



HYDROGEN SULFIDE (H₂S)

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PURPOSE

The purpose of this policy is to identify the hazards and risks of H₂S, implement control measures, establish safe working procedures, and ensure the risk of worker exposure to H₂S is eliminated or controlled to a safe level.

SCOPE

This procedure applies to all locations where Rival Services ("Rival") employees and/or contracted personnel may be exposed to H₂S at or above OSHA exposure levels, and provides the framework for working safely around H₂S.

All processing operations in which H₂S may reasonably be expected to be encountered must be coordinated and conducted in accordance with the requirements of this policy.

REFERENCES

This document was written to comply with applicable government regulations and American Petroleum Institute (API) guidelines, including:

- OSHA 29 CFR 1910.1000, Table Z-2, *Limits for Air Contaminants*.
- OSHA 29 CFR 1910.134, *Respiratory Protection*
- API RP 49, *Recommended Practice for Drilling and Well Servicing Operations Involving Hydrogen Sulfide*

OVERVIEW

Hydrogen Sulfide (H₂S) is a highly toxic, flammable, colorless gas found in numerous industries, notably the petroleum industry. It is classified as a chemical asphyxiate. When inhaled in high concentrations, it can cause almost immediate death as it acts on the central nervous system resulting in paralysis of the respiratory system. Even low concentrations can irritate the eyes and respiratory tract. H₂S affects the nerve centers of the brain which control inhalation, further impacting breathing in an adverse manner. The OSHA Permissible Exposure Limit (PEL) for H₂S is a 20 part per million (ppm) ceiling value with a 50 ppm 10 minute maximum peak. The NIOSH Immediately Dangerous to Life and Health (IDLH) level is 100 ppm. H₂S has an offensive odor at low concentrations of less than 1 ppm, similar to the smell of rotten eggs. H₂S rapidly deadens one's sense of smell at higher concentrations of 100 to 150 ppm, so odor is not a reliable means of detecting the poisonous gas.

Hydrogen Sulfide:



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- Is flammable with an explosive range between 4 – 44%.
- Burns with a blue flame, producing Sulfur dioxide (SO₂), which is also a toxic gas.
- Is heavier than air (1.19 vapor density); tends to settle in low-lying areas.
- Is readily dispersed by wind movement or air currents.
- Is soluble in water.
- Is highly corrosive to certain metals.
- Is more deadly than carbon monoxide and almost as toxic as hydrogen cyanide gas.

In the oil and gas industry H₂S may be present in sour gas wells and when handling recycled drilling mud or water from sour crude wells. H₂S may also be present during well blowouts, tank gauging (tanks at producing, pipeline and refining operations), field maintenance, and at tank batteries and wells.

H ₂ S Concentration (ppm by volume in air)	Physiological Effects
0.1 – 0.5 ppm	First detectable by smell
5 ppm	Easily detectable odor.
10 ppm	Obvious unpleasant odor; eye irritation. Respiratory protection required.
25 ppm	Strong, unpleasant odor. Eye and respiratory tract irritation
50 ppm	Coughing, eye irritation, loss of sense of smell 2-5 minutes
100 ppm	Immediately dangerous to life and health. Serious respiratory, central nervous, and cardiovascular system effects.
200-300 ppm	Marked eye and respiratory tract irritation, rapid loss of smell
500 - 700 ppm	Dizziness, breathing ceases in a few minutes; need prompt respiration. Death will result if not rescued promptly
700 + ppm	Immediately fatal

Table 1: Toxicity of H₂S at various concentrations

PERSONNEL REQUIREMENTS

In order to comply with government regulations and to provide a safe environment to all employees whose work potentially exposes them to H₂S, Rival Services requires that all affected personnel shall:



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- Comply with the applicable government regulations and industry standards previously cited;
- Complete Rival's H₂S training course prior to working in an area containing H₂S, and,
- Complete medical testing and pass a respiratory fit test prior to working in an area containing H₂S.

At NO time should personnel who are not protected with a full face mask and supplied breathing air system be exposed to more than 10 ppm of H₂S,

RESPONSIBILITIES

Operations Management and the HSE Department have the responsibility for identifying potential employee exposures to H₂S during the course of a particular task. If the work will involve employee exposures to H₂S above the OSHA PELs, site personnel must be informed as to when and where exposures may occur and the precautions to be taken to protect themselves from harm. Operations Management, with assistance from the HSE Department, has the overall responsibility for implementing this procedure at the jobsite.

Operations Supervisors are responsible for:

Verifying that employees are properly trained and equipped for the job and ensuring that employees who have not completed H₂S training do not enter areas where they may be exposed.

- Ensuring that the necessary respiratory protection is available for workers.
- Ensuring that the necessary H₂S gas detection and area monitors are utilized on the jobsite to alert employees to the presence of H₂S at a pre-set level of 10 ppm or less.
- Posting H₂S warning/danger signs in the work area(s) that contains or may contain H₂S.
- Monitoring compliance with the provisions of this procedure and associated work practices and taking appropriate disciplinary actions as needed.
- Participating in the review and creation of applicable written safe work procedures/practices.

The HSE Department is responsible for:

- Identifying areas, jobs, or tasks where exposure to H₂S is probable.
- Identifying engineering and workplace controls to eliminate or reduce employee exposures.
- Where engineering and workplace controls are not sufficient to adequately protect personnel, identify the types of personal protective equipment needed as required by 29 CFR 1910.133 and 1910.134.
- Ensuring that area and or personnel monitors are made available.
- Providing necessary resources, training, and materials required to execute this policy.
- Audit compliance with this procedure and the associated work practices.
- Monitor the need for additional written safe work procedures/practices.



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Employees are responsible for:

- Completing the required training;
- Being Medically Qualified before working in H₂S environments;
- Complying with the provisions of this procedure and the associated work practices, and,
- Notifying supervision of any identified problems.

PROCEDURE

Planning

Prior to entering a site, the following steps should be taken to account for the possible presence of H₂S:

- Complete a hazard and risk assessment. (See section below, “Hazard Assessment.”)
- Identify if the work area is known to have a presence of H₂S.
- Identify if the work processes will create a presence of H₂S.
- Ensure that each worker that may be exposed to H₂S has completed approved H₂S training.
- Establish and implement safe procedures for conducting gas detection.
- Ensure the necessary H₂S gas detector and H₂S personal monitor equipment is made available; the alarm must be set to 10ppm; the alarm must be worn on the chest over fire resistant clothing or other PPE in order to confirm H₂S levels near nose and mouth.
- H₂S monitors must be tested daily and/or before the beginning of each shift. Bump tests are required monthly.
- H₂S monitor must have:
 1. A response time of 15 seconds or less.
 2. A lower detection limit of at least 0.5 ppm.
 3. An accuracy of plus or minus 0.05 ppm.
 4. Built-in data logging function for data collection and analysis.
 5. Low temperature drift (less than 0.1 ppm for the zero reading).
 6. Intrinsically safe design for use in areas where a combustible atmosphere may exist.
- Confirm that the monitor is tested (“bumped”) prior to the start of work each day. Bump station must have traceable bump test mode for checking sensor accuracy, stability, and response time.
- Confirm that training is provided for the person that will be operating a gas detector or personal H₂S monitor.
- Confirm that the person conducting gas detection is protected with supplied breathing air if there is a possibility the person may be exposed to H₂S, or if the person is entering an area with unknown substances or contamination.



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- Confirm the necessary PPE, including supplied breathing air, is made available.
- Provide H₂S warning/danger signs.
- Install a wind sock so workers can easily identify the wind direction.
- Conduct a pre-shift meeting with all of the applicable workers to communicate the hazards, risks and control measures for working in an area with H₂S.
- Establish area specific emergency procedures to safely shut down equipment in the event of an unexpected or uncontrolled release of H₂S.
- Establish area specific emergency evacuation procedures for the event of an unexpected or uncontrolled release of H₂S. (See section below, “Emergency Response Plan.”)
- Establish area specific procedures for tasks involving the controlled release of H₂S.

Hazard Assessment

Possible exposures to H₂S and other hazardous materials should be considered during every Pre-job JHA. For areas of inherent or assumed H₂S risk, a Hazard Assessment and Risk Analysis must be completed to establish control measures specific to the work area and tasks involved.

Engineering controls and work practices may include, but are not limited to; vapor control systems, flaring, venting, purging, flushing, confined space entry, personal or area monitors that alarm when PEL exceeds the preset level of 10 PPM, and line breaking procedures. Location-specific procedures should be developed and implemented for Confined Space Entry (Rival HSE policy 10.1) as outlined in 29 CFR 1910.146. In addition, site-specific procedures should be developed for flare and vent line maintenance and repair.

The following is a list of general control measures:

- Inform all workers of the areas that have or may have a presence of H₂S as well as the concentration of H₂S.
- Post warning/danger signs.
- Set the personal H₂S monitor and the H₂S gas detector to alarm at 10ppm.
- Always perform a gas test of the work area suspected of containing H₂S before starting work and at specified intervals during the work shift.
- Wear supplied breathing air when entering an atmosphere that contains more than 10ppm of H₂S or if the H₂S concentration is unknown.
- Designate a safety watch where necessary for tasks involving the controlled release of H₂S.
- Immediately vacate the work area when the personal H₂S monitor alarms.

Emergency Response Plan



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If the potential exists that employees will be exposed to H₂S, the provisions of this procedure must be implemented. This should involve a joint meeting with client personnel to identify areas, jobs, or tasks that may expose personnel to harmful levels of H₂S and coordinate location work practices and emergency reporting and response procedures.

An Emergency Response Plan must be written for the work that involves the risk of exposure and should include the following elements:

- Work area - Exact location, structure/layout of any buildings or structures within the work area, hazards that may impede rescue, location of emergency SCBA (self-contained breathing air) packs, and location of communication equipment.
- Rescue team - Names, location of rescue team, communication method, and projected response time for rescue team.
- Procedures for safely shutting down equipment.
- Procedures for extricating a worker.
- Procedures for transporting an injured worker to a hospital or medical center.

Emergency Procedures

In event of an area or personnel H₂S alarm activation or emergency involving H₂S, all work shall be stopped and personnel shall evacuate to a predetermined, safe location in accordance with the contingency plan. Windssocks/flags shall be provided to indicate wind direction. Personnel shall be trained to travel at a right angle to the wind direction and then proceed to a safe upwind location. Only pre-designated and trained rescue personnel using approved self-contained breathing apparatus or an airline respirator with escape SCBA shall attempt rescue of a downed employee. Personnel shall not be allowed to re-enter the work area until the company and client safety personnel have surveyed the scene to assure it is safe to do so.

PERSONAL PROTECTIVE EQUIPMENT

Personal Protective Equipment (PPE) shall be provided at no cost to the employee and worn when:

- Engineering controls are being implemented.
- Engineering controls are not feasible or do not achieve the appropriate level of control.
- Work practices and procedures dictate usage.
- During emergencies.

Depending on exposure, the appropriate PPE may include skin, eye and respiratory protection. This may require implementation and conformance with the requirements of 29 CFR 1910.134 (Respiratory Protection) and 29 CFR 1910.133 (PPE). Respiratory protection provided for H₂S



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exposures shall consist of NIOSH approved Self-Contained Breathing Apparatus (SCBAs) or a full face airline respirator with an escape bottle.

FIRST AID

The following are the minimum requirements for first aid. Supervisors must also ensure that personnel who have inhaled H₂S receive emergency medical care in a timely manner.

- A qualified first aid attendant must be designated for a workplace that contains a presence of H₂S.
- First aid, including CPR, must be provided by a qualified first aid attendant. (See Rival HSE Policy 6.1, *First Aid*.)
- A person exposed to more than 10ppm of H₂S that is not protected by supplied breathing air must be removed to fresh air immediately.
- A person knocked down from H₂S exposure must be examined by a medical doctor immediately for the risk of pulmonary edema and other illnesses/injuries.

TRAINING

All personnel working on locations where H₂S is present will receive the following training prior to being initially assigned to the area:

- Rival's H₂S policies and work practices.
- Hazards and risks of working in an H₂S environment.
- Hazard Communication Training as outlined in 29 CFR 1910.1200(h)(1) and (2) with emphasis on the hazards and safeguards associated with H₂S.
- Methods of detecting the presence of H₂S including the use of area and personnel monitors and alarms.
- Identification of work areas that contain or may contain H₂S.
- Site-specific emergency/contingency plans.
- Care, use, and limitations of personal protective equipment with emphasis on the use of supplied breathing air equipment.
- Correct use, inspection, and maintenance of gas detection equipment (both area and personal).

Training will be conducted by a qualified Rival training instructor or an approved contracting firm. Only the Training Manager may approve H₂S training contractors. Refresher training shall be provided at least annually for all personnel who may be exposed to H₂S.

EVALUATION

Evaluations of compliance with the provisions of this procedure will be conducted at least annually. During the evaluation, the following will be assessed:



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- Areas, jobs, and tasks involving H₂S exposure have been identified.
- The required training has been performed and documented.
- Engineering controls are in place and effective.
- Safe work practices are being followed.
- The appropriate PPE is being worn correctly.
- An adequate supply of SCBAs and full face airline respirators (with escape bottles) are readily available.
- Emergency reporting and response procedures are current and well understood.