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REVIEW OF INNOVATIVE METHODS FOR WELL SPUD-IN AND RIG POSITIONING IN ULTRA DEEP WATER

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Abstract

Review of Innovative methods for spud-in and drilling rigs positioning in ultradeep water. Every Drilling Rig will move every 2 months, for a new location. whatever the choice of strategy of drilling program (batch drilling or not), for New field development, or when drilling exploration wells, every 45 days / 2months, very expensive drilling units will spend several hours for moving, re-positioning and spud in. Advanced Subsea purpose is to develop a strategy and implement procedures to prepare these moves and complete operation safely, saving a maximum of rig time.
This paper will propose a review of the various methods used for positioning a drilling unit on a new well location, making its DP system ready for operation and performing accurate spud-in.
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1. Introduction

Expression 'Rig positioning' (or Rig move) covers in fact, 2 different operations:
* "anchoring" a rig on top of the new work area, using jacking legs, anchor lines, or dynamic positioning systems
* positioning the drill bit on the seabed for a new well, within required tolerance: "spud-in" operation

Strategy, Means & methods for completing these 2 operations are not systematically the same, depending on the phase of operation
* for anchoring a rig, surface position is the reference,
* for positioning accurately the spud-in point, seabed position is the reference
then, depending on the type of unit and on the waterdepth
* For Jack-up Rig (shallow water) position of the legs is strategic, as the rig will not move once positioned and jacked-up.
* Anchored (physically or dynamically) rig can adjust there position once anchored, accuracy of the spud-in position is the challenge.
* for shallow water or exploration wells, surface positioning fits with accuracy requirement
* for intermediate depth or accuracy, surface and medium accuracy acoustic systems can be used
* for development wells or deep and ultra-deep waters, high accuracy acoustic systems are required.

2. How to improve Rig Positioning Services in ultra deep water?

* <u>support for rig move and reporting</u>
In shallow water, rig positioning services consist of being ready for operation with qualified personnel and calibrated equipment, develop a positioning procedure, quality control plan and provide a well position report. This remainse valid even for a more complex situation

* <u>support to the selection of rigs</u> to be contracted by analysing various rigs DP position reference used, array deployment & calibrations procedure and time consumption,
For deep water operation, rig positioning Service contractors must be in the loop at the early stage of drilling program, because even the choice of a drilling unit, has a large impact on time savings. The kind of DP system

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references, standard rig reference array deployment method, method for calibration of transponders, ROV system in use, tether length, …

* development of specific procedures for the unit in order to guaranty a high level of accuracy and to minimise the time spend for arrays calibration and well positioning.
Once the unit is chosen and the drilling program developed, a specific procedure has to be implemented and approved by all actors: Company, Drilling contractors, HSE, …
Various strategies exist, based on the Position Reference used by the DP system installed onboard the drilling unit:

- DGPS with various accuracy
- USBL (ultra-short baseline), L/USBL (mixed long+ ultrashort baseline) - Sonardyne or Simrad systems
- SBL (short baseline, L/SBL systems, Nautronics RS925
- Underwater GPS Nautronics Nasnet
- Acoustic positioning software capabilities, specific calibration procedures
- Type of transponder: wide or narrow beam,
- Use of additional sensors such as INS (inertial system), RMS (riser monitoring system)

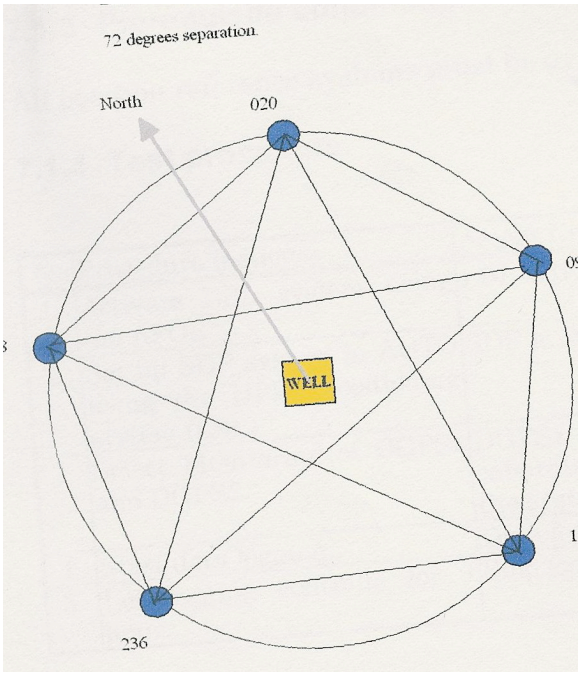
* Implementation of a specific Quality Control activity plan for the unit
As soon as Drilling unit DP reference systems are used for positioning, all parameters used for derivating positions have to be controlled and "calibrated":

- Validity of various sensors calibration datasheet, servicing of the systems: VRU, Gyrocompass, DGPS, transponders, Sound Velocity sensors.
- Check of all offsets versus 'center of rotation' of the unit: DGPS antennas, USBL transducer position, VRU location,
- DGPS health check using a fully independent system: comparison of positions
- DP system gyrocompass calibration and cross comparison: sunshot or GPS-gyro method can be used
- USBL/ SBL system calibration to be checked or performed once a year

* development of an Acoustic Frequency Management plan in order to allocate to any vessel or unit working in the area, within 5 km, a dedicated number of frequency slots (MF,LF) and then to avoid acoustic interferences while drilling

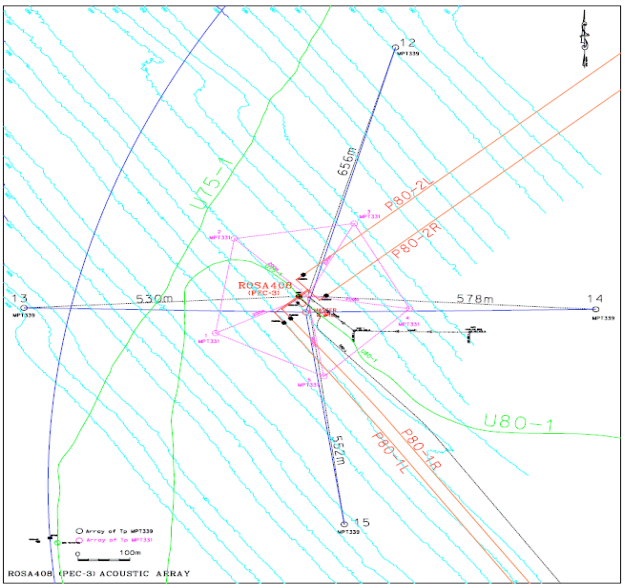
* development of innovative Methods independent of the drilling unit
In this case, additional means or methods are used in order to anticipate the operation and reduce the time of positioning:

- Pre-deployment of transponder arrays for spud-in using another vessel, eventually calibration. The rig will have to calibrate its DP reference array upon arrival.



- Pre-deployment and calibration of seabed reference arrays, which can be used for USLB, SBL or LBL systems. It consists of designing, deploying and accurately positioning a semi-permanent array of stands with buckets for populating with acoustic transponders when required by operation. For field development, this reference array is useful for Construction activity, such as subsea structure installation, cut-to –length calculations, etc… This requires a DP2 ROV support vessel at some stage before the drilling campaign starts.

- Pre-deployment and pre-calibration of acoustic reference system and spud-in array, input of calibrated position of transponder in the DP system upon arrival (feasibility depending on DP Acoustic software features). This requires a DP2 ROV support vessel prior to rig move.



- use of an intervention AUV (Alive or similar) able to be launched from the drilling unit or from a supply vessel using rig crane, to proceed to the new location using inertial and acoustic methods (SLAM), programmed for autonomously deploy and calibrate Rig LBL arrays

3. Synthesis table Savings vs Action

IMPROVEMENT DOMAINS	SYSTEM REQUIRED	INTEREST	RATING
DP CRITERIA IN RIG SELECTION		OPTIMISATION	XXX
RIG POSITIONING PROCEDURE		QA/QC	XXX
ANCHORED RIGS			
* MOORING LINES INSTALLATION	TMS (+USBL)	STANDARD	X
* RIG POSITIONING	DGPS (+USBL)	STANDARD	X
EXPLORATION WELLS:			
* DP LBL ARRAY FOR STATION KEEPING	DGPS+ LBL	SAVE TIME	XXX
* SPUD-IN POSITIONING	DGPS+ SBL/ USBL	SAVE TIME	XX
FIELD DEVELOPMENT WELLS:			
* DP LBL ARRAY FOR STATION KEEPING	DP LBL Array	SAVE TIME	XXX
* ACCURATE SPUD-IN POSITIONING	DP LBL + LBL Georef	SAVE TIME	XXX
* RE-ENTRY	DGPS + DP LBL	SAVE TIME	XX
PERMANENT ACOUSTIC ARRAY	DP2 RS/VESSEL	SAVE TIME	XXX
ACOUSTIC FREQUENCY MANAGEMENT		HSE + INTERFERENCE	XXX

4. Conclusion

The various methods described above, were implemented for Moho Bilondo well drilling, AKPO field development, Rosa & Dalia field development in West Africa. The use of intervention AUV is a Research project.

Note on the author : Jacques SCHOELLKOPF is an Expert in Deep Water Survey Construction Support. He is the President and Founder of the ADVANCED SUBSEA Group of companies, deeply involved in Services, Consulting, & innovation in the domain of Deep Water Subsea operations.
He worked successively with C.G.DORIS, S2O a R&D Company, ACERGY (ETPM), TECHNIP (Coflexip) then with SAIBOS, being in charge for several years of Survey Construction Support for CASTORO OTTO and SAIBOS FDS.
For several years, ADVANCED SUBSEA was involved in survey method development & validation for TOTAL E&P DeepWater projects: Canyon Express (GoM), Girassol (Angola), Matterhorn (GoM), Dalia, Rosa (Angola), Moho-Bilondo (Congo), Akpo, Usan (Nigeria).
Jacques is currently focusing on Advanced Subsea do Brasil development, a new AS subsidiary established in Rio de Janeiro, dedicated to deep water Services of Rig Positioning, Metrology and Survey Construction Support based on AUV.