



PRAIRIE DOG DRILL

Operations and Maintenance Manual

September 16, 2019

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1.0 PURPOSE

The purpose of this document is to provide the operator with a working knowledge of the Prairie Dog, how it is assembled and operated and the basic construction of the system. The operator of the Prairie Dog should also be familiar with the use of the PICO 4-inch Hand Auger coring drill system (SSEC Document #8507-0009) and the use of the SideWinder (SSEC Document #8507-0010) for powering a hand auger coring drill.

2.0 SCOPE

This document describes the Prairie Dog system as well as two associated drill systems, the PICO 4-inch Hand Auger and the SideWinder.

2.1 This document describes how the Prairie Dog works and in which conditions its use is most beneficial. This document also describes how the Prairie Dog is only an auxiliary drilling tool and is always used in conjunction with other drilling equipment.

2.2 The PICO 4-inch Hand Auger is a stand-alone drilling system used to drill a hole and collect a continuous 4-inch diameter core from that hole. It consists of the drilling stem used to turn the coring drill barrel, the coring barrel itself in either one meter or two meter lengths, and a T-handle with which the barrel may be turned by hand. The Prairie Dog may replace the coring barrel portion of the PICO 4-inch Hand Auger system as the actual coring device.

2.3 The SideWinder is a drilling system that powers a hand auger drilling system, assisting in turning and the lifting and lowering of the drill string. It is almost always used in conjunction with the Prairie Dog, as the Prairie Dog is employed when a deeper hole is desired and therefore the drill string becomes too heavy to lift by hand.

3.0 REFERENCES

3.1 **8507-0009** PICO Hand Auger Operations and Maintenance Manual

3.2 **8507-0010** SideWinder Operations and Maintenance Manual

4.0 DEFINITIONS

4.1 **Firn** – The term given to snow over one year in age that is, by definition, also characterized by porosity. In places where firn accumulates over many seasons, firn densifies with depth and eventually transitions to ice at the depth where it is no longer porous.

4.2 **IDP** – U.S. Ice Drilling Program, formerly IDDO.

4.3 **NRFI** – Not Ready For Issue.

4.4 **Operator** – Any person involved in the assembly and use of the equipment described in this document.

- 4.5 **PICO** – Polar Ice Coring Office, a predecessor to IDP.
- 4.6 **QAS** – Quality Assurance and Safety group.
- 4.7 **RFI** – Ready For Issue.
- 4.8 **Simple-flighted coring barrel**—Typical to almost all hand auger coring systems, the simple-flighted coring barrel is a tube with helically-wrapped ‘flighting’ attached to the exterior. The flighting acts as an auger to move chips produced during coring upward along the outside of the barrel. The top of the barrel also has small windows through which the chips fall back into the barrel and rest on top of the ice core for transport from the borehole to the surface. A drill stem is connected to the top of this tube with removable pins. The drill stem provides the power necessary to turn the single-flighted coring barrel during operation.
- 4.9 **SSEC** – University of Wisconsin-Space Science & Engineering Center

5.0 RESPONSIBILITIES

- 5.1 **IDP Management** is responsible for ensuring that operators of IDP drilling equipment are provided with accurate, up-to-date operating procedures.
- 5.2 **IDP Engineering** is responsible for the creation and maintenance of this manual.
- 5.3 **Drilling Equipment Operators** are responsible for ensuring that the procedures described herein are followed and safety warnings adhered to.
- 5.4 **SSEC QAS** is responsible for ensuring that the proper procedures for document creation, review, approval, maintenance and updating are followed.

6.0 SAFETY

- 6.1 Only personnel who have read this manual, and both reference manuals, in their entirety should operate the Prairie Dog system. All operators should read and understand the following safety precautions.
- 6.2 Situational Safety
 - 6.2.1 The Prairie Dog system can be operated by one person, but it is required that two people are always present during operations.
- 6.3 Milwaukee Drill Safety
 - 6.3.1 Operators will stay alert, watch what they are doing, and use common sense when operating a power tool. They will not use a power tool while tired or under the influence of drugs, alcohol, or medication. A moment of inattention while operating power tools may result in serious personal injury.
 - 6.3.2 Prevent unintentional starting. Ensure the switch is in the off-position before connecting to a power source, picking up, or carrying the tool.

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- 6.3.3 Remove any adjusting key or wrench before turning the power tool on. A wrench or a key left attached to a rotating part of the power tool may result in personal injury.
 - 6.3.4 Keep proper footing and balance at all times. Only operate the drill from a stable and secure surface.
 - 6.3.5 Use the auxiliary handle for proper control of the drill.
 - 6.3.6 The Milwaukee drill can output a significant amount of torque that is only held in check by the operator. If the cutter head suddenly binds downhole, the drill will jerk on the surface. Operators will always maintain proper arm and wrist alignment while operating the drill so they can safely and securely brace against any potential jerks.
 - 6.3.7 Always operate with the drill trigger in the operator's right hand. This ensures that if the drill jerks, the on-off trigger will be pulled away from the operator's body instead of pressed into it.
 - 6.3.8 Do not overreach. Do not operate the drill above shoulder level. It is difficult to brace the drill in this position, which puts the operator at risk of a head injury.
- 6.4** Personal Protective Equipment (PPE)
- 6.4.1 PPE – Workers shall wear appropriate hand, eye, and ear protection during drilling operations.
- 6.5** Mechanical Safety
- 6.5.1 Pinch Points – There are several areas on the equipment where a finger, hand, arm, or clothing could be pinched. Operators should identify all pinch points prior to operation and should be mindful of all such points during operation. Pinch points include the cutter head, outer barrel, anti-torque section, extension stem connections, winch cradle, and power drill.
 - 6.5.2 Rotating Components – Sheaves, barrels, drills, ropes, and drums may be rotating and exposed to the operator on the surface. Keep hands, limbs, loose clothing, and hair away from any rotating components during operations.
 - 6.5.3 Cold Hazard – Metal components may be extremely cold after being in the borehole. Always wear appropriate gloves when handling.
 - 6.5.4 Slippery Surfaces – Rig footing and surrounding ice may become slippery when wet with fluids or meltwater. Use caution whenever walking around the operational area.
 - 6.5.5 Overhead Masses – Equipment may be above head level. Be mindful of hazards and always work as a team when using the system.

6.6 Electrical Safety

6.6.1 Voltage – Extreme care shall be taken when assembling, disassembling, and servicing electrical equipment. Always disconnect power before servicing equipment.

6.6.2 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 generator.

6.7 Chemical Safety

6.7.1 Use care and observe all safety warnings when handling Ethanol and/or other chemicals.

6.8 Environmental Safety

6.8.1 Cold – This system will be deployed to extremely cold climates. Operators shall wear outerwear suitable to protect themselves from the cold, and should monitor their own and fellow workers' activities for overexposure to cold.



Figure 1 - The Prairie Dog being removed from a borehole. Through the semi-transparent outer barrel ice chips can be seen resting on the flights of the inner barrel.

7.0 DESCRIPTION OF THE PRAIRIE DOG

7.1 Benefits of the Prairie Dog System

- 7.1.1 The Prairie Dog (Figure 1) is similar to a simple-flighted coring barrel in that it has a flighted tube that is turned by power generated from the surface. Both of these systems collect both the core and the chips within themselves. The difference with the Prairie Dog is that it has an additional outer tube, or outer barrel (Figure 2).



Figure 2 – Prairie Dog inner and outer barrels with core trays

- 7.1.2 Having an outer barrel means that the chips travel upward between the two barrels, rather than against the wall of the borehole. The outer barrel is also flighted, but with straight strips attached vertically. For the chips to transport, the flights must move relative to each other, therefore, the outer barrel must not turn with respect to the inner barrel. This is accomplished by an 'anti-torque' attached to the outer tube (Figure 3). The anti-torque interacts with the borehole wall to prevent the outer barrel from turning but without restricting it from moving downward. The anti-torque on the Prairie Dog is a mechanism that extends three blades outward toward the borehole wall as the weight of the drill string sits down upon it. The anti-torque also centers the top of the drill in the hole, guiding the drill down a straight penetration path.



Figure 3 – Prairie Dog anti-torque

- 7.1.3 Typically, with a single-barrel coring drill, the chips are augered upward and deposited on top of the core when the barrel is filled, occasionally leading to problems removing the drill from the borehole and a consistent loss of excess chips to the bottom of the borehole. With a double-barrel drill such as the Prairie Dog, both chip collection and transport are more efficient. When the Prairie Dog inner barrel is full, the chips will pack until the drill will no longer turn, notifying the operator that the run is complete.
- 7.1.4 The second barrel also adds stiffness to the Prairie Dog. This stiffness, combined with the ability of the anti-torque blades to center the barrel in the hole, also leads to fewer breaks in the core. Longer cores are produced and more chips are collected per run, which also leads to fewer trips down hole. The Prairie Dog System also uses less power since chip transport is more efficient and the flights do not grind against the borehole wall.

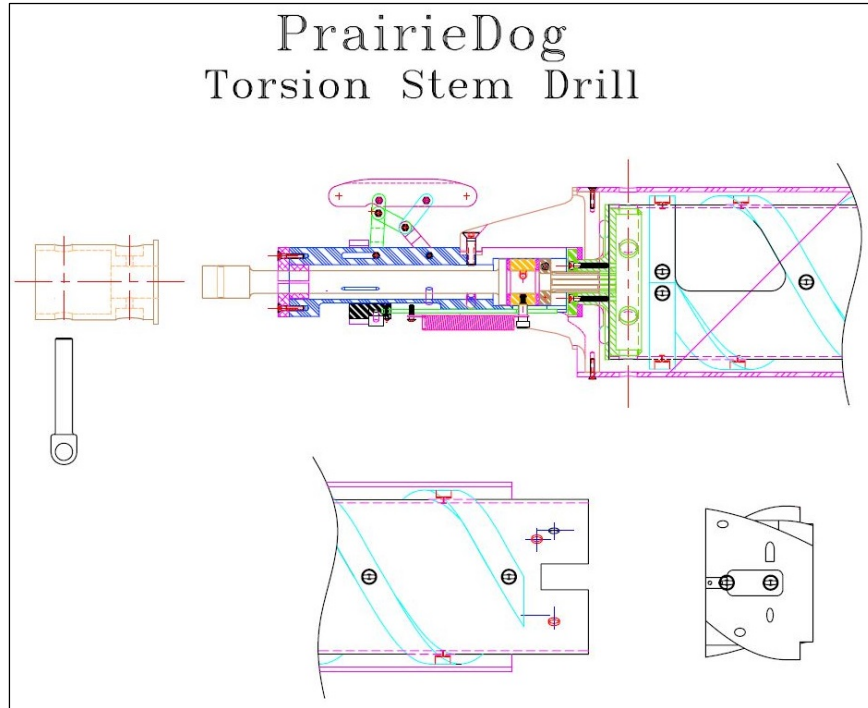


Figure 4 - This sectional view shows the torsion stem adapter removed from the sliding power shaft. The pin shown is the rope attachment pin necessary to use the SideWinder for power lifting. Only one of the three anti-torque blades is shown for clarity. The outer barrel is seven feet (2.1m) in length. The total length of the Prairie Dog is approximately eight feet (2.4m).

7.2 Using the Prairie Dog with the PICO 4-inch Hand Auger

The Prairie Dog is used in conjunction with the PICO 4-inch Hand Auger system for multiple reasons:

- 7.2.1 The drive connection at the top of the Prairie Dog mates nicely with the stem of the PICO 4-inch Hand Auger system.
- 7.2.2 The coring heads of both systems are basically interchangeable. The major diameters of the two, and the core size produced is the same. Therefore, the PICO drill barrel and the Prairie Dog could be used interchangeably during the drilling of the borehole.

Note: Because the coring heads of the Prairie Dog and the PICO 4-inch Hand Auger are the same, directions for any adjustments to be made to the coring head will be found in the hand auger operator's manual (SSEC Document #8507-0009: PICO Hand Auger Operations and Maintenance Manual). However, unless one is drilling through dirt layers and needs to change cutters, head adjustments are rare.

Note: Soft snow blades have been developed and can be added to certain anti-torques modified to accommodate them, but borehole initiation is generally much easier with the PICO drill barrel.

7.3 Required Equipment

The Prairie Dog uses much of the same equipment as the PICO 4-inch Hand Auger:

- 7.3.1 Both the Prairie Dog and the 4-inch PICO Hand Auger drills have a drive pin that secures the core barrel to the drill stem.

Note: The drive pins for these two drills are different in that they have grooves in different places. The grooves match the spring detents to hold the pins in place (Figure 5). Be sure you are using the proper pins for each drill.

Prairie Dog pin has an additional groove in the middle.

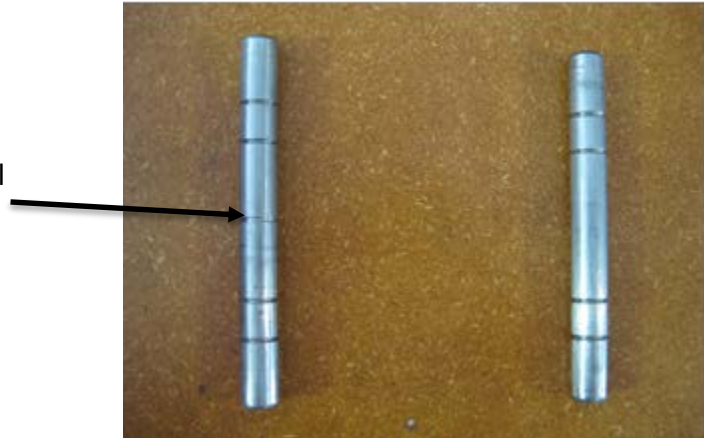


Figure 5 – Drive pins; Prairie Dog (left), PICO Hand Auger (right)

- 7.3.2 Both drills, however, use the same stem-to-drill pin, the bottom pin of the drill stem.
- 7.3.2.1 When drilling with either system, the bottommost pin in the drill stem, that which attaches the stem with either the adapter in the case of the PICO core barrel, or the adapter on the top end of the Prairie Dog, is similar to a bolt with a locking nut. All the other joints that connect the stem together are a simple ½-inch diameter pin with a groove around the middle. With both the PICO stem-to-barrel adapter and the Prairie Dog drive connection, there is no detent to hold a stem pin so a self-locking pin is needed.
- 7.3.2.2 If using the SideWinder, the bottom pin in the stem will be the rope pin, which is the lifting point for the SideWinder. With either drill, this pin will remain in place for the duration of the drill's use, that is, one does not need to remove the bottom piece of stem.
- 7.3.3 The basic tools required for the PICO 4-inch Hand Auger are included in the kit, however, additional tools are often included for other maintenance issues that may arise, such as a generator issue. A complete list of the drill components and tools included in a PICO 4-Inch Hand Auger with Prairie Dog kit can be found in Appendix A.

8.0 PRAIRIE DOG SHIPPING & ASSEMBLY

8.1 Shipping

The Prairie Dog System is shipped in three pieces: the barrels together as one piece, the coring head and the anti-torque section.

- 8.1.1 The outer/inner barrels are normally combined with the PICO 4-inch Hand Auger system in long red bags during shipping. The inner barrel should be placed inside of the outer barrel and the coring head removed and shipped separately.
- 8.1.2 The coring head and the anti-torque section are shipped in padded cases to prevent damage.

8.2 Assembly

- 8.2.1 The mounting of the coring head is self-explanatory, but is explained in the PICO Hand Auger manual (SSEC Document #8507-0009).
- 8.2.2 The anti-torque section of the Prairie Dog is attached to the outer barrel by six flat head machine screws. Simply slide the two pieces together and align the holes. Insert the screws and secure with an Allen wrench.

8.3 Transportation of Assembly

When assembled, the Prairie Dog is too long to be included in the long red bags of the PICO 4-inch Hand Auger system and thus should remain separate. A sturdy cardboard or similar cover should be placed around the coring head and the anti-torque section to prevent damage to the equipment or those handling it during transport.

9.0 DRILLING

Note: If the SideWinder will not be used in conjunction with the Prairie Dog, please ignore references to it in the following section.

9.1 Beginning the Hole

- 9.1.1 The First Drill Run - The borehole is begun in the same manner whether or not one intends to attach the Prairie Dog later and whether or not the SideWinder is being used. The PICO 4-inch coring barrel, using either the 1-meter or 2-meter barrel, is used alone to start the hole. This is done by turning the barrel by hand until such time that power can be applied (if using the SideWinder). Use the horizon to determine if the barrel is plumb. If plumb is required, a carpenter's level may be used. The barrel can be drilled into the snow to its very top, and then removed by hand.
- 9.1.2 Subsequent Drill Runs - In cold snow and firn, one will continue using the PICO 4-inch coring barrel to a depth of approximately five or six meters. At this depth, the borehole wall will be hard enough for the Prairie Dog anti-torque blades to hold. It is also the length of drill string that can be lifted by hand from the hole as one piece, both for reasons of weight and manageability. From this depth onward, the drill stem will be broken into manageable segments and pinned together as the drill string is being lowered into or removed from the borehole.

9.1.3 Attaching the Prairie Dog

9.1.3.1 When the hole is between five and six meters deep, the firn should be dense enough to begin use of the Prairie Dog. This is also the point where it becomes necessary to break the drill stem into sections for handling.

9.1.3.2 Slide the inner barrel inside of the outer barrel and connect it with a drive pin through the window of the outer barrel. To obtain the correct alignment hold the stem in place while rotating the outer barrel.

9.1.3.3 Connect the anti-torque section to the bottom of the drill stem (Figure 6). If using the SideWinder, be sure to use the SideWinder rope pin; otherwise use the same pin that was used with the PICO adapter.

Note: The SideWinder makes it very easy to break the stem into manageable lengths.

9.2 After Prairie Dog Attachment

As the Prairie Dog moves down the borehole for the first time, drilling continues as with the PICO 4-inch coring barrel. For the most part, addition of the Prairie Dog will be transparent regarding drilling technique. One difference is that the operator is notified that the Prairie Dog barrel is full and that the run is complete when the drill becomes difficult to turn. This can be expected after approximately 1.2-1.4 meters of drilling, depending on the density of the firn or ice that is being drilled.

9.2.1 Breaking Free from the Borehole Bottom

Depending on the method of core capture employed by the coring head, breaking free from the bottom with either the PICO 4-inch coring barrel or the Prairie Dog can be the most difficult part of drilling. The Prairie Dog eases core breaks regardless of the core capture mechanism involved for two reasons. First, it has a smooth outer surface and is not held by the chips against the borehole wall as is the PICO 4-inch coring barrel. Second, it has a built in "hammer" effect because of the sliding power shaft within the anti-torque mechanism. This allows for the drill string above the Prairie Dog to gain momentum before the Prairie Dog begins to move.

9.2.2 Lifting the Prairie Dog from the Borehole

Lifting the Prairie Dog from the borehole can be difficult because it is heavy, long and slick. It is helpful to have a second person to assist. The anti-torques can be used as a lifting point without risking damage to them, however, unless operators are very tall, the Prairie Dog cannot be lifted all of the way out in this manner. Thus, it is necessary to get a second hold of the system while either clamping it in between one's knees or while someone else holds it.

9.2.3 Removing core

While the Prairie Dog is horizontal, rotate the outer barrel while holding the drill stem until the drive pin lines up with the windows in the outer barrel. Then use a pin pusher to remove the drive pin. Move to the other end of the coring barrel and slide the inner barrel out of the outer barrel. The core can then be pushed out the top of the inner barrel.

Note: Remember to clean any chips or snow out of both the outer barrel and inner barrel flights.

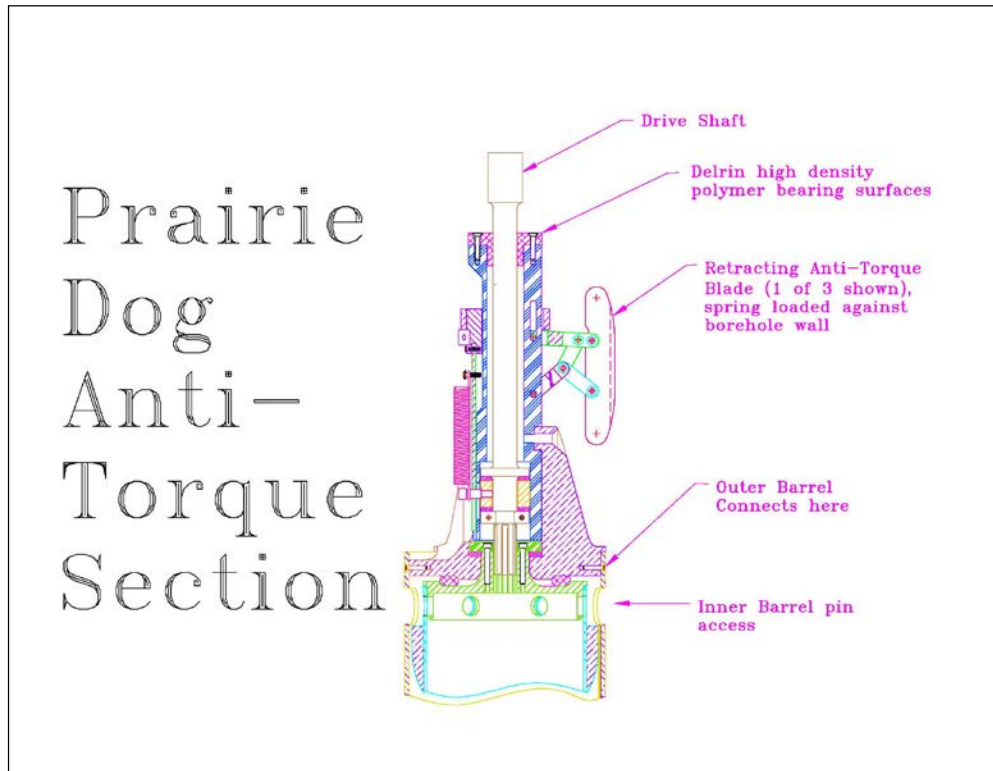


Figure 6 - Sectional view of the Prairie Dog anti-torque section.

10.0 DISASSEMBLY

10.1 Disassembly of the Prairie Dog is completed simply by undoing the steps of assembly:

- 10.1.1 Remove the inner barrel from the outer barrel by removing the drive pin and pulling it out.
- 10.1.2 Remove the six flathead screws holding the anti-torque section to the outer barrel and pull the two pieces apart.
- 10.1.3 Remove the coring head from the inner barrel as described in the PICO Hand Auger Manual (SSEC Document #8507-0009).
- 10.1.4 Clean all snow and ice off parts and dry them before packing. If possible, oil the steel parts to prevent rusting during shipping.
- 10.1.5 Repack all parts into the appropriate cases as they were shipped to you.

11.0 APPENDIX A: PRAIRIE DOG INSPECTION PROCEDURES AND FORMS

11.1 Upon arrival of any parts in Madison, IDP staff will:

11.1.1 Clean, test, and store all components.

11.1.1.1 Track quantities through the Hand Auger Inventory spreadsheet at C:\EPDM\IDDO\Hand Augers\.

11.1.1.2 Any parts that are out of spec or broken will be removed from the general inventory until they are repaired or replaced.

11.2 Prior to any parts leaving Madison, IDP staff will:

11.2.1 Pack the kit per the PI's field request.

11.2.2 Fill out a Fit Checklist (11.5) and an Inventory Checklist (11.6), including a paper copy in the kit.

11.2.3 Update the Hand Auger Inventory spreadsheet.

11.2.4 If sending part designs that have not been field tested, proven backup methods will be included as well.

11.3 Upon arrival of any parts in the field, field personnel will:

11.3.1 Verify that all components arrived undamaged.

11.4 Prior to any parts leaving the field, field personnel will:

11.4.1 Clean and dry all components as best as possible.

11.4.2 Use the Inventory Checklist (11.6) to verify that the correct components are being returned.

11.5 IDP Staff- Fit Checklist

Season:		User:
Where Used:		Prairie Dog ID # _____
Contents:		
Done?	Task	
	Perform all tasks on PICO Fit Checklist	
	Perform all tasks on Sidewinder Fit Checklist	
	Fit outer barrel(s) to inner barrel(s)	
	Fit cutter head(s) to inner barrel(s)	
	Verify cutters are correct size for Prairie Dog (PD) outer barrel	
	Verify function of anti-torque section	
	Fit anti-torque section to outer barrel(s)	
	Fit anti-torque section to inner barrel(s)	
	Fit anti-torque section to all extensions	

11.6 Inventory Checklist

Season:		User:		
Where Used:		Prairie Dog ID # _____		
Contents of Shipping Crate:				
	Item	Standard Qty	Qty Packed	Notes
1	Long Bag	2 Each		
2	4" PICO Barrel	1 Each		
3	Prairie Dog Inner Barrel	1 Each		
4	Outer Barrel	1 each		
5	Core Push Rod	1 Each		
6	2-m Extension	18 Each		
7	1-m Extension	4 Each		
8	Head Cover	2 Each		
9	Tool Bag	1 Each		
Contents of Tool Bag:				
10	Dead Blow Mallet	1 Each		
11	3/16-inch Standard Screwdriver	1 Each		
12	¼-inch Standard Screwdriver	1 Each		
13	Phillips Screwdriver	1 Each		
14	SAE Allen Wrench Set	1 Each		
15	Diamond Hone	1 Each		
16	Duct Tape	1 Each		
17	Crescent Wrench	1 Each		
18	Dial Caliper	1 Each		
19	Kevlar Gloves	1 Pair		
20	Vice Grip	1 Each		
21	Needle Nose Pliers	1 Each		
22	Slip Joint Pliers	1 Each		
23	Side Cutters	1 Each		
24	Flat Bastard File	1 Each		
25	Prairie Dog Manual	1 Each		
Note: Download Manual from http://icedrill.org/documents/view.shtml?id=369				
26	PICO Hand Auger Manual	1 Each		
Note: Download Manual from http://icedrill.org/documents/view.shtml?id=142				
Contents of Hardigg Case:				
27	Anti-Torque Section	1 Each		
28	4" PICO Head (complete)	2 Each		
29	4" Cutter (wide)	4 Each		
30	4" Cutter (narrow)	2 Each		
31	Penetration Shoe	2 Each / size		
32	Set Screw 3/8"-16 x ½"	4 Each		
33	Dowel pin 3/16" x 7/8"	4 Each		
34	FHCap screw ¼"-20 x 7/8"	2 Each		
35	FHCap screw 6-32 x ½"	6 Each		
36	Hex bolt ¼"-20" x ¾"	2 Each		
37	Washer ¼"	4 Each		
38	Lock washer ¼"	2 Each		
39	Nut ¼"-20	2 Each		
40	Core Dog 4" long	2 Each		
41	Dowel Pin 1/8" x 1-1/2"	4 Each		
42	Torsion Spring .160" x 1-1/2"	10 Each		
Optional Items:				
43	Sidewinder kit in Hardigg	1 Each		
44	2k generator in Hardigg	1 Each		