International Association of Drilling Contractors

Jack-up Committee
Subcommittee on Installation/Retrieval
October 21, 2014
IADC Offices
10370 Richmond Av
Houston, Tx 77042

Minutes

Mike Dowdy opened the meeting at 1:37 with a welcome to all attendees.

I. GENERAL DISCUSSION

After introductions, safety briefing, and instructions from IADC's Alan Spackman on the IADC policy that discussions should be limited to technical issues. Mike Dowdy and other began an open discussion of the going on/off location subject.

1. ABS has a study for going on/off location which is addressing some of the problems identified as critical to this issue. They have completed an overview of the problem in Phase I and are in the process of doing additional work, funded by FELS, as part of Phase II. Future work on this issue by ABS is deferred until Phase II is completed.
2. It is important that the industry define and prioritize the critical issues before they can be addressed. One example is consideration of design robustness for "Non-Vertical" Loading. This includes consideration of what industry describes as "Transparent Leg". Alberto Morandi offered that some highly optimized leg designs lack sufficient reserve strength against an event that was not explicitly considered in the design process. . It is important to know a design's reserve strength when an event occurs.
3. Jose Vazquez. mentioned that there needs to be clarification of terminology so that we all are clear on the subtle distinctions of when "GoL starts and ends" as in some people's mind, Going on location ends once the legs have engaged bottom and the hull starts to move up, but others include the process of preloading and GoL doesn't end until full airgap is reached. The same goes for pulling out leg vs going off location.
4. Colin Nelson suggested that we need to use the "Right Operating Conditions" in our assessments. This includes rig moves as part of a site assessment. He noted that the drilling contractor should compare how many encounters of the 100-year storm event have actually occurred versus the number of going on/off location. In the latter case the loads from the going on/off location are likely to stress the leg to it design limits. It was also suggested that consideration will be given to having a discussion with liftboat operators for wind farms who have encountered more location moves and storm events that reach design level loads. Finally, a review of rig accidents/incidents during installation and removal (are there similar reports for wind farm and liftboat operations?) may identify additional issues.
5. Currently training in the rig moving process is handed down based on previous experience. Training would benefit from defining critical parameters rather than continue the current "hand-me-down" philosophy.
6. Linda Stacey noted Noble Drilling Services is working on a set of guidance to formalize Noble's Corporate Marine Standards. One of these documents will include a Rig Move Guidance / Procedure.

7. Others referenced guidance in the typical Marine Operations Manuals providing guidance on the operations and capabilities of the jack-up.
8. In preparation for each rig move, Transocean has a rig moving process that includes the following elements:
    a. Rig Move Plan
    b. Risk Assessment
    c. Guidelines
    d. Preloading Plan
    e. OIM and Warranty Surveyor who will be performing the rig move are included in development the plan.
9. It would be beneficial if the participants would share personal "Lessons Learned" from various rig previous moves (should be expanded?). Experiences shared at the meeting:
    a. Maersk noted that unplanned or unexpected events will cause difficulties with rig moves. Freak waves presented a problem for a move in the Bass Straights even though information from nearby wave rider buoys was being used when setting the rig on location.
    b. Henrik Stadsgaard from Maersk experience from studies of motion response for the units found those that were less stiff performed better during installation.
    c. Colin Nelson noted the industry needs a better understanding of the inclined loads on unit during preload (punch-through) and leg pull out. Also, the additional loads resulting from the hull in water attracting wave/current should be considered during penetration/pull-out as this may result in stresses approaching the design loads. This effect is not appreciated by the rig mover.
    d. Colin Nelson noted that going-on is less of a problem than coming off location. This is a result of the need to go into the water with limited ability to determine the seastate at the location which is complicated if there is difficulty with leg extraction.
    e. Steve Nowak noted that rigs with "stepped leg wells" affect the performance of the rig as the rig moved on location.
    f. Warren Weaver noted that too often there is careful planning but when the rig is ready to move, there is a new rig manager and/or the rig mover. In too many cases the OIM or rig mover shows up the day before and these people have not been part of the process.

II. Identification of Critical Issues

The meeting identified those issues the participants believed to be critical. The following summarized the discussion into categories. An attempt was made to capture all critical issues presented during the discussions. No attempt has been made to determine if a consensus exists for a particular issue or to prioritize any issue unless such opinion was made during the discussion. Clarification of a particular issue is only provided where it is believed to be beneficial.

1. General:

    The only class society that currently provides any guidance on going on/off location is DNV which provides a method for evaluating the leg when touching down. This guidance is generally believed to be conservative due to assuming very stiff foundation. The going on/off location is a more common design condition than the severe storm event. For this reason, class rules should include Going on/off location as part of classing a rig.

Rig move procedures and associated risks should be planned in anticipation of all moves. Consideration in the rig move procedure should include consideration of the current or future location. For example, rigs which are currently located adjacent or moving next to the platform should be treated differently than those in open water locations.

It is important to know the motions of the rig and the effect these have when going on location to have a better understanding of the loads applied to the system

The primary rig move considerations fall into 5 Categories

- Location risks (e.g. platforms)
- Seastates (Wave Loads on Hull)
- Hull Inclinations
- Leg – Guide Support Structure / Systems
- Bottom / Foundation Hardness

2. Definitions: One problem found during the development of a rig move procedure is that no common set of definitions exist between the parties. This leads to confusion between stakeholders. Therefore, a common set of definitions is needed so all parties (the drilling contractor, operator, assessor, and marine warranty surveyor) have better understanding of the rig move process, procedures, risks, and the procedure developed.
3. Communications:

   Many problems associated with rig moves may be solved with better communications between all parties involved in the move. Improved communications is something all contractors can implement now.

   Operators need to have an understanding of the limits of the unit moving to/from their location. This requires well defined parameters and procedures for the particular rig design be developed and understood by all parties participating in the move. Arbitrary variation from this procedure, such as moving onto a location outside of the rig move procedure, should not be suggested or required of the rig owner.

   The rig mover, warranty surveyor, and OIM who have participated in the development of the rig move plan should be the ones that execute the plan. One problem that can affect a rig move is that after careful planning, when the rig is ready to move, a new rig manager and/or the rig mover will be responsible for the move but they have had not participated in the development of the rig move procedure. This situation is complicated further when this rig mover/OIM arrive shortly before the move.

   The Marine Operations Manual should be followed. There are too many instances where the OIM or Rig Mover, for example do not preload to the required level, follow the MOM or location requirements.

4. Seastate

   A need exists to have real-time knowledge of seastate at the location during installation/leg extraction. The use of instrumentation may be used to improve the understanding of the seastate.

   The rig move plan should account for wave/current loads on hull.

   Swell areas present problems for rig moves. Where swells occur a correct and accurate understanding of the effect of wave and swell on the response of the unit and the resulting induced loads is essential. In areas like eastern Canada the swell combined with seastates exacerbates the problem with putting a rig on a location.

5. Structural Issues

   Issues that affect the structural modeling of the rig move need to be defined and shared with designers, class society, and marine warrantee companies. A Sample of the issues are described below:

   a. Structural Model
      - Jacking System Stiffness/Capacity;
        - The jacking system will experience both elevating loads and installation loads simultaneously.
        - Modeling gear train stiffness for going on location is different than for elevated analysis. However, no guidance is available as to how this should be addressed.
        - Pinions may experience low vertical loads but high horizontal loads.
        - An understanding of the robustness of system for non-vertical load is critical to properly model the jacking system.
      - Leg/Guide Support System
        - Number of legs
        - Types of guide system (Opposed versus unopposed).
        - Leg stiffness (axial, bending, shear)
        - The length of leg below the lower guide (deployed leg)
        - The relative position of the spudcan center at the seabed to the jack-up leg center at the guide should be considered. Guide clearance and maintenance will have an effect on this value.
      - Dynamic Considerations;
        - Natural periods; as the rig is going on/off location as it transition between elevated, partially elevated, and afloat the natural period will undergo a change.
        - Added mass
   b. Legs
        - Accelerations when spudcan touches down (tagging bottom)
        - Damage to Horizontal & Diagonals during leg extraction for deep penetration from soil on top of the can
   c. Spudcan
        - Shape
        - Uneven spudcan support from sloping seabed or previous footprint interactions
   d. Hull
        - Hull motions
        - Inclination
        - Hull shape (e.g. for three/four leg, stepped leg wells)

6. Soils
   a. Properties for analysis are critical for determine the capability of the unit.
   b. Soils information that is developed for the going on/off location condition needs to be defined. As with site locations studies for the elevated condition, the quality of the soils data is unknown. Geotechnical studies may not be available for the location where the rig is to be elevated or no geotechnical data has been collected. Soils studies are performed for other

purposes than the rig move operation. The soils data collected is not suited to for determining leg extraction.

c. Soil stiffness (normally consolidated clay to stiff soils) affects the results.
d. Modeling issues, such as deceleration during punch-through, complicates analysis.
e. Deep penetration (pulling legs)

III. PRESENTATIONS

3Dent Technology's Jose Vazquez presented results from studies they have performed for going on location. This study is comparable to another going on location study by Rowan on their Gorilla unit in that it shows a concave up curve of permissible wave heights vs period. A summary of the presentations that captures the high points is included below.

As of the date of the presentation, 3DENT has performed going on location analyses on 10 jack-ups or liftboats. 3DENT has developed two methodologies for going on location analyses using regular or random waves. The study used the simplified method and focused on a study of four jack-ups and one liftboat for single location (i.e. specific water depth, and soil condition). The study accounted for hull shape, pinion stiffness/capacity, jacking speed, and spudcan shape.

In performing the study three types of analyses were performed.

1. Frequency-domain diffraction analysis (WAMIT) to calculate the wave load and dynamics on the system model.
2. Structural analysis (SACS)
3. Time-domain response analysis (OrcaFlex) for motions and spudcan loads during installation from jacking.

Simplifying assumptions used in the analysis included:

1. Time domain simulation using regular waves over a range of wave periods
2. Simplified method were used to address wave forces on the hull
3. Soil strength increased linearly over depth
4. Moment in leg was determined by shear magnification
5. Stiffness of elevating system was assumed to be equal to the elevated condition.
6. Similarly, the pinion capacity was assumed to be equal to the elevated case.
7. Lateral loading of spudcan is estimated from the FEA analysis performed
8. Damping ratios also were estimated from the FEA analyses
9. Critical direction was selected to simplify analysis
10. The analysis did not take into account effects of penetration

Included in the study was a sensitivity analysis of the following:

1. "Apparent friction coefficient"
2. Water depth
3. Spudcan size
4. Damping ratio

The conclusions based on the results that included spudcan shape, soil stiffness, and jacking speed are:

1. The use of single limiting wave height or angle is too restrictive.
2. Permissible wave heights versus periods may be developed. These curves follow the shape from motion as shown in RAOs. Some findings from these curves are:

a. At low periods heave and pitch are small, therefore permissible wave height is large and the associated rig angle small.
b. At intermediate periods (below pitch natural period), pitch RAO increase and heave RAO is either flat or increasing, therefore permissible wave decreases and associated permissible rig angle increases.
c. When the wave period is greater than natural period, pitch RAO decreases and heave RAO is flat. Therefore, permissible wave height increases and rig angle decreases
d. At very high periods pitch is small and heave RAO approximates 1. The permissible wave is therefore flat.

Mike Dowdy presented some results from a going on location study by their engineering group for a Super Gorilla unit that demonstrated comparable trends, with the notable exception that at the higher periods, the curve did not flatten out. There was uncertainty as to whether or not the study by ROWAN included heave effects or just rotations.

IV. RECOMMENDATIONS

It was again noted that the industry needs to provide input on the critical parameters to be considered and assist designers by defining issues needed to be included in original design process. The problems experienced when going on/off location need to be addressed during the design phase and this information needs to be available for the owner (Q: should a separate MOM focused only on rig move operations which includes installation/retrieval be considered?).

Waiting on weather is a known problem associated with the rig move and industry would benefit from an understanding of the limits of the contractors units.

The design of rigs should be expanded to included load cases that address the going on/off location requirements. Two examples of conditions that should be included are 1) inclined cases and 2) preloading or leg extraction with the hull in the water (B.N.; In addition to the analytical evaluation of the jack-up consideration of the condition at the leg guide at the time of the move should be included. Where damage has occurred or worn guides may be the more significant problem.). Colin Nelson recommended class requirements include these and other similar conditions in addition to the elevated operations currently required when a design is reviewed. The current available guidance defines the limits without consideration of the "end user" resulting in difficulty going on location and damaged rigs. This is unacceptable to industry.

When going on/off location we need to have a good understanding of Sea State at the time and also effective tools to measure that seastate. Available tools are:

- Weather service
- Nearby wave rider buoys or instrumentation on platforms
- Look-down "infrared" sensor Infrared for wave information
- Instrumented rigs

It may be possible to use accelerometers to measure real-time rig motions. This information then would be useful in assisting in moving a rig onto location.

It was suggested that a guideline, which would be less prescriptive, would be better alternative than a standard. A benefit of the guideline is improved analysis methods are needed before a standard can be considered to allow the user to better understand the rig move limits. A guideline would allow the

flexibility to improve the analysis methods. Mike Dowdy suggested that a guideline should consider the use of rig design dependent curves which address soil parameters for multiple water-depths.

V. CONCLUDING DISCUSSION;

Collin Nelson wanted to emphasize that the focus of industry should be on the areas that have the most effect on rigs going on/off location. These are summarized again in these notes as follows:

- Wave Loads on Hull including heave
- Hull Inclination
- Leg/Guide (support system)
- Bottom Hardness
- Open Location versus next to platform
- (B.N. by DRL: Robustness for Punchthrough is another concern)

Colin also suggested that the consulting community could develop the analyses tools to evaluate critical rig move issues and then test the tools against actual rig moves.

The meeting concluding discussions center on several options. A suggestion was offered that we should consider developing Rig Moving standard for industry use. A consensus was clear that it was too early for a standard or a guideline as the critical issues and consensus of which issues should be included in a standard are not clear. All agreed that the participants in the meeting represented a broad range of the interested parties with the expertise to develop the standard. The group further agreed that this group should drive the development rather than allow a third party, without the industries experience and expertise, to define the actions that must be followed.

Mike Hoyle noted that this issue has been raised in several ISO meetings and also by CSA (Canadian Standard Association) in the past two years. Industry has a desire to have something and if they perceive that industry is just delaying the process then ISO will develop a standard which may not reflect the industry's experience and expertise.

Mike Dowdy advised the group of the need to provide funding for the analysis and studies to define how critical issues can be addressed. While it was agreed funding needed to be provided the discussion of this subject was limited.

VI. REFERENCES:

Those documents that are available to the public will be posted on the IADC jack-up committee website under the resource folder.

1. HSE information sheet; "Jack-up (self-elevating) installations: floating damage stability survivability criterion, Offshore information Sheet No 6/2007 (Rev 2009)
2. Review of the Jack-ups: Safety in Transit (JSIT) technical working group", HSE Research Report 049, by BMT Fluid Mechanics Ltd, 2003
3. "Guidelines for the Selection and Operation of Jack-ups in the Maine Renewable Energy Industry; Issue 2: 2013; published by Renewable UK
4. Rules and Regulations, Standards and Guidelines Governing; The Offshore Drilling Industry in Norway and UK Waters
5. IADC, "General Ocean Tow Recommendations for Jackup DrilLing Units", February 13, 1991
6. "Guidance for the Positioning of Dynamically Positioned (DP) Jack-up Vessels on and off the seabed", International Marine Contractors Association, IMCA M223 – April 2013