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An Analysis of Drilling Projection Uncertainty and Implications for Collision Avoidance Management Systems

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Abstract

During well planning, specifying the separation that must be maintained from offset wellbores is critical to ensuring safe operations. Recent efforts on API RP 78, an upcoming recommended practice for wellbore placement, have provided guidelines for calculating safe separation distances and engineering considerations for those calculations. A major milestone was the publication of a separation rule (Sawaryn, et al. 2019) standardizing a formula for separation factor (SF), which in turn defines the minimum allowable separation distance (MASD) between two wellbores and the allowable deviation from plan (ADP) for a wellbore being drilled. One element of this formula, σpa, describes the accuracy with which a future wellpath can be predicted. Prior guidance provides a suggested value for σpa (1.6ft or 0.5m at 1-sigma) based on heuristics. A more rigorous approach for estimating this value is presented, where the design of the drilling program can be considered.

A framework is proposed for modeling deviation from a projected path using a planned trajectory, bottom hole assembly (BHA) properties, and survey practices. The method identifies where a deviation is detected through survey measurements and estimates a planned recovery operation. Equations are provided for estimating the distance from plan at deviation detection along with the maximum expected deviation during recovery. Common drilling scenarios are analyzed for sensitivity to operational parameters such as survey course length, sensor offset, toolface control, and BHA performance. The impact of varying σpa is explored across prototypical collision avoidance cases. A discussion of the relationships between the σpa value and the common collision avoidance calculations such as SF, MASD, and ADP is included along with considerations for the design of a risk management policy.

Survey course length, survey sensor offset and uncertainty in directional performance are all shown to have a significant impact on the potential maximum deviation from plan. An additional factor considered is the aggressiveness expected when performing recovery operations. An analysis of common drilling scenarios suggests the previously provided guidance of 1.6ft at 1-sigma appears suitable for cases where the directional behavior of the BHA is well characterized and the combination of course length and survey sensor offset is kept to 150ft or less. Longer survey course lengths, larger sensor offsets, or uncertainty in directional performance of the BHA can produce larger σpa values, in some scenarios causing a significant impact on the MASD and ADP.

Previous work has called attention to the uncertainty in drilling to a projection, but up to now there has not been a rigorous method for estimating that quantity. With the methods outlined in this paper well planners and drilling engineers can make more informed decisions on how to ensure safe separation practices in their own operations.