75 in | 6 in | 7 in | 8 in |
|-------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| Description | 1,000 ft (304.8 m) Core bag roll | 1,000 ft (304.8 m) Core bag roll | 1,000 ft (304.8 m) Core bag roll | 1,000 ft (304.8 m) Core bag roll |
| Part Number | 475-5000 | 600-5000 | 700-5000 | 800-5000 |

Visqueen

| | |
|-------------|------------------------------|
| Description | 6 mil. x 20 in x 100 ft roll |
| Part Number | 8400429 |

Pipe Dope

| | |
|-------------|--|
| Description | Well Guard Pipe Dope - 1 Gallon Bucket (36 / Pallet) |
| Part Number | 8400308 |

APPLICATION

| | |
|----------------------|----|
| Stabbing | 42 |
| Make-up | 42 |
| Pre-loading | 42 |
| Thread Break-In | 43 |
| Break-out/Fluid Seal | 44 |

STABBING

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 not aligned, 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 face of the pin thread mates against the face 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 1/4 to 1/2 turn will correct the misalignment. Once successfully lowered, rotate the stabbing rod to ensure proper thread engagement (see make-up).

MAKE-UP

Rods and casing make-up slowly by rotating the pin into the box (clockwise for rod and core barrels, counterclockwise for casing). If the stand-off gap is outside specification or if the joint does not close after applying a small amount of make-up torque, break-out the joint, clean and inspect both threads. This is an indication of 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 TORQUE (PRE-LOADING)

After the stand-off gap is closed, additional make-up is required to sufficiently pre-load the joint. Make-up can be applied with the drill head or other power make-up devices. This is to ensure 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. Another visual sign of insufficient make-up is

pitting-wear in the joints due to fretting and fatigue failures.

The pin end of a drill rod 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.

THREAD BREAK-IN (FOR NEW DRILL ROD/CASING)

Breaking-in new threads is necessary to help prevent problems that may occur when making or breaking pipe during drilling. Introducing newly machined threads to each other multiple times removes any imperfections from them.

THREAD BREAK-IN PROCEDURE

Step 1

Apply ample amount of thread compound to the pin end of the new thread.

Step 2

Using the drill head, thread the new pin end into the new box end of the mating pipe. (keep rotation pressure below 1,000 PSI)

Step 3

Thread and un-thread the pipe 4 to 5 times.

Step 4

Remove excess grease from both the pin end and box end of the pipe. This will remove any burrs or imperfections that may have been removed during the introduction process.



BREAK-OUT

Theory and laboratory tests show break-out torque should be 70 - 80% of the make-up or drilling torque applied to each joint. Despite this, breaking-out may be problematic due to adhesion wear or the fact that some drill rigs do not have the same load capacity in breaking as they do in making-up or drilling. Additionally, during drilling the joints are subject to vibration and loss of thread compound reducing the frictional resistance and allowing incremental make-up. Note that a poor choice of 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 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 and potentially cause fatigue failures and may void the Boart Longyear warranty. Once the threads have disengaged, the pin can be slowly unthreaded. Cleaning and re-lubricating is recommended to maximize wear life.

FLUID SEAL

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

Note: Applying wrenches to external shoulder will cause leakage (see stabbing)





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WEAR AND CARE

| | |
|--------------------------|----|
| Lubrication & Cleaning | 48 |
| Transit and Storage | 48 |
| Thread Wear | 49 |
| Loads and Deviated Holes | 50 |
| Serialization/Lot Code | 50 |

LUBRICATION AND CLEANING

Boart Longyear™ drill rod threads are created with thread compound (lubricant) for shipment from the factory. For initial use, it is neither necessary nor desirable to remove the thread compound unless contamination has occurred. Thereafter, each time the rods are used, clean and re-lubricate the threads with Boart Longyear recommended compound. Use enough compound to cover both thread and shoulder surfaces. A 40 to 50 mm (1.5 in to 2 in) brush is excellent for applying compound.

Note:

- 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.

The thread compound is critical to the wear life of the joint. 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. This in turn determines the joint load efficiency: how much torque and vibration 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, decreasing efficiency loading to overload failure. Environmentally friendly compounds must contain non-toxic, bio-stable, solid particles of similar properties and performance characteristics to that of typical zinc particles in order to perform.



PREPARATION FOR TRANSIT

Load rods on at least two 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.

Note: Always provide proper protection for threaded ends.

STORAGE FOR DRILL RODS

Always clean and grease the pin and box end threads of the rods before storing. Store rods horizontally on a minimum of two cross supports no less than 30 cm (12 in) from the ground to keep moisture and dirt away from the rods.

Note: always provide proper protection for threaded ends.

When rods are to be temporarily stacked in the mast, always provide a rod cup 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 regularly. Discard bent rods immediately as these cause additional vibration and can hamper drilling performance. Restraightening of rods is not recommended as this further reduces the bend strength of the mid-body and bending will likely reoccur (see mid-body wear).



THREAD WEAR

The wear of sliding steel-on-steel surfaces, such as in a rod or casing joint, is well defined in engineering literature. Galling is the common industry term given to thread wear which mainly consists of adhesion and abrasion wear as a result of making and breaking. While some wear can be tolerated without compromising performance, worn surfaces are prone to further wear. Unattended, the degree of wear can worsen to the point where it can cause premature failure or in case of mating surfaces of similar hardness, seize the joint. Alternatively, 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 the following variables:

- Lubrication or wear factor: published values are greater for poor lubrication; less for mating surfaces of dissimilar hardness (see lubrication and cleaning)
- 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 (See lubrication and cleaning)

- 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 greater hardness on the softer thread
- Reduce the sliding contact distance by choosing joints with greater taper
- Reduce or eliminate 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.

Another source of rod joint wear is worn accessories. All threaded accessory equipment, such as drivers, adapter subs, hoist plugs, 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 an uncompromising global standard.

LOADS AND DEVIATED HOLES

Fatigue failures are brittle failures or cracks that occur under stress or load levels that are significantly below static load ratings; however, the loads are applied or cycled a large number of times. This phenomenon is common in rotary Sonic drilling, but is enhanced when a rod string is rotating in a deviated hole, the surface of the rod undergoes both tension and compression in each revolution in addition to the vibration. 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 - regardless of heat treatment or deviation capacity of the joint.

A further limitation on the ability of a drill rod joint to perform through a bend is due to a peculiarity of the steel material itself. If there is a constant tension load applied in addition to a cyclical load, the fatigue strength is even further reduced. In the case of drill rod joints, if the joint is properly made up the pin end will always be under a greater tension load than the box end (see make-up torque). As a result, the pin end is the weakest part of a drill rod and is the typical location of failure under an excessive cyclic load. A fatigue failure crack always occurs 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 which can only be caused by bending. If the crack is axially oriented it is either the result of heat-check cracking or indicates that the cyclic load was circumferentially oriented and this can only be caused by improper fit of a joint in terms of make-up, deformation, foreign debris, or wear. Fatigue failures can be avoided by limiting the level of cyclic loads with consideration for the down pressure.

SERIALIZATION / LOT CODING



All Boart Longyear sonic tooling currently being manufactured will have the manufacturer's lot code pin stamped or engraved into the pin end of the piece. Items that do not have a bit joint will have the lot code pin stamped or engraved into the top shoulder of one of the box ends.

It is important to find this information when reporting potential quality or safety issues to Boart Longyear.

WARRANTY

WARRANTY

Limited Warranty.

(a) Consumables. Boart Longyear warrants for a period of one (1) year after the date of shipment of the consumable products manufactured by it, or the performance of related services, under the Contract, that such consumable products are free from defects in materials and workmanship and such services are performed in a professional and workmanlike manner; provided, however, with respect to consumable products purchased through an authorized Boart Longyear distributor, the warranty period shall commence on the date of purchase by the end-user.

(b) Capital Equipment. Boart Longyear warrants that the capital equipment manufactured by it is free from defects in materials and workmanship for a period equal to the lesser of (i) one (1) year after the date of shipment, or (ii) the initial 1,000 operating hours. Boart Longyear warrants for a period of six (6) months after the performance of related services that such services are performed in a professional and workmanlike manner.

(c) General Terms. Boart Longyear further warrants that, to the extent applicable, as of the date of shipment or performance, all goods manufactured by it and services performed shall conform to the written specifications agreed between the parties. THIS IS BOART LONGYEAR'S ONLY WARRANTY. BOART LONGYEAR MAKES NO OTHER WARRANTY, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. As a condition to Boart Longyear's warranty obligations, Purchaser must: (i) contact Boart Longyear and request authorization to return any goods claimed to be defective promptly upon Purchaser's discovery of the alleged defect, (ii) upon receipt of an approved authorization code from Boart Longyear, return any goods claimed to be defective under the foregoing warranty, at Purchaser's expense, to the facility designated by Boart Longyear, and (iii) with respect to consumable products purchased through an authorized Boart

Longyear distributor, the party making the warranty claim must also deliver to Boart Longyear reasonable evidence of the date of purchase. Boart Longyear shall perform its examination of the goods so returned by Purchaser and shall report the results of its examination to Purchaser within thirty (30) days following its receipt of such goods from Purchaser, or, if longer time is required to complete such examination, within such time as would be required through the exercise of reasonable diligence. As a further condition to Boart Longyear's obligations hereunder for breach of warranty, Purchaser shall offer its reasonable cooperation and assist Boart Longyear in the course of Boart Longyear's review of any warranty claim. If requested by Purchaser, Boart Longyear will promptly repair or replace, at Boart Longyear's expense, goods that are confirmed to be non-conforming as a result of Boart Longyear's examination and according to Boart Longyear's warranty as set forth herein. All removal and installation of goods shall be at Purchaser's expense; provided, however, Boart Longyear will reimburse the Customer for an amount equal to the reasonable expenses incurred by the Customer and attributable to the removal and shipment of any defective goods. Boart Longyear reserves the right to reimburse Purchaser for an amount equal to the purchase price of any defective goods in lieu of providing repaired or replacement goods. Anything contained herein to the contrary notwithstanding, in no event shall Boart Longyear be liable for breach of warranty or otherwise in any manner whatsoever for: (i) normal wear and tear; (ii) corrosion, abrasion or erosion; (iii) any goods, components, parts, software or services which, following delivery or performance by Boart Longyear, has been subjected to accident, abuse, misapplication, modification, improper repair, alteration, improper installation or maintenance, neglect, or excessive operating conditions; (iv) defects resulting from Purchaser's specifications or designs or those of its contractors or subcontractors other than Boart Longyear; (v) defects associated with consumable parts or materials, the lifetime of which is shorter than the warranty period set forth in this Section; (vi) defects associated with

Purchaser's specifications or designs or those of its contractors or subcontractors other than Boart Longyear; (vii) defects resulting from the manufacture, distribution, promotion or sale of Purchaser's own products; or (viii) accessories of any kind used by the Purchaser which are not manufactured by or approved by Boart Longyear.

(d) Sourced Goods. If the defective parts or components are not manufactured by Boart Longyear, the guarantee of the manufacturer of those defective parts or components is accepted by the Purchaser and is the only guarantee given to the Purchaser in respect of the defective parts or components. Boart Longyear agrees to assign to the Purchaser on request made by the Purchaser the benefit of any warranty or entitlement to the defective parts or components that the manufacturer has granted to Boart Longyear under any contract or by implication or operation of law to the extent that the benefit of any warranty or entitlement is assignable.

(e) Limitation on Liability. Except as provided for herein, in no event will Boart Longyear be liable for any indirect, incidental, special, consequential, punitive or similar damages including, but not limited to, lost profits, loss of data or business interruption losses. In no event will the total, aggregate liability of Boart Longyear under the Contract exceed the value of the Contract under which liability is claimed. The liability limitations shall apply even if Boart Longyear has been notified of the possibility or likelihood of such damages occurring and regardless of the form of action, whether in contract, negligence, strict liability, tort, products liability or otherwise. The parties agree that these limits of liability shall survive and continue in full force and effect despite any termination or expiration of any Contract. Any action by Purchaser against Boart Longyear must be commenced within one year after the cause of action has accrued. No employee or agent of Boart Longyear is authorized to make any warranty other than that which is specifically set forth herein. The provisions in any specification, brochure or chart issued by Boart Longyear are descriptive only and are not warranties.

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