Los Cerritos Wetlands
Health and Safety Plan
2011

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Los Cerritos Wetlands Health & Safety Plan

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INTRODUCTION

Los Cerritos Wetlands is a complex project site containing many potential hazards, sensitive habitat and several types of terrain. The site has active oil operations as well as still and moving water throughout and around the project site. Field work will occur starting in summer of 2011 as part of the Los Cerritos Wetlands Conceptual Restoration Plan. Listed below are the Health and Safety Objective, Training discussion and precautionary materials list, Health and Safety Issues, Incident Reporting Information, Communications information, nearest hospital and directions, and Safety Coordinator contact information.

1. HEALTH & SAFETY OBJECTIVE

Fieldwork can be dangerous; however, all accidents are preventable, and with proper training and execution ecological field workers can conduct their tasks free from health and safety incidents. Every worker has the responsibility to look out for his or her own health and safety and address and/or report potential problems as they arise. All workers should discuss any questions or concerns with their supervisor and co-workers. The goal of the Los Cerritos Wetlands Health and Safety Plan is to conduct all fieldwork free from accidents. This Health & Safety Plan is not intended to cover every conceivable issue that might arise, but is meant to point out known potential risks of fieldwork at Los Cerritos Wetlands.

2. TRAINING & PRECAUTIONARY MATERIALS LIST

Prior to beginning fieldwork workers will be provided a copy of the Health & Safety Plan for their use. The fieldwork supervisor will discuss this Plan with the workers and address any issues. Listed below are precautionary materials to be worn on field workers or carried in field vehicles:

- Proper closed-toe footwear
- First-aid kit
- Copy of Health and Safety Plan
- Cell Phone
- Sunscreen and sun protection
- Adequate amounts of water
- Hard hat

3. H&S ISSUES

The following are the most likely issues to affect fieldworkers at Los Cerritos Wetlands. A standard first aid kit (including Benadryl for allergic reactions) and first aid manual should be included in every vehicle as standard field equipment. Workers should carry the first aid kit when they are working far away from their vehicle. It is every worker's responsibility to inform all co-workers and their supervisor of any pre-existing conditions that may affect their health and safety in the field and that may require special awareness by other workers (i.e. diabetes, allergies, vision or hearing impairments). Field teams should discuss health and safety issues when beginning a new work task and decide on appropriate responses to potential situations.

3.1 Oil Operations

Some potential Oil Operations hazards that field personnel may be exposed to during field activities are physical and chemical. The potential physical hazards at the site are active oil pumps and pipes. This oil infrastructure should be considered dangerous as contents may be flammable and explosive. Many pumps are activated automatically with moving parts that can cause serious harm or death if caution around them is not used. Avoid tampering with, standing on, or trying to move any oil operation infrastructure and treat all materials associated with oil operations as potentially dangerous. Additionally, other physical hazards associated with oil operations include razor wire, buried or exposed metal and overhead lines. Occasionally, oil company personnel may service their oil operation infrastructure. If overhead activities are present, hard hats are required and discussion with the on-site oil operation supervisor is necessary to make aware of fieldworker's presence and to determine specific dangers.

The potential chemical hazards at the site are petroleum vapors, hydrogen sulfide, benzene, and n-hexane. Exposure pathways to chemical hazards include skin contact, inhalation of vapors, and ingestion. Oil operations are monitored regularly for any imbalances regarding chemical hazards however all field workers need to be observant and aware of their surroundings when working around oil operations. If any irregular smells, lightheadedness or nausea is present or if any field worker feels faint or otherwise sick, it is necessary to remove oneself from the area as quickly as possible and contact the safety coordinator. Specific information and instructions regarding potential chemical hazards can be found in Appendix B.

3.2 Sunburn

Sunburn is one of the most likely health hazards. Each worker should wear protective clothing and use adequate amounts of sunscreen to avoid over exposure to the sun.

3.3 Dehydration

Each fieldworker should carry sufficient water or other drinks and drink regularly to ensure they do no become dehydrated.

3.4 Water Safety

A drowning hazard exists at the shoreline, along the San Gabriel River, along streams and channels, and at ponds. Some fieldwork may require wading in the water; though other than ocean tides and effluent from the power-plants there is generally no swift water at Los Cerritos Wetlands. If fieldwork requires work in water greater than four feet deep or from a boat a separate health and safety plan will be prepared for that activity (Note: boats should be licensed and boat operators should be certified). Every field worker should inform their supervisor of their swimming ability and workers should not be placed in situations they feel is beyond their ability to swim if the need arises. When working near water each worker should be aware of their surroundings and weather conditions (check local weather reports before beginning water work) and plan adequate escape routes where necessary. When working near water team members should always have a partner.

3.5 Plants

The most likely poisonous plants that will be encountered at Los Cerritos Wetlands is stinging nettle however each field worker's response to the many various plant species on site may be different and each field worker should take necessary allergy precautions. Each field worker should discuss these plants with their supervisor and learn to recognize the plants. Avoid contact with these plants where possible. Wear protective clothing to prevent exposure to skin when working near these plants. In event of stinging nettle exposure refer to general treatments in a first aid manual. There are other potentially dangerous plants due to sharp thorns, spines or barbs. Each worker should learn to identify the potentially dangerous plants and should discuss these plants with their supervisor. There is also a danger from being struck by falling tree limbs when working on site. Work should not occur near or under areas with trees on days when the wind is causing tree limbs to break and fall.

3.6 Wildlife

Los Cerritos Wetlands are wild lands and wild life is found on site. Coyotes are regularly seen on site. Coyotes rarely pose a threat to humans and it is best to avoid them when sighted. There have also been sightings of rattlesnakes in Los Cerritos Wetlands though they are not common. Fieldworkers should be aware of their surroundings and avoid stepping into areas or putting their hands into places that have not first been inspected. Mosquitoes occur at the Park and are most likely at night and early in the morning. Insect repellent can be used and protective clothing worn to help avoid mosquito and other insect bites. Wild bees, spiders and wasps also occur on site and should be avoided when observed in a work area; use special caution when working off trails because bees, spiders and wasps generally nest in the ground in areas with heavy leaf litter. Hantavirus, a respiratory disease potentially fatal to humans, is known from wild deer mice in California, though the presence of this disease in mice at Los Cerritos Wetlands is unknown. Rabies may also occur in some animals on site.

While uncommon, ticks have the potential to be found at Los Cerritos Wetlands during some seasons and may be difficult to avoid during fieldwork. Workers should wear light colored clothing where possible and regularly inspect for ticks that could be removed prior to biting. Insect repellants and wrapping pant-leg-bottoms may also help avoid tick bites. Each day after completing fieldwork workers should inspect their bodies for ticks.

Wildlife should not be handled unless otherwise discussed with supervisor and safety coordinator. Prior to handling any animals an activity-specific health and safety plan will be prepared to ensure workers receive any necessary inoculations, protective clothing, and instruction in safe handling of animals. In general, handling live mice out-of-doors in well ventilated areas is not a risk for hantavirus. Handling live mammals, such as mice, rats, rabbits, fox, and skunk has a risk of bites or scratches. Only persons with previous experience and training should attempt to handle live animals, and appropriate protective clothing, such as leather gloves, and restraint devices, such as capture bags, should be used.

3.7 Hiking
Dangers from hiking include slipping on uncertain ground, twisting ankles and falling onto hard surfaces. Workers should wear proper footwear and pay attention to where they are stepping when hiking. Slippery rocks are likely, especially at the shoreline and mudflats, so great care should be taken when rocks are wet or covered with vegetation.

3.8 Lifting
Some fieldwork requires lifting and carrying bulky or heavy objects. Each worker should not lift/carry more than they are able. When lifting heavy objects workers should use their legs to spare their backs, use lifting aids/tools where possible, and ask for help from fellow workers.

3.9 Getting Lost
Los Cerritos Wetlands are completely surrounded by urban infrastructure of roads and buildings. However, fieldwork often requires work off of established trails and it is possible to become disoriented. Workers should always inform their supervisor and safety coordinator where they are going to be and expected times of departure and return. Fieldworkers should take a cellular telephone when possible. Fieldworkers should carry a map, compass, and/or GPS unit.

3.10 Driving
Each field worker is expected to follow all driving laws when operating a vehicle. While driving on property, staying on designated roads is necessary. Each worker should receive instruction from his or her supervisor for proper techniques of off-highway vehicle use (on dirt roads). Any time a worker is uncomfortable with their ability to drive in a given situation they should inform the supervisor and a solution be developed. All accidents, no matter how minor, should be reported to and investigated by the local law enforcement. It is of special importance to drive no faster than 15mph on dirt roads on site and to not go off-trail in vehicles as uncertain ground and oil operations are many times directly adjacent to dirt roads.

4. REPORTING INCIDENTS
Affected field workers should immediately report any injury or health risk exposure to the safety coordinator. Immediate first aid should be used whenever necessary. An incident form should be completed after an incident as soon as reasonably possible and given to the safety coordinator (an example of the form is attached in Appendix D).

5. COMMUNICATIONS
If a team is working a considerable distance from a public telephone, a cell phone should accompany every team in the field and the phone numbers and phones be shared by the team members according to their needs during the fieldwork. Before each day of fieldwork a team member should report the status of the field team to the Safety Coordinator. If incidents occur during fieldwork, reporting such incidents by the end of that day’s work to the safety coordinator is necessary. This check-in is intended as a brief report that all hands are safe and accounted for.

6. HOSPITAL AND CONTACT NUMBERS

Call 911 for any emergency. The 2nd Street and Studebaker intersection is a good reference to use when contacting emergency personnel.

Hospitals:

The nearest hospital to Los Cerritos Wetlands, about 8.2 miles away, is:

Long Beach Memorial Hospital
2801 Atlantic Avenue, Long Beach, CA 90806
(562) 933-2000

Directions:
Proceed Northbound on Studebaker Road to the I-405 N exit. Merge onto the I-405 N and continue until the Atlantic Avenue exit. Exit the freeway at the Atlantic Avenue exit and Memorial Hospital will be on the left.

The nearest medical clinic, about four miles from the Park, is:

Kaiser Permanente
3900 East Pacific Coast Highway
Long Beach, CA 90804-2000
(310) 325-5111

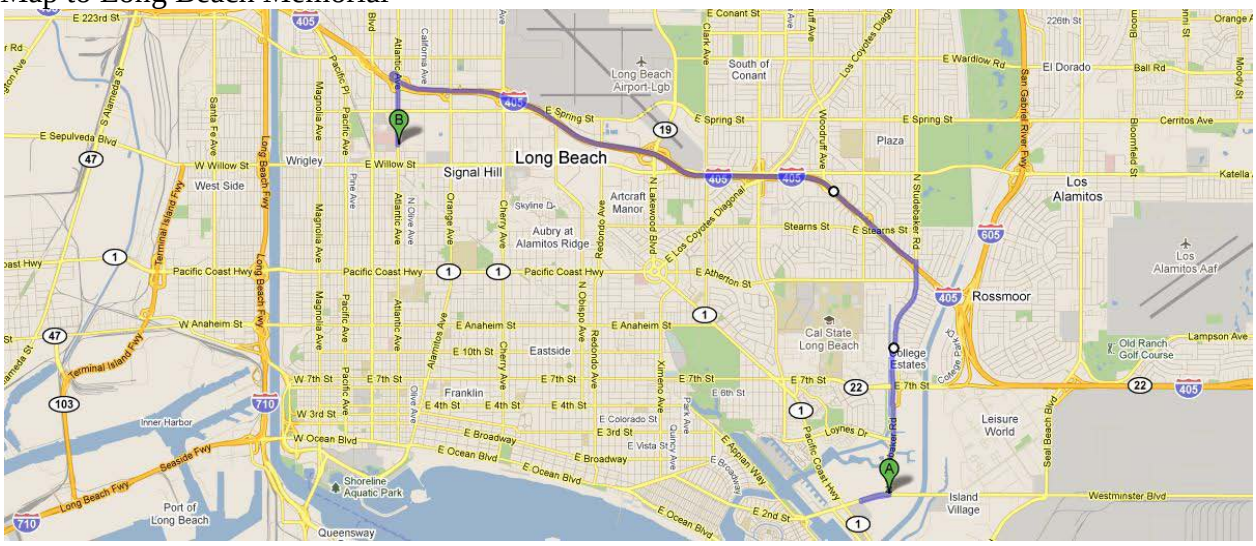
Directions:
Proceed Westbound on 2nd St. to Pacific Coast Highway. Turn left onto PCH and continue going North on PCH through the traffic circle. Kaiser Permanente will be on the left.

Safety Coordinator Contacts:

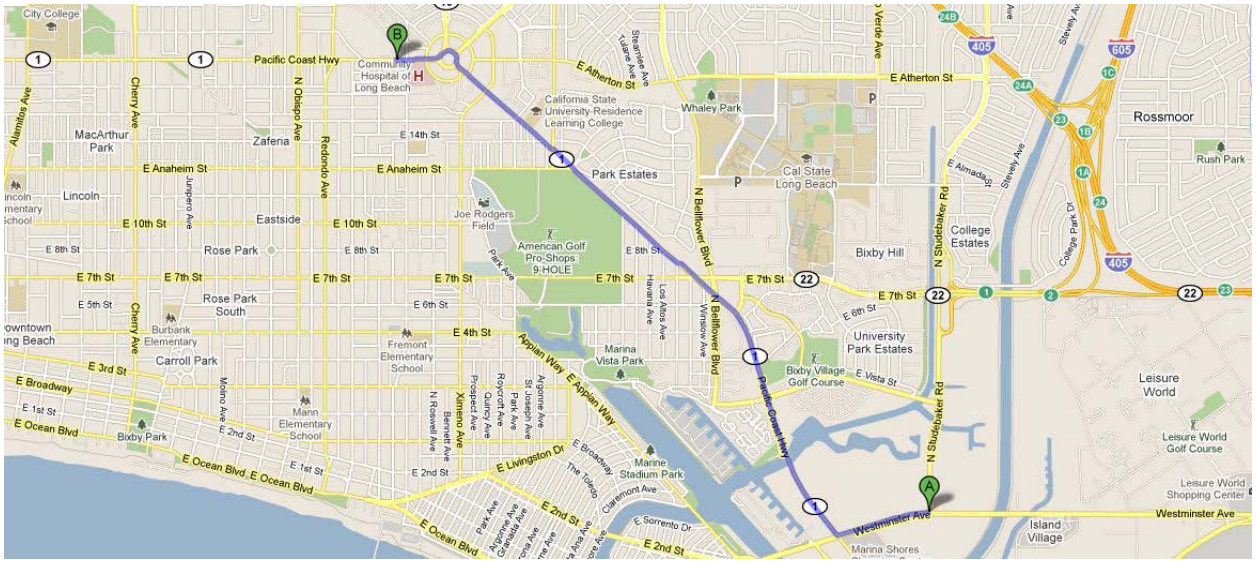
Taylor Parker – 562.331.0226
Eric Zahn – 858.353.6113

Appendix A
Maps to Hospitals

Map to Long Beach Memorial



Map to Kaiser Permanente



Appendix B:
Potential Chemical Hazards

Publication No. M10

DRILLING AND OPERATING OIL, GAS, AND GEOTHERMAL WELLS IN AN H_2S ENVIRONMENT

DIVISION OF OIL, GAS, AND GEOTHERMAL RESOURCES
WILLIAM F. GUERARD, JR., *State Oil and Gas Supervisor*

DRILLING AND OPERATING OIL, GAS, AND GEOTHERMAL WELLS IN AN H_2S ENVIRONMENT

by Murray W. Dosch
&
Susan F. Hodgson

SACRAMENTO
1981
1982
1986
1997

Foreword

The development of oil, gas, and geothermal resources in a hydrogen sulfide (H_2S) environment can be hazardous unless adequate safety precautions are taken. H_2S gas may be emitted from geothermal wells and power plants and from oil and gas wells, gas plants, and sweetening units during drilling, workover, production, injection, gathering, handling, storage, and transmission operations. H_2S gas is toxic to humans and very corrosive to metals, including high–strength steel.

The best protection against H_2S–related accidents is knowing where H_2S environments are likely to be found and being well–informed about safe drilling and operating methods within them. It is to these ends that the present manual has been prepared.

Any use of trade names and trademarks in this publication is for descriptive purposes only and does not constitute endorsement.

Contents

I. H_2S

TEST YOUR KNOWLEDGE

Poisoning by inhalation is the principal threat to human life from H_2S gas. **True or False**

When people are overcome by H_2S gas, immediately rush to their aid. **True or False**

You can rely on smelling the odor of rotten eggs when H_2S gas is in the vicinity. **True or False**

Cal/OSHA has set 10 ppm as the Permissible Exposure Limit (PEL) of H_2S in the air. **True or False**

H_2S gas released at a well site disperses evenly around the site. **True or False**

(Answers: True, False, False, True, False.)

CHARACTERISTICS

H_2S is a colorless, acidic gas, almost as toxic as hydrogen cyanide and between 5 and 6 times more toxic than carbon monoxide. H_2S gas may be present in crude oil and natural gas produced from oil or gas wells, and in hydrothermal fluids produced from geothermal wells. **Life threatening**

The principal threat of H_2S gas to human life is poisoning by inhalation. Whenever H_2S gas is present, respiratory protection is of extreme importance.

The sense of smell cannot be relied upon to indicate either the presence or the concentration of H_2S gas. **Toxicity**
Taste and Odor

TABLE AC-2
EXCURSION EXPOSURES

Skin [a]	Substance	PEL [b] ppm [c]	PEL [b] mg/M3 [d]	Excursion Limit	Excursion Duration [e]	Ceiling Limit
	Hydrogen sulfide	10	15	20 ppm	10 min/8 hrs	50 ppm

(a) Refer to Section 5155(d) for the significance of the Skin notation.
(b) For the definition and the application of the Permissible Exposure Limit (PEL), refer to Section 5155(b) and (c)(1).
(c) Parts of gas or vapor per million parts of air by volume at 25° C and 760 mm Hg pressure.
(d) Milligrams of substance per cubic meter of air at 25° C and 760 mm Hg pressure.
(e) Exposures to concentrations above the "excursion limit", but not exceeding the "ceiling limit", are permitted for a time period not to exceed the "excursion duration".

According to the California Occupational Safety and Health Administration (Cal/OSHA), the Permissible Exposure Limit (PEL) of hydrogen sulfide for an employee in an 8 hour work period is 10 ppm. If an employee is exposed to a concentration of hydrogen sulfide above 20 ppm but never above 50 ppm for a maximum period of 10 minutes during an 8 hour work period, these exposures must be compensated for by exposures to hydrogen sulfide concentrations less than 10 ppm during the same work day such that the permissible exposure limit of 10 ppm is not exceeded.

Lower concentrations

Lower concentrations of H_2S gas have a sweet taste, and the odor of rotten eggs can be detected. However, prolonged exposure to lower concentrations can cause injury or death.

Higher concentrations

Upon exposure to higher concentrations of H_2S gas (100 ppm or above), the sense of smell is impaired in 2 to 15 minutes due to paralysis of the olfactory nerve (National Safety Council). In addition, death from exposure to still higher concentrations of H_2S gas can occur from lung paralysis before any odor is detected.

TOXICITY OF H_2S GAS FOR HUMANS

H_2S ppm	0–2 Min	2–15 Min	15–30 Min	30 Min–1 Hr	1–4 Hr	4–8 Hr	8–12 Hr
50–100				Mild, conjunctivitis, respiratory tract irritation			
100–150		Coughing; irritation of eyes, loss of sense of smell	Disturbed respiration, pain in eyes, sleepiness	Throat irritation	Salivation and mucous discharge; sharp pain in eyes, coughing	Increased symptoms.*	Hemorrhage and death.*
150–200		Loss of sense of smell	Throat and eye irritation	Throat and eye irritation	Difficult breathing, blurred vision; light shy	Serious irritating effect.*	Hemorrhage and death.*
250–350		Irritation of eyes, loss of sense of smell	Irritation of eyes.	Painful secretion of tears, weariness	Light shy, nasal catarrh, pain in eyes, difficult breathing; conjunctivitis	Hemorrhage and death.*	
350–450		Irritation of eyes, loss of sense of smell.	Difficult respiration; coughing, irritation of eyes.	Increased irritation of eyes and nasal tract; dull pain in head; weariness, light shy	Dizziness, weakness, increased irritation; death	Death.*	
500–600	Coughing; collapse and unconsciousness.*	Respiratory disturbances; irritation of eyes; collapse.*	Serious eye irritation, light shy, palpitation of heart, a few cases of death	Severe pain in eyes and head, dizziness; trembling of extremities, great weakness, and death.*			
600–1,500	Collapse;* unconsciousness;* death.	Collapse;* unconsciousness;* death.*					

*Data secured from experiments on dogs, which have a susceptibility similar to men.
Source: National Safety Council data sheet D-chem 16.

NOTE:

Hydrogen sulfide concentration is expressed in two ways:

(a) By ppm in liquid by weight, and
(b) By ppm in vapor by volume.

There is a significant difference between the two measurements, and under certain controlled conditions, this difference can become extreme.

Chemists have measured a deadly concentration of 7,000 ppm in the vapor stream coming out of an opening of a tank being topped off with crude oil that contained only 70 ppm of H_2S as measured in the liquid. It is vitally important to remember that a hydrocarbon liquid such as sour crude oil containing 50 ppm of H_2S gas can release vapors at much higher and sometimes lethal concentrations.

Boiling point: –76°F

H_2S gas becomes less soluble in water as the water temperature increases.

Water solubility ratio:
4 volumes gas to 1 volume water at 32°F

H_2S gas is heavier than air. Because of this, H_2S gas becomes concentrated close to the ground, accumulating in low areas such as well cellars and ditches.

Heavier than air
(H_2S specific gravity = 1.192 [2]
Air specific gravity = 1.0)

Special precautions must be taken to prevent spontaneous ignition fires when vessels that have contained hydrogen sulfide are opened. Ignition is caused by the reaction of *iron sulfide* with air to form *iron oxide*. The conversion of the sulfide to oxide generates enough heat to ignite flammable vapors.

Ignition temperature:
500°F (Highly flammable)

To prevent these spontaneous fires, iron sulfide on container surfaces or sulfide sludge inside the tanks or vesssels must be kept wet, with water, until the vessels are gas–free.

Explosive range:
4.3% – 45.5% by volume [2]
(Forms explosive mixtures with air or oxygen)

H_2S gas burns with a blue flame, producing sulphur dioxide (SO_2) gas that is very irritating to the eyes and lungs. SO_2 gas is less hazardous than H_2S because the odor is so pungent at nonfatal concentrations that humans cannot stand to be around it. However, like H_2S gas, SO_2 gas can cause serious injury as well as death to persons exposed to it.

Blue flame; SO_2 produced

TOXICITY OF **SO_2** GAS FOR HUMANS

1 ppm	Pungent smell may cause respiratory changes.
5 ppm	Safe for eight–hour exposure. Normally, a person can detect the gas in this concentration range.
12 ppm	Throat–irritating cough, constriction of the chest, tearing of the eyes.
150 ppm	So irritating that it can only be endured for a few minutes.
500 ppm	Causes a sense of suffocation, even with first breath.
1,000 ppm	Will cause death with short–term exposure.

[2] Superior figures refer to entries in a list of references at the end of the report.

II. Drilling and Operating Oil, Gas, and Geothermal Wells

Many oil, gas, and geothermal wells have been drilled and operated successfully in an H_2S environment. No mishaps occurred when wells were properly planned and safe drilling and operating methods for H_2S areas were used.

While drilling and operating a well, safety meetings should be held routinely to review H_2S safety practices and to train personnel to use detection equipment and air breathing equipment.

Drilling and operating wells safely in an H_2S environment is not possible without proper well site design. To design a safe site, these factors must be known: weather conditions including wind speed and direction; terrain; site space available; and whether the site is in an urban or a rural area.

SAFETY FIRST

WELL SITE PLANNING

(Many suggestions in this section are taken from API publication RP49, *Safe Drilling of Wells Containing Hydrogen Sulfide*. The API has requested that "Section I, Scope," of publication RP49 be reprinted here, as well.)

SECTION I, SCOPE

1.1 Drilling operations where hydrogen sulfide may be encountered should include provisions to use the safety guidelines outlined in this publication. These guidelines should be administered where there is a reasonable expectation that hydrogen sulfide gas–bearing zones will be encountered that could potentially result in atmospheric concentrations of 20 ppm or more of hydrogen sulfide. These are requirements for deep, high pressured wells located in or near a populated area.

1.2 Several factors, including but not limited to hydrogen sulfide content, potential surface pressure, potential flow characteristics, and geographical location, may dictate modifications or exceptions to the recommendations set forth herein. These safety recommendations have been developed, considering land locations with unconfined areal boundaries, to safeguard personnel at the rig site and surrounding area and to minimize risk exposure to rig equipment. Recognizing that there are many locations with confined boundaries (such as locations found in marsh, marine, urban, and mountainous areas), attention should be given to safety recommendations resulting from these geographical limitations. Additional safety guidelines for these confined locations are set forth under Section 4, "Location".

1.3 Recommended safety procedures on rank wildcat drilling operations should be initiated immediately after setting of the intermediate casing string. On development wells or wells where knowledge of formation type allows good correlation, recommended safety procedures should begin well in advance of reaching a depth where hydrogen sulfide may be encountered.

Site size

A well site planned for an H_2S environment should be larger than usual, i.e., larger reserve pits, turnaround room, etc. The extra room allows for a greater margin of safety in well site activities.

Access routes

Two access routes to the well site are needed so safe site entrance and exit routes are always available. Access routes to the well site should be planned so they can be barricaded if H_2S emergency conditions arise.

Passageways

Unobstructed passageways are needed between well site areas, including easy access between the rig floor and the drill stem test head if a drill stem test is made.

Ventilation

Drilling rig ventilation

The drilling rig should be placed so that prevailing winds blow across the rig towards the reserve pits.

Allow for adequate ventilation on the rig floor. In addition, take down the rig curtains and windbreakers when drilling approaches sour gas production zones. Remove all canvasses at drill stem testing time and make use of blower fans at the rotary and shale shaker.

Use every precaution to prevent the escape of gas into the air.

Wind streamers

Erect at least three sets of wind streamers on streamer poles to give wind directions at tree top level, draw works level, and at a level 8 feet above the ground.

All wind streamers should be visible from the rig floor and illuminated at night.

Bug blowers

There should be three, explosion–proof bug blowers:

1. One blowing across the cellar area towards the pits;
2. One blowing across the rotary table; and
3. One blowing on the derrick work board to remove gas fumes near the derrickman.

Well site buildings

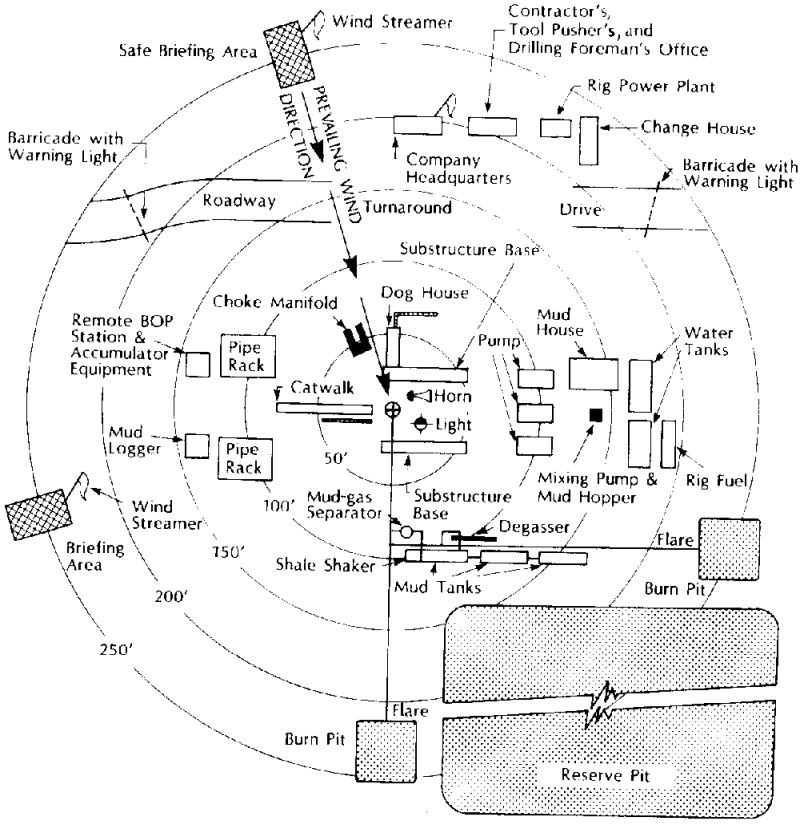
Well site buildings should be located on rises when the terrain is uneven. All buildings should be placed upwind from the well bore or any anticipated gas source.

Well cellars

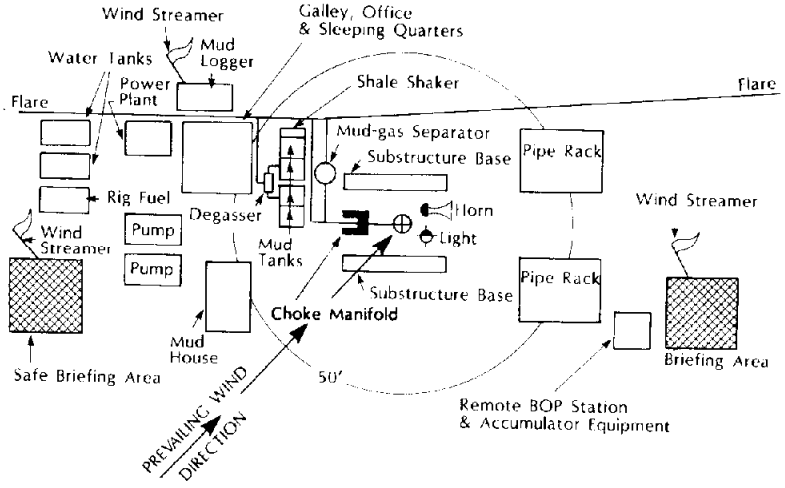
In areas such as Santa Maria where highly toxic H_2S gas is produced with crude oil, operators should eliminate well cellars whenever possible. Any new cellars should not be more than 2 ½ feet deep.

Mud tanks

Place mud tanks away from the substructure to maximize the movement of fresh air around the cellar. This will lessen the danger if any gas breaks out of the mud.



Typical drilling equipment layout—unconfined location. After API publication RP49. Reprinted with permission.



Typical drilling equipment layout—confined location. After API publication RP49. Reprinted with permission.

BOP equipment

The prevailing wind directions should be identified. Controls to operate blowout prevention equipment should be placed upwind, a safe distance from the well.

An auxiliary closing unit should be provided that can be activated when the primary controls are not accessible.

The installation of the BOPE choke manifold system, including pipe and choke, should be planned carefully. The choke should be located far enough from the rig to remain operational if trouble develops. Before all piping, collars, flanges, and valves are placed in the system, care must be taken to see that they are made of proper materials.

BOPE choke manifolds should be supported and anchored to withstand pressure and vibration. Flow lines laid with 90 degree turns and sharp bends create the most serious hazards. Be sure the flow lines are anchored properly and not plugged with mud.

Conduct BOPE drills. When each crew member knows how to handle a task, the training pays off in an emergency.

The warning signs for wells in H_2S areas are similar to signs occurring when any gas is encountered:

1. Drilling breaks;
2. Pit mud gains;
3. Mud weight decreases; and
4. Wells trying to flow.

Briefing areas

Two or three, cleared, briefing areas should be designated that are at least 225 feet from blowout prevention equipment so they offset prevailing winds perpendicularly (or at a 45° angle if wind direction tends to shift in the area). Self–contained breathing equipment for the crew and on–site personnel should be kept in each of the briefing areas so equipment would not have to be moved with shifts in the wind.

The briefing area most upwind is designated as the "Safe Briefing Area". In an emergency, personnel must assemble at this upwind area for instructions from their supervisor.

Logging units

Consider terrain and prevailing wind when locating logging units. Place logging units away from the shale shaker mud tank and at least 125 feet from BOPE areas to eliminate congestion and increase safety for all.

Electrical generators

Locate electrical power generators at least 150 feet from BOP equipment to reduce the danger of an explosion and to allow the generators to be used under conditions when they otherwise would be shut down because combustible gases are present.

Flare areas and flare lines

Depending on the environment, it is usually safer to burn H_2S gas than to let it blow into the atmosphere. Primarily, burning H_2S gas produces sulfur dioxide (SO_2). The heat carries the SO_2 and H_2S gases high into the air, mixing them with a greater volume of air, thereby lowering the concentration of the H_2S.

Photo 1. Flare gun used to ignite H_2S flared at the well site. Upon ignition, the H_2S is converted to SO_2. *Photo by Murray Dosch.*

Two flare areas should be located 90 degrees from each other. The flare areas should be at least 150 feet from the rig and other installations to protect workers during testing and trouble periods. The ground should be cleared around flare areas to prevent brush and grass fires.

Two flare lines should be installed with proper valves so the flow can be transferred from one pit to the other at any change in wind direction. Install flare lines to the burn pits from the degasser, choke manifold, and mud/gas separator. The diameters of the flare lines should be large enough to allow easy, unrestricted flow of H_2S.

Flow lines and flare lines should be targeted with running tees and staked securely. Flow lines to flare areas should be as long (150 feet, minimum) and as straight as possible, free from 90 degree turns. After installation, flare lines should be tested with air, natural gas, or butane to ensure proper operation.

Every effort should be made to keep H_2S flare lines lighted at all times. This may be done with burning pots or a propane pilot light. Special flare gun shells are a relatively safe means of lighting a flare. A combustible gas indicator should be provided for identifying the presence of an H_2S gas mixture.

Lay a kill line of ample strength to a point from which fluid can be pumped into the well safely.

Emergency relief valves and vent lines

Place emergency relief valves and vent lines a safe distance from work areas. When venting into the atmosphere is unsafe, the H_2S gas should be disposed of inside a closed system.

Miscellaneous equipment

All lines, fittings, valves, etc., should be installed and maintained in a manner that eliminates all gas and oil leaks.

All electrical wiring, devices, and lights should be vapor proof to reduce the possibility of explosion.

The use of ground level tank gauges, automatic custody transfer units, and vapor recovery systems reduces the exposure of personnel to H_2S gas.

Photos 2a and 2b. Emergency equipment: stretcher, rope, safety harness, resuscitator with an oxygen tank, fire blanket, and first aid kit. *Photos by Ed Hickey and Murray Dosch.*

Heaters used on the rig floor and in the doghouse should be flameproof and MUST BE TURNED OFF when H_2S is first encountered.

Fire extinguishers

At least five 30–pound dry–chemical fire extinguishers should be located at strategic positions at the drill site.

Other emergency equipment

Wall–type first aid kits with standard contents should be mounted at the safe briefing areas and in the trailers.

Two 500–foot rolls of 400 pound–test, soft, fire–resistant rope should be provided to use as safety lines.

A rigid, body–fitting litter should be in a location accessible from the work area.

Outside communication

Telephone or radio communication should be available at the rig. Each employee should know how to contact the nearest doctor and hospital. Post these numbers near the telephone or radio.

Warning signs

"Warning", "Keep Out", and "Keep Off Rig Floor" signs should be hung at the well site and at well site approaches to keep unauthorized people away from well sites and to warn others unfamiliar with the dangers of H_2S gas.

"No Smoking" signs should be placed in areas adjacent to the wellbore, rig floor, and mud pits.

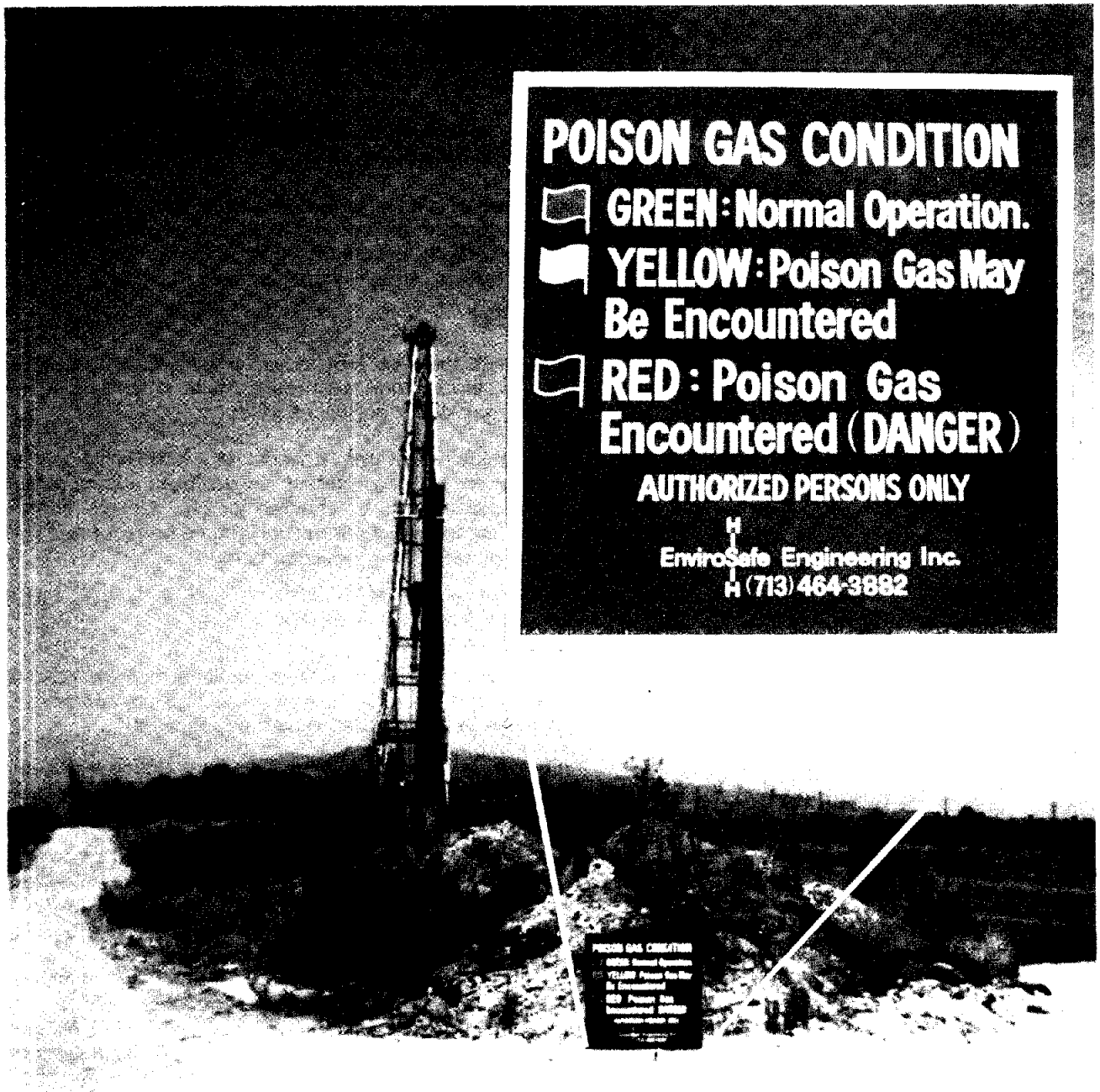


Photo 3. Well site sign describing poisoneous gas conditions. *Photo by Murray Dosch.*

Radius of exposure

To calculate potential well area toxicity from H_2S emissions, it is necessary to know the volume of oil or gas produced and the concentration of the hydrogen sulfide in the oil or gas.

From these data, the radius from the source to the 300 ppm and 100 ppm–H_2S concentration units can be determined on scales as shown in the examples. Potential sources of toxic gas emissions include wells and production, treatment, processing, and storage facilities.

The most stringent safety precautions must be undertaken in the areas with the highest concentrations of H_2S.

Contingency plan

The locations of all structures within the exposed areas should be noted on a map. It is essential that all occupied buildings be marked and a list compiled of the number and names of the occupants and their telephone numbers. Contact with these people should start once drilling begins, to explain the hazards and the fact that evacuation might be necessary if an emergency develops. Procedures to notify these persons in an emergency should be worked out before drilling begins.

Because of high–pressure dispersion, the probability of a lethal concentration of H_2S extending beyond a 1–mile radius is unlikely, except on a dead–calm day with a tremendous release of heavily concentrated vapors.

Livestock

Livestock must be moved out of pastures in hazardous zones before a drill stem test is made. Animals are overcome quickly by poisonous gases.

SERVICE OR WORKOVER RIG OPERATIONS

Before equipment from a service or workover rig enters a well where H_2S was present, the wellhead, casing, tubing, and gauges should be checked for H_2S damage. Furthermore, the following information should be requested from the exploration or production company:

1. Date of the last H_2S test;
2. Who tested the well; and
3. Test results.

In addition to these steps, the procedures recommended for drilling and operating a well in an H_2S environment, as outlined in this chapter, should be followed.

PRODUCTION

Warning signs

Danger signs should be posted at all production tank batteries where the thief hatch reading for H_2S has reached or could exceed Cal/OSHA standards. The sign should say:

> DANGER
>
> HYDROGEN SULFIDE
>
> Self–contained breathing equipment must be worn when opening tank hatches.

Facilities inspection

Regular preventative maintenance and safety inspections should be made to detect leaks and prevent malfunction of equipment. Inspected items should include tank hatch seals, tank vent lines, and relief valves.

Use the Pasquill–Gifford equation to determine the location of the 100 ppm radius of exposure:

$X = [(1.589)\ (\text{mole fraction } H_2S)\ (Q)]^{(.6258)}$

Where:

X = radius of exposure in feet

Q = maximum volume determined to be available for escape in cubic feet per day

H_2S = mole fraction of hydrogen sulfide in the gaseous mixture available for escape

In making dispersion calculations, the values used in the equation shall be specific well or facility ones and not averaged lease figures.

Calculation of volume of produced gas:

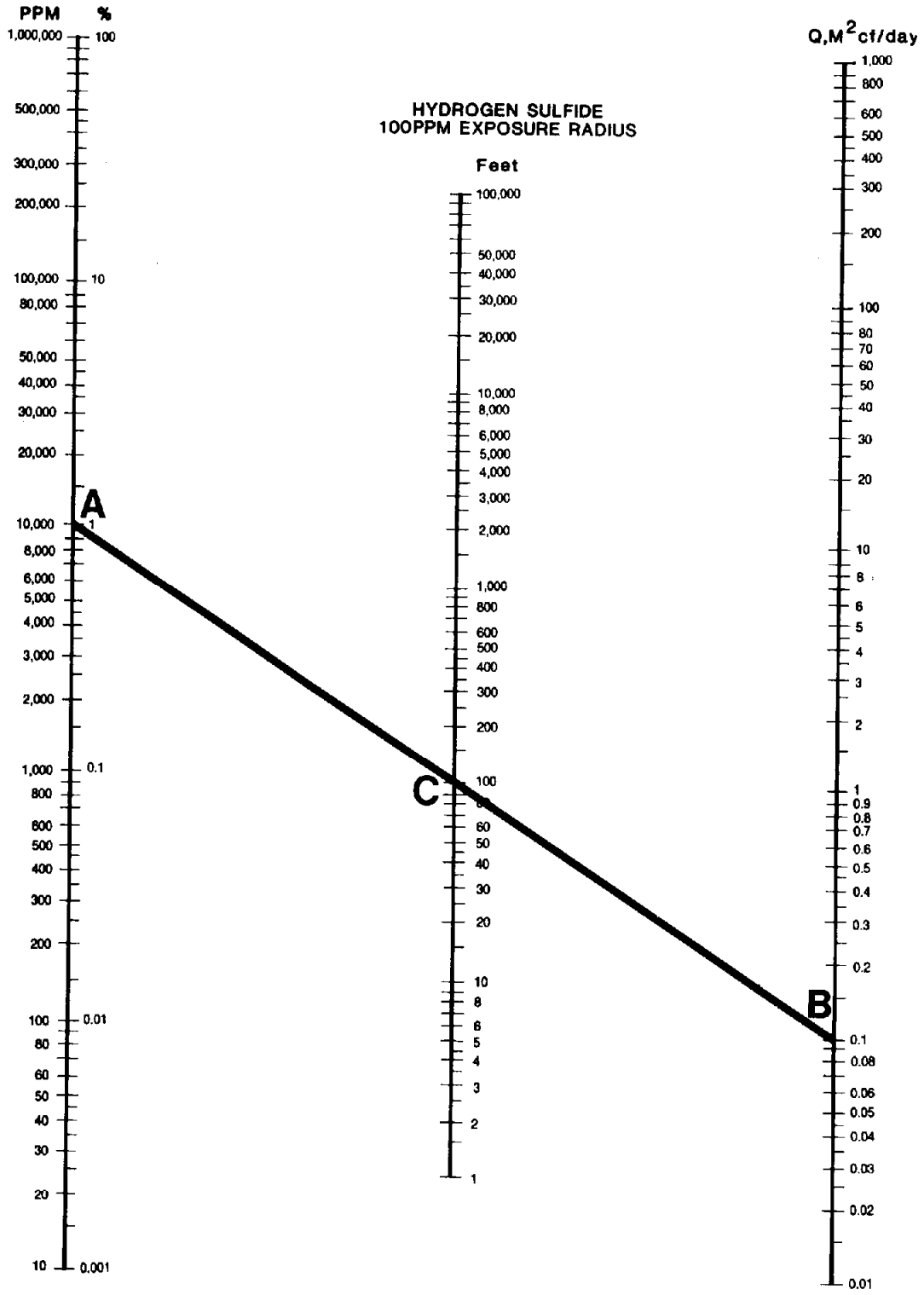
The volume used as the escape rate in determining the radius of exposure shall be that specified below, as is applicable:

a. The maximum daily volume rate of gas containing hydrogen sulfide handled by that system element for which the radius of exposure is calculated.

b. For existing gas or geothermal wells, use the current adjusted daily open–flow rate, or the operator's estimate of the well's capacity to flow against zero back–pressure at the wellhead.

c. For new wells drilled in developed areas, the escape rate shall be determined by using the current adjusted open–flow rate of offset wells, or the field average current adjusted open–flow rate, whichever is larger.

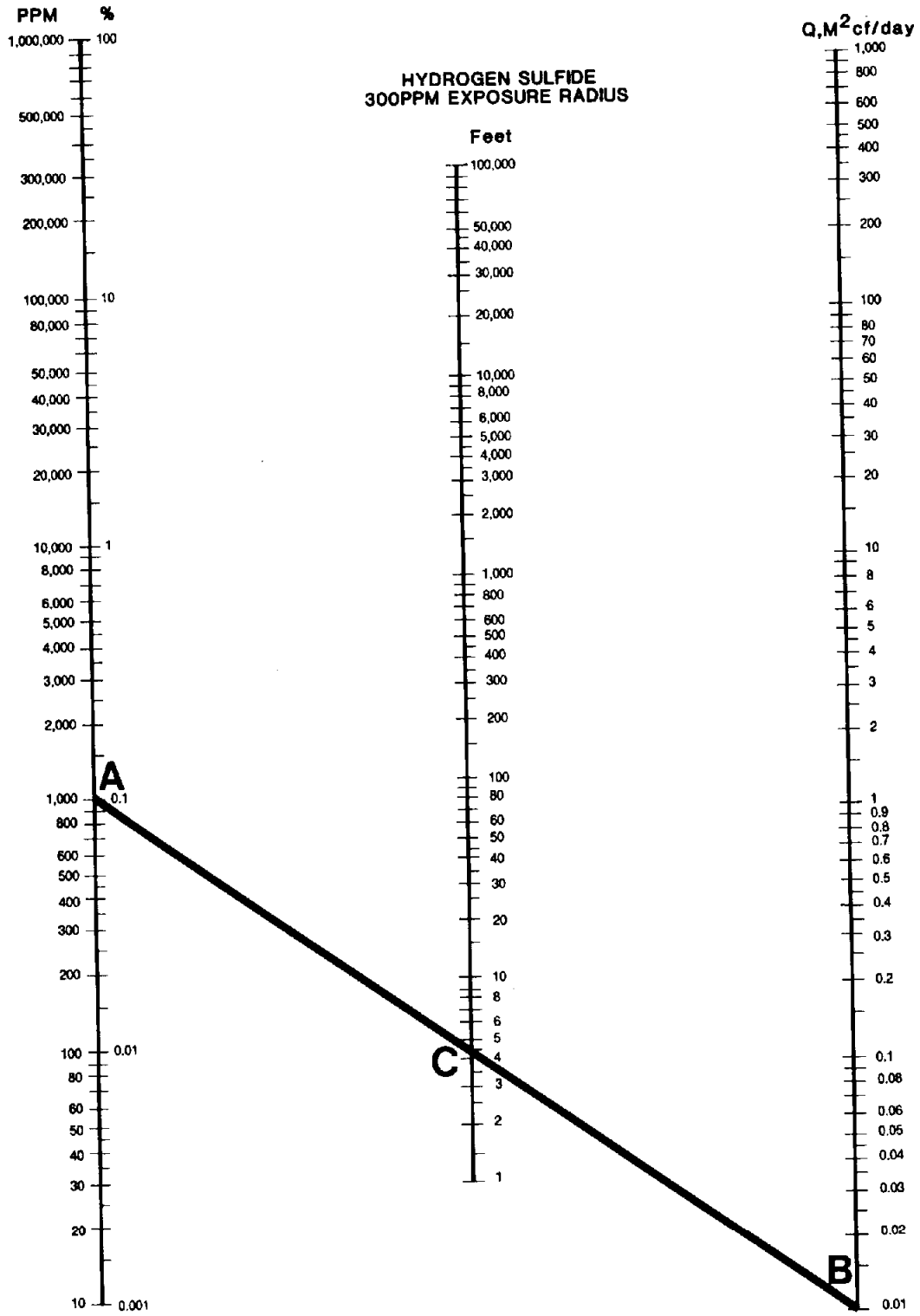
d. The escape rate used in determining the radius of exposure for oil and gas wells shall be corrected to standard conditions of 14.7 psia (California) and 60° F.



Example:

A = H_2S concentration of 10,000 ppm.
B = H_2S emissions of 100,000 cu. ft./day.
Connect points A and B to find the H_2S 100 ppm exposure radius of 100 ft. (C).

Scales to determine H_2S 100 ppm exposure radius.



Use the Pasquill–Gifford equation to determine the location of the 300 ppm radius of exposure:

$$X = [(1.0218)\ (\text{mole fraction } H_2S)\ (Q)]^{.6258}$$

Where:

- X = radius of exposure in feet
- Q = maximum volume determined to be available for escape in cubic feet per day
- H_2S = mole fraction of hydrogen sulfide in the gaseous mixture available for escape

In making dispersion calculations, the values used in the equation shall be specific well or facility ones and not averaged lease figures.

Calculation of volume of produced gas:

The volume used as the escape rate in determining the radius of exposure shall be that specified below, as is applicable:

a. The maximum daily volume rate of gas containing hydrogen sulfide handled by that system element for which the radius of exposure is calculated.

b. For existing gas or geothermal wells, use the current adjusted daily open–flow rate, or the operator's estimate of the well's capacity to flow against zero back–pressure at the wellhead.

c. For new wells drilled in developed areas, the escape rate shall be determined by using the current adjusted open–flow rate of offset wells, or the field average current adjusted open–flow rate, whichever is larger.

d. The escape rate used in determining the radius of exposure for oil and gas wells shall be corrected to standard conditions of 14.7 psia (California) and 60° F.

Example:

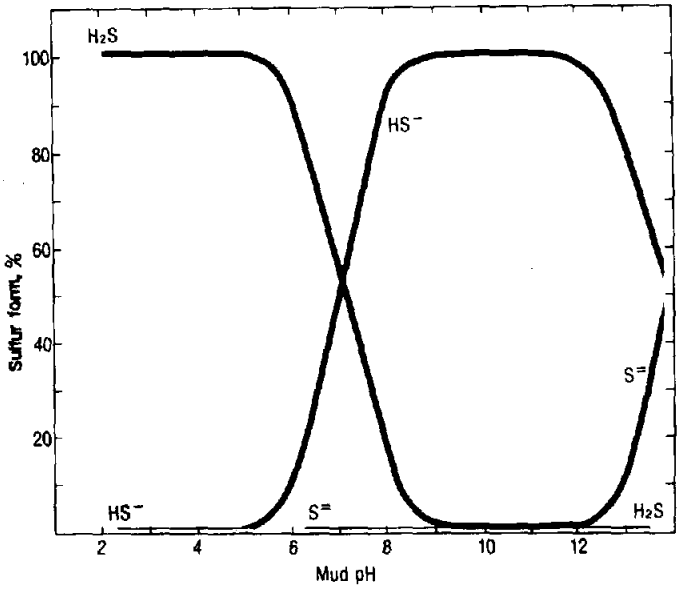
A = H_2S concentration of 1,000 ppm.
B = H_2S emissions of 10,000 cu. ft./day.
Connect points A and B to find the H_2S 300 ppm exposure radius of 4.5 ft. (C).

Scales to determine H_2S 300 ppm exposure radius.

H_2S GAS CONTROL IN DRILLING MUD[10 (March 1980)]

H_2S gas control in drilling mud means, first, a mud sufficiently alkaline to neutralize the acidic, H_2S gas and to form soluble sulfide salts. The drilling fluid pH level should be maintained above 9.5 at all times.[2] In some cases, this may mean a pH of 11.5 to prevent a pH reduction below 9.5 while tripping the drill string.

For further H_2S gas protection, heavy metal compounds are added to the mud as scavengers, precipitating the soluable sulfides salts as insoluable metal sulfides.[8] Once, copper compounds were common as scavengers. Today, they are not recommended because of electronic corrosion of copper against iron.[17]



Hydrogen sulfide in solution. [10 (March 1980)]

Mud types	H_2S presence on coupons	Hydrogen embrittlement	Corrosion rate (MPY)
1. Invermul (3 lb/bbl lime)	No	No	5.30
2. Invermul (8 lb/bbl lime)	No	No	3.99
3. Low lime	No	No	3.23
4. High lime	No	No	3.42
5. Non dispersed – low lime with saturated salt, polymer, starch	Yes	Yes	26.60
6. Lignite/lignosulfonate (starting pH 9-11)	Yes	Yes	107.47
7. Lignite/lignosulfonate (starting pH 11)	Yes	Yes	70.02

Effect of mud type on corrosion.[10 (March 1980)] Series of tests using mild steel coupons and prestressed bearings contaminated with 2,400 ppm H_2S rolled 16 hr at 150°F. MPY= mils/year. (From N.L. Baroid)

Dissolved gas	Decrease from air-endurance limit, %
H_2S	20
CO_2	41
CO_2 + Air	41
H_2S + Air	48
H_2S + CO_2	62
Air	65

Corrosion fatigue of steel in brine.[10 (March 1980)]

Analyzing drilling mud

The iodometric method is one field method of analyzing drilling mud for H_2S gas. This method shows trends of sulfides in strata and allows sulfides to be measured over a 0 to 200 ppm–concentration range.

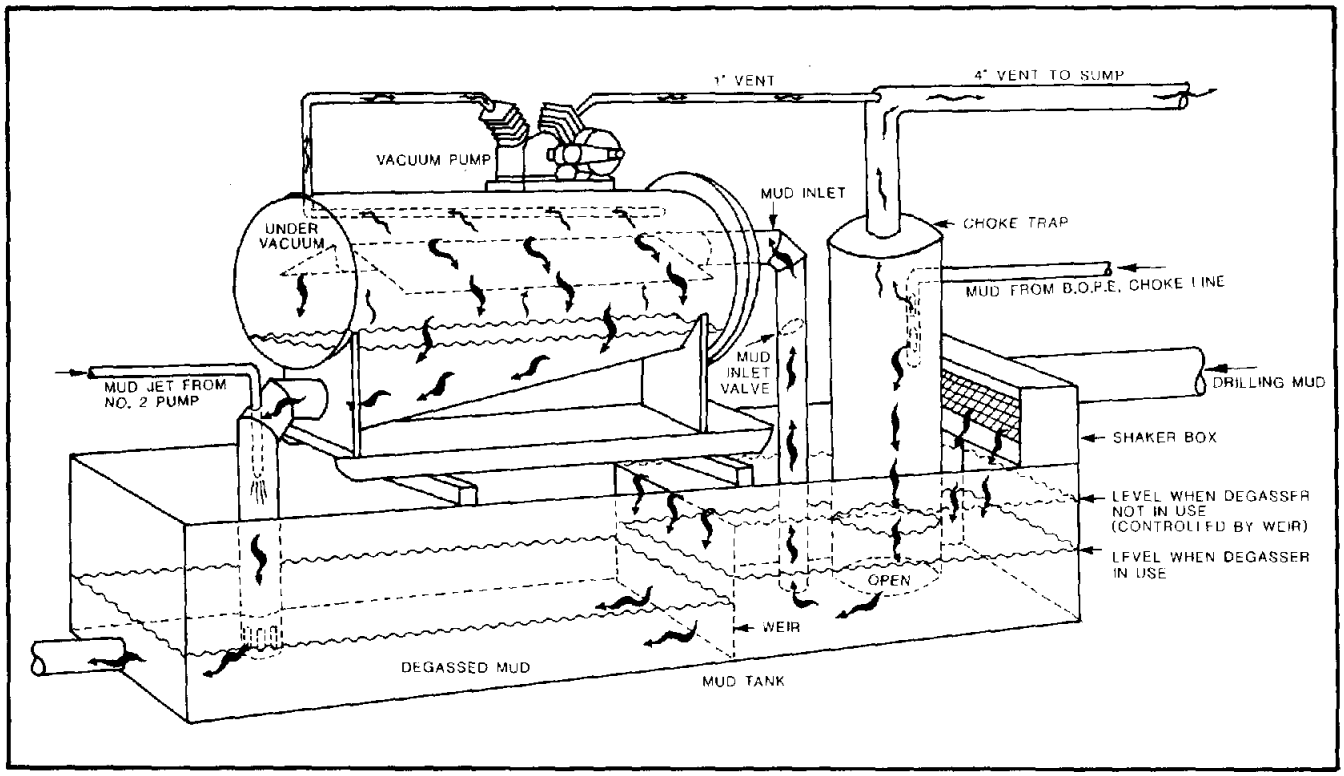
Mud degassers

When gas cutting of drilling mud occurs, the blowout preventers are closed immediately and normal circulation maintained through the choke lines (choke wide open) to the choke trap.

The choke trap is a barrel–like apparatus suspended upside down in the shaker tank with the lower lip of the barrel below normal mud level. The mud and gas flow into the side of the barrel. A four–inch vent line leads from the top of the barrel to a safe distance from the mud stream in the choke trap, and the gas can be vented and flared safely through the four–inch line.

The mud containing residual gas passes out the bottom of the choke trap and enters a degasser installed for separating gas from the drilling fluid between the first and second mud tanks. The degasser operates under a vacuum of 10–20 inches of mercury, extracting virtually all of the remaining gas by allowing the mud to flow over a series of baffles.

Vacuum in the degasser is maintained by a jet on the discharge side of the degasser and by a vacuum pump mounted on the top. The vacuum pump discharge should be vented at a safe distance from the rig and flared, if necessary. A partition in the mud tank, between the intake and the discharge of the degasser, separates the gas–cut mud from the degassed mud. The jet is operated by the standby mud pump.



Hook–up for SWACO degasser and choke trap.

Adequate ventilation and, where necessary, air blowers are generally employed to keep the rig floor and the area under the rig floor relatively free of any residual H_2S gas. The use of lime mud with a high pH also assists in minimizing the hazards of H_2S by neutralizing the gas in the well bore. Mud additions of 500 to 1,000 pounds of both caustic and lime are frequently employed for this purpose when the mud becomes gas cut.

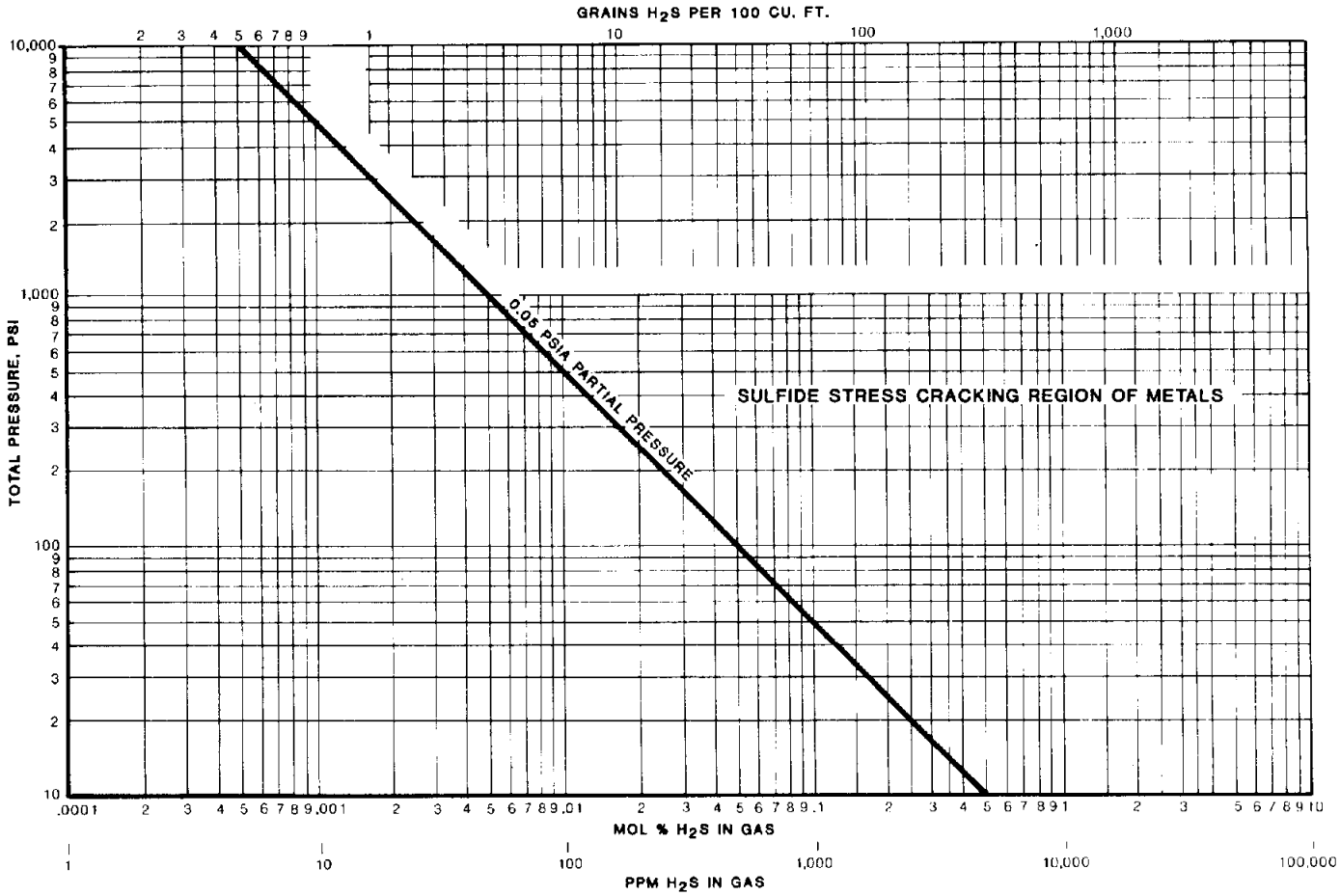
Normally, after circulating for a few hours with the blowout preventers closed, the amount of gas will decrease to the point where the blowout preventers can be opened and drilling operations resumed without using the choke trap.

The degasser will continue to be employed until the mud is gas free. This may take up to one to two days of more–or–less continuous operation. If the gas cutting exists for longer periods, usually a small amount of weight material will be added to the mud. Normally, this will eliminate the continuous type of gas cutting, although trip gas still may persist.

Trip gas is handled with the degasser; and, if it is severe, the blowout preventers are closed again and the flow turned through the choke trap for a few minutes.

EMBRITTLEMENT

H_2S gas is very corrosive to metals, including high–tensile



Correlation between partial pressure of H_2S in mole percent and H_2S content in grains per 100 cubic feet with total pressure. From the National Association of Corrosion Engineers Publication No. MR–01–75: *Material Requirements-Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Equipment.*

steel, which H_2S can embrittle. Drilling mud especially formulated for an H_2S environment reduces the reaction of H_2S with the drill string, tool joints, pump fluid ends, choke, and piping.

Minimizing embrittlement

To minimize embrittlement:

a. Select tubular goods, wellhead equipment, and other drilling–related equipment with metallurgical properties most resistive to H_2S embrittlement;

b. Avoid exposing high strength drill pipe to H_2S gas;

c. Use drill pipe coated internally with plastic (effective only in preventing exposure of pipe bore to H_2S gas encountered during drill stem testing or drilling);

d. Maintain mud pH at 9.5 or higher;

e. Limit periods of drill stem testing with marginally susceptible drill pipe to one hour if gas containing H_2S flows at less than 1,000 Mcf per day, or 15 minutes if gas containing H_2S flows at more than 1,000 Mcf per day.

f. Use an inhibitor in the water cushion prior to the drill stem test when H_2S exposure is anticipated.

g. Flush out the drill stem through the pump–out sub following drill stem tests and prior to handling the pipe on a trip out of the hole. Use an inhibited mud or solution to clean the pipe as quickly as possible.

h. Use appropriate inhibitors in the mud system. Although many inhibitors are sold for sulfide–stress corrosion control, the best seem to be the filming–type amines. Both soluble and insoluble types are available for direct application to metal, plug–type addition, and continuous addition to the mud system.

i. Use care in out–of–hole handling of susceptible pipe that has been exposed to embrittling conditions. Special care should be exercised in use of tongs and slips to avoid the introduction of localized high stresses at notches.

j. Minimize down–hole stresses in the drill string.

III. Detection Devices and Protective Equipment

H_2S DETECTION METHODS

Related material: Entry No. 10 in Selected References.

Hydrogen sulfide monitor

A quantitative, electronic hydrogen sulfide monitor has been designed for permanent 24-hour-a-day operation in a fixed location on oil, gas, and geothermal rigs and production facilities. It can have from 1 to 12 channels on which sensors are attached. The sensors are positioned around the rig in low areas, including the bell nipple, shale shaker, rig floor, and mud pits. The monitor is placed in a conspicuous place and monitors the channels separately. The monitor has a needle indicator that gives a continuous readout, in parts-per-million, of H_2S concentrations. The system is usually equipped with a strobe light that activates at a certain gas concentration, and an audio alarm that automatically sounds when higher concentrations are present. The monitor must be calibrated and checked periodically to ensure proper functioning.

Paper detector

The paper used in paper H_2S detectors has been impregnated with lead acetate that , when exposed to H_2S, forms lead sulfide. Lead sulfide changes the paper color to shades of brown, depending on the concentrations of H_2S.

Badge- or spot-type detectors can be worn or carried by workers, and the paper can be changed after exposure.

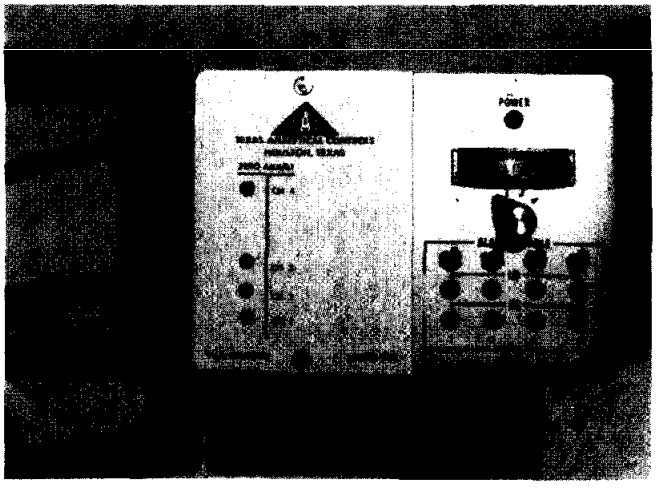


Photo 4. Electronic H_2S monitor. The 4-channel monitor, built by Texas Analytical Controls, Inc., measures H_2S concentrations between 0 and 50 ppm.

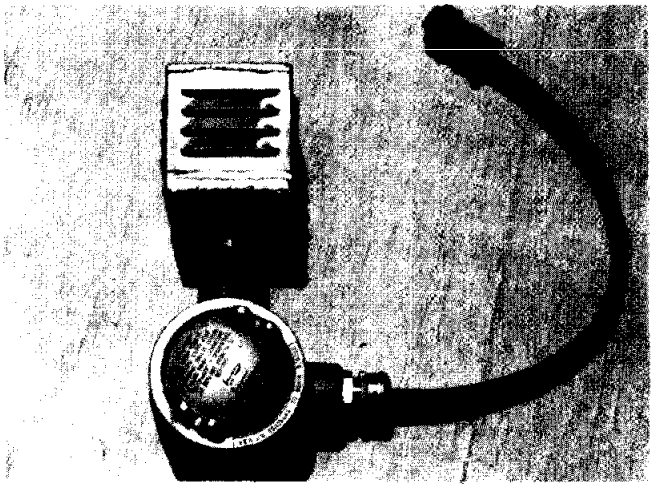


Photo 5. Sensor head for an H_2S monitoring system. Sensor heads should be placed at the bell nipple, shale shaker, mud pits, and rig floor. *Photo by Ed Hickey.*

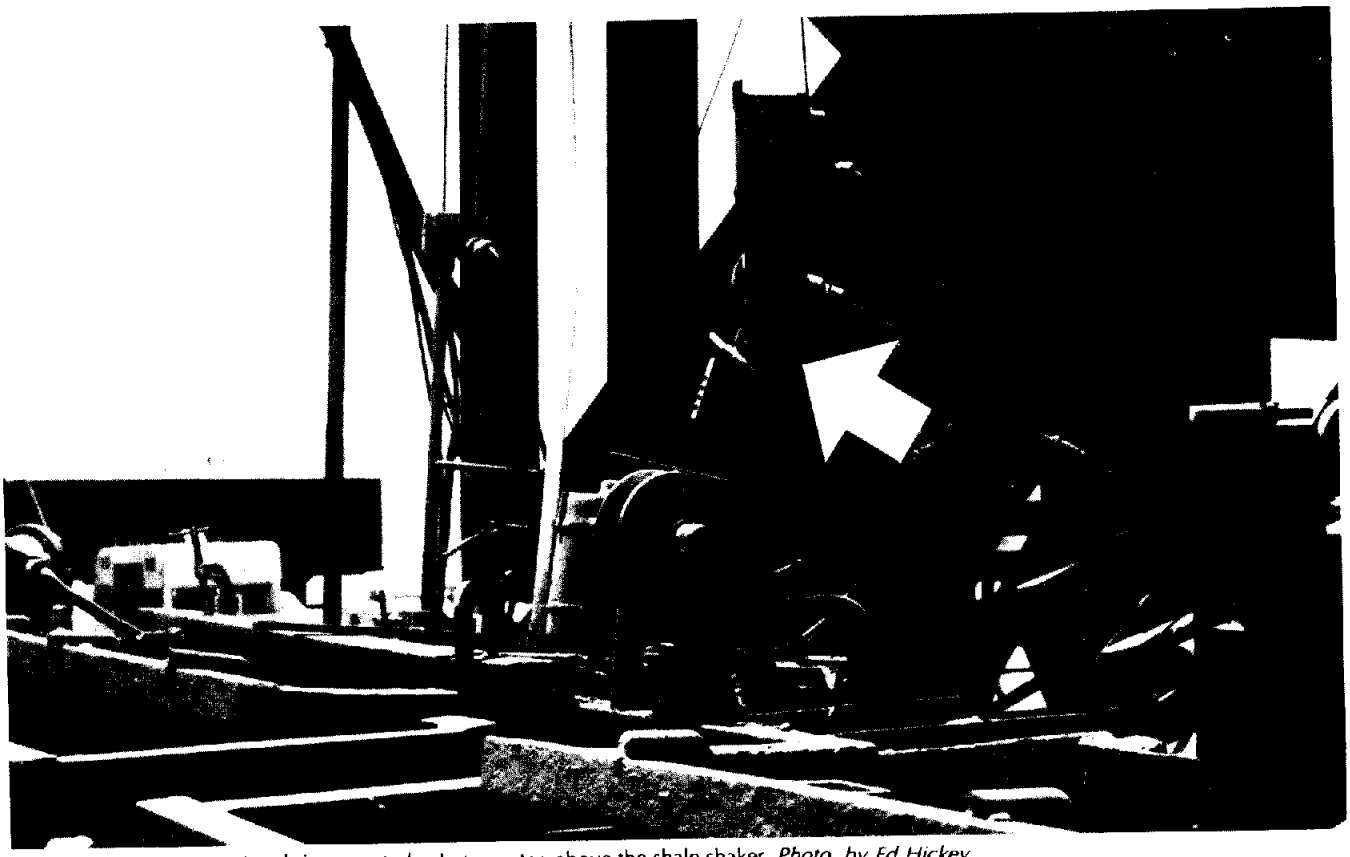


Photo 6. H_2S sensor head is mounted, photo center, above the shale shaker. *Photo by Ed Hickey.*

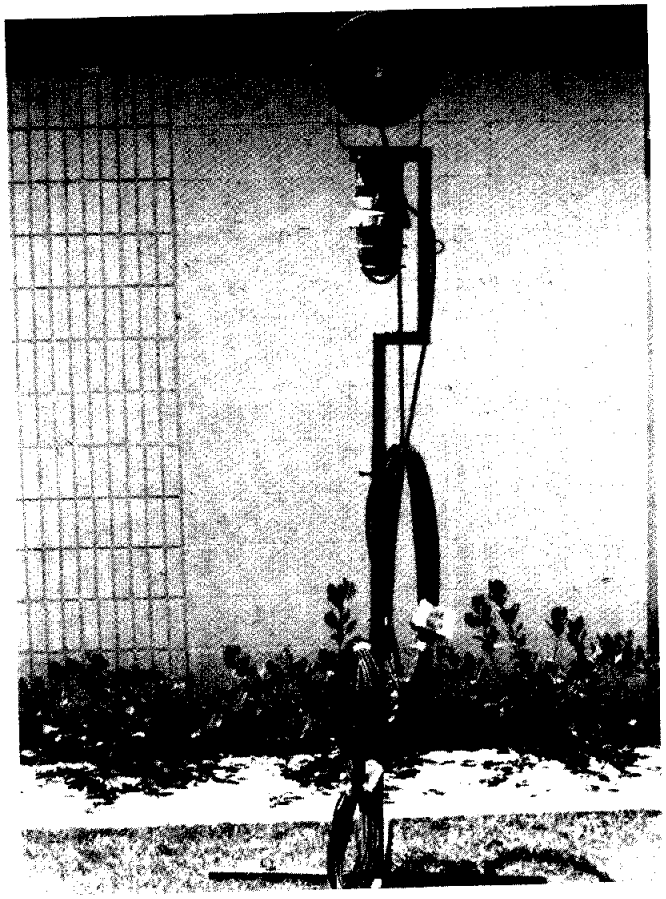


Photo 7. Portable audio and visual alarm, with a siren alarm and a flashing strobe light. *Photo by Murray Dosch.*

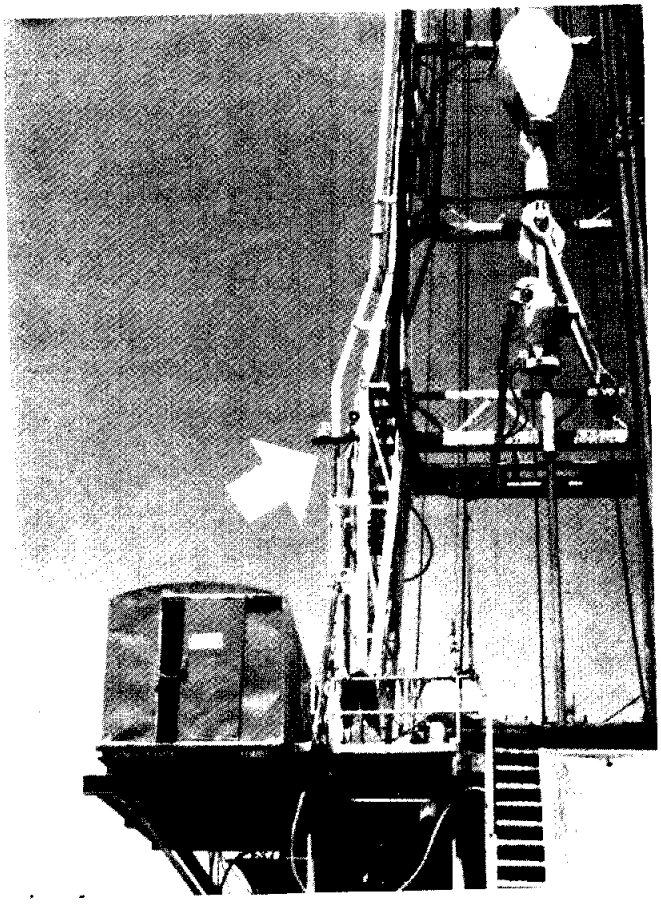


Photo 8. Portable audio and visual alarm mounted on the rig at photo center, to the right of the dog house. *Photo by Ed Hickey.*

Three to 5 minutes are needed to record a reaction on a paper detector, a possibly dangerous time lapse when large concentrations of H_2S are encountered. Therefore, paper detectors are used mainly to indicate when H_2S is present and not to determine the concentration of the gas, although the detector has an approximate range of 0 to 20 ppm H_2S.

Capsule detector

A capsule detector is made of glass filled with granules and covered with a nylon sheath. To use, the capsule is broken and attached to clothing with a string. When hydrogen sulfide contacts the granules, they turn brown.

This type of detector is used to indicate the presence of H_2S, but the maximum concentration of the gas that can be measured is 20 ppm. Use life is 6 days.

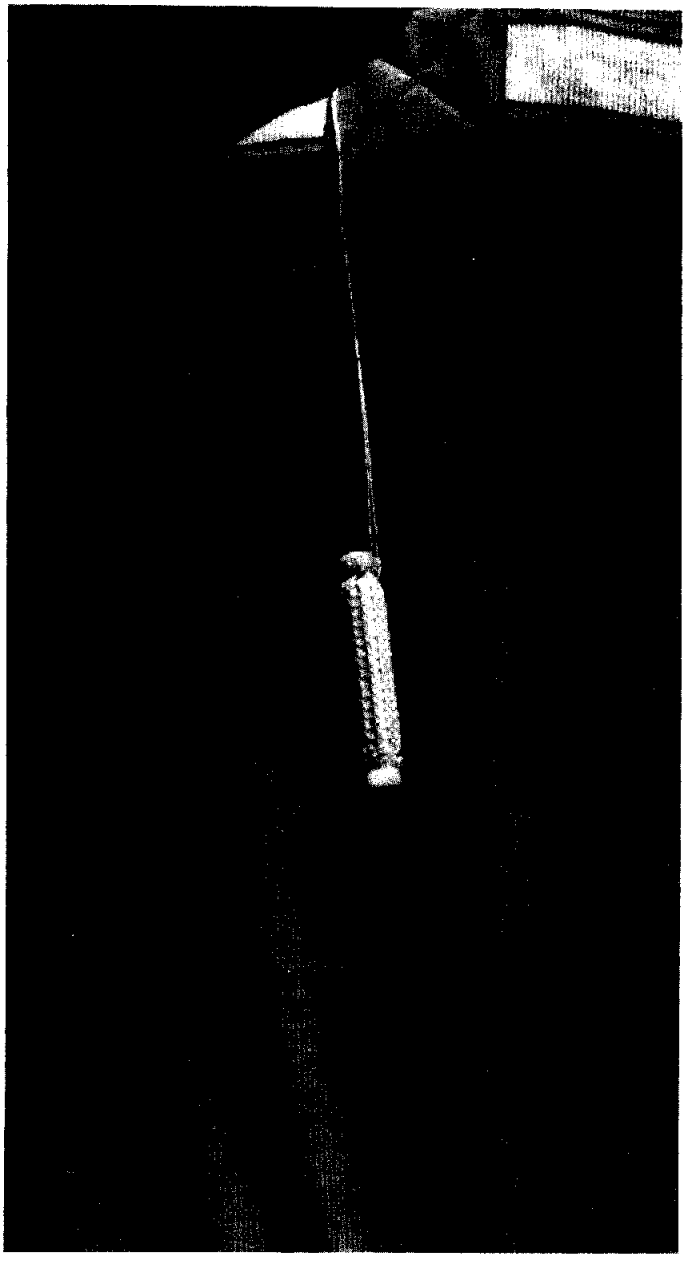
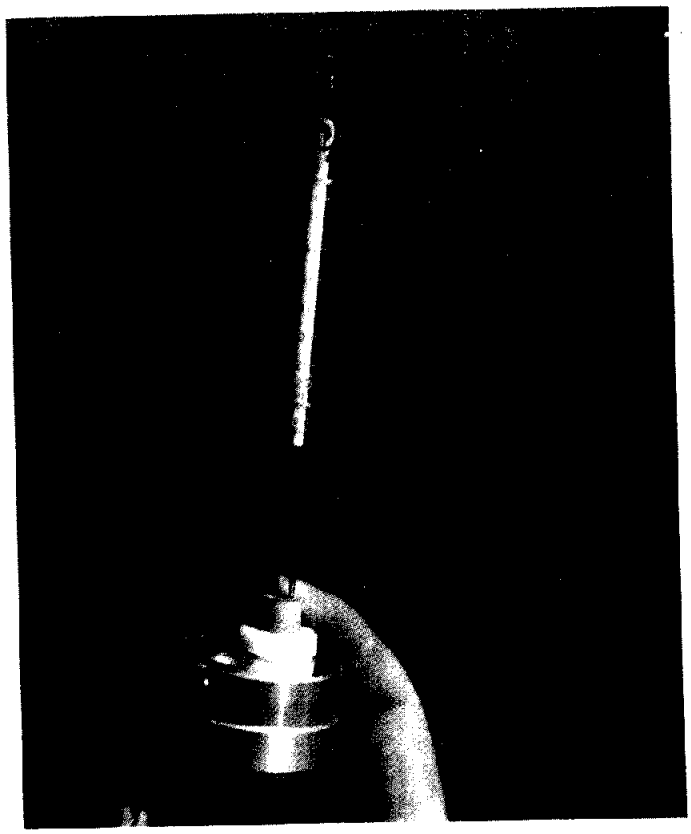


Photo 9. Glass capsule H_2S detector, covered with a nylon sheath.
Photo by Ed Hickey.

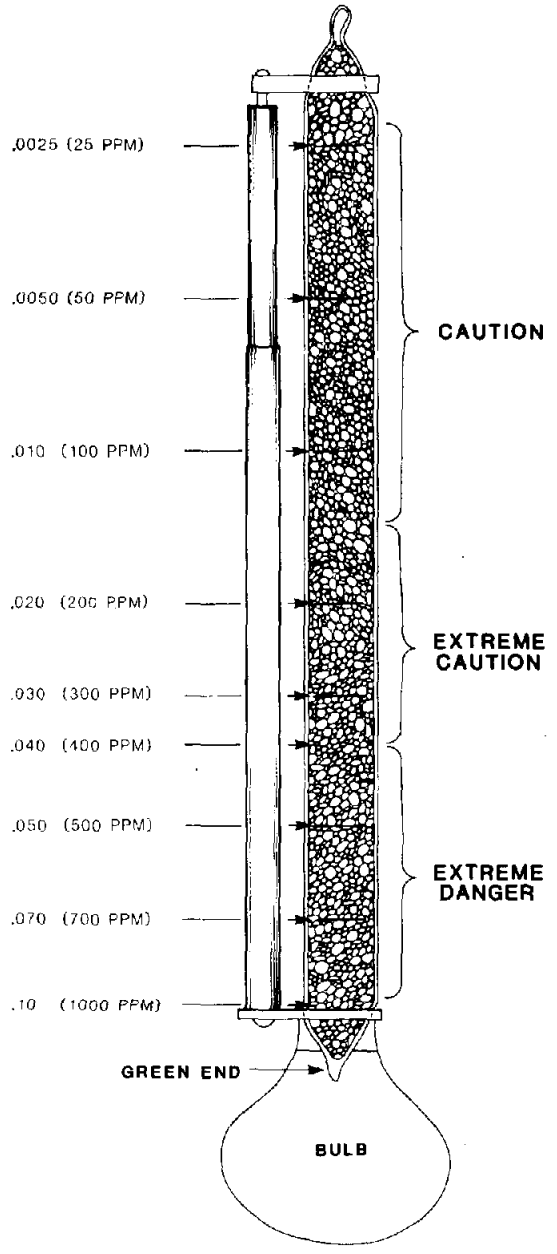


Photos 10a and 10b. Bendex–Gas Tec. H_2S pump–style detectors. *Photos by Ed Hickey.*

Pump detector

Pump detectors are comprised of glass tubes and hand pumps. The sealed tubes are filled with granules impregnated with a chemical. To use, a tube is broken on both ends and attached to a hand pump or bulb that is operated to draw in an air sample. For samples of low H_2S concentration, it may take 10 strokes on the pump to get an adequate sample; for samples of high H_2S concentration, it may take only one stroke. The H_2S gas reacts with the granules, and the concentrations can be read directly from tube calibrations.

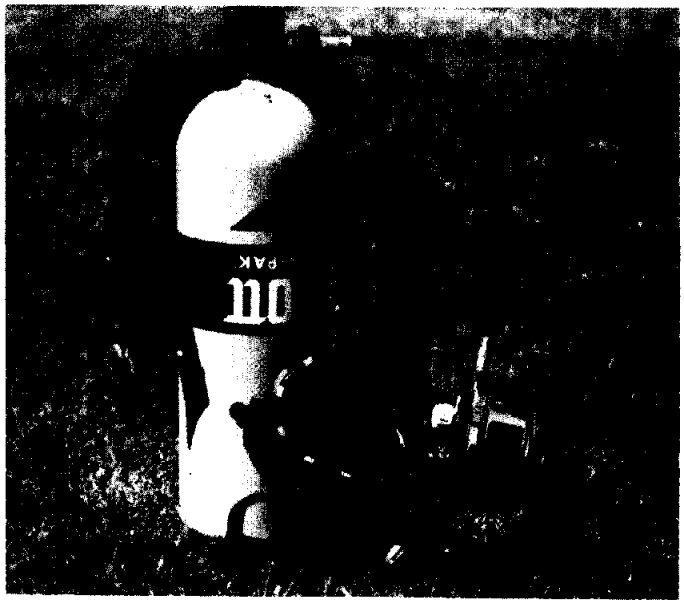
Tubes with different concentration ranges can be used after the tips are broken (as long as no indication of H_2S is present). Detector accuracy depends on the experience of the user; concentrations between 1 and 1,000 ppm can be measured.



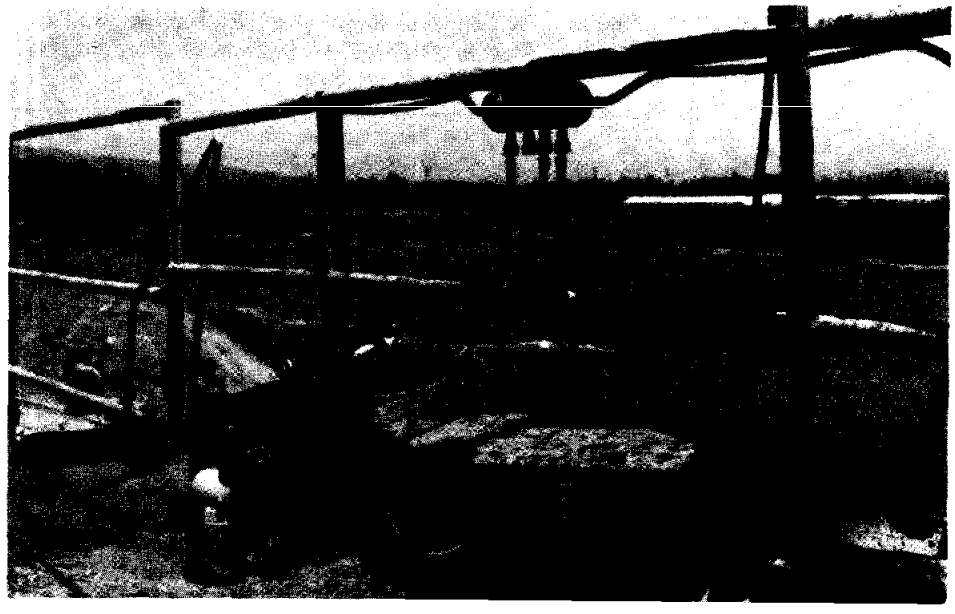
MSA H_2S gas detector—bulb type.

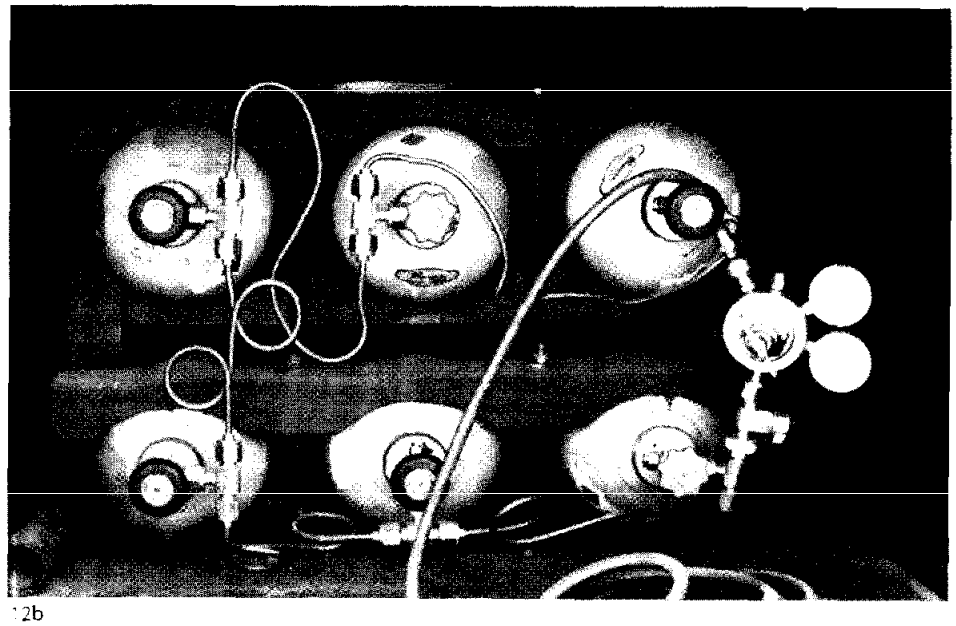
Belt type

The belt–attached, hydrogen sulfide detector is a battery–operated electronic device with an audible alarm. The detector has a sensor head that will detect H_2S gas and measure concentrations between 0 to 50 ppm. The detector is usually preset to respond at 20 ppm. Response time is about 35 seconds. This detector must be calibrated and checked periodically to ensure proper functioning.



Photos 11a and 11b. Scott air pac. Tank holds a 30 minute supply of air. When 78 percent of the air has been used, an alarm sounds, warning the wearer to leave for a safe-breathing area. *Photos by Ed Hickey.*





12b

12c

Photos 12a, 12b, and 12c. Well cascade system designed for workers on the rig floor. Air is supplied from a battery of tanks, such as those in photo 12b. Each tank holds a 3 hour supply of air.

The workers wear small containers of air, such as the Scott 5 minute–escape air tank, to use when they must escape from the rig. Notice the breakaway valve released in photo 12c. *Photos by Ed Hickey.*

AIR BREATHING EQUIPMENT

Types of self–contained air breathing equipment range from short–term escape units to long–term work units.

Regulations on the selection, type, use, and maintenance of respirators are in the following publications:

1. Occupational Safety and Health Administration (OSHA): Occupational Safety and Health Standards for General Industry, 29 CFR 1910 (1978) 128.

2. OSHA: Table Z–2(a)(3), 29 CFR 1910, Table 2, p. 1001.

3. Department of Health, Education, and Welfare (DHEW); National Institute for Occupational Safety and Health (NIOSH): Criteria for a Recommended Standard for Occupational Exposure to Hydrogen Sulfide, publication No. 77–158.

4. DHEW: A Guide to Respiratory Protection, 30 CFR, Part II (1976) 52. A table from this guide has been reprinted below.

DHEW Respirator Selection Guide for Hydrogen Sulfide[10]

H_2S Concentration	Respirator type approved under provisions of 30 CFR II
Less than or equal to 70 mg/cu meter (50 ppm)	1. Any supplied-air respirator with full facepiece. 2. Any self-contained breathing apparatus with full facepiece.
Greater than 70 mg/cu meter (50 ppm)	1. Self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive-pressure mode. 2. Combination Type C supplied-air respirator with full facepiece operated in pressure-demand or other positive-pressure or continuous-flow mode and auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressue mode.
Emergency (entry into area of unknown concentration for emergency purposes, e.g., firefighting)	1. Self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive-pressure mode. 2. Combination Type C supplied-air respirator with full facepiece operated in pressure-demand or other positive-pressure or continuous-flow mode and auxiliary self-contained breathing apparatus operated in pressure-demand or other positive-pressure mode.
Escape (from an area of unknown concentration)	1. Any self-contained breathing apparatus. 2. Any gas mask providing adequate protection against hydrogen sulfide (not to be used in confined spaces).

Regulators

A regulator is the part of the respirator that reduces the air pressure from the tank to the mask. There are two types, the demand mode in which the wearer draws the air into the mask under slight vacuum, and the pressure-demand mode in which the regulator allows a slight pressure buildup in the mask. The main difference between the two is that once a leak occurs, the demand mode type would leak inward and the pressure demand mode, outward.

The pressure demand mode limits the possibilities of contaminates being drawn into the mask, and this is the reason it is required to be used in atmospheres where the TLV (tolerance limit value) concentration for hydrogen sulfide is being exceeded. Some units are equipped with a bypass valve that allows partially regulated air to be delivered to the mask in case of regulator failure. A mask with a full face piece must be used and the respirator must be approved by the National Institute for Occupational Safety and Health (NIOSH) and the Mine Enforcement Safety Administration (MESA).

When to use self–contained air breathing equipment

Use self–contained air breathing equipment:

1. When Cal/OSHA H_2S standards are or could be exceeded (see page 2).
2. While rescuing a person overcome by H_2S.

Persons with a perforated ear drum *should never* work in an H_2S environment with concentrations above 10 ppm, even with self–contained breathing equipment, because gas can enter the lungs through a damaged ear passageway. For this reason, physical examinations of crew members should include ear examinations.

When *not* to use self–contained air breathing equipment

VI. Hazard Levels and Safety Procedures *

CONDITION I:
Potential Danger

H_2S gas concentration

0 to 20 ppm

Characterized by

Minor gas breakout from mud or equipment.

Probable occurrence

As a drill show, trip gas, or lost circulation.

General action

The procedures outlined in this section, or similar procedures, should be implemented whenever a concentration over 10 ppm of H_2S gas is detected.

1. The driller should shut down mud pumps and continue to rotate the drill pipe.
2. If the well attempts to flow, the driller should stop rotating the drill pipe and close the blowout preventers.
3. The following personnel must immediately put on their breathing equipment with the mask in a ready position:
   a. All personnel on the rig floor.
   b. All personnel at the mudpits, and
   c. All personnel required to work below and down wind of the rig.
4. Check all gas monitoring devices and increase gas monitoring activities.
5. Immediately begin to ascertain the source of the H_2S and take steps to suppress the H_2S. Drilling should not proceed until the source is determined and the well is circulated. Rig floor and mud pit personnel should wear breathing equipment while monitoring this circulation.

*Procedures have been adopted from many sources, including the SOHIO Petroleum Company, cited as Number 20 in the list of Selected References.

6. The mud engineer should run a sulfide determination of the flowline mud.

7. The drilling foreman and the drilling rig tool pusher should be notified.

8. The drilling foreman should alert all personnel that Condition I exists. The drilling rig tool pusher should be prepared to shut off the forced air circulating system.

9. The drilling rig tool pusher should make sure all nonessential personnel are out of potentially dangerous areas such as the mud pit area, mud shack, and mud storage room. All persons who remain in potentially dangerous areas should utilize the buddy system.

10. All personnel should ensure that their safety equipment is working properly and is in the proper location.

11. Protective breathing apparatus should be worn by all working personnel. Personnel with perforated eardrums should be evacuated from the site. Nonworking personnel should go to the SAFE BRIEFING AREA, taking their breathing equipment.

CONDITION II:

Moderate to Extreme Danger

H_2S concentration

20 ppm–50 ppm

Characterized by

Moderate gas breakout from mud or equipment.

Probable occurrence

As trip gas, well kick, or lost circulation.

General action

If the H_2S concentration reaches 50 ppm, the following steps must be taken:

1. Order evacuation of local residents if gas threatens their safety. Request help from local authorities if required, but do not delay evacuation of persons in the Danger Area.

   Set up roadblocks and minimize personnel movements.

2. All nonessential personnel or all personnel, as appropriate, shall remain in the SAFE BRIEFING AREA.

3. The driller should shut down the pumps and continue to rotate the drill pipe.

4. If the well attempts to flow, the driller should stop rotating the drill pipe and close the blowout preventer.

5. The driller should notify the drilling foreman and the drilling rig tool pusher and all other persons on the emergency telephone list.

6. The drilling rig tool pusher should alert all personnel that the dangerous situation exists and be sure the forced air circulation system is shut off.

7. Always put on a portable air breathing mask before proceeding to assist anyone affected by the gas or before entering areas of possible contamination; utilize the buddy system. If the affected person is stricken in a high concentration area, put on a safety belt with 50 feet of tail line and obtain standby assistance before entering the area.

CONDITION III: Extreme Danger

H_2S concentration

Over 50 ppm

Characterized by

Full-scale blowout (or) poisonous gas concentrations above hazardous limits.

Probable occurrence

Complete loss of well control during drilling.

General action

1. Stay in the SAFE AREA if you are not working to correct or control the situation.

2. Follow all instructions of the supervisor in charge.

3. Order evacuation of local people within danger zone.

4. Assign someone to notify the company and the California Division of Oil and Gas.

5. Set up roadblocks and prevent entry of unauthorized persons.

6. Request help from local authorities to evacuate people and to control traffic in the threatened area.

7. The driller should shut down mud pumps and continue to rotate the drill pipe.

8. If the well attempts to flow, the driller should stop rotating the drill pipe and close the blowout preventer.

9. It may be necessary to ignite the gas. Once the gas is ignited, burning H_2S gas will be converted to SO_2 gas that is less toxic. Continue to observe emergency procedures.

10. Conduct all operations with a minimum of personnel.

V. First Aid

INFORM LOCAL HEALTHCARE PERSONNEL

The sheriff, ambulance, hospital, and nearby doctors should be contacted after drilling begins in an H_2S area. These people should be alerted to the situation and to what could happen in an emergency. Most doctors have not treated H_2S inhalation cases, and operators should offer to give doctors pertinent information.

Every person working in an H_2S environment should know the effects of inhaling H_2S in toxic concentrations and rescue and first aid procedures to use when this occurs. Specifically, each person at the drill site needs to know about:

1. Self–contained air breathing equipment;
2. The buddy system;
3. Rescue breathing techniques (cardiopulmonary resuscitation if possible);
4. The resuscitator (Pneolator); and
5. Additional first aid techniques.

RESCUE TECHNIQUES*

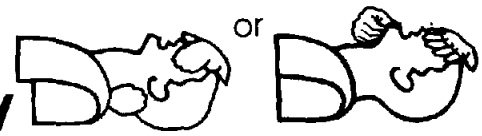
Remember, speed is essential in rescuing a victim and in administering proper first aid.**

1. Don breathing apparatus before entering danger area to rescue a victim of H_2S inhalation. You, too, can become a victim if this is not done. Work with a partner on a lifeline, when possible.
2. Move victim to fresh, pure air at once.
3. Let *someone else* get the resuscitator and *someone else* call a physician.

*First aid techniques for H_2S victims should be posted in a place close to the work site such as a crew change room or driller's station.

**The following first aid procedures represent practices recommended by the Workmen's Compensation Board, Alberta, Canada, and the American Heart Association.

*4. Airway



If you find a collapsed person, determine if victim is conscious by shaking the shoulder and shouting "Are you all right?" If no response, shout for help. Then open the airway. If victim is not lying flat on his back, roll victim over, moving the entire body at one time as a total unit.

To open the victim's airway, lift up the neck (or chin) gently with one hand while pushing down on the forehead with the other to tilt head back. Once the airway is open, place your ear close to the victim's mouth:

- Look – at the chest and stomach for movement.
- Listen – for sounds of breathing.
- Feel – for breath on your cheek.

If none of these signs is present, victim is not breathing.

If opening the airway does not cause the victim to begin to breathe spontaneously, you must provide rescue breathing.

5. Breathing

The best way to provide rescue breathing is by using the mouth-to-mouth technique. Take your hand that is on the victim's forehead and turn it so that you can pinch the victim's nose shut while keeping the heel of the hand in place to maintain head tilt. Your other hand should remain under the victim's neck (or chin), lifting up.

Immediately give four quick, full breaths in rapid succession using the mouth-to-mouth method.

6. Check Pulse

After giving the four quick breaths, locate the victim's carotid pulse to see if the heart is

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beating. To find the carotid artery, take your hand that is under the victim's neck and locate the voice box. Slide the tips of your index and middle fingers into the groove beside the voice box. Feel for the pulse. Cardiac arrest can be recognized by absent breathing and an absent pulse in the carotid artery in the neck.

For Infants and Small Children

Basic life support for infants and small children is similar to that for adults. A few important differences to remember are given below.

Airway

Be careful when handling an infant that you do not exaggerate the backward position of the head tilt. An infant's neck is so pliable that forceful backward tilting might block breathing passages instead of opening them.

Breathing

Don't try to pinch off the nose. Cover both the mouth and nose of an infant or small child who is not breathing. Use small breaths with less volume to inflate the lungs. Give one small breath every three seconds.

Check Pulse

The absence of a pulse may be more easily determined by feeling over the left nipple.

7. *If you CAN find the pulse,* continue rescue breathing until victim revives or the resuscitator is readied. (Exercise care due to possible lung congestion.) According to the American Red Cross rescue breathing instructions, you should:

   - Repeat breaths about 12 times a minute for an adult or 20 times a minute for a child.
   - Establish a rhythm.
   - If victims's stomach rises, press it gently to remove air.
   - As patient revives, watch closely. Treat for shock.

7. *If you CANNOT find the pulse,* the victim needs CPR, Cardiopulmonary Resuscitation. CPR should be administered ONLY by a person properly trained and certified. It is too complicated to be taught from printed pages alone.

   Free CPR courses are offered by the American Heart Association and the American Red Cross.

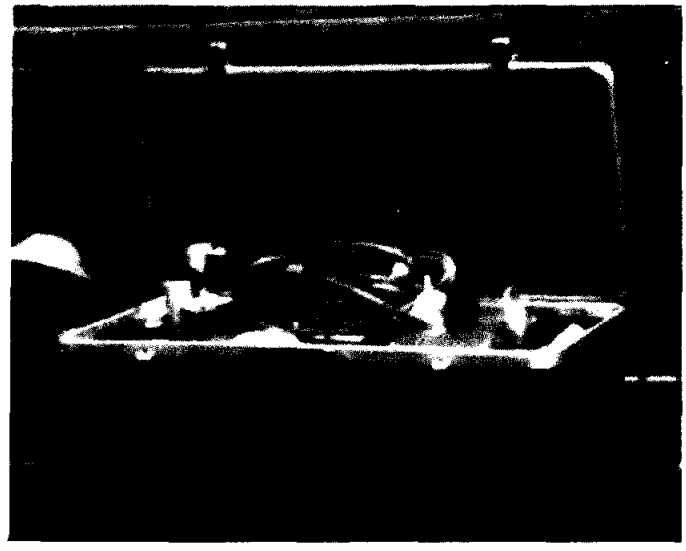


Photo 13. A resuscitator. *Photo by Murray Dosch.*

The resuscitator (Pneolator)

8. The Pneolator is an instrument that performs artificial respiration with an automatic, predetermined pressure on inhalation, and without suction on exhalation. This most nearly represents normal respiration and has been selected by medical authorities as the method of choice in restoring breathing.

   Once the patient is breathing, the Pneolator becomes an effective oxygen inhalator by a simple adjustment. If the air passage is obstructed by mucous or foreign material, a warning is immediately given by a chattering of the cycling valve, and the Pneolator provides an aspirator for removing the obstruction. The Pneolator can be taken with a victim to the hospital.

   NOTE: The small oxygen bottles carried by most ambulances are not the type required for a Pneolator. The 21 cubic foot bottle of oxygen in the Pneolator should be checked and filled to capacity *before* all well testing operations. Furthermore, it is strongly recommended that an extra supply of oxygen (a commercial tank) be kept on hand as a "standby" supply.

   This large oxygen cylinder can be hooked up to the resuscitator while it is being used to increase the volume of oxygen that is available for use should there be more than one victim overcome.

Victim position

9. Keep victim warm and quiet, but never unattended.

Physician visit

10. A person who has been overcome by H_2S gas and revived could go into shock. Because of this, take the victim to a doctor at once. Patients should be kept under medical observation until the doctor declares them fit to return to work.

11. A patient breathing normally may be given stimulants such as tea or coffee. (Alcohol is a depressant).

Stimulants

12. If eyes are affected by H_2S, wash them thoroughly with clear water. For slight eye irritation, cold compresses will help.

Eyes affected by H_2S

13. Once a victim is removed to fresh air and normal respiration restored before heart action ceases, rapid recovery may be expected.

Minor exposure

In cases of slight or minor exposures, where the worker has not been totally unconscious and wants to return to work after a short rest period, it is recommended that duty be postponed until the following day. Reflexes may not have returned to normal, and the person could be subject to injuries from other work hazards.

OIL AND GAS
DISTRICT BOUNDARIES

(Black lines indicate oil and gas district boundaries)

Offices

Headquarters 801 K Street, 20th Floor, MS 20-20, Sacramento, CA 95814-3530
Phone (916) 445-9686, TDD (916) 324-2555
Telefax (916) 323-0424

District No. 1 245 W. Broadway, Suite 475, Long Beach, CA 90802
Phone (562) 590-5311
Telefax (562) 590-5307

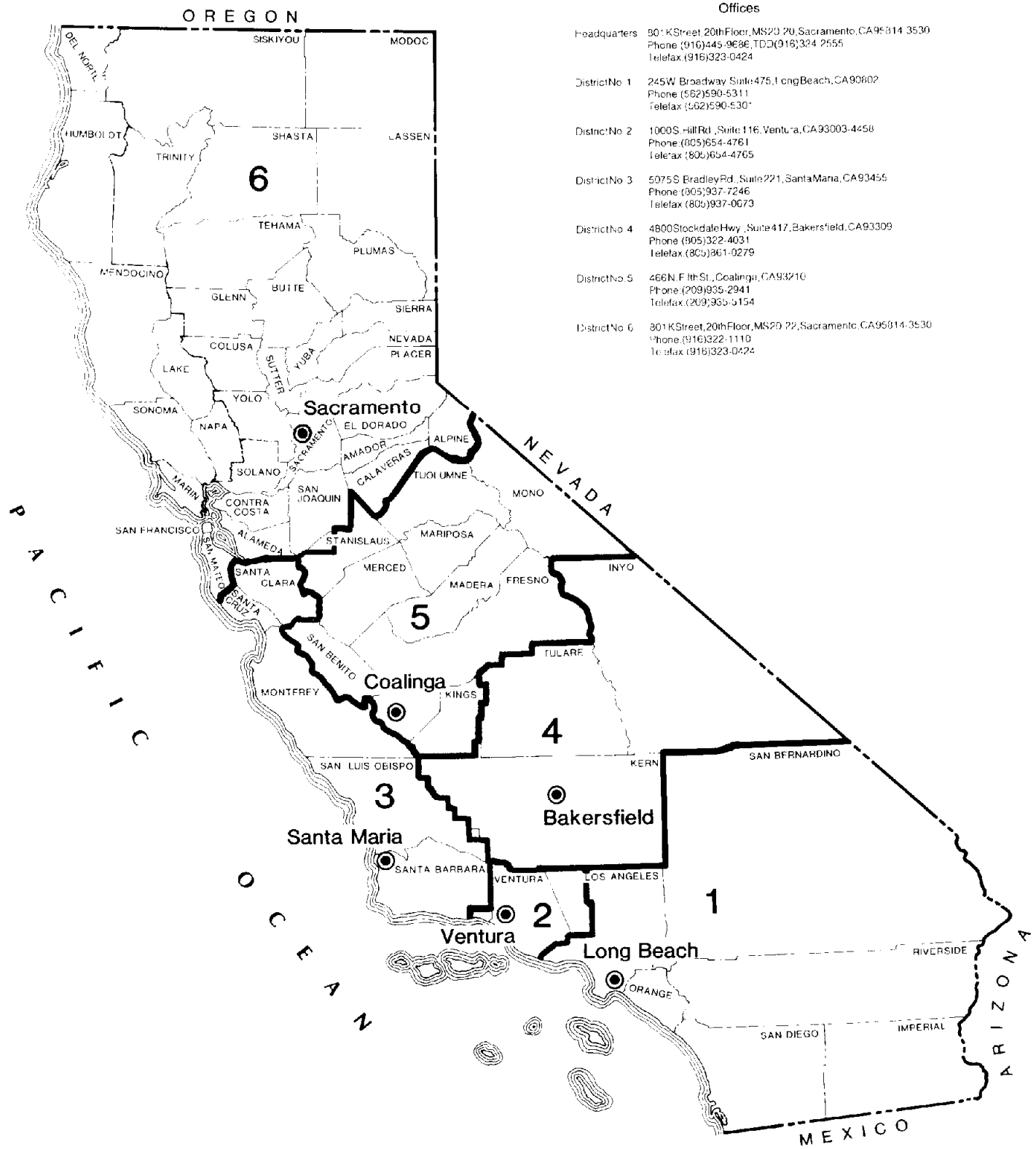
District No. 2 1000 S. Hill Rd., Suite 116, Ventura, CA 93003-4458
Phone (805) 654-4761
Telefax (805) 654-4765

District No. 3 5075 S. Bradley Rd., Suite 221, Santa Maria, CA 93455
Phone (805) 937-7246
Telefax (805) 937-0673

District No. 4 4800 Stockdale Hwy., Suite 417, Bakersfield, CA 93309
Phone (805) 322-4031
Telefax (805) 861-0279

District No. 5 466 N. Fifth St., Coalinga, CA 93210
Phone (209) 935-2941
Telefax (209) 935-5154

District No. 6 801 K Street, 20th Floor, MS 20-22, Sacramento, CA 95814-3530
Phone (916) 322-1110
Telefax (916) 323-0424



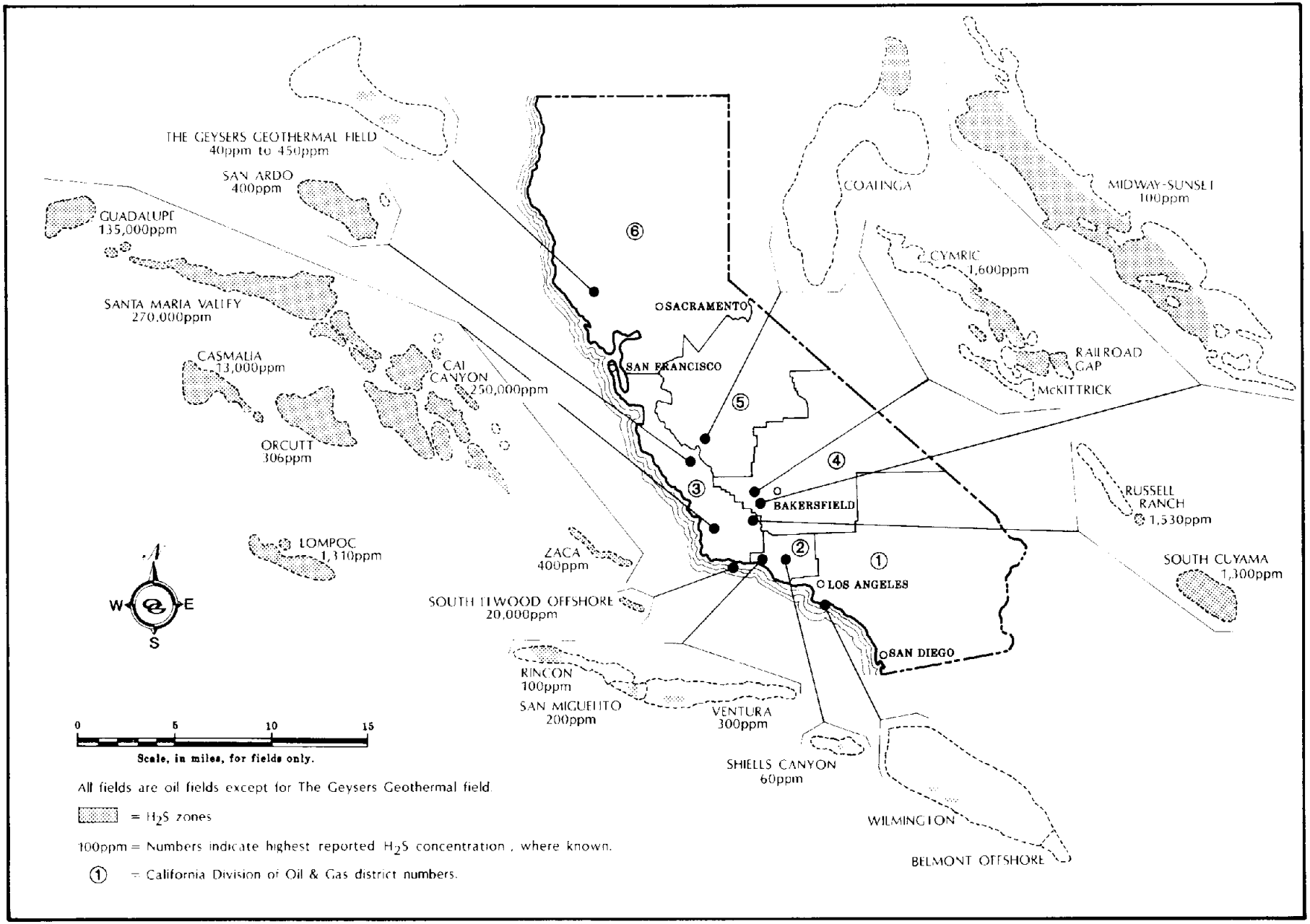
VI. H_2S in California Oil, Gas, and Geothermal Fields

H_2S in various concentrations is found in oil, gas, and geothermal fields throughout California. Some of the fields are included on maps in this chapter. Where known, the H_2S concentrations are noted, as well.

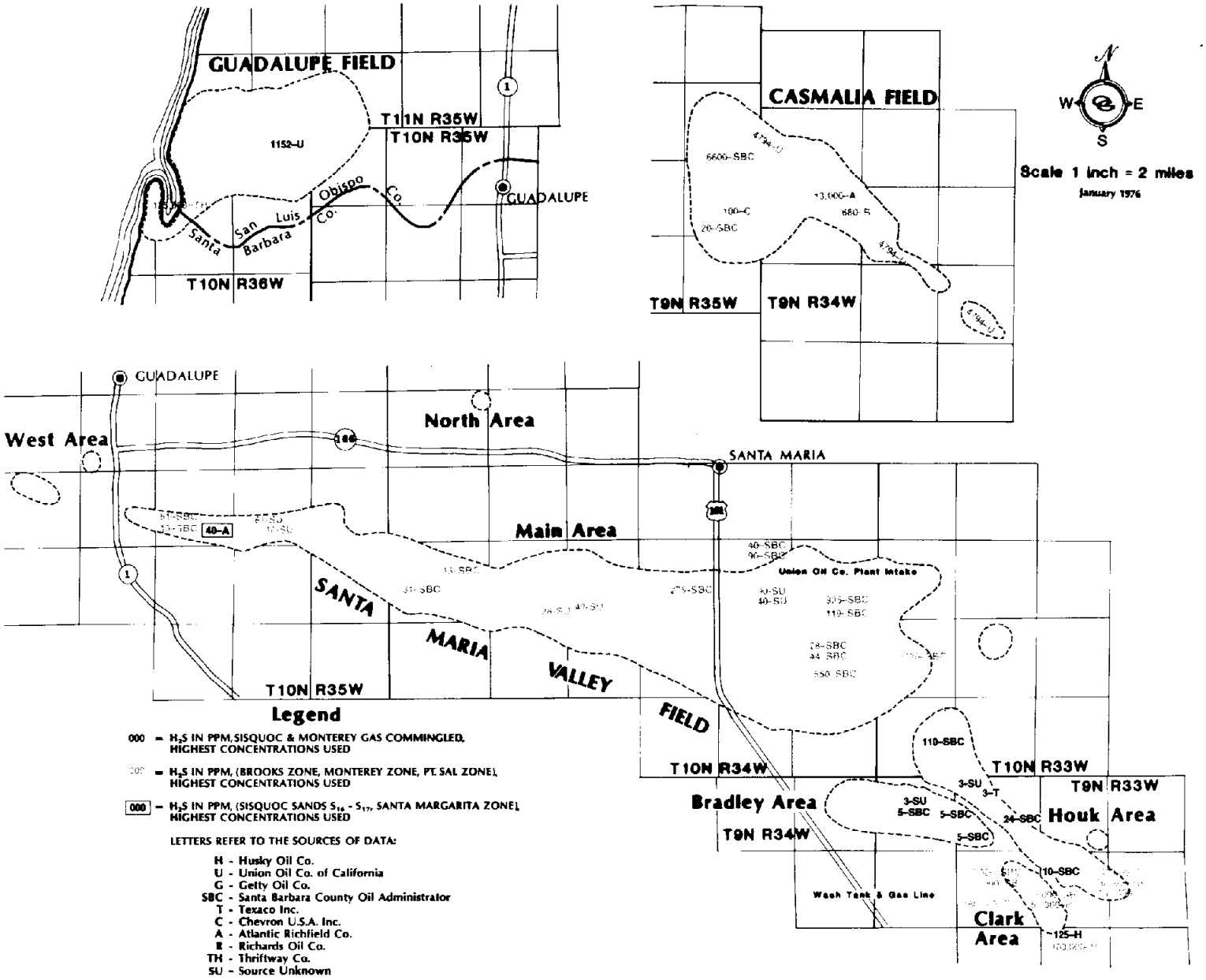
Any operator requesting a well permit from the California Division of Oil and Gas for well operations in a known H_2S area will be notified of this hazard on the permit (P–Report) issued by the division.

Oil and Gas District	Fields with H_2S Concentrations of 100 ppm or above	Fields with H_2S Concentrations under 100 ppm	Fields with H_2S Odor, but with Concentrations Unknown
1	—	—	Wilmington, Huntington Beach, Newport, Torrance , Brea Olinda
2	Rincon, 100 ppm San Miguelito, 200 ppm Ventura, 300 ppm	Shiells Canyon 60 ppm	Aliso Canyon, Bardsdale, Big Mountain, Del Valle, Las Llajas, Oak Park, Oakridge, Ojai, Piru, Santa Paula, Santa Susana, Simi, South Mountain, Tapo Canyon So., Temescal, Torrey Canyon, and West Mountain
3	Casmalia, 13,000 ppm Cat Canyon, 250,000 ppm Cuyama So., 1300 ppm Elwood So., Offshore, 20,000 ppm Guadalupe, 135,000 ppm Lompoc, 1,310 ppm Orcutt, 306 ppm Russell Ranch, 1,530 ppm San Ardo, 400 ppm Santa Maria Valley, 270,000 ppm Zaca, 400 ppm	—	Capitan Onshore, King City Four Deer
4	Midway Sunset, 100 ppm Cymric, 1,600 ppm	—	North Belridge, South Belridge, Blackwells Corner, Edison, Northeast Edison, Kern River, Lost Hills, McKittrick, Mount Poso, Poso Creek, Railroad Gap, and Wheeler Ridge
5	—	—	Coalinga
6	—	—	—
Geothermal District			
G3	The Geysers, 40–450 ppm	—	—

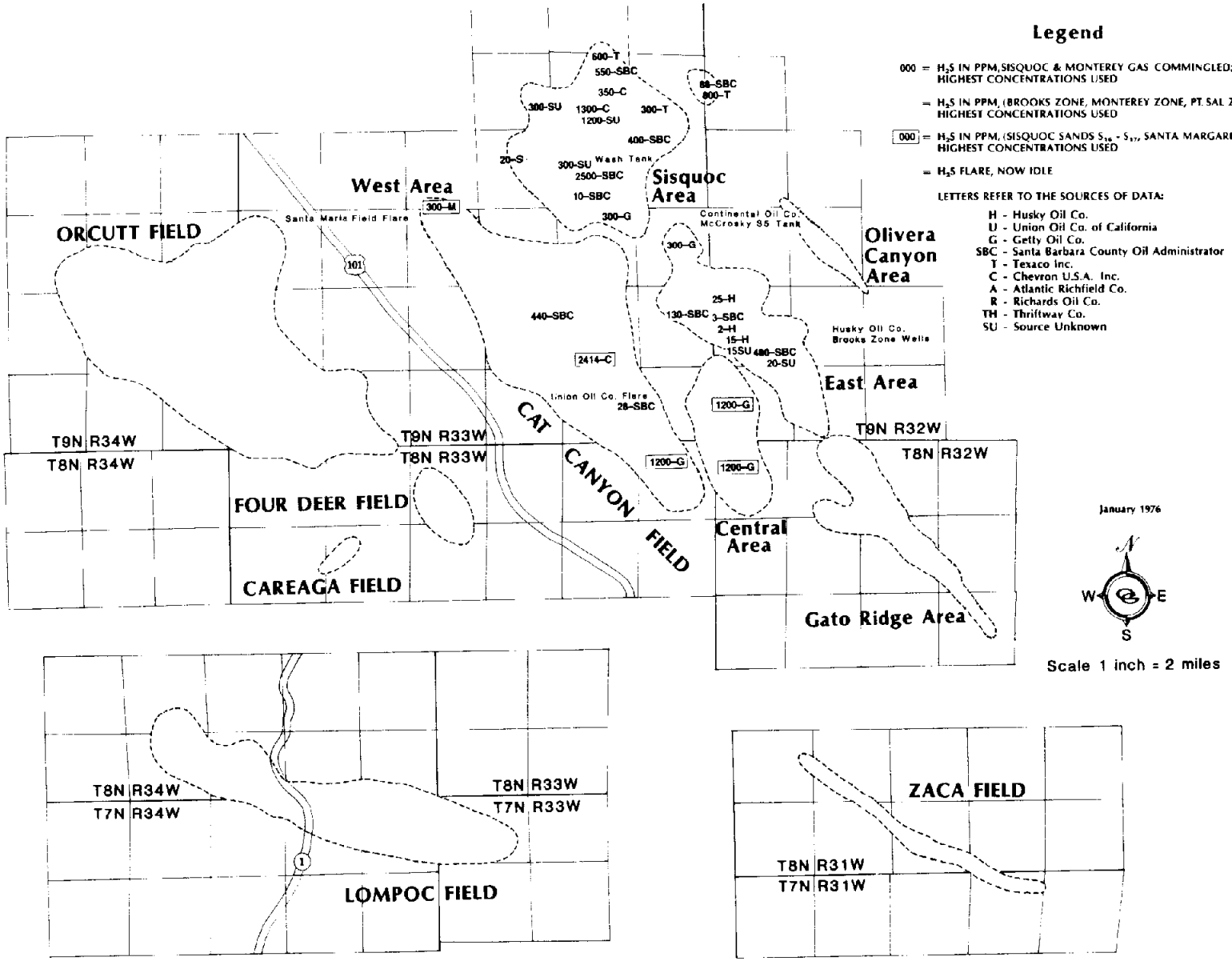
H_2S in some California oil and geothermal fields. Data compiled in September 1976. (Data in the first two columns are on the map following this figure.)



Parts per million of H_2S gas in some California oil and geothermal fields. Data compiled in September 1976.



Parts per million of H_2S gas in some California oil fields. Data compiled in 1976.



Parts per million of H_2S gas in some California oil fields. Data compiled in 1976.

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See pages 25 and 26 for additional references to regulations on the selection, type, use, and maintenance of respirators.

Appendix C:
Oil Operations

General Safety and Health


Welding with fire control

- Safety and Health Program
  - General Safety and Health Resources
  - Slips, Trips, and Falls
  - Strains and Sprains
  - Weather Conditions
- Hot Work/Welding
  - Hot Work, Fire, and Explosive Hazards
  - Welding, Cutting, and Brazing
  - Cylinder Storage
  - Grinding
  - Well Site Ignition Sources
- Hydrogen Sulfide Gas
  - Release of H_2S
  - Metal Fatigue
  - Accumulation of H_2S
  - Appendix A - Physical Properties and Physiological Effects of Hydrogen Sulfide
- H_2S Special Precautions
  - No Hazard Condition
  - API Condition I - Low Hazard
  - API Condition II - Medium Hazard
  - API Condition III - High Hazard

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General Safety and Health >> Safety and Health Program

This page lists many general safety and health concerns. Each topic is linked to a page with more information about the activity and sources of information.


Fig. 1. Welding with fire control

- Establish a safety and health program. For further guidance see Safety and Health Management Systems eTool. Contact your workers compensation insurance provider engineering group for further information about behavior based safety programs. See Oil and Gas Well Drilling and Servicing Safety and Health Topics pages.
- Contact OSHA consultation services. From the OSHA consultation service employers can find out about potential hazards at their worksites, improve their occupational safety and health management systems, and even qualify for a one-year exemption from routine OSHA inspections.
- General Safety and Health Resources
- Slips, Trips, and Falls
- Strains and Sprains
- Weather Conditions

General Safety and Health Resources ^ TOP

Crane, Derrick, and Hoist Safety

Electrical Systems

Fire Safety

H_2S Controls

- Confined Spaces
- Handling Pressure Cylinders
  - Compressed Gas Equipment
  - Control of Hazardous Energy (Lockout/Tagout)
- Hydrogen Sulfide

- Ventilation
- **OSHA Interpretation:**
  - 04/14/1993 - Respiratory protection as it relates to oil fields. (H_2S)

Hot Work - Welding

Lockout-Tagout

Motor Vehicles Safety

Powered Industrial Trucks

Protective Clothing and Equipment

- Eye and Face Protection
- Foot Protection
- Head Protection
- Hearing Protection
- Respiratory Protection
- Work Clothes

Using Hand and Power Tools

Slips, Trips, and Falls

^ TOP

There are many ways to protect from slips, trips, and falls. Even so, they still happen and the following are means to either prevent slips, trips, and falls or to minimize the consequences if they should happen.

- Wear personal protective equipment (such as hard hats, work gloves, safety shoes, and eye protection).
- Be aware of the slipping and falling hazards when working on the drilling floor, servicing rig floors or other platforms.
- Keep all work areas clean and clear of oil, tools, and debris.
- Use non-skid surfaces where appropriate.
- Provide guardrails and guards around work areas that are prone to slips, trips, and falls.
- Install, inspect, and secure stairs and handrails. [1926.1052]
- Instruct workers on proper procedures for using and installing ladders.
- Use only ladders in good repair that do not have missing rungs.
- Do not install stairs with missing or damaged steps. Repair them before installing them.
- Keep walkways clean and free of debris and tripping hazards. [1910.22]

- Keep all cords and hoses orderly and clear of walking spaces.
- Cover open cellars.
- Conduct a pre-job inspection to identify, then eliminate or correct hazardous work surfaces.
- Walking/Working Surfaces Standard requires [1910.22(a)(1)]: Keep all places of employment clean and in an orderly condition.
- Keep aisles and passageways clear and in good repair, with no obstruction across or in aisles that could create a hazard [1910.22(b)(1)]. Provide floor plugs for equipment so power cords need not run across pathways.
- Use waterproof footgear to decrease slip/fall hazards.

Additional Resources:

- Walking/Working Surfaces, Safety and Health Topics page
- 1910.22 Walking/working surfaces, general requirements
- Walking/working Surfaces, OSHA small business training
- Fall Protection
  - ANSI Z359.1
  - Body Harness (Please recognize that there is a weight limit, including equipment)
  - IADC Fall Protection Guidance
  - Webbing

Strains and Sprains

∧ TOP

General solutions for strains and sprains include:

- Use proper lifting technique.
- Hoist slowly to limit pipe momentum.
- Seek assistance when moving awkward and heavy guards and covers.
- Use proper stance and slip-lifting techniques. Slips have three handles and should be lifted jointly by more than one person.
- Use lifting equipment and limit manual positioning of elevators.
- Practice proper hand placement and use of pullback (tail) ropes.
- Use mechanical lifting aids, proper lifting techniques, and team lifting where appropriate.
- Use proper hand and body positioning.
- Ergonomics

- Hand Injury
- Lifting
- Repetitive motions

Weather Conditions

^ TOP

Weather conditions can create hazardous working conditions: therefore it is necessary to monitor weather conditions and forecasts to allow time to prepare for such conditions as may occur. Lightning is especially hazardous and unpredictable. When lightning is present, crews must avoid situations where they could become part of potential current paths.

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General Safety and Health >> Hot Work / Welding

Hot work is any work that involves burning, welding, using fire- or spark-producing tools, or that produces a source of ignition. Welding and cutting operations are common to drilling and servicing operations. Test for flammable gases in the work area before starting any hot work. Potentially hazardous areas include, but are not limited to, well heads, fuel tanks, mud tanks, tank batteries, gas separators, oil treaters, or confined spaces where gases can accumulate.


Fig. 1. Hot work - welding

Hot Work, Fire, and Explosive Hazards

^ TOP

Workers performing hot work such as welding, cutting, brazing, soldering, and grinding are exposed to the risk of fires from ignition of flammable or combustible materials in the space, and from leaks of flammable gas into the space, from hot work equipment.


Fig. 2. Welding with fire control

Potential Hazard:

- Getting burned by fires or explosions during hot work.

Possible Solutions:

The basic precautions for fire prevention are:

- Perform hot work in a safe location, or with fire hazards removed or covered. [1910.252(a)(1)(i)]
- Use guards to confine the heat, sparks, and slag, and to protect the immovable fire hazards. [1910.252(a)(1)(ii)]

Special Precautions:

- Do not perform hot work where flammable vapors or combustible materials exist. Work and equipment should be relocated outside of the hazardous areas, when possible. [1910.252(a)

(1)(ii)]

- Make suitable fire-extinguishing equipment immediately available. Such equipment may consist of pails of water, buckets of sand, hose, or portable extinguishers. [1910.252(a)(2)(ii)]
- Assign additional personnel (fire watch) to guard against fire while hot work is being performed. Fire watchers are required whenever welding or cutting is performed in locations where anything greater than a minor fire might develop. [1910.252(a)(2)(iii)(A)]
  - Fire watchers shall:
    - Have fire-extinguishing equipment readily available and be trained in its use.
    - Be familiar with facilities for sounding an alarm in the event of a fire.
    - Watch for fires in all exposed areas, try to extinguish them only when obviously within the capacity of the equipment available, or otherwise sound the alarm.
    - Maintain the fire watch at least a half hour after completion of welding or cutting operations to detect and extinguish possible smoldering fires. 1910.252(a)(2)(iii)(B)

Potential Hazard:

- Getting burned by a flash fire or explosion that results from an accumulation of flammable gases, such as Methane or Hydrogen Sulfide, around the wellhead area.

Possible Solutions:

- Monitor the atmosphere with a gas detector. If a flammable or combustible gas exceeds 10 percent of the lower explosive level (LEL), the work must be stopped.
- Identify the source of the gas and repair the leakage.

Additional References:

- OSHA Standards
  - 1910.106, Flammable and Combustible Liquids.
  - 1910.252, Welding, Cutting, and Brazing - General Requirements.
  - 1910.253, Oxygen-fuel gas welding and cutting.
  - 1910.254, Arc welding and cutting.
  - 1910.255, Resistance welding.
- API RP54, Recommended Practice for Occupational Safety for Oil and Gas Well Drilling and Servicing Operations
- API Publication 2201
- NFPA 30, 51-B, Flammable and Combustible Liquids Code, National Fire Protection Association
- Hot Work. AESC, 12 KB PDF, 2 pages.

Welding, Cutting and Brazing

^ TOP

All hot work is potentially hazardous and a hazard assessment should be performed to determine where the hazards exist.

Fig. 3. Welding - hot work

Potential Hazard:

- Injury and illness caused by hot work (such as, welding fumes, UV light, sparks, noise, or skin injury).

Possible Solutions:

- Inspect the work area to ensure that all fuel and ignition sources are isolated by shielding, clearing the area, lockout/tagout, soaking flammable material with water.
- Wear appropriate PPE, such as face shield, leather welder's vest, and gauntlet gloves. Use cotton or denim clothing.
- Provide UV shielding for arc welding where practical.
- Inspect welding and cutting equipment before use (arc or gas welding/burning).
- Leak test gas torches, gauges, and hoses.
- Review the hot work permit if available.
- Ensure the availability of adequate fire watch/fire protection equipment.
- Ensure adequate ventilation from toxic welding and cutting fumes.

Special Hazard:

- Accumulation of toxic gases within a confined space.
- A hazardous atmosphere exists in oxygen-deficient (atmospheric concentration of less than 19.5 percent) or oxygen-enriched (atmospheric concentration of more than 23.5 percent). 1910.146 confined space entry.

Possible Solutions:

- Ventilate toxic metal fumes mechanically, if entering a confined space, such as inside of a mud tank, water tank, oil tanks, hoppers, sump, pit or cellar.
- Use a written permit system to document authorization to enter, the work to be performed, and the results of the gas monitoring where there is a potential for toxic, flammable, or oxygen-deficient atmosphere. Both a hot work and confined entry permit may be required for welding, cutting or brazing within a confined space.

Additional Information:

- AESC Recommended Safe Procedures and Guidelines for Oil and Gas Well Servicing. Section X, Welding, Cutting and Brazing and Hot Work, pp. 77-80, April 2000.
- ANSI Z49.1-67 Safety in Welding and Cutting, American National Standards Institute.
- AWS Z49.1-88, Safety in Welding and Cutting and Applied Processes, American Welding society.

Cylinder Storage

∧ TOP

Fig. 4. Properly stored cylinders

Potential Hazard:

- Falling or rolling injuries from improper gas cylinder storage

Possible Solutions:

- Ensure cylinders are properly stored in an upright position and chained in separate racks.
- Store full and empty cylinders separately.

Potential Hazard:

- Valve opening or break off, exposing workers to toxic fumes and flammable gas, caused by improper gas cylinder storage

Possible Solutions:

- Store cylinder properly.
- Always remove gauges and regulators, and install protective valve caps before transporting.

Potential Hazard:

- Gas cylinders causing fires or explosions

Possible Solutions:

- Store cylinders in a dry, well-ventilated location.
- Avoid storing flammable substances in the same area as gas cylinders.
- Avoid storing cylinders of oxygen within 20 feet of cylinders containing flammable gases.
- Store all cylinders upright and chained in separate racks.
- Store full and empty cylinders separately.

Additional Information:

- Compressed Gas Cylinders. AESC, 16 KB PDF, 3 pages.

Grinding

∧ TOP

Fig. 5. Hand grinding

Potential Hazard:

- Grinding (that results in sparks, noise, eye and skin injury from flying metal filings, grinding wheel pieces, etc.).
- Having fingers or hands caught in the grinding wheel, resulting in amputation.
- Being struck by portable grinder.

Possible Solutions:

- Wear appropriate PPE, such as face shield. Use cotton or denim clothing.

- Inspect grinding equipment before use.
- Review the hot work permit if available.
- Ensure the availability of adequate fire watch/fire protection equipment.

Well Site Ignition Sources

^ TOP

There are a number of potential sources of ignition for flammable gases and liquids on the drill site. It is necessary to provide for a general ignition safety program which could pre-empt potential hazards of fire and explosion.

Fig. 6. Ignition source

Potential Hazard:

- Ignition and explosions of flammable gases or vapors from:
  - Internal-combustion engine sparks
  - Open flames from any source
  - Smoking
  - Welding operations
  - Electric power tools
  - Two-way radios
  - Vehicles with catalytic converters
  - Portable generators

Possible Solutions:

- Provide spark arrestors for internal-combustion engines.
- Post "NO SMOKING" signs wherever a flammable gas or vapor hazard exists.
- Locate "spark producing" equipment or facilities well away from potential hazard areas.
- Prohibit vehicles with catalytic converters from the immediate vicinity of the rig.
- Prohibit open flames from the vicinity of the rig.

Additional Information:

- API, 500, 505
- API, RP54
- IADC, Accident Prevention Reference Guide
- AESC, Recommended Safe Procedures and Guidelines for Oil and Gas Well Servicing
- 1910.106, OSHA Flammable and Combustible Liquids.
- 1910 Subpart S, OSHA Electrical

Oil and Gas Well Drilling and Servicing eTool

General Safety and Health >> Hydrogen Sulfide Gas

Note: It is not the intent of this section to create an H_2S contingency plan.

Hydrogen Sulfide or *sour gas* (H_2S) is a flammable, colorless gas that is toxic at extremely low concentrations. It is heavier than air, and may accumulate in low-lying areas. It smells like "rotten eggs" at low concentrations and causes you to quickly lose your sense of smell. Many areas where the gas is found have been identified, but pockets of the gas can occur anywhere. [more]

Iron sulfide is a byproduct of many production operations and may spontaneously combust with air.

Flaring operations associated with H_2S production will generate Sulfur Dioxide ($S0_2$), another toxic gas.

Active monitoring for hydrogen sulfide gas and good planning and training programs for workers are the best ways to prevent injury and death.

Also see: NIOSH Classification of H_2S Hazard Areas.

Fig. 1. Hydrogen Sulfide warning sign

Release of H_2S ^ TOP

All personnel working in an area where concentrations of Hydrogen Sulfide may exceed the 10 Parts Per Million (PPM) should be provided with training before beginning work assignments.

Potential Hazard:

- H_2S exposure greater than the Permissible Exposure Limit (PEL)

Possible Solutions:

Implement an H_2S contingency plan (see API) including, but not limited to:

- Appropriate instruction in the use of hydrogen sulfide safety equipment to all personnel present at all hydrogen sulfide hazard areas.
- Gas detection where hydrogen sulfide may exist.
- Appropriate respiratory protection for normal and emergency use. Respiratory Protection Standard, [1910.134] (H_2S).

For emergency response information, see Hazardous Waste and Emergency Response (HAZWOPER) Standard, [1910.120].

Comprehensive training should be provided for workers in H_2S operations. Example topics include:

- The characteristics, sources, and hazards of Hydrogen Sulfide.
- Proper use of the Hydrogen Sulfide detection methods used on the site.
- Recognition of, and proper response to, Hydrogen Sulfide warnings at the workplace.
- Symptoms of Hydrogen Sulfide exposure.
- Proper rescue techniques and first-aid procedures to be used in a Hydrogen Sulfide exposure.
- Proper use and maintenance of personal protective equipment. Demonstrated proficiency in using PPE should be required.
- Worker awareness and understanding of workplace practices and maintenance procedures to protect personnel from exposure to hydrogen sulfide.
- Wind direction awareness and routes of egress.
- Confined space and enclosed facility entry procedures.
- Locations and use of safety equipment.
- Locations of safe briefing areas.

Fig. 2. SCBA

Fig. 3. Gas detector

- Use and operation of all Hydrogen Sulfide monitoring systems.
- Emergency response procedures, corrective action, and shutdown procedures.
- Effects of Hydrogen Sulfide on the components of the Hydrogen Sulfide handling system.
- The importance of drilling fluid treating plans prior to encountering Hydrogen Sulfide.

Additional Information:

- API RP 49, 2.02 MB PDF. Recommended Practice for Drilling and Well Servicing Operations Involving Hydrogen Sulfide, Current Edition.
- Use of Respirators. AESC, 68 KB PDF, 18 pages.
- H_2S precautions. AESC, 16 KB PDF, 2 pages.

Metal Fatigue

∧ TOP

Metal fatigue, including Hydrogen embrittlement or Sulfide stress cracking, can result in a release of Hydrogen Sulfide gas.

Fig. 4. H_2S metal fatigue

Potential Hazard:

- Being exposed to Hydrogen Sulfide.
- Getting Injured due to equipment failure.

Possible Solutions:

- Select materials in accordance with the National Association of Corrosion Engineers (NACE MR 0175) criteria for H_2S service.
- Treat drilling fluids to chemically reduce corrosion failures.

Accumulation of H_2S

∧ TOP

It is possible for Hydrogen Sulfide gas to accumulate in any low or enclosed area, such as a gas venting system, mud system, cellars, pits, and tanks.

Potential Hazard:

- Being exposed to Hydrogen Sulfide.

Possible Solutions:

- Provide adequate ventilation for the removal of any accumulation of H_2S.
- Implement effective confined space entry program.

Additional Information

∧ TOP

Additional guidance materials are available from:

- American Petroleum Institute (API) in the recommended practice document RP 49 (*Drilling and Well Servicing Operations Involving Hydrogen Sulfide*, Current Edition) and Spec 6A
- Association of Energy Service Companies (AESC)
- National Association of Corrosion Engineers (NACE)
- International Association of Drilling Contractors (IADC)

- OSHA Standard Interpretation 04/14/1993 - Respiratory protection as it relates to oil fields. Respiratory Protection Standard, [1910.134]
- NFPA 70, National Electrical Code. See the National Fire Protection Agency website (NFPA) 2002 Edition

State Programs:

- **California**: Cal/OSHA Standards: California Code of Regulations, Title 8; Chapter 4, Division of Industrial Safety; Subchapter 14. Petroleum Safety Orders--Drilling and Production
- **Texas**: Texas Administrative Code (TAC); Title 16. Economic Regulation; Part 1. Railroad Commission of Texas; Chapter 3. Oil and Gas Division
- **Utah**: Title 34A, Chapter 6, Utah Occupational Safety and Health Act of 1973. Rule R614-2. Drilling Industry
- **Wyoming**: Employment, Dept. of Occupational Health & Safety - Oil & Gas Well Drilling - Rules
- Alaska: Oil and Gas Commission Alaska Administrative Code Title 20 - Chapter 25

Training Programs

- TEEX
- ASSE: Hydrogen Sulfide Safety Training, ASC Z390

H_2S Training and Information Links

- American Petroleum Institute (API) in the recommended practice document RP 49 (*Drilling and Well Servicing Operations Involving Hydrogen Sulfide*, 3rd Edition, 2001) and Spec 6A
- National Association of Corrosion Engineers (NACE)
- International Association of Drilling Contractors (IADC)

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General Safety and Health >> H_2S Special Precautions

Hydrogen Sulfide gas is very corrosive and causes metals to become brittle. Therefore, employers need to take special precautions when choosing equipment when they may reasonably expect to encounter H_2S. This may include appropriate H_2S trimming of equipment in accordance with National Association of Corrosion Engineers (NACE) Standards.

All well-drilling sites should be classified according to areas of potential and/or actual exposure to H_2S. The recommendations and employee instruction will vary depending on the type of area.

- No Hazard Condition
- API Condition I - Low Hazard
- API Condition II - Medium Hazard
- API Condition III - High Hazard

Hydrogen Sulfide warning sign

Additional Information:

- API
- ANSI
- IADC HSE Reference Guide
- AESC - Recommended Safe Procedures and Guidelines for Oil and Gas Well Servicing
- NACE
- ASSE
- NIOSH

No Hazard Condition

^ TOP

Any well that will not penetrate a known Hydrogen Sulfide formation would be categorized as a No Hazard Area. Special Hydrogen Sulfide equipment is not required.

API Condition I - Low Hazard

^ TOP

Work locations where atmospheric concentrations of H_2S are less than 10ppm.

Recommended for Area:

- Hydrogen Sulfide warning sign with green flag warning device present.
- Keep all safety equipment in adequate working order.
- Store the equipment in accessible locations.

API Condition II - Medium Hazard

^ TOP

Work locations where atmospheric concentrations of H_2S are greater than 10ppm and less than 30ppm.

Recommended for Area:

- Legible Hydrogen Sulfide warning sign with yellow flag warning device present.
- Keep a safe distance from dangerous locations if not working to decrease danger.
- Pay attention to audible and visual alarm systems.
- Follow the guidance of the operator representative.
- Keep all safety equipment in adequate working order.
- Store the equipment in accessible locations.
    - An oxygen resuscitator.
    - A properly calibrated, metered hydrogen sulfide detection instrument.

API Condition III - High Hazard

^ TOP

Work locations where atmospheric concentrations of H_2S are greater than 30ppm.

Recommended for Area:

- Post legible Hydrogen Sulfide warning sign with red flag warning device.
- Post signs 500 feet from the location on each road leading to the location, warning of the hydrogen sulfide hazard.
- Check all Hydrogen Sulfide safety equipment to ensure readiness before each tour change.
- Establish a means of communication or instruction for emergency procedures and maintain them on location, along with contact information of persons to be informed in case of emergencies.
- Ensure usability of two exits at each location.
- Do not permit employees on location without hydrogen Sulfide safety training. (Employees may be permitted on location for specific Hydrogen Sulfide training purposes that does not include general rig training.)
- Pay attention to audible and visual alarm systems.
- Store the equipment in accessible locations.
    - Two Hydrogen Sulfide detectors should be present (one should be a properly calibrated, metered detection instrument, and the other should be a pump type with detector

tubes. The maximum permissible exposure limit (PEL) is 20 ppm. Respiratory protection would be required if periodic testing indicates employee exposures to H_2S at concentrations above the PEL. See OSHA Standard Respiratory Protection, [1910.134]).

- Oxygen resuscitator.
- Three wind socks and streamers.
- Two NIOSH/MSHA 30-minute, self-contained breathing apparatus for emergency escape from the contaminated area only.

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Physical Properties and Physiological Effects of Hydrogen Sulfide

A.1 Physical Data

- Chemical Name: Hydrogen Sulfide
- CAS Number: 7783-06-4
- Synonyms: Sulfureted hydrogen, hydrosulfuric acid, dihydrogen sulfide
- Chemical Family: Inorganic sulfide
- Chemical Formula: H_2S
- Normal Physical State: Colorless gas, slightly heavier than air. Vapor density (specific gravity) at 59°F (15°C) and 1 atmosphere = 1.189.
- Auto ignition Temperature: 500° F
- Boiling Point: -76° F
- Melting Point: -117.2° F
- Flammable Limits: 4.3-4.6 percent vapor by volume in air
- Solubility: Soluble in water and oil: solubility decreases as the fluid temperature increases
- Combustibility: Burns with a blue flame to produce sulfur dioxide (SO2). Refer to Appendix B Odor and Warning Properties: Hydrogen sulfide has an extremely unpleasant odor, characteristic of rotten eggs, and is easily detected at low concentrations: however, due to rapid onset of olfactory fatigue and paralysis (inability to smell) ODOR SHALL NOT BE USED AS A WARNING MEASURE.

A.2 Exposure Limits

The American Conference of Governmental Industrial Hygienists recommends a Threshold Limit Value of 10ppm and a short-term exposure (STEL) limit of 15 ppm averaged over 15 minutes. Exposure at the STEL should not be repeated more than four times per day with at least 60 minutes between successive exposures in this range.

A.3 Physiological Effects

Inhalation at certain concentrations can lead to injury of death. The 300 ppm is considered by the ACGIH as Immediately Dangerous to Life and Health. Hydrogen sulfide is an extremely toxic, flammable gas that may be encountered in the production of gas well gas, high-sulfide, high sulfur content crude oil, crude oil fractions, associated gas, and waters. Since hydrogen sulfide is heavier than air, it can collect in low places. It is colorless and has a foul rotten egg odor. In low concentrations, H_2S sometimes can be detectable by its characteristic odor; however, the smell cannot be relied upon to forewarn of dangerous concentrations (greater than 100ppm) of the gas because it rapidly paralyzes the sense of smell due to paralysis of the olfactory nerve. A longer exposure to the lower concentrations has a similar desensitizing effect on the sense of smell.

It should be well understood that the sense of smell will be rendered ineffective by hydrogen sulfide, which can result in an individual failing to recognize the presence of dangerously high concentrations. Exposure to hydrogen sulfide causes death by poisoning the respiratory system at the cellular level. Symptoms from repeated exposures to low concentrations usually disappear after not being exposed for a

period of time. Repeated exposures to low concentrations that do not produce effects eventually may lead to irritation if the exposures are frequent.

A.4 Respiratory Protection

Respiratory protection shall be worn above the action level. Refer to 6.6 for proper breathing equipment recommendations for oil and gas well drilling and servicing operations involving hydrogen sulfide.

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Appendix D:
Incident Forms

OSHA
Forms for Recording
Work-Related Injuries and Illnesses

U.S. Department of Labor
Occupational Safety and Health Administration

Dear Employer:

This booklet includes the forms needed for maintaining occupational injury and illness records for 2004. These new forms have changed in several important ways from the 2003 recordkeeping forms.

In the December 17, 2002 Federal Register (67 FR 77165-77170), OSHA announced its decision to add an occupational hearing loss column to OSHA's Form 300, Log of Work-Related Injuries and Illnesses. This forms package contains modified Forms 300 and 300A which incorporate the additional column M(5) Hearing Loss. Employers required to complete the injury and illness forms must begin to use these forms on January 1, 2004.

In response to public suggestions, OSHA also has made several changes to the forms package to make the recordkeeping materials clearer and easier to use:

- On Form 300, we've switched the positions of the day count columns. The days "away from work" column now comes before the days "on job transfer or restriction."
- We've clarified the formulas for calculating incidence rates.
- We've added new recording criteria for occupational hearing loss to the "Overview" section.
- On Form 300, we've made the column heading "Classify the Case" more prominent to make it clear that employers should mark only one selection among the four columns offered.

The Occupational Safety and Health Administration shares with you the goal of preventing injuries and illnesses in our nation's workplaces. Accurate injury and illness records will help us achieve that goal.

Occupational Safety and Health Administration
U.S. Department of Labor

What's Inside...

In this package, you'll find everything you need to complete OSHA's *Log* and the *Summary of Work-Related Injuries and Illnesses* for the next several years. On the following pages, you'll find:

- ***An Overview: Recording Work-Related Injuries and Illnesses —*** General instructions for filling out the forms in this package and definitions of terms you should use when you classify your cases as injuries or illnesses.

- ***How to Fill Out the Log —*** An example to guide you in filling out the *Log* properly.

- ***Log of Work-Related Injuries and Illnesses —*** Several pages of the *Log* (but you may make as many copies of the *Log* as you need.) Notice that the *Log* is separate from the *Summary*.

- ***Summary of Work-Related Injuries and Illnesses —*** Removable *Summary* pages for easy posting at the end of the year. Note that you post the *Summary* only, not the *Log*.

- ***Worksheet to Help You Fill Out the Summary —*** A worksheet for figuring the average number of employees who worked for your establishment and the total number of hours worked.

- ***OSHA's 301: Injury and Illness Incident Report —*** A copy of the OSHA 301 to provide details about the incident. You may make as many copies as you need or use an equivalent form.

Take a few minutes to review this package. If you have any questions, ***visit us online at www.osha. gov*** **or** ***call your local OSHA office.*** We'll be happy to help you.

An Overview: Recording Work-Related Injuries and Illnesses

The Occupational Safety and Health (OSH) Act of 1970 requires certain employers to prepare and maintain records of work-related injuries and illnesses. Use these definitions when you classify cases on the Log. OSHA's recordkeeping regulation (see 29 CFR Part 1904) provides more information about the definitions below.

The *Log of Work-Related Injuries and Illnesses* (Form 300) is used to classify work-related injuries and illnesses and to note the extent and severity of each case. When an incident occurs, use the *Log* to record specific details about what happened and how it happened. The *Summary* — a separate form (Form 300A) — shows the totals for the year in each category. At the end of the year, post the *Summary* in a visible location so that your employees are aware of the injuries and illnesses occurring in their workplace.

Employers must keep a *Log* for each establishment or site. If you have more than one establishment, you must keep a separate *Log* and *Summary* for each physical location that is expected to be in operation for one year or longer.

Note that your employees have the right to review your injury and illness records. For more information, see 29 Code of Federal Regulations Part 1904.35, *Employee Involvement*.

Cases listed on the *Log of Work-Related Injuries and Illnesses* are not necessarily eligible for workers' compensation or other insurance benefits. Listing a case on the *Log* does not mean that the employer or worker was at fault or that an OSHA standard was violated.

When is an injury or illness considered work-related?

An injury or illness is considered work-related if an event or exposure in the work environment caused or contributed to the condition or significantly aggravated a preexisting condition. Work-relatedness is presumed for injuries and illnesses resulting from events or exposures occurring in the workplace, unless an exception specifically applies. See 29 CFR Part 1904.5(b)(2) for the exceptions. The work environment includes the establishment and other locations where one or more employees are working or are present as a condition of their employment. See 29 CFR Part 1904.5(b)(1).

Which work-related injuries and illnesses should you record?

Record those work-related injuries and illnesses that result in:

- death,
- loss of consciousness,
- days away from work,
- restricted work activity or job transfer, or
- medical treatment beyond first aid.

You must also record work-related injuries and illnesses that are significant (as defined below) or meet any of the additional criteria listed below.

You must record any significant work-related injury or illness that is diagnosed by a physician or other licensed health care professional. You must record any work-related case involving cancer, chronic irreversible disease, a fractured or cracked bone, or a punctured eardrum. See 29 CFR 1904.7.

What are the additional criteria?

You must record the following conditions when they are work-related:

- any needlestick injury or cut from a sharp object that is contaminated with another person's blood or other potentially infectious material;
- any case requiring an employee to be medically removed under the requirements of an OSHA health standard;
- tuberculosis infection as evidenced by a positive skin test or diagnosis by a physician or other licensed health care professional after exposure to a known case of active tuberculosis.
- an employee's hearing test (audiogram) reveals 1) that the employee has experienced a Standard Threshold Shift (STS) in hearing in one or both ears (averaged at 2000, 3000, and 4000 Hz) and 2) the employee's total hearing level is 25 decibels (dB) or more above audiometric zero (also averaged at 2000, 3000, and 4000 Hz) in the same ear(s) as the STS.

What is medical treatment?

Medical treatment includes managing and caring for a patient for the purpose of combating disease or disorder. The following are not considered medical treatments and are NOT recordable:

- visits to a doctor or health care professional solely for observation or counseling;

What do you need to do?

1. Within 7 calendar days after you receive information about a case, decide if the case is recordable under the OSHA recordkeeping requirements.
2. Determine whether the incident is a new case or a recurrence of an existing one.
3. Establish whether the case was work-related.
4. If the case is recordable, decide which form you will fill out as the injury and illness incident report.

   You may use *OSHA's 301: Injury and Illness Incident Report* or an equivalent form. Some state workers compensation, insurance, or other reports may be acceptable substitutes, as long as they provide the same information as the OSHA 301.

How to work with the Log

1. Identify the employee involved unless it is a privacy concern case as described below.
2. Identify when and where the case occurred.
3. Describe the case, as specifically as you can.
4. Classify the seriousness of the case by recording the **most serious outcome** associated with the case, with column G (Death) being the most serious and column J (Other recordable cases) being the least serious.
5. Identify whether the case is an injury or illness. If the case is an injury, check the injury category. If the case is an illness, check the appropriate illness category.

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Occupational Safety and Health Administration

- diagnostic procedures, including administering prescription medications that are used solely for diagnostic purposes; and
- any procedure that can be labeled first aid. (*See below for more information about first aid.*)

What is first aid?

If the incident required only the following types of treatment, consider it first aid. Do NOT record the case if it involves only:

- using non-prescription medications at non-prescription strength;
- administering tetanus immunizations;
- cleaning, flushing, or soaking wounds on the skin surface;
- using wound coverings, such as bandages, BandAids™, gauze pads, etc., or using SteriStrips™ or butterfly bandages.
- using hot or cold therapy;
- using any totally non-rigid means of support, such as elastic bandages, wraps, non-rigid back belts, etc.;
- using temporary immobilization devices while transporting an accident victim (splints, slings, neck collars, or back boards).
- drilling a fingernail or toenail to relieve pressure, or draining fluids from blisters;
- using eye patches;
- using simple irrigation or a cotton swab to remove foreign bodies not embedded in or adhered to the eye;
- using irrigation, tweezers, cotton swab or other simple means to remove splinters or foreign material from areas other than the eye;
- using finger guards;
- using massages;
- drinking fluids to relieve heat stress

How do you decide if the case involved restricted work?

Restricted work activity occurs when, as the result of a work-related injury or illness, an employer or health care professional keeps, or recommends keeping, an employee from doing the routine functions of his or her job or from working the full workday that the employee would have been scheduled to work before the injury or illness occurred.

How do you count the number of days of restricted work activity or the number of days away from work?

Count the number of calendar days the employee was on restricted work activity or was away from work as a result of the recordable injury or illness. Do not count the day on which the injury or illness occurred in this number. Begin counting days from the day after the incident occurs. If a single injury or illness involved both days away from work and days of restricted work activity, enter the total number of days for each. You may stop counting days of restricted work activity or days away from work once the total of either or the combination of both reaches 180 days.

Under what circumstances should you NOT enter the employee's name on the OSHA Form 300?

You must consider the following types of injuries or illnesses to be privacy concern cases:

- an injury or illness to an intimate body part or to the reproductive system,
- an injury or illness resulting from a sexual assault,
- a mental illness,
- a case of HIV infection, hepatitis, or tuberculosis,
- a needlestick injury or cut from a sharp object that is contaminated with blood or other potentially infectious material (see 29 CFR Part 1904.8 for definition), and
- other illnesses, if the employee independently and voluntarily requests that his or her name not be entered on the log.

You must not enter the employee's name on the OSHA 300 *Log* for these cases. Instead, enter "privacy case" in the space normally used for the employee's name. You must keep a separate, confidential list of the case numbers and employee names for the establishment's privacy concern cases so that you can update the cases and provide information to the government if asked to do so.

If you have a reasonable basis to believe that information describing the privacy concern case may be personally identifiable even though the employee's name has been omitted, you may use discretion in describing the injury or illness on both the OSHA 300 and 301 forms. You must enter enough information to identify the cause of the incident and the general severity of the injury or illness, but you do not need to include details of an intimate or private nature.

What if the outcome changes after you record the case?

If the outcome or extent of an injury or illness changes after you have recorded the case, simply draw a line through the original entry or, if you wish, delete or white-out the original entry. Then write the new entry where it belongs. Remember, you need to record the most serious outcome for each case.

Classifying injuries

An injury is any wound or damage to the body resulting from an event in the work environment.

Examples: Cut, puncture, laceration, abrasion, fracture, bruise, contusion, chipped tooth, amputation, insect bite, electrocution, or a thermal, chemical, electrical, or radiation burn. Sprain and strain injuries to muscles, joints, and connective tissues are classified as injuries when they result from a slip, trip, fall or other similar accidents.

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Classifying illnesses

Skin diseases or disorders

Skin diseases or disorders are illnesses involving the worker's skin that are caused by work exposure to chemicals, plants, or other substances.

Examples: Contact dermatitis, eczema, or rash caused by primary irritants and sensitizers or poisonous plants; oil acne; friction blisters, chrome ulcers; inflammation of the skin.

Respiratory conditions

Respiratory conditions are illnesses associated with breathing hazardous biological agents, chemicals, dust, gases, vapors, or fumes at work.

Examples: Silicosis, asbestosis, pneumonitis, pharyngitis, rhinitis or acute congestion; farmer's lung, beryllium disease, tuberculosis, occupational asthma, reactive airways dysfunction syndrome (RADS), chronic obstructive pulmonary disease (COPD), hypersensitivity pneumonitis, toxic inhalation injury, such as metal fume fever, chronic obstructive bronchitis, and other pneumoconioses.

Poisoning

Poisoning includes disorders evidenced by abnormal concentrations of toxic substances in blood, other tissues, other bodily fluids, or the breath that are caused by the ingestion or absorption of toxic substances into the body.

Examples: Poisoning by lead, mercury, cadmium, arsenic, or other metals; poisoning by carbon monoxide, hydrogen sulfide, or other gases; poisoning by benzene, benzol, carbon tetrachloride, or other organic solvents; poisoning by insecticide sprays, such as parathion or lead arsenate; poisoning by other chemicals, such as formaldehyde.

Hearing Loss

Noise-induced hearing loss is defined for recordkeeping purposes as a change in hearing threshold relative to the baseline audiogram of an average of 10 dB or more in either ear at 2000, 3000 and 4000 hertz, and the employee's total hearing level is 25 decibels (dB) or more above audiometric zero (also averaged at 2000, 3000, and 4000 hertz) in the same ear(s).

All other illnesses

All other occupational illnesses.

Examples: Heatstroke, sunstroke, heat exhaustion, heat stress and other effects of environmental heat; freezing, frostbite, and other effects of exposure to low temperatures; decompression sickness; effects of ionizing radiation (isotopes, x-rays, radium); effects of nonionizing radiation (welding flash, ultra-violet rays, lasers); anthrax; bloodborne pathogenic diseases, such as AIDS, HIV, hepatitis B or hepatitis C; brucellosis; malignant or benign tumors; histoplasmosis; coccidioidomycosis.

When must you post the Summary?

You must post the *Summary* only — not the *Log* — by February 1 of the year following the year covered by the form and keep it posted until April 30 of that year.

How long must you keep the Log and Summary on file?

You must keep the *Log* and *Summary* for 5 years following the year to which they pertain.

Do you have to send these forms to OSHA at the end of the year?

No. You do not have to send the completed forms to OSHA unless specifically asked to do so.

How can we help you?

If you have a question about how to fill out the *Log*,

- ❑ ***visit us online at www.osha.gov*** or
- ❑ ***call your local OSHA office.***

Optional

Calculating Injury and Illness Incidence Rates

What is an incidence rate?

An incidence rate is the number of recordable injuries and illnesses occurring among a given number of full-time workers (usually 100 full-time workers) over a given period of time (usually one year). To evaluate your firm's injury and illness experience over time or to compare your firm's experience with that of your industry as a whole, you need to compute your incidence rate. Because a specific number of workers and a specific period of time are involved, these rates can help you identify problems in your workplace and/or progress you may have made in preventing work-related injuries and illnesses.

How do you calculate an incidence rate?

You can compute an occupational injury and illness incidence rate for all recordable cases or for cases that involved days away from work for your firm quickly and easily. The formula requires that you follow instructions in paragraph (a) below for the total recordable cases or those in paragraph (b) for cases that involved days away from work, *and* for both rates the instructions in paragraph (c).

(a) *To find out the total number of recordable injuries and illnesses that occurred during the year,* count the number of line entries on your OSHA Form 300, or refer to the OSHA Form 300A and sum the entries for columns (G), (H), (I), and (J).

(b) *To find out the number of injuries and illnesses that involved days away from work,* count the number of line entries on your OSHA Form 300 that received a check mark in column (H), or refer to the entry for column (H) on the OSHA Form 300A.

(c) *The number of hours all employees actually worked during the year*. Refer to OSHA Form 300A and optional worksheet to calculate this number.

You can compute the incidence rate for all recordable cases of injuries and illnesses using the following formula:

Total number of injuries and illnesses x *200,000* ÷ *Number of hours worked by all employees* = *Total recordable case rate*

(The 200,000 figure in the formula represents the number of hours 100 employees working 40 hours per week, 50 weeks per year would work, and provides the standard base for calculating incidence rates.)

You can compute the incidence rate for recordable cases involving days away from work, days of restricted work activity or job transfer (DART) using the following formula:

(Number of entries in column H + Number of entries in column I) x *200,000* ÷ *Number of hours worked by all employees* = *DART incidence rate*

You can use the same formula to calculate incidence rates for other variables such as cases involving restricted work activity (column (I) on Form 300A), cases involving skin disorders (column (M-2) on Form 300A), etc. Just substitute the appropriate total for these cases, from Form 300A, into the formula in place of the total number of injuries and illnesses.

What can I compare my incidence rate to?

The Bureau of Labor Statistics (BLS) conducts a survey of occupational injuries and illnesses each year and publishes incidence rate data by various classifications (e.g., by industry, by employer size, etc.). You can obtain these published data at www.bls.gov/iif or by calling a BLS Regional Office.

Worksheet

Total number of injuries and illnesses		200,000	÷	Number of hours worked by all employees	=	Total recordable case rate
	x					

Number of entries in Column H + Column I		200,000	÷	Number of hours worked by all employees	=	DART incidence rate
	x					

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How to Fill Out the Log

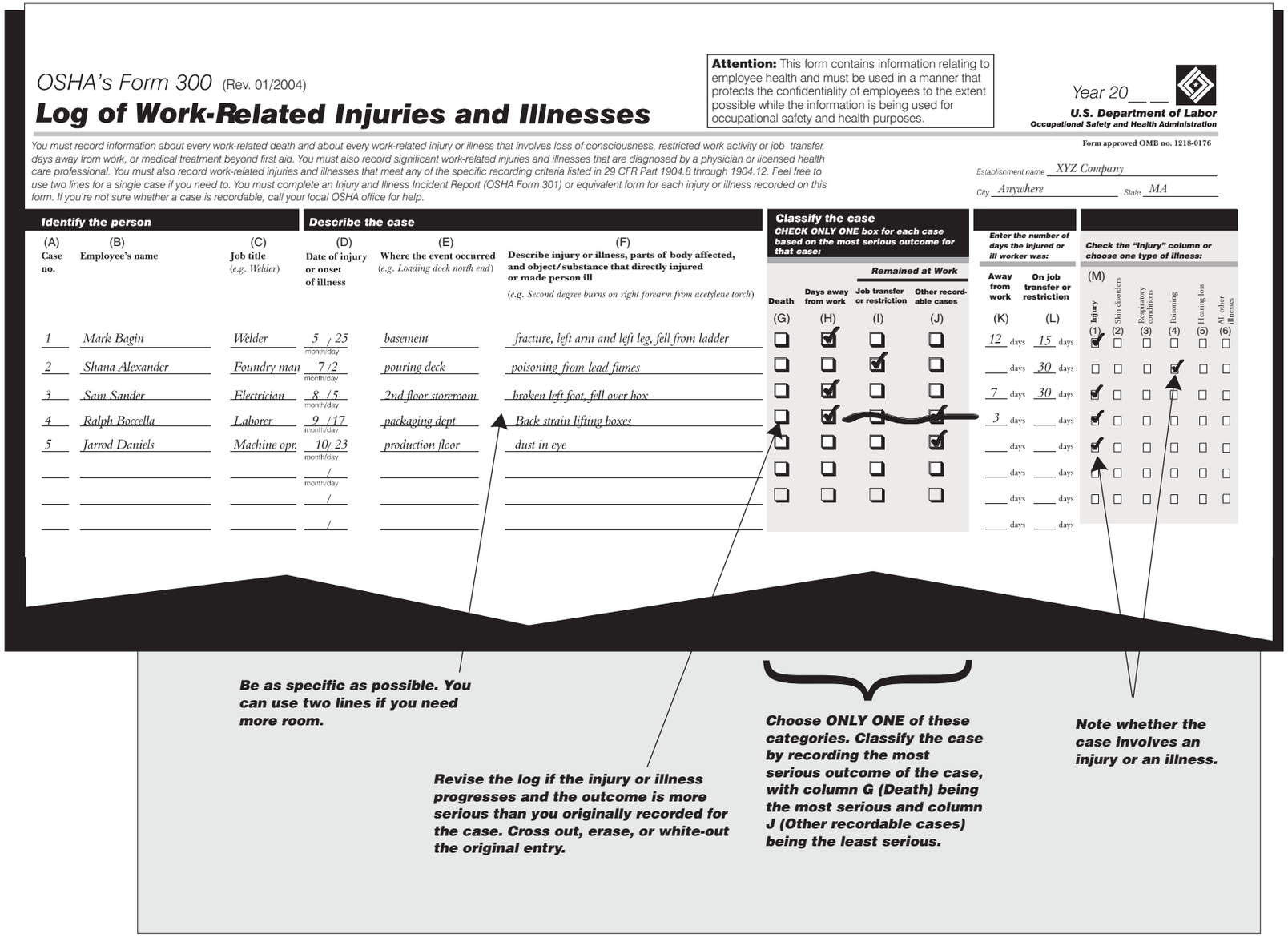
The *Log of Work-Related Injuries and Illnesses* is used to classify work-related injuries and illnesses and to note the extent and severity of each case. When an incident occurs, use the *Log* to record specific details about what happened and how it happened.

If your company has more than one establishment or site, you must keep separate records for each physical location that is expected to remain in operation for one year or longer.

We have given you several copies of the *Log* in this package. If you need more than we provided, you may photocopy and use as many as you need.

The *Summary* — a separate form — shows the work-related injury and illness totals for the year in each category. At the end of the year, count the number of incidents in each category and transfer the totals from the *Log* to the *Summary*. Then post the *Summary* in a visible location so that your employees are aware of injuries and illnesses occurring in their workplace.

You don't post the Log. You post only the Summary at the end of the year.



OSHA's Form 300 (Rev. 01/2004)

Log of Work-Related Injuries and Illnesses

Attention: This form contains information relating to employee health and must be used in a manner that protects the confidentiality of employees to the extent possible while the information is being used for occupational safety and health purposes.

Year 20__ __

U.S. Department of Labor
Occupational Safety and Health Administration

Form approved OMB no. 1218-0176

You must record information about every work-related death and about every work-related injury or illness that involves loss of consciousness, restricted work activity or job transfer, days away from work, or medical treatment beyond first aid. You must also record significant work-related injuries and illnesses that are diagnosed by a physician or licensed health care professional. You must also record work-related injuries and illnesses that meet any of the specific recording criteria listed in 29 CFR Part 1904.8 through 1904.12. Feel free to use two lines for a single case if you need to. You must complete an Injury and Illness Incident Report (OSHA Form 301) or equivalent form for each injury or illness recorded on this form. If you're not sure whether a case is recordable, call your local OSHA office for help.

Establishment name: XYZ Company
City: Anywhere State: MA

Identify the person			Describe the case			Classify the case (CHECK ONLY ONE box for each case based on the most serious outcome for that case:)				Enter the number of days the injured or ill worker was:		Check the "Injury" column or choose one type of illness:					
							Remained at Work										
(A) Case no.	(B) Employee's name	(C) Job title (e.g. Welder)	(D) Date of injury or onset of illness	(E) Where the event occurred (e.g. Loading dock north end)	(F) Describe injury or illness, parts of body affected, and object/substance that directly injured or made person ill (e.g. Second degree burns on right forearm from acetylene torch)	Death (G)	Days away from work (H)	Job transfer or restriction (I)	Other recordable cases (J)	Away from work (K)	On job transfer or restriction (L)	(M) Injury (1)	Skin disorders (2)	Respiratory conditions (3)	Poisoning (4)	Hearing loss (5)	All other illnesses (6)
1	Mark Bagin	Welder	5/25	basement	fracture, left arm and left leg, fell from ladder	☐	☑	☐	☐	12 days	15 days	☑	☐	☐	☐	☐	☐
2	Shana Alexander	Foundry man	7/2	pouring deck	poisoning from lead fumes	☐	☐	☑	☐	___ days	30 days	☐	☐	☐	☑	☐	☐
3	Sam Sander	Electrician	8/5	2nd floor storeroom	broken left foot, fell over box	☐	☑	☐	☐	7 days	30 days	☑	☐	☐	☐	☐	☐
4	Ralph Boccella	Laborer	9/17	packaging dept	Back strain lifting boxes	☐	☑	☐	☐	3 days	___ days	☑	☐	☐	☐	☐	☐
5	Jarrod Daniels	Machine opr.	10/23	production floor	dust in eye	☐	☐	☐	☑	___ days	___ days	☑	☐	☐	☐	☐	☐
			/			☐	☐	☐	☐	___ days	___ days	☐	☐	☐	☐	☐	☐
			/			☐	☐	☐	☐	___ days	___ days	☐	☐	☐	☐	☐	☐
			/			☐	☐	☐	☐	___ days	___ days						

Be as specific as possible. You can use two lines if you need more room.

Revise the log if the injury or illness progresses and the outcome is more serious than you originally recorded for the case. Cross out, erase, or white-out the original entry.

Choose ONLY ONE of these categories. Classify the case by recording the most serious outcome of the case, with column G (Death) being the most serious and column J (Other recordable cases) being the least serious.

Note whether the case involves an injury or an illness.

OSHA's Form 300 (Rev. 01/2004)

Log of Work-Related Injuries and Illnesses

Attention: This form contains information relating to employee health and must be used in a manner that protects the confidentiality of employees to the extent possible while the information is being used for occupational safety and health purposes.

Year 20__ __

U.S. Department of Labor
Occupational Safety and Health Administration

Form approved OMB no. 1218-0176

You must record information about every work-related death and about every work-related injury or illness that involves loss of consciousness, restricted work activity or job transfer, days away from work, or medical treatment beyond first aid. You must also record significant work-related injuries and illnesses that are diagnosed by a physician or licensed health care professional. You must also record work-related injuries and illnesses that meet any of the specific recording criteria listed in 29 CFR Part 1904.8 through 1904.12. Feel free to use two lines for a single case if you need to. You must complete an Injury and Illness Incident Report (OSHA Form 301) or equivalent form for each injury or illness recorded on this form. If you're not sure whether a case is recordable, call your local OSHA office for help.

Establishment name ____________________

City ________________ *State* ________

Identify the person			***Describe the case***			***Classify the case*** **CHECK ONLY ONE box for each case based on the most serious outcome for that case:**				***Enter the number of days the injured or ill worker was:***		***Check the "Injury" column or choose one type of illness:*** (M)					
(A) Case no.	(B) Employee's name	(C) Job title (*e.g., Welder*)	(D) Date of injury or onset of illness	(E) Where the event occurred (*e.g., Loading dock north end*)	(F) Describe injury or illness, parts of body affected, and object/substance that directly injured or made person ill (*e.g., Second degree burns on right forearm from acetylene torch*)	**Death** (G)	**Days away from work** (H)	***Remained at Work*** **Job transfer or restriction** (I)	***Remained at Work*** **Other record-able cases** (J)	**Away from work** (K)	**On job transfer or restriction** (L)	**Injury** (1)	Skin disorder (2)	Respiratory condition (3)	Poisoning (4)	Hearing loss (5)	All other illnesses (6)
			/ month/day			☐	☐	☐	☐	days	days	☐	☐	☐	☐	☐	☐
			/ month/day			☐	☐	☐	☐	days	days	☐	☐	☐	☐	☐	☐
			/ month/day			☐	☐	☐	☐	days	days	☐	☐	☐	☐	☐	☐
			/ month/day			☐	☐	☐	☐	days	days	☐	☐	☐	☐	☐	☐
			/ month/day			☐	☐	☐	☐	days	days	☐	☐	☐	☐	☐	☐
			/ month/day			☐	☐	☐	☐	days	days	☐	☐	☐	☐	☐	☐
			/ month/day			☐	☐	☐	☐	days	days	☐	☐	☐	☐	☐	☐
			/ month/day			☐	☐	☐	☐	days	days	☐	☐	☐	☐	☐	☐
			/ month/day			☐	☐	☐	☐	days	days	☐	☐	☐	☐	☐	☐
			/ month/day			☐	☐	☐	☐	days	days	☐	☐	☐	☐	☐	☐
			/ month/day			☐	☐	☐	☐	days	days	☐	☐	☐	☐	☐	☐
			/ month/day			☐	☐	☐	☐	days	days	☐	☐	☐	☐	☐	☐
			/ month/day			☐	☐	☐	☐	days	days	☐	☐	☐	☐	☐	☐
					Page totals ➤	___	___	___	___	___	___	___ Injury (1)	___ Skin disorder (2)	___ Respiratory condition (3)	___ Poisoning (4)	___ Hearing loss (5)	___ All other illnesses (6)

Be sure to transfer these totals to the Summary page (Form 300A) before you post it.

OSHA's Form 300A (Rev. 01/2004)

Summary of Work-Related Injuries and Illnesses

Year 20__ __

U.S. Department of Labor
Occupational Safety and Health Administration

Form approved OMB no. 1218-0176

All establishments covered by Part 1904 must complete this Summary page, even if no work-related injuries or illnesses occurred during the year. Remember to review the Log to verify that the entries are complete and accurate before completing this summary.

Using the Log, count the individual entries you made for each category. Then write the totals below, making sure you've added the entries from every page of the Log. If you had no cases, write "0."

Employees, former employees, and their representatives have the right to review the OSHA Form 300 in its entirety. They also have limited access to the OSHA Form 301 or its equivalent. See 29 CFR Part 1904.35, in OSHA's recordkeeping rule, for further details on the access provisions for these forms.

Number of Cases

Total number of deaths	Total number of cases with days away from work	Total number of cases with job transfer or restriction	Total number of other recordable cases
_____	_____	_____	_____
(G)	(H)	(I)	(J)

Number of Days

Total number of days away from work	Total number of days of job transfer or restriction
_____	_____
(K)	(L)

Injury and Illness Types

Total number of . . .

(M)

(1) Injuries _____

(2) Skin disorders _____

(3) Respiratory conditions _____

(4) Poisonings _____

(5) Hearing loss _____

(6) All other illnesses _____

Post this Summary page from February 1 to April 30 of the year following the year covered by the form.

Establishment information

Your establishment name _____

Street _____

City _____ State _____ ZIP _____

Industry description (*e.g., Manufacture of motor truck trailers*)

_____

Standard Industrial Classification (SIC), if known (*e.g., 3715*)

___ ___ ___ ___

OR

North American Industrial Classification (NAICS), if known (e.g., 336212)

___ ___ ___ ___ ___ ___

Employment information *(If you don't have these figures, see the Worksheet on the back of this page to estimate.)*

Annual average number of employees _____

Total hours worked by all employees last year _____

Sign here

Knowingly falsifying this document may result in a fine.

I certify that I have examined this document and that to the best of my knowledge the entries are true, accurate, and complete.

_____ _____
Company executive Title

( ) - / /
Phone Date

Optional

Worksheet to Help You Fill Out the Summary

At the end of the year, OSHA requires you to enter the average number of employees and the total hours worked by your employees on the summary. If you don't have these figures, you can use the information on this page to estimate the numbers you will need to enter on the Summary page at the end of the year.

How to figure the average number of employees who worked for your establishment during the year:

❶ ***Add*** the total number of employees your establishment paid in all pay periods during the year. Include all employees: full-time, part-time, temporary, seasonal, salaried, and hourly.

The number of employees paid in all pay periods = ❶ _____

❷ ***Count*** the number of pay periods your establishment had during the year. Be sure to include any pay periods when you had no employees.

The number of pay periods during the year = ❷ _____

❸ ***Divide*** the number of employees by the number of pay periods.

❶ _____ / ❷ _____ = ❸ _____

❹ ***Round the answer*** to the next highest whole number. Write the rounded number in the blank marked *Annual average number of employees*.

The number rounded = ❹ _____

For example, Acme Construction figured its average employment this way:

For pay period...	Acme paid this number of employees...
1	10
2	0
3	15
4	30
5	40
▼	▼
24	20
25	15
26	+10
	830

Number of employees paid = 830 ❶

Number of pay periods = 26 ❷

830 / 26 = 31.92 ❸

31.92 rounds to 32 ❹

32 is the annual average number of employees

How to figure the total hours worked by all employees:

Include hours worked by salaried, hourly, part-time and seasonal workers, as well as hours worked by other workers subject to day to day supervision by your establishment (e.g., temporary help services workers).

Do not include vacation, sick leave, holidays, or any other non-work time, even if employees were paid for it. If your establishment keeps records of only the hours paid or if you have employees who are not paid by the hour, please estimate the hours that the employees actually worked.

If this number isn't available, you can use this optional worksheet to estimate it.

Optional Worksheet

_____ ***Find*** the number of full-time employees in your establishment for the year.

X _____ ***Multiply*** by the number of work hours for a full-time employee in a year.

_____ This is the number of full-time hours worked.

\+ _____ ***Add*** the number of any overtime hours as well as the hours worked by other employees (part-time, temporary, seasonal)

_____ ***Round*** the answer to the next highest whole number. Write the rounded number in the blank marked *Total hours worked by all employees last year.*

U.S. Department of Labor
Occupational Safety and Health Administration

OSHA's Form 301
Injury and Illness Incident Report

Attention: This form contains information relating to employee health and must be used in a manner that protects the confidentiality of employees to the extent possible while the information is being used for occupational safety and health purposes.

U.S. Department of Labor
Occupational Safety and Health Administration

Form approved OMB no. 1218-0176

This *Injury and Illness Incident Report* is one of the first forms you must fill out when a recordable work-related injury or illness has occurred. Together with the *Log of Work-Related Injuries and Illnesses* and the accompanying *Summary,* these forms help the employer and OSHA develop a picture of the extent and severity of work-related incidents.

Within 7 calendar days after you receive information that a recordable work-related injury or illness has occurred, you must fill out this form or an equivalent. Some state workers' compensation, insurance, or other reports may be acceptable substitutes. To be considered an equivalent form, any substitute must contain all the information asked for on this form.

According to Public Law 91-596 and 29 CFR 1904, OSHA's recordkeeping rule, you must keep this form on file for 5 years following the year to which it pertains.

If you need additional copies of this form, you may photocopy and use as many as you need.

Completed by _____

Title _____

Phone (_____)_____--_____ **Date** ____/ ____/ ____

Information about the employee

1) **Full name** _____

2) **Street** _____

City _____ **State** _____ **ZIP** _____

3) **Date of birth** _____ / _____ / _____

4) **Date hired** _____ / _____ / _____

5) ❒ **Male**
❒ **Female**

Information about the physician or other health care professional

6) **Name of physician or other health care professional** _____

_____

7) **If treatment was given away from the worksite, where was it given?**

Facility _____

Street _____

City _____ **State** _____ **ZIP** _____

8) **Was employee treated in an emergency room?**
❒ **Yes**
❒ **No**

9) **Was employee hospitalized overnight as an in-patient?**
❒ **Yes**
❒ **No**

Information about the case

10) **Case number from the *Log*** _____ *(Transfer the case number from the Log after you record the case.)*

11) **Date of injury or illness** _____ / _____ / _____

12) **Time employee began work** _____ **AM / PM**

13) **Time of event** _____ **AM / PM** ☐ **Check if time cannot be determined**

14) ***What was the employee doing just before the incident occurred?*** **Describe the activity, as well as the tools, equipment, or material the employee was using. Be specific.** ***Examples:*** **"climbing a ladder while carrying roofing materials"; "spraying chlorine from hand sprayer"; "daily computer key-entry."**

15) ***What happened?*** **Tell us how the injury occurred.** ***Examples:*** **"When ladder slipped on wet floor, worker fell 20 feet"; "Worker was sprayed with chlorine when gasket broke during replacement"; "Worker developed soreness in wrist over time."**

16) ***What was the injury or illness?*** **Tell us the part of the body that was affected and how it was affected; be more specific than "hurt," "pain," or sore."** ***Examples:*** **"strained back"; "chemical burn, hand"; "carpal tunnel syndrome."**

17) ***What object or substance directly harmed the employee?*** ***Examples:*** **"concrete floor"; "chlorine"; "radial arm saw."** ***If this question does not apply to the incident, leave it blank.***

18) ***If the employee died, when did death occur?*** **Date of death** _____ / _____ / _____

If You Need Help...

If you need help deciding whether a case is recordable, or if you have questions about the information in this package, feel free to contact us. We'll gladly answer any questions you have.

- **Visit us online at www.osha.gov**
- **Call your OSHA Regional office and ask for the recordkeeping coordinator**

  or

- **Call your State Plan office**

Federal Jurisdiction

Region 1 - 617 / 565-9860
Connecticut; Massachusetts; Maine; New Hampshire; Rhode Island

Region 2 - 212 / 337-2378
New York; New Jersey

Region 3 - 215 / 861-4900
DC; Delaware; Pennsylvania; West Virginia

Region 4 - 404 / 562-2300
Alabama; Florida; Georgia; Mississippi

Region 5 - 312 / 353-2220
Illinois; Ohio; Wisconsin

Region 6 - 214 / 767-4731
Arkansas; Louisiana; Oklahoma; Texas

Region 7 - 816 / 426-5861
Kansas; Missouri; Nebraska

Region 8 - 303 / 844-1600
Colorado; Montana; North Dakota; South Dakota

Region 9 - 415 / 975-4310

Region 10 - 206 / 553-5930
Idaho

State Plan States

Alaska - 907 / 269-4957

Arizona - 602 / 542-5795

California - 415 / 703-5100

*Connecticut - 860 / 566-4380

Hawaii - 808 / 586-9100

Indiana - 317 / 232-2688

Iowa - 515 / 281-3661

Kentucky - 502 / 564-3070

Maryland - 410 / 767-2371

Michigan - 517 / 322-1848

Minnesota - 651 / 284-5050

Nevada - 702 / 486-9020

*New Jersey - 609 / 984-1389

New Mexico - 505 / 827-4230

*New York - 518 / 457-2574

North Carolina - 919 / 807-2875

Oregon - 503 / 378-3272

Puerto Rico - 787 / 754-2172

South Carolina - 803 / 734-9669

Tennessee - 615 / 741-2793

Utah - 801 / 530-6901

Vermont - 802 / 828-2765

Virginia - 804 / 786-6613

Virgin Islands - 340 / 772-1315

Washington - 360 / 902-5601

Wyoming - 307 / 777-7786

*Public Sector only

U.S. Department of Labor
Occupational Safety and Health Administration

U.S. Department of Labor
Occupational Safety and Health Administration

Have questions?

If you need help in filling out the *Log* or *Summary,* or if you have questions about whether a case is recordable, contact us. We'll be happy to help you. You can:

- Visit us online at: **www.osha.gov**
- Call your regional or state plan office. You'll find the phone number listed inside this cover.