

Industry guidebook

# Working Safely with Slurry



Branchearbejdsmiljøudvalget Jord til Bord

# Foreword

This guidebook on working safely with slurry is a publication of the Jord til Bord ["Farm to Table"] industry working environment committee.

The members of the Jord til Bord committee represent various parties within the labour market. It is a permanent committee operating under the auspices of BFA Transport, Service, Turisme og Jord til Bord, a Danish industry association.

The Agricultural Working Environment Committee [Danish: Jordbrugets Arbejds miljøudvalg] is a permanent sub-committee under the Jord til Bord committee. This committee handles matters related to working environments in the agriculture, forestry, horticulture, and landscape gardening industries.

The committee's members, purpose, and work are outlined on the Jord til Bord website. The Agricultural Working Environment Committee has prepared this guidebook in collaboration with SEGES, an independent research and development organisation.

The Danish Working Environment Authority has reviewed this guidebook and determined that its contents conform to the provisions of the Danish Working Environment Act. The Danish Working Environment Authority has only reviewed the guidebook on an as-is basis, without regard for whether it addresses all relevant topics in the area in question. This determination may be invalidated by future technological developments.

A digital version of the guidebook is available from [www.baujordtilbord.dk](http://www.baujordtilbord.dk)

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# Introduction

Slurry-related deaths still occur in the agricultural industry. Slurry must be handled with great caution, as it can release gases at concentrations that are high enough to be fatal.

Stored slurry produces hydrogen sulphide (H<sub>2</sub>S), a gas that is then released when the slurry is moved. Even small amounts of hydrogen sulphide can inhibit your sense of smell, preventing you from smelling that there is danger present. There have been cases in which the concentration of hydrogen sulphide was so high that farmers lost their lives while working on pre-tanks and other installations. At high concentrations, respiratory failure can occur after just one or two breaths, and death follows shortly thereafter. There are **no warnings**—*nothing you can see and nothing you can smell*—to indicate the presence of dangerously high concentrations.

The purpose of this guidebook is to inform farmers and farm employees about focal points for working environments in and around slurry systems, tanks, and pumping sites so as to avoid causing harm to those working with slurry.

The guidebook includes a collection of fact sheets that illustrate and describe working environment and safety conditions to be aware of when working with slurry. Slurry handling occurs in a variety of situations; these fact sheets present five specific situations. The guidebook also includes explanatory content about the dangers of handling slurry without taking proper precautions. It concludes with examples of signs that can be posted in appropriate places at an agricultural operation.

## Alive and well

**One farmer is lucky to be alive and well after a severe case of hydrogen sulphide poisoning caused by slurry gas while working in a dry well at a depth of two metres. As he was coming up and out of the well, he became completely paralysed, fell backwards, and sustained injuries to the back of his head.**

**An employee from a machinery contractor was tasked with monitoring the situation and keeping the well free of slurry using a suction device. He and a female farm employee were able to fasten a rope around the farmer's waist twice.**

**Both were severely affected by the gas during the incident. The farmer was lifted from the well using the suction device's crane, and the crew of the ambulance that had been called provided first aid.**

**The farmer was not using personal protective equipment. If other people and the right equipment had not been present, the farmer likely would have died.**

# Facts about slurry gases

## Gases in slurry

There are two gases in particular to be aware of when working with slurry: hydrogen sulphide ( $\text{H}_2\text{S}$ ) and ammonia ( $\text{NH}_3$ ). Both ammonia and hydrogen sulphide come from manure, and they are released when slurry is set in motion.

The gases move upwards through the slurry. Particularly when agitating or emptying chambers and channels, large volumes of these gases may be released.

Methane ( $\text{CH}_4$ ) is another slurry gas. Methane is not toxic, but it does present an explosion hazard. Like hydrogen sulphide and ammonia, methane is produced in the absence of oxygen. Methane can displace air (and by extension, oxygen), creating a risk of asphyxiation. The main concern with methane is the risk of an explosion at a covered pump site or slurry tank. At the right concentration, the gas can explode in the presence of a spark (e.g., from a tool or a lit cigarette).

## Hydrogen sulphide

Hydrogen sulphide is produced in oxygen-free environments, such as slurry channels, chambers, pipes, and closed tanks. Hydrogen sulphide is formed during the anaerobic decomposition of organic substances in manure; this process begins in the animal's digestive system.

Hydrogen sulphide is not found in sheds where slurry remains stationary in channels or chambers, but when these are emptied, the slurry begins to move, releasing the hydrogen sulphide and allowing it to come up into the sheds. Disruptions to normal operations can lead to dangerous situations, such as when working on a clogged slurry system.

## Hydrogen sulphide

Hydrogen sulphide is a colourless gas with a characteristic smell, often described as the smell of rotten eggs.

The catch is that the gas can only be smelled at low concentrations. At harmful concentrations, the sense of smell is inhibited, so it is no longer possible to smell the gas.

In other words, there are no warnings—nothing to see and nothing to smell—that indicate the presence of dangerously high concentrations.



The photos above show various types of gas detectors. These detectors can be carried in various ways. They may be fastened to clothes, placed on a key ring, held in the hand, or worn on a lanyard around the neck.

Hydrogen sulphide is toxic because it inhibits the blood's ability to transport oxygen, and it damages the tissues of the eyes and lungs.

Because hydrogen sulphide cannot be smelled at harmful concentrations, a gas detector is needed to identify the presence of the gas. Various kinds of gas detectors with different designs are available. A typical gas detector is about the size of a mobile phone. It can be fastened to clothing with a clip, held in the hand, or worn around the neck with a lanyard. In the presence of harmful gas concentrations, the detector sounds an alarm.

Human reactions to different concentrations of hydrogen sulphide are listed in Table 1.

#### What is ppm?

Gas concentrations are given in ppm (parts per million).  $\text{ppm} = \frac{\text{cm}^3}{\text{m}^3}$ ; the measurement represents a given concentration of a gas in a given volume of air.  $1000 \text{ ppm} = 0.1\%$  of the air.

#### Ammonia

At high concentrations, ammonia is recognisable as a strong, pungent, stinging, and sharp odour. It creates an unpleasant sensation in the nose.

Ammonia is primarily formed by the decomposition of urine and is present in the air in sheds. Ammonia can irritate the skin and mucous membranes, as well as the upper respiratory tract. Breathing concentrations of ammonia above the limit value (20 ppm)

### Death in a pre-tank

**Two men had entered a pre-tank for slurry to fix a pipe that had begun leaking.**

**But something went wrong, and a third man arrived to help get the two men out.**

**For one of them, it was already too late. He had inhaled hydrogen sulphide, which had formed an invisible "blanket" on top of the slurry.**

**The man was not using personal protective equipment.**

**There was no opportunity to save the man in this accident.**

can make a person more susceptible to upper respiratory tract infections. However, serious injury only occurs at or above concentrations of about 700 ppm.

Farmers who are exposed to lower concentrations of 25–100 ppm for extended periods may experience mild acute symptoms, such as discomfort, coughing, and watery eyes. Fatal accidents involving ammonia are rare, but respiratory

**Table 1. Human reactions to different concentrations of hydrogen sulphide.**

Concentration, ppm	Human reaction
0.025-0.1	Lower olfactory threshold
1	Weak smell
3-5	Smell is unpleasant, like rotten eggs
5	The hygienic limit value: concentrations above this limit value can cause injuries
30	Strong, unpleasant smell; mild eye irritation
30-100	Upper olfactory threshold: The sense of smell is inhibited, accompanied by pressure in the chest, difficulty breathing, headache, nausea, and dizziness
500-600	Exposure to concentrations of 500-600 ppm is fatal after 30 minutes.
> 700	Consciousness is lost after one or two breaths and respiratory failure occurs, followed by death

illnesses, such as asthma and similar conditions, can occur.

Human reactions to different concentrations of ammonia are listed in Table 2.

The concentration of ammonia can be monitored using a gas detector, which will sound an alarm at high concentrations. These gas detectors are about the size of a mobile phone, and they can be fastened to clothing or equipment.

#### **Limiting the production of slurry gases**

Agitating slurry when it is stationary will cause the hydrogen sulphide in it to rise (much like the carbonic acid in a fizzy drink), so great caution is needed. Emptying, agitation, and back-flushing must be carefully planned and executed to preclude the risk of hydrogen sulphide poisoning.

Agitation and back-flushing should only be performed when slurry channels are empty, and before beginning agitation and channel back-flushing, an extended pump cycle should be run to allow the slurry to off-gas.

When emptying slurry channels, there must be an air gap of at least 0.5 m between the shed floor (with drainage holes) and the surface of the slurry. Where possible, ventilation should also be increased to eliminate slurry gases and odours as quickly as possible.

The safest approach is to ensure that emptying (agitation and back-flushing) does not start until the day's work in the shed has ended, thereby precluding the exposure of personnel to high concentrations of NH<sub>3</sub>, hydrogen sulphide, and unpleasant odours in the shed.

**Table 2. Human reactions to different concentrations of ammonia.**

<b>Concentration, ppm</b>	<b>Human reaction</b>
5-15	Olfactory threshold at about 5-15 ppm
20	The hygienic limit value: concentrations above this limit value can cause injuries
100	Eye, nose, and throat irritation experienced after a few minutes
700	Irritation and perception of asphyxiation
5,000	Pulmonary oedema, possible respiratory failure, seizures
10,000	Fatal

# Design, placement, and monitoring of slurry systems

Slurry systems must be responsibly designed. Their components must be made from suitable materials and in dimensions that confer the necessary strength and durability.

Slurry systems must be secured to avoid putting users and others at risk. This should be achieved through design to the greatest extent possible, and otherwise through the use of safety equipment.

Slurry tanks, pre-tanks, and other pump sites must be placed in open outdoor locations.

Sheds and pump sites should be connected so as to effectively prevent gases released from slurry (e.g., during agitation and pumping) from entering sheds and other buildings.

In areas where traffic may pass, coverings on pre-tanks and other pump sites should be designed to allow large machinery to pass over them. If a container's cover is not designed to handle traffic, barriers should be put up around it to prevent vehicles from accessing it.

Containers for liquid manure and silage liquid (with capacities of 100 m<sup>3</sup> or greater) must be inspected at least every 10 years, or every 5 years for certain containers. The inspection must ensure that liquid manure and silage liquid are stored in properly maintained containers that meet strength and tightness requirements set out in applicable regulations.

Those carrying out such inspections must take appropriate precautions, including using the required safety equipment.



# Instructions for use

When a slurry system is designed and installed, it must be accompanied by instructions for use which, at a minimum, indicate that:

- the correct safety signage must be posted
- agitation and back-flushing should only be performed when slurry channels are emptied
- emptying, agitation, and back-flushing of slurry channels should be appropriately planned
- only water or slurry that has off-gassed in an extended pump cycle should be used for agitation and back-flushing of slurry channels
- when agitating and back-flushing slurry channels, there must be an air gap of at least 0.5 m between the shed floor (with drainage holes) and the slurry surface
- for work that requires entering a slurry container, slurry channel, or similar space, a safety line and self-contained breathing apparatus must be used; there should additionally be a helper to operate a hoist capable of pulling the worker back up and out of the space
- descent into slurry containers, pump shafts, and slurry channels should be left to companies that use self-contained breathing apparatus, and whose employees are trained in the use of such breathing apparatus

- when a person descends into a slurry container or slurry channel, if the person is not equipped with a self-contained breathing apparatus, all of the following conditions must be met before descent begins:
  - the container must be completely free of slurry
  - storage tank and discharge system dampers must be secured to prevent accidental opening
  - the container must be responsibly ventilated; closed containers must be ventilated with blowers, and all openings must be opened
  - the concentration of hydrogen sulphide in the air must not be harmful, and must be below the applicable limit value (5 ppm or 7 mg/m<sup>3</sup>).

## Instructions for use

**Store the instructions together with your APV so that it is easy to find when planning slurry management operations.**

# Working with slurry

Assume that the concentration of hydrogen sulphide in any *slurry or liquid manure container, pre-tank, pump shaft, slurry channel, floor drainage channel, or slurry transport tank* is high enough to cause injury.

Properly plan slurry management operations:

- determine and inform employees of where and when slurry operations will occur
- require a minimum of two people to be present for all slurry operations
- remain in contact during operations; ensure each person knows where the others are
- keep a charged mobile phone with you to facilitate contacting team members

## Fatal concentrations

Lethal concentrations of hydrogen sulphide—as high as 700 ppm—have been measured downwind from slurry during agitation. At slurry pump outlets, even concentrations as high as 3000 ppm have been measured!

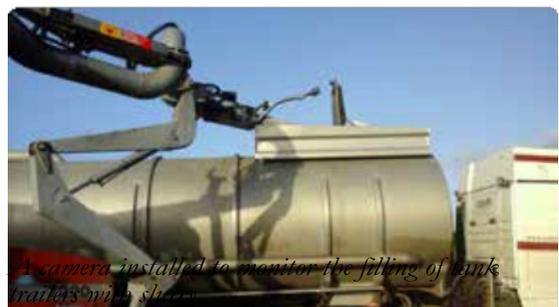
- if appropriate, use a gas detector (attached to your clothing) to measure hydrogen sulphide, so you can be alerted to hazardous concentrations
- ensure the proper tools and equipment are within reach;

## Too close for comfort—but alive and well

This incident occurred one day in winter when slurry was to be transferred into a tank trailer. An employee was standing on top of the trailer to observe the tank's fill level. While on top of the tank, the employee suddenly began to feel ill from exposure to slurry gases. He was able to stop the pump with a remote control, get down from the trailer, and run away. While running, he experienced severe tremors and briefly lost consciousness. Miraculously, the employee managed to escape unharmed.

This employee was not using personal protective equipment.

After the incident, a camera was installed on the slurry pump, and it is now used to monitor pumping operations.



for instance, a fixed hoist that a safety line can be attached to. Familiarise yourself with the equipment so that you can use it confidently when needed.

#### Use a breathing apparatus

- a self-contained breathing apparatus should be used when descending into tanks, channels, sumps, pump sites, or slurry transport tanks where there is a risk of encountering an environment low in oxygen and high in hydrogen sulphide and ammonia.
- a filter-based breathing apparatus (with or without turbo) with an appropriate gas filter should be used when working near moving slurry where there is a risk of hydrogen sulphide release, but where there is no risk of encountering low-oxygen conditions.

#### Use of additional safety equipment

If there is a risk of coming into contact with slurry, you should also use:

- gloves (made of waterproof material)
- eye protection
- a protective suit (made of breathable, waterproof material), if you will be descending into a pump site, slurry tank, slurry channel, or slurry transport tank.

### Calling in the experts

Repair and clean-up work that involves descending into slurry containers, pump sites, slurry channels, sumps, and slurry transport tanks should be left to companies that use self-contained breathing apparatus and have employees trained in performing these tasks.

#### Descent into slurry containers or slurry channels



Anyone descending into open slurry containers, pump sites, sumps, or slurry channels must ***always*** be equipped with a **self-contained breathing apparatus** ***and*** must be aware of all of the following conditions:

- the container must be completely free of slurry
- storage tank and discharge system dampers must be secured to prevent accidental opening
- the container must be responsibly ventilated; closed containers must be ventilated with blowers, and all openings must be opened
- always use a safety line with a hoist. The hoist should be installed in a fixed location. At least one helper should be available to man the hoist and retrieve the descending person.

# Breathing apparatus

Employers whose business involves handling slurry should ensure that:

- personnel are provided with their own breathing apparatus
- breathing apparatus are in use as soon as any work involving slurry begins
- breathing apparatus remain in use throughout the entire job, from start to finish

- breathing apparatus are in working order, clean, dry, and disinfected before use
- users are familiar with the correct use of their breathing apparatus, including the instructions supplied with the equipment
- users are aware of the risks involved in failing to use breathing apparatus.



*An employee with a breathing apparatus that requires a compressor or pressurised cylinder to provide a supply of air.*

*A red filtration panel is visible. This panel removes small particles and odours. The panel should only be installed and used if the air source is a compressor (as opposed to a pressurised cylinder).*

*A compressor installed for this purpose **must** be approved to supply breathable air and meet the standards in DS/EN 12021.*

There are two primary types of breathing apparatus to choose from:

- self-contained breathing apparatus
- filter-based breathing apparatus

A breathing apparatus can either supply clean air on its own (self-contained breathing apparatus) or filter ambient air before it is inhaled (filter-based breathing apparatus).

Breathing apparatus should be chosen according to the type and concentration of contaminants present. If there is a risk of encountering an oxygen-deficient atmosphere, **always** choose self-contained breathing apparatus.

### Self-contained breathing apparatus

When performing work in pump sites, slurry tanks, slurry channels, or slurry transport tanks, a self-contained breathing apparatus **must** be used. A filter-based breathing apparatus is **not** sufficient.

#### Several types of self-contained breathing apparatus are available:

- Breathing apparatus with air supplied by a compressor or stationary pressure vessel. This type of apparatus has an unlimited air supply and is easy to maintain, but the user's movement is restricted by a hose.
- Breathing apparatus with air supplied by portable cylinders. The cylinders weigh 5–18 kg and offer a limited supply of air, but the user's movement is not restricted.
- A rebreather is a type of breathing apparatus that uses compressed oxygen.
- A supplied-air respirator is a type of breathing apparatus which allows the user to breathe through a hose that runs to a location with fresh air. This system is less safe than other types of breathing apparatus; as a result, it should ordinarily not be chosen.

Naturally, using any kind of self-contained breathing apparatus correctly is **absolutely vital**.

A self-contained breathing apparatus can be used for an entire work day, provided that breaks are taken. The duration of breaks can be adjusted depending on the user's workload and level of discomfort.

### Self-contained breathing apparatus

**In-depth knowledge of the proper use of any self-contained breathing apparatus is crucial.**

**If there are any doubts about the correct equipment to use, or the correct manner in which to use the equipment, a qualified professional *must* be contacted and hired to perform the work.**

### Filter-based breathing apparatus

Filter-based breathing apparatus may consist of a full or half mask with a replaceable filter.

A particulate filter is not sufficient for protection from slurry gases; an appropriate gas filter must be used. Be certain you are using the correct type of filter. Your supplier can guide you to the right type of filter for your particular application.



*An employee wearing a full-mask filtration apparatus pulling a slurry plug in a pig shed. Note that the employee is also wearing a hydrogen sulphide detector.*

A filter-based breathing apparatus with an appropriate gas filter should be used when working near moving slurry where there is a risk of hydrogen sulphide release, but where there is **not** a risk of encountering an oxygen-deficient environment. When pulling slurry plugs, there is a risk of hydrogen sulphide release, so a filtration apparatus may be needed to perform this work safely.

Filter-based breathing apparatus may also be equipped with a "turbo unit", which is a battery-powered motor that blows air into the apparatus through a filter. This makes it easier to breathe compared to using

a filtration apparatus without such a unit, so this type of apparatus can be used beyond the ordinary three-hour limit.

Because breathing through filtration apparatus puts strain on the respiratory system, they may only be used for three hours per workday. The three hours need not be continuous. If a breathing apparatus will be required for more than three hours in a single day, either a turbo blower-equipped apparatus or a self-contained breathing apparatus should be used for the entire day.



*An employee wearing a full-mask filtration apparatus equipped with a turbo unit. The battery-powered motor is visible on the employee's lower back. Note that the employee is also wearing a hydrogen sulphide detector.*

# Use of safety signage

In any operation where work situations involving risks may occur, warnings must be posted as to the nature of the risks. A uniform marking system with international symbols and colours is used.

Take note of the following:

- Employers must use appropriate safety signs to guide, warn, and instruct employees regarding risks
- Safety signage should be as simple as possible
- Safety signs should be made of materials that can withstand impacts, adverse weather conditions, and other stress from the surrounding environment
- Safety signage must be placed in well-lit, conspicuous areas.

## Signage training

Employers must ensure that their employees are given appropriate and adequate training on the meanings of signs.

For example, the meanings of signs and how employees should react to their presence could be a topic for review at a staff meeting.

## Signage

Be aware of the following signage requirements for slurry systems:

Poison hazard warning signs must be posted at all access openings to *slurry containers and pump sites (including pre-tanks) alongside* first aid information for poisoning incidents.

Fire hazard warning signs must be posted at *pump sites*.

*Any shed* equipped with a slurry system must clearly display a sign explaining the system's operation and safety precautions, *as well as* a poster with first aid information for poisoning incidents.

For *slurry transport tanks*, weatherproof signs must be affixed to the front end of the tank and any ladders, indicating that slurry can release deadly gases during filling and that no person may remain on top of the tank during filling.



# Establishing a floating layer in a slurry tank

To minimise the evaporation of ammonia, at a minimum, slurry containers should always be covered with either:

- a fixed cover, such as a canvas sheet, a tent cover, a concrete cover, or a similar object; or
- a dense, naturally floating layer of a material like straw, lightweight clay aggregate (Leca), or a similar material.

Using straw as a floating layer is safe, and contractors can be readily hired to place a floating layer of straw.

## Slurry tank inspections

Danish law requires that users of containers with dense, non-fixed coverings

***Never step out onto a floating layer, no matter how solid it looks!***

keep a logbook updated at least once per month. The logbook must include a description of the condition of the floating layer, which requires a monthly inspection of the layer in the slurry tank.

During the inspection, be mindful of safety measures so that there is no risk of falling into the slurry tank, falling down a platform or ladder, or slurry poisoning.



*A machinery contractor placing a floating layer of cut hay. This process can generate considerable dust, so the driver must remain inside the cabin or wear a dust mask. Any other employees who must perform work near this operation must also wear dust masks.*

# Workplace assessment (APV)

The first step in conducting a workplace assessment [Danish: arbejdspladsvurdering (APV)] is to evaluate the working environment at the facility and describe any problems or challenges it faces.

The safe handling of slurry is a natural point for consideration. This includes the use of personal protective equipment, supportive equipment, awareness of safety signs, training, and staffing during particular work tasks.

The use of external support for specific tasks (e.g. pump repair, tank cleaning, etc.) is also included in this kind of assessment.

As part of the workplace assessment process, a discussion should be held to address:

- how individual slurry handling tasks are carried out at this particular workplace
- what to do if something goes wrong along the way
- how to handle accidents.

*Preparing a workplace assessment requires the involvement of employees, and safe handling of slurry is a natural topic to discuss.*



# Contingency plan

A contingency plan is a practical tool that management and staff can use when dealing with extraordinary events; for example, when an accident occurs.

Such a plan should provide a general description of how situations will be handled. For instance, who should be contacted? What sources are there for help dealing with practical matters? First aid? Acute, professional psychological assistance?

This plan must be known to employees and management so that they can actually apply it in the event of an accident.

Review the plan at a staff meeting and ensure that all new employees are informed of it. Suggested discussions for a contingency plan review:

- Review the first aid reference poster
- Determine whether a first aid course is needed
- Find out where the nearest automatic external defibrillator (AED) is.
- Consider organising a drill to test workplace preparedness in the event of a slurry poisoning incident, for example.
- Discuss the use and maintenance of safety equipment.

## Slurry spills and leaks

If an accident occurs that results in a slurry leak or spill, measures must be taken to mitigate its impact.

Before handling the slurry, it is important to wear safety equipment to preclude personal injury during the mitigation process.

In Denmark, immediately contact the municipal emergency response centre (by calling 112), which can help contain the spill and assist with clean-up.



*Sign placed on a shed door to inform employees of the location of a defibrillator.*

## 112 app

With Denmark's official [112 app](#), you can call the emergency response centre and send the centre your mobile's GPS co-ordinates at the same time. Your GPS co-ordinates can make a critical difference in getting help as quickly as possible. Ultimately, this information could save lives.

The TrygFonden Hjertestart app can provide you with the address of the nearest defibrillator.

Also see BAU Jord til Bord's [Contingency Plans for Personal Injury guide](#), which can help you to develop a contingency plan for your own business.

## Agriculture

# Pre-tank and other pump sites

**Slurry gases are a cause of fatal accidents in agriculture. In the case of storage tanks and other pump sites, the primary risk is none other than that of slurry gas-induced poisoning.**

Despite the risk of death, there are still instances of farmers entering pump sites with no protective equipment whatsoever, such as to repair a pump.

### Agitation

The risk of a gas-related accident is greatest when slurry is moved, such as during pumping or agitation. During agitation, toxic and explosive gases (hydrogen sulphide, ammonia, and methane) are released. Hydrogen sulphide has been repeatedly shown to be deadly and resulted in fatal accidents.

### Repairs

The pump and agitator must be able to be lifted into the open for maintenance and repairs. Bring a front loader, lift the pump out, and safely repair it in an open outdoor area.

Repairing and cleaning are **best** left to professionals with specialised equipment.

### Switches

Start and stop switches must be located at least 1.5 metres from pump shaft openings.

### Coverings

A missing or damaged covering

unnecessarily elevates the risk of falling into a slurry system.

- Pump shafts must be securely sealed with coverings.
- Coverings must be intact and secured so as to make removing them non-trivial.

### Signs

Safety signs indicating the possible presence of deadly slurry gases should be posted, as well as first aid posters. Fire hazard warnings must also be posted at pump sites. Signage must be in good condition and placed in well-lit, conspicuous locations.

### Near pump sites

Avoid conducting any other work near a pump site when pumping slurry.

- Stay as far upwind from the pump as is practical, so the wind carries the gases away from you.
- This is a good time to use a gas detector that measures hydrogen sulphide, which will sound an alarm in the presence of harmful concentrations.

### Train and plan

Train all employees on how to handle work in and around pump sites.

Collaborate to plan work in these areas.



Do **not** climb into a pre-tank without full personal protective equipment!

Remember—there are professionals you can call to help you with this work.

When descending, **always** use a self-contained breathing apparatus **and** keep **all** of the following points in mind:

1. The container must be completely free of slurry.
2. Storage tank valves must be completely closed to prevent slurry from flowing out.
3. The container must be responsibly ventilated;
4. Always use a safety line with a hoist. The hoist should be installed in a fixed location. At least one helper should be available to man the hoist and retrieve the descending person.

[www.baujordtilbord.dk](http://www.baujordtilbord.dk)

### Laws and regulations

[DWEA Regulation 2.6.1.1 from August 1996 on liquid manure systems](#) includes provisions regarding [safety signage](#) required for pre-tanks, as well as [first aid](#) information

DWEA Guideline D.5.4 from January 2008 on [respiratory protection](#)

## Agriculture

# Slurry tank

**Slurry gases are a cause of fatal accidents in agriculture. When dealing with slurry tanks, the primary risk is none other than that of slurry gas-induced poisoning.**

To homogenise slurry, which is required before emptying a tank, the slurry must be agitated. During agitation, toxic and explosive gases (hydrogen sulphide, ammonia, and methane) are released. Hydrogen sulphide has been repeatedly shown to be deadly and resulted in fatal accidents

### Coverings

The pump site's covering must be handled from the ground using the fitted liners.

**Never** walk or drive on or over the tarpaulin.

### Access openings

Any covered container which personnel can descend into for access must be capable of being ventilated through at least two openings with a blower.

The access opening must be designed to permit helpers to easily rescue an unconscious person.

### Signs

Safety signage indicating the possible presence of deadly slurry gas must be posted at all slurry container access openings, alongside first aid posters.

Signage must be in good condition and placed in well-lighted, conspicuous locations.

### Barriers

Slurry tanks must be secured by fences or coverings, for the safety of children and others who should not be present in or around these areas.

Open slurry tanks must be surrounded by solid fencing of a height of at least 1.5 metres above ground level. If there are work platforms present, they must also be fenced off.

If wire fencing is used, the mesh spacing may not exceed 40 mm. Fence locks must not be unlockable without the use of an additional implement.

No trees, ladders, tyres, straw bales, pallets, etc. may be placed around or against a slurry tank. This could negate the effect of the fence by allowing children to climb up the objects and potentially fall into the slurry tank.

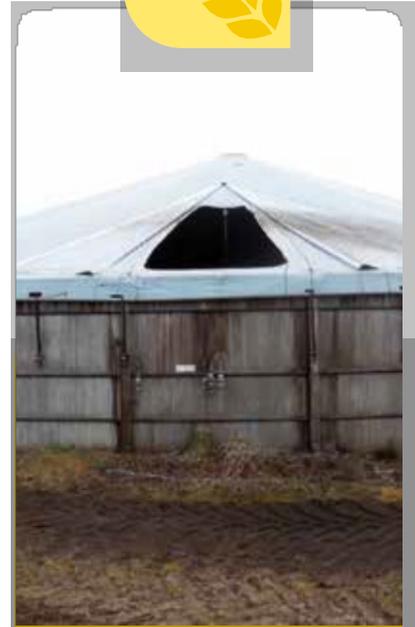
### Clean-up

Remember that professional help is available for clean-up jobs.

### Train and plan

Train all employees on how to handle work in and around tanks.

Collaborate to plan work in these areas.



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Remember—there are professionals you can call to help you with this work.

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1. The container must be completely free of slurry.
2. The container must be responsibly ventilated;
3. Always use a safety line with a hoist. The hoist should be installed in a fixed location. At least one helper should be available to man the hoist and retrieve the descending person.
4. This is a good time to use a gas detector that measures hydrogen sulphide, which will sound an alarm in the presence of harmful concentrations.

[www.baujordtilbord.dk](http://www.baujordtilbord.dk)

### Laws and regulations

[DWEA Regulation 2.6.1.1 from August 1996 on liquid manure systems](#) includes provisions regarding [safety signage](#) required for slurry tanks, as well as [first aid](#) information [DWEA Guideline D.5.4 from January 2008 on respiratory protection](#)



Branchearbejdsmiljøudvalget Jord til Bord

## Agriculture

# Slurry transport tank

**Slurry gases are a cause of fatal accidents in agriculture. Transporting slurry can present the risk of slurry gas-induced poisoning if the slurry is not handled safely and correctly.**

About 30 million tonnes of slurry are transported in March and April. The transport period is short, so many hours are worked every day during this time. This comes with the risk of fatigue and carelessness.

**Prepare slurry transport tanks well ahead of time.** Safely transporting slurry begins with preparing transport tanks in advance. Inspect, repair, lubricate and replace components to avoid technical breakdowns, so you can avoid stressful situations during the slurry season.

### Filling

- Keep clear of the transport tank's filling point when pumping slurry from a storage tank into a transport tank.
- Stay as far upwind from the pump as is practical, so the wind carries the gases away from you.
- This is a good time to use a gas detector that measures hydrogen sulphide, which will sound an alarm in the presence of harmful concentrations.
- Consider staying in the driver's compartment; an activated charcoal filter in the cab's ventilation system can minimise the risk of inhaling slurry gases.

### Keep the level gauge in working order

Make sure the level gauge on the transport tank works correctly to eliminate the need for visual inspection.

### Signs

Signs must be displayed on slurry transport tanks to warn of the risk of slurry gas-induced poisoning and indicate that remaining on the tank during filling is prohibited.

The signs must be placed on the front end of the slurry tanker or on a ladder, if present, and in positions where they will not be contaminated by slurry.

The signs must also be legible and made of weatherproof materials.

### Cleaning

Use a stable work platform to clean the exterior of the slurry transport tank and tractor after transporting slurry.

### Use a rear-view camera

Install a rear-view camera and use it. It can be difficult to get a clear view while backing up, and pedestrians can go unnoticed.

### Train and plan

Train all employees on how to handle the work in and around slurry transport tanks.

Collaborate to plan work in these areas.



Do **not** enter a slurry transport tank without full personal protective equipment.

Remember—there are professionals you can call to help you with this work.

When performing clean-up or repair work inside a slurry transport tank, **always** use a self-contained breathing apparatus **and** keep the following points in mind before entering the tank:

1. The tank must be completely free of slurry.
2. Ensure that the tank cannot be filled while work is in progress.
3. The tank must be responsibly ventilated.
4. Always open the manhole for ventilation.
5. Clean the tank thoroughly before carrying out repairs.
6. Consider using a gas detector.

[www.baujordtilbord.dk](http://www.baujordtilbord.dk)

**Laws and regulations**

[DWEA Regulation 2.6.1.1 from August 1996 on liquid manure systems](#) includes provisions regarding [safety signage](#) required for slurry transport tanks, as well as [first aid](#) information

Read more about self-contained breathing apparatus: DWEA Guideline D.5.4 from January 2008 on [respiratory protection](#)

Read more about working environments and safety when transporting slurry [here](#)

## Agriculture

# Pig shed

**Slurry gases are a cause of fatal accidents in agriculture. In a pig shed, if work is not properly planned and executed with safety in mind, there may be a risk of slurry gas-induced poisoning.**

When slurry is set in motion, slurry gases are released, presenting a poisoning hazard. Consequently, slurry should only be agitated within pump sites, which are separated from slurry channels in sheds by water traps. These prevent toxic gases from passing backwards into sheds.

### Back-flushing

Back-flushing should only be performed with water or off-gassed slurry. The slurry in the pump site should be thoroughly agitated to ensure it has off-gassed before beginning back-flushing.

### Posters

Posters must be clearly displayed in sheds with slurry systems, describing how to operate the system and what safety precautions should be taken, both for ordinary operation and in the event of a disruption. These posters should be kept up to date (e.g., to reflect experiences from using the slurry system). They must be kept in good condition and placed conspicuously.

### Pulling slurry plugs

- Keep your back straight and bend your knees slightly when pulling plugs.
- Never work on your knees or from a squatting position, as gas concentrations are highest near the floor.
- The pulling hook should be long enough to allow the plug to be pulled from an upright position.
- Keep hooks with various handle lengths on hand to accommodate employees of different heights.

### Discharging slurry

- Discharge slurry regularly; how often varies from one shed section to another.
- Hydrogen sulphide formation is greater the longer the slurry is left in place.
- No other work should be performed in the shed during the slurry discharge process.
- If possible, leave the shed while slurry is being discharged.
- Make sure to reinsert the plug correctly after the discharge process has ended.
- Inform all employees of where and when slurry will be discharged.
- If possible, work in pairs when discharging slurry and use breathing apparatus with gas filters during the process.

### Signs of slurry gas in sheds

Unconscious animals may be a sign of a high concentration of hydrogen sulphide. Exit the shed and do not re-enter it until it has been thoroughly ventilated.

You may wish to use a gas detector that measures hydrogen sulphide, which will sound an alarm in the presence of harmful concentrations.

### Train and plan

Train all employees on the dangers of working with slurry and how to safely handle slurry in sheds.

Collaborate to plan work in these areas.



**Never** enter a sump without full personal protective equipment.

Remember—there are professionals you can call to help you with this work.

When descending, **always** use a self-contained breathing apparatus.

[www.baujordtilbord.dk](http://www.baujordtilbord.dk)

### Laws and regulations

DWEA Regulation 2.6.1.1 from August 1996 on liquid manure systems

Among the provisions of this regulation are requirements for safety signage on slurry transport tanks, as well as first aid information requirements. Read more about filtration and self-contained breathing apparatus here



## Agriculture

# Cattle shed

**Slurry gases are a cause of fatal accidents in agriculture. When undisturbed slurry is set in motion, slurry gases are released, presenting a poisoning hazard.**

### Agitation

Slurry should only be agitated within pumping and agitation chambers, which are separated from slurry channels in sheds by water traps. These prevent toxic gases from passing backwards into sheds.

### Back-flushing

Back-flushing should only be performed with water or off-gassed slurry. The pump tank must be agitated thoroughly to ensure that the slurry has off-gassed before it is pumped back into the channels.

### Agitation chamber

Slurry in the ring channel is kept mixed by passing daily through an outdoor agitation chamber. During normal operations, agitation ensures the slurry is homogeneous, reducing the risk of deposition and of hydrogen sulphide release into a shed. Implement a periodic system check procedure. Agitation chambers must be covered with a gapped floor or other grate-like surface to allow gases to escape into the open air. They must be placed such that any escaping slurry gas does not disturb others.

Agitation chambers should be surrounded by fences at least 1.5 m above ground level to keep humans and animals away.

### Slurry accumulation in channels

Slurry can accumulate in channels beneath sheds and where it runs into a primary collection channel, potentially causing clogs. Some-

times, the accumulated slurry must be manually dislodged, such as by spraying with water. Remember to wear respiratory protection with a gas filter when performing this task.

### Slippery floors

Be mindful of the risk of slipping on slippery floors. Ensure calf guards are intact so there is no risk of falls into the collection channel.

### Sand in pens

Use fine-grained sand with a low clay content to reduce the risk of deposited sand in slurry channels and the subsequent need for manual intervention.

### Posters

Posters must be clearly displayed in sheds with slurry systems, describing how to operate the system and what safety precautions should be taken, both for ordinary operation and in the event of a disruption. These posters should be kept up to date (e.g., to reflect experiences from using the slurry system). They must be kept in good condition and placed conspicuously.

### Train and plan

Train all employees on the dangers of working with slurry and how to safely handle slurry in sheds.

Collaborate to plan work in these areas.



**Never** descend into channels or agitation chambers without full personal protective equipment.

Remember—there are professionals you can call to help you with this work.

When descending, **always** use a self-contained breathing apparatus **and** keep **all** of the following points in mind:

- The channel must be completely free of slurry
- Channels must be properly ventilated.

### Gas detector

This is a good time to use a gas detector that measures hydrogen sulphide, which will sound an alarm in the presence of harmful concentrations.

### **Laws and regulations**

[DWEA Regulation 2.6.1.1 from August 1996 on liquid manure systems](#)

Among the provisions of this regulation are requirements for [safety signage](#) on slurry transport tanks, as well as requirements for [first aid](#) information

Read more about self-contained breathing apparatus: DWEA Guideline D.5.4 from January 2008 on [respiratory protection](#)



Branchearbejdsmiljøudvalget Jord til Bord

## Appendix I. First aid poster

The first aid poster can be downloaded [here](#):

# First aid slurry gas-induced poisoning

### STOP AND CONTAIN THE INCIDENT

- Protect yourself with an effective breathing apparatus
- Warn others of poisoning hazards
- Help the person out into fresh air
- Call emergency services (112).

## 112

**1.** Is the person conscious? →

- Ensure plenty of fresh air
- Keep the person conscious until the ambulance arrives.

**2.** Shake the person gently. Yell loudly: "Are you OK?"

**3.** Is the person unconscious and →

- 1. Clear airways
- 2. Place the person in a stable



**4.** The person is not breathing. → **If you are with others: send someone to retrieve the nearest**

- 3. Regularly check the person's breathing

## 5. Immediately begin CPR

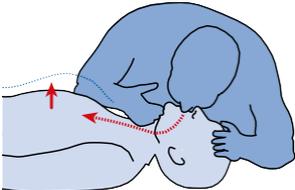
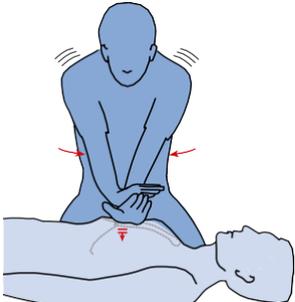
**Place your hands in the centre of the person's chest**



**Perform chest compressions:**

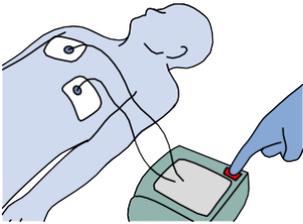
- Apply firm pressure to a depth of at least 5 cm **30 times** at a pace of at least 100 compressions per minute.
- Seal your lips around the person's mouth
- Blow until the person's chest rises
- Give the next breath once the chest has fallen
- Continue CPR with 30 compressions and **2 breaths** until the person regains consciousness or help arrives to take over.

## Compressions 30 : 2



## Turn on the defibrillator and place the pads

- Follow the instructions from the defibrillator
- Place the pads as indicated
- If more than one person is present, one person should continue to provide CPR following the **30:2** rule while another person places the pads.
- **Move everyone away and administer shock:** Do not touch the person while the defibrillator is performing its analysis or administering a shock.



**If the person responds (i.e., moves, opens their eyes, or breathes normally): Stop chest compressions and breaths. Still unconscious: Place the person in a stable position on their side and check breathing continuously.**

## Appendix 2. Slurry system poster

The slurry system poster can be downloaded [here](#):

# Warning slurry system

### This shed is equipped with a slurry system

When slurry ferments in the system, it produces gases that pose health, fire, and explosion hazards. See precautions below and

### Hydrogen sulphide is deadly

Hydrogen sulphide is a gas that is deadly to both humans and animals. Agitating and pumping the slurry can release lethal amounts of hydrogen sulphide in 1-2 minutes.



#### When discharging slurry:

- no other work may be performed in the shed; this should be performed at the end of the work day
- breathing apparatus with a gas filter must be used; work in pairs, if possible
- good air flow must be established to limit the concentration of hydrogen sulphide.

#### Hydrogen sulphide is dangerous

Hydrogen sulphide can inhibit the sense of smell, so people are not aware of the danger before they lose consciousness. Poisoning can occur in sheds, pre-tanks, pump shafts, slurry tanks, slurry transport tanks, etc.

The risk of gas release is greatest in livestock buildings where large quantities of slurry are stored for long periods. If stored for long periods, the only certain way to avoid the lethal gases is to keep people and animals out of the shed when the slurry is being agitated or pumped.

#### Hydrogen sulphide poisoning

If animals in the shed show signs of poisoning, immediately stop pumping and agitation. Do **not** enter the shed without a self-contained breathing apparatus.

If a self-contained breathing apparatus is not available, trained specialists with self-contained breathing apparatus must be called in.

#### Help is available by calling:

Company name:

Telephone number:

#### Planning and organising work with slurry

Everyone working with slurry in the shed must be thoroughly trained and instructed. Training must include information on safe slurry system operation during discharge, agitation, and back-flushing, where applicable.

In the event of disruptions, the owner or operator must be contacted so that work can be planned and carried out safely.

**Safety equipment**, such as safety harnesses, lines, and self-contained breathing apparatus **are**

**Contact person in case of incident:**  
Name:

Phone number:

#### First aid

See the first aid poster. Even if an unconscious person wakes up and claims to feel fine, an ambulance should be called. When reporting an incident to emergency services, inform the operator that an accident involving a slurry system has occurred.

#### Updated:

--  
(date)

### Appendix 3. Warning signs for slurry transport tanks required by law



Signs must be displayed on slurry transport tanks to warn of the risk of slurry gas-induced poisoning and indicate that remaining on the tank during filling is prohibited.

The signs must be placed on the front end of the slurry transport tank or on a ladder, if present, and in positions where they will not be contaminated by slurry.



## Appendix 4. Warning signs required by law for pre-tanks and other pump sites



All pump site access openings must display poison hazard, poison first aid, and fire hazard warning signs.

*Proper signage posted at a pre-tank, including poison hazard, poison first aid, and fire hazard warning signs.*



Side length: 325 mm.

**DEADLY GAS**  
NO ACCESS WITHOUT OPEN- OR  
CLOSED-CIRCUIT SELF-CONTAINED  
BREATHING APPARATUS NO  
ACCESS WITHOUT SAFETY  
HARNES AND LINE, HOIST, AND AT  
LEAST ONE HELPER ABOVE



**Fire hazard**

Side length: 325 mm.

### First aid Slurry gas-induced poisoning

**STOP AND CONTAIN THE INCIDENT**

- Protect yourself with an effective breathing apparatus
- Warn others of poisoning hazards

**112**

- Is the person conscious?
  - Keep the person conscious until the
- Shake the person gently. Yell loudly: "Are you OK?"
  - 1. Clear airways
  - 2. Place the person in a stable
- Is the person unconscious and
  - 3. Regularly check the person's breathing
- The person is not breathing.
  - If you are with others: send someone to retrieve the nearest defibrillator

**5. Immediately begin CPR**

Place your hands in the centre of the person's chest

**Perform chest compressions:**

- Apply firm pressure to a depth of at least 5 cm **30 times** at a pace of at least 100 compressions per minute.
- Seal your lips around the person's mouth
- Blow until the person's chest rises
- Give the next breath once the chest has fallen
- Continue CPR with 30 compressions and 2 breaths until the person regains consciousness or help arrives to take over.

**Compressions 30 : 2**

**Turn on the defibrillator and place the pads**

- Follow the instructions from the defibrillator
- Place the pads as indicated
- If more than one person is present, one person should continue to provide CPR following the 30:2 rule while another person places the pads.
- Move everyone away and administer shock: Do not touch the person while the defibrillator is performing its analysis or administering a shock.

If the person responds (i.e., moves, opens their eyes, or breathes normally): Stop chest compressions and breaths. Still unconscious: Place the person in a stable position on their side and check breathing continuously.

## Appendix 5. Warning signs required by law for slurry tanks



All slurry tank access openings must display poison hazard and poison first aid warning signs.

*Proper signage at a slurry tank, including poison hazard and poison first aid warning signs.*



Side length: 325 mm.

**DEADLY GAS**  
NO ACCESS WITHOUT OPEN- OR  
CLOSED-CIRCUIT SELF-CONTAINED  
BREATHING APPARATUS NO  
ACCESS WITHOUT SAFETY  
HARNES AND LINE, HOIST, AND AT  
LEAST ONE HELPER ABOVE

### First aid Slurry gas-induced

<p><b>STOP AND CONTAIN THE INCIDENT</b></p> <ul style="list-style-type: none"> <li>Protect yourself with an effective breathing apparatus</li> <li>Warn others of poisoning hazards</li> </ul> <p><b>112</b></p>	<p><b>1.</b> Is the person conscious?</p> <ul style="list-style-type: none"> <li>Ensure plenty of fresh air</li> <li>Keep the person conscious until the ambulance arrives.</li> </ul>
<p><b>2.</b> Shake the person gently. Yell loudly: "Are you OK?"</p>	<p><b>1.</b> Clear airways</p> <p><b>2.</b> Place the person in a stable position</p>
<p><b>3.</b> Is the person unconscious and not breathing?</p>	<p><b>3.</b> Regularly check the person's breathing</p>
<p><b>4.</b> The person is not breathing.</p> <p>If you are with others: send someone to retrieve the nearest defibrillator</p>	<p><b>5. Immediately begin CPR</b></p> <p>Place your hands in the centre of the person's chest</p> <p>Perform chest compressions:</p> <ul style="list-style-type: none"> <li>Apply firm pressure to a depth of at least 5 cm <b>30 times</b> at a pace of at least 100 compressions per minute</li> <li>Seal your lips around the person's mouth</li> <li>Blow until the person's chest rises</li> <li>Give the next breath once the chest has fallen</li> <li>Continue CPR with 30 compressions and 2 breaths until the person regains consciousness or help arrives to take over.</li> </ul> <p><b>Compressions 30 : 2</b></p>
<p><b>Turn on the defibrillator and place the pads</b></p> <ul style="list-style-type: none"> <li>Follow the instructions from the defibrillator</li> <li>Place the pads as indicated</li> <li>If more than one person is present, one person should continue to provide CPR following the 30:2 rule while another person places the pads.</li> <li><b>Move everyone away and administer shock:</b> Do not touch the person while the defibrillator is performing its analysis or administering a shock.</li> </ul>	<p>If the person responds (i.e., moves, opens their eyes, or breathes normally): Stop chest compressions and breaths. Still unconscious: Place the person in a stable position on their side and check breathing continuously.</p>

# Laws and regulations

## — well worth knowing

DWEA regulation no. 518 of 17 June 1994 with subsequent amendments, on [safety signage and other types of signs](#)

DWEA regulation no. 559 of 17 June 2004 with subsequent amendments, on [the performance of work Regulation on the inspection of containers for the storage of liquid manure and silage liquid](#)

Ministry of the Environment, 2012

DWEA regulation no. 507 of 17/5/2011 with subsequent amendments

[Regulation on limit values for substances and materials](#)

[DWEA Guideline 1.7.1 on training and instruction obligations for work involving a particular risk](#)

DWEA Guideline D.5.4 from January 2008 on [respiratory protection](#)

Guidance on inspection of liquid manure and silage liquid containers, Ministry of the Environment, 2014

[Guidance on inspection of liquid manure containers](#)

[DWEA Guideline D.1.1 on workplace assessments \(APVs\)](#)

DWEA order no. 2.6.1.1 of August 1996 on [liquid manure systems \(slurry systems and liquid manure containers\) DS/EN 12021. Specification of quality requirements for compressed breathable air](#)

## Informative materials from BAU Jord til Bord

[Working environment. Health, safety, and work technology, 2008](#)

### Fact sheet on accidents in agriculture

[http://www.barjordtilbord.dk/Files/Billeder/BARjobo/pdf/Ulykker\\_i\\_landbruget\\_Faktaark.pdf](http://www.barjordtilbord.dk/Files/Billeder/BARjobo/pdf/Ulykker_i_landbruget_Faktaark.pdf)

Fact sheet no. 15 on "machine checks" in the publication "Accidents in Agriculture: Fact Sheets on Prevention"

Fact sheet no. 18 on safety in operating and repairing slurry systems, in the publication "Accidents in Agriculture: Fact Sheets on Prevention"

### Agricultural working environment management made easy

<http://www.barjordtilbord.dk/Default.aspx?ID=5834>

### Contingency plan

<http://www.barjordtilbord.dk/Default.aspx?ID=5843>

### Safety manual for agriculture and machinery contractors. Published by BAR Jord til Bord, 2014

<http://www.barjordtilbord.dk/Files//Filer/BARjobo/Landbrug%2014.pdf> Page 69, on slurry plants

### Working environment and safety in slurry transport

[https://www.landbrugsinfo.dk/Tvaerfaglige-emner/Arbejdssikkerhed/Sider/Gylleudbringning\\_2010.pdf](https://www.landbrugsinfo.dk/Tvaerfaglige-emner/Arbejdssikkerhed/Sider/Gylleudbringning_2010.pdf)

## Other information

DWEA Guideline 1.7.1 on [training and instruction obligations for work involving a particular risk](#)

### Download signs and notices

An overview of various safety signs for mandates, prohibitions, warnings, etc. can be found in the agricultural info [here](#)

Construction sheet on ring channel systems in cattle sheds, a construction and operation guide, Landbrugets Byggeblad

[https://www.landbrugsinfo.dk/Byggeri/Byggeblade/Sider/bb\\_103\\_05\\_05.pdf](https://www.landbrugsinfo.dk/Byggeri/Byggeblade/Sider/bb_103_05_05.pdf)

Construction sheet on pipes and pump lines, from shed to storage, Landbrugets Byggeblad

[https://www.landbrugsinfo.dk/byggeri/byggeblade/sider/bb\\_103\\_05\\_04.pdf](https://www.landbrugsinfo.dk/byggeri/byggeblade/sider/bb_103_05_04.pdf)

[Guidance and construction sheet for slurry containers](#) Ministry of the Environment, 2015.

This data sheet collects existing rules, norms, and standards for the construction of slurry containers

Denmark's official **112 app** can be downloaded [here](#)

The TrygFonden Hjertestart app can provide you with the address of the nearest defibrillator. Download the **Hjertestart app** [here](#)



**Agricultural Working  
Environment Committee**  
Agro Food Park 15,  
8200 Aarhus N  
jordbruget@baujordtilbord.dk  
T 8740 3400

**The Workers' Secretariat**  
Kampmannsgade 4  
1790 Copenhagen V  
barjordtilbord@3f.dk  
T 8892 0991

[www.baujordtilbord.dk](http://www.baujordtilbord.dk)



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