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Report on Ignitability Testing of the "No-Flow" Push Bit

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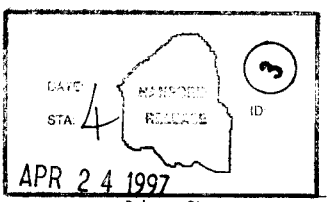
Abstract: Testing was done to determine if an ignition occurs during a sixty foot drop of a Universal Sampler onto a push-mode bit in a flammable gas environment. Ten drops each of the sampler using both a push-mode and rotary mode insert onto a push-mode bit were completed. No ignition occured during any of the drops.

Release Approval 4/23/97 Date



Release Stamp

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REPORT ON IGNITABILITY TESTING OF THE "NO-FLOW" PUSH BIT

HNF-SD-WM-TRP-272
REV. 0

January 9, 1997

Keith S. Witwer

Engineering Testing Laboratory
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REPORT ON IGNITABILITY TESTING OF THE "NO-FLOW" PUSH BIT

1.0 INTRODUCTION

The Numatec Hanford-Engineering Testing Laboratory (ETL) received funding from the SGN Eurisys Services Corporation (SESC) Characterization Equipment Group to test a new sampler and bit design. This testing followed Test Plan WHC-SD-WM-TP-510[1] and much of the specifics are described therein. Briefly, the goal of testing was to drop a Universal Sampler, inside a vertically suspended drill string, from a height of 18.3 meters (60 ft) onto the inside bearing surface of a core sampling drill bit. The sampler and drilling bits have recently been redesigned to incorporate a new mating surface geometry between the inside of the drill bit and the end of the sampler. The drop testing would determine if an ignition of flammable gas, which surrounded the drill bit, would occur upon impact. This testing was needed because recent safety documentation requires any new drilling equipment, which will be used in a flammable gas environment, to be proof tested in a flammable gas environment before it can be used in the field. A flammable gas mixture of stoichiometric hydrogen and air (30/70) was used. This mixture has been used in previous ignitability testing and has been shown[2] to be the bounding gas mixture in terms of minimum energy needed for ignition.

The ETL enlisted the services of the National Institute of Occupational Safety and Health (NIOSH) - Fires, Explosions, and Explosives Group under Memorandum of Agreement 14-09-005-3666[3]. NIOSH provided necessary facilities, equipment and manpower to support this effort. Testing was performed during November 1996 at the U.S. Government Pittsburgh Research Center in Pittsburgh, PA.

2.0 TEST METHOD

Per the test plan, a length of 18.3 meters (60 ft) of standard 5.7 cm (OD) (2.25 in) drill string was suspended vertically with the bottom end placed in an airtight test chamber. The bottom end of the drill string was capped with a push mode drill bit[4]. The sampler inserts, both rotary and push-mode, attach to the end of a Universal Sampler body. Since the contact geometry of the sealing surface on both inserts is identical, they can both be used in either a push or rotary core drill bit. Likewise, the rotary and push bit internal sealing surfaces are identical. Because of this, only a push bit was used for the drop tests.

A 120 liter mixing chamber was used to supply flammable gas to the 20 liter test chamber. A stoichiometric mixture of hydrogen and air (30/70) was obtained by feeding partial pressures of each component into the evacuated mixing chamber and then mixing the components with an internal fan. The mixture was then fed to the test chamber as needed at

0.028 m^3 (1ft^3) for seven minutes. Gas monitoring equipment in previous ignitability testing[5] verified that this purge time was adequate to fully displace any existing atmospheric gasses. Gas flow was shut off after this initial purge and the sampler was immediately dropped.

The top of the drill string was fitted with a cable and pulley assembly. The pulley allowed a latching unit to be lowered onto the sampler and raised by an operator. For each test the sampler was raised to the top of the drill string, flammable gas was fed into the system, and then a sharp pull on the cable released the sampler down into the drill string and onto the drill bit.

Each test was recorded using a high speed video camera. Pressure transducers mounted on the test chamber fed signals during an ignition to a data acquisition system to be recorded for each test.

3.0 TEST EQUIPMENT

Table 1 below lists the pertinent equipment items used for the testing.

Table 1 - Pertinent Equipment Items

Equipment Item	Part/Drawing Number
Sampler	Fab Shop Package # 2H-96-01231/F *
Push Mode Bit	Longyear[a] P/N 1000VD/1 (P.O. # A04142)
Push Mode Insert	Fab Shop Package # 2H-96-01230/F - Item 74
Rotary Mode Insert	Fab Shop Package # 2H-96-01230/F - Item 9
Five Foot steel drill string	Longyear P/N 200182
Core Barrel	H-2-821457-13

* A unique shop-built sampler[6] was used for testing. This sampler had the same weight and outside geometry as the normally used Universal sampler. However, the end section which holds the insert was machined without a hole bored through the center. The forces developed during a sixty foot drop are such that a standard sampler is deformed during impact and rendered unusable for further testing. The modified sampler withstood the impact forces and allowed several drops with the same sampler while still maintaining proper sampler geometry and weight.

Photograph 1 below shows the drop test equipment setup.

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[a] Longyear is a trademark of Longyear, Inc.

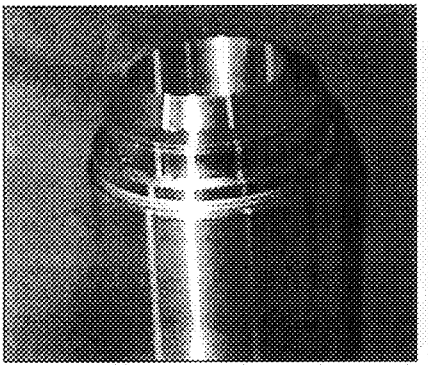
Photograph 1 - Drop Test Equipment Arrangement

4.0 TEST RESULTS

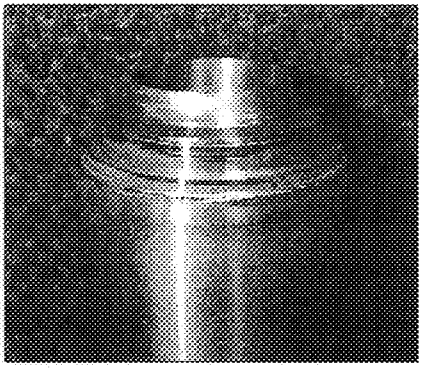
Ten drop tests using the push mode insert and ten drop tests with the rotary mode insert were completed without any ignitions occurring. The gas mixture was intentionally ignited with a hot wire ignitor after each test to confirm presence of the gas mixture. Information on each test is contained in controlled logbook number WHC-N-984-1 and A detailed listing of each test is provided in Appendix A and photocopies of the controlled logbook entries for each test is found in Appendix B.

Photographs 2 and 3 below show a before and after drop test photo of a rotary-mode insert.

Photograph 2- Rotary Insert Before Drop Test



Photograph 3 - Rotary Insert After Drop Test



Notice that other than some compression of the sealing surface, the impact area shows very little deformation after drop testing.

As described in section 2.0 (Test Method), both the rotary and push mode bits have the same internal sealing geometry. This can be seen in Figures 1 and 2 below. This identical geometry along with both bits being of the same material composition allowed using just the push mode bit for testing.

Figure 1 - Push and Rotary Mode Insert and Bit Configurations

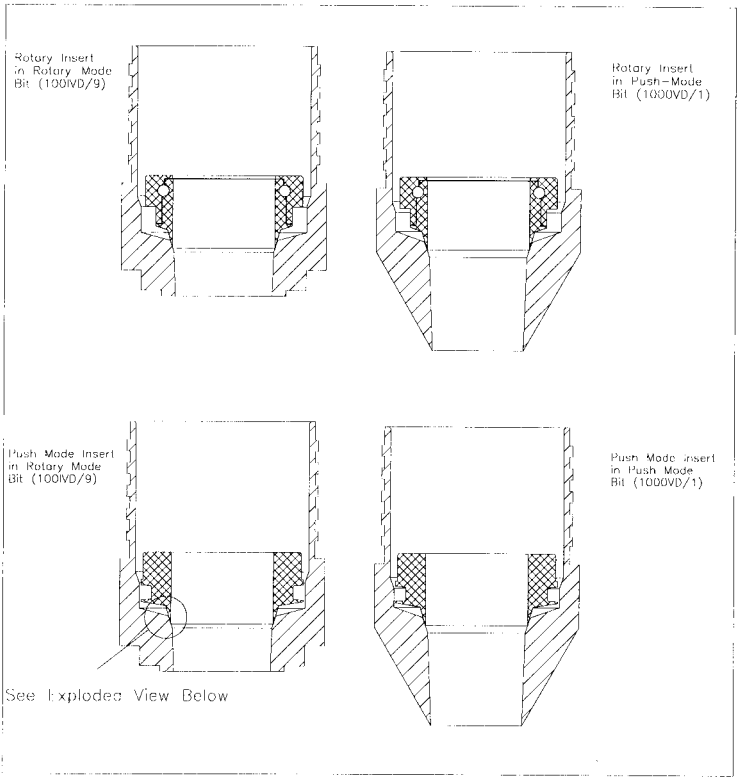
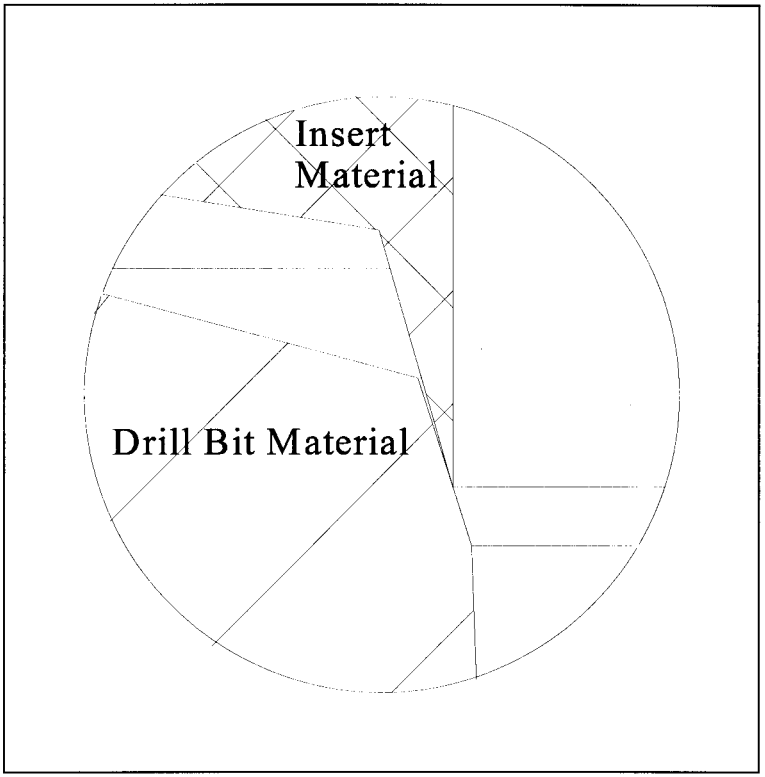


Figure 2 - Exploded View of Insert Bit Mating Surface



5.0 CONCLUSIONS AND RECOMMENDATIONS

These drop tests show the ability of the inserts to absorb significant impact energy during a sixty foot drop without causing ignition of stoichiometric hydrogen and air gas mixture. These results provide necessary information to allow use of the inserts in a flammable waste tank environment. The testing is complete.

6.0 REFERENCES

1. Witwer, K.S., WHC-SD-WM-TP-510, Rev. 0, "Ignitability Testing of the No-Flow Push Bit", 9/96.

2. Kuchta, J.M., "Investigation of Fire and Explosion Accidents in the Chemical, Mining, and Fuel-Related Industries - A Manual", Bulletin 680 - US Bureau of Mines, 1985.

3. MOA 14-09-005-3666, P.D. Braun, WHC, to J. Murphy, U.S. Bureau of Mines, PMM-PDB-026, March 12, 1996.

4. Drill bits obtained from Longyear Company on Purchase Order # A04142.

5. Witwer, K.S., WHC-SD-WM-TRP-257, Rev 0, "Test Report for Core Drilling Ignitability Testing", 8/96.

6. 2H-96-1231/F , Drop Test Dummy Sampler Shop Fabrication Request, 9/96.

7. 2H-96-1230/F , "No-Flow" Push and Rotary Insert Shop Fabrication Request, 9/96

7.0 APPENDIX A - DETAILED LISTING OF TESTS

Pittsburgh Drop Testing - Knife Edge Insert Drill Bit - November 1996
NHC Engineering Testing Laboratory - Pittsburgh Research Center

Date	Test #	H2 %	Air %	Temp. C	Test piece	Notes
11/15/96	8053	30	70	> or = 100	Push Insert #2H-96-01230, 60' Drop	Test 1 of 10, no ignition
"	8054	30	70	> or = 100	(Test Ignite OK)	
"	8055	30	70	> or = 100	Push Insert #2H-96-01230, 60' Drop	Test 2 of 10, no ignition
"	8056	30	70	> or = 100	(Test Ignite OK)	
"	8057	30	70	> or = 100	Push Insert #2H-96-01230, 60' Drop	Test 3 of 10, no ignition
"	8058	30	70	> or = 100	no PC data (Test Ignite OK)	
"	8059	30	70	> or = 100	Push Insert #2H-96-01230, 60' Drop	Test 4 of 10, no ignition
"	8060	30	70	> or = 100	Bag Popped Off, Less Ignition Noise	
"	8061	30	70	> or = 100	Push Insert #2H-96-01230, 60' Drop	Test 5 of 10, no ignition
"	8062	30	70	> or = 100	(Test Ignite OK)	
"	8063	30	70	> or = 100	Push Insert #2H-96-01230, 60' Drop	Test 6 of 10, no ignition
"	8064	30	70	> or = 100	(Test Ignite OK)	
"	8065	30	70	> or = 100	Push Insert #2H-96-01230, 60' Drop	Test 7 of 10, no ignition
"	8066	30	70	> or = 100	(Test Ignite OK)	
"	8067	30	70	> or = 100	Push Insert #2H-96-01230, 60' Drop	Test 8 of 10, no ignition
"	8068	30	70	> or = 100	Side Bag Popped Off During Drop	
"	8069	30	70	> or = 100	Push Insert #2H-96-01230, 60' drop	Test 9 of 10, no ignition
"	8070	30	70	> or = 100	(Test Ignite OK)	

Date	Test #	H2 %	Air %	Temp. C	Test piece	Notes
"	8071	30	70	> or = 100	Push Insert #2H-96-01230, 60' drop	Test 10 of 10, no ignition
"	8072	30	70	> or = 100	(Test Ignite OK)	
11/19/96	8073	30	70	> or = 100	Rotary insert (P/N TBD) 60' drop	Test 1 of 10, no ignition
"	8074	30	70	> or = 100	(Test Ignite OK)	
"	8075	30	70	> or = 100	Rotary insert (P/N TBD), 60' drop	Test 2 of 10, no ignition
"	8076	30	70	> or = 100	(Test Ignite OK)	
"	8077	30	70	> or = 100	Rotary insert (TBD), 60' drop	Test 3 of 10, no ignition
"	8078	30	70	> or = 100	(Test Ignite OK)	
"	8079	30	70	> or = 100	Rotary insert (TBD), 60' drop	Test 4 of 10, no ignition
"	8080	30	70	> or = 100	no PC data (Test Ignite OK)	
"	8081	30	70	> or = 100	Rotary insert (TBD), 60' drop	Test 5 of 10, no ignition
"	8082	30	70	> or = 100	bag broke during drop	
"	8083	30	70	> or = 100	Rotary insert (TBD), 60' drop	Test 6 of 10, no ignition
"	8084	30	70	> or = 100	(Test Ignite OK)	
"	8085	30	70	> or = 100	Rotary insert (TBD), 60' drop	Test 7 of 10, no ignition
"	8086	30	70	> or = 100	purge gas added too early	
"	8087	30	70	> or = 100	Rotary insert (TBD), 60' drop	Test 8 of 10, no ignition
"	8088	30	70	> or = 100	(Test Ignite OK)	
"	8089	30	70	> or = 100	Rotary insert (TBD), 60' drop	Test 9 of 10, no ignition
"	8090	30	70	> or = 100	(Test Ignite OK)	
"	8091	30	70	> or = 100	Rotary insert (TBD), 60' drop	Test 10 of 10, no ignition
"	8092	30	70	> or = 100	no PC data (Test Ignite OK)	

8.0 APPENDIX B - CONTROLLED LOGBOOK NOTES

Ignitability Testing of The No Flow Push Bit

11/15/96 141

These Tests follow Test Plan WHC-SD-WM-TP-510 Rev 0. They are being carried out at the Pittsburgh Research Center in Pittsburgh, PA. This involves drop Testing, from 60 ft, a core sampler onto a push mode drill bit. The insert which screws onto the bottom edge of the sampler has been redesigned. Both the push mode insert and the rotary mode have been redesigned. This change involves a new sealing geometry as well as a new material composition. The drill bits (push and rotary) have also been redesigned to accomodate this change in geometry. These changes require drop testing in a flammable gas environment to determine if they will cause an ignition. Previous Testing per Test Plan WHC-SD-TP-WM-411 tested the prior designs and determine some of the variables for this testing

NO-FLOW BIT IGNITABILITY

USBM TEST 8053

- Stoichiometric Hydrogen & Air (30/70) Flammable Gas mix
- Chamber Temperature @ 100°C
- Push Mode Insert P/N 2H-96-01230
- Push Mode Bit P/N 1000UD/1
- 60 ft drop
- System (test chamber & drill string) purged of air for 7 minutes before drop

Result: - No ignition occured during drop. Mixture did ignite after test using hot wire ignitor (to confirm flammability of mixture). The sampler head which the insert screws into was deformed preventing removal of the dropped insert. This prevented reuse of the head for the next drop. Will replace with spare. The insert showed very little damage. This was most likely due to the close tolerance centering of the insert into the push bit. The push bit showed no noticable damage - so it can be reused.

This was Test # 1 of 10 with this configuration. Test Numbers will skip even #'s since these are used for system checks (i.e. 8054, 8056, etc.)

no entry

- USBM TEST 8055
- Exact repeat of last test. New insert (Push) 11/15/96

142

Result No ignition occured during drop. Sampler head was modified to allow insert to sit on head better, but enough deformation occured during drop that insert threads galled when it was removed. Will use new head on next drop. Mix did ignite w/hot wire after test.

- USBM 8057
- Exact repeat of last test. ~~Mix~~

Result: No ignition during test. Mixture ignited w/ ~~[illegible]~~ hot wire after test

- USBM 8059
- Exact repeat of last test. New insert

Result: No ignition during test. Mixture ignited w/ hot wire after test

- USBM 8061 11/18/96
- Exact repeat of last test. New push insert

Result: No ignition during test. Mixture ignited w/hot wire after test.

- USBM 8063
- Exact repeat of last test. New push insert.

Result: No ignition during test. Mixture ignited w/hot wire after test.

- USBM 8065
- Exact repeat of last test. New push insert

Result: No ignition during test. Mixture ignited w/hot wire after test.

- USBM 8067
- Exact repeat of last test. New push insert
- Result: No ignition during test. Mixture ignited w/hot wire after test

- USBM Test 8069
  - Exact repeat of last test. New push insert

11/18/96
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Result: No ignition during drop test. Mixture ignited after test using hot wire.

- USBM TEST 8071
  - Exact repeat of last test. New push insert.

Result: No ignition during drop test. Mixture ignited after test using hot wire.

This completes 10 consecutive drops using this new push mode insert onto a new push mode bit.

11/19/96

The following tests involve dropping a sampler with a rotary insert mounted on it from 60 ft in the air. The sampler/insert will drop through a standard steel drill string onto a push-mode bit like the testing described on the preceding pages. This effort follows Test Plan WHC-SD-WM-TP-510. A rotary bit is not used because it was unavailable and the contact geometry and material composition is identical anyway.

- Test USBM 8073
  - 60 ft drop of Rotary Insert (P/N - TBD) & sampler onto Push Bit
  - Stoichiometric 30% H_2 70% Air & flammable Gas mixture
  - 7 min purge @ 1 ft^3/min prior to drop
  - Internal chamber (Test chamber where bit is situated) kept at 100°C minimum
  - Push Mode Bit P/N 1000UD/1

Result: - No ignition during drop test. Mixture ignited w/electric match after test

- TEST USBM 8075
  - Exact repeat of last test

Result: No ignition during drop. Mixture ignited w/electric match after test

1994 Ignitability Testing
1995-9 Ignitability Testing
DRILL STRING IGNITABILITY
HOLLOW BIT IGNITABILITY

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– Test USBM 8077
  – Exact repeat of last test

Result: No ignition during drop test. Hot wire ignited mix after test

– Test USBM 8079
  – Exact repeat of last test.

Result: No ignition during drop test. Hot wire ignited mix after test

– Test USBM 8081
  – Exact repeat of last test.

Result: No ignition during drop test. Hot wire ignited mix after test.

– Test USBM 8083
  – Exact repeat of last test.

Result: No ignition during drop test

– Test USBM 8085
  Exact repeat of last test.) Nitrogen accidently purged into chamber.
Result: No ignition → so no ignition after test.

~~Test~~ FSW

– Test USBM 8087
  – Exact repeat of last test.

Result: No ignition during drop test. Mixture ignited w/hot wire after test

– Test USBM 8089
  – Exact repeat of last test.

Result: No ignition during drop test. Mixture ignited w/hot wire after test.

– Test USBM 8091
  – Exact repeat of last test

Result: No ignition during test. Mixture ignited w/hot wire after test
This completes 10 of 10 drops w/no ignitions

DISTRIBUTION SHEET

To	From	Page 1 of 1
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