HYDROGEN SULFIDE - HIGH TEMPERATURE DRILLING CONTINGENCY PLAN

OCEAN DRILLING PROGRAM
TEXAS A&M UNIVERSITY

Technical Note 16

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HYDROGEN SULFIDE-HIGH TEMPERATURE DRILLING CONTINGENCY PLAN

OCEAN DRILLING PROGRAM

LEG 139 SEDIMENTED RIDGE SCIENTIFIC DRILLING OPERATIONS

RIG CONTRACTOR - UNDERSEAS DRILLING, INC.*

Drillship - SEDCO/BP471

(6/13/91 - REV 7)

* Underseas Drilling, Inc. (UDI) is an affiliate of SEDCO FOREX, a Schlumberger Technology Company.

PREFACE

Attached is the **"HYDROGEN SULFIDE-HIGH TEMPERATURE DRILLING CONTINGENCY PLAN"** that will be used for ODP coring and drilling operations on Leg 139. Prior to commencing with operations at the first site on Leg 139, all safety equipment and measures described shall be in place and operational. The H_2S Technicians shall have confirmed that all personnel working in the designated hazardous areas (rig floor, core receiving deck, core lab and core reefer/s) have read his/her copy of the contingency plan. Each person will be required to sign a log that states that he/she has read and understands the document.

During coring operations on Leg 139, at all sites where there is a H_2S hazard as defined by geological considerations and past drilling experience, the procedures and policies outlined in this contingency plan will be implemented. This document is not intended to facilitate continued operations for any extended periods of time under emergency Conditions I, II, or III. Rather, this plan defines safety equipment and procedures that must be in place in the event H_2S and/or steam flash conditions are encountered.

Additional information on metallurgical considerations with regard to H_2S environments is provided in the Leg 139 Engineering and Planning Document. Also, detailed information on steam flash conditions is contained in the Leg 139 Engineering and Planning Document. The UDI Drilling Superintendent, ODP Operations Superintendent, Captain, H_2S Technicians, ODP Lab Officers and Scientists are to read the Engineering and Planning Document in addition to the Contingency Plan. The "HYDROGEN SULFIDE-HIGH TEMPERATURE DRILLING CONTINGENCY PLAN" takes **precedence** over the "LEG 139 ENGINEERING AND OPERATIONS PLAN" with regard to safety actions and procedures.

6/13/91

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I. INTRODUCTION

This plan defines the precautionary measures, safety equipment, emergency procedures, responsibilities, and duties pertaining to drilling/coring operations aboard the SEDCO/BP471. Specifically, safety measures and actions are defined for the rig floor, core walk, core lab, core storage area, and living quarters with regard to hydrogen sulfide (H_2S) and high downhole temperatures that may be encountered during operations on Leg 139. This document describes procedures for handling the core barrels on the rig floor, removing and handling the cores on the core receiving deck and processing the cores in the core lab. H_2S detection equipment is described and the location in each area is defined. The type, quantity and location of the breathing-air equipment is described. Contained in this document are the definitions of the occupational exposure limits, scales, initial response to H_2S and toxicity limit values as defined by the Canadian occupational health and safety legislation and the American National Standards Institute (ANSI).

The plan also defines special operational procedures that will be required for working in both high temperature and H_2S environments. Methods of circulation during routine coring operations are specified to maximize hole cooling during wireline and other special downhole operations. Situations when H_2S and CO_2 scavengers and inhibitors should be mixed with the drilling fluid are also included. The drill string safety valve and its operation are also described.

It should be noted that drilling and coring operations conducted aboard the SEDCO/BP 471 by the OCEAN DRILLING PROGRAM are not conventional. Drilling and coring are done without a marine riser (no return circulation), drilling for the most part is done with seawater rather than mud systems, and there is no blowout prevention system.

ODP does not intend to operate for any extended period of time under Emergency Conditions I, II or III as defined in Section V. Rather this plan defines safety equipment and emergency procedures that must be ready in the event H_2S and/or steam flash conditions are encountered. The contingency plan is intended to be used as a means to recognize, recover from and eliminate potentially dangerous

situations. Drilling and coring operations are to be suspended during Emergency Conditions I, II and III and may not be resumed until the source of H_2S has been identified and either suppressed or dissipated below 10 PPM (parts per million).

The concentration levels can be minimized by allowing the H_2S to diffuse out of the split cores outside the core lab in a well-ventilated area and providing forced ventilation in the areas where H_2S is present.

II. SAFETY EQUIPMENT LIST AND LOCATION

Before commencing with drilling and coring operations on Leg 139, the procedures set forth and equipment described in this document shall be in place and operational.

A. SAFE BRIEFING AREA

The safe briefing areas will be the **port and starboard life boat stations** located forward on the foc'sle deck. The location of the designated safe briefing area will be posted by the Captain or Mates next to the ship's station bills. The port and starboard life boat stations have been designated as the safe briefing areas because when the drillship is in the "dynamic positioning mode," the bow of the ship is nearly always oriented into the prevailing wind. However, if for some reason the stern of the ship was oriented into the wind, the Captain would notify all ship personnel that the safe briefing area would be the **heliport.** **Note: the designated safe briefing area will be posted on the station bills by the Captain. Signs will also be posted at the location of the designated safe briefing area. The signs will clearly identify the area as the designated safe briefing area.** Drawings of the ship showing those designated areas are included in the Appendix. In the event an excess of 10 PPM of H_2S is detected at one of **"the fixed H_2S sensors"**, the ship's Captain or the Mate on duty will determine the appropriate course of action and the alarm state/condition that applies. The location and emergency state (Conditions I, II, and III described later in Section IV) will be broadcast using coded bell signals and verbally over the ship's public address system. It is important that the location of the H_2S source be broadcast so that personnel can avoid the H_2S danger area as they make their way to the safe briefing areas. All personnel aft of the rig floor not assigned emergency duties shall proceed forward to the safe briefing stations along the mezzanine or main deck on the windward side of the ship. Personnel aft must avoid entering areas

designated as potential H_2S danger areas as they proceed forward to the safe briefing areas. Note: rig floor activity, weather and sea conditions will dictate the best routes to be taken to the safe briefing area from each particular location on the ship. The routes will be decided by the Captain and reviewed in safety meetings held with personnel working in each area of the ship.

B. WIND DIRECTION INDICATORS

Windsocks and streamers (bright colored) will be installed on the derrick, bow and stern, positioned as to be seen from any location above the main deck. See drawing SK 9002.

C. H_2S WARNING SIGNS

The following warning shall be posted at the entrance/s of the potential H_2S areas when operating at sites where H_2S may be encountered:

WARNING HAZARDOUS AREA
HYDROGEN SULFIDE H_2S
UNAUTHORIZED PERSONNEL KEEP OUT
NO SMOKING

Specifically, warning signs are to be posted in the following areas:

1. RIG FLOOR
2. CORE RECEIVING PLATFORM
3. CORE LAB - in all areas where cores will be processed.
4. CORE STORAGE REEFER - including reefer entrance/s.
5. BOTTOM OF CORE LAB STAIRWELL - H_2S gas may accumulate in this area.
6. LIVING QUARTERS EXITS THAT ARE ENTRANCES INTO DESIGNATED H_2S DANGER AREAS - all deck levels.

D. H_2S DETECTORS AND ALARMS

FIXED SENSORS

A fixed continuous "wireless" multi-point gas monitoring system having sensors located on the rig floor, core lab, core receiving deck and core reefer storage area/s will be installed. The detector system to be used is manufactured in Canada by BW Technologies. TOTCO is providing field service for the system. The detector units have two sensors that can be placed strategically in each of the hazardous areas. Each detector unit has a transmitter that sends a signal back to the main alarm panel. The detector units have an alarm

response of less than 8 seconds. This is based on an alarm setting of 10 PPM and exposure to 20 PPM of H_2S gas. A central alarm panel for all sensors will be installed on the bridge. Warning lights and horn units will be installed in each of the designated hazardous working areas (rig floor, core lab, core reefer areas). A local audible and visual alarm will sound in the hazardous area where H_2S is detected. That is, if H_2S is detected on the rig floor, an audible alarm and warning light will flash on the rig floor. At the same time, an audible and visual alarm will be triggered on the central alarm panel. The Captain will then determine the appropriate course of action and which alarm state/condition applies. For detailed operating instructions and specifications, see the TOTCO/BW factory manual. See drawing SK 9004 for the location of the gas monitoring system equipment. Note: All fixed H_2S sensors will be set to alarm at 10 PPM.

FIXED SENSORS - RIG FLOOR/CORE WALK

A fixed continuous multi-point gas monitoring system (wireless), capable of sensing a minimum of 10 PPM in air, will be mounted in the vicinity of the rig floor. The remote sensors are to be strategically placed on the rig floor and core receiving platform. See drawing SK 9004. Any sensor can activate the alarm. The sensors will be located as follows:

1. Rig Floor - A sensor will be placed in the vicinity of the drawworks on line with well center or attached to the iron roughneck. A second sensor shall be placed on the forward side of the rig floor where the core barrel is broken out and the cores are pulled from the core barrel.

2. Core Receiving Platform - Two sensors will be mounted in the area where the core is cut into 1.5 meter long sections on the core receiving deck.

FIXED SENSORS - CORE LAB AREA

A fixed continuous multi-point gas monitoring system (wireless) shall be installed in the core lab. See drawing SK 9004. Sensors are to be installed in the following locations:

1. Core Storage Rack - A sensor shall be mounted in the vicinity of the core storage rack. Core sections 1.5 meters long are stored on

this rack prior to splitting. A secondary rack will be located outside the lab stack on the core receiving platform for storage of whole cores.

2. Core Splitting Room - A sensor is required in this area because this is where the cores are initially split and exposed to the atmosphere. Until that time the 1.5 meter core sections are in sealed plastic liner sections.

3. Core Processing Area - Two sensors will be placed in the description and core sampling areas. One will be placed adjacent to the storage of "working" halves and the second between the core photo and description table.

FIXED SENSORS - CORE REEFER STORAGE AREA/S

A fixed continuous multi-point gas monitoring system (wireless) shall be mounted in the core reefer located on the lower 'tween deck used for storing the cores (those that contain H_2S). One sensor will be mounted inside the reefer and a second sensor will be mounted in the lower 'tween landing just outside the core storage door. See drawing SK 9004.

Note: cores containing significant levels of H_2S will be stored in a separate reefer container located above deck. One sensor will be mounted inside the container and a second sensor will be mounted just outside the container door. If all the H_2S cores are stored in the above deck reefer container, the sensors in the lab reefer located on the lower 'tween deck may not be needed.

Additional sensors will be located in the lab stairwell. A fixed, continuous, multi-point gas monitoring system shall be mounted in the hold deck landing. This system will have two sensors connected to a single alarm monitor. One will be mounted inside the forward hold storage area and the second at the bottom of the stairwell. Emergency air escape packs (3 ea) will be located inside the elevator. Consideration should be given to disabling the ability on the elevator control to select the lowermost two decks in the lab stack from inside the elevator car. (The ODP and UDI Superintendents are to decide on the best way to handle this situation.)

Fixed sensors will also be located in the living quarters fresh air intake vent and the core lab fresh intake vent.

PORTABLE PERSONAL MONITORS

In addition to the fixed sensor systems described above, portable personal monitors will be placed in strategic locations in the hazardous areas as follows.

1. Core Splitting Room - A portable personal monitor will be placed in the core splitting room. The portable monitor will be used for checking for localized gas concentrations around groups of freshly split core sections.

2. Core Processing Area - Two portable personal monitors will be placed in the main lab areas where the cores are initially handled. Those monitors can be moved to the areas (different lab stack levels as required) where cores are being processed.

3. Rig floor - Two portable personal monitors will be placed on the rig floor for taking localized readings when the drill string is opened and when core catchers are broken out. One of those detectors will be carried by the derrickman at all times when working in the pump room.

4. Core Receiving Platform - A portable personal monitor will be placed on the core receiving platform for taking localized readings when the core is cut into 1.5 meter long sections.

5. Reefer Area - A portable monitor will be placed next to the reefer fixed monitor unit located in the stairwell. That monitor is to be carried by personnel when entering the reefer and in areas such as the forward hold or stores area.

E. DRILL PIPE SAFETY VALVE AND FLOAT VALVE

A safety valve (ODP part number OG 0785) with 5-1/2" internal flush (I.F.) box and pin connections is kept on the rig floor. The safety valve has a 3.9" throughbore. The valve is intended to be used as an in-line blowout preventer (BOP) in the event of excessive backflow of fluid through the drill string. If excessive backflow does occur, the valve is to be installed in the drill string. Once the 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 fluid to be pumped down the drill string but prevents fluids contaminated with H_2S or hot fluids from backflowing up the drill string. **The float valve is to be used for special operations only. If the float valve is installed, some downhole tools cannot be run. Both the drill pipe safety valve and the float valve must be trimmed for H_2S service.**

F. H_2S SCAVENGERS

Drilling fluid additives (H_2S and CO_2 scavengers) will be carried on board to help reduce downhole concentrations of H_2S and CO_2 that may enter the wellbore. Since returns are not brought back to the surface, it is not practical or economical to continuously pump the scavengers or inhibitors. A sufficient volume of H_2S scavenger shall be on board to allow slugs to be pumped when not circulating for long periods of time and between cores if required.

G. WORK-CYLINDER RECHARGE STATION

The work-cylinder recharge station for recharging the portable air breathing cylinders will be located on the bridge deck roof behind the DP Control Room.

H. CASCADE AIR BREATHING SYSTEM

A cascade air breathing system will be installed on the rig floor, core receiving deck, inside the core lab and in the alternate core splitting area if used. Refer to drawings SK 9002 and SK 9050 for the location and detailed layout of the equipment that will be placed in each area. The cascade breathing system will allow breathing equipment to be worn for long periods of time. The air mask units will have a 50-foot hose that connects in the cascade air supply. Each air mask unit will also have a self-contained 5-minute air supply. If it becomes necessary to evacuate the area, the 50-foot hose can be disconnected from the mask. The self-contained 5-minute air supply is turned on and used to move to a safe area.

The cascade stations designated C^1, C^2 and C^3 are supplied with air from an air compressor located on

the bridge deck roof. See the cascade system operating manual for details of the operation and maintenance of all the cascade system components.

I. SELF-CONTAINED BREATHING APPARATUS (SCBA)

Self-contained breathing units (30-minute) will be placed in the following locations:

1. Rig Floor - SCBA units (6 ea) for the rig crew will be stored in a readily accessible location on the rig floor. The storage location/s shall be away from the immediate well center where the H_2S is likely to be emitted.

2. Core Lab - SCBA units (4 ea) for personnel assigned with emergency duties shall be placed in this area. There will be 2 ea SCBA units on the core receiving deck.

3. Safe Briefing Area - SCBA units (6 ea) shall be placed and maintained in safe briefing areas. Those air packs will be assigned to personnel with emergency duties such as rescue of personnel in hazardous areas.

4. Reefer - SCBA units (2 ea) shall be placed in the vicinity of the reefer in the stairwell on the lower tween deck.

J. EMERGENCY AIR ESCAPE PACKS

Three (3) emergency air escape packs shall be located inside the lab stack elevator. The escape packs provide a 5-minute emergency supply of air.

K. LIST OF SAFETY EQUIPMENT

The location and quantity of all safety equipment (including respirators, resuscitators, H_2S detectors, etc.) will be maintained on a separate "Safety Equipment Inventory" by the designated H_2S Safety Technicians. Also a location layout drawing is provided in this section for reference.

L. VENTILATION EQUIPMENT

One electric fan (bug blower) with an explosion proof motor will be installed on the rig floor and one will be installed on the core receiving deck. The bug blowers are to be directed aft/downwind. Two portable smoke ejector fans will be placed in the lab stack. The fans will be used to ventilate areas where concentrations of H_2S have been detected in areas such as the core splitting room, main lab, etc.

In addition to the fans, positive pressure normally will be maintained in the lab stack. That will help to force air out of the exits when it is necessary to use the portable smoke exhaust fans in localized areas in the lab stack. Note: the lab stack ventilating system is separate from the living quarters system. Scrubber fan units will be located in the core lab in the vicinity of core description tables to help control the level of H_2S in the lab.

III. NORMAL OPERATING PROCEDURES

A. PRIOR TO COMMENCING WITH OPERATIONS AT LEG 139 SITES

1. The list of phone numbers of shorebased personnel to be contacted concerning H_2S emergencies is included in Appendix V. A copy of the list will be posted in the following locations:

   a. ODP Operations Superintendent's office
   b. UDI Drilling Superintendent's office
   c. UDI Captain's office
   d. ODP Lab Officer's office
   e. UDI radio room

2. All safety equipment and H_2S-related hardware must be set up as outlined on the location layout drawings contained in the Appendix. All safety equipment must be routinely inspected, paying particular attention to breathing apparatus and recharge stations.

3. All personnel assigned to emergency duties will be assigned self contained breathing apparatus and notified as to where the breathing apparatus is stored. ODP and UDI

personnel assigned to emergency duty in the following areas will be provided with breathing-air equipment:

a. Rig Floor
b. Core Receiving Platform
c. Core Lab
d. Reefer
e. Rescue Team in Safe Briefing Area

4. All personnel aboard the drillship, without exception, shall be notified of the potential dangers of H_2S, and to a lesser extent, CO_2, radon and hydrocarbon gases. All personnel without exception shall watch the UDI H_2S video training module. All personnel (UDI Crew, ODP Operations Personnel, Scientists, LDGO and Lab Techs) working in the designated hazardous areas (rig floor, core walk, core lab, and core reefer) must complete a H_2S safety course taught by a qualified H_2S instructor. The course will include thorough training in the use of breathing equipment, emergency procedures, responsibilities and first aid for H_2S victims.

The H_2S Safety Technicians must keep a list of all personnel who have completed the special training programs aboard the vessel. All personnel (UDI Crew, ODP Operations Personnel, Scientists and Lab Techs) working in or around the designated hazardous areas shall be given a copy of the H_2S contingency plan and a copy of "The Hydrogen Sulfide Technical Manual". The H_2S Technician must keep a list of all persons that have copies of the plan and signatures verifying they have read and understand the contingency plan and technical manual thoroughly.

B. ON SITE OPERATIONS

1. The H_2S detection equipment will be maintained by designated H_2S Safety Technicians. The detector/sensor units will be calibrated during the initial installation. As per the manufacturer's recommendation, no additional calibration is required for 90 days unless there is a specific problem with one of the units. During the first week of operation, the detector/sensor units are to be tested 3

times on different days. Both sensors on each of the units are to be tested. The detectors should be tested more frequently if problems with any specific detector unit occurs. After the first week of operation the detector units are to be tested once a week. The time of tests and results will be logged by the H_2S Safety Technicians.

In the event that a H_2S detector or sensor on the rig floor does not test successfully, drilling will cease until the defective item is (1) repaired/replaced, and (2) approval to proceed is given by the UDI Drilling Superintendent. Spare sensors and a spare detector will be available on board.

2. Blowout drills will be held as often as deemed necessary by the UDI and ODP Operations Superintendents to acquaint the crews and service personnel with their responsibilities and the proper way to secure the drill pipe safety valve.

3. All personnel aboard the vessel will be instructed in the use of breathing-air equipment until supervisory personnel are satisfied that they are capable of using the equipment.

4. After familiarization, personnel working in the designated hazardous areas must perform a weekly drill with the breathing-air equipment. The drill should include getting the equipment, putting it on, and a short work period. A record should be kept of the crews drilled and the date.

   Blowout drills which incorporate the use of the breathing equipment with the installation of the drill pipe safety valve will be conducted until the supervisory personnel are satisfied that rig floor personnel are capable of using the equipment effectively.

5. Along with the normal weekly fire and boat drill and safety meeting, a weekly breathing-air equipment demonstration and H_2S training

session must be held for all personnel that were not required to complete the in-depth H_2S safety course.

6. Rig Crews, Scientists and Lab Techs shall be made aware of the location of the spare air bottles, the resuscitation equipment, portable fire extinguishers and H_2S detectors. Knowledge of the location of H_2S detection sensors is vital to understanding the emergency conditions. Key personnel must be trained in the use of the resuscitator and H_2S personal monitors.

7. The H_2S portable personal monitors are available for working personnel as needed. After H_2S is detected by any fixed sensor, periodic inspections of all areas of poor ventilation (such as bottom or lab stairwell and forward hold area, etc.) shall be made with a portable H_2S personal monitor.

8. All personnel on the ship must become "wind-conscious" and be aware at all times of the direction of the prevailing winds. **Remember, H_2S is heavier than air and will collect in low places when the air is still.**

9. In the event H_2S is detected at the surface, no welding shall take place until the surrounding air is thoroughly tested with an explosimeter. A hot work permit shall be required for all welding in the designated hazardous at all times whether gas has been detected or not. **(H_2S has a low ignition point of 500 degrees F and is explosive when mixed with air in concentrations between 4.3 and 46 percent.)**

10. After drilling into an H_2S zone, increased monitoring of the working areas will be provided during coring operations, special downhole measurement operations, logging and running of subsea hardware. If the H_2S level reaches 10 PPM at a fixed H_2S sensor, protective breathing apparatus must be worn by all working personnel.

IV. OPERATING CONDITIONS - CLASSIFICATIONS

Drilling and coring operations may occur under four possible conditions.

A. NORMAL OPERATIONS - H_2S NOT PRESENT

H_2S ALERT - WHEN H_2S LEVELS BELOW 10 PPM ARE INITIALLY DETECTED THE CAPTAIN WILL ANNOUNCE THAT A H_2S ALERT CONDITION EXISTS FROM THE POINT IN THE HOLE/CORES WHERE MINUTE AMOUNTS OF H_2S ARE ENCOUNTERED.

B. CONDITION I - POTENTIAL DANGER TO LIFE - H_2S PRESENT AT 10 TO 20 PPM.

C. CONDITION II - MODERATE DANGER TO LIFE - H_2S PRESENT AT 20 TO LESS THAN 50 PPM.

D. CONDITION III - EXTREME DANGER TO LIFE - H_2S PRESENT AT 50 PPM OR GREATER.

A detailed description of operating conditions is included in the Appendix.

V. H_2S EMERGENCY PROCEDURES

Note: drilling and coring operations will not be conducted if an Emergency Condition I, II or III exists on the rig floor, core walk or core lab. The Emergency Condition must be brought under control before drilling operations proceed.

A. EMERGENCY PROCEDURE FOR CONDITION I

If, at any time, as much as 10 PPM of H_2S is detected by a fixed H_2S sensor, the following steps are to be taken:

1. The person detecting the H_2S must immediately notify the Captain or Mate on watch as to the area (rig floor, core receiving platform, core lab, etc.) where the gas was detected. The Captain or Mate will then decide on the appropriate course of action and if a Condition I emergency status is warranted. The bridge will then notify the Driller, ODP Operations Superintendent and UDI Drilling Superintendent of the action required.

   The following personnel will immediately put on their breathing-air equipment.

a. All personnel assigned to emergency duties in the area/s where the Condition I emergency exists (rig floor, core receiving platform, core lab and reefer).

b. All personnel that are required (for emergency or other vital reasons) to work below and downwind of the source of H_2S.

The H_2S Safety Technician/s on duty will bring portable H_2S detectors to the area where the H_2S was detected to find the source.

2. Upon notification by the bridge of a Condition I emergency occurrence on the rig floor, core receiving platform, or core lab, the Driller will make the string backup (if open), pick up off bottom and maintain circulation.

3. The Captain will alert all personnel that a Condition I exists. All personnel not assigned to emergency duties must get their life jacket/survival suits and report to the upwind safe briefing area for further instructions. The Captain will be prepared to shut down ventilation systems and to close all hatches downwind and below the source of H_2S.

4. Supervisory personnel shall make the maximum effort to determine the source of the H_2S and to suppress the H_2S as quickly as possible. **Drilling/coring operations must not proceed until the source of H_2S is located and suppressed to a level below 10 PPM. Note: depending on the source of the H_2S, the hole may be terminated as determined by the ODP and UDI Drilling Superintendents. The hole could also be terminated for H_2S concentrations being too high in the core lab as well as on the rig floor.** <u>If concentrations of H_2S in the cores produce Emergency Conditions I, II, or III in the core lab, this is potentially a more dangerous situation than on the rig floor due to the confined space and reduced ventilation.</u>

5. The UDI Drilling Superintendent will ensure that all nonessential personnel are out of the potential danger area (rig floor, core receiving platform, and core lab areas). All persons who remain in the potential danger area must utilize the "buddy system" (see Appendix).

6. The Captain or Mate will ask all personnel to check their safety equipment to confirm that it is working properly and stored in the proper location.

7. The on-duty Safety Technicians will confirm that all H_2S monitoring devices are functioning properly, reading accurately, and will increase gas monitoring activities with portable detection units.

8. Depending on the location of the Condition I emergency the fans on the rig floor or in the core lab should be turned on if not already in operation. **Note: if the exhaust fans in the lab stack are turned on to exhaust H_2S the Driller is to be notified because the exhaust fans exhaust air above the rig floor.**

9. The ODP Operations Superintendent shall notify the Canadian National Energy Board as soon as possible of the situation and the actions taken (see Appendix V for contacts).

B. EMERGENCY PROCEDURES FOR CONDITIONS II AND III

If the H_2S concentration reaches 20 PPM at a <u>fixed</u> sensor the following steps will be taken.

1. The person detecting the H_2S must immediately notify the Captain/Mate on watch of the area (rig floor, core receiving platform, core lab, etc.) where the gas was detected. <u>The Captain or Mate will then decide on the appropriate course of action and if a Condition II or III emergency status is warranted.</u> The bridge will then notify the Driller, ODP Superintendent and UDI Drilling Superintendent of the action required as directed by the Captain or Mate.

   The following personnel will immediately put on their breathing-air equipment.

   a. All personnel assigned to emergency duties in the area where the Condition II or III emergency exists (rig floor, core receiving platform, core lab, and reefer).

   b. All personnel required (for emergency or other vital reasons) to work below and downwind of the source of H_2S.

The H_2S Safety Technician on duty will bring portable H_2S detectors to the area where the H_2S was detected to find the source.

2. Upon notification by the Captain or Mate of Condition II or III emergency, the driller will make the string back up (if open), pick up off bottom and maintain circulation.

3. The Captain will alert all personnel that a Condition II or III exists. All personnel not assigned to emergency duties must get their life jacket/survival suits and report to the upwind safe briefing area for further instructions. The Captain will have one member of the ship's crew prepared to shut off ventilation systems and close all hatches downwind of the H_2S source.

4. Always put on a portable breathing air unit before proceeding to assist anyone affected by the gas and utilize the "Buddy System" (see Appendix). If the affected person is stricken in a high concentration area, put on a safety belt with 50' of tail line and obtain stand-by assistance before entering the area. Always use the "buddy system" when entering possible contaminated areas.

5. The Captain or Mate on duty shall notify any nearby vessels to go upwind, and maintain a radio and visual watch.

6. Supervising personnel shall make a maximum effort to determine the source of the H_2S and to suppress the H_2S as quickly as possible. **Drilling/coring operations will not proceed until the source of H_2S is located and suppressed. Note: depending on the source of the H_2S the hole may be terminated as determined by the UDI Drilling Superintendent. The hole may be terminated for H_2S concentrations being too high in the core lab as well as on the rig floor.** If concentrations of H_2S in the cores produce Emergency Conditions I, II, or III in the core lab this is potentially a more dangerous situation than on the rig floor due to the confined space and reduced ventilation (see Appendix II - H_2S Core Handling Procedures).

7. The UDI Drilling Superintendent will make sure that all nonessential personnel are out of the potential danger area (rig floor, core receiving platform,

and core lab areas). All persons who remain in the potential danger area must utilize the "buddy system."

8. The ODP Superintendent will ask all personnel to check their safety equipment to confirm that it is working properly and stored in the proper location.

9. The on-duty Safety Technicians will confirm that all H_2S monitoring devices are functioning properly, reading accurately, and will increase gas monitoring activities with portable detection units.

10. The ODP Operations Superintendent will notify the Canadian National Energy Board as soon as possible of the situation and actions taken (see Appendix V for contacts).

The UDI Drilling Superintendent, in consultation with the ODP Superintendent, will assess the situation and assign duties to each person to bring the situation under control. When the severity of the situation has been determined, all persons on the vessel will be advised. **As stated above, depending on the location of the H_2S Condition II or III emergency, the UDI Drilling Superintendent may elect to immediately terminate drilling and coring operations in the hole.**

In the event the concentration of H_2S present results in injury to personnel the designated shorebased medical facility shall be contacted. If it is deemed necessary by the ship doctor to evacuate the person/s, arrangements shall be made with the designated helicopter service. In the event an evacuation and/or H_2S/wellbore fluid blowout occurs, the National Energy Board is to be notified by the ODP Operations Superintendent. The Captain or Mate on duty shall notify air and water craft in the immediate vicinity of the drilling location.

VI. SPECIAL OPERATIONS

A. CORING

During coring operations where it is likely that H_2S gas will be encountered, the following procedure shall be followed:

1. Circulation will be maintained while a core barrel is dropped or wirelined into and out of the hole.

2. After a core has been cut, circulation will be maintained while running the wireline assembly into the hole for retrieval of the core barrel.

3. After the overshot has been engaged on top of the core barrel, it may be necessary to stop the pumps momentarily while unseating the core barrel from the outer core barrel assembly. The core barrel should be slowly pulled up above the top of the bottom hole assembly (BHA). The wireline winch should be stopped at this point and three volumes (number of bbls.) of fluid (equal to the volume required to
fill the inside of the BHA) should be pumped to clear any H_2S fluid that may have been swabbed in the BHA when the core barrel was unseated.

4. As the core barrel is wirelined to the surface, circulation down the drill string will be maintained. Wireline speeds are to be controlled such as to prevent/minimize swabbing H_2S fluids into the drill string from the wellbore.

5. At the point in the hole where H_2S is detected (1 PPM or more) all personnel working on the rig floor are to put on breathing-air equipment 10 stands before each core barrel reaches the surface. This procedure will be followed until H_2S is no longer viewed as a threat in each hole where the gas is encountered. When the drill pipe is initially opened, one of the rig crew shall use a personal monitor to check for the presence of H_2S gas in the drill pipe.

Note: The pipe must be confirmed not to contain H_2S prior to sending one of the rig crew up in the derrick to remove the sinker bars from the blocks and to close the WKM valve.

If H_2S is detected, breathing-air equipment should be worn by all personnel working in the area while the core barrel is being pulled from the drill string, laid down, broken out and removed. Portable personal monitors should be used to monitor for H_2S when the drill string is 1) opened prior to removing

the core barrel from the drill string and 2) after the core barrel is laid down and the core catcher is removed. When those detectors indicate a safe atmosphere, the breathing-air equipment can be removed.

The following practices must be followed for every core barrel pulled:

1. Due to the difficulty in communicating while wearing breathing-air equipment, it is required that a chalk board/chalk and note pads be available during coring operations.

2. The importance of wearing breathing-air equipment must be stressed to personnel connected with the coring operations. The most critical times are:

   (1) When the drill string is initially opened to remove the core barrel on the rig floor. (If H_2S was swabbed in the drill pipe as the core barrel was retrieved, a concentration of the gas could possibly exist at the surface below and around the core barrel.)

   and

   (2) When the core barrel is opened. **H_2S may be contained in the core inside the core barrel.**

3. All personnel on board not wearing breathing-air equipment should stay a safe distance upwind from the core barrel as defined by the Captain or Mate.

4. If the core contains H_2S, the 1.5 meter long core sections are to be marked indicating the presence of H_2S.

5. If the core contains H_2S, the liner/"D" tubes are to be marked as such. The core will be stored on the core receiving deck and the liner will be perforated. **Note: specific handling procedures for processing cores containing H_2S are contained in the Appendix.**

B. DOWNHOLE MEASUREMENTS, SAMPLING AND LOGGING

As with coring operations, special precautions must be taken when running downhole measurement, sampling and logging tools in areas where H_2S gas may be encountered. The procedures below shall be followed:

1. Circulation is to be maintained while running wireline tools in and out of the hole. **Care shall be taken to ensure that excessive flow rates, sufficient to pump the wireline tools off the wireline, are not used. This has happened in the past with logging tools.**

2. After the measurements or sampling has been completed and the wireline tool/s have been retrieved inside the BHA, the sampling or measuring tool is to be stopped above the top of the BHA. Three volumes (number of bbls) of fluid (equal to the volume of fluid required to fill the inside of the BHA) are to be pumped to clear any H_2S fluid that may have been swabbed into the BHA when the tool was pulled inside the BHA.

3. As the wireline tool/s are retrieved to the surface, circulation down the drill string is to be maintained. Wireline speeds are to be controlled such as to prevent swabbing H_2S fluids into the drill string from the wellbore.

4. After H_2S has been detected (1 PPM or more) all personnel working on the rig floor are to put on breathing-air equipment 10 stands before the measuring/sampling tool reaches the surface.

   Breathing-air equipment should be worn by all personnel in the area while the measuring/sampling tool is being pulled from the drill string, laid down, broken out and removed. Portable personal monitors should be used to monitor for H_2S around the measuring/sampling tool. When the detectors indicate a safe atmosphere, the breathing-air equipment may be removed.

   Note: prior to sending one of the rig crew up in the derrick to remove the measuring/sampling tools from the blocks and to close the WKM valve, the pipe must be confirmed not to contain H_2S.

5. When water sampling tools and pressure core barrels are run, extreme caution must be used in handling the sample chambers containing the wellbore fluids. **Prior to deployment, each tool is to be carefully inspected to determine if it is suitable for collecting water samples that may contain H_2S. If there is any question as to whether a tool is suitable for use in a H_2S environment, do not run the tool.**

   Upon retrieval of a sampler containing fluids from a zone suspected to contain H_2S, the sample chamber is to be marked **"possible presence of H_2S".** The fluid contained within the sample chamber will be assumed to contain H_2S until actual measurements are made on the fluid that indicate otherwise.

   In addition to the possible presence of H_2S in the wellbore, CO_2 and corrosive brine solutions may also be present. The wellbore fluids may have pH levels as low as 2 to 4. These fluids are highly corrosive. Components that are not designed for operation in H_2S and CO_2 environments are susceptible to sulfide and stress corrosion cracking. The cracking may occur downhole or at the surface over relatively short periods of time.

   In the event fluids containing corrosives are stored in the sample chamber for even short periods of time, a failure may occur if the chamber is not made of the proper material.

   Special precautions and extreme caution are to be observed when storing as well as when handling sample chambers with H_2S fluids under pressure.

VII. HIGH-TEMPERATURE WELL CONTROL PROCEDURES

In the unlikely event a steam flash occurs, the first indication at the surface would be backflowing of seawater at the rig floor when making-up or breaking-out a connection (or the Cavins wireline packoff in the derrick if pulling a core barrel). Because of the water depth, steam may never reach the surface but **hot water containing H_2S could reach the surface if the backflow continued at the surface for a long enough period of time.** (See the Leg 139 ODP Engineering and Operations Planning Document for additional information.)

1. If excessive backflow is observed at the rig floor for a significant length of time and H_2S is not

present, the top drive should be immediately made back up to the drill string. In the event the top drive is stood back, the drill pipe safety valve is to be immediately installed. This will control the backflow while the top drive is being picked up.

2. If H_2S is detected when the backflow occurs, emergency procedures as defined in Condition I, II or III are to be implemented immediately. **The rig crew should first put on breathing-air equipment, then install the safety valve.**

   Blowout drills which incorporate the use of the breathing equipment with the installation of the drill pipe safety valve will be conducted until the supervisory personnel are satisfied that rig floor personnel are capable of using the equipment effectively.

In the event it is necessary to use the drill pipe safety valve, the following procedure will be followed. The drill pipe safety valve is installed in the open position. Once the valve is made up, it can be closed, bringing the backflow of seawater under control. **Note: short-term backflowing at the rig floor is normal and can be caused by cuttings and/or weighted mud "U tubing" in the hole.** Under normal conditions, when backflowing occurs due to "U tubing" of cuttings, the top drive kelly joint is made back up to the drill string hung off at the rig floor. Regardless of the cause of backflow, making the top drive kelly back up to the drill string is still the preferred method for controlling backflow.

If it is necessary to use the safety valve, a second "**optional**" sub containing a Baker model G (5f-6R) float valve can be made up to the safety valve after the safety valve is in place and is closed. The float valve acts as check valve allowing fluid to be pumped down the drill string but preventing backflow of fluid up the drill string. If the valve is put into the string and the pipe is run down the hole, there is a high risk of sticking the drill string. Chances of getting loose downhole are reduced to nil if circulation is plugged off (too hot for explosives).

The top drive or the circulating head can be made up to the safety valve and/or float valve subs. At that point, circulation down the drill string can be re-established by opening the safety valve and pumping. Depending on the bottom hole temperatures and hole conditions, it may be possible to cool the hole back to manageable levels (as is done in the geothermal industry). Depending on the severity of the backflow and the circumstances that caused the backflow, the UDI Drilling Superintendent may elect to terminate the hole.

If H_2S is detected in the backflowing fluid, the hole is to be terminated immediately.

As stated above, short-term backflowing at the rig floor is normal and can be caused by cuttings and/or weighted mud "U-tubing" in the hole. Once the backflow has been brought under control and the hole stabilized, the ODP and UDI Drilling Superintendents may elect to continue operations in the hole. If, after the hole has been stabilized, backflowing continues to occur and high temperatures are present downhole, the hole should be terminated due to the possibility of a steam flash. **Note: depending on the bottom-hole temperature, pumping of muds (weighted or otherwise) may result in plugging of the bit jets and core barrel circulation ports.**

If the hole is terminated due to continued/excessive backflow problems, it may be necessary to cool the hole down several times while tripping the pipe out of the hole. Time should be minimized for breaking out and laying out connections. Between connections, it may be necessary to circulate at high flow rates to prevent additional backflow from occurring. Times of greatest risk for a steam flash/backflowing occurrence are during operations that prevent or minimize circulation such as when making connections, wirelining core barrels in and out of the hole, logging, and taking downhole measurements/samples. **Considerable caution and discretion must be used when undertaking such operations in sections of the hole where bottom hole temperatures are high.**

To minimize possible steam flash problems and to prevent swabbing in of corrosive wellbore fluids, special precautions must be taken. When running the wireline retrieval system in the hole and when pulling core barrels, circulation at low flow rates (50 GPM or higher) shall be maintained. When the core barrel is initially unseated and clears the top of the BHA, the wireline is to be stopped momentarily. During this time three volumes of drilling fluid (equal to the volume required to fill the inside of the BHA) are to be pumped to clear out any corrosive wellbore fluids that may have been swabbed into the BHA when the core barrel was initially unseated. **Note: depending on bottom hole temperatures, there is a possibility of "high temperature" gelation of mud. This could plug the bit if circulation is stopped for any reason before the mud clears the bit.** If bottom hole temperatures warrant, seawater or a high-temperature mud system (if available) should be used instead of a conventional mud system. Circulation will be continued while the core barrel is wirelined out of the hole. The time required for breaking the drill string and removing/replacing the core barrels should be minimized.

There is no real-time method available to monitor downhole temperatures or H_2S levels. It is planned to monitor temperatures by use of heat tabs and temp-stick material strategically placed on the core barrels. That will give an indication of the operating temperatures in the BHA. Levels of H_2S being emitted from the cores will be measured with the portable personal monitors. Levels of H_2S contained within the cores will be measured by one of two means, either in gas or fluid samples taken from the core. See memorandum titled "H_2S Detection on the JOIDES Resolution" written by Dr. Marta Von Breymann in the "Engineering and Planning Document".

VIII. HOLE ABANDONMENT AND MOVING OFF LOCATION

In the unlikely event that uncontrollable or excessive backflow occurs, the following action will be taken by UDI:

1. Make the top drive back up to the string. If the top drive is set back, the safety and float valves can be used to arrest the flow while the top drive is being picked up. Once the top drive has been picked up, circulation will be initiated and maintained in order to cool the hole and hopefully stop the backflow. If this is ineffective, the pipe will be slugged with heavy mud. Once the hole is static, the pipe will be tripped out in doubles.

2. In the event the pipe becomes irretrievably stuck, there are drill pipe severing and back-off tools on board that can be run inside the drill pipe on the logging cable. The severing tools carry an explosive charge that is capable of cutting the drill string above the stuck point. The severing tools have a maximum temperature above which the electronics and/or logging cable will not function. There is also a maximum safe drilling fluid surface temperature for handling the charges on the rig floor, above which the explosives could detonate prematurely. The Schlumberger operator shall determine the temperatures and advise the UDI Drilling Superintendent.

   As long as there is no backflow and circulation can be maintained, the drill pipe can be severed or backed off in the conventional manner.

   * If backflow is occurring, the procedures described in Section VII are to be used to cool the hole and to stop the backflow prior to running the severing tool or back-off tool.

3. If it is not possible to perform either action described in 1 and 2 above, the pipe should be tripped in the hole until it parts at the seafloor. This has unintentionally been demonstrated to work in the past.

   If breaking the pipe at the seafloor is not possible, a blind back-off with the top drive should be attempted.

   If that procedure fails, the drill string may possibly be released from the elevators using a tugger/s to open the elevator doors. Note: if H_2S is present in sufficient concentration inside the drill pipe at the surface, an explosion will result if a torch is used to cut the pipe free.

   As a last resort after attempting the above procedure the following may be considered:

   If none of the other procedures worked, then driving the ship off location may be attempted if conditions are extreme. This action may result in pulling the pipe free at the sea floor or the **pipe parting at the surface**. This action is extremely dangerous. **All personnel should be clear of the rig floor and the drill pipe should be hung off in the elevators on the rig floor with the links disconnected.**

IX. RESPONSIBILITIES AND DUTIES

As stated in Special Provision No. 17 (pg. II-13) of the UDI/TAMRF Subcontract, it is UDI'S "sole and exclusive duty at all times" to determine whether operations can be continued or undertaken, therefore the responsibilities outlined below are not intended to circumvent the contract terms but are merely to assist in or prevent an emergency situation. In any event, all final decisions shall be UDI'S.

A. All Personnel

1. It is the responsibility of **all personnel** working in the designated hazardous areas (rig floor, core walk, core lab and reefer) to familiarize themselves with the procedures outlined in this Contingency Plan.

2. Each individual is responsible for his/her assigned safety equipment and is to see that it is properly stored and easily accessible.

3. Each person assigned to emergency duties in the designated hazardous areas must be familiar with the location of all safety equipment aboard the vessel and be able to use all safety equipment upon notice.

4. All personnel working in the hazardous areas must read and understand the information in the article titled "SAFETY CONSIDERATIONS WHILE OPERATING IN AREAS WHERE HYDROGEN SULFIDE MAY BE PRESENT" contained in the Appendix.

5. Any person detecting H_2S must notify the Captain or Mate as to the area (rig floor, core receiving platform, core lab, etc.) where the gas was detected. The Captain or Mate will notify the Driller, ODP Superintendent, UDI Drilling Superintendent.

B. ODP OPERATIONS SUPERINTENDENT

1. The ODP Superintendent shall be trained and will assist the UDI Drilling Superintendent in enforcing the "HYDROGEN SULFIDE--HIGH TEMPERATURE DRILLING CONTINGENCY PLAN."

2. The ODP Superintendent will assist the UDI Drilling Superintendent in seeing that all safety and emergency procedures outlined in the contingency plan are observed by the personnel aboard the drillship.

3. The ODP Operations Superintendent will assist the UDI Drilling Superintendent in seeing that all personnel are trained as specified under Section III, "NORMAL OPERATING PROCEDURES".

4. The ODP Operations Superintendent will ensure that the ODP H_2S Technicians are maintaining all ODP H_2S and high-temperature safety equipment (H_2S detectors, breathing equipment, drill string safety valve, etc.) on the rig in good operational condition.

C. UDI DRILLING SUPERINTENDENT

1. It is the responsibility of the UDI Drilling Superintendent to thoroughly understand and, along with the assistance of the ODP Operations Superintendent, to see that all safety and

emergency procedures outlined in this "HYDROGEN SULFIDE--HIGH TEMPERATURE DRILLING CONTINGENCY PLAN" are observed by all personnel aboard the drillship.

2. The UDI Drilling Superintendent shares the responsibility with the assistance of the ODP Operations Superintendent to ensure that all personnel aboard the ship have been trained as specified under Section III, "NORMAL OPERATING PROCEDURES."

3. The UDI Drilling Superintendent, with the assistance of the ODP Superintendent, is responsible for seeing that all H_2S and High-Temperature Safety Equipment (H_2S detectors, breathing equipment, drill string safety valve, etc.) on the rig are maintained in good operational condition.

4. The UDI Drilling Superintendent or UDI Rig Superintendent shall notify the Captain or Mate on duty of all H_2S emergencies.

D. UDI CAPTAIN

1. When H_2S is encountered, the Captain or Mate 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.

2. The Captain or Mate on duty is solely responsible for designating the safe briefing area. This area will change depending on the wind direction. Another safe assembly area may be designated if the originally designated briefing (2 ea) areas are found to be unsafe for some reason.

3. The Captain or Mate on duty is responsible for keeping all personnel advised of the current safe briefing area.

4. The Captain or Mate on duty is responsible for alerting all personnel during a Condition I, II, or III alert.

5. The Captain or Mate on duty is responsible for notifying vessels and aircraft in the area of H_2S emergencies.

6. A ship's officer will always be present on the bridge once an "alert" condition has been reported.

E. UDI DRILLER

1. The driller and his crew must be completely familiar with the steps they must take during a Condition I, II or III emergency as outlined under Section V, "H_2S EMERGENCY PROCEDURES".

2. The driller and his crew must be completely familiar with special procedures to be carried out while coring, and running downhole measurement/sampling and logging tools as outlined in Section VI, "SPECIAL OPERATIONS".

3. The driller and his crew must be completely familiar with special procedures for high-temperature well control outlined in Section VII, "HIGH-TEMPERATURE WELL CONTROL PROCEDURES".

4. The Driller shall be familiar with hole abandonment procedures outlined in Section VIII, "HOLE ABANDONMENT AND MOVING OFF LOCATION".

F. H_2S SAFETY TECHNICIANS

Designated members of the UDI Deck Department (Mates) and the ODP Lab Officers/Techs will be assigned duties as H_2S Technicians.

1. The H_2S Safety Technicians are responsible for inspecting all continuous monitoring H_2S sensors.

2. The H_2S Technicians are responsible for the calibration of the H_2S monitors and alarm system (fixed and personal type).

3. The H_2S Technicians are responsible for inspecting and maintaining all breathing-air equipment. A list showing all breathing-air equipment and its location will be checked weekly.

4. The H_2S Technicians are responsible for the familiarization of all personnel on the vessel with the "HYDROGEN SULFIDE-HIGH TEMPERATURE DRILLING CONTINGENCY PLAN" as directed by the UDI and/or ODP Superintendents.

5. The H_2S Technicians are responsible for the familiarization of all new personnel arriving on the vessel with the "HYDROGEN SULFIDE--HIGH TEMPERATURE DRILLING CONTINGENCY PLAN" and the present condition under which the vessel is operating.

6. The H_2S Technicians are responsible for assisting the ODP and UDI Drilling Superintendents as needed during H_2S drills and Emergency Conditions I, II and III.

7. The H_2S Technicians shall confirm that all personnel working in the designated hazardous areas have completed all required safety training courses.

8. The H_2S Technicians shall confirm that the H_2S warning signs are posted in the locations as specified in Section II (C) "H_2S WARNING SIGNS".

G. UDI PHYSICIAN

As is normal procedure, the Physician shall confirm that all leg participants have completed the required physical. In addition to the standard requirements, personnel working in the hazardous areas must be examined to confirm that they do not have a punctured ear drum. Even if personnel are wearing breathing equipment, H_2S can enter the body through a punctured ear drum.

The Physician will be responsible for ensuring that the ship is stocked with any special medical supplies that may be needed for treating personnel exposed to H_2S. The Physician will also assist with training in resuscitation and H_2S first aid procedures.

X. PROCEDURE FOR INFORMING PERSONNEL OF THE H_2S CONTINGENCY PLAN

Prior to commencing operations, the H_2S Technicians shall have confirmed that all personnel working in the designated hazardous areas (rig floor, core receiving platform, core lab and reefer) have read his/her copy of the "HYDROGEN SULFIDE DRILLING CONTINGENCY PLAN". Each person will be required to sign a log that he/she has read and understands the plan. If, during the leg, additional personnel come onto the vessel, it is the H_2S Technicians' responsibility to ensure that the new personnel are given and have read their copy of the Contingency Plan.

XI. APPENDIX

APPENDIX I

SAFETY CONSIDERATIONS WHILE OPERATING IN AREAS WHERE HYDROGEN SULFIDE MAY BE PRESENT

This document is intended to familiarize personnel with conditions that can exist when drilling/coring operations are conducted in areas where H_2S gas may be present.

All personnel should become familiar with all safety equipment on the vessel, its use, and its location. The windsock and wind streamers are provided to show which direction the wind is blowing so that the "SAFE BRIEFING AREA" can easily be defined. Personnel should become "wind conscious" and observe the wind direction indicators. All persons aboard the SEDCO/BP 471 will receive instructions on the use of safety equipment and on what to do during a H_2S emergency. The designated hazardous areas (rig floor, core receiving platform, core lab and core reefer/s) will be monitored by fixed continuous H_2S detectors. Portable personal monitors will also be placed in all of the designated hazardous areas.

The following conditions will be in effect during drilling and coring at sites where H_2S is anticipated to be encountered. Once H_2S has been encountered in an area, the Captain or Mate will decide if Condition I, II, or III is warranted.

A. NORMAL OPERATIONS - H_2S NOT PRESENT AND H_2S ALERT

1. WARNING SIGNS - Warning signs will be posted and maintained at all times in all designated hazardous areas as defined in Section II C of the "HYDROGEN SULFIDE-HIGH TEMPERATURE CONTINGENCY PLAN."

2. ALARM - None

3. CHARACTERIZED BY - Drilling and coring operations being conducted at sites that may contain hydrogen sulfide. This condition will be in effect continuously at all sites unless it is necessary to go to a Condition I, II or III.

4. GENERAL ACTION

   a. Be alert for a changing condition.
   b. Keep all safety equipment available and sensors functioning properly.
   c. Perform all drills for familiarization and proficiency.

B. CONDITION I - POTENTIAL DANGER TO LIFE - H_2S PRESENT AT 10 TO LESS THAN 20 PPM

1. WARNING SIGNS - Warning signs will be posted and maintained at all times in all designated hazardous areas as defined in Section II C of the "HYDROGEN SULFIDE-HIGH TEMPERATURE CONTINGENCY PLAN".

2. ALARM - In the hazardous area (rig floor/core receiving platform, core lab and reefer/s) where H_2S is detected at a fixed sensor in concentrations of 10 PPM or greater, a flashing strobe light will come on. In designated areas (rig floor, core lab, and reefer/s) a siren will also sound. The alarms (flashing light and siren) will be local only for the area where H_2S is detected. At the same time, an alarm will be triggered on the central alarm panel. The alarm signal will continue as long as the H_2S concentration is 10 PPM or greater in the area or until deactivated by the H_2S Technicians, ODP Operations Superintendent, or UDI Drilling Superintendent.

3. CHARACTERIZED BY: - Drilling and coring operations halted until the source of H_2S is located and suppressed. This condition will be in effect continuously from the time the H_2S concentration reaches 10 PPM unless it is necessary to go to Condition II or III.

4. GENERAL ACTION

   a. Follow the procedures outlined under Section V, "H_2S EMERGENCY PROCEDURES". All personnel not assigned to emergency duty shall report to the safe briefing area.

   b. There will be "No Smoking" outside of living quarters. Welding or open fires are not allowed in the hazardous areas at any time without a hot work permit.

   c. Check all safety equipment for proper location and functioning. Keep it available.

   d. Follow the instructions of the Supervisor/s.

e. All personnel working in the hazardous area will wear self contained breathing equipment. All personnel will restrict their movements as directed by the UDI and ODP Operations Superintendents.

C. CONDITION II - MODERATE DANGER TO LIFE - H_2S PRESENT AT 20 TO LESS THAN 50 PPM

1. WARNING SIGNS - Warning signs will be posted and maintained at all times in all designated hazardous areas as defined in Section II C of the "HYDROGEN SULFIDE-HIGH TEMPERATURE CONTINGENCY PLAN".

2. ALARM - In the hazardous area (rig floor/core R/P, core lab and reefer/s) where H_2S is detected at a fixed sensor in concentrations of 10 PPM or greater a red flashing light will appear. In designated areas (rig floor, core lab, and reefer/s) a siren will also sound. The alarms (flashing light and siren) will be local for only the area where H_2S is detected. At the same time an alarm will be triggered on the central alarm panel. The alarm signal will continue until as long as the H_2S concentration present is 10 PPM or greater in the area or until deactivated by the H_2S Technicians, ODP Operations Superintendent, or UDI Drilling Superintendent.

3. CHARACTERIZED BY: - Drilling and coring operations halted until the source of H_2S is located and suppressed. This condition will be in effect continuously from the time the H_2S reaches 20 PPM to less than 50 PPM unless it is necessary to go to Condition III.

4. GENERAL ACTION

a. Follow the procedures outlined under Section V, "H_2S EMERGENCY PROCEDURES". All personnel not assigned to emergency duty shall report to the safe briefing area.

b. There will be no smoking outside of living quarters. Welding or open fires are not allowed in the hazardous areas at any time without a hot work permit.

c. Check all safety equipment for proper location and functioning. Keep it available.

d. Follow the instructions of the Supervisor/s.

e. All personnel working in the hazardous area will wear self-contained breathing equipment. All personnel will restrict movements as directed by the UDI and ODP Superintendents.

D. CONDITION III - EXTREME DANGER TO LIFE - H_2S PRESENT AT 50 PPM OR GREATER

1. WARNING SIGN - Follow the procedures outlined under Section V, "H_2S EMERGENCY PROCEDURES". All personnel not assigned to emergency duty shall report to the safe briefing area.

2. ALARM - In the hazardous area (rig floor/core R/P, core lab and reefer/s) where H_2S is detected in concentrations of 10 PPM or greater a red flashing light will appear. In designated areas (rig floor, core lab, and reefer/s) a siren will also sound. The alarms (flashing light and siren) will be local for only the area where H_2S is detected. At the same time an alarm will be triggered on the central alarm panel. The central panel alarm will continue until deactivated by personnel on the vessel's bridge.

3. CHARACTERIZED BY - Drilling and coring operations halted until the source of H_2S is located and suppressed. This condition will be in effect continuously from the time the H_2S reaches 50 PPM or greater.

4. GENERAL ACTION

a. Follow the procedures outlined under Section V, "H_2S EMERGENCY PROCEDURES". All personnel not assigned emergency duties shall report to the SAFE BRIEFING AREA. Radio communications shall be used to alert known air and water craft in the immediate vicinity. Notification of regulatory agencies will be made.

b. All personnel not specifically assigned to correct or control the emergency shall stay in the SAFE BRIEFING AREA until the situation is brought under control. If the situation becomes life threatening to personnel in the safe briefing areas, at the UDI Drilling Superintendents discretion, non-essential personnel are to be evacuated off the ship in

the life boats as necessary. A suggested list of essential personnel to be left on board will be prepared by UDI.

c. There will be no smoking outside of living quarters. Welding or open fires are not allowed in the hazardous areas at any time without a hot work permit.

d. Check all safety equipment for proper location and functioning. Keep it available.

e. Follow the instructions of the Supervisor/s.

f. All personnel working in the hazardous area will wear self contained breathing equipment. All personnel will restrict movements as directed by the UDI and ODP Superintendents.

E. GENERAL INFORMATION ON H_2S SAFETY

1. During an emergency, persons should utilize the "buddy system" to prevent anyone from entering an H_2S area alone. If you are wearing a mask, do not remove it until you are absolutely certain the air is safe to breathe. A personal H_2S monitor can be used to check the area. If a sudden gas release occurs without warning, you should:

   a. Hold your breath and rapidly evacuate the area containing the H_2S. Move upwind if possible. Climb up the derrick or move up a floor or climb atop the lab stack.

   b. Put on breathing-air equipment.

   c. Help anyone who may be affected by the gas. NOTE: <u>Put on your breathing-air equipment before helping anyone overcome by H_2S.</u> Then get him/her to a safe area and administer resuscitation or oxygen as needed.

   d. Evacuate quickly to the "SAFE BRIEFING AREA" to receive instructions from supervisory personnel.

   e. Do not panic.

2. All personnel, including the Captain and Mates working in the designated hazardous areas, shall become familiar with the "HYDROGEN SULFIDE-HIGH TEMPERATURE CONTINGENCY PLAN". Particular attention should be paid to the following topics:

a. H_2S EMERGENCY PROCEDURES
b. RESPONSIBILITIES AND DUTIES
c. SAFETY EQUIPMENT LIST AND LOCATION

3. Personnel wearing eyeglasses and contact lenses must take special precautions when wearing breathing equipment. The ear pieces on the eyeglasses will interfere with the seal on the face mask of both the self contained breathing apparatus and the cascade breathing system. Lens holders will be provided to mount eyeglasses inside the face masks with the ear pieces removed.

Injuries have been sustained by personnel wearing contact lenses using breathing-air equipment. The positive pressure in the face mask can push the lens up inside the cavity of the eye. The positive air pressure also dries the eye out behind the eye. Therefore, contact lenses should not be worn with the breathing equipment face masks. Instead, a pair of conventional glasses should be worn inside the face mask using the lens holder as described above.

The tables on the following pages list various poisonous gases and the concentrations at which they become dangerous.

F. MEDEVAC

We have established contact with Pacific Rim Helicopter, based at Vancouver International Airport. They have confirmed that they can provide a helicopter (Bell 222, equipped for offshore operation) on an as needed basis to transfer a patient from the ship to shore, weather permitting.

APPENDIX II

H_2S CORE HANDLING PROCEDURES

1.0 OBJECTIVE:

The objective of this document is to provide procedures for the safe handling of H_2S-rich cores by technicians and scientists. These procedures will cover core handling in the core receiving, core lab and core storage areas.

These procedures are probably extremely conservative. It is expected that the Operations Superintendent, Lab Officer, and H_2S Safety Technician will re-evaluate these procedures throughout the cruise. Some modification of these procedures may be necessary.

2.0 CORE HANDLING

2.1 From the rig floor to the core receiving platform

During an H_2S Alert (defined in the *H_2S Contingency Plan*), it will be assumed that each core can produce hazardous levels of H_2S. Until testing indicates otherwise, personnel on the rig floor are required to use a personal protective breathing apparatus. Procedures for handling cores on the rig floor are covered in the *H_2S Contingency Plan*.

When a core arrives on deck:

1) Non-essential personnel will not be allowed on the rig floor or on the core receiving platform.

2) Core handlers without protective breathing apparatus must remain upwind from the rig floor and outside the ship's hazardous zone. The hazardous zone is the area within a 50-ft. radius of the well (see the *SEDCO/BP 471 Marine Operation's Manual* for more detailed description). For Leg 139 the boundary of this zone will be marked on the core receiving platform.

When the core is ready to be transferred to the receiving platform:

1) Core handlers must use their protective breathing apparatus.

All safety precautions must remain in effect until both:

1) Accumulated free gases inside the liner have vented.

2) H_2S levels in the core receiving area are below 10 ppm.

The core lab H_2S safety technician will notify personnel when precautions are no longer necessary.

2.2 On the core receiving platform

2.2.1 Gas shows:

As soon as the core is laid out on the core racks, it must be inspected for gas shows (ie. foamy sediment, bubbles and expansion voids). If gas is evident, then:

1) The core lab H_2S safety technician insures that:

   a) Non-essential personnel are not on the core receiving platform and remain indoors until the "all clear" is given.

   b) Core handlers are using personal protective breathing apparatus.

2) Take gas samples (vacutainer) for lab analysis (science data).

3) Perforate the core liner as necessary to relieve accumulated free gases.

4) Measure H_2S levels of escaping gas with a portable air monitor. If portable air monitors detect H_2S levels greater than 10 ppm then:

   a) Immediately notify the mate-on-watch of the situation.

   b) Check fixed air monitors. If H_2S levels are greater than 10 ppm, then relocate the core to a "safe area" for degassing (see 5.0 for definition of a safe area).

Note: For both opaque plastic and metal (split and continuous) liners, <u>the presence of free gas will always be assumed</u> and the above degassing procedures must be performed.

-Opaque plastic liners: perforated at least every 50 cm for degassing and testing.

-Split metal liners: remove the top half of the liner for degassing. Monitor escaping gases with a portable air monitor.

-Continuous metal liners: core material must be extruded into pre-split plastic liners. During the extrusion process, all safety precautions must be in use. Monitor escaping gases with a portable air monitor.

The core lab H_2S safety technician will give the "all clear" when both of the following conditions exist:

1) There are no gas shows **or** all accumulated free gases inside the liner have vented.

2) Both portable and fixed air monitors indicate H_2S levels less than 10 ppm.

2.2.2 H_2S/LAB Test:

The H_2S/LAB test will determine the amount of H_2S in the core. This will be performed on the Interstitial Water sample (IW). The IW is taken immediately after accumulated free gases inside the liner have been vented. Pore waters are squeezed from the sediment and the concentration of H_2S is determined by standard laboratory methods.

This test will be performed on all cores during Leg 139, whether or not the Contingency Plan is in effect. The H_2S safety technician and shipboard geochemists will decide where and how many samples to take. If gas shows are not present, samples can be taken without special precautions. Otherwise, the precautions used for gas shows must be continued until accumulated free gases in the liner have vented, and both portable and fixed monitors indicate H_2S levels less than 10 ppm.

The H_2S/LAB test results are compared to two threshold levels for H_2S in the interstitial waters. These levels are designated as the Lab Threshold (LT) and Storage Threshold (ST). The determination of the LT and ST values are discussed in section 4.0.

Cores that have H_2S levels above the LT:

1) <u>Cannot</u> be taken inside the lab spaces.

2) Are to have H_2S warning stickers affixed to liners.

3) Must be degassed until their H_2S levels are below the LT.

4) Must be repeat tested until H_2S levels are below the LT.

Most core degassing can be accomplished by perforating the core liner. Cores with very high levels of H_2S can be split in half to expose more surface area. A portable core splitter will be provided to split cores outside the core lab.

Cores that have H_2S levels above the ST and below the LT:

1) Are to have H_2S warning stickers affixed to liners.

Cores with H_2S levels below the ST can be processed and stored as usual.

2.3 Inside the Core Lab

There are no specific H_2S tests performed inside the core lab. Harmful cores are identified by the H_2S/LAB test and prevented from entering the lab. Personnel should remain alert, however, to the possible buildup of H_2S inside the core lab. It is important that the following tasks/precautions be performed:

1) Monitor H_2S levels near the Core Entry's core rack.

2) Monitor H_2S levels in the Core Splitting room whenever a core is split (especially those cores marked with H_2S warning stickers).

3) Make sure that cores with H_2S levels above the ST have H_2S warning stickers affixed to both archive and working half liners, D-tubes and core boxes.

4) Do not split a new core until the previous core is stored in its D-tube. All cores are to be sealed in the tri-laminated foil before being stored in the D-tubes. Cores will be sealed as quickly as possible to reduce H_2S fumes inside the lab spaces.

5) Ensure that bench top H_2S scrubbers are functioning properly.

6) Ensure that the lab stack's air conditioning and exhaust systems are balanced and functioning properly

7) In the event that the lab levels of H_2S detected at any sensor exceed 10 ppm: All personnel are to be evacuated and the H_2S safety technicians will remove all unsealed cores from the core lab. The fans will be used to vent the lab and personnel will not reenter the lab until H_2S levels are below 10 ppm.

2.4 Storage

As previously mentioned, cores with H_2S levels above the ST are stored outside the lab stack. Cores with H_2S levels below the ST can be stored in the ship's core storage area as long as these are sealed in the tri-laminated foil before being put in the D-tubes. Although an H_2S scrubber system will be installed inside the ship's core storage space and in the "outside" storage area, personnel entering these spaces should be cautious and must always:

1) Check the air monitor for hazardous H_2S levels.

2) Work with a partner. **Never enter alone!**

3) Carry a portable air monitor on his/her person while inside the storage area.

3.0 CORE LAB H_2S SAFETY TECHNICIAN JOB DESCRIPTION

The core lab H_2S safety technician is a member of the H_2S Safety squad (see the *H_2S Contingency Plan* for additional information). During an H_2S Watch condition, he/she must be present on the core receiving platform as each core is recovered and will be responsible for the following tasks:

1) Enforcing H_2S safety policy on the core receiving platform and in the core lab.

2) Ensuring that all H_2S testing is completed and conducted in a safe manner.

3) Recording the results of all tests for each core.

4) Ensuring that cores with H_2S levels above the ST have H_2S warning stickers affixed to their liners, D-tubes and core boxes, for both archive and working halves.

5) Ensuring that personnel handling hazardous cores are using their personal protective breathing apparatus correctly.

6) Ensuring that safety equipment is in good condition and functioning properly.

7) Ensuring that monitoring equipment is calibrated and functioning properly.

8) Being responsible for notifying the UDI/ODP Drilling Superintendents when H_2S alarm conditions exist or when H_2S levels measured by the H_2S/LAB test are above the LT.

9) Testing the pH of each core for acidic fluids. If acidic fluids are found, ensure that core handling personnel are wearing protective clothing.

10) Posting warning signs and limiting access to hazardous areas.

4.0 DETERMINATION OF THE LAB & STORAGE THRESHOLD VALUES

4.1 Definitions (also see 2.2.2):

LAB THRESHOLD: The Lab Threshold (LT) is defined as the concentration of H_2S for a given amount of split core (both archive and working halves) that will produce a concentration of 10 ppm of H_2S in the air volume of the Core Splitting room after one hour of exposure.

STORAGE THRESHOLD: The Storage Threshold (ST) is defined as the LT for 950 cm of core recovery. (With 100% recovery, 950 cm is the length of core recovered in one core barrel.)

4.2 Equations:

Equation 1 is used to calculate the amount of H_2S produced by molecular diffusion for a given concentration, core surface area and time.

(1) $\mathbf{J}(\mu g/cm^2\ sec) * \mathbf{A}(cm^2) * \mathbf{T}(sec) = \mathbf{M}(\mu g)$

where: **J** is the mass flux per unit area with time

A is the area of the split core's surface

T is time of exposure

M is the mass of H_2S

The concentration of H_2S in the air volume is given by:

(2) $\mathbf{C_L}(\mu g/g) = \mathbf{M}(\mu g)/[\mathbf{V}(cm^3) * \mathbf{P_{air}}(g/cm^3)\ ]$

or

$\mathbf{M}\ (\mu g) = \mathbf{C_L}(\mu g/g) * \mathbf{P_{air}}(g/cm^3) * \mathbf{V}(cm^3)$

where: $\mathbf{C_L}$ is the concentration of H_2S in the lab air space

P_{air} is the density of air

M is the mass of H_2S

V is the volume of air

Combine equations 1 and 2:

$$J(\mu g/cm^2\ sec) * A(cm^2) * T(sec) = C_L(\mu g/g) * P_{air}(g/cm^3) * V(cm^3)$$

Expand the mass flux term **J**:

The value J is determined by Fick's first law (Crank, 1975):

$$J = D\ \partial C_C/\partial X$$

where: **D** is the diffusion constant

C_C is the concentration of H_2S in the core. This value is determined by the H_2S/LAB test. Because the concentration of H_2S in the air is assumed zero, then $\partial C_C = C_C$

X is the diffusion path. We'll assume that all gases released from the core are homogeneously mixed in the lab air space. Therefore the term $\partial X = X$

Substitute for the **J** term:

(3) $[D(cm^2/sec) * C_C(\mu g/cm^3) / X(cm)] * A(cm^2) * T(sec) = C_L(\mu g/g) * P_{air}(g/cm^{3)} * V(cm^3)$

4.3 Determination of the LT and ST values:

To determine the LT and ST limits we must solve for C_C. This is done by rearranging equation 3 as follows:

(4) $C_C(\mu g/g) = [C_L(\mu g/g) * P_{air}(g/cm^{3)} * V(cm^3) * X(cm)] / [D(cm^2/sec)\ A(cm^2) * T(sec)]$

Before solving equation 4, values for the above terms must be defined:

C_L: 10 $\mu g/cm^3$ the maximum level of H_2S allowed in the Core Splitting room by definition.

P_{air}: density of air 1.204 $x10^{-3}$ g/cm^3

V: volume of the air space above Core Splitting table: 250 cm x 100 cm x 100 cm = 2.5×10^6 cm^3

X: diffusion path from the center of the split core to its surface = 1.6 cm

D: diffusion constant = 10×10^{-6} cm^2/sec. H_2S in solution will be mainly in the species HS- which has an activity coefficient similar to the Cl- ion. The diffusion constant for Cl- in a typical fine grained marine sediments ranges from 10 to 20 * 10^{-6} cm^2/sec. The effects of tortuosity, temperature, chemical reaction and inter-ion effects are not considered.

A: area of the split core's surface for both archive and working halves = **R**(cm) * 6.6 cm , where **R** is the core recovery. Because there are two halves this value is multiplied by **2**. Also because the surface is rough, term **A** must be multiplied by a roughness factor of 5 (estimate).

T: 1 hour of exposure = 3.6×10^3 sec (average time to process a core after splitting)

Substitute the values for equation 4:

(4) $C_c(\mu g/cm^3)$ = [**10** $\mu g/g$ * **1.204 x** 10^{-3} g/cm^3 * **2.5 x** 10^6 cm^3 * **1.6** cm] / [**1.0 x** 10^{-5} cm^2/sec * [**R** (cm) * **6.6** cm * **2 * 5**] * **3.6 x** 10^3 sec]

Simplify the equation to produce the formula for the Lab threshold value as a function of core recovery. This function is graphed below.

(5) For LT: $C_c(\mu g/cm3)$ = **2 x** 10^4 $(\mu g/cm2)$/ **R** (cm)

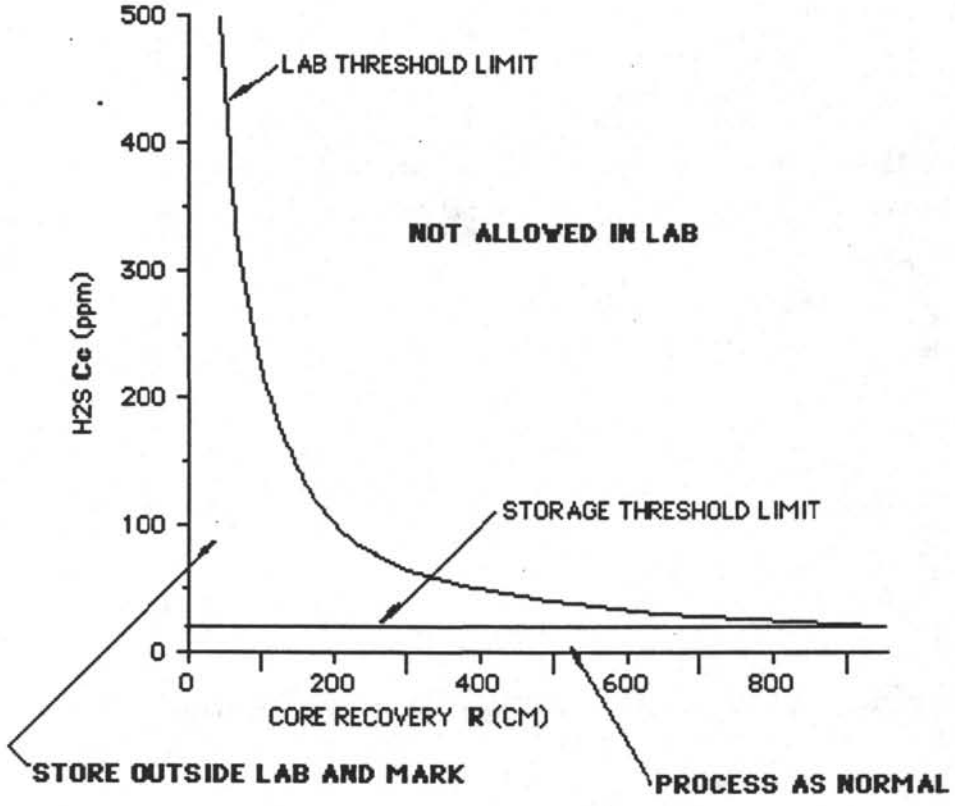
To determine the ST value set **R** to 950 cm and solve equation 5.

(5) $C_c(\mu g/cm3)$ = **2 x** 10^4 $(\mu g/cm2)$/ **950** (cm)= 21.3 or **20 ppm** in the interstitial waters

4.4 Threshold Graph:

By plotting the ppm of H_2S vs. core recovery on the following graph, the H_2S hazard potential for each core can be determined.

Note: This graph is based on the assumption roughness factor of 5; diffusion constant of 10; exposure of 1 hour, and an LT of 10 ppm. This graph is for illustration purposes only!



4.6 A Word of Caution:

As you have probably noticed, the values used in the above equations for the diffusion constant, roughness factor, etc., are "guesstimates". As we gain experience handling H_2S cores we may need to revise these estimates. Because of our lack of experience of handling H_2S cores it is important that the core lab safety procedures outlined in section 2.3 be followed to maintain a safe working environment inside the core lab.

5.0 SAFE AREA

The "safe area" is an exterior location on the ship where cores can degas without creating a downwind hazard for other personnel. Because weather will influence the location of this area, its selection will be made by the ship's personnel and approved by the UDI/ODP Drilling Superintendents. Any changes in ship's heading during an H_2S Watch must be approved by the ODP/UDI Drilling Superintendents. Also, any changes in the wind direction must be reported to the ODP/UDI Drilling Superintendents, and corrective action taken immediately.

APPENDIX III

TOXICITY OF VARIOUS GASES

Common Name	Chemical Formula	Gravity (Air=1)	Threshold[1] Limit	Specific Hazardous[2] Limit	Lethal[3] Concentration
Hydrogen Cyanide	HCN	0.94	10 ppm	150 ppm/1 hr	300 ppm
Hydrogen Sulfide	H_2S	1.18	10 ppm	250 ppm/1 hr	600 ppm
Sulfur Dioxide	SO_2	2.21	2 ppm	---	1000 ppm
Chlorine	CL_2	2.45	1 ppm	4 ppm/1 hr	1000 ppm
Carbon Monoxide	CO	0.97	50 ppm	400 ppm/1 hr	1000 ppm
Carbon Dioxide	CO_2	1.52	5000 ppm	5%	10%
Methane	CH_4	0.55	90000 ppm	Combustible Above 5% in air	---

[1]Threshold - concentration at which it is believed that all workers may repeatedly be exposed, day after day, without adverse effect.

[2]Hazardous - concentration that may cause death.

[3]Lethal - concentration that will cause death with short-term exposure.

PROPERTIES OF GASES

The produced gas will probably be a mixture of carbon dioxide, hydrogen sulfide, and methane.

A. Carbon Dioxide

1. Carbon dioxide (CO_2) is usually considered inert and is commonly used to extinguish fires. It is heavier than air (1.5 times), and CO_2 will concentrate in low areas of quiet air. Air containing 5% CO_2 will cause disorientation in a few minutes. Continued exposure to CO_2 after being affected will cause convulsions, coma, and respiratory failure.
2. The threshold limit of CO_2 is 5,000 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.

B. Hydrogen Sulfide

1. Hydrogen sulfide itself is a colorless, transparent gas and is flammable. It is heavier than air and hence, may accumulate in low places.

2. Although the slightest presence of H_2S in the air is normally detectable by its characteristic "rotten egg" odor, it is dangerous to rely on the odor as a means of detecting excessive concentrations because the sense of smell is rapidly lost, allowing lethal concentrations to accumulate without warning. The following table indicates the poisonous nature of Hydrogen Sulfide, which is more toxic than Carbon Monoxide.

CONCENTRATION			EFFECTS
$\%H_2S$	PPM	(GR/100)SCF	
0.001	10	0.65	Obvious and unpleasant odor. Safe for 8 hours.
0.002	20	1.30	Safe for 4 hours exposure.
0.01	100	6.48	Kills smell in 3 to 15 minutes; may sting eyes and throat.
0.02	200	12.96	Kills smell shortly; stings eyes and throat.
0.05	500	32.96	Dizziness; breathing ceases in a few minutes; needs prompt artificial respiration.
0.07	700	45.36	Unconscious quickly; death will result if not rescued promptly.
0.1	1000	64.80	Unconscious at once; followed by death within minutes.

C. Sulfur Dioxide

1. Sulfur dioxide is a colorless, transparent gas and is nonflammable.

2. Sulfur dioxide (SO_2) is produced during the burning of H_2S. Although SO_2 is heavier than air, it will be picked up by a breeze and be carried downwind at elevated temperatures. While sulfur dioxide is extremely irritating to the eyes and mucous membranes of the upper respiratory tract, it has exceptionally good warning powers in this respect. The following table indicates the toxic nature of the gas.

CONCENTRATION		EFFECTS
%SO2	PPM	
.0002	2	Safe for 8 hours.
.0005	3 to 5	Pungent odor - normally a person can detect SO_2 in this range.
.0012	12	Throat irritation, coughing, constriction of the chest, tearing and smarting or burning of eyes.
.015	150	So irritating that it can only be endured for a few minutes.
.05	500	Causes a sense of suffocation, even with first breath.

APPENDIX IV

MUD CHEMICALS PROCEDURES FOR H_2S CONTAMINATION

The option of treating the circulating fluid with chemicals has been considered at some length. Because Sedco-BP 471 is not equipped with a recirculating mud system, any treatment chemical would be circulated through the hole quickly and lost. Thus no chemical change in the borehole fluid could be sustained during drilling/coring operations while circulation is maintained. Continuous treatment of the seawater drilling fluid is not considered to be either necessary or practical. Under certain circumstances (stuck pipe, unusual logging/sampling operations, etc.) where there is an influx of H_2S-bearing fluid and the drill string must remain in the hole without circulation, there will be a provision for filling the hole with fluid containing chemical scavengers. Depending upon the situation, the fluid will be fresh-water-based bentonite mud, seawater-based sepiolite mud, or seawater. The fluid will be mixed with a concentration of 5 lb/bbl of ironite sponge and 5 lb/bbl hydrated lime for scavenging H_2S and CO_2, respectively.

APPENDIX V

EMERGENCY TELEPHONE CONTACT NUMBERS

- The following personnel should be notified in the event of an H_2S Emergency Condition II or III, **or** in the event of uncontrollable backflow or steamflash:

R. M. Grout	ODP	Office:	(409) 845-2144
		Home:	(409) 693-6410
or			
M. A. Storms	ODP	Office:	(409) 845-2101
		Home:	(409) 696-8035
C. V. Greif	UDI	Office:	(409) 696-7955
		Home:	(409) 776-5840
or			
R. P. Nabholz	UDI	Office:	(409) 696-7955
		Home:	(409) 774-4558

- The following regulatory agencies must be notified as soon as possible in the event of a H_2S Emergency Condition, **or** in the event of uncontrollable backflow or steamflash:

I. Emergency Condition II or III (Greater than 10 ppm)

National Energy Board	Office:	(613) 991-2017
F. Lepine	Home:	(613) 224-8302
	Fax:	(613) 993-9897
or		
G. Yungblut	Office:	(613) 993-3760
	Home:	(613) 722-9286
or		
P. Ragusa	Office:	(613) 991-2021
	Home:	(613) 830-9350

II. Emergency Condition III (Greater than 50 ppm)

Canadian Coast Guard — Via Radio: 2182 KHz
Victoria, B.C. - Search & Rescue — VH F16

Telephone: (604) 363-2333
(800) 742-1313

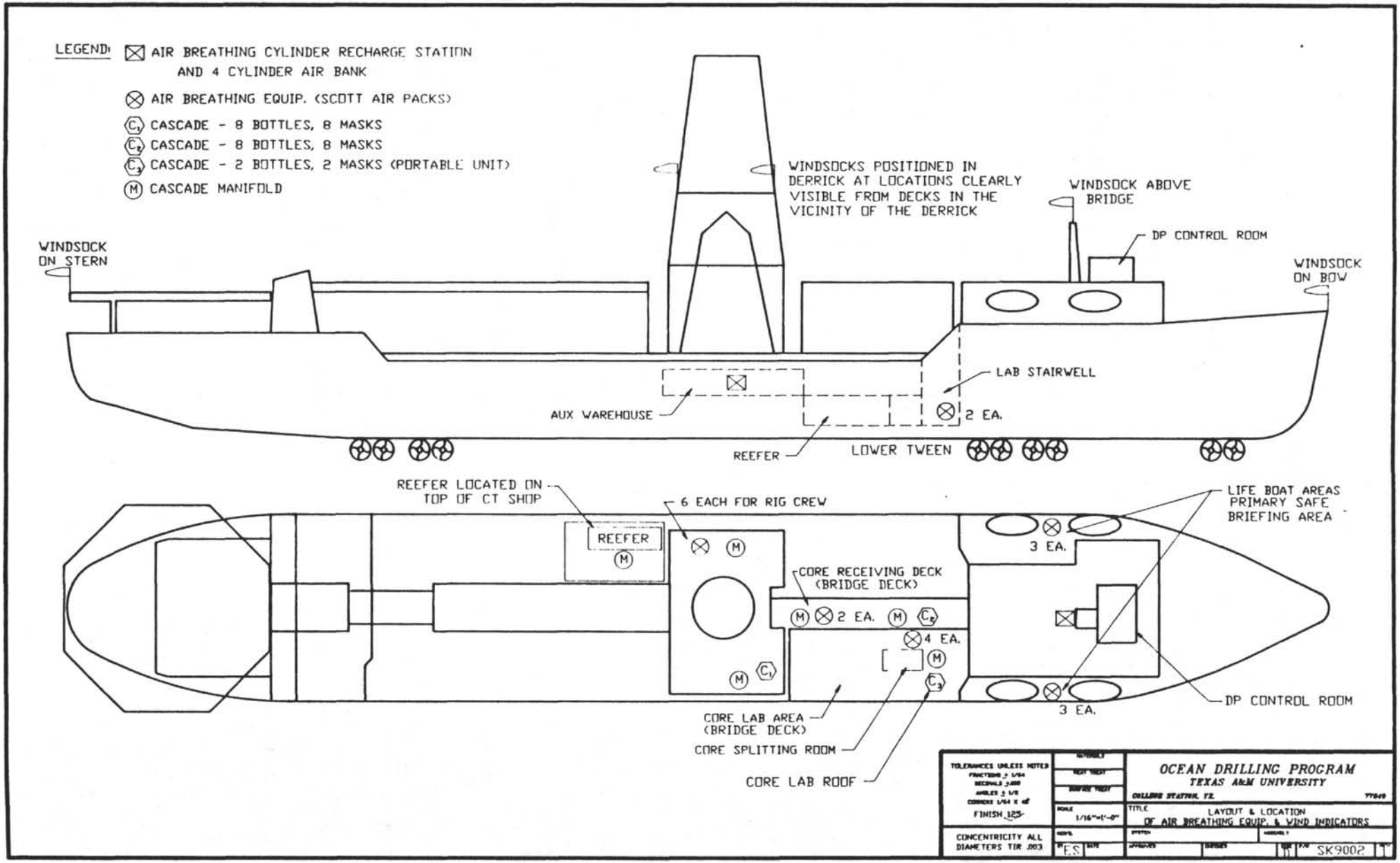
- The following hospital is the primary treatment center for any injuries:

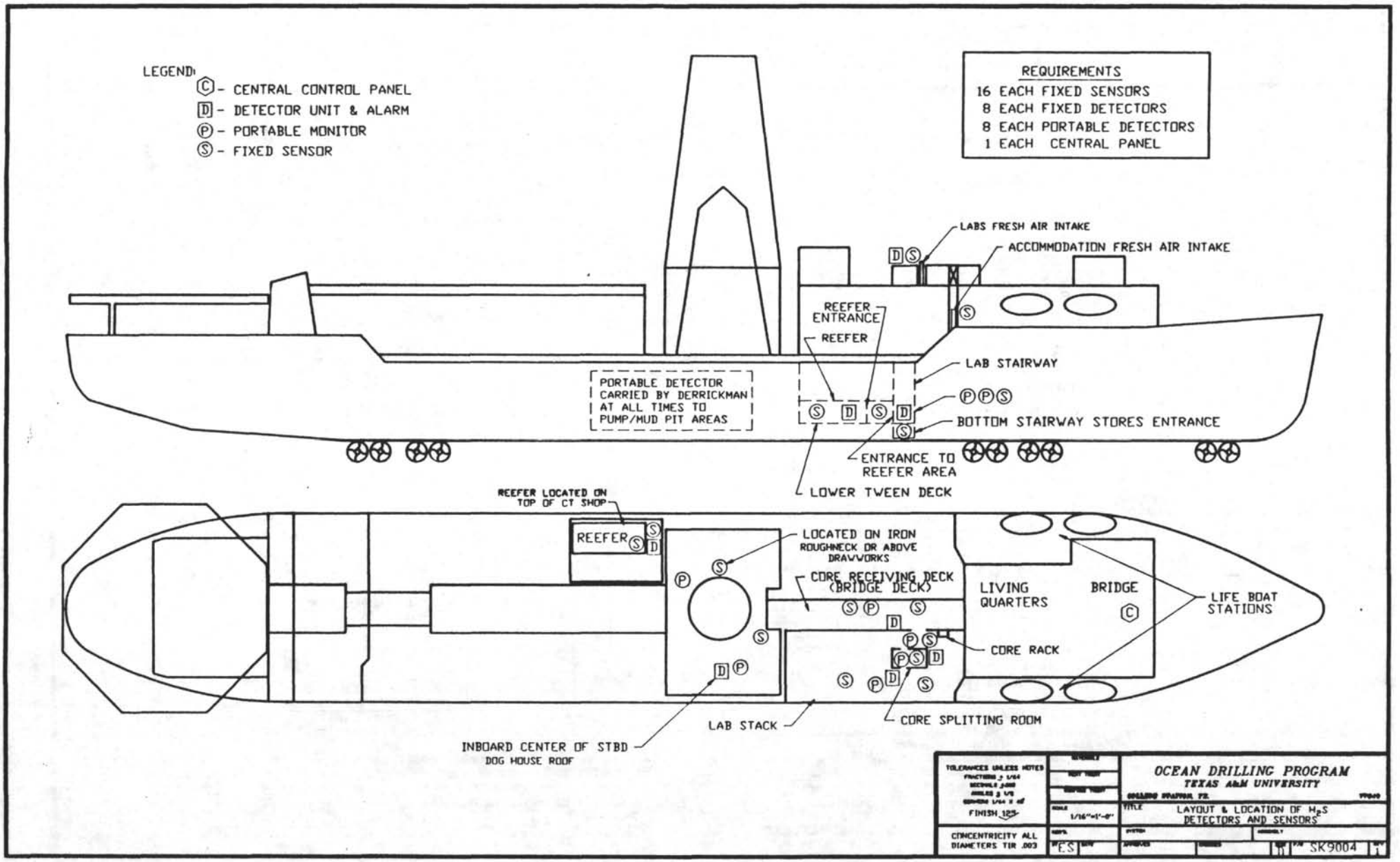
Victoria General Hospital
Victoria, B.C.
Telephone: (604) 727-4181
24 hrs/day

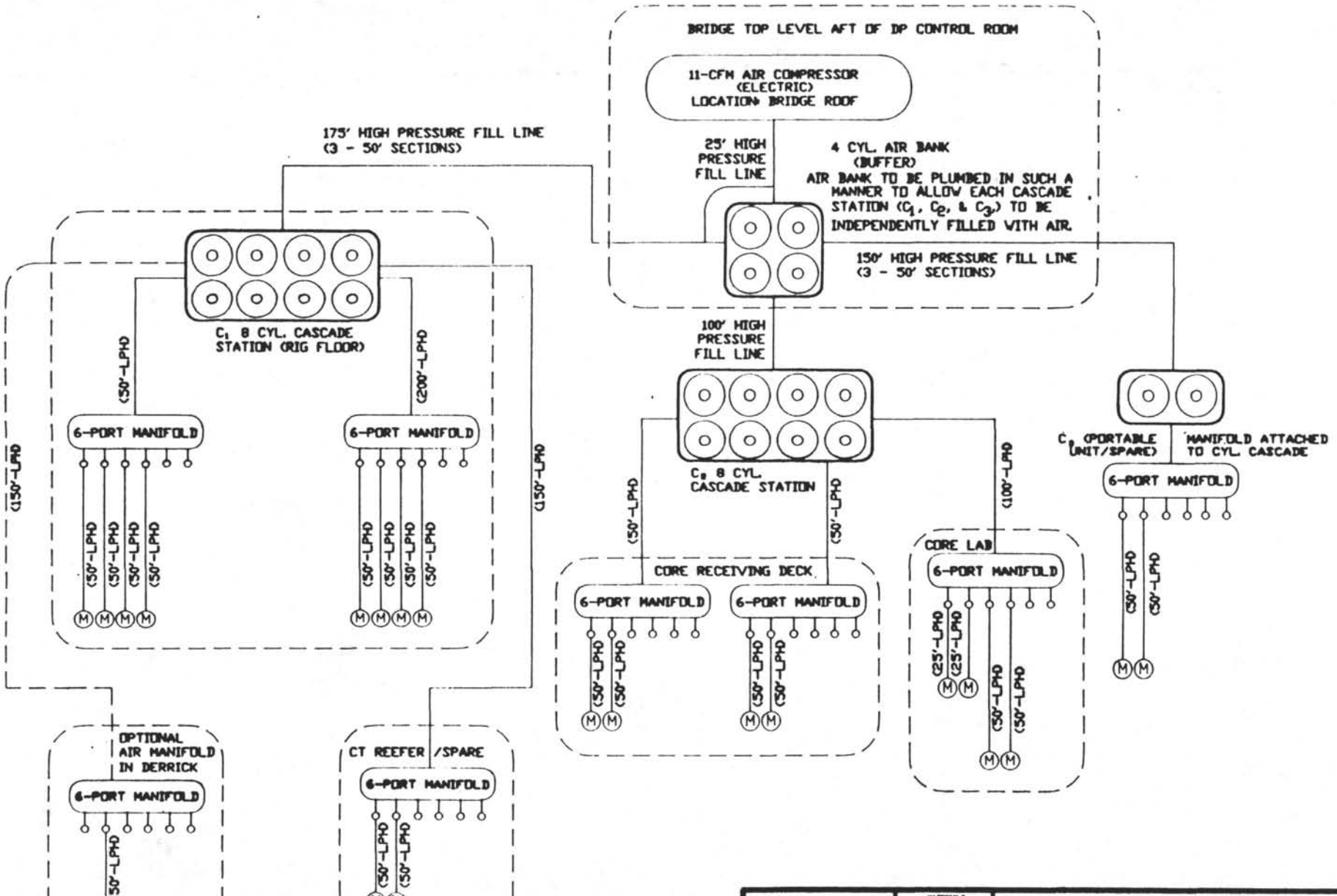
- The following helicopter service will be used for Medevac/emergency transport:

Pacific Rim Helicopter
Vancouver International Airport
ATTN: G. Kearney
Telephone: (604) 276-0015
24 hrs/day

APPENDIX VI


LEGEND:
AIR BREATHING CYLINDER RECHARGE STATION AND 4 CYLINDER AIR BANK
AIR BREATHING EQUIP. (SCOTT AIR PACKS)
C1 CASCADE - 8 BOTTLES, 8 MASKS
C2 CASCADE - 8 BOTTLES, 8 MASKS
C3 CASCADE - 2 BOTTLES, 2 MASKS (PORTABLE UNIT)
M CASCADE MANIFOLD
WINDSOCKS POSITIONED IN DERRICK AT LOCATIONS CLEARLY VISIBLE FROM DECKS IN THE VICINITY OF THE DERRICK
WINDSOCK ABOVE BRIDGE
DP CONTROL ROOM
WINDSOCK ON STERN
WINDSOCK ON BOW
LAB STAIRWELL
AUX WAREHOUSE
2 EA.
REEFER
LOWER TWEEN
REEFER LOCATED ON TOP OF CT SHOP
6 EACH FOR RIG CREW
LIFE BOAT AREAS PRIMARY SAFE BRIEFING AREA
REEFER
CORE RECEIVING DECK (BRIDGE DECK)
2 EA.
4 EA.
3 EA.
3 EA.
DP CONTROL ROOM
CORE LAB AREA (BRIDGE DECK)
CORE SPLITTING ROOM
CORE LAB ROOF
TOLERANCES UNLESS NOTED
FINISH 125
CONCENTRICITY ALL DIAMETERS TIR .003
OCEAN DRILLING PROGRAM
TEXAS A&M UNIVERSITY
COLLEGE STATION, TX. 77843
1/16"=1'-0"
TITLE
LAYOUT & LOCATION OF AIR BREATHING EQUIP. & WIND INDICATORS
SK9002


LEGEND:
C - CENTRAL CONTROL PANEL
D - DETECTOR UNIT & ALARM
P - PORTABLE MONITOR
S - FIXED SENSOR
REQUIREMENTS
16 EACH FIXED SENSORS
8 EACH FIXED DETECTORS
8 EACH PORTABLE DETECTORS
1 EACH CENTRAL PANEL
LABS FRESH AIR INTAKE
ACCOMMODATION FRESH AIR INTAKE
REEFER ENTRANCE
REEFER
LAB STAIRWAY
PORTABLE DETECTOR CARRIED BY DERRICKMAN AT ALL TIMES TO PUMP/MUD PIT AREAS
BOTTOM STAIRWAY STORES ENTRANCE
ENTRANCE TO REEFER AREA
LOWER TWEEN DECK
REEFER LOCATED ON TOP OF CT SHOP
REEFER
LOCATED ON IRON ROUGHNECK DR ABOVE DRAWWORKS
CORE RECEIVING DECK (BRIDGE DECK)
LIVING QUARTERS
BRIDGE
LIFE BOAT STATIONS
CORE RACK
LAB STACK
CORE SPLITTING ROOM
INBOARD CENTER OF STBD DOG HOUSE ROOF
OCEAN DRILLING PROGRAM
TEXAS A&M UNIVERSITY
COLLEGE STATION, TX.
LAYOUT & LOCATION OF H2S DETECTORS AND SENSORS
SK9004



TOLERANCES UNLESS NOTED FRACTIONS ± 1/64 DECIMALS .XXX ANGLES ± 1/2° CORNERS 1/64 R 45° FINISH 125	MATERIALS HEAT TREAT SURFACE TREAT SCALE NONE	OCEAN DRILLING PROGRAM TEXAS A&M UNIVERSITY COLLEGE STATION, TX. 77843 TITLE LEG 139 CASCADE STATION SCHEMATIC
CONCENTRICITY ALL DIAMETERS TIR .003	REV'S DRAWN FS 4-19-91 CHECKED APPROVED	SYSTEM ASSEMBLY PGM P/N SK90510 REV 1

Breathing-air equipment

Conditions may develop which require air breathing masks/respirators to be worn by personnel working in the 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. This results in the respirator permitting negative air pressure inside the face piece during inhalation, and causing excessive penetration by an air contaminant.

Personnel wearing eyeglasses and contact lenses must take special precautions when wearing breathing equipment. The ear pieces on the eyeglasses will interfere with the seal on the face mask of both the self contained breathing apparatus and the cascade breathing system. Lens holders will be provided to mount eyeglasses inside the face masks with the ear pieces removed.

Injuries have been sustained by personnel wearing contact lenses using breathing-air equipment. The positive pressure in the face mask can push the lens up inside the cavity of the eye. The positive air pressure also dries the eye out behind the eye. Therefore, contact lenses should not be worn with the breathing equipment face masks. Instead, a pair of conventional glasses should be worn inside the face mask using the lens holder as described above.

PERSONNEL WORKING IN HAZARDOUS AREA(S)

Persons assigned tasks in the hazardous area(s) that require the use of breathing equipment during situations shall not have stubble, beards, sideburns, or moustaches.

SCIENTISTS WORKING IN THE LAB STACK

Those scientists that (1) have work activities confined to the inside of the lab and (2) are not assigned emergency duties may elect not to shave facial hair. 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 suitably seal because of interfering facial hair and I choose not to hold the Ocean Drilling Program responsible for any accidents, illness, or medical problems that might occur if it becomes necessary for me to use a breathing apparatus during an H_2S emergency.

Signature_____Date_____

Witness_____Date_____

(H_2S Technician)