Hydrogen Sulfide Safety Program
Purpose

To inform personnel of the dangers of Hydrogen Sulfide (H2S) and how to protect themselves from exposure to this gas.

Scope

This program was chosen to be established for emergencies that may potentially arise from exposure to Hydrogen Sulfide.
Hydrogen Sulfide

Occurrence

This gas can accumulate in sewers or sewage treatment plants due to its presence in petroleum. Well drillers, tunnel workers, and miners may be exposed if an underground pocket is discovered. While Hydrogen Sulfide occurs naturally in the Earth via crude petroleum and natural gases, it may also result from the following:

- Refineries
- Wastewater treatment facilities
- Sulfur production
- Tar and asphalt manufacturing plants
- The breakdown of human and animal wastes by bacteria
- Industrial activities such as food processing
- Coke ovens
- Kraft paper mills
- Rayon textile manufacturing
- Tanneries
Properties

Hydrogen Sulfide is a colorless and poisonous flammable gas that is known for smelling strongly of rotten eggs. Detection can occur at concentrations ranging from .01-.03 parts per millions. Relying on detection via smell is dangerous because a ppm of above 100 can deaden a person’s sense of smell in minutes. If rust or corrosion deposits exist, Hydrogen Sulfide may react to become Iron Sulfide which can ignite spontaneously when combined with air.

Explosive Properties

High concentrations of Hydrogen Sulfide can catch fire or explode near a source of ignition. Other toxic gases can be formed upon the ignition of this gas and may further react with those toxins.
Limits

Exposure Limits

Various agencies of the US government have set the following standards for H2S exposure:

- OSHA ceiling = 20 ppm
- OSHA maximum peak = 50 ppm
- NIOSH IDLH = 100 ppm
- AIHA ERPG-2 = 30 ppm
Health Effects

Toxicity

Hydrogen sulfide is extremely toxic. Workers are exposed when they inhale hydrogen sulfide in the air, and this toxic gas is quickly absorbed by the lungs. It is believed that exposure to hydrogen sulfide prevents the brain from using oxygen.

Short Term Exposure

Short-term (acute) exposure to hydrogen sulfide can cause irritation to the nose, throat, eyes and lungs. Exposure to higher concentrations can cause very serious health effects, and even death. The following table will show some key numbers and health effects:
<table>
<thead>
<tr>
<th>Concentration (ppm)</th>
<th>Health Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01 - 0.3</td>
<td>Odor threshold</td>
</tr>
<tr>
<td>1 - 20</td>
<td>Offensive odor, possible nausea, tearing of the eyes or headaches with prolonged exposure</td>
</tr>
<tr>
<td>20 - 50</td>
<td>Nose, throat and lung irritation; digestive upset and loss of appetite; sense of smell starts to become fatigued; acute conjunctivitis may occur (pain, tearing and light sensitivity)</td>
</tr>
<tr>
<td>100 - 200</td>
<td>Severe nose, throat and lung irritation; ability to smell odor completely disappears.</td>
</tr>
<tr>
<td>250 - 500</td>
<td>Pulmonary edema (buildup of fluid in the lungs)</td>
</tr>
<tr>
<td>500</td>
<td>Severe lung irritation, excitement, headache, dizziness, staggering, sudden collapse (knockdown), unconsciousness and death within a few hours, loss of memory for the period of exposure</td>
</tr>
<tr>
<td>500 - 1000</td>
<td>Respiratory paralysis, irregular heartbeat, collapse and death without rescue.</td>
</tr>
<tr>
<td>&gt; 1000</td>
<td>Rapid collapse and death</td>
</tr>
</tbody>
</table>
Health Effects

Pulmonary Edema

It is important to note that the symptoms of pulmonary edema (buildup of fluid in the lungs), such as chest pain or shortness of breath, can be delayed for up to 72 hours after exposure.

Acute Exposure Recovery

Workers who survive a serious hydrogen sulfide exposure (concentrations above 500 ppm) may recover completely or suffer long-term health effects. In some cases, there can be permanent nervous system effects, such as fatigue, anxiety, irritability, or impaired learning and memory. Workers who experience unconsciousness tend to have a greater chance of having permanent effects to the respiratory system, with symptoms such as shortness of breath on exertion, wheezing, chest tightness, hypersensitive airways and permanent lung damage.
Health Effects

Long Term Exposure

Hydrogen sulfide does not accumulate in the body. Repeated or prolonged exposure may cause low blood pressure, headache, nausea, loss of appetite, eye inflammation, and chronic cough.
Health Effects

Chronic Exposure Effects

The following health effects due to long-term (chronic) exposure to hydrogen sulfide have also been reported in scientific literature:

- Reduced lung function
- Neurological effects, such as headaches, nausea, depression, weakness, personality changes. Exposure to other reduced sulfur gases such as dimethyl sulfide and thiols (mercaptans) at the same time may contribute to this effect
- Eye irritation
- Irritation to the mucous membranes
- Damage to the cardiovascular system
Health Effects

First Aid

The following first aid measures should be followed for exposure to H2S:

First, immediately remove the victim from further exposure. Designated rescuers must wear properly fitting, positive pressure self-contained breathing apparatus other required safety equipment appropriate to the work site. If the worker is not breathing, apply cardio-pulmonary resuscitation in the nearest safe area. Remove contaminated clothing but keep the individual warm. If the individual is conscious, keep them at rest.
Health Effects

First Aid

- Be aware of possible accompanying injuries (e.g. the victim may have fallen when they were overcome) and treat them accordingly
- If the victim’s eyes are red and painful, flush with large amounts of clean water for at least 15 minutes
- Ensure the worker receives medical care as soon as possible. The worker must not be allowed to return to work or other activities
Preventative Measures

Engineering Controls

Engineering controls are used to eliminate exposure to a substance. Engineering controls remove the substance from the air or provide a barrier between the worker and the substance. For example:

- Ventilation to control hydrogen sulfide concentrations in the air
- Closed systems that vent to a flare
- Treatment methods to remove hydrogen sulfide from liquid and gas streams
Preventative Measures

Flaring

Flaring is controlled burning of gas. It’s a technique used by the petroleum industry to remove waste gases from crude oil. However, when hydrogen sulfide is burned, another toxic gas, sulfur dioxide, is produced. Therefore, flaring is becoming a less popular way of dealing with waste gases in petroleum products.
Preventative Measures

Chemical Treatment

Chemical treatment can be used to remove hydrogen sulfide from crude oil, gas and water streams. The most common method is called the Claus Process where hydrogen sulfide is separated from the gas stream by amine treatment and then converted to less toxic element sulfur using combustion and chemical reaction.

Where hydrogen sulfide is present in off-gases from wastewater treatment or other industrial processes, there are a variety of scrubbers and filters that can be used. In water, hydrogen sulfide can be treated by chlorination, manganese greensand filters, aeration, ozonation, activated carbon and bio-filters. Hydrogen sulfide treatment of drilling fluids, along with proper pH control, should be used to reduce the amount of hydrogen sulfide that is re-circulated.
Preventative Measures

Administrative Controls

Work practices that can be implemented to reduce potential exposure to hydrogen sulfide include:

- Educating workers about the hazards associated with hydrogen sulfide and symptoms of overexposure.
- Courses such as “H2S Alive” and First Aid are recommended when workers may be exposed to hydrogen sulfide at the work site.
- Developing safe work procedures for environments that may contain hydrogen sulfide.
- Using engineering controls and other equipment to reduce exposure.
- Using personal or area monitoring equipment, with alarms, where there are potential sources of hydrogen sulfide.
Preventative Measures

Safe Work Practices

Evaluating the hazard from hydrogen sulfide must be included in the hazard assessment for the work site. Below are some pertinent questions to measure your sites preparedness.
Preparedness Questions

- Has the potential for a release of H2S into the atmosphere at levels of 10 ppm or greater been evaluated?
- Does every worker on site know where and how an uncontrolled release of H2S could occur?
- Does every worker know what precautions to take when there is a potential for an H2S release?
- Do workers know what to do in case of an emergency?
- Have the areas which require the mandatory use of breathing apparatus been identified?
- Does every worker who could be exposed to H2S have appropriate training?
- Is there a procedure to test the atmosphere for H2S concentrations and are workers trained in this procedure?
- Is all the necessary equipment readily available to workers who require it?
Preparedness Questions

- Are you certain that your workers follow safe work practices developed by your organization?
- Have you determined if you need a code of practice for operations involving H2S?

If the answer to any of the questions is “no”, workers may be in danger from exposure to hydrogen sulfide.
Monitoring

There is a variety of monitoring equipment available, depending on the purpose of the monitoring. It is important to select monitoring equipment that fits the needs of the work environment. When selecting monitoring equipment, the user should also check for substances that could interfere with the equipment.

Monitoring equipment for hydrogen sulfide should be set to alarm at no higher than the OEL for hydrogen sulfide. Portable monitors will alarm at the appropriate PEL of 20 PPM for 1910 or 10 PPM for 1926. It is also very important that the instrument be calibrated and operated properly.
Hydrogen sulfide is frequently encountered in work environments (e.g. oil and gas industry, sewage treatment plants) where other flammable or combustible gases are present. In these work environments, it is recommended that monitoring be done for both hydrogen sulfide and other flammable/combustible vapors so the hazards can be properly assessed.
If it is not practicable or feasible to use engineering or administrative controls to reduce the potential for exposure to hydrogen sulfide, or if these measures are not sufficient, Wetherbee Electric, Inc. will provide workers with appropriate respiratory protective equipment. There are many types of respirators available and it is important to select the correct level of respiratory protection.
Personal Protective Equipment

Since hydrogen sulfide is irritating to the eyes, air-tight goggles or full-face respirator masks should be worn. A full-facepiece, positive pressure supplied air respirator is needed for work areas where hydrogen sulfide concentrations exceed the OEL. The National Institute for Occupational Safety and Health (NIOSH) specifies an immediately dangerous to life or health concentration for hydrogen sulfide as 100 ppm. Above these concentrations, or for emergency or planned entry into unknown concentrations, a full-facepiece positive pressure supplied air respirator must be used. Whatever the type of respirator used, the worker must be clean-shaven where it seals to the skin of the face and must be fit-tested for the type of equipment being used.
Code of Practice

A code of practice is required for work sites where there may be more than 10 kg of hydrogen sulfide present as a pure substance, or in a mixture in a concentration over 0.1% by weight and at least 10 kg of hydrogen sulfide in aggregate.
Code of Practice

Contents

The code of practice should include:

- Company policy and persons responsible for the code of practice
- Safe work procedures
- Required personal protective equipment
- Worker training requirements if needed
- H2S certification
- Emergency procedures and designated emergency personnel.
- Alarms (personals and/or stationary)
- Wind socks will be established and in view of the work area
- Developing egress routes to safe zones when alarms sound
- Be aware of client’s contingency/emergency plans
Exposure Monitoring

Methods

When conducting monitoring for hydrogen sulfide to comply with the OEL, either NIOSH Method 6013, or a continuous reading direct reading instrument may be used.

Calibration and Maintenance

When a direct-reading instrument is used to measure hydrogen sulfide exposure, it must be used, calibrated and maintained according to the manufacturer’s instructions. The employer is responsible to ensure that the instrument is operating properly when it is used at the work site.
Additional Requirements

- Development of safe work procedures.
- Ensuring that an emergency response plan is developed for the work site and that personnel are designated for emergency response activities.
- Training, personal protective equipment and other equipment needed. Training of workers on health hazards associated with exposure to hydrogen sulfide.
- Ensuring that the need for ventilation is properly assessed and systems that are installed are properly designed and maintained. Workers also need to be trained on the proper operation of these systems.
Training

All employees will be trained in the hazards of H2S upon being hired or assigned to a job that has the potential to expose the employee to H2S. Training takes 3-4 hours and will include the following:

- Physical and chemical properties
- Sources
- Human physiology and medical evaluation
- Work procedures
- Personal Protective Equipment
- Contingency plans and emergency response
- Burning, flaring, and venting
- State and federal regulatory requirements
- Release dispersion models
- Detection and monitoring
- Engineering controls

Frequency

After initial training, employees will be retrained annually.
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