



# **SIPRE HAND AUGER**

## **Operations and Maintenance Manual**

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September 16, 2019

## Table of Contents

1.0	Purpose .....	1
2.0	Scope .....	1
3.0	References .....	1
4.0	Definitions .....	1
5.0	Responsibilities .....	1
6.0	Records .....	1
7.0	Operator’s Manual .....	2
8.0	Appendix A: Field Maintenance .....	6
9.0	Appendix B: Sharpening Cutters .....	8
10.0	Appendix C: Penetration Screw Adjustment .....	9
11.0	Appendix D: Special Drilling Conditions .....	10
12.0	Appendix E: Problem Solving .....	12
13.0	Appendix F: Inspection Procedures and Forms .....	13
14.0	Appendix G: Quick Guide .....	16

## **1.0 PURPOSE**

The objective of this document is to provide the operator a working knowledge of how the SIPRE Hand Auger is assembled, tuned and operated under a variety of conditions. Step-by-step instructions are included for those with no experience with hand coring drills. Those who have experience are encouraged to scan the Tips, Notes, Cautions, and Warnings throughout the document. The appendices may be useful should problems arise or unique ice conditions be encountered.

## **2.0 SCOPE**

This document applies to:

**2.1** SIPRE Hand Augers

## **3.0 REFERENCES**

**3.1** None.

## **4.0 DEFINITIONS**

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

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

**4.3 SIPRE** – Snow, Ice and Permafrost Research Establishment

**4.4 UW SSEC** – University of Wisconsin-Space Science & Engineering Center, the home of IDP.

**4.5 QAS** – Quality Assurance and Safety group.

## **5.0 RESPONSIBILITIES**

**5.1** IDP Management is responsible for ensuring that operators of the SIPRE drills are provided with accurate, up-to-date operating procedures.

**5.2** IDP Engineering is responsible for the creation and maintenance of this document.

**5.3** SIPRE Auger Operators are responsible for ensuring these procedures are followed and any safety warnings contained herein are heeded.

**5.4** SSEC QAS is responsible for ensuring that the proper procedures of document creation, review, approval, maintenance and updating are followed.

## **6.0 RECORDS**

**6.1** None.

## 7.0 OPERATOR'S MANUAL

### 7.1 Introduction

- 7.1.1 The SIPRE hand auger drill system is a small light weight, portable drill system. It is designed primarily to take core from firm ice, but has successful taken core from many types of solid ice.
- 7.1.2 The SIPRE hand auger produces cores 3-inches in diameter.
- 7.1.3 The SIPRE hand auger produces core samples in ½-meter lengths.
- 7.1.4 The SIPRE hand auger kit contains everything needed to take core to a depth of 6-meters.
- 7.1.5 There are two versions of the SIPRE hand auger system. The older system features a narrower kerf (5/8-inch) and typically has a silver or green barrel. The newer system features a wider kerf (3/4-inch) and typically has a black barrel. Both systems are fully functional and operate the same way, but many parts are not interchangeable.

### 7.2 Inspection

- 7.2.1 If possible, before leaving for the field, inspect the SIPRE hand auger kit to make sure all parts, tools and spares are included and in good condition. An inspection form (Appendix F) will be included in the kit to assist you with this inspection.
- 7.2.2 Using the inspection form as a guide, make sure the drill is complete and in good condition.
- 7.2.3 It is also a good idea to assemble the kit prior to deploying to your field site in order to familiarize yourself with the assembly and function of the parts.

### 7.3 Assembly

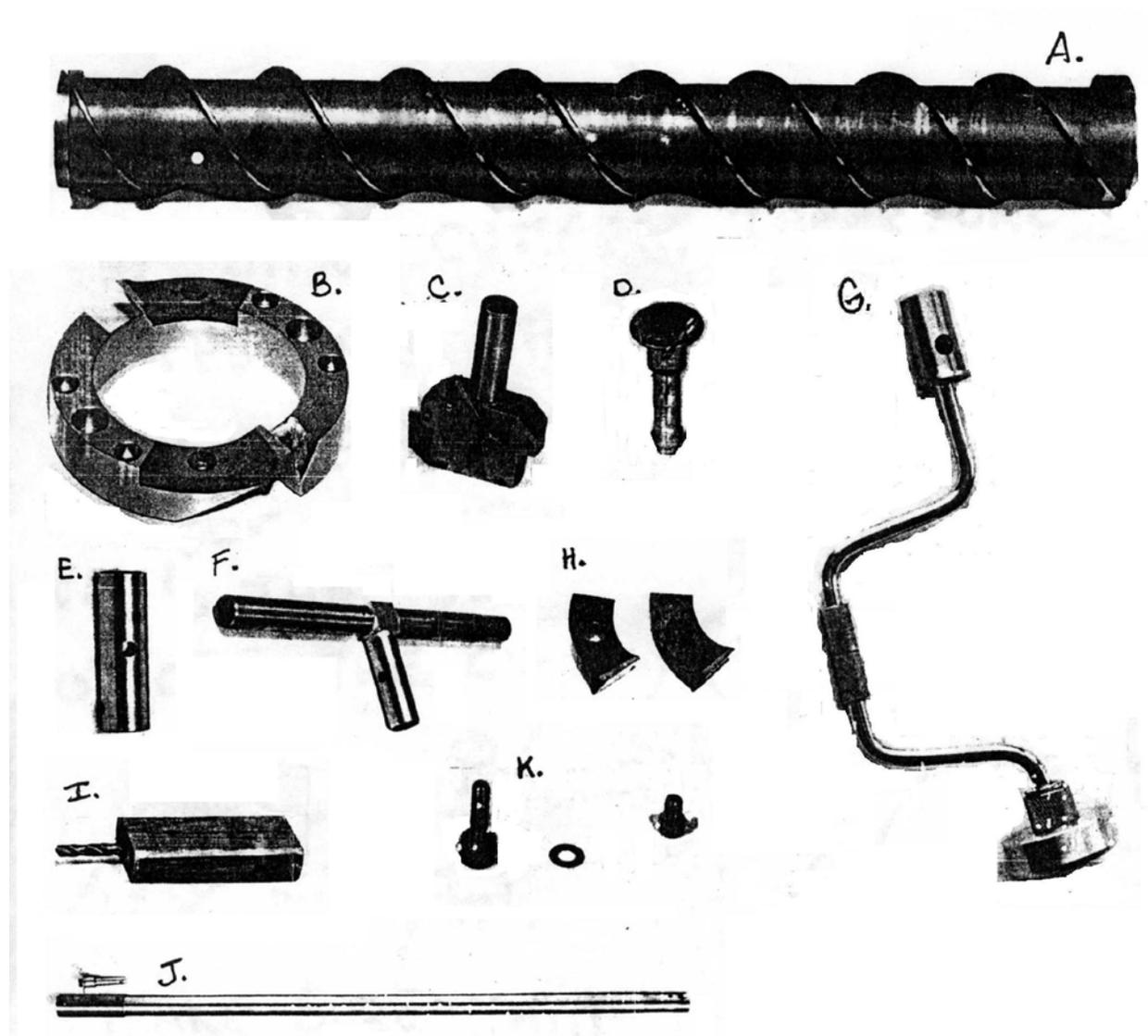
***CAUTION! The cutters are sharp. The use of gloves is recommended.***

- 7.3.1 Remove the following items from the Hardigg case:
  - The core barrel (Item A, Figure 1) [core head (Item B, Figure 1) attached].
  - The drive adapter (Item C, Figure 1).
  - The adapter tube (Item E, Figure 1).
  - The brace handle (Item G, Figure 1).
- 7.3.2 Insert the drive adapter into the top of the barrel and rotate the lever to lock it in place.

***TIP! Keep the protective cover on the core head while assembling the SIPRE hand auger. This will protect the cutters and minimize the chance of injuries.***

- 7.3.3 Pin the adapter tube onto the drive adapter.
- 7.3.4 Pin the brace handle onto the adapter tube.

***TIP! For most drilling conditions, you will find it necessary to replace the brace handle and adapter tube with the T-handle shortly after starting the hole.***



**Figure 1: SIPRE Kit Parts**

**7.3.5 Adding extensions:**

- Disconnect the adapter tube from the drive adapter.
- Place an extension between the drive adapter and the adapter tube.
- Pin both connections together.

**7.3.6 Mounting the core head to the core barrel:**

- Tools needed for mounting the core head.
  - Allen wrench
  - Six screws
- Use the locating ring of the core head to align it with the barrel.
- Carefully rotate the head until the six mounting holes line up.
- Begin screwing in the screws.

- Do not fully tighten any screws until all six have been started.
- Tighten down all of the screws with the Allen wrench.

#### 7.3.7 Removing the core head from the core barrel:

- Tools needed for removing the core head.
  - Allen wrench
- Unscrew the six screws holding the head to the barrel.
- Gently remove the head from the barrel.

### 7.4 Operation

#### 7.4.1 Drill Site Preparation

- It is best to drill on a level surface. It is easier to move around the drill, and it is less likely the hole will become contaminated by material that slides or rolls down the slope into the hole.
- When drilling on a sloped surface, consider cutting a shelf into the slope large enough for the drilling operation. Place barriers uphill from the drill site to minimize the chance of contamination.
- Set up your core handling area away from, but convenient to, the drill site.
- If possible, erect tarps to shade the core handling area. This is to prevent the sun from heating up the drill and melting the core samples.
- Keep insulated core boxes close at hand for safe storage of the core. Consider burying filled core boxes in the snow for extra protection. If core boxes are not available, bagged core samples can be buried in the snow for safekeeping until core boxes arrive.

#### 7.4.2 Taking the First Core Sample

- Remove the protective hood from the core head.
- Hold the drill upright at the drilling location.
- Turn the drill clockwise, while applying slight downward pressure on the drill. Continue until the top of the core barrel is approximately 6-inches above the surface.

**TIP!** *When taking the first sample, have someone standing off to your right or left to verify you are not leaning the drill toward or away from you.*

**TIP!** *When first starting a hole, it may be easier to keep the drill stable by turning the core barrel with your hands on the barrel. Once the drill is about a foot or so in, use the T-handle.*

- Stop turning the drill and grasp the T-handle with both hands. Give the T-handle a sharp jerk upward to break the core sample free from the bottom of the hole.
- Remove the drill from the hole.

**WARNING!** *Be careful not to drop anything down the hole! This can contaminate the samples, and may damage the cutting edges of the drill.*

- Turn the lever on the drive adapter and remove it from the barrel.

- Carry the core barrel to the core handling area.
- Push the core sample out the top of the barrel.
- The core must be supported by a core tray. There are many designs in use. You may have a preference for one type or another. Most find a piece of PVC pipe cut in half lengthwise works well.

#### 7.4.3 Taking Subsequent Core Samples

- Remove the T-handle from the drive adapter.
- Add an extension to the drive adapter and replace the T-handle.
- Attach the core barrel to the drive adapter.
- Place the core barrel into the hole and turn clockwise until the core barrel is full.

***CAUTION! Do not over drill! If you see ice chips piling up on top of the drive adapter you are over drilling. This may cause the drill to become stuck in the hole. If the drill becomes stuck, refer to Appendix E: Problem Solving.***

***NOTE:*** *The first sample should be about 1-meter long. The chips that were in the flights of the core barrel when the first sample was removed fall to the bottom of the hole. When the second core sample is taken, you must first drill through these chips. The core barrel will be partially filled with these chips, which leaves less room for core. Also, while drilling the second core, chips travel up the flights and fall into the core barrel on top of the core sample. For these reasons, you will only get about a ½ meter core the second trip (and all subsequent trips) down the hole.*

- Break the core free from the bottom of the hole and deliver it to the core handling area.
- Continue adding extensions as you get deeper.

### 7.5 Disassembly and Packing

7.5.1 Disassembly of the drill is done in the reverse order it was assembled.

7.5.2 It is not necessary to remove the core head from the barrel.

7.5.3 Be sure the protective hood is firmly attached on the core head.

7.5.4 Before putting the parts back into the case, remove as much snow as you can and dry the components.

7.5.5 Use the inspection form (Appendix F) to make sure everything is repacked in the kit.

7.5.6 Use the inspection form to note any missing or damaged items.

7.5.7 Once everything is back in the kit, make sure all locks are securely fastened.

## 8.0 APPENDIX A: FIELD MAINTENANCE

### 8.1 Cutters

8.1.1 The SIPRE hand augers come with both inserted carbide cutters and one-piece steel cutters.

8.1.2 Generally, the kits will be setup with inserted cutters when you receive it, but either style can be used with success.

8.1.3 Removing One-Piece Cutters:

8.1.3.1 Tools required to remove the cutters:

- Allen wrench
- Vice grip pliers
- Dead blow mallet

8.1.3.2 Using the Allen wrench, remove the flat head cutter binding screw.

8.1.3.3 Grip the cutter with the vice grip pliers and pull the cutter off (it may help to lightly tap the vice grip with the dead blow mallet while pulling).

8.1.3.4 The alignment pins may cling to the core head or to the cutter. If they cling to the cutter remove them using the vice grip and tap them back into the core head.

8.1.4 Installing One-Piece Cutters:

8.1.4.1 Tools required to install the cutters:

- Allen wrench
- Dead blow mallet

8.1.4.2 Align the cutters with the alignment pins on the core head.

8.1.4.3 Tap the cutter down into the cutter pocket using the dead blow mallet.

8.1.4.4 Install the flat head cutter binding screw and tighten with the Allen wrench.

***NOTE: Each cutter has a matching one. If replacing one cutter, replace the other as well. Keep cutter pairs together to ensure good results.***

8.1.5 Inserted Cutters:

8.1.5.1 The inserted cutters are an assembly of three parts.

- Insert holder.
- Insert.
- Insert screw.

8.1.5.2 The inserts can be replaced without removing the insert holders from the core head.

8.1.6 Removing the inserts:

8.1.6.1 Using a 5/64 inch Allen wrench, loosen and remove the insert screw.

8.1.6.2 Remove the insert from the insert holder.

8.1.6.3 Repeat Steps 8.1.6.1 and 8.1.6.2 for each cutter.

8.1.7 Replacing the inserts:

8.1.7.1 Insert a new insert into the insert holder and ensure that it is fully seated in the pocket.

8.1.7.2 Using a 5/64 inch Allen wrench, replace and tighten the insert screw.

8.1.7.3 Repeat Steps 8.1.7.1 and 8.1.7.2 for each cutter.

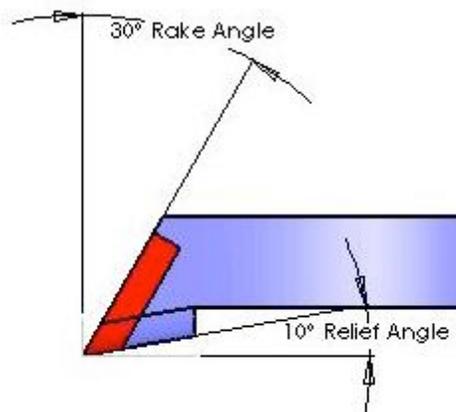
## 9.0 APPENDIX B: SHARPENING CUTTERS

9.1 The short answer to how to sharpen the cutters is to not do it in the field. If you expect dirty, sandy or rocky ice, request carbide inserted cutters and plenty of spares. In clean ice/firn, the standard kit spares should suffice. If you must sharpen cutters in the field read on.

9.2 Tools Required:

9.2.1 Diamond hone

9.3 The cutting edge of the cutter is made up of two intersecting angles. The rake angle (Figure B.1) may vary from  $30^{\circ}$  to  $45^{\circ}$ . The relief angle (Figure B.1) may vary from  $10^{\circ}$  to  $15^{\circ}$ . When sharpening the cutters, care should be taken to avoid changing either of these angles, **particularly the relief angle**. Changing the relief angle will adversely affect the penetration rate of the drill.



**Figure B.1: Rake and Relief Angles**

9.4 It is also very important that all cutters are sharpened equally. If one is sharpened more than the other(s), the high cutter will do all of the cutting. Also, it may cause the drill to wobble in the hole. This may adversely affect core quality.

9.5 Place the diamond hone on a firm level surface.

9.6 Place the rake angle surface flat on the diamond hone and slide it along the hone's length. Slight pressure will be required. At the end of the stroke, repeat the process. Count the number of strokes and repeat them on the other cutter(s).

9.7 Turn the cutter over and place the relief angle flat on the diamond hone. To do this you will have to hang the tail of the cutter over the edge of the hone. Repeat the process described in paragraph 6.

9.8 Repeat this process until all nicks are removed and the cutter is razor sharp.

## 10.0 APPENDIX C: PENETRATION SCREW ADJUSTMENT

### 10.1 Tools required:

10.1.1 3/16 Allen wrench

10.1.2 Washers

### 10.2 Washers can be placed underneath the penetration screws in order to limit the bite depth of the cutters.

10.2.1 The penetration screws are the middle one of each set of three that attaches the head to the barrel.

10.2.2 Ice conditions dictate what type of adjustment to make

- For firm or sea ice, the penetration screws should have no washers underneath then and should be screwed all the way into the barrel.
- For lake/hard ice, the penetration screws should protrude slightly by placing 1 to 4 washers under each before tightening.
- For brittle ice, the penetration screws should stick out significantly (but not exceed the cutting edge) by placing 4 or more washers under each before tightening.

### 10.3 Adjustment

10.3.1 Remove the penetration screws completely with the Allen wrench.

10.3.2 Insert the appropriate number of washers.

***NOTE: Identical washers should be used on each side to prevent the drill from biting unevenly and/or wobbling in the hole.***

10.3.3 Insert the penetration screw and tighten all the way with the Allen wrench.

## 11.0 APPENDIX D: SPECIAL DRILLING CONDITIONS

### 11.1 Firn

11.1.1 Firn is the easiest ice to core. The surface will probably be harder, with softer snow underneath. The penetration screws do not have enough surface area to have much effect in firn. Therefore, it's safe to ignore penetration screw adjustments.

### 11.2 Solid Ice includes:

11.2.1 Blue Ice – Ice that is formed at depth but comes up as the glacier moves to an area where sublimation occurs, such as near an exposed land mass that absorbs sunlight and warms the air. The sublimation removes the upper layers of firn and snow and over time exposes the ice. It will probably have a near uniform temperature profile in its upper few meters and should be straightforward to core with a hand auger. It may have some residual stresses from its movement and may be a bit brittle.

11.2.2 Lake Ice – Can be multiple years in age and many meters thick or just annual ice only a few centimeters thick. If it is near exposed land, it may have dirt and dust in layers or throughout. It may have snow accumulated on its surface. Any embedded dirt/dust will dull the cutters and slow drilling, but penetration is still achievable.

11.2.3 Sea Ice is ice that forms on the surface of salt water. The ice contains varying degrees of salinity and may contain pockets of liquid salt water. The freezing temperature of salt water is lower than that of fresh water and varies with the level of salinity.

### 11.3 Ice with dirt, sand or very small rocks

11.3.1 Penetration screw adjustment will be based more on what kind of ice it would be without the dirt and/or sand. However, the height of the penetration screws may change as they wear down. Check them often and make adjustments as needed.

***NOTE: Request carbide cutters and plenty of spares.***

### 11.4 Rocky ice

11.4.1 Success drilling in ice embedded with rocks has mostly been achieved with powered rotation and a controlled feed rate using carbide cutters. If you hit a rock, ease up on the downward force you are applying to the drill. Lightly scrape away at the rock until through. Continue drilling for a few cm and pull up the drill. Examine the core. If the core quality is good below the rock return to drilling. If not, replace the cutters/inserts.

***NOTE: Request carbide cutters and plenty of spares.***

### 11.5 Temperate Ice/Snow

- 11.5.1 Core drilling in temperate ice (ice that is at or very near 0°C) should NOT be attempted with the SIPRE hand augers. The chips will pack to form near solid ice around the auger flights and coring head, which will become so stuck that one will have to dig the drill out or abandon it. Only drills with both inner and outer core barrels may be considered for core drilling in temperate snow and ice.

## 12.0 APPENDIX E: PROBLEM SOLVING

### 12.1 Stuck drill

12.1.1 Try turning the drill backwards while pulling up on the T-handle. If the flights are packed with snow, you may be able to screw it out.

12.1.2 Pour 1 or 2 liters of alcohol down the hole. Let it sit for 2 or 3 hours and try removing the drill. Do not use alcohol mixes less than 25%.

12.1.3 If the above retrieval methods fail, the drill will need to be dug out.

### 12.2 Item dropped down the hole

12.2.1 It depends on what is down the hole. If the object is magnetic, try fishing it out with a magnet. If it is small and non-magnetic, try to carefully drill beyond it and bring it up with the chips. This may damage the cutters, so be prepared to replace them. If you have a generator and a shop vacuum, you can also try to vacuum it out.

12.2.2 If a core barrel has been dropped down the hole, try fishing it out with a wire hook on the end of some parachute cored (p-cord). If you can hook one of the chip holes you should be able to pull it out. If you have bungee cords available, hook one end in the holes at the bottom of the extension tubes (remove the drive adapter first). Trip the extension tube string down the hole. Wiggle it around a bit and see if you can hook the core barrel on the bungee cords.

12.2.3 If there are extension tubes attached to the core barrel, try this:

- Assemble enough extension tubes to reach the down-hole string.
- Trip the assembly down the hole and slip the bottom end over the mating down-hole extension tube.
- Make a slipknot in the end of a length of p-cord.
- Loop the slip knot over the extension assembly and work it down the hole until it is below the coupling on the uppermost dropped extension tube.
- Pull up on the P cord. The slip knot should cinch down and grip below the coupling.
- Remove the extension tube assembly from the hole (to minimize the weight of the drill string).
- Pull the remaining drill string out of the hole using the p-cord.

**13.0 APPENDIX F: INSPECTION PROCEDURES AND FORMS**

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

13.1.1 Clean, test, and store all components.

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

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

**13.2** Prior to any parts leaving Madison, IDP staff will:

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

13.2.2 Fill out a Fit Checklist (13.5) and an Inventory Checklist (13.6), including a paper copy in the kit.

13.2.3 Update the Hand Auger Inventory spreadsheet.

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

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

13.3.1 Verify that all components arrived undamaged.

**13.4** Prior to any parts leaving the field, field personnel will:

13.4.1 Clean and dry all components as best as possible.

13.4.2 Use the Inventory Checklist (13.6) to verify that the correct components are being returned.

**13.5 IDP Staff-Fit Checklist**

IDP Staff Fit Checklist - SIPRE Drill	
Season:	User:
Where Used:	SIPRE Drill ID# _____ Wide _____ or Narrow _____
Contents:	
Done?	Task
	Fit Tee Handle to all Extensions
	Fit Brace Handle to Extension Adapter
	Fit Extension Adaptor to all Extensions
	Fit all Extensions to each other
	Check function of all Extension Pins
	Fit all Extensions to Core Barrel Drive Adapter
	Fit Core Barrel Drive Adapter to Core Barrel
	Fit Starting Guide to Core Barrel
	Fit Cutter Head to all Cutters and Holders
	Fit all Inserts to all Holders
	Fit Badger Drive Adapter to all Extensions

## 13.6 Inventory Checklist

SIPRE Drill Inventory Checklist				
Season:		User:		
Where Used:		SIPRE Drill ID# _____ Wide _____ or Narrow _____		
Contents:				
#	Item	Standard Qty	Qty Packed	Notes
1	Transit Case	1 Each		
2	Starting Guide	1 Each		
3	Core Barrel with Head Assembly	1 Each		
4	1-meter Extensions	5 Each		
5	Core Barrel Drive Adapter	1 Each		
6	Extension Adapter	1 Each		
7	T-handle	1 Each		
8	Brace Handle	1 Each		
9	Extension Pins	8 Each		
10	Core Head Hood	1 Each		
11	Diamond Hone	1 Each		
12	Allen Wrench Set or 3/16"	1 Each		
13	Rag	1 Each		
14	Flathead Screwdriver	1 Each		
15	Magnet with cord	1 Each		
16	SIPRE Manual	1 Each		
Note: Download Manual from <a href="http://icedrill.org/documents/view.shtml?id=368">http://icedrill.org/documents/view.shtml?id=368</a>				
17	Medium Bottle	2 Each		
Contents of Bottles:				
#	Item	Standard Qty (without/with inserts*)	Qty Packed	Notes
18	One Piece Cutters	6 Each / 4 Each		
19	Insert Holders	0 Each / 4 Each		
20	Carbide Inserts	0 Each / 20 Each		
21	Insert Screws 6-40 x ¼'	0 Each / 20 Each		
22	SHCap Screw ¼"-20 x 1" long	4 Each		
23	Roll Pin 1/8" inch Dia x ½" long	4 Each		
24	SHCap Screw ¼"-20 x 3/8" long	2 Each		
25	Washer ¼" ID x 3/8" OD x .02" thk	10 Each		
26	Washer ¼" ID x ½" OD x .02" thk (Narrow kits only)	10 Each		
27	SHCap Screw ¼"-20 x 1" Large Head (Narrow kits only)	2 Each		
28	Badger Drive Adapter	0 Each		

\* Carbide insert parts are included if necessary for the deployment.

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**14.0 APPENDIX G: QUICK GUIDE**

- 14.1** Verify that the kit is complete and that all critical pieces fit together before use.
- 14.2** It is significantly easier to drill on a level surface, so if drilling on a sloped area, consider cutting a level shelf into the snow to operate on.
- 14.3** To start drilling a vertical hole, place the cutters against the surface and turn clockwise with the brace handle while applying slight downward pressure. When the cutting gets tougher, replace the brace handle with the T handle and continue. It is good habit during the first meter of drilling to periodically check for plumbness with a carpenter level as the first meter determines the orientation of the entire hole.
- 14.4** To drill, rotate the handle clockwise while applying minimal (ideally zero) downward pressure. As the depth increases, add extensions to the drill stem.
- 14.5** On the first run, the drill will be able to recover 1 meter of core, but on every subsequent run it will only be able to obtain ½ meter of core because of chips.
- 14.6** Do not over-drill. Doing so will cause the chips to overflow on top of the barrel and wedge it firmly in place, making it very difficult to remove.
- 14.7** Break the core free by giving a quick, sharp jerk upwards on the T handle. Do not gradually apply force, as this will only serve to compact the chips in the flights and stick the barrel.
- 14.8** Remove the core from the barrel by disconnecting the drive adapter from the barrel and then sliding the core out the top of the barrel.
- 14.9** In between runs, it is a good idea to brush off and/or dry the core barrel and head, as water accumulation may freeze the barrel in the hole, making it near impossible to remove.
- 14.10** Be careful when the cutter head is exposed as the cutters are very sharp. Consider wearing gloves when dealing with the head.
- 14.11** When finished using the SIPRE drill, be sure to dry off all parts and securely latch the case to prevent rusting during transport and/or storage.