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Gas Poisoning On The Farm

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Tragic news accounts remind us that the agricultural workplace can be extremely hazardous. Each year in Canada, a number of people are victims of toxic gas poisoning on the farm.

This booklet has been prepared to help agriculturalists recognize some of the toxic hazards that may be encountered around the farm. An understanding of how these gases are formed and some of their properties will enable the reader to deal with them in a safe manner.

Health Hazards to Life Support System

The human body requires air, food and water in order to maintain our life support systems.

Since we must breathe constantly in order to survive, an airborne contaminant (such as a gas or dust) that is inhaled represents a potential health hazard. The health hazard could mean death within a few minutes, or it may take several years to develop into some form of disability. Either way we can't take a chance.

Care must also be taken that the chemical substances that are normally used on the farm (fertilizers, pesticides, etc.) do not directly contaminate any food that is about to be eaten or is spilled into drinking water sources. Skin contact with many substances must also be avoided, as they may be absorbed through the skin and interfere with the body's systems.

The Air We Breathe

Normal air consists of approximately 21 percent oxygen and 79 percent nitrogen. The oxygen is required to sustain life. The nitrogen does not normally react with the body's systems. If the amount of oxygen in the air is reduced (as it may be in a silo or liquid manure holding system) then we cannot perform properly. If the level of oxygen is reduced to a significant degree, eventually unconsciousness and death will follow.

Classification of Gases

From the standpoint of breathing, gases can be generally divided into three areas: (1) irritants, (2) asphyxiants and (3) toxic substances. While breathing is the most common manner for a gas to enter the body, it is possible for certain types of gases to be absorbed through the skin.

1 Irritants

These gases injure the eyes, nose, throat and lungs by causing inflammation and irritation to tissue.

2 Asphyxiants

Asphyxiants include gases that do not normally react with the body's systems; however, they represent a major hazard as they may displace oxygen from the air which is essential to sustain life. Also, even if the concentration of asphyxiants does not reduce the oxygen content enough to be a significant health hazard, the substance may be flammable and the danger of explosion or fire may exist.

3 Toxic Substances

Farm workers, depending on their work environment may be exposed to a variety of harmful substances. In order to evaluate the exposure to dangerous levels of dusts, fumes, gases, vapours, mists, noise vibration, heat and radiation, a system of rating various agents exists. These ratings are generally referred to as Threshold Limit Values or T.L.V.'s.

Threshold Limit Values

A practical definition of a T.L.V. is: "the concentration of a substance that should not represent a health hazard for most workers during a normal eight hour work day". Note that some people may be more sensitive than others and may not be able to withstand these values. For them, special precautions may be required. A few people may become sensitized to some substances and cannot work with them at all. The T.L.V.'s for gases are expressed in "parts per-million" (ppm).

Ammonia*

Ammonia is a gaseous by-product of the putrification of nitrogenious substances. Probably the most common source of nitrogen in agriculture is manure.

Ammonia is a clear, colourless gas with a specific gravity of .60. Being much lighter than air, it readily dissipates into the atmosphere. Although ammonia is classified as an irritant and is relatively toxic (T.L.V. - 25 ppm), the danger of being overcome by this gas is remote. Owing to the extremely pungent odour of ammonia in even small concentrations, an active person will not voluntarily remain in the presence of the gas for any extended period of time.

Ammonia is a gas which can be readily liquified by pressure to form anhydrous ammonia. Anhydrous ammonia and aqua ammonia are used extensively as fertilizers.

**(The Farm Safety Association publishes a Fact Sheet on Safe Handling of Anhydrous Ammonia)*

Carbon Dioxide

Carbon dioxide is a principal gaseous by-product of such common processes as respiration, fermentation and combustion. For people, it is the principal component of exhaled breath from the lungs.

Carbon dioxide is a clear, colourless and odourless gas which can be toxic in high concentrations. It is slightly narcotic at very high concentrations, with decreasing visual acuity and increasing blood pressure. Utimately unconsciousness will occur.

Owing to the fact that carbon dioxide is much heavier than air (specific gravity 1.53), it poses some real problems around farms. Sealed oxygen limiting silos and liquid manure systems, grain storage and feed storage tanks can hold carbon dioxide in lethal concentrations.

Although carbon dioxide is not nearly as toxic (T.L.V. - 5,000 ppm) as other gases dealt with in this booklet, it should be noted that it probably is the most common type of gas on any farm. It is possible for a person to breathe relatively large concentrations of carbon dioxide and not be affected too severely.

All the basic rules for confined space entry * should be followed closely if there is a possibility of carbon dioxide being present.

**Refer to appendix for safe procedure for entry to confined space.*

Hydrogen Sulfide

Manure Gas

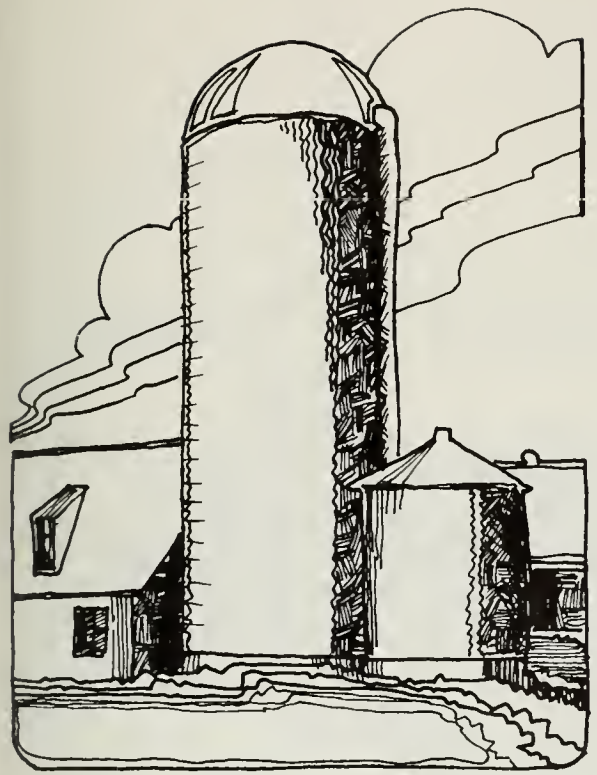
Hydrogen sulfide is formed as a result of the decomposition of organic material. It is a clear, colourless gas and can be recognized in small concentration by its rotten egg odour. However, human ability to smell this gas disappears rapidly as a result of continued exposure and with increased concentration.

Liquid manure systems can produce relatively large concentrations of hydrogen sulfide (as well as carbon dioxide). Many modern barns are constructed with slatted floors directly over the liquid manure tank. Since hydrogen sulfide is heavier than air (specific gravity 1.19), it will settle on the surface of the liquid in a manure tank. As the liquid level rises, the gas also rises and may eventually be forced above the floor. Confined livestock are in great danger under these circumstances. The greatest danger period from hydrogen sulfide occurs during agitation of the tanks. The turbulence created causes gas trapped within the liquid to be liberated and can force the gas up into the barn area.

Hydrogen sulfide is classified as a toxic chemical; in high concentrations, it will lead to *almost instantaneous poisoning and death.* Exposure to smaller concentrations may cause nausea, coughing, headache, dizziness and eye irritation.

Keeping liquid manure at a safe level in the holding tank will reduce much of the danger. All sources of entry into a liquid manure system should be secured. Prior to agitation and pumping, all people and animals should be evacuated from the barn. Thorough and complete ventilation should be provided during the agitation and pumping process. No one should enter a liquid manure holding tank (or spreader tank) at any time without following the rules for confined space entry*.

**Refer to appendix for safe procedures for entry to confined space.*



Nitrogen Dioxide

(Silage Gas) *

Nitrogen Dioxide or Silage Gas has become more prevalent in recent years. Nitrogen dioxide is often formed as a by-product of the fermentation process which takes place in silos during the early stages of ensiling. Nitrogen dioxide may be visible as reddish orange fumes; it also has a bleach-like odour.

This gas is classified as an irritant. When inhaled, it reacts with the moisture in the respiratory tract to form nitric and nitrous acids which can cause severe irritation and chemical pneumonia. Exposure to heavy concentrations can result in death within seconds. Lesser concentrations may lead to extensive lung damage.

Nitrogen dioxide can form within a very short period of time after putting chopped material into a silo, and may be present for a period of up to two to three weeks. After this period of time, danger is greatly reduced. However, adequate steps should be taken to ventilate the silo before entering. The silo may be ventilated by removing the silo door closest to the level of silage and running the forage blower for 20 to 30 minutes. The silo feed room at the base of the silo chute should also be mechanically ventilated, since silo gas, if it is present, will flow down the silo chute (specific gravity 1.58). The door separating the feed room and barn areas should be tightly sealed to prevent contamination of barn areas. Silos should be declared off-limits to visitors and children during the danger period.

If it is necessary to enter a silo during the two to three week danger period, all rules for confined space entry * should be followed. Never enter a silo during the danger period without using a self-contained breathing apparatus. Use a life-line with someone stationed outside of the silo.

**(The Farm Safety Association publishes a Fact Sheet on Silage gas - Nitrogen dioxide)*

**Refer to appendix for safe procedures for entry to confined space.*

Carbon Monoxide The Silent Killer

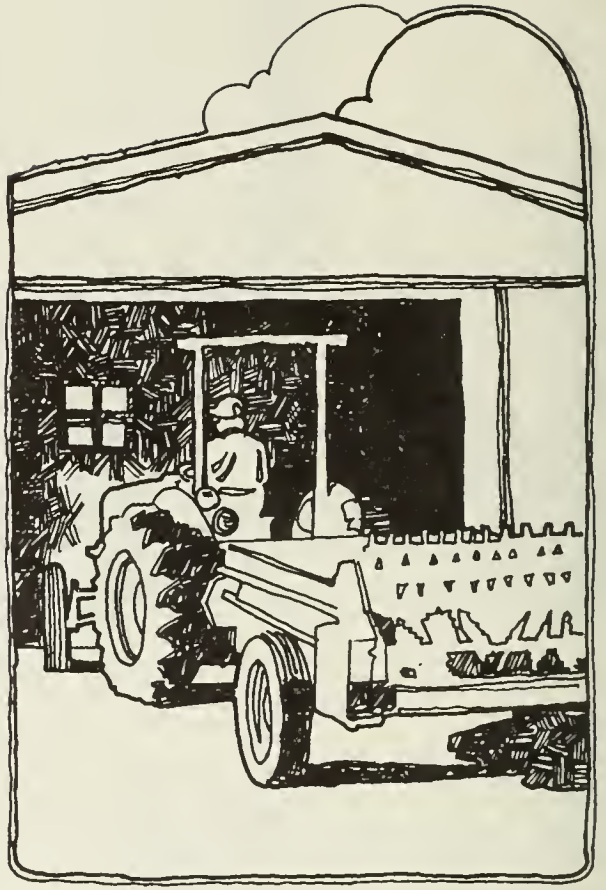
Carbon monoxide gas (CO) has often been described as the silent killer owing to the fact that it is difficult to detect. Carbon monoxide is a by-product of the incomplete combustion of carbonaceous material e.g. exhaust from an internal combustion engine.

Clear, colourless, and tasteless, carbon monoxide is especially dangerous during winter months. Exhaust fumes from running engines, welding gases and fires are common sources of this lethal gas. If adequate ventilation is not provided, garages and workshops which are tightly sealed from the winter elements can become death traps.

Carbon monoxide poses an additional hazard; in concentrations from 12 to 74 percent by volume of air, it is highly flammable and explosive. (At these levels, an exposed person would be overcome very quickly with fatal results.)

Carbon monoxide is classified as a toxic chemical. Inhalation of excess concentrations of the gas may cause tightness across the forehead, headache, weariness, nausea and dizziness. Exposure to concentrations of over 4,000 ppm will cause rapid collapse, with death following within a few minutes. Repeated exposure to small doses of carbon monoxide will often result in headaches, dizziness and general weakness.

All confined work areas that may contain carbon monoxide producing equipment should have sufficient exhaust ventilation to maintain average exposure below 35 ppm's, the guideline for Ontario. Properly tuned engines will give off much less carbon monoxide. Stoves and furnaces should be well vented.



Confined Space Entry

Silos, grain storage tanks, liquid manure holding tanks and tank spreaders, chemical tanks, etc., could all be described as confined spaces. A number of basic rules should be followed to the letter while working in, or around such areas.

1 Ventilation

Ventilation is one of the best means of purging gases from any system. This is true for all of the gases dealt with in this booklet.

2 Pre Entry Check

Before entry is made, there are a number of questions to consider. Does a danger of toxic gas exist? Is there enough oxygen to support life? Is there a danger of explosion? Is there a danger of mechanical failure or faults that may be a hazard?

3 Entry

In dealing with toxic gases, it is better to err on the safe side. Entry into liquid manure systems at all times, and the silo during the two to three week danger period, should only be carried out while using a self-contained breathing apparatus, *a particle respirator is not acceptable.* Confined spaces should never be entered unless a lifeline is attached to someone outside the area of danger. Never enter a confined space under *any* circumstance without another person present.

4 Detection

Detection equipment is available for a number of toxic gases. However, it should be noted that this equipment can be relatively expensive and some skill may be required to obtain accurate readings.

Toxic Farm Gases

Toxic Gases	Chemical Symbol	Specific Gravity	*Threshold Limit Value	Flammability % By Volume of air	Description
Nitrogen Dioxide *(Silage Gas)*	NO^2	1.58	5 ppm	—	Reddish orange in certain concentrations, bleach-like odour, secondary by-product of fermentation process in silos
Hydrogen Sulfide *Manure Gas*	H^2S	1.19	10 ppm	4 - 50%	Clear, colourless, pungent odour, formed as a result of uncontrolled anaerobic digestion of organic substances
Carbon Monoxide *Silent Killer*	CO	.96	50 ppm	12 - 74%	Clear, odourless, by-product of incomplete combustion of carbonaceous material
Carbon Dioxide	CO^2	1.53	5000 ppm	—	Odourless, colourless, principal component of air discharged from lungs
Ammonia	NH^3	.60	25 ppm	10 - 30%	Clear, colourless, pungent odour, by-product of putrification

**American Conference of Government and Industrial Hygienists*

Artificial Respiration

In most cases, artificial respiration is the only means of reviving an individual who has been overcome by toxic gases. The person must be removed from the danger area before artificial respiration is administered. Never enter a confined space to retrieve an unconscious person unless wearing self-contained air breathing equipment; use a lifeline to haul him out.

Farm Safety Association Inc.

The Farm Safety Association publishes fact sheets on Nitrogen Dioxide (Silage Gas) and the Safe Handling of Anhydrous Ammonia.