



## A Technology to Selectively Core and Drill with Realtime Wireline Retrievable MWD Applied in Deepwater

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### Abstract

This paper describes the evolution of the CoreDrill technology and its application advancements through year-to-date field case history summaries.

The long-term economic success of a petroleum exploration and production operating company is highly dependent on its ability to effectively quantify, develop and produce the hydrocarbon reserves in its offshore deepwater assets. Recent innovations and improvements in core acquisition technology involving the CoreDrill (CD1) system have advanced its use from land to offshore and now in deepwater coring applications. With rig time saving measured in days, the CoreDrill Navi-Gamma (CD2) offers an option and can be a cost-effective alternative to conventional coring methods.

The Core Drill Navi-Gamma technology is a rotary drilling system designed to selectively drill and core without the need to trip the drilling string or the BHA. This concept has been applied successfully on land type operations in hole sizes ranging from 7 7/8" to 8 3/4". More recently, the first deepwater use of this technology was performed in Brazil. It significantly changed the scope of application for CoreDrill and opened up a whole new area of operation in the offshore environment.

CD2 is instrumented with a battery operated retrievable MWD directional sensor package providing real-time position of the borehole whilst drilling. In addition, the probe features a nearbit gamma ray sensor to aid in the detection and interpretation of formation tops and the selection of core points.

The change from drilling to coring mode and vice versa is operated by running a fishing overshot on wireline through the drill pipe to sequentially remove the MWD probe and to run the core barrel. The core size is 2-inch. With ever-increasing pressures to reduce rig operating cost and the drilling time curve of the well, CD2 technology offers an alternative to conventional and side wall coring. The typical well candidate would pre-qualify

on the merits of the balance of the following decisive factors: the ability to achieve the core analysis objectives with a 2 inch core, the ability to manage the risks and safety factors of the well and, the overall performance and potential savings derived from the project.

The increased confidence shown by the core laboratories to achieve a wide range of core analysis objectives using a 2-inch core opens the prospects for the use of the CD2 system.

### Introduction

In 1993, Amoco tested a wireline retrievable coring and drilling system that would work on conventional rigs without the need to significantly change the drill string. Between 1996 and 1998, the CD1 system was used to cut in excess of 25,000 ft. of core and drill 2,000 ft. of rock.

Although the system proved technically sound, its use was essentially limited to the onshore applications. In order to make CoreDrill attractive to the offshore environment, the following key technologies and application factors which were lacking had to be addressed:

1. No MWD capability in the drilling mode;
2. No formation evaluation sensor while drilling to select core points;
3. Insufficient flow rate and hydraulic cleaning efficiency at the bit to drill.

The development of CD2 has encompassed the above issues for deepwater applications.

### The CoreDrill Navi-Gamma (CD2) Concept

A schematic view of the tool is shown in Figure 1. The CD2 system combines 30 ft of Non- Magnetic corebarrel with a realtime retrievable probe based MWD retrofitted inside the core barrel. The MWD system is battery

powered and connected to a drill plug seated inside a bearing lodged in the center of the bit. When drilling, the drilling torque is transmitted from the Non-Mag outer barrel to the 2" drill plug via a drive latch mechanism located behind the bit. The near bit gamma ray is the sole formation evaluation sensor located 9 ft behind the drill plug. A mud pulser transmits real time data to the surface. The data is acquired, analyzed and recorded at surface.

Changes between drilling and coring modes are executed by retrieving the MWD with the drill plug and replacing it with a core barrel. These changes are operated through the drill pipe by running an overshot dressed onto a braided cable mounted to a wireline unit. Prior to operating the wireline, the CD2 tool may have to be pulled back inside the casing. The use of a lubricator with a stuffing box to operate the wireline is recommended (Figure 2).

### CD2 Applications

To pre-qualify a CD2 project candidate, one has to model and balance the overall economics of the core acquisition operation and the core analysis objectives of the well. Besides deciding whether a 2" core is a good compromise to meeting these objectives, the risk factors associated with deploying the CD2 tool in the well need to be understood and managed. For most well candidates, the pre-qualification study is a pre-requisite and should serve as an aid to the planning requirements of the job. CD2 technology is applicable to reasonably competent rock in the hole size range of 7 7/8" to 8 3/4". The application potential can be triggered by any of the following:

- Coring long sections with multiple trips
- Drilling out of the casing shoe to core a target with the same bit trip
- Drilling and coring multiple zones that require several BHA changes
- Coring deep targets
- Alternative to side-wall cores

### Tool Specifications

- Each Non Magnetic CD2 tool section is 30 ft long with an intermediate stabilizer at 15 ft.
- BHA has a drift ID requirement of 2 13/16".
- The 2" battery powered retrievable MWD with pulser has a maximum OD of 2.5 inch
- The 2" drill plug sits in the center of the bit
- The core size is 2 inch.
- WOB : 0 - 30,000 lbs
- GPM: 100 - 650
- RPM: 50 - 200

### Deepwater Case History

The extensive onshore experience acquired from 1996 to 1998 served to convince Petrobras to deploy CD1 in a first deepwater application offshore Brazil. The plan was to run the CD1 system to core and drill a total of 200 ft in 8 1/2" hole. The well was deviated and located in water depths in excess of 3,500 ft. The objective was to demonstrate the effectiveness of the CD1 system in achieving the core acquisition requirements. The CD1 planning assumptions were based on the offset well information compared to the conventional cores planned to be taken in the well. Two core points were identified and separated by an interval to be drilled. The decision to run the CD1 system was finally taken on the balance of good economic drivers.

Despite the core bit balling problems encountered whilst coring through hydrating shales, the customer's objectives were met. A total rig time saving of 53 hours was achieved compared to the prognosed conventional coring and drilling operations originally planned for the interval. This CD1 job was regarded as successful and opened the doors to CD2 in Deepwater applications.

In the meantime, CD2 underwent a drilling field test at the Baker Hughes drilling site in Tulsa. As a result of the first offshore CoreDrill project in Brazil, the interest for CD2 shifted to the North Sea. The tool gained noticeable interest with most operators in the UK sector and was subsequently sent to Aberdeen. It was deployed at the end of 1999 for the first time on a high profile directional well for BP Amoco. The plan was to drill out of the casing shoe and core two horizons located several hundred feet below the casing shoe. The casing shoe was successfully drilled out and the core point was positively identified using the nearbit Gamma Ray. The wireline overshot tool was run and pumped down through the near-to-horizontal section of the cased well to retrieve the MWD probe. Unfortunately, the overshot became unlatched when pulling the MWD tool around a curvature. A decision was taken to terminate the CD2 operation after a second attempt to fish the tool proved

unsuccessful. Although this incident resulted in the inability to cut core, the CoreDrill Navi-Gamma (CD2) proved its ability to drill and to pick the core point. It transpired that the near to horizontal profile of the well was a first time experience in the history of CoreDrill and led to operating conditions where the latching mechanism had not operated before. The lesson learned provided a solution to prevent the overshot to become unlatched when pulling through dog-legs or severe curvatures. The modifications have now been implemented and renewed our confidence for a new launch of CD2 in the field. BP Amoco UK indicated they would use the CoreDrill Navi-Gamma again.

### Conclusions

1. Based on case history experience, CoreDrill (CD1) has demonstrated that it is possible to drill and core selectively without tripping the BHA in rotary drilling applications using conventional drillstrings.
2. CD1 technology has been used extensively onshore but lacks offshore experience.
3. A successful deepwater coring & drilling operation with CD1 demonstrated its applicability offshore but revealed limitations when drilling.
4. The CoreDrill Navi-Gamma (CD2) has been introduced offshore to successfully drill with real-time MWD. Improvements in drill bit cutter technology combined with better hydraulics have made this possible.
5. The real-time near-bit gamma ray sensor as instrumented in the CD2 system has shown to be effective for selecting core point.
6. A solution to resolve the unlatching of the MWD during wireline retrieval has been implemented for future deployments.

### Acknowledgements

Baker Hughes and the authors would like to thank Petrobras for allowing CoreDrill's first success in a deepwater application offshore Brazil.

We also wish to extend an acknowledgement to BP Amoco for their support of this innovative technology and for their commitment to deploying CoreDrill Navi-Gamma in the North Sea.

### Nomenclature

*CD1= CoreDrill (version 1)*  
*CD2=CoreDrill Navi Gamma ( version 2)*  
*MWD= Measurement While Drilling*  
*BHA = Bottomhole assembly*  
*ID=Internal Diameter*  
*OD=Outer Diameter*  
*WOB=Weight on bit*  
*ROP = Rate of penetration*  
*GPM=Gallon per minute*  
*rpm = revolutions per minute*

### References

1. Tommy M. Warren, Allen L. Sinor, Sue Behr "Wireline Retrievable Coring with Conventional Drilling Equipment" (13 Sep. 1993 ), Amoco Production Company – Research Department - Tulsa

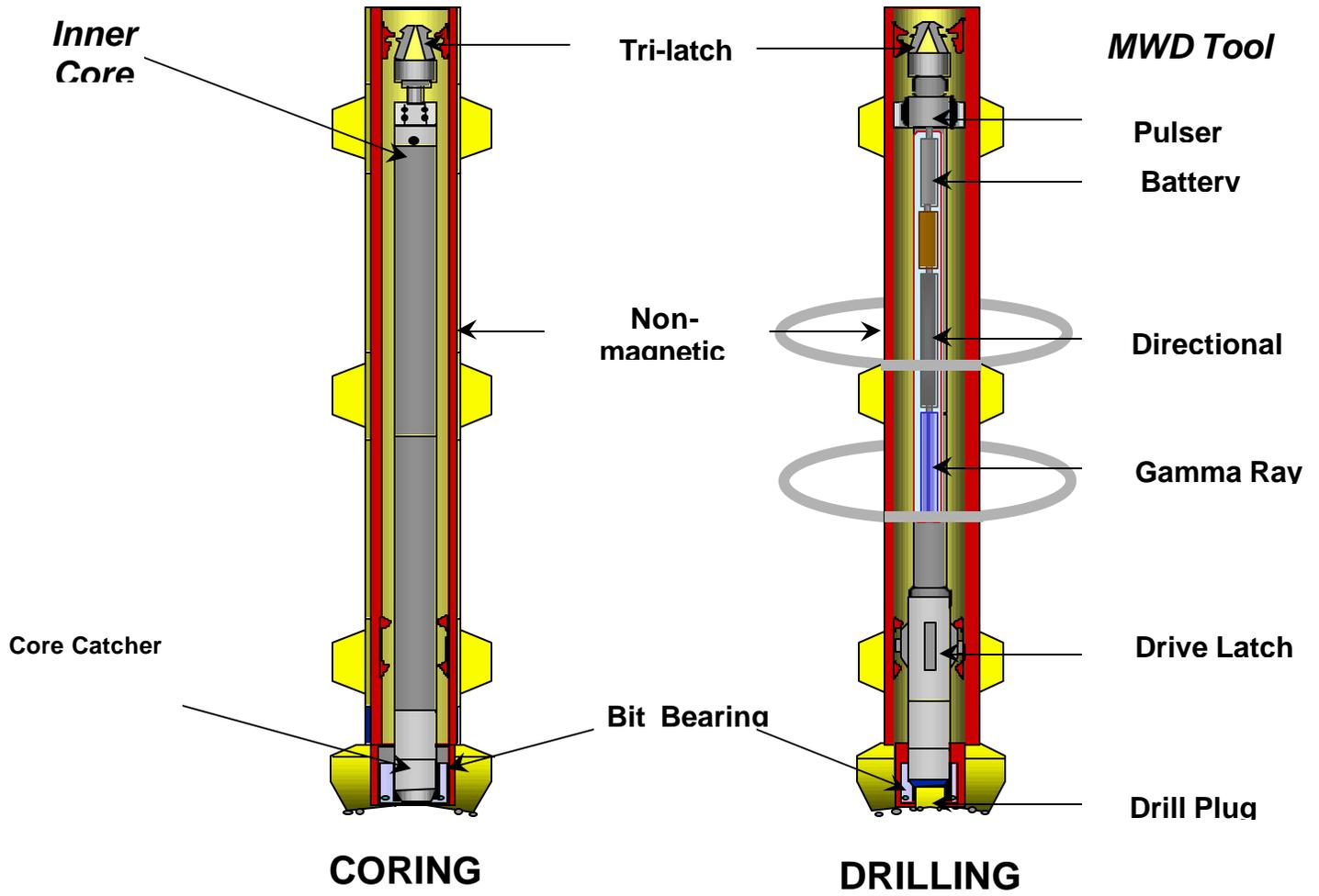


Figure 1: Schematic of CoreDrill Navi-Gamma

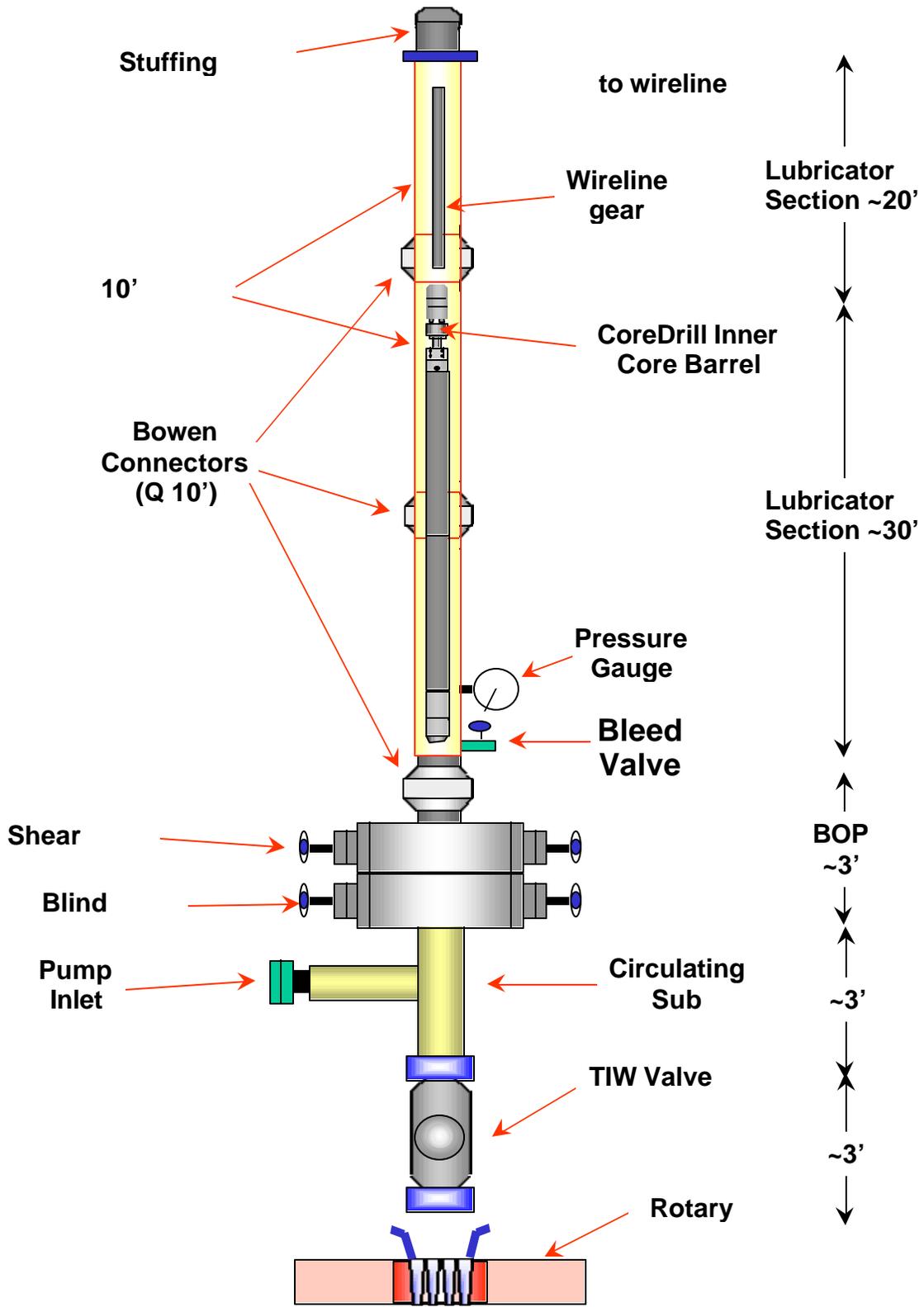


Figure 2: Schematic of wireline lubricator and pressure control rig-up