THE UNIVERSITY OF WISCONSIN
SPACE SCIENCE & ENGINEERING CENTER
MADISON, WI

DOCUMENT IDENTIFICATION

Title:	**ASIG Drill**
	ASIG Drill Upgrade Project
	Air Drop Test Report

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DOCUMENT APPROVAL

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1.0 PURPOSE

The purpose of this test is to characterize the change in fluid pressure seen when the ASIG core tube is dropped through air onto a column of drill fluid in the drill rod.

2.0 DEFINITIONS

2.1 IDP – Ice Drilling Program

2.2 PSL – Physical Sciences Laboratory

2.3 QAS – Quality Assurance and Safety Group

2.4 ASIG – Agile Sub-Ice Geological

2.5 SSEC – Space Science and Engineering Center

3.0 RESPONSIBILITIES

3.1 IDP Engineering is responsible for the generation and maintenance of this document.

3.2 SSEC QAS is responsible for ensuring that this document is created, reviewed, approved, maintained and changed per applicable SSEC processes.

3.3 Project personnel are responsible for understanding this document.

4.0 TEST OBJECTIVES

Measure pressure in ASIG drill rod when core tube is dropped through air on to the drill fluid column in the drill rod. Drops should be performed with fluid at depths similar to those seen in the Pirrit Hills field season 2016-17.

5.0 BACKGROUND

Fluid circulation was lost when drilling at Pirrit Hills. A possible explanation may be the fracture of the ice caused by dropping the core tube on to the fluid column several feet below the top of the drill rod. This testing will help to quantify the pressure that may have been created during the drop and possibly help to identify the cause of the circulation loss.

6.0 SET-UP

A pressure transducer, Penn P599RAPS102, was mounted to an ASIG TK56 drill rod using a sub-adapter.

The drill rod was installed in the test well at the University of Wisconsin and filled with 96” of ASIG (Isopar K) drill fluid.

A National Instruments data acquisition module USB-9162 was used to monitor voltage output from the transducer using LabView software. This provided a pressure value based on calibration data for the transducer.

The test set-up used a 1.5m ASIG core barrel assembly (Sandvik TK56). A para-cord was attached for to retrieve the barrel after the drop. The recovery assembly was activated by turning the top latch clockwise locking the spring in the compressed state typical of core tube deployment.

Figure 1: Test Well Facility at University of Wisconsin

Figure 2: Core Barrel Assembly (left), Drill Rod Assembly (right) including drill rod, plastic spacer ring, sub-adapter and pressure transducer. The plastic spacer was included to prevent the core tube from being damaged on impact with the sub-adapter.

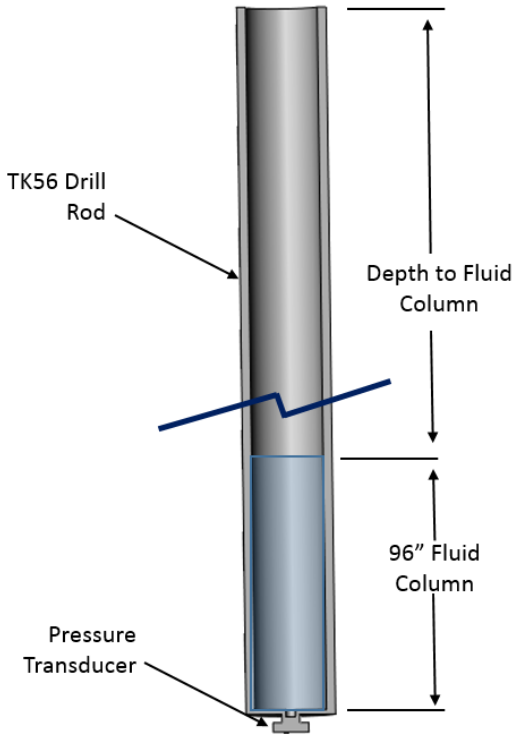

Figure 3: Schematic of Drill Rod Test Configuration

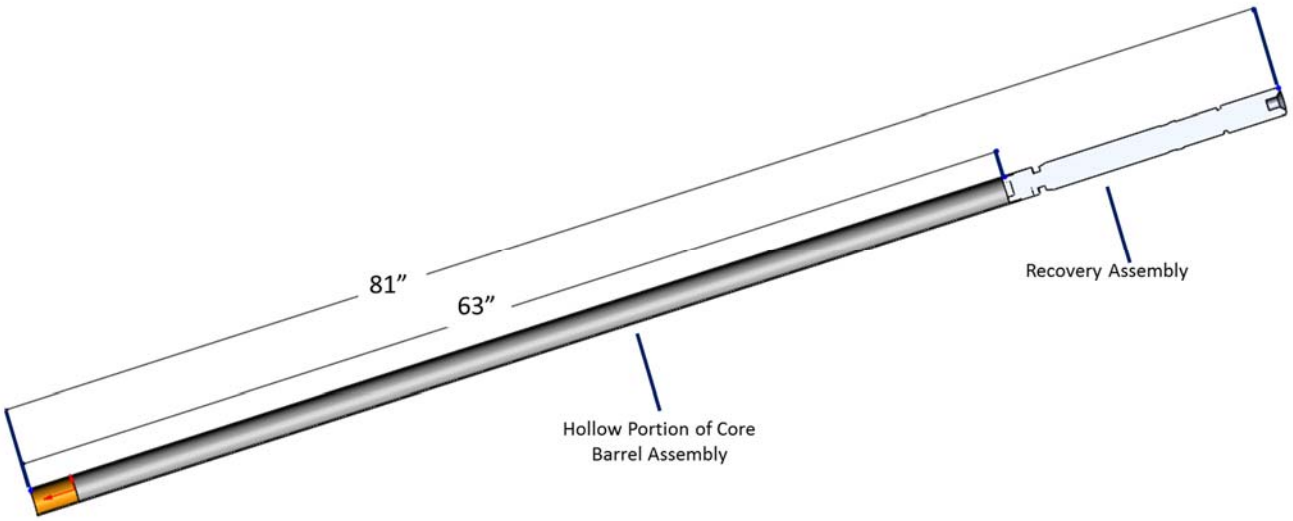

Figure 4: Cross-section of Sandvik TK56 Inner Core Barrel Assembly.
63" Hollow Portion of the Inner Core Barrel Assembly,
81" Overall (Hollow Portion with Recovery Assembly)

8 PROCEDURE

The top of the recovery assembly was aligned with the top of the drill rod, data acquisition started and the entire inner core barrel assembly was dropped.

This was repeated 6 times. Additional length of rod was added to increase depth to fluid. In total, 30 drops were performed, 6 drops at each of 5 depths.

Note: Drops from 84" and 108" were performed in the IDP warehouse. The drop from 108" used 6' of drill fluid rather than 8' used in all other cases.

9 RESULTS

Figure 5 and Table 1 show the highest value recorded for each of the 30 drops. This shows a large variation from about 20 psi to over 80psi with fluid depth of 84"(2.1m) to 255" (6.5m). The highest value recorded in all 30 drops was 84psi at 255" (6.5m).

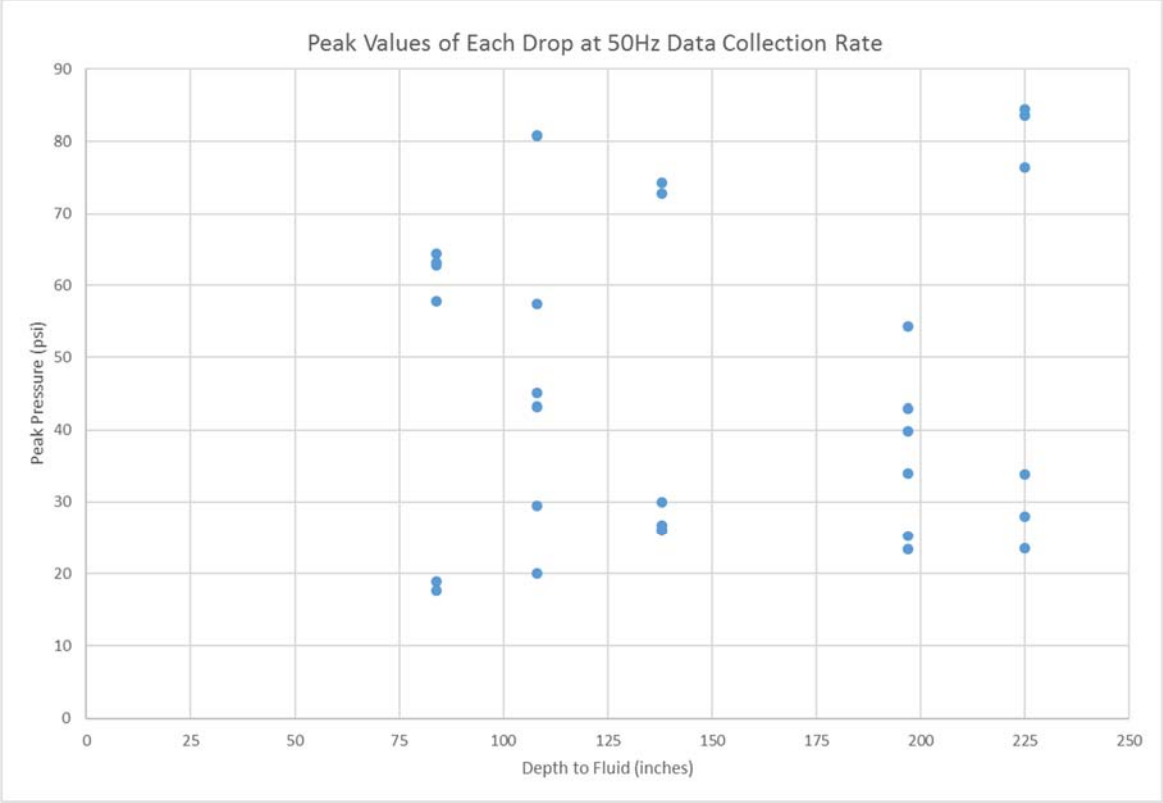

Figure 5: Highest recorded value from each of 30 drops.

Table 1: Highest recorded value from each of 30 drops.

Drop #	Depth to Fluid (in)	Reading (V)	Pressure (psi)
1	84	14.2	63
2	84	13.4	58
3	84	14.5	65
4	84	6.8	18
5	84	14.3	63
6	84	7.0	19
7	108	11.3	45
8	108	13.3	57
9	108	17.2	81
10	108	11.0	43
11	108	7.2	20
12	108	8.7	29
13	138	8.8	30
14	138	8.2	26
15	138	15.9	73
16	138	8.3	27
17	138	8.2	26
18	138	16.1	74
19	197	11.0	43
20	197	10.4	40
21	197	12.8	54
22	197	7.7	23
23	197	9.5	34
24	197	8.1	25
25	225	17.7	84
26	225	7.8	24
27	225	17.6	84
28	225	8.5	28
29	225	9.5	34
30	225	16.4	76

Figure 6 shows the pressure profile of the five drops that provided the highest measurement at each fluid depth. These profiles show a consistent pattern of an initial broad wave followed by smaller broad waves before a large, narrow spike of pressure.

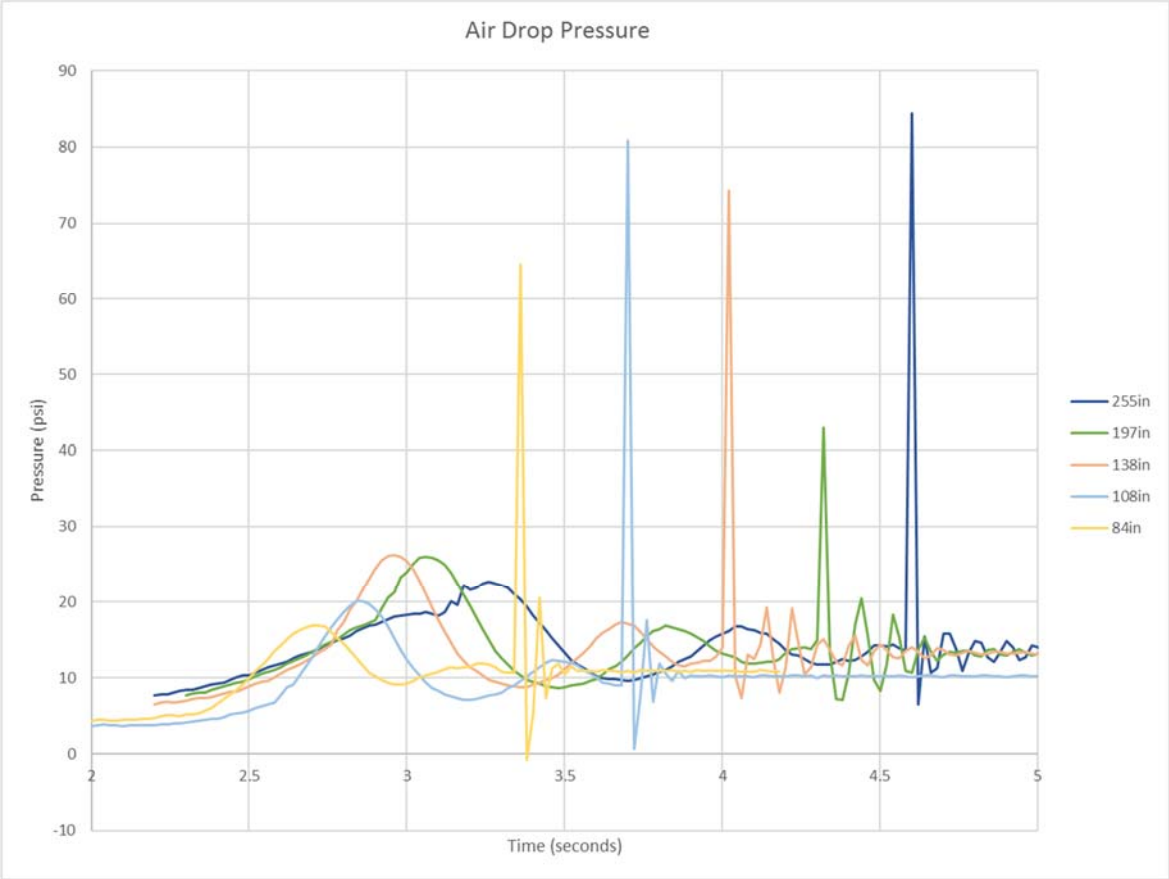

Figure 6: Pressure profile for the drop with highest peak value at each height.

10 DISCUSSION

One can imagine that the initial impact of the open portion of the core barrel with the fluid surface created the broad pressure pulse at the transducer. The largest pressure spike, however, occurred roughly 1 second later. This was possibly the result of the solid surface of the recovery assembly hitting the fluid surface.

Due to the 50Hz sample rate limit of the data acquisition module, it is possible that somewhat higher peaks occurred between samples. This helps to explain the variation between the six drops at each height. It also suggests that the measured peaks may underestimate the peak instantaneous values.

Additional errors in measurements result from variations in how the core barrel was dropped including variation in drag on the drill rod. Although the light-weight para-cord appeared to add little resistance, any drag from the para-cord would tend to lower the peak pressure values. On the other hand, any frictional losses through drill rod to 87m at Pirrit Hills may have reduced actual pressures relative to measured values.

The drill log for Pirrit Hills includes the note, *"pump pressure = 80-90 psi during coring, 1 brief pressure spike to ~150 psi (paused penetration briefly to clear probable chip blockage)"* on the run before fluid circulation was lost. This was in forward circulation and so the pressure would have been, at least initially, in the drill rod. Pumping pressures were generally below 80psi while drilling in earlier operations in reverse circulation making it entirely possible, that the highest pressure seen at the bit before loss of circulation was at the time the inner core barrel assembly was dropped.