Hydrogen Sulfide Program
Revision 6 – April, 2015 - Reviewed: April, 2015

1.0 Introduction. Hydrogen Sulfide or sour gas (H₂S) 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, such as well-heads, oil tanks, water tanks, or gas and oil sampling ports. For more information see Appendix C.

Flaring operations associated with H₂S production will generate Sulfur Dioxide (SO₂), 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.

2.0 Purpose. This Program provides Jacam personnel with the procedures to ensure the safety and health of those employees working in environments in which they may have a risk of being exposed to Hydrogen Sulfide (H₂S).

3.0 Scope. This Program applies to all Jacam employees, who work in environments in which they have a risk of being exposed to Hydrogen Sulfide (H₂S), or other dangerous gases.

4.0 Responsibilities.

4.2 Safety Manager. The HSE Manager is responsible for developing and maintaining Jacam’s Hydrogen Sulfide Program. The Program is available for review and is kept at the HSE office in Sterling.

4.3 Area Manager. The Area Manager will provide training to individuals requiring training at the request of the HSE Manager. Training may be conducted by others with the HSE Manager’s prior approval.

4.4 Employees. All employees are required to attend training before entering any area in which H₂S concentrations are known or suspected to exist. Employees are also required to follow other procedures listed under the next section.

5.0 Procedure.

5.2 No Jacam employee is permitted to enter an area where H₂S exists or is suspected to exist without prior and current H₂S training by a qualified instructor. Training is good for one year or per customer requirements.

5.3 All Jacam employees are required to wear a personal hydrogen sulfide monitor with audible and visual alarms when on location. Alarms will be set at 10 and 15 ppm. Employees will leave areas in which the H₂S concentration exceeds 10 PPM & don the appropriate PPE required for the amount of H₂S present (see appendix A) before resuming work. All monitors will be bump tested and calibrated pursuant to the manufacturer’s specifications or after an alarm event, (see appendix B). All bump tests & calibrations will be documented & emailed to the Jacam HSE group where the record will be retained on file by the HSE Manager.

5.4 No Jacam employee is permitted to enter any area in which the H₂S concentrations are known or suspected to be greater than 10 ppm without the appropriate PPE.
5.5 No Jacam employee will enter an H2S area until all relevant testing and training required for that level of PPE required has been completed. Example. If H2S is 20 ppm employee will not enter area until they have satisfied all the requirements of Jacam’s respiratory protection program in order to wear the full face mask and appropriate H2S cartridges.

5.6 Employees are not permitted to open any tank, line, flange, etc. which may release hydrogen sulfide to the atmosphere greater than 10 ppm without the proper PPE.

6.1 Training.
6.2 All covered employees will be trained initially and then annually in Hydrogen Sulfide operations. Training must occur before an employee is allowed to enter any area that is known or suspected to contain hydrogen sulfide. The following topics shall be covered in training at a minimum:

- The characteristics, sources, and hazards of Hydrogen Sulfide, oxygen deficiency, oxygen or nitrogen enrichment, and carbon monoxide.
- Proper use of the Hydrogen Sulfide detection methods, portable and fixed, used on the site.
- Use and operation of personal and analytical Hydrogen Sulfide monitoring systems.
- Proper donning and doffing techniques of respiratory equipment.
- Proper inspection, hook up and maintenance techniques of location provided or portable breathable air systems.
- Recognition of, and proper response to, Hydrogen Sulfide warnings and gas alarms.
- 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 and participate in emergency evacuation drills.
- Wind direction awareness and site-specific contingency/emergency plans.
- Locations and use of safety equipment.
- 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.

7.0 Recordkeeping. The HSE Manager will keep records of all training, evaluation & monitor testing.
Appendix A – PPE requirements as they pertain to known OSHA H2S values.

<table>
<thead>
<tr>
<th>H2S Concentrations (PPM)</th>
<th>Jacam requirement when obtaining samples, opening tanks, truck treating, or when customer requires.</th>
<th>OSHA Thresholds.</th>
<th>Potential result of not wearing PPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01-1.5</td>
<td>H2S monitor only</td>
<td>OSHA 8-hr limit (TWA @ 10 ppm). Ok to work at this level up to 8 hours. TWA = Time weighted average.</td>
<td>You can smell it</td>
</tr>
<tr>
<td>1.5-10</td>
<td>H2S monitor only</td>
<td>OSHA 10 minute limit (PEL @ 50 ppm) Only allowed one exposure at this level for up to 10 minutes once a day. PEL = Permissible exposure limit.</td>
<td>Possibly Fatigue, loss of appetite, dizziness</td>
</tr>
<tr>
<td>11-20</td>
<td>Full respirator mask with appropriate H2S cartridge.</td>
<td>(IDLH @ 100 ppm), IDLH = Immediate Danger to Life or Health.</td>
<td>Possibly Fatigue, loss of appetite, dizziness</td>
</tr>
<tr>
<td>21-99</td>
<td>Full respirator mask with appropriate H2S cartridge.</td>
<td>OSHA 10 minute limit (PEL @ 50 ppm) Only allowed one exposure at this level for up to 10 minutes once a day. PEL = Permissible exposure limit.</td>
<td>Possibly Fatigue, loss of appetite, dizziness</td>
</tr>
<tr>
<td>100</td>
<td>SCBA type mask with tank or alternate supplied air source. 2nd person on hand as backup. Jacam or customer designated employee.</td>
<td>OSHA 10 minute limit (PEL @ 50 ppm) Only allowed one exposure at this level for up to 10 minutes once a day. PEL = Permissible exposure limit.</td>
<td>Loss of sense of smell, altered breathing, drowsiness. Death possible.</td>
</tr>
<tr>
<td>700-1000</td>
<td>SCBA type mask with tank or alternate supplied air source. 2nd person on hand as backup. Jacam or customer designated employee.</td>
<td>(IDLH @ 100 ppm), IDLH = Immediate Danger to Life or Health.</td>
<td>Rapid unconsciousness, immediate collapse within 1-2 breaths. Death likely.</td>
</tr>
</tbody>
</table>

- Employees requiring the use of any respiratory protection equipment must satisfy the needs of Jacam’s respiratory protection program.
- All respiratory equipment needs to be inspected and maintained in accordance with manufacturers guidelines.
- Adequate controls must be in place to ensure employees without authorization do not use respiratory protection.
- Supplied air above and beyond what’s included with the SCBA must be available. Supplied air may be available by the following means:
  - On-location compressed air system.
  - Supplied Air truck coordinated through customer.
  - Supplied Air truck coordinated through local safety company such as Total Safety.
  - Jacam issued supplied air trailer. See appendix D.
Appendix B – Jacam H2S Monitor Requirements.

As of March 1, 2015 Jacam Chemicals 2013, LLC. opted to make RKI our sole provider of personal H2S gas and 4 gas monitors. Below are the RKI part numbers we purchase through Argus-Hazco and Jacam’s expectations for bump tests and calibrations.

RKI 03 Series Single Gas Monitor:  
RKI GX-2009 4 Gas Monitor:  
Pump for 4 gas Unit RP-2009

RKI Single Gas Calibration Unit SDM03-01  
RKI 4 Gas Calibration Unit SDM2009-01

Calibration guidelines:  Calibration of the single and 4 gas monitors quarterly per the manufactures instructions.

Bump Testing: Bump test units weekly.  ** Or if a unit alarms for any reason, the unit must be bump tested prior to going back in the field.** Sensors can be overwhelmed and fail from high exposures, this is why bump testing prior to returning to the field is required.

Record Keeping: The calibration unit retains records by serial #. Please retain records locally and email to the HSE office for record. Your Regional Support Coordinator can assist in training on this topic.
Appendix C - Physical Properties, Exposure limits & Physiological Effects of Hydrogen Sulfide

A.1 Physical Data

- Chemical Name: Hydrogen Sulfide
- CAS Number: 7783-06-4
- Synonyms: Sulfurated hydrogen, hydrosulfuric acid, dihydrogen sulfide
- Chemical Family: Inorganic sulfide
- Chemical Formula: H₂S
- 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: 500º F
- Boiling Point: -76º F
- Melting Point: -117.2º 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 (SO₂). 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

- OSHA permits work done in H₂S areas of 10 ppm or less during an 8 hour day based on a time weighted average (TWA).
- The Permissible Exposure Limit (PEL) is an H₂S exposure up to 50 ppm up to 10 minutes in duration once during the work day. Once the PEL has been exceeded, the employee is not authorized to work in a H₂S environment without PPE until the next day.
- OSHA states that immediate danger to life and or health (IDLH) of H₂S starts at 100 ppm. Inhalation at certain concentrations can lead to injury or death.
- Death is considered likely to occur within 1-2 breaths at concentrations above 700 ppm.

A.3 Physiological Effects

In extremely low concentrations, H₂S sometimes can be detectable by its characteristic odor; however, the smell cannot be relied upon because it rapidly paralyzes the sense of smell due to paralysis of the olfactory nerve.

Starting at very low concentrations, H₂S can cause nausea, dizziness & vertigo. Employees should stop work and leave the area if these symptoms occur as a severe fall or injury is more likely to occur.

At higher concentrations, H₂S can cause extreme energy loss or paralysis, making leaving the area or communicating almost impossible. Repeated exposures to H₂S are likely to cause adverse reactions at low H₂S exposure in the future.

A.4 Respiratory Protection

Respiratory protection shall be worn above the action level of 10 ppm. Refer to the Respiratory Program for proper breathing equipment recommendations for oil and gas well drilling and servicing operations involving hydrogen sulfide or other dangerous gases.
APPENDIX D – Facial Hair Chart

The shaded portions are your respirator seal areas. Facial hair is NOT PERMITTED on these portions of the face.

**UNACCEPTABLE**
- FULL BEARD
- GOATEE & NARROW MUSTACHE
- GOATEE & WIDE MUSTACHE

**ACCEPTABLE**
- EXTENDED SIDE BURNS
- FU MANCHU MUSTACHE
- WIDE MUSTACHE
- CLEAN SHAVEN
- NARROW MUSTACHE
APPENDIX E Jacam supplied air trailer options

- 2 man supplied air system on trailer.
- Holds approximately 5 full working days of air.
- Takes approximately 24 hours to refill.
- Approximate cost including trailer $12,000.
- Design recommended by Chesapeake.

- 2 man supplied air system on trailer.
- Holds approximately one days’ worth of air.
- Short refill time.
- Approximate cost including trailer $4,000.
- Truck bed installed for approximately $2,000.
- Design required by SandRidge.
- Built by Total Safety.