DOWNHOLE VIBRATION MONITORING & CONTROL SYSTEM QUARTERLY PROGRESS REPORT #15

Starting date: April 1, 2006

Ending Date: June 30, 2006

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Date Issued: August 16, 2006

DOE Award Number: DE-FC26-02NT41664

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ABSTRACT

The objective of this program is to develop a system to both monitor the vibration of a bottomhole assembly, and to adjust the properties of an active damper in response to these measured vibrations. Phase I of this program, which entailed modeling and design of the necessary subsystems and design, manufacture and test of a full laboratory prototype, was completed on May 31, 2004.

The principal objectives of Phase II were: more extensive laboratory testing, including the evaluation of different feedback algorithms for control of the damper; design and manufacture of a field prototype system; and, testing of the field prototype in drilling laboratories and test wells. Phase II concluded on January 31, 2006. The final report on Phase II was issued during this quarter.

Work on Phase III of the project began during this quarter. We completed several modifications in the prototype design to make it more suitable for field testing and more practical for commercial use. This included redesigning the LVDT to measure relative motion of the bit and drillstring, and moving hydraulic and electronic components into the upper sub, leaving the lower sub compatible with standard industry parts. All of the long-lead items were ordered during this quarter.

The current extreme lead times quoted by oilfield machine shops for collar components, will delay the deployment of the field prototypes. The longest lead for a part is currently September 28, which will preclude deployment for a field test by Q3-06; the field tests are currently scheduled to begin in October.

The precommercial prototypes are being developed in parallel, so the overall project should be completed per the current schedule.

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Executive Summary

The objective of this program is to develop a system to both monitor the vibration of a bottomhole assembly, and to adjust the properties of an active damper in response to these measured vibrations. Phase I of this program, which entailed modeling and design of the necessary subsystems and design, manufacture and test of a full laboratory prototype, was completed on May 31, 2004.

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Design

Redesign of laboratory prototype

COMPLETE.

Design of feedback system

COMPLETE.

Intermediate prototype design

COMPLETE

Design of field prototype tool

During assembly and test of the intermediate prototype tool, several observations were made that had significant bearing on the design of the field prototype and the eventual commercial tool. These include:

- The internal position monitor (LVDT) did not produce sufficient signal within the collar to control the feedback loop, and it was necessary to rely upon an external sensor during the TerraTek testing. This has necessitated a complete redesign of the LVDT, which is currently underway. Tests with a ¼-scale model were very promising and a full-scale laboratory prototype is currently being assembled.
- Assembly of the laboratory prototype, and its conversion to the drilling lab prototype, demonstrated that the current design was overly complicated and extremely difficult to assemble, and not commercially viable.
- Furthermore, potential commercial partners indicated a strong preference for a system which can be integrated into their existing shock subs. A significant part of the DVMCS (bearings, Belleville springs, etc.) is very similar to a shock sub, with the key addition being the active feedback and control system.

Based on these considerations, the use of our existing prototype in the field was not considered practical and began a redesign. The result will be a much improved tool. In particular:

- The hydraulic compensation system was modified so that it uses a single reservoir at the top of the tool. By eliminating the lower reservoir, the bottom end of the tool becomes essentially identical to a standard shock sub. This permits its integration into existing products and will greatly reduce manufacturing costs.
- A reconfiguration of the tool permits greater flexibility in assembly and maintenance. In particular, it will not be necessary to depressurize the MR fluid section to perform routine maintenance.
- The part count has been significantly reduced.

These efforts were all completed during this quarter.

While key parts were ordered as soon as their designs were frozen, the present boom in oil & gas drilling has created long lead times at shops building BHA components. As a result, one key item now has a delivery date of September 28, which will prevent the completion of the prototype by the end of Q3.

Design of precommercial prototype tool

The precommercial prototype design is being produced largely in parallel with that of the field prototype. Its design will be essentially the same, with the addition of the LVDT. Therefore, many of the long lead items can be ordered at the same time, with only those parts affected by the LVDT integration being held until its design is fixed.

Experimental

Retesting of DVMCS prototype

COMPLETE

Preparations for Testing at TerraTek

COMPLETE

Testing at TerraTek Drilling Laboratory

COMPLETE.

Analysis

COMPLETE. The analysis of the TerraTek data was included in the Final Report of Phase II.¹

Units

To be consistent with standard oilfield practice, English units have been used in this report. The conversion factors into SI units are given below.

1 ft.	=	0.30480 m
1 g	=	9.82 m/s
1 in.	=	0.02540 m
1 klb.	=	4448.2 N
1 lb.	=	4.4482 N
1 rpm	=	0.01667 Hz
1 psi	=	6984.76 Pa

References

¹ Martin E. Cobern, "Downhole Vibration Monitoring & Control System Final Report – Phase II," April 30, 2006.