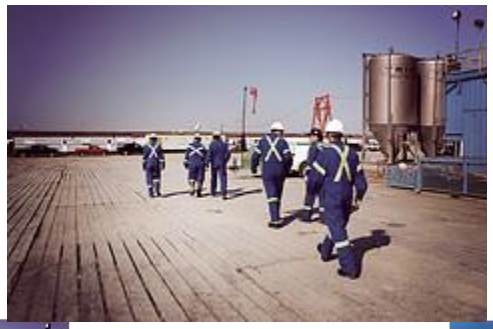
Hydrogen Sulfide – H2S



INSTRUCTOR MANUAL

H2S Awareness

Learning Objectives

The purpose of this course is to ensure awareness and promote safety among employees who may be exposed to H2S in the work-site. The objective is to ensure that employees operate in the safest possible manner in situations where contact with H2S is likely.

At the conclusion of this course, students should Understand:

1. Hazards
2. Worker Exposure Limits
3. Longer Term Effects
4. Safety Hazards
5. Hydrogen Sulfide in Workplaces
6. Protection against H2S Exposure
7. Entering Dangerous H2S Atmospheres
8. Never Attempt a Resuce without Porper Respiratory Protection and Without Being Properly Trained To Perform Such A Rescue
9. Osha Interpretations
10. Personal Protective Equipment
11. Air and Environmental Monitoring
12. Site Emergencies
13. Decontamination Procedures
14. Medical Surveillance

Prerequisites

None

Registration

Contact us at 337- 905-6060 or paul@peaksafetyservice.com or visit us online at www.peaksafetyservice.com

Group Discounts are available.

H2S OUTLINE/SCHEDULE

No.	Curriculum Topic Title	Time
	DAY ONE	
	Registration / Meet / Safety Information	8:00 – 8:15
1	Course & Test	8:30 – 9:30

Hazards

Health Hazards

Hydrogen sulfide gas causes a wide range of health effects. Workers are primarily exposed to hydrogen sulfide by breathing it. The effects depend on how much hydrogen sulfide you breathe and for how long. Exposure to very high concentrations can quickly lead to death.

Short-term (also called acute) symptoms and effects are shown below:

Worker Exposure Limits	
NIOSH REL (10-min. ceiling): 10 ppm	
OSHA PELs: General Industry Ceiling Limit: 20 ppm General Industry Peak Limit: 50 ppm (up to 10 minutes if no other exposure during shift) Construction 8-hour Limit: 10 ppm Shipyard 8-hour limit: 10 ppm	
NIOSH IDLH: 100 ppm	
IDLH: immediately dangerous to life and health (level that interferes with the ability to escape) (NIOSH) **PEL:** permissible exposure limit (enforceable) (OSHA) **ppm:** parts per million **REL:** recommended exposure limit (NIOSH)	
Concentration (ppm)	**Symptoms/Effects**
0.00011-0.00033	Typical background concentrations
0.01-1.5	Odor threshold (when rotten egg smell is first noticeable to some). Odor becomes more offensive at 3-5 ppm. Above 30 ppm, odor described as sweet or sickeningly sweet.
2-5	Prolonged exposure may cause nausea, tearing of the eyes, headaches or loss of sleep. Airway problems (bronchial constriction) in some asthma patients.

20	Possible fatigue, loss of appetite, headache, irritability, poor memory, dizziness.
50-100	Slight conjunctivitis ("gas eye") and respiratory tract irritation after 1 hour. May cause digestive upset and loss of appetite.
100	Coughing, eye irritation, loss of smell after 2-15 minutes (olfactory fatigue). Altered breathing, drowsiness after 15-30 minutes. Throat irritation after 1 hour. Gradual increase in severity of symptoms over several hours. Death may occur after 48 hours.
100-150	Loss of smell (olfactory fatigue or paralysis).
200-300	Marked conjunctivitis and respiratory tract irritation after 1 hour. Pulmonary edema may occur from prolonged exposure.
500-700	Staggering, collapse in 5 minutes. Serious damage to the eyes in 30 minutes. Death after 30-60 minutes.
700-1000	Rapid unconsciousness, "knockdown" or immediate collapse within 1 to 2 breaths, breathing stops, death within minutes.
1000-2000	Nearly instant death

What about longer term health effects? Some people who breathed in levels of hydrogen sulfide high enough to become unconscious continue to have headaches and poor attention span, memory, and motor function after waking up. Problems with the cardiovascular system have also been reported at exposures above permissible exposure limits. People who have asthma may be more sensitive to hydrogen sulfide exposure. That is, they may have difficulty breathing at levels lower than people without asthma.

The explosive range of hydrogen sulfide in air is 4.5 to 45.5 percent. This range is much higher than the PEL.

Safety Hazards

- Hydrogen sulfide is a highly flammable, explosive gas, and can cause possible life-threatening situations if not properly handled. In addition, hydrogen sulfide gas burns and produces other toxic vapors and gases, such as sulfur dioxide.

- In addition to exposure to hydrogen sulfide in the air, exposure to liquid hydrogen sulfide can cause "blue skin" or frostbite. If clothing becomes wet, avoid ignition sources, remove the clothing and isolate it in a safe area to allow it to evaporate.
- The effect called knockdown (rapid unconsciousness) often results in falls that can seriously injure the worker.

Hydrogen Sulfide in Workplaces

Hydrogen sulfide is produced naturally from decaying organic matter. It can be released from sewage sludge, liquid manure, and sulfur hot springs, and with natural gas. It is also used or is a by-product in many industrial processes such as:

- Petroleum production and refining
- Sewer and wastewater treatment
- Agricultural silos and pits
- Textile manufacturing
- Pulp and paper processing
- Food processing
- Hot asphalt paving
- Mining

Many workers are at risk for exposure to hydrogen sulfide, especially when working in confined spaces. For example,

- Sanitation workers can be exposed when cleaning or maintaining municipal sewers and septic tanks.
- Farm workers can be exposed when cleaning manure storage tanks or working in manure pits.

- Workers in oil and natural gas drilling and refining may be exposed because hydrogen sulfide may be present in oil and gas deposits and is a by-product of the desulfurization process of these fuels.

  See OSHA Oil and Gas Well Drilling and Servicing eTool [links directly to H_2S subpage].

In general, working in the following areas and conditions increases a worker's risk of overexposure to hydrogen sulfide:

- Confined spaces (for example pits, manholes, tunnels, wells) where hydrogen sulfide can build up to dangerous levels.
- Windless or low-lying areas that increase the potential for pockets of hydrogen sulfide to form.
- Marshy landscapes where bacteria break down organic matter to form hydrogen sulfide.
- Hot weather that speeds up rotting of manure and other organic materials, and increases the hydrogen sulfide vapor pressure.

Example of a confined space – storage silo.

For more information on the workplaces that face hydrogen sulfide hazards:

- National Occupational Exposure Survey: Hydrogen Sulfide (1981-83). National Institute for Occupational Safety and Health (NIOSH), (1990, July 1). Types of occupations and estimated number of employees potentially exposed to hydrogen sulfide.
- Health Effects of Low-Level Hydrogen Sulfide in Ambient Air [266 KB PDF, 43 pages]. Michigan Environmental Science Board, (2000, August). Includes a lengthy list of occupations with potential hydrogen sulfide exposure.

OSHA Safety and Health Information Bulletins (SHIBs)

- Chemical Exposures from Industrial Valve and Piping Systems. (1996, May 14). Discusses the potential hazard that exists for releasing hazardous chemicals into the workplace when a normally closed system is opened.
- Corrosion of Piping in Hydroprocessing Units. (1994, July 29). An explosion and fire resulted when severe corrosion caused the failure of the hydrocracking Reactor Effluent Air Coolers (REAC) and adjacent piping at a refinery.
- Confined Space Entry on Drilling Rigs. (1990, May 30). Overview of two near casualties involving confined space entry on drilling rigs.
- Anaerobic Decomposition in Cooling Water Systems. (1990, March 5). A fireball developed when a pipefitter used a cutting torch on a cooling water system pipe. Hydrogen sulfide created from anaerobic decomposition was the probable causative agent for the production of explosive gases.

Trade News Release Banner Image

OSHA -CITATION

Region 6 News Release: 11-479-DAL

April 8, 2011

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US Department of Labor's OSHA cites 5 companies for exposing

workers to hydrogen sulfide at Eustace, Texas, work site

EUSTACE, Texas – The U.S. Department of Labor's Occupational Safety and Health Administration has cited five companies for serious safety and health violations following a combustible dust flash fire that released hydrogen sulfide at the Eustace Gas Processing Plant in Eustace and hospitalized five workers. Proposed penalties total $125,300.

"Employees working in a confined space were exposed to hydrogen sulfide, a highly toxic and flammable gas that can affect the nervous system," said Stephen Boyd, OSHA's area director in Dallas. "If management had ensured that proper health and safety measures were followed during vacuuming of explosive dust, it is possible this incident could have been avoided."

OSHA's Dallas Area Office began the investigation Oct. 10, 2010, at the plant on County Road 2854, after workers were injured while vacuuming explosive dust to clean out a natural gas processing unit. Alvin-based Team Industrial Services, a mechanical and piping systems services company, was cited with seven violations. Among these are failing to evaluate permit-required confined space conditions, verify that conditions in a permit space were acceptable for entry, identify acceptable entry conditions, and conduct a process hazard analysis to determine the

fire protection and explosion prevention provisions necessary when vacuuming combustible dust. Proposed penalties total $49,000.

Tristream East Texas LLC, the owner and operator of the facility, was cited with seven violations including failing to establish or implement an emergency action plan, maintain ladders in a safe condition and evaluate a prospective rescue service's ability to function appropriately while rescuing workers from a permit space. Proposed penalties total $34,300. Tristream East Texas in Eustace is a subsidiary of Sugar Land-based Tristream Energy LLC.

Two Kilgore-based companies each were cited with three violations. They are Benchmark Industrial Services, doing business as Waterblastco, an industrial services company, and RHI Co., doing business as Canon Safety, a safety and health monitoring company. Both failed to protect employees from being struck by or caught between a crane's rotating superstructure, and to maintain material safety data sheets that are readily accessible to employees. Proposed penalties total $18,900 and $14,700 for Benchmark Industrial Services and RHI, respectively.

Maybank-based Crane Services Implement was cited with two violations for failing to ensure the crane was level and blocked when necessary, and to protect workers from being struck by or caught between a crane's rotating superstructure. Proposed penalties total $8,400.

A serious violation occurs when there is substantial probability that death or serious physical harm could result from a hazard about which the employer knew or should have known.

The companies have 15 business days from receipt of the citations to comply, request an informal conference with OSHA's Dallas area director or contest the citations and penalties before the independent Occupational Safety and Health Review Commission. Employers and employees with questions about workplace safety and health standards can call OSHA's Dallas office at 214-320-2400 or the agency's toll-free hotline at 800-321-OSHA (6742) to report workplace incidents, fatalities or situations posing imminent danger to workers.

Under the Occupational Safety and Health Act of 1970, employers are responsible for providing safe and healthful workplaces for their employees. OSHA's role is to ensure these conditions for America's working men and women by setting and enforcing standards, and providing training, education and assistance. For more information, visit http://www.osha.gov.

Evaluating and Controlling Exposure

To protect workers from harmful hydrogen sulfide exposures:

- Evaluate exposure to know whether H_2S gas is present and at what levels.
- Eliminate the source of hydrogen sulfide whenever possible.
- If the source cannot be eliminated, control exposures by:
  - Using engineering controls as the next best line of defense.
  - Developing administrative controls and safe work practices to reduce exposures to safe levels.
- Use personal protective equipment if engineering controls and work practices alone cannot reduce hydrogen sulfide to safe levels.

Evaluate Exposure

Example of a portable meter that can measure hydrogen sulfide.

- **Identify processes that could release or produce hydrogen sulfide**. This includes identifying known sources of hydrogen sulfide and evaluating possible fire and explosion hazards. Use a Process or Job Hazard Analysis for identifying and controlling hazards (see Hazard Analysis Methodologies in OSHA's Safety and Health Management eTool).

- **Test (monitor) the air** for hydrogen sulfide. This must be done by a qualified person. Use the right test equipment, such as an electronic meter that detects hydrogen sulfide gas.

  Conduct air monitoring prior to and at regular times during any work activity where hydrogen sulfide exposure is possible. When working in confined spaces air monitoring must be conducted in accord with the applicable OSHA standards. Detector tubes, direct reading gas monitors, alarm only gas monitors, and explosion meters are examples of monitoring equipment that may be used to test permit space atmospheres.

- Procedures for Atmospheric Testing in Confined Spaces [21 KB PDF*, 2 pages]. OSHA Fact Sheet. Discusses the importance of evaluating the hazards of the confined space and verifying that acceptable conditions exist for entry into that space.

Information on general atmospheric testing methods:

- Hydrogen Sulfide. OSHA Chemical Sampling Information webpage. Lists sampling techniques and methods for hydrogen sulfide.

- Hydrogen Sulfide. OSHA Method 1008. Describes the collection of airborne hydrogen sulfide through specially constructed hydrogen sulfide samplers containing silver nitrate coated silica gel using a personal sampling pump.

- NIOSH Method 6013 [24 KB PDF, 4 pages]. Air samples are collected with a glass tube and personal sampling pump and analyzed with ion chromatography.

Follow OSHA requirements for confined space entry. Enter the space only if necessary and follow established procedures:

- Test (monitor) the air in the space from the outside before entering.
- Test (monitor) the air in the space continuously during work operation.

- Determine if entry permit is required.
- Ventilate area continuously to remove accumulated hydrogen sulfide.
- Make sure that rescue procedures, personnel, and equipment (e.g., positive pressure SCBAs) are in place.
- Maintain contact with trained attendant.

See also: Permit-Required Confined Spaces in General Industry [53 KB PDF*, 2 pages]. OSHA QuickCard. Explains what workers should do before entering a confined space, such as underground vaults, tanks, storage bins, silos or manholes based on the requirements of OSHA's Standard for Permit-required Confined Spaces [29 CFR 1910.146].

DO NOT rely on your sense of smell to indicate the continuing presence of hydrogen sulfide or to warn of harmful levels. You can smell the "rotten egg" odor of hydrogen sulfide at low concentrations in air. But after a while, you lose the ability to smell the gas even though it is still present (olfactory fatigue). This loss of smell can happen very rapidly and at high concentrations and the ability to smell the gas can be lost instantly (olfactory paralysis).

Control Exposures

- **Use exhaust and ventilation systems** to reduce hydrogen sulfide levels. Make sure that the system is:
  - Non-sparking
  - Grounded
  - Corrosion-resistant
  - Separate from other exhaust ventilation systems
  - Explosion-proof

These safety measures are important because hydrogen sulfide is flammable and can corrode materials if they are not properly protected. When working in confined spaces ventilation should operate continuously and must be conducted in accord with the applicable OSHA standards.

- **Train and educate workers about hazards and controls**. Training topics may include:
  - Characteristics, sources and health hazards of hydrogen sulfide
  - Symptoms of hydrogen sulfide exposure
  - Types of hydrogen sulfide detection methods and applicable exposure limits

Workplace practices and procedures to protect against hydrogen sulfide exposure
Emergency plans, locations of safety equipment, rescue techniques, first-aid
Confined space procedures

- **Establish proper rescue procedures** to safely rescue someone from a hydrogen sulfide exposure.

A sign warning workers of hydrogen sulfide hazards.

WARNING: First responders must be trained and properly protected before entering areas with elevated levels of hydrogen sulfide.

Rescuer protection should include:

Positive-pressure, self-contained breathing apparatus (SCBA).
A safety line to allow for rapid exit if conditions become dangerous.

- **Use respiratory and other personal protective equipment**. If engineering and administrative controls cannot reduce hydrogen sulfide below OSHA's permissible exposure limit, employers must provide respiratory protection and other personal protective equipment (PPE), such as eye protection and possibly fire-resistant clothing. Employers must complete a PPE hazard assessment and equipment selection process in accord with the OSHA regulations before beginning any work activities. Respiratory protection should be at least:

  For exposures below 100 ppm, use an air-purifying respirator with specialized canisters/cartridges for hydrogen sulfide. A full face respirator will provide eye protection.

  For exposures at or above 100 ppm, use a full face pressure demand self-contained breathing apparatus (SCBA) with a minimum service life of thirty minutes or a combination full face pressure demand supplied-air respirator with an auxiliary self-contained air supply. **Exposures at or above 100 ppm are considered immediately dangerous to life and health (IDLH).**

Self-contained breathing apparatus (SCBA).

Whenever respirators are used, the employer must have a respiratory protection program that meets the requirements of OSHA's Respiratory Protection standard (29 CFR 1910.134). This program must include proper respirator selection, fit testing, medical evaluations, and training. For more information on respiratory protection see:

OSHA's Respiratory Protection Safety and Health Topics Page. Provides information on what respirators are, how they work, and what is needed for a respirator to provide protection.
OSHA's Small Entity Compliance Guide for the Respiratory Protection Standard [5.61 MB PDF*, 128 pages]. This guide is intended to help small businesses comply with the OSHA Respiratory Protection standard.

Refer to Other Resources for more information about controlling hydrogen sulfide exposures in specific industries and operations.

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Other Exposure Limits for Hydrogen Sulfide

NIOSH Recommended Exposure Limit (REL): 10 ppm, 10-minute ceiling

Concentration considered immediately dangerous to life and health (IDLH): 100 ppm

ACGIH® recommends a threshold limit value (TLV®) of 1 ppm as an 8-hour time weighted average (TWA) and a short-term exposure limit (STEL) of 5 ppm.

OSHA Standards

Hydrogen sulfide exposure is covered under the following OSHA standards:

Worker Exposure Limits (Enforceable)

- **General Industry:** 29 CFR 1910.1000 TABLE Z-2, Toxic and hazardous substances

Exposures must not exceed 20 parts per million (ppm) (ceiling) with the following exception: if no other measurable exposure occurs during the 8-hour work shift, exposures may exceed 20 ppm, but not more than 50 ppm (peak), for a single time period up to 10 minutes.

- **Construction:** 29 CFR 1926.55 Appendix A, Gases, vapors, fumes, dusts, and mists

  Sets exposure limit of 10 ppm (15 mg/m^3) time-weighted average (TWA)

- **Shipyard:** 29 CFR 1915.1000 Table Z, Air contaminants

  Sets exposure limit of 10 ppm (15 mg/m^3) TWA

29 CFR 1910.119 App A and 29 CFR 1926.64 App A, List of highly hazardous chemicals, toxics and reactives (mandatory). Hydrogen sulfide is included in these lists of toxic and reactive highly hazardous chemicals and is considered to present a potential for a catastrophic event at or above 1500 pounds.

Below are standards that include OSHA requirements for evaluating (e.g., process safety, toxic and hazardous substances) and controlling (ventilation, respiratory protection) hydrogen sulfide exposures, including in confined spaces. Industry-specific requirements (construction, shipyard, marine terminals and longshoring) follow.

General Industry (29 CFR 1910)

- 1910 Subpart G, Occupational health and environmental control
  - 1910.94, Ventilation
- 1910 Subpart H, Hazardous materials
  - 1910.119, Process safety management of highly hazardous chemicals.
- 1910 Subpart I, Personal protective equipment
  - 1910.134, Respiratory protection
  - Appendix B to Subpart I to Part 1910, Non-mandatory compliance guidelines for hazard assessment and personal protective equipment selection
- 1910 Subpart J, General environmental controls
  - 1910.146, Permit-required confined spaces

    - 1910.146 App C, Examples of permit-required confined space programs
    - 1910.146 App D, Sample permits
    - 1910.146 App E, Sewer system entry
- 1910 Subpart Z, Toxic and hazardous substances
  - 1910.1000, Air contaminants
  - 1910.1200, Hazard communication
    - Appendix A, Health hazard criteria (mandatory)
- 1910.1450, Occupational exposure to hazardous chemicals in laboratories
  - Appendix A, National Research Council recommendations concerning chemical hygiene in laboratories (non-mandatory)

Construction (29 CFR 1926)

- 1926 Subpart D, Occupational health and environmental control
  - 1926.55, Gases, vapors, fumes, dusts, and mists
  - Appendix A, 1970 American Conference of Governmental Industrial Hygienists' Threshold Limit Values of Airborne Contaminants
- 1926 Subpart S, Underground construction, caissons, cofferdams, and compressed air
  - 1926.800, Underground construction

Shipyard Employment (29 CFR 1915)

- 1915 Subpart B – Confined and enclosed spaces and other dangerous atmospheres in shipyard employment
  - 1915.12, Precautions and the order of testing before entering confined and enclosed spaces and other dangerous atmospheres
- 1915 Subpart Z, Toxic and hazardous substances
  - 1915.1000, Air contaminants

Marine Terminals (29 CFR 1917)

- 1917.1, Marine terminals, scope and applicability
- 1917.73, Terminal facilities handling menhaden and similar species of fish

Safety and Health Regulations for Longshoring (29 CFR 1918)

- 1918.1, Safety and health regulations for longshoring, scope and application
- 1918.94(f), Ventilation and atmospheric conditions. Employees shall not enter the hold when the hydrogen sulfide level exceeds 20 ppm ceiling or when the oxygen content is less than 19.5 percent, except in emergencies.

Letters of Interpretation (supplementary guidance that clarifies the application of an established Agency policy or procedure)

- The appropriate method for assessing hydrogen sulfide peak exposure levels. (1995, September 28).
- Respiratory protection requirements for sour crude oil tank gauging operations. (1989, April 25).
- Post-emergency response and medical surveillance requirements of HAZWOPER. (1993, August 5).
- Respiratory protection as it relates to oil fields. (1993, April 14).
- Interpretation of OSHA requirements for personal protective equipment to be used during marine oil spill emergency response operations. (1995, September 11).
- Order of testing for permit spaces. (1994, July 13).
- Potentially hazardous amine absorber pressure vessels used in refinery processing. (1986, April 11).
- Use of Bureau of Mines approved gas mask canisters. (1985, November 15).
- HHCs as it applies to hydrochloric acid, hydrofluoric acid, hydrogen sulfide, hydrogen cyanide. (1994, June 9).
- Interpretation of substances with high acute toxicity as used in the occupational exposures to hazardous chemicals in the laboratory standard. (1990, July 5).
- Respirator rules as applied to open hatch gauging of sour crude oil storage tanks. (1990, June 11).

- Interpretation of "high degree of acute toxicity" under the laboratory standard. (1990, July 30).
- NIOSH approved respirator during the period of an employee's escape from a chemical release of phosgene. (1997, July 1).
- Release of hazardous chemicals from gas calibration bottles. (1994, January 3).
- OSHA's policy on classification of a wet well as a Class 1, Division 1 location. (1979, November 5).
- Fires involving spills or releases of hazardous substances. (1991, June 17).
- Compliance and enforcement activities affected by the PELs decision. (1993, August 5).
- The appropriate atmospheric monitoring equipment to the wine making industry for compliance with OSHA standard 1910.146. (1995, June 21).

State Plans

Twenty-five states, Puerto Rico, and the Virgin Islands have OSHA-approved state plans and have adopted their own standards and enforcement policies. States usually adopt standards that are identical to those of Federal OSHA. However, some states have adopted different standards applicable to this topic or may have different enforcement policies.

H2S – Class Sign In Sheet

No.	Please Print Clearly Student Name	Student Signature	Last 4 SS#
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Instructor _____

Date _____

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H2S **Class Sign In Sheet**

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Instructor _____

Date _____

Student Registration And Release

Name:_____ (First, Last & Middle Initial)

Social Security Number:_____

Home Address:_____

City:_____, State:_____ Zip:_____

Home or Cell Phone:_____

Name of Employer:_____

Address of Employer:_____

City:_____, State:_____ Zip:_____

Company Phone:_____

Industry you work in:_____

Type of work you perform:_____

By completing this registration form and signing below you agree and understand to abide by all school rules. Failure to do so may be reason for course termination. We reserve the right to refuse service. You agree to allow Peak Safety Services LLC, Peaks Safety USA LLC, Peak Safety & Consulting LLC to release your training records to your employer:_____. Any additional transcripts or certificate duplication request will be subject to addition cost and additional release authorization agreement.

Please Sign Here:_____

Date:_____

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