HYDROGEN SULFIDE (H_2S)

MANAGEMENT

Purpose

The purpose of this plan is to establish minimum requirements for site-specific H_2S safety, which will enhance safety in the occupational setting where hydrogen sulfide is present or is recognized as being potentially present.

Scope

This plan sets forth accepted practices for Hydrogen Sulfide (H_2S) operations management. This program applies to all employees of Arrow S Energy Operating (the company), consultants, and any contractors working for Arrow S Energy Operating. When work is performed by a contractor employee or consultant on a company site, the contractor's program shall take precedence. This program may be adopted for use by contractors who do not have a formal H_2S Management Program.

Definitions

Contingency Plan - a site-specific written document that provides an organized plan for alerting and protecting the public within an area of exposure following the accidental release of all potentially hazardous atmospheric concentrations of hydrogen sulfide.
Exposure Level - permissible exposure level of hydrogen sulfide is 10 PPM for an 8-hour, time-weighted average.
Gas Detector Instrument - An instrument/detector to measure levels of H_2S. Instruments may be electronically or manually operated.
Hydrogen Sulfide (H_2S) - is an extremely deadly, toxic gas that in its pure state is colorless and is heavier than air. Additionally:

- It is the second most toxic gas known to man, ranking behind hydrogen cyanide and ahead of carbon monoxide.
- It has the odor of rotten eggs at low concentrations.
- In higher concentrations rapidly paralyze the olfactory nerves (sense of smell).
- Is soluble in water and is flammable and poses a definite threat of explosion.

Parts Per Million (PPM)- parts of vapor or gas per million parts of contaminated air by volume.
Personal (H_2S) Monitor- An electronic instrument worn on the person that is set to alarm at 10 PPM of H_2S.
Possible Locations of Where Workers May Be Exposed to (H_2S) During Their Job Functions- The majority of time H_2S can be located in drilling operations, recycled drilling mud, blowouts, water from sour crude wells, blowouts, tank gauging, tanks at producing, pipeline and refining operations, during routine field maintenance involving hydrocarbons, tank batteries and wells.
Venting - the process of discharging a material to the atmosphere through a series piping and/or venting devices, to facilitate the proper and safe dispersion of toxic materials and to minimize personnel exposure.

Key Responsibilities

Managers and Supervisors

- Shall ensure all employees who are to be assigned to work at locations where hydrogen sulfide is known to be present, or suspected to be present in any concentration, have been trained in hydrogen sulfide safety.
- To ensure employees have been medically approved to wear respirators and trained on the safe use of respirators, including a respirator fit test in accordance with Arrow S Energy Operating's Respiratory Protection Program.
- To ensure employees have been trained and familiar with personal H_2S monitors and gas detection instruments.
- To insure contractors have been provided with the client's safety procedures.
- To ensure the necessary respiratory equipment to perform the work safely is available.
- That each employee has been provided with a copy of this program.

Employees

- Employees are responsible to comply with this program.

Characteristics of Hydrogen Sulfide

Hydrogen Sulfide

The characteristics of hydrogen sulfide include: toxic, colorless, with the odor or rotten eggs at low concentrations, is soluble in water and is flammable:

- Toxicity – See table below. Hydrogen sulfide is a very dangerous and deadly gas - it is colorless and heavier than air. It can accumulate in low places and in small concentrations. Exposure to certain concentrations of H_2S can cause serious injury or death.
- Color - H_2S is colorless – you can't see it.
- Odor – it has a strong, pungent, somewhat distasteful odor similar to rotten eggs. In higher concentrations, it can deaden the sense of smell (olfactory nerve). Do Not Rely On Smell To Detect H_2S – Rely Strictly On Instruments Designed To Measure Concentrations Of H_2S.
- Solubility – H_2S mixes with water.
- Flammability – H_2S is an explosive gas.
- Toxic Byproducts – H_2S presence can create sulfur dioxide which can ignite without warning

Toxic Effects of Hydrogen Sulfide

CONCENTRATION	PHYSICAL EFFECT
.01 PPM	Can smell odor.
10 PPM	Obvious and unpleasant odor. Beginning eye irritation. ANSI permissible exposure level for 8 hours (enforced by OSHA).
100 PPM	Immediately Dangerous to life or Health (IDLH) Kills smell in 3-15 minutes; may sting eyes and throat. May cause coughing and drowsiness. Possible delayed death within 48 hours.
200 PPM	Kills smell shortly, stings eyes and throat. Respiratory irritation. Death after 1-2 hours exposure.

500 PPM	Dizziness; breathing ceases in a few minutes. Need prompt rescue breathing (CPR). Self-rescue impossible because of loss of muscle control.
700 PPM	Unconscious quickly; death will result if not rescued promptly.
1000 PPM	Unconscious at once, followed by death within minutes.

Health Effects of Exposure to Hydrogen Sulfide
Some basic health effects of H_2S can include eye irritations and effect nerve centers of the brain which control breathing.

Hydrogen Sulfide Procedures

General Requirements
Each person entering a H_2S designated location, regardless of the concentration, shall wear a personal H_2S monitor that is set to alarm at 10 PPM. When the alarms sound the employees must either evacuate the area or don the SCBA's or airline respirators.

When work requires opening any equipment on location that has the potential of releasing concentrations of H_2S at 100 PPM or higher, two or more H_2S trained persons shall be present and follow these procedures prior to and during the opening of the equipment:

- Each person entering the H_2S location shall don a personal H_2S monitor prior to entry.
- A tailgate meeting will be held with everyone on location to discuss the work plan, the responsibilities of each person and the site specific contingency plan.
- Each person shall have either a self-contained breathing apparatus (SCBA) or a supplied airline respirator equipped with a 5-minute escape pack and shall be worn when opening the equipment to the surrounding atmosphere.
- At least one person (per two workers), equipped with a SCBA will act as a stand-by person and may not participate in the work being performed until the atmosphere has been tested and found to have no H_2S present in quantities over 10 PPM. The stand-by person shall be stationed up wind, within 100 feet and in clear view of the workers.
- If an operator or other third party provides the stand-by person, it will be the responsibility of the Arrow S Energy Operating manager/supervisor in charge to verify that the person has been H2S, CPR, and First Aid trained, and that they have been provided the proper respiratory equipment.
    - Only Arrow S Energy Operating employees may wear Arrow S Energy Operating respirator equipment.
    - If Arrow S Energy Operating employees will use third party equipment, the equipment must be inspected to ensure it is safe to use and meets Arrow S Energy Operating's requirements.
- After the equipment has been locked and tagged out (per Arrow S Energy Operating Lockout/Tagout Program), opened and the H_2S concentration has been cleared to less than 10 PPM, the stand-by person will no longer be required. Work may then be performed without respiratory equipment, except for the required 5-minute escape pack.

H_2S Contingency Plan
An H2S Contingency Plan (H2SCP) is required for any operations where:

- 100 ppm ROE is in excess of 50 ft., includes any public area

- 500 ppm ROE is greater than 50 ft., includes any public road
- 100 ppm ROE is 3,000 ft. or greater

The H2SCP shall be made readily available on location and all on-site workers shall be made aware of the location of the plan. All active H2SCP's are located at https://hse.arrowsenergy.com/h2s

Safe Work Procedures

- Maintain compliance with permit requirements of Arrow S Energy Operating and any requirements by the contractor.
- Verify that proper safety equipment is available, functioning properly and is utilized.
- Check and remain aware of wind conditions and direction.
- Perform a thorough check of the downwind area prior to the start of any potentially hazardous work activity.
- Check for other personnel and ignition sources.
- Ventilate work areas by venting and purging lines and vessels prior to beginning any work activities.
- Keep all non-essential personnel away from work areas.
- Immediately vacate the area when any H_2S monitor sounds and do not re-enter without proper respiratory protection.
- Service companies shall utilize H2S trained personnel to work on H2S system/s or well and where such work could allow the escape of H2S gas.

Required Equipment

The following equipment shall be provided and used as required by this program:

- Methods of detecting H_2S by the use of fixed or portable monitors and will alarm at the appropriate permissible exposure limits of 10 PPM
- Personal or area monitors that alarm when PEL exceeds the preset level of 10 PPM.
- Portable H_2S gas testing instrument, either electronic or manual pump operated, capable of testing the suspected concentrations of H_2S in the system. Each testing instrument must be capable of testing the suspected concentrations of H_2S by using the manufacturer's recommended calibrated tube or other means of measuring the concentration of gas. Testing instruments shall be calibrated periodically according to the manufacturer's recommendation, and at least annually.
- Calibration kits with regulator for calibrating the personal monitor.
- Calibration gas cylinder for testing the personal monitor.
- Approved respiratory protection equipment.

Warning and Maker Signs

Where the 100 ppm radius of exposure is in excess of 50 feet, the operation shall be subject to the following warning and marker sign requirements:

- For above-ground and fixed surface facilities, where permitted by law, there shall be clearly visible warning signs on access roads or public streets, or roads which provide direct access to facilities located within the area of exposure.
- In populated areas such as cases of townsites and cities where the use of signs is not considered to be acceptable, then an alternative warning plan may be approved upon written request to the Railroad commission.
- For buried lines, a marker sign shall be installed at public road crossings. Marker signs shall be installed along the line, when it is located within a public area or along a public road, at intervals frequent enough so as to provide warning to avoid the accidental rupturing of line by excavation. The marker sign shall contain sufficient information to establish the ownership and existence of the line and shall indicate by the use of the words "Poison Gas" that a potential danger exists. Markers installed in compliance with the regulations of the federal Department of Transportation shall satisfy the requirements of this provision.
- Marker signs must be of sufficient size to be readable at a reasonable distance from the facility.
- Signs shall use the language of "Caution" and "Poison Gas" with a black and yellow color contrast. Colors shall satisfy Table I of American National Standard Institute Standard 253.1-1967. Signs installed to satisfy this section are to be compatible with the regulations of the federal Occupational Safety and Health Administration.

Medical

Each employee shall have completed a medical evaluation by a physician or licensed health care professional to determine the employee's ability to wear a respirator as required by the Arrow S Energy Operating Respiratory Protection Program.

Each employee will successfully complete the medical questionnaire and examination before being allowed to be fit tested with a respirator.

Training

Employees required to work on H_2S locations will be trained on the following topics:

- Physical and chemical properties of H_2S
- Sources of H_2S
- Human physiology
- Signs and symptoms of H_2S exposure, acute and chronic toxicity
- Symptomatology of H_2S exposure
- Medical evaluation
- Work procedures
- Personal protective equipment required working around H_2S
- Use of contingency plans and emergency response
- Burning, flaring, and venting of H_2S
- State and federal regulatory requirement
- H_2S release dispersion models
- Rescue techniques, first aid, and post exposure evaluation
- Use, care, and calibration of personal monitors and gas detection instruments
- Respirator inspections and record keeping

Site supervisors must be trained in the following:

- Effects of H2S on metals
- Corrective actions and shutdown procedures.
- Well control - If a drilling operation
- Knowledge of contingency plan.

Each respirator wearer will complete Respiratory Protection training and a Respirator Fit Test, after being given a medical clearance and before entering any H_2S location.

Employees and other personnel visiting H_2S locations who will not be involved in the work shall be briefed on the following prior to entering:

- Site-specific sources of H_2S
- Health hazards of H_2S
- Routes of egress
- Emergency assembly areas
- Applicable alarm signals and
- How to respond in the event of an emergency.

Respiratory Protection
The following guide shall be used to determine the type of breathing equipment required when working in an H_2S environment:

- 0-10 ppm: No respirator is needed, below the recommended exposure limit (REL).
- 10-100 ppm: Powered Air-Purifying Respirator (PAPR), Full Face Mask Cartridge Respirator, or Self-Contained Breathing Apparatuses (SCBA).
- 100-100,000 ppm: A level of H2S gas at or above 100 ppm is Immediately Dangerous to Life and Health (IDLH). Entry into IDLH atmospheres can only be made using:
    1. a full facepiece pressure demand self-contained breathing apparatus (SCBA) with a minimum service life of thirty minutes, or
    2. a combination full facepiece pressure demand supplied-air respirator with an auxiliary self-contained air supply. If H2S levels are below 100 ppm, an air-purifying respirator may be used, assuming the filter cartridge/canister is appropriate for hydrogen sulfide. A full facepiece respirator will prevent eye irritation. If air concentrations are elevated, eye irritation may become a serious issue. If a half mask respirator is used, tight fitting goggles must also be used.

Respirators shall be inspected by the employee before each use and at least monthly.

The inspection will include the respirator face piece, hose, harness, 5-minute escape pack cylinder and all other components of the air supply/ air purifying systems used.

Monthly inspections will be documented as per Arrow S Energy Operating Respiratory Protection Program and will be kept on file at the local office for review during safety assessments.

Monitors and Gas Detector Calibration
When required each personal H_2S monitor shall be calibrated at least monthly and the results recorded on a calibration log maintained by the employee in possession of the monitor.

Those monitors that do not require calibrating shall be bump checked with calibration gas to test alarms, monthly or prior to use if not used routinely.

Rescue

Each employee, when working alone in a H_2S designated area, shall plan and become familiar with self-escape procedures to include being aware of wind direction and obstacles to avoid when exiting the work area.

Employees working under the buddy system shall pre-plan an emergency rescue and/or evacuation procedure prior to commencing work and arrange for periodic communications with his/her supervisor and document the discussion on each employee's service report.

NEVER attempt a rescue in an area that may contain hydrogen sulfide without using appropriate respiratory protection and without being trained to perform such a rescue.