

HSE information sheet

Jack-up (self-elevating) installations: review and location approval using desk-top risk assessments in lieu of undertaking site soils borings

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Introduction

This information sheet provides guidance on when a desk-top risk assessment may be undertaken in lieu of a detailed geotechnical site investigation. It also details the requirements for such an assessment.

Before a jack-up can be moved to a particular site to undertake a programme of operations, a site-specific assessment of the integrity of the structure and its supporting soils needs to be undertaken. This requires site-specific soil data to be gathered and analysed. Normally this information is obtained by the client hiring the jack-up, usually by undertaking a geotechnical site survey including one or more soil borings. In a limited number of circumstances information gleaned from nearby boreholes, allied with other intelligence on the site soil conditions, may be used in a desk-top risk assessment in lieu of undertaking a site-specific boring(s).

Background

The Offshore Installations (Safety Case) Regulations 2005 (SCR05) Schedule 6 Part 10 Para a(iii) requires particulars of “*the properties of the seabed and subsoil*” to be included in the notification of well operations that must be sent to HSE prior to operations commencing. This would require, as a minimum, sufficient information to be able to estimate the likelihood of sudden penetration during the jacking process and the overall suitability of the jack-up structure and the soil supporting it during operation.

HSE has received several well notifications involving jack-ups, for which no soil boring has been undertaken at the site that the jack-up is planned to operate. Instead, a desk-top risk assessment has been undertaken using information from various sources. This approach is permitted in the industry practice captured in SNAME T&R Bulletin 5-5A¹, and the draft of the ISO Standard² that is currently being developed. However, neither of these documents gives clearly defined criteria for when such an approach is reasonable. The Oil & Gas UK document describing the conduct of mobile drilling rig site surveys³ also provides guidance on the need to obtain soils data from a borehole and/or cone penetration equipment.

There are a number of potential hazards associated with the foundations conditions that should be considered in a risk assessment undertaken for a jack-up prior to moving it on to a particular site. These require varying levels of knowledge about the near and sub-surface soils characteristics in order to draw conclusions with sufficient confidence regarding the acceptability of the risks. The SNAME T&R Bulletin 5-5A provides a list of foundations hazards, and the means by which information on the site conditions can be obtained in order to assess the associated risks. The hazards include, but may not be limited to:

- punch-through;
- settlement under storm loading / bearing failure;
- sliding failure;
- scour;
- seafloor instability (mudslides);
- shallow gas;
- faults;

- metal or other debris, sunken wreck, anchors, pipelines, etc.;
- local holes (depressions) in seabed, reefs, pinnacle rocks, wooden wrecks, etc.;
- footprints of previous jack-ups;
- spudcan-pile interaction; and
- leg retrieval during moving off location.

The information obtained from site soil borings contribute to assessing the risks associated with punch-through, scour, settlement under storm loading / bearing failure, sliding failure, seafloor instability, and difficulty in retrieving legs during moving off location.

Jack-up Suitability on Location

The duty holder must demonstrate that the selected jack-up rig is suitable for the setting-up and removal process and for the anticipated duration in the elevated condition to ensure that the management of structural integrity, as required by Regulation 8 of the Offshore Installation and Wells (Design and Construction, etc.) Regulations 1996 (DCR), is satisfied. HSE recommends that, where reasonably practicable, a soil boring at the location is obtained and that the soil parameters are evaluated for use in the jack-up site assessment and approval. Duty holders may be able to show that a risk based desk study demonstrates a sufficiently low level of personnel residual risk due to foundation failure in cases when they are unable to obtain a suitable geotechnical survey vessel, but a robust justification for such an approach must include:

- The site-specific assessment being performed using good industry practice as defined by SNAME 5-5A, and accounting for the uncertainties in the site soils characteristics due to the absence of site borings.
- The review and acceptance of the desk-top risk assessment by the rig owner/operator and their Marine Warranty Surveyor (MWS) where they are involved.
- Using the data from an existing nearby geotechnical borehole provided that it can be demonstrated that the planned site is in the same shallow soils province as the borehole by means of a reliable interpretation along a geophysical site survey tie line. A suitable stand-off location will also need identification and acceptance by the duty holder when working alongside an existing installation.
- A detailed review of the practicability of gathering suitable soil data from the jack-up itself as it arrives on location instead, bearing in mind the risks associated with only undertaking a partial pre-loading and encountering adverse weather during the soil boring operations. If soil data is obtained in this way then adequate and good quality tests should be performed on soil samples and a 'real time' load-penetration analysis should be undertaken by, or to the satisfaction of, the MWS.
- The identification from nearby boreholes, local geology interpretation and shallow seismic data correlation that layered soils and/or soils prone to severe scour and/or soils subject to cyclic strength degradation in severe storms are unlikely to be present at the selected location.

Layered soils where softer clay underlies a sand strata on which the jack-up ultimately rests are more prone to punch-through and can only realistically be evaluated by having a soil boring throughout the load bearing strata. In addition, where the surface granular soil is prone to scour then the risks associated with punch-through, sliding and possible loss of sufficient air-gap increase, and again the establishment of soil properties via a borehole is recommended.

- That back-calculation of soil bearing capacity and strata characteristics from actual pre-load penetration curves will be undertaken during pinning and pre-loading and before operations commence in order to confirm the assumptions made in the desk-top risk assessment. If the soils characteristics found during pinning and pre-loading differ from those predicted then further assessment of the integrity of the structure and the soil supporting it may be required before operations commence.
- Demonstration that the jack-up is to be operated in water depths and environmental conditions well within its design limits, but with any possible adverse effects of leg strength variance with height and structural dynamic response being explicitly accounted for.
- Information gathered e.g. load penetration, leg bearing pressure, borehole data and geophysical surveys from previous experience of jack-up rigs at nearby and similar locations.
- Careful selection of a pre-loading procedure that includes provision of a suitable weather window to ensure pre-loading is undertaken at a minimum air-gap (or partially in water). Further risk reduction measures that may be included in the pre-loading procedure include pre-loading one leg at a time. Such procedures should include how to recover from sudden leg penetration should it occur (including the dumping of any pre-load before leveling the jack-up).
- A detailed review of the jack-up owner's integrity management arrangements for safety critical elements such as pinion load monitoring and/or measurements of leg Rack Phase Difference (RPD) which minimise the potential for structural failure of the rig.
- Demonstration of the competency of the person(s) appointed to undertake the risk based desk study and the MWS approval (where used).
- Consideration by the installation safety case duty holder and the well operator (as defined by DCR) of the operations that are to be undertaken from the installation at the planned location. This should include assessment of the consequence of a structural failure against the risk profile for the well to be worked on and ensuring that the lack of soil data does not increase the risk profile for the planned operations.

Notwithstanding the above, duty holders must be aware that at locations that require a jack-up to operate close to its design operating limits, **a soil boring is strongly recommended by HSE**, as is a detailed structural assessment for the unit that takes account of the non-linear behaviour of the soil/structure system during extreme storm conditions as given in the SNAME 5-5A document.

Actions

Duty holders must ensure, where reasonably practicable, that the soil conditions are established by suitable borehole(s) and testing, and in cases where this is not undertaken it is recommended that the guidance contained in this Information Sheet is followed. Hence, the need to undertake a soil boring must be considered at the earliest stage possible in order to maximise the time available to source a suitable geotechnical survey vessel.

Duty holders must also ensure that on-board operating procedures prescribe appropriate limits to which the jack-up installation can be safely operated. Such limits should address all relevant failure modes and the results of the site investigation and/or desk-top risk assessment. The limits may be established from the original design specification; however duty holders must ensure that they remain appropriate for each specific site.

Relevant legal requirements

The relevant legal requirements are:

The Offshore Installations and Wells (Design and Construction, etc) Regulations 1996, regulations 7, 8

The Offshore Installations (Safety Case) Regulations 2005 (SCR05) Regulation 17 and Schedule 6

Health and Safety at Work etc Act 1974 (HSWA), Sections 2 and 3

References

1 SNAME (2002) Technical and Research Bulletin 5-5A Guidelines for Site Specific Assessment of Mobile Jack-up Units Society of Naval Architects and Marine Engineers

2 ISO 19905-1 (draft) Petroleum and natural gas industries – Site-specific assessment of mobile offshore units – Part 1: Jack-Ups

3 Guidelines for the Conduct of Mobile Drilling Rig Site Surveys Volume 2 Oil & Gas UK (formerly UKOOA) April 1997

Further information

Any queries relating to this information sheet should be addressed to:

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This information sheet contains notes on good practice which are not compulsory but which you may find helpful in considering what you need to do