H2S Contingency Plan

For

Bill Barrett Corporation

Koskie 16H-28-38-16

1,034’ FSL – 205’ FEL
SESE, Section 28
Township 38N, Range 16W

Elevation 7,914’

Montezuma County, CO

Bill Barrett Corporation
1099 18th Street Suite 2300
Denver Co 80202

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Introduction

It is the policy of Bill Barrett Corporation to provide a safe and healthful work environment for all of its employees as well as contractors that may work on any Bill Barrett Corporation leases. Bill Barrett Corporation makes a continued effort to comply with laws and regulations relative to worker safety and health, and to manage all operations in a manner to reduce risk.

The following is a H2S contingency plan for the Bill Barrett Corporation Koskie 16H-28-38-16 well. It is designed for personnel working on this project to follow in case of an accidental release of hydrogen sulfide during completion operations. For the plan to be effective, all personnel must review and be familiar with onsite duties as well as the safety equipment involved.

The purpose of this plan is to act as a guideline for personnel working on the wellsite in the event of a sudden release of hydrogen sulfide. All personnel working on the wellsite as well as service personnel that may travel to location on an unscheduled basis must be familiar with this program. The cooperation and participation of all personnel involved with the operation is necessary for this plan to be effective.

Directions to Location:

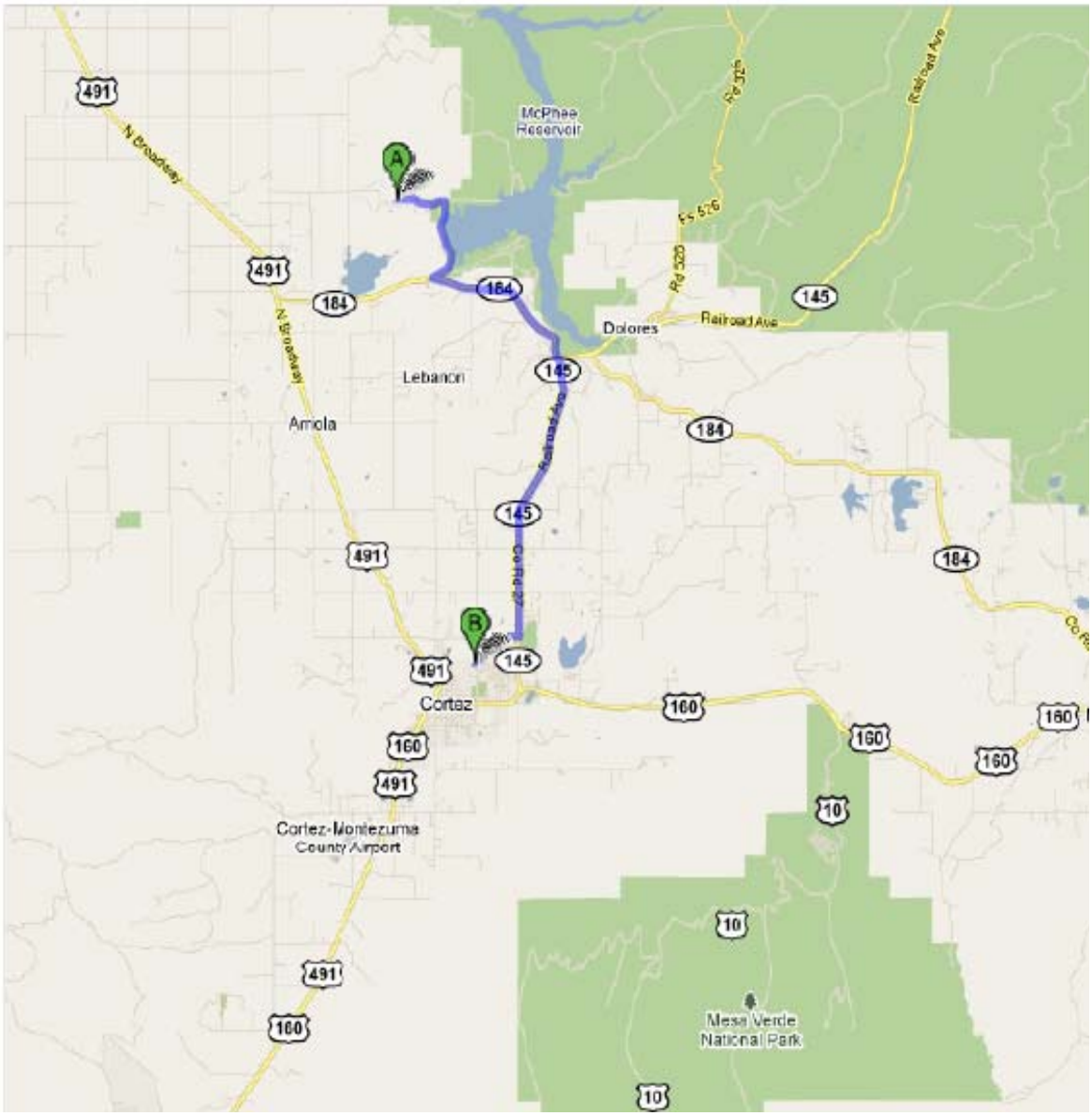
Proceed in a northwesterly direction from Cortez, CO along US Highway 491 approximately 10.2 miles to the junction of this road and an existing road to the east (hwy 184). Turn right and proceed in an easterly, then northeasterly direction for approximately 4.0 miles to the junction of this road and an existing road to the northeast (County Road 25). Turn left and proceed in a northeasterly, then northerly direction for approximately 2.1 miles to the junction of this road and an existing road to the west (County Road X). Turn left and proceed in a westerly direction for approximately 1.4 miles to the junction of this and the access road, turn right and proceed north 0.15 miles to location.

Directions to Southwest Memorial Hospital (see Figure 1)

SOUTHWEST MEMORIAL HOSPITAL
1311 N MILDRED RD
CORTEZ,CO 81321
(970) 565-6666

1. Point A (wellsite location) - From rig exit access road, turn (left) East on CR X, go 1.2 mi.
2. Take the 1st right onto Rd 25, go 2.1 mi.
3. Turn left at CO-184E, go 4.1 mi.
4. Turn right at CO-145 S/Railroad Ave, go 6.6 mi.
5. Turn right at Alamosa Rd/Co Rd L, go 1.0 mi.
6. Turn left at CO Rd 26/N Mildred Rd, go 0.5 mi.
7. Take the 1st right onto Cottonwood St, go 364 ft.
8. Take the 1st left onto Doctor East E Johnson Drive, Point B on the left.

FIGURE 1 - MAP TO HOSPITAL



I. Duties & Responsibilities

In order to assure proper execution of the contingency plan, it is essential that one person be responsible for and in complete charge of implementing the procedures outlined in this plan. The order of responsibility will be as follows:

1. BILL BARRETT CORPORATION representative on location - if unable to perform his/ her duties

2. Alternate BILL BARRETT CORPORATION representative - if unable to perform his/ her duties

3. Rig Toolpusher, Frac Crew Supervisor - if unable to perform his/ her duties

4. Safety consultant representative- if available

A. All Personnel

1. Always be alert for possible H2S alarms- both audible and visual.

2. Be familiar with location of Safe Briefing Areas (SBA) and protective breathing equipment.

3. Develop “wind awareness”. Be aware of prevailing wind direction as well as nearby uphill areas, should there be no wind.

4. Familiarize yourself with nearest escape routes for safe evacuation

5. Should H2S alarm sound, DON’T PANIC - Remain calm and follow instructions of person in charge.

6. If the H2S alarms sound:

a. Essential personnel shall don the appropriate respiratory protective equipment and follow company procedures. Essential personnel will continue to wear respiratory protective equipment until the area is deemed safe (H2S concentration less than 10 PPM)

b. Non-essential personnel shall evacuate to the appropriate safe briefing area using escape-breathing systems. Wait there for further instructions from BILL BARRETT CORPORATION representative.

C. Initiate rescue protocol if necessary- following training procedures.

B. Bill Barrett Corporation

1. The BILL BARRETT CORPORATION foreman will confirm that all personnel on location at any time are trained in H2S safety and aware of above list of duties.

2. The BILL BARRETT CORPORATION foreman will ensure that all personnel observe all safety and emergency procedures.

3. The BILL BARRETT CORPORATION foreman will make an effort to keep the number of personnel on location to a minimum and to ensure that only essential personnel are on location during critical operations.

4. Should an extreme danger condition exist, the BILL BARRETT CORPORATION foreman will:

a. Assess the situation and advise all personnel by appropriate means of communication.
b. Be responsible for determining that the extreme danger condition is warranted and the red flag shall be posted at location entrance.
c. Go to safe briefing area and give clear instructions relative to hazard on location, and actions for personnel to follow.
d. Notify company and regulatory groups of current situation as outlined in company protocol. Follow appropriate emergency procedures for emergency services notification.
e. Proceed to rig floor and supervise operations with rig supervisor. Take action to control and reduce the H2S hazard.
f. Ensure that essential personnel are properly protected with supplied air breathing equipment and that non-essential personnel are in a “poison gas free” area.
g. Be responsible for authorizing evacuation of persons/ residents in area surrounding the drilling location.
h. Commence any ignition procedures if ignition criteria are met.

C. Rig Toolpusher, Frac Crew Supervisor

1. If the BILL BARRETT CORPORATION foreman is unable to perform his/ her duties, and the alternate foreman is also unable or unavailable to perform his duties, the completion rig toolpusher, or frac crew lead will assume command of wellsite operations and all responsibilities listed above for drilling foreman.

2. Ensure that all rig personnel are properly trained to work in H2S environment and fully understand purpose of H2S alarms, and actions to take when alarms activate. Ensure that all crew personnel understand the buddy system, safe briefing areas, and individual duties as well as emergency evacuation procedures.

3. Should an extreme danger operational condition arise, the rig toolpusher shall assist the BILL BARRETT CORPORATION foreman by:

a. Proceeding to the rig floor and assist in supervising rig operations.
b. Ensure that only essential working personnel remain in hazardous areas.
c. Ensure that all crewmembers that remain in hazardous area, wear respiratory protective equipment until notified that area is “clear” of any toxic gases.
d. Assign rig crewmember or other service representative to block entrance to location. No unauthorized personnel will be allowed entry to location.
e. Help to determine hazardous “danger zones” on location using portable detection equipment and position electric fans to move gas in any high concentration areas.

D. <u>Safety Consultant</u>

1. During normal operations (no H2S present), the safety consultant will be responsible for the following:

a. Ensure that all wellsite safety equipment is in place and operational.
b. Ensure that all wellsite personnel are familiar with location safety layout and operation of all safety equipment.
c. Assist the BILL BARRETT CORPORATION foreman in performing weekly H2S drills for location personnel.

2. When an operational condition is classified as extreme danger, the safety consultant will be responsible for the following:

a. Account for all wellsite personnel
b. Assess any injuries and direct first aid measure.
c. Ensure that all safety and monitoring equipment is functioning properly and available.
d. Monitor the safety of wellsite personnel
e. Maintain a close communication with BILL BARRETT CORPORATION foreman.
f. Be prepared to assist BILL BARRETT CORPORATION foreman with support for rig crew or other personnel using breathing equipment.
g. Be prepared to assist BILL BARRETT CORPORATION foreman with emergency procedures including possible well ignition.
h. Be prepared to assist with evacuation of any area residents or other personnel working in the immediate area.

E. <u>Operation Center Foreman (Same as Foreman)</u>

1. The BILL BARRETT CORPORATION Operations Center Foreman will be responsible for notifying and maintaining contact with company production manager as well as other company supervisory personnel.

2. Maintain communication with the BILL BARRETT CORPORATION foreman to proceed with any other assistance that might be required.

3. Travel to wellsite if appropriate

4. Assist BILL BARRETT CORPORATION foreman with all other notifications - both company and regulatory.

II. Well Location Layout

A. Location

1. All respiratory protective equipment and H2S detection equipment will be rigged up 1000 ft prior to entering the first sour formation. The rig crews and other service personnel will be trained at this time. All rig crews will be trained and all safety equipment in place and functioning when work begins on that well formation.

2. The rig, or other necessary equipment will be situated on location to allow for the prevailing winds to blow across the rig toward the circulation tanks or at right angles to the lines from the B.O.P.s to the circulation tanks.

3. The entrance to the location is designed so that it can be barricaded if a hydrogen sulfide emergency condition arises. An auxiliary (foot path) exit route will be available so that in case of an emergency, a shift in wind direction would not prevent escape from the location.

4. A minimum of 2 safe briefing areas (SBA) shall be designated for assembly of personnel during emergency conditions. These will be located at least 200 ft. or as practical, from the wellbore and in such a location that at least one area will be upwind of the well at all times. Upon recognition of an emergency situation, all personnel will be trained to assemble at the designated briefing area for instructions.

5. Designated smoking areas will be established. BBC policy does not allow smoking on location.

6. Reliable 24 hour telephone communications will be available on location..

7. All equipment that might come in to contact with hydrogen sulfide - tubing, coil tubing, blowout preventers, choke system, flowback equipment, etc. will meet BILL BARRETT CORPORATION metallurgy requirements for H2S service.

8. The location will have a continuous electronic H2S detection system that automatically will activate visible and audible alarms if hydrogen sulfide is detected. The visible light will activate if 10 ppm H2S is present. The audible siren will activate if 15 ppm H2S or higher concentration is present. There will be at least 3 H2S sensors in place on the location. Additional sensors will be positioned at the discretion of the completion foreman. At least 1 light and 1 siren will be placed on the location to indicate the presence of hydrogen sulfide. The light and siren will be strategically placed to be visible

to all personnel on the site. Additional alarm lights & sirens may be added to ensure that all personnel on the drill site are able to notice the alarms at any time.

9. The H2S detection equipment will be calibrated as recommended by the manufacturer. Calibration records will be maintained on location.

10. Adequate windsocks will be placed around the site to ensure that everyone on the can readily determine wind direction.

11. All respiratory protective equipment will be NIOSH/ MSHA approved positive pressure type and maintained according to manufacturer's guidelines. All breathing air used for this equipment will be CGA type Grade D breathing air.

12. Both 30-minute self-contained breathing apparatuses (SCBA) and workline units with escape cylinders will be available on location. All respiratory protective equipment will use nose cups to prevent fogging in temperatures below 32 F. Spectacle kits will be available for personnel that require corrective lenses when working under mask.

13. H2S drills will be conducted at least weekly to ensure that all well site personnel are competent in emergency donning procedures. These drills will be recorded in the daily completion report, as well as in the safety trailer logbook.

14. Electronic voice-mikes will be available for essential personnel to use when working under mask to facilitate communication.

15. Additional breathing equipment will be provided for non routine operations that require additional service personnel on the well location to ensure that all personnel on the well location have a dedicated supplied air respirator.

16. Location access will be monitored and controlled during "non- routine" operations such as perforating, pressurized pumping, and well testing. The number of personnel on location will be restricted to "essential" personnel only.

III. Safety Procedures

A. Training

All personnel who come onto the location must be properly trained in hydrogen sulfide, nitrogen, and oxygen deficient atmospheres safety. The personnel shall carry documentation with them indicating that the training has occurred within the previous 12 months. All training will comply with federal and state regulatory guidelines.

Training topics shall include at a minimum:

1. Hazards and characteristics of hydrogen sulfide, nitrogen, and oxygen deficient atmospheres and symptoms of exposure to these gases.

2. Proper use, care and limitations of respiratory protective equipment with hands on practice.

3. Use of both fixed and portable detection toxic gas equipment.

4. Work practices to reduce opportunities for toxic gas exposure as well as confined space procedures.

5. First aid for toxic gas exposure and resuscitation equipment.

6. The buddy system

7. Emergency evacuation procedures

8. A review of the contingency plan for the well.

B. Operating Conditions

A three color- flag warning system will be used to notify personnel approaching the drill site as to operating conditions on the wellsite. This system is in compliance with BLM OO#6 and follows industry standards.

Green Flag - Potential Danger

Yellow Flag - Moderate Danger

Red Flag- Extreme Danger - Do Not approach if red flag is flying.

C. Evacuation Plan

There are multiple permanent residents within a 2-mile radius of the site. Due to the high density of residences in the area **as soon as ANY H2S is detected the well will be shut in, and operations will cease.** If H2S is detected and operations cease, there will be no further operations conducted until a FULL evacuation plan and reverse 911 call system for ALL residents has been established.

All regulatory agencies will be notified as soon as possible.

D. Emergency Rescue Procedures

Well site personnel should not attempt emergency rescues unless they have been properly trained. A trained person who discovers another person overcome by hydrogen sulfide **should not attempt to rescue without donning the proper breathing equipment.** When making an emergency rescue always use the following procedures:

1. Don rescue breathing equipment before attempting to rescue someone.

2. Remove the victim from the contaminated area to an area free of toxic gas by traveling upwind or cross wind. Be certain that you are in a safe area before removing your breathing equipment.

3. If the victim is not breathing, initiate mouth- to mouth resuscitation immediately. Follow CPR guidelines and replace mouth to mouth with a bag mask resuscitator if available.

4. Treat the victim for shock, keeping the victim warm and calm. Never leave the victim alone.

5. Any personnel who experience hydrogen sulfide exposure must be taken to a hospital for examination and their supervisor notified of the incident.

6. Their supervisor shall follow the company Emergency Preparedness plan.

IV. H2S Safety Equipment on Location

Item	Amount	Description
1.	1	safety trailer with a cascade system of 10-300 cu. ft bottles of compressed breathing air complete with high-pressure regulators
2.	At least 1000 ft.	Low-pressure airline equipped with Hanson locking fittings. This airline will be rigged up with manifolds to supply breathing air to the rig floor, substructure, derrick, shale shaker area, and mud mixing areas. Three high-pressure refill hoses will be attached to cascade systems for cylinder refill.
3.	Appropriate	Scott 30 minute self-contained breathing apparatuses (SCBA).
4.	Appropriate	Scott airline units with emergency escape cylinders.
5.	One (1)	4- channel continuous electronic H2S monitor with audible and visual alarms. The set points for these

		alarms are 10 ppm for the low alarm and 15 ppm for the high alarm.
6.	Two (2)	Sensidyne portable hand operated pump type detection units with tubes for hydrogen sulfide and sulfur dioxide.
7.	One (1)	Oxygen resuscitator with spare oxygen cylinder.
8.	One (1)	Trauma first aid kit
9.	One (1)	Stokes stretcher and one (1) KED.
10.	Four	Windsocks
11.	At least one (1)	Well condition sign with 3 flag system.
12.	Two (2)	Safe Briefing Area (SBA) signs
13.	One (1)	Fire blanket
14.	One (1)	Set air splints
15.	One (1)	Bullhorn and chalk board
16.	Three (3)	300 cu. ft. air bottles for the safe briefing area.
17.	Two (2)	30 # fire extinguishers
18.	Two (2)	Battery powered voice mikes for communication when wearing air masks.
19.	One (1)	Battery powered combustible gas meter

A drawing of the drilling location will be inserted in this page showing the actual placement of the all safety equipment relative to the other equipment on the drill site.

This drawing will be completed as soon as all equipment is in place, tested, and inspected.

V. Well Ignition Procedures

If it should become apparent that an uncontrolled release of hydrogen sulfide to the atmosphere might endanger the health and safety of the public or well site personnel, the BILL BARRETT CORPORATION foreman will make a decision to ignite the well. The following procedure should be followed before attempting to ignite the well.

A. Ignition equipment - The following equipment will be available for on-site for use by the ignition team.

1. 2-12 gauge flare guns with flare shells
2. 2-500 ft. Fire resistant retrieval ropes
3. 1 portable combustible gas meter
4. Self contained breathing apparatus (SCBA) for each member of the ignition team.
5. 1 backup vehicle with communication equipment

B. Ignition Procedures

1. The BILL BARRETT CORPORATION foreman will ensure that well site personnel are evacuated to a safe area upwind of the well bore prior to any ignition action.

2. The BILL BARRETT CORPORATION foreman and a designated partner “buddy” backed up by well site safety personnel will comprise the ignition team. All team members will be wearing 30 minute SCBAs.

3. The backup crew will be positioned near a radio-equipped vehicle at a safe distance from the sour gas release. They will standby to rescue the actual team igniting the well.

4. The partner of the ignition team will carry a combustible gas/ hydrogen sulfide meter to continuously monitor the area in which they are working and define the perimeter of the gas cloud.

5. The BILL BARRETT CORPORATION foreman will carry the flare gun and shells.

6. The ignition team will determine the hazardous area and establish safe working perimeters. Once this is identified the team will proceed upwind of the leak and fire into the area with flare gun. If trouble is encountered in trying to light the leak, retry to ignite by firing the flare shells at 45 and 90 angles to the gas source, but DO NOT approach closer to the leak.

7. After ignition, monitor for sulfur dioxide and work with the support group to restrict access to the contaminated area.

VI. Residents - Public in R.O.E.

There are multiple permanent residents within a 2-mile radius of the site. Due to the high density of residences in the area **as soon as ANY H2S is detected the well will be shut in, and operations will cease.** They will be notified in the event of a release as soon as possible. They will also be given a copy of this contingency plan upon its approval. The BILL BARRETT CORPORATION may have personnel working in the area and their contact numbers are included. The surrounding area is privately owned and maintained. This land may be used for recreational purposes including hunting and recreational vehicles any time during the drilling or completion of this well.

BILL BARRETT CORPORATION

Title	Name	Phone
Manager Environmental Health & Safety	Scot Donato	Office: (303) 312-8191 Cell: (303) 549-7739 Home: (303) 733-0130 Fax: (303) 291-0420
Safety Coordinator	Johnny Thayne	Office: (435) 725-3515 Ext 6 Cell: (435) 669-8108
Public Relations	Jim Felton	Office: (303) 312-8103 Cell: (303) 241-3364 Home: (970) 668-1624 Fax: (303) 291-0420
Drilling Engineer	Jim Davidson	Office: (303) 312-8115 Cell: (303) 720-2154
Operations Engineer	Dominic Spencer	Office: (303) 312-8164 Cell: (303) 877-5236 Home: (303) 216-1738

VII. Emergency Phone Directory

A. BILL BARRETT CORPORATION.

Title	Name	Phone
EH&S Manager	**Scot Donato**	**303-312-8191**
Safety Coordinator	**Johny Thayne**	**435-725-3515 ext 6**
Public Relations	**Jim Felton**	**303-312-8103**
Drilling Engineer	**Jim Davidson**	**303-312-8115**
Operations Engineer	**Dominic Spencer**	**303-312-8164**
Production Superintendent	**Monty Shed**	**307-262-1511**
Completions Foreman	**Bill Kelly**	**3070360-6266**

B. EMERGENCY SERVICES PHONE LIST

1. Hospital -	Southwest Memorial Hospital	970-565-6666
2. Ambulance Services –	Dove Creek, CO	970-677-2500
3. Sheriff Department-	Montezuma County, CO	970-565-8441
4. Highway Patrol -	Montezuma County, CO	970-249-9575
5. Fire Department –	Montezuma County, CO	970-565-3157
7. Medical Helicopter -	St. Mary’s Careflight	800-633-3590
8. Burn Center-	General	720-848-7583
9. Poison Control	General	800-222-1222

This page will be a map of the well location site showing the section and other related facilities and residents within a 2-mile radius of the well.

TO BE ADDED WHEN AVAILABLE

Location Layout for Workover/ Completion

1. All H2S safety equipment will be available up at the time that personnel first move onto the well site. Respiratory protection equipment as well as detection equipment will be on hand should any H2S gas be detected during the initial rig up period.

This map will be added upon beginning completion operations

Completions and Workovers

Title	Name	Phone
Completion & Workover Foreman	Bill Kelly	Cell: (307) 360-6266
Operations Engineer	Dominic Spencer	Office: (303) 312-8164 Cell: (303) 877-5236 Home: (303) 216-1738
Field Foreman	Monty Shed	Office: (970-876-1959 Cell: (307) 262-1511
Manager Environmental Health & Safety	Scot Donato	Office: (303) 312-8191 Cell: (303) 549-7739 Home: (303) 733-0130 Fax: (303) 291-0420

PROPERTY OF GAS

If gas should be produced, it could be a mixture of Carbon Dioxide, Hydrogen Sulfide, and Methane.

TOXICITY OF VARIOUS GASES

Common Name	Chemical Formula	Specific Gravity of Air=1	1 Threshold Limit	2 Hazardous Limit	3 Lethal Concern
Hydrogen Cyanide	HCN	0.94	10 ppm	150 ppm/hr	300 ppm
Hydrogen Sulfide	H_2S	1.18	10 ppm	250 ppm/hr	600 ppm
Sulfur Dioxide	SO_2	2.21	2 ppm	--------	1,000 ppm
Chloride	CL_1	2.45	1 ppm	4 ppm/hr	1,000 ppm
Carbon Monoxide	CO	0.97	50 ppm	400 ppm/hr	1,000 ppm
Carbon Dioxide	CO_2	1.52	5,000 ppm	5%	10%
Methane	CH_4	0.55	90,000 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 side effects.

2 **Hazardous**=Concentration that may cause death.

3 **Lethal**=Concentration that will cause death with short-term exposure.

HYDROGEN SULFIDE

GENERAL PROPERTIES

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

Although the slightest presence of H2S 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 be accumulated without warning. The following table indicates the poisonous nature of Hydrogen Sulfide, which is more toxic than Carbon Monoxide.

COMMON NAMES: Sour Gas, Rotten Egg Gas, Sulphurated Hydrogen, Hydrogen sulfide, Stink Damp, H2S, Acid Gas, Sweet Gas*

PHYSICAL-CHEMICAL PROPERTIES

Chemical Formula H2S

1. Specific Gravity (Air = 1.000) .....1.193 (@ 77^{o}F)

2. Color.....None

3. Odor .....Compared to Rotten Eggs

4. Odor Threshold.....0.13 part of 1 ppm

5. Corrosivity.....Reacts with metals, plastics, tissues and nerves.

6. Solubility in Water.....4.0 to 1 in H2O @ 32^{o}F
2.6 to 1 in H2O @ 68^{o}F

7. Effects on Humans .....Olfactory nerves, respiratory nerves, irritates sensitive membranes in eyes, nose, and throat.

8. Vapor Pressure.....19.6 atmospheres at 25^{o}C

9. Explosive Limits.....4.3% to 46% by volume in air.

*** H2S is a sweet tasting Gas, but often the word "tasting" is left out.**

10. Ignition Temperature……. 18°F (Burns with a pale blue flame)

11. Molecular Weight…….. 34.08

12. Conversion Factors…… 1 mg/1 of air = 717 ppm (at 25°C and 760 mm HG). 1 ppm = 0.00139 mg/1 of air.

13. pH…… 3 in water

INDUSTRIAL OCCURRENCES

Hydrogen Sulfide exposures occur in certain processes in the petroleum industry, chemical plants, chemical laboratories, sulfur and gypsum mines, viscose rayon and rubber industries, tanneries, and in the manufacture of some chemicals, dyes, and pigments. It may be encountered in excavations in the swampy or filled ground. It is produced when sulfur-containing organic matter decomposes, and it can therefore be found in sewage or organic-waste treatment plants. A common sewer gas, it may find its way into utility manhole, particularly dangerous when encountered in tanks, vessels, and other enclosed spaces.

TOXIC PROPERTIES

Hydrogen Sulfide is an extremely toxic and irritating gas. Free Hydrogen Sulfide in the blood reduces its oxygen carrying capacity, thereby depressing the nervous system. Sufficiently high concentrations can cause blockage of the phrenic nerve, resulting in immediate collapse and death due to respiratory failure and asphyxiation.

Because Hydrogen Sulfide is oxidized quite rapidly to sulfates in the body, no permanent after effects occur in cases of recovery from acute exposures unless oxygen deprivation of the nervous system is prolonged. However, in cases of acute exposures, there is always the possibility that pulmonary edema may develop. It is also reported that symptoms such as nervousness, dry nonproductive coughing, nausea, headache, and insomnia, lasting up to about 3 days have occurred after acute exposures to Hydrogen Sulfide.

At low concentrations the predominant effect of Hydrogen Sulfide is on the eyes and respiratory tract. Eye irritation, conjunctivitis, pain, lacrimation, keratitis, and photophobia may persist for several days. Respiratory tract symptoms include coughing, painful breathing, and pain in the nose and throat.

There is no evidence that repeated exposures to Hydrogen Sulfide results in accumulative or systemic poisoning. Effects such as eye irritation, respiratory tract irritation, slow pulse rate, lassitude, digestive disturbances, and cold sweats may occur, but these symptoms disappear in a relatively short time after removal from the exposure. Repeated exposures to Hydrogen Sulfide does not appear to cause any increase or decrease in susceptibility to this gas.

The paralytic effect of Hydrogen Sulfide on the olfactory nerve is probably the most significant property of the gas. This paralysis may create a false sense of security. A worker can be overcome after the typical rotten-egg odor has disappeared. Rather than the characteristic Hydrogen Sulfide odor, some victims of sudden acute overexposure have reported a brief sickeningly sweet odor just prior to unconsciousness.

Subjective olfactory responses to various concentrations of Hydrogen Sulfide have be summarized as follows:

0.02 ppm	**No odor**
0.13 ppm	**Minimal perceptible odor**
0.77 ppm	**Faint, but readily perceptible odor**
4.60 ppm	**Easily detectable, moderate odor**
27.0 ppm	**Strong, unpleasant odor, but not intolerable**

Physiological responses to various concentrations of Hydrogen Sulfide have been reported as follows:

10 ppm	**Beginning eye irritation**
50-100 ppm	**Slight conjunctivitis and respiratory tract irritation after 1 hour exposure**
100 ppm	**Coughing, eye irritation, loss of sense of smell after 2-15 minutes. Altered respiration, pain in the eyes, and drowsiness after 15-30 minutes, followed by throat irritation after 1 hour. Several hours[1] exposure results in gradual increase in severity of these symptoms and death may occur within the next 48 hours.**
200-300 ppm	**Marked conjunctivitis and respiratory tract irritation after 1 hour exposure**
500-700 ppm	**Loss of consciousness and possibly death in 30 minutes.**

700 ppm **Raped unconsciousness, cessation of respiration, and death.**

1000-2000 ppm **Unconsciousness at once, with early cessation of respiration and death in a few minutes. Death may occur even if individual is removed to fresh air at once.**

ACCEPTABLE CONCENTRATIONS

ACCEPTABLE EIGHT-HOUR TIME-WEIGHTED AVERAGE

To avoid discomfort, the Time-Weighted average concentration of Hydrogen Sulfide Shall not exceed 10 ppm.

ACCEPTABLE CEILING CONCENTRATION

The acceptable concentration for protection of health for an eight-hour, f ive-day week shall be 20 ppm, Fluctuations are to occur below this concentration.

ACCEPTABLE MAXIMUM FOR PEAKS ABOVE ACCEPTABLE BASE LINE FOR CONTINUOUS EXPOSURE

A single-peak concentration not exceeding 50 ppm for a maximum of 10 minutes is allowable provided that the daily time-weighted average is not exceeded.

H_2S EQUIVALENTS

Parts Per Million	Percents	Grains per 100 cu. Ft.
1	.0001	.055
10	.001	.55
18	.0018	1.0
100	.01	5.5
1000	.1	55.5
10000	1.0	555.5

Grains per 100 cu. Ft. = % by volume Mole 636.4
1% by volume = 10,000 ppm

SULFUR DIOXIDE

Sulfur Dioxide (SO_2) is a colorless, transparent gas and is non-flammable.

Sulfur Dioxide is produced during the burning of H_2S. Although SO_2 is heavier than air, it will be picked up by a breeze and 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.

CONCENTRATIONS		EFFECTS
%SO_2	**ppm**	
.0002	**2**	**Safe for eight (8) hour exposure**
.0005	**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 of the eyes.**
.015	**150**	**So irritating that it can only be endured for a few minutes.**
.05	**500**	**Causes a sense of suffocation, even with the first breath.**

PHYSICAL PROPERTIES AND CHARACTERISTICS

Chemical Formula ..... SO_2

1. Specific Gravity 2.212

2. Color ..... None

3. Flammable ..... No

4. Odor ..... Characteristic, pungent, gives ample warning of its presence.

5. Corrosivity ..... **Dry---not corrosive to ordinary metals.**
Wet---corrosive to most common metals.

6. Allowable Concentrations ..... **2 ppm (ACGIH)**
2 ppm (OSHA)

7. Effects on Humans ..... **Irritates eyes, throat and upper**
Respiratory system.

TOXIC PROPERTIES

Sulfur Dioxide is an irritating gas in its vapor form and the odor is so intensely irritating that concentrations of 3 to 5 parts per million in the air are readily detectable by the normal person. In higher concentrations, the severely irritating effect of the gas makes it unlikely that any person would be able to remain in a Sulfur Dioxide contaminated atmosphere unless they were unconscious or trapped.

Sulfur Dioxide gas is intensely irritating to the eyes, throat, and upper respiratory system. Inhalation of this gas in concentrations of 8 to 12 parts per million in air causes throat irritation, coughing, constriction of the chest, tearing and smarting of the eyes. 150 parts per million is so extremely irritating that it can be endured only for a few minutes. 500 parts per million is so acutely irritating to the upper respiratory tract that it causes a sense of suffocation, even with the first breath.

Out of numerous reported exposures to Sulfur Dioxide, there are few references that would indicate pneumonia as an after effect.