

**UK OFFSHORE OPERATORS ASSOCIATION LIMITED
(SURVEYING & POSITIONING COMMITTEE)**

**Guidelines for
CONDUCT OF
MOBILE DRILLING RIG
SITE SURVEYS**

Volume 1

Issue 1.2

Acknowledgement

These Guidelines were originally compiled in 1995 by a Joint Industry work group formed by the UKOOA Surveying and Positioning Committee. Comments or questions arising from these Guidelines should, in the first instance, be directed to the UKOOA Secretariat marked for the attention of the Chairman of the Surveying and Positioning Committee.

While Regulations clearly establish a requirement for rig site surveys be undertaken, the survey methods described in these guidelines are not mandatory. Operators may adopt different methods in particular situations where to do so would maintain an equivalent standard of quality and of Health, Safety and Environmental protection.

LONDON

2nd Floor
232-242 Vauxhall Bridge Road
London SW1V 1AU

Tel: 020 7802 2400
Fax: 020 7802 2401

ABERDEEN

9 Albyn Terrace
Aberdeen AB10 1YP

Tel: 01224 626652
Fax: 01224 626503

Web Site <http://www.oilandgas.org.uk>

Email info@ukooa.co.uk

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1. Introduction

The Offshore Installations (Safety Case) Regulations 1992 require owners of mobile installations in the UKCS to submit a Safety Case for each installation. The Case must include particulars of (a) the limits of the environmental conditions beyond which the installation cannot be safely stationed or operated and (b) the properties of the seabed and subsoil which are necessary for the safe stationing and operation of the installation. The Offshore Installations and Wells (Design and Construction, etc.) Regulations 1996 require well operators to assess (a) the geological strata and any fluids within them and (b) any hazards which the strata may contain. A rig site survey is required by the well operator to adequately assess the hazards of shallow formations and for the rig owner to demonstrate that the environment and seabed conditions are suitable for the rig.

These Guidelines aim to clarify current regulatory requirements and describe what is regarded as "good industry practice" for the conduct of rig site surveys in support of mobile drilling rig operations. As a more formally mandated UKOOA document, they are an update and take the place of the "**Technical Notes for the Conduct of Mobile Drilling Rig Site Surveys**" issued in 1990.

Volume 1 of the UKOOA Guidelines for the Conduct of Mobile Drilling Rig Site Surveys summarises objectives and requirements for such surveys. Volume 2 describes in greater detail, the basis for the requirements, and the technical standards and methods required to fulfil them. It is recognised that these Guidelines will need to be revised as new equipment and techniques become available.

It is not intended that these Guidelines are a text book on geophysics or geodetic positioning. Literature on these subjects is abundant and a selection is given in the References and Bibliography Section of this Volume (*Section I*).

While regulations clearly establish a requirement for rig site surveys to be undertaken, the survey methods described in these Guidelines are not mandatory. Operators may adopt different methods in particular situations where to do so would maintain an equivalent standard of quality and of Health, Safety and Environmental protection. It is stressed that it is the responsibility of Operators themselves to keep abreast of Legislation, Regulations, Statutory Instruments and Departmental Notices, as well as local government laws and bye-laws.

2. Definitions

For the purposes of these Guidelines, the following terms and meanings apply:

- 2.1 **Operator** - is the person or company having a valid UK Government Licence to explore for and/or produce hydrocarbons in a defined area of the UKCS and who is responsible for specifying the drilling requirements. Current legislation defines this person or company as the 'Concession Holder'.
- 2.2 **Rig Owner** or **Owner** - is the person or company who controls the operation of the rig.
- 2.3 **Survey Contractor** or **Contractor** - is the company contracted by the Operator or the Rig Owner to conduct geophysical, hydrographic and/or geotechnical investigations at a proposed drilling location.

2.4 Specialist Advisor or Specialist - is a qualified and experienced geophysicist, hydrographic surveyor or geotechnical engineer, as appropriate to the technical context of the subject in question.

3. Existing Regulations and Guidelines

3.1 Acts of Parliament and Regulations

The requirement to undertake rig site surveys prior to offshore drilling is established on the basis of (amongst others) the following Acts and associated Regulations. The text of relevant sections can be found in *Volume 2*.

- Coast Protection Act, 1949
- Continental Shelf Act, 1964
- Minerals Workings (Offshore Installation) Act, 1971
- Petroleum and Submarine Pipelines Act, 1975
- The Health and Safety at Work Act, 1974 (HSWA).
- Offshore Safety Act, 1992
- Petroleum Act (Production) (Seaward Areas) Regulations, SI 1988, No.1213
- The Offshore Installations (Construction and Survey) Regulations, SI 1974, No 289
- The Offshore Installations (Safety Case) Regulations, SI 1992, No 2885, and HSE Guidance
- The Offshore Installations and Wells (Design and Construction, etc.) Regulations, SI 1996, No 913
- Application for Consent to Drill an Exploration or Appraisal Well, DTI PON 4, May 1996
- Notification of Geophysical Surveys, DTI PON 14, May 1996
- Record and Sample Requirements for Surveys and Wells, DTI PON 9, May, 1996
- Liaison with other bodies, HSE Offshore Operations Division. Operations Notice 3, February 1995

3.2 Other Relevant Notes for Guidance

The scope of surveys and methods employed depend partly upon the type of rig concerned (e.g. floating or jack-up, anchored or dynamically positioned). Other formally issued guidance notes (listed below) have been used as a source in formulating good industry practice.

- Seabed and Subseabed Data Required for Approvals of Self Elevating Platforms. Noble Denton International Ltd, 1987;
- Guideline and Recommended Practice for the Site Specific Assessment of Mobile Jack-up Rigs. American Society of Naval Architects and Marine Engineers, May 1994;
- Guidelines for the Anchoring of vessels in the Vicinity of UKCS installations and Pipelines and their Subsea Equipment. UKOOA, December 1994;
- Guidelines for the Use of Differential GPS in Offshore Surveying. UKOOA, September 1994.
- Environmental Guidelines for Exploration Operations in Near-shore and Sensitive Areas. UKOOA, September 1995.
- Guidelines for Minimising Acoustic Disturbance to Small Cetaceans, Department of the Environment, February 1995.
- Offshore Installations: Guidance on Design, Construction and Certification. Section 14, Site Investigations. Section 20, Foundations. Dept of Energy. Fourth Edition, June 1990.

- A guide to the Offshore Installations (Safety Case) Regulations 1992. Guidance on Regulations. Health and Safety Executive, L30, 1992.
- New Guidance on Coast Protection Act - Consent to Locate and the Marking of Offshore Installations. HSE Offshore Safety Division, operations Notice No. 14, February 1995.
- Environmental Guidelines for Worldwide Geophysical Operations. IAGC, January 1994
- Health, Safety and Environmental Schedules for Marine Geophysical Operations. E&P Forum. Report No. 6.34/206, July, 1994.
- Procedures Relating to the Notification of Vessels Intending to Anchor in the Vicinity of Pipelines or Other Subsea Installations. UKOOA Procedures Guide, agreed August 1986

4. Objectives and Limitations of these Guidelines

These guidelines provide information for a standard approach to rig site surveys, with the emphasis on good oil field practice. Accepted industry practice is to consider each and every drilling location on its own merits and to design the survey accordingly.

It may be necessary to undertake more than one type of survey to acquire all the information needed to plan a drilling location. To assess the suitability of a drilling location and drilling impact, the following survey types may be required:-

1. High resolution seismic (multi-channel or single channel) and hydrographic survey (bathymetry and seabed features) with limited seabed sampling. Occasionally current measurements may be required.
2. Geotechnical borehole coring and testing.
3. Environmental baseline measurements.
4. Shipping movement studies, where required by the Consent to Locate requirements in the specific area.
5. Post drilling impact or 'debris' surveys.

Current industry practice is to undertake these survey types separately. These guidelines cover the first category of study, commonly known as 'Rig Site Surveys' and, to a limited extent, categories 2 and 5. Rig site surveys are acquired with several objectives, including shallow gas detection, prediction of soil lithologies, identification of seabed hazards and measurement of water depth. They involve the application of 'state of the art' survey acquisition techniques.

It is important to recognise that, even with good data acquired to the limits of available technology and with careful analysis of the data, the geophysical survey results are still an interpretation. In the case of shallow gas surveys, due to limitations of the data and interpretation, the results should be viewed as a preventative measure, reducing the risk of encountering shallow gas rather than eliminating it.

Lithology predictions should not be considered definitive. They are improved by correlation of seismic data with borehole or well data. The need to acquire site specific geotechnical (borehole) data for mobile drilling rigs should therefore also be consciously addressed when planning rig site survey requirements.

Acquisition of good quality rig site survey data is only possible in weather conditions suitable for the type of work being conducted. It is not possible to be prescriptive regarding acceptable sea conditions as vessel and equipment capabilities are also significant factors.

Operators are advised to take Specialist Advice on this aspect of planning and execution of the survey.

Sub-standard data and inadequate or improper use of survey results may jeopardise safety and have considerable financial implications. Specifying surveys in accordance with the guidelines will not alone guarantee the quality of the survey. Careful Quality Control by Specialists of the data acquisition, processing and interpretation is also required.

5. Responsibility for Compliance & Quality Assurance

It is the Rig Owners who are required to submit safety cases. However, due to the comparatively long lead times in planning drilling locations, and the often uncertain situation with regard to drilling rig availability, the Operator contracts in services for undertaking rig site surveys. The Operator therefore should provide the Rig Owner with a comprehensive rig site survey assessment report which is in compliance with good oil industry practice and on which they can base the safe planning of their operation.

To ensure the timely acquisition and quality of the great variety of rig site survey data, operations should be controlled in accordance with well established Quality Management Systems. It is beyond the scope of this guideline to fully describe appropriate Quality Control procedures, which are the Survey contractor's responsibility to operate. However, a summary of those aspects of quality which are essential for the Operator to manage, can be found in *Volume 2*.

6. Rationale for Rig Site Surveys

As stated in the Regulations, rig site survey data are required to *determine the physical environment in which a rig is to be located*. Survey objectives therefore include identification of safety hazards, features and conditions that may constrain the positioning of the well. The objectives can be divided into sub-seabed, seabed, and sea surface/water column. Survey objectives include identification and mapping of:-

6.1.1 Sub-seabed

- Shallow gas
- Soils (conditions for anchoring, conductor/casing design and or foundations)
- Buried pipelines, cables, wrecks and well completions
- Tophole lithology

6.1.2 Seabed

- Water depth
- Seabed features
- Seabed installations, pipelines and cables
- Wrecks and other non-oil industry related artefacts

6.1.3 Sea surface and water column

- Offshore installations
- Anchor chains
- Navigation or obstruction warning buoys
- Areas restricted for navigation (Shipping routes, deep water and marine traffic separation schemes, military exercise areas etc.)
- Tidal streams and currents
- Waves

Some of the above features or hazards can be identified in the planning stage of a rig site survey, from existing information and publications such as Admiralty Charts and British Geological Survey (BGS) publications. In the case of restricted navigation areas, data can be obtained from the Department of Transport (DoT). Rig Owners and Survey contractors should satisfy themselves that they have used all relevant data. Operators should assist in provision of relevant data, particularly in-house data, in order that the position of potential hazards and their relevance to drilling operations may be verified during the rig site survey process.

Rig site surveys are then conducted to acquire additional information to complete the assessment of the physical environment of the site. The principal survey objectives are shallow gas detection, interpretation of soil lithology, water depth measurement and detection/identification of seabed or water column obstructions.

The validity of rig site surveys is a subjective issue, and is dependant on a variety of considerations, amongst which are:

- Operator familiarity with the area
- previous well history and shallow gas problems
- recent oil industry activity (wells, pipelines, boreholes)
- recent maritime activity
- water depth and (associated) seabed sediment movements

Tophole lithology and foundation conditions assessments are potentially valid indefinitely. Shallow gas assessments are also valid indefinitely unless there has been drilling activity in the area which could have resulted in movement of hydrocarbons. For very shallow foundation conditions, bathymetry, and seabed features/obstructions, data validity will depend upon activity (natural and man made) in the area of the location. Tentative validity periods are included in *Volume 2*.

7. Planning For Rig Site Surveys

The planning cycle is summarised, in flowchart form, in *Figure 1*. To meet regulatory requirements, the planning cycle for rig site surveys should preferably start 22 weeks before the planned spud date of a well. This time frame allows for all necessary statutory notifications to be exercised correctly and sufficient time for data acquisition, processing, interpretation and reporting. The planning cycle also allows time for geotechnical borehole work to be undertaken if required and for submission of the results to the relevant authorities.

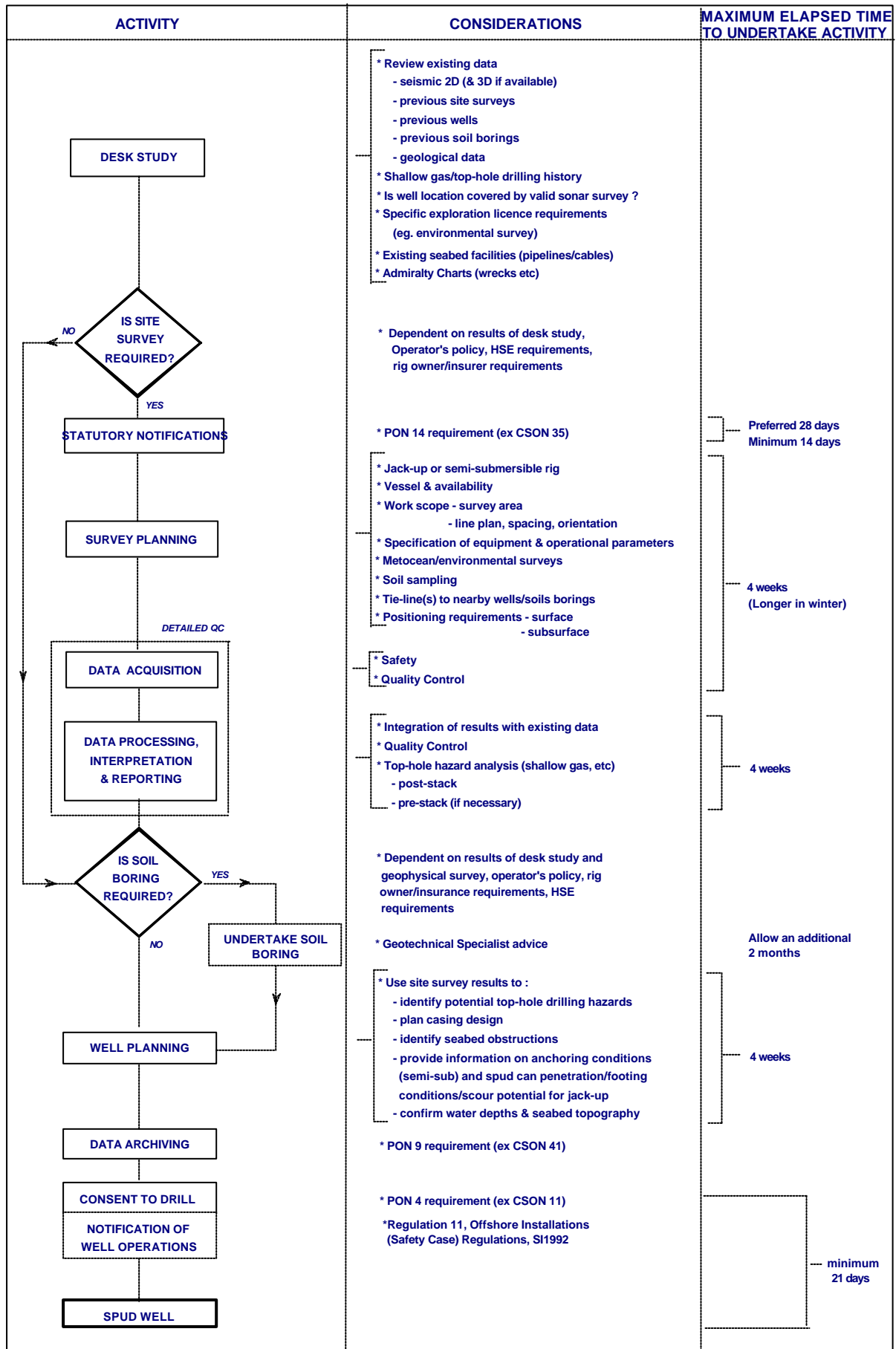


Figure 1

8. Shallow Gas Surveys

8.1 Scope and Rationale

Shallow gas, when present, is a hazard when drilling from all types of rigs. The objective of a shallow gas survey is to identify and map possible gas accumulations down to the sub-seabed depth at which normal well killing procedures can be applied by means of a Blow Out Preventer (BOP). This depth generally corresponds to the depth at which suitable casing is set. This may be greater than 1000m sub-seabed, but will vary according to local geology, drilling target depth and individual Operator's drilling practices.

It is not possible to definitively set a lower limit to the thickness or areal extent of a gas charged unit which represents a drilling hazard. The objective of the survey is therefore, to identify all gas accumulations within the 1000m sub-seabed interval. However, in practice there are limits to vertical and lateral resolution. Resolution will degrade with increasing sub-seabed depth. A realistic objective at 1000m sub-seabed is the resolution of potential gas accumulations of at least 5m thickness and 200m diameter areal extent. Gas accumulations of less than 5m thickness will be detected (1m thickness in ideal conditions) but the top and bottom of the unit may not be resolvable. With this objective at 1000m sub-seabed, smaller gas accumulations will be detectable in the shallower levels.

Using modern seismic acquisition techniques, most shallow gas accumulations should be detected. However, even with data acquired to the limits of available technology, these surveys cannot guarantee that all shallow gas accumulations will be found. Due to limitations in resolution and data interpretation, the surveys should be viewed as a preventative measure, reducing the risk of encountering shallow gas rather than eliminating it. Identification of potential reservoirs in the shallow section is also useful, as areas which are interpreted to be free of gas may later become gas charged if drilling causes gas to migrate from other levels.

Successful imaging of the sub-seabed down to 1000m depends upon the type and quality of equipment, equipment tuning, survey line planning, data processing and interpretation. Careful consideration should, therefore, be given to these items in designing the rig site survey.

If 3D exploration seismic data is available across the survey area, this should be used to interpret the shallow geology and to assist in the detection of shallow gas. Before the shallow gas hazard survey is undertaken, these data should be used to ensure that resources are targeted effectively by defining areas of likely hazard and, if necessary, moving the proposed location. Post survey, the 3D data can greatly assist in developing an understanding of the shallow geology and the extent of shallow gas accumulations. Due to bandwidth limitations these data do not replace shallow gas surveys.

An overview of the shallow gas hazard element of the rig site survey is given overleaf. Detailed information on the selection of equipment, methods to be used, and recommended scope of work is provided in *Volume 2*.

However, it is stressed that Specialist advice should be taken in defining the specific scope for each individual rig site survey.

8.2 Equipment

Equipment should be capable of imaging the sub-seabed to the nominal depths discussed above in *Section 8.1*. Seismic resolution should be sufficient to identify all significant lithology variations within the depth of interest. Resolution of the data will be a function of geology but also of equipment type and tuning which must therefore be optimally calibrated and operated.

8.3 Survey Pattern and Line Orientation

Survey pattern should consist of a number of lines (defined by Operator's Specialist Advisors) nominally shot at 100m separation. Denser (50m spaced) lines should be considered near the proposed location. Some lines should be orthogonal to the main pattern. A recommended standard line plan is included in *Volume 2* but the actual pattern selected is at Operator's discretion.

For reliable interpretation of geophysical data, tie lines should always be acquired to nearby wells, boreholes or other data calibration points. Such tie lines should allow sufficient overlap for differences in positioning accuracies and, in the case of multi-channel seismic data, comprise full fold stacked data.

Line orientation should be defined to optimise subsurface imaging, based on pre-existing knowledge of the geology and local environmental conditions.

8.4 Extent of the Survey Area

The survey extent depends upon the degree to which the Operator has scope to move the location in the event of shallow gas being detected. It is advisable to maintain a lateral distance of at least 100m between the limit of a suspected shallow gas accumulation and the drilling location. As a minimum, the surveyed area of the closely spaced (50m) lines should extend 200m radius from the notional rig location to allow for lateral uncertainties in interpretation. To allow a move of the proposed location due to unsuitable site conditions, the survey area should be increased to an area of approximately 1 km x 1 km. In addition, a minimum of two orthogonal lines should be surveyed to a distance of approximately 1 km from the notional location in order to provide a reliable local/regional setting for the interpretation. Where possible, tie lines should be acquired to existing wells or boreholes.

8.5 Data Processing

The objectives of processing seismic data include optimisation of signal-to-noise ratio and vertical/lateral resolution, suppression of multiple events, and enhanced display of data. There is no uniquely defined way of correctly processing seismic data, and a processor's subjectivity can affect the final results. However, a recommended minimum processing sequence is given in *Volume 2*, together with details of processing techniques. Appropriate Quality Control should be applied throughout data processing.

Seismic processing systems are available, which allow seismic data processing on-board the vessel, and sometimes 'on-line'. These systems are very useful for quality control of seismic data in the field. With Specialist supervision they can also be used to provide final processed data to a similar quality to data processed onshore.

8.6 Interpretation

Interpretation of data for shallow gas detection is subjective and should only be undertaken by Specialists. All sources of available data should be incorporated. Wherever possible this should include top hole well data, borehole data, exploration seismic data, adjacent rig site survey data, regional geological data (e.g. BGS and other literature) and in-house knowledge of the area. All the data sets acquired during the survey should be carefully integrated for the overall interpretation of the survey area. Interpretation of the rig site survey data within the regional framework is important for a full understanding of the geology and potential hazards. Input from the exploration interpreter, and reference to the exploration data, is therefore required.

Seismic workstations should be used for interpretation of the seismic data. Enhanced display options and attribute analysis contribute to easier identification of potential shallow gas.

9. Seabed and near seabed soil conditions

9.1 Scope and Rationale

Data may also be required for the prediction of soil variations which potentially affect drilling operations (e.g. Jack-up foundation conditions, guidebase support and conductor/casing setting studies). In addition, the data may be useful at a later stage for foundation studies for installation of fixed structures (e.g. platforms, subsea completions) during field development.

Reconnaissance of soil conditions is required in order to begin to establish design criteria for the following types of mobile rig and drilling operations:

- Jack-up rigs for which load bearing strength of the foundation soils is critical.
- Anchoring of semi-submersible drilling rigs (or jack-ups for stand-off locations).
- Conductor/casing setting for any rig type.
- Initial spudding of drilling equipment, including guidebase stability, from any rig type.
- Top-hole drilling.

Seismic data should only be used for the prognosis of general soil lithology and geotechnical conditions. On its own, the survey data will not provide quantitative data for either jack-up leg penetration calculations or well conductor/casing design. **A geotechnical site investigation will additionally be required if Specialist Advisors consider that there is insufficient pre-existing, quantitative information.** If anchor holding is critical, consideration should be given to obtaining and testing soil samples at specific anchor locations.

The usefulness of these data for soil predictions will depend upon the sub-seabed penetration and the resolution of the seismic data. All significant soil variations should be identified within the depth of interest. Acquisition and processing of the seismic data should therefore aim at providing optimum vertical and lateral resolution to the objective depth. An overview of the objective depths is provided below:-

9.1.1 Leg penetration prediction

To assist the geotechnical process of predicting leg penetration, the survey should be designed to acquire optimal data to a sub-seabed depth at least equal to the best estimate of leg penetration plus one times the spud can diameter (based upon Specialist Advisor's regional knowledge and experience). The maximum depth of interest is the sub-seabed depth to which loose or unconsolidated soils are expected. In the UKCS, depths of investigation are typically in the order of 30m sub-seabed.

9.1.2 Anchor holding prediction

To support anchor holding predictions, the survey should be designed to acquire optimal data to 10m sub-seabed.

9.1.3 Guidebase support studies

To support these studies seabed and near seabed data (10m sub-seabed) should be acquired.

9.1.4 Conductor/Casing setting and top hole drilling studies

To support these studies interpretation of the seismic data throughout the complete data length may be required.

Accepted industry practice is to consider each and every drilling location on its own merits and to design the survey accordingly. An overview of the shallow soils element of the survey is given below. Detailed information on the selection of equipment, methods to be used, and recommended scope of work is provided in *Volume 2*.

However, it is stressed that Specialist advice should be taken in defining the specific scope of work for each individual rig site survey.

9.2 Equipment

Equipment should be capable of imaging the sub-seabed to the nominal depths discussed above in *Section 9.1*. Seismic resolution should be sufficient to identify all significant lithology variations within the depth of interest. Resolution of the data will be a function of geology but also of equipment type and tuning which must therefore be optimally calibrated and operated.

9.3 Survey Pattern and Line Orientation

Survey pattern should consist of a number of lines (defined by Operator's Specialist Advisors) nominally shot at 50 - 100m separation, some of which should be orthogonal to the main pattern. For jack-up, dense lines (maximum 50m spacing) should be acquired in the vicinity of the proposed location. Recommended standard line plans are included in *Volume 2* but the actual pattern selected is at Operator's discretion.

For reliable interpretation of geophysical data, tie lines should always be acquired to nearby wells, boreholes or other data calibration points. Such tie lines should allow sufficient overlap for differences in positioning accuracies and, in the case of multi-channel seismic data, comprise full fold stacked data.

Line orientation should be defined to optimise subsurface imaging, based on pre-existing knowledge of the geology and local environmental conditions.

9.4 Extent of the Survey Area

Survey area depends upon the degree to which the Operator has scope to move the location in the event of unsuitable soil conditions being encountered.

For a jack-up rig, a minimum area of approximately 200m radius centred on the proposed location should be surveyed with close line separation. However there should also be a minimum of two orthogonal lines extending to a nominal distance of approximately 1 km in each direction from the proposed location. To allow a move of the proposed location due to unsuitable site conditions, the survey area should be increased to an area of approximately 1 km x 1 km. Where possible, tie lines should be acquired to existing wells or boreholes.

For floating rigs, where anchors are to be deployed, the survey area should encompass the expected limit of any anchors plus 1 km (allowance for location moves). The anchor radius depends upon water depth, mooring design (all chain, all wire or a combination) and is therefore rig specific. Anchor radii typically range from 1.5 km (all chain) to 5 km (all wire).

9.5 Data Processing

Soil conditions seismic data is usually processed offshore and recorded in an analogue manner (on paper). Subsequent data processing is rarely undertaken as it is difficult unless the data is recorded in digital format. If the seismic data is processed, then the same considerations and limitations apply as for the processing of the seismic data for shallow gas assessment.

9.6 Interpretation

All relevant sources of available survey data should be incorporated in the interpretation of the seismic data. Wherever possible this should include borehole data, shallow core or Cone Penetration Test (CPT) data, adjacent rig site survey data, adjacent well data (particularly jack-up leg penetration information), regional geological data (e.g. BGS and other literature) and in-house knowledge of the area.

Seismic character should be used carefully to interpret data, particularly if there is no direct calibration of soil units. Survey data should only be used for prognosis of general lithology and soil conditions. For example, sand sequences may be discriminated from clay sequences, and soft clays from hard clays. However, lithology cannot always be conclusively determined.

Important geotechnical characteristics such as shear strength, friction angle and relative density cannot be defined directly from geophysical data. Geophysical survey data should therefore never be used for estimating soil parameters for jack-up leg penetration predictions and well conductor design unless there is geotechnical data available which can be correlated to the location with complete confidence. Specialist Advisor input is recommended. Discussion of the soil's ability to hold anchors is inappropriate as this depends on knowledge of the geotechnical characteristics of the soils and the type of anchor to be used.

10. Bathymetry And Seabed Features

10.1 Rationale

Mapping of bathymetry and seabed features (particularly navigational obstructions) are required to ensure safe rig navigation, anchor pattern design and assist jack-up planning. Water depth is also required as a drilling datum.

Bathymetry becomes critical in water depths approaching the draft of the rig when under tow. However, this is an unusual occurrence in UKCS operating areas. Operators should ensure that there is a safe navigable approach to the location and consider surveys to assess the approach route if existing information indicates a need.

Mapping of seabed features, including the detailed shape of the seabed superimposed upon general bathymetry, is required as an aid to the design of anchor patterns and to the exact placement of spud-cans and guidebases. It is desirable to avoid, or at least to be aware of, features such as boulders, small sand waves or depressions in the seabed.

In addition to natural features there are occasional man-made artefacts on the seabed in parts of the UKCS. Some of these are connected with oil industry activity but there are many other obstructions such as telephone cables and wreckage. These may be wholly or partially buried in the seabed. Obstructions may also exist in mid water, such as mooring cable from navigation buoys or other installations. Planning of the drilling location should therefore first take account of all known features of this nature. The rig site survey should then find or relocate all potential obstructions so that they can be avoided when navigating and anchoring a rig on location.

Bathymetry and seabed features information can usually be acquired simultaneously with soil conditions seismic data (*see Section 9*).

An overview of the bathymetry/seabed features element of the rig site survey is given below. Detailed information on the selection of equipment, methods to be used, and recommended scope of work is provided in *Volume 2*.

However, it is stressed that Specialist advice should be taken in defining the specific scope for each individual rig site survey.

10.2 Equipment

Echo sounders are required for bathymetry measurements and side scan sonars for seabed feature detection. A magnetometer should be used for the detection of power and communication cables and any magnetic objects.

Echo sounders (conventional or multi-beam systems) should be capable of sounding to the maximum expected depth in the survey area to a resolution of approximately 1% of the maximum water depth expected. Equipment should be correctly calibrated for vessel draft settings and for the velocity of sound in water.

Side scan sonars should be capable of providing minimum coverage of 100% of the specified survey area. They should be capable of detecting objects 50-100 cm cube (nominal) or linear features 20 cm in diameter (nominal). For detection of small obstructions, a side scan sonar which can detect linear features 10 cm in diameter (nominal) should be considered. To achieve this resolution, favourable operating conditions are required and the equipment must be carefully selected, optimally tuned, calibrated and operated.

10.3 Survey Pattern and Line Orientation

Survey pattern will normally be determined by the soil conditions seismic survey requirements (*see Section 9*) which are generally more critical. Echo sounding and side scan sonar imaging should be conducted on all survey lines, including orthogonal lines, in order to provide multiple observations for checking data integrity.

Where water depths are critical to the safe navigation of the rig, it may be necessary to survey bathymetry at a denser line spacing than is used for soil conditions seismic surveys. However, use of multibeam echo sounders will mean that wider line spacing is acceptable in deep water. Specialist Advisors should suggest alternative methodologies where necessary.

Side scan sonar line spacing is dependant upon water depth, instrument tow depth and range capability of the sonar in use. Minimum coverage should be 100% over the specified survey area from lines in the principle pattern direction. Some orthogonal lines (25-50% of main pattern) should also be run. Where there are linear features, lines parallel to these should be run to obtain optimal images. Any significant features should be 'boxed in' by means of running closely spaced lines to ensure the object is viewed from all sides and that its position can be plotted.

For bathymetric surveying, line orientation is generally not critical in UKCS operating areas. The line orientation of the soil conditions seismic survey should be acceptable. However, if the seabed is expected to be steeply dipping (> 10 degrees), or there are significant seabed features in the area (e.g. sand waves), consideration should be given to optimising the orientation. Specialist advice should be taken if there are such bathymetric conditions.

10.4 Extent of Survey

Survey extent will also normally be determined by the soil conditions seismic survey. For an anchored rig, the area should extend to a minimum radius equal to the anchor pattern plus a nominal 1 km to allow for a possible move in location. Specialist advice should be taken before reducing the size of a survey area.

10.5 Data Processing

Echo sounder data should be processed using heave compensator data to remove survey vessel heave caused by wave action, or swell. These data should be processed to incorporate the correct speed of sound in water and the transducer depth. Data should be reduced to Lowest Astronomical Tide (LAT). Where multi-beam echo sounding (swathe) methods are used, particularly close Quality Assurance attention needs to be applied to data processing as this is susceptible to the introduction of bias errors if not undertaken correctly. Tidal corrections based on predicted tides for the survey area can normally be used for initial data reduction unless water depths are critical to rig navigation. A more rigorous, but time consuming solution, is to reduce the data using observed tides. These can be either measured data from the survey area, or measured at the nearest Standard Port and extrapolated to the survey area using constants derived from Admiralty Co-tidal Charts.

10.6 Interpretation

Interpretation can be undertaken either manually, from analogue paper records, or computer aided using digitally recorded data. Digitally recorded sonar data enables the creation of mosaics, enhancing the presentation and interpretation possibilities. Interpretation of sonar data requires experience and should only be undertaken by Specialists. Knowledge of the area under investigation, combined with the integration of all other available survey data, will improve the interpretation.

11. Reports And Survey Data

11.1 Recipients of the Report(s)

Usually, the Survey Contractor prepares a comprehensive Rig Site Survey Report which is delivered to the Operator. Timing for the delivery of the reports should be in accordance with the planning cycle given in *Section 6*. It is the Operators' responsibility to distribute copies of the report and data to mandatory recipients and interested parties. A list of potential report/data recipients follows below:-

11.1.1 Mandatory Government Recipients

Department of Trade and Industry (DTI). Statutory requirements for the provision of data are defined in DTI Petroleum Operations Notice No 9 (DTI PON 9), issued May 1996. This requires that the DTI Well Records Centre be provided with the following within one month of final processing.

Only if requested, the following data shall be provided within 30 days of the request.

Section 2.3 - Site Survey Data (if requested)

- (1) One Reproducible transparency of each final processed seismic section together with a reproducible transparency of the shot point location map at a suitable scale.
- (2) Where acquired, copies of side scan sonar records with their track charts.
- (3) If available, a copy of the final interpretation report of the seabed/superficial deposits investigation of drilling locations or installation sites.

11.1.2 Other non Operator Recipients

Rig Owners

Rig Insurers

Partners. On whose behalf the Operator may be drilling the well on a shared basis (depending on partnership arrangements)

The Hydrographic Office. Bathymetry information and information on wrecks

British Geological Survey (BGS). For archiving and national geological mapping purposes (UKOOA Council recommendation 13 September 1995)

11.1.3 Operator Recipients

Recipients within the Operator Company clearly depends upon the organisation in place. The following is reasonably representative of current industry practice.

Survey Department. Department responsible for contracting and overseeing the Rig Site Survey

Interpreter(s). The Department responsible for geological interpretation of the planned well

Drilling Department. Department responsible for well engineering design and for contracting Rig services

Operations Geologist. Department responsible for interfacing between the Drilling Department and the Interpreter(s) on a daily basis as the well is drilled

Marine Department. Department responsible for overseeing the work of the Rig Owner in positioning, anchoring and/or jacking-up a rig on the specified location

11.2 Recommended Minimum Contents

Reports should be concise and relevant to the survey objectives which themselves should be clearly defined in the report. Consideration should be given to the information needs of all users of the report. As many users are not geoscientists, geological/geophysical descriptions and jargon should be avoided.

The reporting style should aim to provide brief and clear statements on the expected conditions at the proposed drilling location. These statements should not be confused by discussion of features in or around the survey area which have no relevance to either rig installation or subsequent drilling at the location.

It is common industry practice to present a one page report summary or Abstract at the front of the report for management overview purposes.

However, Operators and Rig Owners should be aware that Rig Site Survey reports address a wide variety of relevant issues and it is critical to the safety cases for rig moves and well operations that the full implications of the report be fully understood by all concerned.

The following further guidance is relevant to specific aspects of the report(s).

11.2.1 Shallow gas hazards

For shallow gas surveys the objective is to identify and map possible gas accumulations which may impact upon the choice of location. The report should therefore clearly indicate the depth and lateral extent of any such accumulations both at the location and nearby. Any information used in the interpretation of the data and assessment of the shallow gas potential should be included.

Whenever possible, top hole well data should be used to calibrate the shallow gas seismic data and to improve the interpretation. Speculative interpretations, unless substantiated by published data (e.g. BGS publications, results of previous wells) should be avoided.

11.2.2 Sub-seabed Soils

For foundation/anchoring purposes, the report should clearly indicate the depth and map the lateral extent of any relevant soil units. Additional information such as sedimentary features, used to characterise soil units should be described. The depth and lateral extent of any relevant features, e.g. sub-seabed channels, should be discussed. Whenever possible borehole or CPT data should be used to confirm the interpretation.

Interpretation of the shallow gas seismic data may also be useful for guide base foundation studies, conductor/casing setting studies and detection of potential zones of difficult drilling. The report should therefore clearly indicate the depth and map the lateral extent, within coverage, of any relevant features (e.g. sub-seabed channels). A prognosis of lithology throughout the objective depth interval should be included.

11.2.3 Bathymetry

The report should clearly indicate water depths at the proposed location and within the survey area, reduced to LAT. Seabed gradients and irregularities (e.g. depressions, sandwaves) should be described, particularly in the areas of jack-up legs and drilling guidebase. Specific attention should be drawn to water depths which are significantly different from those previously charted.

11.2.4 Seabed Conditions and Obstructions

Seabed sediments and any obstructions within the survey area (e.g. wrecks, boulders, cables, other moorings) should be described in the text and mapped in their correct position. This information should be derived from survey data and any other sources (e.g. Admiralty charts). Specific attention should be drawn to features and obstructions which have not been previously charted or are found to be in positions different from those previously charted. Obstructions previously charted but not found during the survey should be mapped but annotated as "not confirmed".

11.3 Data Retention

Rig site survey data may be in paper form or in computer compatible media format (CCM), or both. Data produced during the course of the survey may include the following:-

- Raw and processed positioning data for all sensors utilised
- Echo sounder records
- Raw and processed digital swathe bathymetry data
- Analogue (paper) Side scan sonar records
- Digital Side Scan Sonar records
- Analogue (paper) seismic records
- Raw and processed digital seismic data
- Processed seismic sections (paper/film)
- Magnetometer data
- Geotechnical data including seabed core/grab samples and analysis of cone penetration tests, core logs and geotechnical parameters
- Acquisition, processing and interpretation reports

All data acquired during the rig site surveys should be retained by the Operator or their agents until the well has been drilled and the rig has been moved off location. If there is further drilling or engineering activity (field development) in the area, any survey records may have value throughout the field life and they should be kept until field abandonment. Before any data disposal, careful consideration should be given to the data value for future developments in the area. The following minimum criteria are recommended in regard to longer term data retention policy for all records created during the Rig Site Survey process.

Reports, positioning data and seismic data (raw and processed) should be retained by the Operator or their agents for as long as there is drilling activity in or around the surveyed area. These data will be useful in planning future surveys and may be incorporated into later interpretations.

Analogue sonar and bathymetry records should be retained by the Operator or their agents for a minimum of two years. In areas with stable seabed conditions and little maritime activity, these data may be of use for a longer period.

12. Glossary

BGS	British Geological Survey
BOP	Blow Out Preventer
CCM	Computer Compatible Media
CPT	Cone Penetration Test
DoT	Department of Transport
DTI	Depart of Trade and Industry
GPS	Global Positioning System
HSE	Health & Safety Executive
LAT	Lowest Astronomical Tide
PON	Petroleum Operations Notice
SI	Statutory Instrument
UKCS	United Kingdom Continental Shelf
UKOOA	UK Offshore Operators Association Limited