Minutes of the Fourth Meeting of the

Industry Steering Committee on Wellbore Survey Accuracy

Mile High Center, Denver, Colorado
10 Oct 1996

Those present:

Hugh Williamson (Chairman and Minutes)	BP Exploration
John Turvill	Halliburton
Brett Van Steenwyk	SDC/Applied Navigation Devices
Fred Watson	SDC/Applied Navigation Devices
Tim Price	SDC/Applied Navigation Devices
Koen Noy	Gyrodata
David Roper	Sysdrill
Roger Ekseth	Statoil
Paul Rodney	Sperry-Sun
Gordon Shiells	Sperry-Sun
Patrick Knight	Sperry-Sun
Wayne Phillips	Anadrill
Philippe Theys	Anadrill
Steve Mullin	Baker Hughes INTEQ
Andy Brooks	Baker Hughes INTEQ
Robert Estes	Baker Hughes INTEQ
George Halsey	RF Rogaland Research
Torgeir Torkildsen	IKU
Alewijn van Asperen	Shell International
Philip Walters	Tensor

1 Introduction

The Chairman welcomed those present and thanked Steve Mullin and John Turvill for organising the venue.

2 Actions from last meeting

Hugh Williamson circulated an unfinished document, "Talking About Wellbore Position Uncertainty" which describes some relevant statistical concepts.

On encouraging the participation of other Oil Companies, it was recognised that some might have a real interest in the Group, without wishing to attend its meetings. Minutes will continue to be circulated to those companies which have expressed an interest.

3 Error Sources Afecting Soid-State Magnetic Survey Systems

Members of the Group made presentations characterising the individual sources of error affecting magnetic survey systems.

3.1 Sensor Errors

Wayne Phillips presented figures representative of tools in the field. The results had been derived from a large sample of tools returned to the testing facility after 500 operational hours. The results assume the following:

- errors are at 1 standard deviation
- only alignment of the sensors within the sensor package is considered
- errors in X and Y sensors are uncorrelated

Paul Rodney confirmed that he had seen no correlation between X and Y sensor errors. Using figures from 26 tool calibrations, he presented the results of a Monte Carlo simulation which predicted the inclination and azimuth errors due to sensor errors and various hole orientations.

It was agreed that all performance figures needed to be representative of tool's performance in the field and that results derived from post-calibration tests need to be treated with caution.

Robert Estes described BHI's concept of "lumped" accelerometer and magnetometer errors. He also showed an example of how a scale factor error can go undetected.

Andy Brooks enlarged on the concept of lumped errors, which are derived from observed inclination and azimuth errors in the test stand. It is not necessary to know the breakdown of the lumped error between different causes - only its overall effect.

Action:
Andy Brooks to circulate documentation on the method (via Hugh Williamson).
Members to test the concept with a view to reaching consensus on its applicability.

3.2 Declination Error

Patrick Knight described the errors caused by calculating magnetic declination from a global geomagnetic model. He split the error into DC and AC components:

DC components:

- Secular Variation (which was shown to be unpredictable)
- Diurnal Variation (which was shown to be modellable from observations. Due to the presence of the Equatorial Electrojet, diurnal variation was, in fact, higher near the equator - up to 120nT - than at mid-latitudes)
- Magnetic Anomalies (could be detected, but not corrected, by maps derived from aeromagnetic surveys)

AC component:

- Magnetic Storms. These do not, contrary to popular belief, show random variation about a mean - offsets from the mean may last for a day or more. Nor is their effect the same at different locations. The well known 11-year and 27-day cycles make recurrence of storms predictable to an extent.

David Roper asked about the effects of magnetic storms below the surface of the Earth. Wayne Phillips confirmed that the effects were unlikely to be attenuated significantly at the depths relevant to well drilling.

3.3 Drillstring Interference

John Turvill concentrated on axial interference, and stated that from numerous BHAs and components tested, including motors, few showed pole strengths greater than 350 micro-Webers. The Group noted that this was at variance with data published previously by Shell, which quoted pole strengths in the 1000 micro-W to 3000 micro-W range.

Gordon Shiells stressed the low probability of a hot-spot with intensity greater than 50 nT occurring close to the magnetic sensors. He suggested that the next meeting could include a talk on the observed frequency, distribution and intensity of magnetic hot-spots by an inspector of non-magnetic collars.

Action:
Gordon Shiells to invite representative of SIAMM Surveys to give such a talk.

3.4 BHA Misalignment

Andy Brooks broke the error due to misalignment of the BHA within the wellbore into 3 components:
a) Sag
b) Errors dependent on BHA geometry
c) Errors dependent on hole geometry
He circulated a document describing each component in some detail.

Wayne Phillips asked about the reliability of BHA sag corrections. David Roper responded that an order of magnitude reduction in error was possible, but that it was very dependent on a knowledge of hole and stabiliser gauges. The Group agreed that sag errors of 0.4° in 12.1/4" hole were not uncommon.

There was a discussion about the best way to treat misalignment errors. It was agreed that those interested could discuss this further before the next meeting.

3.5 Measured Depth

George Halsey will give a presentation on measured depth errors at the next meeting.

4 Quality Aspects

Alewijn van Asperen presented Shell's MATQUS system for MWD quality assurance and performance prediction.

There was some discussion over the detail of the method, in particular the status of the predicted errors. Alewijn van Asperen confirmed that these errors could be considered maximum values, assuming the absence of gross errors. He stressed that the use of measured magnetic field values could enhance the estimate of uncertainty generated by the system.

Wayne Phillips felt that satisfying QC parameters could build confidence in correct tool performance, but that it could never guarantee results. Robert Estes didn't accept that surveys falling outside normal QC parameter tolerances could necessarily be attributed to sensor malfunction.

The Group identified focal points for the collection and rationalisation of information on each source of error. The focal points will be as follows:

Tool/Sensor Errors:	Wayne Phillips
Magnetic Declination:	Gordon Shiells
Drillstring Magnetisation:	John Turvill
BHA Misalignment:	Steve Mullin
Measured Depth:	Philippe Theys
Post-Correction Residuals:	Andy Brooks
Gross Errors:	Hugh Williamson
Quality Aspects:	Alewijn van Asperen

Action:
Members to forward their data, values etc. to focal points
Focal points to make brief presentation of consensus (if any!) at next meeting.

5 Gyroscopic Tool Errors

Koen Noy and Brett van Steenwyk made presentations on the sources of error affecting gyroscopic survey tools.

The Group returned to the "specific vs. generic" discussion on gyro tool error modelling. Steve Mullin objected to a generic gyro error model on the grounds that no-one was running a generic gyro tool. Instead, he suggested working on a methodology for creating and validating tool-specific models. David Roper felt that tool-specific models, maintained by each vendor, would avoid a complex change management process. Roger Ekseth felt that a generic model for use at the planning stage would be useful. He did not support the idea of "black-box" tool-specific models, since final survey uncertainty would always need to be calculated by combining errors from several tools.

Steve Mullin mentioned INTEQ's ongoing work to fit SDC's and Gyrodata's own models into the INTEQ framework. He felt that this work would largely address the needs of the Group. This was supported by Hugh Williamson, although he felt the INTEQ model might require some modification.

Action:
Steve Mullin to report on progress of this work at the next meeting.

6 Other Business

It was noted that the POSC data model currently contained no provision for wellbore position uncertainty.

Action:
David Roper to propose, to POSC and the Group, a standard format for survey data and wellbore positional uncertainty.

John Turvill pointed out that the IMS (International MWD Society), currently under the auspices of the SPWLA, was considering its future affiliation(s).
Note: At the IMS seminar on 31 Oct, a majority of attendees favoured continued affiliation with the SPWLA, although a significant proportion, about half as many, preferred the SPE.

7 Next Meeting

The next meeting will be hosted by Shell in the Netherlands, to co-incide with the SPE/IADC Drilling Conference to be held from 4-6 March 1997 in Amsterdam.

Action:
- Alewijn van Asperen and Hugh Williamson to organise arrangements for the meeting and advise members accordingly.