

Anhydrous Ammonia Gas - Safety in Agriculture

Management of anhydrous ammonia gas
workplace hazards for broadacre agriculture
and farming in Queensland

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What is anhydrous ammonia gas used for in agriculture and farming?

Anhydrous ammonia gas often referred to simply as ammonia gas has been used as a fertiliser in agriculture since the 1930s and plays an important role because it is one of the most widely used sources of nitrogen necessary for optimal plant growth, protein production and photosynthesis. It is also one of the most cost effective and concentrated forms of nitrogen fertiliser at around 82% nitrogen by weight.

When applied as ammonia gas it is directly injected (nominally 10cm to 20cm) into the soil using specialised agricultural equipment to prevent gas loss to the atmosphere. Once in the soil, ammonia reacts with water to form ammonium which is absorbed by plants as a source of nitrogen. Ammonia gas is commonly used in several intensive broadacre agricultural cropping such as cotton, corn (maize) and winter cereals including wheat, sorghum, barley and canola.

What this guidance note covers

This Guidance note is not intended to be an exhaustive reference to all relevant standards and safety procedures, rather it is intended to be a plain English consolidated general guidance note drawing together the key relevant safety information and legislation which should be considered for the safe use of ammonia gas within an agricultural setting in Queensland.

While ammonia gas has many benefits in agriculture, it is a **hazardous chemical** and the uncontrolled accidental release of ammonia gas has resulted in significant safety incidents and fatalities, and should be transported, stored, handled and used by appropriately authorised and trained workers using specifically designed and certified equipment and vessels (tanks).

As a hazardous chemical ammonia gas is subject to a number of legislative, dangerous goods and workplace health and safety requirements.

This Guidance note outlines some of the key workplace safety and legislative obligations in relation to the use of ammonia gas within a workplace as well as aspects of storage and transport.

Hazardous properties of ammonia

Ammonia gas poses several hazards which are important to understand when utilising this gas. One of the most significant hazards is that ammonia gas is acutely toxic if inhaled. What this means in practical terms is that if ammonia gas is released and individuals are exposed and inhale the gas, it is likely to result in death or serious permanent damage to the respiratory system. Ammonia gas is also flammable, pressurised, cryogen (very low temperature) and will cause both immediate and long-term impacts if released into aquatic environments. Below is a summary of these hazards.

Table 1: Properties of ammonia gas (anhydrous ammonia)

Hazardous property	Hazard Labelling	
	GHS	UN Model Regulations
Ammonia gas is a flammable gas and can ignite relatively easily if exposed to an ignition source.		
Ammonia gas is a liquified gas which is stored under pressure. Ammonia gas can expand if heated, and for this reason ammonia tanks should only be filled to a maximum of 85%.		
Ammonia gas is acutely toxic for inhalation exposure. Inhaling ammonia gas can result in pulmonary oedema and potential permanent lung damage if not immediately fatal.		
Ammonia gas exposure can result in serious eye damage or irritation.	NA	NA
If released into an aquatic environment ammonia gas can result in acute (immediate) and long-term environmental harm.		NA
Ammonia gas (anhydrous) liquified gas is a cryogenic liquid, which is around -33 C°. Dermal exposure to ammonia gas can cause cryogenic (cold/thermal) burns.	NA	NA

General safe handling of ammonia gas and training

Ammonia gas is a hazardous chemical, however the risks associated with its use can be managed provided there is an understanding of the hazards, correct safety and engineering controls and protective equipment are in place and provided those workers undertaking the handling and use of ammonia are appropriately trained.

It is important to note that manufacturers, suppliers and the person conducting the business or undertaking (PCBU), such as the farm itself, all have duties under the *Work Health and Safety Act 2011* (Qld) to take all reasonably practicable actions to ensure that the health and safety of

workers is not placed at risk. Among other duties, this includes the provision of information, training and instruction on the safe use, handling and storage of substances, such as ammonia gas¹. Similarly, manufacturers² and suppliers³ are subject to relevant duties care.

Based on the hazardous properties of ammonia gas outlined above, and in the context of its use in an agricultural setting as a gas injected fertilizer, the following are some key safe handling principles which should be followed **in addition to any manufacturer or supplier specifications or instructions**.

- Regardless of wearing personal protective equipment (PPE) or any other safety controls, always position yourself up-wind when undertaking any ammonia transfer activity and ensure you have an unobstructed evacuation path.
- Ensure you have and are familiar with the emergency procedures for the equipment being used, including shut-down and for notifying local emergency services.
- If operating a tractor pulling ammonia injection plant or equipment or moving an ammonia tank, keep your respirator mask with you at all times.
- Always ensure the area is safe before commencing any ammonia transfer or application process and that no other people are present within the area (unless wearing recommended PPE and positioned up-wind).
- Emergency shut-off button should be immediately accessible within the work area where the transfer is occurring.
- Always wear the **full** recommended PPE and check canister exposure times before use.
- Ensure pressure vessels (tanks and equipment) are certified and current (see *Licensing, authorisation and transport requirements*).
- Always inspect hoses, fittings, valves, tanks and equipment for cracks, cuts, abrasions, leaks or excessive icing before use.
- Never lift valves or hoses using the valve wheel or handle, hold the valve body.
- Always inspect hitch pins to confirm they are in good condition and safety pins are in place before moving ammonia equipment.

Personal protective equipment

Ammonia gas (anhydrous ammonia) is a hazard chemical which the potential to cause serious injury and even death, it is considered immediately dangerous to life and health. It must be remembered that Personal protective equipment (PPE) is a **last line of defence** and should not be relied upon solely to protect workers and health. The hazards associated with using ammonia gas should be managed to the extent possible through elimination, engineering (such as high flow valves, emergency shut offs or dry-break couplings as examples) and administrative controls (such as training and procedures for safety work).

¹ S.13(3) *Work health and Safety Act 2011*

² S.23 *Work health and Safety Act 2011*

³ S.25 *Work health and Safety Act 2011*

The following table summarises the minimum PPE which should be used when handling or using ammonia gas or in any other situation where there is a risk of exposure or release of ammonia gas.

Table 2: Recommended minimum PPE for working with ammonia gas (anhydrous ammonia)

Specific recommended PPE	Relevant Standards	Example of Recommended PPE
Full-face 'Air Purifying Respirator' or APR	AS/NZ 1715 AS/NZS 1716	
Multi-gas (ammonia: green band) rated ABEK type canister	AS/NZ 1715 See canister section below for further detail	
Thermal gloves (Thermal and chemical resistant, e.g. neoprene or similar)	AS/NZS 2161 Part 2,3 and 5	
Heavy duty chemical resistant apron <u>or</u> chemical resistant suit	AS/NZS 2161	

Specific recommended PPE	Relevant Standards	Example of Recommended PPE
Appropriate enclosed safety footwear ⁴	AS/NZS 2210	
Eye protection ⁵	AS/NZS 1337	NA

Canister selection and 'saturation or breakthrough' time

Canisters

Canister used for full face respirators selective for the specific gases which they provide protection from, not all canisters provide chemical protection or indeed protection from ammonia gas. It is therefore essential that the canisters selected and used are appropriate otherwise they may offer no protection from exposure to ammonia gas. Canisters are colour coded and include other information which is important to understand.

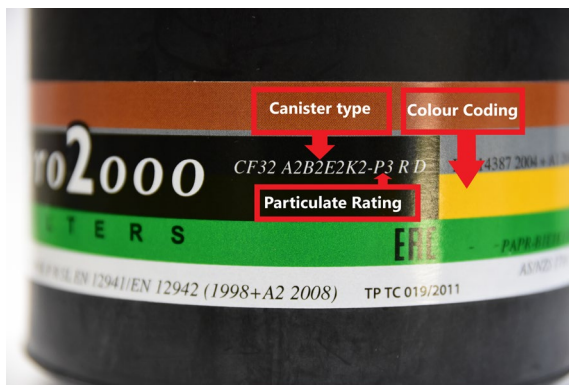


Figure 1: Multi-gas APR canister

⁴In an agricultural setting, standard safety steel toe or composite footwear may suffice. Where possible chemical resistance safety footwear or gumboots may be suitable. However, aprons or safety clothing should be placed **over** the top of gumboots as shown above to prevent ammonia liquid from spilling directly into boots.

⁵Eye protection would only be required when wearing a half-face respirator (such as commonly used in spraying application). However, in applying s.4 of AS/NZS 1715 *Selection, use and maintenance of respiratory protective equipment*, the risk profile of ammonia gas requires the use of a **full-face respirator**, removing the need for eye protection and noting the use of half-face respirators does not manage the risk **so far as reasonably practicable**.

Canister codes, such as A2B2E2K2-P3 (see Image 1), identify the canister type and coloured bands indicate which chemical or chemical groups the canister provides protection against. Canister designations (i.e. A, B, E, K) and colour-coding are standardised internationally, although they may vary in some countries. Always check the manufacturer's instructions to confirm which chemicals or chemical groups the canister provides protection against.

Table 3: Canister type, colour codes and meaning

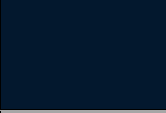
Type	Colour	Canister provides protection from:
A		Gases and vapours of organic compounds including solvents with boiling points > 65 °C
B		Acid gases including inorganic gases and vapours e.g. chlorine, hydrogen sulphide or hydrogen cyanide
E		Sulphur dioxide and hydrogen chloride
K		Ammonia and organic ammonia derivatives
NO-P3		Nitrogen oxides, e.g. NO, NO ₂ , NO _x
Hg-P3		Mercury vapours

Table 4: Non-colour-coded canister types and meaning

Type	Meaning
R	Indicates that the canister can be reused (limited), subject to exposure and breakthrough times.
D	Indicates that the canister has passed a dolomite dust-clogging test. This is an additional test for the particulate filters and certifies that the filter has a very high absorption capacity for particles.
NBC	Indicates that the canister has passed testing for chemical warfare agents (CWAs).
1	Indicates a filter 'Class 1' (or P1) low efficiency particulate filter. Generally suitable for mechanically generated dusts e.g. wood or silica.
2	Indicates a filter 'Class 2' (or P2) medium efficiency particulate filter. Generally suitable for mechanically and thermally generated particulates e.g. metal fumes, as well as contaminant dusts and some biological hazards.

Type	Meaning
3	Indicates a filter 'Class 3' (P3 or P100 equivalent) high efficiency particulate filter up to 100% efficient for high toxicity or irritant substances when worn with a full-face respirator (i.e. an APR).

Saturation or breakthrough

It is important to remember that canisters have a limited service life and additionally that each canister has a **saturation** or **breakthrough** time for each chemical or chemical type. This means that after a period of time filter medium (normally activated charcoal) will become '*saturated*' and may no longer prevent that chemical from entering the respirator mask. This information will normally be provided in the manufacturer's product information sheet. The breakthrough times vary but for some chemicals the breakthrough time will be lower than for other chemicals, this is true for chlorinated chemicals and ammonia.

Always be aware of the **saturation** or **breakthrough** time for ammonia in the canister being used. It is important to have spare canisters on hand and monitor the time that the canister is used in the presence of ammonia gas and change the canister when indicated.

Siting of ammonia tanks on farms

Given the hazards posed by ammonia gas care needs to be taken when considering the location of an ammonia gas tank on a property, this includes mobile plant and ammonia gas tanker trailers. Australian and New Zealand standard for Anhydrous ammonia – storage and handling (AS/NZS 2022:2003) sets out minimum separation distances for ammonia gas storage tanks from sensitive places. For a typical 20-to-23-ton ammonia gas tanker this means that it should be located not less than 150 metres from residential buildings particularly.

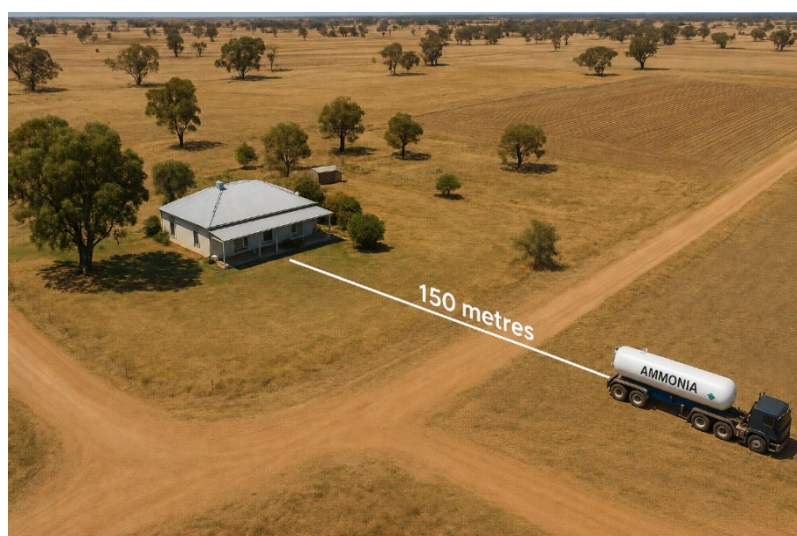


Figure 2: Recommended 150-metre separation from residential buildings

Table 5: Additional AS/NZS 2022:2003 separation distances for ammonia gas storage tanks

Tank capacity m ³	Example	Minimum distance from sensitive place (m)		
		Residential buildings, workplaces or places where people gather	Highly sensitive locations such as hospitals, schools or other similar places	Major roadways, rail or transport routes
$>2 \leq 7$	This would include small tanks such as 1-to-2-ton tanks on injection equipment pulled by a tractor	60	90	15
$>7 \leq 100$	This will include large in-situ or mobile tankers, such as typical 20-ton road tanker (approx. 30 m ³) ⁶	150	180	15
> 100	Refer to AS/NZS 2022:2003			

Movement and transport of mobile ammonia tanks

It is strongly recommended that if a farm is receiving delivery of ammonia gas as a mobile nurse tank for transfer into applicator equipment, that the nurse tank is positioned at one location on the property in accordance with the information provided from AS/NZS 2022:2003 as set out above under '*Siting of ammonia tanks on farms*'.

Minimising the movement of mobile ammonia tanks minimizes the risk of accidents or impacts occurring, which is one of the highest risks associated with the storage and use of bulk ammonia gas tanks on properties, particularly where farm roads may be unformed, uneven or where risk of roll-over is present.

It is important to note that while mobile bulk ammonia tanks can be moved within a farm on private roads, the movement of a mobile bulk ammonia tanker trailer on or across a public road

⁶ Based on ammonia density of 682 kg/m³ at 20 °C

triggers a number of important transport and dangerous goods licencing requirements. These requirements do not apply to applicator tanks on ploughing or other applicator equipment. The key legal restrictions which apply to movement on or across public roads in Queensland include:

- If crossing or travelling on a public road, the driver must hold a *Dangerous Goods Driver and Vehicle* licence
- If crossing or travelling on a public road, the mobile ammonia tanker trailer must display dangerous goods placards specified under the Australian Dangerous Goods (ADG) Code
- It is an offence under s.144A of the Transport Operations (Road Use Management – Dangerous Goods) Regulation 2018 to park a placarded load (i.e. mobile ammonia tanker) in any public place, this includes roadways and any road reserves outside the property boundary.

Where mobile ammonia gas tanks need to be moved around property is recommended that consideration be given to roads and parking areas where these tanks are moved and located on a regular basis. To minimize the risk of impacts or roll-overs, improvements may need to be made to minimize the risk of accidents occurring. It is also recommended that at each location where an ammonia tank is frequently located, that a low cost wind sock (illustrated right) is installed to allow for immediate identification of safe wind direction.



Figure 3: Wind-sock

Bleed off procedures

Always follow the manufacturers inspections when undertaking a bleed off procedure. The following additional information is important from a safety perspective because during the bleed off process, to depressurise hoses or lines before disconnecting, ammonia gas will be discharged, and a potential exposure risk exists. There are several key considerations and steps which should be taken before, during and after undertaking a bleed off procedure, these include:

Before bleed off procedure

- Always observe the nurse tank before approaching and be alert for any hazards or visible emissions or strong ammonia odours.
- Take note of the wind direction and always approach and keep yourself upwind of the tank whenever possible.
- Put on all of the correct PPE well before you approach the tank, note PPE should not be left at the tank and should remain with you at all times (especially the respirator).
- It is also critical to make sure that there are no other people in the vicinity when undertaking any ammonia gas transfer or bleed off activity unless they are also wearing the correct PPE.

- Ensure flow control valves on the applicator equipment are closed and the applicator system is drained of product. Follow equipment manufacturer instructions, but generally it is recommended that this is done while the shanks are in the ground and the applicator is pulled down the field for a distance before raising the shanks and moving to the nurse tank.

During the bleed off procedure

- Bleed off procedures will vary depending on the equipment manufacturer, always follow the manufacturer instructions for bleeding hoses and/or lines.
- When opening the bleed valve and hose end valve, try to remain up-wind.
- If pressure does not relieve within a reasonable amount of time, check that all flow valves are closed.
- Ensure all ammonia gas is discharged from the bleed valve by lifting the withdrawal and applicator hoses.
- Be observant for freezing on valves, if bleed valves fail immediately activate emergency shutoff on the nurse tank and initiate the emergency procedure, ensuring the area is evacuated.

After the bleed off procedure (disconnecting from nurse tank)

- This is a critical activity where a high number of accidents and releases have occurred.
- This activity (along with any other ammonia gas transfer or handling activity) should only be undertaken by appropriately trained and competent workers.
- Follow the manufacturer's instructions carefully, and always undertake from an up-wind position.
- Never disconnect any hose or coupling until all pressure has been released via the bleed valve.
- Ensure the main liquid withdrawal valve on the nurse tank and applicator are correctly closed.

Emergency response

Ammonia gas as a direct injected nitrogen fertilizer has considerable application within some agricultural sectors, particularly broadacre agriculture including cotton, winter grains and other crops. However, it is important to understand the hazards which ammonia gas can pose as outlined in this guidance note.

Along with understanding the hazards, controls and training requirements and obligations necessary to use ammonia safely within an agricultural workplace it is essential to have an emergency plan in place.

Emergency plans will be specific for the workplace where the ammonia gas is stored, handled and used, but should include as a minimum the following considerations:

- Identify all potential incidents which could occur at the workplace involving the ammonia gas, this could include impacting and rupture of the bulk ammonia tanker with a tractor or other equipment during movement or decanting, roll-over during movement, bushfire or other hazards.
- The highest risk involving ammonia gas from a worker health and safety perspective is an accidental uncontrolled release of ammonia gas, having a plan for how to respond and evacuate in this instance is critical.
- Have an evacuation plan, this includes for all workers (and family members), an evacuation plan will be informed by location of the tank and wind-direction among other things (a key reason tanks should never be located close to residential dwellings).
- Contact your local emergency services and ensure they are aware that bulk ammonia gas is used on the property. This is typically best notified to Queensland Fire Department who will be the primary response agency for any accident or releases involving ammonia gas.
- In the event of an uncontrolled release of ammonia gas, this is an 'emergency situation' and should be immediately notified to '000' and the operator informed that **"ammonia gas has been/is being released, the location and if possible, provide the wind direction and details (condition) and location of any exposed or injured persons"**.
- Ensure everyone at the workplace, including any family members or other people who may reside on the property are aware of the emergency and evacuation plan and the emergency contacts.
- Finally, it is important to test the emergency and/or evacuation plan on at least an annual basis this includes with workers and any family members or other people who may reside at the workplace or property.

Registration and maintenance of pressure vessels

- Ammonia gas tanks including both mobile or stationary nurse tanks, applicator tanks and equipment are "pressure equipment" under the Work Health and Safety Regulation 2011 (Qld). There are specific requirements in the Regulations for the design and use of pressure equipment. Pressure equipment is a type of plant.
- Pressure equipment over a set size and pressure must have their design registered AND must be registered for use. An ammonia tank with a design pressure greater than 900kPa and a volume greater than 500L must be design registered and item registered with a WHS regulator.
- The design registration number must be provided with the tank when it is supplied, and you must keep this number available. It is recommended that the number is stamped on the name plate of the tank. You should confirm with any tank suppliers that they have the design registration number for the tanks they supply.

- When the tank is put into service at your property you will need to ensure you have registered each individual tank you own. The plant item registration process requires the reporting of the inspection and maintenance with any application or registration renewal.
- It is acceptable for any company that hires or temporarily leaves tanks at your property for your use to hold the registration, however, you should have access to that information.
- There are also requirements that require inspections of pressure equipment on a regular basis. As the tanks are required to be registered the competent person completing the inspection must have vocational qualifications in an engineering discipline or knowledge of the relevant technical standards for the plant. The relevant standard for the inspection of pressure equipment is AS/NZS 3788 Pressure equipment in-service inspection.
- The requirement for design registration and plant item registration will apply to bulk mobile ammonia tankers operating in Queensland and is the legal duty of the equipment owner.
- Further information on plant registration and plant design registration can be accessed at the licencing and registration webpage at: <https://www.worksafe.qld.gov.au/licensing-and-registrations>

Licencing, authorisation and transport requirements

- A **property** (workplace) in Queensland where ammonia gas (listed hazardous chemical) is stored or used meets the definition of a manifest quantity workplace (MQW) and is required to be registered under s.348 of the Work Health and Safety Regulation 2011. This obligation applies to the **property owner or person in control of the workplace**.
- A s.348 notification can be lodged online at: [Notification of a manifest quantity workplace \(s348\)](#).
- A **property** (workplace) in Queensland where ammonia gas is present or frequently present in a quantity exceeding 20 tonnes is required to notify Workplace Health and Safety Queensland by submitting a notification under s.536 of the Work Health and Safety Regulation 2011. This duty applies to the owner of the bulk tank or mobile nurse tank equipment, and should be submitted for each property at which their equipment is located or supplied.
- A s.536 notification can be lodged online at: [Notification of a facility exceeding 10% of schedule 15 threshold \(s536\)](#).
- A workplace (including a farm) at which ammonia gas is stored or used must display a 'HazChem' placard at the entrance to the workplace (property)⁷. Where large properties are separated by public roads, it is recommended that appropriate HazChem signage is placed at the entrance to any farming or cropping area where the mobile ammonia tank may be located regardless of the duration for which the tank may be present.

⁷ S.4 Work Health and Safety Regulation 2011

References

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3. Australian/New Zealand Standard 1716:2012 Respiratory protective devices
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