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Night Shot-Hole Drilling, A New Approach for Successful Completion of Mega Onshore 3D Seismic Survey*

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Abstract

The Partitioned Zone (PZ) is a common prospecting area shared between the Kingdom of Saudi Arabia (KSA) and the State of Kuwait for exploration and production of hydrocarbons, the PZ onshore prospects are operated by the Wafra Joint Operations (WJO) which has recently completed one of the largest onshore 3D seismic acquisition projects. The project was nearly 4612 sq.km surface area inundated with various challenges and possibilities. This surface area is divided into the development western side and the exploration eastern side.

Since the area of operation crossed many different environments, different strategies, geometries, and energy sources were adopted. The eastern half of the survey consisted of mixed geological locations. Transition zones, wet areas, sabkhas, and tidal zones are just some of the environments that led the team to move away from the regular vibroseis operation and adopt explosives as the sources of energy.

Stuck vibroseis and sinking drill rigs demanded that we develop new methods of deployment suitable to such challenges. Hence pilot drill rigs were designed in France and deployed in the field. In addition to the special vehicles (Hagglund) that were deployed to help with the challenging conditions. Once the rigs and the personal were in place the drilling could commence and the team soon realized that the saline water and the compacted hard subsurface layers were hampering the progress and put the completion time of the survey in jeopardy. Hence it was decided that for the first time we would change the drilling strategy and start the drilling operations at night to meet our completion target. To complete the night shot hole drilling process on time without compromising any of the EHS standards the following best practice approaches were adopted:

- Collaboration and synergic operation in day and night shift avoided information gaps and encouraged SIMOPS.

- Advance reconnaissance of the area during daytime and planning by drilling supervisor for night shift.
- EHS document updating for night Shot Hole Drilling (SHD) and training to the crew in accordance with the changes.
- Additional activities incorporated in bridging document and reviewed for risk analysis.
- Onsite maintenance and support from technical crew as well as POL filling through creation of field stage area.
- Fuel supply, water supply, and medical support was vital for this unique operation first time tried in the middle east.
- Use of UV light for bio-hazard and other threats.
- Additional Logistic supports such as Ambulance, water tankers, lighting, and IR/UV interface for field.
- Plan and Strategize for Night SHD Operations and review from all the stakeholders.

Shot-hole drilling night operation was a historical and extremely challenging activity that was completed in time with all safety norms in place and opens a new chapter in the field of seismic data acquisition that can be referred to for future ventures.

Introduction

The Partitioned Zone (PZ) is a common prospecting area shared between the Kingdom of Saudi Arabia (KSA) and the State of Kuwait for exploration and production of hydrocarbons, the PZ onshore prospects are operated by the Wafra Joint operations (WJO) which has recently completed this project of nearly 4612 sq.km surface area inundated with various challenges and possibilities. The area is depicted in (Figure 1) and is divided into NS portions (Figure 2) termed as Development Block in the West and Exploration Block in the East based on the production profile of the prospect areas, oil findings, and presence.

3D Seismic survey was planned for onshore only covering 4600 sq.km of the surface, it was not possible to shoot the area as a single volume and hence the area was further subdivided in to three NS running blocks as shown in Figure 2. Blocks 1, 2, and 3 were divided in such a way to facilitate the operational preparations. General shooting plan is shown in Figure 3, which clearly indicates that the shooting started from Block-1 south and project completed in Block 3 North.

Since the area of operation ran across the open desert, habitat areas, oil fields installations, agriculture farms, nature reserve, wet Sabkhas, and coastal areas, different strategies were adapted to cover the areas selecting different geometries as well as different energy sources. Hence the western block was shot with only vibrators as the energy source while the eastern part was shot with a combination of explosives in the areas inaccessible to the vibrators and the rest of the areas with the vibrators.

Discussion

The eastern part or the exploration block is comprised of mixed geology such as open dry desert, wet areas, transition zone, fringe areas covering Sabkhas, water channels and tidal zones, deceptive sink holes as well as soft near surface crust which was not conducive to the regular vibroseis survey and conventional shot-hole drilling activities. Figure 4 shows the clear demarcation of such features and areas not accessible.

There are many challenges while planning the shot hole drilling operation and the most important one was the selection and deployment of the drilling rigs suitable for such challenging conditions of sinking at the near surface, presence of brackish water in the shot hole, drilling in sandy conditions, and keeping the hole intact for the shooting purposes. Hence drilling rigs were designed in France and deployed in the field. In addition to the drilling rigs, special vehicles were also deployed to operate in such hostile conditions to deal with the challenges of movement across the profiles. Figure 5 shows the drilling rig while Figure 6 shows the other vehicles such as Hagglund etc.

Areas in Block-2 and 3 South were scouted with the help of vibrator to study the near surface characteristics and feasibility studies for possible deployment of Vibrators to maximize the vibroseis points for reducing the cost component as well as faster operations. It was found that the wet patches and the surrounding Fringe areas were deceptive and posed severe threat to the vibroseis operation which is visible in Figure 7.

It can be noted here that along the low, flat and sandy shores, salt flats or Sabkhas have formed in shallow depressions. Due to the high rates of evaporation, salt crusts developed that when the salt is relatively free from sand, have been exploited locally. Under storm conditions, these low-lying areas may be flooded by the sea, which can extend miles inland and are deceptive in nature due to hard surface and soft near surface formations.

Sabkha mapping was done prior to the shot hole drilling plan and was dynamic in process to assess the diurnal variation as well as the seasonal fluctuation of the sea water due to tidal behavior in transition zone areas shown in Figure 8.

Nearly 18,750 shot points were estimated to be drilled after reconnaissance of the area and shot hole depth of 20 meter was decided after detailed charge depth optimization experimentation in the field.

Plan and Execution of Drilling Operations

The main challenge of bringing in the state of the art drilling rigs were over as initially four rigs were deployed to start the work. These rigs needed to drill around 19,000 shot holes of over 20 m depth in the areas inaccessible to the vibrators. These holes needed to be drilled, cased and left for over six months to start the explosive operations from Block 2 south and hence a concrete plane was designed to avoid any production loss at later stages.

Shot hole drilling operation started in the month of February 2015. It was observed that the challenges of subsurface and saline water were affecting the production due to frequent maintenance and breakdown of the drilling rigs they were deployed for the first time as pilots in the field. Hence it was decided to change the drilling strategy and start the operation during the night to meet our targets. This was not a simple decision but had to be executed in a different approach focusing on the EHS challenges in the field which include biohazards and driving fatigues in addition to the lighting on profile.

Night drilling operation could be started in the month of July 2015 which boosted production for shot hole drilling. As per the EHS initiatives, separate EHS wing was created and the following steps (Figure 9) were followed prior to start of the night shot hole drilling operation.

There were challenges of carrying the drilling water to the field as there was no light in the open desert area. This was met with the idea of storing water by making pits and illuminating the area for safety purposes. Later these pits (Figure 10) were filled in by the green team and area maintained to in situ conditions.

Night drilling operation was a routine for the seismic crew and was very well accepted by the workforce. A tool box meeting is shown in Figure 18.

Drilling crews adapted strategy for not bringing in additional workforce but engaging the team in such a way that the resources were optimized and not strained to avoid mechanical as well as emotional breakdown in such a challenging environment. Work detailing was clearly known to each individual on the team and there were no extra hands to avoid chaos during the operation as roles were defined for each individual as shown in Figure 11.

Team of skilled workers were well equipped and trained to deal with the challenges (Figure 12) and were supported by the additional flood light illuminating the area.

Drilling, washing, and casing the drilled shot holes were the three major activities but teams also put maximum efforts to make the rigs operational for the day trips also by cleaning and maintaining the equipment after drilling activities. Some of these activities are shown in Figure 13 and Figure 14 which made it possible for the drilling crew to carry forward the operations without losing time in cleaning and maintenance prior to start of operations which was well appreciated by the stakeholders.

It is quite evident from the above data that only after induction of night shot hole drilling operation, production increase vertically between July and August and later sustained at relatively higher level (Figure 15). This resulted in achieving the timelines prescribed for the drilling operations and completing the explosive operation well in time. Comprehensive data of drilled holes is shown in Figure 16 which illustrates that August onwards; drilling progress was always high in comparison to the earlier months.

Safety, Health, and Environment Compliance

The crew adhered to the stringent safety measures while in operation and followed the instructions to its core. It can be noted that nearly 5 Million man-hours of operation were completed with no recordable incidents. Night drilling supervisor was made responsible under the overall command of the Party Manager and EHS representative and activities as reflected in Figure 17 were observed.

It was clear from very beginning that the operation of this sort needed synergy and collaboration of all to come up with best in the industry while practicing the safety as paramount which was achieved through delegation of work as per strength and core activities (Figure 19).

Safety procedures were implemented as per the following details: Journey management, P.P.E equipment, Maintenance, Man lost procedures, Vehicle requirements, Communication, Medical evacuation, Coordination, and Training (Figure 20).

Conclusion

Shot-hole drilling night operation was a historical and extremely challenging activity that was completed in time with all safety norms in place and opens a new chapter in the field of seismic data acquisition that can be referred for future venture.

Acknowledgement

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Figure 1. Showing Partitioned Zone location in the Area.

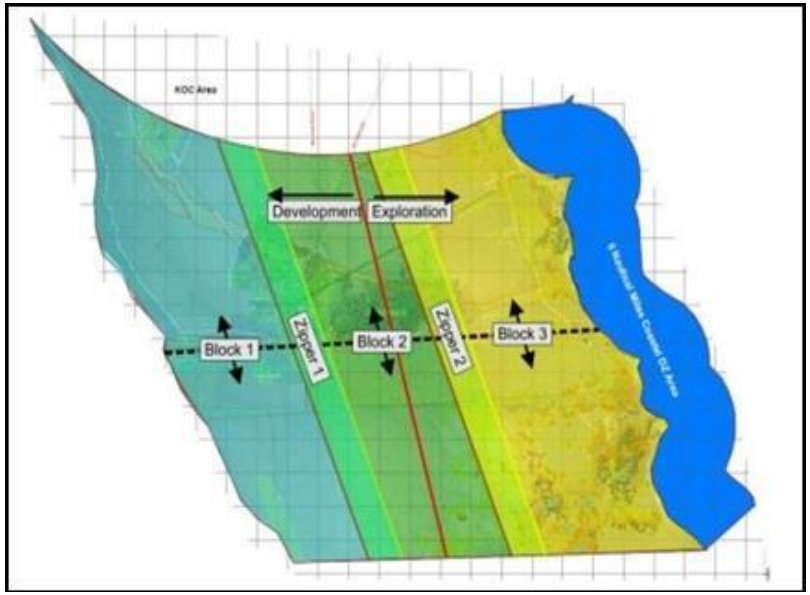

Figure 2. Showing Development and Exploration Blocks.

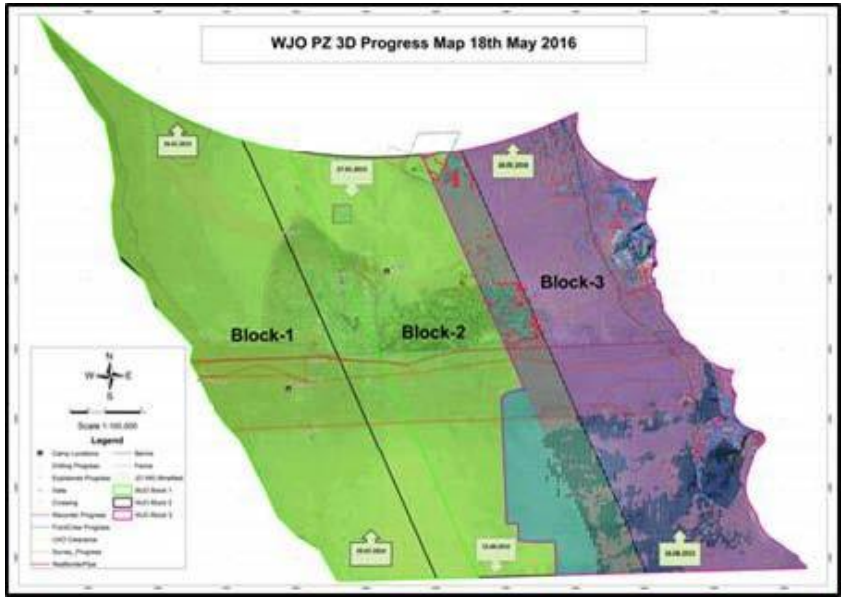

Figure 3. Shooting Progress Map across PZ.

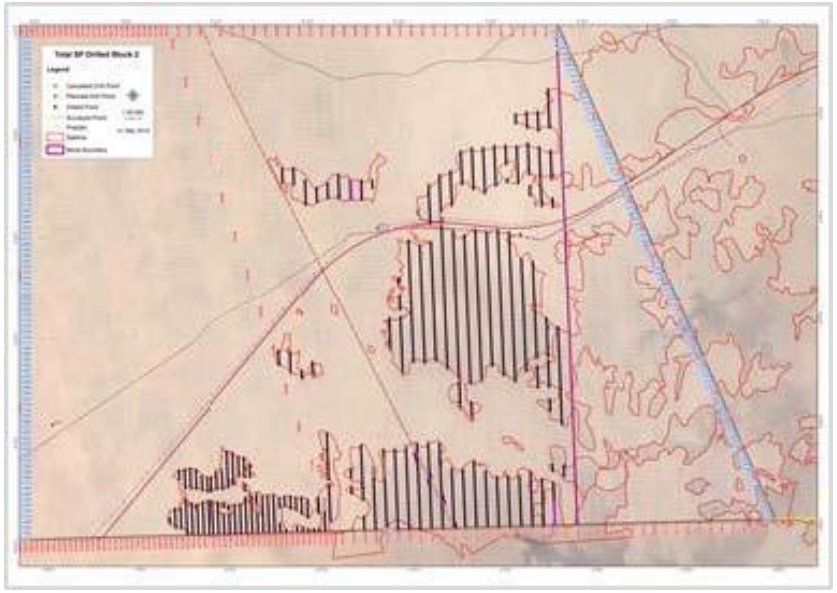

Figure 4. Shaded area shows Shot Hole Drilling activities.

Figure 5. Specially designed SHD rig.

Figure 6. Hagglund deployed in the field.

Figure 7. Vibrators stuck in Sabkhas.

Figure 8. Sabkhas and transition Zone.

Figure 9. Plan and strategy for Night Shot Hole Drilling activities.

Figure 10. Pits for temporary storage of drilling water.

Figure 11. Night Shot-hole drilling in progress.

Figure 12. Skilled workers with head lamp for safety.

Figure 13. Casing being prepared.

Figure 14. Pulling out in progress.

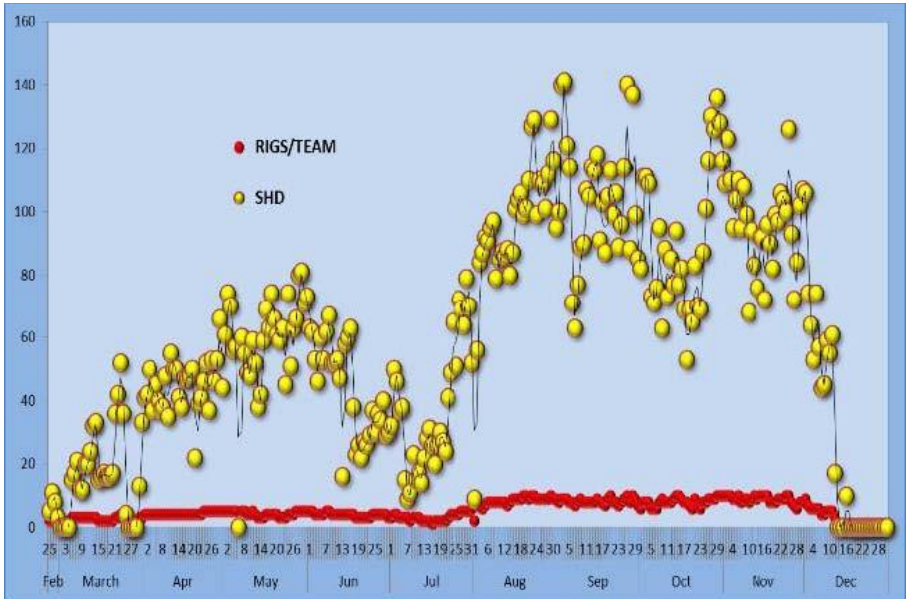

Figure 15. Variation of drilled hole with drill rigs deployment.

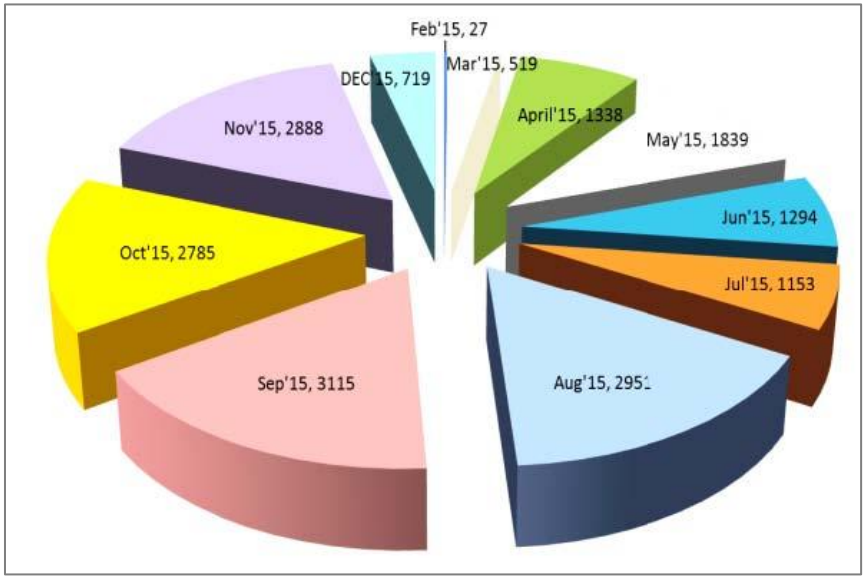

Figure 16. Variation of shot-hole drilled per month.

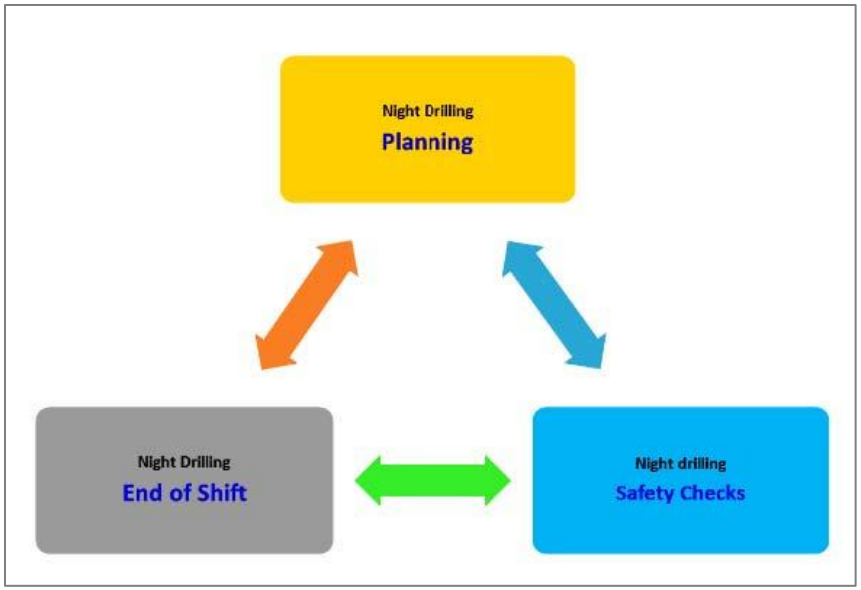

Figure 17. Night drilling protocol and sequence.

Figure 18. Drilling crews meeting.

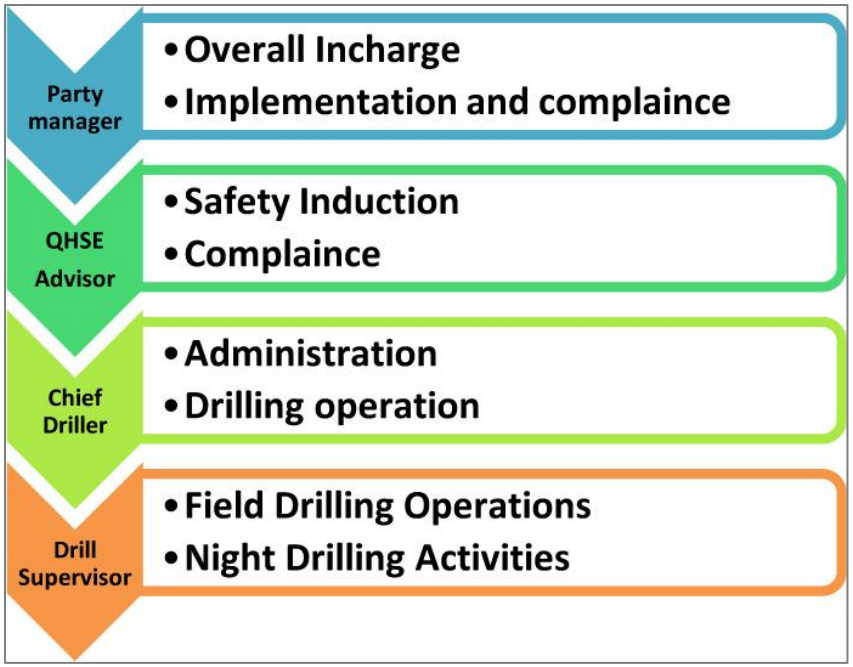

Figure 19. Responsibilities and Accountability.

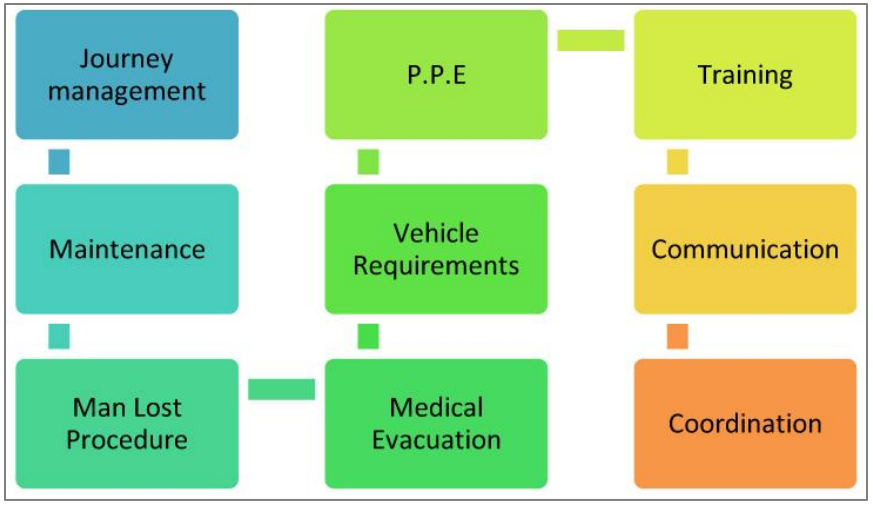

Figure 20. Details of the safety procedures implementation.