

HYDROGEN SULFIDE DRILLING CONTINGENCY PLAN^{1,2}

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OVERVIEW

Introduction

This document guides personnel aboard the *JOIDES Resolution* in recognizing, preparing, and mitigating potentially dangerous hydrogen sulfide (H₂S) situations during drilling operations.

Not all situations can be foreseen on board the *JOIDES Resolution*, nor can detailed instructions be provided for every situation that might be encountered. The policies and guidelines set forth in this document should be considered as a *minimum* set of requirements for preparing and dealing with H₂S exposure.

In addition, these policies and guidelines can be used with other heavier-than-air toxic gases, provided that the proper gas detector systems have been installed and calibrated for the specific gas.

Scope

This document supersedes and replaces the two previous Ocean Drilling Program (ODP) H₂S safety documents, *Technical Note 16* (Howard and Reudelhuber, 1991) and *Technical Note 19* (Foss and Julson, 1993). This *Technical Note* is intended to supplement existing ODP and ship operator safety documents.

This document includes information about the following:

- Identifying, classifying, and responding to different levels of H₂S hazard;
- Preparing to core H₂S-bearing formations;

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²See [Disclaimer](#).

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- Processing H₂S-bearing cores;
- Setting up the fixed H₂S detection system;
- H₂S safety training, drills, and record keeping;
- Responsibilities and duties of personnel in regard to the policies set forth in this document;
- Technical information about H₂S and other gas hazards; and
- Copies of waiver forms.

Distribution

An electronic copy of this manual will be kept on the ODP Web site policy page. An annually updated hard copy of this manual will be kept in the offices of both the ODP Operations Manager and the ship’s Off-shore Installation Manager.

Both electronic and hard copies *will be available to all personnel* aboard the *JOIDES Resolution*.

H₂S HAZARD CONDITIONS

There are five H₂S hazard conditions, excluding “normal operations” (Table T1). This manual provides a minimum set of guidelines for each hazard condition covering the following topics:

- H₂S monitoring,
- Precautions and special procedures,
- H₂S response, and
- Special concerns.

The H₂S hazard condition is set by the offshore installation manager based on the concentration of H₂S (ppm) in air, the type of H₂S source, the location of the detector (open air or confined space), and the relative distance of the detector from the H₂S source.

Table T1. Hydrogen sulfide operating conditions.

H ₂ S condition	H ₂ S (ppm) measured from		Danger to life	Action
	Open air	Core/Drill string		
Normal operations	No H ₂ S potential		None	None
Watch	Potential H ₂ S		None	Monitor
Alert	1–19	NA	None	Monitor, use BAs as needed
Danger	20–49	>20	Moderate	Stop coring operations
Emergency	>50	NA	Extreme	Evacuate to safe areas

Notes: BA = fixed or portable self-contained breathing system. NA = not applicable.

Common H₂S Sources

The most common H₂S sources (see “Appendix B”) on the *JOIDES Resolution* are

- Gases diffusing from recovered core and samples taken from the core;

- Gases that have accumulated in the core barrel and escape when the core catcher and/or the core liner is removed;
- Gases that are “swabbed” up the drill string when a core, down-hole tool, or logging tool is recovered and escape when the drill string is opened at the rig floor;
- Gases that escape from downhole or logging tools when opened in the laboratory after use;
- Gases displaced when the inner core barrel is washed out;
- Decomposition of recovered H₂S clathrates; and
- Well blowout that releases gases up through the drill string or into the surrounding waters.

In all these cases (except for clathrates and blowout situations), the source of H₂S is small in volume or must pass through a small opening first (i.e., the open end of the drill string) before reaching a work area.

H₂S Detectors

Fixed-Area Detection Stations

Fixed-area detection stations are mounted around the ship (see “[Appendix A](#)”) where H₂S sources are present or in areas where H₂S may accumulate. One or two sensors can be attached to each detection station. The stations are mounted in open areas and continuously monitor for H₂S in the work area atmosphere. The detection stations are connected via radio to an alarm control panel mounted on the ship’s bridge. In addition, each station may have either an audio or a visual alarm, or both.

All fixed H₂S sensors are set to detect a minimum of 10 ppm. Warning lights and horn units are installed on each detector station. If H₂S is present at concentrations at or above 10 ppm, a local audible and visual alarm will sound in the hazardous area where H₂S is detected. At the same time, an audible and visual alarm will be triggered on the central alarm panel on the bridge.

For detailed operating instructions and specifications, see the manufacturer’s operator manual.

Portable Detectors

The staff on the rig floor and core-receiving platform use handheld portable detectors to spot check for the presence of H₂S. In addition, this style of detector can be used to monitor the work atmosphere.

Personal Detectors

Staff wear personal detectors while working directly with potential H₂S sources.

H₂S Hazard Determination

To determine the level of the H₂S hazard (see “[Appendix C](#)”), it is important to remember the following facts:

- H₂S concentrations will diminish with distance from the source.

- Moving air will greatly reduce the concentration of H₂S with distance from the source.
- Moving air can direct H₂S away from the sensor.
- H₂S is denser than air and will accumulate in unventilated rooms or in low areas on the ship (e.g., in the elevator well).

The following examples demonstrate why it is important to understand where and how H₂S was detected before assigning a hazard classification.

- H₂S has been swabbed up the drill pipe and released onto the drill floor when the pipe was opened to retrieve a core barrel. A fixed detector, mounted 20 ft away and downwind from the open drill pipe, measures an H₂S level of 4 ppm (no alarm).
- On the core-receiving platform, a marine specialist measures 100 ppm of H₂S using a portable detector with the sampling tube inside the cut end of the core liner.
- The alarm of the H₂S station monitoring the refrigerated core storage has gone off.

In the first example, the H₂S level measured at the detector has been reduced by distance. It is possible that the concentration of H₂S near the open drill string is at a lethal level. In an open-air location, a fixed detector cannot be used as the primary means of H₂S detection. However, the detection of *any* H₂S by a fixed detector in an open-air location could indicate a *very* serious condition near the source. When a fixed detector is activated in an open-air setting, personnel not wearing a portable breathing apparatus (BA) must leave the work area immediately until the source has been discovered (using a portable detector) and the concentration of H₂S has dropped to a safe level.

In the second example, the H₂S measurement was taken directly at the source in a confined space. Because the staff working on the core-receiving platform are in an open-air environment, a measurement should be taken 12 in away from the core to determine the actual hazard level. If this measurement shows an H₂S level >20 ppm, then BAs are only needed for individuals working directly over the core; other individuals working on the core-receiving platform do not need to wear a BA.

The third example is a serious situation because the detector is monitoring a confined space. Only individuals wearing BAs should enter this area to begin ventilation. *Note, however, that H₂S readings taken in a confined space should not necessarily be used to determine H₂S hazard conditions for the entire ship.*

H₂S Hazard Responsibilities

Offshore Installation Manager

- Understands the H₂S guidelines and policies set forth in this document and ensures that all personnel aboard the *JOIDES Resolution* observe the same;
- Informs the operations manager, ship's master, and shipboard supervisors of the current H₂S hazard condition;

- May modify the policies in this document to fit the safety requirements of the situation; and
- Is qualified to conduct the shipboard H₂S safety training.

Night Tool Pusher

- Assists in carrying out the offshore installation manager's responsibilities listed above and
- Is qualified to conduct the shipboard H₂S safety training.

ODP Operations Manager

- Assists the offshore installation manager in enforcing the policies set forth in this document;
- Keeps ODP shipboard staff informed of the H₂S hazard situation;
- Keeps ODP onshore management informed of H₂S hazard situation; and
- Is qualified to conduct the shipboard H₂S safety training.

Ship's Master and Officers

When an H₂S emergency (>50 ppm) condition is encountered, the ship's master or ship's officer on duty is solely responsible for determining what action is required and, as necessary, sounding the general alarm to notify personnel to report to the designated safe-briefing area.

The ship's master or officer

- Designates the safe-briefing areas;
- Keeps all personnel advised of the current safe-briefing area;
- Notifies vessels and aircraft in the area of an H₂S emergency;
- Maintains both fixed and portable breathing systems in a safe and working order; and
- Maintains a 24-hr watch on the bridge to monitor the H₂S central alarm panel.

Laboratory Officer

- Is qualified to conduct the shipboard H₂S safety training;
- Provides H₂S training to the science party;
- Oversees technical staff in setting up, calibrating, and testing the H₂S detector systems;
- Posts H₂S warning signs;
- Assigns the H₂S safety technician's duties;
- Ensures that the scientific party has personal protection equipment (PPE) and knows how to use it;
- Documents all training and maintains training records; and
- Assists the offshore installation manager in enforcing the policies set forth in this document.

Assistant Laboratory Officer

- Is qualified to conduct the shipboard H₂S safety training and
- Assists the laboratory officer in carrying out his responsibilities as listed above.

Ship's Department Supervisor

- Keeps staff (including the consultant and subcontractors) informed of the current H₂S hazard and
- Provides appropriate PPE and ensure that staff know how to use it.

Core Technician

- Monitors H₂S levels on the rig floor;
- Knows and executes the H₂S monitoring policies set forth in this document; and
- Keeps the offshore installation manager, operations manager, and H₂S safety technician advised of the H₂S situation in their work area.

H₂S Safety Technician

- Monitors H₂S levels on the core-receiving platform and in the core laboratory;
- Knows and executes the H₂S monitoring policies set forth in this document; and
- Keeps the offshore installation manager, operations manager, laboratory officer, and assistant laboratory officer advised of the H₂S situation in their work area.

Ship's Physician

- Confirms that personnel working in the hazardous areas do not have punctured eardrums;
- Ensures that the ship is stocked with any special medical supplies that may be needed for treating personnel exposed to H₂S; and
- Assists with training in resuscitation and H₂S first aid.

All Personnel

All personnel working in the designated hazardous areas (rig floor, core-receiving platform, core laboratory, and reefer) must

- Be familiar with the procedures outlined in this document;
- Complete an H₂S safety training course;
- Be responsible for their PPE and that it is properly stored and easily accessible;
- Be familiar with the location of all safety equipment in their work area and be able to use it upon notice;
- Stay informed of the current H₂S hazard condition; and

- Follow instructions set forth in this document or as provided by their supervisor.

PREPARATION FOR H₂S OPERATIONS

General

H₂S detection equipment, training materials, and warning signs must be kept on board the *JOIDES Resolution* and in an operational state for every leg, regardless if H₂S is expected or not. Responsible positions are defined in the following sections.

Pre-cruise

All ship personnel are tested for perforated eardrums as part of their medical exam. Individuals with perforated eardrums will be permitted to work with or in proximity to H₂S cores provided they sign an indemnity waiver (see “[Appendix F](#)”) and do not work in any areas where a BA is required because of H₂S.

The laboratory officer ensures that all H₂S safety equipment that has been returned to the vendor for repair is fixed and sent back to the ship and that an adequate supply of calibration gases is on board before the ship leaves port.

Before Arriving on Site Where H₂S is Expected

Training

H₂S safety training courses are held for all shipboard personnel, and records are kept for all who attend. The laboratory officer will conduct this training for the science party as part of their specific hazard training. The original record of training is sent to ODP and filed with the human resources office. A copy is kept on board, filed in the laboratory officer’s office. The offshore installation manager will conduct this training for the ship staff.

H₂S safety training covers

- General safety concepts, procedures, and policies of this document;
- Location and use of air breathing equipment;
- Hazards of H₂S;
- First aid for H₂S victims;
- How to operate personal and portable H₂S detectors; and
- Becoming “wind-conscious” (aware of the direction of the prevailing winds at all times).

Ship’s Captain

- Conducts at least one H₂S evacuation drill and
- Opens the upper air intake and closes the lower air intake on the ship’s air-conditioning plenum.

Offshore Installation Manager

The offshore installation manager conducts blowout drills until supervisors are satisfied that rig floor personnel can install the drill pipe safety valve while using breathing equipment.

Laboratory Officer

- Posts H₂S warning signage;
- Establishes the core-receiving platform as a NO SMOKING area;
- Mounts the fixed H₂S detectors and alarms at locations noted in “Appendix A;”
- Calibrates and tests fixed, portable, and personal H₂S detectors;
- Distributes portable and personal H₂S to staff as needed and makes sure that the staff know how to operate detectors;
- Designates two H₂S safety technicians for 24-hr coverage; and
- Places emergency air escape packs (three each, 5 min of air) inside the elevator.

Ship’s Officers

- Install wind direction indicators per “Appendix B” and
- Ensure that both portable and fixed BA systems are in operating order.

NORMAL OPERATIONS

During normal drilling operations, H₂S is typically first detected by odor (<1 ppm). When H₂S odor is detected, the offshore installation manager should be notified immediately. After consultation with the operations manager and scientists, the offshore installation manager determines whether invoke one of the H₂S hazard conditions.

During an H₂S hazard condition of ALERT or higher, all drilling operations are suspended until the presite H₂S preparations are completed, including H₂S safety training, which can be given to each shift before they start work.

In addition, the offshore installation manager can permit drilling operations to resume while fixed-station detectors are being installed, provided portable detectors are available for monitoring and H₂S levels do not exceed 20 ppm when measured at the drill string or core.

At a minimum, a fixed detector must be installed on the rig floor and on the core-receiving platform.

Unexpected H₂S Release

In case of an unplanned or unexpected release of H₂S gas, all personnel should

- Hold their breath if air breathing equipment is not available;
- Rapidly evacuate the area containing the H₂S and move upwind if possible;
- Move up a deck to get upwind of the source;

- If available, put on a BA;
- Evacuate anyone who may be affected by the gas to a safe area; administer resuscitation or oxygen as needed or call the ship's doctor;
- Put on air breathing equipment before helping anyone overcome by H₂S;
- Quickly evacuate to the assigned or announced safe-briefing area to receive instructions from supervisory personnel; and
- Not panic.

H₂S OPERATIONS

The location, source, and concentration of H₂S when detected are important in determining the potential H₂S hazard condition and resulting actions. The following guidelines address the various locations and activities where H₂S might be encountered.

H₂S Monitoring Responsibilities

Bridge

The ship's officers provide 24-hr monitoring of the central H₂S alarm panel while operating on a H₂S site. When an alarm goes off on this panel, it is the responsibility of the ship's officer to take the appropriate action.

Table T2 is provided for guidance *only* and may be modified by the offshore installation manager and the ship's master as the situation and experience with the local H₂S environment dictates.

Table T2. Hydrogen sulfide alarm locations.

Alarm area	Action
Core laboratory	Notify H ₂ S safety technician
Core receiving platform*	Notify H ₂ S safety technician
Core entry	Notify H ₂ S safety technician
Core catcher bench*	Notify H ₂ S safety technician
Lower 'tween deck landing	Notify laboratory officer and investigate
Hold 'tween deck landing	Notify laboratory officer and investigate
Fresh air intake plenum*	Shut down intake fans and investigate
Rig floor*	Notify core technician
Multiple alarms on "*" detectors above	Sound alarm using coded bell signals and announce H ₂ S EMERGENCY via public address system
Possible blowout!	

Rig Floor

The two core technicians are responsible for monitoring H₂S levels on the rig floor during their shift to provide 24-hr coverage. The core technician works under the authority of the offshore installation manager and the night tool pusher. Note that in the following instructions, references to the offshore installation manager include the night tool pusher or other offshore installation manager designee.

Core Receiving Platform, Core Laboratory, and Core Storage Areas

The H₂S safety technicians are two marine specialists assigned the responsibility for monitoring H₂S levels on the core-receiving platform and in the core laboratory. There is an H₂S safety technician assigned to each shift for 24-hr coverage. The H₂S safety technicians work under the authority of the laboratory officer and assistant laboratory officer.

Downhole and Logging Tools

The technicians operating these tools are responsible for monitoring any H₂S that maybe trapped inside the tool.

General Safety Practices

- Use fans to ventilate work areas. Fans can keep the H₂S concentration low enough so that BAs are not required;
- If stationkeeping permits, head the ship so that the wind hits the ship just off the port bow, blowing across the core-receiving platform and through the rig floor;
- *Always* use the buddy system when working in potentially hazardous areas;
- *Always* check PPE at the beginning of the work shift. Never assume that someone has left it in working order; and
- Do not let materials pile up around fixed H₂S sensors.

Opening the Drill String on the Drill Floor

The following guidelines apply when retrieving a core barrel or other tools deployed through the drill string.

H₂S Monitoring

The core technician is responsible for monitoring H₂S levels on the drill floor with a portable detector. The drill pipe opening (while opening), upper drill string connection, top of inner core barrel, and bottom of core catcher sub are areas that should be monitored.

Precautions and Special Procedures

Table T3 gives guidance on who must wear a BA before opening the drill string and measuring the H₂S levels.

Table T3. Breathing apparatus required before opening drill string.

H ₂ S hazard condition	Core technician	Rig floor crew	Driller (driller's shack)
Watch	No	No	No
Alert	No	No	No
Danger	Yes	Yes	No
Emergency	Yes	Yes	Yes

H₂S Response

When H₂S is detected at the drill pipe, the following procedures must be implemented, depending on the concentration detected and how it was measured.

1–19 ppm, Measured with a Portable Detector at the Drill Pipe

After a positive reading, the core technician notifies the offshore installation manager, who may change the H₂S hazard condition to ALERT.

20–49 ppm, Measured with a Portable Detector at the Drill Pipe

- The rig floor crew working around the drill pipe put on BAs.
- The drill pipe is reconnected and circulation begins.
- The core technician notifies the offshore installation manager and operations manager.
- After the drill string has been completely flushed, the pipe is reopened and H₂S levels are checked. If they are still >20 ppm, steps 2 through 4 are repeated unless otherwise instructed by the offshore installation manager.
- The offshore installation manager may change the H₂S hazard condition to DANGER.

>50 ppm, Measured with a Portable Detector at the Drill Pipe or ≥10 ppm at Rig Floor's Fixed Station

- The rig floor crew, including the driller, put on BAs.
- Personnel on the core-receiving platform put on BAs or evacuate the area.
- The drill pipe is reconnected and circulation begins.
- The core technician notifies the offshore installation manager and operations manager of the situation.
- Personnel wait for instructions from the offshore installation manager.
- The offshore installation manager may change the H₂S hazard condition to EMERGENCY and notify the ship's master to sound alarms and evacuate ship personnel to safe areas.

Special Concerns

H₂S Blowout

Although unlikely, a set of circumstances could occur that would cause an H₂S blowout to discharge gas up the drill string. The first sign that this situation is occurring would be backflow when the drill string is opened. There are many situations other than a blowout that can cause backflow, but while drilling in an environment where H₂S is present the following steps should be taken if backflow is detected unless otherwise instructed by the offshore installation manager:

- The drill string is reconnected as quickly as possible.
- The core technician checks atmosphere for H₂S.
- The core technician notifies the offshore installation manager and operations manager of situation.

- Technicians await instructions from the offshore installation manager.

Removing Core from Core Barrel on the Drill Floor

H₂S Monitoring

The core technician is responsible for monitoring H₂S levels on the drill floor with a portable detector. The bottom of the core catcher sub and bottom of the core barrel (after removing the core catcher) should be monitored.

Precautions and Special Procedures

Table T4 provides guidance to determine who must wear a BA before the removing the core catcher and measuring the H₂S levels.

Table T4. Breathing apparatus required before removing core catcher.

H ₂ S hazard condition	Core technician	Rig floor crew	Core handlers
Watch (potential)	No	No	No
Alert (1–19 ppm)	No	No	No
Danger (20–49 ppm)	Yes	Yes	Yes
Emergency (>50 ppm)	Yes	Yes	Yes

H₂S Response

If H₂S is detected from the core barrel, the following procedures are implemented.

1–19 ppm, Measured with a Portable Detector at the Core Barrel

- The core technician notifies the H₂S safety technician.
- The core technician notifies the offshore installation manager and operations manager. The offshore installation manager may change the H₂S hazard condition to ALERT.

>20 ppm, Measured with a Portable Detector at the Core Barrel

- The rig floor crew opening the core barrel and the core handlers put on BAs.
- The core technician notifies the H₂S safety technician.
- The core technician notifies the offshore installation manager and operations manager. The offshore installation manager may change the H₂S hazard condition to DANGER.

≥10 ppm, Measured at the Rig Floor's Fixed Station

- The rig floor crew, including the driller, put on BAs.
- Personnel on the core-receiving platform put on BAs or evacuate the area.
- The core technician locates the source of the H₂S and notifies the offshore installation manager and operations manager of the situation.

- Technicians wait for instructions from the offshore installation manager.
- The offshore installation manager may change the H₂S hazard condition to EMERGENCY and then notifies the ship's master to sound alarms and evacuate ship's personnel to safe areas.

Core Processing on the Core-Receiving Platform

H₂S Monitoring

The H₂S safety technician is responsible for monitoring H₂S levels on the core-receiving platform with a portable detector. The core (vent holes and cut ends), 12 in above the core, the core catcher, and core storage racks (outside the laboratory) should be monitored.

Precautions and Special Procedures

Moving Core from Rig Floor to Core Rack

- Before the core handlers receive the core from the rig floor, the H₂S level is measured, as described in the section above. If H₂S levels are >20 ppm at the core barrel, core handlers wear BAs while transferring the core from the rig floor to the core rack.
- Core handlers should hold the core at waist level when moving it to the core rack. The core should not be placed on the shoulder or held anywhere near the face. If the core liner ruptures, the face will have more protection from sharp core liner fragments and direct exposure to H₂S.
- When working with very gassy cores, face shields and Kevlar aprons, sleeve protectors, and gloves should be worn. The H₂S safety technician determines when this special protection is needed.

Curating Core on the Core Rack

- After the core is placed in the core rack, 1/8-in diameter holes are drilled through the liner to depressurize the core. The holes should not be drilled in a straight line, as this can cause a core liner to rupture. Rather, the holes should be staggered around the circumference and spaced apart as necessary.
- As gas vents, H₂S levels are monitored. Vent holes are checked to see if H₂S is present.
- H₂S levels at the surface of the core liner determine if core handlers and other personnel working on the core-receiving platform need to wear BAs (See "**H₂S Emergency Condition**").
- The core is not cut into sections until after depressurization, to keep material from being extruded out of the liner.
- If any part of a core contains H₂S, the core liner of each section and all whole-round samples are marked with "H₂S." H₂S warning stickers may be used, as well.

Moving Core Sections into the Core Entry Area of the Core Laboratory

- Sections of *whole* cores may be brought into core entry area provided that the core has depressurized and is no longer actively

venting gas (i.e., causing core expansion gaps) and any remaining H₂S diffusing from the core is <20 ppm when measured 12-in above the core.

- Sections of core that do not meet the above criteria remain outside until they do.
- Vent holes and end caps are sealed with tape if the H₂S level is >10 ppm measured 12-in above the core.

H₂S Response

When H₂S is detected above the core liner during venting, the following procedures are followed.

1–9 ppm, Measured with a Portable Detector at the Surface of the Core Liner

- BAs are not required.
- The H₂S safety technician continues monitoring until the core has depressurized (as defined above).
- The H₂S safety technician notifies the offshore installation manager and operations manager.
- The offshore installation manager may change the H₂S hazard condition to ALERT.

>10 ppm, Measured with a Portable Detector 12 in above the Core

- BAs are required for core handlers. *All other individuals on the core-receiving platform MUST leave the area.*
- The H₂S safety technician continues monitoring until core has depressurized (as defined above).
- The H₂S safety technician notifies the offshore installation manager and operations manager. The offshore installation manager may change the H₂S hazard condition to HAZARD or higher.

≥10 ppm, Measured at the Core-Receiving Platform's Fixed Station

- BAs are required for core handlers. *All other individuals on the core-receiving platform MUST leave the area.*
- The H₂S safety technician identifies the source of H₂S and notifies the offshore installation manager and operations manager of the situation.
- Wait for instructions from the offshore installation manager.
- The offshore installation manager may change the H₂S hazard condition to EMERGENCY and notify the ship's master to sound alarms and evacuate ship's personnel to safe areas.

Special Concerns

H₂S Clathrates

Clathrates (gas hydrates) are crystalline substances composed principally of three-dimensional cages of water in which various gases (e.g., CH₄ and H₂S) can enter and stabilize the structure. At room temperature and pressure, a clathrate will disassociate, releasing a volume of H₂S gas that can be greater than the original volume of the clathrate.

If a clathrate is recovered from a site where H₂S is expected, the following steps should be taken:

- Core Handlers wear BAs.
- Personnel not handling core leave the core-receiving platform.
- The section of the core containing the clathrate is cut out.
- H₂S is quickly measured while the clathrate is being removed.
- The clathrate is processed according to the scientist's instructions. Usually this involves placing the clathrate in a pressure container or into liquid N₂.
- If H₂S is detected, place an H₂S warning label on the container.
- The H₂S safety technician notifies the offshore installation manager the first time a clathrate is recovered at a particular site.

An H₂S clathrate may only be brought into the laboratory in a sealed pressure container. Liquid N₂ dewars holding H₂S clathrates are stored outdoors, away from supply ventilations and sources of ignition, and are marked with warning signs.

Core Processing in the Core Laboratory

H₂S Monitoring

The marine specialists and the H₂S safety technicians are responsible for monitoring H₂S levels in the core laboratory with a portable detector. Core storage racks (inside the laboratory), air in the core splitting room, the cut surface of split cores after splitting, and the cut surface of split cores while laying out in the core laboratory are monitored.

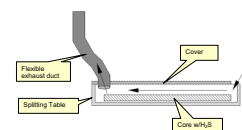
Precautions and Special Procedures

While cores are waiting to be split or measured on the multisensor track (MST), they continue to warm up and may possibly resume degassing. Should this happen, the marine specialists remeasure the H₂S levels. If the H₂S level is <10 ppm, the core may remain in the laboratory. If it is >10 ppm, the core is removed from the laboratory until it can be sealed as mentioned in the previous section. *Warning:* cores that are no longer actively emitting H₂S may release additional H₂S during the core splitting process (especially if the super saw is used). The H₂S levels from split cores are often greater than the levels measured in the whole round.

Prior to splitting cores two BAs must be available and *ready* for use. There must be at least two marine specialists in the splitting room when a core is split. During the splitting process the H₂S levels are continuously monitored with a handheld detector. If the H₂S level in the splitting room is >20 ppm, core splitting stops and the two the marine specialists cutting the core put on their BAs; all others leave the room.

Cores may be taken back outside the laboratory to finish degassing or left on the splitting table, covered, and vented using the flexible exhaust duct provided in the splitting room (Fig. F1). Core halves do not leave the splitting room until *all* signs of active degassing have stopped and the remaining H₂S concentration from the core is <10 ppm. Note: some individuals may be very sensitive to low levels of H₂S. The 10-

F1. Core on splitting table, p. 33.



ppm level may have to be set lower for these individuals or a BA provided for them to use.

All D-tubes and core boxes holding cores that have emitted H₂S are tagged with H₂S warning labels. H₂S warning signs are placed on core refrigerators where these cores are stored.

To keep the air fresh in the core laboratory,

- Fully open the fresh air supply to the core laboratory and top deck air handlers;
- Open doors and windows, if weather permits; and
- Use fans to force additional fresh air into the laboratory.

H₂S Response

When H₂S is detected in the core Laboratory, the following procedure must be followed.

≥10 ppm at any Fixed Station in the Core Laboratory

- The immediate area is evacuated.
- The H₂S safety technician identifies the source of H₂S and notifies the laboratory officer of the situation.
- Technicians wait for instructions from the laboratory officer.

Handling Downhole and Logging Tools at Various Locations

H₂S Monitoring

Because each tool is unique, it is the responsibility of the technician operating the tool to carefully check for H₂S in sampling chambers or for H₂S trapped inside the tool's housing.

Precautions and Special Procedures

If the H₂S hazard condition is ALERT (1–19 ppm) or higher, then the tool's sampling chambers are vented outside or in a controlled manner such that there is no chance of H₂S escaping into the work area. The laboratory officer will approve such controls prior to tool's operation.

Should the technician suspect the tool's housing has been compromised and may possibly contain fluids or materials with H₂S, the technician opens the housing in an open-air location.

If samples collected are transferred to another container, that container must have an H₂S warning tag (see "[Pressure Core Samplers, Autoclaves, Transfer/Storage/Logging Containers, and Sampling Manifolds](#)").

H₂S Response

If H₂S is released, the immediate area is evacuated until the air is tested.

Pressure Core Samplers, Autoclaves, Transfer/Storage/Logging Containers, and Sampling Manifolds

Downhole tools that return core/gas/liquid under pressure must comply with the following.

All pressure corers and pressurized transfer/storage/logging containers must have a written operator's manual that has been submitted to and approved by ODP and the ship operator's management prior to deploying the tool on the *JOIDES Resolution*. The manual must not only instruct the user on safe operation of the tool but also clearly state the types of hazards the tool presents to the operator. In regard to the potential release of H₂S, the operator must be informed of all potential locations on the tool where pressure containment could fail (seals, valves, rupture disks, etc.).

When a pressure sampler is retrieved on the rig floor, all potential locations for containment failure must be surveyed with a handheld detector.

If the contents of the pressure sampler are transferred to secondary sample chamber or into a manifold/collection system, a handheld detector must be used to monitor the transfer operation.

When operating in a WATCH (H₂S potential) or higher H₂S hazard condition, then it must be assumed that the pressure sampler or transfer/storage/logging container contains H₂S until the trapped gases can be sampled and determined otherwise. The following applies to both pressure samplers and transfer containers:

- Pressure samplers and transfer/storage/logging containers are tagged with an H₂S hazard label.
- Pressure samplers and transfer/storage/logging containers are surveyed with a handheld detector each time they are relocated to a new storage area.
- Personnel handling pressure samplers and transfer/storage/logging containers indoors wear a personal detector.
- H₂S warning signs are posted in areas where the pressure samplers and transfer/storage/logging containers are stored.
- Pressure samplers and transfer/storage/logging containers are vented outdoors in a location where personnel downwind are not affected.

SPECIAL CORING PROCEDURES FOR H₂S SITES

Guidelines

The following guidelines should be used unless otherwise instructed by the offshore installation manager.

- Maintain circulation while a core barrel is dropped or wirelined into and out of the hole.
- Control wireline speeds to prevent/minimize swabbing of H₂S-bearing fluids into the drill string from the well bore.
- Engage the core barrel with the overshot.
- Stop the pumps, if necessary, while unseating the core barrel from the outer core barrel assembly (OCB).

- Pull the core barrel up slowly above the top of the bottom-hole assembly (BHA).
- Stop the wireline winch once the core barrel is pulled above the top of the BHA.
- Pump three volumes of fluid (equal to the volume required to fill the inside of the BHA) to clear any H₂S-bearing fluid that may have been swabbed into the BHA when the core barrel was un-seated.

See “[Opening the Drill String on the Drill Floor](#)” for additional operational safety information.

Rig Floor

Drill Pipe Safety Valve

A drill pipe safety valve is kept on the rig floor. The valve can be used to prevent excessive backflow of fluid through the drill string. Such backflow could be the result of a hydrocarbon or hydrothermal fluid “kick.” Either could possibly carry H₂S to the surface.

Install the valve in the drill string if excessive backflow occurs and the top drive is not readily available (i.e., racked back) for immediate makeup to the drill string.

Baker Float Valve

Once the safety valve is in place and closed, a second sub containing a float valve assembly can be made up on top of the safety valve.

The Baker model G (5F-6R) float valve acts as a check valve allowing drilling fluid to be pumped down the drill string while preventing hot or H₂S-contaminated well bore fluids from backflowing up the drill string.

The drill pipe safety valve and Baker float valve assemblies are to be used under special circumstances only (i.e., when the top drive is not installed or is otherwise inoperable for circulation). Note that if the Baker float valve is installed, no downhole tools can be deployed.

Downhole

BHA Installed Float Valves

The rotary core barrel (RCB) BHA is equipped with a float (flapper) valve that is compatible with the RCB wireline coring system. The advanced piston corer/extended core barrel/pressure core sampler (APC/XCB/PCS) BHA can be equipped with a lockable float (flapper) valve (LFV).

Each of these float valves serves to prevent excessive drill cuttings from “U-tubing” or being swabbed up into the BHA during core barrel retrieval. When functional, these flappers seal the throat of the core bit and prevent backflow into the drill string via that path. It should be noted, however, that neither of the BHA float valves seal the bit jets, and therefore they do not completely seal off the lower end of the drill string from the well bore.

The 6¾-in drill collar/BHA used with the advanced diamond coring barrel (ADCB) coring system is not compatible with either of the float valves used with the RCB or the APC/XCB/PCS coring systems. It has

been suggested, therefore, that use of the ADCB coring system be avoided in formations where H₂S might be present.

SPECIAL LOGGING PROCEDURES FOR H₂S SITES

The following guidelines should be used unless otherwise instructed by the offshore installation manager:

- Maintain circulation while wireline tools are run into and out of the hole.
- Control wireline speeds to prevent swabbing H₂S fluids into the drill string from the well bore.
- Stop the tool above the top of the BHA once sampling or measurements are completed and the wireline tool(s) is/are retrieved inside the BHA.
- Pump three volumes of fluid (equal to the volume of fluid required to fill the inside of the BHA) to clear any H₂S-rich fluid that may have been swabbed into the BHA as the tool was pulled inside it.

See “[Handling Downhole and Logging Tools at Various Locations](#)” for additional safety information. Do not use excessive flow rates that may be sufficient to fail cablehead weak points and pump the wireline tools off the wireline (this has happened in the past). Components that are not designed for operation in H₂S and CO₂ environments are susceptible to sulfide and stress corrosion cracking. The cracking may occur downhole or at the surface over relatively short periods of time.

H₂S EMERGENCY CONDITION

Instructions

When an H₂S EMERGENCY (>50 ppm) condition has been called by the offshore installation manager, implement the following procedure:

1. All rig floor personnel put on BAs and remain on the rig floor unless otherwise instructed by the offshore installation manager.
2. All drilling/coring operations stop and the driller makes the string back up (if open), picks up off bottom, and maintains circulation.
3. The offshore installation manager notifies the ship’s officers and operations manager of the situation.
4. The ship’s officers sound the alarm using coded bell signals and verbally announce to all personnel via the public address system that an H₂S EMERGENCY exists and to report to a safe-briefing area.
5. The ship’s officers shut down the ventilation systems.
6. The ship’s officers notify any nearby vessels to go upwind and maintain a radio and visual watch.
7. At the safe briefing the ship’s officers (or designees) take roll and account for all ship personnel.

8. The ship's emergency response team, using BAs, make maximum effort to determine the source of the H₂S and suppress the H₂S as quickly as possible.
9. All personnel not assigned to emergency duties or working on the rig floor report to the upwind safe-briefing area for further instructions.
10. Drilling/coring operations remain suspended until the source of H₂S is located and the atmospheric level falls to a level <10 ppm.
11. The buddy system is utilized for all personnel remaining in the potential danger area.
12. The hole may be terminated, depending on the source of the H₂S, by the offshore installation manager.
13. The operations manager notifies the appropriate personnel on shore as soon as possible of the situation and the actions taken.
14. The driller is notified if the exhaust fans in the laboratory stack are turned on to exhaust H₂S because the exhaust fans discharge air above the rig floor.

Safe-Briefing Area

The primary safe-briefing areas are the *port and starboard lifeboat stations* located forward on the fo'c'sle deck. The port and starboard lifeboat stations are the safe-briefing areas because when the drillship is in dynamic-positioning (DP) mode, the bow of the ship is nearly always oriented into the prevailing wind.

The routes to the safe-briefing area are determined by the master and reviewed in safety meetings held with personnel working in each area of the ship. The best route from each location on the ship is dictated by rig floor activity, weather, and sea conditions.

All personnel not assigned emergency duties who are aft (i.e., back by the helideck) of the rig floor proceed forward to the safe-briefing stations along the mezzanine or main deck on the windward side of the ship. Personnel must avoid entering areas designated as potential H₂S danger areas as they proceed forward to the safe-briefing areas.

If, for some reason, the stern of the ship is oriented into the wind, the master announces to all ship personnel that the safe-briefing area is the helideck. The location of the designated safe-briefing area is posted by the master or mates next to the ship's station bills (where lifeboat assignments are posted) on each deck.

PERSONNEL RESCUE

It is possible that gases other than H₂S may be encountered, but they pose a much lower hazard (see "[Appendix D](#)" and "[Appendix E](#)"). In general, the measures taken to protect against H₂S exposure will also be effective against other gases.

When H₂S levels are above 20 ppm, use a detector...don't assume! Always use a portable H₂S detector to monitor H₂S levels in a confined space. Low oxygen levels can be just as lethal as H₂S. The ship's officers have oxygen meters to determine if a space has enough oxygen, but the oxygen meters *do not* measure H₂S levels. In some cases it is necessary to use both types of meters. H₂S levels may be safe at the entrance to a confined area but can change quickly to lethal levels, depending on the

source. H₂S is denser than air and will settle into low areas. Do not enter a confined space without using a BA to rescue someone who has passed out.

The following procedures describes implementing personnel rescue:

1. Put on a BA before proceeding to assist anyone affected by the gas.
2. Put on a safety belt with 50 ft of tail line and obtain standby assistance before entering the area if the person is in a high-concentration area.
3. Utilize the buddy system when entering possible contaminated areas.
4. Move the victim to fresh air.
5. Administer resuscitation or oxygen as needed. Call the Ship's Doctor.
6. If the person is injured because of exposure to H₂S, arrange for evacuation to a shore-based medical facility.

REFERENCES

- Foss, G.N., and Julson, B.D., 1993. Revised hydrogen sulfide drilling contingency plan—*JOIDES Resolution*. *ODP Tech. Note*, 19.
- Howard, S.P., and Reudelhuber, D.H., 1991. Hydrogen sulfide—high temperature drilling contingency plan. *ODP Tech. Note*, 16.

APPENDIX A

Location of Fixed Area Detectors

Each detector station can support two sensors. The sensors should be mounted 6–12 in above the deck. Detector areas and number and position of fixed sensors follow:

Core Processing Area

- Sensor 1: Below the sampling table next to the working half storage rack.
- Sensor 2: Below the description table.

Core Receiving Platform

- Sensor 1: Mount on handrail at the forward end of the platform next to the outdoor storage rack.
- Sensor 2: Mount on the handrail at the midpoint of the platform.

Core Entry

- Sensor 1: Mount at the base of the aluminum core rack.
- Sensor 2: Mount beneath the splitting table.

Core Catcher Bench

- Sensor 1: Mount on the handrail at the aft end of the core receiving platform.
- Sensor 2: Mount beneath core catcher bench.

Lower 'tween Deck Landing

- Sensor 1: Mount inside the lower 'tween core refrigerator at the base of the unistrut shelving.

Hold Deck Landing

- Sensor 1: Mount inside the hold core refrigerator at the base of the unistrut shelving.
- Sensor 2: Mount at the bottom of the stairwell.

Fresh-Air Intake Plenum

- Sensor 1: Mount inside the fresh air intake plenum where the air enters the A/C on the main deck.
- Sensor 2: Mounted on the forward end of the core receiving platform.

Rig Floor

- Sensor 1: Mount at the base of forward starboard tugger.
- Sensor 2: Mount at the base of aft starboard tugger.

Warning Signs

Post warning signs at the entrance(s) to potential H₂S areas during operations at sites where H₂S may be encountered. Use the following text on the warning signs:

WARNING--HAZARDOUS AREA

HYDROGEN SULFIDE H₂S

UNAUTHORIZED PERSONNEL KEEP OUT

NO SMOKING

Warning signs are to be posted in the following areas:

- Rig floor,
- Core receiving platform,
- Core laboratory—in all areas where cores will be processed,
- Core storage reefer—including reefer entrance(s),
- Bottom of core laboratory stairwell—H₂S gas may accumulate in that area, and
- Living quarter exits that are entrances into designated H₂S danger areas—all deck levels.

Wind Direction Indicators

Wind socks are mounted on the following areas:

- Ship's bow,
- Crane no. 1,
- Crane no. 2, and
- Crane no. 3.

Bright color streamers are located in the following areas:

- Along the catwalk aft of crane no. 2,
- Under the rig floor on the mezzanine deck, and
- Along the port side of the core-receiving platform.

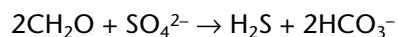
APPENDIX B

Origin of H₂S

Formation and Consumption in Sediments

In most cases where ODP is coring, H₂S forms as a byproduct of the degradation of organic matter. Because sulfate is plentiful in the ocean, sulfate reduction and, hence, hydrogen sulfide production is common in marine sediments.

Specifically, H₂S forms during sulfate reduction via the generalized formula



where

CH₂O = organic matter,
SO₄²⁻ = sulfate, and
HCO₃⁻ = bicarbonate or alkalinity.

Despite their common presence in marine sediments, H₂S concentrations do not usually reach very high levels. Relatively low concentrations of H₂S are maintained primarily because either the reactants (organic matter and/or sulfate) may be limited or iron combines with the sulfide to form iron sulfide minerals (e.g., pyrite).

The highest H₂S concentrations encountered during Deep Sea Drilling Project (DSDP)/ODP operations were located in the carbonate-rich sediments of the south Australian margin (Leg 182; 150,000 ppm in a single core). High sedimentation rates, low iron content, and sulfate-rich pore fluids led to extensive production of H₂S.

Typically, diffusion from overlying seawater is the main source of sulfate. However, on some continental margins brines may provide an additional source of sulfate for sulfate reduction and production of H₂S.

In areas where overlying seawater is the main source of sulfate, H₂S concentrations will eventually decrease with depth. Even when there is high organic matter content, sulfate eventually becomes depleted with depth. Thus, H₂S may be encountered over several cores but, like sulfate, H₂S should also decline with depth.

Environments

Typical environments where H₂S may be present are terrigenous continental margins, carbonate-rich continental margins or carbonate banks, gas hydrate sediments, and hydrothermal systems.

H₂S may be present in terrigenous continental margin environments, especially where coastal upwelling results in sediments with high organic matter content. Typically in this setting, the sedimentary components often provide plenty of available iron, resulting in the removal of H₂S via iron sulfide precipitation.

Slopes of carbonate-rich continental margins or carbonate banks with high sedimentation rates may be a source of H₂S. Although carbonate-rich sediments are typically not rich in organic matter, the slopes can be characterized by high sedimentation rates. High accumulation rates bury organic matter, creating an increased potential for organic matter availability for sulfate reduction. Carbonate-rich sedi-

ments also have low iron contents, so H₂S is rarely quantitatively precipitated as iron sulfides.

Another potential point source of H₂S on continental margins is gas hydrates (clathrates). Although most natural marine hydrates are dominated by methane, H₂S-methane hydrates have been encountered (e.g., Cascadia margin, Legs 146 and 182). Incorporation of H₂S into the hydrate structure shifts the hydrate stability field; hence, H₂S-rich hydrates are found at *shallower depths than methane hydrates*.

H₂S may be encountered in hydrothermal systems (e.g., massive sulfide deposits). Consequently, appropriate precautions should be in place when recovering such fluids or coring sediments whose pore fluids may contain a hydrothermal component.

APPENDIX C

Properties of H₂S

Hydrogen sulfide is colorless, transparent, and flammable, smells like “rotten eggs” at very low concentrations, and is denser than air and thus may accumulate in low places.

The slightest presence of H₂S in the air is normally detectable by its characteristic “rotten-egg” odor; however, it is dangerous to rely on odor as a means of detecting life-threatening concentrations because the sense of smell is lost rapidly, allowing lethal concentrations to accumulate without warning.

Table AT1 describes the poisonous nature of hydrogen sulfide.

Table AT1. Effects of hydrogen sulfide.

Concentration of H ₂ S			Effect
(%)	(ppm)	(g/100 ft ³)	
0.001	10	0.65	Obvious and unpleasant odor; safe for 8 hr
0.002	20	1.3	Safe for 4 hr exposure
0.01	100	6.48	Kills sense of smell in 3–15 min; may sting eyes and throat
0.02	200	12.96	Kills sense of smell; stings eyes and throat
0.05	500	32.96	Dizziness; breathing ceases in minutes; need prompt artificial respiration
0.07	700	45.26	Unconscious quickly; death will result if not rescued promptly
0.1	1000	64.8	Unconscious immediately, followed by death within minutes

APPENDIX D

Other Hazardous Gases

Carbon Dioxide

Carbon dioxide (CO₂) is commonly found dissolved in hydrothermal fluids and could be released from pore water when cores are recovered. CO₂ is usually considered inert and is heavier than air (1.5 times), concentrating in low areas of quiet air.

Carbon dioxide gas is toxic in higher concentrations but much less so than H₂S (see Table AT2). The threshold limit of CO₂ is 5000 ppm. Short-term exposure to 50,000 ppm (5%) is reasonable. This gas is colorless and odorless and can be tolerated in relatively high concentration.

Air containing 5% CO₂ will cause disorientation in a few minutes. Continued exposure to CO₂ after being affected will cause convulsions, coma, and respiratory failure. If a massive flow of CO₂ from the well bore should occur (highly unlikely), the principal danger would be from asphyxiation due to lack of air.

Using a BA will provide adequate oxygen until the emergency can be controlled.

Table AT2. Chemical vapor toxicity.

Common name	Chemical formula	Specific gravity (air = 1)	Threshold* limit (ppm)	Hazardous† limit (ppm/hr)	Lethal‡ concentration (ppm)
Hydrogen cyanide	HCN	0.94	10	150	300
Hydrogen sulfide	H ₂ S	1.18	10	250	600
Sulfur dioxide	SO ₂	2.21	2	—	1,000
Chlorine	Cl ₂	2.45	1	4	1,000
Carbon monoxide	CO	0.97	50	400	1,000
Carbon dioxide	CO ₂	1.52	5,000	5%	100,000
Methane	CH ₄	0.55	90,000	>5% in air	—

Notes: * = concentration at which it is believed that all workers may repeatedly be exposed, 8 hr/day, every day, without adverse effect. † = concentration that may cause death. ‡ = concentration that will cause death with short-term exposure.

Hydrocarbon Gas

Hydrocarbon compounds are known to be present in sediments and potentially in hydrothermal fluids. These hydrocarbons are primarily in the form of methane gas, but some heavier gases and even liquids are possible.

The toxicity of methane is very low (see Table AT2), but it is often a “carrier” of H₂S. Because hydrocarbon gas is lighter than air, it does not tend to settle and is easily dispersed. The major threat from natural gas is its extreme flammability and explosivity. Hydrocarbon liquids may be carcinogenic, so common sense should be used in handling them if they are encountered.

The blowout control measures specified in this document can be used to control hydrocarbon gas as well as H₂S.

Radon

The barite precipitated in seafloor rocks and sediments by hydrothermal activity has been found to contain measurable amounts of radioactive radium-226, which is chemically similar to barium. Small amounts of radon may also be present in the pore water.

The radium emits very small amounts of radon-222 gas through radioactive decay, which also is radioactive. The radiation is in the form of alpha particles, which have extremely limited ability to penetrate tissue. Thus, the principal danger comes from inhaling or ingesting the radioactive material. Furthermore, the levels of radioactivity are extremely low—on the nannocurie scale.

ODP has investigated the potential effect of that radiation on health and safety on board the ship. Nevertheless, cores will be monitored for radioactivity if radioactive material is present.

The following precautions are to be taken if radon is encountered:

- Use extra ventilation around cores (as with H₂S) before packing and when D-tubes are opened.
- Seal D-tubes to contain gas and/or ventilate storage areas.
- Avoid eating and drinking in the immediate area of the cores.
- Wash hands thoroughly after handling barite-rich cores or samples.

Sulfur Dioxide

Sulfur dioxide is produced during the burning of H₂S. Sulfur dioxide is colorless, transparent, nonflammable, heavier than air, but will be picked up by a breeze and carried downwind at elevated temperatures, and extremely irritating to the eyes and mucous membranes of the upper respiratory tract.

Table AT3 indicates the toxic nature of the gas.

Table AT3. Effects of sulfur dioxide.

Concentration of SO ₂		Effect
(%)	(ppm)	
0.0002	2	Safe for 8 hr
0.005	3–5	Pungent odor; normally a person can detect SO ₂ in this range
0.0012	12	Throat irritation, coughing, chest constriction, eyes tear and burn
0.015	150	So irritating that it can only be endured for a few minutes
0.05	500	Causes a sense of suffocation, even with first breath.

APPENDIX E

Facial Hair Waiver

Waiver: Hydrogen Sulfide Exposure—FACIAL HAIR

Conditions may develop that require air breathing masks/respirators to be worn by personnel working in designated hazardous areas. A proper seal between the surface of a respirator face piece and the wearer's skin is imperative. Facial hair, such as beards, sideburns, moustaches, and even a few days' growth of stubble will prevent a good seal. Facial hair results in the respirator permitting negative air pressure inside the face piece during inhalation and causing excessive penetration by an air contaminant.

If the individual elects *not* to shave facial hair, he must sign the statement provided below.

My signature below (with witness) indicates that I have been informed of the dangers associated with using a breathing apparatus that might not seal properly because of interfering facial hair, and I choose not to hold the Ocean Drilling Program–Texas A&M University, Texas A&M Research Foundation, National Science Foundation, or the owners of the *R/V JOIDES Resolution* responsible for any accidents, illness, or medical problems that might occur if it becomes necessary for me to use a breathing apparatus during an H₂S emergency.

Signature: _____ Date: _____

Witness: _____ Date: _____

APPENDIX F

Perforated Ear Drum Waiver

Waiver: Hydrogen Sulfide Exposure—Perforated Ear Drum

Due to the nature of operations on Leg ____, participants face potential exposure to hydrogen sulfide (H₂S) gas. Situations may develop that require air-breathing masks/respirators to be worn by personnel working in designated hazardous areas. Since the protective breathing apparatus does not cover the ears, H₂S may enter the body through a perforated or punctured eardrum.

If an individual suspects or has been diagnosed to have a punctured/perforated eardrum but elects to participate on ODP Leg ____, he or she must sign the statement provided below.

My signature below (with witness) indicates that I have been informed of the dangers associated with hydrogen sulfide (H₂S) exposure when a perforated or punctured eardrum condition exists. I choose not to hold the Ocean Drilling Program–Texas A&M University, Texas A&M Research Foundation, National Science Foundation, or the owners of the *R/V JOIDES Resolution* responsible for any accidents, illness, or medical problems that might occur as a result of H₂S exposure via a punctured or perforated eardrum.

Signature:_____

Date:_____

Witness:_____

Date:_____

PUBLISHER'S NOTES

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Figure F1. Core on splitting table.

