Hydrogen Sulfide (H₂S) Safety Procedures

Purpose
This H₂S program has been developed for Apache Corporation to promote a safe and healthful work environment for employees who work in oil and gas producing operations where there is the potential for H₂S exposure.

Scope
These guidelines are written in order to limit the potential for H₂S exposure of our employees and contractors during the performance of their duties. The program addresses the following topics:

- Source Identification Surveys
- Exposure Monitoring
- Categorization of H₂S Areas
- Personal Protective Equipment
- H₂S Monitors
- Wind Indicators
- Emergency Procedures
- Employee Training
- Program Evaluation
- Recordkeeping

Responsibility
The Person in Charge (PIC), Lead Operator, Consultant, or Production Superintendent is responsible for:

- Facility compliance with elements of the program and shall see that each facility’s program under their oversight complies with the following:
  a) Adherence with approved H₂S contingency plan(s)
  b) Appropriate H₂S monitors are available
  c) H₂S exposure monitoring is being conducted
  d) Feasible engineering controls are being utilized
  e) H₂S source identifying surveys are conducted
  f) Ensure personnel are trained according to the program requirements
  g) Enforcing employee compliance with this program
  h) Requiring H₂S monitoring equipment to be inspected and calibrated.

Employees and Contract Personnel are responsible for:

- Complying with the procedures outlined in this program and the required training.
Requirements

Contingency Plans
In H2S present environment(s) (see H2S definition), a contingency plan shall be developed and approved by BSEE prior to commencing operations. When personnel are made aware of such potential H2S environments, they shall immediately contact their supervisor and the EH&S Department. All H2S activities and contingency plans shall follow the requirements set forth in 30 CFR Part 250.

Personal Protective Equipment
When exposure to personnel is anticipated and engineering controls fail to reduce breathing zone concentrations to below 10 ppm averaged over 8 hours, or 20 ppm for a maximum of 15 minutes, individuals shall be required to wear appropriate respiratory protection. A good rule of thumb to follow would be to automatically mask up for gauging those tanks that have H2S levels in excess of 20 ppm.

When respiratory protection is required, a full-face piece supplied-air respirator, operated in the positive pressure mode, shall be used. If an airline respirator is used, it must be equipped with an emergency egress bottle.

Personal, Portable and Fixed H2S Monitors
Three basic types of continuous reading monitors (personal, portable, fixed) can be used when work tasks involve potential exposure to H2S. These monitors shall be selected based on the various requirements of each work area.

Personal Monitors
When routine and/or maintenance tasks involve potential exposure to H2S at or above 10 ppm in the breathing zone, or 20 ppm or more at the source, the use of continuous direct reading personal monitors with audible, visual and/or vibrator alarms is required. The following requirements are applicable:

- Personal monitors shall be set to alarm at 10 ppm.
- Personal monitors shall be properly maintained and calibrated in accordance with the manufacturer’s recommendation.
- Calibration shall be performed no less frequently than every 3 months; or more frequently if recommended by the manufacturer.
- Monitors shall be challenged, or “bumped”, with span gas prior to each use.
- Personal monitors must be worn on the outside of all clothing.

Note: The use of personal monitors by each individual working in a H2S area is strongly recommended. However, when a group of personnel are working in the same area, with the same exposure potentials, it is not mandatory for each individual to wear a personal monitor.
A portable monitor may be used for work groups as long as it adequately samples the work area and is representative of the exposure of each member of the group. Individuals of a group working together and making use of a common monitor are not allowed to leave that group and enter an area with potential breathing zone concentrations of 10 ppm or sources at or above 20 ppm unless the individual is utilizing a personal monitor.

**Portable Monitors**

Continuous reading portable monitors may be available for use at H₂S facilities. Portable monitors may be used to check the suspect area prior to entry. A probe extension should be used so entry into the suspect area can be avoided until either it is deemed safe for entry, or the proper PPE is utilized.

When using a portable monitor, emphasis should be placed on testing low-lying areas where H₂S can accumulate and concentrate. Areas which warrant particular attention include, but are not limited to:

- Confined spaces such as pits, process vessels, pipe ditches, and tanks
- Pumps and flow lines
- Amine treating units
- Sulfur recovery units
- Compressor buildings.

**Fixed Monitors**

Areas where sources of H₂S equal to or exceed 20 ppm and there is a potential for a sudden release of H₂S should be evaluated for the installation of permanent fixed H₂S monitoring systems. Fixed monitor sensors should be placed in proximity to potential sources of an H₂S release.

Sensors should be situated in a manner that ensures adequate coverage under any wind direction situation. The monitor’s warning device, audible and visual, shall be located so that the alarm can be easily recognized throughout the facility.

Additionally, the following apply to fixed monitors:

- Continuous reading fixed area monitors shall be inspected and calibrated on a monthly basis and/or as recommended by the manufacturer, if more stringent.
- When an alarm sounds (personal, portable, or fixed), individuals shall leave the area and shall not re-enter until the airborne concentration of H₂S is below 10 ppm.
- If it is necessary to enter a work environment where concentrations are above 10 ppm, a full-facepiece supplied-air respirator operated in the positive pressure mode shall be used.
- All low level alarms shall be set at a maximum of 10 ppm or less H₂S concentration.

**Warning Signs**
Warning signs shall be posted to remind personnel of potential hazards at all H₂S facilities. In some cases, a facility may be designated as an H₂S facility based upon a single source above 20 ppm. If a facility is classified based on one source (e.g., an amine unit above 10 ppm with all other sources less than 10 ppm), signs may be posted only in that area of the facility.

The following are additional warning sign requirements:

- For offshore operations, signs are to be located on the outboard sides of the facility to inform boaters of a potential H₂S danger.
- Signs for offshore use shall be a minimum of 8 feet wide and 4 feet high, with wording a minimum of 12 inches in height.
- The sign(s) shall be high-visibility yellow color with black lettering.
- The sign shall be legible and large enough to be read by all persons approaching the facility.
- All signs, and when appropriate, flags, shall be visible to all personnel when approaching the facility under normal lighting and weather conditions.

Wind Indicator

Wind indicators such as wind socks, streamers or vanes, are required in facilities where sources of H₂S are equal to or greater than 20 ppm. Wind indicators shall be placed at locations and heights which enable free movement and accurately indicate the wind direction. The indicators shall be visible from normal entrances to the facility.

Wind direction shall be determined prior to performing outdoor tasks where H₂S may be encountered. If possible, work tasks should be performed upwind from an H₂S source to reduce the potential for exposure. All personnel should develop wind direction consciousness.

Flares

A flare system, when appropriate, shall be designed and installed to safely gather and burn H₂S bearing gas. The flare system shall be equipped with a suitable and safe means of ignition. Where noncombustible gas is to be flared, the system shall be provided supplemental fuel to maintain ignition.

Emergency Response Plan

The site-specific emergency response or contingency plan should provide an organized immediate action plan for alerting and protecting employees and the public in the event of a major H₂S release.

The contingency plan must contain information on, but not limited to, the following subjects:

1) Emergency Procedures (to include)
   - Responsibilities of personnel
   - Immediate Action Plan
• Telephone numbers and communication methods
• Safety equipment and supplies available (e.g., number and location of breathing air equipment)
• Location of first aid kits, litter or Stokes basket, resuscitators, and spare oxygen bottles.

2) Characteristics of Hydrogen Sulfide

3) Characteristics of Sulfur Dioxide

   Note: This is required only if the facility is flaring or burning the H₂S as a disposal method.

4) Facility Description, Maps and Drawings (to include)

   • Plants
   • Tank Batteries, gas conditioning facilities, flow lines
   • Compression facilities.

5) Training and Drills (to include)

   • Responsibilities and duties of essential personnel
   • Onsite or classroom drills
   • Training and attendance documentation
   • Briefing of public officials

Training

Personnel who work in areas where there is a potential for exposure to H₂S shall be instructed and trained initially on the following subjects:

• Hazards, characteristics, properties, and sources of H₂S
• Proper use of H₂S detectors and monitoring equipment
• Symptoms of overexposure to H₂S
• First aid for H₂S victims, including resuscitators
• Proper selection, use and maintenance of respiratory protection equipment
• Safe work procedures and precautions
• Wind direction awareness and routes of egress
• Job hazards
• Effects of H₂S on equipment (corrosion, hydrogen embrittlement, etc.)
• Confined spaces
• Emergency procedures
NOTE: A comprehensive examination should be administered after the training class. Periodic refresher training should be conducted at least annually. Refresher training will review the key elements of the H2S program.

Recordkeeping
Records on training, equipment calibration, source identification surveys, exposure monitoring, and notification to affected personnel should be maintained as follows:

a) **Training** - signed documentation of annual training shall be kept at the facility (or nearest field office) for a period of three years.

b) **Equipment Calibration and Inspection List** - documentation of equipment calibration and the inspection list shall be kept at the facility (or nearest field office) for a period of two years.

c) **Source Identification Surveys** - documentation of source identification surveys shall be maintained at the facility (or nearest field office) for a minimum of two years.

d) **Exposure Monitoring** - documentation of exposure monitoring of personnel shall be maintained at the facility (or nearest field office) for 30 years following the duration of employment of individuals monitored.

Note: Records may be kept at other designated locations for archive purposes after personnel are no longer employed by Apache or the contract company, or the facility has been closed down.

Definitions

**H2S Present Means**: that drilling, logging, coring, testing, or producing operations have confirmed the presence of H2S in concentrations and volumes that could potentially result in atmospheric concentrations of 20 ppm or more of H2S.

**Breathing Zone** - A space forward of the shoulders with a radius of 6 to 9 inches.

**Hydrogen Sulfide (H2S)** - A colorless, flammable, toxic gas that is heavier than air and can be found in fluids encountered in oil and gas productions and gas processing operations. Inhalation at certain concentrations can lead to injury or death.

- The health effects associated with H2S are primarily determined by the concentration of the gas in the individual’s breathing zone, the length of exposure period(s), and the individual’s susceptibility to H2S. This gas exhibits potential health hazards, even at relatively low concentrations of 10-20 ppm. At these concentrations H2S may cause eye irritation. At concentrations above 600 ppm, H2S can cause immediate respiratory arrest, loss of consciousness, and death.

- An important effect of H2S exposure is olfactory fatigue, or temporary loss of the sense of smell. H2S odor can be detected at concentrations as low as 0.13 ppm. At concentrations up to or about 50 ppm, H2S has an odor similar to rotten eggs. However, at concentrations above this level, the sense of smell diminishes. At concentrations above 100 ppm, H2S causes a rapid and total loss of the ability to smell. Because of this characteristic, odor must never be used as a warning indicator for H2S exposure.
Immediately Dangerous to Life or Health (IDLH)- an atmospheric concentration of any toxic, corrosive, or ashpyxiant that poses an immediate threat to life, or that would cause irreversible adverse health effects, or that would interfere with an individual’s ability to self-rescue from a dangerous atmosphere. The IDLH level for H₂S is 100 ppm as set by NIOSH.

Source - As it pertains to this program, crude oil, produced gas, water, and the atmosphere inside of a container, i.e. tank, vessel, line, etc., which contains H₂S.