SPE Wellbore Positioning Technical Section

Collision Avoidance Work Group

3rd meeting, Doubletree Anaheim Hotel, 14th November 2007

Present:
Darren Akelstad, Bill Allen, Andy Brooks, Bjorn Bruun, Jerry Codling, Steve Grindrod, Stein Havardstein, Angus Jamieson, Patrick Knight, Jim Oberkircher, Shola Okewunmi, Wayne Phillips, Benny Poedjono, Regis Studer, Torgeir Torkildsen, Harry Wilson

Apologies:
Dave McRobbie, Calum Shand, Jim Towle

Guest speakers:
Noel Zinn (Exxon Mobil)

1. Introductions and Agenda

The attendees listed above introduced themselves, as did a number of observers, then Harry Wilson presented the agenda.

2. Close out Bibliography and Lexicon

Steve Grindrod reported that the bibliography and lexicon had been carried on the SPE website, but may no longer be present following their migration to a new system. The bibliography and lexicon are on the iscwsa.org website.
It was resolved that the work group would undertake to keep the bibliography and lexicon up to date by reviewing its contents every year or two. In the case of the lexicon, it is expected that companies, such as software suppliers, will contribute new terms as they are coined.

3. Default rules

Regis Studer reported on a poll of directional drilling companies' anti-collision policies, conducted by Total. The results were similar for the three major service companies, all using ISCWSA error models, but with differences in calculating separation factors as shown in the following summary:

CC = center to center separation
RR = sum of wellbore radii
P_r, P_o = 1σ pedal curve radii for reference and object well (P_{ro} for combined ellipse)

Baker Hughes INTEQ

$SF_B = (CC - RR)/[3\cdot(P_r + P_o)]$

$SF_B \leq 1$	re-plan or stop drilling
$1 < SF_B \leq 1.5$	requires monitoring in office as well as on rig
$SF_B > 1\ 5$	ok, drill ahead

Sperry-Sun

$SF_H = CC/[2\cdot(P_r + P_o)]$

$SF_H \leq 1$	stop drilling
$1 < SF_H \leq 1.25$	execute shut-in procedures
$1.25 < SF_H \leq 1.5$	monitoring required
$SF_H > 1.5$	no special requirements

Schlumberger $OSF = (CC - RR)/(2.79\cdot\sqrt{2}\cdot P_{ro})$

Wayne Phillips clarified that the pedal radius of the combined ellipsoid (P_{ro}, obtained by summing the covariance matrices) is used.

$CC <$ MAS	(surface rule) stop drilling, exemption or risk assessment required
$OSF \leq 1$	major risk, stop drilling, exemption or risk assessment required
$1 < OSF \leq 1.5$	minor risk, stop drilling, exemption or risk assessment required
$1.5 < OSF < 5$	alert

Regis noted that during the course of this study Total suffered 5 collisions, every one caused by gross error. Angus Jamieson noted that his clients were not happy with differing definitions of separation factor among different companies. He proposed a variation in which the separation factor is defined as the scale factor by which ellipses or ellipsoids of uncertainty may be enlarged until they touch. Harry Wilson thought that the work group should be able to develop a more rigorous indicator than this.

It was agreed that if the search for such a method did not produce results within 12 months, the group's efforts should switch to identifying an existing method, or variation on an existing method, which can be recommended to the industry.

4. Traveling Cylinder vs 3D Scan

Harry Wilson pointed out that the outcome of the calculation depends on the scanning plane. Regis noted that Total do not use the traveling cylinder plane, they look ahead of the bit. It was agreed that there is a need to educate the industry and to include this point in our description of current practice.

5. Geodetics Work Group

Noel Zinn (Exxon Mobil) reported on discussions from the April meeting of the Geodetics work group, concerning probability of collision. The probability can be estimated by defining relative uncertainty between the wells using Gauss's law of variance-covariance propagation, which can include surface location uncertainty and correlated uncertainty terms. When there are no correlated terms, the result should be similar to that obtained by adding the respective covariance matrices. The length of the separation vector in standard deviations can then be converted to a probability. A bias of 0.3σ can be added to allow for improper geodetic corrections, which may become important at small separations.

Harry Wilson pointed out that some companies are currently employing similar rules which make use of relative uncertainty. Wayne Phillips noted that a separate backup rule is required in surface hole, where the separation factor changes rapidly. The use of a normal distribution function was discussed; while the Central Limit Theorem provides some support, the applicability of this theorem is weakened if one or two error terms are dominant.

6. Description of Common Practice

Harry Wilson presented for review a draft version of a description of common practices. The aim of the document is limited to education about current practices; it was agreed that we should add some commentary on the various methods, but we do not propose to issue recommendations. It was also agreed that we should include a table of example outcomes for the various methods.

7. Oriented Separation Factor

Wayne Phillips gave a presentation on the Oriented Separation Factor described in SPE paper 108279. The aim is to provide a simple number which bears a direct relationship to the probability of collision, independent of the orientations of the ellipsoids of uncertainty. The OSF is normalized such that a value of 1 is equivalent to two 95% spheres of uncertainty which just touch, i.e. $2.79 \cdot \sqrt{2}$ standard deviations, corresponding to a probability of about 1 in 27000.

8. Statoil Hydro Research Project

Bjorn Bruun described a study of error distributions by a Statoil Hydro intern working on his master's thesis. It was observed that geomagnetic data do not follow a normal error distribution, and that many error distributions appear to be skewed. In particular, the tails of the distributions tend to be more significant than those of skewed normal distributions. By the use of a Q-Q plot it was shown that an Asymmetric Normal Inverse Gaussian distribution provides a better fit.

9. Work group status report

Harry Wilson reported on the status of the work group. The last step of the educational goal (Objective 1) is almost complete. We intend to circulate the "description of current practices" document for comments and to post the final version on the website by the end of 2007. It was decided that the group would undertake to keep current the documents on the website. We decided not to publish the comparison of methods provided by Total and described in item 3 above.

Little progress has been made towards Objective 2 (development of improved methods), as we have relied on Statoil's research project (item 8) until now. However, it was suggested that members of the work group should turn their attention to this before the next meeting.

10. Discussion of tolerable risk

A brief discussion took place concerning what risk levels are tolerable. It was observed that contractors tend to be more conservative than operators, and that existing major risk rules are normally in the region of 10^{-5} for conductor, 10^{-6} for surface casing, and 10^{-7} deeper.