



# Oil and Gas Well Drilling and Servicing eTool

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Welding with fire control

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## [General Safety and Health](#) >> [Safety and Health Program](#)

This page lists many general safety and health concerns. Each topic is linked to a page with more information about the activity and sources of information.

- Establish a [safety and health program](#). For further guidance see [Safety and Health Management Systems eTool](#). Contact your workers compensation insurance provider engineering group for further information about behavior based safety programs. See [Oil and Gas Well Drilling and Servicing Safety and Health Topics](#) pages.
- Contact [OSHA consultation services](#). From the OSHA consultation service employers can find out about potential hazards at their worksites, improve their occupational safety and health management systems, and even qualify for a one-year exemption from routine OSHA inspections.
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Fig. 1. Welding with fire control

### General Safety and Health Resources

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- **OSHA Interpretation:**
  - 04/14/1993 - [Respiratory protection as it relates to oil fields. \(H<sub>2</sub>S\)](#)

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## Slips, Trips, and Falls

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There are many ways to protect from slips, trips, and falls. Even so, they still happen and the following are means to either prevent slips, trips, and falls or to minimize the consequences if they should happen.

- Wear personal protective equipment (such as hard hats, work gloves, safety shoes, and eye protection).
- Be aware of the slipping and falling hazards when working on the drilling floor, servicing rig floors or other platforms.
- Keep all work areas clean and clear of oil, tools, and debris.
- Use non-skid surfaces where appropriate.
- Provide guardrails and guards around work areas that are prone to slips, trips, and falls.
- Install, inspect, and secure stairs and handrails. [[1926.1052](#)]
- Instruct workers on proper procedures for using and installing ladders.
- Use only ladders in good repair that do not have missing rungs.
- Do not install stairs with missing or damaged steps. Repair them before installing them.
- Keep walkways clean and free of debris and tripping hazards. [[1910.22](#)]

- Keep all cords and hoses orderly and clear of walking spaces.
- Cover open cellars.
- Conduct a pre-job inspection to identify, then eliminate or correct hazardous work surfaces.
- Walking/Working Surfaces Standard requires [\[1910.22\(a\)\(1\)\]](#): Keep all places of employment clean and in an orderly condition.
- Keep aisles and passageways clear and in good repair, with no obstruction across or in aisles that could create a hazard [\[1910.22\(b\)\(1\)\]](#). Provide floor plugs for equipment so power cords need not run across pathways.
- Use waterproof footwear to decrease slip/fall hazards.

**Additional Resources:**

- [Walking/Working Surfaces](#), Safety and Health Topics page
- [1910.22](#) Walking/working surfaces, general requirements
- [Walking/working Surfaces](#), OSHA small business training
- [Fall Protection](#)
  - ANSI Z359.1
  - [Body Harness](#) (Please recognize that there is a weight limit, including equipment)
  - [IADC Fall Protection Guidance](#)
  - [Webbing](#)

**Strains and Sprains**

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**General solutions for strains and sprains include:**

- Use proper lifting technique.
- Hoist slowly to limit pipe momentum.
- Seek assistance when moving awkward and heavy guards and covers.
- Use proper stance and slip-lifting techniques. Slips have three handles and should be lifted jointly by more than one person.
- Use lifting equipment and limit manual positioning of elevators.
- Practice proper hand placement and use of pullback (tail) ropes.
- Use mechanical lifting aids, proper lifting techniques, and team lifting where appropriate.
- Use proper hand and body positioning.
- [Ergonomics](#)

- Hand Injury
- Lifting
- Repetitive motions

## Weather Conditions

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Weather conditions can create hazardous working conditions: therefore it is necessary to monitor weather conditions and forecasts to allow time to prepare for such conditions as may occur. Lightning is especially hazardous and unpredictable. When lightning is present, crews must avoid situations where they could become part of potential current paths.

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## [General Safety and Health](#) >> [Hot Work/Welding](#)

Hot work is any work that involves burning, welding, using fire - or spark -producing tools, or that produces a source of ignition. Welding and cutting operations are common to drilling and servicing operations. Test for flammable gases in the work area before starting any hot work. Potentially hazardous areas include, but are not limited to, well heads, [fuel tanks](#), [mud tanks](#), tank batteries, [gas separators](#), oil treaters, or confined spaces where gases can accumulate.

- [Hot Work, Fire, and Explosive Hazards](#)
- [Welding, Cutting and Brazing](#)
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Fig. 1. Hot work - welding

### Hot Work, Fire, and Explosive Hazards

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Workers performing hot work such as welding, cutting, brazing, soldering, and grinding are exposed to the risk of fires from ignition of flammable or combustible materials in the space, and from leaks of flammable gas into the space, from hot work equipment.

#### Potential Hazard:

- Getting burned by fires or explosions during hot work.

#### Possible Solutions:

The basic precautions for fire prevention are:

- Perform hot work in a safe location, or with fire hazards removed or covered. [\[1910.252\(a\)\(1\)\(i\)\]](#)
- Use guards to confine the heat, sparks, and slag, and to protect the immovable fire hazards. [\[1910.252\(a\)\(1\)\(ii\)\]](#)

#### Special Precautions:

- Do not perform hot work where flammable vapors or combustible materials exist. Work and equipment should be relocated outside of the hazardous areas, when possible. [\[1910.252\(a\)\]](#)



Fig. 2. Welding with fire control

[\(1\)\(ii\)](#)

- Make suitable fire-extinguishing equipment immediately available. Such equipment may consist of pails of water, buckets of sand, hose, or portable extinguishers. [\[1910.252\(a\)\(2\)\(ii\)\]](#)
- Assign additional personnel (fire watch) to guard against fire while hot work is being performed. Fire watchers are required whenever welding or cutting is performed in locations where anything greater than a minor fire might develop. [\[1910.252\(a\)\(2\)\(iii\)\(A\)\]](#)
  - Fire watchers shall:
    - Have fire-extinguishing equipment readily available and be trained in its use.
    - Be familiar with facilities for sounding an alarm in the event of a fire.
    - Watch for fires in all exposed areas, try to extinguish them only when obviously within the capacity of the equipment available, or otherwise sound the alarm.
    - Maintain the fire watch at least a half hour after completion of welding or cutting operations to detect and extinguish possible smoldering fires. [1910.252\(a\)\(2\)\(iii\)\(B\)](#)

**Potential Hazard:**

- Getting burned by a flash fire or explosion that results from an accumulation of flammable gases, such as Methane or Hydrogen Sulfide, around the wellhead area.

**Possible Solutions:**

- Monitor the atmosphere with a gas detector. If a flammable or combustible gas exceeds 10 percent of the lower explosive level (LEL), the work must be stopped.
- Identify the source of the gas and repair the leakage.

**Additional References:**

- OSHA Standards
  - [1910.106](#), Flammable and Combustible Liquids.
  - [1910.252](#), Welding, Cutting, and Brazing - General Requirements.
  - [1910.253](#), Oxygen-fuel gas welding and cutting.
  - [1910.254](#), Arc welding and cutting.
  - [1910.255](#), Resistance welding.
- [API](#) RP54, Recommended Practice for Occupational Safety for Oil and Gas Well Drilling and Servicing Operations
- [API](#) Publication 2201
- [NFPA 30](#), 51-B, Flammable and Combustible Liquids Code, National Fire Protection Association
- [Hot Work](#). AESC, 12 KB PDF, 2 pages.

All hot work is potentially hazardous and a [hazard assessment](#) should be performed to determine

where the hazards exist.

#### Potential Hazard:

- Injury and illness caused by hot work (such as, welding fumes, UV light, sparks, noise, or skin injury).

#### Possible Solutions:

- Inspect the work area to ensure that all fuel and ignition sources are isolated by shielding, clearing the area, lockout/tagout, soaking flammable material with water.
- Wear appropriate PPE, such as face shield, leather welder's vest, and gauntlet gloves. Use cotton or denim clothing.
- Provide UV shielding for arc welding where practical.
- Inspect welding and cutting equipment before use (arc or gas welding/burning).
- Leak test gas torches, gauges, and hoses.
- Review the hot work permit if available.
- Ensure the availability of adequate fire watch/fire protection equipment.
- Ensure adequate ventilation from toxic welding and cutting fumes.



Fig. 3. Welding - hot work

#### Special Hazard:

- Accumulation of toxic gases within a confined space.
- A hazardous atmosphere exists in oxygen-deficient (atmospheric concentration of less than 19.5 percent) or oxygen-enriched (atmospheric concentration of more than 23.5 percent). [1910.146](#) confined space entry.

#### Possible Solutions:

- Ventilate toxic metal fumes mechanically, if entering a [confined space](#), such as inside of a mud tank, water tank, oil tanks, hoppers, sump, pit or cellar.
- Use a written permit system to document authorization to enter, the work to be performed, and the results of the gas monitoring where there is a potential for toxic, flammable, or oxygen-deficient atmosphere. Both a hot work and confined entry permit may be required for welding, cutting or brazing within a confined space.

#### Additional Information:

- [AESC](#) Recommended Safe Procedures and Guidelines for Oil and Gas Well Servicing. Section X, Welding, Cutting and Brazing and Hot Work, pp. 77-80, April 2000.
- [ANSI](#) Z49.1-67 Safety in Welding and Cutting, American National Standards Institute.
- [AWS](#) Z49.1-88, Safety in Welding and Cutting and Applied Processes, American Welding society.



**Potential Hazard:**

- Falling or rolling injuries from improper gas cylinder storage

**Possible Solutions:**

- Ensure cylinders are properly stored in an upright position and chained in separate racks.
- Store full and empty cylinders separately.

**Potential Hazard:**

- Valve opening or break off, exposing workers to toxic fumes and flammable gas, caused by improper gas cylinder storage

**Possible Solutions:**

- Store cylinder properly.
- Always remove gauges and regulators, and install protective valve caps before transporting.

**Potential Hazard:**

- Gas cylinders causing fires or explosions

**Possible Solutions:**

- Store cylinders in a dry, well-ventilated location.
- Avoid storing flammable substances in the same area as gas cylinders.
- Avoid storing cylinders of oxygen within 20 feet of cylinders containing flammable gases.
- Store all cylinders upright and chained in separate racks.
- Store full and empty cylinders separately.

**Additional Information:**

- [Compressed Gas Cylinders](#). AESC, 16 KB PDF, 3 pages.



Fig. 4. Properly stored cylinders

**Grinding****Potential Hazard:**

- Grinding (that results in sparks, noise, eye and skin injury from flying metal filings, grinding wheel pieces, etc.).
- Having fingers or hands caught in the grinding wheel, resulting in amputation.
- Being struck by portable grinder.

**Possible Solutions:**

- Wear appropriate PPE, such as face shield. Use cotton or denim clothing.



Fig. 5. Hand grinding

- Inspect grinding equipment before use.
- Review the hot work permit if available.
- Ensure the availability of adequate fire watch/fire protection equipment.

## Well Site Ignition Sources

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There are a number of potential sources of ignition for flammable gases and liquids on the drill site. It is necessary to provide for a general ignition safety program which could pre-empt potential hazards of fire and explosion.

### Potential Hazard:

- Ignition and explosions of flammable gases or vapors from:
  - Internal-combustion engine sparks
  - Open flames from any source
  - Smoking
  - Welding operations
  - Electric power tools
  - Two-way radios
  - Vehicles with catalytic converters
  - Portable generators



Fig. 6. Ignition source

### Possible Solutions:

- Provide spark arrestors for internal-combustion engines.
- Post "NO SMOKING" signs wherever a flammable gas or vapor hazard exists.
- Locate "spark producing" equipment or facilities well away from potential hazard areas.
- Prohibit vehicles with catalytic converters from the immediate vicinity of the rig.
- Prohibit open flames from the vicinity of the rig.

### Additional Information:

- [API](#), 500, 505
- [API](#), RP54
- [IADC](#), Accident Prevention Reference Guide
- [AESC](#), Recommended Safe Procedures and Guidelines for Oil and Gas Well Servicing
- [1910.106](#), OSHA Flammable and Combustible Liquids.
- [1910 Subpart S](#), OSHA Electrical



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## [General Safety and Health](#) >> [Hydrogen Sulfide Gas](#)

**Note:** It is not the intent of this section to create an H<sub>2</sub>S contingency plan.

Hydrogen Sulfide or *sour gas* (H<sub>2</sub>S) is a flammable, colorless gas that is toxic at extremely low concentrations. It is heavier than air, and may accumulate in low-lying areas. It smells like "rotten eggs" at low concentrations and causes you to quickly lose your sense of smell. Many areas where the gas is found have been identified, but pockets of the gas can occur anywhere. [\[more\]](#)

Iron sulfide is a byproduct of many production operations and may spontaneously combust with air.

Flaring operations associated with H<sub>2</sub>S production will generate Sulfur Dioxide (SO<sub>2</sub>), another toxic gas.

Active monitoring for hydrogen sulfide gas and good planning and training programs for workers are the best ways to prevent injury and death.

Also see: NIOSH [Classification of H<sub>2</sub>S Hazard Areas](#).

- [Release of H<sub>2</sub>S](#)
- [Metal Fatigue](#)
- [Accumulation of H<sub>2</sub>S](#)
- [Additional Information](#)
- [Appendix A](#) - Physical Properties and Physiological Effects of Hydrogen Sulfide



Fig. 1. Hydrogen Sulfide warning sign

### Release of H<sub>2</sub>S

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All personnel working in an area where concentrations of Hydrogen Sulfide may exceed the 10 Parts Per Million (PPM) should be provided with training before beginning work assignments.

#### Potential Hazard:

- H<sub>2</sub>S exposure greater than the Permissible Exposure Limit (PEL)

## Possible Solutions:

Implement an H<sub>2</sub>S contingency plan (see API) including, but not limited to:

- Appropriate instruction in the use of hydrogen sulfide safety equipment to all personnel present at all hydrogen sulfide hazard areas.
- Gas detection where hydrogen sulfide may exist.
- Appropriate respiratory protection for normal and emergency use. Respiratory Protection Standard, [1910.134] (H<sub>2</sub>S).

For emergency response information, see Hazardous Waste and Emergency Response (HAZWOPER) Standard, [1910.120].

**Comprehensive training should be provided for workers in H<sub>2</sub>S operations. Example topics include:**

- The characteristics, sources, and hazards of Hydrogen Sulfide.
- Proper use of the Hydrogen Sulfide detection methods used on the site.
- Recognition of, and proper response to, Hydrogen Sulfide warnings at the workplace.
- Symptoms of Hydrogen Sulfide exposure.
- Proper rescue techniques and first-aid procedures to be used in a Hydrogen Sulfide exposure.
- Proper use and maintenance of personal protective equipment. Demonstrated proficiency in using PPE should be required.
- Worker awareness and understanding of workplace practices and maintenance procedures to protect personnel from exposure to hydrogen sulfide.
- Wind direction awareness and routes of egress.
- Confined space and enclosed facility entry procedures.
- Locations and use of safety equipment.
- Locations of safe briefing areas.
- Use and operation of all Hydrogen Sulfide monitoring systems.
- Emergency response procedures, corrective action, and shutdown procedures.
- Effects of Hydrogen Sulfide on the components of the Hydrogen Sulfide handling system.
- The importance of drilling fluid treating plans prior to encountering Hydrogen Sulfide.



Fig. 2. SCBA



Fig. 3. Gas detector



## Additional Information:

- [API RP 49](#), 2.02 MB PDF. Recommended Practice for Drilling and Well Servicing Operations Involving Hydrogen Sulfide, Current Edition.
- [Use of Respirators](#). AESC, 68 KB PDF, 18 pages.
- [H<sub>2</sub>S precautions](#). AESC, 16 KB PDF, 2 pages.

## Metal Fatigue

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Metal fatigue, including Hydrogen embrittlement or Sulfide stress cracking, can result in a release of Hydrogen Sulfide gas.

### Potential Hazard:

- Being exposed to Hydrogen Sulfide.
- Getting Injured due to equipment failure.

### Possible Solutions:

- Select materials in accordance with the National Association of Corrosion Engineers ([NACE MR 0175](#)) criteria for H<sub>2</sub>S service.
- Treat drilling fluids to chemically reduce corrosion failures.



Fig. 4. H<sub>2</sub>S metal fatigue

## Accumulation of H<sub>2</sub>S

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It is possible for Hydrogen Sulfide gas to accumulate in any low or enclosed area, such as a gas venting system, mud system, cellars, pits, and tanks.

### Potential Hazard:

- Being exposed to Hydrogen Sulfide.

### Possible Solutions:

- Provide adequate ventilation for the removal of any accumulation of H<sub>2</sub>S.
- Implement effective [confined space](#) entry program.

## Additional Information

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Additional guidance materials are available from:

- American Petroleum Institute ([API](#)) in the recommended practice document RP 49 (*Drilling and Well Servicing Operations Involving Hydrogen Sulfide*, Current Edition) and Spec 6A
- Association of Energy Service Companies ([AESC](#))
- National Association of Corrosion Engineers ([NACE](#))
- International Association of Drilling Contractors ([IADC](#))



- OSHA Standard Interpretation 04/14/1993 - [Respiratory protection as it relates to oil fields.](#) Respiratory Protection Standard, [[1910.134](#)]
- NFPA 70, National Electrical Code. See the National Fire Protection Agency website ([NFPA](#)) 2002 Edition

#### State Programs:

- **California:** Cal/OSHA Standards: California Code of Regulations, Title 8; Chapter 4, Division of Industrial Safety; Subchapter 14. [Petroleum Safety Orders--Drilling and Production](#)
- **Texas:** Texas Administrative Code (TAC); Title 16. Economic Regulation; Part 1. Railroad Commission of Texas; Chapter 3. [Oil and Gas Division](#)
- **Utah:** Title 34A, Chapter 6, Utah Occupational Safety and Health Act of 1973. [Rule R614-2. Drilling Industry](#)
- **Wyoming:** Employment, Dept. of Occupational Health & Safety - [Oil & Gas Well Drilling - Rules](#)
- Alaska: [Oil and Gas Commission Alaska Administrative Code Title 20 - Chapter 25](#)

#### Training Programs

- [TEEX](#)
- [ASSE: Hydrogen Sulfide Safety Training, ASC Z390](#)

#### H<sub>2</sub>S Training and Information Links

- American Petroleum Institute ([API](#)) in the recommended practice document RP 49 (*Drilling and Well Servicing Operations Involving Hydrogen Sulfide*, 3rd Edition, 2001) and Spec 6A
- National Association of Corrosion Engineers ([NACE](#))
- International Association of Drilling Contractors ([IADC](#))

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## [General Safety and Health](#) >> [H<sub>2</sub>S Special Precautions](#)

Hydrogen Sulfide gas is very corrosive and causes metals to become brittle. Therefore, employers need to take special precautions when choosing equipment when they may reasonably expect to encounter H<sub>2</sub>S. This may include appropriate H<sub>2</sub>S trimming of equipment in accordance with National Association of Corrosion Engineers (NACE) Standards.

All well-drilling sites should be classified according to areas of potential and/or actual exposure to H<sub>2</sub>S. The recommendations and employee instruction will vary depending on the type of area.

- [No Hazard Condition](#)
- [API Condition I - Low Hazard](#)
- [API Condition II - Medium Hazard](#)
- [API Condition III - High Hazard](#)

### Additional Information:

- [API](#)
- [ANSI](#)
- [IADC HSE Reference Guide](#)
- [AESG](#) - Recommended Safe Procedures and Guidelines for Oil and Gas Well Servicing
- [NACE](#)
- [ASSE](#)
- [NIOSH](#)



Hydrogen Sulfide warning sign

### No Hazard Condition

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Any well that will not penetrate a known Hydrogen Sulfide formation would be categorized as a No Hazard Area. Special Hydrogen Sulfide equipment is not required.

### API Condition I - Low Hazard

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Work locations where atmospheric concentrations of H<sub>2</sub>S are less than 10ppm.

**Recommended for Area:**

- Hydrogen Sulfide warning sign with green flag warning device present.
- Keep all safety equipment in adequate working order.
- Store the equipment in accessible locations.

### API Condition II - Medium Hazard

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Work locations where atmospheric concentrations of H<sub>2</sub>S are greater than 10ppm and less than 30ppm.

#### Recommended for Area:

- Legible Hydrogen Sulfide warning sign with yellow flag warning device present.
- Keep a safe distance from dangerous locations if not working to decrease danger.
- Pay attention to audible and visual alarm systems.
- Follow the guidance of the operator representative.
- Keep all safety equipment in adequate working order.
- Store the equipment in accessible locations.
  - An oxygen resuscitator.
  - A properly calibrated, metered hydrogen sulfide detection instrument.

### API Condition III - High Hazard

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Work locations where atmospheric concentrations of H<sub>2</sub>S are greater than 30ppm.

#### Recommended for Area:

- Post legible Hydrogen Sulfide warning sign with red flag warning device.
- Post signs 500 feet from the location on each road leading to the location, warning of the hydrogen sulfide hazard.
- Check all Hydrogen Sulfide safety equipment to ensure readiness before each tour change.
- Establish a means of communication or instruction for emergency procedures and maintain them on location, along with contact information of persons to be informed in case of emergencies.
- Ensure usability of two exits at each location.
- Do not permit employees on location without hydrogen Sulfide safety training. (Employees may be permitted on location for specific Hydrogen Sulfide training purposes that does not include general rig training.)
- Pay attention to audible and visual alarm systems.
- Store the equipment in accessible locations.
  - Two Hydrogen Sulfide detectors should be present (one should be a properly calibrated, metered detection instrument, and the other should be a pump type with detector)

tubes. The maximum permissible exposure limit (PEL) is 20 ppm. Respiratory protection would be required if periodic testing indicates employee exposures to H<sub>2</sub>S at concentrations above the PEL. See OSHA Standard Respiratory Protection, [[1910.134](#)].

- Oxygen resuscitator.
- Three wind socks and streamers.
- Two NIOSH/MSHA 30-minute, self-contained breathing apparatus for emergency escape from the contaminated area only.

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## Physical Properties and Physiological Effects of Hydrogen Sulfide

### A.1 Physical Data

- Chemical Name: Hydrogen Sulfide
- CAS Number: 7783-06-4
- Synonyms: Sulfureted hydrogen, hydrosulfuric acid, dihydrogen sulfide
- Chemical Family: Inorganic sulfide
- Chemical Formula: H<sub>2</sub>S
- Normal Physical State: Colorless gas, slightly heavier than air. Vapor density (specific gravity) at 59°F (15°C) and 1 atmosphere = 1.189.
- Auto ignition Temperature: 500° F
- Boiling Point: -76° F
- Melting Point: -117.2° F
- Flammable Limits: 4.3-4.6 percent vapor by volume in air
- Solubility: Soluble in water and oil: solubility decreases as the fluid temperature increases
- Combustibility: Burns with a blue flame to produce sulfur dioxide (SO<sub>2</sub>). Refer to Appendix B Odor and Warning Properties: Hydrogen sulfide has an extremely unpleasant odor, characteristic of rotten eggs, and is easily detected at low concentrations: however, due to rapid onset of olfactory fatigue and paralysis (inability to smell) ODOR SHALL NOT BE USED AS A WARNING MEASURE.

### A.2 Exposure Limits

The American Conference of Governmental Industrial Hygienists recommends a Threshold Limit Value of 10ppm and a short-term exposure (STEL) limit of 15 ppm averaged over 15 minutes. Exposure at the STEL should not be repeated more than four times per day with at least 60 minutes between successive exposures in this range.

### A.3 Physiological Effects

Inhalation at certain concentrations can lead to injury or death. The 300 ppm is considered by the ACGIH as Immediately Dangerous to Life and Health. Hydrogen sulfide is an extremely toxic, flammable gas that may be encountered in the production of gas well gas, high-sulfide, high sulfur content crude oil, crude oil fractions, associated gas, and waters. Since hydrogen sulfide is heavier than air, it can collect in low places. It is colorless and has a foul rotten egg odor. In low concentrations, H<sub>2</sub>S sometimes can be detectable by its characteristic odor; however, the smell cannot be relied upon to forewarn of dangerous concentrations (greater than 100ppm) of the gas because it rapidly paralyzes the sense of smell due to paralysis of the olfactory nerve. A longer exposure to the lower concentrations has a similar desensitizing effect on the sense of smell.

It should be well understood that the sense of smell will be rendered ineffective by hydrogen sulfide, which can result in an individual failing to recognize the presence of dangerously high concentrations. Exposure to hydrogen sulfide causes death by poisoning the respiratory system at the cellular level. Symptoms from repeated exposures to low concentrations usually disappear after not being exposed for a



period of time. Repeated exposures to low concentrations that do not produce effects eventually may lead to irritation if the exposures are frequent.

#### **A.4 Respiratory Protection**

Respiratory protection shall be worn above the action level. Refer to 6.6 for proper breathing equipment recommendations for oil and gas well drilling and servicing operations involving hydrogen sulfide.

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