



Ice Drilling Program Office

Dartmouth – University of New Hampshire

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Title:	SCIENCE REQUIREMENTS: RAPID ACCESS ICE DRILL
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DOCUMENT APPROVAL	
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IDPO:	Albert, Twickler, Souney

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1	Original Document	21 January 2012	See Above
2	Amendment 1	23 January 2014	See Above



Science Requirements: Rapid Access Ice Drill

Approved by IDPO January 23, 2014

Background:

The IDPO led an Ice Drilling Science Community Planning Workshop in April 2011 in order to identify compelling emerging science and associated drilling needs. From that workshop, an interdisciplinary goal was articulated that spanned a wide range of science targets including understanding the Mid-Pleistocene transition from 40 kyr to 100 kyr climate cycles (by sampling ice as old as ~1.5 Ma), documenting the presence of Eemian-age ice to test models of ice sheet collapse in West Antarctica (~125 Ka), exploring the deep interior geology of Antarctica for the first time, evaluating the bed conditions at the base of the ice sheets, characterize geological features that have been imaged with geophysical data, and test models of cratonic growth related to supercontinent assembly in the Mesoproterozoic (~1 Ga). The IDPO Science Advisory Board identified in the IDPO Long Range Science Plan 2011 a need to move forward with plans to develop the Rapid Access Ice Drill. From a planning meeting organized by IDPO in October 2011 and follow-up teleconferences, discussions with the research community and with IDDO staff, the following are the science requirements for the Rapid Access Ice Drill:

Scientific Requirements

1. Produce 3300 m bore to base of ice in ≤ 200 hours of drilling operation, including drilling and retrieval of at least one 50 cm-long ice core and at least 25 m of sub-glacial rock and / or unconsolidated, frozen sediment core
2. Minimize bore-fluid and rod weight requirements by producing ≤ 3 " diameter ice borehole, and ideally 2.75" diameter ice borehole (nominal BQ size). Minimize complexity by avoiding stepped borehole diameter.
3. Ice drilling through dry, frozen-bed conditions (i.e., "clean access" system not required)
4. Retrieve short ice cores (~50 cm long) of ≥ 1.4 " diameter at up to 3300 m depths
5. Retrieve at least 25 m of bedrock cores of ≥ 1.4 " diameter (nominal BQ size)
6. Borehole walls must be left clean and essentially free of debris for borehole logging measurements
7. System is equipped with drilling-fluid recirculation, chip-removal and disposal system
8. Stand-alone, traverse-capable, over-ice system (not reliant on a fixed support camp)
9. Minimal staff for drilling operations in the field, with an objective of 24-hour-per day operations; 3 shifts per day; each shift consisting of 2 or 3 dedicated and experienced drillers; other field staff in support of drilling operations to be provided separately
10. Keep borehole open for up to 5 years, allowing for some deformation and/or decrease in diameter; tolerances will be determined separately for each borehole as determined by ice conditions and fluid density requirements
11. Completion of bore, including the provision of a suitably dense, bore-filling fluid, to allow for logging:
 - a) immediately after ice drilling is complete and before rock coring is initiated (requiring the removal of the drill string so as not to interfere with borehole logging), and
 - b) subsequent to rock coring for purposes of logging *only*, as determined in item 10 above



12. Non-freezing, non-ice-reactive (“hydrophobic”) drilling fluid will have a density similar to water ice and provide pressure stabilization, but this fluid system need not provide perfect hydrostatic compensation (consistent with materials and safety requirements covered elsewhere, and consistent with long-term observation requirements)

13. Drilling fluid or a fluid “system” (to be determined) will be compatible with borehole logging (i.e. transparent; ideally has a refractive index similar to that of water ice, for the light wavelength(s) of observation)

Discussion:

Minimizing the amount of drilling fluid needed is an important consideration in terms of limited logistics, and so it is desired to keep the diameter of the hole in the ice as small as possible. Ice and rock coring systems may be de-coupled, if cost-effective. The drilling system units do not need to fit within the cargo bay of an LC-130 aircraft. Such a drilling system has utility in both Greenland and Antarctica; it could be deployed in both areas, either by transport of one system or by duplication. For RAID deployment, a traverse-capable infrastructure to operationally support it should include, but is not necessarily limited to:

- a. fuel and drilling fluid of all kinds and for all purposes (use bladders for low-friction surface hauling)
- b. fuel delivery, storage, spill containment, and dispensing equipment, etc.
- c. lubricants and other consumables for logistical machinery of all kinds
- d. repair and maintenance facility, and spare parts for logistical machinery
- e. sledges and/or air pontoons for low-friction traversing of the entire operation
- f. towing machinery of all kinds
- g. cranes, if they are required for set-up of RAID equipment
- h. staff housing on sleds or air pontoons
- i. mess facilities on sleds or air pontoons
- j. ablution and waste disposal of all kinds
- k. electrical power generation systems, power transformation, distribution and conditioning components as may be required
- l. heating
- m. safety equipment
- n. medical-dental emergency facility
- o. other logistical infrastructure.
- p. scientist/staff personnel change out via Twin Otter
- q. no prepared skiway as RAID will move locations every 8-10 days or so

A drilling contractor is not responsible for providing these facilities. At some sites, snow accumulation rates may require interim work, such as the upward extension of the casing prior to the closure of a “5-year” observation window. The site-specific necessity for casing extension work will be determined by the science project, and the cost for carrying out such site-specific interim work will accrue to the scientific proposal for that particular bore site. No part of the scientific requirements shall be construed as a requirement for “replicate coring” *equipment capability* or “replicate coring” *operations*, neither during the original occupation of the drill site, nor during any subsequent occupation of the site.



Amendment 1 (January 21, 2014)

RAID PIs (Goodge and Severinghaus) added Amendment 1 to Science Requirement #5, which also has been approved by IDPO:

5. Retrieve at least 25 m, “**but not more than 50 m**” of bedrock cores of ≥ 1.4 ” diameter (nominal BQ size)