# SEDIMENT LADEN LAKE ICE DRILL

## Operations and Maintenance Manual

September 17, 2019

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

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## 1.0 PURPOSE

**1.1** This document outlines proper set up and operation of the Sediment Laden Lake Ice Drill.

## 2.0 SCOPE

**2.1** This document applies to all personnel working with the Sediment Laden Lake Ice Drill.

## 3.0 REFERENCES

**3.1** 8392-0003 Sediment Laden Lake Ice Drill Science Requirements

**3.2** 8392-0004 Sediment Laden Lake Ice Drill Engineering Requirements

**3.3** 8392-0005 Sediment Laden Lake Ice Drill Failure Mode and Effects Analysis

## 4.0 DEFINITIONS

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

**4.2** PI – Principal Investigator

**4.3** PPE – Personal Protective Equipment

**4.4** QAS – Quality Assurance and Safety group

**4.5** SLLID – Sediment Laden Lake Ice Drill

**4.6** SSEC – University of Wisconsin-Space Science & 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 changed per applicable SSEC processes.

**5.3** Project personnel are responsible for understanding this manual for safe set up and operation of the Sediment Laden Lake Ice Drill.

## 6.0 RECORDS

**6.1** None.

## 7.0 SAFETY

**7.1** The Sediment Laden Lake Ice Drill is a portable hot water drill capable of melting 5" diameter holes to a depth of 6m in ice. Only trained personnel should operate the Sediment Laden Lake Ice Drill and should read and understand the following safety precautions.

**7.2** Personal Protective Equipment

7.2.1 PPE – Workers shall wear appropriate hand, eye, and ear protection during all drill operations and setup

**7.3** Mechanical Safety

7.3.1 Pinch Points – There are several areas on the drill where a finger, hand, arm, or clothing could be pinched; specifically at all places where hose connections are made. Operators should identify all pinch points prior to operation and should be mindful of all such points during operation and setup.

7.3.2 Eye Protection – Operation of the SLLID requires eye protection to be worn by operators at all times.

7.3.3 Burn Hazard – The exhaust and engines of both the SLLID and the generator can become extremely hot. Avoid contact with either component. If service is required, allow time for the components to cool.

7.3.4 Combustibles – This system uses combustible glycol and fuels while also creating lots of heat. Take care to properly store all combustibles away from all major heat sources.

7.3.5 Hot Fluids – This system heats fluids above 100°C. Use appropriate PPE to prevent burns. Note that this heat will transfer from the fluid to a lot of the metal parts of the system. Take care to avoid burns from accidentally touching hot components.

7.3.6 Super-heated Fluids – This system has the potential to create super-heated fluids. Do not disconnect fittings while the fluid inside is near peak temperature.

7.3.7 Cold Hazard – Metal components may be extremely cold. Always wear appropriate gloves when handling.

7.3.8 Slippery Surfaces – The surrounding ice may become slippery when wet with melt water. Use caution whenever walking around the drill operations area.

**7.4** Electrical Safety

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

7.4.2 Grounding – Because the drill sits upon a large thickness of ice, a common earth ground cannot be established. Workers shall ensure that all electrical equipment is bonded together to a common ground back to the generator.

**7.5** Chemical Safety

7.5.1 Use fluid resistant gloves and eye protection whenever handling glycol-water, hot fluids, or fuel.

7.5.2 Use care and observe all safety warnings when handling chemicals.

**7.6** Environmental Safety

7.6.1 Cold – This drill 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 exposure to cold.

## 8.0 SYSTEM OVERVIEW

Figure 1: Overall System Layout

**8.1** The Sediment Laden Lake Ice Drill is designed for fast drilling in ice. It employs a two loop closed circulation drilling method. This means that one loop circulates a small volume of glycol-water through the heater, which always maintains a high temperature. A plate heat exchanger transfers the heat from this loop to the water loop, which circulates water within the borehole. Figure 1.

**8.2** The main drill system requires an existing water-filled borehole to drill, so a hand auger and coil heat exchanger are included to facilitate the creation of this initial hole. Figure 2.

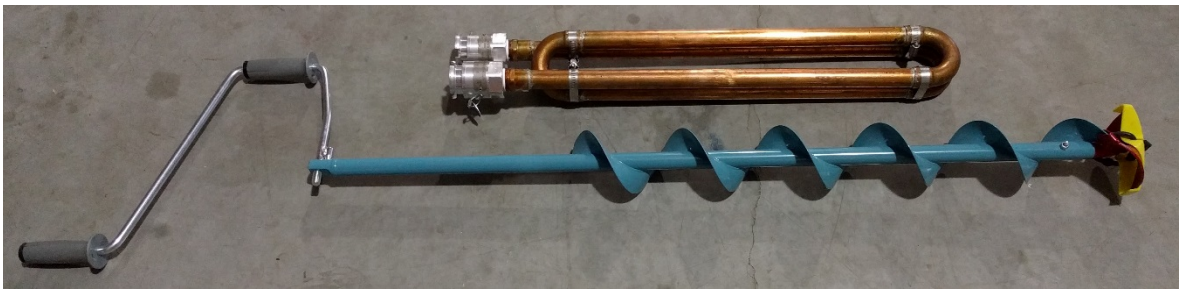

Figure 2: Auger and Coil Heat Exchanger

**8.3** The main system components consist of a gasoline generator, control box, fuel tank, diesel-fired glycol-water heater, glycol-water tank, plate heat exchanger, submersible pump, and nozzle.

**8.4** The heating loop utilizes 1.5” ID chemical hoses with dry lock connections, while the drilling loop uses 1.0” ID lay-flat hoses with cam lock fittings.

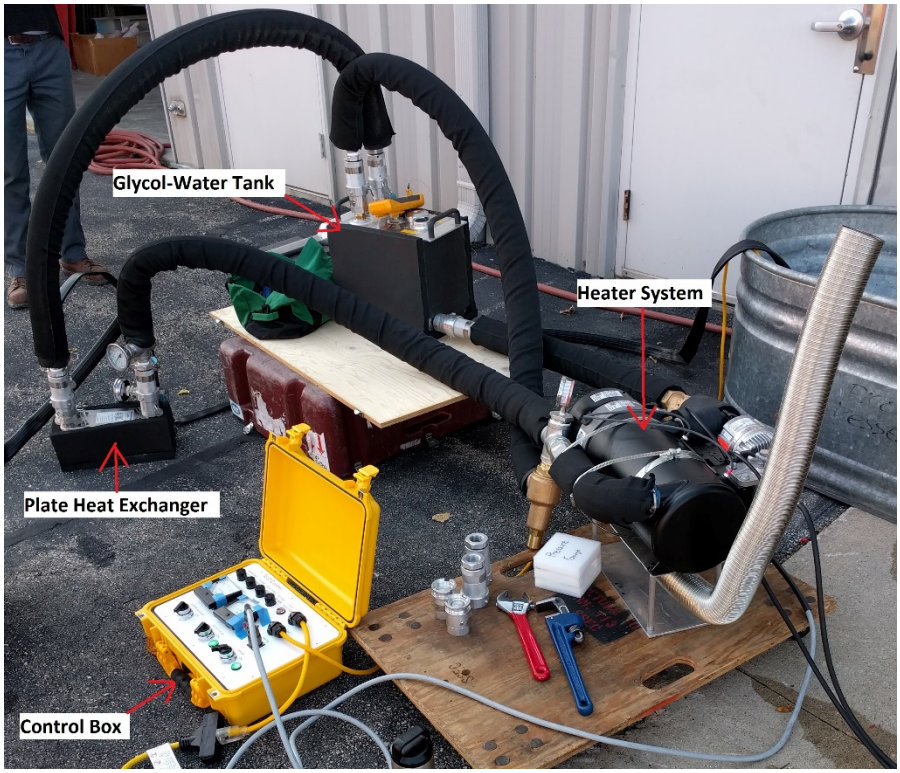


Figure 3: Heating Loop Components

**8.5** The heating loop starts at the glycol-water tank, where glycol-water is drawn into the heater. Figure 3. To avoid negative suction pressure and cavitation, it is necessary to elevate the tank to the height of the heater or higher. A strainer is provided on the suction line to prevent debris from entering the heater. Figure 4. Check this strainer’s filter daily and keep it clean.

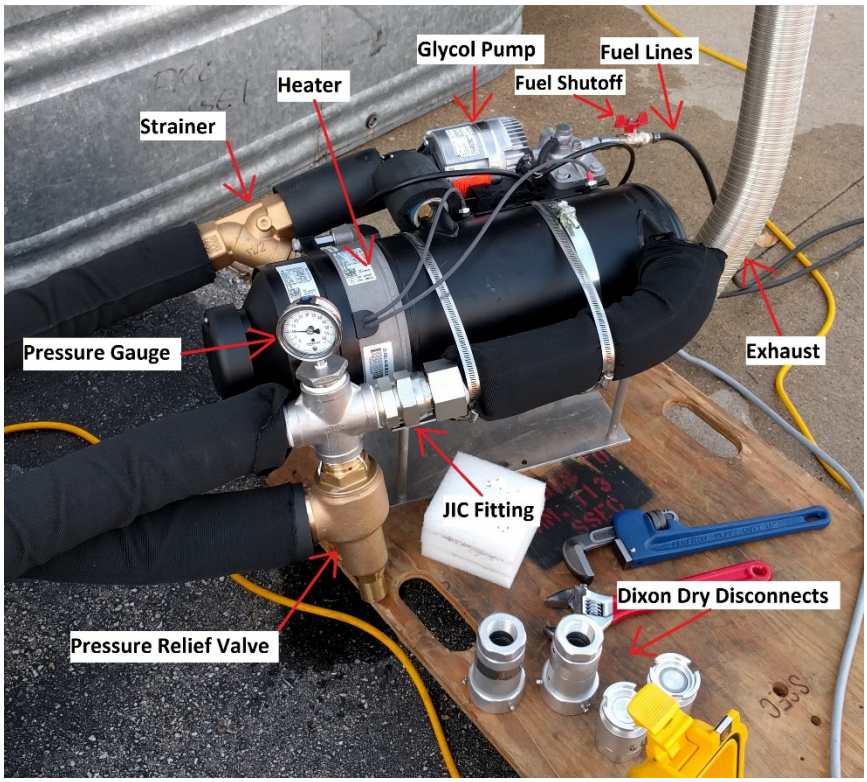


Figure 4: Heater Components

**8.6** There is a pump attached to the heater that pushes the fluid through the system. Both are powered by a 24V DC power supply within the control box. Max discharge pressure of the pump is 30 psi, and there is a pressure relief valve on the discharge line to protect the system from overpressure. The relief valve is factory set for 30 psi; do not adjust the pressure setting without consultation.

**8.7** The fluid gains thermal energy in the heater. The heater is diesel-fired, controlled automatically, and contains built-in high-temperature safeties.

**8.8** A 5 gallon fuel tank provides fuel to the heater. It should be placed on the same level as the heater. More fuel than required is drawn by the heater fuel pump, after which excess is returned to the tank. This system avoids having to bleed air from the fuel lines. The fuel lines use dry quick couplings to prevent significant spills. The fuel tank features a spill-proof breather vent on top.

WARNING! THE HEATER SHOULD NEVER BE OPERATED WITHOUT BOTH FUEL LINES CONNECTED. THIS MAY DAMAGE THE INTERNAL FUEL PUMP.

**8.9** After the heater and pump, the fluid enters a plate heat exchanger where thermal energy is transferred to the drilling loop.

**8.10** The drilling loop starts at the submersible pump that pushes the borehole water through this part of the system. It is powered by 120 VAC from the control box and has built-in protections for dry running and overheating. Figure 5.

Figure 5: Submersible Pump

**8.11** The water gains thermal energy in the plate heat exchanger. A strainer is provided on the input to the heat exchanger to prevent debris from entering it. Figure 7. Check this strainer's filter daily and keep it clean.

**8.12** After the heat exchanger, the hot water is propelled through the drill nozzle and spraying tip in order to widen and/or deepen the borehole.

**8.13** The drill hose is paid in and out of the borehole by hand.

**8.14** The drill nozzle is perhaps one of the most critical pieces of hardware. It provides weight so that drilling can be steered straight by gravity, and also integrates the spraying tip. Spraying tip selection is made on the type of drilling being done, specifically whether the operator chooses to focus on widening or deepening the borehole.

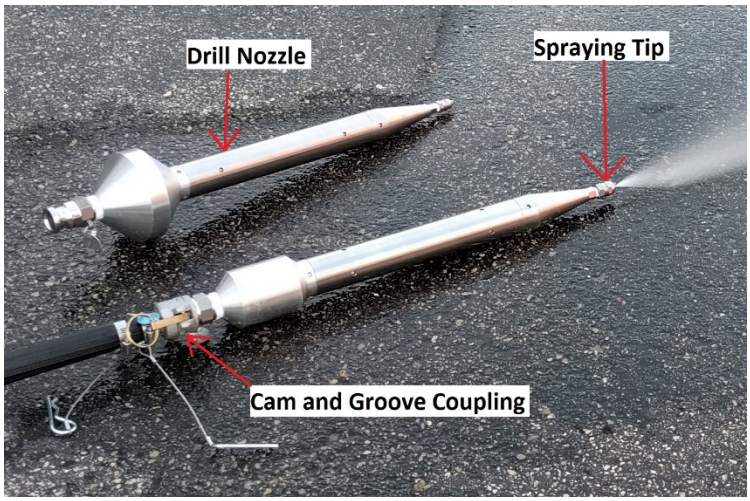


Figure 6: Drill Nozzle Components

## 9.0 UNPACKING AND SETUP

**9.1** Heater

9.1.1 The heater unit ships inside a hooded crate. It can be left on its shipping bases for all field operations; only the lid needs to be removed.

**9.2** Glycol-water connections

9.2.1 One glycol-water connection is made with 1.5" JIC hose fittings. Figure 4.

9.2.2 Tighten this fitting with two wrenches and periodically check for leaks during the season.

9.2.3 The rest of the connections are made with 1" Dixon dry disconnects and are labeled with metal tags. Figure 4.

9.2.4 These connections are made by hand by pressing together and rotating one-third of a turn clockwise until it clicks.

9.2.5 Starting from the glycol-water tank and moving through the system, the connections are as follows:

9.2.5.1 Hose A – tank to heater

9.2.5.2 Hose B – heater to plate heat exchanger (or to trombone coil)

9.2.5.3 Hose C – pressure relief valve to tank

9.2.5.4 Hose D – heat exchanger (trombone coil to initially melt chips drilled by the auger, or plate heat exchanger to begin drilling in the established fluid-filled hole) to tank

**9.3** Water connections

9.3.1 All water connections are made with 1" locking cam and groove couplings. Figure 6.

9.3.2 Secure these fittings manually by closing the cam levers and then inserting the cotter pins to prevent accidental reopening.

9.3.3 Hose G connects the submersible pump to the plate heat exchanger. Figure 7.

9.3.4 Hose F connects the plate heat exchanger to the drill nozzle. Figure 7.

9.3.4.1 One side of hose F has depth markings on it which signify the distance to the spraying tip. This side should be connected to the drill nozzle.

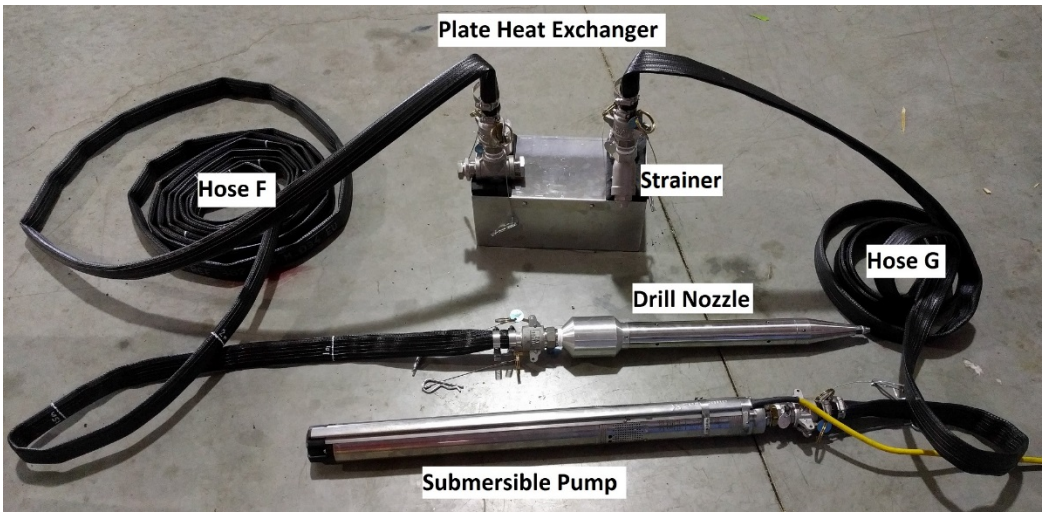


Figure 7: Drilling Loop

9.3.5 On the downhole connections, a hose clamp or rope can be used to hold the lanyards and key rings in tight and prevent them from possibly dragging on the borehole wall.

**9.4** Fuel connections

9.4.1 Both fuel connections are made with ¼" Snap-Tite quick couplings.

9.4.2 The connections are keyed such that they can only be connected to the proper inlet or outlet.

9.4.3 The fill port should be closed at all times except for when filling the tank.

9.4.4 The tank should always be placed upright in order to allow the breather vent to function properly and prevent a vacuum from being drawn.

9.4.5 There is a red fuel shutoff valve next to the fuel filter on the fuel input line. Check that this valve is open prior to operating. Figure 4.

**9.5** Electrical connections

9.5.1 Plug the 120 VAC plug of the control box into a 2 kW (or larger) generator.

9.5.2 Plug the submersible pump into the 120 VAC socket pigtail in the control box.

9.5.3 Plug the heater's Amphenol connector into the "heater" receptacle on the control box faceplate. Figure 8.


Figure 8: Control Box

**9.6** Temperature Gauges

9.6.1 The system is shipped without temperature gauges installed in order prevent damage to them.

9.6.2 Screw one gauge into the thermowell on the plate heat exchanger output F.

9.6.3 Screw one gauge into the thermowell on the end of the heater output hose B.

## 10.0 STARTUP

**10.1** Setup the heater, control box, and glycol-water loop as described in 9.0.

10.1.1 Install the trombone coil heat exchanger, not the plate heat exchanger, for initial startup.

**10.2** Pour 2 gallons of glycol and 2.5 gallons of water into the glycol-water tank.

10.2.1 The heater can safely operate from 10% glycol up to 50% glycol.

**10.3** Power on the glycol-water pump and observe the pressure reading near the heater.

10.3.1 If the pressure reading is less than 7 psi, then that means the loop is not flowing properly. Work through the following suggestions:

10.3.1.1 Verify that the glycol-water tank has sufficient fluid in it. The tank should be at least half full.

10.3.1.2 Verify that the tank is at or above the level of the heater.

10.3.1.3 Verify that no hoses are kinked.

10.3.1.4 Verify that all connections are securely open.

10.3.1.5 Lift the glycol water tank a couple feet.

10.3.1.6 Lift, shake, and tilt the heat exchanger.

10.3.1.7 Ensure the cap is on, then lay the glycol tank on its side until a flow is established. After establishing a flow, return the tank to an upright position.

10.3.1.8 Add more fluid mixture to the glycol tank until it is almost full.

10.3.1.9 Disconnect hose B from the heat exchanger and reattach to connection C or D on the tank. Work through the above suggestions to establish a flow without a heat exchanger. Once established, reinsert the heat exchanger and try again.

10.3.2 If the pressure reading is around 11 psi, then that means the loop is primed and flowing properly.

10.3.2.1 In addition, the operator should be able to hear fluid splashing in the glycol-water tank.

**10.4** Power on the heater and give it approximately 5 minutes to sufficiently heat up the fluid.

**10.5** Use the Nils hand auger or other means to create a hole for the rod well. Leave some cuttings in the hole to melt into seed water.

**10.6** Lower the trombone coil heat exchanger into the chip filled hole and allow it to create an auxiliary rod well (i.e. shallow hole) of sufficient size.

**10.7** Remove the trombone coil heat exchanger from the hole.

**10.8** Power off the heater, then the water pump.

**10.9** The water pump will continue running for a while after being switched off to allow the heat to dissipate from the heater.

**10.10** Once the flow has stopped and the DC current reading drops to 0 A, disconnect the trombone coil heat exchanger from the heating loop and replace it with the plate heat exchanger.

CAUTION! POTENTIAL EXPOSURE TO HIGH PRESSURE STEAM; WAITING FOR THE FLOW TO STOP IS IMPORTANT TO MINIMIZE THIS RISK. THE HEAT EXCHANGER AND FITTINGS WILL BE HOT. WEAR GLOVES WHILE CHANGING ALL CONNECTIONS.

**10.11** Hook up the drilling loop as described in 9.2 and 9.3.

## 11.0 DRILLING OPERATIONS (5" OR GREATER HOLE DIAMETER)

**11.1** Setup the wide body drill nozzle with a 30 degree spraying tip.

**11.2** Power on the glycol-water pump and verify that it is running properly as described in 10.3.

**11.3** Power on the heater and wait until the heater output temperature reaches at least 80°C.

**11.4** Lower the submersible pump into the previously drilled auxiliary rod well.

**11.5** While holding the drill nozzle pointed into the auxiliary rod well, power on the submersible pump.

**11.6** Use the nozzle spray to melt a primary borehole that is conjoined with the auxiliary rod well. Figure 9.

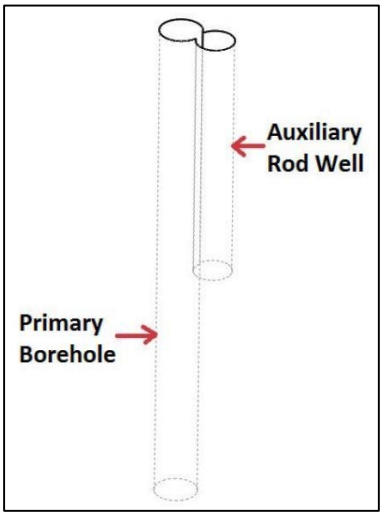


Figure 9: Borehole Layout

**11.7** As soon as the borehole is wide enough to fit the drill nozzle, start paying out hose to lower the nozzle down the primary borehole.

**11.8** Monitor hose tension during drilling. The strategy is to drill slowly enough that the entire borehole is reamed to the desired diameter during the first drill pass. If the hose starts to become slack, the nozzle will steer itself off track. If this happens, either slow down or stop pay out.

**11.9** If too much sediment is building up in the bottom of the borehole and inhibiting drilling, it will be necessary to change to a 0 degree spraying tip and the drilling method described in 13.0. Attempt to ream as much as possible after the borehole has been flooded with cold water.

**11.10** Pull the hose out of the borehole, pull the submersible pump out of the auxiliary rod well, and shut off the submersible pump.

## 12.0 DRILLING OPERATIONS (3" – 5" HOLE DIAMETER)

**12.1** Repeat the steps described in 11.0, but use the narrow body drill nozzle.

**12.2** If the desired borehole diameter is less than 4" the entire borehole can be drilled with the 0 degree spraying tip.

**12.3** If the desired borehole diameter is between 4" and 5", use any of the spraying tips, depending on the specific site characteristics.

## 13.0 DRILLING OPERATIONS (NON-ACCESS HOLE)

**13.1** If the system is being used to drill a blind hole in the ice (i.e. a simple hole in the ice that will not enter subglacial water below), the following modifications and additions to the instructions of 11.0 and 12.0 will be beneficial.

**13.2** Alternatively to 11.1, setup the narrow body drill nozzle with a 0 degree spraying tip and the wide body drill nozzle with a 30 degree spraying tip. Attach the narrow nozzle to the drilling loop.

**13.3** Perform 11.2 through 11.7 as described.

**13.4** Instead of 11.8, the strategy is to drill fast but always have the full down-hole weight on the hose. This assures that the drill is hanging free and straight in the hole. Pay even closer attention to hose tension when using this method to prevent the hole from deviating.

**13.5** The focus of this primary pass is to quickly get a 3" diameter hole melted down to the maximum depth.

**13.6** Proceed slightly past the desired maximum depth, then pull the hose out of the borehole and shut off the submersible pump.

**13.7** Drilling initially in this method will minimize the risk of getting stuck on sediment buildup:

13.7.1 The narrow jet will continuously stir up the bottom of the hole.

13.7.2 The 3" diameter nozzle will create a minimum diameter borehole and introduce the least amount of sediment into the borehole.

13.7.3 Drilling slightly past the desired depth will give a place for sediment to eventually settle without impacting the desired science range.

**13.8** Replace the narrow body drill nozzle with the wide body one.

**13.9** Place the drill nozzle in the primary borehole, then power on the submersible pump.

**13.10** Drill as many passes as are needed until the borehole reaches the desired diameter.

13.10.1 The top section of the drill nozzle is 5" diameter. If this nozzle can reach the bottom of the borehole that guarantees that the narrowest point of the borehole is at least 5" diameter.

**13.11** Pull the hose out of the borehole, pull the submersible pump out of the auxiliary rod well, and shut off the submersible pump.

## 14.0 CHANGING HOLES

**14.1** Power down the system during any move of more than a few feet.

**14.2** If it is only a short move, the entire drill system could be loaded onto a sled and dragged to its new location.

**14.3** For longer moves, disconnect all of the quick disconnect hoses and move the system in pieces.

14.3.1 Before shutting off the glycol pump, close connection D at the glycol tank. This will ensure that fluid remains in hose D and will make the system easier to re-prime later.

14.3.2 Remove the two temperature gauges to prevent damage to them.

**14.4** Allow all of the water lines to drain.

**14.5** Leave the glycol-water hoses and the heater filled with fluid. Reuse the glycol-water mixture in the tank at the next location.

## 15.0 END OF SEASON

**15.1** Allow the submersible pump to run dry with no hose connected, in order to fully drain it.

**15.2** Power down the system.

**15.3** Remove the two temperature gauges.

**15.4** Disconnect all of the quick disconnect fittings.

**15.5** Disconnect the 1.5" JIC fitting between the pressure relief valve and the heater.

**15.6** Drain the heater, heat exchangers, tanks, and all of the hoses as much as field conditions allow.

15.6.1 Use the spare Dixon connectors (Figure 4) to open the glycol-water lines for draining.

15.6.2 Use compressed air to blow out the lines if it is available.

15.6.3 Allow components to sit open in a warm, dry environment overnight if possible.

**15.7** Return contractor supplied equipment to the support contractor.

**15.8** Refer to the original packing lists to repack the remaining equipment as it was shipped out from Madison (or as close as possible).

15.8.1 Dry all equipment as much as possible before repacking.

**15.9** Make the appropriate arrangements to return the cargo to IDP in Madison WI.

15.9.1 Contact the IDP Field Project Support Manager for assistance, if needed.

## 16.0 APPENDIX A: PREVENTATIVE MAINTENANCE CHECKLISTS

| SLLID Preventive Maintenance Checklist | | | |
|---|---|---|---|
| **DAILY CHECKS** | **DATE:** _____ | | |
| **ITEM** | **ACTION** | **DATE** | **INITIALS** |
| | | | |
| **FLUID CIRCULATION** | | | |
| Hoses | Inspect for damage | | |
| Leaks | Check all joints for leaks | | |
| Strainers | Clean out both strainers | | |
| Water hoses | Drain fully when not in use | | |
| **POWER DISTRIBUTION** | | | |
| Generators | Inspect for damage / check oil | | |
| Cables | Inspect for cable damage | | |
| **TOOLS** | | | |
| Tools | Inspect for damaged/missing tools | | |
| **COMMENTS:** | | | |

## SLLID Preventive Maintenance Checklist

### SEASONAL CHECKS

**(to be performed once per drill season or before shipment to field)**

| ITEM | ACTION | DATE | INITIALS |
|---|---|---|---|
| | | | |
| **CONTROL SYSTEM** | | | |
| Control box wiring | Check for loose connections | | |
| System | Verify switch and indicator functionality | | |
| **ELECTRICAL** | | | |
| Power and signal cords | Inspect for damage | | |
| Grounding | Verify the system shares one ground back to the generator | | |
| **HEATER** | | | |
| System | Inspect for damage | | |
| System | Verify fluid pump establishes sufficient flow | | |
| System | Verify fuel delivery | | |
| System | Verify high temperature shutoff | | |
| System | Verify temperature cycling range of heating fluid loop | | |
| **SUBMERSIBLE PUMP** | | | |
| System | Verify dry-running protection | | |
| System | Verify flow rate | | |
| **SYSTEM** | | | |
| Packing list | Verify that complete system is packed | | |
| **COMMENTS:** | | | |
| | | | |

## 17.0 APPENDIX B: INSPECTION PROCEDURE AND FORMS

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

17.1.1 Clean, test, and store all components.

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

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

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

17.2.2 Fill out a Fit Checklist (17.5) and an Inventory Checklist (17.6), including a paper copy in the kit.

17.2.3 Perform the tasks on the Seasonal Preventative Maintenance Checklist (16.0).

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

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

17.3.1 Verify that all components arrived undamaged.

17.3.2 Review the Daily Preventative Maintenance Checklist (16.0) and plan to implement it during the field season.

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

17.4.1 Clean and dry all components as best as possible.

17.4.2 Use the Inventory Checklist (17.6) to verify that the correct components are being returned.

**17.5** IDP Staff Fit Checklist

| Season: | Sediment Laden Lake Ice Drill |
|---|---|
| User: | Where Used: |
| Contents: | |
| Done? | Task |
| | Perform all seasonal preventative maintenance |
| | Verify function of all dry-lock connectors |
| | Layout system in initial hole mode and fit all hose connections |
| | Layout system in drilling mode and fit all hose connections |
| | Fit temperature gauges into housings and verify function |
| | Verify there are no leaks at any joints or any of the tanks |
| | Fit Nils auger to its handle |
| | Fit spraying tips to drill nozzles |
| | Clean both strainer filters and check fit spares |

## **17.6** Inventory Checklist

| Season: | | Sediment Laden Lake Ice Drill | | |
|---|---|---|---|---|
| User: | | Where Used: | | |
| Contents of the SL1 Grey Hardigg Case: | | | | Weight: 140 lbs Cubes: 14.8 |
| | Item | Standard Qty | Qty Packed | Notes |
| 1 | Heater System | 1 Each | | |
| 2 | Pressure Relief Valve w/ Hoses | 1 Each | | |
| Contents of the SL4 Zarges Case: | | | | Weight: 90 lbs Cubes: 8.3 |
| 3 | Glycol-Water Hose D | 1 Each | | |
| 4 | Glycol-Water Tank | 1 Each | | |
| 5 | Fuel Tank | 1 Each | | |
| 6 | Plate Heat Exchanger | 1 Each | | |
| 7 | Layflat Hose w/ Couplings | 2 Each | | |
| 8 | Temperature Gauge | 2 Each | | |
| 9 | Instruction Manual | 1 Each | | |
| Contents of the SL2 Zarges Case: | | | | Weight: 80 lbs Cubes: 5.5 |
| 10 | Drill Nozzle | 2 Each | | |
| 11 | Nils Auger w/ Handle | 1 Each | | |
| 12 | Submersible Pump | 1 Each | | |
| 13 | Trombone Coil Heat Exchanger | 1 Each | | |
| Contents of the SL3 Zarges Case: | | | | Weight: 75 lbs Cubes: 5.3 |
| 14 | Chemical/Heat Gloves | 8 Each | | |
| 15 | Spare Pressure Relief Valve | 1 Each | | |
| 16 | Spare Dixon Couplings | 4 Each | | |
| 17 | Spare Set of Hose Clamps | 1 Each | | |
| 18 | Spare Glycol Strainer Filter | 1 Each | | |
| 19 | Spare Water Strainer Filter | 1 Each | | |
| 20 | Spare Fuel Filter | 1 Each | | |
| 21 | Spare Layflat Hose | 1 Each | | |
| 22 | Spare Cam and Groove Couplers | 4 Each | | |
| 23 | Spare Set of Stepless Clamps | 1 Each | | |
| 24 | Spare Pressure Gauge | 1 Each | | |
| 25 | Spare Temperature Gauge | 2 Each | | |
| 26 | Spare Auger Head | 1 Each | | |
| 27 | Spare Glycol Pump | 1 Each | | |
| 28 | Funnel | 1 Each | | |
| 29 | Set of Drill Nozzle O-Rings | 1 Each | | |
| 30 | Spare Fuses (4 Types) | 5 Each / Type | | |
| 31 | Tool Bag | 1 Each | | |

| Contents of the Green Tool Bag: | | | | Weight: (included SL3) Cubes: (included SL3) |
|---|---|---|---|---|
| 32 | Pipe Wrench | 2 Each | | |
| 33 | Large Crescent Wrench | 2 Each | | |
| 34 | 11/16” Socket + Wrench | 1 Each | | |
| 35 | Dead Blow Mallet | 1 Each | | |
| 36 | Tape Measure | 1 Each | | |
| 37 | Safety Glasses | 4 Each | | |
| 38 | PTFE Tape | 4 Each | | |
| 39 | Metric Allen Set | 1 Each | | |
| 40 | Box Cutter | 1 Each | | |
| 41 | Scissors | 1 Each | | |
| 42 | Small Crescent Wrench | 2 Each | | |
| 43 | Triangular File | 1 Each | | |
| 44 | Phillips Screwdriver | 1 Each | | |
| 45 | Flathead Screwdriver | 1 Each | | |
| 46 | Paint Marker | 2 Each | | |
| 47 | 5/16” Nut Driver | 1 Each | | |
| 48 | 3/16” Nut Driver | 1 Each | | |
| 49 | Spanner Wrench | 2 Each | | |
| 50 | Set of Spraying Tips | 1 Each | | |
| Contents of the SL5 Yellow Hardigg Case: | | | | Weight: 20 lbs Cubes: 0.8 |
| | Item | Standard Qty | Qty Packed | Notes |
| 51 | Control Box | 1 Each | | |
| Contents of the SL6 Yellow Hardigg Case: | | | | Weight: 20 lbs Cubes: 0.8 |
| 52 | Spare Control Box | 1 Each | | |
| Items to be requested in SIP: | | | | |
| 53 | Ethylene Glycol | 2 Gallon | | |
| 54 | Jugs for Water | 2.5 Gallon | | |
| 55 | Diesel Fuel | 0.75 Gallon per 6m hole | | |
| 56 | Fuel Containment Berm | 1 Each | | |
| 57 | 2 kW Generator | 1 Each | | |
| 58 | Spare Generator | 1 Each | | |
| 59 | Gas for Generator | 0.25 Gallon per 6m hole | | |
| 60 | Fire Extinguisher | 1 Each | | |