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# Brunel Energy, Inc.

## Hydrogen Sulfide (H2S)

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## 1. Purpose

- 1.1. Brunel Energy, Inc., hereinafter referred to as, the “Company,” has established a program compliant with OSHA 29 CFR 1910.1000 and OSHA 29 CFR 1926.64
- 1.2. The purpose of this program is to establish minimum requirements for site specific H2S safety, which will enhance safety in the occupational setting where hydrogen sulfide is present or is recognized as being potentially present.
- 1.3. The company limits employee occupational exposure limit (OEL) or the permissible (PEL) to H2S, as stated as an eight-hour time weighted average (TWA). The OSHA PEL for Construction is 10 parts per million (ppm) as an eight-hour TWA and the OEL followed by ANSI, API, and NIOSH is 10 ppm as an eight-hour TWA. OSHA General industry standards do not offer a PEL for industry, instead and accepted ceiling concentration (ACC) of 20 ppm is used.

## 2. Applicability

- 2.1. This policy applies to employees, subcontractors and/or visitor(s) of the Company. For the purposes of this policy, an employee shall be considered on the job whenever he/she is:
  - 2.1.1. On or in, any Company or client property, including parking areas; or
  - 2.1.2. On company time even if off Company premises (including paid lunch, rest periods and periods of being on call).
- 2.2. As a condition of employment, Company employees are required to abide by additional governmental or customer policies and requirements that may be imposed at a worksite in addition to the requirements of these policies and procedures. Nothing set forth in this policy constitutes, construes, or interprets in any way as a contract of employment.

## 3. Definitions

- 3.1. **Air-line respirator** is a breathing apparatus that is connected to a stationary source of breathing air by a hose. The air is delivered continuously in a sufficient volume to meet the wearer's breathing requirements. The length of the hose connection and the dangers of damage to the hose can restrict the user.
- 3.2. **Hydrogen sulfide (H2S)** is a colorless, toxic, extremely poisonous gas that has a very disagreeable odor, much like that of rotten eggs at low concentrations, but deadens the sense of smell at higher concentrations. In dangerous concentrations, it is extremely corrosive and poisonous, causing damage to skin, eyes, breathing passages, and lungs and attacking and paralyzing the nervous system, particularly that part controlling the lungs and heart. Hydrogen sulfide is flammable; in an excess of air, it burns to form sulfur dioxide (SO2).

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- 3.3. **Immediately Dangerous to Life or Health (IDLH) Atmosphere** means an atmospheric concentration of any toxic, corrosive, or asphyxiate substance that poses an immediate threat to life or would cause irreversible or delayed adverse health effects or would interfere with an individual's ability to escape from a dangerous atmosphere. The IDLH for H2S is 100 ppm.
- 3.4. **Permissible Exposure Limit (PEL)** (10 ppm for H2S) is an exposure limit that is set and enforced by OSHA. PEL is the maximum amount or concentration of a chemical or agent that a worker may be exposed to. The PEL can be based on either a time-weighted average (8 hours), or the maximum exposure limit described by the regulation.
- 3.5. **Safety Watch** is an individual trained and qualified for rescue and retrieval to provide "stand-by service" for individuals working in IDLH atmospheres.
- 3.6. **Self-Contained Breathing Apparatus (SCBA)** is an air supplied to a full-face mask from a cylinder worn by the worker. This gives greater movement than an air-line respirator, but the air supply is limited.

#### 4. Responsibilities

- 4.1. Manager(s):
  - 4.1.1. Shall control worker exposures to an H2S level below 10 ppm.
  - 4.1.2. Make appropriate respiratory protection available for prevention of H2S overexposures while performing specific tasks, and for emergency response.
  - 4.1.3. Shall ensure all employees and contractors are trained in H2S safety prior to working in areas where H2S may be present.
  - 4.1.4. Shall ensure all air-supplied respiratory equipment is inspected, maintained, cleaned, and stored correctly.
- 4.2. HSE Supervisor(s)
  - 4.2.1. Assisting in identifying areas, procedures, tasks, and other situations that can result in exposure to H2S.
  - 4.2.2. Assisting in implementing H2S exposure controls.
  - 4.2.3. Providing guidance during emergency exposure incidents.
- 4.3. Employee(s):
  - 4.3.1. Upon discovery or suspicion of Hydrogen Sulfide being present on a jobsite, employees are to stop the work immediately, evacuate the area and inform their supervisor.
  - 4.3.2. Protect themselves and others from unnecessary Hydrogen Sulfide exposure.
  - 4.3.3. Use required PPE and personal monitors.

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- 4.3.4. Immediately report to a supervisor any changes, deficiency or breaches in site controls established to isolate employees from Hydrogen Sulfide hazards on a jobsite.
- 4.3.5. Participate in JSA and hazard recognition activities. Make every effort to identify potential H2S hazards during daily JSA's.
- 4.3.6. Follow all written (H2S) Safe Work, Confined Entry and Permit to Work procedures.
- 4.3.7. Respect all controlled access areas and Hydrogen Sulfide (H2S) Hazard signs and postings.
- 4.3.8. Employees must be aware of and follow all provisions of the site-specific contingency plan.
- 4.4. Subcontractor(s):
  - 4.4.1. Upon discovery or suspicion of Hydrogen Sulfide being present on a jobsite, employees are to stop the work immediately, evacuate the area and inform their supervisor.
  - 4.4.2. Protect themselves and others from unnecessary Hydrogen Sulfide exposure.
  - 4.4.3. Use required PPE and personal monitors.
  - 4.4.4. Immediately report to a supervisor any changes, deficiency or breaches in site controls established to isolate employees from Hydrogen Sulfide hazards on a jobsite.
  - 4.4.5. Participate in JSA and hazard recognition activities. Make every effort to identify potential H2S hazards during daily JSA's.
  - 4.4.6. Follow all written (H2S) Safe Work, Confined Entry and Permit to Work procedures.
  - 4.4.7. Respect all controlled access areas and Hydrogen Sulfide (H2S) Hazard signs and postings.
  - 4.4.8. Employees must be aware of and follow all provisions of the site-specific contingency plan.

## 5. Requirements

### 5.1. H2S Contingency Plan

- 5.1.1. Employees with exposure to or conducting any of the following operations could have a potential of exposure to Hydrogen Sulfide: Drilling Operations, Recycled Drilling Mud, Water from sour crude wells, Blowouts, Tank Gauging (tanks at producing, pipeline & refining operations), Field Maintenance, and Tank batteries and wells, etc.

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- 5.1.2. Identifying locations where employees might be exposed to H2S during their job functions is extremely important. It is necessary to identify the existence of potential H2S exposure as early as possible, preferably during the contract tender process. The probability of encountering H2S and the anticipated severity of the exposure are topics of utmost importance, which will determine the Company's response.
- 5.1.3. Employees must be aware of site-specific and host facility contingency/emergency plans.
- 5.1.4. Alarms will sound on personal, and area monitors if the exposure limits exceed 10 parts per million (ppm) or 20 ppm.
- 5.1.5. Any exposure or potential for exposure to H2S which results in provision of monitoring and respiratory protective equipment must be promptly reported to the HSE Manager using the H2S Operations Equipment Report Form (Appendix 7.1).

5.2. Hazard Assessment and Control

- 5.2.1. The following probability/severity matrix is to be used to assess the risk and to determine the appropriate equipment, commensurate with the apparent degree of hazard.

H2S Exposure Matrix		
Probability	Severity	Response
Know to not exist	None	None
Suspected to exist	Unknown	Level II
Suspected to exist	Low	Level I
Suspected to exist	High	Level II
Known to exist	Low	Level I
Known to exist	High	Level II

5.3. Guidance on levels

- 5.3.1. (Level I and Level II) are provided in the table above. All H2S contingency planning shall, as a minimum, conform to this procedure.
- 5.3.2. Guidance to equipment selection is provided in detail below; however, several points deserve special mention here:
  - 5.3.2.1. Ten minutes or 15-minute SCBA's used in Level II equipment will have connections, without exception.
  - 5.3.2.2. Canister-type gas masks are not acceptable for use with an H2S exposure under any circumstances whatsoever.

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- 5.3.2.3. Provision of Level I equipment is only acceptable under the condition that the Client and The Company mutually understand and agree, in advance of commencement of operations, that no work of any duration, aside from immediately securing the well, is to be undertaken upon the occurrence of H2S at the worksite.
- 5.3.2.4. All contingency planning is to conform to this procedure. Departures at the request of either the Client or an H2S service company must be submitted to and approved by the Manager.
- 5.3.2.5. Compliance with local regulations is mandatory; however, where The Company standards are greater than local requirements, The Company standards must prevail.
- 5.3.2.6. The following sets forth The Company standards for monitoring and personal protective equipment for the protection of personnel against the hazards of H2S. The equipment listed represents the Company Standards. Any questions or exceptions must be referred to the Manager prior to agreement to equipment provision with either the Client or an H2S service company.
- 5.3.2.7. Guidance to decision making for equipment selection is found in this procedure, compliance with which is mandatory.
- 5.4. Ensure Worker Safety
  - 5.4.1. Ensure workers are provided with appropriate training, equipment, and facilities to ensure that work at hydrogen sulfide classified sites can be done safely and without detrimental effects to health.
  - 5.4.2. Evaluate worker safety by asking the following questions:
  - 5.4.3. Has the potential for a release of H2S into the atmosphere at levels of 10 ppm or greater been evaluated?
    - 5.4.3.1. Does every worker know where and how an uncontrolled release of H2S could occur?
    - 5.4.3.2. Does every worker know what precautions to take when there is a potential for an H2S release?
    - 5.4.3.3. Do workers know what to do in case of an emergency?
    - 5.4.3.4. Does every worker who could be exposed to H2S have appropriate training (i.e., H2S Clear)?
    - 5.4.3.5. Is there a procedure to test the atmosphere for H2S concentrations and are workers trained in this procedure?
    - 5.4.3.6. Is all the necessary equipment readily available to workers who require it?
    - 5.4.3.7. Are you certain that your workers follow safe work practices developed by your organization?

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- 5.4.3.8. Have you determined if you need a code of practice for operations involving H2S?
- 5.4.4. If the answer to any of the above questions is "no", take action to reduce identified hazards.
- 5.4.5. Prepare work permits as required.
- 5.4.6. Provide properly designed and installed ventilation systems.
- 5.4.7. Provide appropriate protective equipment, including respirators, where concentrations of hydrogen sulfide cannot be controlled below safe limits.
- 5.4.8. Develop site-specific safe work procedures.
- 5.4.9. Ensure all rules, regulations, company standards and policies are implemented and enforced.
- 5.5. Level I- Monitoring
  - 5.5.1. A four-point continuous monitor with sensors located in various areas, which will alarm when PEL exceeds the preset level of 10 PPM.
  - 5.5.2. Alarms shall be provided in areas in various locations and shall be visible and audible throughout the location.
  - 5.5.3. A 30-minute SCBA shall be provided for all supervisors with a spare cylinder for each SCBA.
  - 5.5.4. A 10-minute or preferably a 15-minute escape SCBA shall be provided for each person on location, plus 10 percent excess.
  - 5.5.5. Miscellaneous Equipment:
    - 5.5.5.1. Voice communication devices (Loudmouths) for each supervisor.
    - 5.5.5.2. One twin cylinder resuscitator.
    - 5.5.5.3. Two H2S/SO2 detectors.
    - 5.5.5.4. A windsock illuminated at night, visible throughout the location.
- 5.6. Level II- Monitoring
  - 5.6.1. A multi-point continuous monitor with sensors located in various areas, which will alarm when PEL exceeds the present level of 10 PPM.
  - 5.6.2. Alarms shall be provided in various areas where they shall be visible and audible throughout the location.
  - 5.6.3. Respiratory Protection
    - 5.6.3.1. 30-minute SCBA shall be provided sufficient for all supervisors with a spare cylinder for each.
    - 5.6.3.2. 5-minute egress SCBA's shall be provided for all persons on location, plus 10 percent excess.

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- 5.6.3.3. 10-minute or preferably 15-minute escape SCBA's shall be provided for all personnel and be positioned, as necessary.
- 5.6.3.4. A cascade storage and supply system shall be provided of a capacity sufficient to provide breathing air to all working crew members for not less than 30 minutes at a consumption rate of 3.5 cubic feet. (99 liters) per man per minute.
- 5.6.3.5. A breathing air compressor shall be provided to fill the cascade storage and supply system cylinders and to maintain them full of normal leakage.
- 5.6.3.6. A tubing/hose distribution system shall be provided which will supply air to work manifolds, placed around as necessary.
- 5.6.4. Miscellaneous Equipment
  - 5.6.4.1. Voice communication devices (Loudmouths) for each supervisor.
  - 5.6.4.2. One twin cylinder resuscitator.
  - 5.6.4.3. Two H2S/SO2 detectors.
  - 5.6.4.4. A windsock illuminated at night, visible throughout the location.
  - 5.6.4.5. A set of green, yellow, and red flags to signal danger status.
- 5.7. Calibration and Testing of H2S Equipment
  - 5.7.1. Facilities with Level I and II monitoring shall ensure that monitoring equipment is tested and calibrated on a regular basis and written records maintained. Monitors must be bump tested at a minimum as required by the manufacturer, if monitor fails a bump test a full calibration is required. Monitors must be calibrated according to the manufacturer's recommendations. Personal alarm monitors must be set to alarm initially at 10ppm H2S, and each contractor should wear an H2S personal alarm monitor when working in all potential H2S areas.
  - 5.7.2. Rescue equipment shall be checked for damage, replaced when damaged, and maintained at full capacity.
- 5.8. Characteristics and Dangers of Hydrogen Sulfide
  - 5.8.1. Found in decaying organic matter, natural oil and gas, silos, sewers.
  - 5.8.2. Found as a gas at temperatures above -60°C.
  - 5.8.3. Colorless
  - 5.8.4. Flammable (burns to form Sulphur dioxide).
  - 5.8.5. Has an odor of rotten eggs at low concentrations (kills all sense of smell at higher concentrations).
  - 5.8.6. Tends to disperse more slowly in sheltered, calm, or low-lying areas.
  - 5.8.7. Extremely toxic.



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- 5.8.8. At lower concentrations (20 to 50 ppm) irritates mucous membranes (eyes, throat, and lungs), causes headache, dizziness, and nausea, and may cause pulmonary edema (fluid in the lungs) upon prolonged exposure.
- 5.8.9. At high concentrations (500 to 1000 ppm) causes paralysis of the respiratory center in the brain (breathing stops, and suffocation occurs).
- 5.8.10. Soluble in water and acts as a weak acid.
- 5.8.11. Toxic by Products, if ignited, the gas burns to produce toxic vapors and gases, such as sulfur dioxide.
- 5.9. Health Effects
  - 5.9.1. Hydrogen sulfide by itself is a highly toxic gas that can elicit numerous psychological and biological reactions in the 0 to 20 ppm range. As with any chemical, all organ systems respond variably to different levels of hydrogen sulfide, with no given level affecting all systems equally at the same time or rate.
  - 5.9.2. In general, single, or repeated exposures of 'normal, healthy adults' to hydrogen sulfide in the 0 to 5 ppm range have not resulted in clinically detectable, irreversible biological or psychological effects. The effect on hyper-susceptible individuals is not currently known.
  - 5.9.3. Although reversible adverse effects may result in temporary discomfort or changes in organ function, they have not been found to have a lasting impact to date.
  - 5.9.4. Certain factors may increase susceptibility of humans to hydrogen sulfide, although scientific evidence is not strong. These include the use of alcohol; age, as in the case of the very young, the elderly or infirm; and pre-existing cardiovascular disease.
  - 5.9.5. Health effects of Hydrogen Sulfide include, throat and eye irritation/inflammation, headache, cough and nausea, loss of sense, blistering, central nervous system weakness, difficulty breathing, unconsciousness and death. H<sub>2</sub>S is an irritant and a chemical asphyxiant with regards to oxygen utilization and the central nervous system. High concentrations may cause death. Chronic exposure to low doses of H<sub>2</sub>S may lead to high blood pressure, chronic headaches, nausea, and sleep disorders.
- 5.10. Emergency Response
  - 5.10.1. Develop a specific contingency/emergency plan for the worksite.
  - 5.10.2. Designate workers for emergency response activities. Employees must be trained in site-specific contingency/emergency plans including evacuation procedures.
  - 5.10.3. When alarms sound employees must don self-contained breathing apparatus (SCBA) and/or evacuate the area and not re-enter or return to work until clearances are given for re-entry. Notify or contact necessary personnel and do not return to work until clearance is given for re-entry.

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- 5.10.4. Provide these workers with the required training, personal protective equipment and other equipment needed.
- 5.10.5. Ensure two people respond to any discrete emergency alarm call-out situations involving hydrogen sulfide.
- 5.10.6. Occupational Exposure Limits
  - 5.10.6.1. Ensure workers' exposure to hydrogen sulfide is kept as low as practical and does not exceed regulatory occupational exposure limits.
  - 5.10.6.2. Ensure all the following conditions are satisfied before any person enters a facility where hydrogen sulfide may be present in concentrations that exceed regulatory occupational exposure limits.
  - 5.10.6.3. Ensure exposure limits are understood and met.
  - 5.10.6.4. Display appropriate warning signs at each main door on buildings that are not equipped with hydrogen sulfide monitoring/alarm equipment.
  - 5.10.6.5. Be aware of operating activities that could increase the potential for occupational exposure limits.

## 6. Procedure

### 6.1. Confined Space Procedure

- 6.1.1. When entering vessels or tanks workers shall use an air supplied respirator in conjunction with a portable hand-held H2S monitor to determine H2S concentrations at the thief hatch. A personal, single gas H2S monitor shall also be worn clipped to the collar or in a breast pocket to measure breathing zone concentrations. Additionally, when workers work on tanks with external floating roofs, they shall assure all the requirements of the Confined Space Entry policy are met before the tank may be entered. The tank mixer shall be off, and no flow may be allowed into or out of the tank for at least two hours prior to entry onto tank roof. The inlet valve to the tank shall be closed.
- 6.1.2. The respirator's face piece shall be donned and pressurized when opening the hatch. H2S concentration measurements are to be taken at the hatch opening using a handheld, portable monitor equipped with an H2S sensor and powered pump.
- 6.1.3. If hatch measurements are below 100 ppm, and breathing zone measurements are below 10 ppm, the face piece can be removed, and gauging and/or sampling can proceed.
- 6.1.4. If hatch measurements are below 100 ppm but breathing zone measurements are greater than 10 ppm gauging and/or sampling shall proceed while wearing the respirator face piece.
- 6.1.5. If hatch measurements are at or greater than the IDLH of 100 ppm the worker shall immediately stop the gauging/sampling and leave the area.

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## 7. Training

- 7.1. All company employees who have the potential to be exposed to hydrogen sulfide (H2S) above the occupational exposure limit (OEL) or the permissible limit (PEL) in the operation of the portable and personal gas detection equipment they are expected to use.
- 7.2. All personnel involved in operations which are in H2S mode (Level I or Level II) shall receive appropriate training, which shall include hazard awareness and practical aspects of H2S response. A key factor in maintaining levels of awareness and competence is the conduct of H2S response drills and exercises. Such drills shall be held as frequently as required to assure an adequate level of response from all personnel on site. Such drills shall be recorded and retained on site for record keeping and auditing purposes.
- 7.3. Ensure all workers hold valid H2S Certificates before entering work sites classified as hydrogen sulfide hazardous. The employer will ensure that employees are trained prior to working in H2S environments with a minimum of 3-4 hours of training. Training programs shall adhere to the ANSI/ASSE Z390.1-2017 Accepted Practices for Hydrogen Sulfide (H2S) Training Programs. Employees are required to refresh training annually.
- 7.4. Conduct regular training sessions in the use and maintenance of breathing apparatus, monitoring/detection equipment and ventilation systems.
- 7.5. Train workers on the safe work procedures developed by your company.
- 7.6. Ensure employees are aware of all locations where they may be exposed to H2S during their job function.
- 7.7. Employees shall be trained in the Emergency Action Plan for H2S.
- 7.8. Employees shall be trained in the operation and maintenance of the portable and gas detection equipment they are expected to use.
- 7.9. Employees will receive training in how to bump test the portable and personal gas detection equipment they are expected to use.
- 7.10. Employees will receive training on how to calibrate the portable and personal gas detection equipment they are expected to use.
- 7.11. Employees shall be trained in the required elements of OSHA's respiratory protection standard, 29CFR 1910.134, to include medical evaluations fit testing and selected respirator training.

## 8. Recordkeeping

- 8.1. Training - All training shall be documented.
- 8.2. Reports – All Hydrogen Sulfide related events shall be reported.
- 8.3. Incident Report - All Hydrogen Sulfide exposure shall be recorded.

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- 8.4. Near Miss Reports - Failures in containment, control methods, isolation, etc., not resulting in employee exposure, but would have resulted in employee exposure if an employee had been in the immediate area shall be record as near miss events on a Near Miss Report.
- 8.5. Control & Retention – Records associated with this program shall be managed in the following manner. H2S incidents shall be managed per the Incident Reporting and Record Keeping Program. Records shall be retained for a minimum of the employee’s duration of employment plus 30 years.

**9. Reference**

- 9.1. OSHA 29 CFR 1910.1000
- 9.2. OSHA 29 CFR 1910.119
- 9.3. ANSI/ASSE Z390.1-2017