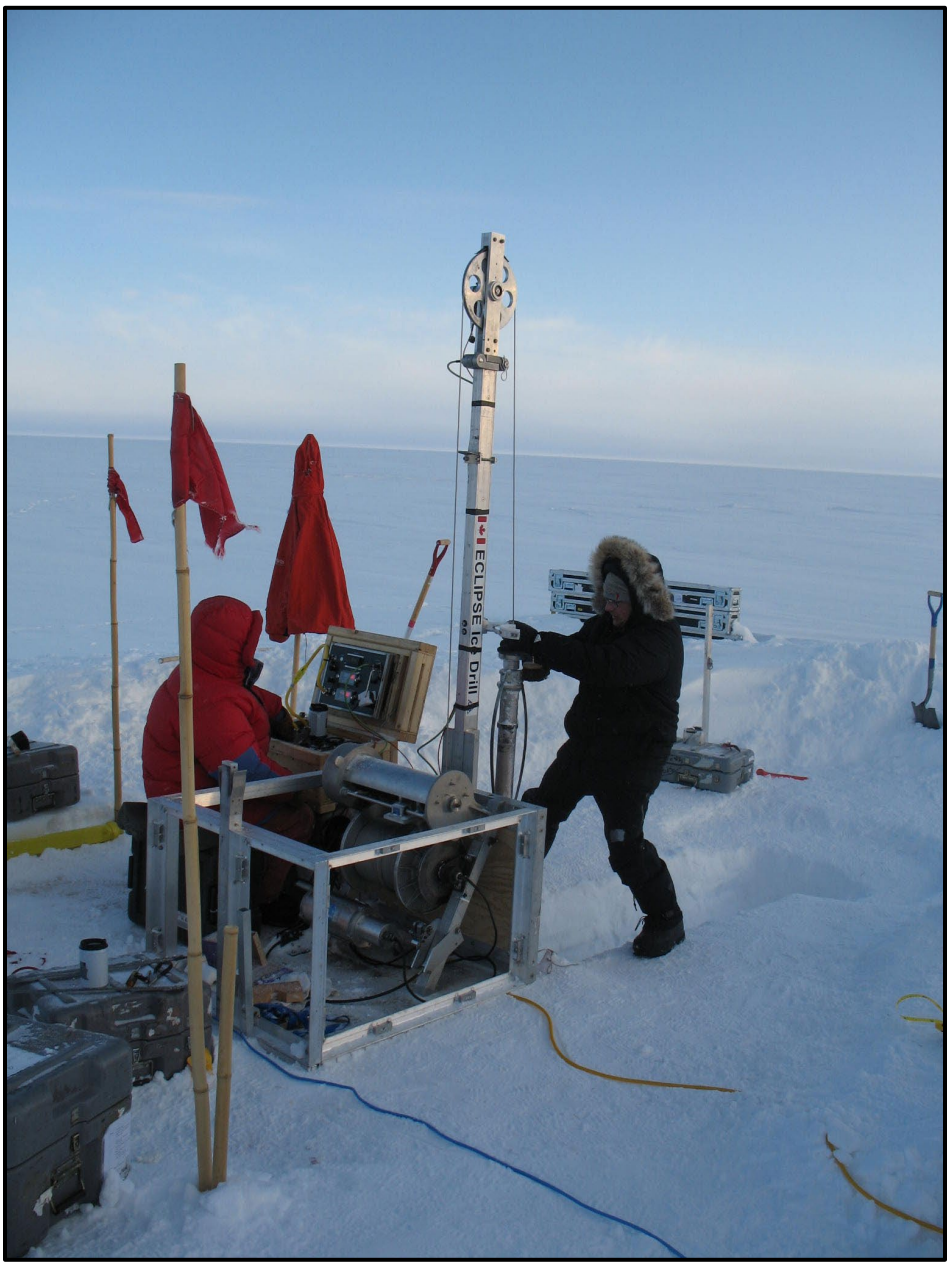

ECLIPSE DRILL

Operations and Maintenance Manual

November 8, 2024

U.S. Ice Drilling Program
University of Wisconsin-Madison Space Science & Engineering Center

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1.0 PURPOSE

1.1 The objective of this document is to provide the operator with a working knowledge of how the Eclipse Drill is assembled, tuned, and operated. This document outlines the assembly instructions, operating instructions, troubleshooting, tips, and the included tools and spares.

2.0 SCOPE

2.1 This Operator's Manual applies to the Eclipse Drills maintained and operated by the Ice Drilling Program (IDP).

3.0 REFERENCES

3.1 8512-0007, Eclipse Failure Mode and Effects Analysis (FMEA) – Table

3.2 8512-0008, Eclipse FMEA - Summary

3.3 8512-0009, LCI90i Quick Setup Guide

3.4 8512-0010, LCI90i User Manual

3.5 8512-0011, Eclipse Control Box Wiring Diagram

3.6 8512-0012, Eclipse Drill Readout Wiring Diagram

4.0 DEFINITIONS

4.1 IDP – U.S. Ice Drilling Program.

4.2 QAS – Quality Assurance and Safety group.

4.3 SSEC – University of Wisconsin-Madison, Space Science and Engineering Center.

5.0 RESPONSIBILITIES

5.1 IDP Engineering is responsible for the generation and maintenance of this document.

5.2 SSEC QAS is responsible for ensuring that this document is created, reviewed, approved, maintained and updated per appropriate procedures.

5.3 Eclipse Drill Field Management and Staff are responsible for ensuring this manual is followed.

6.0 RECORDS

6.1 Drill logs

7.0 SAFETY NOTICE

All operators of the Eclipse Drill should read and understand the following safety precautions of this device prior to using.

Personal Protective Equipment (PPE)

- PPE – Workers shall wear gloves, eye, ear, arm or fall protection whenever there is the potential for injury.

Mechanical Safety

- Cutters – The cutters on the drill are extremely sharp. Operators shall use care whenever handling cutter assemblies or cutter blades and should wear protective gloves whenever possible.
- Pinch-points – There are several areas on the drill where a finger, hand, arm or clothing could be pinched. Workers should wear gloves whenever working around potential pinch-points.
- Suspended Loads – Users shall never stand under suspended loads. Injury may result from a moving, rotating, falling or unbalanced load.
- Eye Protection – Standard operations of the Eclipse Drill do not require eye protection be worn by operators; however, eye protection shall be available onsite in the event of non-standard operations such as those using chemicals to free a stuck drill.
- Hardhats – Hardhats shall be worn whenever workers are exposed to a potential for head injury from falling or flying objects.

Electrical Safety

- Voltage – Extreme care shall be taken when assembling, disassembling and servicing electrical equipment. Electrical equipment should only be serviced by personnel trained in electrical safety.
- Grounding – Because the drill sits upon a large thickness of ice, a common earth ground cannot be established. Workers shall ensure that all drilling equipment is bonded together to a common ground back to the drill operation's generator(s).
- Lockout Tagout procedure – Lockout/tagout procedures shall be followed whenever servicing electrical equipment.

Chemical Safety

- Use care and observe all safety warnings when handling or using Ethanol or other chemicals.

Fall Protection Safety

- Use care when walking on slippery surfaces (i.e. the ice surface) and when working near boreholes.
- The trench cut in the ice around the drill poses a fall risk, the area should be marked with spray paint to increase visibility. A warning line around the trench installed 3 feet above ground level is recommended.

Environmental Safety

- Cold Exposure – This drill will be deployed to extremely cold climates. Workers shall wear outerwear suitable to protect themselves from the environment and monitor their own and fellow workers' activities for exposure to cold.

8.0 ECLIPSE DRILL USER MANUAL

The following contains the Icefield Instruments, Inc. User Manual for the Eclipse Ice Coring Drill; Rev. 6 dated February 2016. This manual has been edited with information specific to the IDP version of the system.

9.0 ASSEMBLY INSTRUCTIONS

9.1 General Notes

- Unless otherwise noted, all the hardware/fasteners on this drill are of Imperial dimensions (fractional inches). Please refrain from using metric tools as damage to the equipment may result.
- Many fasteners on this drill are secured using Loctite. Red (permanent) Loctite is used, for example, on the screws holding the plastic flights onto the inner barrel. If you suspect that a screw or bolt is not rotating because it has Loctite applied to it, you can briefly heat the part with a torch to soften the locking compound. Take care not to damage plastic and/or rubber components while applying heat.
- Some frame fasteners are stainless steel. Where they attach to load-bearing aluminum parts, there is often a steel Helicoil® thread insert. If you see evidence of thread damage on a fastener (the inserts are harder than the fastener), please replace the fastener as soon as possible.
- Fasteners mating to Helicoil® inserts should be treated with anti-seize compound (thread lubricant).
- Assembling a large machine with many close-tolerance parts can be simplified if fasteners are left a bit loose until all the fasteners are in place.
- All frame parts that bolt together are painted with alignment marks, as well as symbols matching those in the hardware box to show what fasteners are needed in each location.

9.2 Case and Shipping Information

9.2.1 Eclipse 1 – Standard Eclipse

Piece ID	Type	Description	Weight (kg)	Cube (ft3)
ECL03	Hardigg	Control Box 3	26	3
ECL04	Hardigg	Control Box 4	26	3
ECL05	Aluminum Case	Levelwind & Tools	97	7
ECL06	Aluminum Case	Winch & Readout Box	125	10
ECL07	ATA Case	Drill AT & Motor Sections	72	5
ECL08	ATA Case	Core Barrel & Mast	70	6
ECL09	ATA Case	Core Barrel	70	6
ECL10	ATA Case	Drill Frame and Sheave	95	11

The approximate weight for the drill system including spare parts and shipping cases is 1500 lbs.

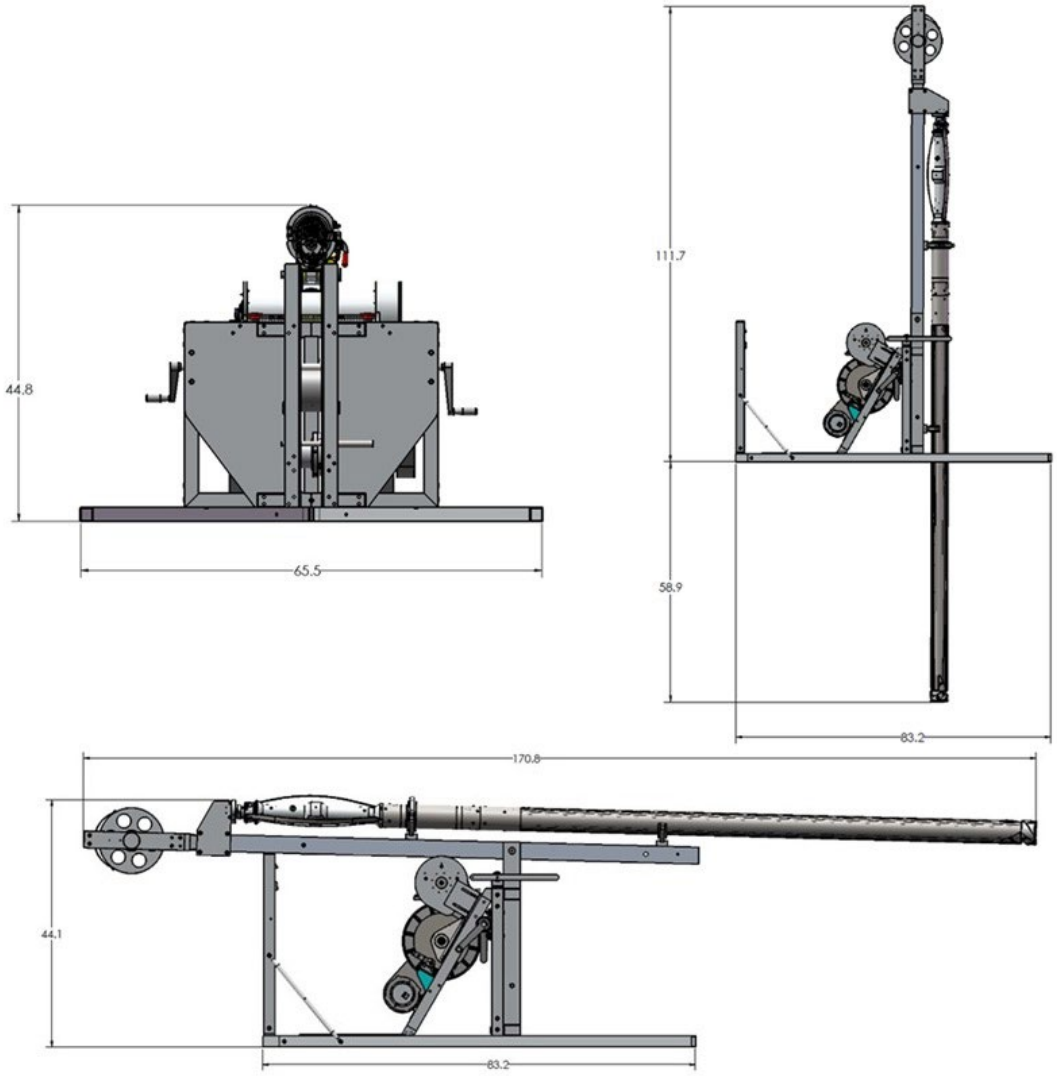


Figure 1. Eclipse 1 Dimensions

9.2.2 Eclipse 2 – Traversing Eclipse

Piece ID	Type	Description	Weight (kg)	Cube (ft3)
ECL-20	ATA Case	Winch Sled & Readout Boxes	345	43
ECL-21	Hardigg	Spare Cable and Tools	57	7
ECL-22	Hardigg	Tools	13	3
ECL-23	Hardigg	Control Box 1	27	3
ECL-24	Hardigg	Control Box 2	27	3
ECL-25	Hardigg	Spares & Tools	52	4
ECL-26	ATA Case	Core Barrel	49	5
ECL-27	ATA Case	Core Barrel & Tower	49	5
ECL-28	ATA Case	Motor Sections	56	4

The approximate weight for the drill system including spare parts and shipping cases is 1500 lbs.

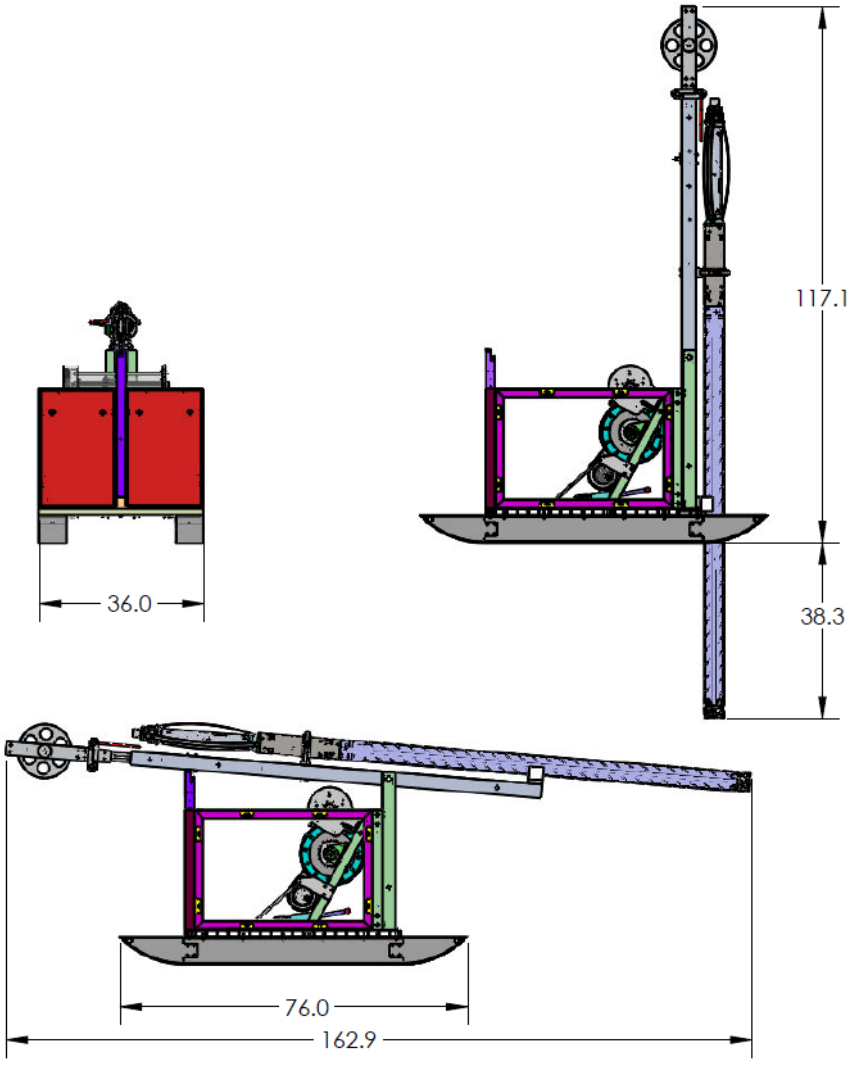


Figure 2. Eclipse 2 Dimensions

9.3 Winch Frame Assembly **(Eclipse 1 Only)**

Reference frame Figure 3 below shows the general layout of the drill when assembled, configured in the horizontal boom position.

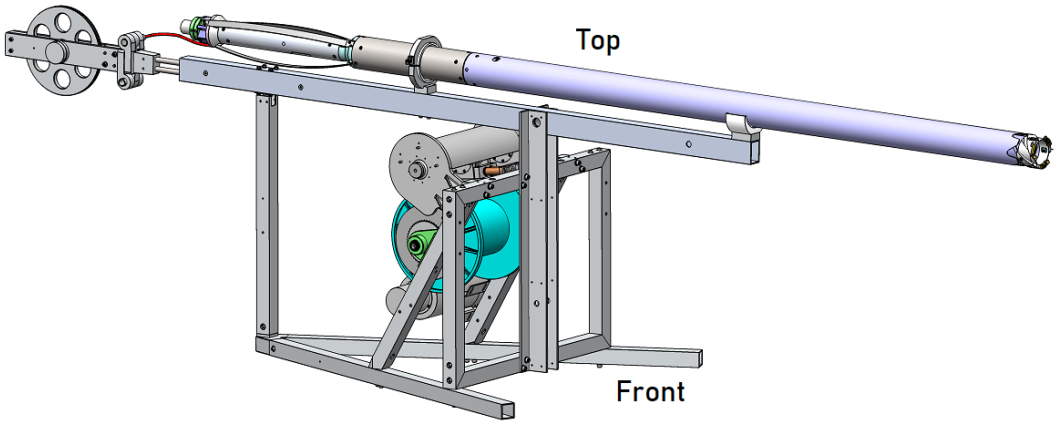


Figure 3. Eclipse 1 Layout

To have a base onto which to assemble other components it is suggested that the winch frame be assembled first, Figure 4.

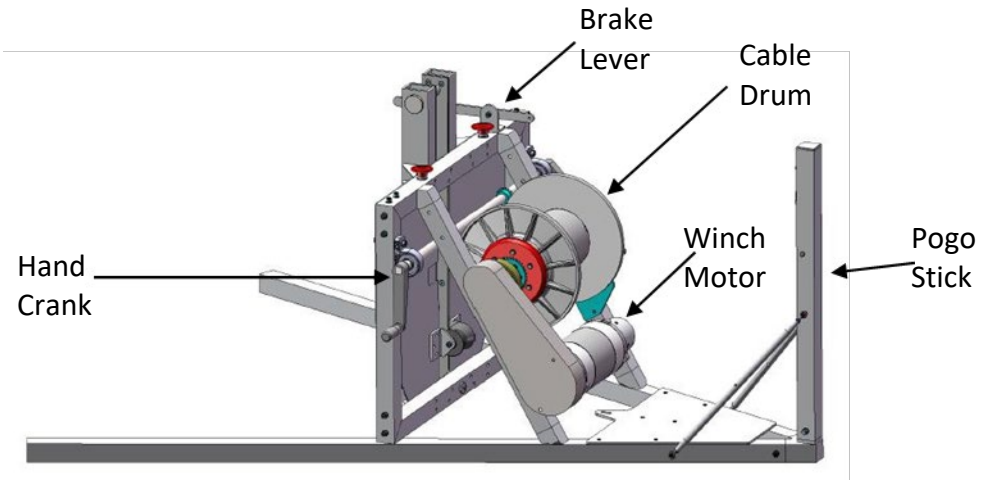


Figure 4. Winch Frame Assembly

9.3.1 Bare Frame Assembly

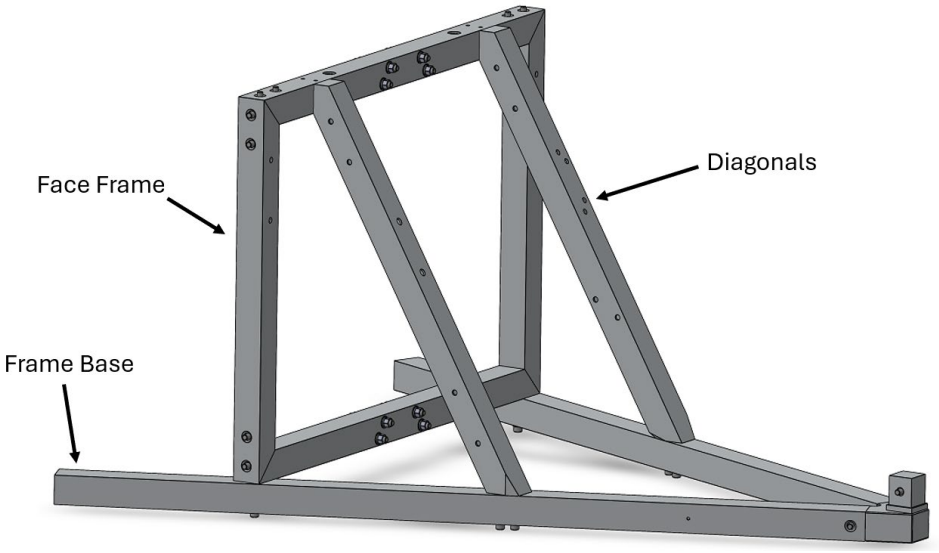


Figure 5. Bare Frame Assembly

First assemble the frame base, Figure 5. This consists of two long base frame members and one A-frame block. The face frame can then be assembled and mounted to the frame base. Next, the diagonal frame members can be mounted.

9.3.2 Mounting the Cable Drum and Winch Motor

The winch motor and cable drum can now be mounted onto the frame. The input shaft of the cable drum should be on the right side of the winch, as shown. Figure 6 shows two chains installed. The right-hand chain (shown in foreground) is used to drive the level winder. The second chain (the bottom is just visible in the photo) is for the handwheel.

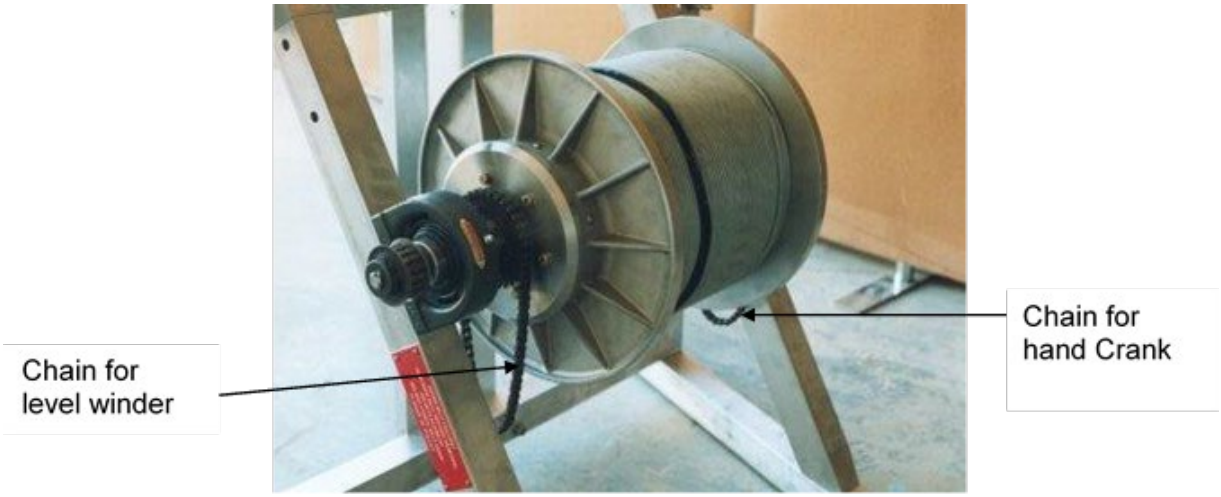


Figure 6. Winch Cable Drum

Mount the winch motor to the diagonal frame members. Before tightening the mounting fasteners for the winch motor, attach the drive belt to the motor and drum. Take care that the belt is not stretched and/or twisted when installed. The belt tension should be such that about 5mm deflection results from modest thumb pressure, Figure 7. Also ensure that the two pulleys are lined up so that the belt runs perpendicular to the shafts.

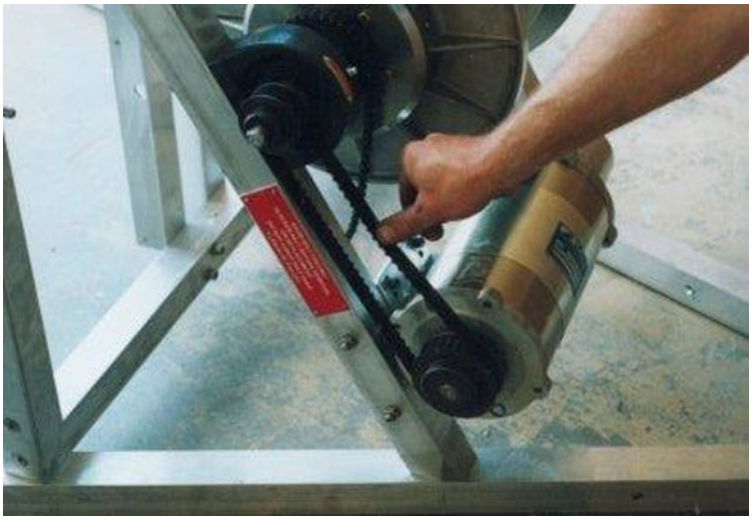


Figure 7. Installing the Drive Belt

Attach the belt cover plate on the two posts attached to the winch motor using the supplied thumb screws, Figure 8.

Figure 8. Installing the Cover Plate

9.3.3 Mounting the Pogo Stick

Mount the pogo stick to the frame base, Figure 9. Also, mount the pogo supports, using a 3/8” nut to space the lower support mounts away from the frame. The pogo supports can be lengthened or shortened by turning the support when its ends are held in place. In this way the pogo stick can be stiffened if required.

Figure 9. Pogo Stick Installation

9.3.4 Mounting the Boom Supports

Mount the boom supports to the front of the face frame, Figure 10. Also insert the boom locking pin into the bottom of the boom supports. It is suggested that this pin be secured to the frame using the supplied cord to avoid losing it downhole.

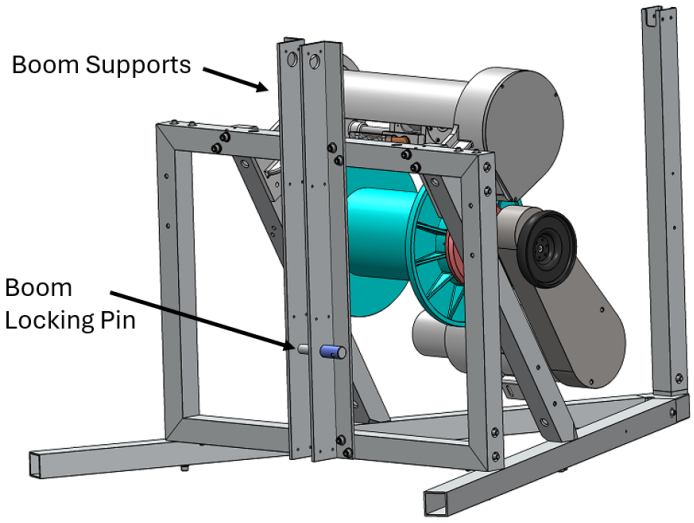


Figure 10. Installing the Boom Supports

9.3.5 Mounting the Hand Brake and Handwheel

Attach the brake assembly to the frame as shown in Figure 11. Slip the handwheel axle through the chain on the brake rotor side of the drum and engage the chain on both cogs. Then attach the axle's bearing blocks on the upright members of the face frame. Mount the handwheel on the side nearest the drill operator. If the gears on the drum and axle are misaligned, move the shaft in the bearing blocks until they are in line.

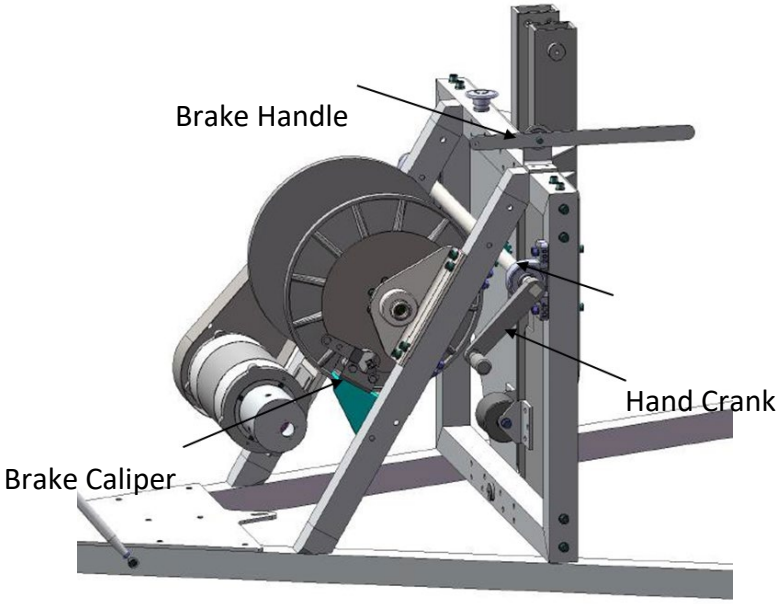


Figure 11. Brake and Crank Installation

9.3.6 Level Winder Assembly

The level winder is a mechanical system for evenly wrapping cable onto the drum of the Eclipse winch. The level winder is shipped fully assembled, lubricated, and ready for installation, Figure 12.

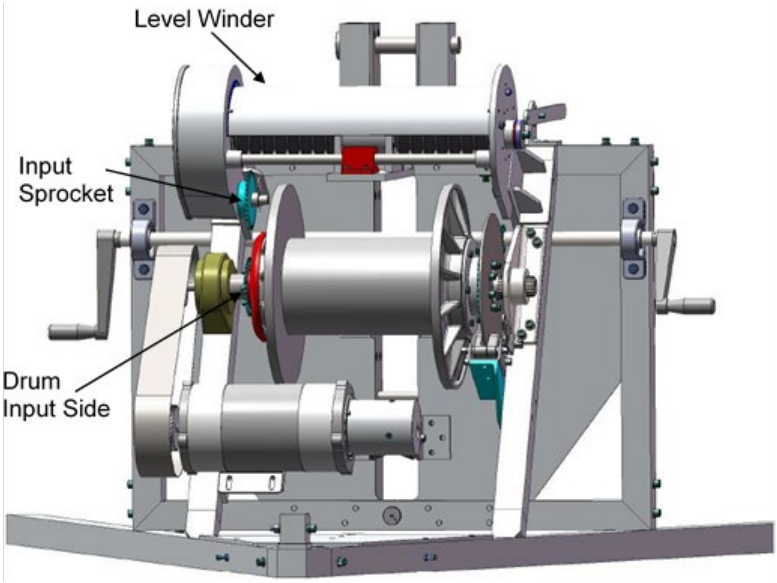


Figure 12. Installation of Level Winder

Mounting the level winder onto the frame is best done with two people. Lift the level winder into place and tip the chain sprocket end downward to loop the drive chain over the input sprocket. Then mount the Level winder in place using the supplied 3/8” X 2” spring pins. Mounting nuts and bolts may be used to secure the level winder, but it is suggested that spring pins are used to locate at least one side of the level winder to allow for movement between the level winder and frame.

9.4 Winch Frame Assembly **(Eclipse 2 only)**

9.4.1 The Eclipse 2 frame and winch are shipped fully assembled, minimizing setup time. The only mechanical setup required is to remove the top and two side panels, providing access to all necessary components.

9.4.2 This case is designed for traversing operations, and thus has removable ski tips on the front and back of the I-beams that support the case. These should be installed for traversing and drilling operations. For shipping they should be removed and stored in the winch case.

9.5 Boom Assembly

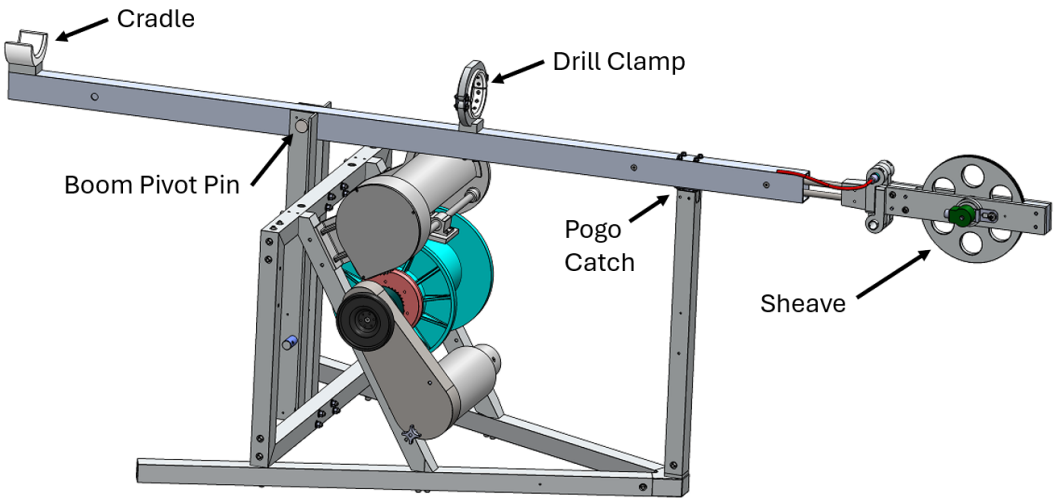


Figure 13. Short Boom Assembly

Mount the boom onto the frame using the boom pivot pin and secure the pin with the linchpin. Then slide the sheave and slide assembly into the boom, with the encoder pointing towards the motor side of the frame as shown in Figure 13. On the slide assembly there are two blocks. Attach these to the boom using the supplied flat head screws, starting with the block nearest the pivot. Then bolt the cradle, drill clamp, and pogo catch onto the boom.

9.6 Control System

The IDP Eclipse Drills use custom control and read-out boxes which have proven more reliable in the field than the Icefield-provided control boxes. The control and read-out boxes are water-tight when opened or closed, and nest together during use, Figure 14.

- A 115VAC power supply is required to run the system. The drill has been run on a generator as small as 2 kW, although it is recommended to use 3 kW or larger to ensure full performance.

- Inspect all cables and connectors before hooking them up. Make sure the connector housings/strain reliefs are tight, and the cables are free of nicks or damage.

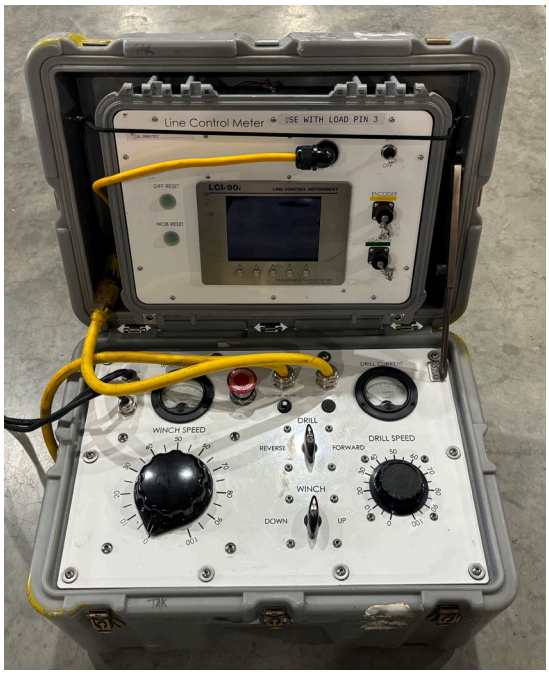


Figure 14. Drill Control System

The winch and drill motors have separate speed controls, direction controls, and amp meters. The power input has a 15A circuit breaker. However, the outputs are not current limited, so it is up to the operator to monitor each motor's current draw and keep it within a safe range, Table 1.

Table 1. Winch and Drill Motor Current Limits

	Continuous Power	Peak power (short duration)
Winch motor	13 amps	15 amps
Drill motor	1.8 amps	5 amps

9.6.1 Control Box Setup

All cables are hardwired to the control box faceplate and are clearly labeled. To minimize the possibility of operator injury or damage to the equipment, confirm the power is turned off or disconnected before installing or removing cables. The black cable labeled “Winch” connects to the winch motor and the other black cable labeled “Drill” connects to the winch shaft, Figure 15. Before powering the control box by either plugging it in or by resetting the E-stop, confirm both the drill and winch direction selector switches are in the center position and the speed knobs are at 0.

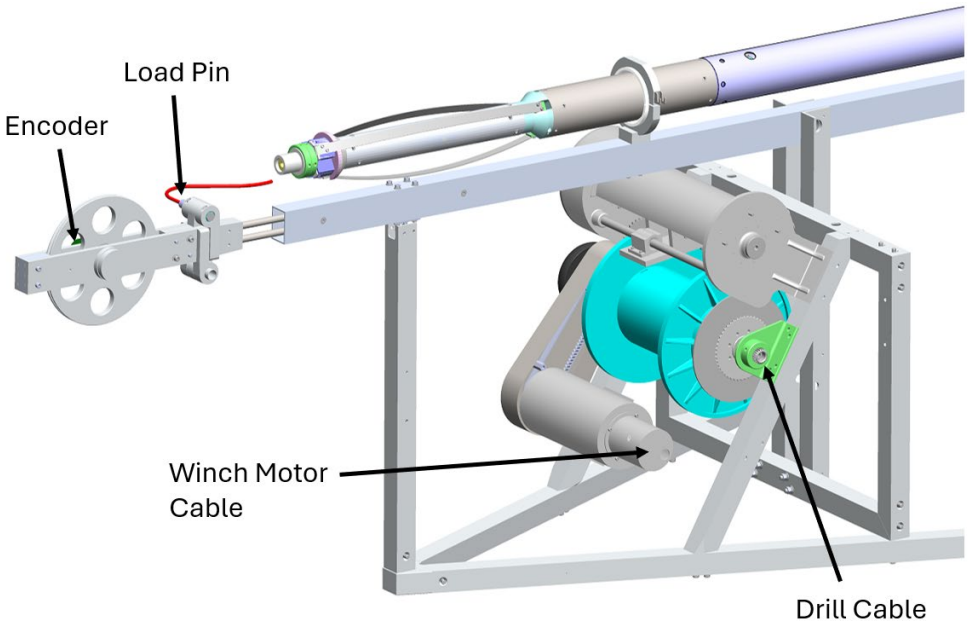


Figure 15. Drill Cable Connection Locations

9.6.2 Readout Box Setup

Unlatch the case lid, pull the two removable hinge pins, Figure 16, and remove the cover. The readout can then be placed in the control box case lid and held in place with the elastic cord, Figure 14.

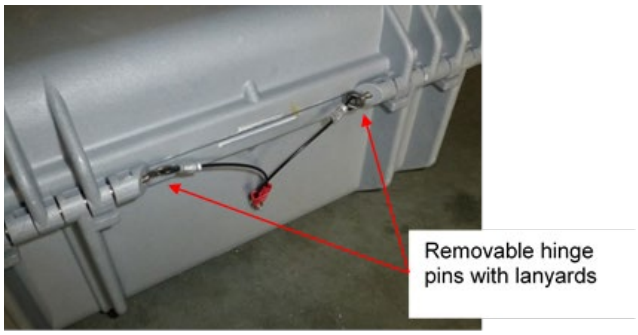


Figure 16. Readout Box Removable Hinge

The yellow power cord can be plugged into any standard 115VAC outlet. However, a receptacle has been provided on the control box specifically for this. There are two receptacles on the readout box faceplate, one for the cable pay out encoder and one for the load pin. Each readout box is calibrated for use with a specific load pin, so be sure to verify you are using the matched load pin. If the readout boxes are swapped out during operation it is recommended to also change the load pin to maintain proper calibration. Plug the load pin cable into the receptacle labeled "LOAD PIN" and install the load pin as shown in Figure 17. To ensure the load pin is as aligned and thus accurate as possible, be sure to push the load pin keeper towards the load pin as you are tightening the two screws. The other cable should be used to connect the encoder to the "ENCODER" receptacle on the readout box. Secure the two cables to the tower using the included Velcro straps, allowing enough slack for the sheave to fully extend.

Note that the LCI-90i display is protected by a 0.625A fuse that can be accessed by removing the faceplate of the readout box, if necessary.

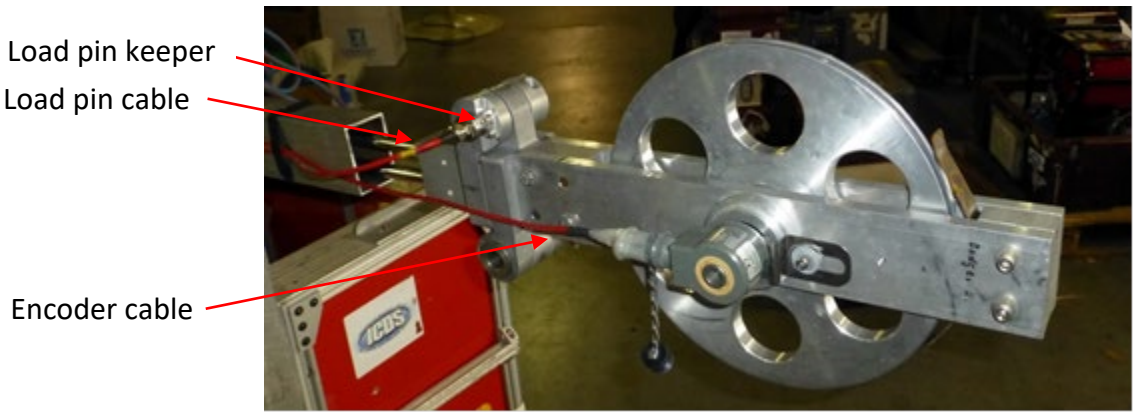


Figure 17. IDP version of the Eclipse Drill sheave

9.6.3 Winch Cable & Drill Motor Wiring

The connectors internal to the drill sonde (between the drill motor assembly and the bottom of the anti- torque section), the connector on the end of the winch drum shaft, and the connector on the end of the drill cable coming from the control box are all wired the same. The pin out is as follows:

The cable plug is an Amphenol MS3116F8-4S (or MS3116E8-4S if there is no strain relief) connecting to an MS3112E8-4P receptacle.

Drill Power Cables	
Pin	**Function**
A	Drill Power -
B	Drill Power -
C	Drill Power +
D	Drill Power +

9.6.4 Winch Motor Cable

The black winch motor cable is hard wired to the control box on one end and has an 8 pin Amphenol connector, PT06E16-8S-SR, at the other end.

Winch Motor Cable	
Pin	**Function**
A	Power +
B	Power +
C	N/C
D	N/C
E	Power -
F	Power -
G	N/C
H	N/C

9.6.5 Encoder Cable

The encoder cable is red with 6 pin Amphenol connectors at either end.

The plug on the readout box end of the cable is an MS3112E10-6P, mating with an MS3102F10-6S socket on the readout face plate. The plug on the encoder end of the cable is an MS3106A-14S-6S.

Encoder Cable		
Pin	**Readout Box Connector**	**Encoder Connector**
A	Sig. A	Com
B	N/C	+ 12v
C	+ 12v	N/C
D	Com	Sig. B
E	Sig. B	Sig. A
F	N/C	N/C

9.6.6 Load Pin Cable

Each load pin comes supplied with an attached red cable. Verify the number on the cable matches the load pin number on the readout box you are connecting it to.

The plug on the readout box end of the cable is a PT06A10-6S, mating with a MS3112E10-6P socket on the readout face plate.

Load Pin Cable	
Pin	**Function**
A	S -
B	GND
C	V +
D	V -
E	S +
F	N/C

9.7 Winch Cable Set-Up

Before the cable is connected to the drill (per sections 8.8 and 8.9) it should be routed through the sheave and the level winder synchronized with the winch.

If the cable is slack on the drum, it is possible to respool the cable under tension by paying it out on the ice and using a Skidoo or weighted sled to apply consistent load during respooling. The cable should be evenly wrapped around the drum with no layers cutting into those below, Figure 18. A shim can be added at the first wrap to ensure proper spooling.

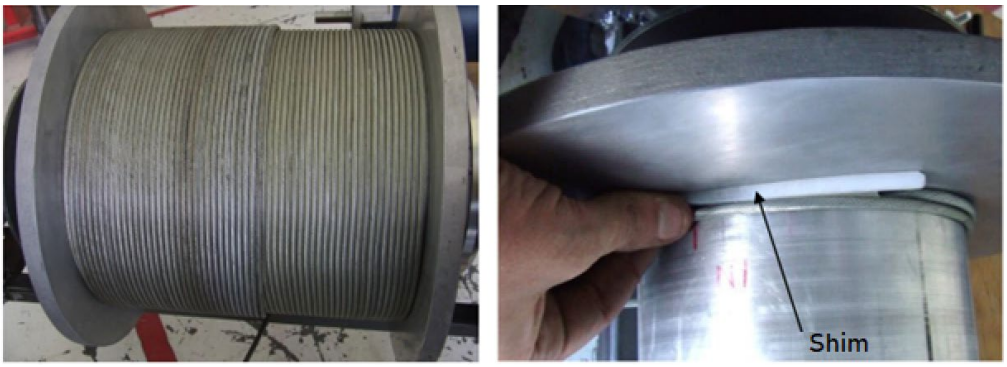


Figure 18. Installing the Winch Cable on Drum

9.7.1 Level Winder Synchronization

For the level winder to work properly it is important that it be synchronized with the cable position on the Winch Drum.

With the cable wrapped onto the drum (if necessary, tidy this up manually) power the winch drive and slowly pay-out a small length of cable from the drum while noting in which direction the shuttle is moving, Figure 20.

NOTICE: Ensure that the cable is under tension so that a large amount of cable does not spring from the drum. This can be achieved by pulling the cable with your hand while paying it out.

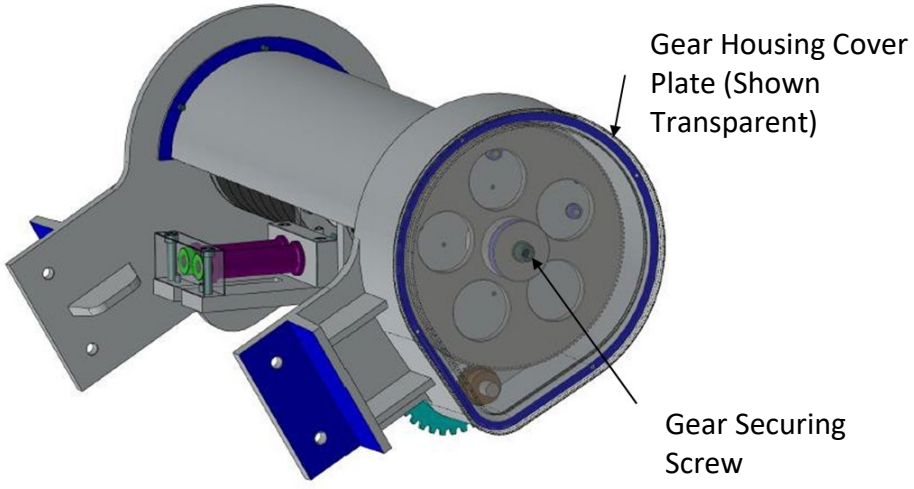


Figure 19. Level Winder Assembly, Gear Side

Remove the gear-housing cover plate. Loosen, but do not remove the socket head cap screw at the center of the large gear, Figure 19. This allows the reverser screw to rotate independently of the gear.

Insert a hex-wrench into the socket head cap screw on the idler side of the reverser screw, Figure 20. Using the wrench, rotate the reverser screw to align the gap between the level winder fairlead rollers with the winch cable and so that the level winder shuttle is moving in the same direction as the winch cable.

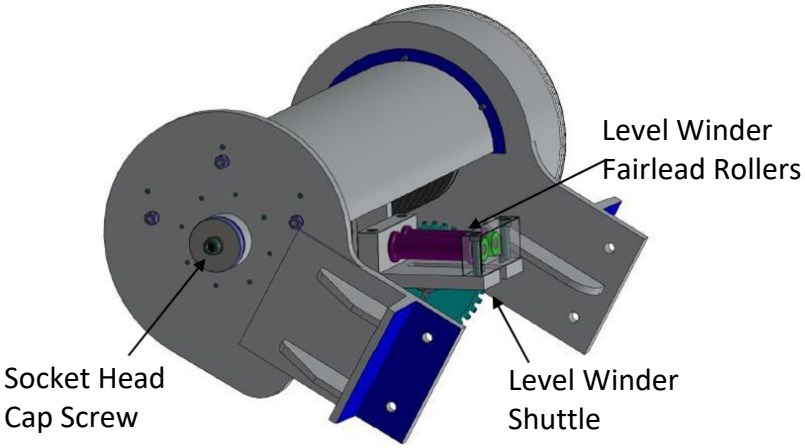


Figure 20. Level Winder Assembly, Idler Side

Once set, lock the synchronization by holding the reverser screw at the non-gear end with a hex-wrench, while tightening the hex-socket bolt at the gear end. Replace the gearbox cover plate.

After the initial (loosely wound and disturbed) cable has been spooled out, it may be necessary to re-synchronize the level wind, but this should only amount to a small positional adjustment.

9.7.2 Routing the Winch Cable

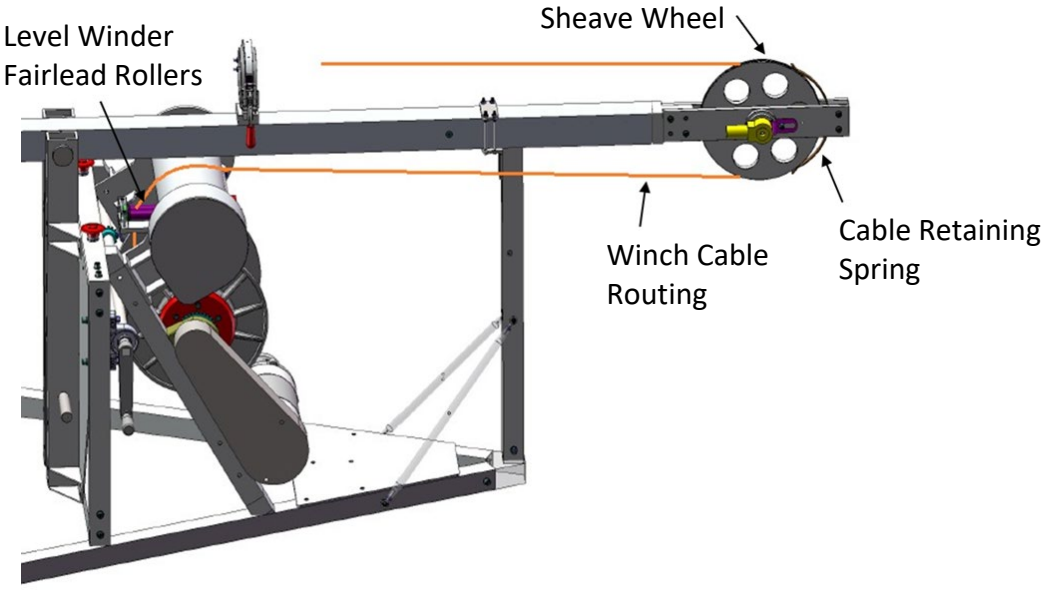


Figure 21. Winch Cable Routing

Using the control panel, slowly turn the winch cable drum (in the down position) to pay out a few meters of cable.

NOTICE: Ensure that the cable is under tension so that a large amount of cable does not spring from the drum. This can be achieved by pulling the cable with your hand while paying it out.

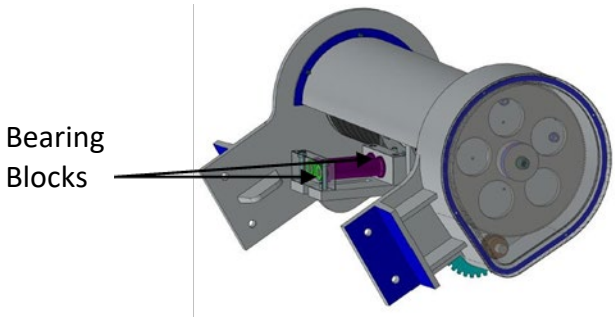


Figure 22. Fair Lead Bearing Blocks

To route the cable through the fairlead rollers in the level winder first undo the bolts securing the outermost bearing block, Figure 22. The bearing block and rollers can then be removed. Route the cable between the rollers and reinstall them and the bearing block.

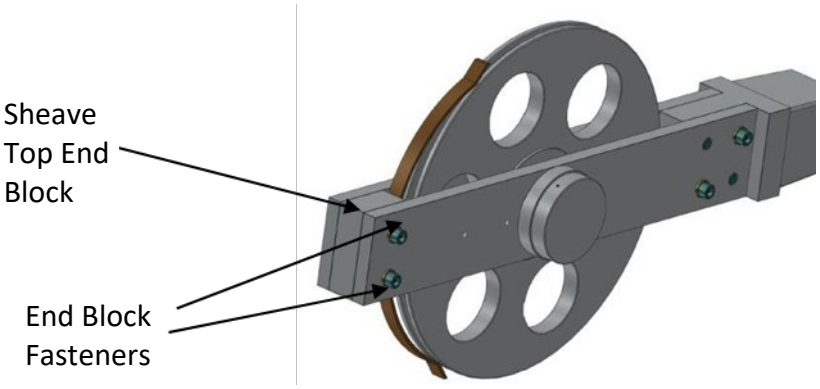


Figure 23. Sheave Top End Block

The winch cable is then routed over the level winder cover and around the sheave wheel. To route the cable onto the sheave wheel, remove the four fasteners holding the sheave top end block, Figure 23. This will allow the top end block to be removed and the cable to be routed onto the wheel.

Ensure that the cable is secure in the groove of the sheave wheel and held in place by the cable retaining spring if present.

9.8 Winch Cable Connection - Evergrip

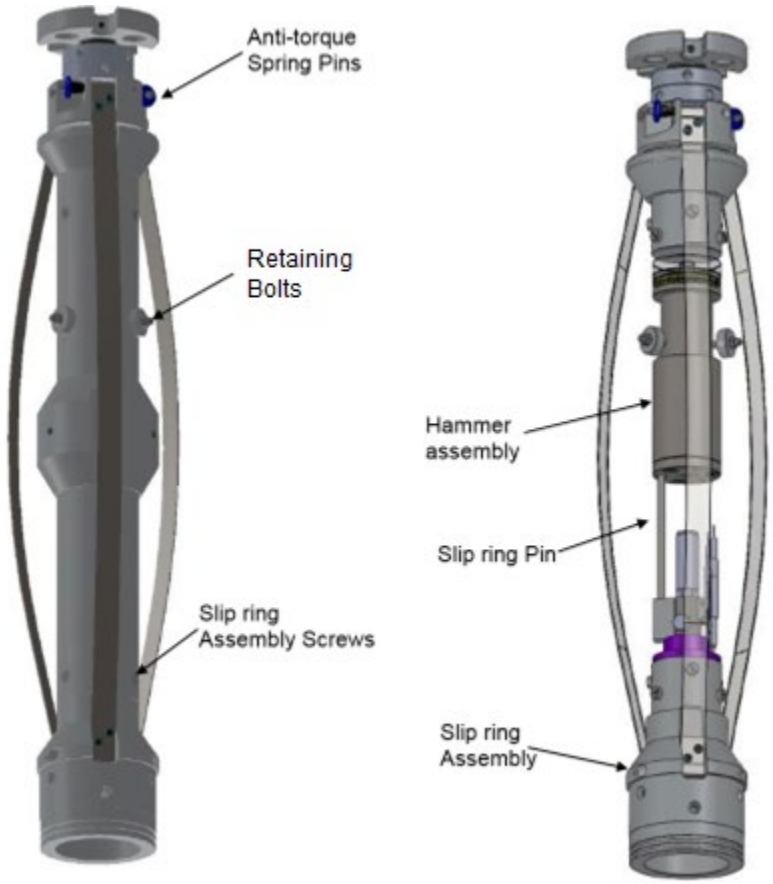


Figure 24. Evergrip Anti-torque Assembly

WARNING: Before the winch cable is terminated, ensure that the drill power cable is unplugged!

Note: Ensure that the recovery loop and locating nuts are installed per Section 8.11 before connecting the cable.

The winch cable termination is inside the anti-torque section of the drill. The termination is a pinch-type termination located inside the hammer.

To attach the winch cable to the drill, the hammer assembly must first be removed from the anti-torque section. First remove the anti-torque spring pins near the top of the anti-torque assembly and, using a large flat head screw driver, remove the six slip ring assembly screws, Figure 24. The slip ring assembly can now be removed.

The hammer can then be removed from inside the anti-torque tube by backing out the three retaining bolts. The hammer assembly has been disabled in all IDP drills. However, if the hammer is used, hammer pin retraction tools are recommended to assist with removing the pins, Figure 25.

Figure 25. Hammer Pin Retraction Tool

Remove the hammer flange from the lower end of the hammer that contains the Evergrip termination, Figure 26. Thread the cable through the upper anti-torque assembly and the hammer and attach the cable to the Evergrip termination according to the manufacturer's instructions.

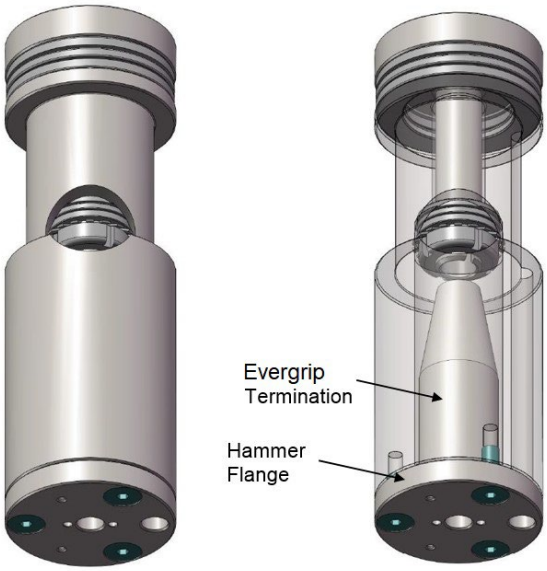


Figure 26. Hammer Assembly

The termination kit is the Evergrip part number P/N 9006120-1, and the re-termination kit (does not include the body) is 9006120-1R. Installation instructions are included with each re-termination kit, but more information is available on the PMI website:

www.pmiind.com/index.php?id=23 .

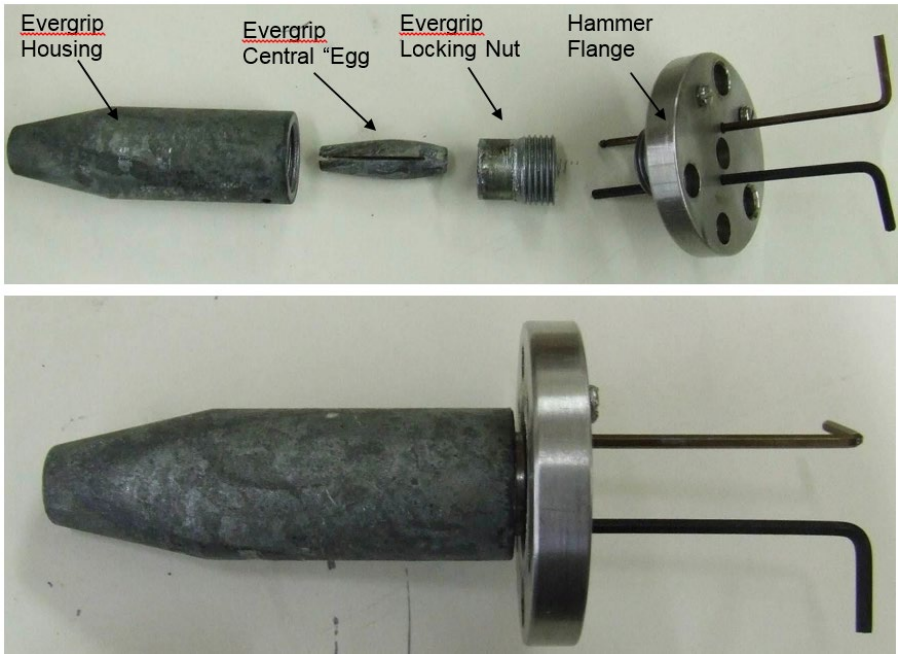


Figure 27. Evergrip Assembly

The two small holes in the base of the hammer can be used (together with the two pins (Allen keys) supplied with the Evergrip termination kit) as a wrench to tighten the over-wraps onto the central "egg", Figure 27. Make sure that while you are tightening the "egg", the flange does not bottom out on the Evergrip housing, thereby giving you a false sense of having tightened up the egg.

Leave about 10 cm of winch cable conductors below the hammer for electrical termination. The strands of the cable armor should be cut off immediately below the termination and covered with a length of heat shrink tubing to protect the conductors. The easiest way to cut the strands is using a Dremel tool with a cut-off wheel, as shown in Figure 28.

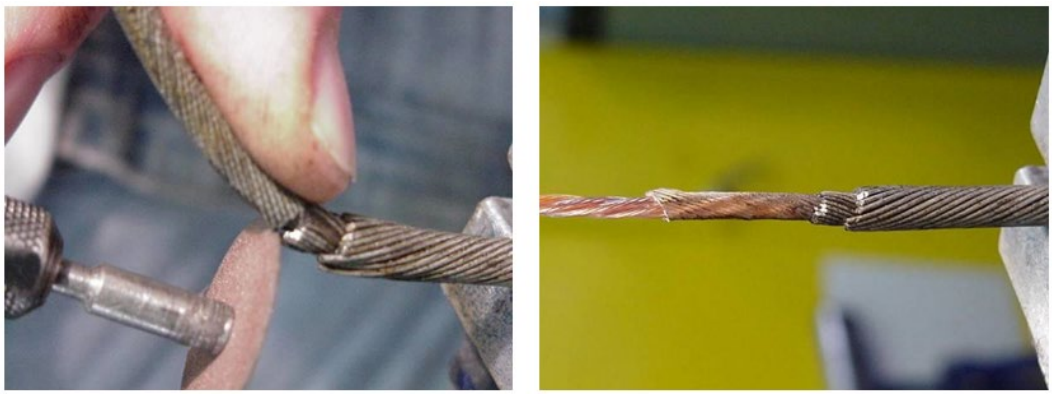


Figure 28. Winch Cable Preparation

When reassembling the hammer, make sure the 6mm (1/4") clearance hole in the flange and the corresponding hole in the hammer body are lined up – this hole accepts the pin on the slip ring assembly that is attached to the bottom hinge block of the anti-torque section, Figure 29.

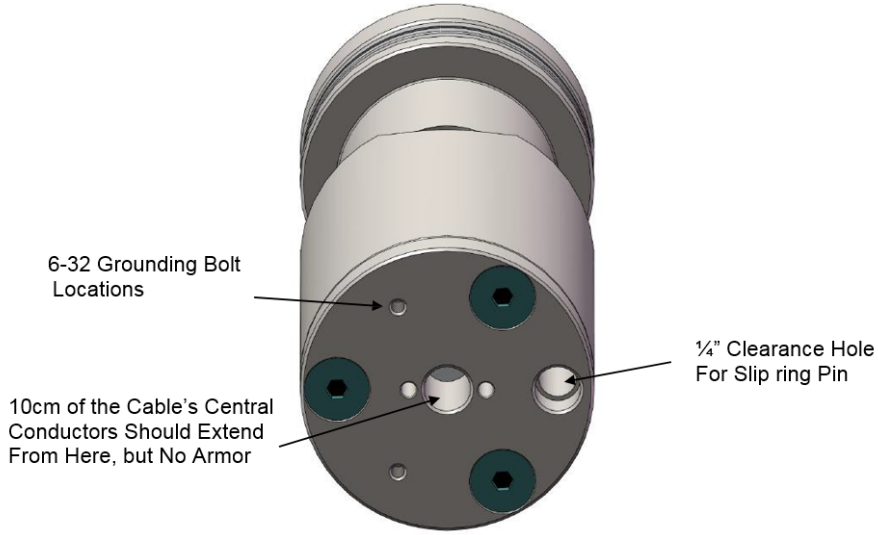


Figure 29. Hammer Flange

9.8.1 Slip Ring Wiring

Figure 30. Slip ring wiring

After the winch cable has been terminated using the Evergrip termination kit, the electrical connection of the winch cable can be connected to the top of the slipring assembly with a 4-pin Amphenol connector. Note, the connector is modified so the wires exit the side of the connector. This is because when the hammer is in its lowest position there is only about ½" of clearance between it and the back of the connector, Figure 30. When installing this connector, be sure pins are wired straight through (A to A, B to B, C to C, and D to D) to the connector on the other end of the cable with a multi-meter. After completing the connector installation, again use a multi-meter to check each of the four wires for continuity, resistance (the resistance on each of the four conductors should be the same), and that they are not shorted to the cable armor. Section 8.6.3 identifies the wire pinouts and functions.

9.8.2 Re-Assembly

After the cable termination and wiring has been completed, the anti-torque assembly can be re-assembled. Make sure that the slip ring pin is lined up with the clearance hole in the hammer assembly.

The anti-torque section can then be reassembled to the drill motor section. Firstly, connect the anti-torque to drill motor jumper, Figure 31.

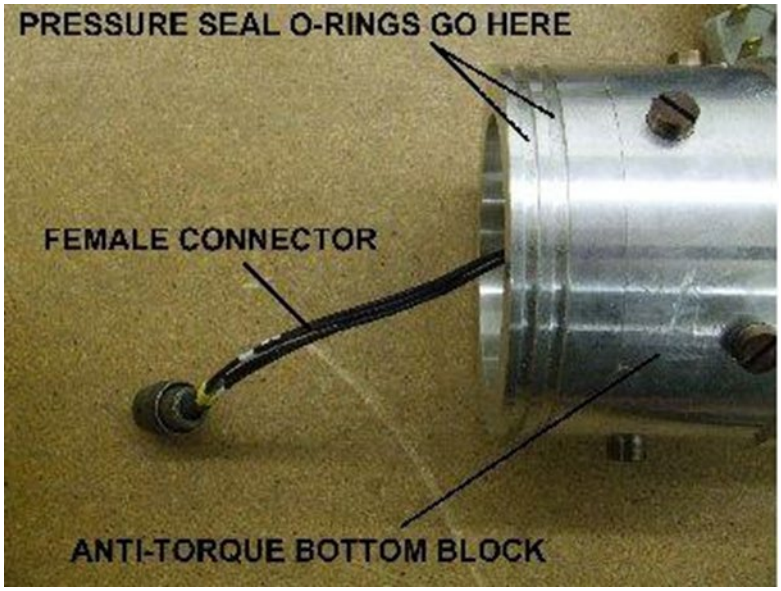


Figure 31. Anti-Torque to Drill Motor Jumper Cable

Insert the anti-torque bottom hinge block into the top plug of the drill motor assembly, Figure 32. Secure the connection using the six drill assembly screws provided.

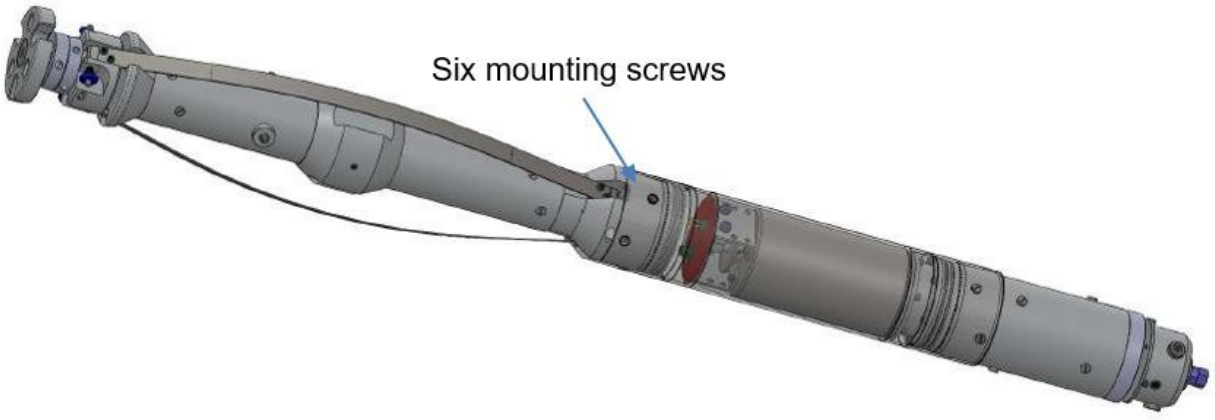


Figure 32. Anti-Torque and Drill Motor Assembly

9.9 Winch Cable Connection – GOI

WARNING: Before the winch cable is terminated, ensure that the drill power cable is unplugged!

Note: Ensure that the recovery loop and locating nuts are installed per Section 8.11 before connecting the cable.

Attaching the GOI connection is most easily done with the boom horizontal and the anti-torque/drill motor assembly clamped in place. Feed the GOI connection through the upper tube on the anti-torque section until the cable end is visible in the window. The GOI connection has a keying feature preventing installation in the wrong orientation; gently push the two halves of the connector together while rotating the sonde-side of the connector until you feel the key align. At this point you can push and thread the connector together by hand until it firms up.

To fully tighten the connection, look into the hole on the side of the anti-torque section beneath the window and rotate the connector in either direction until a matching hole appears. Insert an Allen key into the hole to prevent the connector from rotating. Use either a pin spanner or punch and hammer to do a final tightening of the threaded coupler, then remove the Allen key.

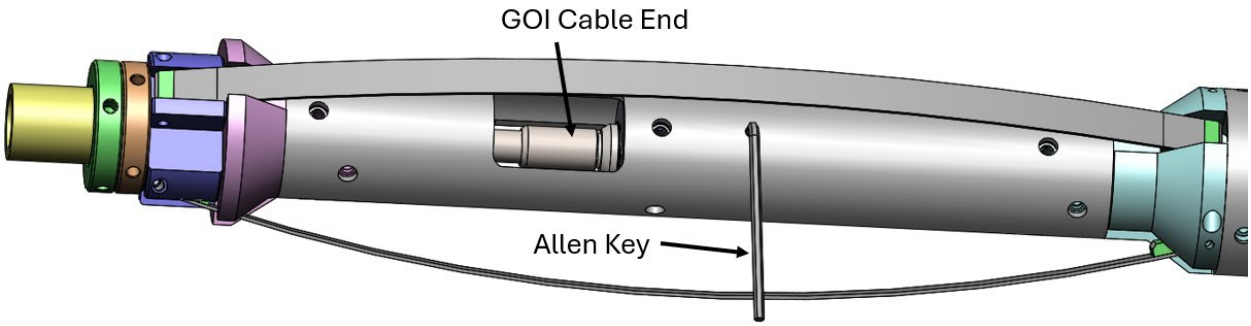


Figure 33. GOI Installation

9.10 Anti-Torque Spring Adjustment

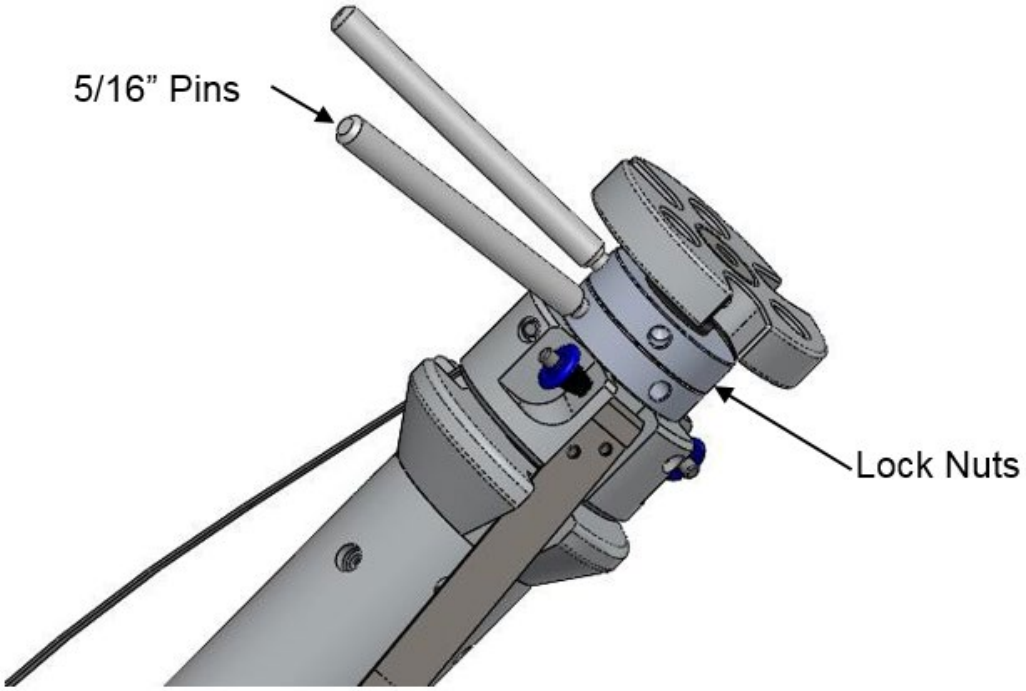


Figure 34. Anti-Torque Spring Adjustment

After the anti-torque section is reassembled, the anti-torque spring tension can be adjusted and locked. The desired tension is dependent on the ice and drilling conditions; this is further discussed in section 10.6. Use the two provided 5/16" pins and the two lock nuts at the top of the drill to adjust and lock in the spring tension, Figure 34.

9.11 Drill Assembly

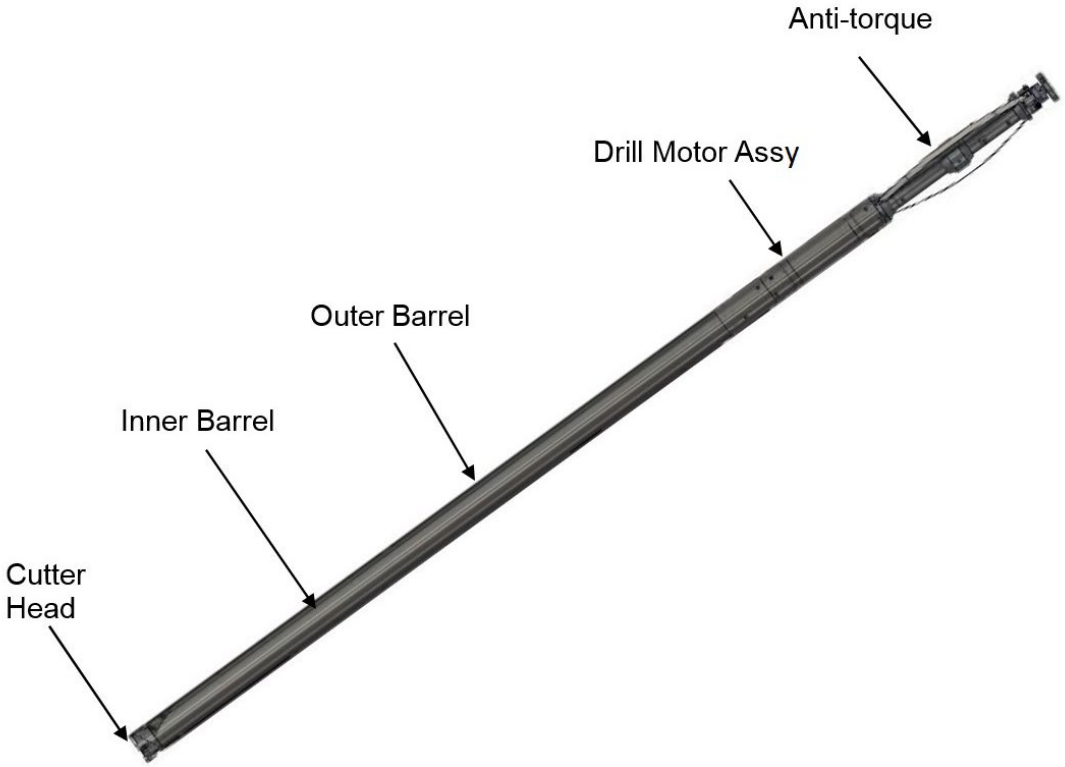


Figure 35. Drill Assembly

9.11.1 Outer Barrel

Place the drill motor/anti-torque assembly on top of the boom and secure it using the cradle. Slide the outer barrel over the drill motor section, Figure 36. This is best done by two people as this is a tight fit. The supplied strap wrenches can be used to facilitate turning the outer barrel into position. Once positioned, secure the outer barrel using six drill assembly screws.

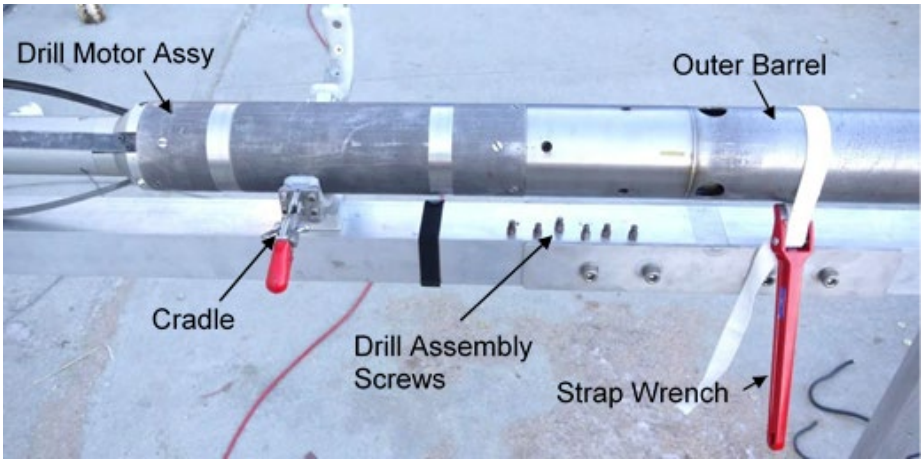


Figure 36. Positioning the Outer Barrel

9.11.2 Inner Barrel

Insert the core plug (also referred to as “mango” or “little man”) into the inner barrel. This core plug must always be present when drilling, as it serves to separate the ice core from the chips that are augured on top during coring. The core plug is suspended in the barrel by a length of para cord with a clip on one end that hooks in one of the chip windows at the top of the core barrel. The length of the cord should be adjusted so the bottom of the plug is about 105cm above the cutters.

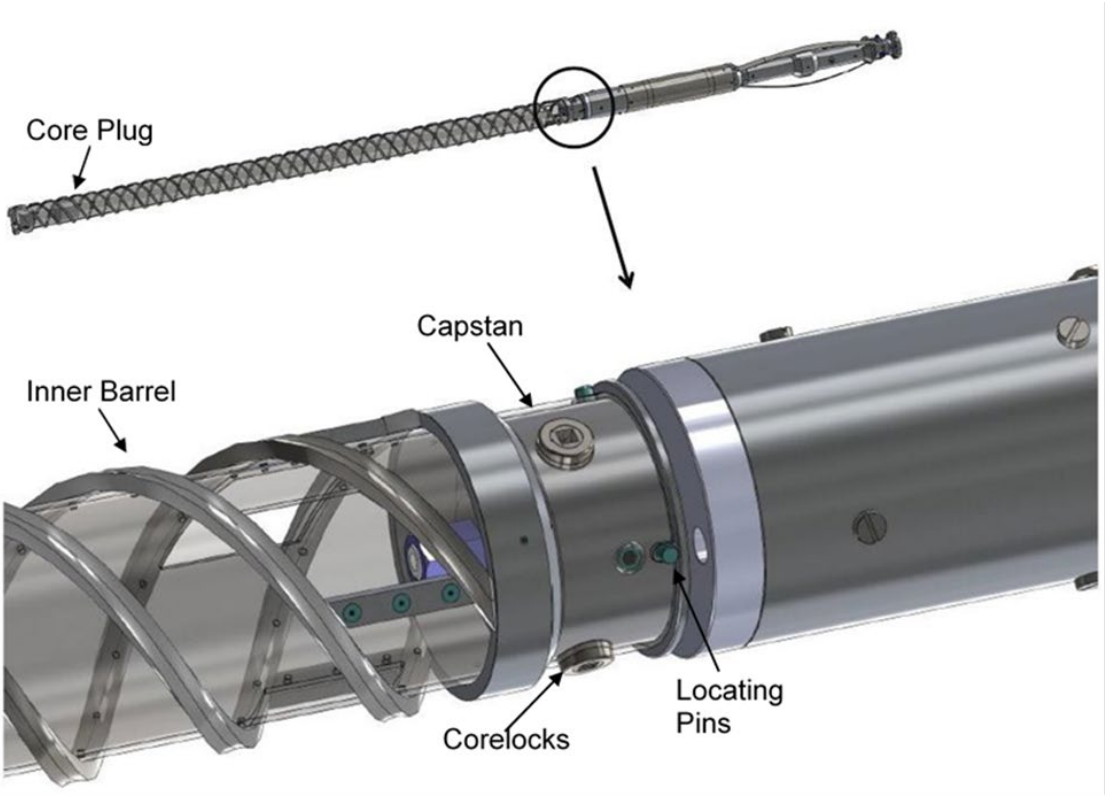


Figure 37. Inner Barrel Assembly

The inner barrel is attached to the capstan by three corelocks, Figure 37. Inner Barrel Assembly. Slide the inner barrel into the outer barrel and turn the inner barrel until the locating pins line up with the notches at the top of the inner barrel.

Note: The Eclipse 1 and 2 have different length inner and outer barrels, and the outer barrels mount at a different height on the motor section. If the barrels do not fit correctly contact IDP.

CAUTION: The cutters are very sharp! Protect your hands from the cutters.

Figure 38. Engaging the Corelocks

Use the control box to turn the drill slowly until the three sockets for the corelocks are accessible from the access port in the outer barrel. Use the provided ¼" driver to push and turn the three corelocks into their extended lock position, Figure 38.

9.11.3 Installing and removing the cutter head

The fit between the cutter head and the inner barrel is very tight. Generally, the head should be installed once at the start of the drilling project and removed only at the end when the drill is packed up. Before installing shoes and cutters, you can use the dead blow hammer to **gently** tap the head onto the barrel. Make sure that the head does not get cocked sideways. The objective is to ensure that the three locking screws line up precisely with the three holes on the inner barrel, Figure 39, as misalignment will cause the locking screws to damage the barrel when they are tightened. If aligning the head to the barrel proves difficult use the custom black handle tool provided in the tool kit. The tapered nose on the tool will align the head with holes in the inner barrel as it is threaded into the locking screw holes. **Gently** tighten the three locking screws being careful not to over tighten the screws as they will deform the end of the core barrel.

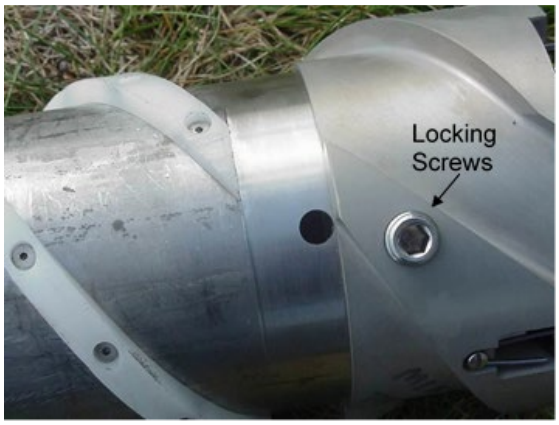


Figure 39. Installing the Cutter Head

To remove the head disengage the three locking screws, and then gently tap the top side of the spiral flutes with a dead blow hammer and provided nylon rod. Knock each flute once, and then move to the next flute. Do not let the head become cocked on the inner barrel (this will stretch the head permanently) and **do not strike the plastic flights** on the inner barrel.

A dead blow hammer is a plastic or hard rubber hammer filled with sand or lead shot. **Never use a metal hammer on the cutter head!**

9.11.4 Installing shoes and cutters

The three cutters and shoes are stacked on pairs of pins on the cutter head, Figure 40. The fit is tight, but this is intentional so that the cutters and shoes stay in place. Individual cutters are not interchangeable and must always be used as a set of 3. The cutter set is laser etched on the tang of the cutter for reference.

The shoes serve to limit the depth of cut. They are numbered and you should always drill with all three shoes of the same number. The number **does not** represent the nominal cutting distance per revolution in mm. Refer to the chart in the cutter box to determine cutting pitch for each shoe number.

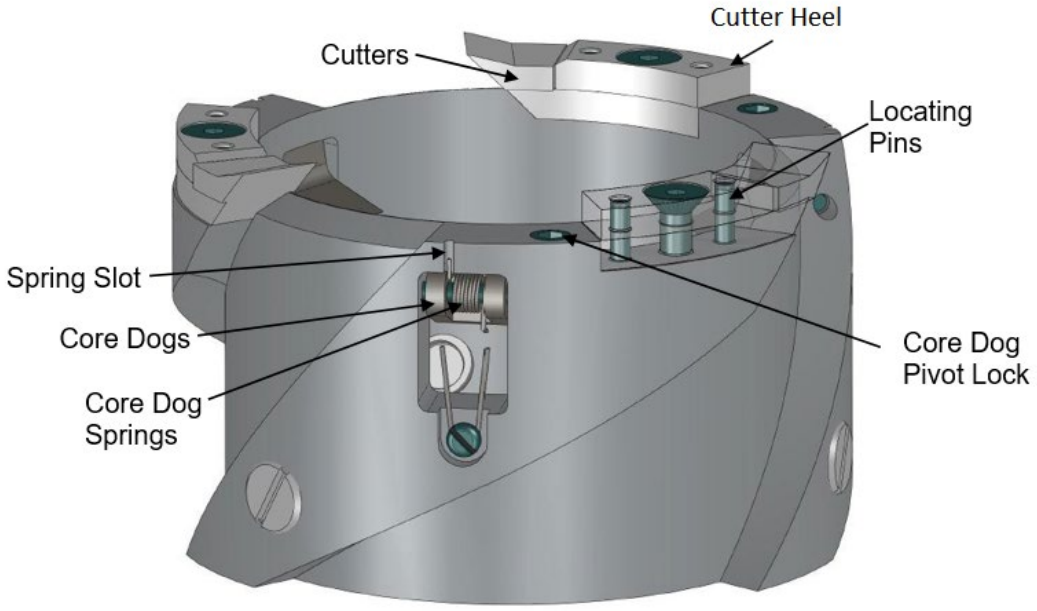


Figure 40. Cutter Head

The core dogs serve two purposes: they keep the core from falling out of the drill, and they break the core when the drill is raised. Long core dogs with weaker core dog springs should be used when drilling in firn (to avoid the dogs “milling” the core). When drilling through the firn-ice transition and into solid ice shorter core dogs with stronger spring need to be installed.

To install springs, loosen the core dog pivot lock (a recessed set screw on the bottom of the cutter head as shown in Figure 40). Retract the pivot pin enough so that only one side of the core dog is on the pin.

Flare the spring so that one arm engages the slot in the head and the other lays on the back of the core dog. Press the spring into the slot until the coil of the spring is lined up with the pin – with your other hand, press the pin through the spring and core dog. Secure the pivot lock set screw.

If you lose a spring, or need one with different strength, it is possible to make them in the field by wrapping spring wire around a mandrel such as a drill bit, Figure 41.

Figure 41. Fabricating Core Dog Springs

Note that the ends of the spring should drop into the spring slot on the cutter head – it is important that the spring does not protrude and get caught on the sidewalls of the hole.

10.0 OPERATING INSTRUCTIONS

10.1 General Comments

10.1.1 Winch Setup

Make sure that the mast locking pin (3/4" diameter aluminum with handle) is tethered to the winch frame. YOU DO NOT WANT THIS PIN TO DROP INTO THE HOLE!!!

Solar radiation can warm the winch frame enough to cause it to sink into the ground. To prevent this, you may want to do the following:

- Clear off loose snow to expose a solid surface for the winch
- Place pieces of plywood under the frame to spread the load

10.1.2 Drill Trench

A deep trench is required into which the drill can swing. A good starting size for the trench is 1.5m deep, 0.6m wide, and 2.1m from the face frame, with steps built into the trench from the side furthest from the drill base. Ensure that there are a couple inches of clearance from the cutter head to the trench and stairs, as cores often hang out a small amount. Occasionally a core will hang multiple inches out of the core barrel, so make sure the bottom of the trench is large enough for a person to reach below the cutter head to push the core into the core barrel.

If operating the drill without a tent, it is recommended you arrange a removable cover for the trench, both for safety and cleanliness, which can be put in place when the drill is not being run.

- Use extreme caution when working around the trench to prevent accidental slips or falls that could result in someone falling into the trench.
- It is recommended to install a warning line around the trench and about 3 feet above ground level. The area should be marked with a spray paint line around the trench to increase visibility.
- To reduce the chances of slips, roughen up the snow surface around the drill site if it becomes compacted or iced up.
- A neat and well-organized work area can help prevent accidental slips and falls.

10.1.3 Hole Cover

Once a hole is started a hole cover should be used whenever the drill is at the surface. The cover can be fashioned from a piece of plywood with hinges made of fabric or leather straps, with a piece of paracord allowing actuation from the surface. Ice screws or nails can secure the straps to the ice or snow. Alternatively, a tetherball on a string can be used.

10.1.4 Jammed Corelocks

If, during drilling, it becomes difficult to actuate a corelock, it may be that snow/chips have packed into the hole. A small amount of anti-freeze or ethanol will un-stick the lock.

Cautions:

- ALWAYS start the drill or winch motors with the speed control set to zero. Starting the motor with higher speed settings may damage the electrical motor and/or the power system.
- Be aware of rotating components in and around the winch and drill.
- The cutters and core dogs are very sharp and will easily cut clothing and skin.

10.2 Drilling Core

To drill core, follow this procedure:

10.2.1 Open the hole cover.

10.2.2 Raise the mast with the drill secured in the drill clamp.

10.2.3 Insert the mast locking pin.

10.2.4 Ensure the cable is tight and the spring-loaded sheave is seated in the top of the mast. Pull in any cable slack using the handwheel.

CAUTION: Failure to ensure there is no slack in the cable before releasing the drill clamp will result in the drill freefalling and producing a shock load higher than the cable's breaking strength.

10.2.5 Release the drill clamp while holding the drill in position with the handwheel.

10.2.6 Set the winch speed to zero (this should be done before each trip into the hole), set the winch motor direction in the "DOWN" position.

10.2.7 Lower the drill to the zero-reference height and reset the zero-depth counter on the readout box if needed.

10.2.8 Lower the drill into the hole, using some winch speed if helpful. As the drill approaches the bottom, bring the speed to zero.

10.2.9 Stop the drill about 50cm above the hole bottom, slowing it using the handwheel and brake if installed.

10.2.10 Reset the Weight On Bit (WOB) by pushing the "WOB rest" button on the readout box.

10.2.11 Set the drill direction to "Forward" and run the speed up to 70-75 on the dial, corresponding to a cutter speed of 60 – 87 rpm. Keeping the drill rotating before it touches the bottom will prevent ice from building up on the bottoms of the shoes, which can prevent penetration. Slowly lower the drill until cutting starts (you can see this happen when the drill motor current rises). Push the "DIFF RESET" button on the readout box to start recording distance drilled. You should be able to drill 90-100cm in ice (more in firn) before the drill motor stalls and the current rises. The operator must respond quickly and stop the motor when stalling occurs. The drill motor should not receive more than 2A.

Note: Until the anti-torque section is below the surface and fully engaged, anti-torque will have to be provided by an operator standing in the drill trench holding the top of the drill.

10.2.12 Record the ending depth and core length in the core log.

10.2.13 Push the "DIFF RESET" button on the readout box before raising the drill. This gives you a depth count down to zero on the next run.

10.2.14 Stop the drill motor if you have not already done so and slowly raise the drill using the winch control. You should be able to hear/feel/see the core break (except in firn and fragile ice which break easily). If the winch motor cannot break the core on its own, you can use the hand crank to assist. For safety's sake, make sure to remove the crank(s) before moving to high speed.

NOTE: The cable's breaking strength is 14.7 kN (3,300 lbf). If using the GOI cable termination, that breaking strength is reduced to 8 kN (1,800 lbf).

10.2.15 Raise the drill (max speed on winch motor is 100% (3000RPM)). Slow down as the surface is reached and the drill comes out of the hole.

10.2.16 Park the drill on the tower and secure the drill with the drill clamp, with the core lock access hole facing the drill operator.

Figure 42. Hanger Core

10.2.17 Remove the mast lock pin and lower the tower onto the locking pogo stick.

NOTE: Before lowering the mast, check that you do not have a "hanger." A hanger is a section of ice core that is protruding from the cutter head, Figure 42. This can happen if the core dogs slip a bit before they manage to grab onto the core. A hanger must be pushed up into the drill – otherwise, there is a risk that the core gets snapped off and falls into the hole.

10.2.18 Replace the hole cover (you have one, correct?).

10.2.19 If it has been difficult to pull out the core barrel in previous runs, try running the drill in reverse to clear chips from the barrel. This can make it easier to pull out the core barrel if the flights were packed with chips.

10.2.20 Remove the inner barrel corelocks – this is done by slowly rotating the drill barrel to the three positions that expose the corelocks through the access hole in the outer barrel. Push each corelock in and rotate it ¼ turn clockwise to lock it in the retracted position. Make sure to return the drill direction selector to the neutral position after this step.

Figure 43. Extracting the Core Barrel

10.2.21 Extract the inner barrel by pulling on the cutter head, Figure 43. If the inner barrel does not come out easily, you can gently knock on the outer barrel with a dead blow hammer to release it. If possible, keep a bucket underneath the end of the outer barrel to catch chips as they fall off the inner barrel during removal.

Figure 44. Removing the Chips

10.2.22 Shake/pull the chips located above the core plug out through the top of the inner barrel. If the chips do not come out, you can CAREFULLY tap the inner barrel with a dead blow hammer to release them. It can help if you place a screwdriver or dowel through the core barrel windows – this will prevent the core plug (and the ice core itself!) from flying out of the barrel, Figure 44.

10.2.23 Remove the core plug

10.2.24 Slide the core out into a bag or tray

10.2.25 Clean the inner barrel and cutter head. If there is ice or chip buildup between the flights use a stiff brush to knock them off. Likewise, if there is any buildup on the cutter head (especially on the cutters, the underside of the shoes, and in the core dog windows) clean using brushes and picks. Ensure that the core dogs are moving freely and spring back easily.

10.2.26 Reinstall the core plug

10.2.27 Reinsert the inner barrel and lock it in place

10.2.28 Repeat procedure!

10.3 Record Keeping

With each run, you should record the following:

- The run number and start time (increment each run, even if no core is recovered)
- Maximum depth reached
- Length of core recovered
- Whether the core had a "flange." A flange is a flaring at the bottom of the core, indicating that the core broke off at the bottom of the hole, just below where the cutters stopped cutting. This is notable because it means that the cumulative core length and depth counter must match at this depth.
- Any notable differences in drill operation or core quality
- Changes made to the drill system (sonde sections, shoes, cutters, core dogs)

11.0 TIPS

The following are general tips for drilling and drill operation.

11.1 Drilling a Straight Hole

Good drilling is a bit of an art. There are several tradeoffs:

- You want big chips to make chip transport efficient (i.e., aggressive cutting)
- You want good quality core with no cracks (i.e., gentle cutting)
- You want a straight, vertical hole, which requires using the sonde as a plumb to hang vertical. If you let all the weight of the sonde rest on the cutters, you will lose the plumb effect and the hole will eventually curve off to the side.
- You want the anti-torque springs to be tight enough to prevent rotation, yet not so tight that they do not allow the drill to descend easily.

Generally, try to use as little weight-on-bit as possible while maintaining the maximum downward cutting speed. Changing ice conditions also mean that different amounts of drill pressure are necessary. For example, in brittle ice you need to reduce pressure to minimize core cracking.

The best technique for the Eclipse drill seems to be to set the winch to pay out cable (but with the speed set to zero, or almost zero) and then to use the hand brake to control the drilling speed as necessary. Under some conditions, you can leave the winch in the "UP" position while drilling, thereby applying a bit of tension to the cable and allowing the drill to pull cable off the winch.

11.2 Keeping the Drill Cold

The Eclipse drill works best when it is cold (below freezing) and dry. Water can freeze on drill components and will tend to gum up the free movement of cuttings. The anti-torque bearing section is prone to icing. Always ensure the cable bearing rotates freely at the surface before drilling.

The sun is your enemy! When the drill is on the surface, solar heating of the drill is rapid. The first place you will notice melting is on the motor section.

There are a number of techniques to keep the drill cold:

- Drill at night or, if not feasible, avoid drilling during the heat of the day.
- Drill under cover, or at least arrange a tarpaulin to shield the sonde from the sun's rays.

11.3 Cleaning the Drill

For certain projects it may be desirable to drill a short (10m or so) hole to "scrub" the inside of the drill clean before beginning science drilling. This can help remove residual particulate/contaminants from the barrels if they were not cleaned and bagged prior to shipment.

11.4 Keeping the Drill Clean

If chip transport issues arise it may be useful to give the inner and outer barrels more intense cleanings. Use the large pipe brush to ensure the grooves in the outer barrel are not iced up.

11.5 Over Night Storage

Frost tends to form in the drill overnight, impeding early-morning operation (the added drag seems to prevent normal chip-transport). To avoid this problem, the last core drilled in the day can be left in the drill and the drill stored at 15-20m depth (below the winter cold wave) overnight. In the morning, the drill is raised to the surface and the core removed – this will ensure that the barrel is clear of frost.

11.6 Setting the Anti-Torque Spring Tension

The anti-torque springs need to be adjusted so that they are tight enough to prevent the drill from rotating when the cutters engage the ice. Generally, the springs need to be tighter in firn than they do in ice. If the springs are too tight, they may prevent the drill from descending easily, resulting in the drill alternating between sticking and slipping when descending. This is seen as a repetitive rise in the weight-on-bit followed by a quick return to normal weight-on-bit. Springs that are too loose in firn will "windmill" and cause large cavities to form. This can be seen as a lack of penetration and whipping of the cable at the surface as well as a twisting sensation felt through the cable.

11.7 "Feeling" the Drill

The driller can learn a lot about what is happening downhole by placing their hand on the cable. Even at depths of several hundred meters, you can feel exactly when the drill begins to cut core and when something happens (such as the anti-torque springs slipping). This is a good habit to develop.

11.8 Cutter Choice

Both medium and wide cutters are available for the Eclipse drill, though the collet will **only** work with the wide cutters. The medium cutters cut a 82.5mm core with a 111mm borehole. The wide cutters cut a 80.7mm core with a 112.8mm borehole.

11.9 Cutter Shoe Choice

The objective when drilling is to produce as large of chips as possible (i.e. using a high-numbered shoe) without causing aggressive drilling damage to the core (cracking or making wafers). Big chips transport better and are less prone to sintering in warm conditions.

As a general rule, #4 shoes work fine in firn and #3 and #2 shoes are better in ice.

11.10 Conical Reamer

A conical reamer is provided for use with the Eclipse Drill, replacing the cutter head. This can be used to ream an existing hole to the 112.8mm diameter created by the wide cutters, maintaining a downward speed of under 300mm/s to ensure no areas are missed.

If a non-magnetic object is dropped downhole or a rock is encountered, the conical reamer can be used to create a central pit that the object will hopefully fall into. The object can then be removed with the next coring run.

11.11 Recovery Magnet

If a magnetic object (such as the corelock pin) is dropped into the hole, it may be possible to recover it using the recovery magnet. Alternating runs with the reamer and magnet may be useful in case the object is embedded into the ice.

12.0 ROUTINE MAINTENANCE OF THE ECLIPSE ICE DRILL

Some routine maintenance is required to keep the Eclipse drill running properly and extend its running lifetime.

12.1 Honing the Cutters and Core Dogs

Efficient cutting and retrieval of core requires razor-sharp cutters and core dogs. Honing these components in the field can be done with a fine diamond stone. The cutters and core dogs are made of hardened D2 tool steel, so sharpening with a file will not work.

12.2 Storing the Drill for the Season

The most important thing to remember when storing the drill for the season is to make sure it is dry. The control box, anti-torque section, and drill motor section (especially if sealed) should be dried carefully, inside and out. In other words, the motor section should be opened at the end of the season.

12.3 Saline environments

If the drill is used in a saline environment, corrosion of the aluminum can be a problem. When it corrodes, aluminum forms an oxide (whitish coating) that thickens the surface (i.e., a shaft-like part will expand). Where such a part is inside another (e.g., the anti-torque section in the motor section top plug), the aluminum part may bind inside. For this reason, please rinse with fresh water before moving to a warm, above-zero environment. The drill should be salt-free and dry before shipping and storage.

12.4 Oil

The Winch motor and the drill motor Harmonic Drive transmissions should be lubricated with Synthetic Dextron II or equivalent automatic transmission fluid.

The oil level of the winch can be checked with the transmission axis horizontal and the plug hole on a horizontal line through the drum axis, Figure 45. The oil should just reach the plug. The normal contents of the transmission are 375 ml of Dextron II fluid.

The oil level of the drill sonde motor can only be checked by opening the transmission. Remove the motor section can from gearbox and motor assembly. With the motor section vertical (motor on top) remove the six screws between the motor adapter and the gearbox and remove the motor. The gearbox spline cup will now be visible. The oil level should be visible in the spline cup and be ¾" below the top edge of the spline cup.

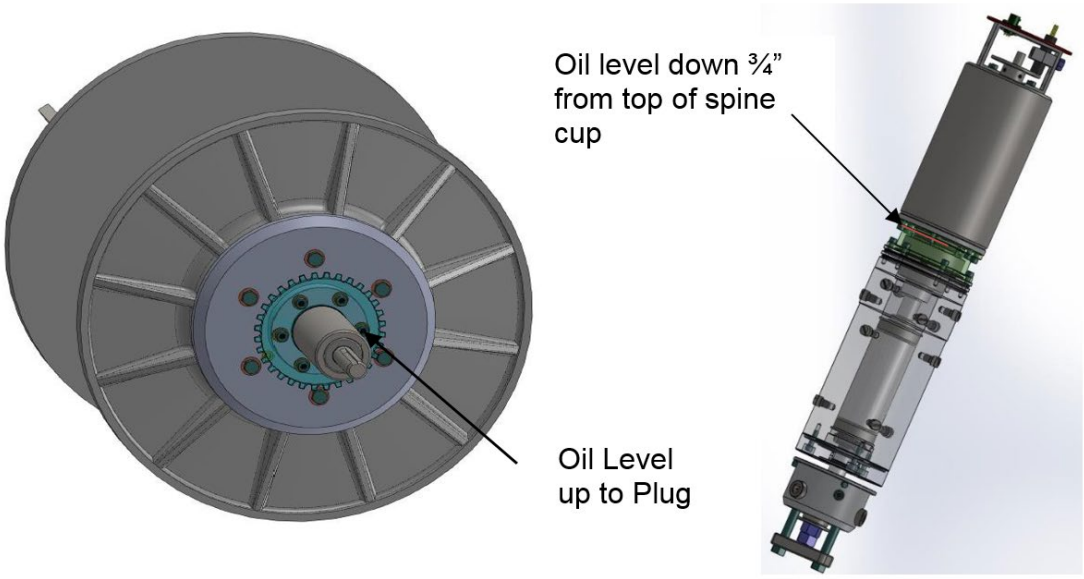


Figure 45. Winch Transmission Oil Level

12.5 Level Winder Maintenance

With the exception of the enclosed gears which are steel and cast iron, the important operating components and framework components of the Level Winder are made of aluminum alloys, stainless steels, and bronze and so are robust and not subject to corrosion. However, we suggest that you:

- Avoid allowing snow to melt and freeze onto the bellows.
- Periodically grease the linear bearing with a high quality corrosion-preventing grease of NLGI #1 consistency, such as "snowmobile grease".
- Use a corrosion-inhibiting spray grease (such as a white lithium-based spray grease) when disassembling and subsequently reassembling the gear train.
- At the end of every season, dry the level wind thoroughly, and re-grease the bushing bearings.

13.0 TROUBLESHOOTING

The tips below are intended to help an operator problem solve some issues that might be encountered. First check the obvious, such as power connections and tripped breakers.

13.1 Drill Motor Will Not Start

- Is the direction switch set to "Forward" or "Reverse"? The motor will not work if the switch is in the middle position.
- Is the emergency stop switch depressed? Pull up on the stop switch to reset.
- Check electrical connections between the control box and the drill motor.
- Check if the 15 Amp circuit breaker is tripped.
- Swap in the spare control box.
- Replace the motor section.

13.2 Winch Motor Will Not Start

- Is the direction switch set to “UP” or “DOWN”? The motor will not work if the switch is in the middle position.
- Is the emergency stop switch depressed? Pull up on the switch to reset.
- Verify the winch motor power cable is connected.
- Check if the 15 Amp circuit breaker is tripped.
- Swap in the spare control box.
- Replace the winch motor.

13.3 Depth Counter Runs In Reverse

Turn the sheave 180 degrees (to move the encoder to the opposite side of the mast).

13.4 Drill Motor Is Trying to Rotate the Barrel, But Not Working

Either the drill is packed full of chips and core, or the barrel is frozen (i.e., water frozen to ice) to the outer barrel. In either case, gently banging the outer barrel with a dead blow hammer will free the chips. Sometimes, running the drill motor in reverse will clear a “packed” drill.

13.5 Freeing A Stuck Drill

The worst has happened. The drill has gotten stuck. The response to this situation should be rapid, particularly if the drill has been trapped by borehole closure (a danger below about 300m, depending on ice temperature).

- Apply tension on the cable with the winch motor
- Preferably using a hose or balloon, deliver a “bomb” of anti-freeze (glycol or alcohol) to the drill to reverse the freezing or counter the closure

13.6 Retrieving A Dropped Drill

The even worst has happened. The cable snapped and the drill fell downhole. Don’t panic, as there are options to retrieve the drill. To start, cut the surface-side cable (ideally using a Dremel) a few inches back from the break to create a non-frayed end. Install this end in the recovery rope socket and pull tight on the socket to set the wedge. Attach the slide hammer and barbed wire grab to the socket and prepare to lower the assembly downhole.

If the cable snapped in the middle of the reel it is likely that the cable still attached to the sonde is piled in a nest on top of the sonde. Lower the recovery assembly into the hole until the full weight of the wire grab and hammer are supported by the wire nest. Slowly pull the wire grab out of the hole with the winch. There will likely be numerous fluctuations in cable tension as knots form and release on the barbs. With luck, the nest will knot itself around the grab and you can retrieve the drill. If the wire grab doesn’t work the first time repeat as necessary until the drill is retrieved.

If the cable snapped at the connection you can still use the wire grab to retrieve the drill. Lower the wire grab downhole until the full weight of the grab and hammer are supported by the top of the drill. Next, slowly lift up using the winch. The barbs can catch the recovery loop, providing a means of retrieving the drill. If the barbs don't catch repeat as necessary, biasing and gyrating the cable to try to shift the grab into different positions to try to catch the loop.

In both cases it is important to maintain some tension on the cable once the sonde is hooked, lest a relaxation causes the barbs to disengage.

13.7 "Gum" In the Sheave

Particularly with a new cable, you may notice a noxious mixture of cable lubricant and ice chips building up in the groove on the sheave. This must get cleaned out so that the depth counter can register accurately.

13.8 Winch Motor Failure

If the winch motor fails while the drill is in the hole, first check that the problem is not simply the circuit breaker on the control panel. If the problem cannot be resolved (e.g., broken generator) it is prudent to get the sonde out of the hole (or at least up to shallow depth where it is accessible). There are two ways to raise the sonde manually.

- Using the hand crank. This is slow and laborious as you are fighting against the winch transmission.
- By pulling on the cable. The easiest way to do this is to grab the cable where it descends to the winch drum and walk away from the winch. Wear gloves!

13.9 Winch Transmission Failure

Since 1996 there has only been one report of the winch transmission failing. When this happens, it is likely that the drill will go into free-fall. If possible, apply the hand brake as quickly as possible to slow the descent of the drill. You may not be able to stop the descent, but the damage will be lessened.

The sonde will then have to be raised using the hand crank.

13.10 The Drill Does Not Advance

This problem can be caused by cakes of ice building up on the bottom of the shoes. The best solution is to prevent this from happening in the first place:

- When starting a new drill run, always approach the bottom of the hole with the drill running; this will prevent the cutter head landing on the chips that are lying at the bottom.

If the drill is in the hole and you suspect that cakes have formed, you can try a few things:

- Reverse the drill motor to try to wipe the cakes off. There is a danger in doing this too much because it will also cause chips that are up in the flights to be driven back down to the cutter head, thereby possibly clogging the cutter head.

- You can use the hammer on the drill to “tap” on the drill (while it is running) to try to get the drilling started; you do this by getting a bit of slack on the cable and tapping the hammer by hand.
- You can also raise the drill a few decimeters (by pulling sideways on the cable) and drop the sonde onto the bottom. If the drill is running, this can knock off the cakes; of course, this is also hard on the drill sonde!

13.11 Calibrating the Depth Counter and Load Pin

If you find the depth encoder or load pin are not reading the correct values, it is possible to recalibrate them in the field. Reference the LCI-90i quick setup guide and manual in Appendix A for further instructions.

14.0 TOOLS AND SPARES

14.1 Supplied Tools List

The following tools are supplied with the ECLIPSE ice drill to aid in assembly, maintenance and basic repair:

- 1/4" square drive hand tool for removing core locks x2
- Trimmed 5/32" hex wrench for disassembly of drill motor section
- 5/16" steel pins for adjusting anti-torque section x3
- Hex wrench (Allen key) kit, imperial, 3/8" to 0.050" x 2
- 6" adjustable wrench
- 5" needle-nosed pliers
- Multi-driver screwdriver (flat, Phillips, etc.)
- Blue Loctite thread locker
- 8" diagonal cutters or linesman pliers
- Rubber or plastic-faced hammer
- Dead blow hammer (plastic hammer with head filled with metal beads)
- Small ball peen hammer
- Claw hammer
- Teflon plumbing tape (for water/oil sealing tapered pipe threads)
- Flat screwdriver for cutter head screws and drill assembly screws
- Magnet for picking up dropped parts
- Diamond plates for core dogs and cutter teeth
- Nylon rods 10’’x1’’diam. and 10’’x1.5’’ diam.
- 2 Strap wrenches
- Locking needle-nose pliers
- 2 sets of diamond files
- Hack saw blades
- 10 plastic zip ties
- Capstan removal tool
- Low temperature grease
- Scotch bright pads
- Sharpies x 2

- Anti-seize compound
- Roll of emeries cloth, 150 grit
- Dremel tool with assortment of bits including cutoff wheels
- Wire brush
- Wire strippers
- Dental pick(s)
- Soldering iron and rosin-type electronics solder (this type of resin does not necessarily require cleaning). Do not use organic or acid flux solder!
- Color assortment of 22AWG PVC-coated stranded copper wire
- 3/16" heat shrink tubing
- Self-vulcanizing electrical splicing tape (or as a poor alternative, electrical tape - splicing tape works better in the cold and leaves no horrible residue). Normal vinyl electrical tape is messy and does not perform well in cold temperatures.
- Sufficient string or cord to lower the supplied magnet to the hole bottom. This may be required to retrieve dropped objects.
- Cordless drill with bits
- Drill bit set
- Socket set
- Wrench set
- Assortment of screw drivers

14.2 Suggested Tools List

The following are items that are not supplied with the drill, but it is suggested that they be available for emergency use.

- 20L of antifreeze to use in case the drill gets stuck in the hole (propylene glycol is preferred as it is aircraft safe and relatively nontoxic – propanol, ethanol, or ethylene glycol may also be used)
- Hose or balloons that can be used to deliver anti-freeze to the drill sonde in case of it getting stuck

14.3 Spare Parts Inventory

These lists contain the minimum quantity of spares provided with an Eclipse drill.

14.3.1 For Winch:

- Mechanical Components
  - 3 ea P.D. drive belt (Eagle)
  - 1 ea Harmonic Drive transmission (HDC-040-050-2A)
  - 1 ea Spare motor (MET 5A-F014336G)
  - 1 ea Misc. spare bolts/nuts/washers
- Electrical components
  - 1 ea Spare control box
  - 1 ea Spare readout box
  - 1 ea Spare depth encoder (Dynapar HS20051263105)
  - 1 ea Spare load pin with cable (Magtrol LB 212)

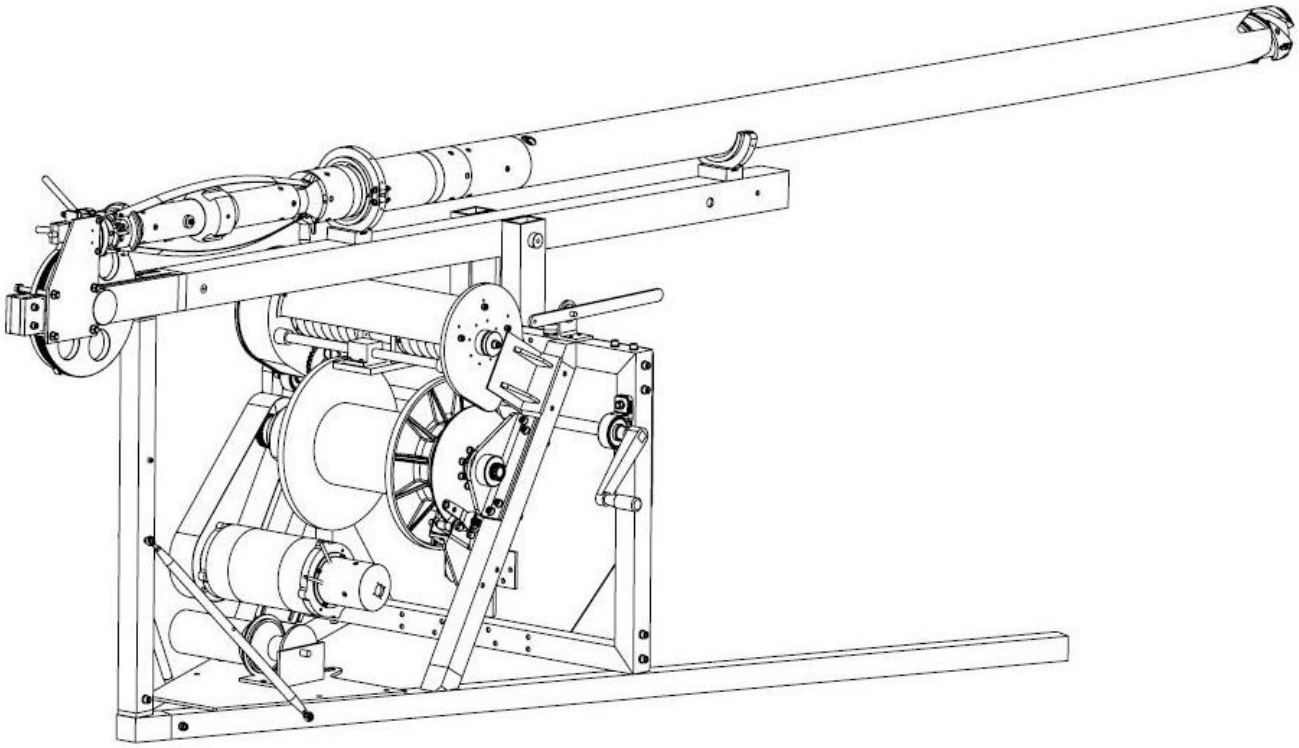
14.3.2 For Drill:

- Mechanical components
  - 2 L Automatic transmission fluid for harmonic drive
  - 1 ea Spare motor section
  - 1 ea Spare core barrel assembly
  - 1 ea Spare cutter head – core dog type
  - 1 ea Collet for collet cutter head
  - 9 ea Cutters (3 operational and 6 spare)
  - 6 ea Short core dogs (3 operational and 3 spare)
  - 6 ea Long core dogs (3 operational and 3 spare)
  - 6 ea Penetration shoes - size 2 (3 operational and 3 spare)
  - 6 ea Penetration shoes - size 3 (3 operational and 3 spare)
  - 6 ea Penetration shoes - size 4 (3 operational and 3 spare)
  - 6 ea Penetration shoes - size 5 (3 operational and 3 spare)
  - 9 ea Penetration shoe shim – 0.002” Thick
  - 9 ea Penetration shoe shim – 0.003” Thick
  - 9 ea Penetration shoe shim – 0.005” Thick
  - 6 ea Flat-head screws for retaining cutters
  - 9 ea Cutter dowel pins
  - 6 ea Set screws to secure core dog pivot pins
  - 9 ea Core dog spring – 6 turn, 0.027” wire
  - 9 ea Core dog spring – 4 turn, 0.019” wire
  - 9 ea Core dog spring – 7 turn, 0.019” wire
  - 6 ea spare ½-13 cutter head retaining screw
  - 1 ea Spare egg/housing for cable termination
  - 3 ea Evergrip cable overwrap (1 operational and 2 spare)
  - 3 ea Leaf springs for anti-torque section
  - 3 ea Spare anti-torque slide hammer retaining screws
  - 8 ea Spare drill assembly screws
  - 1 ea Core barrel lock pin assembly
  - 1 ea Misc. Heat Shrink tubing

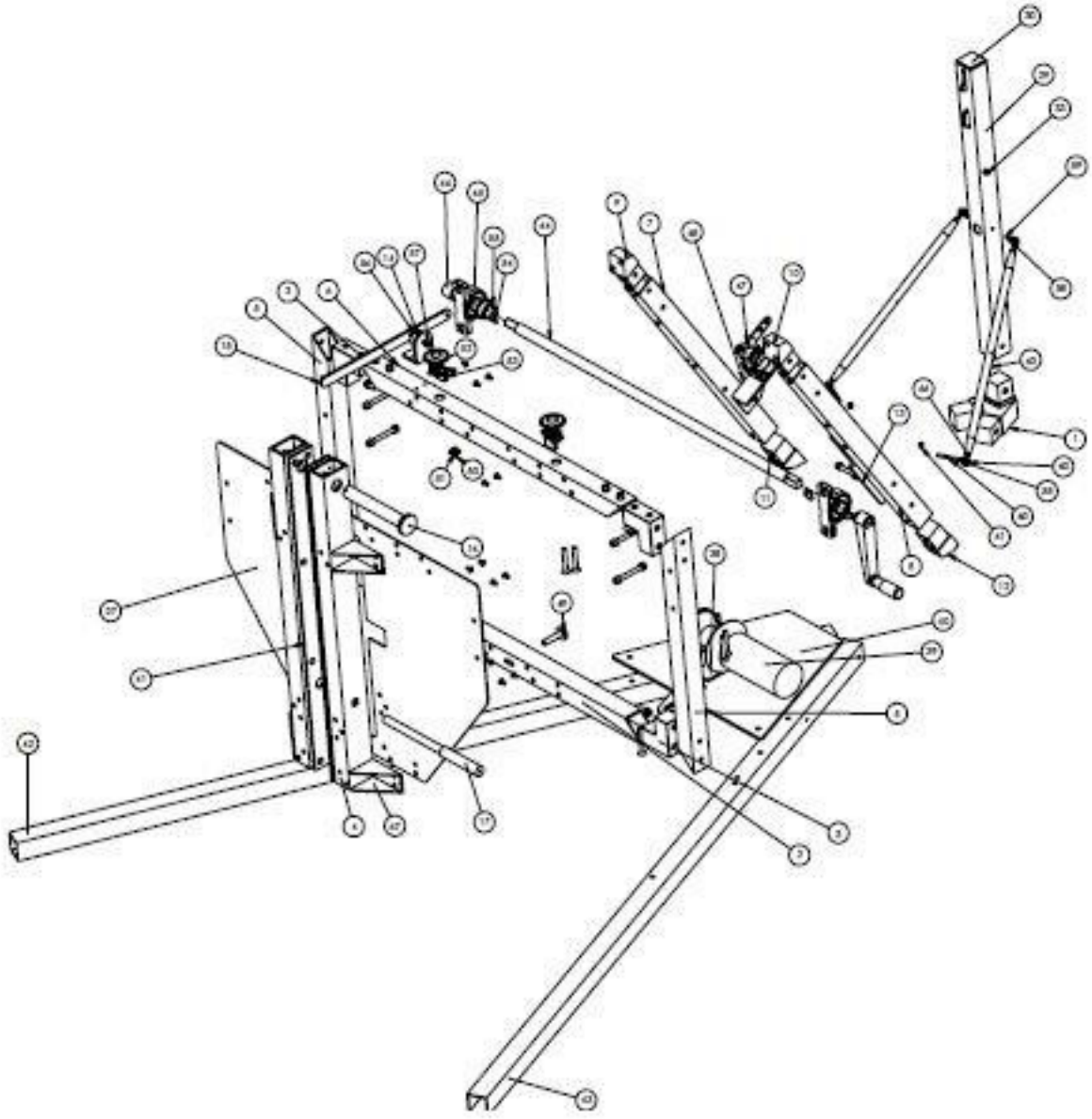
15.0 DRAWINGS

These drawings are for information purposes only. Please contact us for more information.

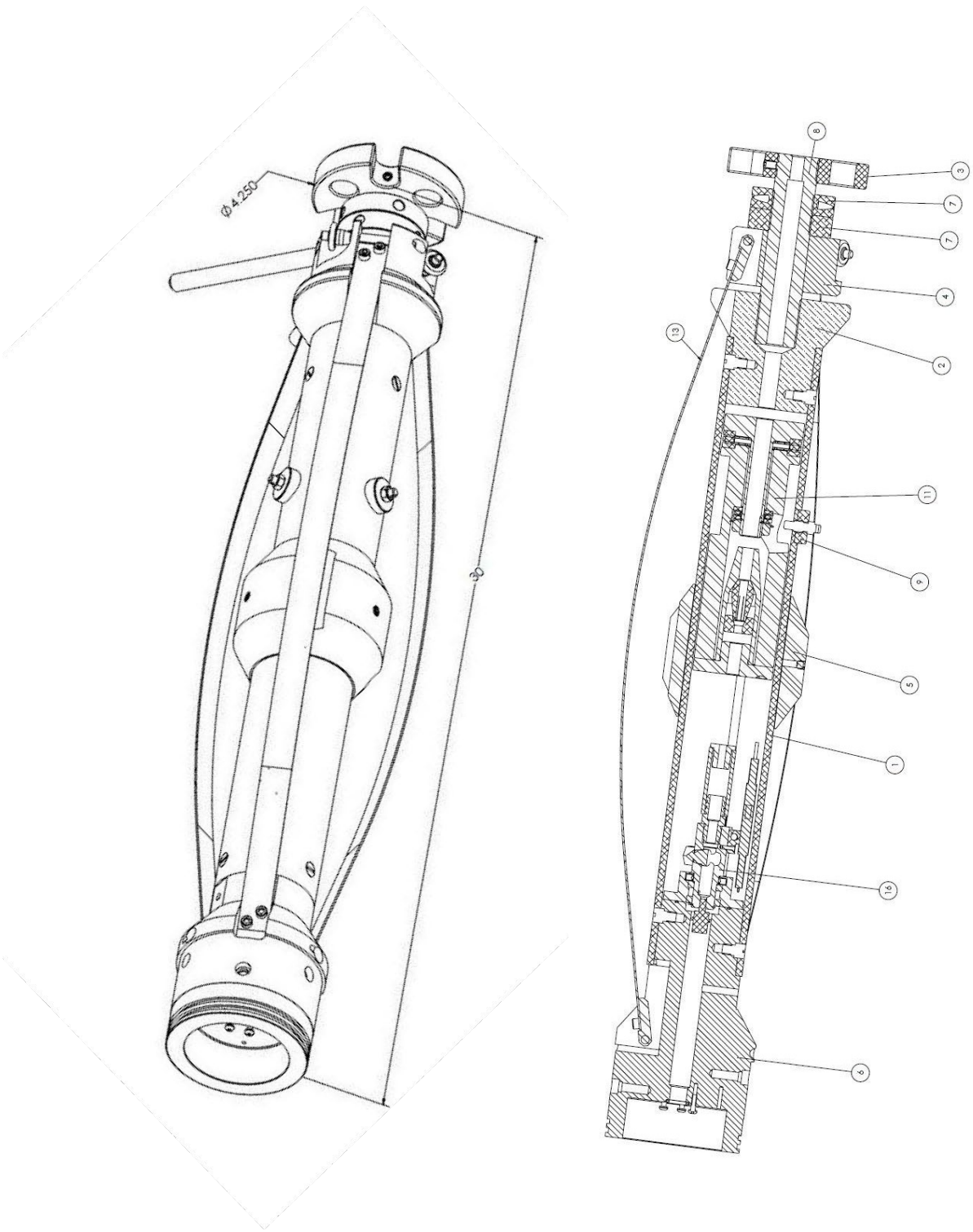
15.1 Complete drill short boom:



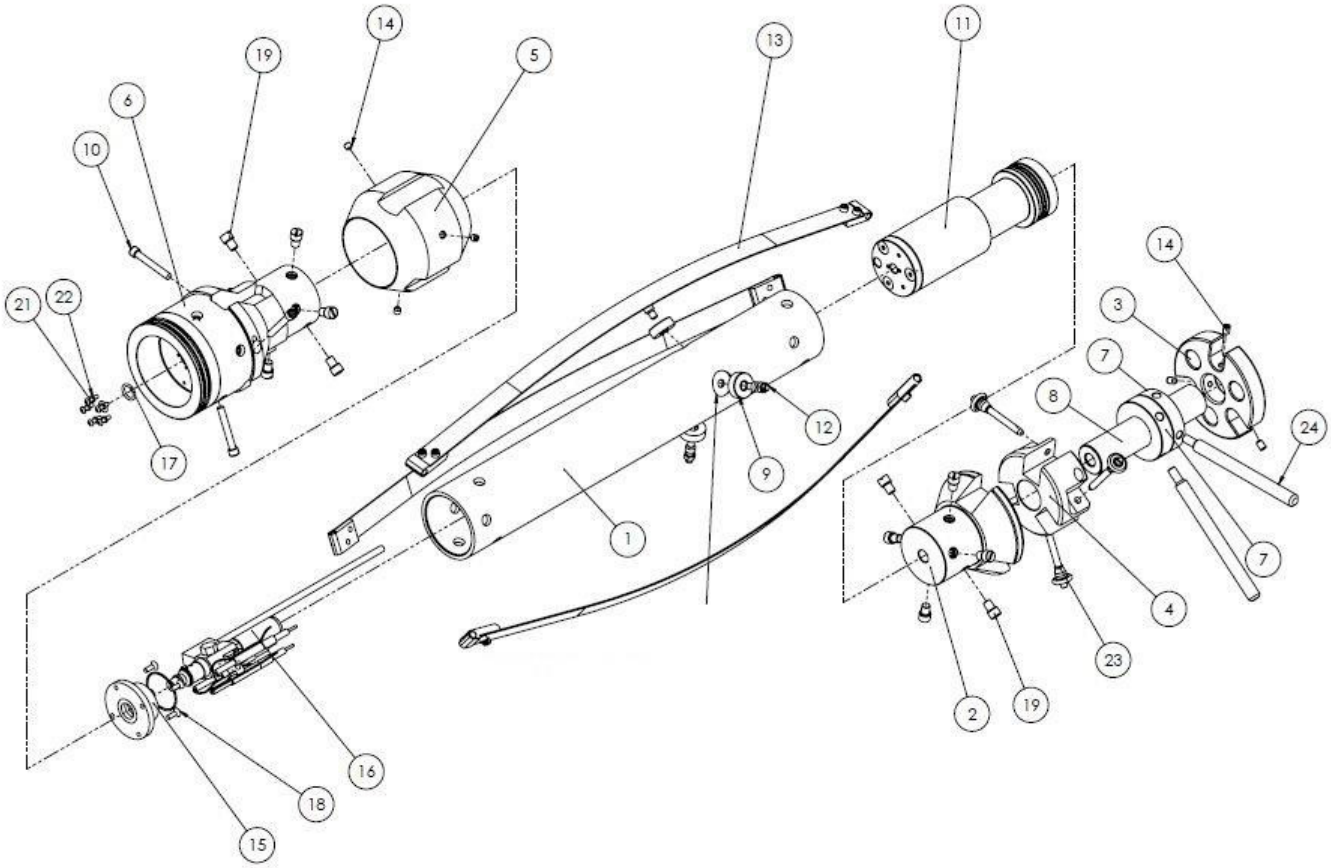
15.2 Frame exploded view:



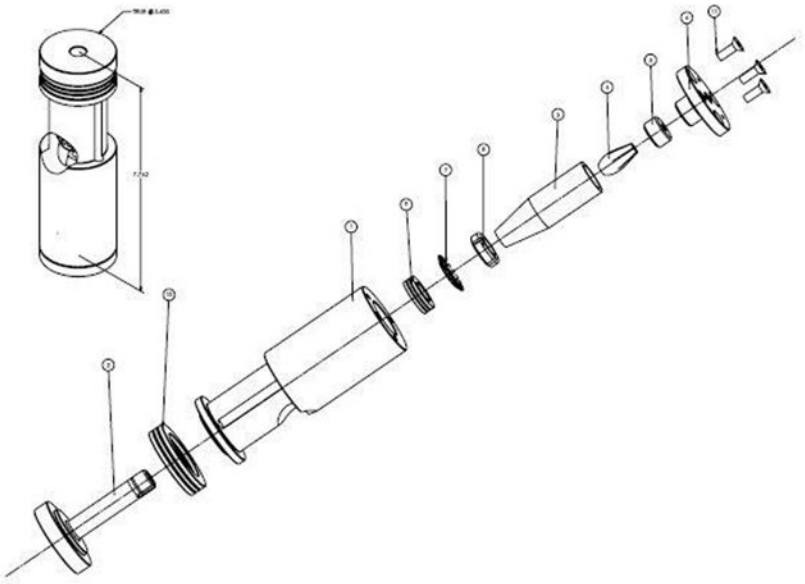
15.3 Evergrip Anti-torque:



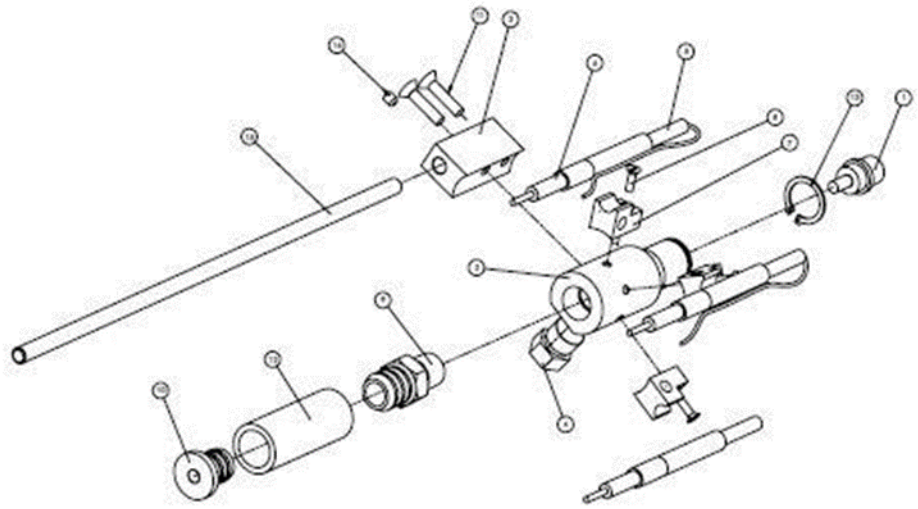
15.4 Evergrip Anti-torque exploded view:



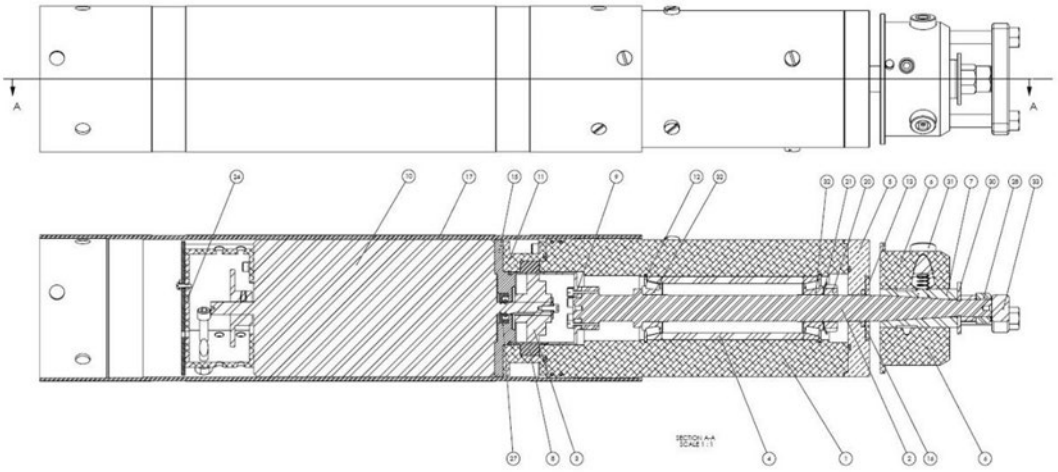
15.5 Hammer assembly in the Anti-torque:

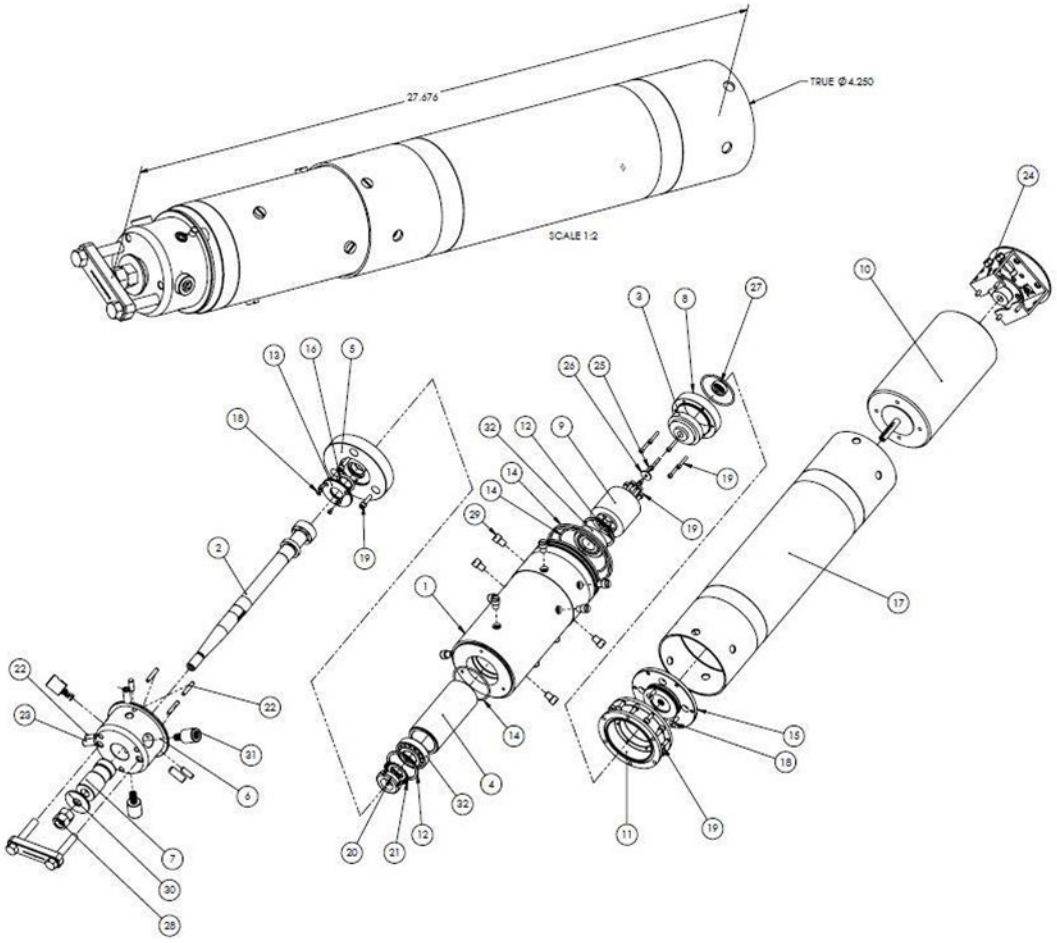


15.6 Slip ring assembly in the Anti-torque:

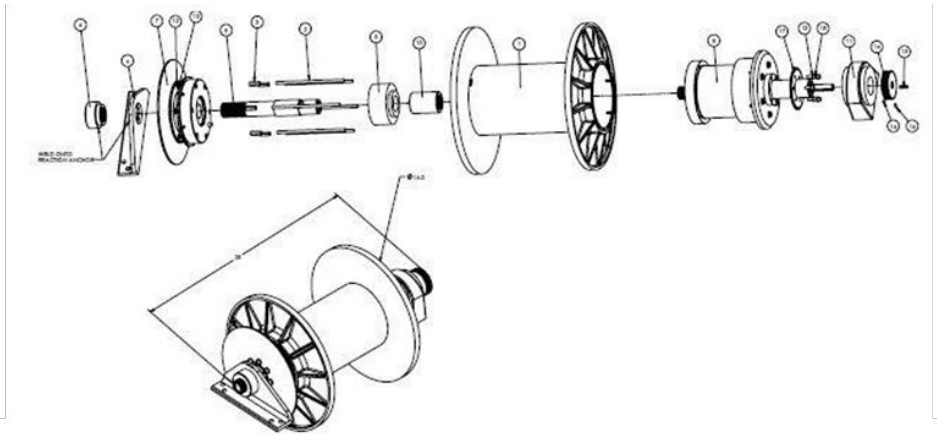


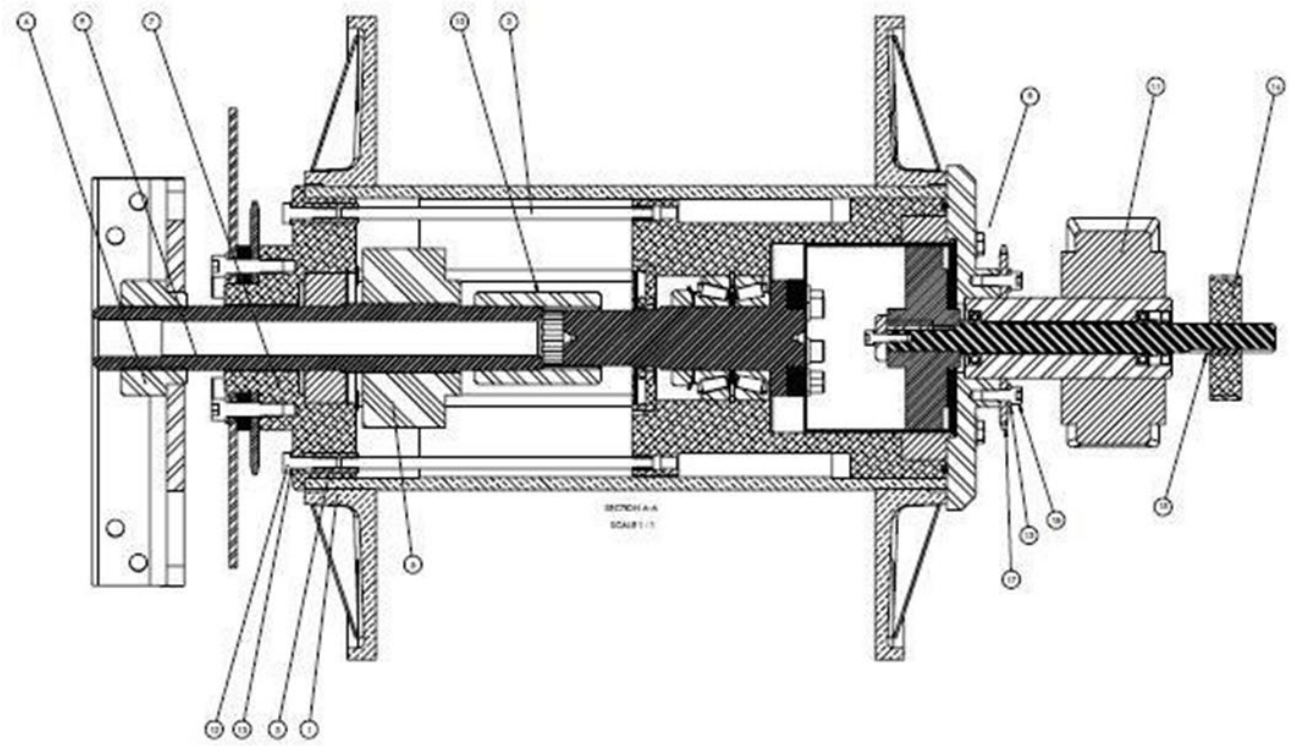
15.7 Drill motor:



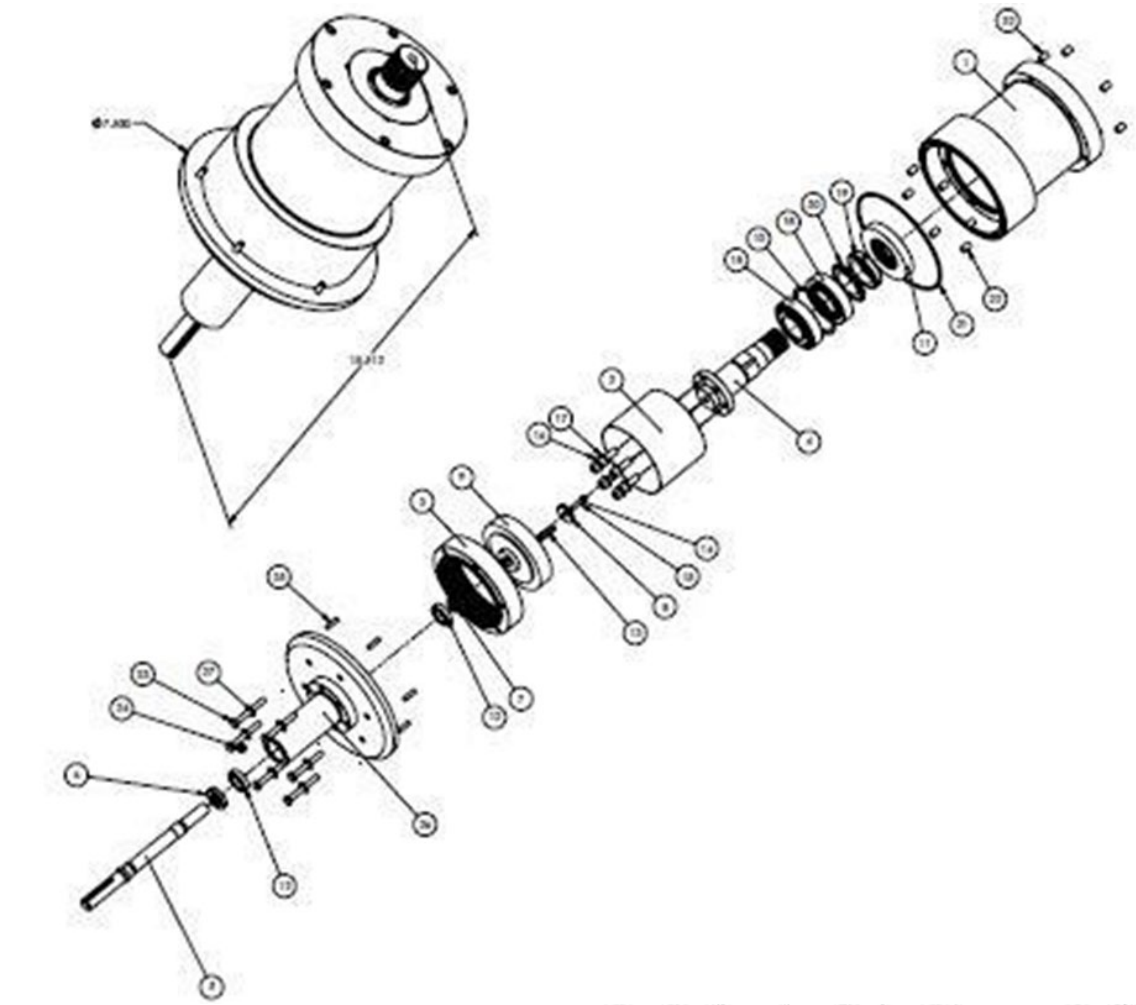


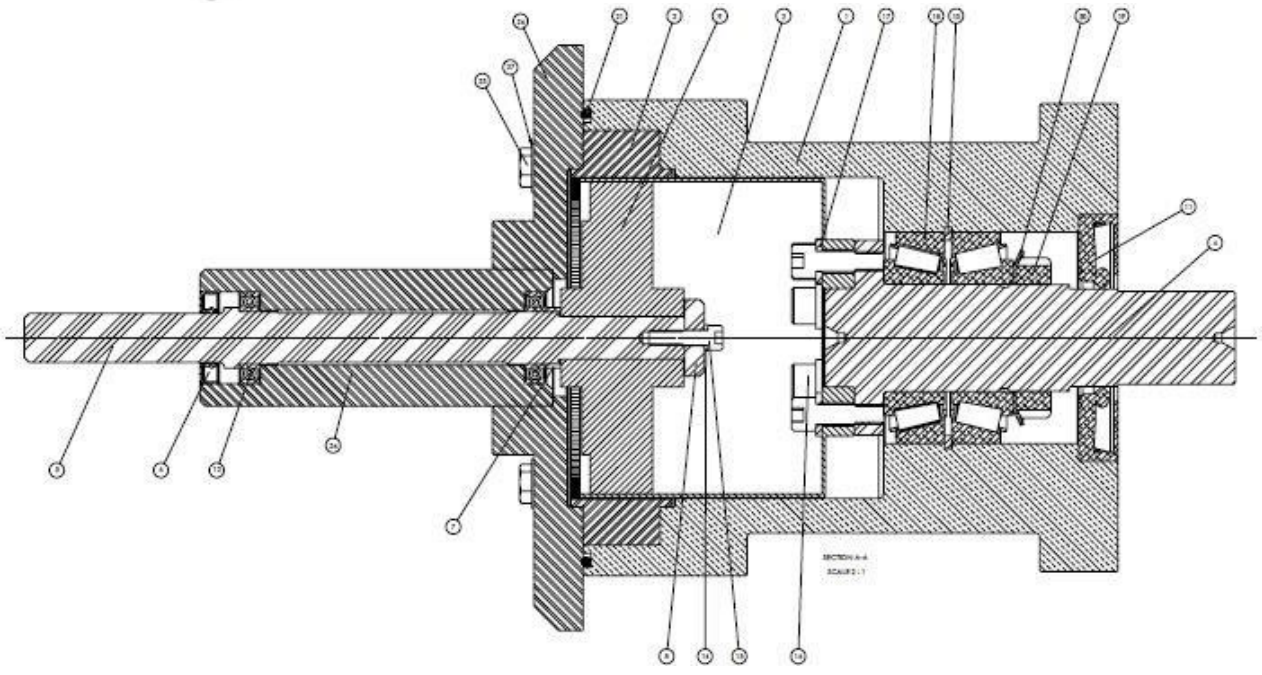
15.8 Winch assembly:



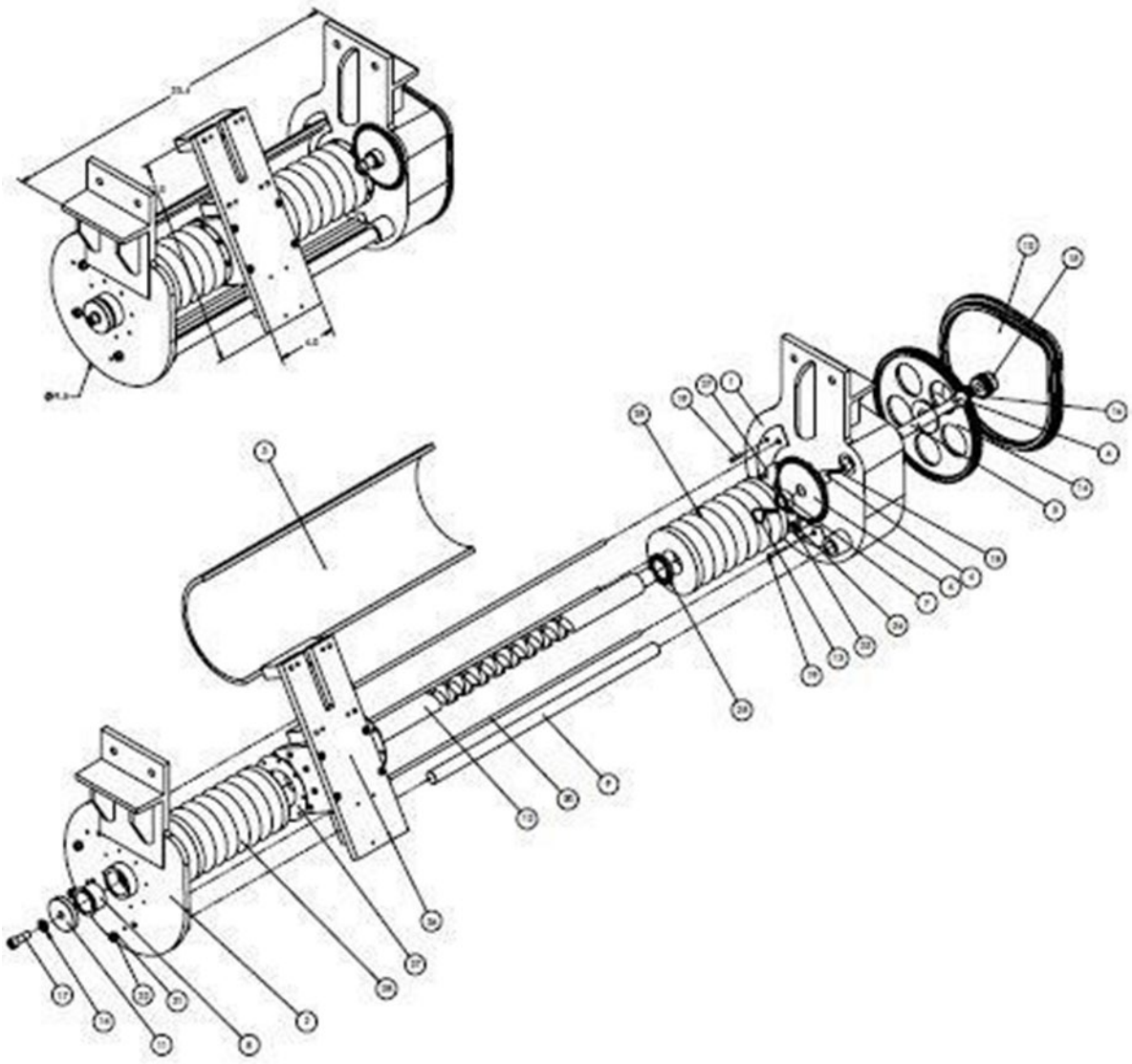


15.9 Winch transmission assembly exploded view:

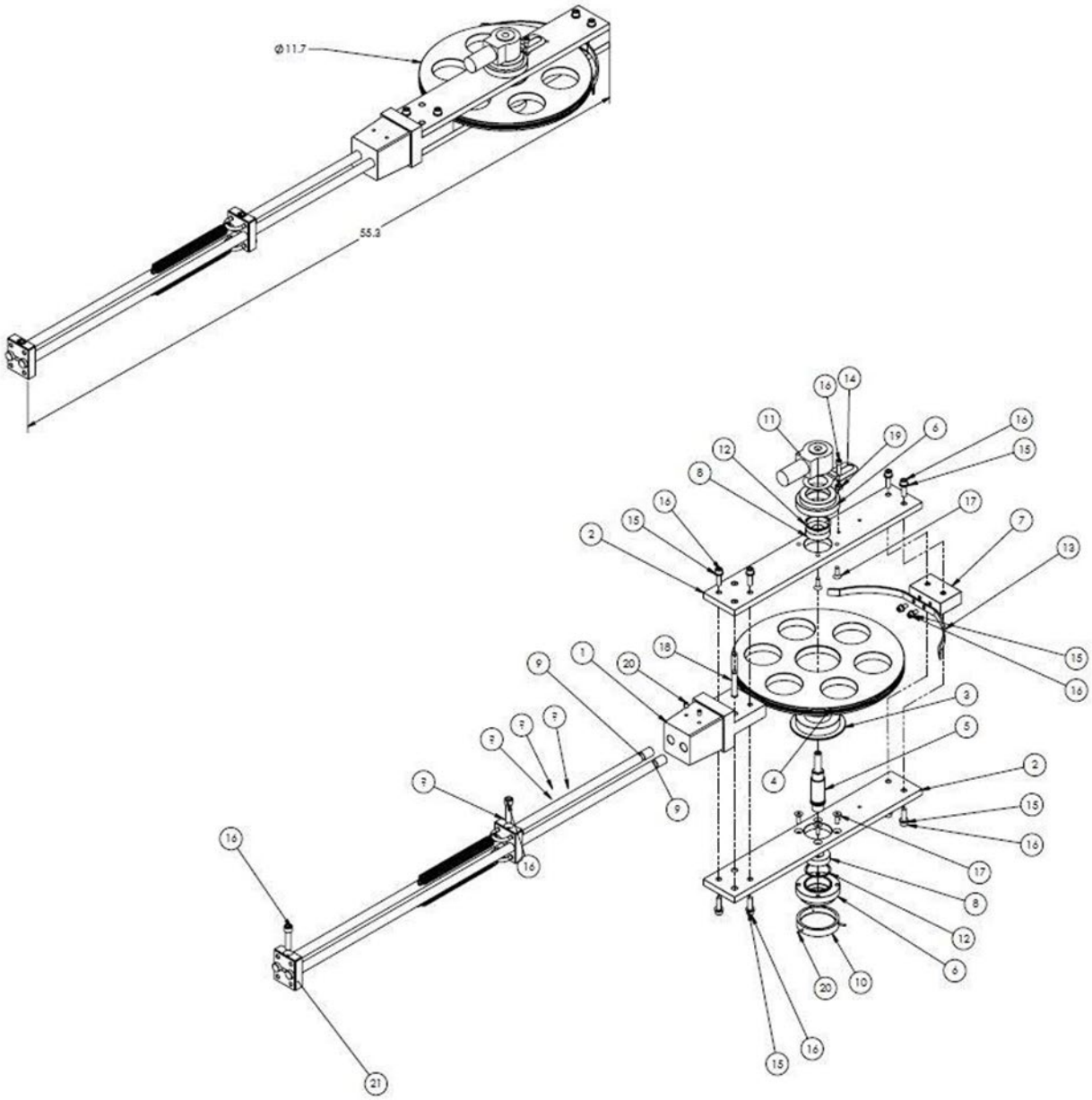




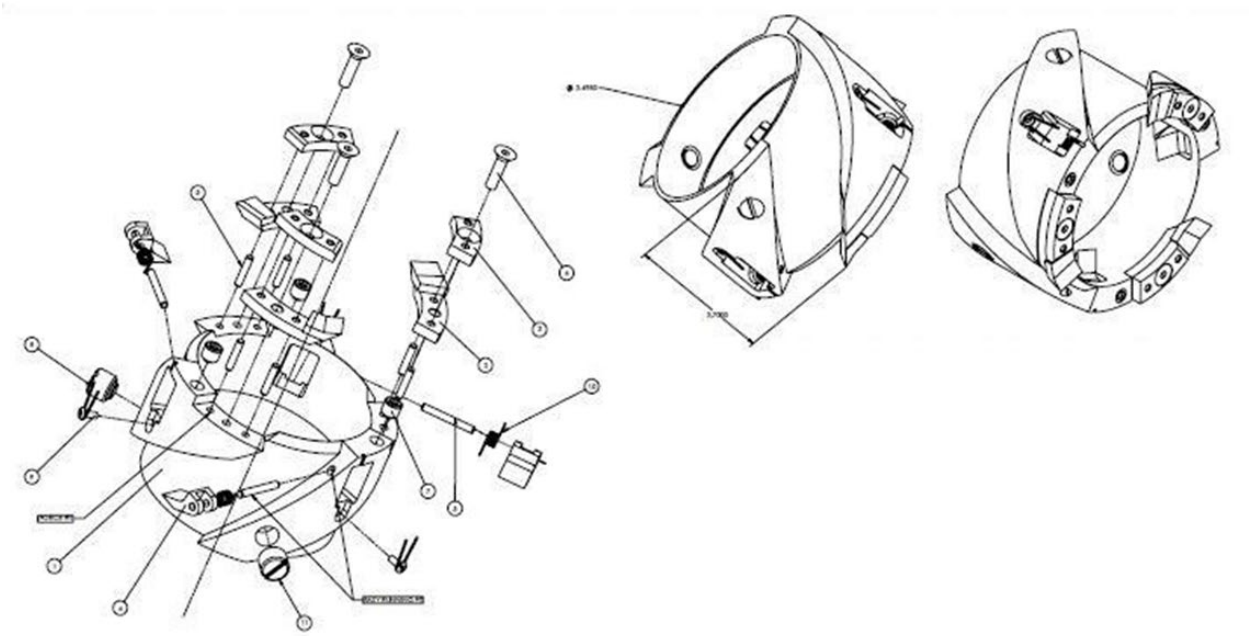
15.10 Level Winder assembly:

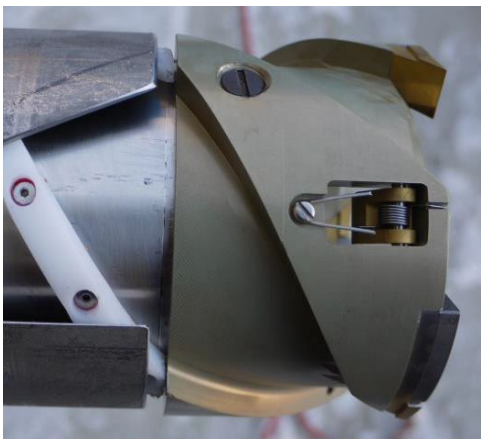


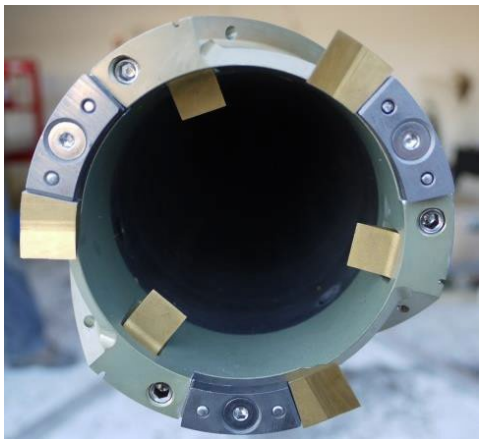
15.11 Sheave assembly:



15.12 Head assembly:







16.0 APPENDIX A: PREVENTIVE MAINTENANCE CHECKLISTS AND DRILL LOG TEMPLATE

Eclipse Drill Preventive Maintenance Checklist				
PRE-SEASON CHECKS (to be performed before the drill system is shipped from IDP)				
Field Project:				
ITEM	**ACTION**	**DATE**	**INITIAL**	**COMMENTS**
DRILL FRAME				
Frame assembly	Inspect components for damage			
Fasteners	Inspect for missing hardware and check for tightness			
WINCH				
Winch cable	Inspect cable and cable termination for damage			
Gearbox	Check for smooth/quiet operation			
Winch motor	Run winch and verify operation in both directions			
Winch brake	Verify functionality and fastener tightness			
CONTROL BOX & DISPLAY				
Control & Display	Inspect for damage/functionality			
Internal connections	Check that all wire terminations are tight			
Cables	Inspect for damage & strain reliefs are tight			
Encoder	Verify proper operation and calibration			
Load pin	Verify proper operation and calibration			
DRILL MOTOR & ANTI-TORQUE SECTIONS				
Drill motor	Run motor and verify operation in both directions			
Gear reducer	Check fluid level if leaking			
Core barrel corelocks	Inspect for damage/functionality			
Anti-torque	Inspect for damage/functionality			
Anti-torque springs	Inspect and sharpen as needed			
Fasteners	Inspect for missing hardware and check for tightness			
CORE BARRELS				
Inner & outer barrel	Inspect for damage/wear			
Fit check	Verify proper fit with motor section and cutter heads			

CUTTER HEADS				
Heads	Inspect for damage and verify fit with mating parts			
Fasteners	Inspect for damage and verify proper quantity			
Springs	Inspect for damage and verify proper quantity			
CUTTERS & SHOES				
Cutters	Inspect for damage and sharpness			
Quantity - Cutters & Shoes	Verify proper quantity & types are included for the project			
CORE DOGS				
Core dogs	Inspect for damage and sharpness			
Quantity	Verify proper quantity & lengths are included for the project			
SPARE PARTS				
Fasteners	Verify spares are included			
Winch gearbox	Verify spare is included			
Winch motor	Verify spare is included			
Transmission oil (MTR sect)	Verify spare is included			
Control box	Verify spare is included			
Cable termination	Verify spare is included			
Load pin and readout box	Verify spare is included			
Encoder	Verify spare is included			
Anti-torque springs	Verify spares are included			
Drill motor and AT sects	Verify spares are included			
Core barrel assembly	Verify spare is included			
NOTES:				

Eclipse Drill Preventive Maintenance Checklist

WEEKLY CHECKS WEEK OF: _____

ITEM	ACTION	DATE	INITIALS	COMMENTS
DRILL FRAME				
Drill frame	Inspect for damage and hardware tightness			
Drill base	Inspect for settling into surface			
Mast and sheave	Inspect for damage and proper operation			
WINCH				
Winch cable	Inspect for damage			
Winch brake	Verify functionality			
Level winder	Verify cable alignment with rollers			
CONTROL AND READOUT BOXES				
Control & Readout Boxes	Inspect for functionality			
Cables	Inspect for damage			
Encoder	Inspect for functionality			
Load pin	Inspect for functionality			
DRILL MOTOR & ANTI-TORQUE SECTION				
Drill motor	Inspect for functionality/damage/oil leaks			
Anti-torque	Inspect for functionality/damage			
Slip Ring	Verify smooth rotation with minimal resistance			
Hardware	Verify all hardware is in place and tight			
BARRELS				
Inner & outer barrel	Inspect for damage			
Inner barrel locking pins	Inspect for functionality			
CUTTER HEAD				
Fasteners	Inspect for damage and tightness			
Cutters and core dogs	Inspect for damage and sharpness			
DRILL TENT (IF USING)				
Fabric and frame	Inspect for damage and wear			
Ropes and rigging	Inspect for damage, wear, and proper tension			
Anchors	Verify anchor points are sound and not coming loose			
NOTES:				

Drill Log

Project:	Control Box:	Motor/AT Section:
Location:	Barrel Set:	AT Setting:
Date:	Head:	Generator:
Drillers:	Core Dogs:	
Drill Configuration:	Cutters:	
Initial Setup:	Shoes:	

C: Core dog drag S: Spall W: Wafers R: Rubble Surface 0: No visible cracks Surface 1: Microcracking Surface 2: Deep/through cracking

Time	Run #	Start Depth [m]	End Depth [m]	cm Drilled	cm Recovered	Longest Piece [cm]	# Pieces >10 cm	Options	Surface	Core Usable	Comments/Changes
								C S W R			
								C S W R			
								C S W R			
								C S W R			
								C S W R			
								C S W R			
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								C S W R			
								C S W R			
								C S W R			

C: Core dog drag S: Spall W: Wafers R: Rubble								Surface 0: No visible cracks Surface 1: Microcracking Surface 2: Deep/through cracking			
Time	Run #	Start Depth [m]	End Depth [m]	cm Drilled	cm Recovered	Longest Piece [cm]	# Pieces >10 cm	Options	Surface	Core Usable	Comments/Changes
								C S W R			
								C S W R			
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