# Guidelines for Drillsite Selection and Near-Surface Drilling Hazard Surveys



**DRAFT**

**Interim Pollution Prevention and Safety Panel**
**Integrated Ocean Drilling Program**

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## Background

This document is an outgrowth of need identified in an iPPSP [interim Pollution Prevention and Safety Panel] meeting held 2-3 December 2002 at a Chevron-Texaco facility in Bellaire, Texas. The issues in this document were further framed in an *ad hoc* working group meeting composed of iPPSP and iSSP [interim Site Survey Panel] members held on 27 December 2002 at a Shell facility in Houston, Texas. The strategy used to generate this document consists of compiling critical sections of guidelines on offshore exploratory drilling taken from the United Kingdom Oil Operators Association (UKOOA), Norwegian Petroleum Directorate (NPD), and the American Mineral Management Service (MMS). This is an initial draft of an evolving document. The authors would be most grateful for any input from the greater IODP community.

## Introduction

With the advent of the Mission Specific Platform (MSP) approach in the Integrated Ocean Drilling Program (IODP), more complete guidelines for hazard assessment surveys at the drillsite are required than had been conducted for the predecessor Ocean Drilling Program (ODP). The wide range of water depths and the variety of drilling rigs available to the IODP raise issues of drilling safety and well control that previously did not need to be considered. The limited pressure control available with the riserless JOIDES/Resolution vessel mandated that the Pollution Prevention and Safety Panel (PPSP) [now called the Environmental Protection and Safety Panel; EPSP] for the Ocean Drilling Program avoid situations that might present risks. The goal of the Mission Specific Platform approach is to allow scientific drilling in a wider variety of areas and conditions than were previously possible. This requires establishing and communicating these more comprehensive guidelines.

The guidelines given here are a compilation from a number of sources. These sources are listed in the references at the end of this report. These guidelines are not to be considered definitive or wholly comprehensive, but are meant to serve to focus on the range of issues to be considered when conducting scientific drilling in the marine environment. In addition, this report will discuss the types of drilling hazards and environmental issues to be considered when planning to drill in a specific location. This report will also discuss a variety of survey tools and techniques, which can be used to examine whether these hazards and situations are present at the wellsite. Finally, guidelines for reporting and data retention are included.

These guidelines are not meant to supercede requirements and regulations, which may be imposed by any governing authority. Locally applicable laws must be met and the IODP seeks assurances and proof that these requirements have been met. It is, however, the goal of the interim Pollution Prevention and Safety Panel (iPPSP) [now called the Environmental Protection and Safety Panel; EPSP] that these guidelines, while remaining flexible, will be designed to meet and/or exceed typical regulations so that IODP may continue the excellent record established by predecessor Programs.



## Rationale

Drillsite and shallow drilling hazard surveys are performed to avoid problems, which can cause damage to, or loss of, well bores, facilities, the environment and lives. These surveys are designed to investigate seafloor conditions and shallow drilling hazards. Seafloor hazards are essentially due to slope stability and foundation variability. Shallow drilling hazards are primarily due to free gas buoyancy effects and overpressured, unconsolidated water bearing sands, and/or formation weakness. The most severe situations are those in which high-pressure formation fluids flow into the wellbore environment. Uncontrolled, or improperly controlled, fluid influx is a significant hazard with the most severe cases being "blowout" situations.

These are hazards to the wellbore and the drilling process. From another perspective are the hazards and risks presented to infrastructure and the environment. IODP drilling platforms and practices must present little or no adverse impact on the environment or existing man-made structures. The following is a list of "hazards" taken with minor revisions from a draft regulation (Notice to Lessees) before the United States Minerals Management Service.

<u>Seafloor Hazards</u>: seafloor geologic hazards which might be identified include fault

escarpments, diapiric structures, gas vents, unstable slopes, mud-flow gullies and lobes, slumps, collapse features, sand waves, fluid expulsion features, chemosynthetic communities, hydrate mounds, mud lumps, mud volcanoes, rock outcrops, pinnacles, and reefs.

Man-made Hazards: to include pipelines, umbilical cables, wellheads, shipwrecks, ordnance and chemical dump sites, communication and power cables, and miscellaneous debris. Such features would be important to initial placement and collision avoidance for near seafloor placed structures, anchorages and mooring systems, pipelines, wellheads, etc.

Subsurface Geologic Hazards: these may include, but are not limited to, faults, erosion and truncation surfaces, hydrate zones, gas-charged sediments (free gas and high-proportion dissolved gas), abnormal pressure zones, shallow water flow zones, buried channels, slumps and salt bodies.

In addition, seafloor and surface currents must be considered. These are important for drilling platform stability (especially for dynamically positioned platforms) and for drilling equipment fatigue.

**Scope of Surveys**

Drilling sites must be surveyed over an area sufficient to ensure that the potential for hazards has been thoroughly determined and to a depth greater than the well is to be drilled without pressure control. The area of interest for hazard assessment is determined by the type of drilling platform employed and to a lesser degree the type and extent of drilling hazard present (see discussion below.) The area of interest for the survey should account for potential hazards identified in the regional geologic setting.

The survey sampling must be dense enough to avoid data gaps. Also, the surveyed area should be large enough to allow for drillsite relocations if hazards or obstructions are found at the primary site in the course of surveying and subsequent data interpretation. The survey area should also be large enough to determine proximity to any seafloor features indicative of hazards and to shallow faults, which the wellbore might intercept at shallow depths. For common situations this means that the survey should cover an area within at least 600 m of the proposed site and to a depth of either 800 m below the seafloor, or a depth of 150 m greater than the depth of the well for setting pressure control (installation of a blowout prevention system), whichever depth is greater. For certain situations, usually riser drilling, geohazard assessment may need to consider much deeper sections of the wellbore.

A major determinant for wellsite survey design is the geologic complexity of the seafloor and the shallow subsurface interval. In some areas, two orthogonal seismic lines might be sufficient to determine the risks of encountering hazards. In other areas, especially shallow water situations, survey requirements will be much greater. The specific requirements for any individual wellsite will also be dependent on the extent of knowledge available for the site. In cases where the anticipated section to be drilled is benign and the site is remote from any infrastructure, minimal survey requirements are in order. In other cases, where the geology is complex, the environment is sensitive, encountering overpressured formation fluids is possible, or the seafloor stability is in question, the required surveys may be quite comprehensive.

## Recommended Drillsite Survey Types

The type of drilling platform determines the types and extents of the surveys required. Rig types can be categorized into three groups: 1) bottom founded, including jack-ups and mat based; 2) anchored vessels, such as semi-submersibles; and 3) dynamically positioned ships.

Type of survey has often been specified by the water depths at the wellsites. This is a very valid approach because water depth generally determines the drilling platform type to be used and, to a certain extent, the resolution of some of the survey tools. With overlap of water depth drilling capability of the various rig types available now and in the future, we prefer to categorize survey requirements based on the three groups given above. Specifics of the survey tools are given in a following section.

**For bottom-founded rigs** the primary concerns are foundation characterization (including biota) and shallow drilling hazards.

Bottom-founded rigs include mat, barge, and jack-up rigs. Hazards review of the very shallow section below the mudline is particularly important for these rigs. The near surface hazard assessment must be focused on an area around a specific well location but must also include the line of approach and any possible alternate locations. The area surveyed must be large enough to identify and map any near surface geologic features, such as channels, faults and gassy sediments. Details of conditions in the immediate vicinity of the wellsite (within at least a 300 m radius) must be fully assessed. Of particular concern are risks to the rig's integrity through loss of seafloor support during loading of the foundation and especially in the event of blowout.

The tophole drilling used by these rigs may be different from that of the other two generic rig types. The geohazards assessment for the tophole section must address shallow gas potential because of the severe consequences of encountering hydrocarbon gases in this section. Wells should not be located within 300 m of any identified shallow gas indications.

The survey tools for these types of drilling rigs may include:

<u>Fathometer</u> – to determine rig type suitability and site approach direction.

<u>Magnetometer</u>– to determine the presence of man-made obstructions.

<u>Sidescan sonar</u> – to supplement the magnetometer for man-made obstructions and to give a measure of the seafloor rugosity and composition.

<u>Subbottom profiler</u> – to determine the near surface geologic continuity and allow mapping of shallow buried features.

<u>2D high-resolution multichannel seismic data</u>– to supplement the subbottom profiler, and, more importantly to determine the likelihood of shallow free gas accumulation.

Jack-up rigs may require a pre-load <u>soil boring</u> for soil strengths and leg penetration. Remotely operated vehicle or other video assessment is also recommended.

Use of 3D seismic data will rarely be acceptable for these rigs, because the seafloor and near seafloor section are not imaged with standard 3D data acquisition in shallow water.

**For anchored, floating platforms** the primary concerns are anchor placement, seafloor biota and shallow drilling hazards.

Anchored rigs include semi-submersible and ship borne platforms and require hazards assessment to be performed over an area of the seafloor sufficient to assess anchoring conditions. In general, these rigs will operate in deeper water depths than bottom-founded rigs and different concerns not applicable to bottom-founded rigs. The seafloor geohazards assessment should focus on the seafloor within the maximum likely anchor-line radius. Special attention should be paid to the anchor and catenary touchdown area where the seafloor will be disturbed by anchor chain and/or wire rope. The expected nature of the shallow materials in which the anchors will be set should also be described.

For spud-in and tophole drilling, the geohazards assessment should focus on the immediate vicinity of the proposed wellsite (within a 300 m radius), and in the tophole section (to a penetration of about 800 m). Wells should not be located within 300 m of any identified shallow gas indications.

The survey tools for these types of drilling rigs may include:

Swath (multibeam) bathymetry – to determine the seafloor rugosity and proximity to various seafloor features.

Fathometer – may be useful for determining approach direction, but is not required.

Magnetometer – may be useful for determining the presence of man-made objects, but will generally not be required.

Sidescan sonar -if possible, to give a measure of the seafloor rugosity and composition, but may be interchanged with swath bathymetry.

Subbottom profiler- to determine the near surface geologic continuity and allow mapping of shallow buried features.

2D high-resolution multichannel seismic data – to supplement the subbottom profiler, and, more importantly to determine the likelihood of shallow free gas accumulation.

Use of 3D seismic data may supplement or replace these tools if it is possible to map bathymetry, adequately and continuously image the near seafloor section, and determine the risk of shallow gas. If 3D data are to be used, we recommend that these data be spectrally enhanced in the near seafloor section to facilitate shallow fault mapping. Rendering of the sea floor (i.e., simulated solar illumination of the seafloor topography) is a powerful tool for recognition of seafloor features and is strongly recommended. Seafloor dip, reflection amplitude and rugosity indications (such as edge detection, i.e., local curvature), are all useful as stability indicators and for assessment of most seafloor hazards.

In all cases where an anchored platform is used, an ROV video assessment is highly recommended. This can be done in an area around the intended site immediately before drilling and is not intended to cover all the anchor locations. However, anchor locations should be assessed from seafloor reflection attributes. ROV monitoring of the wellhead for indications of gas and/or shallow water sand flow during drilling of the shallow section is also highly recommended.

**For Dynamically Positioned (DP) platforms** the primary concerns are shallow drilling hazards, sea floor stability and biota.

Geohazards assessment for DP rigs should focus on the tophole section. Shallow gas is the primary concern and drilling locations should be at least 300 m from any identified shallow gas. Shallow water flow sands are a secondary concern since they are not an immediate safety risk, but they are a potential source of problems for the wellbore environment and should be mapped and assessed. Attention should be paid to the seafloor in the immediate vicinity (within a 1000 m) of wellsites for signs of instability and for sensitive biota.

The survey tools for these types of drilling rigs may include:

Swath (multibeam) bathymetry – to determine the seafloor rugosity, proximity to various seafloor features and preferred direction of approach and departure especially in cases of emergency disconnect of the riser (and preferably processed for backscatter intensity).

Fathometer – may be useful for determining approach direction, but is not required.

Magnetometer – may be useful for determining the presence of man-made objects, but will generally not be required.

Sidescan sonar -if possible, to give a measure of the seafloor rugosity and composition, but may be interchanged with swath bathymetry.

Subbottom profiler- to determine the near surface geologic continuity and allow mapping of shallow buried features.

2D high-resolution multichannel data – to supplement the subbottom profiler, and, more importantly to determine the likelihood of shallow free gas accumulation.

3D seismic data that are processed for deep objectives data may be used instead of these tools if it is possible to map bathymetry, adequately and continuously image the near seafloor section, and determine the risk of shallow gas. We recommend that these data be spectrally enhanced in the near seafloor section to facilitate shallow fault mapping. Rendering of the sea floor (simulated solar illumination of the seafloor topography) is a powerful tool for recognition of seafloor features and is strongly recommended. Seafloor dip, reflection amplitude and rugosity indications (such as edge detection, i.e., local curvature), are all useful as stability indicators and for assessment of most seafloor hazards.

In all cases where a dynamically positioned platform is used, an ROV video assessment in the immediate vicinity of the well location is highly recommended prior to drilling. The pre-spud survey can be done in an area around the intended site immediately before drilling. Real-time ROV video is also strongly recommended as a well-monitoring procedure during drilling of the shallow section to watch for indications of shallow gas and/or shallow water sand flow.

**For all rig types** the identification of permeable units is important for safety and drilling performance. The fluids from these units will mix with the drilling fluid and affect the borehole environment. (The identification of overpressured and/or reactive clays is also important for drilling performance but is not generally a safety or environmental concern.)

Shallow gas is the single most important hazard. Even under normal pressure conditions for formation waters, buoyancy causes overpressure of the formation fluid and can cause influx into the wellbore. Free gas entering the borehole reduces downhole pressure and expansion of the gas as it rises further reduces the downhole pressure (allowing further influx) and these conditions can readily lead to a blowout.

Permeable units with a high-proportion of dissolved gas in the formation fluids may also present a risk for safety. The dissolved gases mix in the drilling fluids and become free gas under the reduced pressure of circulation. This dissolution occurs near the surface so the reduced fluid density generally does not pose a risk of loss of pressure control, but free hydrocarbon gas may be a fire hazard.

Shallow water flow sands are unconsolidated, permeable units with formation fluids over simple hydrostatic pressure. When their pressures are uncontrolled they can cause loss of the well foundation. While the environmental risk is low, these shallow water flow sands may be a significant risk to the borehole integrity and therefore a financial risk. Any methods, which can be used to identify them, should be employed.

**Standard Data Types and Recommended Parameters**

Standard geohazard assessment tools include:

Fathometer
Magnetometer
Sidescan Sonar
Subbottom profiler
High resolution seismic data
Deep penetration seismic data –2D and 3D
Soil samples
Geotechnical boreholes
ROV, AUV visual
Renderings
Offset Well Logs and Drilling Reports
Meteorological and Oceanographic Data
Regional Studies
Satellite Imagery



Specification for all of these data types are not needed or presented here. However, all of these may provide relevant data for drilling hazard assessment and should be studied whenever available.

As a general rule, the closer the sensors are to the seafloor, the better the resolution. For sidescan sonar, magnetometer, and subbottom profiler the tools should be positioned near the seafloor (and the position accurately tracked). For multichannel seismic data, lateral resolution is achieved with seismic migration because the hydrophone sensors cannot, in general, be placed at near seafloor depths. Currently, in cases where bottom cables are used for 3D seismic surveys, near-seafloor coverage is incomplete so these data are usually unsuitable for site analysis.

The standard types of data and survey coverage required are directly dependent on the type of drilling platform to be used. All existing geophysical and geotechnical (soil sampling) should be reviewed in support of survey design and incorporated in final site analysis.

Navigation

Standard and widely accepted geodetic positioning must be used. The reference datum, spheroid and projection must be specified. WGS 84 is the preferred system. GPS (supplemented by DGS) survey positioning is desired. Care must be taken to ensure geodetic and positioning consistency throughout the drillsite selection, surveying and assessment process.

Surface positioning of survey vessels is required to a precision of – 5 m. Position fixes should be digitally logged at least every 12.5 m along vessel track and annotated on all records at intervals no greater than 125 m A final shot point chart shall show fixes at intervals no greater than every 125 m.

Acoustic positioning of towed sensors is preferred in water depths greater than 100 m to allow accurate mapping of any contacts identified. If acoustic positioning of a towed sensor is used, a laid-back fish position chart should be enclosed in any hazards report so that accurate positioning of any anomalies can be readily determined.

Bathymetry

Bathymetric data should be obtained using a hull-mounted, high-frequency, narrow-beam hydrographic echosounder. Data shall be displayed on a graphic recorder and digitally logged. Water column sound velocity determinations by use of a CTD should be made frequently to ensure calibration of the sounder-derived depths. The system shall be configured and "gated" to record the range of water depths expected across the survey area. The system should include a heave compensator to remove effects of vessel movement from the data.

The IODP encourages the use of swath bathymetry systems in deeper water in preference to sidescan sonar systems. Where at all possible, final processed data cell sizes should be no greater than 10 m. The data should be stored in a digital format to allow further imaging and analysis of the data. Backscatter intensity should be captured (within a suitable dynamic range) whenever possible.

Sidescan Sonar

Where sidescan sonar is required (generally in shallow water) a dual channel, dual frequency, side-scan-sonar system should be used to provide seafloor clearance survey data. A 100 kHz system should be used to provide general images of the seafloor. In particularly complex areas a 500 kHz system is preferable to provide higher resolution. Line spacing and display range should be designed to ensure 200% coverage of the proposed survey area.

Data should be displayed on a graphic recorder capable of adjusting the data for slant range effects and variable speed along line. Data should be recorded digitally to facilitate generation of a continuous coverage georeferenced mosaic of the data.

Subbottom Profiler

A 3 kHz (or similar central frequency) subbottom acoustic profiler operating in pinger or "chirp" mode should be used to acquire a continuous and high resolution image of the section immediately below mudline. The depth of penetration ideally will exceed the expected depth of penetration of the legs for a jack-up rig or the expected anchor penetration for an anchored rig. These data are not required for a DP platform but are useful for surface conductor penetration analysis.

The data should be recorded digitally to allow signal processing and graphical workstation display and interpretation.

Magnetometer

Magnetometer data are required whenever a bottom-founded rig is to be used. Magnetometer data is intended to detect any ferrous (likely man-made) material lying on or buried immediately under the seafloor. In particular, it is intended to determine the position of cables, pipelines or debris. Data should be recorded on an analog strip recorder and on digital tape. Lay-back distances must be monitored and recorded.

The system should be capable of a sample rate of one per second and have a 1 nanotesla (1 nT) sensitivity to total field strength. The sensor should be towed as close to the seafloor as possible and sufficiently far away from the vessel to isolate the sensor from the magnetic field of the survey vessel.

2D Multichannel High Resolution Seismic System

Multichannel high-resolution (HR) digital seismic surveys should be acquired over proposed well locations to detect shallow free gas accumulations. (Note that 3D seismic data that are processed for deep objectives may be suitable and preferable in many deepwater situations in which cases 2D HR is not required.) The depth of investigation should be from the seafloor to a depth of 150 m greater than the depth at which pressure control is to be set. Processing of the data must be aimed at maximum resolution (i.e., seismic migration is required to maximize lateral resolution and deconvolution for maximum vertical resolution). **Relative reflection amplitude** must be preserved throughout recording and processing gain recovery processes. **Reflection polarity** must be clearly discernable from obvious interface reflections or otherwise determined and stated.

High-resolution surveys should employ a seismic source with a stable, repeatable signature in the 20-300Hz band. Analog systems and “sparker” sources are not to be used. The recommended dynamic range of the recording system should be 128 dB.

The following parameters are recommended:

Source and streamer tow depths should be no greater than 3 m. A minimum of 48 receiver channels is recommended with at least 600 m to the far offset to allow for “normal moveout” velocity determination to a depth appropriate for setting of pressure control for the well.

Data should be recorded with a digital multichannel recording system. Recording sample interval should be no greater than 1 millisecond and field high-cut filters should be set no lower than 300 Hz. Record length must be sufficient to image to a depth greater than the expected depth for emplacement of pressure control.

Field data copies, along with appropriate documentation (navigation and observers records) must be retained for possible reprocessing.

A typical minimum acquisition system is as follows:

| | |
|---|---|
| Source | 100 cu in airgun at 2000 PSI |
| Sample rate | 1 millisecond |
| Record length | 2 seconds |
| Source interval | 12.5 meters |
| Number of channels | 48 |
| Receiver group interval | 12.5 meters |
| Source and receiver nominal depths | 2.5 meters |
| High cut filter | 300 Hz |
| Low cut filter | 8 – 15 Hz |
| Near receiver offset | Less than half of the water depth |
| Maximum feather angle | 7 degrees |
| Streamer noise levels | 7 microbars with 20-microbar bursts (near offsets may be higher) A conversion from recorded mV to microbars should be specified. |

Seafloor Samples

Seafloor sampling is required (in the absence of prior experience in the immediate area) for bottom-founded rigs. Sampling techniques include gravity cores, piston cores, box cores and geotechnical borings. Soil strengths must be determined to avoid instabilities. In conjunction with soil sampling, sidescan sonar and subbottom profiler data must be studied to determine the suitability of the sample location as indicative of the overall conditions for the rig foundation or anchor locations. Pre-load borings to determine geotechnical parameters may be required for jack-up rigs to gauge leg penetration depth. "Punch through" during full loading of a jack-up rig's legs is a particularly damaging situation. In some instances, soil sampling via gravity or piston coring may be necessary to determine anchor conditions. Any sampling must be done to avoid impact to sensitive seafloor biota, especially chemosynthetic communities.



**Survey Density**

Most site survey data are collected in linear traverses of the area to be surveyed. For a bottom-founded rig, 50 m primary line spacing, with tie lines at 100 m spacing near the intended site, is usually required to adequately sample the seafloor and subsurface geology. For anchored and dynamically positioned rigs a survey with 200 m line and 500 m tie line spacing should be used. Primary lines should be oriented in the direction of the near seafloor bedding dip. This usually will allow for shallow gas detection. In all cases, survey design should be reviewed by site survey specialists with consideration for rig type, water depth and survey tool resolution.

Vertical resolution is a function of source bandwidth and proximity to the target, or for near surface seismic recording, the source and receiver depths below the sea surface. Lateral resolution is commonly referenced to the Fresnel zone, which is a function of frequency, with higher frequencies yielding a smaller Fresnel zone and higher lateral resolution. Two-dimensional seismic migration collapses the Fresnel zone and significantly increases the lateral resolution in the direction of the survey line but cannot improve resolution in the direction perpendicular to the 2D line.

3D Data Acceptability

3D seismic data may be used in hazard studies in lieu of high resolution, subbottom profile and sidescan sonar data when the 3D data are processed to their maximum amplitude, spatial and temporal resolution. The following are general indications of the suitability of the data for hazards analysis:

The dataset within the first second of section below mudline should at be least 60Hz at the high end of its bandwidth and contain more than two octaves of bandwidth. The sample interval of the data must be 4 milliseconds or less.
The seafloor reflection should be free of gaps and defined by a wavelet of stable shape and phase. Processing of the data should preserve spatial variation of seafloor reflection amplitude.

Acquisition artifacts such as cross-line statics and, or, amplitude striping, though possibly identifiable in the shallow section, should not detract from the overall interpretation of a picked event when mapped in time or amplitude.

The bin size of the processed data should be commensurate with the maximum spatial resolution of the data (based on the acquisition parameters and the expected dimensions of features of interest).

The data must have deconvolution and 3D seismic migration applied. Spectral enhancement should be applied to maximize bandwidth and vertical resolution. Only processes, which preserve relative reflection amplitude, may be used.

A good indication of the suitability of 3D data is whether the expression of faults at the seafloor evident on renderings is clearly evident on vertical seismic sections.



## Geohazards Analysis and Reporting

Purpose

The purpose of a geohazards report is to describe and assess seafloor and shallow ("tophole") conditions to help plan safe and efficient drilling operations, and to help meet IODP requirements. The geohazards report will help to design an environmentally sensitive drilling program.

The specific goals of the geohazards report are:

1 To provide a concise document that facilitates understanding of significant issues,
2 To assess the potential effects of the proposed drilling operation on cultural resources and protected biological communities,
3 To provide the drilling engineer with a clear understanding of seafloor and tophole conditions and an assessment of their potential effects on the proposed drilling operations.

<u>Scope of Reporting Requirements</u>

This is a minimum requirement specification. All geohazards reports must include at least the specified contents listed for both text and graphics. Additional information may be included at the discretion of each individual geohazards specialist or operator. In such cases, the additional information shall be appropriately integrated into the overall reporting framework specified here.

Geohazards reports must provide full identification and assessment of all seafloor and tophole geologic and man-made features and constraints to proposed drilling operations based on information obtained from a shallow geohazards survey and/or other information. Geohazard reports must include a review and integration of all information pertinent to the geohazards issue and related issues, including biological community and cultural resource issues.

Examples of information to be reviewed along with shallow geohazards data are logs from offset wells, logs from soil sampling programs, existing hazards reports, 2D or 3D seismic exploration data, and information about man-made features such as shipwrecks, existing wells, and infrastructure. Depth of reporting below the mudline (BML) is to be nominally 800 m.

Conditions to be Defined and Assessed

All natural and man-made conditions on the seafloor or in the tophole section that are potentially hazardous to drilling operations, including anchoring, are to be assessed. Please refer to "Rationale" section for a description of the hazards and conditions to be assessed. The potential impact of the proposed drilling operation on reefs, protected hardgrounds, and chemosynthetic communities is to be addressed

Risk Assessment

The degree of risk assigned to geohazards identified must be clearly reported in the text, maps, and other graphics that make up the geohazards report. The risk assessment criteria must be provided. For each potential hazard, the risk must be stated in terms of the likelihood of encountering the hazard at the specific location. The severity that the risk of the hazard presents to drilling operations and the environment is to be clearly specified.

Recommendations for a move of location to avoid a hazards and/or the application of suitable drilling techniques for mitigation of a recognized hazard should be included as appropriate.

Supporting Information

A short description of the regional geologic setting should be included. This should give a general description of the recent geological history of the study area pertinent to the seafloor and tophole section.

Conclusions and Recommendations

Principal conclusions regarding drilling geohazards, cultural resources, and biological communities should be listed in a concise section. Recommendations for avoiding or reducing the impact of the conditions addressed should also be listed. Graphical Data to be Included in Geohazards Reports

1) Location map(s) should show the location of the drillsite and the survey area with respect to widely recognized geographic features such as coastlines and international boundaries.

2) Contoured bathymetry maps are to be labeled and contour interval is to be such that seafloor shape is fairly portrayed without impairing easy use of the map.

3) Geologic features/geohazards maps should show all detected natural and man-made features (including all unidentified magnetic anomalies). These include features that could adversely affect the planned drilling operations, or features that could be adversely affected by the planned drilling operations (including cultural resources, environmental stipulation zones around protected hardground and live-bottom areas and/or chemosynthetic communities). Inferred active geological features must be differentiated from inactive ones [for example, active vs. inactive (buried) faults, fluid vents, or landslides].

4) Shallow structure map(s) are required at sites where strata are not horizontal or not continuous over the study area (i.e., either the shallow horizons are dipping, faulted, or have been locally eroded). The structure horizon that is mapped should be selected to show structural trends and features that could trap shallow formation pressures, especially in permeable units. Shallow structure maps are used to help select casing points and to develop the overall drilling plan. Therefore, structural contours must be labeled in meters and below the sea surface, based on the best available velocity information.

5) The method of seismic time-to-depth determination must be stated. Velocity surveys from nearby wells should be used whenever possible if the applicability in terms of geologic similarity can be determined and described. Seismic "moveout" velocities are usually acceptable if the source-to-receiver maximum offset is within 1.3 times the depth of the tophole section of the well, and the derived velocities are well behaved within lateral distance at least twice the tophole section depth. In rare cases, seismic refraction velocities may be used.

6) Isopach maps are required on the continental shelf if inferred weak surficial strata overlie a potentially stronger substrate. This will help to indicate areas that may need further analysis to determine jack-up punch-through potential. Isopach maps of the seafloor to the tops of the sand units are also desirable for analysis of shallow water flow sands.

7) Annotated data examples for each survey tool should be included to demonstrate typical data quality and geologic conditions. Additional data examples shall be added to help illustrate and explain the interpretations and conclusions reached. All data examples must be properly referenced in the text.

8) For proposed wellsites being assessed, the annotated data from each of the two (preferably perpendicular) lines nearest each proposed wellsite are to be included (only one line of side-scan data is required).

9) A seafloor rendering is requested in cases where dense, continuous seafloor bathymetric data are available. Seafloor reflection amplitude, edge, and dip magnitude maps are also requested. These are particularly desirable in areas which have evidence of formation fluid expulsion and/or appear to be favorable for chemosynthetic communities.

**Data Retention Requirements**

Survey data must be retained for further analysis and possible future enhancement. To insure that this is possible a number of procedures must be followed at the time of recording and the data must be retained in acceptable formats and with proper support information.

All field analog records must be properly annotated, retained and forwarded after analysis and reporting. All survey data must be digitally recorded. Analog playbacks must be made in the field from digital records to verify that digital records are readable. Digital field tapes must be read and played back in the field to ensure that recording media and systems are in proper order. All data must be accompanied by positioning references. Field notes of recording parameters and digital file references must be maintained and retained.

Types of data to be retained

Reflection Seismic Data (2D and 3D):

Field Data – as recorded (usually SEGD) + Observers reports

Navigation Data – UKOOA positioning and SPS?

Processed Data – SEGY format must be accompanied by a processing description including gain type and parameters, deconvolution type and parameters, stacking velocities, migration type and velocities. For 2D data, a clear description of the shot point to CDP position relationship should be included in the EDCDIC header. Any use of non-standard data fields must be described. Prestack CDP gathers as well as final, stacked, migrated output.

Special Processing – Such as AVO analyses, attribute derivation (and algorithm used) should be retained in SEGY format

High Frequency Acoustics

Fathometer, sidescan sonar, subbottom profiler, swath bathymetry – all analog playouts with field annotations and all digital recordings in recording system formats with observers reports from time of acquisition.

Soil sampling

Gravity cores, piston cores and geotechnical borehole logs and physical cores

ROV visual

Recordings with format description, time, date and depth stamps, and narratives.

Magnetometer

Analog plots as generated and annotated in the field and digital recordings with format descriptions and observers logs.

Derived products

Workstation derived horizon seismic horizon picks, and derived maps as described above in the reporting section.
Renderings derived 3D seismic and/or swath bathymetry

## Reference Materials

Guidelines for Site Survey and Safety, May 2002, Compiled by Karen Graber, ODP/TAMU Drilling Services Department.

Guidelines for the Conduct of Mobile Drilling Rig Site Investigations in Deep Water, Version 1.0, UK Offshore Operators Assoc iation. July, 2002.

PPSP Guidelines for Riser Drilling- as Draft of Safety Manual- Issue 1/ Revision 0, Compiled by Dr. Uko Suzuki, Center for Deep Earth Exploration (CDEX), Japan Marine Science and Technology Center (JAMSTEC),November 2002.

United States Department of the Interior, Minerals Management Service, Gulf of Mexico Region, NTL N0. 98-20, Notice to Lessees, Shallow Hazards Requirements, September 15, 1998.

United States Department of the Interior, Minerals Management Service, Gulf of Mexico Region, NTL N0. 200X-GXX, Information Requirements for Exploration Plans and Development Operations Coordination Documents, Draft, effective May 17, 2002.

UKOOA Surveying and Positioning Committee Seabed Survey Technical Sub Committee, Technical Notes for the Conduct of mobile drilling Rig Site Surveys (Geophysical and Hydrographic), December 1990.

Guidelines to Regulations Relating to Materials and Information in the Petroleum Activities (The Information Duty Regulations), Norwegian Petroleum Directorate, January 1, 2002.

# APPENDIX 1

## Hazard Impact Tables

This appendix is taken from the draft regulation (Notice to Lessees) before the United States Minerals Management Service. Minor modifications have been made to generalize it for IODP purposes.

### A. Bottom-founded Rigs

| Hazard Type or Concern | Impact on Operations | Comment |
|---|---|---|
| **Water Depth** | Suitability of Rig<br>• Barge draught<br>• Barge Freeboard<br>• Leg Length<br>• Expected seafloor penetration<br>• Achievable air gap | Derived from results from a precise bathymetric survey |
| **Seafloor Morphology**:<br><br>• Slope angle<br>• Fault escarpments<br>• Diapiric structures<br>• Gas vents<br>• Unstable slopes<br>• Mud-flow gullies<br>• Slumps<br>• Collapse features<br>• Sand waves<br>• Fluid expulsion features<br>• Rock outcrops<br>• Pinnacles<br>• Reefs | Choice of<br>• Rig Type (Barge, Mat or multi-leg jack up)<br>• Well location Can impact upon<br>• Risk of scour<br>• Rig stability<br>• Spud can damage | Mapped on the basis of an integrated use of<br>• Bathymetric data<br>• Side scan sonar data<br>• Profiler data |
| **Man-made Hazards**<br>• Pipelines<br>• Umbilicals<br>• Power Lines<br>• Communication cables<br>• Wellheads<br>• Miscellaneous Debris | Choice of<br>• Well location<br>• Stand-off location<br>• Direction of approach to and departure from location<br>• Positional tolerance<br>• Anchor locations | Mapped from the integrated use of<br>• Side scan sonar data<br>• Towed magnetometer data<br>• Profiler data<br>• Published pipeline and cable route charts |

| Hazard Type or Concern | Impact on Operations | Comment |
|---|---|---|
| | Can result in<br>• Spills and emissions<br>• Structural damage to rig or seafloor facilities<br>• Spud can damage | |

| | | |
|---|---|---|
| **Marine Sanctuaries** | Choice of<br>• Emergency transit locations<br>• Stand-off Locations<br>• Direction of approach on to and departure from location | As defined by regulatory authorities |
| **Shipping Clearways and Military Training Areas** | Choice of<br>• Location<br>• Stand-off locations<br>• Direction of approach onto and departure from location | As defined on published nautical charts |
| **Archaeological Features** | Choice of<br>• Location<br>• Stand-off locations<br>• Direction of approach onto location | As required by regulatory authorities Mapped from the integrated use of<br>• Side scan sonar data<br>• Towed magnetometer data<br>• Profiler data |
| **Shallow Soils**<br>• Sediment type<br>• Soil strengths<br>• Strength inversions<br>• Gas inclusions<br>• Hardpan<br>• Calcareous soils<br>• Coral | Choice of<br>• Rig type<br>• Well location<br>• Spud can or foundation type<br>• Drive pipe/conductor setting depth relative to leg penetration Can impact upon<br>• Footing Stability<br>• Amount of leg penetration.<br>• Punch-through<br>• Drive pipe/conductor driveability | Defined on the basis of an integrated use of<br>• Profiler data<br>• Multichannel HR seismic data<br>• Geotechnical soil data (where available)<br>• Side scan sonar data<br>• Offset well reports |
| **Hazard Type or Concern** | **Impact on Operations** | **Comment** |
| | • Tophole inclination | |
| **Hard Grounds** | Choice of<br>• Location Can impact upon<br>• Scour and differential rig settlement.<br>• Footing stability<br>• Spud can damage<br>• Conductor driveability<br>• Tophole inclination | |

| | | |
|---|---|---|
| **Shallow Faults** | Can result in<br>• Lost circulation<br>• Flow to surface in event of underground blowout, seafloor cratering, and resultant loss of rig.<br>• BHA deflection<br>• Stuck pipe and/or twistoffs<br>• Casing hang-ups<br>• Requirement for additional casing strings | Defined on the basis of an integrated use of<br>• Profiler data<br>• Multichannel HR seismic data<br>• Side scan sonar data |
| **Shallow Gas and Gas Cut Mud Sections** | Risk of<br>• Blowout<br>• Uncontrolled flow to seafloor<br>• Seafloor cratering<br>• Loss of rig Impacts<br>• Choice of location<br>• Setting depth of surface casing string<br>• Shallow casing plan | Shallow gas is defined as any gas pocket encountered above the setting depth of the first pressure containment string. Presence determined on the basis of an integrated use of<br>• Multichannel HR seismic data<br>• Offset well data<br>• Profiler data |
| **Tophole Geology**<br>• Sand<br>• Mud<br>• Clay<br>• Swelling clays or gumbo. | Choice of<br>• Length of drive pipe/ conductor<br>• Setting depth of first pressure containment string and subsequent | Defined on the basis of an integrated use of<br>• Profiler data.<br>• Multichannel HR seismic data<br>• Offset well and |

| **Hazard Type or Concern** | **Impact on Operations** | **Comment** |
|---|---|---|
| • Marl<br>• Loose formations<br>• Carbonate<br>• Salt<br>• Discontinuities<br>• Dip angle | casing strings<br>• Drilling parameters<br>Resulting from the risk of<br>• Overpressured zones<br>• Adverse lithologies<br>• Stuck pipe<br>• Twist off<br>• Poor hole condition | geotechnical borehole<br>data |

## B. Anchored Rigs

| **Hazard Type or Concern** | **Impact on Operations** | **Comment** |
|---|---|---|
| **Water Depth** | Suitability of rig<br>• Maximum permissible draught (coastal waters)<br>• Anchor system limitations (limb length and winch capacity)<br>• Boat support needs for anchoring<br>• Riser length available<br>• Maximum useable mud weight (in deep water)<br>• Amount of fatigue loading on riser | Derived from results of a precise bathymetric survey, although reflection seismic survey data may be used if properly calibrated. |
| **Seafloor Morphology**:<br>• Slope angle<br>• Fault escarpments<br>• Diapiric structures<br>• Gas vents<br>• Unstable slopes<br>• Mud-flow gullies<br>• Slumps<br>• Collapse features<br>• Sand waves<br>• Fluid expulsion features<br>• Rock outcrops<br>• Pinnacles<br>• Reefs | Choice of<br>• Well location<br>• Anchor locations Impacts on<br>• Anchor deployment and slippage<br>• Requirement for piggy back anchors<br>• Difficulty of spud in<br>• Leveling of wellhead<br>• Wellhead scour caused by current focusing | Mapped on the basis of an integrated use of a combination of these data types<br>• Bathymetry<br>• Side Scan Sonar<br>• Profiler data. In some cases, adequately processed 3D seismic imagery might assist in assessing the seafloor morphology. In water depths greater than 2000 feet 3D seismic imagery might provide an acceptable replacement for towed side scan sonar data. |
| **Chemosynthetic Communities** | Choice of environmentally neutral<br>• Location<br>• Anchor Locations<br>• Catenary touchdown points | Only applicable in water depths greater than 400 m. Defined using similar methods to 'Seafloor Morphology' above. |
| **Man-made Hazards**<br>• Pipelines<br>• Umbilicals<br>• Power Lines | Choice of safe<br>• Location<br>• Anchor Locations<br>• Design of anchor | Mapped from the integrated use of<br>• Side scan sonar<br>• Towed magnetometer |
| **Hazard Type or Concern** | **Impact on Operations** | **Comment** |
| • Communication Cables<br>• Wellheads<br>• Miscellaneous Debris | catenary profile | • Profiler data<br>• Published pipeline and cable route charts |
| **Marine Sanctuaries** | Choice of<br>• Anchor locations | As defined by regulatory authorities |

| | | |
|---|---|---|
| **Shipping Clearways and Military Training Areas** | Choice of<br>• Location | As defined by published nautical charts |
| **Munitions or Chemicals Dumping Grounds** | Choice of safe<br>• Well location<br>• Anchor locations<br>• Catenary touchdowns | Areas as defined by regulatory authorities |
| **Archaeological Features** | Choice of<br>• Location<br>• Anchor and catenary touchdown locations | Mapped from the integrated use of<br>• Side scan sonar data<br>• Towed magnetometer data<br>• Profiler data |
| **Shallow Soils** | Choice of<br>• Anchor type<br>• Anchor fluke setting angle.<br>• Anchor placement<br>• Requirement for piggy back anchors<br>• Influence mud mat design due to wellhead instability<br>• Length and strength of conductor<br>• Conductor installation technique<br>• Tophole inclination | Defined on the basis of an integrated use of<br>• Profiler data<br>• Multichannel HR seismic data<br>• Geotechnical soil data (where available)<br>• Side scan sonar data<br>• Offset well reports |
| **Hard Grounds** | Choice of<br>• Location<br>• Type of mooring system, i.e. all wire or wire and chain<br>• Anchor and catenary touchdown locations Can impact on | |
| **Hazard Type or Concern** | **Impact on Operations** | **Comment** |
| | • Anchor fluke setting angle<br>• Need for piggy back anchors<br>• Spud-in difficulty<br>• Tophole inclination | |

| | | |
|---|---|---|
| **Shallow Faults** | Can result in<br>• Lost circulation<br>• Broaching to surface in the event of underground lowout leading on to seafloor cratering and loss of the well<br>• BHA deflection<br>• Stuck pipe and/or twist-offs<br>• Casing hang-ups<br>• Requirement for additional casing strings | Defined on the basis of an integrated use of<br>• Profiler data<br>• Multichannel HR seismic data<br>• Side scan sonar data |
| **Shallow Gas and Gas Cut Mud Sections** | Can lead to<br>• Minor gas flow<br>• Hydrate formation on wellhead (water depths greater than 2000 feet)<br>• Gas kick<br>• Blowout<br>• Loss of well<br>• Loss of vessel buoyancy<br>• Uncontrolled environmental emissions Has direct impact on choice of<br>• Location<br>• Setting depth of surface casing string.<br>• Need for additional casing strings.<br>• Riser or riserless drilling approach. | Shallow gas is defined as any gas pocket encountered above the setting depth of the first pressure containment string. Presence determined on the basis of an integrated use of:<br>• Multichannel HR seismic data<br>• Offset well data<br>• Profiler data |
| **Hazard Type or Concern** | **Impact on Operations** | **Comment** |
| | • Drilling and cementing practices | |

| | | |
|---|---|---|
| **Shallow Water Flow** | Can lead to<br>• Uncontrolled flow to seafloor<br>• Problem cementing surface casing string<br>• Loss of integrity to surface casing string<br>• Formation fracture and flow to surface outside conductor.<br>• Loss of foundation support to wellhead<br>• Casing collapse<br>• Loss of well Has direct impact on<br>• Setting depth, and number of shallow casing points<br>• Shallow drilling practices<br>• Cementing practices | Shallow water flow is defined as a water flow from an overpressured aquifer at a depth above the setting depth of the surface casing. Predicted on the basis of an integrated use of<br>• Multichannel HR seismic data<br>• Offset well data and reports<br>• Exploration 3D data |
| **Gas Hydrate** | Presence of seafloor hydrate indicates<br>• Temperature and pressure conditions are suitable for formation of hydrate<br>• Seepage to seafloor<br>• Possibility of chemosynthetic communities.<br>• Potential for shallow gas Formation of hydrate can lead to<br>• Difficulty with emergency, or temporary location abandonment.<br>• Wellhead abandonment | Gas hydrate is an issue in water depths greater than 600 m. Predicted on the basis of an integrated use of<br>• Temperature probe data<br>• Side scan sonar data<br>• Profiler data<br>• Multichannel HR seismic data<br>• Exploration 3D data<br>• Offset well data and reports |

| **Hazard Type or Concern** | **Impact on Operations** | **Comment** |
|---|---|---|
| **Tophole Geology**<br>• Sand<br>• Mud<br>• Clay<br>• Swelling clays or gumbo.<br>• Marl<br>• Loose formations<br>• Carbonate<br>• Salt<br>• Discontinuities<br>• Dip angle | Impacts upon choice of<br>• Casing point(s)<br>• Setting depth of surface casing string | Defined on the basis of an integrated use of<br>• Profiler data.<br>• Multichannel HR seismic data<br>• Offset well and<br>• Geotechnical borehole data |

### C. Dynamically Positioned Rigs

| Hazard Type or Concern | Impact on Operations | Comment |
|---|---|---|
| **Water Depth** | Suitability of rig<br>• Riser length available<br>• Maximum useable mud weight | Results from Echo Sounder or Swath Bathymetry data **or** derived from reflection seismic survey data that has been properly calibrated. |
| **Seafloor Morphology**:<br>• Slope angle<br>• Fault escarpments<br>• Diapiric structures<br>• Gas vents<br>• Unstable slopes<br>• Mud-flow gullies<br>• Slumps<br>• Collapse features<br>• Sand waves<br>• Fluid expulsion features<br>• Rock outcrops<br>• Pinnacles<br>• Reefs | Choice of<br>• Well location<br>• Difficulty of spud in.<br>• Leveling of wellhead<br>• Layout of seafloor acoustic array.<br>• Wellhead scour caused by current focusing.<br>• Direction of departure in event of emergency disconnect | Mapped by the integrated use of a combination of these data types:<br>• Bathymetry data<br>• Side Scan Sonar data<br>• Profiler data In deep water, adequately processed 3D seismic imagery might assist in definition of the seafloor morphology. 3D seismic data may be an acceptable replacement for towed sidescan sonar data. |
| **Chemosynthetic Communities** | Choice of environmentally neutral well location | Defined using similar methods to 'Seafloor Morphology' above |
| **Man-made Hazards**<br>• Pipelines<br>• Umbilicals<br>• Power Lines<br>• Communication Cables<br>• Wellheads<br>• Miscellaneous Debris | Choice of safe location | Mapped from the integrated use of<br>• Side scan sonar<br>• Towed magnetometer<br>• Profiler data<br>• Published Pipeline and Cable route charts |
| **Munitions or Chemicals Dumping Grounds** | Choice of a safe well location | Areas as defined by regulatory authorities |
| **Shipping Clearways and Military Training Areas** | Choice of well location | As defined by published nautical charts |
| **Archaeological Features** | Choice of well location | Mapped from the integrated use of a combination of:<br>• Side scan sonar data |
| **Hazard Type or Concern** | **Impact on Operations** | **Comment** |
| | | • Towed magnetometer data<br>• Profiler data |

| Hazard Type or Concern | Impact on Operations | Comment |
|---|---|---|
| **Shallow Soils** | Choice of<br>• Mud mat design due to risk of wellhead instability<br>• Length and strength of conductor<br>• Conductor installation technique | Defined on the basis of an integrated use of:<br>• Profiler data<br>• Multichannel HR seismic data<br>• Geotechnical soil data (where available)<br>• Side scan sonar data<br>• Offset well reports |
| **Hard Grounds** | Choice of:<br>• Well location Can impact on:<br>• Need for piggy back anchors<br>• Spud-in difficulty<br>• Tophole inclination leading to need to re-spud. | |
| **Shallow Faults** | Can result in<br>• Lost Circulation<br>• Broaching to surface in the event of underground lowout leading on to seafloor cratering and loss of the well<br>• BHA deflection<br>• Stuck pipe and/or twist-offs.<br>• Casing hang-ups<br>• Requirement for additional casing strings. | Defined on the basis of an integrated use of<br>• Profiler data<br>• Multichannel HR seismic data<br>• Side scan sonar data In deep water integrated use of 3D exploration seismic data, in support of the above data types, might assist, depending on data quality, in assessing the presence and geometry of shallow faulting. |
| **Shallow Gas and Gas Cut Mud Sections** | Can lead to<br>• Minor gas flow<br>• Hydrate formation on wellhead (deep water only)<br>• Gas kick<br>• Blowout<br>• Loss of well<br>• Loss of vessel buoyancy<br>• Uncontrolled environmental emissions Has direct impact on choice of<br>• Well location<br>• Setting depth of surface casing string<br>• Need for additional casing strings<br>• Drilling and cementing practices | Shallow gas is defined as any gas pocket encountered above the setting depth of the first pressure containment string. Presence determined on the basis of an integrated use of<br>• Multichannel HR seismic data<br>• Offset well data<br>• Profiler data In deep water, and in some cases in shelf waters, integrated use of 3D or 2D exploration seismic data, in support of the data types listed above, might assist in assessing the presence of shallow gas and |

| | | |
|---|---|---|
| | | migration routes from depth. |
| **Shallow Water Flow** | Can lead to<br>• Uncontrolled flow to seafloor<br>• Problem cementing surface casing string<br>• Loss of integrity to surface casing string<br>• Formation fracture and flow to surface outside conductor<br>• Loss of foundation support to wellhead<br>• Casing collapse<br>• Loss of well Has direct impact on<br>• Setting depth, and number, of shallow casing points<br>• Shallow drilling practices<br>• Cementing practices | Shallow water flow is defined as a water flow from an overpressured aquifer at a depth above the setting depth of the surface casing. Predicted on the basis of an integrated use of<br>• Multichannel HR seismic data<br>• Offset well data and reports<br>• Exploration 3D data |
| **Gas Hydrate** | Presence of seafloor hydrate indicates | Gas hydrate is an issue in water depths greater than 600 |

| **Hazard Type or Concern** | **Impact on Operations** | **Comment** |
| --- | --- | --- |
| | • Temperature and pressure conditions are suitable for formation of hydrate<br>• Seepage to seafloor<br>• Possibility of chemosynthetic communities.<br>• Potential for shallow gas<br><br>Formation of hydrate can lead to difficulty with<br><br>• Emergency disconnect<br>• Temporary location abandonment or cessation of operations<br>• Wellhead abandonment | m. Predicted on the basis of an integrated use of<br>• Temperature probe data<br>• Side scan sonar data<br>• Profiler data<br>• Multichannel HR seismic data<br>• Exploration 3D data<br>• Offset well data and reports |
| **Tophole Geology**<br>• Sand<br>• Mud<br>• Clay<br>• Swelling clays or gumbo<br>• Marl<br>• Loose formations<br>• Carbonate<br>• Salt<br>• Discontinuities<br>• Dip angle | Impacts upon choice of<br>• Setting Depth of surface casing string<br>• Casing point(s)<br>• Drilling and cementing practices | Defined on the basis of an integrated use of<br>• Profiler data.<br>• Multichannel HR seismic data<br>• Offset well and geotechnical borehole data |

# APPENDIX 2

## Terminology

Terms used in these guidelines:

AUV – An Autonomous Underwater (or Undersea) Vehicle (AUV) is a submersible vehicle designed to dive and run a preprogrammed route. AUV can be used as survey platforms for sidescan sonar, swath bathymetry, subbottom profiler and video. These vehicles are not directly connected to the mother survey vessel but communication is usually possible through a low speed acoustic connection. Survey data are stored for retrieval at the surface.

Blowout Preventer – A mechanical system designed to control fluid flow from a wellbore through the use of annular flow restrictors or complete obstruction of the wellhead by use of a mechanical device to sever the drillpipe and seal the borehole.

CTD – Conductivity, Temperature, Density probe. A device, which is lowered through the water column, used to record these parameters for the acoustic velocity of the water.

Fathometer– A narrow-beam echosounder used to determine the water depth directly beneath a vessel. (Must be used in conjunction with a CTD probe and heave compensator.)

Fresnel Zone – A theoretical measure of the lateral resolution of seismic data. It is defined as the lateral radius from a central reflecting point within which the reflected energy arrives within one -half cycle of the energy from the central point. Because the Fresnel Zone definition is frequency dependent and the seismic data is composed of a band of frequencies, the dominant frequency of the seismic pulse is usually chosen for the computation. Seismic migration collapses the Fresnel zone and increases the lateral resolution.

Gas-cut Mud Sections – Some permeable subsurface formations contain formation fluids with a high proportion of dissolved gases. The gases may come out of solution and become free gas under the reduced pressure experienced with circulation to the surface.

Heave Compensation – all acoustic devices fixed to the survey vessel hull, such as the narrow-beam echosounder and swath bathymetry should have a heave compensation system to account for the rise and fall of the vessel due to wave and sea swell motions.

Magnetometer– A device constructed to be very sensitive to total magnetic intensity. It is very useful for detecting man-made ferrous materials such as pipelines, cables and debris.

Pressure Control – Pressure control is accomplished in two ways. The first and most desirable method is through balancing of formation pressures with fluid pressures due to the drilling fluids. The second is through mechanical restraint of fluid flow from the borehole through use of a “blowout” preventer (BOP).

Rendering – A surface representation using illumination azimuth and elevation, as well as vertical exaggeration and color to enhance and emphasize subtle geologic features.

Riser – A large diameter pipe extending from the wellhead on the seafloor to the drilling platform. During riser drilling, the drill string is run through the riser and the drilling mud pumped down through the drill string is circulated and returned to the drilling platform in the annular space between the drill string and the riser pipe.

ROV – A Remotely Operated Vehicle (ROV) is a tethered submersible vessel, which can be operated from the surface to observe underwater conditions and manipulate underwater facilities.

Shallow Gas – May be free (undisolved) gas of any composition, including hydrocarbon and carbon dioxide, and presents a hazard when allowed to enter the wellbore. Not only do hydrocarbon gases present a fire hazard, but gases with hydrogen sulfide portions are extremely toxic. Any free gas, which enters the seawater column, presents a hazard for loss of buoyancy to any floating platform or attending vessel. Free gas in or entering the formations which provide foundation for drilling platforms also present a hazard for loss of formation strength and rig stability.

Shallow Water Flow (SWF) -Unconsolidated sands with overpressured fluids encountered in the tophole section. When the formation fluid pressures are not contained sands may flow into the wellbore and under some circumstances their flow may erode the annulus around the surface conductor pipe and the foundation of the wellhead may be lost.

Sidescan Sonar– A side-looking sonar system towed at a relatively low height above the seafloor to record reflections from seafloor topography and objects lying on the seafloor. Sidescan sonar systems for hazard surveys usually operate at 500 or 100 kHz. In the 500 kHz mode the range is approximately 50 m. The range in the 100 kHz mode is over 100 m but with the increased range there is lower resolution.

Soil Borings – Sediment cores extracted for the seafloor from which soil strengths are measured.

Subbottom Profiler – an echosounder designed to record near-seafloor reflections. Profilers operate in pinger (narrow bandwidth) or chirp (broader frequency range) mode. The central frequency is usually 3 kHz for either pinger or chirp modes.

Swath Bathymetry – Also called multibeam, swath bathymetry is a hull-mounted echosounder system acquired to determine the water depth not only directly beneath the survey vessel but in "swaths" directly abeam to each side of the vessel track. Beams may be downward directed to cover an arc of 120 degrees (60 degrees from vertical for each side of the vessel. These data may also be recorded in "backscatter mode" where the intensity of the echo return is recorded and used as a measure of the water bottom hardness.

Tophole – The section of the well to be drilled without riser to bring drilling fluids and cuttings back to the drilling rig and also without a blowout preventer.

2D High-resolution Multichannel Seismic Data – A reflection seismic system designed to recorder high frequency, high-resolution seismic reflections from the first several hundred meters beneath the seafloor.