ISCWSA / SPE Wellbore Positioning Technical Section

Error Model Maintenance Work Group

Minutes of the Meeting at ISCWSA#49, Den Haag, 7th March 2019

Present

Andy McGregor	H&P Technologies	Jonathan Lightfoot	Occidental
Jon Bang	Gyrodata	Chad Hanak	Superior QC
Harry Wilson	BHGE	Anne Holmes	Halliburton
Scott Farmer	Total	Benny Poedjono	SLB
Phil Scott	DGI	Frank Satijn	Shell
Darren Aklestad	SLB	Koen Noy	Shell
Manoj Nair	NOAA	AnaS Sikal	Pathcontrol
Pete Clark	Chevron	Denis Reynard	Pathcontrol
Andy Sentence	DGI	Lu Jiang	SLB
Adrian Ledroz	Gyrodata	Saredy Escobar	Husky
Stefan Maus	H&P Technologies	Barry Smart	Gyrodata
Erik Nyrnes	Equinor	David Erdos	Erdos Miller
Gunnar Tackmann	BHGE	Ciaran Beggan	BGS
Steve Grindrod	Copsegrove	Steve Sawaryn	Independent
Jerry Codling	Halliburton	Susan Macmillan	BGS
Ellen Clarke	BGS		

Long Course Length Models

Jerry Codling has produced a document which details the proposed form of the long course length models. This was circulated to members shortly before the meeting.

This use the same weighting functions as previously described, but they are modified now to use a tangential rather than balance tangential approximation to ensure the uncertainty applies at the survey of interest and not deeper in the well. This formulation will work better for irregular survey intervals.

Jerry and Andy McGregor have compared results for regular 30m and 100m survey intervals and have had good agreement. Care must be taken to ensure that azimuth differences are calculated 'the short way around the compass' and that since azimuth is not defined when vertical, the azimuth change from or to vertical should considered to be zero.

Andy M. has suggested a variation on these functions for use for inclination only surveys, but so far this has not been checked by anyone else.

The meeting therefore agreed that these XCL terms should be accepted into a revision 5 of the model subject to a working group checking the following points:

a) Irregular course lengths (it was suggested this could be 300m intervals with the points of inflection of the well also included).
b) Very long course lengths (> 600m intervals)
c) High rate continuous data.
d) Clarification on terms to be used for inclination only wells.

The desire was to get this revision documented and released before the next meeting. Therefore, validation will take place over the next few weeks.

ACTION: Andy S. to circulate details of how he ensures deltaAz is calculated via the short route.
ACTION: Jerry & Andy M to check the remaining test points.
ACTION: One other software implementer to validate results (Andy S, Darren, Steve G.)
ACTION: Actions to be completed by mid-April 2019.

Hole Misalignments

Revision of the hole misalignment terms has been discussed at the last few meetings since they may currently be overly conservative. Jerry again presented his suggested changes to

i) increasing the XYM3/XYM4 terms to 0.3° and changing these terms to random propagation.

ii) Replace the existing sag weighting function with a sin(Inc) to power 0.25 function.

These changes work together as a package to better model the effect of misalignment. Jerry's work is based on comparisons of gyro and MWD data and these comparisons are documented.

These changes are in the write up that Jerry has produced. Jerry and Andy M. have also had good agreement when validating these proposals.

AnaS Sikal from Pathcontrol reminded the group that they had suggested similar changes several years ago. Those changes were not adopted at that time.

It was agreed that a small working group would consider this and meet by conference call within two weeks to decide whether Pathcontrol or Jerry Codling's proposal was the better. The committee agreed to accept the decision of this working group and to add a change to misalignments to the forth coming revision.

Furthermore, after the main ISCWSA meeting, two members of the committee suggested that there might be a problem with this formulation for high rate continuous data, since the random sources will have little effect, even over a short length of well. This point should be considered before final adoption.

ACTION: Working group (Andy M, Jerry, AnaS, Darren, Harry, Andy S, Steve) to consider which approach to take forward.
ACTION: Software teams to implement and assess the effect.

Effect of Error Correlation on Uncertainty Value

Over previous meetings we had defined a means of handling partial correlation between error sources, in support of the work of the Collision Avoidance committee.

At the last meeting Andy McGregor presented a method of introducing new magnetic terms for the various components of the Earth's field. This would mean that only integer correlations would be used and the partial correlation values would be automatically handled by the terms in the tool-code. Furthermore, this would avoid the need for either the directional software or user to determine which correlation value to apply.

The proposed breakdown of terms at the previous meeting has been updated to reflect more recent work by Stefan Maus on the underlying correlation values. This has required further terms to be added, such that the current four global magnetic terms (DEC, DBH, MDI and MFI) are replaced by a total 24 new terms. The existing random magnetic terms remain as before.

Andy has now been fully implemented in software and therefore is a practical solution. The meeting also accepted this for the new release, subject to the verification of implementation by another software team.

A poll of the software teams by email determined that the best way to handle any backward compatibility issues is by software checking that the names of the error sources used in apply global correlations are from the list of 'new sources' and that the global correlations will not be applied to existing sources (DECG, DBHG, MDIG, MFIG or DSTG).

Final details of the term values have still to be verified with the geo-magnetic model providers. The combination of correlated values and geomagnetic uncertainty look-up tables is deferred.

Action: Andy McGregor write up the method and provide diagnostics to other software teams.
Action: Group of software team leads to implement and validate Andy's results.
Action: Andy M to send latest analysis to geo-mag institutes.

Release of Revision 5

XCL terms, changes to hole misalignment and adoption of relative correlations have all been accepted for Revision 5 of the error model. Release of this revision is approved subject to the various technical and implementation details noted above, being checked and resolved.

This group anticipates that the OWSG will follow these changes and that the OWSG models should be available on the ISCWSA website in such a way that Rev5 and the OWSG models are all in the same place. It was recognised that the distinction between ISCWSA and OWSG models was confusing to the wider industry.

ACTIONS:
The following actions should be completed for a fully documented release:
1) **Create a release note – Andy M.**

2) **Update error model definition document – Andy M.**
3) **Format models in OWSG spreadsheet form – Steve G.**
4) **Ensure ISCWSA test well definitions are available in the same location – Andy M.**
5) **Create diagnostic files for new models – Steve G.**
6) **Update sample error model calculation spreadsheets – Andy M.**
7) **All documentation to be placed on website – Andy M. to liaise with Phil Harbidge.**
8) **A note to be sent to all ISCWSA members that a new release is available – Andy M. to liaise with Ryan Kirby.**

Shell Error Model Standardisation

Koen Noy presented a roadmap of the work done by Shell to standardise their worldwide set of error models. The business goal is ISCWSA error model implementation to drive significant simplification on directional well planning, collision avoidance modelling and monitoring for Shell. They moved over from what they had in SESTEM to ISCWSA format models and verified the new models against a large database of SESTEM data.

Some term values (specifically misalignments) and gyro weighting functions were changed when compared to the ISCWSA standard definitions and OWSG model set. The final set selected by Shell was then rolled out to their business units worldwide along with associated process and documentation. The final set has also been rolled out to Baker Hughes, Schlumberger and Halliburton to support consistent global application in operations among Shell and their integrated services suppliers.

Koen was offering this work up for consideration by the committee. His plea was that the industry should move to a common set of models to minimise the confusion of users and unnecessary duplication of effort in matching models when transferring data. Given that is the intention of the OWSG model set, changes to individual models should really be discussed by the OWSG committee.

ACTION: Andy M to supply Koen with details of the Rev5 misalignment changes so that Shell can validate against their SESTEM database.
ACTION: Koen to provide details of gyro weighting function changes proposed by Shell to be considered at a future meeting.

BGGM Lookup Tables

Susan Macmillan presented the latest changes to the BGGM model. For 2019 the BGGM will be released to a degree in the range of 800 to 1440. The latest release of the BGGM model will include a 1 x 1 deg look up table for uncertainty values at a 1-sigma equivalent level (95.4% confidence level / 2.0). BGS showed that there is detail in the uncertainties that cannot be adequately modelled with simple term values. In some areas (particularly over South America) the existing values are over optimistic.

Susan asked the group to define what constitutes a high definition model. The discussion centred around trying to define a common uncertainty grid for all high definition models. However, this is not straightforward and different vendors look to define the uncertainties differently (i.e. as pertaining

globally or as pertaining to oil field areas.) Furthermore, validation data for this modelling is often proprietary meaning a like for like dataset for evaluation is not possible.

Concerns were identified where uncertainty values might change as new look up tables are released or in situations where uncertainty values are obtained from web services. These values might need to be transferred between different parties such as operators and service companies and would be required for use for the entire lifetime of the well.

The committee voted that it would like to proceed with the use of lookup tables. A working group was formed to consider the practical implications and recommend solutions for handling magnetic uncertainties which do not come from fixed term values in the tool code definitions.

ACTION: Working group (Darren, Andy S, Jerry, Steve G) to consider the implications of handling magnetic uncertainties from lookup tables or web services.

WITSML

Total have been leading a work group to define a WITSML protocol to allow transfer of error models.

Scott Farmer gave an update on this work. A complete schema for transfer of error models has been created and this is available for review. In order to validate the schema, it is necessary for at least two teams to implementer the schema and ensure that they can properly exchange models. Total believe they have sufficient involvement from members of this committee that these objectives can be met. Scott encouraged anyone with an interest in the WITSML model transfer to review the schema definitions.

Items Carried Forward

Two matters arising from the previous meeting were not discussed but should have been included on the agenda. The actions therefore carry over for now.

Demonstrating MWD Tool Meets Error Model

The was discussed at the previous meeting. The action carries on to the next meeting.
ACTION: A workgroup was formed consisting of Andy McGregor, Randy Riggs, Gunner Tackman, Chad Hanak, and Marc Willerth. This group to review Randy's calculations and progress from there.

Gyro Model Verification

It is still the case that more verification data is needed to ensure that the gyro models can be correctly replicated. The action is carried over.
ACTION: Steve Grindrod, Adrian Ledroz and SDI to look into what is needed.