THE UNIVERSITY OF WISCONSIN
SPACE SCIENCE & ENGINEERING CENTER
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DOCUMENT IDENTIFICATION

Title:	**DEEP ICE SHEET CORING (DISC) DRILL**
	DISC DRILL SYSTEM
	SCIENCE REQUIREMENTS DOCUMENT

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DOCUMENT APPROVAL

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REVISION HISTORY
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REV	ECN	DESCRIPTION	DATE	APPROVAL
A	1120	- Deleted section 6.3 “Deviation (Replicate) Core Drilling”. - Deleted section 6.8 “Bedrock Drilling”. - Added reference to Replicate Coring science requirements document.	4/13/09	KRD
-	N/A	Original Document	3/13/07	See above

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1.0 PURPOSE

1.1 This document is the set of science requirements for the Deep Ice Sheet Coring (DISC) Drill System. The original document, dated November 21, 2002, was prepared by Kendrick Taylor, with assistance from the Ice Core Working Group and others in the U.S. ice coring community, with the intent of defining what features the science community needed in a new deep ice coring drill.

2.0 SCOPE

2.1 The requirements listed in this document focus on what samples and information need to be collected as part of a deep ice coring program. They do not cover the logistics, safety, and operations issues that must also be considered. This document does not specify any of the equipment that will be used to collect the core.

2.2 This document provides the top-level science requirements for the DISC drill system.

3.0 REFERENCES

3.1 Deep Ice Core Drill Science Requirements document, dated November 21, 2002, prepared by Kendrick Taylor

3.2 8505-0007, Deep Ice Sheet Coring (DISC) Drill Engineering Requirements

3.3 8613-0002, Deep Ice Sheet Coring Drill, Replicate Coring, Science Requirements

4.0 DEFINITIONS

4.1 **DISC** – Deep Ice Sheet Coring Drill System

4.2 **Chief Scientist** – The scientist who has been given the responsibility to head the Science Coordination Office of the WAIS Divide Ice Coring Project, the science project for which the DISC Drill is being developed.

4.3 **Core** - In this document “core” is all the ice recovered from the top of the hole to the bottom.

4.4 **Core segment** - A “core segment” is the ~1m long unit of ice that goes in a core tube for shipment and storage. A core segment may be made up of one or more separate pieces of ice.

4.5 **Core piece** - A "core piece" of ice means a mechanically coherent piece of ice without any internal fractures that is part of the central portion of the ice that is intended to be recovered by the drill. The core piece is the ice as retrieved from the drill and may be anywhere from sub-meter lengths to multiple meters long.

4.6 **UW-SSEC** – University of Wisconsin-Space Science & Engineering Center.

4.7 **ICDS** – Ice Coring and Drilling Services

4.8 **NICL –** National Ice Core Laboratory

5.0 RESPONSIBILITIES

5.1 The WAIS Divide Chief Scientist and the DISC Drill System Project Manager are responsible for the generation and updating of this document.

5.2 The SSEC Quality & Safety Manager is responsible for ensuring that this document is reviewed, approved, and changed per SSEC processes.

6.0 DISC DRILL SCIENCE REQUIREMENTS

General Comments:

Listed below are the science requirements for a new Deep Ice Sheet Coring Drill. Some desirable features that are not firm requirements are also listed and are highlighted in *plain italics*. They are included to help guide the development of the drill system to allow the future inclusion of optional or additional capabilities.

6.1 General Requirements

6.1.1 Ability to continuously collect core to a depth of 4000 m.

6.1.2 Ability to core in ice with 5% silt for a distance of 50 m.

6.1.3 Ability to drill in ice that is within 2^{o} C of the pressure melting point.

6.1.4 *Ability to drill in ice that is within 2^{o} C of the pressure melting point without using antifreeze fluids. (This may not be practical.)*

6.1.5 Required ability to drill at borehole temperatures as low as –40 C, and surface temperatures as low as –30 C.

6.1.6 *Ability to drill at borehole temperatures as low as –60 C, and surface temperatures as low as –40 °C.*

6.2 Core Characteristics:

6.2.1 Complete core recovery, as close to 100% as possible, from top to bottom.

6.2.2 Ice pieces to fit snugly together without any gaps.

6.2.3 In non-brittle ice, the packed core should have no more than 12 pieces of ice per 10-meter section of core.

6.2.4 In brittle ice there may be a lot of pieces in a single ~ 1m core segment, but the pieces must fit together and retain stratigraphic order. More than 80% of the ice volume must be in pieces that each have a volume > 2 liters.

6.2.5 Ability to determine the in situ orientation of core segments to within $\pm 10^{o}$.

6.2.6 Core diameter to be > 98 mm. It is desirable that it does not vary by > 3 mm.

6.2.7 Core should not have any "healed fractures", which cannot be seen but trap drilling fluid in the interior of the sample. "Healed fractures" probably form during drilling, then take up drilling fluid, and later close off so they are not visible. The best way to avoid this is to not fracture the core.

6.2.8 Ability to know the drilling and core handling history of each core.

6.3 Drilling Fluid

6.3.1 Drill fluid to be evaporated from cores prior to packing so that it does not produce hazardous vapor at NICL.

6.3.2 Drill fluid to be immiscible with water.

6.3.3 *Refractive index similar to ice (1.33 +/- 0.06).*

6.3.4 Drill fluid must not interfere with high-vacuum mass spectrometry.

6.4 Hole Characteristics

6.4.1 Hole diameter not to vary by more than 2% over 50 m, except for special conditions such as deviation drilling.

6.4.2 Hole inclination < 5 degrees from vertical except for deviation drilling, which should not exceed 15 degrees.

6.4.3 Hole to remain open and accessible to the bottom for at least 10 years after drilling. The diameter of the hole during these 10 years must be at least 80 mm.

6.4.4 Hole wall to be smooth enough for optical logging after the completion of the drilling operations.

6.4.5 Inclination, azimuth and diameter of the hole to be determined as a function of depth.

6.5 Depth Measurement of Drilling System

6.5.1 Absolute depth measurement accuracy of 0.2% of depth.

6.5.2 Relative depth measurement accuracy while drilling of 0.02 m over the length of the drilling run. (i.e. ability to measure the length of core to within 0.02 m while the drill run is underway.)

6.6 Drilling Information

6.6.1 Recording of the following parameters 0.03-8.00 times/second while drilling:

6.6.1.1 Depth, drill rotation rate, cutting torque, weight on bit, penetration rate, fluid temperature, core barrel acceleration.

6.6.1.1.1 Frequency of recording will depend upon the parameter being measured.

6.6.1.2 *Measurement of core barrel flexing.*

6.7 Core Handling

NOTE: The following requirements relate to the handling and processing of core once it has been removed from the core barrel and are not specifically applicable to the drill. They are included for completeness.

6.7.1 Ability to electronically image every core segment.

6.7.2 Ability to measure the length of each core to within 0.001 m.

6.7.3 Surface temperature of the core after removal from the drill.

6.7.3.1 Core temperature never to exceed 0^{o}C

6.7.3.2 Core temperature never to exceed -2^{o} C for >2 minutes.

6.7.3.3 Core temperature never to exceed -10^{o} C for >20 minutes.

6.7.3.4 Core temperature never to exceed -15^{o} C for >1 hour.

6.7.4 Core segments to have a length of 0.90 to 1.01 m when packed in ~1 m long core tubes.

6.7.5 Ability to know the drilling and core handling history of each core segment.

7.0 RECORDS

7.1 Documentation of the Chief Scientist's approval of changes to the science requirements will be maintained in the project file.