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Rig Contractor's Best Practices and Lessons Learned for Contractor Owned MPD Deepwater Systems

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Abstract

For many years, the MPD industry was expecting the definitive adoption of the technology by the offshore rig contractor. During that period, rental models were the norm, but the trend is showing definitive signs of rig companies investing in MPD capital as well as preparing their own personnel to run MPD directly.

With equipment that will be permanently installed on the rig, the rig contractors demand the level of technology that will better fit their business model for many years from MPD suppliers. Including capabilities to handle different MPD techniques with the same equipment in an efficient way in the event the project requires quick switches between MPD techniques such as, Constant Bottom Hole Pressure, Pressurized Mud Cap Drilling, and Riser Gas Handling.

The rig contractor is now the owner of the MPD equipment and can offer it directly to the operator company instead of using a third-party service provider as an intermediary. With that said to have an entire MPD independence, the rig crew must be trained properly and comply with the competency system that third parties have demonstrated to be successful in using it during the developing years.

This paper summarizes the practices, lessons learned, and knowledge transfer process that made the rig contractor successful in installing and using the acquired MPD equipment in different areas of the world while at the same time preparing their rig crew to operate the MPD software provided by the third-party MPD service provider.

Introduction

There is firm trend nowadays regarding the MPD deepwater business model that operator companies are welcoming. Instead of dealing with multiple service providers, contracts, logistics, performance management, repair and maintenance, crew competencies, MPD control software development, etc., the market is now guiding towards seeing more and more commercial tenders requiring MPD equipped rigs with a more visible expectation to negotiate and operate directly with the rig contractor.

Since the evolution of MPD equipment, particularly the components designed to be integrated with the rig riser as the Below the Tension Ring Rotating Control Device (BTR-RCD) in 2012, the deepwater rig contractors have also made their business model evolve together with the contractual requirements from the operator companies. From a 100% rental MPD service model for few drillships between 2012 and 2015 until a current (2024) 56% adoption of the global drillship fleet with MPD equipped rig plus an additional 10% of MPD ready rigs (rigs that have surface piping and other modifications ready to receive MPD equipment). These numbers do not include the fleet of semi-submersible rigs, Jack-ups and permanent offshore rig installations that are also showing signs of evolution to the capital sales business model.

The first capital sales of MPD equipment on deepwater was formally dated in 2015 and since then up to today the rental market has reduced and switched to a dominant model of MPD equipment owned by rig contractor, showing today an approximate 82% owned (fully or partially) versus the rest on rental.

In terms of MPD equipment, there is a dominant trend in terms of what the rig contractor can now handle 100% of the design phase to the deployment and operation. This is mainly the equipment located downstream the MPD Integrated riser joint. With the experience gained by the rig contractor on MPD, many different and convenient designs and configurations for downstream equipment (MPD line sizes, bypasses, number of MPD chokes and trims, junk catchers, buffer manifolds, detection systems, redundancies, etc) have been designed and installed. This trend of rig owned downstream equipment is trending to the 90% today and it will not take long before it reaches 100%.

However, the perfect adoption of the MPD technology in the deepwater market is not just about equipment ownership but actually more of an integration of several component like an MPD rig crew prepared with the standards of the specialized service providers through purposely designed MPD trainings, controls systems adapted to the processes that will be handled on the rig by the MPD rig crew, operating and contingency procedures standardization, remote support, repair and maintenance strategies, etc.

From the perspective of a rig provided service that have to endure and continuously evolve in order to be competitive, all the components of MPD previously mentioned have also to be adapted to the many MPD types of applications or variances (Constant Bottom Hole Pressure, Pressurized and Floating Mud Cap Drilling, adapted Riser Gas Handling, and in some cases also Dual Gradient).

The following sections will describe the best practices and lessons learned that three of the most important deepwater rig contractors have been recording, during the adoption phase of the MPD "rig owned and managed" era. Between Transocean, Noble, and Valaris, they cover today around 70% of the market for MPD-equipped deepwater rigs in the world.

Transocean Offshore

Transocean first purchased MPD equipment in 2018, since then they have installed a combination of 20 MPD systems (in between surface pressure-controlled systems and dual gradient), 11 of which are owned by Transocean.

Due to this experience, along with the operators and locations they have worked globally, Transocean have developed a robust MPD specification and integration philosophy. The rig contractor have standardized equipment selection as of 2021 and now install a Transocean designed surface system which covers all scenarios such as flowrates, friction through the system, dual redundancies and PRV philosophies amongst others.

Transocean have experience running and operating four different styles of IRJ across their fleet where TOI takes the lead on the deployment of these systems. Using the experience with previously integrated equipment, TOI have strengthened the approach with regards to MPD procedures, repair & maintenance strategy, and in-house training combined with service providers expertise on their specifically designed system. Alongside the equipment, Transocean have worked closely with a software provider to develop a control system that covers all currently known MPD variations (PMCD / FMCD / CML) and scenarios.

With this full coverage service, which also includes the MPD well planning & MPD onshore and offshore engineering support, this allows them to react swiftly to rig site demands.

In addition to this added coverage, TOI have also streamlined and standardized the MPD procedures throughout their fleet to help reduce confusion and enhance efficiency. Transocean have brought in OEM's, operators, service providers, and technical writers to assist in making these procedures clear and concise and to provide further standardization across the MPD enabled fleet.

This experience has allowed them to mesh the pros and cons from all the available MPD systems on their vessels to provide continuous improvement for the operator company.

The rig contractor is pushing the MPD systems to have greater reliability rates in-line with BOP reliability levels. This is driven by entering into care agreements with the MPD providers to ensure both parties are held accountable as MPD systems now fall under rig contractual obligations. This allows the rig contractor to work in tandem to increase the probability of success. Including this equipment both into their, and external, remote monitoring systems, Transocean is enabling to have further visibility on MPD operations, equipment reliability and any erratic data points that would lead to take the necessary measures.

Along with this monitoring process, Transocean have run maintenance workshops with the OEM's to ensure that the manufacturer recommended maintenance is provided at the proper intervals and followed correctly as per the OEM manuals and instructions. The MPD equipment has been placed into our existing inventory and maintenance system. Regardless of this equipment being operated by the TOI team or the manufacturer, these maintenance points are still entered into the TOI system as we want to ensure the same level of quality regardless of the MPD system set on rental or Transocean owned model.

Transocean MPD equipment is maintained today by a full TOI crew that have been implemented on the rigs where they are fully responsible for operation and maintenance of the systems. This crew consists of two MPD supervisors, two MPD specialists, and one MPD Engineer. These crew members are experienced MPD professionals who have gained MPD experience through many of the different OEM providers. Further to this we also have onshore MPD engineers, MPD equipment SME's and management to allow the rig contractor to further improve their service.

With regards to training, Transocean currently ensure all their drilling team from assistant driller and above are taking the in-house MPD courses they have offered and standardized. This MPD course uses their in-house simulator which has the relevant MPD OEM software system tied into it, so that they can ensure the crew is correctly trained on the appropriate MPD control software to the rig they are assigned. With this, Transocean is currently applying for the IADC accreditation for the MPD course that they will begin offering internally. Additionally, TOI have run operation specific training such as tripping above closed BSR's, AAR's and MPD lessons learned.

Transocean is also implementing desktop simulators to allow for software competency and troubleshooting where TOI personnel operate the control system.

Noble Corporation

Noble currently have ownership of nine MPD systems on their floaters, with no rentals. Their deepwater fleet is continuously growing through merges and acquisitions.). Those mergers and acquisitions combine knowledge and experiences and result in a diverse array of MPD systems.

Noble's strategy and vision is to have the drilling contractor provide a complete MPD service 100% in house. This has been the strategy even through the mergers and acquisitions. Noble is well positioned with experienced crews to manage any MPD system. Noble currently owns and operates the biggest portion of the active MPD equipped deepwater rigs in the world.

The rig contractor have a dedicated MPD SME team in the office, MPD Manager and Technical Superintendents through the Operational Excellence process support the rigs and operations at all stages.

Noble is well aligned with the fact that the deepwater drilling contractors are taking onboard MPD competencies. Regulators, classification authorities, and industry institutions have published requirements and guidelines for MPD, and future high-specification new build designs will include MPD and are likely to be fitted with a system fully integrated into the rig arrangement. The company has embraced for many years to today the future of MPD in terms of the market projection to be 100% managed by the rig contractor. The Noble Valiant was the first deepwater MPD vessel approved by the Bureau of Safety and Environmental Enforcement (BSEE) to operate in the US Gulf of Mexico. The drillship was also one of the first vessels that received the ABS MPD notation recognizing the highest equipment standard onboard.

Noble handle also multiple shallow waters and semisubmersible rigs and they make adopt the same MPD adoption strategy independently from the type of rig. The Noble Lloyd Noble was the first Jack-up drilling rig that received a fully integrated MPD system deployed in Norway and certified by DNV. The Noble Deliverer, upon acceptance from the local regulator NOPSEMA, delivered the first-ever MPD services in Australia. The Noble Developer was delivering the first Controlled Mud Level (CML) MPD services outside Norway. And the list can continue mentioning most of the drilling rigs in the Noble fleet.

The Noble MPD strategy, targets the ability to deliver full-scale MPD services for their clients, where both hardware and personnel will be provided by Noble. Only limited involvement from MPD service companies can be expected, mainly concerning software and other highly specialized matters.

The rig contractor has a dedicated MPD function team, with the objectives of:

- Supporting ongoing MPD operations,
- Marketing support in tenders required MPD services,
- Support of rig upgrade projects with MPD expertise,
- MPD strategy maturing,
- Collaboration with Drilling support on MPD procedures and policies,
- Supporting the development of MPD training programs,
- Building and assessing MPD competencies of offshore employees,
- MPD vendors and service providers' qualifications,
- Participating in industry forums

For the offshore teams operating the MPD equipment, the company use dedicated personnel to provide the most accountability, to operate the equipment efficiently and reliably, and utilize the rig's vast resources. The company deploys MPD personnel where service provider personnel were previously used.

Competency of the crew are addressed internal and external training programs., Noble is pursuing the new IADC MPD accreditation program and will put their MPD personnel and drilling department through it when commercially available. Noble is also applying for the IADC accreditation program in house through NobleAdvances.

Valaris

Valaris also came from the merge between Ensco and Rowan, and with it came a number of drillships with already installed Riser Gas Handling systems. The company proceeded to upgrade big part of their fleet with the Below the Tension Ring Rotating Control Device (BTR-RCD) from the same MPD service provider as well the same MPD control software, having today 100% of the critical components provided by the same MPD service contractor. Valaris strategy goes along with the optimization of the MPD deployment using a single source for the technology, making more efficient and effective the planned rapid growth of the MPD

service by their company as well as the handling of communications through a single focal point, single logistics and unique repair and maintenance program.

Initially, also the MPD crew was 100% handled by the same MPD service provider with the agreement to use the provider internal training and competency program to be extended to the rig personnel assigned to start taking the role to operate the MPD system in a timely manner. At today, many Valaris employees are capable of handling the MPD system by themselves.

The knowledge and competency program transfer from the service provider to Valaris is divided in 3 level (similar to what the other rig contractors have been instructed during the transition stage). Level 1 and Level 2 are classroom training. Level 1 training covers MPD fundamentals, Equipment, software, crews roles and responsibilities, communication protocol and basic well design under MPD. In this stage, the Valaris Drilling Simulator integrated with the MPD provider Control Software is used for practicing the critical procedures. Level 2 Training covers Flow paths, MPD Matrix and MPD Critical Procedures walk through, usually with life practice using a flow loop using similar MPD equipment and the same control software. Level 3 considers the most critical aspects of MPD operations and as performed on the rig during a benign section of a well, the exercises are extremely realistic. This training also improves the communication between MPD operators and Drilling Crew.

From the point of view of an MPD system integration in the vessel, the MPD system is designed such that few minimal changes are performed to the vessel for the MPD system to fit the rig. The advantages of having a fleet of sister rigs extremely facilitates the adoption of the same MPD technology on all of them.

Regarding the common MPD equipment used by Valaris, the MPD system can be broken down into three major subcomponents: Subsea, Surface, and Software and control system. In general cases, the rig contractor has the capability to use all these components from the MPD provider or select each from separate MPD providers and combine them for the best practice.

Subsea component: While selecting subsea component, following selection criteria are important. Length of MPD joint, single lift, pass through rotary, dual redundancy, load handling capacity, reliability of components, and history of the performance for each part/tool. The subsea component majorly consists of a Rotating Control Device (RCD), Riser Gas Handler (RGH)/Surface Annular, 2x divertor lines with 2x valves on each line, swivels, and API 17K Hoses.

Surface Component: The surface component includes return flow distribution manifold, junk catcher, choke manifold, flow detection manifold and pressure relief system. Again, while selecting the surface components, the following criteria are important: dual redundancy, maximum flow rate and cuttings handling capability, discharge of pressure relief system, and controlling and monitoring of all the surface components from Driller's cabin.

Software and Control Component: The software to the MPD control chokes from the information collected from well and rig parameters is the brain of the MPD system. The Software is connected to the hydraulic or electric operated chokes.

Valaris and the MPD system provider have identified the following critical phases at the time of integrating the MPD equipment and control software in their fleet of drillships:

1. Asset Identification: The assets are identified which will require to have Rig MPD ready. Some rigs have existing RGH or Choke manifold and only require remaining components to make it MPD ready rig. Few Rigs have no MPD components and will require complete set.
2. Rig Survey: The rig survey helps to identify the location of the MPD components, structural and electrical modification required on rig to Fit and operate the MPD components. Apart from Rig survey, hose analysis, Riser MPD Joint interface diagram, Draft version of clocking of MPD Joint Flanges with Riser Joint flanges are also performed. All the above reports are then submitted to technical team from the rig contractor and rig operator for review.

3. Project Planner: Once reviewed and accepted, a project planner is created to prepare the specific MPD equipment at the MPD vendors facility and to follow the plan for rig modifications. The planner will provide a start date, end date, dependencies of the tasks and provide an overall timeline of MPD equipment ready in town and ready for operation on the vessel. A Project Manager from the MPD service provider company is appointed who is the focal point of the integration project. Some Projects have dual PM, one from the rig contractor end and other one from the MPD service providers. The Team meets weekly to discuss the project status, roadblocks and resource allocation.
4. HAZID/HAZOP/FMECA: The next process is to perform Hazard Identification (HAZID)/ Hazard Operability (HAZOP)/ FMECA (Failure Mode Effects and Critical Analysis for MPD system). HAZID - An inherent physical, chemical or other source that individually, or in combination, has the potential to cause harm to people, environment, assets, and reputation. HAZOP - is a "guide word examination" in which a multi-discipline team systematically searches for deviations from the design intent. Failure Modes Effects and Criticality Analysis (FMECAs) evaluates how equipment, and equipment components, can fail, or be improperly operated, and the effects these failures can have on equipment performance.
5. Factory acceptance Test (FAT): The Factory acceptance Test (FAT) is performed when individual equipment at the MPD providers facility is ready for test. The FAT is witnessed by 3rd party governing Body DNV or ABS and/or any 3rd party company appointed by Rig contractor.
6. Onshore System Integrity Test (SIT): Once the FAT is completed, all the components of the FAT are connected to perform a SIT in town before shipping the component to the rig. The SIT is witnessed by Rig contractors Technical Team and Contract owner. The SIT helps to identify if there are any system failures.
7. Rig Installation: The next step is to install the Equipment on rig. In some cases, the Equipment needs to be broken down into subcomponents and then moved to desired location and then re - assembled at the final location. At this stage, all the equipment, except Integrated Riser Joint are permanently installed on the Rig.
8. Offshore System integrity Test (SIT): In this test, The MPD Integrated Riser joint is connected to Rig Risers and all the components of MPD Risers are function and pressure tested. All the surface manifolds with interconnected Piping are pressure tested and function tested., This Tests are witnessed by DNV or ABS regulator to provide the required certification that MPD has been successfully integrated and tested on the desired vessel.

These steps above have been followed fand managed together between the MPD service provider and the rig contractor for all the fleet of drillships that now are operating around the world.

The MPD system installed on Valaris drillships requires minimum 5 personnel. 2x MPD Wellsite Supervisor, 2x MPD Panel operator and 1x MPD Field Engineer. Most of the MPD maintenance is provided by the rig personnel. Those roles, initially handled by the service provider are transferred during the competency program to the rig assigned personnel that will handle it once ready to run the function.

1. Roles of MPD Well Site Supervisor: Focal point for rig operations and shored based personnel related with equipment, parts, and crew mobilization. Supervise equipment functionality and application of procedures. Coordinate 24/7 communications with Rig operator, Rig contractor, and third parties. Lead MPD equipment rig up/down, maintenance and repairs. Lead RCD Bearing Assembly install removal and change of sealing elements. Verify flow alignment for each MPD stage. Lead and keep track of PTW/JHAs for MPD operations.
2. Roles of MPD Panel operator: Maintain proper functionality of panels and hydraulic model. Perform calibration of MPD system. Constantly monitor MPD and well parameters for influx, loss, and any other anomaly during the MPD phases. Constantly communicating with driller, MPD Engineer and

WSS. Ensure surface and downhole pressure targets are maintained according to plan. Keep organized daily MPD data.

3. Roles of MPD Field Engineer: Perform MPD hydraulic simulations for planning and execution phases (ECD/ESD, rollovers, surge, swab, provide and maintain updated the MPD matrix/IME, and any other simulation required for MPD operations). Stay ahead on required MPD strategies. Act as an MPD advisor to driller, company man and WSS for strategies to be adopted under MPD to maintain operational objectives on track. Keep daily reporting up to date, including MPD plots and RCD performance.

Valaris continues to progress into the independence of operating the MPD system while at the same time working on upgrading equipment to newer generations provided by the same MPD contractor with the main scope of maintaining competitive advantage through technology.

The role of the MPD service provider today

The MPD service provider is also transitioning. While still few MPD systems available in the market available for rental purposes and managed by the MPD service company and there is also continuity on the training program for rig contractor personnel, newer visions and roles are now emerging in order to continue evolving with the technology. Some of the most important new roles in current development:

- MPD equipment upgrades: Designing and testing new equipment that could be used to upgrade partially or totally an existent MPD system (from the same MPD provider or another). Upgradable system will come better adaptive to rapid installations and easier interchangeability. Standardizing pieces and parts around the existing and future offering in order to reduce the number of parts and orders. Replace older generations with competitive systems.
- Repair and Maintenance (R&M): Investigating, testing, and producing new materials and designs to allow a reduction on frequency of maintenance. New designs of critical components that would allow perform soft maintenance on the rig instead of shipping to shore facilities. Create and operate centers of excellence that will centralize the R&M process, with efficient mechanism to process order, monitor parts delivery and provide excellence on level of service delivery and quality, offering rapid turn arounds and standardized quality deliverables for the same provider's equipment around the world.
- Control software, reliability data monitoring, and real time support centers: the next control software have components of AI, machine learning and adaptability to challenging well and environment conditions, remote control, digital twin, replicability from support centers, integration with other control software from the same service provider existent on the project, extremely efficient processors and other electronic components that would allow not just to control the operation during the well construction phase but also to have predictability function for process optimization and life of components related with MPD and other services. The centers of excellence will also provide support in terms of consultancy (well construction as onsite maintenance and troubleshooting), as well as key performance indicators tracking and MPD well engineering solutions for planning and execution phases. Many of these remote services not just available to the rig contractor but also and maybe mainly to the operator company and regulators.
- Develop new MPD variant solutions or simply the next step after the advanced MPD technology we know today.

Conclusions

Many papers have been written between 2008 and 2010 saying that MPD would have been adopted by the rig contractor the same way as a BOP or a Top Drive was adopted years earlier. The market went through

many changes and challenges until having us to observe the inflection point between rental services and rig managed technology today. A change in the business model that is not just evident on the offshore market but also on the land applications.

The real winners after this evolution in the business model are the operator companies, who now have evidence on how the simplification of the process to contract the service and have a direct and single point of contact on the rig contractor works for the best of the well construction process.

Now that the business model is well established, rig contractors are more independent at the time of operating the systems available in the market, getting proactive at the time of developing tools that will allow them to standardize processes across their fleet of deepwater rigs.

MPD service providers are also evolving into a more rapid transition to more efficient processes for R&M as well as optimization and new development on the components of the MPD technology, promoting rapid and economical transitions and evolutions to more competitive partial or complete MPD packages.

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Nomenclature

BTR	- Below the Tension Ring
CML	- Controlled Mud Level
ECD	- Equivalent Circulating Density
ESD	- Equivalent Static Density
FMCD	- Floating Mud Cap Drilling
IME	- Influx Management Envelope
MPD	- Managed Pressure Drilling
JHA	- Job Hazard Analysis
PMCD	- Pressurized Mud Cap Drilling
PTW	- Permit To Work
R&M	- Repair and Maintenance
RCD	- Rotating Control Device
SIT	- System Integrity Test
SME	- Subject Matter Expert
WSS	- Well Site Supervisor