IT’S A DAY LIKE ANY OTHER ON THE DAIRY. Morning milking is done, and you’re emptying the manure reception pit. Your nephew told you that new parts for the pump arrived yesterday, and he plans to haul the pump out and work on it in the afternoon. But while he’s cleaning the parlor, the pump clogs when the pit is nearly empty. You decide not to wait.

You’re not worried about entering the pit, even with no one around. You’ve done it many times before with no problem. But today is different.

As you climb down the ladder, your chest feels heavy. You’ve entered a confined space where there is no ventilation. You get to the bottom of the pit and take a few steps toward the pump, but you can’t remember what you came down to do. You stop to think. Your eyes start to burn and tears stream down your cheeks. You’re panting and can’t seem to take a deep breath. You’re only vaguely aware that there’s a problem. In another minute, you’re unconscious.

Three things save you. Your nephew walks past the pit and sees you lying face up. He knows that victims of manure gas are often would-be rescuers who rapidly succumb to asphyxiation, sometimes in quick succession. He doesn’t attempt a rescue but calls 911.

When you wake up later in the emergency room, you remember only sketchy details about what nearly killed you. Severe injury and death from exposure to manure gas isn’t a common occurrence on dairies. But even one death or one survivor with permanent lung damage or, in the worst cases, brain damage, is too many – especially when it can be prevented.

**What’s in manure gas?**

Some microorganisms that live in manure pits and other

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For information and training materials for emergency responders, contact the Cornell Farmedic Training Program at (800) 437-6010. Website: www.farmedic.com

Access OSHA Part 1928 Occupational Safety and Health Standards for Agriculture at this website: www.osha.gov/pls/osohweb/owadisp.display_standard_group?p_toc_level=1&p_part_number=1928


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oxygen-deficient environments can break down manure and produce manure gas, which contains carbon dioxide, methane, hydrogen sulfide and ammonia. All of these gases are colorless. (See Table 1 for other important properties and hazards.)

<table>
<thead>
<tr>
<th>Gas</th>
<th>Odor</th>
<th>Weight Compared to Air</th>
<th>Hazards</th>
<th>OSHA Permissible Exposure Limit (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen Sulfide</td>
<td>Rotten egg smell at low concentrations but deadens sense of smell above 150 ppm</td>
<td>Heavier</td>
<td>• Displaces oxygen</td>
<td>5,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Displaces oxygen</td>
<td>No limit listed</td>
</tr>
<tr>
<td>Ammonia</td>
<td>Pungent</td>
<td>Lighter</td>
<td>• Poisonous</td>
<td>20^3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Paralysis of diaphragm with first breath at 1,000 ppm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Explosive</td>
<td>50</td>
</tr>
<tr>
<td>Methane</td>
<td>No smell</td>
<td>Lighter</td>
<td>• Irritation of eyes and respirator tract</td>
<td></td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>No smell</td>
<td>Heavier</td>
<td>• Flammable</td>
<td></td>
</tr>
</tbody>
</table>

The air contaminant limits shown in this table are derived from 29 CFR 1910.1000, OSHA's standard on air contaminants. This standard covers general industry and the construction industry, but it has not been extended to cover agriculture. This information is provided for advisory purposes only.

1The OSHA permissible exposure limit is the concentration in air that is considered safe for human exposure during an eight-hour day and a 40-hour workweek, for a work lifetime.

2Neither OSHA, NIOSH, nor the ACGIH has established exposure limits nor limits “immediately dangerous to life and health” for methane, as it is biologically inert and produces its effects by causing asphyxiation as a result of oxygen deprivation. The concentration of available oxygen is the limiting factor.

3This is a ceiling value and is the maximum exposure allowed over an eight-hour shift; except that a person can be exposed to 50 ppm for 10 minutes only once if no other measurable exposure occurs during that eight-hour shift.

Carbon dioxide and hydrogen sulfide are both heavier than air and will tend to settle and accumulate in low, confined areas. Methane and ammonia are lighter than air and may accumulate underneath ceilings. The effects of ammonia range from irritating to corrosive; hydrogen sulfide is poisonous.

The concentration of hydrogen sulfide in manure gas is variable and can’t be predicted. Agitation and splashing release this gas from liquid manure into the atmosphere, thus its concentration in manure gas can change quickly and with little advance warning.

Hydrogen sulfide can burn the lining of the lungs in just a few breaths. Exposure to concentrations of 1,000 ppm is rapidly fatal. Eye and lung irritation occurs at 10 to 20 ppm. Hydrogen sulfide deadens the sense of smell at 150 ppm, so don’t assume the gas is gone if you can’t smell it after a few minutes.

Methane can displace all or part of the atmosphere in a confined space, and the hazards presented by such displacement vary greatly. With only 10% displacement, methane produces an atmosphere that is adequate for respiration, but can explode violently. By contrast, with 90% displacement, methane will not burn or explode, but it will asphyxiate an unprotected person within about five minutes.

Oxygen deficiency especially targets brain cells, which need 10 times the oxygen of other types of body cells. Normal air is 21% oxygen. As the level of oxygen drops below 19.5%, which is the minimum safe level, judgment and coordination become impaired. Loss of consciousness occurs at 8 to 10%, and an atmosphere of 4 to 6% oxygen is rapidly fatal.

What is a confined space?

When manure gas is produced in a confined space without ventilation, it displaces air, creating an atmosphere with insufficient oxygen to support human life. Covered manure storage and collection pits, digester tanks, covered lagoons, upright storage tanks and tanker spreaders are examples of places where manure gases can accumulate to produce a deadly atmosphere. The atmosphere can also be hazardous in an open manure pit.

The Occupational Safety and Health Administration’s (OSHA) Confined Space Standard (29 CFR 1910.146) regulates work in confined spaces. Confined spaces are those that have limited or restricted means of entry or exit, are large enough for a person to enter, and are not designed for occupancy. Confined space openings can be small and barely big enough to fit through or large like the top of some manure pits.

![Photo by Brian Aldrich](https://www.manuremanagement.cornell.edu)
When OSHA comes calling

Are you prepared for an Occupational Safety and Health Administration inspection?

By Eleanor Jacobs

The folks at Matlink Dairy were more than a little surprised when an OSHA inspector showed up. OSHA hadn’t called ahead, says Ted Mathews, managing partner of the 575-cow Clymer, N.Y., dairy. “She (the inspector) said we could ask her to leave, but she’d be back with a Marshall.”

That settled, the OSHA inspection went forward with civility. Mathews credits his cooperation and that of the dairy’s staff to avoiding a possible $10,000 fine. Instead, OSHA fined the dairy $750 for one violation.

A complaint to the Department of Labor precipitated the inspection. Though the OSHA inspector couldn’t say who filed the complaint, it was clearly a disgruntled fired employee, Mathews says. The OSHA Notice of Alleged Safety or Health Hazards cited that an employee suffered eye burns from spraying iodine as teat dip and lung irritation from sawdust bedding. Also the dairy had not conducted hazard communication training for employees.

What OSHA sees

The inspector asked to see only those areas where the employee would normally go as part of his job, explains Mike Frederickson, herd manager. That included the parlor, freestall housing and utility room. She did not look at any component of the manure handling system, which includes an anaerobic digester built in 2001. But wherever an inspector goes on a farm, “if she sees an OSHA violation, she’s bound to bring it to our attention whether or not it’s part of the complaint,” says Frederickson.

In the utility room, the inspector cited the dairy for not closing the covers on the breaker boxes and for not installing “dummy” breakers where ones were removed. The dairy had a week to correct those violations before re-inspection.

“This is an indication of the sensitivity of OSHA’s safety threshold,” Mathews says.

OSHA also cited the dairy for not having:
- A written hazard communication for employees, prompting the $750 fine.
- Hazard communication training for employees, and written proof of training.
- A copy of Material Safety Data Sheets (MSDS) for hazardous chemicals, which include everything from WD40 to Clorox.
- A log of all OSHA 300 occupational injuries and illnesses, required of businesses with more than 10 employees.

For items cited, Matlink Dairy had to develop an “abatement certification” that states what was done to correct the problem and when it was done. Vinny Howden, bookkeeper and parlor manager, spent many hours to complete these.

Changes made

The complaints that initiated OSHA’s visit to Matlink Dairy were dismissed. The dairy uses teat cups, not spray, and the sawdust wasn’t considered a hazard.

The OSHA inspection, trying as it was, produced positive results. The dairy contracted with the Cornell Agriculture Health & Safety Program for training in how to comply with OSHA’s hazard communication standard. (See FYI.) Among other changes, Howden now conducts safety training and has new employees sign a form to verify they were trained.

The OSHA inspection set off alarms for Mathews regarding the manure handling system. “I thought, are we nipping at the tip of the iceberg? What about the digester?” he says, wondering about possible hazards in the system.

Mathews arranged for a safety inspection of the manure handling system, conducted by Nellie Brown, a certified industrial hygienist and director of the Cornell Workplace Health and Safety Program, and Curt Gooch, PRO-DAIRY agriculture engineer.

Safety walkthrough

Brown assessed each component of the manure handling system from alley cleaning to collection, digestion, separation and distribution of the final products – solids, liquids and biogas. She evaluated the tasks related to every phase and interviewed employees on those jobs. She assessed the ramifications of system failure or vandalism, making it possible to develop risk management strategies, Brown says.

Two issues related to Matlink’s manure system stood out in her evaluation:

- Confined space. “It’s a maintenance task issue,” Brown
Manure gas can be deadly from page 16
to confirm:

- There is adequate oxygen – over 19.5%.
- Methane levels are not potentially explosive.
- Hydrogen sulfide levels do not exceed 20 parts per million (ppm). Note that in some confined spaces, hydrogen sulfide levels may remain high regardless of how much the area is ventilated.

Portable air testing equipment is affordable and easy to use.

3. Provide powered, continuous fresh-air ventilation with an explosion-proof blower and hose to turn over the air before and during entry. If air testing indicates a level of methane above the lower explosive limit, keep all ignition sources – smoking, radios, sparking tools, etc. – far away from the pit while ventilating.

4. Wear a self-contained breathing apparatus (SCBA) or a supplied-air respirator as an alternative to ventilating a confined space. Note that air-purifying respirators (those with cartridges) or disposable dust masks will not protect you from oxygen deficiency or hydrogen sulfide.

Keep in mind that to wear any kind of respirator, you must be clean-shaven where the respirator seal touches your face. If not, leakage can be as bad as if you weren’t wearing one at all.

5. Wear a harness or safety belt with a lifeline secured to mechanical equipment, such as a winch, hoist or pulley, outside of the pit. Instruct coworkers on its operation.

6. While in the pit, maintain constant conversation with your coworker so the person can tell if you get into trouble or start acting “funny.”

7. If you find an unconscious person overcome by manure gas, call 911. Be sure rescue is done by someone with adequate training. If you enter a pit and try to rescue someone by “holding your breath,” you may well become a fatality, too. Do not enter a pit to rescue someone without wearing a SCBA or until adequate ventilation has been proven.

Prevent accidents

Implementing the following practices can help keep you and others on your dairy safe around manure hazards and confined spaces

1. Conduct on-going worker training that helps employees recognize manure hazards, how to work safely around them and what to do in emergencies.

2. Provide Farm medic training to local rescue squad personnel. Include farm facilities in the actual training so that emergency personnel are familiar with your dairy’s layout and potential hazards.

3. Conduct first-on-the-scene training with employees so they know what steps to take in the event of an emergency.

4. Post hazard signs at all openings to manure pits and confined spaces, on manure storage tanks, and around manure ponds and lagoons.

5. Fit all openings to manure pits with metal grill covers to prevent falls or other accidental entries, and periodically check these covers for corrosion to ensure they will support a person standing on them.

6. Incorporate safe designs that minimize confined spaces and the need to enter them when building new facilities.

Follow the same advice when working around manure storages as you would for any job on a dairy: If you have a bad feeling about a situation – it doesn’t look right, smell right or feel right – stop and find out the hazards before you begin the job.

When OSHA comes calling from page 17

says. “How do employees maintain the system and avoid entering into confined spaces, which is the goal.” Employees had developed a number of ways to do both, she found.

- The layout of the system puts the PVC pipe that biogas travels through to the flare and generator very close to the digester cover. “The system didn’t have a flame arrester,” Brown says. “It’s important to look at where the layout may be hazardous.”

Brown is developing a checklist for farmers to use to evaluate safety factors related to their manure handling system, no matter what type.

“It’s a misconception that agriculture is exempt from OSHA standards,” says Ellen Abend, safety and health educator with the Cornell Agriculture Health & Safety Program. OSHA must visit every farm where there’s a fatality, which farms must report, she says. But under its “General Duty” clause, which states a business must provide a safe work environment, OSHA can inspect dairies. Abend also points out that some OSHA offices, such as those in Syracuse and western New York, seem to be taking more interest in what is happening on farms.

The Cornell Agriculture Health & Safety Program has a grant through the Department of Labor to conduct Worker Safety Training to bring farms into compliance with OSHA hazard communication standards. The training is available to all farms. For information, contact Ellen Abend at (607) 255-1597. E-mail: HYPERLINK “mailto:ela4@cornell.edu” ela4@cornell.edu.

For more about OSHA, see its website: www.osha.gov