NOTE TO READER

This document was published in July 2002. If you need additional information, please contact ODP representatives in JOIDES, JOI, TAMU, or LDEO.

Additionally, page numbers listed in the Table of Contents and throughout this document are not accurate. They make reference to the format used in the 2002 document.

GUIDELINES

FOR

SITE SURVEY AND SAFETY

July 2002

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EXECUTIVE SUMMARY

All drilling operations involve some risk of accident or pollution. This has been recognized throughout history of the Deep Sea Drilling Project (DSDP) and Ocean Drilling Program (ODP). Policies to minimize drilling hazards originally developed during DSDP have been continually updated and improved by ODP.

These revised guidelines supercede the *JOIDES Journal ODP Guidelines for Pollution Prevention and Safety* (1992, volume 18) and were developed with input from the Pollution Prevention and Safety Panel (PPSP), Site Survey Panel (SSP), Lamont Doherty Earth Observatory (LDEO), Texas A&M University (TAMU), and the Joint Oceanographic Institutions, Inc. (JOI).

Section I is designed to help proponents prepare for the Site Survey and Safety Panel Reviews. There is a Safety and Site Survey Checklist on page five to assist proponents in completing the ODP Site Description Forms. Section II discusses the principal hazards that can be encountered during a cruise, including environmental hazards. Section III briefly describes hydrocarbon flow, kicks, and abandonment procedures. Section IV lists some of the issues to keep in mind during logging activities, and Section V describes some of the precruise and cruise responsibilities, including authority of key personnel.

The reader is referred to the following documents for additional information concerning safety practices and assessment:

- Introduction to Shipboard Organic Chemistry on the *JOIDES Resolutio*n, 2001, ODP Technical Note 30.
- Laboratory Safety and Hazard Communication Compliance Manual, unpublished.
- Hydrogen Sulfide Drilling Contingency Plan, 2002, ODP Technical Note XX**.

Safety and Site Survey Checklist

Proposal Information

__ New or revised proposal
__ Title of proposal
__ Date the form is being submitted
__ Site-specific objectives (must include general objectives in proposal)
__ List previous drilling in area

General Regional Information

__ Leg number, if assigned
__ Site name (e.g., BON-9A)
__ Latitude and longitude of site in degrees and minutes
__ Priority of site (e.g., primary or alternate)
__ General location or geomorphic province of site
__ Jurisdiction
__ Distance to land (nmi)
__ Water depth (m)
__ Probable thickness of sediments (m)
__ List possible hazards (ice, hydrocarbons, dumpsites, cables, etc.)
__ Is there a weather window? If so, what is it?

Operations

__ Proposed total penetration (m)
__ Proposed sediment penetration (m)
__ Proposed basement penetration (m)
__ Description and nature of anticipated sediment lithology(ies) (i.e., carbonate ooze [200 mbsf], mudstone [200-350 mbsf) with chert stringers, limestone [350-400 mbsf])
__ Description and nature of anticipated basement lithology(ies) (i.e., fractured pillow basalts, 2 Ma, 400 mbsf to TD)
__ Coring tools
__ Logging Plan (check as many as apply)
__ Estimated number of days of drilling/coring and logging
__ Total days on site

Detailed Coring Plan

__ Coring Plan (circle as many as apply)
__ Sediment penetration (m)
__ Basement penetration (m)
__ Specialty tools required and number of runs/measurements (i.e., APC core orientation, APCT, APCM, DVTP-P, PCS, WSTP, FWS, packers, etc.)

Detailed Logging Plan

__ Answer conical side-entry sub question.
__ Answer high-temperature question.
__ Are there any other special requirements for logging? Describe if answer is yes.
__List scientific objectives for different logging measurement types (see page 3 of site description form) and relevance logging tool has to meeting scientific objectives.

Detailed Site Survey Information

__Fill in the data type boxes 1-17 on page 2 of site survey form (seismic reflection, seismic velocity, seismic grid, refraction, 3.5 kHz, swath bathymetry, side-looking sonar, photography or video, heat flow, magnetics, gravity, sediment cores, rock sampling, water current data, ice conditions, OBS microseismicity, navigation, other. (List all that apply).

__ DSDP/ODP Holes

__ Piston cores

Pollution & Safety Hazard Summary

__List all hydrocarbon occurrences greater than background levels based on previous DSDP/ODP drilling.

__ List all commercial drilling that produced or yielded hydrocarbon shows.

__ List indications of gas hydrates.

__ List any reasons to expect hydrocarbon accumulations at this site.

__ List any special precautions during drilling.

__ List abandonment procedures.

__ List other natural or manmade hazards.

__ Summarize the major risks.

INTRODUCTION

The value of the scientific objectives that are sought in the Ocean Drilling Program (ODP) must be balanced against potential hazards so that ODP will achieve these objectives while maintaining high standards of safety and pollution prevention. With diligent planning and careful operational procedures, it is possible to achieve desired goals and minimize risks.

Adherence to the old adage of "an ounce of prevention is worth a pound of cure" offers the surest route to safety and prevention of pollution. Money and time spent on extra care in preliminary site surveys, choice of site locations, and in planning drilling operations may forestall an accident that could cause loss of life, property, and damage to the environment, and could also handicap or even cause termination of this major international scientific endeavor.

The diverse sites planned for ODP drilling require emphasis on pollution prevention and safety, both during site evaluation and cruise operations. This is especially the case given the continued interest in deeper sediment penetrations, natural flow features, hydrates, high-temperature features, and in shallower water sites on continental margins.

Purpose

The purpose of this document is two-fold: (1) it is a guide for proponents as to the role the JOIDES Pollution Prevention and Safety Panel (PPSP) and Site Survey Panel (SSP) play in the review process, (2) it updates the information provided by the *JOIDES Journal* Special Issue No. 7, and (3) it is a document of shipboard, precruise, cruise, and postcruise safety activities. The purpose of these "guidelines" is to provide a practical and flexible framework on which leg and site-specific "procedures" can be based by mutual agreement of the science and ship's operators (ODP at TAMU and Transocean Sedco-Forex [TSF]) management, scientific community, and shipboard supervisors. It is not possible in one document to foresee and clearly cover all the contingencies, combinations of reactions, or ultimate effects that may occur in a given situation; therefore, a team effort is crucial to determine the best course of action and coordinate operations.

The reader is also referred to the following documents for additional information concerning safety practices and assessment:

- Introduction to Shipboard Organic Chemistry on the *JOIDES Resolutio*n, 2001, ODP Technical Note 30.
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I. GUIDELINES FOR SITE SURVEY AND SAFETY REVIEWS

I.A. OVERVIEW OF SCIENTIFIC PROPOSAL PROCESSING

The JOIDES office provides scientific direction and planning advice to JOI for the Science Operator at Texas A&M University (ODP/TAMU) and Wireline Logging Services Operator (Lamont-Doherty Earth Observatory [ODP/LDEO]) through an advisory structure of panels and committees. There are two main committees: (1) EXCOM (Executive Committee), which oversees all policies and procedures and (2) SCICOM (Science Committee), which oversees the science. These two committees and their associate subgroups forward recommendations to the ODP prime contractor, the JOI for action. Recommendations concerning the science operator are forwarded to ODP/TAMU.

JOIDES service panels provide advice to the advisory structure and include the Site Survey Panel (SSP), Pollution Prevention and Safety Panel (PPSP, also known as Safety Panel), and Scientific Measurements Panel (SciMP). The Technology and Engineering Development Committee (TEDCOM) provides advice to ODP through the Operating Committee (OPCOM) on technical matters, drilling tools, and techniques to meet scientific objectives as well as monitors the progress of their development.

Scientific proposals are reviewed by the Science Steering and Evaluation Panels (SSEPs) for Environment and Interior, which select scientifically mature proposals for external review. SCICOM (with advice from the SSEPs) creates small focused short-term Program Planning Groups (PPGs) to work with proponents to produce mature proposals that cover specific scientific themes.

Following reviews of proposals by external panels, the SSEPs forward scientifically mature proposals to SCICOM with a recommendation for inclusion in the drilling program. SCICOM ranks all the proposals and sends them to OPCOM. OPCOM receives reports from the SSEPs and PPGs and recommends the drilling program schedule to SCICOM for approval. The SSP provides advice to ODP through OPCOM on the adequacy of, and need for, site survey information relating to proposed drilling targets. The PPSP provides advice to ODP through OPCOM regarding potential safety and pollution hazards that may exist because of general or specific geology of the seafloor or as a consequence of human activities.

Both the JOIDES PPSP and the ODP/TAMU Safety Panel (SP) give advice and make recommendations that are incorporated in the final decision on whether a specific site will be drilled, including maximum depth of penetration and any precautionary procedures required. The

Co-Chief Scientists typically attend the formal joint safety review with the PPSP about 9 to 12 months prior to the leg. Co-Chief Scientists or a delegate document during the safety review potential safety issues extant at proposed sites and the safety panels examine these data.

The ODP/TAMU Drilling Services Department (DSD) provides ODP/TAMU management with a preliminary leg review, and ODP/TAMU management advises SCICOM and OPCOM on operational feasibility, time, cost, location, and environmental factors. SCICOM reviews and approves the proposed drilling schedule recommended by OPCOM and forwards it to EXCOM for approval. ODP/TAMU management assembles a ship schedule and assigns key personnel, and the ODP/TAMU DSD formulates a detailed operating plan in concert with the Staff Scientist/Leg Project Manager, Co-chiefs, TSF, and LDEO.

A Precruise meeting is held with the Co-Chiefs at ODP/TAMU about 6-12 months prior to the leg, and the ODP/TAMU Operations Manager (Ops Mgr), Staff Scientist/Leg Project Manager (LPM), and Lab Officer become involved in detailed planning with the Co-Chiefs. A final detailed Scientific Prospectus is prepared as a result of the precruise meeting, reflecting the agreed upon priorities and implementation strategies.

I.B. SITE SURVEY (SSP) AND SAFETY (PPSP) PANEL REVIEWS

On notification from the JOIDES Office, proponents of proposals that have been highly ranked by the SSEPs must submit supporting site survey data packages to the ODP Site Survey Data Bank for archiving (see check list page 5). These data packages are evaluated by the SSP and PPSP to determine if (1) the proposed sites are adequately imaged from the data, (2) the sites selected based on the data can answer the scientific questions that have been posed, (3) the sites are in feasible places for the *JOIDES Resolution* to core, (4) the package contains sufficient information to support both the science and the drilling operations at each site, and (5) no natural or manmade hazards are evident near the proposed drill site that will endanger the ship, its crew, or the environment. SSP reviews highly ranked proposals as advised by the JOIDES Office, and follows those placed on the drilling schedule until each leg sails. The PPSP, on the other hand, generally reviews only scheduled legs, but will preview proposals that are identified as having potential safety concerns. The PPSP previews provide proponents an opportunity to address safety issues before the final PPSP review.

I.B.1. Site Survey Review

At their winter and summer meetings the SSP reviews full proposals that have undergone external review. The SSP provides advice to proponents on specific data requirements for each proposed site. These requirements are based upon the objectives of each site and the local geologic environment. SSP only reviews data submitted to the ODP LDEO Site Survey Data Bank.

The time required for a proposal to become a scheduled drilling leg depends to a large degree on completeness of the site survey data package. Proponents are therefore urged to submit as much of the required data as early as possible, once they are notified to do so by the JOIDES Office. Data must be received in the Data Bank no later than the 15th of February and the 1st of July to be reviewed by SSP at their Winter and Summer meetings, respectively. If survey data are to be collected in the future, information on the timing of cruises, firmness of funding, and period required for data processing before submission should all be noted in the proposal.

The Site Survey Panel will review these proposals and the supplied data and provide advice to proponents on how to improve their data packages. SSP also provides comments to SCICOM and OPCOM on the status of the site survey data package with respect to its readiness for drilling. At the same time, it identifies those proposals that may have potential safety problems, and passes this information along to the PPSP and the proponents. Proponents of these proposals may be asked to present their data to the PPSP for a safety preview at the panel's earliest convenience. The PPSP, on examination of the data package, will provide guidance on site selection and data processing to improve imaging of the sites, and on modification of site locations so that they are safe to drill and still meet the scientific objectives.

I.B.2. Site Survey Target Types and Data Standards

Proponents should be aware that the comments below are only guidelines. The Site Survey Panel's advice to SCICOM/OPCOM on the acceptability of a data set is based on scientific judgment. In particular, SSP seeks to determine: (1) are the regional and site-specific survey data of sufficient quality and quantity that it will be possible to pick the best possible sites at which to address the scientific questions posed in the proposal and, (2) if a site is drilled, are the regional and site-specific survey data of sufficient quality and quantity that it is likely to be possible to extrapolate the results from this borehole over a usefully broad portion of the ocean and/or to apply the results from this borehole to related questions and analogous sites worldwide?

(a) Target Types

Target categories describe broad types of drilling objectives. Individual sites with multiple objectives may be required to meet the standards of more than one of the target categories. For example, sites frequently have shallow advanced piston corer (APC) objectives (Target A) and deeper sedimentary and basement objectives (Targets D or E).

These guidelines cover drilling targets in more than 650 m of water. **Proposed sites in less than 650 m of water, regardless of target type, are governed by additional shallow-water hazard survey requirements.** See the *Guidelines for Shallow Water Hazards Surveys, Report of the Shallow Water Drilling Working Group* and section II.C.4. in this manual for details on these specialized requirements.

Table 1. Target Types

Target A:	Paleoenvironment or fan, generally APC/extended core barrel (XCB) penetration into undeformed sediments.
Target B:	Greater penetration than a few hundred meters on a passive margin.
Target C:	Greater penetration than a few hundred meters on an accretionary wedge, fore-arc, or sheared margin.
Target D	Greater penetration than a few hundred meters in a deep ocean environment. May or may not include basement penetration.
Target E:	Sediment thickness of less than a few hundred meters on oceanic crust; typically with basement as a primary objective.
Target F:	Bare rock drilling, e.g., ridge crest or fracture zone ridge.
Target G:	Topographically elevated feature. Elevated features with widely varying sediment thickness, e.g., seamount or fracture zone ridge. Basement is often an objective.
Target H:	Offset drilling into Tectonic Windows.

(b) Types of Survey Data

The most commonly used techniques for site surveying are conventional and swath bathymetry, magnetic and gravity field measurements, coring and dredging, heat flow, single and multichannel seismic reflection profiling, side-looking sonar, and crustal seismic refraction using ocean-bottom seismometer and wide-angle reflection sonobuoy measurements. All survey methods are not appropriate for all sites, and specific combinations are chosen by proponents to get the maximum useful information for the minimum cost.

The following matrix (see Table 2) shows site survey guidelines for each target environment. Sites that lack a data type characterized as "X: required" will generally not be scheduled for drilling. Lack of a data type characterized as "Y: recommended" will not keep a site off the drilling schedule; however, if data of a recommended type does exist, the proponents are expected to submit the data for use by the ODP community in site selection and post-drilling interpretation. For data types marked as "X*" or "Y*", the SSP will advise, on a site by site basis, whether the specific data type is required or recommended to support the proposed science.

Data in support of each proposed site must be submitted to the ODP Site Survey Data Bank. For details on the proper format and annotation of the data packages, refer to the section on "Guidelines for Data Submissions" or go to www.ldeo.columbia.edu/databank.

The major data categories are:

1. High-resolution seismic reflection:

Acquisition and processing are designed for optimal imaging of the shallow (<1 second) section. Digital acquisition is preferred. For Target Type B, high-resolution seismics may be required where there is concern about slumping or shallow gas. For Target Types D and E, basement objectives must be clearly imaged using either high-resolution or deep-penetration seismics, as appropriate. For Target Type H, high-resolution seismic data and/or 3.5 kHz data will be required if sites are proposed to spud into sediment pockets. For Target Type F, regional high-resolution seismics and/or 3.5 kHz are recommended to identify potential backup sites in sediment pockets. Seismic reflection data should penetrate at least as deep as proposed total depth of drilling.

2. Deep-penetration seismic reflection:

Acquisition and processing are designed for optimal imaging of the deep (>1 sec) section (i.e. multichannel seismic (MCS) with a large-volume, low frequency source and a long enough streamer to provide adequate multiple suppression). For Target Types D and E, basement objectives must be clearly imaged using either high-resolution or deep-penetration seismics, as appropriate. For Target Type H, a regional MCS or OBS-refraction survey (not necessarily including lines exactly over the site) is recommended to determine the regional crustal structure before tectonic dismemberment.

3. Seismic velocity:

Seismic velocity data are used to determine sediment thickness and drilling depths at proposed sites. Proponents are urged to submit sound velocity data that include a brief description of how they were derived, where they apply, and an estimate of their accuracy. SSP suggests that the data presentation include a graph of two-way travel time below seafloor vs. calculated meters below seafloor (mbsf) and actual (proven by drilling) VSP log velocity data in similar geologic/lithologic settings. Velocity information is required when drilling is proposed for sites with over 400 m of sediment penetration.

4. Grid of intersecting seismic profiles:
A seismic grid and/or crossing lines over the proposed site is required. Required density of the seismic grid depends on each particular situation.

5. Refraction:
See Table 2 for requirements on 5a) near-surface and 5b) near-bottom collected refraction data. Sonobuoy or ocean bottom seismometer refraction profiles; tomographic imaging; expanding spread profiles or wide-angle refraction profiles. For Target Type H, a regional MCS or OBS-refraction survey is recommended to determine the regional crustal structure before dismemberment. For Target Types F and H, near-bottom source/near-bottom receiver seismic imaging is an experimental technique that holds great promise as a site survey tool. SSP is following the development of this technology with great interest, and may upgrade this data type to "required" at a future date. OBS surveys are especially important in vertical relief areas (e.g., ridges and canyons).

6. 3.5 kHz:
High-frequency data to resolve small scale features and give some indication of sediment type. For Target Type H, high-resolution single channel seismic (SCS) data and/or 3.5 kHz data will be required if sites will spud into sediment pockets. For Target Type F, regional SCS and/or 3.5 kHz data are recommended to identify potential backup sites in sediment pockets.

7. Swath bathymetry:
Swath bathymetry, as from a multi-narrow-beam echo sounder or an interferometric side-looking sonar system is required for all bare-rock drilling sites. This information also may be required for any site with steep or complex topography. Areas where slumping may occur should have swath bathymetry and/or side-looking sonar data.

8. Side-looking sonar imagery:
See Table 2 for requirements for 8a) surface collected and 8b) near-bottom tow data. Acoustic reflectivity from sonar devices is needed on fans and in topographically complex terrains. Areas where slumping may occur should have swath bathymetry and/or side-looking sonar data.

9. Photography or Video:

Visual imagery from a towed vehicle or submersible is required for siting bare-rock guide bases, and may be desirable to understand the tectonic or geological setting of specific nonbare rock sites.

10. Heat flow:

Pogo-type profiles or piston core heat-flow measurements in detail, with in situ thermal conductivity for highest accuracy, as appropriate to the scientific problem.

11a. Magnetics:

Regional magnetics are required if magnetic age of crust is important. For Target Type H, a regional magnetic survey is required to determine the age of the oceanic crust and the plate kinematic history of the site.

11b. Gravity:

Gravity for subsidence studies; Seasat data may complement regional gravity picture.

12. Sediment Cores:

Cores should be taken near all paleoenvironmental sites. All reentry sites should be supported by cores, core descriptions, and geotechnical measurements (contact ODP/TAMU for geotechnical requirements). The two limiting factors for reentry operations are sufficient sediment thickness, and the ability to wash through the sediment section. Sediment cores will be required for Target Types F and H only if back-up sites are proposed in sediment pockets.

13. Rock sampling:

Dredging, submersible sampling, and/or rock coring may be required when basement drilling is included in the objectives. For Target Type H a closely spaced, precisely positioned suite of samples is required in the immediate vicinity of the drill sites, as well as a less-dense suite of samples over a broader region. Samples must be analyzed for geochemical and/or petrological and structural characteristics. For Target Types B and C, the recommended rock sampling refers to outcrops in nearby canyons or other exposures, where available.

14a. Water Current Data:

Information on bottom currents will be required when currents exceed 2 kt, frequently change directions (gyres), or bottom shear might be a problem. Shallow water sites may need tidal current information as well.

14b. Ice Conditions:

Data on ice conditions and timing. This information is needed for hazard assessment, scheduling drilling, and planning for ice boat support in northernmost and southernmost latitudes as appropriate.

14c. Weather:
Data on optimal weather periods and periods to avoid. This information is needed for scheduling and hazard assessment.

15. OBS Microseismicity:
Microseismicity as determined from ocean bottom seismometers is recommended in regions where active basement faulting is expected.

16. Navigation:
Navigation will be accepted in date/time or shotpoint units for newly acquired data. Submission of common depth point (CDP) and common mid point (CMP) navigation is discouraged as the numbering schemes often change with further processing. Whatever type of navigation is submitted must match the units that appear on the actual seismic lines.

17. Other
Any type of data that is not listed but which may be useful in documenting the geological environment of the proposed site. For example, weather forecasts from local/regional sources, including historical data and man-made hazards, e.g., pipelines, submarine cables, munitions dumps, abandoned holes, etc.

(c) Commercial Data
Proponents should be aware that, in addition to SSP's data requirements, they will eventually have to meet the additional requirements of the PPSP (for a brief overview of safety reviews see section I.C.). As part of a safety review, proponents should present maps of commercial well locations near their proposed drill sites, and information regarding nearby hydrocarbon occurrences (production data, reservoir and source intervals, shows, etc.) to PPSP. Seismic ties to nearby commercial wells, and heat-flow data with which to assess potential hydrocarbon maturation may also be requested. As it can take considerable time to acquire such information from commercial sources, proponents are urged to begin the effort as early as possible. Leaks in existing wellbores can change previously unpressured zones.

TABLE 2. Site Survey data-type requirements for each drilling environment (Target Type).

	TARGET TYPE	A	B	C	D	E	F	G	H
	DATA TYPE	Paleo environ-ment or Fan (APC/XCB)	Passive Margin	Active Margin	Open Ocean Crust (>400 m sediment)	Open Ocean Crust (<400 m sediment)	Bare-rock Drilling	Topo-graphically Elevated Feature	Tectonic Window
1	High-Resolution Seismic Reflection	X	Y, X*	Y, X*	X or 2	X*	Y, X*	Y, X*	X* or 6
2	Deep Penetration Seismic Reflection		X	X	X or 1	X*	Y, X*	Y, X*	Y or 5a
3	Seismic Velocity Determination	X*	X	X	X*	X*		X*	
4	Grid of Intersecting Seismic Profiles	Y, X*	X	X	Y, X*	Y, X*	Y*	Y, X*	
5a	Refraction (surface source)		Y, X*	Y, X*	Y, X*	Y, X*	Y, X*	Y, X*	Y or 2
5b	Refraction (near bottom source and receiver)						Y*		Y*
6	3.5 kHz	X	X	X	X	X	Y, X*	X	X* or 1
7	Swath Bathymetry	Y, X*	Y, X*	X	Y*	Y, X*	X	Y, X*	X
8a	Side-looking Sonar (shallow towed)	Y*	Y, X*	Y		Y*	Y	Y, X*	Y
8b	Side-looking Sonar (near-bottom towed)	Y, X*	Y, X*	Y, X*		Y*	Y, X*	Y, X*	Y, X*
9	Photography or Video			Y			X	Y, X*	X
10	Heat Flow		Y, X*	Y, X*		Y, T	Y		
11a	Magnetics		Y	Y	Y, X*	Y, X*	Y, X*	Y	X
11b	Gravity		Y	Y	Y*	Y*	Y*	Y	Y
12	Sediment Cores	X	Y, R	Y, R	R	R, T	X*	Y, X*, R	X*
13	Rock Sampling		Y	Y		Y, X*	X	Y, X*	X
14a	Water Current Data	X*	X*	X*			X*	X*	X*
14b	Ice Conditions	X*	X*	X*	X*	X*	X*	X*	X*

15	OBS Microseismicity						Y*		Y*
16	Navigation	X	X	X	X	X	X	X	X
17	Other	X*	X*	X*	X*	X*	X*	X*	X*

X = Required
X* = May be required for specific sites
Y = Recommended
Y* = May be recommended for specific sites

R = Required for reentry sites
T = Required for high-temperature environments
Data on Ice Conditions are for sites in high-latitude areas

I.C. POLLUTION PREVENTION AND SAFETY PANEL (PPSP) REVIEW

The PPSP is composed of petroleum geologists, geophysicists, engineers, and organic geochemists drawn from industry, government, and academia, who are recognized authorities in the fields of marine research and offshore oil exploration. They provide independent advice on the safety of drill sites to both JOIDES and ODP. The PPSP is actually composed of two separate groups, the JOIDES Safety Panel and the TAMU Safety Panel (SP). In questioning presenters during a PPSP review, reviewing data and discussing problems, there is no distinction between the two groups. Following reviews of the site data and PPSP advice, ODP/TAMUSP makes a final recommendation regarding site safety and the operations plan.

All drilling operations involve some risk of accident or pollution. This has been recognized throughout the history of the Deep Sea Drilling Project (DSDP) and ODP. Policies to minimize drilling hazards originally developed during DSDP have been continually updated and refined for ODP. The value of the potential scientific results of any drilling proposal must be balanced against the potential hazards so that ODP can continue to achieve valuable scientific results without jeopardizing the health of individuals, the environment, or the future of the program.

The diverse sites planned for ODP drilling involve additional hazards not encountered in previous DSDP drilling. Holes are now planned for deeper sediment penetration and/or in shallower water on continental margin sites. Moreover, the *JOIDES Resolution* continues to face drilling hazards inherent in operating without a drilling riser to the surface, return circulation, or standard blowout preventers. Although improved seismic surveys, an expanded borehole logging program, and advanced hydrocarbon monitoring capabilities help detect hazardous conditions during the cruise, the key to preventing an accident is the selection of safe drilling locations before the ship ever sails.

Once a full proposal has undergone SSP review and is placed onto the drilling program, it will be scheduled for further review by the PPSP at least six months prior to the leg's departure. Co-Chiefs or delegate of the newly scheduled leg must prepare a written safety report that examines each site from the perspective of potential hazards, and they must also make an oral presentation of the existing data to the Panel at their meeting. Failure by Co-Chief Scientists or their delegate to meet their responsibility of providing adequate data for review will result in rejection of drill sites by the PPSP.

I.C.1. Written Safety Report

Prior to the scheduled PPSP review, the Co-Chiefs or their delegate of the scheduled leg must produce a written synthesis of the geological, geochemical, and geophysical data at each site, with an emphasis on hydrocarbon potential, possible trap structures, and other possible hazards. This report is submitted to the ODP Site Survey Data Bank, which then provides electronic versions on the WWW site for access by PPSP members prior to the meeting. Safety reports are also required for proposals being previewed by the panel. Generally, the reports contain the following information.

Table 3. Information required for the written safety report to PPSP.

1.	Regional map showing bathymetry, latitude and longitude, nearest land areas, and proposed site locations.
2.	Track charts showing proposed sites and specific lines or line segments included for review.
3.	Cross-tied seismic reflection lines of sufficient length and details to define closures. Seismic events should be legible to the depth of proposed penetrations. Seismic data may be presented as records or photographic prints. Suitable annotated negatives of prints must be sent to the ODP Site Survey Data Bank. The following annotations should be included on these lines (a) site number, location, and penetration depth; (b) traverse direction; (c) horizontal scale in kilometers; (d) vertical scale in seconds or meters; (e) course changes; (f) identification of important reflections; and (g) cross-line intersection points.
4.	Sketches of major structural elements, sediment thicks and thins, and areas of distinctive reflection character.
5.	Safety review check sheets.

Material submitted for each site should be indexed and annotated to enable ready identification of structural features, line locations, line directions, wells, grab samples, cores, etc.

The purpose of the written report is twofold. First, it requires the individuals to shift focus from the science of their sites to safety and operational issues. Secondly, by having the report in-hand prior to the meeting, the PPSP members are able to locate additional data from their own sources that can be brought to the meeting to assist in site discussion. The report must include a complete set of Safety Checksheets (pages 4 and 5 of the site description forms) for each proposed site. Contact the ODP/LDEO Site Survey Data Bank for assistance in preparation of the report.

I.C.2. Oral Safety Presentation

At the PPSP meeting, Co-Chiefs or their delegate must make a formal presentation of pertinent data for each site and then discuss any safety issues with the panel. Most of the data needed for these safety reviews are also required for the SSP review, however additional, safety related items should be submitted to the ODP Site Survey Data Bank in an appropriate format prior to the PPSP meeting.

Based on the data presented, the PPSP will advise the presenter that a site either: (a) is recommended for approval as proposed, (b) should be moved to a safer location that is still compatible with the scientific objectives; or (c) is rejected due to inadequate data or inherent risk. The PPSP may recommend a preferred order of drilling if safety is a factor, and may also specify conditions of approval, such as maximum depth of penetration, or special monitoring requirements. It should be noted that proposing sites on structural highs will generally yield recommendations to relocate them onto the flank of the structure. The PPSP is also inclined to relocate drill sites to intersections of seismic lines, especially where sedimentary sections are thick and where traps could occur. In general, the panel will expect to see full size copies of the information listed in Table 4.

I.C.3. Shallow-Water Hazards Surveys

During their October 1992 meeting, concern regarding potential for gas blowouts in shallow-water settings caused the JOIDES and ODP/TAMU Safety Panels to disapprove a number of proposed drill sites on the New Jersey shelf. The special blowout danger in shallow-water drilling is that gas, with its attendant threats of fire and explosion, will reach the sea surface at or in close proximity to the drilling vessel. In ODP drilling, this danger is compounded by the drillship's lack of a blowout preventer (BOP) and limited ability to use weighted drilling mud to contain gas release on a scale comparable to a standard oil and gas exploration rig.

Table 4. Information required for the oral report to PPSP.

1.	All available bathymetric data.
2.	Track charts with locations of geological, geophysical and geochemical data; seismic lines to be reviewed; site locations.
3.	Structure maps, sedimentary thickness maps and maps of estimated depth to base of clathrate horizons.
4.	Seismic reflection data sufficient to defend the safety of each site. In the event a site is moved, it is necessary to base the new location on additional seismic data. Documentation should be available for alternate locations. Drilling below the depth

	of resolution of seismic data will not be approved. Interval velocity information should also be provided.
5.	Seismic refraction, gravity and magnetic data.
6.	Hydrocarbon occurrences at nearby boreholes or exploration wells should be tabulated. Oil companies should have been encouraged to release such data. Potential source rocks should have been identified and mapped.
7.	International jurisdiction and extent of nearby oil leases.
8.	Lithologic descriptions of available cores and dredges, together with existing analyses of sediments and bottom water for presence of hydrocarbons.
9.	Regional geologic maps and cross-sections for consideration of possible relationship of onshore and offshore geologic sections. Reservoir data should also be made available, if possible.

Shallow-Water Drilling Guidelines

JOIDES and ODP have seen an increasing number of drilling proposals with sites located in shallow water (<650 m) on the continental shelves. Shallow-water operations follow the recommendations adopted by the JOIDES panels of the Shallow-Water Drilling Working Group (SWDWG).

These guidelines include:

1. Open-hole drilling in shallow water is reasonably safe if proper hazards surveys are conducted and combined with proper data processing and interpretation. See "Guidelines for Water Depth Ranges under II.C.4.
2. Hazards surveys must be a requirement for ODP drilling on sedimented shelves in water depths of 650 m or less.
3. Sub-bottom penetrations at those depths, without BOP and mud-weight capabilities, must be limited to 1000 m.
4. Operational procedures for shallow water drilling such as: maintaining kill weight mud, slow coring for adequate evaluation, monitoring the seabed for gas escape, and safety contingency plans must remain in force.
5. Interpretation of the survey data in terms of shallow gas hazards should be made by experts in the field who are not associated with the scientific proposals justifying the program.
6. ODP's slim, open-hole drilling from a dynamically-positioned vessel is a relatively safe method for shallow-water operations but blowouts must be avoided.

The guidelines developed by the SWDWG continue to be modified as necessary. Regulatory and scientific differences make change a necessity. Evolution of geophysical equipment used in high-resolution hazards surveys is continual. In general, state-of-the-art equipment will be required for ODP shallow-water surveys. The Shallow-Water Site Survey Guidelines are as follows:

The objective of a shallow-water gas hazards survey (SWGHS) is to identify occurrence of gas, from the seafloor down to at least 1000 m, at a site proposed for ODP drilling. SWGHS is required at proposed sites to allow the Science Operator (ODP/TAMU), together with the JOIDES PPSP and the ODP/TAMUSP, to properly evaluate the safety aspects of a site and to determine whether drilling should be undertaken or not.

ODP/TAMU shall be involved with the proponents in the planning of Shallow Water Gas Hazards Surveys and shall be responsible (both technically and fiscally) for quality control during data acquisition, processing, and interpretation of Shallow Water Gas Hazards Surveys for full proposals undergoing review. Funds to conduct Shallow Water Gas Hazards Surveys (including ship time, data acquisition, and data processing) are the responsibility of the proponent(s).

Shallow water is defined as water depths less than 650 m. The reason for selecting this depth is that gas blowouts at greater depths should not be catastrophic to the drill rig, whereas blowouts from shallower depths can be.

It is assumed that prior to the SWGHS proponents will have acquired seismic data sufficient to justify the scientific objectives and to specify actual drill sites to address the science objectives. The SWGHS specifications are designed so that safety aspects of specific sites can be evaluated. In general the SWGHS will provide the proponent with images of the scientific targets that are better than those acquired previously. The proponent should bear in mind that sites may have to be moved for safety reasons and that alternate sites could be picked from the SWGHS, providing the area covered by the survey is large enough to do this.

A shallow water hazard survey will have seven general requirements:

1. Accurate navigation
2. A dense survey grid
3. Side-scan surveys to identify seafloor features
4. High-resolution MCS imaging of the subsurface down to at least 1000 m
5. Independent quality control of MCS data acquisition
6. High-resolution imaging of the subsurface down to about 100 m

7. Independent interpretation of the data by an expert in the field of shallow gas

The current requirements for SWGHSs are described in detail in the Shallow-Water Drilling Working Group's Report, proponents should consult the details of this report prior to planning any shallow water hazards survey.

I.C.4. Site Summary Forms

Proponents must use the site summary forms to document the scientific objectives, available site survey information, logging plans, and safety at each proposed site. The set of forms uses a layered approach in describing each site, with the first page documenting basic site information, and subsequent pages adding further details as the proposal matures and moves through the JOIDES review system. **Proponents are to fill out all parts of the form which are shaded in gray.** A complete set of forms is presented in Appendix I. Electronic versions of these forms are available on the JOIDES web server (http://joides.rsmas.miami.edu/).

Page 1 - General Site Information

This form should be submitted for each site when submitting a preliminary proposal, and whenever the sites are moved or updated. The purpose of this form is to document each site's name, location, basic objectives, and drilling plan.

Section A

New or Revised Checkboxes: Check "New" when initially proposing the site, check "Revised" for all updates and changes.

<u>Title of Proposal</u>: This should be the same as the title on the cover page of the proposal.

<u>Date Form Submitted</u>: Date the form was filled out. Important for tracking latest site revisions.

<u>Site-Specific Objectives</u>: This should be a short description of the objectives for this site. (e.g., Cenozoic history of (1) deep-water chemistry and (2) carbonate productivity.

<u>Previous Drilling in Area</u>: List any DSDP, ODP, or industry holes drilled at or near this site location.

Section B

<u>Site Name</u>: The site naming conventions were developed to ensure that each point on the seafloor considered for drilling has a unique name that is never used to describe other points on the seafloor. This is extremely important for matching proposed sites to the site survey data in the ODP Data Bank. Moving a site but not changing the site designation leads to mismatches between the data and proposed sites.

Proper site names are of the form XXXXX-##X (e.g., SUBSAT-10A). As shown, site names are constructed of three parts. To the left of the hyphen (-) there is a string of up to 6 characters which is the descriptive "name" of the proposed site. On the right side of the hyphen is a two digit number indicating the site number, and one character which indicates the version of the site. As a proposal matures, the site objectives may change or site locations may be shifted, it is, therefore, important that the right side of the site name be updated as well. Generally, small shifts in a site's location that do not move it off of the existing survey lines would be documented by a change in the one character version identifier. However, if a site is moved to such an extent that it is no longer within the same set of survey lines, then a new site should be designated with a higher two digit number and a version designation of 'A'. An example of this is shown in the following diagram. Please note that site names do not indicate the priority of the site or whether it is an alternate. This information is provided on another part of the form.

Lat. and Long.: Latitude and longitude must be presented in degrees and decimal minutes. Please use as many significant digits for the fractions of minutes as your navigation data allow.
Priority of Site: Indicate whether your site is a primary or alternate site. If alternate, you may indicate for which site it is an alternate.
Area: A name to describe the area where the site is located, such as "Blake Outer Ridge."
Jurisdiction: The territorial jurisdiction of the area in which the proposed site is located.
Distance to Land: Distance to nearest land in kilometers.
Water Depth: Water depth in meters.

Section C

Thickness/Penetration: An estimate of the predicted total sediment thickness at the proposed site, as well as the proposed penetration of sediments, basement, and total penetration in meters.
General Lithologies: Brief list of anticipated lithology(ies) should be given for both sediments and basement, including an approximation of thickness (m) for each distinct lithology.
Coring Plan: Proponents are asked to circle the type of coring device they expect to use at each site. A short explanation of each device is provided below. Proponents are encouraged to contact the Science Operator (ODP/TAMU) for detailed information on coring options.

> **APC:** The advanced piston corer recovers soft ooze and sediments. The hydraulically activated system strokes out in ~1.5 s with 23,000 to 28,000 lb of force, plunging a knife-edged cutting shoe into the formation to recover an undisturbed core. If requested, a magnetic orientation system references the core to magnetic north. In some cases more than one coring hole is required at a given site

to provide an undisturbed composite core section. The core length is a nominal 9.5 m.

XCB: The extended core barrel continues coring in firm sediments after piston coring is no longer effective. A saw toothed cutting shoe can either extend up to 8.5 inches beyond or retract back to the main bit face. In many formations this trimming technique produces better core quality than roller cone bits alone. The core length is a nominal 9.5 m.

RCB: The rotary core barrel recovers medium to hard crystalline rocks. The RCB requires a separate bottom-hole assembly (BHA) from the APC/XCB and is rotated from the surface. The RCB uses a tungsten carbide insert four-cone bit to cut the core. The inner barrel remains stationary to minimize core disturbance. The core length is a nominal 9.5 m.

MDCB: The motor driven core barrel recovers interbedded materials including hard and fractured rocks. Large quantities of seawater are pumped through a multilobed motor that produces higher torque and speed at the cutting shoe. Diamond-impregnated or surface-set cutting shoes trim the core. This tool is compatible with the APC/XCB (BHA) and the core length is a nominal 4.5 m.

PCS: The pressure core sampler recovers core at in situ pressures up to 10,000 PSI. The hydraulically activated system retrieves a one-meter core sample in a removable pressurized chamber. Once on deck, the samples can be transferred for scientific testing and evaluation.

Reentry Cone: A reentry cone can be used if a hole is to be entered more than once such as in the case of setting casing, making multiple bit changes, or deployment of downhole equipment.

Free-Fall Funnel: The Free-Fall Funnel (FFF) is free-fall deployed to the seafloor before the bit is pulled out of the existing hole. This system provides a quick and low-cost method to reenter the hole to facilitate bit and bottom-hole assembly (BHA) changes

HRRS: The hard rock reentry system (HRRS) uses a unique percussion-drill BHA along with a fluid powered hammer drill for the purpose of installing a reenterable cased hole on sloping fractured hard-rock surfaces.

Logging Plan: Proponents should check boxes for logging tools they expect to use. Detailed information on available logging tools is given at the ODP/LDEO website (www.ldeo.columbia.edu/BRG/ODP/LOGGING).
Estimated days: Total on-site estimates should be given for the number of days drilling/coring, logging, and any experimental operations. These estimates should be viewed as preliminary. To assist the proponent, guidelines have been prepared for estimating ODP coring and logging times (see http://www.ldeo.columbia.edu/BRG/ODP/LOGGING/HELPER/helper.html or ODP Technical Note No. 1: *Preliminary Time Estimates for coring Operations*). Manually prepared time estimates can be made using curves for drill string trip time and RCB, APC, and XCB coring cycles. The website also has a simplified Excel coring and trip time estimator. They can be used to estimate times in both single-bit and reentry holes. These curves, along with procedures for approximating coring and logging times, are available to assist proponents in developing realistic drilling time estimates. Whenever possible, time estimates for ODP holes should be based on data from similar locations and/or lithologies. Because of the complexity of ODP operations, however, the ODP Drilling Services Department should be contacted for detailed operational planning. Once a site has been approved and its objectives defined, a final time estimate based on detailed planning becomes the responsibility of the Science Operator.
Hazards/Weather: List any information available on possible hazards from ice, hydrocarbons, shipping lanes, military exercise areas, dumpsites, cables, and typhoons etc. Information on ice conditions must be provided with high-latitude proposals. Note the optimum weather window for your proposed drilling area. It is recommended that proponents begin to search for industry data on hydrocarbons at an early stage, as it can take some time to obtain this information, and it will be required for the PPSP review should the proposal be scheduled as a leg.

Page 2 - Site Survey Detail
This form should be submitted for each site when submitting a full proposal, and whenever survey data need to be updated. The purpose of this form is to document the available survey data for each proposed site. Include as much detail as possible for each data type. Please be specific regarding the locations of data on survey lines by indicating exact dates/times or shotpoints.

New or Revised Checkboxes: Check "New" when initially proposing the site, check "Revised" for all updates and changes.

Proposal Info: List proposal number, the site name (e.g., SUBSAT-10A), and the current date.
Data Types: List all data available for the proposed drill site. Please give as much information as possible, including cruise names, line numbers when available, and specific date/time or shotpoint locations of sites on track line data. List as much data as possible, and indicate survey cruises that may collect additional data and their expected dates. For details regarding site survey requirements for specific drilling environments, please see the section on Site Survey Target Types and Data Standards.

Page 3 - Detailed Logging Plan

This form should be submitted for each site when submitting a full proposal, and whenever the logging plan is updated. The purpose of this form is to outline the logging program for the proposed drill sites.

New or Revised Checkboxes: Check "New" when initially proposing the site, check "Revised" for all updates and changes.
Proposal Info: List proposal number, the site name (e.g., SUBSAT-10A), and the current date.
Water Depth and Penetration: List depths in meters.
Measurement types: Fill in as much detail as possible on the scientific objectives of each logging tool that will be run at this site. For details on what can be achieved with each tool, contact ODP/LDEO Wireline Logging Services (www.ldeo.columbia.edu/BRG/ODP).

Page 4 - Pollution and Safety Hazard Summary

This page should be submitted for each site once the proposal is placed on the drilling schedule. The newly scheduled leg will need to be reviewed by the PPSP. The information presented on this form will be used by PPSP to evaluate the safety of each drill site.

New or Revised Checkboxes: Check "New" when initially proposing the site, check "Revised" for all updates and changes.
Proposal Info: List proposal number, the site name (e.g., SUBSAT-10A), and the current date.
Safety information: Please answer questions 1 through 9 with as much detail as possible. The PPSP will use this information to evaluate the safety of each site. It is recommended that proponents begin to search for industry data on hydrocarbon occurrences even before the proposal becomes a leg, as this information is often difficult to obtain.

Page 5 - Lithologic Summary

This page should be submitted for each site once the proposal is placed on the drilling schedule.

New or Revised Checkboxes: Check "New" when initially proposing the site, check "Revised" for all updates and changes.
Proposal Info: List proposal number, the site name (e.g., SUBSAT-10A), and the current date.
Lithologic Summary: A sketch of the general lithologies expected to be encountered should be drawn on this page.

I.D. DRILL SITE SELECTION

While proposed drill sites are reviewed by both the SSP and the PPSP, their objectives are different. The SSP seeks to ensure that there are sufficient data of the appropriate kind to document a site's position and suitability for the proposed science. The PPSP then reviews these and other data to ensure that the drill site will be safe for ship operations and poses no pollution threat. Usually the data required for SSP review are sufficient for the PPSP review, but reprocessing or reformatting may be requested to enhance the data for use in hazard detection.

I.D.1. Site Survey Requirements Framework

Site survey data requirements vary depending upon the type of environment in which the proposed drill site is located and the proposed depth of penetration. SSP has defined eight Target Types, each with different data requirements, which are summarized in Table 1. If proposed sites fall into two classes, they may need to meet requirements of both target types. The data requirements for each of these target types are summarized in Table 2.

Details on each of the data types listed in the table can be found on the ODP Data Bank web pages (http://www.ldeo.columbia.edu/databank) along with guidelines on submitting data packages. Contact the Data Bank Manager (odp@ldeo.columbia.edu) with any questions regarding data formats or presentation styles.

Twice a year the Site Survey panel will review the data packages of the proposals referred to them and will report on the readiness of each package to OPCOM and the drilling proponents. If any potential pollution or safety hazards are noted during SSP review, the sites may be referred to the PPSP for a preview. Flagging these hazards at an early stage allows for site locations to be adjusted to avoid the problem, or allows time for the location of additional data (such as from the petroleum industry) to further document and assess the hazard.

I.D.2 Geologic Framework for Safety Requirements

I.D.2.a. Stratatigraphic Framework

It is basic to pollution prevention and safety to make the best possible estimate of thickness of the sedimentary section at drill sites and to infer the nature of the rocks to be penetrated. Knowing the thickness of the sedimentary rock above igneous or metamorphic basement is most useful in deciding whether a drill site has potential petroleum hazards resulting from thermochemical action on organic matter in the sediments. It is difficult to predict whether there has been an adequate supply of organic matter in the section to have allowed substantial petroleum generation. However, seismic data usually provide adequate information on sedimentary rock thickness at a proposed drill site. If there is no definite information on the absence of petroleum source material, thick sedimentary sections (1500 m or more) must always be considered possible progenitors of petroleum and should be drilled with appropriate caution.

For purposes of estimating petroleum hazards, ocean areas may generally be divided into those with more than 1000 m of sediment above basement (shelves, slopes, and rises adjacent to continents or islands; many small ocean basins and troughs; a few sediment-filled basins far from land in the main oceans), and those with less than 1000 m of sediment (constituting most of the vast central areas of the major oceans, the mid-ocean ridges, and many trenches and local areas closer to land).

Sediment sections less than 1000-m-thick usually have not experienced sufficient heating to generate abundant petroleum. An exception to this general rule would be high-heat flow areas near hydrothermal vents or mid-ocean ridges and gas hydrate or H_2S deposits. Areas of thin sediments are therefore relatively free of petroleum hazards, provided the following conditions are also fulfilled:

a. these areas have no possibility of having once been more deeply buried;
b. such areas are not pinch-out margins of thicker downslope sedimentary sections from which lateral migration of hydrocarbons could have taken place; and
c. such areas cannot have experienced greater than normal heat flow.

In general, PPSP considers central oceanic areas, with 500 m or less of sediment above basement, to be nearly free of petroleum hazards. Even in such areas, however, consideration must be given to the possibility that older sedimentary sections may underlie acoustic basement or that biogenic methane may be present.

Obviously, hydrocarbon hazards are enhanced if good potential reservoir strata are present in the section (Pimmel and Claypool, 2001). This factor has an important modifying effect on safety conclusions based on sedimentary thicknesses and organic contents. Seismic data and regional geologic considerations may give helpful information on the probability of substantial reservoirs being present.

The presence of evaporites, overpressured shales, gas-hydrate zones, and other seals, below which hydrocarbons may be trapped, also has an important bearing on the depth to which a drill hole can be safely carried. Presence of diapirs or flowing faults is a danger signal.

I.D.2.b Structure

At least one continuous seismic profile must be obtained across any prospective drill site, and two profiles intersecting at approximately right angles must cross at prospective sites on shelves, slopes and rises, or at any site where a single profile suggests the possibility of a trap. Features of significance on seismic profiles include anticlines, faults, pinchouts, unconformities, etc. Any sort of structural or stratigraphic trap should be avoided in choice of drilling locations. While reliance must be primarily on seismic sections for identification of traps, gravity, magnetics and bathymetric data may also be helpful.

I.D.2.c Regional Setting

Where thickness and character of rock sequences suggest adequate hydrocarbon source potential, quality of seismic data is critical. Migrated depth sections may be needed to evaluate faults as migration paths. Maps on key horizons may be necessary to document local structure and trapping configurations. Regional maps to ascertain relief on pinchouts may be needed to evaluate potential stratigraphic traps. Site proponents are urged to select sites off structure, where desired objectives can be reached, even if this action means an increase in drilling depth.

Known Oil and Gas Occurrences

In planning a drilling leg, available information on oil and gas wells or seepages close to proposed sites, both on and offshore, must be obtained. This information is vital on continental margins. Shallow piston cores near proposed sites may provide information on hydrocarbon occurrences in surface sediments. Petroleum companies who hold or have held concessions in the general vicinity are good sources of information of this type. It must be noted that presence of an industry "dry hole" near a proposed site does not equate with a complete absence of hydrocarbons at that site. Drilled holes can breach seals and become a path for fluid migration and pressurization of shallow zones.

Abnormal Pressures

Areas and stratigraphic intervals containing fluids under greater-than-normal hydrostatic pressure should be avoided because of their common association with oil and gas and their tendency to cause blowouts. Presence of undercompacted shale is a warning that fluids may be encountered at more than normal hydrostatic pressure. An undercompacted shale is one in which fluid expulsion has not kept pace with increased fluid pressure, so that formation fluids in the shale and associated sands are not only under hydrostatic pressure but also bear part of the weight of the overlying rock column. Fluid pressures in such shales may also have a component of pressure generated internally by buoyant forces related to contained gas. Pressure-compacted shales may be identified by decreases in their interval velocities related to their abnormally high fluid content. They may also appear in seismic sections as distorted, convoluted reflections. Undercompacted shales may show up on gravity profiles because of their lower densities. Absence of velocity inversion does not preclude abnormal formation pressure, nor does its occurrence always result from an undercompacted shale section. Nevertheless, drill sites at which marked velocity inversions are detected should be avoided unless the inversion can be related to some other lithologic change.

Thermal Gradients

Heat flow data should be acquired at prospective drill sites to assess the possibility of migrated petroleum and because higher temperatures are commonly associated with abnormally high pressures and hydrocarbon accumulations.

Water Depth

Blowout danger to the ship diminishes greatly with increased water depth. Violent surface blowout may occur in water depths as great as 500 m, but there is little likelihood that such blowout danger would affect the ship in water depths of 650 m or more. Slow seepage of oil or gas into the sea, with consequent risk of pollution at remote down current sites can occur while drilling in any water depth.

II. PRINCIPAL HAZARDS

II.A. HYDROCARBON

II.A.1. Oil and Gas Escape

The main hazard in scientific ocean drilling, with respect to pollution prevention and safety, is the possibility of encountering a charged reservoir, thereby allowing oil or hydrocarbon gas to escape in large quantities into the sea and atmosphere. Because natural submarine seeps of both oil and gas exist in many parts of the world, apparently with little deleterious effect on the environment, it is difficult to say what amounts of oil or gas released into the sea or atmosphere by drilling operations should be termed hazardous. Certainly, as a pollutant, oil must be considered more serious than gas. On the other hand, as a hazard to personnel and property, gas is more dangerous than oil because of its mobility, high flammability, negative effect on water buoyancy, and difficulties in controlling its pressure.

II.A.2. Hydrocarbon Origin and Occurrences

The term "petroleum" is applicable to any hydrocarbon substance, although it is popularly reserved for crude oil, natural gas, and asphalt. Mixtures of petroleum hydrocarbons exist as gaseous, liquid, and solid phases depending on temperature, pressure and composition of the system. Under earth surface conditions, C_1-C_4 hydrocarbons (methane, ethane, propane, and butane) are predominantly in the gaseous phase, whereas C_5 and heavier hydrocarbons are predominantly liquid.

Hydrocarbon gases, largely methane (C_1), may be generated in significant quantities from organic matter in sediments (Pimmel and Claypool, 2001, Technical Note 30), either under near-surface conditions by bacterial action (Claypool and Kaplan, 1974) or at greater depths by thermochemical action (Schoell, 1988). Liquid petroleum (oil), however, is almost exclusively the product of thermochemical generation from hydrogen-rich organic matter in deeply buried sediments. This generation appears to become quantitatively important only as temperatures reach 50° to 150°C (typically at burial depths of 1500-5000 m for average geothermal gradients). Hydrocarbon gases are generated with the oil, and although they consist largely of methane, they usually include quantities of ethane (C_2), propane (C_3), butane (C_4), and heavier hydrocarbons. Thermochemical conversion of organic matter to hydrocarbons continues at accelerating rates with increasing depth and temperature, until all organic matter, including the oil itself, has been converted largely to methane and carbon-rich residues. It should be stressed that although biogenic hydrocarbons are generated at relatively shallow depths and thermochemical hydrocarbons at relatively greater depths, either may be found at any drilling depth because of migration, subsequent burial, or exhumation.

Biogenic methane is commonly found in swamps where it is known as "marsh gas," but it is also formed in marine sediments that contain sufficient concentrations of organic matter. Biogenic methane can usually be distinguished from thermochemical methane by means of isotopic ratio mass spectrometry; the biogenic form has a distinctly greater abundance of light carbon isotope ^{12}C relative to the heavy carbon isotope ^{13}C. Although thermochemical methane is formed along with ethane and heavier hydrocarbons in the early stages of hydrocarbon generation, the ratio of methane to ethane gradually decreases as hydrocarbons of thermochemical origin become more abundant. More complete discussion of geologic factors involved in the origin and occurrence of petroleum can be reviewed in Tissot and Welte (1984) and Hunt (1979).

Both biogenic and thermochemical methane may be found in many ODP boreholes. There is no appreciable difference in their physical and chemical properties. Both can catch fire and cause blowouts. Both can be associated with some ethane and can occur in substantial quantities at shallow depths. The only significant difference is that the conditions that produce thermochemical methane may also produce liquid oil, while oil of microbial origin is unknown.

A common misconception is that if methane is identified as biogenic, it can be disregarded as a safety hazard. A serious blowout occurred in offshore drilling in Cook Inlet, Alaska, apparently due to biogenic gas. Also, one of the world's largest gas fields and more than 20% of the world's gas reserves are apparently biogenic. It has been wrongly suggested that if methane/ethane or $^{12}C/^{13}C$ ratios exceed certain values, gas dangers can be dismissed because it is only "marsh gas," not true thermogenic gas. *It is the quantity of gas present in reservoir strata rather than its origin that is of primary concern.*

The PPSP and TAMUSP (usually referred to as the Safety Panel) is strongly in favor of getting all information possible on the character of hydrocarbons in ocean sediments. However, PPSP deplores as a menace, rather than an aid to safety, the setting of "magic numbers" as substitutes for balanced judgment based on the multitude of geological, geochemical, operational, and experience factors that should enter into decision-making concerning safety. *Arbitrarily imposed numerical guidelines for safety decisions are dangerous, because numerical guidelines may tend to be used blindly as crutches to obscure sound and reasoned judgment.*

II.A.3. Blowouts

In oil well-drilling operations, formation fluids (water, oil, or gas) will flow into the well bore when the pressure of the fluid in the reservoir exceeds the pressure in the drill hole. If the fluid entering the well bore is less dense than the drilling fluid, it will move upward in response to buoyancy.

When the formation fluid is gas, gas-charged water or gas-charged oil, it may permeate the drilling fluid, causing it to be filled with gas bubbles ("gas-cut"), thus diminishing the drilling fluid's density and ability to exert pressure on surrounding formations. Gas entering the well bore undergoes rapid expansion because of pressure reduction while traveling up the hole. Because of the confinement of the narrow borehole, increasing expansion of gas in the drilling fluid as it moves upward causes a flow of displaced drilling fluid from the hole mouth, further reducing the weight and pressure of the fluid column in the hole. The consequence is a "chain reaction." Gas enters the hole at ever-increasing rates as the pressure differential between gas-bearing formation and hole is increased. If not promptly brought under control, the process results in violent ejection of drilling fluid, which results in a "wild," unrestrained flow of gas or gas-charged formation fluid at the surface. Such an event is called a "blowout" and is extremely dangerous to life, property and the environment.

II.A.4. Differences in Blowout Risks Between ODP and Petroleum Operations

Elaborate measures are employed by the petroleum industry to prevent blowout occurrences: weighting of drilling muds, application of back pressure with pumps, use of mechanical blowout preventors, etc. In ODP operations, the drilling equipment is very different from customary oil and gas drilling, mainly because of lack of means for return circulation, use of seawater as a drilling fluid rather than heavy drilling mud, lack of a riser and BOP, and generally greater water depths involved. In ODP operations, gas encountered under pressure sufficient to cause it to enter the hole, permeate the sea-water drilling fluid, and move upward would be confined by the hole walls only until it reached the ocean floor or soft, soupy fluid sediment that often underlies the seafloor. Gas continuing upward would tend to dissipate away from the borehole into seawater and would reach the ocean surface in lower, perhaps imperceptible, concentrations over a broad area, with dimensions proportionate to the water depth the gas traversed.

Considering the great water depths usually involved in ODP drilling, there is relatively less danger of violent discharge of gas at the sea surface. However, means of mechanically controlling gas flow into the hole in ODP operations are limited. Moreover, even though the escape of gas or oil at the ocean surface from holes drilled in water depths of thousands of meters might be so diffuse as not to be readily discernible, total pollution of the ocean by hydrocarbons might be substantial over time.

A gas blowout imperils the vessel and crew in several ways: releasing toxic gases, triggering fires, and causing a loss of buoyancy as a result of charging surrounding seawater with gas bubbles. The shallower the water at the drill site, the greater the potential of danger of buoyancy loss, which could destabilize the ship.

The greatest fire danger on *JOIDES Resolution* would result if a blowout occurred *through* the drill pipe. In relatively shallow water, gas escaping to the surface from around the drill pipe may present a fire hazard. ODP drill crews are trained in standard oil field practices to avoid and control these possibilities. Buoyancy impairment is unlikely in water depths usually encountered at ODP sites. However, buoyancy problems have occurred at least twice in commercial drilling for oil in shallow waters and cannot be ignored at shallow ODP sites.

II.A.5. Intercommunication Between Reservoirs and Exchange of Fluids

Situations can occur where formation fluids from deep, overpressured zones, flowing up the borehole, encounter shallower, lower-pressured zones. Under these conditions, the higher pressured fluids (oil, gas, or water) may enter a zone that opens to the seafloor via fractures or permeable beds, resulting in an uncontrollable leak. The higher pressured fluids may charge shallower zones with fluids having more than normal hydrostatic pressures, thus making future shallow drilling in the area hazardous. It is also possible, though not likely under most ODP conditions, that deep, saline formation water might contaminate shallower, fresh water offshore aquifers in this way.

II.A.6. Drilling Active Ridges

High-temperature hydrothermal systems close to magma chambers present special hazards for scientific ocean drilling. The behavior of water in hydrothermal systems is governed by pressure-volume-temperature (PVT) relationships. When the specific volume (V) of water at constant temperature is plotted as a function of P, below the critical temperature of water (374°C) there is an abrupt change of slope corresponding to the phase change resulting from boiling. Above the critical temperature, the rate of change of volume with pressure is gradual. Cold, and thus denser, seawater pumped down the drill pipe provides a hydrostatic overpressure that suppresses flow into the pipe. A safety valve is available for installation at the top of the drill string should a flow occur. The kelly hose/valve/standpipe is rated to 10,000 psi working pressure. Steam flow to the surface through a cold drill string is extremely unlikely, especially if some seawater is being pumped periodically. Cold (2°-4°C) seawater cools the hole near the bit by as much as 90°C, which can cause thermal stressing and sloughing of rock chips into the hole. Gradually cooling the hole by circulation every 500 m while tripping in the hole can reduce thermal shock.

II.A.7. BSRs and Hydrates

The known presence of Bottom Simulating Reflectors (BSRs), hydrates (clathrates), gassy sediments, and H_2S should be considered at the Precruise Meeting, and special precautions should be reviewed with TSF and noted in the leg Prospectus operations plan. Operations may be slowed to permit adequate evaluation and handling of the cores. Operations may be terminated if liner failures or unsafe levels of gas or H_2S are detected in the core handling area, lab cutting room, or enclosed ship areas.

There are several hazards that could occur from a combination of these effects:

- Hydrates and authigenic (biological methanogenic) carbonates can form an effective pressure seal and free gas can accumulate under the seal (Leg 164). Pressure Core Sampler (PCS) data indicated that the biogenic-gas pressure can be 350 psi above sea-water hydrostatic pressure (i.e., it is overpressured) at 450 mbsf; however, no gas flow has been noted to date in BSR penetrations. Poor permeability in silty clays under the hydrates may have restricted flow thus far; however, this may not always be the case.

- Hydrates were analyzed as 98.5% methane and 1.5% carbon dioxide. Typically, hydrates are not composed of thermogenic or liquid hydrocarbons, nevertheless, BSRs and hydrate sections should be penetrated carefully (see Sassen et al., 1998 for an exception).

II.B. HYDROGEN SULFIDE

Hydrogen sulfide (H_2S) is the principal noxious gas that might be released. H_2S is easily detected in extremely low concentrations by its characteristic odor and by using commercially available monitors. It is a transparent, colorless, flammable, heavier-than-air gas that is lethal in concentrations measured in a few hundred ppm. Below 100 ppm, this gas is characterized by its "rotten egg" odor. However, over a period of a few minutes at concentrations approaching 100 ppm, ability to smell this gas is lost. The threshold limit, 10 ppm, is the concentration at which it is believed that all workers may repeatedly be exposed, day after day, without adverse affects. *Concentrations of 250 ppm are considered hazardous and may cause death with prolonged exposure. Concentrations of 700 ppm are considered to be **lethal** and will cause death with **short-term exposure**.*

Geochemical considerations, together with past drilling experience, direct observations, and sampling from research submersibles, have shown that excessive H_2S may interplay with high temperature to further complicate active ridge drilling. H_2S solubility in water is a function of PVT conditions. This fact dictates a safety approach in which depths and temperature anticipated at specific drill sites determine safety measures to be taken for a given active ridge drilling leg. This approach was followed in drilling on the Juan de Fuca Ridge and Escanaba Trough (Legs 139 and 169) and TAG (Leg 158). Extensive safety procedures for avoiding H_2S-related accidents were spelled out for Leg 139 in ODP Technical Note No. 16, *Hydrogen Sulfide-High Temperature Drilling Contingency Plan.* Technical Note No. 16 was updated in 1993 and became ODP Technical Note No. 19, *Revised Hydrogen Sulfide Drilling Contingency Plan.* Technical Note No. 19 was recently updated to Technical Note No. XX** in 2002, *Hydrogen Sulfide***

Unusual isolated concentrations of H_2S gas are possible (i.e., especially in cases of active hydrological down-flow or sulfate-rich up-flow in faults or in carbonate-rich sediments where H_2S is not quantitatively precipated as iron sulfides (e.g., pyrite) due to low iron contents, for example). H_2S concentrations to 150,000 ppm (vacutainer) were handled safely in core sections from one site during Leg 182. However, coring operations should be suspended when H_2S concentrations in the ambient air on the core-handling-deck exceed 10 ppm until proper safety measures can be implemented. Operations should be terminated if necessary core handling procedures on the catwalk and labs cannot be completed in a safe manner.

Most gas hydrates encounter by ODP have contained mostly C_1 with a small amount of CO_2; however, H_2S concentrations were noted in the presence of hydrates on Leg 146. Therefore, the potential for H_2S in hydrates should be treated with extreme caution because of the potential for sudden high-volume releases of H_2S. If H_2S is noted in the presence of hydrates, a full H_2S alert should be declared and coring should be halted pending an evaluation of the situation.

ODP Technical Note 16, *Hydrogen Sulfide-High Temperature Drilling Contingency Plan* reviews extreme safety procedures for a heavy hydrogen sulfide leg; however, experience in handling H_2S cores and new safety equipment (such as air dilution fans, hose-fed air packs, and gas evacuation fans) has improved H_2S safety procedures and permitted safe handling of degassed (<10 ppm) H_2S cores.

If the potential for H_2S is known or suspected in an operating area, H_2S precautions should be reviewed before the leg, a training program should be conducted for all personnel, an H_2S evacuation drill should be conducted, general H_2S precautions should be in effect, safety equipment should be serviced and staged, lab personnel should receive safety equipment training, and monitors should be calibrated and in operation (**H2S tech note, 2002). H_2S concentrations are normally less than 50 ppm in the normal near seafloor sulfate reduction zone, which is fed by seawater (to about 40 mbsf). Cores containing H_2S are quickly degassed outside on the core handling deck by drilling holes in the liner and sectioning the cores. The H_2S is diluted by normal air flow mixing aided by the fan on the core-handling-deck. The suction fan in the core cutting room should be used to further vent gas liberated by cutting the cores. Marine Lab Specialists (MLS) personnel may need to wear air packs when handling and cutting the cores. It is prudent to allow core sections with H_2S concentrations exceeding 10 ppm to degas on the outside core storage rack.

II.C. ENVIRONMENTAL HAZARDS

II.C.1. Weather

Transocean Sedco-Forex is required to provide trained personnel for weather related duties. ODP is responsible for providing and maintaining the weather equipment and to provide training in its operation. The vessel's deck officers are responsible for copying and interpreting weather maps and satellite photos, as well as recording and transmitting routine weather observations. The TSF Offshore Installation Manager (OIM), ODP Ops Mgr, and Co-Chiefs should stay informed about the approach of storms or other weather conditions that could affect operations; however, the Master's (i.e., Captain) decision is final in weather-related matters concerning the safety of the vessel and/or on board personnel. This includes course changes to avoid or minimize weather effects, tripping or hanging-off the drill string, departing the area, etc.

The *JOIDES Resolution* may encounter extreme weather conditions such as cyclones, otherwise known as typhoons or hurricanes, and storm tracks and frequencies that are likely to threaten the ship's safety. The Master is required to follow policies for dealing with and avoiding tropical cyclones as set forth in the TSF "Hurricane/Cyclone Contingency Plan. The provisions of the document are highly conservative in terms of lead time to abandon site operations and depart the area.

II.C.2. Currents

DSDP and ODP operating experience indicates that deep-water ocean currents can be more complex and capricious than generally believed. Subsurface currents may exist with velocities and directions in complete disagreement with published charts and they also may come or go completely without warning or on a diurnal cycle. Major currents, such as the Gulf Stream or Arctic currents, can produce strong and deep-running eddies and "spin-off vortices" of surprising velocity and direction.

A strong current is defined in this document as a sustained general movement of subsurface water mass at a speed of 2.0 kt or more and may induce swirling water motion by movement through, over, and around obstacles, or by interaction with tidal surges. Currents are deep running and distinct from transitory water-mass motion induced solely by surface waves or swells or wind action. While current information on nautical charts and publicly available data can be characterized as generally accurate, the *JOIDES Resolution* is fixed at a specific site and experience has demonstrated that current effects vary locally and hourly.

Current velocities estimated as high as 3 kt (Kuroshio off Japan) and 4 kt (Gulf Stream in the Florida Straits) have been encountered during ODP operations. The current forces were handled by the JR's propulsion power, but station keeping and vessel motion limits were exceeded when 50-kt winds and 20-ft swells developed at right angles to the Kuroshio Current. The strength of the current forced the vessel to maintain its heading into the current and to lie in the trough. Off northeast Australia and in the Florida Straits, the strong current extended to the seafloor in relatively shallow water and physically tilted the positioning beacon down-current, hampering the ship's stationing-keeping capability.

The design/contractual capabilities for the JR include the ability to maintain horizontal position within 3% of water depth with wind limits of 45 kt (gusts to 50 kt); maximum wave height of 27 ft; and surface current of 2.5 kt (with the prevailing environmental forcing function within 30° of the bow or stern).

ODP operations in areas with strong currents (of more than 2.0 kt) have been affected to a limited extent. Pipe has audibly and visibly vibrated (e.g., strummed by current like a taunt string at 20-60 cycles/second) when it is used in strong current areas. Bottom hole assemblies, drill pipe, casing, and guide bases have been tilted off-vertical in excess of 5° by the force of the surface current against the sail-area of the object, which resulted in problems making up the next (vertical) joint and latching the dual elevators. Running pipe can be difficult because the pipe and tool joints are pressed against the upper and lower guidehorns. Vibration-isolated television (VIT) frames have noticeably vibrated, tilted, and "weather-vaned." VIT coax cables have vibrated, been wrapped around the pipe by a weather-vaning frame, and been pushed against the edge of the moonpool thereby damaging the cable.
Successful coring operations were conducted in the Gulf Stream and Kuroshio currents where deep running current velocities were in excess of 2.5 knots. On a few occasions, the crew has experienced an inability to maintain the ship position during operations conducted under the following conditions.

- A high angle of divergence between strong wind and strong current forces (such as sudden strong wind gusts from canyons or glaciers, storms approaching from the side of the ship, and sudden tidal surges in channels).

- Swirling vertical and horizontal vortex-type currents that rapidly changed direction and force (such as Arctic eddy currents over underwater obstructions and sills in the Yermak Straits).

- A rapidly changing interaction of tidal surges and high current in shallow water, (such as on the New Jersey Shelf in 100 m water depths), where tidal and (Gulf Stream) current eddies combined to produce strong and rapidly changing environmental forces.

II.C.3. High- and Low-Latitude Operations and Ice

The drill ship is adapted for high-latitude operations, with winterized and heated work areas and an ice-strengthened hull to Class 1B for navigation in medium ice conditions. Successful operations have been carried out in both Arctic and Antarctic waters under hostile environmental conditions. Winterization of the ship includes the addition of special additives to lower the pour point of the fuel, changing to low-temperature coolants and lubricants in topside machinery, rigging windwalls around exposed work stations, activating the special boilers that circulate heated water to various locations, and adding anti-freeze to tool storage shucks.

In areas where free-floating ice or other objects may be encountered, "alert zone" and "safety zone" radii are calculated in accordance with procedures jointly developed by ODP and TSF:

(1) An "alert zone" radius will be calculated once on site based on the time required to suspend operations, pull out to 50 m below the seafloor, and set the safety landing sub or 500 ton elevators plus contingency time. The "alert zone" is dependent on depth and expands as the penetration depth increases. If free floating ice or other objects enter the alert zone, operations will be suspended, and the bit will be pulled to 50 m below the seafloor while the situation is evaluated.

(2) A "safety zone" radius is also calculated based on the time required to terminate operations and pull above the seafloor far enough for safe maneuvering plus contingency time. The "safety zone" is also dependent on depth and expands as the penetration depth increases. If free floating ice or other objects enter the safety zone, operations in the hole will be terminated, and the bit will be pulled as far as required to clear seafloor obstacles and permit the ship to move.

(3) If time permits, the Master should keep the TSF OIM, Ops Mgr, Staff Scientist, and Co-Chiefs informed of the situation to make a joint decision on the suspension or termination of operations.

(4) A drill-string landing sub below the top drive and/or 500 ton elevators should be used anytime that an emergency drive-off situation may occur. If time permits, the compensator will be locked and the 500-ton elevators will be landed on the rotary. All personnel will be restricted from the rig floor.

II.C.4. Shallow-Water Operations

Operations in water depths of <75 m are not permitted at present, and operations in 76-650 m of water require special operational guidelines to insure safety for the crew and equipment. The ODP and TSF management and supervisors, Master, and Co-Chiefs should reach agreement prior to the leg on detailed limitations, operational procedures, etc. that will be imposed to reduce the risk of stuck pipe and operational problems. The operational agreement should be reviewed on the ship prior to arrival at each site so that all personnel are aware of the limitations.

II.C.4.a. General Guidelines for Shallow-Water Operations

Positioning control is especially critical in shallow-water situations because the short drill string provides less flexure and elasticity if the ship moves off the hole. Coring should be suspended and the core barrel should be withdrawn, if a substantial loss of positioning or a horizontal excursion is anticipated.

Guidelines for Water Depth Ranges

(1) 0 to 75 m water depth:

- Operations will not be conducted in less than 75 m of water depth.

(2) 76 to 300 m water depth:

(a) Operations will be terminated if a gas flow is detected. The Driller is authorized to load the hole with 10.5 ppg kill mud pumped at 500 to 1000 gpm (for a dynamic kill effect) as soon as possible. A 12.5 ppg kill mud may be pumped in holes in more-consolidated formations. A flapper-type float valve will be run in the BHA to prevent flow up the pipe, and a drill string valve will be available on the rig floor. A drill will be conducted with both crews to practice drill-string-valve installation. Hatch covers and water-tight doors should be closed. Combustible gas detectors should be checked. Crews and watch standers should be alerted to watch for signs of gas flows.

(b) Operations will not be conducted in areas where the distance to unnavigable shallow water (less than 30 m deep) is less than one nautical mile (nmi). This is to allow time to drop the anchor and stop drifting in the event of a total power failure.

(c) The TSF and ODP supervisors will be advised as soon as possible if overpull reaches 70K lb or if hole drag increases appreciably or reaches 30K lb. The initial response to hole problems will be to attempt to circulate the hole clean with a high viscosity mud sweep of 15 to 35 bbl. If the hole problem remains, a wiper trip will be made to the position in the hole above the problem area before coring proceeds. Coring will be terminated to avoid stuck pipe, if hole problems cannot be reduced by corrective action.

(d) A hole conditioning or "wiper trip" should be made as often as required to maintain good hole conditions (i.e., generally less than 30K lb drag up and down, less than 300 amps torque off-bottom, and less than a 150 psi increase in pump pressure). Experience has indicated that wiper trips should be planned about every 2 to 3 days under normal circumstances (if coring is expected to continue for another day). The first wiper trip should be made to about 50 mbsf (to get the top of the large diameter drill collars above the seafloor). Subsequent wiper trips can be made to the previous wiper trip depth (if hole conditions are good at that point). Any tight hole sections should be wiped through without rotation or circulation until they are trouble-free on the wiper trip. If firm obstructions are encountered, pick up the top drive and ream-out the obstructions with the bit until they can be wiped through.

(e) In the event of stuck pipe, the compensator will be left partially open (allowing movement in either direction) while working the pipe.

(f) If stuck pipe cannot be pulled free with up to 200K lb overpull, preparations will be made to sever the lower 5-1/2 in. joint of transition drill pipe above the tapered drill collar. If a Mechanical Bit Release (MBR) is in the BHA, it may be possible to release the bit or pull the MBR apart in an attempt to free the pipe.

(g) A drill-string landing sub below the top drive and/or 500 ton elevators should be used in shallow-water operations because time may not be available to take other action in the event of an emergency "loss of positioning" situation. If time permits, the compensator will be locked and the 500-ton elevators will be landed on the rotary. All personnel will be restricted from the rig floor.

(h) Coring will cease if the heave compensator stroke (top to bottom) exceeds 3.25 ft (1.0 m), if wind gusts exceed 40 kt, or if the weather/sea state is rapidly deteriorating. If free-floating ice or other objects may be encountered, "alert zone" and "safety zone" radii should be calculated (see above for definition). An "alert zone" radius is based on the time required to suspend operations, pull out to 50 m below the seafloor, and set the landing sub or 500 ton elevators plus contingency time. A "safety zone" radius is based on time required to terminate operations and pull above the seafloor far enough for safe maneuvering plus contingency time. If time permits, the ODP Staff Scientist/Leg Project Manager, Ops Mgr, Co-Chiefs, TSF OIM, and Master should stay informed and make a joint decision on the suspension or termination of operations.

(i) The maximum allowable overpull on the drill string will be posted in the dog house as part of the "Standing Instructions to Drillers" (SID), but should not exceed 200K lbs.

(3) 301 to 650 m of water depth:

(a-f) Same as Item 2., 76 to 300 m water depth, a-f.

(g) Operations will cease if the heave compensator stroke (top to bottom) exceeds 6.5 ft (2.0 m), if wind gusts exceed 40 kt, or if the weather/sea state is rapidly deteriorating.

(h-i) Same as above Item 2., 76 to 300 m water depth, h and i.

II.C.4.b. Positioning Control Considerations and Beacons

Positioning control is especially critical in shallow-water situations because the short drill string provides less flexure and elasticity if the ship moves off the hole. Coring should be suspended and the core barrel should be withdrawn, if a substantial loss of positioning or a horizontal excursion is anticipated. As a practical matter, the standard yellow (2% of water depth) and red (3% of water depth) warning lights are overly cautious when operating in shallow-water areas with soft seafloors because they represent horizontal (lateral) excursions off the hole that are relatively minor. It is advisable in shallow-water areas with soft seafloors to increase the "yellow and red warning light tolerance" (Table 5) so that frequent positioning warnings for minor lateral excursions do not unnecessarily shut down operations. The suggested warning light tolerances are:

1. 4% and 8% in 76 to 300 m water depth,
2. 3% and 6% in 301 to 650 m water depth, and
3. 2% and 3% in 651 m and greater water depths.

Table 5. Warning tolerances for water depths at various horizontal offsets. Bold values indicate yellow and red warning light values.

Water Depth (WD) (m)	Horizontal Excursion at 2% WD = 1.1° Angle	Horizontal Excursion at 3% WD = 1.7° Angle	Horizontal Excursion at 4% WD = 2.3° Angle	Horizontal Excursion at 6% WD = 3.4° Angle	Horizontal Excursion at 8% WD = 4.6° Angle
76	1.5 m	2.3 m	**3.0 m**	4.6 m	**6.1 m**
301	6.0 m	**9.0 m**	12.0 m	**18.1 m**	24.1 m
651	**13.0 m**	**19.5 m**	26.0 m	39.1 m	52.1 m

In areas with soft seafloor sediment, the pipe can pull into the soft wall of the hole near the seafloor, and the curved 350 ft radius on the guide horn reduces severe bending angles at the ship. Excursions of 5% to 20% have occurred without drill string damage, and coring was resumed without tripping the pipe. In areas with hard seafloors, a more cautious approach is required to avoid drill pipe damage or getting stuck in key-seats.

Beacons for shallow-water operations should have lower power-output (i.e., reduced from the standard 208 dB to 199 dB) to avoid multi-pathing, which is bouncing sound signals back and forth between the bottom of the ship and the seafloor. Low-powered beacon tests in shallow water and good weather have demonstrated that the narrow transmission angle of a standard beacon transducer can be acquired even with substantial ship excursions and thruster noise (+20% displacement in 200 m water depth with 80% thruster power rating).

Currents in shallow water are often stronger at or near the bottom and may cause the tethered beacon to sway; therefore, it has been necessary in some instances to fix the beacon to a frame (e.g., Leg 133). Operating primary and backup beacons shall be deployed in shallow water, especially where operations could be impacted by confined locations, shipping lanes, potential high currents, severe weather, hard seafloors, or deep penetration (long-term) operations.

II.C.4.c Logging in Shallow Water

Logging should not be attempted in shallow water (0 to 650 m water depths) unless hole conditions are good. The CSES (conical side-entry sub) should not be used to log holes in shallow water. This reduces potential exposure to stuck pipe (especially while handling and rigging the CSES), and the added danger of sticking a logging tool because of bad hole conditions. Holes in shallow water that are logged should be loaded with sepiolite mud after the wiper trip as a precaution to provide the best hole conditions for logs. Upper hole sections from 0-250 mbsf may start to react and swell into the hole after 3 to 5 days. Upper hole sections down to 400 mbsf tend to wash-out to progressively larger diameters and become unstable with extended drilling.

The best hole conditions are normally obtained by logging the upper hole sections as soon as practical; therefore, if time permits, drilling a dedicated logging hole should be considered in reactive formations that require five or more days to core. A dedicated logging hole usually provides a fresh and more in-gage hole that has not had time to react or become unstable. This is especially true in shallow water, because the trip for a drill bit requires less time and logging operations in unstable holes are more risky.

II.C.5. High-Temperature Formations

Operations have been successfully conducted in 316°+C high-temperature hydrothermal zones; however, in high-temperature formations there is a potential danger of possible steam flash problems, swabbing in corrosive (pH=2-6) wellbore fluids, and/or H_2S. When retrieving core barrels or when a core barrel is in place (holding the float valve open), circulation should be maintained at low pump rates (50 gpm) to prevent swabbing or prevent fluid from U-tubing up into the drill string. It is sometimes possible to cool high-temperature holes by stopping every 500 m on trips to circulate at 500 gpm. The primary danger of getting stuck in a high-temperature hole is that the temperature limit of the Schlumberger explosive severing devices might be exceeded, especially if the pipe and hole were plugged or could not be cooled by circulation.

III. HYDROCARBON FLOW DURING DRILLING

III.A. FLOWS AND KICKS

III.A.1. Backflow

Backflow from the drill pipe is a normal occurrence when a connection is broken at the rig floor. Backflow can result from the "density differential" of warm (low density) surface water pumped down the pipe against cold (denser) water in the ocean, from air that has been trapped during connections and pumped down the pipe, from dense cuttings or mud in the annulus flowing back ("U-tubing") to equalize hydrostatic pressure, etc. Backflow into the pipe is usually reduced by the closure of the down-hole float valve, but also occurs while retrieving core barrels and through the bit nozzles. Hydrocarbons, hot acidic fluids, H_2S, and/or cuttings and debris from the hole may backflow into the pipe and plug the pipe or bit nozzles or jam the downhole float valve open. Backflow will usually gradually decrease within a short time as the pressure differential is equalized.

III.A.2. Detecting A Kick

In deep water, an uncontrolled flow (or "kick") of hydrocarbon gases or fluids exiting from a drilled hole at the seafloor probably would be diluted by mixing with the seawater column and dispersed by currents so that the flow might not be visibly evident on the ship. Fluctuating pump pressures, packing off in the annulus, decreasing string weight, and hole problems may indicate that a kick is in progress. The precision depth recorder (PDR) could be used to look for suspicious "plumes" in the water column if a gas flow is suspected. The VIT-TV could be used to check the hole at the seafloor for flow (i.e., an unusual debris cloud or turbidity). If a hydrocarbon kick is suspected, a kill procedure should be started immediately.

A kick up the pipe is most likely to occur when the annulus is packed-off, the pipe is open-ended (i.e., no float valve), or when the float valve is held open by a core barrel, debris, or malfunction. A kick inside the drill pipe might be differentiated from normal flow-back events because the flow-back rate from the pipe becomes progressively stronger with time. Note: as the pressure is reduced when gas rises, gas expands in inverse proportion (Boyles Law: $P_1V_1=P_2V_2$). In the event of heavy and increasing flow from the drill string, circulation should be reestablished as quickly as possible to pump intruding fluid out of the pipe. If the top drive is in use, it should be made back up to the drill string immediately. If the top drive has been racked, it will be faster to install the rig-floor safety valve and close the valve to stop backflow. The top drive or a circulating head can then be used to circulate down the drill string.

III.A.3. Running Back To Bottom

It is more difficult to kill a flow if the bottom of the pipe is not below the flow. If the pipe is off-bottom and the Ops Mgr, TSF OIM, and Master agree that an attempt to kill the flow does not pose a risk to the ship and personnel, an attempt may be made to run pipe back in to bottom. If a drill string safety-valve has been installed, it may be necessary to install a sub with a Baker model G (5f-6R) float valve above the safety valve so the safety valve can be opened at the rig floor. A rig-floor safety sub with a Baker float valve is on the rig floor at all times to act as a check valve, permitting fluid to be pumped down the pipe but preventing back-flow on connections. The Baker float valve can be used in instances (such as when using a logging bit or after dropping a bit) when the top drive is set back and/or a float valve is not in the string.

Most often, the pipe can be run back down into the good open-hole section, using the top drive to fill the pipe (to ensure gas is not moving up the pipe). The drill string should not be forced down into bad hole conditions because stuck-pipe severing operations would not be possible through a drill string float valve. Bad hole conditions probably indicate that the hole is collapsing and the flow will kill itself. The crew should attempt to pump kill mud as deep as possible under good hole conditions.

III.A.4. Controlling A Kick

The record of DSDP/ODP remains unblemished with regard to hydrocarbon pollution from scientific boreholes. That is a tribute to the careful screening procedures of scientific planning and safety panels, adherence to shipboard monitoring procedures, and the application of proper abandonment procedures by shipboard personnel. The possibility remains that an uncontrolled flow of gas or petroleum (known as a "kick") could occur despite all the safety precautions. In case a kick should occur, the Ops Mgr must be prepared to take immediate and appropriate action in concert with the TSF OIM to kill the flow if possible.

There is no riser, recirculating mud system, Blow-out Preventor (BOP), or choke and kill lines on the *Resolution* to control hydrocarbon or water kicks in the normal oil field manner (i.e., circulating heavy mud through a choke with back pressure). Penetrating a significant hydrocarbon reservoir is unlikely because potential traps for significant hydrocarbon accumulations are strictly avoided. In ODP’s scientific operations, open (uncased) holes are cored to relatively shallow penetration depths in soft to semi-indurated sediments in deep water; therefore, the formations could not withstand the pressure of a heavy-mud hydrostatic-column.

The objective in killing a flow is to quickly fill the hole with a mud column that has enough hydrostatic pressure to slightly exceed the formation pore pressure. However, the kill-mud weight must not exceed the formation fracture pressure, which would cause the mud to flow laterally, reducing the effective height and hydrostatic pressure of the kill mud column.

It may be prudent to advance the bit on a core-by-core basis if there is an increasing indication of migrated (but not liquid) hydrocarbons. In most circumstances, the detection of migrated and more-thermally-mature or liquid hydrocarbons requires suspension of drilling operations. Some areas with known gas seeps or dead hydrocarbon stains have been cored successfully using data from offset holes and a series of pilot "test" holes that are down-dip from the primary site.

Any flow or "kick" is likely to be from flow along a fault or of the low-pressure and low-volume "shallow gas pocket" or "salt water" variety. Without casing for hydrostatic pressure containment; circulating dense ("heavy") mud weights exceeding 10.5 ppg (1.26 gm/cc) might fracture soft sediments.

The fracture gradient at the weakest point in the hole (usually the casing shoe) is the effective limit on the imposition of additional hydrostatic kill pressure. A standard Gulf of Mexico Pore Pressure/Fracture Gradient/Mud Weight graph for riserless drilling can be used to predict formation pore pressures. For example, in 915 m (3000 ft) water depth and 915 mbsf (3000 ft) of penetration, the predicted formation pore pressure is 10.1 ppg (2925 psi). If the hole were loaded with 10.1 ppg kill mud, the formation fracture gradient would be exceeded at about 150 m (500 ft) with normal trip (surge) and circulation pressures. Therefore, 10.1 ppg mud would probably fracture (i.e., break down) the formation, and the mud would flow out into the formation at that point (i.e., more or heavier mud would not increase hydrostatic pressure control).

At 1500 mbsf penetration, the pore pressure is 10.5 ppg and the fracture gradient would be exceeded above 450 m (1500 ft). Therefore, overall considerations indicate that a 10.5 ppg kill mud is probably the heaviest practical kill mud for holes less than 1500 mbsf penetration under normal circumstances. A volume of heavier kill mud (perhaps 100 bbl of 12.5 ppg) could be placed on bottom (i.e., below 10.5 ppg mud) in deeper holes if fracture gradient conditions permit. Note that cement does not set in the presence of a gas flow; therefore, mud must be used to kill a gas flow before the hole is plugged with cement.

If a kick occurs, an attempt should be made if practical (and safe) to run pipe to total depth and fill the hole with pre-mixed kill mud and/or cement slurry. As in all well-control situations, judgment and rapid response are critical. It is probable that regardless of any attempt at human intervention, the turbulence from flowing fluids during the kick would destabilize the soft sediments in the borehole wall and the hole would load up with debris and/or collapse and reseal itself (which is what happens in natural flow events).

III.A.5. Minor Flows

A relatively minor or weak flow of gas or liquid hydrocarbons could seep into the hole from a formation that has been penetrated and could go completely undetected for the duration of drilling operations in deep water. A minor flow could manifest itself in unstable hole conditions and "packing off" around the drill string. If a flow is suspected, the PDR could be used to look for suspicious "plumes" in the water column it might be possible to run the VIT-TV to look for gas bubbles or liquids escaping from the hole, which might be detectable as white "hot spots" on the Mesotech sonar. An attempt should be made to kill such a suspected flow if it appears to be a safe operation.

ODP policy requires that sufficient 10.5 lb/gal kill mud should be pre-mixed and in the reserve pit at all times to completely fill the hole being drilled (usually about 250 to 350 bbl). If the pipe is open-ended or the downhole float valve is malfunctioning, the drill-string safety valve and drill-string float valve should be put into the drill string below the top drive before the pipe is run to total depth to displace the kill mud (in case the annulus packs off during pumping operations and flow is diverted up the pipe). While the kill mud is being displaced, preparations should be made to follow it with heavier mud or cement if required. If the flow can be stopped, the hole should be plugged with cement in accordance with PPSP Guidelines.

III.A.6. Major Flows

In the event that a hydrocarbon flow is detected, coring or drilling operations should be terminated immediately. The Ops Mgr, TSF OIM, Staff Scientist, and Master, in dialog with the co-chiefs, should review the situation and agree on a plan of action. ODP is a self-regulating program with a long history of pollution-free scientific ocean drilling and is committed to maintaining an environmentally sound pollution-free operation. However, if either the Ops Mgr, TSF OIM, or Master feel that a kill attempt is too risky to the ship or personnel, the bit should be pulled above the seafloor and the ship should be moved off location up-wind in DP mode before the remainder of the drill string is recovered. On the positive side, environmental damage from shallow gas blowouts is usually limited because the soft sediments in shallow holes tend to collapse and kill the flow after a relatively short time.

Less than 650 m water depth:

If the water depth is less than 650 m, refer to Section on Shallow-Water Operations.

More than 650 m water depth:
In water deeper than 650 m, an attempt should be made to kill hydrocarbon flows by pumping 10.5 lb/gal kill mud at high pump rates (500 to 1000 gpm) as soon as possible if:

a) the Ops Mgr, TSF OIM, and Master agree that a kill attempt is safe, and
b) there are no other mitigating risk factors (such as bad hole conditions).

The kill mud should be followed by heavier kill mud (if required to control the flow) and cement to permanently plug the hole. A flowing open hole is often unstable, and the chances of getting the pipe stuck are significant. If the drill string becomes stuck, the normal through-the-drill-string severing procedures might be impossible or too hazardous. In an emergency situation that required moving the ship immediately away from hydrocarbons, the options would be to intentionally offset or drive-off or drop the drill string. However, the danger to the ship and personnel from a hydrocarbon flow in deep water (with riserless operations) would be small under normal conditions. Hasty actions such as offsetting the ship before the pipe is clear of the seafloor or dropping the drill string might aggravate the situation, endanger personnel, or lead to the unnecessary loss of expensive hardware, if not done properly.

III.B. ABANDONMENT

III.B.1. Drilling and Early Abandonment Practices

Rapid pipe or tool movements that may swab fluid into the hole or fracture formations should be avoided. If hydrocarbons are detected or anticipated in substantial quantities, drilling should be stopped and the hole plugged.

III.B.2. Plugging and Abandonment Procedures

III.B.2.a. Plugging with Cement

The hole should be filled with viscous gel barite mud of 10.5 ppg (78 lb/ft^3) weight, allowing extra volume for hole enlargement and loss by displacement. The hole should be filled to the uppermost competent layer and a cement plug spotted. A minimum sized plug should be 200 sacks of 12-15 ppg. Where possible, a plug catcher or calibrated displacement tanks should be used in placing the cement.

If hydrocarbons are indicated, and the hole has penetrated semi-consolidated or consolidated rocks, proper placement of cement should be confirmed by probing with the drill string or sampling the cement with the core barrel. The cement plug should be calculated to be at least 15 m and preferably 30 m in length.

III.B.2.b. Plugging without Cement

The hole should be filled with viscous gel barite mud of 10.5 ppg (78 lb/ft^3) weight, allowing extra volume for hole enlargement and loss during displacement.

III.B.2.c. Standard Abandonment Procedures

Holes drilled in consolidated or semi-consolidated rocks on the continental shelf, slope, or rise should be plugged with cement. Holes drilled in unconsolidated sediments in which shows of oil or gas occur should be filled with mud. Holes on the deep ocean floor in which no shows are encountered or holes in igneous rocks may be abandoned without plugging.

IV. LOGGING

IV.A. ODP LOGGING SERVICES

ODP Logging Services provides downhole logging operations, as well as log data processing, distribution, and database services for ODP. ODP Logging Services is managed by the Borehole Research Group of the Lamont-Doherty Earth Observatory, but also includes logging groups in the UK, France, Germany, and Japan. ODP Logging Services is responsible for (1) shipboard logging operations and staffing, (2) shore-based log analysis, (3) log database development and management, (4) data publication and distribution, and (5) engineering development.

IV.B. SITUATIONS TO AVOID WHILE LOGGING

Holes containing bridges and ledges can pose extreme risk of loss to logging tools. Numerous scenarios to be avoided are detailed in the Logging Manual CD and therefore will not be listed here. Use of the conical side-entry sub may assist logging operations in difficult holes and therefore its use should be thoroughly considered.

IV.C. HIGH-TEMPERATURE LOGGING PRECAUTIONS

There are several procedures that should be followed before, during, and after logging operations in high-temperature environments. The Logging Staff Scientist should make arrangements with the logging subcontractor and logging engineer prior to the leg for having the capabilities of measuring in situ borehole fluid temperatures during all tool deployments. Discussions prior to the leg should also include the availability of high-temperature wireline cable and cable heads. This will ensure that high temperature logging operations can be carried out during the leg and that borehole temperatures will be monitored closely, thus avoiding potential damage to the tool strings.

The Logging Staff Scientist and the Ops Mgr should plan to perform several hours of hole circulation procedures before any tool deployment, if the temperatures exceed the safe operational limits of the tool strings. In some cases where there is a quick thermal rebound, the deployment of the side-wall entry sub (CSES) might be necessary for avoiding tool damage and saving time if more hole circulation is needed once the logging operations have already begun. The Logging Staff Scientist, Ops Mgr, and Co-Chief Scientists should also discuss time estimates, potential benefits, and procedures for such deployment.

Cautionary measures should be taken at the time of retrieving a tool string as hot fluids may spray a large area of the rig floor. Significant amounts of H_2S and hot fluids may also concentrate along joints in large tool strings, therefore; protective clothing and eyewear should be used when dismantling the tools. *If a memory tool that uses* ***lithium batteries*** *has been deployed in these environments,* ***extreme caution*** *will be needed before dismantling the tool as* ***exploding batteries*** *can be extremely* ***harmful****. Deployment of lithium batteries should be avoided in high temperature environments.*

After logging operations in a high temperature environment have been completed, the Logging Staff Scientist and Logging Engineer should conduct a careful inspection of the wireline cable and tools in order to assess any potential damage from prolonged exposure to H_2S. At this time, it may be necessary to discard sections of the cable that may show signs of corrosion due to exposure to high concentrations of H_2S.

IV.D. LOGGING-WHILE-DRILLING PRECAUTIONS

Drilling operations with logging-while-drilling (LWD) and measurement-while-drilling (MWD) collars can under most circumstances proceed by following standard drilling guidelines. Because the physical nature of these tools is vastly different than that of a standard drill collar, special care and attention must be paid to key drilling procedures to avoid a stuck or lost drill pipe situation. LWD and MWD collars deployed in ODP operations are typically 6-3/4" in diameter while drill collars are larger than 8-1/4 in. This difference in size creates two problems: (1) a stabilizer on the density neutron tool must be used to ensure constant contact with the borehole wall, and (2) the interface between the drill collars and LWD/MWD collars is not as strong as a drill collar to drill collar connection. Caution must be used when spudding into a hardened or crusty substrate to avoid excessively loading the drill pipe and possibly causing a "weak link" failure between the drill collars and LWD/MWD collars. Caution must continue to be exhibited until the LWD/MWD collars have penetrated below the seafloor.

Jars can be used to provide assistance in freeing a stuck BHA. In past ODP experience however, jars were frequently jammed by cuttings or were located below the stuck point, where they could not be operated. Additional problems are that jars further weaken the BHA and the sediments may leak, providing undesirable pathways for down-going circulated seawater.

In the event an LWD/MWD collar becomes irretrievably stuck, the stored data and radioactive sources must be retrieved using the wireline "LINC" tool. The LINC retrieval operation will consume approximately the same amount of time as one standard wireline run.

IV.D.1. Fluid Pumping Strategies

Drilling muds such as sepiolite should be used to stabilize the borehole prior to logging. Fluids should never be pumped while a tool is in the open hole or while a logging tool is in the BHA. If drilling in unconsolidated materials and the LWD/MWD collars become lodged, make all attempts using standard drilling techniques to free the tool. If this is unsuccessful, allow the formation to relax by not pumping for 10 to 15 minutes and then apply overpull. This scenario occurred on Leg 174 where the LWD collar was considered hopelessly stuck yet it was eventually recovered after pumping ceased.

IV.D.2. Overpressure

LWD/MWD tools are most often used where difficult formations are expected and hole stability is a significant concern. Environments such as convergent margins and in particular, décollements pose a serious risk to high-dollar drilling equipment. More conservative drilling techniques must be used to avoid a LWD/MWD assembly from becoming lodged in a zone of overpressure where hole instability is a possibility.

IV.D.3. Recovery Attempts and Tool Abandonment

If a tool is lost downhole, a reasonable effort must be made to recover it to satisfy our obligations to the environment, Schlumberger, and the insurance provider. The recovery effort should follow accepted practices and include multiple recovery attempts if technically feasible. The shore-based ODP Logging Services representative must be notified of the stuck or lost tool situation by the Logging Staff Scientist or the Ops Mgr.

If all reasonable efforts have been made to recover a stuck or lost tool without success, then the decision to abandon the tool must be made collectively by the Logging Staff Scientist, Ops Mgr, OIM, Co-Chiefs, Staff Scientist, and the Schlumberger engineer. In the event of loss involving a radioactive source, the tool and hole must be filled with cement, plugged, and abandoned to safely entomb the sources. Following the incident, a report must be filed by the Ops Mgr and delivered to the Logging Staff Scientist for possible use for insurance purposes. A copy of the ship's log must be included in this report.

IV.D.4. Tool Replacement Strategies

If a wireline or LWD/MWD tool is lost downhole, a backup tool should be put into service only after an appropriate recovery effort. Duplicate LWD/MWD and wireline tools are often, but not always available. Substitutes for all routine measurements are available. The backup strategy is as follows:

Wireline

Primary	Alternate I	Alternate II
HNGS	NGT	NGT
HLDS	HLDT	CNT-G
DSI	LSS	No backup
FMS	FMS	No backup
GHMT	No backup	
DLL	DLL	DIT
DIT	DIT	DLL
BHTV	No backup	
WST	WST	No backup
GLT	No backup	
AACT	No backup	

LWD

Primary	Alternate I	Alternate II
CDR	CDR	No backup
ADN	ADN	No backup
MWD	MWD	No backup
LINC	No backup	

IV.E. HAZARDOUS MATERIAL SAFETY

Logging operations often involve the use of radioactive sources and more seldom explosive sources. The Schlumberger or Anadrill engineer is trained and qualified in the safe handling and use of such sources. The radioactive and explosive materials must only be handled by authorized personnel. Several key safety steps must always be followed by all other shipboard personnel when radioactive or explosive source handing is occurring: (1) All personnel besides the logging engineer must clear the vicinity of the source work, and (2) when a source is loaded into a tool or collar, the tool must not be raised above the rotary table when personnel are about the rig floor. Additionally, electronic neutron generators (minitrons) must not be switched on when the tool is above rotary table.

The Schlumberger engineer will maintain an up-to-date hazardous material manifest and a copy provided to the Master. Any changes to the hazardous material manifest are registered with the bridge.

V. RESPONSIBILITY AND AUTHORITY

V.A. PRECRUISE RESPONSIBILITIES

V.A.1. Proponents, SSP, and PPSP Interaction

An Executive Committee (EXCOM) presides over JOIDES and advises the ODP prime contractor, the Joint Oceanographic Institutions, Inc. (JOI) on policy issues. Scientific leadership is provided by the Science Committee (SCICOM), which heads the JOIDES science advisory structure. Scientific proposals are reviewed by the Science Steering and Evaluation Panels (SSEPs) for Environment and Interior, which select scientifically mature proposals for external review.

SCICOM (with advice from the SSEPs) creates small focused short-term Program Planning Groups (PPGs) to work with proponents to produce mature proposals that cover specific scientific themes. JOIDES service panels provide advice to the advisory structure and include the Site Survey Panel (SSP), Pollution Prevention and Safety Panel (PPSP, also known as Safety Panel), and Scientific Measurements Panel (SciMP).

Following reviews of proposals by external panels, the SSEPs forward scientifically mature proposals to SCICOM with a recommendation for inclusion in the drilling program. SCICOM ranks all the proposals and sends them to the Operations Committee (OPCOM). OPCOM receives reports from the PPGs and recommends the drilling program schedule to SCICOM for approval. The Technology and Engineering Development Committee (TEDCOM) provides advice to ODP through OPCOM on technical matters, drilling tools, and techniques to meet scientific objectives as well as monitors the progress of their development. The SSP provides advice to ODP through OPCOM on the adequacy of, and need for, site survey information relating to proposed drilling targets. The PPSP provides advice to ODP through OPCOM regarding potential safety and pollution hazards that may exist because of general or specific geology of the seafloor or as a consequence of human activities.

Both the JOIDES PPSP and the ODP/TAMUSP give advice and make recommendations that are incorporated in the final decision on whether a specific site will be drilled.

V.A.2. Science Operator

The operation of the drillship, which includes planning and implementation of cruises, is managed from ODP facilities at **Texas A&M University** (TAMU) in College Station, Texas. This facility also serves as a repository for cores from the Pacific and Indian Oceans. As science operator, TAMU is responsible for (1) Co-Chief scientists selection (based on recommendations from SCICOM), (2) implementing science planning and operations, (3) final drilling approval, (4) guiding engineering development and improvement of drilling technology, (5) selecting scientists for the shipboard scientific parties, (6) designing, furnishing, and maintaining shipboard and shore-based laboratories necessary to meet the needs of the shipboard scientific staff, (7) curating and distributing all core samples and data, (8) shipboard safety, (9) obtaining clearance to drill/core, (10) publishing scientific results, and (11) providing public information about ODP.

V.A.3. Staff Scientist/Leg Project Manager Precruise Responsibilities

The advisory structure of ODP determined in 1996 that the Program incorporate the principles of project management as an operational paradigm. With this shift, the Staff Scientist was assigned as the LPM. This position is pivotal for successful completion of each cruise and coordination of the leg team and management of leg-related resources. LPM/Staff Scientists are supervised by the Deputy Director for Operations who oversees LPM tasks and the Manager of Science Operations who oversees all other job functions. The Staff Scientist is responsible for ensuring the successful implementation and completion of the cruise-based science plan as defined by the JOIDES panels through project management of the cruise related resources. As cruise project manager, the staff scientist interacts with Co-Chiefs, coordinates the shipboard scientific party before and during the cruise, and coordinates operational planning. In addition, the staff scientist coordinates development of shipboard measurement procedures and laboratory equipment; interfaces with scientists as customers and with the JOIDES advisory and planning structure; contributes to shaping ODP's future through continued improvements in strategies, policies and services; conducts scientific research to maintain and expand the expertise required to act effectively as a staff scientist.

Specific duties include:

1. Coordination of a leg project team composed of representatives from each department to ensure efficient precruise and cruise operations.
2. Working closely with the Co-Chief Scientists to prepare the cruise Scientific Prospectus in a timely manner.
3. Scheduling, coordination, and hosting of precruise meetings with the Co-Chief Scientists to complete precruise planning and related ODP policies and procedures.
4. Provide a link at ODP/TAMU for communication with shipboard scientists before the cruise and ensuring that all pertinent cruise information is sent to shipboard scientists prior to the cruise.

V.A.4. Co-Chief Scientists Precruise Responsibilities

1. Aid ODP staff in refining the scientific objectives of the cruise, taking into account operational constraints and ensuring that the necessary geologic, geophysical, oceanographic, and meteorological data are assembled.
2. Aid ODP Site Survey Databank personnel as necessary in preparation of the safety package for formal review by JOIDES Pollution Prevention and Safety Panel (PPSP).
3. Review scientists' applications for participation on the cruise. Make recommendations to the ODP manager of Science Services for the selection of participants.
4. Participate in the Co-Chief Scientists' precruise meeting to finalize cruise planning and meet ODP personnel.
   (a) Finalize cruise operation strategy
   (b) Finalize Scientific Prospectus
   - Agreement between Co-Chiefs, panels, and TAMU/LDEO concerning cruise operations in meeting cruise objectives
   - Provide shipboard participants with specific cruise strategy for completion of individual sample requests
   - Clearance documents

   (c) Provide guidance concerning services available by ODP/TAMU and LDEO
5. Prepare the cruise scientific prospectus in ODP format for distribution to cruise participants and the JOIDES community. Complete document by the end of the precruise meeting.
6. Review requests for samples from the cruise. Aid curatorial personnel in addressing "problem" requests prior to the cruise. Prepare letter to participants addressing team approach.
7. Arrive at the ship the first day of port call.
8. Cross over with previous Co-Chiefs during port call, when appropriate.

V.A.5. Logging Staff Scientist Precruise Responsibilities

Shortly after the drill ship schedule has been set by SciCOM at the August meeting, ODP Logging Services appoints a Logging Staff Scientist for each scheduled leg. The Logging Staff Scientist is considered to be the leader of the Logging Services project team. In addition to any people sailing, the team usually consists of the following personnel:

- LDEO Manager of Technical Services or tool deployment and engineering issues
- Engineering Assistant for shipping issues
- Manager of Information Services for data handling issues
- Log Analysts for log processing services
- CD-ROM coordinator for issues involving the Log Data CD

- Systems Analyst for any computer or software issues

In addition, there may be other engineering or scientific personnel involved if special projects are planned for the cruise. The LDEO Deputy Director of Operations is responsible for coordinating the activities of the leg project managers. She and the Director are available to assist as needed.

The Logging Staff Scientist is responsible for ensuring the successful implementation of the logging program for each cruise. He/she provides a link between ODP Logging Services and the shipboard scientists before, during, and after the cruise. The role of the Logging Staff Scientist during the cruise includes:

- Coordination of all leg-related logging activities
- Training of any new logging scientists
- Interfacing with the Co-Chief Scientists, TAMU Staff Scientist, JOIDES Logger, Geophysical Properties Specialist, and the Ops Mgr, and Drilling Superintendents

V.B. CRUISE RESPONSIBILITIES

V.B.1. Co-Chief Scientists

The Co-Chief Scientists are **responsible for the scientific success of the cruise**. At sea they are responsible for optimum use of the vessel's time, except as abridged by policies set by the ODP Program Plan (available from ODP/TAMU), safety considerations, and/or laws of the sea. The Co-Chief Scientists are charged with implementing the recommendations of the JOIDES Planning Committee for drilling, coring, and logging, after the recommendations have been reviewed operationally and approved by ODP management.

Specific cruise duties include:

1. Represent the JOIDES community in the shipboard leadership team (with the LPM/Staff Scientist, Ops Mgr, Lab Officer, and curator) in coordinating the shipboard science activities toward attaining cruise objectives set by the JOIDES scientific and operational committees.
2. As a member of the Sampling Allocation Committee (SAC), supervise the implementation of the cruise sampling plan and see that all shipboard scientists help in its completion.
3. Ensure that scientific data obtained during the cruise is entered into the ODP database by the Shipboard Scientific Party.

4. Share with the Ops Mgr the responsibility of avoiding drilling into hydrocarbon accumulations by ensuring that all hydrocarbon monitoring procedures are carried out. Also ensure that recommendations of the JOIDES PPSP are followed during the cruise.
5. Determine when and what types of underway geophysical data are collected while underway between sites and to and from ports.
6. Provide ODP with a concise report of the scientific results obtained at each site immediately upon its completion (Site Summary), and provide a weekly science progress summary when sites are occupied for extended times.
7. Report information generated during the cruise in a cruise Preliminary Report and a cruise press release. These reports must be completed prior to docking at the end of the cruise.
8. Complete a Cruise Evaluation Form, or otherwise provide written assessment of performance of equipment, procedures, and ODP and Sedco personnel to the manager of Science Services.

V.B.2. Staff Scientist/Leg Project Manager Cruise Responsibilities

1. Aide the Co-Chief scientists in preparation and finalization of the cruise sampling plan.
2. Act as liaison to further communication between the Co-Chiefs, Ops Mgr, and scientific party.
3. Act as liaison with internal departments and the external science community concerning leg activities.
4. Ensure that departments comply with appropriate regulations concerning shipments to foreign ports where the research vessel is locating.
5. Ensure that shipboard reports for the *Initial Reports* are properly written and submitted in a timely manner (including Site Reports, Leg Summaries, and Barrel Sheets).
6. Ensure that the Weekly Reports, Site Summaries, Preliminary Report, and a press release are properly written and submitted in a timely manner.
7. Coordinate science meetings during cruise.
8. Coordinate shipboard measurements, including use of standard and special instrumentation, data quality control, data archiving, use of data acquisition, analyses, and reporting programs.
9. Assist Ops Mgr and Co-Chiefs in daily operations planning.
10. Act as a member of the shipboard scientific party.
11. Compile a draft table of contents for the Initial Reports and Scientific Reports volumes with the shipboard party.
12. Ensure successful implementation of port call activities including shipping and receiving.

V.B.3. Operations Manager Cruise Responsibilities

The Operations Manager (Ops Mgr) is the **senior ODP/TAMU representative aboard ship**. He/she is responsible for (1) the execution of the recommendations and procedures made by the

JOIDES Safety Panel and approved by ODP/TAMU; (2) all matters affecting the technical and operational success of the expedition; (3) planning and directing the activities of shipboard Sedco personnel through their designated supervisors; (4) ensuring that the best possible techniques, equipment, and work efforts are used to maximize scientific results with minimum risk of loss of equipment or personal safety; (5) representing ODP/TAMU in determining acceptable drilling conditions; (6) dealing with matters pertaining to discipline of the ship, drilling, and scientific crews; (7) approving on-site changes in equipment or drilling and coring procedures and (8) completing accurate reports of drilling, coring, and ship operation/maintenance, and for transmission of this information ashore (daily operations reports). The Ops Mgr, if necessary, will remind the Co-Chiefs and other scientific party members that if any hole at a site is drilled to a depth ≥400 m, at least one of the holes must be logged. All communications with Sedco personnel regarding cruise operations or any other business matters must go through him. The Ops Mgr also has direct supervision of the Operations Engineer. It is the Ops Mgr's obligation, after consulting the Co-Chief Scientists and Staff Scientist, to terminate drilling operations whenever necessary to prevent any possible release of hydrocarbons. **Final authority to terminate drilling/coring resides with the Ops Mgr.**

The Contract between Texas A&M Research Foundation (TAMRF) and Ocean Drilling Limited (TSF), specifies that the ODP Ops Mgr is the **ONLY ODP contract representative** on board who is authorized to issue orders to TSF (the Contractor). All ODP instructions and business with the Contractor must come from the Ops Mgr and should be given (preferably in writing) to the TSF OIM.

The Ops Mgr is responsible for working with the Contractor's supervisory personnel to ensure compliance with the contract and insure the most effective safe use of time and materials in compliance with the Prospectus, science plan, and leg operations. The ODP/TAMU Administration Department is responsible for administering and interpreting the Contract. The Contract has numerous modifications and additions, which have modified and extended the contract. A copy of the Contract is maintained in the Ops Mgr's office on board the ship. The ODP Administration Department should be contacted for the latest additions and interpretation of the contract.
In addition, action by the Planning Committee (PCOM) and JOI have clarified policy with regard to the role of the Ops Mgr in operational decision-making. These interpretations concern not only logging and downhole instrumentation, but overall scientific site objectives.

Paragraph 562 of the JOI ODP Policy Manual states: "The ODP Ops Mgr is the official representative of the Ocean Drilling Program and has the responsibility of seeing that the

SCICOM (formerly PCOM) drilling and logging guidelines are followed during the cruise operations."

This is not to imply that the Ops Mgr has the authority to make or alter scientific decisions. The operational plans and scientific objectives described in the cruise prospectus reflect the official directives and policies to be followed on a given leg.

V.B.4. Logging Staff Scientist Cruise Responsibilities

- Training of any new logging scientists sailing on the cruise
- Interfacing with the Co-Chief Scientists, TAMU Staff Scientist, JOIDES Logger, Geophysical Properties Specialist, and the Ops Mgr, and TSF OIM
- Cruise and postcruise reporting of logging objectives and operations
- Participation in and supervision of at-sea logging operations, including data acquisition, interpretation and integration, and data distribution.
- Schlumberger data acquisition: supervision and quality control
- Conducts scientific research to maintain and expand the expertise required to act effectively as a logging staff scientist.

V.B.5. Master and TSF Offshore Installation Manager Cruise Responsibilities

Maritime law states that the ultimate and overall responsibility for safety on board the ship resides with the master of the vessel (i.e., the Captain). Transocean Sedco-Forex (TSF) company policy is that the TSF Offshore Installation Manager (OIM) is the senior TSF representative on board and is in charge of TSF drilling related operations when the ship is in dynamic positioning mode (except where the safety of the ship is involved). The vessel’s viability as everyone's life-support system has first priority. The safety of individuals has priority over the safety of the drill string and other equipment.

Specific duties of the Master include:

1. Overall responsibility for safety, vessel stability, barge control, deck and hull load distribution, draft and trim adjustments, position of rig over hole, and monitoring weather.
2. Supervises navigation, port entry/exit, running and retrieving anchors, towing and steaming, material/personnel transfer, and crane operations.
3. Supervises maintenance of safety equipment, operation of thrusters, preventive maintenance programs, pollution control, mooring systems, rig bulk systems, bilge alarm systems, and cathodic protection systems.
4. Monitors structural integrity of ship and supervises systematic inspections.
5. Oversees maintenance of medical, communications, sanitation, food preparation, and handling and storage facilities.
6. Ensures rig meets all regulatory requirements.
7. Assists and plans crew training and oversees adherence to safety policies and procedures.
8. Directs and trains crew in emergency operations.

Specific Duties of the OIM include:

1. Supervise coring and drilling, including casing and cementing, out-of-the-ordinary operations, well control measures, and weather monitoring.
2. Oversees preventative and planned maintenance programs on equipment.
3. Oversees maintenance of medical, communications, sanitation, food preparation, and handling and storage facilities.
4. Directs crew in emergency situations and makes decisions to evacuate/abandon rig.
5. Prepares crew schedules and trains crew.
6. Prepares incident reports as required.

Specific Duties of the Tool Pusher include:

1. Supervises coring operations, drilling, including casing and cementing, and out-of-the-ordinary operations.
2. Monitors vessel stability, rig stationing on location, and weather.
3. Oversees preventative and planned maintenance programs on equipment.
4. Directs crew in emergency situations.
5. Prepares crew schedules and trains crew. Oversees company rig training program and adherence to requirements of regulatory agency.

V.B.6. Laboratory Officer Cruise Responsibilities

While at sea, the Lab Officer (LO) reports to the Ops Mgr and is responsible to the Co-Chief and Staff Scientists for the direct **supervision, performance, and safety of the ODP technical staff** in the collection of core material and recording of data; and for the proper, efficient, and safe operation and maintenance of the ship's laboratories and related equipment. On most cruises, a member of the technical staff is designated Assistant LO, handling part of these responsibilities. The technical staff on board *JOIDES Resolution* usually consists of a LO, eight Technicians, one Photographer, one Yeoperson, two Chemists, two Electronics Technicians, two Computer System Managers, and one Curatorial Representative. In normal practice, the LO directs these activities in a way consistent with the guidelines and overall priorities, policies, and assignments made by ODP/TAMU.

The LO is **responsible for all shipboard scientific equipment** and supply items. All samples, data, and equipment, including necessary paper work, are prepared for shipment under his direction.

The LO works with Sedco through the Ops Mgr when his areas of responsibility involve ship's personnel, equipment, or operations.

V.B.7. SCICOM/Safety Panel Cruise Responsibilities

It is rare in ODP operations that the prospectus can be followed in its entirety. Time limitations, delays, and unexpected drilling results usually dictate that certain objectives or operations must be deleted or changed. The authority to alter the science objectives does not reside on the drillship. Changes can be effected only with the approval of the SCICOM and/or the Safety Panel through communications with ODP/TAMU management. Changes to the approved operational plan require the approval of ODP/TAMU management.

It is the Ops Mgr's responsibility to keep the Co-Chiefs and ODP management sufficiently informed about events that will force a departure from the prospectus plan. Co-Chiefs may need to be reminded to submit their recommendations for alternative plans to ODP management for discussion with SCICOM and or PPSP as appropriate. If it is avoidable, the situation should not be allowed to "slide" until a last minute shipboard decision must be made.

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APPENDIX I

Pollution Prevention Safety Panel Form

APPENDIX II DEFINITION OF ACRONYMS

ACRONYM	DEFINITION
AACT	Aluminum activation clay tool
ADN	Azimuthal Density Neutron tool
APC	Advanced piston corer
bbl	barrels
BHA	Bottom-hole assembly
BHTV	Borehole televiewer downhole tool
BOP	Blow-out preventor
BSR	Bottom simulating reflectors
CD	Compact disc
CDP	Common depth point
CDR	Compensated dual resistivity log
CD-ROM	compact disc-read-only memory
CMP	Common mid point
CNT-G	Dual porosity compensated neutron tool
CSES	Conical side-entry sub
dB	Decibel
DIT	Phasor dural induction tool
DLL	Dual laterolog (resistivity)
DP	Dynamic positioning
DSD	Drilling Services Department
DSDP	Deep Sea Drilling Project
DSI	Dipole shear sonic imager
EXCOM	Executive Committee
FMS	Formation MicroScanner
ft	foot or feet
gal?	gallon
GHMT	Geological high sensitivity magnetometer
GLT	Geochemical logging tool
gm/cc	grams per cubic centimeter
gpm	gallons per minute
H_2S	Hydrogen sulfide

HLDS	Hostile environment lithodensity sonde
HLDT	Hostile environment lithodensity tool
HNGS	Hostile environment natural gamma ray sonde
HRRS	Hard rock reentry system
JOI	Joint Oceanographic Institutions, Inc.
JOIDES	Joint Oceanographic Institutions for Deep Earth Sampling
kt	knots
lb	pound
lb/ft^3	pounds per cubit foot
LDEO	Lamont Doherty Earth Observatory
LINC	LWD Inductive Coupling tool
LO	Lab Officer
LSS	Long-spaced sonic logging tool
LWD	Logging while drilling
m	meter
MBR	Mechanical bit release
mbsf	meters below seafloor
MCS	Multichannel seismic
MDCB	Motor driven core barrel
MLS	Marine Lab Specialists
MWD	Measurement while drilling
NGT	Natural-gamma spectrometry tool
nmi	nautical mile
OBS	Ocean-bottom seismometer
ODP	Ocean Drilling Program
OIM	Offshore Installation Manager
OPCOM	Operating Committee
Ops Mgr	Operations Manager
PCOM	Planning Committee
PCS	Pressure core sampler
PDR	Precision depth recorder
ppg	pound per gallon
ppm	parts per million
PPSP	Pollution Prevention and Safety Panel

psi	pounds per square inch
PVT	Pressure-volume-temperature
RCB	Rotary core barrel
SAC	Sampling Allocation Committee
SCICOM	Science Committee
SciMP	Scientific Measurements Panel
SCS	Single channel seismic
Seasat	Sea satellite
SID	Standing instructions to drillers
SSEPs	Science Steering and Evaluation Panels
SSP	Site Survey Panel
SWDWG	Shallow-Water Drilling Working Group
SWGHS	Shallow-water gas hazards survey
TAMRF	Texas A&M Research Foundation
TAMU	Texas A&M University
TAMUSP	TAMU Safety Panel
TEDCOM	Technology and Engineering Development Committee
TSF	Transocean Sedco-Forex
VIT	Vibration-isolated television
VPC	Vibra percussive corer
VSP	Vertical seismic profile
WD	Water depth
WST	Well seismic tool
WWW	World wide web
XCB	Extended core barrel

Amendments