

**Gulf**of**Mexico**



**Operations: HSE**

**Health and Industrial Hygiene**

**Hydrogen Sulfide Safe Work Practice (SWP)**

## AMENDMENT RECORD

Amendment Date	Revision Number	Amender Initials	Amendment
10/02/2014	3	VDM/CAF	Updated formatting and added Appendix - Controlling H2S Formation in to address waste tanks and other containers to prevent the buildup of H2S gas on offshore installations, drilling/work-over rigs, and supply vessels.
10/1/12	2	<p>Authority: Director, Health and Safety</p> <p>Custodian: Health and Industrial Hygiene Team Leader</p>	<p>Updated SPU to Region.</p> <p>Updated document authority and custodian.</p> <p>Updated GoM Industrial Hygiene Coordinator to Regional Health and Industrial Hygiene Team. Added reference to OMS Element 3.4 – Health and Industrial Hygiene.</p> <p>Defined “Escape-Only respirator”.</p> <p>Changed MMS to BSEE.</p> <p>Added requirement to wear a personal monitor when aboard “H2S present” or “H2S unknown” facilities.</p> <p>Added the requirement for “H2S present” and “H2S unknown” facilities to meet the annual GoM respiratory protection SWP.</p> <p>Added Key Responsibilities</p> <p>Included Exposure Guidelines Table</p> <p>Visitors who do not meet the requirements of OSHA’s respiratory protection SWP must be provided an escape-only respirator.</p> <p>Supplied breathing air must be grade D.</p> <p>H2S monitors required to read down to 1 ppm. Amended audible and visual warning requirements.</p>

			<p>Allowing for local ventilation in lieu of respiratory protection so long as breathing zone levels are &lt; 1ppm</p> <p>Added section 5.14 – mud systems and well control on H2S present and unknown facilities Added section 5.15 – Well testing on H2S present and unknown facilities</p> <p>Added Section 5.16 – Metallurgical properties to address metals and sulfide compatibility considerations during design Added Section 5.30 to address the potential buildup of H2S in sealed water tanks (e.g. bilge tanks, barges or pit tanks).</p> <p>Updated exposure limits to meet ACGIH TLV for H2S and SO2</p> <p>Updated references to reflect document changes</p>
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# 1 Introduction

The purpose of this document is to provide guidance for the control of Hydrogen Sulfide (H<sub>2</sub>S) hazards where they exist on GOM offshore installations, drilling/work-over rigs, and supply vessels. H<sub>2</sub>S as a workplace contaminant is heavily regulated and has been recognized as a significant potential oil and gas drilling and production hazard for many years. Title 30, Part 250.490 is the primary regulation and reference used and its requirements are enforced by the Bureau of Safety and Environmental Enforcement (BSEE).

Additional regulations and guidance have been issued by the Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH).

## 2 Scope

This Practice applies to GoM offshore installations, drilling/work-over rigs, and supply vessels.

## 3 Key Responsibilities

### 3.1 Offshore Installation Manager (OIM), Wellsite Leader, and Onshore Facility Manager

- A. Implement this SWP by ensuring that the proper assessments have been made with regard to workplace H<sub>2</sub>S exposures.
- B. Verify notification to the BP GoM Regulatory Advisor takes place when air concentrations of 20 ppm H<sub>2</sub>S are detected (15-minute time-weighted average concentrations).
- C. Verify treatment procedures are followed by facility to control H<sub>2</sub>S formation.

### 3.2 Team Leaders

Verify that workers are trained in anticipating, recognizing, evaluating and controlling H<sub>2</sub>S exposure hazards and ensuring that appropriate equipment is available to workers (e.g., training media, ventilation equipment, personal protective equipment or barricade/decontamination equipment).

### 3.3 H&S Site Lead

- A. Assist management, supervisors and workers with requests regarding training and personal protective equipment use/supply
- B. Consult on anticipating, recognizing, evaluating, preventing, and controlling H<sub>2</sub>S hazards as part of the hazard identification and task risk assessment (HITRA) process.

### 3.4 Workers

Utilize engineering controls, appropriate administrative controls (e.g., decontamination procedures, as applicable) and personal protective equipment when performing jobs with potential for exposure to H<sub>2</sub>S.

### 3.5 Industrial Hygienist

- A. Consult on H2S workplace exposure control, including the development of an H2S practice, training media, interpretation of regulations and internal procedures, and professional resources to conduct workplace exposure assessments, as requested.
- B. Assess the results of self-assessments and audits to identify trends, emerging risks and opportunities to improve risk reduction measures for preventing non-compliance and overexposure to hydrogen sulfide.

### 3.6 Regulatory Advisor

- A. Receive and accept notification information from the field concerning H2S releases and notifying BSEE in a timely, appropriate manner as required by the regulations.
- B. Notify the Health Manager if any assistance or guidance is needed regarding the safety practices of H2S.
- C. Submit H2S Contingency plans for approval where applicable and communicate with BSEE where appropriate.

### 3.7 Mud Engineer or Chemical Technician

- A. Treat water and waste containing oily waste and organic materials with biocides or scavengers.
- B. Conduct H2S sampling.

### 3.8 Rig Clerk/Materials Coordinator

Document test results on manifest and send to Supply Base for transfer authorization.

### 3.9 Supply Base Coordinator

- A. Verify facility has properly tested and treated waste for H2S and results are documented on manifest.
- B. Provide transfer authorization to Vessel Captain and rig/platform
- C. Request a 3rd party vendor to test waste fluids upon vessel arrival at dock.

### 3.10 Vessel Captain

- A. Accept liquid waste that has been approved by Supply Base Coordinator.
- B. Conduct H2S sampling and monitoring on vessel.

## 4 General Requirements

- A. Prior to the commencement of initial operations in a field, an H2S classification must be obtained from the BSEE Regional Supervisor. Classifications are:
  - 1. H2S absent
  - 2. H2S present
  - 3. H2S unknown

- B. A request for reclassification of a zone must be submitted anytime that additional data indicates a different classification is needed.
- C. BSEE requirements apply, as appropriate, to drilling, well completion/well work-over, and production operations in zones with H<sub>2</sub>S present and H<sub>2</sub>S unknown.
- D. Offshore Rigs shall carry a minimum of 6 X 30 minute ready to use SCBA work packs to allow emergency situations to be managed safely.
- E. No one shall attempt to enter a hazardous atmosphere for the purpose of rescue unless they are properly trained, using the buddy system, and they are wearing respiratory protection.
- F. If atmospheric concentrations of H<sub>2</sub>S of 10 ppm or more are encountered, respiratory protection is required. See Section 5.5.1.
- G. All H<sub>2</sub>S releases that result in a 15 minute time-weighted average atmospheric concentration of H<sub>2</sub>S of 20 ppm or more anywhere on an OCS facility must be reported to your Regulatory Advisor within 8 hours.
- H. Each facility where exposures to H<sub>2</sub>S may exceed 20 ppm (H<sub>2</sub>S present and H<sub>2</sub>S unknown facilities) must have a written H<sub>2</sub>S contingency plan
- I. If on a H<sub>2</sub>S present facility, personnel must wear H<sub>2</sub>S detectors whenever outside the living quarters, galley and office spaces.
- J. Where there is potential to generate SO<sub>2</sub> through burning and flaring of H<sub>2</sub>S, fixed or personal electronic SO<sub>2</sub> detection methods shall be utilized to determine personnel exposure.

## 5 Process

### 5.1 H<sub>2</sub>S & SO<sub>2</sub> Emergencies

- A. Safe briefing areas shall be established for all manned H<sub>2</sub>S facilities. Conspicuous signs shall designate safe briefing areas.
- B. For H<sub>2</sub>S/SO<sub>2</sub> Alarms, non-essential personnel shall evacuate the operational areas crosswind to the upwind safe briefing area. Essential personnel shall prepare to don their respiratory protection and report to their duty station.

**Table 1. H2S & SO2 Emergency Response during Alarm Events**

H2S/SO2 Concentration	Alarm Type and Set Points (where installed)	Action
10 ppm H2S	Low Alarm: Flashing blue lights and fast alternating tones	Evacuate the operational areas crosswind to the upwind safe briefing/muster area. Notify Industrial Hygienist.
20 ppm H2S	High Alarm: Flashing blue lights and fast alternating tones.	Initiate BSEE reporting requirements. Evacuate the operational areas crosswind to the upwind safe briefing/muster area. Do I need to notify BSEE in the event of an H2S release? You must notify BSEE without delay in the event of a gas release which results in a 15-minute time-weighted average atmospheric concentration of H2S of 20 ppm or more anywhere on the OCS facility. You must report these gas releases to the District Manager immediately by oral communication, with a written follow-up report within 15 days, pursuant to §§ 250.188 through 250.190
2 ppm SO2	Low Alarm	You must pipe gases from stored test fluids into the flare outlet and burn them.
5 ppm SO2	High Alarm	You must pipe gases from stored test fluids into the flare outlet and burn them. Evacuate the operational areas crosswind to the upwind safe briefing/muster area. Notify Industrial Hygienist.

## 5.2 First Aid/CPR Treatment of Hydrogen Sulfide Exposed Personnel

- A. Activate written H2S contingency plan and telephone for help.
- B. Using the buddy system, always don proper respiratory protection before entering a potential H2S area, then remove the person to a safe area and begin first aid/CPR.
- C. Initiate CPR/First Aid.
- D. Treat for shock (keep the person warm).
- E. Ensure that all personnel with signs or symptoms of H2S exposure are examined by the Medic or approved physician.

## 5.3 Written Contingency Plan

Operations in H2S present and H2S unknown areas may not commence until a written H2S contingency plan is developed and approved by BSEE. A copy of the approved plan must be kept at the facility. Consult with your Regulatory Advisor.

The written H2S contingency plan must include emergency procedures for 2 ppm or greater SO2. The contingency plan must include:

- A. Safety procedures and rules to be followed concerning equipment, drills, and smoking.
- B. Training to be provided for employees, contractors, and visitors.
- C. Job position and title of the person responsible for the overall safety of personnel.
- D. Other key positions, how these positions fit into the organization and the functions, duties, and responsibilities of those job positions.
- E. Actions to be taken when the concentration of H<sub>2</sub>S in the atmosphere reaches 10 ppm such as evacuation or the use of respiratory protection, who will be responsible for those actions and a description of the audible and visual alarms to be activated.
- F. Briefing areas where personnel will assemble during an H<sub>2</sub>S alert. At least two briefing areas must be identified on each facility. Use the briefing area that is upwind of the H<sub>2</sub>S source at any given time.
- G. Criteria used to decide when to evacuate the facility and procedures used to safely evacuate all personnel from the facility by vessel, capsule, or lifeboat and, if helicopters are used during H<sub>2</sub>S alerts, describe the types of H<sub>2</sub>S emergencies during which the risk of helicopter activity is considered acceptable and the precautions taken during the flights.
- H. Procedures used to safely position all vessels attendant to the facility indicating where vessels will be located with respect to wind direction including the distance from the facility and what procedures are to be used to safely relocate the vessels in an emergency.
- I. How respiratory protection is provided for all personnel in H<sub>2</sub>S present or H<sub>2</sub>S unknown areas, including contractors and visitors.
- J. Notification to the agencies and facilities in case of a release that constitutes an emergency, how they are notified, and their telephone numbers, including all facilities that might be exposed to atmospheric concentrations of 10 ppm or more of H<sub>2</sub>S.
- K. The medical personnel and facilities used, their addresses, and telephone numbers.
- L. The operational conditions expected to flare gas containing H<sub>2</sub>S, including the estimated maximum gas flow rate, H<sub>2</sub>S concentration, and duration of flaring.
- M. An assessment of the risks to personnel during flaring and what precautionary measures are to be taken.
- N. Primary and alternate methods to ignite the flare and procedures for sustaining ignition and monitoring the status of the flare (i.e., ignited or extinguished).
- O. Procedures to shut off the gas to the flare in the event the flare is extinguished.
- P. Portable or fixed SO<sub>2</sub> detection system(s) used to determine SO<sub>2</sub> concentration and exposure hazard when H<sub>2</sub>S is burned.
- Q. Increased monitoring and warning procedures taken when the SO<sub>2</sub> concentration in the atmosphere reaches 0.25 ppm.
- R. Engineering controls and personnel protection measures or evacuation procedures initiated when the SO<sub>2</sub> concentration in the atmosphere reaches 2 ppm.
- S. Any special equipment, procedures, or precautions used when conducting any combination of drilling, well completion, well work-over, and production operations simultaneously.
- T. H<sub>2</sub>S sensor locations in production facilities producing gas containing 10 ppm or more of H<sub>2</sub>S, including an H<sub>2</sub>S detector location drawing showing.
- U. All vessels, flare outlets, wellheads, and other equipment handling production containing H<sub>2</sub>S.
- V. Approximate maximum concentration of H<sub>2</sub>S in the gas stream.

## 5.4 Exposure Guidelines

**Table 2. H2S Exposure Guidelines**

Exposure Guideline	H2S Concentration (ppm)	SO2 Concentration (ppm)
BP GoM Instantaneous Concentration in Breathing Zone Requiring Respiratory Protection (regardless of task exposure) length).	10	2.0
ACGIH TLV – eight-hour TWA	1.0	-
ACGIH TLV – 15-minute STEL	5.0	0.25

## 5.5 Respiratory Protection Requirements

- A. Positive pressure full-face SCBA with a hose line capability and a breathing time of at least 30 minutes or a positive pressure full-face airline respirator with an escape bottle must be used when concentrations exceed those listed in Section 5.4. The use of Air Purifying Respirators for protection against H2S is prohibited.
- B. At least two voice transmission devices, which can be used while wearing a respirator, must be provided for use by designated personnel.
- C. Breathing air bottles must be labeled as containing breathing-quality air for human use. Check Grade D breathing air certificate from supplier. If generating breathing air, test the air against Grade D criteria quarterly in accordance with the written GoM Respiratory Protection SWP.
- D. Attendant vessels must carry appropriate respiratory protection for each crewmember.
- E. The flight crew and passengers must use respiratory protection when approaching facilities during H2S emergencies. Limit flights in accordance with the contingency plan.

## 5.6 H2S Training & Drills

- A. H2S Training is required for all personnel required to work offshore when H2S concentrations are equal to or above 10 ppm. This training must be completed prior to going offshore. Annual refresher training is required.
- B. Respirator medical clearance, fit-testing, and respiratory protection training is required per the GoM Respiratory Protection SWP.
- C. A drill for each person at the facility is conducted at least once every 7-day period. The drills consist of a dry-run performance of personnel activities related to assigned jobs.
- D. Drill performance, new H2S considerations at the facility and other updated H2S information shall be discussed in safety meetings.
- E. Documentation must be maintained at the facility where the individual is assigned or the individual must carry a training completion card. Contractors must document and provide verification of H2S training of their employees. Trained employees or contractors transferred from another facility must attend a supplemental site-specific briefing on H2S equipment and procedures before beginning duty.

- F. Safety meetings and drill attendance records shall be kept until drilling, well completion and well work-over operations at the facility are completed. For production operations, these records shall be maintained at the facility or for one year.

## 5.7 Training Exemptions and Briefing Requirements

- A. Visitors who depart before spending 24 hours on the facility are exempt from the H2S training required. However, they must, upon arrival, complete a briefing that includes;
- B. Information on the location and use of an escape-only respirator and limit their access to non-respirator required tasks and areas.
- C. Information on the safe briefing areas, alarm system, and hazards of H2S and SO2
- D. Instructions on their responsibilities in the event of an H2S release.

## 5.8 H2S&SO2 Monitoring Equipment

The H2S monitoring system must activate a visual alarm when the concentration of H2S in the atmosphere reaches 10 ppm. The system must activate audible and visual alarms when the concentration of H2S in the atmosphere reaches 20 ppm. Personal detectors shall be used by personnel working without respiratory equipment where there is a probability that H2S levels may reach 10 ppm or greater in the breathing zone.

On facilities burning H2S and designated as H2S present and H2S unknown, an SO2 detection system capable of detecting a minimum of 1 ppm of SO2 must be provided. The system may be portable or fixed. When there is a potential for the creation of SO2, readings are taken at least hourly. Readings must also be taken anytime personnel detect SO2 odor (like burnt matches) or nasal irritation. If SO2 concentrations in the work area reach 2 ppm, the personnel protective measures specified in the H2S contingency plan must be implemented.

### 5.8.1 Monitoring Drilling/Work-over Operations

When drilling/work-over operations are being conducted at a facility, H2S sensors must be located in the following areas:

- A. bell nipple,
- B. mud-return line receiver tank (possum belly),
- C. pipe-trip tank,
- D. shale shaker,
- E. well control fluid pit area,
- F. driller's station,
- G. living quarters and
- H. all other areas where H2S may accumulate.

Continuous Monitoring is required during the following operations when:

- A. Pulling a wet string of drill pipe or work-over string,
- B. Circulating bottoms-up after a drilling break,
- C. During cementing operations,
- D. During logging operations and
- E. Circulating to condition, mud or other well control fluid.

## 5.8.2 Monitoring Production Operations

On a platform where gas containing H<sub>2</sub>S of 10 ppm or greater is produced, processed, or otherwise handled, sensors must be located in the following areas;

- A. At least one sensor per 400 square feet of deck area and fractional part thereof.
- B. Rooms, buildings, deck areas, or low-laying deck areas where atmospheric concentrations of H<sub>2</sub>S could reach 10 ppm or more.
- C. Buildings where personnel have their living quarters.
- D. Within 10 feet of each vessel, compressor, wellhead, manifold, or pump that could release enough H<sub>2</sub>S to result in atmospheric concentrations of 10 ppm at a distance of 10 feet from the component (one sensor to detect H<sub>2</sub>S around multiple pieces of equipment, provided the sensor is located no more than 10 feet from each piece).
- E. At least two sensors to monitor compressors exceeding 50 horsepower.
- F. Consider the location of system fittings, flanges, valves and other devices subject to leaks to the atmosphere when placing the sensors.

## 5.8.3 Monitoring Calibration and Detector Bump Testing

- A. Personnel trained to calibrate the particular H<sub>2</sub>S monitors shall perform calibrations by exposing them to a known concentration in the range of 10 to 30 ppm of H<sub>2</sub>S. If the results of any functional test are not within 2 ppm or 10 percent, whichever is greater of the applied concentration, recalibrate the instrument.
- B. When conducting drilling, drill stem testing, well completion, or well work-over operations in areas classified as H<sub>2</sub>S present or H<sub>2</sub>S unknown, all sensors are calibration-checked at least once every 24 hours. When drilling, bump checks are indicated before the bit is 1,500 feet (vertically) above the potential H<sub>2</sub>S zone.
- C. When conducting production operations, calibrate all sensors at least every 14 days.
- D. All H<sub>2</sub>S detectors (personal use) must be bump tested before each day's use, by exposing the detector to a known concentration in the range of 10 to 30 ppm of H<sub>2</sub>S.
- E. The SO<sub>2</sub> detection system shall be calibrated at least every 3 months.
- F. All records shall be maintained at the facility and available for inspection by BSEE. H<sub>2</sub>S calibration records must include dates and details concerning;
  - 1. installation,
  - 2. removal,
  - 3. inspection,
  - 4. repairs,
  - 5. adjustments and
  - 6. reinstallation.

## 5.9 Other Safety Equipment Associated with H<sub>2</sub>S Operations

- A. Retrieval ropes with safety harnesses,
- B. Oxygen resuscitators (at least three resuscitators on manned facilities and a number equal to the personnel on board, not to exceed three, on normally unmanned facilities),
- C. Explosion-proof ventilation devices (located in areas where H<sub>2</sub>S or SO<sub>2</sub> may accumulate and movable ventilation devices must be provided in work areas),
- D. First aid kit,
- E. Litter or an equivalent stretcher type device, or

- F. Chalkboards and/or note pads for communication (located on the rig floor, shale-shaker area, the cement-pump rooms, well-bay areas, production processing equipment area, gas compressor area, and pipe line pump area),

## 5.10 H2S Monitoring on Vessels

Vessels stationed overnight alongside facilities in areas of H2S present or H2S unknown or those used to store and transport tanks and other containers with bulk liquids and waste materials that contain organic materials which can produce H2S due to biological activity must be equipped with an H2S detection system that activates audible and visual alarms at atmospheric concentrations of 10 ppm. This requirement does not apply to vessels positioned upwind and at a safe distance from the facility in accordance with the positioning procedure described in the approved H2S contingency plan.

The BSEE District Manager may require that the company equip nearby facilities with an H2S system if dispersion modeling indicates H2S concentrations could exceed 10 ppm at these facilities.

## 5.11 Alarms and Warning Signs

### 5.11.1 Alarms

Personnel will receive a briefing upon arrival to the facility covering all alarms and emergency conditions.

Other alarm requirements include:

- A. Alarms and detection equipment must be intrinsically safe or appropriate for the electrical classification of the area.
- B. Audible alarms must generate a unique sound used only for H2S
- C. When warning devices are activated, the person designated in the contingency plan as the responsible person must inform personnel of the level of danger and issue instructions in accordance with the contingency plan.

### 5.11.2 Warning Signs & Wind Direction Equipment

Wind direction equipment is provided in a location visible at all times to individuals on or in the immediate vicinity of the facility. Warning signs must be displayed at all times on facilities with wells capable of producing H2S and on facilities that process gas containing H2S in concentrations of 10 ppm or more.

Each sign must be a high-visibility yellow color with black lettering as follows;

- A. Danger - Poisonous Gas - Hydrogen Sulfide (12 inch high lettering) and
- B. Do Not Approach if Red Flag is Flying (7 inch high lettering)
- C. Do Not Approach if Red Lights are Flashing (7 inch high lettering) unless red lights are not used
- D. Existing signs containing the words "Danger – Hydrogen Sulfide – H2S" may be used provided the words "Poisonous Gas: Do Not Approach if Red Flag is Flying" or "Red Lights are Flashing" in lettering of a minimum of 7 inches in height are displayed on a sign immediately adjacent to the existing sign.
- E. Warning flags must be flown for the duration of sustained H2S releases of 10 ppm or more. Each flag must be red, rectangular, a minimum width of 3 feet, and a minimum height of 2 feet. Sufficient numbers of flags must be hoisted to be visible to vessels and aircraft.
- F. Illuminate all signs and flags at night and under conditions of poor visibility.

## 5.12 Buddy System

The Buddy System must be implemented where there is a potential for an atmospheric concentration of H<sub>2</sub>S greater than 10 ppm. The person performing the activity or in this area must wear a H<sub>2</sub>S detector and immediately evacuate if the detector alarms at 10 ppm or higher. The buddy must have means to summon the rescue team in the event of an overexposure and failure to evacuate.

No tank, line, valve, flange, etc., which may create an H<sub>2</sub>S concentration of 10 ppm or greater in the breathing zone, may be opened to the atmosphere unless proper respiratory protection is worn by personnel performing the job.

As specified in a level 2 risk assessment, equipment that contains greater than 10 ppm H<sub>2</sub>S shall be depressurized, isolated, purged/cleaned and tested with a H<sub>2</sub>S monitor before and during "opening" or "breaking" the equipment. Respiratory protection must be worn when opening the equipment to atmosphere and during testing.

After opening equipment to atmosphere, the atmosphere inside the equipment is tested to determine the H<sub>2</sub>S level. If concentrations exceed 10 ppm in the breathing zone, respiratory protection must continue to be worn for the duration of the job or until the H<sub>2</sub>S level drops below 10 ppm.

All work involving H<sub>2</sub>S levels at 10 ppm or greater, requires that rescue teams and the Medic to be on standby, equipped with respiratory protection and ready to respond.

## 5.13 Site-Specific Work Procedures for Operations

For the offshore handling, safe transportation, onshore handling, disposal, and treatment of tanks and other containers on offshore installations, drilling/work-over rigs, and supply vessels where there is potential for buildup of H<sub>2</sub>S due to bulk liquids and waste materials that contain organic materials which can produce H<sub>2</sub>S due to biological activity, follow the procedures in the **Appendix - Controlling H<sub>2</sub>S Formation in Tanks and Other Containers**.

### 5.13.1 Tank Gauging on H<sub>2</sub>S Present Facilities

All production tanks on facilities designated as H<sub>2</sub>S present are tested periodically to determine the H<sub>2</sub>S levels. All employees must wear respiratory protective equipment during tank gauging operations unless tank levels can be determined with a sight glass.

All samples should be taken level with the thief hatch or in the vapor space. Offshore platform tanks may be sampled at alternate test points that provide equivalent measurements.

Local exhaust ventilation may be used in lieu of respiratory protective equipment if it is capable of reducing the H<sub>2</sub>S concentrations in the employees' breathing zone to less than 1 ppm. Employees must wear an H<sub>2</sub>S detector to facilitate immediate evacuation if the levels exceed 10 ppm.

Tests may be done using hand held pumps and detector tubes or equivalent approved intrinsically safe H<sub>2</sub>S monitors. Respiratory Protection must be worn during tests/monitoring.

When concentrations of H<sub>2</sub>S level with the thief hatch exceed 10 ppm, the following sign is posted at the base of the stairs. This sign with the following language is required at those locations where the tank vents through the hatch;

- Danger (red, black and white),
- Hydrogen Sulfide and
- Respiratory Protection Required.

## 5.14 Site-Specific Work Procedures for Drilling/Wells Activities

For the offshore handling, safe transportation, onshore handling, disposal, and treatment of tanks and other containers on offshore installations, drilling/work-over rigs, and supply vessels where there is potential for buildup of H<sub>2</sub>S due to bulk liquids and waste materials that contain organic materials which can produce H<sub>2</sub>S due to biological activity, follow the procedures in the **Appendix - Controlling H<sub>2</sub>S Formation in Tanks and Other Containers**.

### 5.14.1 Mud Systems/Well Control

- A. When conducting operations in an area classified as H<sub>2</sub>S present or H<sub>2</sub>S unknown, it is permissible to use either water or oil-base muds. If water-based well control fluids are used and if ambient air sensors detect H<sub>2</sub>S, either the Garrett Gas Train test or a comparable test for soluble sulfides must be conducted to confirm the presence of H<sub>2</sub>S.
- B. Before conducting the testing, monitor the air for H<sub>2</sub>S with a calibrated H<sub>2</sub>S monitor to confirm that the ambient levels are below 1 ppm. Personnel in the area must wear H<sub>2</sub>S detectors. If the concentration detected by air sensors is over 10 ppm, personnel must evacuate. Personnel may re-enter wearing respiratory protection.
- C. Sufficient quantities of additives for the control of H<sub>2</sub>S, well control fluid pH, and corrosion equipment are maintained at facilities designated as H<sub>2</sub>S present or as H<sub>2</sub>S unknown.
- D. When H<sub>2</sub>S is detected, scavengers are added as needed. Drilling operations are suspended until the scavenger is circulated throughout the system. Other means of H<sub>2</sub>S reduction include the use of biocides, nitrate based treatments, etc. Contact the Site Engineer for technical assistance.
- E. If water-base well control fluids are used, a pH of 10.0 must be maintained.
- F. Additives are added to the well control fluid system as needed for the control of corrosion.
- G. Well control fluids containing H<sub>2</sub>S are de-gassed at the optimum location for the particular facility. The gases removed are collected and burned in a closed flare.
- H. In the event of an H<sub>2</sub>S kick, one of the following alternatives is used to dispose of the well-influx fluids, giving consideration to personnel safety, possible environmental damage, and possible facility well- equipment damage;
  - 1. contain the well-fluid influx by shutting in the well and pumping the fluids back into the formation or
  - 2. control the kick by using appropriate well-control techniques to prevent formation fracturing in an open hole within the pressure limits of the well equipment (drill pipe, work string, casing, wellhead, BOP system, and related equipment).
  - 3. H<sub>2</sub>S and other gases must be burned separately from the well control fluid. The well control fluid must be treated to neutralize H<sub>2</sub>S and restore/maintain proper quality.

### 5.14.2 Well Testing

- A. Before starting a well test, a safety meeting is to be conducted for all personnel who will be on the facility during the test. At the meeting, the use of protective breathing equipment, first aid procedures, and the contingency plan is emphasized.
- B. Only competent personnel who are trained and are knowledgeable of the hazardous effects of H<sub>2</sub>S are engaged in well tests.
- C. Before conducting the well testing, monitor the air for H<sub>2</sub>S with a calibrated H<sub>2</sub>S monitor to confirm that the ambient levels are below 1 ppm. Personnel in the area must wear H<sub>2</sub>S detectors. If the concentration detected by air sensors is over 10 ppm, personnel must evacuate. Personnel

- may re-enter wearing respiratory protection. Well testing is performed with the minimum number of personnel in the immediate vicinity of the rig floor.
- D. Before flaring gas-containing H<sub>2</sub>S, SO<sub>2</sub> monitoring equipment must be activated. If SO<sub>2</sub> concentrations in excess of 2 ppm are detected, personnel evacuate. Personnel may re-enter wearing respiratory protection. Follow requirements of 30CFR250.1164.
  - E. Gases from stored test fluids must be piped into the flare outlet and burned.
  - F. All surface test units, down hole test tools, tubulars, and wellhead equipment must be suitable for H<sub>2</sub>S service. No drill pipe can be used for well testing.
  - G. Water cushions must be inhibited to protect the metal from H<sub>2</sub>S. The test string fluid must be treated after the test.

### **5.14.3 Metallurgical Properties of Equipment**

- A. When operating in a zone with H<sub>2</sub>S present, equipment is to be constructed of materials with metallurgical properties that resist or prevent sulfide stress cracking (also known as hydrogen embrittlement or stress corrosion cracking), chloride-stress cracking, hydrogen-induced cracking, and other failure modes.
- B. Comply with 30CFR250.198.
- C. Minimize welding during installation or modification of a production facility and weld in a manner that ensures resistance to sulfide stress cracking.

### **5.14.4 Coring Operations**

When conducting coring operations in H<sub>2</sub>S-bearing zones, all personnel in the working area must wear respiratory protection in accordance with the GoM Respiratory Protection SWP at least 10 stands in advance of retrieving the core barrel. Cores to be transported are to be sealed and marked for the presence of H<sub>2</sub>S. Emergency teams must be on standby.

### **5.14.5 Logging Operations**

Treat and condition well control fluid to minimize the effects of H<sub>2</sub>S on equipment

### **5.14.6 Stripping Operations**

Personnel must monitor displaced well-control fluid returns and wear respiratory protection in accordance with the GoM Respiratory Protection SWP in the working area when the atmospheric concentration of H<sub>2</sub>S reaches 10 ppm or if the well is under pressure.

### **5.14.7 Gas-Cut Well Control Fluid or Well Kick in H<sub>2</sub>S present zone**

Personnel in working area during bottoms-up and extended-kill operations must wear respiratory protection in accordance with the GoM Respiratory Protection SWP.

### **5.14.8 Drill-String and Work-over-String Design and Precautions**

Refer to 30CFR250.490 for details

### **5.14.9 Flare System**

The flare outlet must be of a diameter that allows easy non-restricted flow of gas.

Flare line outlets are to be located on the downwind side of the facility and as far from the facility as is feasible, taking into account the prevailing wind directions, the wake effects caused by the facility and adjacent structure(s), and the height of all such facilities and structures.

The flare outlet must be equipped with an automatic ignition system including a gas source for the pilot-light or an equivalent system. An alternate method for igniting the flare must be provided.

Vents, which might release H<sub>2</sub>S from production process equipment, tanks, relief valves, burst plates, and similar devices must be piped to the flare system.

### **5.14.10 Corrosion Mitigation**

Monitor and control corrosion by H<sub>2</sub>S and CO<sub>2</sub> in the down hole and surface portions of the production system.

### **5.14.11 Wireline Lubricators and Elastomer seals**

These items which may be exposed to fluids containing H<sub>2</sub>S must be H<sub>2</sub>S corrosion resistant.

### **5.14.12 Fuel and/or Instrument Gas**

Gas containing H<sub>2</sub>S may not be used for instrument gas. Gas containing H<sub>2</sub>S may not be used for fuel gas without the prior approval of BSEE.

### **5.14.13 Sensing Lines and Devices**

Metals used for sensing line and safety-control devices, which are necessarily exposed to H<sub>2</sub>S-bearing fluids, must be constructed of H<sub>2</sub>S corrosion resistant materials or coated to resist H<sub>2</sub>S corrosion.

### **5.14.14 Water Disposal**

Disposing of produced water by means other than subsurface injection requires the submittal of H<sub>2</sub>S analysis of the water to the District Manager. Refer to 30 CFR 250.490 for details.

### **5.14.15 Deck Drains**

Open deck drains must be equipped to prevent the escape of H<sub>2</sub>S to the atmosphere.

### **5.14.16 Sealed Voids**

Precautions are required to eliminate sealed spaces in piping design (e.g., slip-on flanges, reinforcing pads) which can be invaded by atomic hydrogen when H<sub>2</sub>S is present.

## 6 Definitions/Acronyms

Terms	Description
Facility	A vessel, structure, or artificial island used for drilling, well-completion, well- work-over, and/or production operations.
H2S	Hydrogen Sulfide

Terms	Description
H2S Absent	<p>BSEE Definition:</p> <p>(1) Drilling, logging, coring, testing, or producing operations have confirmed the absence of H2S in concentrations that could potentially result in atmospheric concentrations of 20 parts per million (ppm) or more of H2S or</p> <p>(2) Drilling in the surrounding areas and correlation of geological and seismic data with equivalent stratigraphic units has confirmed an absence of H2S throughout the area to be drilled.</p> <p>For Personnel Protection: Confirmed air concentrations of zero.</p>
H2S Present	<p>BSEE Definition: 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.</p> <p>For Personnel Protection: Air concentrations of 10 ppm or greater.</p>
H2S Unknown	<p>BSEE Definition: A zone or geologic formation where neither the presence nor absence of H2S has been confirmed,</p> <p>For Personnel Protection: Air concentrations of 10 ppm or greater.</p>
Self-Contained Breathing Apparatus (SCBA)	An air supplied respirator for which the breathing air source is designed to be carried by the user. NOTE: if using a SCBA, ONLY Positive pressure SCBA's with a hoseline capability and a breathing time of at least 30 minutes are permitted for H2S.
Supplied-air Respirator (SAR) or Airline Respirator	An atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user. NOTE: if using an airline respirator, ONLY a Positive pressure Airline Respirator with an escape bottle is permitted for H2S.
Escape-only Respirator	A respirator intended to be used only for emergency exit.
SO2	Sulfur Dioxide
CPR	Cardiopulmonary Resuscitation
Well-Control Fluid	Drilling mud and completion or work-over fluid as appropriate to the particular operation being conducted.
TWA	Time Weighted Average (averaged over 8 hours)
STEL	Short Term Exposure Limit (15 minute exposure)
NIOSH REL	National Institute for Occupational Safety and Health Recommended Exposure Limit
Terms	Description
ACGIH	American Conference of Governmental Industrial Hygienists
TLV	Threshold Limit Value

## 7 Key Documents/Tools/References

- A. GP 10-30, Hydrogen Sulphide and Hazardous Materials in Well Operations

- B. Occupational Health and Safety Administration, Department of Labor; 29 CFR 1910.134 and 1910.1000
- C. American National Standards Institute, 286-1-1973 and 237.2-1972
- D. American Petroleum Institute, RP 55 October, 1981
- E. API RP49, Oil and Gas Drilling Operations Involving Hydrogen Sulfide
- F. API RP 55, Conducting Oil and Gas Producing and Gas Processing Plant Operations Involving Hydrogen Sulfide
- G. API RP 68, Well Servicing and Work-over Operations Involving Hydrogen Sulfide
- H. ANSI Accepted Practices for Hydrogen Sulfide Safety Training SWPs, ANSI Z390.1.
- I. BSEE 30 CFR 250.490, Hydrogen Sulfide
- J. BSEE 30 CFR 250.504, Hydrogen Sulfide
- K. BSEE 30 CFR 250.604, Hydrogen Sulfide
- L. BSEE 30 CFR 250.808, Hydrogen Sulfide
- M. Texas Railroad Commission Title 16 Chapter 3.36, Oil, Gas, or Geothermal Resource Operations in Hydrogen Sulfide Areas
- N. GoM Respiratory Protection SWP

## 8 Appendix - Controlling H<sub>2</sub>S Formation in Tanks and Other Containers

### 8.1 General Requirements

- A. For the offshore handling, safe transportation, onshore handling, disposal, and treatment, these procedures shall be followed to prevent the buildup of H<sub>2</sub>S gas in tanks and other containers on offshore installations, drilling/work-over rigs, and supply vessels.
- B. Offshore installations, offshore supply vessels and the Supply Base shall follow these procedures.
- C. This procedure applies to tanks and other containers that are used for storing and/or transporting bulk liquids and waste materials that contain organic materials which can produce H<sub>2</sub>S due to biological activity (i.e., sulfate reducing bacteria or SRB).
  - 1. Bulk liquids and waste materials can include:
    - a. Drilling, completion, and work-over fluids
    - b. Hydraulic fluids
    - c. Oils and other hydrocarbon based products or chemicals
    - d. Deck drainage, seawater, brine, or potable water
    - e. Produced water filters
  - 2. H<sub>2</sub>S has been identified to be present in the following:
    - a. Bulk, MPT, bilge, pit, and water storage tanks
    - b. Cutting boxes
    - c. Totes
    - d. Water Filters
  - 3. Drilling/Work-over activities with the potential to generate fluids contaminated with H<sub>2</sub>S include the following:
    - a. Well bore clean-up operations where oil based mud is displaced from the wellbore to seawater or completion brine
    - b. Operations and drilling activities where water based mud or wellbore fluids become contaminated with oil base mud, oil, or condensate

- (1) Cementing operations
    - (2) Pit and tank cleaning operations
  - c. Rig floor drains where the fluid becomes oil contaminated
- D. The potential for H<sub>2</sub>S shall be mitigated prior to placing tanks and containers on a vessel for transport.
  1. Factors leading to the gas formation include warm temperatures, extended storage which leads to stagnation, the presence of seawater, and the organic contamination.
  2. Holding vessels for water contaminated with organic materials and/or various amounts of oil may lead to the buildup of H<sub>2</sub>S due to anaerobic conditions and sulfur-reducing bacteria (SRBs). Tanks (e.g. such as bilge tanks, pit tanks or water storage tanks) which store water for a period longer than a few days without flushing or agitation may create conditions which will lead to the production of H<sub>2</sub>S gas.
- E. Onsite laboratory testing shall be completed and provided to offshore supply vessels and the Supply Base to confirm the absence of H<sub>2</sub>S in tanks and other containers prior to transport. SDSs may not accurately describe the chemical composition of liquids and waste materials.

## 8.2 Risk Assessment and Control of Work

- A. Prior to transfer of any fluids or waste to a supply vessel, a Control of Work permit shall be developed.
- B. Personnel shall be aware of the potential hazards of H<sub>2</sub>S, address these during pre-job risk assessments.
- C. Prevent stagnation of water and waste by flushing, agitating or ventilating affected tanks.
- D. Water and waste containing oily and organic materials shall be treated with biocides or scavengers if it will be stored for any length of time by Chemical Technicians and Mud Engineers.
- E. No tank, line, valve, flange, etc., which may create an H<sub>2</sub>S concentration of 10 ppm or greater in the employee's breathing zone, may be opened to the atmosphere unless proper respiratory protection is worn by personnel performing the job.
  1. Equipment that contains H<sub>2</sub>S should be depressurized, isolated, purged/cleaned and tested with a H<sub>2</sub>S monitor before and during "opening" or "breaking" the equipment, when possible.
  2. Respiratory protection must be worn when opening the equipment to atmosphere and during testing. After opening equipment to atmosphere, the atmosphere inside the equipment shall be tested to determine the H<sub>2</sub>S level. If concentrations exceed 10 ppm in the breathing zone, the job must be stopped until the level of H<sub>2</sub>S dissipates by environmental or engineering controls.
- F. Personnel shall not perform activities where H<sub>2</sub>S is present where there is a potential for an atmospheric concentration of H<sub>2</sub>S greater than 10 ppm unless the "buddy system" is used. The person performing the activity and in the area must wear a H<sub>2</sub>S detector and immediately evacuate if the detector alarms at 10 ppm or higher. The buddy must have means to summon the rescue team in the event of an overexposure and failure to evacuate and also be equipped with respiratory protection.
- G. The Supply Base upon receiving a manifest that indicates safe handling of wastes has been verified, the Supply Base will notify the Vessel Captain that it is safe to take on the product.
  1. Acceptable loads are based on the onsite testing, reported analytical laboratory information and chemical composition, and physical properties
  2. Material transfer by tanks and containers or hose connections shall not occur unless there is agreement between the Vessel Captain, offshore installation or drilling/work-over rig, and the Supply Base.

### 8.3 Sampling Procedures

- A. The H<sub>2</sub>S concentration in the gas phase can be determined with a portable or fixed on-site monitor as part of the operational control that is already integrated into the facility systems.
- B. Prior to liquid or waste material transfer, use a portable monitor, remove sample container plugs or open sample ports and place the monitor and any sample tubing into the head space of the tank or container.
- C. For representative sampling, the tank or container mixture should be homogeneous. Liquids and waste materials in tanks and other containers can stratify as solids settle and oil and water separate.
  1. Offshore installation, drilling/work-over rig, or supply vessel motion is not sufficient to mix the contents into a homogeneous mixture.
  2. Container contents should be stirred/agitated for sufficient time prior to collecting a sample. For example, a sample could be collected in conjunction with agitating the tank for H<sub>2</sub>S treatment, taking into account all precautions listed above and sending the sample to a BP approved laboratory for analysis.
- D. If H<sub>2</sub>S is detected during onsite testing, a second confirmation test should be collected if there is any question regarding H<sub>2</sub>S results. Once testing is complete, no additional product or material shall be added to tank or container.
- E. Sampling for SRBs can be completed by the Chemical Technician.

### 8.4 Treatment Procedures

- A. Wellsite Leaders shall verify the treatment procedures are followed by the facility.
- B. Biocides kill the bacteria, but do not remove dissolved H<sub>2</sub>S. H<sub>2</sub>S scavenger will remove dissolved H<sub>2</sub>S but does not stop biological activity.
- C. The Chemical Technician or Mud Engineer shall add approved biocides, scavengers, or other treatment chemicals for the amount of fluids and water materials in the tanks.
  1. For tanks containing waste liquids that contain organic materials, treat for SRBs prior to being pumped or placed on to any vessel for transport to the Supply Base for disposal using the following:
    - a. Tetrakis (hydroxymethyl) Phosphonium Sulfate, (THPS), is the recommended chemical to kill the SRBs, resulting in the prevention of H<sub>2</sub>S generation.
      - THPS has a half-life of approximately 40 days at a neutral pH and in an environment that does not contain oxygen.
      - Based on the length of time the waste fluid is in the tanks, the half-life of the product will have to be taken into consideration and additional biocide treatments may have to be performed.
      - If the waste fluid has been treated with THPS, and the fluid has been stored for less than 40 days after treatment, then further sampling for the purpose of detecting H<sub>2</sub>S in the fluid is not necessary.
    - d. The initial treatment should consist of adding 500 ppm (2 gallons / 100 barrels) of THPS into the holding tank. However, a higher dosage may be necessary based on SRB count.

- The tank should be circulated and/or agitated while the biocide is being added with a continuation of circulation for an additional 24 hours, if possible.
  - Provisions shall be made to vent any gas to the atmosphere and precautions shall be taken to verify that no personnel are present in, around or below the venting area because of H<sub>2</sub>S gas releases.
2. This initial treatment should kill the bacteria present in the fluid which will stop the continuous generation of H<sub>2</sub>S.
    - e. Ongoing treatments will prevent the proliferation of SRBs and if performed timely and properly will stop the generation of H<sub>2</sub>S.
    - f. Subsequent treatments should be performed as the tank is filling in the same manner as above, but with 120 ppm (0.5 gallons / 100 barrels) of THPS.
    - g. For questions about treatment procedures, contact the Production Chemist or Mud Engineer.
- D. Circulate bulk tanks and other containers for 24 hours, if possible.
  - E. After the 24 hour circulation test for H<sub>2</sub>S, if readings are detected, continue treatment and circulate. The use of an H<sub>2</sub>S scavenger may be required, the BP recommended scavenger is a triazine based chemical. If no H<sub>2</sub>S is detected, the Rig Clerk shall include test results on manifest and send (via email or fax) to the Supply Base for transfer authorization. The manifest shall note that waste products have been treated and no H<sub>2</sub>S was detected. Supply Base requirements shall be complied with prior to transfer.
  - F. The Supply Base confirms with the Vessel Captain that it is agreed to accept the product based on the review of the manifest and treatment conducted.
  - G. In addition to the chemical treatment, keeping the holding tank clean and limiting fluid holding times will decrease the potential for bacterial growth and H<sub>2</sub>S generation.
  - H. Once the load arrives to the Supply Base, an additional test for H<sub>2</sub>S will be completed by the company accepting waste prior to offload from the offshore supply vessel to confirm no changes to the concentration levels of H<sub>2</sub>S have occurred during transport.
  - I. For discrepancies between the offshore and onshore testing, additional treatment will be required prior to offload at the Supply Base.
  - J. If the tank or container requires cleaning, the results of the testing shall also be provided to the cleaning company. Cleaning of the tanks will prevent product from being added to existing product left in the tanks or containers to prevent cross contamination of fluids.

## 8.5 Personal Protection

- A. PPE and handling requirements to use biocides and scavengers are specified on the SDS. For additional information, contact BP Health and Industrial Hygiene Team.
- B. Assets and rigs shall verify that PPE required to handle treatment chemicals is present and available prior to treatment.
- C. Offshore installations and supply vessels shall be equipped with portable H<sub>2</sub>S detection equipment. At a minimum, two H<sub>2</sub>S meters are required per vessel.
- D. Respiratory protection equipment, including escape packs, shall also be available when H<sub>2</sub>S concentrations equal or exceed 10 ppm

## 8.6 Waste Manifesting

- A. Manifest and placarding will be based on the type of waste and DOT requirements for muds, chemicals and/ or other added constituents as reported in their respective SDS.
- B. Manifesting should clearly indicate that waste was treated to prevent H<sub>2</sub>S build up. This is a requirement prior to shipping wastes to shore.

## 8.7 Placarding

Placarding is required on tanks holding and/or receiving THPS. THPS is a toxic liquid which carries a 6.1 classification. These requirements are provided in the SDS for the chemical. For assistance with locating SDSs, contact the BP IH team and for placarding requirements, contact the BP Waste Advisors.

## 8.8 Vendor Credit on Un-Used Oil Products

For un-used products such as oil based mud being returned to the vendor for credit, the following shall be completed:

- A. Circulate and test tank or container. If not H<sub>2</sub>S is detected, the product can be transferred.
- B. If H<sub>2</sub>S is detected, the facility or rig will notify the vendor for recommended treatment options.
- C. Once the product is pumped off the vessel at the Supply Base, the tanks will be cleaned to prevent product from being added to existing product left in the tanks leading to cross contamination.