Hydrogen Sulphide Awareness

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What is Hydrogen Sulphide Gas (H₂S)?
Hydrogen Sulphide (H₂S) is a gas found in a variety of geological formations and is a result of decomposing biological material such as animal manure in the absence of oxygen (anaerobic).

Decomposition takes place immediately after it is excreted by the animal and occurs in the presence or absence of oxygen.

Hydrogen sulphide is the most dangerous of the gases and is often referred to as manure gas.

Formation of Hydrogen Sulphide
The compound sulphur is present in manure in 6 of the 15 essential amino acids that are required for the development of protein.

<table>
<thead>
<tr>
<th>Mineral Contents, %</th>
<th>Calcium</th>
<th>Phosphorus</th>
<th>Sulphur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td>.08</td>
<td>.40</td>
<td>.15</td>
</tr>
<tr>
<td>Soybean Meal</td>
<td>.25</td>
<td>.60</td>
<td>.40</td>
</tr>
<tr>
<td>Meat meal</td>
<td>8.0</td>
<td>4.0</td>
<td>.50</td>
</tr>
</tbody>
</table>

Decomposing animal manure gives off hydrogen sulphide gas, ammonia, carbon dioxide and methane. In the decomposition process, microorganisms use the manure to synthesize new cellular material and to create energy for synthesis. Oxygen is not required for this process to take place. The process is continuous and begins as soon as the animal excretes manure.

H₂S is different from other gas as it does not bubble off, but rather sticks on the edge of the manure and continues to build up in an anaerobic situation. When the manure is agitated, hydrogen sulphide is released from its attached position on the manure. The longer the manure sits idle, the more the hydrogen sulphide will build up, ready to be released.

Most manure storage systems are not constantly agitated so when the manure is relatively undisturbed, rate of gas release is slow.

In a liquid manure system, water keeps air out and maintains an anaerobic situation.

Agitation of Manure Occurs in the barn when?
1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
Locations of Manure and Consequently $\text{H}_2\text{S}$ in a Hog Operation
- Shallow barn gutters
- Underground storage tanks or outside holding storage tanks
- Earthen manure storage facilities

Properties of $\text{H}_2\text{S}$ gas

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Physical State:</td>
<td>Colourless gas</td>
</tr>
</tbody>
</table>
| 2. Odour: | Smells like “rotten eggs”  
Dulls the sense of smell at relatively low concentrations |
| 3. Vapour Density: | Slightly heavier than air ($\text{H}_2\text{S}$ is 1.19 compared to 1.0 for air)  
The surrounding atmospheric conditions (temperature and vapour density) can affect the level of the gas  
It may flow or settle into low-lying areas, such as manure pits, shallow gutters and natural depressions surrounding Earthen Manure Storage (manure tanks/wagons) |
| 4. Flammability: | Requires high concentrations to be flammable (43,000 ppm) |
| 5. Solubility: | Dissolves in water  
$\text{H}_2\text{S}$ is released when agitated |
| 6. Corrosiveness | Reacts to form metal sulphides |

It is highly unlikely that a burning cigarette tossed into a pit will ignite $\text{H}_2\text{S}$ because there would not be a sufficient concentration of gas (43,000 ppm). Beware: concentrations of $\text{H}_2\text{S}$ can rise rapidly during agitation.
Effects of H₂S on Humans

H₂S enters the body through the lungs. It dissolves in the blood and is carried throughout the body in the bloodstream. It affects breathing by causing the respiratory control centre in the brain to shut down. Without messages from the brain, respiration stops. Death occurs as oxygen in the blood is quickly used up, causing the heart to stop.

Short-term effects:
“Prolonged exposure at fairly low levels irritates the eyes, nose, mouth and throat, causes light sensitivity, eyelid spasms and sneezing. Giddiness, nervousness, depression, loss of appetite or energy may follow. Fluid in the lungs or pneumonia also will occur.”

Pulmonary edema (fluid in the lungs) can develop after H₂S exposure. Anyone knocked down by H₂S must be examined by a doctor immediately. The brain can only survive for 4 - 6 minutes without a continuous supply of oxygen.

Effects of Long-Term (Chronic) Exposure:
“Whether or not long-term poisoning by H₂S occurs is controversial. The disagreement centres on the nature of the symptoms, which include fatigue, headache, dizziness, hoarseness, cough and irritability. These symptoms are not specific to H₂S exposure and could be due to a number of other causes.” (Canadian Centre for Occupational Health and Safety)

Effects of H₂S on Pigs

<table>
<thead>
<tr>
<th>Take Home Message:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effects of H₂S on Swine</td>
</tr>
<tr>
<td>The affects of H₂S exposure on swine can be observed as follows:</td>
</tr>
<tr>
<td>➢ 100 ppm causes severe distress, eye irritation and drooling</td>
</tr>
<tr>
<td>➢ 250 ppm causes cyanosis, convulsions and death</td>
</tr>
</tbody>
</table>

Occupational Exposure Limits (OEL) to H₂S gas
Scales for measuring H₂S:
1. Percentage: is given as a percentage of a million.
   (eg. 2.5% is 25,000 ppm)
2. Parts per Million (ppm): divides the total into 1,000,000 parts.
## Exposure Limits

<table>
<thead>
<tr>
<th>H₂S Exposure Levels</th>
<th>Expected Effect or Symptom</th>
</tr>
</thead>
</table>
| 0.13 ppm – 30 ppm (10ppm is workplace 8 hour contamination limit) | ➢ Eye irritation  
➢ Odor is obvious and unpleasant |
| 50 ppm | ➢ Dryness and irritation of the nose and throat  
➢ Prolonged exposure may cause a runny nose, cough, hoarseness, shortness of breath and pneumonia |
| 100 – 150 ppm | ➢ Temporary loss of smell  
➢ Immediately dangerous to life and health (IDLH)  
➢ Gas seems odourless due to loss of smell |
| 200 – 250 ppm | ➢ Severe irritation, headache, nausea, vomiting and dizziness  
➢ Prolonged exposure may cause lung damage (fluid)  
➢ Exposure of 4 – 8 hours can cause death |
| 300 – 500 ppm | ➢ Same symptoms as above but sooner and more severe  
➢ Death can occur in 1 – 4 hours |
| 500 ppm | ➢ Excitement, headache, dizziness, staggering, unconsciousness and respiratory failure occurs in 5 min to 1 hour  
➢ Death can occur in 30 min to 1 hour |
| 500 ppm + | ➢ Causes unconsciousness and death.  
➢ Severe exposures that do not result in death may cause long-term symptoms such as memory loss, paralysis of facial muscles or nerve tissue damage |
| 600 ppm + | ➢ One or two breaths of air with as little as 600 ppm can cause a person to lose consciousness  
➢ Continued exposure can kill |

The established immediate danger to life and death (IDLH) level for H₂S is 100ppm.
Occupational Health and Safety Act and Regulations

**Act**
Section 18
An employer shall ensure that each worker:
- A. Is informed of the provisions of the Act and any regulations pursuant to this Act that apply to the worker’s work at the place of employment; and
- B. Complies with the Act and those regulations.

**Table 2**

<table>
<thead>
<tr>
<th>Contamination Limits</th>
<th>8 hour average Contamination Limit mg/m³</th>
<th>15 minute average Contamination Limit mg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen Sulphide</td>
<td>14 (10ppm)</td>
<td>21 (14ppm)</td>
</tr>
</tbody>
</table>

**Regulations**

Chemical and Biological Substances
- Regulations #302 – 314

Ventilation
- Regulations #65 – 67

Self Contained Breathing Apparatus
- Regulations #86, 87, 88, 89, 90, 97, 99

Confined Space
- Regulations #266 – 275

Right to Refuse Dangerous Work
- Act 0-1.1, Part 1V, 23

* Milligram of substance per cubic metre of air

Every employer is responsible for ensuring each worker is informed of the provisions set out in the Occupational Health and Safety Act.
Liquid Manure Management

Hazards of handling liquid manure

General
- $\text{H}_2\text{S}$ gas is formed without oxygen in a manure storage site
- $\text{H}_2\text{S}$ builds up in confined spaces
- $\text{H}_2\text{S}$ is released when agitation of the manure occurs
- Temperature affects the amount of $\text{H}_2\text{S}$ being produced
- Proper handling of liquid manure is critical. Rapid agitation or surface agitation of the manure will release large amounts of $\text{H}_2\text{S}$. During agitation, levels can soar from 5 ppm to over 500 ppm in seconds

Pulling Pits
- High manure levels bring the concentration of $\text{H}_2\text{S}$ gas higher within the pit or the room
- Maintain adequate ventilation (fans on full) especially if the manure is being agitated. High toxic gases can accumulate rapidly even with the ventilation system operating
- Never bend over and lean into a pit to retrieve an item dropped accidentally – empty or full
- If possible remove animals from the room when draining pits
- Always allow at least one foot of space between the slats and the manure level of the pit. Pigs lying on slats could be overcome by accumulating gases.

Pumping manure at a lift station
- Never enter a confined space to fix something without following the Standard Operating Procedure. Refer to Occupational Health & Safety Regulations. Reg Sec. 266-275

Lagoon Management
- Windless days increase the potential for localized pockets of $\text{H}_2\text{S}$ during agitation of lagoons
- Trees
- Fences
- Narrow berms
- Weed control

Before considering any deviation from Standard Operating Procedures, stop and reassess the risk. Consult with your barn supervisor.
Hazardous Locations in the Barn

1. In-barn shallow gutters
2. Gutters are not deep, but if a worker’s head is below the level of the floor, there is a danger
3. Danger increases if the barn fans are not blowing sufficient air to keep concentrations of $\text{H}_2\text{S}$ at safe levels
4. When the manure is disturbed, $\text{H}_2\text{S}$ can be released into the air in high concentrations
5. In-barn shallow gutters are safer than in-barn deep pits because less manure is stored inside the barn. Further decrease of the hazard is obtained by draining the gutters more often

In-barn deep manure pits

- In-barn deep manure pits can be very hazardous because large quantities of manure can be stored inside the barn. Pumping out the pits more often can decrease the hazard.
- Manure should not sit in the pit for more than 3 weeks
- Before starting to agitate manure in pits, ensure all workers are out of the barn, windows and doors are open and the fans are set on high. Proper ventilation is essential to keep concentrations of manure gases at safe levels.
- Agitate manure very slowly, increasing speed gradually. Use little agitation as possible.
- A worker must not go into a pit or gutter. If his head is below floor level, he is placing himself at even greater risk.

Take Home Message:

- Proper pit management can significantly reduce the risk associated with $\text{H}_2\text{S}$ in swine production units.
- Standard operating procedures need to be established regarding the handling of manure throughout the production system.
- Emergency plans should be included in the Standard Operating Procedure.
- Ensure regular maintenance is carried out on all manure handling equipment.
Outside holding storage tanks

- Agitation or the transfer of manure can result in sudden releases of H₂S
- Work in a tank to unplug a line must be treated as hazardous confined space entry (See OH&S Reg. 266-274)
- Automation of the system is considered the safest process

Outside earthen manure storage

- Agitation of the earthen manure storage prior to pumping releases H₂S gas
- Pockets of gas may form around the mixer during agitation

Spreader tanks

- The danger of H₂S in spreader tanks is often greater than that of a liquid manure pit
- No one should ever enter a spreader tank without a self-contained breathing apparatus and a lifeline that is attached to a mechanical winch on the outside
- The most common type of self-contained breathing apparatus for entering tanks or other confined spaces is a full-face piece air supplied respirator with an escape bottle. The air is supplied to the respirator from a large tank of breathing air located outside the confined space. Workers performing this task must be fully trained in wearing and using a self-contained breathing apparatus.
Hydrogen Sulphide Awareness

Be Prepared – Save a Life

1. Evacuate the area
2. Issue an alarm
3. Assess the situation and decide what action to take
4. Protect yourself by putting on breathing apparatus
5. Rescue the Individual
6. Revive the individual using rescue breathing and/or CPR
7. Get medical aid for the individual
Proper Rescue Techniques Associated with a H₂S Situation

Collar Drag
Place the victim on his back, roll up the collar to get a firm grip, support his head on your forearms and pull the victim to safety.

Note: Employee is wearing a dust mask. This mask is NOT protection from the hazards of H₂S gas.

Two-Arm Drag
Place the victim on his back; lift him into a sitting position supporting his head and neck (Figure 1). Place your arms under his armpits, grab his wrists and drag him to safety (Figure 2).
Figure 2

Figure 3
Two-Person Carry
Place the victim on his back with one rescuer supporting the neck and head while the other rescuer goes to the victim’s feet. The rescuer at the victim’s feet crosses the victim’s leg over the other. The first rescuer places his arms under the victim’s armpits and grabs the victim’s wrists. The rescuers lift the victim evenly and carry him to a predetermined safe area.
Rescue Breathing
If the victim is not breathing, artificial respiration must be administered immediately.

Steps in rescue breathing

✓ Determine responsiveness

✓ Open the airway
  Tilt head and lift chin
  Look for the chest and stomach to rise and fall
  Listen for the sound of breathing
  Feel for the victim’s breath on your cheek
  If the victim is breathing, place him in the recovery position

✓ Give two slow breaths
  Allow 1.5 to 2 seconds per breath
  Watch for the chest to rise
  Allow for exhalation between breaths
  If the victim is breathing, place him in the recovery position

✓ Check carotid pulse
  Allow 5 to 10 seconds to check pulse
  If the victim is not breathing, but there is a pulse, continue rescue breathing
  Give 1 breath every 5 seconds at a rate of 12 per minute. If you are trained in CPR, administer CPR to the victim if he/she has no pulse

Recovery Position
Detection of Hydrogen Sulphide gas

Detector Tube Devices

Detector tube devices are used to measure the amount of gas in a room at one point in time. Detector tubes are made to measure different concentrations of gas in either percentages or ppm.

First break both ends of the detection tube. Then a sample of air is drawn into the tube either by a piston-type unit or a bellows-type unit. The pump or the bellows creates a vacuum through which air is drawn into the tube. The gas discolours the tube and a reading can be taken.

The accuracy of the tubes will vary depending on type and make. To improve the accuracy of the reading, make sure that the tubes have not expired and that the unit is in good condition to ensure air tightness. Tubes should be stored in a cool dark place. Test the unit as per manufacturer’s instructions.

Operation of the unit (Follow the manufacturer’s instructions):

Break both ends of the tube.
Insert the tube into the pump inlet with the arrow pointing toward you.
Place the unit in the area to be tested.
Pump the number of strokes required.
Read the H$_2$S concentration.

Extension hoses are available for the piston-type that allow samples to be taken at a distance. It is important not to enter a potentially contaminated area just to take a sample. The detector tube is located at the far end of the extension hose on the pump. Don’t attach any hose to the inlet of the tube.

Electronic Monitors

Electronic monitors give a continuous reading of gas concentration levels. These monitors are either portable units worn by the employee or fixed monitors which are mounted and have sensors situated throughout the room. An alarm goes off when H$_2$S concentrations reach a certain level. Units must be tested and calibrated regularly by following the manufacturer’s instructions.

Respiratory Protective Equipment

- Self-contained breathing apparatus (SCBA)
A SCBA contains its own air cylinder that is filled with of compressed air. Most units are made to contain 30 minutes of air. The air cylinder is attached to the operator by a harness. The operator wears a facemask attached to the regulator that regulates the flow of air from the air cylinder to the face piece. When using a SCBA remember to breathe normally.
Case Studies
Case Study #1

Situation
1. Manure pump had been plugged previously with solids, so the holding tank was
   being re-circulated with the main pump to mix solids and liquids together to be
   pumped to the lagoon.
2. Floor was wet with liquid manure from uncoupling piping previously.
3. The pump was stopped from outside the shed because the inside controls are
   inoperable.
4. Shed was entered immediately after stopping the pump and an attempt was made to
   connect the pump’s hose to the lagoon line. This was unsuccessful because the
   worker’s hands began to quiver.
5. He immediately stepped around the tank hole and tried to plug in the exhaust fan to
   the extension cord. His hands were still trembling, but he succeeded in plugging in
   the fan. He then noticed that the other end of the extension cord was unplugged.
6. He took two large breaths from inside the fan housing. Stepped around the tank
   hole, grabbed the other end of the extension cord, reached up to plug into the
   overhead plug-in. Hands were trembling too much. Breathing was out of control,
   very fast but shallow.
7. He then tried to run out the open door, thought that he had made it outside, passed
   out and fell down with head hanging partly over the edge of tank hole.
8. When he gained consciousness he was very disoriented and confused. He got out
   of the manure shed and stumbled around outside and fell a number of times. Lost
   consciousness again outside. Regained consciousness and made it into the barn
   where he received help.

Answer the following:

1. What do you estimate the ppm to be when the worker’s hand began to quiver?
2. List the possible causes of this incident.
3. What did he do wrong?
4. Develop procedures to ensure that a similar incident does not re-occur.
Case Study #2

Situation
1. Four men proceeded to unplug a sewage pipe leading from the hog barns into a sewage pit. The pit is approximately 4’x4’ at the opening and 16’ in depth.
2. The first man proceeded down the fixed metal ladder in the sewage pit. He was then handed a water hose from the two men at the top of the pit. The hose is equipped with a special nozzle that forces its way through the pipes and unplugs them. The fourth man was asked to go and get a water truck from one of the barns.
3. When he returned about 15 minutes later all 3 men were gone. He spent an hour searching around the yard for them before he proceeded to get help.
4. The 3 men were found dead in the sewage pit.

Answer the following:

1. List the possible causes of this incident.

2. Develop procedures to ensure that a similar incident does not re-occur.
Case Study #3

Situation

1. A worker had just pulled a pit plug, with the intention to stay near the plug as there were hogs in the room.
2. As soon as she pulled the plug she noticed that instead of the liquid flowing down the pipe smoothly there was a gurgling up of bubbles. She bent down to get a closer look.
3. She and 3 nearby hogs were knocked down.
4. A co-worker happened to be in the room at the same time and witnessed the incident. The co-worker closed the plug and moved the knocked-down worker and the hogs.

Answer the following:

1. List the possible causes of this incident.

2. What protective measures should the rescuing employer have taken?

3. Develop procedures to ensure that a similar incident does not re-occur.
Case Study #4

Situation
1. A worker pulled the pit plug in a nursery room when the manure level was at slat height. The worker left the room while the pit was to drain completely.
2. The pit plug in the next nursery room was removed and the level was also at slat height. The worker left the room to attend to another task.
3. Worker returned 10 minutes later and noticed that 2 nursery pigs in a pen adjacent to the plug were in distress. Within seconds other piglets began to succumb.

Answer the following:

1. List the possible causes of this incident.

2. Develop procedures to ensure that a similar incident does not re-occur.
Case Study #5

Situation
1. While pulling the plug on a pit, a worker began to lose his breath and feel dizzy.
2. After moving into the fresh air, he felt better and continued to work.
3. He identified the smell of rotten eggs and felt that the smell came out of the line, not from the pit.

Answer the following:

1. What do you estimate the ppm to be?

2. List the possible causes of this incident.

3. Develop procedures to ensure that a similar incident does not re-occur.
Contraventions
Contravention #1

Officer observed that a small pump room had been erected over the liquid manure collection pit. This pump room is connected to the barn and the access door to the barn is normally kept open. Employees must enter the pump room to start the pump that empties the pit.

During inspection of the facility and while employees were draining gutters, the officer took air samples inside the pump room. The air samples showed concentrations of hydrogen sulphide above 75 ppm. The 8-hour contamination limit for $H_2S$ set out in Table 21 of the Regulations is 14 mg/m$^3$ or 10 ppm.

This contravenes section 307 of the Occupational Health and Safety Regulations 1996.

To comply with the regulations the employer shall:
- Develop and implement written procedures that will ensure employee safety when draining gutters and pumping the pit.
- Evaluate the design of the mechanical ventilation system and make changes necessary to prevent the accumulation of contaminants in the place of employment.

Note: Officer observed a dangerous occurrence at this place of employment. The employer must now take corrective action that will prevent reoccurrence. Corrective action involves the implementation of short and long-term controls.

- **Short-term controls**, in this case, would be the implementation of procedures to enable the potentially hazardous tasks to be performed safely without modifying the existing ventilation system. The main advantage of procedures is they can be developed and implemented quickly and at a low cost. The main disadvantage is that the root cause of the problem still exists. If the procedures are not followed the hazardous condition will return.

- **Long-term controls**, in this case, would be the installation of an exhaust fan. The exhaust fan would draw air from the manure pit and maintain a negative static pressure in the pit. This would prevent manure gases, including $H_2S$, from entering the pump room. This action would provide a permanent long-term solution by removing the root cause of the hazard.

Obviously the best solution is to remove the hazard by installing an exhaust fan. However, in some cases, the employer may be given a choice and allowed to control the hazard by implementing adequate safe operating procedures. In every case, the employer must show that he has done everything reasonably practicable to protect the health and safety of his employees.
**Contravention #2**

Officer formed the opinion that the employer does not have a system in place that will ensure the adequate ventilation of place of employment.

This contravenes section 65 of the Occupational Health and Safety Regulations 1996.

**Ventilation and air supply**

65 An employer, contractor or owner shall:

(a) ensure the adequate ventilation of a place of employment; and
(b) to the extent that is reasonably practicable, render harmless and inoffensive, and prevent the accumulation of, any contaminants or impurities in the air by providing an adequate supply of clean and wholesome air and maintaining its circulation throughout the place of employment.

To comply with the regulations the employer shall:

- Evaluate the design of the mechanical ventilation system and make changes necessary to prevent the accumulation of contaminants in the place of employment.
- Develop and implement written procedures suitable to ensure the proper operation of the mechanical ventilation system.

Develop and implement written procedures for the scheduled inspection, maintenance and cleaning of the mechanical ventilation system.
Contravention #3

During a routine inspection of a facility, an officer became aware that a dangerous occurrence involving the knock down of 2 employees had taken place. Information gathered by officers indicates that escape of toxic fumes from natural gas water heaters and direct fired unit heaters coupled with the failure of ventilation system may have caused the knock down. Incident was of a type that may have caused the death of a worker. Incident occurred 3 weeks prior to inspection and had not been reported to OH&S.

This contravenes section 9 & 31 of the Occupational Health and Safety Regulations 1996.

To comply with regulations the employer shall:
- Provide a written report to the division indicating date, time, location and circumstances related to the dangerous occurrence as outlined in section 9 of the regulations.
- Do an accident investigation and provide a written report to the division as outlined in section 31 of the regulations.
  - The attached “Accident Report Form” shall be completed and returned by (date) Report will include:
    - Description of the dangerous occurrence;
    - Any graphics, photographs or other evidence that may assist in determining the cause or causes of the dangerous occurrence;
    - An explanation of the cause or causes of the dangerous occurrence;
    - The immediate corrective action taken; and
    - Any long-term action that will be taken to prevent the occurrence of a similar dangerous occurrence or the reasons for not taking action
Contravention #4

During inspection of the facility:

1) I observed that there is one liquid manure collection pit for the entire site, located outside the barn. Employees are required to pull drain plugs inside the barns to empty individual shallow manure pits. A 12-inch main sewer line runs from the pull plug system inside the barn, to the outside pit.
   a) I observed that the main sewer line enters the manure collection pit above the liquid level and is not air locked to prevent the transfer of H$_2$S and other sewer gases into the barn. The regular agitation of liquid manure by submersible pump will constantly release H$_2$S gas into the dead air space above the liquid in the collection pit. The collection pit is sealed and unventilated. Over time, high concentrations of H$_2$S gas will build up in the dead air space in the manure collection pit.
   b) I observed that exhaust fans must maintain a negative static pressure inside barns for the ventilation system to operate properly.
   c) I concluded that employees pulling and replacing drain plugs are performing a very hazardous procedure. When pulling plugs employees must take care to ensure that shallow pits are never allowed to drain completely empty. If the inside pits are empty when the drain plug is pulled, the H$_2$S gas in the collection pit will be drawn into the barn by the ventilation system. The employee pulling or replacing the plug will be positioned directly over the drain and be directly exposed to the stream of H$_2$S gas as it enters the barn.
   d) I observed that there is no written procedure in place for the employees to follow when pulling plugs. Employees sometimes work alone and are not fully aware of the hazards associated with pulling plugs.
   e) I recommend:
      i) The employer develops procedures for informing, instructing and training employees who are required to pull drain plugs.
      ii) The employer develops procedures to facilitate the rescue of employees knocked down by H$_2$S gas inside the barn.
      iii) The employer air lock the main sewer line to prevent the transfer of H$_2$S and other sewer gases into the barn.

2) I observed that this facility was very clean and well maintained.
   a) Floors, passages, storage rooms, maintenance rooms and electrical rooms were clean and free of clutter.
   b) Dead animals were removed daily and stored off-site. Saskatoon processors pick up deads weekly.
   c) MSDS sheets were updated and posted for reference by workers.
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