



Ice Drilling Program Office

Dartmouth – University of New Hampshire – Colorado School of Mines

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IDPO Science Requirements: RAM Drill

Background

The IDPO Long Range Science Plan 2016 identified science goals for ice drilling that spanned a wide range of science targets. For field projects with limited logistical support where geophysical information is needed, an agile, scientist-operated, shot hole drill is needed to rapidly create holes in firn to depths of approximately 40-100 m depths. From discussions organized by IDPO with iterative discussions between IDPO, scientists, and IDDO staff, the following are the science requirements for the drill:

Scientific Requirements

1. The Drill should produce holes in firn for a 10 cm nominal hole diameter in the top 40-100 m of a wide variety of firn types, including use in West Antarctica or Greenland. A minimum hole diameter of 7.5 cm is needed, in order to freely pass a cartridge of 5.5 cm diameter and 124.5 mm long to the bottom of a hole that is 100 m deep. The system may include modular hoses/winch/compressor subsystems to allow for access to either only the top 40 m, or to drill to the full max depth of 100 m, with reduced logistics needs for the 40 m system configuration.
2. The goal for the drilling rate should be to produce 15 ten-centimeter diameter holes to 100 m depth in 6 hours or less of drilling (not including drill transport time between sites). The longest acceptable drilling time per 100 m hole is 40 minutes.
3. The drill should have stand-alone capability for operation at small field camps at remote sites with no heavy equipment.
4. The drill should be operable in cold ambient temperatures down to -30 C (+/- 5 C) and winds of up to 25 knots. The firn and ice are expected to be frozen.
5. Drilling depth should be available during drilling.
6. The modules for transport shall be sized appropriately to be easily handled by 2 people with loading assist equipment provided with the drill. The goal for the total system weight with aircraft packaging is to be less than approximately 4,000 lb.
7. The drill should be very field portable, with the ability to be towed over rough terrain. It is a goal that the 40 m system should be towed ideally by a single snowmobile, and the 100 m system towed by several snowmobiles or by a Tucker.
8. If towing the 40 m system by a single snowmobile is not achievable, then a modular system is desired that be easily separated for transport (and subsequently reconnected). Consider a “power plant/ compressor” sled and a drill sled that are only connected by few hoses/cables.



9. The drill control should be simple and intuitive for use in the field by a scientist who has had training before going into the field. Two personnel (one trained and one other) should be able to set up and do the drilling operations in the field.
 10. Setup time for the drill should be within 8 hours after initial unpacking on site.
 11. Drill operations shall be such that two fit people can raise and lower the hose and drill head for a full day without excessive fatigue. Consider providing a mechanical assist to lessen fatigue during drilling operations.
 12. Drill storage in the field at the end of the day should be planned and designed, in the case of an anticipated storm. The SOP should be designed for storms with 30-40knot winds and blowing snow.
 13. The drill should be maintainable in the field by scientists, and instructions and parts for maintenance in the field should be included with the drill.
 14. No more than 1 drum of one type of fuel should be required for 12hr operation.
 15. Engineers should design an SOP for retrieving stuck drills or clogged exhaust hose. Possible ideas may include glycol bombs, or attaching a bullet heater to the air line, or heat tape integrated in the hose and head that can be turned on in an emergency, or other. The generator must be appropriately sized for these emergency situations, or else include a requirement for a 2nd “emergency/backup/spare” gen. A failure mode and effects analysis shall be performed and the drill system shall include documentation, tools, equipment and spare parts required to address high-risk situations in the field.
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Notes:

1. During the development of the Science Requirements, this drill was called the “Agile Shot Hole Drill” but has been renamed to “RAM” drill since it is an update of the older RAM drill.
2. This drill is intended to perform at all depths up to 100 m in conditions West Antarctica and Greenland; it is intended to replace the existing IDDO RAM Drill.
3. If fuel consumption is 3 gallons or less per hole, then a single drum of fuel (400 lb) would suffice per day.
4. Chris: A commercially available 100m compressed-air exploration rig weighs a minimum of 10,000lbs. As a point of reference, a Skidoo traverse capacity benchmark is 2,000 lbs total pulled on two Siglin sleds. With two Skidoos this is only 4,000 lb capacity for both equipment and fuel. So, it seems likely a Tucker will be required to keep number of operators to 2 without shuttling back and forth.
5. Chris: Air Compressors will be our challenge in this regard. RAM compressors weigh 6000lbs ea. We’ve looked into an exploration drill rated to 100m using double walled



tube. It uses 2000lb compressors.

<http://northspan.ca/Portals/Northspan/documents/drills/Northspan%20Hornet%20Product%20Sheet2.pdf> There is a practical limit of the extent to which we can break these into smaller units without making the system overly complex and prone to issues. BAS has 1000 lb modules on their hot water drill that are loaded or unloaded from a Twin Otter with a ramp and hand winch (photo) while a Helo Sling-load can accommodate up to 2000lbs.

6. Sridhar: I think the Twin Otter/Helo capability will be difficult. If the “lighter” (4000 lb) drill can be designed and arranged for Tucker towing, that might be a great start. The current weight (and the “option 1” weight) of 10+ klbs is heading towards 2 LC-130 flights. The 4-5klb system would allow for 1 flight. Of course the Tuckers would be needed unless Chris has some good ideas on bringing the drill down to 1000 lb components --then skidoo towing by 4 skidoos may be possible, but I would want to see the tradeoffs in complexity and risk with the plumbing having to be re-made every hole.