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Hydrogen Sulfide (H_2S) Safety Program

Background:

Hydrogen sulfide presents a potential hazard to workers at the work site. It usually occurs as an unwanted by-product and can result in worker exposure in many different industries or occupations. To ensure protection against exposure to hydrogen sulfide, both workers and employers must be aware of its properties, how it affects the body and what to do in emergency situations. The Safety and Health Manager shall ensure that all personnel who will be working at the job site will be properly trained in H_2S awareness and contingency procedures.

Occurrence of Hydrogen Sulfide:

Hydrogen sulfide exposures usually occur during the drilling for or production of natural gas, crude oil and petroleum products. Hydrogen sulfide is also produced by the putrefaction of organic matter and may accumulate in sewers, sewage treatment plants or hide storage pits in the tanning industry. Well drillers and tunnel workers, as well as miners, may be exposed when underground pockets of hydrogen sulfide are encountered.
Hydrogen sulfide may be used in the manufacture of inorganic sulfides, sulfuric acid and mercaptans.

Locations where employees may be exposed to hydrogen sulfide are:

- Petroleum Refineries
- Storm drains
- Sewer environments
- Utility Vaults
- Tanks and storage containers at producing, pipeline and refining operations
- Tank Batteries and wells
- Paper Mills
- Tanneries
- Well Water

Characteristics of Hydrogen Sulfide:

Hydrogen sulfide (H_2S) is a toxic, colorless gas with a powerful nauseating smell of rotten eggs. The odor is a poor warning property because hydrogen sulfide exposure quickly deadens the sense of smell. The gas is heavier than air and may collect in low areas such as sewers, pits, tunnels or gullies. Hydrogen sulfide is soluble in water and is flammable. High airborne levels of hydrogen sulfide (between 4.3 and 46.0 percent of gas by volume in the air) may catch fire if there is a source of ignition. If the gas is burned, toxic products such as sulfur dioxide will be formed. Hydrogen sulfide is incompatible with oxidizing agents, such as nitric acid and chlorine trifluoride, and may react violently or ignite spontaneously.

Health Effects on the Body:

Hydrogen sulfide is extremely toxic. It may cause death instantaneously in high airborne concentrations. Low levels may be extremely irritating to the lungs, nose, throat and eyes. It effects nervecenters of the brainb which control breathing. Hydrogen sulfide can be detected by smell at levels as low as 0.13 parts hydrogen sulfide per million parts air (ppm). Odor cannot be used as a warning because the gas can deaden the sense of smell within 2 to 15 minutes in exposures of approximately 100 ppm. A single breath of hydrogen sulfide at about 1000 ppm may paralyze the respiratory system and result in coma and death. Convulsions may also occur. Prolonged exposure at about 250 ppm hydrogen sulfide may cause the lung tissue to swell and fill up with water (pulmonary edema). This effect may occur after the exposed worker recovers from the irritant effects of the gas. Exposures of 20 to 50 ppm hydrogen sulfide for one hour may cause inflammation of the cornea and the delicate lining of the eye and eyelid (a condition called keratoconjunctivitis). Exposures for long periods at 50 ppm may cause severe irritation of the nose, throat and lungs. Workers exposed to lower concentrations of hydrogen sulfide may develop headaches, eye disorders and chronic bronchitis.

Purpose:

The purpose of this Program is to protect public health and safety and those personnel essential to maintaining control of the well. This Program identifies Pagoda Electrical, Inc.'s uniform national requirements and minimum standards of performance expected from operators when conducting operations involving oil or gas that is known or could reasonably be expected to contain hydrogen sulfide (H_2S) or which results in the emission of sulfur dioxide (SO_2) as a result of flaring

H_2S. This Program also identifies the gravity of violations, probable corrective action(s), and normal abatement periods.

Scope:

HY2S6

This Program is applicable to all onshore oil and gas lease when drilling, completing, testing, reworking, producing, injecting, gathering, storing, treating operations, and/or operations that are being conducted in zones which are known or could reasonably be expected to contain H_2S or which, when flared, could produce SO_2, in such concentrations that upon release could constitute a hazard to human life. The requirements and minimum standards of this Program do not apply when operating in zones where H_2S is presently known *not to be present* or cannot reasonably be expected to be present in concentrations of 100 parts per million (ppm) or more in the gas stream. In the event Pagoda Electrical, Inc. is hired to perform work for another Contractor, Pagoda Electrical, Inc. and employees shall be aware of the Contractor's contingency/emergency plan provisions and policies and procedures.

Strict adherence to Pagoda Electrical, Inc.'s Confined Space Entry Program shall be observed when employees will be working inside tanks, vessels or in other situations that fall into the Confined Space Entry Program. Employees shall be trained per the requirements of CFR 1910.146(g).

Definitions:

A. Authorized officer means any employee of Pagoda Electrical, Inc. authorized to perform the duties described in 43 CFR Groups 3000 and 3100 (3000.0-5).

B. Christmas tree means an assembly of valves and fittings used to control production and provide access to the producing tubing string. The assembly includes all equipment above the tubing head top flange.

C. Dispersion technique means a mathematical representation of the physical and chemical transportation, dilution, and transformation of H_2S gas emitted into the atmosphere.

D. Escape rate means that the maximum volume (Q) used as the escape rate in determining the radius of exposure shall be that specified below, as applicable:

1. For a production facility, the escape rate shall be calculated using the maximum
   daily rate of gas produced through that facility or the best estimate thereof:
2. For gas wells, the escape rate shall be calculated by using the current daily

absolute open flow rate against atmospheric pressure;

3. For oil wells, the escape rate shall be calculated by multiplying the producing
   gas/oil ratio by the maximum daily production rate or best estimate thereof;
4. For a well being drilled in a developed area, the escape rate may be determined by using the offset wells completed in the interval(s) in question.

E. Essential personnel means those on-site personnel directly associated with the operation being conducted and necessary to maintain control of the well.

F. Exploratory well means any drilled beyond the known producing limits of a pool.

G. Gas well means a well for which the energy equivalent of the gas produced, including the entrained liquid hydrocarbons, exceeds the energy equivalent of the oil produced.

H. H_2S Drilling Operations Plan means a written plan which provides for safety of essential personnel and for maintaining control of the well with regard to H_2S and SO_2.

I. Lessee mean. a person or entity holding record title in a lease issued by the United States.

J. Major violation means compliance which causes or threatens immediate. substantial, and adverse impacts on public health and safety, the environment, production accountability, or royalty income.

K. Minor violation means noncompliance which does not rise to the level of a major violation.

L. Oil well means well for which the energy equivalent of the gas produced exceeds the energy equivalent of the gas produced, including the entrained liquid hydrocarbons.

M. Operating rights owner means a person or entity holding operating rights in a lease issued by the United States. A lessee may also be an operating rights owner if

the operating rights in a lease or portion thereof have not been severed from record title .

N. Operator means any person or entity including but not limited to the lessee or operating rights owner who has stated in writing to the authorized office, that he/she is responsible under the terms of the lease for the operations conducted on the leased lands or a portion thereof.

0. Potentially hazardous volume means a volume of gas of such H_2S concentration and flow rate that it may result in radius of exposure-calculated ambient concentrations of 100 ppm H_2S at any occupied residence, school, church, park, school bus stop, place of business or other area where the public could reasonably be expected to frequent, or 500 ppm H_2S at any Federal, State, County or municipal road or highway.

P. Production facilities means any wellhead, flowline, piping, treating, or separating equipment, water disposal pits, processing plant or combination thereof prior to the approved measurement point for any lease, communitization agreement, or unit participating area.

Q. Prompt Correction means immediate correction of violations, with operation suspended if required at the discretion of the authorized officer.

R. Public Protection Plan means a written plan which provides for the safety of the potentially affected public with regard to H_2S and SO_2.

S. Radius of exposure means the calculation resulting from using the following Pasquill -Gifford derived equation, or by such other method(s) s may be approved by the authorized officer:

1. For determining the 100 ppm radius of exposure where the H_2S concentration in the gas stream is less than 10 percent:

$$X= [1.589)(H_2S \text{ concentration})(Q)] (0.6258)$$ or

2. For determining the 500 ppm radius of exposure where the H_2S concentration in the gas stream is less than 10 percent:

$X=[(0.4546)(H_2S$ concentration)$(Q)]$

Where:

X= radius of exposure in feet:

H_2S Concentration = decimal equivalent of the mole or volume

fractions of H_2S in the gaseous mixture;
Q= maximum volume of gas determined to be available for escape in cubic feet per day (at standard condition of 14.73 psia and 60F).

3. For determining the 100 ppm or the 500 ppm radius of exposure in gas streams containing H_2S concentrations of 10 percent or greater, a dispersion technique that takes into account representative wind speed, direction, atmospheric stability, complex terrain, and other dispersion features shall be utilized.
Such techniques may include, but shall not be limited to one of a series of computer models outlined in the Environmental Protection Agency's "Guidelines on Air Quality Models (EPA-450/2-78-027R)."

4. Where multiple H_2S sources (i.e., wells, treatment equipment, flowlines, etc.) are present, the operator may elect to utilize a radius of exposure which covers a larger area than would be calculated using radius of exposure formula for each component part of the drilling/completion/workover/ production system.

5. For a well being drilled in an area where insufficient data exits, to calculate a radius of exposure, but where H_2S could reasonably be expected to be present in concentrations 3,000 feet shall be assumed.

T. Zones known to contain H_2S means geological formation in a field where prior drilling, logging, coring, testing, or producing operations have confirmed that H_2S -bearing zones will be encountered that contain 100 ppm or more of H_2S in the gas stream.

U. Zones known not to contain H_2S means geological fractions, in field where prior drilling, logging, coring, testing, or producing operations have confirmed the absence of H_2S -bearing zones that contain 100 ppm or more of H_2S in the gas stream.

V. Zones which can reasonably be expected to contain H_2S means geological formations in the area which have not had prior drilling, but prior drilling to the same formations in similar field(s) within the same geologic basin indicates there is not potential for 100 ppm or more of H_2S H_2S in the gas stream.

W. Zones which cannot reasonably be expected to contain H_2S means geological formations in the area which have not had prior drilling, but prior drilling to the same

formations in similar field(s) within the same geologic basin indicates there is not a potential for 100 ppm or of H_2S in the gas stream.

Pagoda Electrical, Inc. Responsibilities:

Workers may not be exposed to airborne levels of hydrogen sulfide which average more than 10 ppm* over an 8 hour work day. In addition, workers may not be exposed to airborne levels of hydrogen sulfide which average more than 15 ppm over any 15 minute period during the work day. At no time may the airborne level of hydrogen sulfide to which workers are exposed exceed 20 ppm. It is important to note that OELs (Occupational Exposure Limits) represent minimum standards for worker protection. All efforts should be taken to keep hydrogen sulfide levels as low as possible. It may be necessary, in some instances, to routinely monitor the air to ensure that airborne levels do not exceed the Occupational Exposure Limits.

In order to protect workers from the hazards of hydrogen sulfide, there are several control options available to Pagoda Electrical, Inc. These may include "engineering out" the hazard, putting safe work procedures in place or using administrative controls. Administrative controls involve such approaches as job rotation, work assignment or time periods away from hydrogen sulfide.
The method(s) used will depend on the condition at the work site. If such measures are inadequate to protect workers, or in the event of an emergency, appropriate breathing apparatus providing positive pressure to the facepiece must be provided. Workers must also be trained in its use. The Respiratory Protection Program chapter shall be consulted and provides information on the selection, care and use of respiratory protective equipment. Other personal protective equipment must also be provided if necessary. If personal protective equipment is used, it must be properly selected and cared for. At the minimum, a NIOSH-certified self-contained breathing apparatus or airline respirator with escape SCBA shall be used.

Worker Responsibilities:

Current regulations require the worker to take reasonable care of himself and others
at the work site. This includes co-operating with Pagoda Electrical, Inc. for the purpose of protecting himself and others. The worker must:

- become aware of the associated hazards and follow work practices and procedures developed by Pagoda Electrical, Inc.;
- wear protective equipment supplied by Pagoda Electrical, Inc. to ensure protection and follow instructions on correct usage.

In Case Of An Emergency and Safety Precautions

Workers and employers both have responsibilities in emergency situations.

Pagoda Electrical, Inc. must:

- have emergency procedures developed in advance of any potential emergency involving hydrogen sulfide leaks;
- ensure that workers are aware of the procedures, are trained and are adequately supervised in an emergency;
- provide workers with appropriate breathing apparatus providing positive pressure to full facepieces;
- ensure that workers use other protective equipment necessary for use in an emergency.

The worker must:

- vacate the area immediately if a sensor alarm is activated and shall not reenter without proper respiratory protection;
- avoid breathing hydrogen sulfide while quickly leaving the area for fresh air;
- move an exposed person who has breathed large amounts of hydrogen sulfide to fresh air at once. If breathing has stopped, perform artificial respiration;
- notify someone else and put into effect the established emergency rescue procedures whenever an exposed person is overcome;
- not re-enter a hydrogen sulfide-filled area of unknown concentration unless equipped with full facepiece positive pressure breathing apparatus;
- be prepared to assist fellow workers, while making sure the correct emergency procedures are followed. It is important not to take unnecessary risks when rescuing or assisting a fellow worker.

Requirements:

The requirements of this Program are the minimum acceptable standards with regard to H_2S operations. This Program also classifies violations as major or minor for purposes of meeting the assessment and penalty provisions of 43 CFR part 3163.

43 CFR part 3163 specifies the corrective action which may be required, and established the normal abatement period following detection of a major or minor violation in which the violator may take such corrective action without incurring an assessment. The authorized officer may, after consideration of all appropriate factors, require corrective actions and abatement periods that in some cases, vary from those specified in this Program and that he/she determines to be necessary to protect public health and safety, or the environment.

H_2S Detection and Monitoring Equipment:

Where hydrogen sulfide is expected and for all confined space entries, Pagoda Electric shall have an H_2S detection and monitoring system that automatically activates visible and audible alarms when the ambient air concentration of H_2S reaches the threshold limits of 10 ppm in air. An alarm will be sounded when PEL exceeds the preset level of 10ppm for 1910 0r 10 PPM for 1926. The sensors shall have a rapid response time and be capable of sensing a minimum of 1 ppm of H_2S in ambient air, with at least 3 sensing points located at the shale shaker, rig floor, and bell nipple for a drilling site and the cellar, rig floor, and circulating tanks or shale shaker for a completion site. The detection system shall be installed, calibrated, tested, and maintained in accordance with the manufacturer's recommendations.