

30-005-29145



## **H<sub>2</sub>S Contingency Plan**

### **Nereid 1 Federal 1H**

**Section 1, T-15S R-31E**

**Chaves County, New Mexico**

**May 2010**

EXHIBIT H

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## **I. H<sub>2</sub>S CONTINGENCY PLAN SECTION**

### **Scope**

This contingency plan establishes guidelines for all company employees and contract employees whose work activities may involve exposure to Hydrogen Sulfide gas (H<sub>2</sub>S).

### **Objective**

1. Prevent any and all accidents, and prevent the uncontrolled release of H<sub>2</sub>S into the atmosphere.
2. Provide proper evacuation procedures to cope with emergencies.
3. Provide immediate and adequate medical attention should an injury occur.

### **Discussion of Plan**

The Seven Rivers, Queen and Penrose formation are capable of producing H<sub>2</sub>S, but not probable in this area. However monitoring of H<sub>2</sub>S and readiness will be started at surface and continue to TD.

Implementation: This plan, with all details, is to be fully implemented before spudding the well.

Emergency Response Procedure: This section outlines the conditions and denotes steps to be taken in the event of an emergency.

Emergency Equipment and Procedure: This section outlines the safety and emergency equipment that will be required for the drilling of this well.

Training Provisions: This section outlines the training provisions that must be adhered to prior to drilling.

Emergency Call Lists: Included are the telephone numbers of all persons that would need to be contacted should an emergency exists.

Briefing: This section deals with the briefing of all people involved in the drilling operation.

Public Safety: Public Safety Personnel will be made aware of the drilling of this well.

CheckLists: Status Check Lists and Procedural Check Lists have been included to insure adherence to the plan.

General Information: A general information section has been included to supply support information.

## **II. EMERGENCY PROCEDURES SECTION**

### **Emergency Procedures**

- I. In the event of any evidence of H<sub>2</sub>S level above 10 ppm, take the following steps immediately:
  - A. Secure breathing apparatus.
  - B. Order non-essential personnel out of the danger zone.
  - C. Take steps to determine if the H<sub>2</sub>S level can be corrected or suppressed, and if so, proceed with normal operations.
- II. If uncontrollable conditions occur, proceed with the following:
  - A. Take steps to protect and/or remove any public downwind of the rig including partial evacuation or isolation. Notify necessary public safety personnel and the NMOCD of the situation.
  - B. Remove all personnel to the Safe Briefing Area.
  - C. Notify public safety personnel for help with maintaining roadblocks and implementing evacuation.
  - D. Determine and proceed with the best possible plan to regain control of the well. Maintain tight security and safety procedures.
- III. Responsibility
  - A. The Company Approved Supervisor shall be responsible for the total implementation of the plan.
  - B. The Company Approved Supervisor shall be in complete command during any emergency.
  - C. The Company Approved Supervisor shall designate a back up Supervisor in the event that he/she is not available.

## **Emergency Procedure Implementation**

### **I. Drilling or Tripping**

#### **A. All Personnel**

1. When alarm sounds, don escape unit and report to upwind Safe Briefing Area.
2. Check status of other personnel (buddy system).
3. Secure breathing apparatus.
4. Await orders from Supervisor.

#### **B. Drilling Foreman**

1. Report to the upwind Safe Briefing Area.
2. Don Breathing Apparatus and return to the point of release with the Tool Pusher or Driller (buddy system).
3. Determine the concentration of H<sub>2</sub>S.
4. Assess the situation and take appropriate control measures.

#### **C. Tool Pusher**

1. Report to the upwind Safe Briefing Area.
2. Don Breathing Apparatus and return to the point of release with the Drilling Foreman or Driller (buddy system).
3. Determine the concentration of H<sub>2</sub>S.
4. Assess the situation and take appropriate control measures.

#### **D. Driller**

1. Don escape unit.
2. Check monitor for point of release.
3. Report to the Safe Briefing Area.
4. Check the status of other personnel (in a rescue attempt, always use the buddy system).
5. Assign the least essential person to notify the Drilling Foreman and Tool Pusher, in the event of their absence.
6. Assume the responsibility of the Drilling Foreman and Tool Pusher until they arrive, in the event of their absence.

#### **E. Derrick Man**

1. Remain in the Safe Briefing Area until otherwise instructed by Supervisor.

#### **F. Mud Engineer**

1. Report to Safe Briefing Area.
2. When instructed, begin check of mud for pH level and H<sub>2</sub>S level.

#### **G. Safety Personnel**

1. Don appropriate breathing apparatus.

2. Check status of all personnel
3. Await instructions from Drilling Foreman or Tool Pusher.

II. Taking a Kick

- A. All personnel report to Safe Briefing Area.
- B. Follow standard BOP procedures.

III. Open Hole Logging

- A. All unnecessary personnel should leave the rig floor.
- B. Drilling Foreman and Safety personnel should monitor the conditions and make necessary safety equipment recommendations.

IV. Running Casing or Plugging

- A. Follow "Drilling or Tripping" procedures.
- B. Assure that all personnel have access to protective equipment.

### Simulated Blowout Control Drills

All drills will be initiated by activating alarm devices (air horn). One long blast, on air horn, for ACTUAL and SIMULATED Blowout Control Drills. This operation will be performed by the Drilling Foreman or Tool Pusher at least one time per week for each of the following conditions, with each crew:

- |         |                     |
|---------|---------------------|
| Drill 1 | Bottom Drilling     |
| Drill 2 | Tripping Drill Pipe |

In each of these drills, the initial reaction time to shutting in the well shall be timed as well as the total time for the crew to complete its entire pit drill assignment. The times must be recorded on the IADC Driller's Log as "Blowout Control Drill".

Drill No.: \_\_\_\_\_  
Reaction Time to Shut-In: \_\_\_\_\_ minutes, \_\_\_\_\_ seconds.  
Total Time to Complete Assignment: \_\_\_\_\_ minutes, \_\_\_\_\_ seconds.

#### I. Drill Overviews

##### A. Drill No. 1--Bottom Drilling

1. Sound the alarm immediately.
2. Stop the rotary and hoist kelly joint above the rotary table.
3. Stop the circulatory pump.
4. Close drill pipe rams.
5. Record casing and drill pipe shut-in pressures and pit volume increases.

##### B. Drill No. 2--Tripping Drill Pipe

1. Sound the alarm immediately.
2. Position the upper tool joint just above the rotary table and set slips.
3. Install a full opening valve or inside blowout preventor tool in order to close the drill pipe.
4. Close the drill pipe rams.
5. Record the shut-in annular pressure.

## II. Crew Assignments

### A. Drill No. 1--Bottom Drilling

1. Driller
  - a. Stop the rotary and hoist kelly joint above the rotary table.
  - b. Stop the circulatory pump.
  - c. Check flow.
  - d. If flowing, sound the alarm immediately.
  - e. Record the shut-in drill pipe pressure.
  - f. Record all data reported by the crew.
  - g. Determine the mud weight increase needed or other courses of action.
2. Derrickman
  - a. Open choke line valve at BOP.
  - b. Signal Floor Man #1 at accumulator that choke line is open.
  - c. Close choke and upstream valve after pipe tams have been closed.
  - d. Read the shut-in annular pressure and report readings to Driller.
3. Floor Man #1
  - a. Close the pipe tams after receiving the signal from the Derrickman.
  - b. Report to Driller for further instructions.
4. Floor Man #2
  - a. Notify the Tool Pusher and Operator Representative of the H<sub>2</sub>S alarms.
  - b. Check for open fires and, if safe to do so, extinguish them.
  - c. Stop all welding operations.
  - d. Turn-off all non-explosion proof lights and instruments.
  - e. Report to Driller for further instructions.
5. Tool Pusher
  - a. Report to the rig floor.
  - b. Have a meeting with all crews.
  - c. Compile and summarize all information.
  - d. Calculate the proper kill weight.
  - e. Ensure that proper well procedures are put into action.
6. Operator Representative
  - a. Notify the Drilling Superintendent.
  - b. Determine if an emergency exists and if so, activate the contingency plan.

B. Drill No.2--Tripping Pipe

1. Driller

- a. Sound the alarm immediately when mud volume increase has been detected.
- b. Position the upper tool joint just above the rotary table and set slips.
- c. Install a full opening valve or inside blowout preventor tool to close the drill pipe.
- d. Check flow.
- e. Record all data reported by the crew.
- f. Determine the course of action.

2. Derrickman

- a. Come down out of derrick.
- b. Notify Tool Pusher and Operator Representative
- c. Check for open fires and, if safe to do so, extinguish them.
- d. Stop all welding operations.
- e. Report to Driller for further instructions.

3. Floor Man #1

- a. Pick up full opening valve or inside blowout preventors and stab into tool joint above rotary table (with Floor Man #2).
- b. Tighten valve with back-up tongs.
- c. Close pipe rams after signal from Floor Man #2.
- d. Read accumulator pressure and check for possible high pressure fluid leaks in valves or piping.
- e. Report to Driller for further instructions.

4. Floor Man #2

- a. Pick-up full opening valve or inside blowout preventors and stab into tool joint above rotary table (with Floor Man #1).
- b. Position back-up tongs on drill pipe.
- c. Open choke line valve at BOP.
- d. Signal Floor Man #1 at accumulator that choke line is open.
- e. Close choke and upstream valve after pipe rams have been closed.
- f. Check for leaks on BOP stack and choke manifold.
- g. Read annular pressure.
- h. Report readings to the Driller.

5. Tool Pusher

- a. Report to rig floor.
- b. Have a meeting with all crews.
- c. Compile and summarize all information.
- d. Calculate proper kill weight.
- e. See that proper well kill procedures are put into action.

6. Operator Representative

- a. Notify Drilling Superintendent.
- b. Determine if an emergency exists, and if so, activate the contingency plans.

### **III. IGNITION PROCEDURES SECTION**

#### **Responsibility**

The decision to ignite the well is the responsibility of the DRILLING FOREMAN in concurrence with the STATE POLICE. In the event the Drilling Foreman is incapacitated, it becomes the responsibility of the RIG TOOL PUSHER. This decision should be made only as a last resort and in a situation where it is clear that:

1. Human life and property are endangered.
2. There is no hope of controlling the blowout under the prevailing conditions.

If time permits, notify the main office, but do not delay if human life is in danger. Initiate the first phase of the evacuation plan.

#### **Instructions for Igniting the Well**

1. Two people are required for the actual igniting operation. Both men must wear self-contained breathing apparatus and attach a safety rope. One man must monitor the atmosphere for explosive gases with the Explosimeter, while the Drilling Foreman is responsible for igniting the well.
2. The primary method to ignite is a 25mm flare gun with a range of approximately 500 feet.
3. Ignite from upwind and do not approach any closer than is warranted.
4. Select the ignition site best suited for protection and which offers an easy escape route.
5. Before igniting, check for the presence of combustible gases.
6. After igniting, continue emergency actions and procedures as before.
7. All unassigned personnel will limit their actions to those directed by the Drilling Foreman.

NOTE: After the well is ignited, burning Hydrogen Sulfide will convert to Sulfur Dioxide, which is also highly toxic. Do not assume the area is safe after the well is ignited.

#### **IV. TRAINING PROGRAM SECTION**

##### **Training Requirements**

When working in an area where Hydrogen Sulfide gas (H<sub>2</sub>S) might be encountered, definite training requirements must be carried out. The Company Supervisor will insure that all personnel, at the well site, have had adequate training in the following:

1. Hazards and characteristics of H<sub>2</sub>S.
2. Physical effects of Hydrogen Sulfide on the human body.
3. Toxicity of Hydrogen Sulfide and Sulfur Dioxide.
4. H<sub>2</sub>S detection.
5. Emergency rescue.
6. Resuscitators.
7. First aid and artificial resuscitation.
8. The effects of H<sub>2</sub>S on metals.
9. Location safety.

Service company personnel and visiting personnel must be notified if the zone contains H<sub>2</sub>S, and each service company must provide adequate training and equipment for their employees before they arrive at the well site.

## **V. EMERGENCY EQUIPMENT SECTION**

### **Emergency Equipment Requirements**

#### **I. Signs**

- A. Located at the location entrance with the following information:

(Lease)

CAUTION-POTENTIAL POISON GAS  
HYDROGEN SULFIDE  
NO ADMITTANCE WITHOUT AUTHORIZATION

#### **II. \* Fresh air breathing equipment**

- A. Air line units for all rig personnel on location.  
B. Cascade system with hose lines to rig floor and one to the derrick man and other operation areas. Spare cascade (trailer) on location

#### **III. Wind socks or wind streamers**

- A. Two 10" windsocks located at strategic locations at a height visible from the rig floor.  
B. Wind streamers (if preferred) to be placed at various locations on the well site to ensure wind consciousness at all times. (Corners of location).

#### **IV. Hydrogen Sulfide detector and alarms.**

- A. 1-four channel H<sub>2</sub>S monitor with alarms.  
B. 4 sensors located at floor, bell nipple, shale shaker, and pits  
\* C. Hand operated detectors with tubes.  
\* D. H<sub>2</sub>S monitor tester.

#### **V. Condition sign and flags**

- A. One each of green, yellow, and red condition flags to be displayed to denote conditions:  
GREEN--Normal Conditions  
YELLOW--Potential Danger  
RED--Danger, H<sub>2</sub>S Present  
B. The condition flag shall be posted at the location entrance.

#### **VI. \* Auxiliary rescue equipment**

- A. Stretcher  
B. Two 100' lengths of 5/8" nylon rope.

VII. \* Mud inspection devices

- A. Garrett Gas Train or Hach Tester for inspection of Hydrogen Sulfide concentration in the mud system.

VIII. Fire extinguishers

- A. Adequate fire extinguishers shall be located at strategic locations.

IX. Blowout prevention equipment

- A. The well shall have hydraulic BOP equipment for the anticipated BHP.
- B. Equipment must be tested upon installation.

X. \* Combustible gas detectors

- A. There shall be one combustible gas detector on location at all times.

XI. BOP testing

- A. BOP, Choke Line and Kill Line will be tested as specified by operator.

XII. Audio system

- A. Radio communication shall be available at the rig.
- B. Radio communication shall be available at the rig floor or trailer.
- C. Radio communication shall be available on vehicles.

XIII. Special control equipment

- A. Hydraulic BOP equipment with remote control on ground.
- B. Rotating head at surface casing point.

XIV. Evacuation Plan

- A. Evacuation routes should be established prior to spudding each well.
- B. Should be discussed with all rig personnel.

XV. Designated Areas

- A. Parking and visitor area.
  - 1. All vehicles are to be parked at a pre-determined safe distance from the wellhead.
  - 2. Designated smoking area.
- B. Safe Briefing Area
  - 1. Two Safe Briefing Areas shall be designated on either side of the location at the maximum allowable distance from the well bore so

they offset prevailing winds or they are at a 180 degree angle if wind directions tend to shift in the area.

2. Personal protective equipment should be stored in both protection centers or if a moveable trailer is used, it should be kept upwind of existing winds. When wind is from the prevailing direction, both protection centers should be accessible.

- \*Additional equipment will be available at Callaway Safety Midland, Texas.
- Additional personnel hydrogen sulfide monitors on location for all hands.
- Automatic flare igniter installed on rig

## VI. CHECK LIST SECTION

### Status Check List

Note: Date each item as they are implemented.

1. Sign at location entrance. \_\_\_\_\_
2. Two (2) wind socks (in required locations). \_\_\_\_\_
3. Wind streamers (if required). \_\_\_\_\_
4. 30 minute pressure demand air packs on location for all rig personnel and mud loggers. \_\_\_\_\_
5. Air packs, inspected and ready for use. \_\_\_\_\_
6. Spare bottles for each air pack (if required). \_\_\_\_\_
7. Cascade system and hose line hook up. \_\_\_\_\_
8. Cascade system for refilling air bottles. \_\_\_\_\_
9. Choke manifold hooked-up and tested.  
(Before drilling out surface casing.) \_\_\_\_\_
10. Remote Hydraulic BOP control (hooked-up and tested before drilling out surface casing.) \_\_\_\_\_
11. BOP Preventor tested (before drilling out surface casing.) \_\_\_\_\_
12. Mud engineer on location with equipment to test mud for Hydrogen Sulfide. \_\_\_\_\_
13. Safe Briefing Areas set-up. \_\_\_\_\_
14. Condition sign and flags on location and ready. \_\_\_\_\_
15. Hydrogen Sulfide detection system hooked-up. \_\_\_\_\_
16. Hydrogen Sulfide alarm system hooked-up. \_\_\_\_\_
17. Stretcher on location at Safe Briefing Area. \_\_\_\_\_
18. 1-100' length of 5/8" nylon rope on location. \_\_\_\_\_
19. 1-20 # or 30# ABC fire extinguisher in safety \_\_\_\_\_

trailer in addition to those on rig.

20. Combustible gas detector on location and tested.
21. All rig crews and supervisors trained (as required).
22. Access restricted for unauthorized personnel.
23. Drills on H<sub>2</sub>S and well control procedures.
24. All outside service contractors advised of potential Hydrogen Sulfide on the well.
25. NO SMOKING sign posted.
26. Hand operated H<sub>2</sub>S detector with tubes on location.
27. 25mm flare gun with flares.
28. Automatic Flare igniter installed on rig

### **Procedural Check List**

Perform the following on each tour:

1. Check fire extinguishers to see that they have the proper charge.
2. Check breathing equipment to insure that it has not been tampered with.
3. Check pressure on supply air bottles to see that they are capable of recharging.
4. Make sure all of the Hydrogen Sulfide detection systems are operative.

Perform the following each week:

1. Check each piece of breathing equipment to make sure that the demand regulator is working. This requires that the bottle be opened and the mask assembly be put on tight enough so that when you inhale, you get air.
2. Blowout preventor skills.
3. Check supply pressure on BOP accumulator stand-by source.
4. Check all work/escape units for operation: demand regulator, escape bottle air volumes, supply bottle of air volume.
5. Check breathing equipment mask assembly to see that straps are loosened and turned back, ready to put on.
6. Check pressure on breathing equipment air bottles to make sure they are charged to full volume.
7. Check breathing equipment air bottles to make sure all demand regulators are working. This requires that the bottles be opened and the mask assembly be put on tight enough so that when you inhale, you get air.
8. Confirm pressure on all supply air bottles.
9. Perform breathing equipment drills with on-site personnel.
10. Check the following supplies for availability:
  - a. Stretcher
  - b. Safety belts and ropes
  - c. Emergency telephone lists
  - d. Spare air bottles
  - e. Spare oxygen bottles (if resuscitator required)
  - f. Hand operated H<sub>2</sub>S detectors and tubes
11. Test the Explosimeter to verify batteries are good.

## **VII. BRIEFING PROCEDURES SECTION**

### **Briefing Procedures**

The following scheduled briefings will be held to ensure the effective drilling and operation of this project:

#### **Pre-Spud Meeting**

**Date:** Prior to spudding the well.

**Attendance:** Drilling Supervisor  
Drilling Engineer  
Drilling Foreman  
Rig Pushers  
Rig Driller  
Mud Engineer  
All Safety Personnel  
Service Companies

**Purpose:** Review and discuss the well program, step-by-step, to insure complete understanding of assignments and responsibilities.

## **VIII. EVACUATION PLAN SECTION**

### **General Plan**

The direct lines of action prepared by CALLAWAY SAFETY EQUIPMENT CO., INC. to protect the public from hazardous gas situations are as follows:

1. When the company approved supervisor (Drilling Foreman, Tool Pusher, Driller) determine Hydrogen Sulfide gas cannot be limited to the well location, and the public will be involved, he will activate the evacuation plan. Escape routes are noted on the Area Map.
2. Company safety personnel or designee will notify the appropriate local government agency that a hazardous condition exists and evacuation needs to be implemented.
3. Company approved safety personnel that have been trained in the use of Hydrogen Sulfide detection equipment and self-contained breathing equipment will be utilized.
4. Law enforcement personnel (State Police, Local Police Department, Fire Department, and the Sheriff's Department) will be called to aid in setting up and maintaining road blocks. Also, they will aid in evacuation of the public if necessary.

NOTE: Law enforcement personnel will not be asked to come into a contaminated area. Their assistance will be limited to uncontaminated areas. Constant radio contact will be maintained with them.

5. After the discharge of gas has been controlled, "Company" safety personnel will determine when the area is safe for re-entry.

**See Emergency Reaction Plan**

## Emergency Assistance Telephone List

### **PUBLIC SAFETY:** **911 or**

|                            |                |
|----------------------------|----------------|
| Chaves Co. Sheriff         | (575) 752-3211 |
| Fire Department (Maljamar) | (575) 676-4100 |
| Ambulatory Service (Hobbs) | (575) 397-9200 |

Prior to starting project – Verify 911

|                             |                |
|-----------------------------|----------------|
| Life Flight:                |                |
| Southwest Air-Med E Vac.    | (800) 242-6199 |
| Location Elev. 4367'        |                |
| Lat: 33.039533° N (NAD83)   |                |
| Long: 103.766288° W (NAD83) |                |
| New Mexico D.O.T.           | (505) 827-5100 |
| Bureau of Land Management   | (505) 393-3612 |
| New Mexico OCD              | (575) 748-1283 |

### **Chesapeake**

|                                          |                                              |
|------------------------------------------|----------------------------------------------|
| Hobbs Office                             | Office (575) 391-1462                        |
| Drilling Superintendent<br>Cecil Luttrul | Cell (432) 631-3414                          |
| Drilling Engineer<br>Chris Gray          | Office (405) 935-4346<br>Cell (405) 301-6515 |

### **Drilling Company      Patterso-Uti Drilling Co      432-561-9382 (office)**

|                                 |                   |
|---------------------------------|-------------------|
| Patterson Rig 62                |                   |
| Patterson Rig Trailer           | Cell 832-217-2569 |
| Richard Watson, Tool Pusher     | Cell 325-207-7866 |
| Mike Underation, Superintendent | Cell 575-631-5205 |
| Rig floor                       | Cell 432-894-2381 |

### **Safety Solutions**

|         |                       |
|---------|-----------------------|
| Midland | Office (432) 563-0400 |
|---------|-----------------------|

Affected Public Notification List  
(within a 24' radius of exposure at 100ppm)

Certain geologic zones will be encountered during drilling that may possibly contain hazardous quantities of H<sub>2</sub>S. The well is located in an area with no residents and/or public roadways. ROE calculations show that H<sub>2</sub>S will affect the immediate area (location). Therefore, the plan is to carefully monitor hazards associated with H<sub>2</sub>S as previously mentioned in this document.

Should these conditions change prior to starting the project; the residents within the affected radius will be notified via a hand delivered written notice describing the activities, potential hazards, conditions of evacuation, evacuation drill siren alarms, and other precautionary measures.

#### Evacuee Description:

Residents and/or

#### Notification Process:

A continuous siren audible to all residence will be activated, signaling evacuation of previously notified and informed residents.

#### Evacuation Plan:

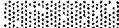
All evacuees will migrate lateral to the wind direction.

Chesapeake will identify all home bound or highly susceptible individuals and make special evacuation preparations, interfacing with the local fire and emergency medical service as necessary.

**X. GENERAL INFORMATION SECTION**

**Chesapeake Operating Inc.  
H2S  
Radius of Exposure Calculations  
Expected H2S ROE that could be encountered while drilling.**

Example: 100 PPM ROE =  $0.001589 \times 250 \text{ PPM} \times 275 \text{ MCF}^{0.6258}$  =  
Example: 500 PPM ROE =  $0.0004546 \times 250 \text{ PPM} \times 275 \text{ MCF}^{0.6258}$  =

 Denotes input data

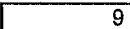
Enter H2S Concentration:  25 PPM

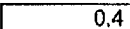
Enter Max. Escape Volume:  5,000 MCF/D

\*\*\*\*\*

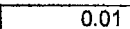
100 PPM Radius of Exposure:  24 Feet

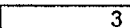
500 PPM Radius of Exposure:  11 Feet

H2S in lbs/day:  9 lb./day

H2S in lbs/hr:  0.4 lb./hr

SO2 in lbs/hr:  0.7 lb./hr

SO2 in 2000-lb tons/day:  0.01 tons/day

SO2 in 2000-lb tons/yr:  3 tons/yr

These radius of exposures are possible only if the well bore is evacuated of fluid and there is an uncontrolled release of gas at the surface!!!!!!

Calculations generated from production test of offset wells.

### Toxic Effects of Hydrogen Sulfide Poisoning

Hydrogen Sulfide is extremely toxic. The acceptable ceiling concentration for eight-hour exposure is 20 ppm, which is .002% by volume. Hydrogen Sulfide is heavier than air (specific gravity-1.192) and colorless. It forms an explosive mixture with air between 4.3 and 46.0 percent by volume. Hydrogen Sulfide is almost as toxic as Hydrogen Cyanide and is between five and six times more toxic than Carbon Monoxide. Toxicity data for Hydrogen Sulfide and various other gases are compared below in Table I. Physical effects at various Hydrogen Sulfide levels are shown in Table II.

Table I  
Toxicity of Various Gases

| Common Name      | Chemical Formula | Specific Gravity | Threshold Limit (A)      | Hazardous Limit (B) | Lethal Concentration (C)    |
|------------------|------------------|------------------|--------------------------|---------------------|-----------------------------|
| Hydrogen Cyanide | HCN              | 0.94             | 10 ppm                   | 150 ppm/hr          | 300 ppm                     |
| Hydrogen Sulfide | H <sub>2</sub> S | 1.18             | 10 ppm (D)<br>20 ppm (E) | 250 ppm/hr          | 600 ppm                     |
| Sulfur Dioxide   | SO <sub>2</sub>  | 2.21             | 5 ppm                    |                     | 1000 ppm                    |
| Chlorine         | CL <sub>2</sub>  | 2.45             | 1 ppm                    | 4 ppm/hr            | 1000 ppm                    |
| Carbon Monoxide  | CO               | 0.97             | 50 ppm                   | 400 ppm/hr          | 1000 ppm                    |
| Carbon Dioxide   | CO <sub>2</sub>  | 1.52             | 5000 ppm                 | 5%                  | 10%                         |
| Methane          | CH <sub>4</sub>  | 0.55             | 90,000 ppm               | (9%)                | Combustible above 5% in air |

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- A. Threshold Limit--Concentration at which it is believed that all workers may be repeatedly exposed day after day without adverse effects.
  - B. Hazardous Limit--Concentration that may cause death.
  - C. Lethal Concentration--Concentration that will cause death with short-term exposure.
  - D. Threshold Limit--10 ppm, 1972 ACGIH (American Conference of Governmental industrial Hygienists)
  - E. Threshold Limit--20 ppm, 1966 ANSI acceptable ceiling concentration for eight-hour exposure (based on 40-hour week) is 20 ppm. OSHA Rules and Regulations (Federal Register, Volume 37, No. 202, Part II, dated 10/18/72).

Table II

Physical Effects of Hydrogen Sulfide

| Percent % | ppm  | Physical Effects                                          |
|-----------|------|-----------------------------------------------------------|
| 0.001     | 10   | Obvious and unpleasant odor.                              |
| 0.002     | 20   | Safe for 8 hrs. exposure                                  |
| 0.01      | 100  | Kills smell in 3 to 5 minutes; may sting eyes and throat. |
| 0.02      | 200  | Kills smell shortly; stings eyes and throat.              |
| 0.03      | 300  | IDLH (Immediately Dangerous to Life & Health) Level       |
| 0.05      | 500  | Dizziness; breathing ceases in a few minutes              |
| 0.07      | 700  | Unconscious quickly; death will result if not rescued.    |
| 0.10      | 1000 | Unconscious at once; followed by death within minutes.    |

\*Caution: Hydrogen Sulfide is a colorless and transparent gas and is highly flammable. It is heavier than air and may accumulate in low places.

### **Use of Self-Contained Breathing Apparatus**

- I. Written procedures shall be prepared covering safe use of respirators in dangerous atmospheric situations which might be encountered in normal operations or in emergencies. Personnel shall be familiar with these procedures and the available respirators.
- II. Respirators shall be inspected frequently, at random, to insure that they are properly used, cleaned, and maintained.
- III. Anyone who may use respirators shall be trained in how to properly seal the face piece. They shall wear respirators in normal air and then in a test atmosphere. (Note: Such items as facial hair (beard or sideburns) and eyeglass temple pieces will not allow a proper seal.) Anyone that may be expected to wear respirators should have these items removed before entering a toxic atmosphere. A special mask must be obtained for anyone who must wear eyeglasses. Contact lenses should not be allowed.
- IV. Maintenance and care of respirators
  - A. A program of maintenance and care of respirators shall include the following:
    1. Inspection for defects, including leak checks.
    2. Cleaning and disinfecting.
    3. Repair.
    4. Storage.
  - B. Inspection: Self-Contained Breathing Apparatus for emergency use shall be inspected monthly, and records maintained, for the following:
    1. Fully charged cylinders.
    2. Regulator and warning device operation.
    3. Condition of face piece and connection.
    4. Elastomer or rubber parts shall be stretched or massaged to keep them pliable and prevent deterioration.
  - C. Routinely used respirators shall be collected, cleaned, and disinfected as frequently as necessary to insure proper protection is provided.
- V. Persons assigned tasks that require the use of Self-Contained Breathing Equipment shall be certified physically fit for breathing equipment usage by the local company physician at least annually.
- VI. Respirators should be worn during the following conditions:
  - A. Any employee who works near the top or on the top of any tank unless tests reveal less than 20 ppm of H<sub>2</sub>S.
  - B. When breaking out any line where H<sub>2</sub>S can reasonably be expected.
  - C. When sampling air in areas to determine if toxic concentrations of H<sub>2</sub>S exist.
  - D. When working in areas where over 20 ppm H<sub>2</sub>S has been detected.
  - E. At any time where there is a doubt as to the H<sub>2</sub>S level in the area to be entered.

## **Rescue-First Aid for Hydrogen Sulfide Poisoning**

**Do Not Panic!!!**

**Remain Calm--THINK**

1. Hold your breath (Do not inhale; stop breathing.) and go to Briefing area.
2. Put on breathing apparatus.
3. Remove victim(s) to fresh air as quickly as possible. (Go upwind from the source or at right angles to the wind; NOT downwind.)
4. Briefly apply chest pressure--arm lift method of artificial respiration to clear the victim's lungs and to avoid inhaling any toxic gas directly from the victim's lungs
5. Provide for prompt transportation to the hospital, and continue giving artificial respiration if needed.
6. Hospital(s) or medical facilities need to be informed, beforehand, of the possibility of H<sub>2</sub>S gas poisoning, no matter how remote the possibility.
7. Notify emergency room personnel that the victim(s) have been exposed to H<sub>2</sub>S gas.

Besides basic first aid, everyone on location should have a good working knowledge of artificial respiration, as well as first aid for eyes and skin contact with liquid H<sub>2</sub>S. Everyone needs to master these necessary skills.