

Confined Space Hazards a Threat to Farmers¹

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Today's modern farming methods have brought new dangers that arise from farmers entering confined areas where oxygen levels may be inadequate or where toxic gases are present. When entering a confined area such as a manure pit, silo, grain bin, or an inadequately ventilated building a farmer may be at risk of being overcome by gases or dusts which can cause permanent lung damage or death.

Gases in manure pits and silos can quickly kill an unsuspecting farmer or an untrained rescue worker who enters the area without adequate protective equipment. Farmers entering grain bins while the bin is being emptied may be taking an unnecessary risk of being crushed or suffocated by flowing grain. Working in grain bins without proper respiratory equipment to filter dusts and molds increases a farmer's chances of developing a respiratory disease. Farmers working in dust-laden buildings run the risk of developing Farmer's Lung, a disease that permanently damages lung functions.

While most farmers are aware of the dangers of poisonous gases and flowing grain hazards, statistics from the past four years show that three to five Michigan farmers are killed each year in accidents involving these hazards. The occurrence of respiratory diseases among farmers cannot be accurately measured, but they are a concern among the rural population.

The intent of this publication is to make the reader aware of the risks associated with entering a confined space area and to provide information about risk reduction techniques for farm and orchard owners.

CHARACTERISTICS OF GASES

There are several gases around farm sites that pose a risk to farmers, the three most common in confined space areas are hydrogen sulfide, ammonia and carbon dioxide.

Hydrogen sulfide (H₂S) is formed during manure decomposition. It is toxic, combustible, and because it is heavier than air, it dissipates oxygen and can suffocate an unsuspecting farmer. Hydrogen sulfide also has a distinctive "rotten egg" stench that dulls the sense of smell, giving the farmer a false sense of security because the original odor disappears as exposure time increases. The gas irritates the eyes and respiratory tract. In low concentrations, hydrogen sulfide has been reported to cause headaches, nausea and dizziness prior to the individual succumbing to the gas.

Ammonia (NH₃) is a suffocant and a toxic gas with a distinct, sharp penetrating odor. Prolonged exposure to ammonia, or exposure to high concentrations of the gas can cause ulceration of the eyes and severe irritation to the respiratory system.

Carbon dioxide (CO₂) is a colorless, odorless suffocant that is produced during decomposition and respiration of plant materials. Excess carbon dioxide in a confined space depletes oxygen levels needed to sustain life. At low levels (CO₂ levels at 3 to 6 percent) the individual may feel drowsy and develop a headache. Death from suffocation may result when carbon dioxide levels are 30 percent or greater.

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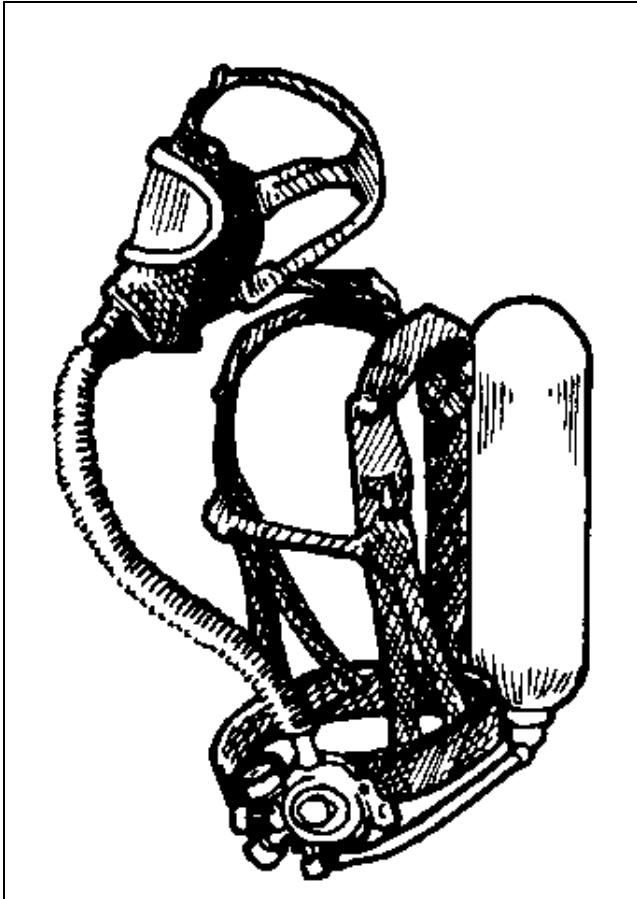


Figure 1.

CHARACTERISTICS OF DUSTS

Dusts are a common hazard in farming. All dusts have the potential to cause health problems, but some organic or toxic dusts may permanently impair a farmer's health.

The type of dust, amount and duration of exposure will determine the degree of severity of the health problem. Some dusts, especially dust from moldy forage, grain, or hay, carries antigens that can cause severe irritation to the respiratory tract. Breathing dust from moldy feed materials can result in a permanent lung condition commonly known as "Farmer's Lung".

Farmer's Lung is one of the most disabling diseases among dairy farmers. Symptoms of Farmer's Lung are easily mistaken for bronchitis or pneumonia and may not be noticed for several hours after exposure to the dust. Irreversible lung damage and sometimes death results when the disease is not diagnosed and treated in early stages. A long-term implication of the disease is shortness of breath which requires the farmer to take frequent rest periods and severely limits the amount of work that can be accomplished.

"Nuisance dust" is a term frequently applied to less noxious forms of dust that a farmer is commonly exposed to while performing field operations or working around livestock. Inhaling these less noxious dusts decreases lung capacity and also causes some people to be more susceptible to respiratory infections such as pneumonia. Prolonged inhalation of dusty air causes lungs to harden and become inelastic; significantly reducing their functional capacity. Smoking of tobacco products has been reported to hasten the damage.

Prevention

To reduce the risk of respiratory problems from dusts, a farmer should store only dry grain and dry, well-cured forages and hay. Mold develops in moist or wet grain, forages, hay and many other moist or stale organic materials.

To reduce dust exposure, a farmer should keep animal areas as clean and dust-free as possible. Stale dust and feed accumulations attract and absorb moisture from the air in the barn, creating an environment for mold and other microorganisms to grow.

Safety Precautions

- Disposable dust masks or a respirator with a replaceable cartridge designed to filter dusts ensures an adequate supply of clean air for the farmer. Change the mask or cartridge frequently for the greatest protection.
- Filter masks may provide adequate protection from common agricultural molds, dusts, and chaffs; however, they will not protect the wearer from agricultural gases. A self-contained breathing apparatus similar to those worn by fire fighters is needed to work in oxygen deficient areas such as silos or manure pits (see Figure 1).

EMPLOYEE PRECAUTIONS WITH CONFINED SPACES

(Agricultural operations with employees should refer to Michigan Department of Labor and Michigan Department of Public Health standards concerning confined spaces and potentially toxic work environments.)

To reduce the risks associated with working in a confined space, farmers should:

- Never enter a confined space without ventilating the area.

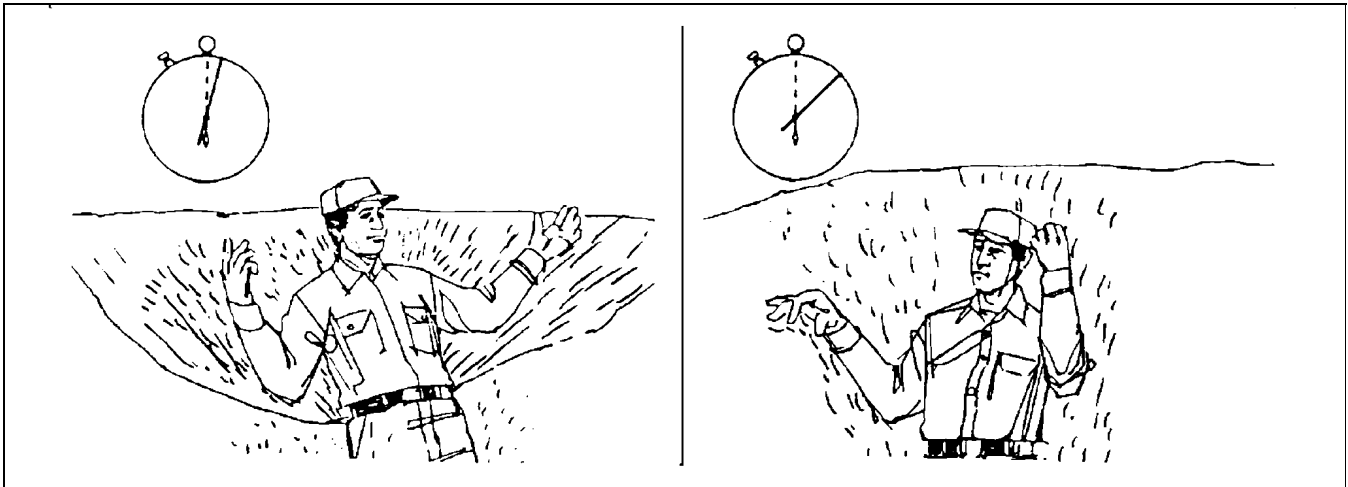


Figure 2. You can be completely submerged in grain in about 8 seconds.

- Test the atmosphere if possible.
- Wear a correctly fitted, approved, self-contained breathing apparatus if the area cannot be ventilated or properly checked. In addition, a safety harness and lifeline should be used.
- A self-contained breathing apparatus may fail or the worker could be trapped when working in a confined space with toxic gases. To reduce the risk to the person entering a confined space, two people should be available to assist in an emergency rescue. At least one person should be equipped with appropriate breathing equipment to execute the rescue.
- Have ladders, ropes and lifts available to assist a person entering a confined space and for rescue efforts if entrapment is possible or if gas fumes may be present.
- Maintain communication with the individual(s) outside the confined space. Communication may be visual, vocal, and/or by signal line.
- All persons who enter or may enter hazardous confined spaces should be trained in the use of safety equipment. A self-contained breathing apparatus should be properly fitted. The smallest leak could be deadly.

Michigan Department of Labor Safety Standards provide strict requirements when employees are required to enter hazardous spaces or confined spaces that test hazardous. Instruction must include information about the nature of the hazards involved, the necessary precautions to be taken, and the correct use of required protective and emergency equipment.

GRAIN BINS

Grain flow is a potentially deadly entrapment that may crush or suffocate anyone caught in the flowing grain. Accidents can occur when someone enters a bin to dislodge a bridge of grain that forms over the auger and stops grain flow. It takes only 3 to 4 seconds for a person to become entrapped in flowing grain; an average adult can become completely submerged in less than 20 seconds (see Figure 2).

Safety Precautions

- Stay out of grain bins, wagons and grain trucks when unloading equipment is running.
- If it is necessary to enter the bin, remember to shut off the unloader. It is a good idea to lock out any unloading equipment before you enter a bin to prevent someone from unintentionally starting the equipment while you are in the bin.
- Children should not be allowed to play in or around grain bins, wagons, or truck beds.
- Ladders and ropes should be installed inside grain bins to provide a grabhold or for an emergency exit. Attach ropes to the ladders and from the top center of the bin. Anyone entering the bin should attach a rope and harness to themselves before entering the bin. Ladders are easier to locate inside a dusty bin if there are brightly painted stripes just above or behind the ladder.

The Michigan Department of Labor Standards for Personal Protective Equipment requires employees to wear a safety belt or a safety harness and a lanyard affixed by a rope grab to a lifeline. All components

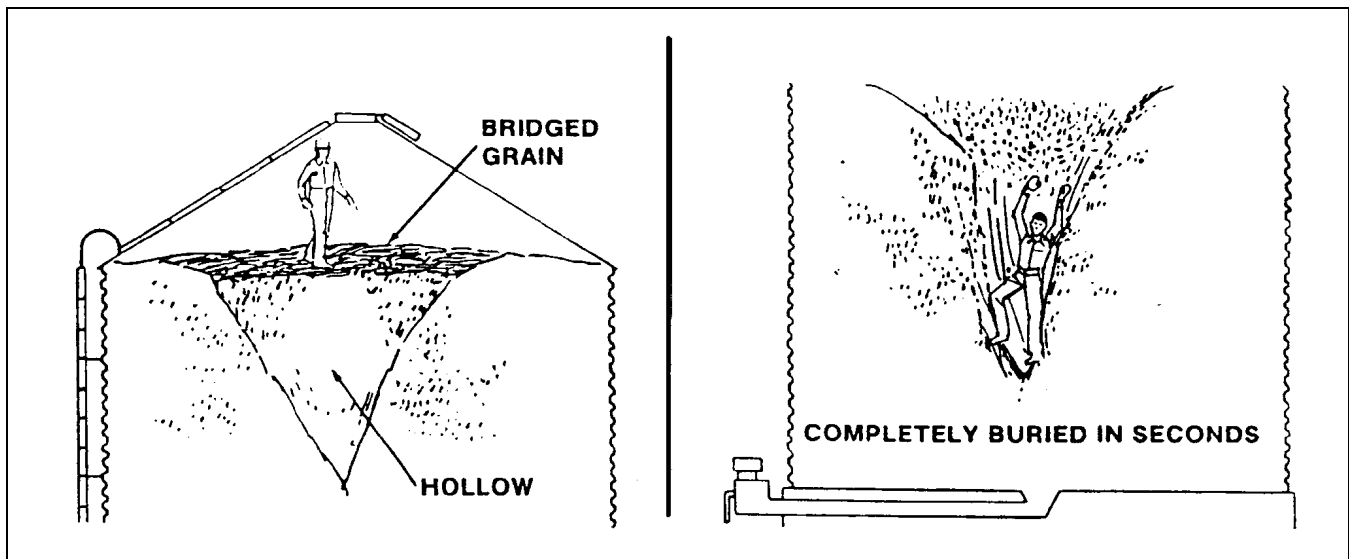


Figure 3. A bridge across the top of a grain bin can collapse under your weight; never enter a bin without taking necessary precautions to protect yourself.

must meet the state requirements. The Michigan Occupational Safety and Health Administration (MIOSHA) requires a lift tripod and harness lifeline arrangement for a rescue from the grain bin.

Remember that crusted grain may be covering voids or cavities that can entrap you. If possible, break up crusted grain from the outside of the bin with a long pole (see Figure 3).

If you must enter the bin:

- Wear a harness attached to a rope.
- Stay near the outer wall of the bin and keep walking if the grain should start to flow.
- Have another person, preferably two people, outside the bin who can help if you become entrapped. These people should be trained in rescue procedures and should know and follow safety procedures for entering the confined space.
- Grain fines and dust may cause difficulty in breathing. Anyone working in a grain bin, especially for the purpose of cleaning the bin, should wear an appropriate dust filter or filter respirator.

SILOS

Several hazards exist when a person is required to enter a filled or partially-filled upright concrete or oxygen-limiting silo. Several different gases are produced during the ensilage process and as forages undergo fermentation.

The most dangerous gas produced in the fermentation process is nitric oxide which, when combined with oxygen, produces nitrogen dioxide commonly referred to as "silo gas" (see Figure 4). In high concentrations, silo gas can kill a farmer after a short exposure.

A strong bleach-like odor or a yellowish or reddish cloud on top of freshly ensiled materials may be an indication that silo gas is present. Dead birds or insects around the base of the silo is another sign that silo gas may be present. But there may be no visual signs or no distinct odor to warn a person of silo gas.

Seek medical attention immediately if you suspect that you have been exposed to silo gas. Many times there is a symptom-free period of ½ to 42 hours after exposure until the onset of health problems. An acute onset of shortness of breath and/or fever and lung infiltrates are symptoms of silo-filler's disease. Frequently there is a relapse of the disease 2 to 6 weeks after the initial symptoms.

Safety Precautions

- Do not enter the silo for 4 to 6 weeks after filling stops.
- Be alert for silo gas odors and/or yellowish-brown or reddish fumes in or near the silo.
- Silo gas is heavier than air and will displace oxygen. Wear a self-contained breathing apparatus if you must enter the silo during the first 4 to 6 weeks after filling stops. Regular respirators or dust masks will

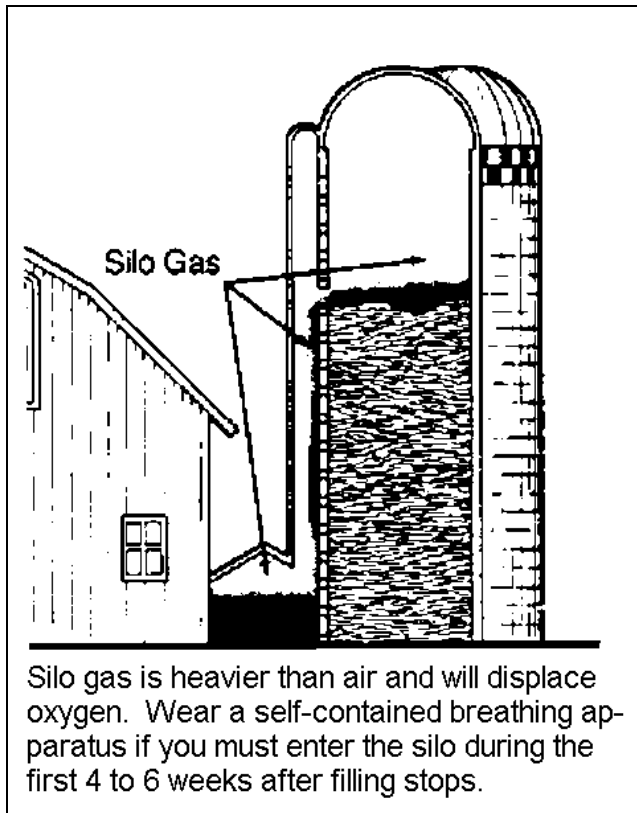


Figure 4.

not protect you from the gas.

- Running the silo blower for 15 to 45 minutes before entering the silo and while you are in the silo will help remove silo gas, but this is not a substitute for a self-contained breathing apparatus if silo gas is suspected.
- Never enter a silo if you are alone, especially during the danger period when gases may still be forming.
- Get to fresh air immediately if you start coughing or experience throat irritation.
- Seek medical attention if you suspect you have been exposed to silo gas.
- During the dangerous loading and fermentation period provide fencing around the silo base to keep children and animals a safe distance away from toxic silo gases. There have been reports of livestock being killed from silo gas flowing down the chute and entering the barn.
- Provide good ventilation to the silo room to dissipate dense gases as they cascade out of the silo during fermentation.

- If the silo adjoins a barn (or other building), keep the door between the two structures closed to prevent gas escaping into the livestock area.

CONTROLLED ATMOSPHERE (CA) STORAGE

Controlled atmosphere storages have high levels of carbon dioxide (CO₂) and low levels of oxygen (O₂) as compared to normal air, which contains 0.035 to 0.04 percent carbon dioxide. Controlled atmosphere storages commonly contain 2 to 5 percent CO₂, a deadly level for human beings. Oxygen levels inside these types of storage facilities ranges from 2.5 to 3 percent, well below the "required" human level of about 21 percent.

Anyone entering a controlled atmosphere room must wear a self-contained breathing apparatus or a supplied-air respirator if the oxygen level is below 17 percent. If possible, open the room to provide thorough ventilation if entry is necessary. The controlled atmosphere can generally be quickly re-established before stored fruit is damaged.

Another safety consideration for CA storages relates to the combustion units used for artificially creating and maintaining the low oxygen atmosphere. Combustion generators can be potentially hazardous and must be operated according to instructions. When incomplete combustion takes place, toxic gases are produced which will harm the fruit as well as people. The toxic gases resulting from incomplete combustion could accumulate in the storage room in explosive concentrations.

MANURE PITS

Gases such as hydrogen sulfide (H₂S), ammonia (NH₃), carbon dioxide (CO₂) and methane (CH₄) are a major concern in manure pits.

Manure pits provide a deceptive hazard. Many pits are semi-open vats, but because many deadly gases are heavier than air they remain in the pit at lethal concentrations.

Adequate ventilation and/or air circulation must be provided before a manure pit is entered. Ventilation and air circulation is also important if the pit is sufficiently close to buildings where livestock are housed or where humans enter.

Open flames or smoking in the area of many gases, especially around highly explosive methane gas, can be deadly.

Safety Precautions

- Provide adequate ventilation during agitation of pit contents.
- Provide backup power for mechanical ventilation in case of power failure. Also, provide for equipment backup if any part of the ventilating system should fail.
- Be sure that humans and livestock are not inside confinement buildings during agitation.
- Always keep at least 12 inches of clear space between the highest manure level and the floor slats.
- Never enter a manure pit without wearing a self-contained breathing apparatus. There are potentially fatal gases in pits, even after the pit has been emptied.

NEVER enter a manure pit without:

1. a self-contained breathing apparatus,
2. a lifeline and harness with adequate retrieval equipment (hoist, etc.), and
3. sufficient personnel standing by to effect a "safe" rescue. Rescue personnel should be equipped with a complete self-contained breathing apparatus and trained in rescue procedures. There has been at least one instance where rescue workers were killed when they entered a pit without proper protection.

REFERENCES

Michigan Department of Labor
Michigan Department of Public Health
John Deere Agricultural Safety (FMO Series)
Illustrations courtesy of John Deere and
Company, *Agricultural Safety*, Fundamentals of
Farm Safety, 1987.

SAFETY NOTE:

*Agricultural operations with **employees** should be familiar with and follow procedures established for an employee(s) working in a confined space (i.e. manure pits, upright silos, grain bins, controlled atmosphere storages, etc.).*