

BURLINGTON RESOURCES

H₂S CONTINGENCY PLAN

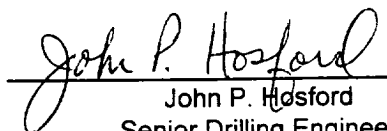
Ute Mountain Ute #51

1500' FSL & 2270' FWL, Section 14, T-32-N, R-14-W

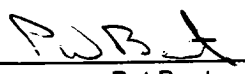
Hermosa, Ismay, Desert Creek, Akah, Barker Creek

San Juan County, New Mexico

Latitude 36 Degrees, 59.1 Minutes, Longitude 108 Degrees, 16.8 Minutes

 5/21/98
John P. Hosford
Senior Drilling Engineer

F. A. Seidel
Drilling Engineering Advisor

 5/22/98
Pat Bent
Drilling Superintendent

RECEIVED
JUN 5 1998
OIL CON. DIV.
PAGE 3

TABLE OF CONTENTS

INTRODUCTION	3
GENERAL EMERGENCY ACTION	4
COMMUNICATIONS DIRECTORY	5
LIST OF RESIDENTS / BUSINESSES / SCHOOLS	7
RESPONSIBILITIES	8
PRECAUTIONARY MEASURES	12
SPECIAL SAFETY TRAINING	13
EQUIPMENT AND MATERIAL SPECIFICATIONS	14
BURLINGTON RESOURCES H ₂ S CONTINGENCY EQUIPMENT CHECKLIST	15
EFFECTS OF HYDROGEN SULFIDE, CO ₂ , ETC. ON DRILLING OPERATIONS	16
CORROSION EFFECTS OF H ₂ S AND CO ₂ ON STEEL	18
EFFECTS OF H ₂ S AND CO ₂ ON DRILLING FLUID	19
SULFIDE TESTING PROCEDURE	20
ATTACHMENTS	21
LOCATION DIAGRAMS	22
BARKER DOME H ₂ S POTENTIALS	24
LIST OF REFERENCES	25

INTRODUCTION

Burlington Resources is permitting to drill and complete the Ute Mountain Ute #51, a 9602' Hermosa, Ismay, Desert Creek, Akah, Barker Creek for the purpose of evaluating and exploiting hydrocarbon reservoirs.

Drilling data indicates that hydrogen sulfide (H₂S) and carbon dioxide (CO₂) may be present from the upper Pennsylvanian formation to Total Depth. Hydrogen sulfide (H₂S) is a flammable and highly toxic gas which, in relatively small concentrations, can have adverse effects on people and equipment (refer to the section - Effects of H₂S). Carbon dioxide (CO₂) is a non-flammable, odorless, colorless, and tasteless gas. Because of carbon dioxide's higher density (it is 1 1/2 times as heavy as air), it may settle to the ground and be dangerous. The carbon dioxide is not poisonous, but it cuts off the necessary supply of oxygen.

Precautionary measures concerning H₂S in this plan have been formulated based on the following assumptions:

1. No significant (greater than 20 ppm) H₂S is expected above the Ismay at 8627'.
2. Based on 12,000 ppm H₂S gas released at a rate of 6.4 MMCF/day (worse case scenario), the maximum 100 ppm H₂S "radius of exposure" (ROE) expected is 1500 feet or 0.285 miles and the maximum 500 ppm H₂S "radius of exposure" (ROE) expected is 700 feet or 0.133 miles. It is unlikely that the rate of a release would be as significant as 6.4 MMCF/day.
3. The 100 ppm H₂S Radius of Exposure and the 500 ppm H₂S Radius of Exposure do not contain public areas.
4. Safety personnel and monitoring equipment will be placed on the drilling location prior to drilling to 7627' (1000' above the Ismay at 8627').

This plan has been designated as a guide for well requirements and special considerations to provide for safe and efficient drilling (or servicing) operations in the presence of either hydrogen sulfide or carbon dioxide.

GENERAL EMERGENCY ACTION

In the event an emergency situation occurs, the following action shall be initiated:

1. If the H2S alarm sounds, stop the rotation of the drill pipe as time and conditions permit.
2. Evacuate quickly to the "Safe Briefing Area".
3. Those who must enter the hazard area must wear self-contained breathing apparatus and use other appropriate safety equipment. Secure rig and apparatus and use other appropriate safety equipment. Secure rig and close well in, if necessary. (Use the "buddy system" at all times.)
4. Account for all personnel and take appropriate action as necessary for personnel safety.
5. Raise appropriate color warning flag to describe the type of emergency.
6. The above procedures will apply for CO2 situations also.

The Burlington Resources Drilling Supervisor will assess the situation and assign duties to various persons to bring the situation under control. The Supervisor will advise the Burlington Resources Drilling Superintendent as soon as the emergency will permit. In the event of a well kick, procedures outlined in the Operations Plan for Drilling will be followed. Stations to be manned and duties to be performed will be listed on the doghouse bulletin board in the Burlington Resources supervisor's trailer, and in the contract safety trailer.

Notification of local law enforcement agencies, residents and emergency vehicles as per the following Communications Director, will be assigned by the Burlington Resources Drilling Supervisor.

Any press inquiries are to be referred to the Burlington Resources Drilling Manager.

BURLINGTON RESOURCES

(505) 326-9700

ALL AREA CODES ARE (505) UNLESS OTHERWISE INDICATED

Drilling Department

<u>Name</u>	<u>Office</u>	<u>Home</u>	<u>Pager/Cellular</u>
Drilling Manager: Pugh, Steve	326-9738	327-6141	326-8834/320-2560
Drilling Operations			
Drilling Superintendents: Bent, Pat	326-9887	325-3752	327-8909/320-1696
Boyer, Bruce	326-9583	564-8024	324-2646/320-2578
des Cognets, Russell	326-9755	564-3699	564-1573/320-8368
Rig Supervisors: Randall, Darren	599-4003	632-0913	324-4285/320-2618
Drilling Engineering:			
Seidel, Frank (Regional Drilling Engineer)	599-4019	327-4097	327-8097/320-2896
Hosford, John	599-4008	327-7358	564-1703/320-2569
Shipley, Kurt	326-9524	325-9361	326-8226/320-1667
Sperry, Donnie	326-9570	325-6560	324-7784/320-2537
White, Leslie	326-9717	326-0321	327-8791/320-2895
McElreath, Ann	326-9864		
Rush, Pam	326-9726		

Environmental & Safety Department

Safety/Environmental Representatives:

Wilke, Travis	326-9502	324-0143	326-8877/320-1796
Graves, Randy	326-9538	327-3256	564-1168/320-1795
Hasely, Ed	326-9841	327-9623	564-1167/320-1803
Schoenbacher, Jeff	326-9537	564-8292	564-1169/320-2653

Contract Safety

Standby Safety Services:

(Cortez, Colorado)			
Dean, Clinton	(970) 565-6391		(970) 749-2294

Well Control Companies

Red Adair/Cudd Well Control Co.	24 HR.	(713) 462-6479
Boots & Coots	24 HR.	(713) 931-8884

BURLINGTON RESOURCES
Emergency Contact Agencies (Cont.)

State Police/Sheriff/City Police:

San Juan County, NM	
State Police:	325-7547
Sheriff's Dept.	911 or 334-6622
Police Dept.	911
Ambulance	911 or 334-6622
Fire Dept.	911 or 334-6622
Medical Facilities	325-5011
Aeromedical Services	911 or (800) 452-9990
La Plata County, CO	
All Emergencies	911 or (970) 247-3232 or (970) 247-1155
Medical Facilities	(970) 247-4311
Aeromedical Services (Grand Junction)	(800) 525-4224
Montezuma County, CO	
All Emergencies	911 or (970) 565-8441
Medical Facilities	(970) 565-6666
Bureau of Land Management:	
Farmington, NM Office	505-599-8900
Mike Flanikin	505-599-6381
Jimmy Morris	505-599-6384
New Mexico Oil Conservation Division:	
Aztec, NM Office	505-334-6178
Contact: Frank Chavez	

Production Operations Department

Dispatch (505) 326-9816

<u>Name</u>	<u>Office</u>	<u>Home</u>	<u>Pager/Cellular</u>
Production Operations Manager:			
Fraser, Jim	326-9803	326-6367	326-8836
Superintendents:			
Muncrief, Rick	326-9802	326-5755	327-8147
Raybon, Ken	326-9804	327-7861	320-0104
Field Foreman:			
Rogers, Noel	326-9808	334-6887	326-8822/320-1158
Osborne, Gary	326-9821	632-2481	326-8873/320-2449
Area Regional Engineer:			
Zieche, Jerry	599-4023	327-2032	

LIST OF RESIDENTS / BUSINESSES / SCHOOLS

There are no residences, businesses, schools, or other public areas located within the 100 ppm Radius of Exposure or the 500 ppm Radius of Exposure.

RESPONSIBILITIES

All Personnel

1. All Personnel who spend over one day on a Burlington Resources location shall be familiarized with the procedures outlined in this directive.
2. All personnel will attend to their personal safety first.
3. If it can be done safely, help anyone who may be injured or overcome from toxic gases by administering first aid.
4. Report to the "Safe Briefing Area" and follow the instructions of the supervisor.

Burlington Resources Drilling Supervisor

1. It is the responsibility of the Burlington Resources supervisor to see that these safety and emergency procedures are observed by all personnel on Burlington Resources's location.
2. The supervisor will advise the Drilling Superintendent whenever the procedures as specified herein are complied with or cannot be followed. One (1) completed copy of the checklist will be forwarded to the Superintendent and one copy to Randy Graves, Safety Representative.
3. The Burlington Resources rig supervisor shall keep the number of personnel on location to a minimum during hazardous operations.
4. The supervisor shall be trained in the use of all safety equipment and completely briefed on safety and emergency procedures. This shall include full knowledge of the requirements in this contingency plan.
5. It is the responsibility of the Burlington Resources supervisor to see that the Contractor has adequately trained the drilling crews in handling emergency situations. He should satisfy himself that this is the case. He should notify the Burlington Resources Superintendent if the Contract supervisor fails to fill this responsibility.
6. If an unexpected emergency occurs, or the H2S alarm sounds, the supervisor (either Burlington Resources or Contractor) will assess the situation and will advise all personnel what conditions exist. Action to be taken under each of three possible conditions is as follows:

CONDITION I - POTENTIAL DANGER TO LIFE (such as hazardous amount of toxic gasses detected at surface)

- a. Order nonessential personnel out of the potential danger area and display the YELLOW CONDITION I warning sign and flag.
- b. Order all essential personnel to check their safety equipment to see that it is working properly and in the proper location (see supervisor's checklist). Persons without respiratory protection cannot work in the hazard area.
- c. Notify Superintendent of condition and action taken.
- d. Increase gas monitoring activities and continue operations as appropriate.

CONDITION II - MODERATE DANGER TO LIFE (such as circulating out a potentially toxic gas kick). In addition to Condition I requirements:

- a. Display only the ORANGE CONDITION II warning sign and flag.
- b. Direct corrective action to control flow of gas.
- c. Set up roadblocks and restrict personnel movements to minimum.
- d. Notify other Regional personnel listed on emergency telephone list.

CONDITION III - EXTREME DANGER TO LIFE (when it appears that well control will be lost). In addition to Conditions I and II requirements:

- a. Contact and request local police to evacuate people and to control traffic within the danger zone. Should the condition be immediately dangerous to the public, take necessary life saving action until local police arrive. Display only the RED CONDITION III warning sign and flag.
- b. Ignite the well if necessary. (See the following section - Igniting the Well.)

NOTE: The Drilling Superintendent will dispatch additional Burlington Resources personnel and/or additional professional safety personnel to the well site as needed to assist the Drilling supervisor.

Contract Drilling Supervisor (Toolpusher)

1. In the absence or incapacitation of the Burlington Resources Drilling Supervisor, the Contractor Drilling Supervisor will assume all responsibilities designated herein to the Burlington Resources Drilling Supervisor.
2. Assist the Burlington Resources Supervisor and Safety Representative in training crews for handling emergency situations.
3. Will be trained for all well control or emergency situations as contained herein and how to properly use all safety equipment.

Driller

1. In the absence or incapacitation of both Drilling supervisors (Burlington Resources and Contractor), the Driller will assume their responsibilities as designated herein.
2. In the event of any emergency, the Driller will don respiratory equipment and secure the rig if time permits.
3. Assist Contract supervisor in crew preparation.

Regional Safety Department

1. Shall provide safety and environmental information and guidance when required.

2. Shall review and approve any changes in safety or environmental procedures.
3. Shall assist as appropriate with operating and maintenance procedures for the safety equipment called for in this plan.
4. Shall assist with arranging initial training on safety procedures and equipment. They will provide assistance as needed for follow up training.

Rig Contractor

1. Shall have his personnel properly trained in First Aid/CPR.
2. Shall keep his personnel trained in use of safety equipment and safety procedures.

Visitors, Service Personnel (Vendors) and Others

1. Only personnel authorized by Burlington Resources Supervisor shall be permitted to enter area when an emergency condition exists.
2. Shall be permitted to enter area under an emergency condition only if needed and then only after being properly instructed in use of safety equipment and have necessary equipment issued or available.
3. Vendors must have all of their personnel trained in H2S procedures which will be on location from 1,000' above the expected H2S zone through rig release.

Igniting the Well

1. Responsibility

The decision to ignite the well is the responsibility of the Burlington Resources Drilling Superintendent. However, the decision should be made only as a last resort and in a situation where it is clear that:

- a. Human life or property are endangered.
- b. There is no hope of controlling the blowout under the prevailing conditions at the well.

In all cases, an attempt should be made to notify the Drilling Manager of the plans to ignite the well, if time permits. However, the Superintendent and Supervisor must not delay a decision if human life is threatened.

NOTE: If the CO₂ content of the effluent stream is higher than anticipated, it is likely that the stream will not sustain combustion.

REMEMBER, if the well is ignited, the burning H₂S will be converted to sulfur dioxide (SO₂) which is also highly toxic. Do not assume that the area is safe after the well is ignited. Follow through with all plans to evacuate endangered persons.

2. Means of Ignition

- a. In preparation for igniting the well, keep unnecessary persons in the "Safe Briefing Area". A two person team is required for the actual ignition. Both team members will wear self-contained breathing units and will have 200 feet retrieval ropes attached to safety harnesses. One team member is responsible for checking the atmosphere for explosive gasses with the explosimeter. The other member is responsible for igniting the well. Persons remaining in the "Safe Briefing Area" will closely watch the

ignition team; and should either man be overcome, they will immediately pull him to safety by the retrieval ropes and apply revival measures.

- b. The primary method for igniting the well will be with a 25 mm meteortype flare gun.
(The location of the flare gun will be in the Burlington Resources supervisor's trailer).
These guns have a range of approximately 500 feet. If this method fails or well conditions are such that a safer or better method is apparent, then the alternate method should be used.
- c. Always ignite the well from upwind and do not approach the well any closer than warranted.
- d. Select a location to fire the flare gun which provides maximum protection to the ignition team (behind equipment) while keeping in visible site by personnel in the "Safe Briefing Area".
- e. Choose a location that has good accessibility and from which retreat can easily be made.
- f. REMEMBER, before firing the flare gun or igniting flammable material, check the atmosphere at your location for combustible gasses with explosimeter.

PRECAUTIONARY MEASURES

These measures are to be in effect prior to drilling out surface casing.

General

1. Two areas shall be designated as safe briefing areas, each located, as a minimum: 150 feet from the wellhead and vent discharge area; spaced 160 degrees apart on an arc, with the wellhead as the center point; and as best suited for topographical considerations and prevailing winds. Six Niosh approved Positive Pressure SCBAs shall be located as follows: one in the Supervisor's office, one in the Tool Pusher's trailer, and two at each of the "Safe Briefing Areas". Packs should be readily accessible and properly protected from exposure to the elements.
2. Emergency equipment shall be on location as described in the H2S Contingency Equipment Checklist.
3. A copy of all emergency telephone numbers shall be posted on the doghouse bulletin board, at the "Safe Briefing Areas", in the Burlington Resources Supervisor's office, and in the Contract Supervisor's office.
4. Wind direction streams shall be located where at least one can be viewed from any position on the location.
5. An automatic hydrogen sulfide (H₂S) monitor shall be provided, with detectors placed at the bell nipple and shale shaker. Either of these detectors shall be capable of sensing a minimum of 5 ppm H₂S in air and shall be able to independently activate visual and audio alarms. The visual alarm will be activated at 10 ppm and the audible alarm at 10 ppm. The audible alarm must be capable of alerting people at any point on the location.
6. A sign which reads, "Caution - Poisonous Gas May be Present", will be posted at the last intersection leading to location.
7. If conditions warrant, two (2) explosion-proof, 24 inch or larger, electric fans will be located: (a) one on the rig floor to blow fumes downwind; (b) the second under the rig floor to clear gas from the substructure.
8. The wellsite shall be equipped with commercial communications. The equipment should be located for safe access and should not be an ignition source.
9. The Burlington Resources Supervisor's vehicle should always be parked a safe distance (at least 100 feet) from the rig, and in an upwind direction when feasible.
10. For all well kicks, the Operations Plan (II;5) will be followed. All drilling contractor personnel shall be trained, and drills shall be conducted to insure proper well control procedures.
11. The checklist of all emergency equipment (see Drilling supervisor's checklist) shall be completed at 1000+ above the suspect formation(s) as identified in the introduction. The equipment shall be inspected by the Drilling Supervisor with assistance, as needed, from Burlington Resources Safety personnel as to working condition, proper placement, etc. The inspection will be noted on the checklist. A copy of the checklist will be placed in the Drilling Supervisor's files and one copy each will be mailed to the Drilling Superintendent and Safety Department.
12. To ensure proper hole filling during tripping operations, a stroke counter and pit level sensor will be utilized at all times.

SPECIAL SAFETY TRAINING

The minimum training for personnel working in affected areas shall include the following elements:

1. Hazards, characteristics and symptoms of hydrogen sulfide (H₂S), sulfur dioxide (SO₂), carbon dioxide (CO₂), carbon monoxide (CO), methane gas, and other hazardous substances as may be appropriate. Effects of these substances are discussed in a section that follows.
2. Effect on metal components of the system.
3. Safety precautions to include possible sources at the site.
4. Operation of safety equipment and life support means and systems.
5. Corrective action and shutdown procedures.
6. Detection and measurements of H₂S, CO₂, CO and combustible gas.

THE BURLINGTON RESOURCES SUPERVISOR ON LOCATION SHALL BE RESPONSIBLE FOR THE OVERALL ON-SITE OPERATION, INCLUDING THE SAFETY AND TRAINING PROGRAM.

All personnel, contracted or employed on an unscheduled basis, shall be trained as a minimum in the severity of H₂S and other toxic gasses, safety precautions, evacuation procedures, and as appropriate, the use of respiratory protection equipment. This training shall be completed prior to entering the H₂S location. Visitors shall also be instructed regarding these matters.

To promote efficient safety procedures, an on-site toxic gas safety program, which includes a bi-weekly drill and training session, shall be established for all crews. Records of attendance shall be maintained on the drilling facility.

EQUIPMENT AND MATERIAL SPECIFICATIONS

1. Wellhead and blowout equipment is to conform as per Operations Plan.
2. BOP equipment will be tested to pressure rating prior to drilling out from the surface casing, with all testing witnessed and recorded by the Burlington Resources Drilling Supervisor.
3. The BOP will be operationally tested on every trip. BOP drills will be held each tour prior to drilling all potential H₂S bearing formations and recorded on the tour sheets.
4. The casing planned for this well is listed in the Operations Plan. This casing has been designed in accordance with Burlington Resources requirements for sour service.

Mud Requirements

1. The pH of the mud system will be maintained above 10.0 to neutralize (disassociate) any H₂S encountered. The pH will be maintained with caustic soda and/or soda ash.
2. While drilling from all potential H₂S bearing formations to total depth, the Mud Engineer is to test daily for filtrate sulfide using a "Hach H₂S Test Kit" and following the procedures of API Standard RP13B (copy in a following section). The results of this test are to be reported on the daily report.
3. Small concentrations of sulfide are expected and can be tolerated. However, concentrations which result in "Hach Tests" of greater than 50 ppm are potentially more serious and should be treated with H₂S scavenger to reduce the concentration of acceptable levels
4. The Hach Test will be routinely "doubled-checked" by means of the Garrett Gas Train.
5. Prior to dumping any significant quantities of drilling fluid (changing over, cleaning pits, cementing, etc.), it will be necessary to treat out all sulfides with H₂S scavenger in order to preclude formation of H₂S gas in the reserve pit.

**BURLINGTON RESOURCES
H2S CONTINGENCY EQUIPMENT CHECKLIST**

Well: _____

Rig N/N: _____

Date: _____

Supervisor: _____

1. ____ (All) **Personnel training with attendance records on site.**
2. ____ (2) **Cleared land areas** for use as "Safe Briefing Areas", 150' from wellhead, and 160 degrees apart.
3. ____ (1) **Warning sign** with current well condition indicator, located at last intersection to location so vehicles may have turn-around area.
4. ____ (3) **Wind direction indicators**, located to provide visibility from any place on location.
5. ____ (3) **No Smoking signs** on drive posts.
6. ____ (3) **Safe Briefing Area signs** on drive posts.
7. ____ (2) **Fans** - electric motor driven and explosion proof; one located on rig floor, and one located in substructure (if conditions warrant).
8. ____ (1) **H2S monitor** (continuous) located in the doghouse with detectors (sensitivity of 5 ppm in air) located at the bell nipple, mud return discharge, and on the rig floor.
9. ____ (1) **Alarm system** capable of individual activation by any detector with maximum settings as follows: visual and audible alarms at 10 ppm (audible must be capable of alerting personnel at any point on location).
10. ____ (5) **Niosh Approved Positive Pressure SCBAs** - 30 min. self-contained breathing apparatus: one in the supervisor's office, and two at each of the "Safe Briefing Areas". Easily accessible, and protected from exposure to the elements.
11. ____ (1) **Flare system** with continuous pilot and remote ignitor.
12. ____ (1) **Trailer** - full enclosure, at location entrance (based on prevailing winds), containing the following items (#13 through #24, and also #25d).
13. ____ (3) **Condition warning flags** (1 each yellow, orange, and red).
14. ____ (1) **Length of Stain Polymetric Tube Type Detectors** with lower range tubes for CO₂, H₂S, and SO₂.
15. ____ (1) **MSHA Explosimeter** (or equivalent).
16. ____ (1) **Flare gun** - 25mm meteor type with flares.
17. ____ (2) **Derrick safety belts** with 10' tail ropes.
18. ____ (2) **200' retrieval ropes.**
19. ____ (3) **Hearing protectors** - muff type.
20. ____ (1) **First aid kit** - 25 unit.
21. ____ (3) **Flashlights** w/batteries (explosion-proof & watertight).
22. ____ (1) **Disinfectant, cleaner, and towels** for breathing apparatus.
23. ____ (1) **Inspection records** for breathing apparatus and air supply.
24. ____ (1) **Fire extinguisher** (rated 60:BC).
25. ____ (4) **Emergency telephone numbers** in plastic weatherproof holders located at: rig bulletin board; Burlington Resources Supervisor's office; Contract supervisor's office; Safe Briefing Area.

EFFECTS OF HYDROGEN SULFIDE, CARBON DIOXIDE AND OTHER GASSES ON DRILLING OPERATIONS

Toxic Effect

1. Hydrogen Sulfide - H₂S

Hydrogen sulfide is a colorless, flammable, extremely poisonous gas. It is 1.2 times as heavy as air and will accumulate in low areas. It forms an explosive mixture with air between 4.3 and 46.0 percent by volume. It can be detected by smell at a concentration in air of only 0.02 ppm. Exposure to 10 ppm can be tolerated up to 8 hours without respiratory equipment. Respiratory equipment is required to protect workers should conditions exceed the foregoing allowable exposure limit. Concentrations in excess of 20 ppm has an effect on the olfactory nerve which deadens the sense of smell. Unconsciousness can occur without warning within seconds of inhalation at concentrations above 500 ppm.

Physical Effects of Hydrogen Sulfide

Concentration Percent (%)	ppm	Physical Effects
0.001	10	Obvious and unpleasant odor.
0.001	10	Safe for 8-hour exposure.
0.01	100	Kills smell in 3 to 15 minutes, may sting eyes & throat.
0.02	200	Kills smell shortly, stings eyes & throat.
0.05	500	Dizziness, breathing ceases in a few minutes. Needs prompt artificial respiration.
0.07	700	Unconscious quickly; death will result if not rescued promptly.
0.10	1000	Unconscious at once; followed by death within minutes.

2. Carbon Dioxide - CO₂

Carbon dioxide is a colorless, odorless gas which can be tolerated in relatively high concentrations. Commonly used to extinguish fires, it is 1.5 times heavier than air and will concentrate in low areas of quiet air. The primary danger from CO₂ is that it causes an oxygen deficiency and requires supplied air systems to be provided for deficiency and requires supplied air systems to be provided for protective measures. Humans cannot breathe air containing more than 10% carbon dioxide without losing consciousness. Air containing 50,000 ppm (5%) CO₂ will cause disorientation if inhaled for 30 minutes or more. Exposure to 5000 ppm CO₂ can be tolerated for a maximum of eight hours. Continued exposure to carbon dioxide after disorientation will cause convulsions, coma and respiratory failure.

3. Sulfur Dioxide - SO₂

Sulfur dioxide is a colorless, nonflammable, intensely irritating gas and 2.2 times heavier than air. It is a by-product of combustion of hydrogen sulfide and is highly toxic. Exposure to 2 ppm can be tolerated for a maximum of 8 hrs. Respiratory equipment will be available and should be used by personnel measuring SO₂ concentration downwind from a flare.

4. Methane - CH₄

Methane is the major component of natural gas and is colorless, odorless and extremely flammable. The chief danger from methane is explosion. Mixture of CO₂, H₂S and CH₄ will burn if the total H₂S and CH₄ content, in any ratio, is above 25 percent. Also the presence of methane causes an oxygen deficient environment and requires adequate ventilation for breathing.

5. Carbon Monoxide - CO

Carbon monoxide is a colorless, odorless toxic gas. It's toxicity results from preferential reaction with the hemoglobin in the blood; however, it has no unique toxic action on any of the bodily tissues. CO displaces oxygen from hemoglobin and reduces the oxygen carrying capability of the blood.

The primary danger from CO is that it causes oxygen deficiency similar to carbon dioxide (CO₂). Respiratory equipment should be used for atmospheres containing greater than 35 ppm. Exposure to 100 ppm (.0190) for three hours produces no perceptible effects; however, after nine hours will tend to cause headaches and nausea. Concentrations above 1500 ppm may be dangerous to life.

In addition to the toxic effects of CO, carbon monoxide burns readily in air. The flammability limits of CO in air change with pressure. At atmospheric pressure, however, the lower limit is $\pm 12.5\%$ and upper limit is $\pm 74\%$.

6. Properties of Various Gasses

<u>Common Name & Chemical Formula</u>	<u>Specific Time Gravity Air=1</u>	<u>Weighted Average*</u>	<u>Hazardous Limit**</u>	<u>Lethal Concentration***</u>	<u>Flammability</u>
Hydrogen Sulfide (H ₂ S)	1.18	10 ppm	100 ppm	600 ppm	4.3% to 46% by volume in air
Sulfur Dioxide (SO ₂)	2.21	2 ppm	—	1000 ppm	
Carbon Dioxide (CO ₂)	1.52	5000 ppm	5%	10%	
Methane (CH ₄)	0.55	Simple Asphyxiant	—	—	5.3% to 14.0% by volume in air
Carbon Monoxide (CO)	0.97	35 ppm	1500 ppm	4000 ppm	12.5% to 74% by volume in air

*Time Weighted Average (TWA) - Employee's average exposure in any eight hour work, of a 40-hour work week which shall not be exceeded.

**Hazardous - Concentration that may cause death.

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

CORROSION EFFECTS OF H₂S AND CO₂ ON STEEL

1. Hydrogen Sulfide (H₂S)

The three forms of hydrogen sulfide corrosion of steel are as follows:

- (a) general or weight loss,
- (b) localized or pitting, and
- (c) sulfide stress cracking.

In both general and localized corrosion, hydrogen sulfide reacts with the steel to produce iron sulfide. General corrosion is characterized by the formation of an iron sulfide film on the surface of the steel. After long periods of exposure, weight loss can lead to a significant reduction in strength. Localized corrosion is much more serious and predominantly occurs in the pH range below six. Chloride or similar ions must be present for pitting to occur. Iron chloride accumulates at the metal to iron sulfide film interface and promotes a localized attack. Pitting corrosion has not presented a significant problem in drilling operations.

Of foremost concern is sulfide stress cracking or hydrogen embrittlement where failure may take place without warning or significant metal loss. This problem is related to strength of the steel, hydrogen sulfide concentration, pH, exposure time, temperature and stress level of the steel. Hydrogen sulfide absorbed on the metal surface promotes the entry of atomic hydrogen into the metal. The atomic hydrogen which enters the steel matrix diffuses to positions of high stress where it can induce hydrogen embrittlement. Thus, brittle failure can occur at stress levels significantly less than normal yield stress. A high total dissolved sulfide concentration can be tolerated if the pH is high enough (9.5 or greater).

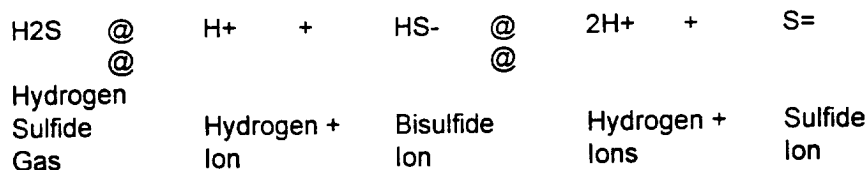
2. Carbon Dioxide - CO₂

In the presence of water, carbon dioxide dissolves and forms carbonic acid. The carbonic acid causes a reduction in pH of the drilling fluid which makes it quite corrosive to steel. Carbon dioxide contamination is possible from oil and/or gas reservoirs. Sufficient quantities of CO₂ in the wellbore under drilling or static conditions will cause high corrosion rates.

EFFECTS OF H2S AND CO2 ON DRILLING FLUID

1. Hydrogen Sulfide - H2S

When H2S is entrained in a drilling fluid, it will disassociate to some degree depending on the pH of the system as follows:



Undissociated hydrogen sulfide is the molecule which attacks steel surfaces and causes corrosion and embrittlement. Below pH, nearly all of the H2S in a system is in this molecular state. With increasing pH, H2S dissociation increases so that above pH 10, effectively all of the H2S is dissociated into bisulfide and sulfide ions. These ions are relatively harmless in the mud as long as the high pH is maintained. If pH is lowered, the reaction will be reversed and hydrogen sulfide gas will be evolved.

In addition to sulfide ions, dissociation of H2S in drilling mud produces hydrogen ions, which will react with hydroxyl ions in a high pH mud to form water. With sufficient H2S contamination, excess lime, if any, can be depleted and pH will begin to drop. A sufficient decrease in pH will, as previously stated, evolve H2S gas.

It is therefore desirable to know whether H2S has been encountered at the least possible time. This can be accomplished by testing the mud for sulfide ions daily, as described in the sulfide testing procedures that follow (API RP 13B).

2. Carbon Dioxide - CO2

When carbon dioxide gas is entrained in a drilling fluid, it will combine with water to form carbonate and bicarbonate ions and will simultaneously reduce pH. If left untreated, this can result in excessive gelation of the drilling fluid. The normal treatment for this contamination is lime, which precipitates out carbonate and raise pH.

SULFIDE TESTING PROCEDURE HACH TEST

PROCEDURE FOR ESTIMATING FILTRATE SULFIDE

Equipment: The following materials are required to estimate the sulfide concentration in the mud filtrate:

- a. Special test vial with vented cap
- b. Lead acetate test paper to fit cap
- c. Color comparison chart

(NOTE: THE HACH HYDROGEN SULFIDE TEST KIT (MODEL HS-7) CONSISTS OF ITEMS a, b, and c ABOVE.)

- d. Distilled water
- e. Hypodermic syringe
- f. Defoamer (such as octyl alcohol or sulfated castor oil)
- g. 0.1N acid, sulfuric or hydrochloric

Procedure: Place one disk of dry lead acetate test paper inside the dry cap of the test vial.

Measure 2.5 cm³ of freshly collected mud filtrate into the test vial. Dilute to the 25 cm³ with distilled water.

Add 2 cm³ of 0.1N acid, immediately add a fresh seltzer tablet, and quickly place the cap with the test paper on the vial. Allow the seltzer tablet to dissolve and then wait one minute.

Remove lead acetate paper and observe for brown coloration. If no coloration can be detected, then report the soluble sulfide as zero. If brown coloration is present, compare the test paper with color comparison chart. Read the appropriate ppm value (0.1, 0.3, 0.5, 1, 2, or 5) from the color chart and multiply by 10 to obtain the test result (1, 3, 5, 10, 20, or 50).

If the test paper matches the darkest color (5 ppm) on the color chart, the test result must be interpreted as greater than 50 ppm.

To extend the test range to higher concentration, dilute the filtrate as follows:

- a. For a test range of 10 to 500 ppm, dilute 1.0 cm³ of filtrate with 9.0 cm³ of distilled water. Use 2.5 cm³ of the diluted filtrate for the sulfide determination. Multiply the color chart value by 100 to obtain the test result.

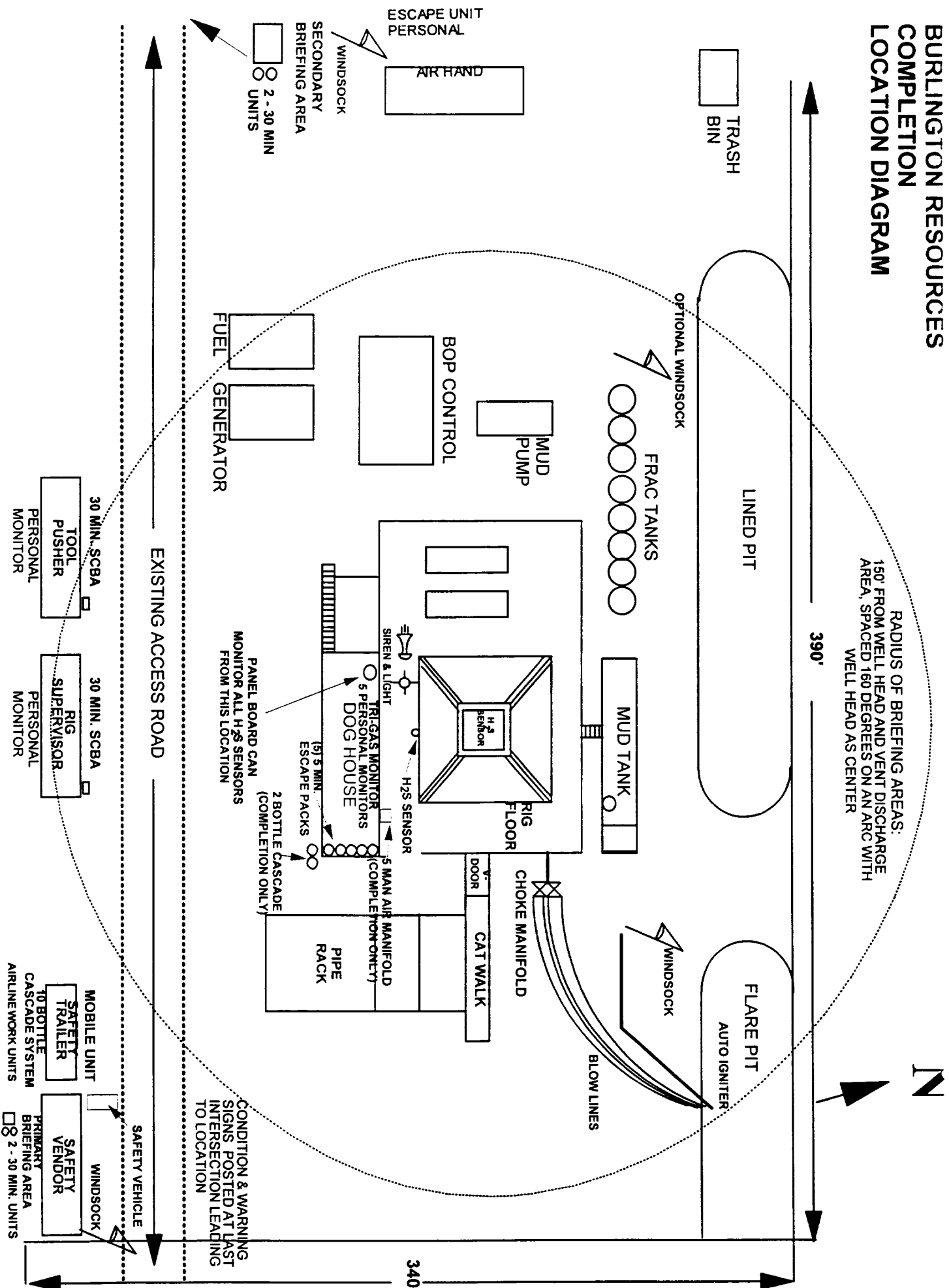
Report the test result as filtrate sulfide in ppm.

NOTE 1: IT IS IMPORTANT TO NOTE THAT THIS TEST IS NOT HIGHLY ACCURATE. THE RESULTS SHOULD BE INTERPRETED AS ROUGH ESTIMATES.

NOTE 2: THE METHOD MAY BE USED FOR WATER USING 25 CM³ SAMPLES OR THE SAME DILUTION PROCEDURE USED FOR MULLED FILTRATE. THIS METHOD MAY ALSO BE USED FOR MUD BUT THE PROBABLE MEANING OF THE RESULTS IS VERY UNCERTAIN. THERE COULD ALSO BE CONSIDERABLE DIFFICULTY IN OBTAINING A REPRESENTATIVE SAMPLE OF DILUTED MUD.

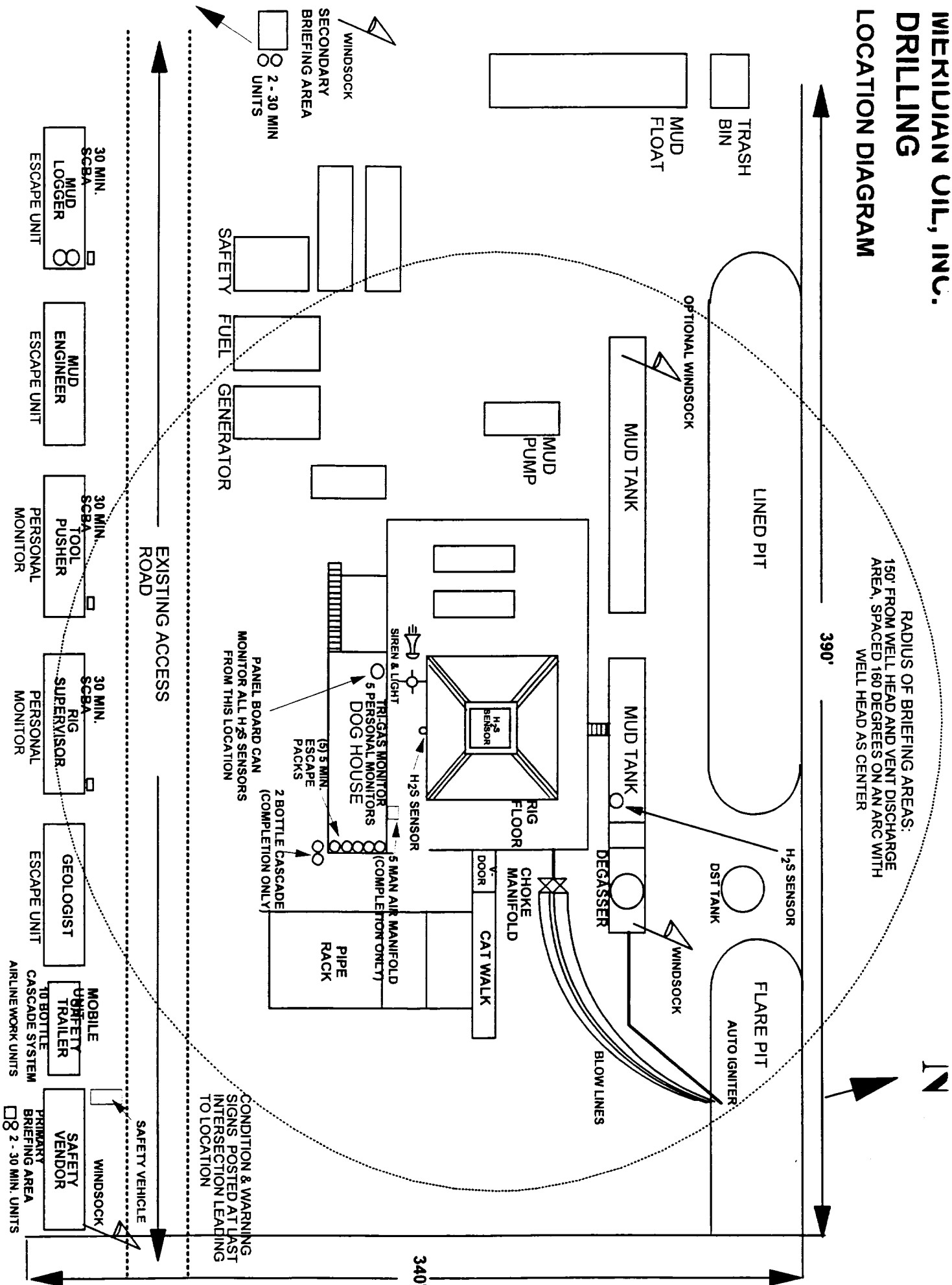
ATTACHMENTS

BURLINGTON RESOURCES COMPLETION LOCATION DIAGRAM



DRILLING

LOCATION DIAGRAM



LIST OF REFERENCES

1. "API Recommended Practices for Safe Drilling of Wells Containing Hydrogen Sulfide", (API RP 49) American Petroleum Institute, Dallas, Texas, 1974.
2. "API Recommended Practice: Standard Procedure for Testing Drilling Fluids", (API RP 13B) American Petroleum Institute, Dallas, Texas, 1976.
3. Clark, R. K., "Hydrogen Sulfide in Water-Base Drilling Fluids - I: Chemistry, Corrosion and Treatment", Technical Progress Report BRC 35-77, Shell Development, Houston, Texas, 1977.
4. "Contingency Plan for Drilling, Completion and Workover, Sour Gas Wells, Safety Regulations and Emergency Procedures", Shell Oil Company, Michigan Operations, Traverse City, Michigan, 1974.
5. "Contingency Plan for the Drilling of Taylor DT 653, Ventura Avenue Field, Ventura County, California; Safety Procedures and Precautionary measures", Shell Oil Company, West Coast Division, Los Angeles, California, 1973.
6. "Drilling Contingency Plan for McElmo Dome Area", Shell Oil Company, Midland Operations, Midland, Texas, 1976.
7. "Drilling Fluid Engineering Manual", Magcobar Operations, Dresser Industries Inc., Houston, Texas, 1972.
8. "Rule 36: Oil, Gas or Geothermal Resource Operation in Hydrogen Sulfide Areas", Railroad Commission of Texas, Oil and Gas Division, Austin, Texas, 1976, as amended effective September 15, 1985.
9. "Safe Practices for Drilling and Well Servicing Operations", Volumes I and II, Shell Oil company Exploration and Production.
10. "Sulfide Stress Cracking Resistant Metallic Material for Oil Field Equipment", NACE Standard MR-01-75. National Association of Corrosion Engineers, Katy, Texas, 1978.
11. "Onshore Order No. 6, Hydrogen Sulfide Operations", Department of the Interior, Bureau of Land Management, 43 CFR Part 3160.