Management of confined spaces in agriculture

Dairy farms

FARSHA

WorkSafeBC

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Introduction

This booklet is a tool to help farmers identify and manage confined spaces on dairy farms. Workers have lost their lives because they didn't know they were entering a confined space that contained hazards and didn't take necessary precautions.

Confined spaces such as tanks and storage bins can be dangerous to workers and others who may be exposed to toxic gases and other hazards that may be present in these spaces. On your farm, it's important to identify these spaces and ensure that no one enters them until proper planning and procedures are in place.

How this booklet is organized

Part A: Confined spaces and hazards describes what a confined space is and the types of hazards that may be present in confined spaces on farm operations.

Part B: Managing confined spaces describes five basic steps you need to follow to address confined spaces on your farm:

1. Identify all the confined spaces on your farm.
2. Post warning signs outside confined spaces, and seal or lock them to prevent anyone from entering.
3. Ensure that a qualified person determines the hazards for each space.
4. Communicate with your workers about the locations of confined spaces and the hazards that are present.
5. Determine which spaces may need to be entered.

Part C: Preparing to work in confined spaces briefly describes the complex requirements that are involved with confined space entry, including the following:

- Confined space entry procedures
- Standby persons and rescue personnel
- Lockout and isolation
- Air testing
- Ventilation

You'll need the help of a qualified person to address many of the issues described in Part C.

Part A: Confined spaces and hazards

Why confined spaces are a concern

Confined spaces are enclosed or partially enclosed areas big enough for workers to enter. Since 2000, 18 workers have lost their lives in confined spaces in British Columbia. Incidents in confined spaces are rare, but when they do occur the consequences can far outweigh the size of the error. Confined space incidents can happen suddenly, often without any warning that something is wrong. Afterwards, conditions in the space can rapidly return to normal.

Incidents involving atmospheric hazards (for example, toxic gases or a lack of oxygen) in confined spaces are very dangerous. Often, they can cause serious injury or death to more than one worker.

Typically, confined space incidents happen when:

- Confined spaces are being prepared for entry
- Workers or others are entering the confined space
- Work is happening in the confined space

Previous incidents in this industry are sober reminders of why it's important that workers have proper knowledge of potential hazards and safe work procedures for confined spaces. The following tragic incidents are examples of what can happen when knowledge and procedures are lacking. By learning from these and other past incidents, as an employer you can help ensure your workers stay safe on the job.

Brown-water cistern

Pump shed

Composting pond

Incident at mushroom composting facility kills three workers

In September 2008, three men died and another two were permanently injured in a pump shed on a mushroom farm in Langley. Three of the men were trying to clear a blocked intake pipe in the shed. When the pipe was disconnected, one worker complained of a strange smell and then collapsed. A second worker remained in the shed with the unconscious worker while the supervisor went for help. Before emergency services arrived, several other workers entered the shed to help.

When the ambulance and fire crews arrived at the site, they found the supervisor outside the pump shed, disoriented and in respiratory distress. Five other workers were recovered from inside the shed. Three workers suffered fatal injuries and two suffered severe and permanent brain injuries from exposure to the toxic atmosphere.

What went wrong? The mushroom farm didn't have a health and safety program or a confined space program. Workers entered the space to rescue their fellow workers without any training or safety equipment. The pump shed had also not been identified as a confined space, so the workers didn't recognize that it might contain a hazardous atmosphere.

Winery incident kills two workers

In November 2002, two Okanagan winemakers died in a wine fermentation tank with low oxygen levels. One worker, standing on a ladder above the hatch of the tank, may have inhaled a high concentration of carbon dioxide gas (a by-product of fermentation) when the hatch was opened. He then lost consciousness and slumped into the chilled liquid in the tank. A fellow worker tried rescuing him but also died after he leaned into the hatch. Two people working nearby recalled hearing the second man say he couldn't breathe. Emergency rescuers tried draining the liquid from the tank and cutting it apart, but it was too late.

Dairy farm tragedy claims five in the US

In 2007, four family members and a worker died from exposure to hydrogen sulfide gas in a manure pit on a dairy farm. A dairy farmer was transferring liquid manure from a small pit to a larger one when the transfer pipe became blocked. After entering the small pit to clear the blockage, he collapsed from being exposed to hydrogen sulfide gas in the pit. Another worker then climbed into the pit to help the farmer but was also overcome by the deadly gas. The farmer's wife and two daughters then entered the pit and were also overcome by the gas. First responders to the scene were unable to revive the victims.

What is a confined space?

A confined space is an enclosed or partially enclosed area that's big enough for a worker to enter. The space may be enclosed on all sides (for example, a tank or manure pit) or as few as two sides (for example, an enclosed conveyor). Confined spaces can be hazardous to enter.

Confined spaces may not always be obvious. Some are large, while others are small. Some are open on top, while others are completely enclosed except for an access opening.

Confined spaces don't have features commonly found in areas intended for regular work, such as:

- Permanent utilities (e.g., ventilation systems, lighting, and plumbing services)
- Wall coverings and furniture
- Easy access (e.g., large doorways and shallow staircases)

Though confined spaces are not designed for someone to work in regularly, occasional entry may be necessary for inspection, cleaning, maintenance, or repairs.

Small openings, hatchways that open at the top, or an interior layout with obstructions can make first aid, rescue, and evacuation difficult. If the space is too small or difficult to move in, a first aid provider may not be able to provide treatment. Preparing an injured worker for transport could also be a problem if a worker needs to be tilted on a stretcher or lifted out of the space using a harness and lifeline.

Workers must not be allowed to enter confined spaces unless proper training, equipment, and procedures are in place. A worker is considered to have entered a confined space just by reaching into or putting his or her head into the opening. If the confined space contains toxic gases, even workers near the opening may be at risk of injury or death.

Typical confined spaces in agriculture

Feed bins

Milk tank

Manure pond

Hazards in confined spaces

Many types of hazards can be found in confined spaces. A confined space may contain a hazardous atmosphere, such as insufficient oxygen, toxic (poisonous) air, or an explosive atmosphere. Confined spaces may also have physical hazards that could crush or bury workers, or cause them to fall or drown. Hazards may not be obvious, so a qualified person must carefully assess every confined space on your farm to identify potential hazards.

What are the typical hazards found in confined spaces?

Oxygen – too little or too much

Lack of oxygen is a leading cause of death for workers entering confined spaces. Low oxygen levels cannot be detected by sight or smell. A very low oxygen level can cause brain damage and stop your heart after a few minutes. In a confined space, something as simple as rusting metal can cause low oxygen levels.

Too much oxygen in a confined space is also dangerous because it greatly increases the risk of fire or explosion. Materials that would not catch fire or burn in normal air may do so extremely quickly and easily where there's a high level of oxygen.

Toxic gases

Toxic gases and vapours can be released in a confined space through:

- Gases or liquids already present in the confined space
- Migration into the space from the surrounding soil
- Evaporation from surfaces within the space (e.g., after cleaning or applying waterproof coatings)
- Work activities, such as painting or welding

The following table describes some of the toxic gases that may be present in confined spaces on dairy farms and the dangers of exposure to these gases.

Contaminant	Where does it come from?	What are the dangers?
Hydrogen sulfide (H_2S)	Released when organic material (e.g., manure) breaks down without oxygen (e.g., in animal barns, manure piles, tanks, pits, or ponds).	• Very toxic – causes lung failure and death • Extremely flammable • Can be released during the agitation of fluids containing trapped gas • Heavier than air – may accumulate at the bottom of the confined space
Ammonia (NH_3)	Produced when high-nitrate organic material (e.g., manure and urine) is decomposed by bacteria (e.g., in manure pits).	• Toxic – causes irritation to the eyes, nose, and lungs; can cause lung damage and death at higher concentrations • Flammable at high concentrations • Lighter than air – may accumulate at the top of the confined space
Methane (CH_4)	The principal gas produced during the bacterial digestion of manure (e.g., in manure pits, composting facilities, silos, and bins).	• Accumulates in areas lacking ventilation • Displaces oxygen • Flammable and explosive • Lighter than air – may accumulate at the top of the confined space
Carbon monoxide (CO)	Comes from sources of combustion (e.g., burners or gasoline or diesel engines).	• Toxic – can cause suffocation; replaces oxygen in red blood cells • May accumulate at the bottom of the space in cool weather
Carbon dioxide (CO_2)	Produced by all living organisms that breathe oxygen. Levels in enclosed dairy barns can be high because cattle exhale CO_2.	• Displaces oxygen • Toxic • Heavier than air – may accumulate at the bottom of the confined space
Nitrogen dioxide (NO_2)	Produced as plant material is transformed into silage (also known as silo gas).	• Toxic – respiratory irritant; can cause death at high concentrations • Heavier than air – may accumulate at the bottom of the confined space

Without careful and thorough assessment of hazardous conditions and preparation to create safe work conditions, entering a confined space can be extremely hazardous, causing serious injury and even death. Taking the proper precautions is critical; otherwise, the risks are just too great.

For more information on confined space hazards, see the WorkSafeBC publication *Hazards of Confined Spaces*.

At concentrations considerably above normal levels, some substances become immediately dangerous to life and health (IDLH). At these levels, even a brief exposure can have a permanent effect on a worker's health, such as causing brain, heart, or lung damage. Workers may become dizzy or unconscious and unable to escape from the confined space. Some substances have very low IDLH levels, which means even a small amount can be hazardous. For example, the IDLH level for hydrogen sulfide is only 100 parts per million (ppm).

Ignitable and explosive atmospheres

Gases or vapours that have accumulated to dangerous levels in confined spaces can ignite and cause fires or explosions. This may happen when volatile substances are spilled or applied to large surface areas (for example, when painting) and there is a lack of appropriate ventilation. Fuels such as gasoline and propane are especially hazardous. Propane or similar substances may also be ingredients in propellants used in many aerosol products.

In some cases, dust from organic materials, such as grain or feed, can be ignited (for example, by an electric arc in a switch or motor), resulting in a highly destructive fire or explosion.

Biological agents

Composted material, manure, grain, and feed can release bacteria, mould spores, allergens, and other bioaerosols into the air. At lower concentrations, workers may show mild symptoms, such as coughing, itchy eyes, stuffy nose, sneezing, and sore throat. For those with asthma or a sensitized immune system, the health effects can be severe. At high concentrations, most people will react to the presence of bioaerosols. Some bacteria and moulds can infect the lungs or open wounds.

Entrapment and engulfment

Grain or compost stored in enclosures can present entrapment and engulfment hazards.

Entrapment usually occurs inside enclosures with inward-sloping sides and slippery interior surfaces, such as storage bins. The worker slides to the bottom, can't get out, and is at risk of other hazards in the space – such as toxic gas or a low oxygen level.

Engulfment occurs when a worker is surrounded, covered, or trapped by liquids or very fine solids, such as grain. Solids, particularly if moist, can form “bridges” with empty spaces underneath them or “shoulders” that are overhead. If a worker walks on the surface of a bridge or underneath a shoulder, it may collapse and engulf the worker in the material. This can happen in seconds.

Bins and hoppers with conveyors or augers are especially dangerous. A worker may be trapped or crushed when material is accidentally discharged into an empty bin or hopper. The design of these confined spaces may increase the risk. For example, in an empty hopper with a floor that slopes steeply to a vertical chute, a worker can slide into the chute and get trapped.

Equipment and machinery

Mechanical equipment (for example, augers, mixers, conveyors, or rotating tanks) can be dangerous to work around – even when the equipment is shut off. For example, someone else could accidentally turn the machine on, or there could be remaining energy, such as accumulated pressure, in equipment if it’s not locked out and de-energized. Even if the equipment is locked out and power is off, unsecured equipment can move, especially if it’s out of balance.

Electrical equipment powers hydraulic and pneumatic power sources. Shutdown of an electric drive motor does not necessarily eliminate energy stored as pressure in the fluid circuits of hydraulic and pneumatic (air-driven) systems.

Electrical shock

Defective extension cords, welding cables, or other electrical equipment can result in electrical shock. Work done in metal enclosures or wet conditions can be especially dangerous. If there’s a danger of electrical shock, install ground fault circuit interrupters (GFCIs) or use assured grounding.

When solid materials (for example, dry grain, feed, or seed) flow or move through pipes, augers, or hoppers, dry conditions can create electrostatic arcs. These can ignite dust clouds and cause an explosion.

Substances entering through piping

Some confined spaces use piping to connect to sources of supply and drainage of chemical products, sewer lines, vents, and emergency relief systems. Piping may contain liquids, gases, or other harmful substances, including:

- Toxic gases
- Hot substances that could burn a worker (e.g., steam)
- Liquids that could drown a worker (e.g., milk or liquid manure)
- Solids that could trap, crush, or bury a worker (e.g., grain or feed)

Piping must be isolated to prevent substances from entering a confined space through the piping. This often involves disconnecting the piping or using solid plates to block off the piping from the confined space.

Temperature extremes

Some confined spaces have temperatures considerably higher than normal levels. Heat stress (hyperthermia) occurs when the core temperature of the body exceeds 38°C. Heat stress can produce sweating, muscle weakness, cramps, fatigue, thirst, and, in severe situations, heat stroke. Untreated heat stroke can lead to death. Allow enough time for cooling of confined spaces that have been steam cleaned.

If workers are exposed to low temperatures, cold stress (hypothermia) may result. Shivering is a common symptom. A ventilation system in a confined space can add to this problem because it makes the body lose heat faster.

Before workers enter confined spaces, such as boilers, reaction vessels, and low-temperature systems, a qualified person must provide safe work procedures.

Noise

Noise in confined spaces can be particularly harmful because it can reflect off the walls. If noise levels cannot be reduced, workers must wear hearing protection. Noise may also make communication difficult, especially between workers in the confined space and the standby persons outside.

Immersion and drowning

Immersion occurs when fluid such as gas, vapour, or liquid rapidly enters a space and surrounds a worker. This can happen when valves are opened or piping and piping components fail. Rapid flooding can also occur. A worker who is unconscious on the floor of the structure can drown in as little as 15 cm of liquid. Confined spaces should be fully drained and dry before entry to prevent drowning. Workers have drowned in small pools of liquid after being knocked out by lack of oxygen, a toxic gas, or a blow to the head.

Part B: Managing confined spaces

Step 1: Identify confined spaces

The first step in addressing confined space requirements involves identifying all the confined spaces on your farm and creating a written inventory of them.

Confined spaces commonly found on dairy farms include:

- Silos
- Bins
- Bunkers
- Manure storage tanks, ponds, and pits
- Water cisterns and tanks
- Wells (clean water)
- Pump or lift stations
- Valve boxes (below ground)
- Sumps
- Milk tanks
- Mobile equipment
- Conveyors
- Crawl spaces or cellars

What is considered a confined space?

A space is classified as a confined space if it meets all four of the following criteria:

1. The space is enclosed or partially enclosed.
2. The space is not designed or intended for continuous human occupancy.
3. The space has limited or restricted means for entry or exit that may complicate the provision of first aid, evacuation, rescue, or other emergency response services.
4. The space is large enough and so configured that a worker could enter to perform assigned work.

Determining whether or not a space is a confined space is not always easy. For example, hopper-bottomed bins are usually considered to be confined spaces, while flat-bottomed bins normally are not.

Hopper-bottomed bins meet the four criteria of a confined space. Usually, the only entry is through a small hatch at the top. Once inside, there's no internal ladder to allow a safe descent, and the sharply sloping bottom walls lead directly to the auger intake. Worker contact with the auger is a potential hazard.

Flat-bottomed bins generally don't qualify as confined spaces because they usually have a large, door-like entry at ground level, which does not restrict access or exit in an emergency.

A piece of mobile equipment is considered a confined space if it meets the four criteria described above. A qualified person must be the one who determines this.

Mobile equipment

Some pieces of mobile equipment may also be considered confined spaces, depending on their size (for example, whether a worker can get inside) and configuration (for example, whether they have hatches or doors).

Get help from a qualified person

A qualified person is someone who has training and experience in recognizing, assessing, and controlling the hazards of confined spaces.

A qualified person is required for:

- Determining the hazards for each confined space
- Developing safe work procedures before workers enter confined spaces
- Testing the atmosphere in a confined space
- Developing rescue procedures

Though it's not a requirement, a qualified person should help identify confined spaces on your farm.

Step 2: Post warning signs and secure entry to confined spaces

Confined space warning sign

Warning signs

Post signs or notices at confined space entrances prohibiting unauthorized persons from entering. Signs and notices should:

- Be clear, visible, and written in the languages used by your workers
- Clearly state that the area is a confined space and that only authorized people may enter

Many workers don't realize they are entering a confined space. You must ensure that all workers on your farm know about the location of each confined space on the farm.

Secure against entry

Secure points of entry with locks, or fence or guard the area to prevent mistaken or unauthorized entry. Use locks on all covers, portholes, and doors that provide access. A lock may not be required if a cover or lid is bolted in place and requires tools for removal, or if the cover or lid is heavy enough to require tools or equipment to be moved.

Pits or lagoons must have at least a barrier or guardrails around the sides. Lock any gates in the barriers or guardrails. Fill the space between the ground level and the top rail of guardrail systems with heavy mesh fencing or similar material – this will prevent children, pets, and livestock from entering the hazard area through the spaces between the guardrails. Post signs and notices on all gates and at intervals along the perimeter barriers or guardrails so the signs and notices will be visible to anyone approaching the area.

Access points and signs must be inspected regularly (at least monthly) to ensure access points are secure, signs are legible, and visibility is not obstructed by vegetation, materials, or equipment.

Step 3: Determine the hazards for each space

A hazard assessment for each confined space must:

- Consider conditions that may exist before workers enter (e.g., because of the location, configuration, or use of the space)
- Consider conditions that may be present while work is being conducted in the space (e.g., cleaning, painting, or welding)

Typical hazards

The following table lists examples of the types of hazards your workers may encounter.

Hazard	Examples
Oxygen – too little or too much	–
Toxic gases	Hydrogen sulfide, methane, ammonia, or carbon monoxide
Explosive gases and vapours	Methane or gasoline vapours
Biological agents	Mould and bacteria
Physical hazards	Solids or liquids that may engulf, entrap, or drown workers
Moving parts or machinery	Mixers or augers
Hazardous energy	Electric shock
Substances entering through piping	Toxic gases, steam, brown water, or liquid manure
Other hazards	Heat, cold, noise, entrapment, or engulfment

Hazard assessments are required for all confined spaces on your farm. These must be prepared by a qualified person who has training and experience in recognizing, assessing, and controlling confined space hazards. If you don't have this training, you must hire a qualified person to prepare the hazard assessment.

The following general information will help in assessing hazards of confined spaces, though you may have confined spaces on your farm that are not listed here.

Auger and conveyor tunnels

Conveyor in a tunnel

Augers and conveyors transport solid material either from a container to a vehicle (for example, grain from a bin to a transport truck) or from place to place (for example, from production to a storage facility). The enclosure containing the auger or conveyor is a confined space.

Depending on the material being transported, toxic gases may build up in the conveyor system. For example, fermenting material, such as compost, may emit toxic gases that can rapidly cause death when inhaled at high concentrations. Grain and feed can emit fumigants and dust.

Hazards

- Carbon dioxide (CO_2)
- Hydrogen sulfide (H_2S)
- Ammonia (NH_3)
- Methane (CH_4)
- Bacteria and mould
- Oxygen deficiency

Workers may be at risk of injury or death if they get caught in the operating machinery of a conveyor or if mechanical equipment is not properly locked out.

Hazardous work

- Inspecting the conveyor system
- Maintaining or repairing conveyor equipment
- Cleaning or removing blockages from the conveyor

To help reduce the risk, choose (or retrofit) equipment that doesn't require entry to the conveyor system.

Bunkers

Above-ground bunker

When damp materials (for example, forage plants, compost, or damp feed) are stored in a bunker they may ferment and produce hazardous gases. Oxygen is consumed by the fermentation process. Other hazardous gases may be produced from vehicles, such as front-end loaders, entering and leaving the bunker. The gases may accumulate at the surface of the material and collect at the base of the bunker – especially if the bunker is below ground level.

Above-ground, open-front bunkers are not normally considered confined spaces as long as it's relatively easy to get workers and equipment into and out of them. However, if bunker contents block the entrance, it may create a confined space. Pit or subsurface bunkers are also considered confined spaces.

Hazards

- Carbon dioxide (CO_2)
- Ammonia (NH_3)
- Hydrogen sulfide (H_2S)
- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- Bacteria and mould
- Oxygen deficiency

Hazardous work

- Loading or unloading material in the bunker
- Packing material using mechanical equipment
- Covering the material with a tarp
- Manually levelling contents
- Repairing or maintaining the bunker

Crawl spaces and cellars

Exterior entrance and crawl space

Crawl spaces or cellars beneath buildings may contain a toxic or low-oxygen atmosphere if there's not enough natural ventilation. Oxygen in the space may be depleted if moisture and metal are present. The oxygen is used up as the metal rusts. Other toxic gases may also accumulate, depending on the use of the building above the crawl space or material being stored in the crawl space.

Hazards

- Hydrogen sulfide (H_2S)
- Carbon dioxide (CO_2)
- Bacteria and mould
- Oxygen deficiency

Hazardous work

- Entering crawl spaces for visual inspections or repairs
- Storing or removing material

Feed bins

Feed bins

Normally, storage of grain or feed in bins does not produce toxic gases. However, entry into bins must take into account previous use of pesticides or fumigants, and possible presence of mould. If the moisture content of the grain is too high, the grain may ferment, and toxic gases can build up and replace oxygen in the air.

Hazards

- Carbon dioxide (CO_2)
- Oxygen deficiency
- Bacteria and mould
- Pesticides and fumigants

Grain may not flow smoothly and can form bridges or shoulders that are an engulfment hazard.

Hazardous work

- Breaking up bridged grain
- Taking grain samples
- Applying pesticides or fumigants
- Cleaning out the last grain from a near-empty bin
- Conducting repairs or maintenance work inside the bin

To help reduce the risk, design the cone of a hopper-bottomed bin using bolted rather than welded joints to allow for easy removal of individual panels. Auger cleaning and maintenance can then be done safely from outside the hopper.

Manure handling structures (storage tanks, ponds, and pits)

Manure pond

Above-ground manure tank

Manure separator

Subfloor manure storage

Manure handling structures contain manure during production, collection, separation from bedding material, and storage. Different dairy farms may have different manure handling structures. Depending on the specifics, some are considered confined spaces.

Manure collection to a subfloor or outside storage chambers may take place using mechanical floor sweepers or mobile equipment. Separation of bedding material creates a watery product suitable for longer-term storage in above- or below-ground storage structures before distribution on fields.

In these structures, manure ferments, producing very toxic gases. The slightest agitation or movement of the liquid or sludge can release bubbles of these gases into the air. In high enough concentrations, they cause death in seconds. These toxic gases can accumulate at the top or bottom of ponds, trenches, or sumps that contain manure.

Ammonia and methane are lighter than air and accumulate at the top. Hydrogen sulfide is heavier and tends to sink. As gases build up in the confined space, they may replace oxygen in the air. Some gases, such as methane, are also extremely flammable and can be an explosion hazard.

Hazards

- Carbon dioxide (CO_2)
- Ammonia (NH_3)
- Hydrogen sulfide (H_2S)
- Methane (CH_4)
- Bacteria
- Oxygen deficiency

Hazardous work

- Agitation during pumping
- Cleaning, maintenance, and repair of equipment, such as agitators and pumps
- Unblocking pumping systems
- Recovering materials such as scraper parts, brooms, or tools dropped in the pits

Another hazard of these types of confined spaces is that workers may accidentally fall into the pits (or through a crust on the surface), become engulfed, and drown.

	To help reduce the risk, choose equipment that doesn't require entry for repair or maintenance, such as a removable agitator. Install fences around pits to prevent unauthorized entry.
Milk tanks  Milk tank  Tanker truck	Milk tanks on dairy farms are usually horizontal stainless-steel cylinders with small entry hatches on top, near one end. Milk tanks are double walled. The space between the walls contains refrigeration piping and insulation. Tanker trucks may be found on dairy farms, though transfer of raw milk usually happens through transport companies specializing in this service. Normally, hazardous gases won't be present in a milk tank. However, some common cleaning and disinfecting chemicals can produce very toxic gases, even in residual quantities. The greatest risk is from mechanical equipment in the tanks,such as an agitator, that has not been properly de-energized and locked out. **Hazards** • Cleaning chemicals and disinfectants **Hazardous work** • Cleaning tank surfaces • Maintaining or replacing agitator parts • Repairing or cleaning pipe fittings To help reduce the risk, install an automated washer system so workers do not have to enter the tanks.

Mobile equipment

Tank wagon

Feed mixer

Mechanical equipment in a feed mixer

Mobile equipment used on dairy farms may include:

- Tank wagons (e.g., for pesticides, fertilizers, and liquid manure)
- Mixers (e.g., for mixing feed)
- Spreaders (e.g., for fertilizers)

Tanks may contain toxic gases from fermenting material, such as liquid manure, as well as aerosols from pesticides. Some of these gases and vapours are toxic and can rapidly cause death when inhaled at high concentrations. Some cleaning chemicals can also produce very toxic gases, even in residual quantities. Low oxygen conditions may occur if the tank has been empty for some time.

Hazards

- Hydrogen sulfide (H_2S)
- Ammonia (NH_3)
- Methane (CH_4)
- Pesticide residues
- Cleaning chemical residues
- Bacteria and mould
- Oxygen deficiency
- Energy stored in mechanical and hydraulic circuits

Mixers and spreaders contain moving mechanical parts. Workers may be at risk of injury or death if they fall into the operating machinery or if mechanical equipment is not properly locked out.

The power take-off of the tractor powers mechanical equipment on the unit, and the hydraulic system of the tractor powers the unit's hydraulic system. It's possible for energy to remain in circuits after the tractor has been shut down and linkages and hoses have been disconnected.

Mobile spreader

Hazardous work

- Adding material (e.g., feed or straw) to tanks, mixers, or spreaders
- Emptying tanks, mixers, or spreaders
- Repairing or cleaning equipment inside tanks, mixers, or spreaders
- Cleaning tank surfaces

To help reduce the risk, choose (or retrofit) equipment that doesn't require entry to mixers or spreaders.

Pump/lift stations

Liquid-manure pump station

Liquid-manure pump chamber

A pump station (also known as a lift station) is a below-ground chamber used to collect drainage from surface and subsurface sources. Pumps move the liquid to a higher level. Higher levels may include the interior of an above-ground storage tank, drainage structure, or sewer.

Pump stations on dairy farms handle raw liquid manure and liquid manure removed from bedding material. They may also handle relatively clean water collected from roofs and other sources.

Agitation (stirring, swirling, or aeration) of sludge by the pump can release trapped toxic gases. Agitation thins the fluid and causes bubbles and foam, releasing gas into the air. High concentrations of these gases released into the air can cause death in a few seconds.

Hazards

- Carbon dioxide (CO_2)
- Hydrogen sulfide (H_2S)
- Methane (CH_4)
- Bacteria and mould
- Oxygen deficiency
- Drowning

Hazardous work

- Cleaning equipment
- Unblocking inflow and outflow piping
- Repairing or modifying pipes or other components

	Workers may also be at risk of electrocution from the circuit on the pump or drowning if they fall. To help reduce the risk, choose (or retrofit) equipment that doesn't require entry to the station for maintenance and repairs.
Silos  Silo	When forage plants are stored in a silo, they ferment and produce hazardous gases. Production of these fermentation gases begins as soon as plants are stored and can continue for several weeks. Oxygen is consumed by the fermentation process. The gases may accumulate at the surface of the silage or forage. The gases may also flow down through the silo chute and collect at the base of the silo in the loading room. They may even flow into the barn if there's no airtight door. **Hazards** • Carbon dioxide (CO_2) • Ammonia (NH_3) • Hydrogen sulfide (H_2S) • Nitrogen dioxide (NO_2) • Bacteria and mould • Oxygen deficiency **Hazardous work** • Installing doors in the silo chute • Levelling forage or laying a tarp after filling • Positioning the unloader • Maintenance work or repairs to the unloader • Repairing or maintaining equipment in the silo • Working on the ladder in the discharge chute • Working in the loading room or in the barn Workers may also be engulfed by material in the silo.

Sumps

Drainage sump

Sumps are below-ground chambers used to collect drainage from surface and subsurface sources. When the trap in the outflow pipe overflows, collected water is then transferred to another location through the outflow pipe. Sumps act as separation chambers before discharging to stormwater drainage.

Sumps on dairy farms can accumulate organic matter in runoff from various sources. Sludge can trap gases from anaerobic digestion. Agitation thins the sludge and releases these gases. Fermentation gases are toxic and can rapidly cause death when inhaled at high concentrations.

Hazards

- Carbon dioxide (CO_2)
- Hydrogen sulfide (H_2S)
- Methane (CH_4)
- Bacteria
- Oxygen deficiency

Hazardous work

- Repairing or cleaning equipment in sumps
- Unblocking inflow and outflow lines
- Repairing or modifying wastewater piping

Workers may also be at risk of drowning if they fall into sumps.

Valve boxes (chambers)

Below-ground valve box

Valve boxes and valve chambers are small in-ground structures that house one or more valves in a piping system. Valve boxes may barely meet the requirements for classification as confined spaces.

However, people have died while working in these small chambers. The main cause of death is an oxygen-deficient atmosphere. Wastewater containing organic matter may remain in valve boxes long enough to ferment. Fermented liquids may leak from pumps, valves, or pipes, or seep from the surface. Fermentation gases are toxic and can rapidly cause death when inhaled at high concentrations.

Hazards

- Carbon dioxide (CO_2)
- Hydrogen sulfide (H_2S)
- Ammonia (NH_3)
- Methane (CH_4)
- Bacteria
- Oxygen deficiency

Hazardous work

- Inspecting valves and piping
- Cleaning, repairing, or modifying equipment in valve boxes
- Unblocking outlet pipes

To help reduce the risk, choose (or retrofit) equipment that doesn't require entry to the valve box for maintenance and repairs. For example, use pump, valve, or motor lifting devices.

Water tanks and cisterns

Water tank

Dairy farms have water tanks or cisterns for storing water that's used to wash down the milk parlour. (A cistern is a waterproof structure used for storing rainwater in arid areas.) These usually include horizontal and vertical tanks made of plastic and steel with hatches at the top. Some farms use open-topped tanks and poured-concrete enclosed cisterns.

Normally, hazardous gases will not be present in a water tank or cistern, provided the water is clean. However, some cleaning and disinfecting chemicals can produce very toxic gases, even in residual quantities. Low oxygen conditions may also occur if the tank has been sitting empty for some time. The greatest risk is from drowning, which can occur in as little as 15 cm of water.

Organic matter that has settled to the bottom of an open outdoor tank may ferment and produce highly toxic gases that can rapidly cause death when inhaled at high concentrations. These gases may be released if workers are disturbing sediment at the bottom of the cistern (for example, by walking on the sediment when the cistern is empty).

Hazards

- Cleaning chemicals and disinfectants
- Hydrogen sulfide (H_2S)
- Bacteria
- Oxygen deficiency

Hazardous work

- Cleaning tank surfaces
- Maintaining or replacing mechanical parts
- Repairing or modifying pipe fittings

There's also a risk of injury or death if mechanical equipment is not properly locked out.

Well pits (potable water)

Well pits

A well pit is the chamber at the top of a wellhead. A chamber located under the floor of a building is considered a confined space.

The well pit provides access to the well and pumping equipment. It also prevents freeze-up in the pressure tank and piping.

Normally, hazardous gases will not be present in a well, provided there's little organic material in the water. However, oxygen depletion can occur when metal rusts. This is most likely when the well pit is closed for a long time and condensation forms on metal surfaces.

Hazards

- Carbon dioxide (CO_2)
- Oxygen deficiency

Hazardous work

- Inspection
- Cleaning or maintenance
- Drowning in water on the floor
- Electrocution from faulty, deteriorated, or improper wiring or equipment

Confined spaces inventory

You can use the following table to help complete the inventory of confined spaces on your farm.

Description of confined space
Location
Access/egress (e.g., locations, sizes, and shapes of openings)
Contents of space (e.g., manure, grain, or milk)
Equipment in space (e.g., pumps, augers, or valves)

Function or use of space
Adjacent spaces
External surroundings
Security (e.g., signage, barriers, locks)
Entry required (Yes/No and reason)
Comments

Step 4: Communicate with workers

Educate your workers about confined spaces. Be sure they know what a confined space is, and make it clear that they must not enter any confined spaces without proper training, equipment, and permission.

Ongoing communication with your workers is important because conditions on the farm can change over time and new hazards can develop. Inform your workers about the specific confined spaces on your farm and the hazards those spaces may contain. Explain what the safety signage means and why some spaces have been locked to prevent unauthorized entry.

Another way to encourage communication about confined spaces on your farm is to talk about them during toolbox talks and safety meetings. Ask your workers to tell you if they find new confined spaces or possible hazards.

You should also encourage your workers to tell each other about possible hazards and to watch out for each other. If a worker sees someone entering a confined space without authorization, he or she should stop that person from entering the space or immediately report it to a supervisor.

Step 5: Determine which spaces need to be entered

Contracting out confined space work

Hiring a qualified contractor is a legitimate and acceptable way to ensure worker safety and delegate the requirement for specialized training and equipment. However, you must still ensure contractors are competent to enter and work in confined spaces, and that they're following safe work procedures prepared by a qualified person. Make sure the contractor has a confined space program and safe entry procedures in place before beginning work in the confined space.

The first step of this booklet focused on identifying confined spaces and creating a written inventory of them. Now, you must determine whether or not workers will need to enter any of those spaces to carry out work. Some confined spaces require entry for inspections, maintenance, or repairs. If entry is required, list the reasons why on your inventory.

Making confined spaces safer

The best way to avoid confined space hazards is to find a way to do any necessary work outside the space. The following are a few examples:

- Workers can use a portable vacuum system to remove remaining material from a bin without entering the confined space.
- You may be able to permanently move equipment to a new location outside the confined space.
- It may be possible to realign equipment so it can be removed from the space for repair and then placed back into the space. For example, consider installing a removable agitator system in a manure pond so workers won't have to enter the pond when repairs are necessary.

If it's absolutely necessary to work inside the confined space, look for ways to make it safer. Can the space be modified? For example, can you enlarge the opening? If the space can only be accessed from the top, can you install another opening at the bottom?

Before a confined space is ready for entry, you must prepare and implement a confined space program that includes safe entry and work procedures.

Part C: Preparing to work in confined spaces

Confined space entry procedures

If you or your workers have to enter a confined space, you must develop and implement a confined space entry program and safe entry procedures. These procedures may be simple or complex, depending on the:

- Nature of the confined space (e.g., how difficult it is to get in and out)
- Types of hazards
- Type of work to be performed (e.g., welding or painting within the space will introduce additional hazards)

A qualified person must write procedures specific to each confined space. These procedures will take into account the conditions in the space before entry, as well as the work activities that will take place inside the space. Workers must be educated and trained (hands-on training) in these entry procedures.

What to include in procedures

Your confined space entry procedures must include:

- Lockout and isolation procedures
- Cleaning procedures, if required
- Air testing requirements for pre-entry and for work being conducted in the space
- Ventilation procedures
- Assignment of a standby person
- Description and use of personal protective equipment (PPE) and any other necessary equipment (e.g., equipment required for entry and exit)
- Rescue procedures
- Coordination of work activities

Confined space entry procedures must also include a confined space entry permit if:

- Work will take place in high-hazard atmospheres
- Lockout or isolation is required
- There's a hazard of entrapment or engulfment

Standby persons and rescue personnel

Standby persons

All confined space entries must have a standby person stationed at or near the entrance to the space. In some cases, more than one standby person may be required, such as if more than one entrance is used by workers in the space. The standby person will maintain communication with the workers in the space and respond to an emergency situation by taking appropriate action, such as summoning confined space rescue personnel.

Rescue personnel

A dedicated rescue team must be available on site for any confined space entry. It may consist of workers on the farm or a subcontracted, qualified rescue services provider. In either case, written rescue procedures for confined spaces must be prepared by a qualified person.

If in-house rescue team members are used, they must be specifically trained for confined space rescue. Training must include practical, hands-on rescue scenarios. Rescue team members must also conduct drills on an annual basis.

Rescue personnel must be stationed at the entrance to the confined space and be properly equipped and capable of entering the space if a rescue is necessary. Do not rely on 911 to provide rescue services. As the employer, you're required to pre-arrange any rescue services.

Lockout and isolation

If a confined space entry is necessary, hazards must be isolated and controlled. Workers must be protected from hazardous energy (electrical, hydraulic, and mechanical) and harmful substances (solids, liquids, gases, and vapours) that could be discharged from pipes or conduits beside or leading to the confined space. Product sources, energy sources, and controls for pumps, motors, and other moving equipment must be locked out (for example, by attaching locks to switches and valves) or isolated (for example, by disconnecting piping or inserting a blank or blind in the piping).

Physical locks are generally used to prevent machinery or equipment from accidentally starting up or moving. Applying a personal lock is important for ensuring the device controlling the energy or other hazard remains in the off position.

Shutdown, lockout, and isolation points will be different for each confined space and activity. A written procedure must be created and followed for lockout and isolation. Each isolation point must be visually checked before a worker enters a confined space.

In addition to specialized confined space entry training, workers involved in confined space entries must receive training, instruction, and information regarding lockout and isolation.

Air testing

Before a worker enters a confined space, the atmosphere must be tested in accordance with written procedures developed by a qualified person. Exposure to explosive gases, toxic gases, or an oxygen-deficient atmosphere can cause serious injury, illness, or death.

Gas monitors contain sensors that detect specific toxic gases (for example, ammonia, carbon monoxide, hydrogen sulfide, and nitrogen dioxide), as well as oxygen-deficient and explosive atmospheres. Testing must be conducted within the confined space before it's ventilated and at least 20 minutes before a worker enters the space. The results must be recorded and posted at all points of entry to the confined space.

At least one worker in the confined space must wear a gas monitor, whenever practicable. The monitor provides continuous readings of the oxygen level and any harmful gases that may be present. If the concentration of any of these gases exceeds the alarm limits, an alarm will warn workers to leave the confined space.

Gas monitors must be properly configured, calibrated, and maintained. An inaccurate monitor could lead to a serious incident. Workers must also be equipped with the right kind of monitor for the situation – for example, monitors with sensors for ammonia and hydrogen sulfide will be useless in a confined space containing carbon monoxide and nitrogen dioxide.

Ventilation

All confined spaces must be ventilated before and during work in the space. Air blowing into a confined space will create air currents that mix outside air with stagnant air. The faster the air moves, the more air mixing will occur. As the mixed air exits the space, it carries out contaminants.

Ventilation commonly consists of electric fans attached to ducting. A qualified person must provide written work procedures that describe the following:

- Types of fans and ducting used
- Number of fans required
- Length and number of allowable bends in the ducting
- Appropriate placement of the equipment (e.g., upwind or downwind of the entrance to the space)

Fans and ducting must be properly positioned to adequately ventilate every occupied area inside the confined space and to leave no pockets of contaminated air. It's good practice to strive for maximum ventilation for the space while maintaining worker comfort.

Notes

Notes

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Visit our website at worksafebc.com.

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