Guidance for

The Positioning of Dynamically Positioned (DP) Jack-up Vessels On and Off the Seabed

International Marine Contractors Association

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1 Aim and Introduction

1.1 Aim

The aim of this document is to provide the owners and operators of dynamically positioned (DP) jack-up vessels with guidance to create procedures for going onto and leaving location.

1.2 Introduction

A DP system interfaces with the vessel's propulsion systems to hold the vessel in position against external forces that are acting to move the vessel.

For DP vessels with jack-up capability – when a vessel moves into position on DP but intends to undertake the work on location as a jack-up vessel – there can potentially be excessive stresses induced into the legs during the transitional period from being on DP to leg touchdown to soft pinning of the legs. The first leg contact with the seabed will restrict the vessel's motion which may indicate a position error to the DP system. This could then lead to an increase of thrust of the vessel's positioning propulsion systems and consequently may impart these excessive stresses on the legs.

2 Risk Analysis

The data and risks to be considered when entering and leaving location can be, but not be limited to, the following:

- Vessel characteristics
- Environmental conditions
- Site specific assessment integrity
- DP specification and performance

2.1 Vessel Characteristics

The jack-up vessel may be either a barge or a ship shaped vessel and have three or more legs that can be mechanically extended to the seabed to lift the vessel above the sea surface. However, whatever the shape of the vessel, when it is in DP operation with the legs in the raised position the centre of gravity of the vessel is much higher than when the legs are in the lowered position. This alters the vessel's stability, affects its motion behaviour and changes the DP performance.

The leg jacking speed of the vessel should be well documented and should be taken into consideration. This can help determine how long the vessel will be in the transition phase between DP operation and leg touchdown to soft pinning, when the DP system can be shutdown.

2.2 Environmental Conditions and Loading

During leg deployment there can be changing environmental forces that influence the vessel's position and consequently the DP system will respond by applying more or less thrust. When the legs are about one metre above the seabed the DP system should be given a settling time to ensure that the DP computer model has acquired these new forces and that vessel position is steady.

Leg designs can be either lattice or solid construction. When propulsion and environmental forces are put upon them, both of these designs can produce different effects on the vessel.

The vessel's DP capability plots should indentify the maximum environmental operating conditions under which vessel position can still be maintained when operating. The worst case failure should be identified for the vessel and used as a basis for determining the weather capability suitable for DP/jacking operations. For information on DP capability plots, reference should be made to IMCA M 140 – *Specification for DP capability plots*. The vessel should be operated so that it will not lose position in event of worst case failure. One method of monitoring this can be the use of the DP system Consequence Analysis function.

2.2.1 Wind

Jack-up legs can be very large structures that can significantly contribute to the overall wind forces that are imposed on a vessel. Wind forces on the vessel may change as the legs are lowered or raised. When in DP mode and lowering of the legs commences, the DP system should recognise this gradual wind force change and compensate the DP system and vessel position accordingly.

2.2.2 Sea State

The vessel should operate within the designed parameters set for certain environmental conditions.

2.2.3 Current

As the legs are continually extended below the hull the current has more area upon which to act. This current force increases with leg lowering. The DP system should recognise this gradual current change and compensate the DP system and vessel position accordingly.

2.3 Site Specific Assessment Integrity

2.3.1 Site Specific Assessment

The site survey, including bathymetry, is required to provide the vessel Master/DPO with the necessary information which should assist in defining the position, boundary and characteristics of the location which should determine the suitability of the site for the operation of a jack-up vessel.

A foundation assessment is required where the vessel is to be jacked-up above the sea surface.

For guidance on site specific assessments refer to Society of Naval Architects and Marine Engineers (SNAME) Technical and Research Bulletin 5-5A, latest revision, "Site Specific Assessment of Mobile Jack-Up Units".

2.3.2 Nearby Structures

The vessel's work site is often in close proximity to other structures such as wind turbines, other support vessels and/or oil and gas platforms. These structures need to be taken into account especially when moving away from location where newly installed structures such as wind turbine monopiles may be extremely close to the vessel.

2.4 DP Specification and Performance

2.4.1 DP System

There are various DP system manufacturers who provide bespoke software to handle the period when specific operations are carried out by a DP vessel, for example, moving from DP to soft pinning the legs, jacking up and eventually switching the DP and propulsion systems off. One system uses an 'auto freeze' option which locks the environmental forces upon sensing seabed contact.

IMCA recommends that any sensing equipment for detecting seabed contact should have redundancy and be treated to the same design and testing standards as the DP system.

Lowering of the legs has been shown in some instances to interfere with the acoustic positioning system. There also may be an issue with the legs interfering with the satellite signals being received by the differential global positioning system (DGPS). It has been reported that the problem usually transfers from the DGPS to the acoustic system as the legs are lowered. Operators should be aware of the positioning of the acoustic beacons to take into account the deployment and final position of the lowered legs. The use of a third reference system (e.g. taut wire) can assist reference system cover if any other reference system drop out is experienced.

3 Background Material

3.1 Company Procedures

Companies operating DP jack-up vessels will need to develop company procedures for vessels undertaking DP and jack-up operations. These should be based on the above risk analyses and may contain the following:

1. Crewing requirements – For DP training, reference should be made to IMCA M 117 – *The training and experience of key DP personnel*;
2. Company communication procedures;
3. Company's preferences for operations;
4. Management of change procedure – IMCA has developed generic guidance for managing operational change: IMCA S&L 001 – *Guidance for the management of change in the offshore environment*;
5. Company's checklists and trials – Checklists are an integral part of quality assurance systems. They are to provide consistent actions and ensure that nothing is overlooked. Checklists should be regularly reviewed;

   Example checklists that are used on a DP jacking vessel are as follows:

   - Field arrival checklist (bridge) – This is to be completed when the vessel arrives on location or when the vessel has moved onto a new location. This checklist normally verifies that the DP system including references and propulsion units are available and selected;
   - Field arrival checklist (engine room) – This is to be completed when the vessel arrives on location or when the vessel has moved location. This checklist normally verifies that the propulsions systems are running and available for use, that standby pumps are on automatic start and all machinery spaces have been inspected. The bridge should be informed when this checklist is complete;
   - Six-hourly DP checklist – This should be completed every six hours when the vessel is on DP for extended periods. This checklist should have a bridge and engine room version and should be completed by the oncoming watchkeeper so he is aware of the operational status of the vessel before he takes over any operational duties;
   - 500 m approach checklist – This should be completed before the vessel enters within 500 m of the offshore structure;
   - Pre-jacking DP checklist (bridge) – This should be completed before jacking operations to confirm that the DP system is set up properly. This can be used for either jacking up or jacking down;
   - Pre-jacking DP checklist (engine room) – this should be completed by the engineers to confirm that the jacking and DP systems are operational prior to commencing DP operations. This can be used for either jacking up or jacking down.

3.2 Vessel Procedures

A company operating a DP jack-up vessel will need to develop an appropriate vessel procedure for going on and leaving location. These procedures should be based upon the vessel specifications (dimensions, performance, power, thruster configuration, DP system installed and the configuration, leg configuration, spud can details, jacking speed, jetting capability, crewing, etc.)

These procedures may contain the following:

1. Environmental limits for the vessel (wind, wave, current, storm surge);
2. Water depth limitations;
3. Acceptable limits for seabed soil characteristics (soil's capability to allow jacking to occur, have acceptable leg penetration without punch through and have the ability to remove the legs);
4. Step-by-step vessel and leg manoeuvres;

5. Vessel procedure for combined jacking/DP based on company and vessel requirements;
6. Emergency response.

3.3 Information for Each Location

The company operating the DP jack-up vessel should use the vessel procedures and information for each location to create a procedure for going onto and leaving each specific location. The vessel should have activity specific operating guidelines in place for the operation and the location.

Data for each location data includes:

1. Date and duration at the location;
2. Weather criteria for the location;
3. Water depth and soil characteristics for the location;
4. Knowledge of:
    a) tasks to be performed at the location
    b) SIMOPS – for guidance on SIMOPS refer to IMCA M 203 – *Guidance on simultaneous operations (SIMOPS)*
    c) activity specific operating guidelines – for guidance on operational activity planning refer to IMCA M 220 – *Guidance on operational activity planning*
    d) field layout (other structures)
    e) knowledge of previous jack-ups which operated on the location and seabed disturbance from their spud cans
    f) client requirements:
        i) location accuracy
        ii) procedural process
        iii) communications.

4 Procedures for a DP Jack-up Vessel Going on and Leaving Location

4.1 Procedure for a DP Jack-up Vessel to Go on Location

The following should be considered in developing the procedure:

a) The environmental conditions and forecast should be reviewed and be within the safe operational limits as defined by the vessel procedures. No DP operations should take place in wind or current combinations where the vessel's DP capability plots show that the worst case failure would lead to loss of station keeping ability. Tidal current analysis should be available to the dynamic positioning operator (DPO). This is important as when the legs are being lowered they may pick up current drag.

b) Checklists and permits should be completed as defined by the vessel procedures.

c) Communications – All communication methods that are to be used during operations should be tested in addition to the emergency communication equipment. This should be defined by company and vessel procedures.

   Standards of communication in offshore projects vary and are often not uniform in style, resulting in some confusion and communication difficulties. Poor communication can cause misunderstandings and misunderstandings cause accidents. For guidance on communications refer to IMCA M 205 – *Guidance on operational communications*.

d) Personnel at stations – All personnel involved with the operation should be available at their relevant station.

e) Set-up of DP system – DP should be set up as defined by the vessel procedures. DP capability plots show the calculated station keeping ability of the vessel in various situations. However, the ability to hold station at any time will also depend on the combined state of the sea, swell and current.

f) Transit to location (speed) – The vessel's speed to the location should be in accordance with the vessel's procedures.

g) Lowering of legs should commence as defined by the vessel procedures.

h) Arrival over exact location for vessel's task. Check and verify the position using the relevant equipment.

i) Further lowering of the legs as defined by the vessel procedures should continue. The DPO should pay very close attention to the DP references and the position of the vessel and allow the DP system time to fully stabilise. Further adjustment of DP – When the legs are positioned the correct distance from the seabed as defined by the vessel procedures, the DP configuration should be selected as defined by the vessel procedures that may, for example, put the DP system into freeze current mode or low gain mode.

j) Agreement from all relevant persons to soft pin the legs as defined in the company procedures.

k) Soft pinning the legs and turning off DP – When the vessel's legs penetrate the seabed, the vessel is then effectively moored on the legs. As soon as it becomes obvious that the DP system is not required anymore for position keeping, the DPO can select manual joystick mode keeping all thruster propulsion at zero thrust. At this stage it is important the DP system keeps the DP model, in case the vessel has to transfer back to full DP mode during the initial stage of soft pinning of the legs.

l) Checking of location – The correct location should be checked and verified by all those concerned.

m) Raising of hull, pre-loading and switching the DP system off should be as defined by the vessel procedures.

4.2 Procedure for a DP Jack-up Vessel to Leave Location

The procedure should contain the following:

a) The environmental conditions and forecast should be reviewed and be within pre-defined safe operational limits. Tidal current analysis should be available to the DPO. This is important as when the legs are being raised they may lose current drag.

b) Vessel's route away from location agreed by the relevant personnel.

c) Checklists and permits should be completed as defined by the vessel procedures.

d) Communications – All communication methods that are to be used during operations should be tested. This should be defined by company and vessel procedures.

e) Personnel at stations – All personnel involved with the operation should be available at their relevant station.

f) Set-up of DP system – DP should be set up as defined by the vessel procedures.

g) Lowering of hull into water (raising the legs) should commence as defined by the vessel procedures.

h) The extraction of the legs from the seabed should commence following the defined vessel procedures. Ideally the extraction of the legs should be carried out in a drift off situation.

i) Moment that the vessel becomes a free-floating vessel again (DP transition) – When the pre-defined clearance above the seabed is reached, giving the vessel enough clearance to move, the propulsion systems can be engaged, ensuring that there is a zero resultant force on the vessel. The DPO and vessel Master should be aware that large thrusts by the vessels propulsion systems can potentially result in damage to the legs or nearby structures.

j) Takeover of vessel positioning in manual control by joystick as defined by the vessel's DP procedures.

k) Transit away from location – The use of auto DP mode is not recommended when transiting from location. There may not be sufficient time to build up the vessel's DP mathematical model with the legs still down. The vessel should continue to be moved away from the installation in joystick mode until in a pre-defined safe area. Full auto DP can then be selected. The DPO should always be aware of the depth of the legs and not exceed the maximum allowable forces on the legs (maximum speed). This information may be available on the DP system.

5 References

IMCA S&L 001 *Guidance for the management of change in the offshore environment*

IMCA M 117 *The training and experience of key DP personnel*

IMCA M 140 *Specification for DP capability plots*

IMCA M 203 *Guidance on simultaneous operations (SIMOPS)*

IMCA M 205 *Guidance on operational communications*

IMCA M 220 *Guidance on operational activity planning*

IMCA S 009 *Guidelines for the shared use of DGPS for DP and survey operations*

IMCA S 012 *Guidelines on installation and maintenance of DGNSS-based positioning systems*

IMCA S 015 *Guidelines for GNSS positioning in the oil & gas industry*

IMCA S 017 *Guidance on vessel USBL systems for use in offshore survey and positioning operations*

IMCA S 018 *Guidance on the selection of satellite positioning systems for offshore applications*

UK Health and Safety Executive – Guidelines for jack-up rigs with particular reference to foundation integrity

Society of Naval Architects and Marine Engineers (SNAME) Technical and Research Bulletin 5-5A, latest revision, "Site Specific Assessment of Mobile Jack-Up Units". This bulletin contains four documents:

- T&R5-5 – "Guideline for Site Specific Assessment of Mobile Jack-Up Units" (First Edition – May 1994)
- T&R5-5A – "Recommended Practice for Site Specific Assessment of Mobile Jack-Up Units" (First Edition – Rev 2, January 2002)
- Commentaries to Recommended Practice for Site Specific Assessment of Mobile Jack-Up Units (First Edition – Rev 2, January 2002)
- Example ("Go-By") Calculation Using Recommended Practice For Site Specific Assessment of Mobile Jack-Up Units (Preliminary Issue – May 1994).