





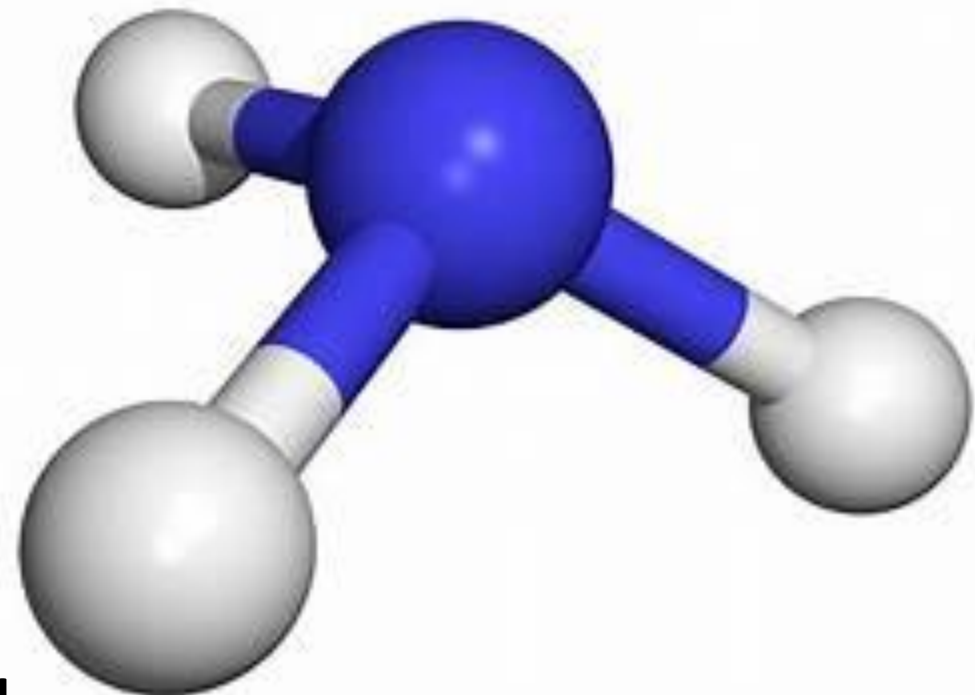
Where does Ammonia naturally occur ?

Ammonia exists naturally in the air at levels between 1 and 5 ppb

Ammonia levels in rivers and bays are usually less than 6 ppm

Ammonia levels in soil are typically between 1 and 5 ppm

Ammonia is produced in the human body primarily from the breakdown of amino acids. Your body removes ammonia through the liver by forming urea and it is then eliminated via the kidneys in your urine.



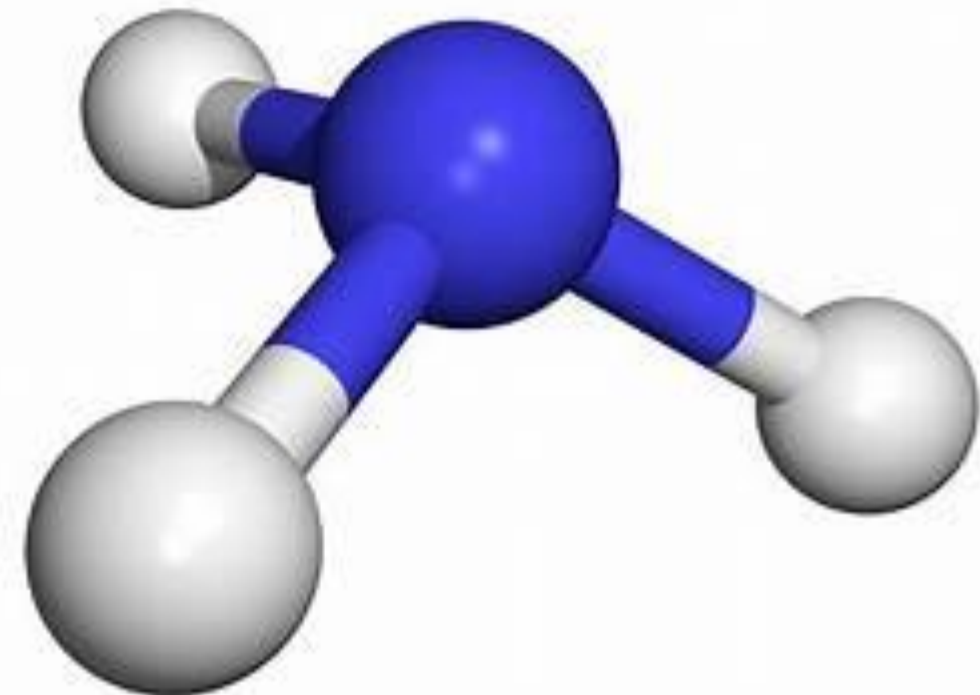
Acute Exposure Guideline Levels

	10 min	30 min	60 min	4 hr	8 hr
AEGL 1	30	30	30	30	30
AEGL 2	220	220	160	110	110
AEGL 3	2,700	1,600	1,100	550	390

AEGL 1 Minor Exposure Low Exposure

AEGL 2 Moderate Exposure

AEGL 3 Acute Exposure



THE FIRST 30 MINUTES

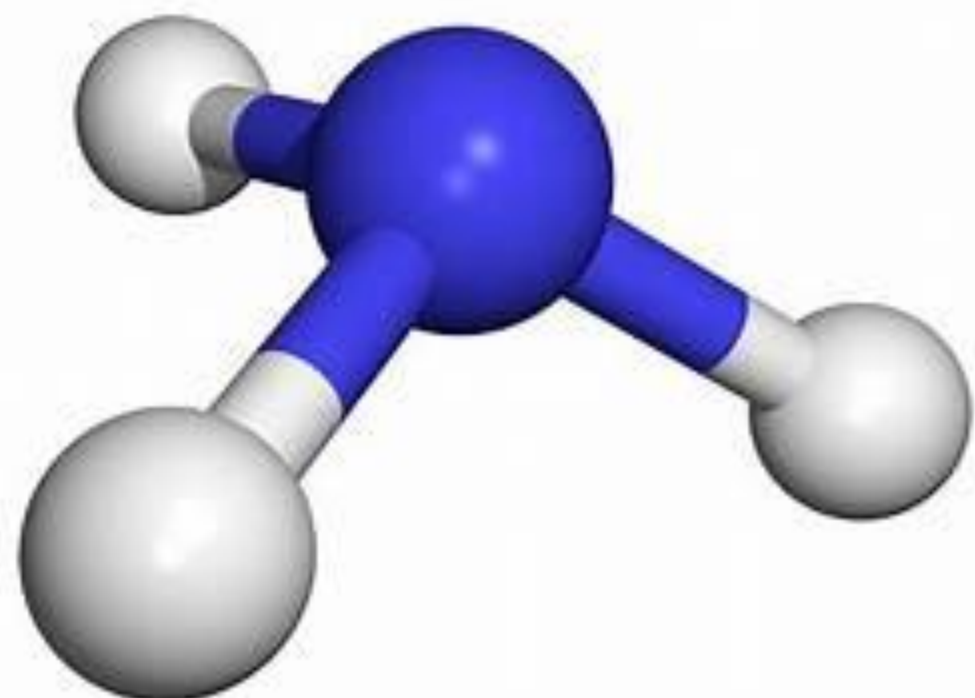
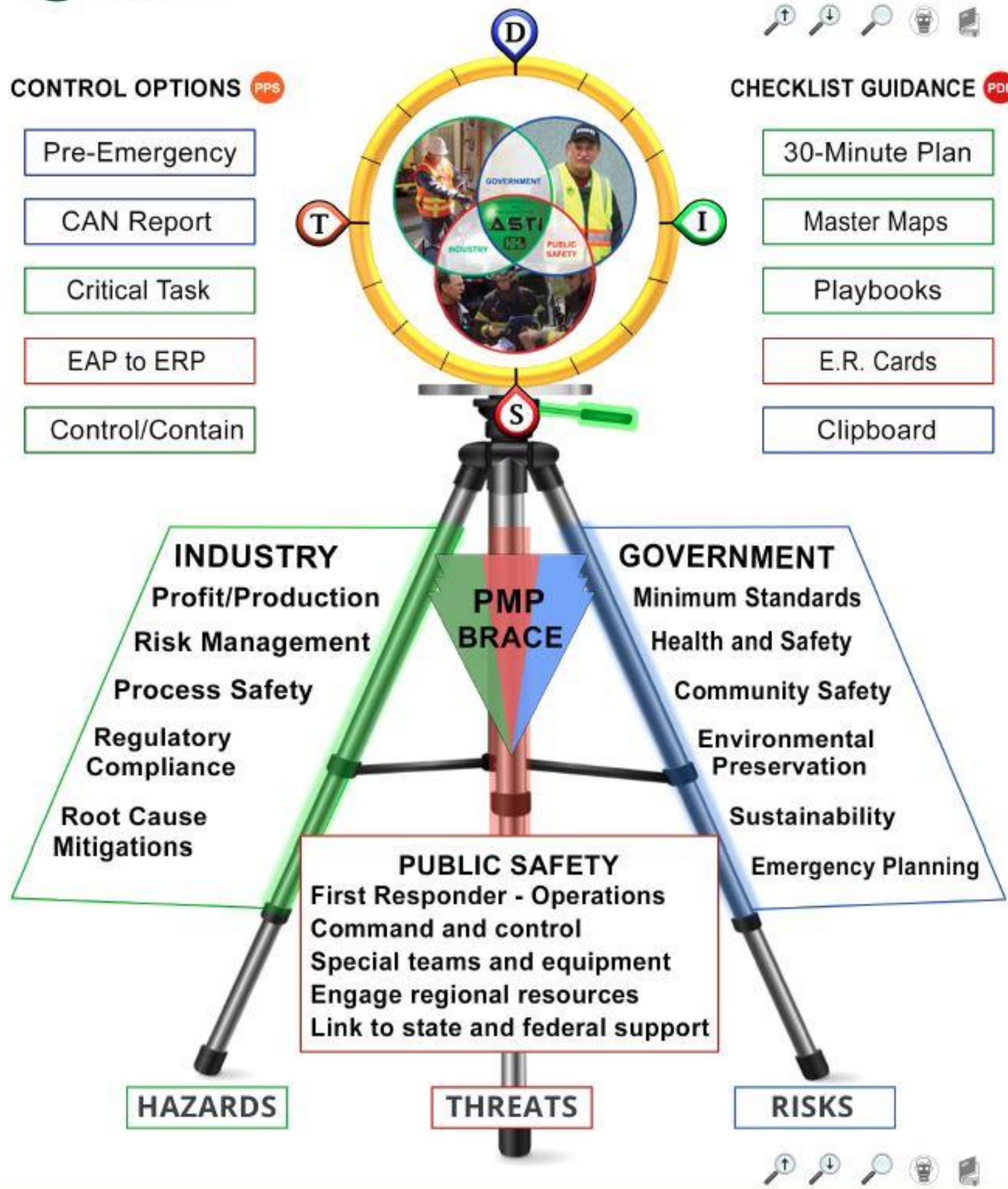


CONTROL OPTIONS PPS

- Pre-Emergency
- CAN Report
- Critical Task
- EAP to ERP
- Control/Contain

CHECKLIST GUIDANCE PDF

- 30-Minute Plan
- Master Maps
- Playbooks
- E.R. Cards
- Clipboard



Prevent Them All or Stop Them Small™



Safety Days

Live Release Training

Table Top Exercises

Joint Training Exercises

Site Specific Emergency Response Plans

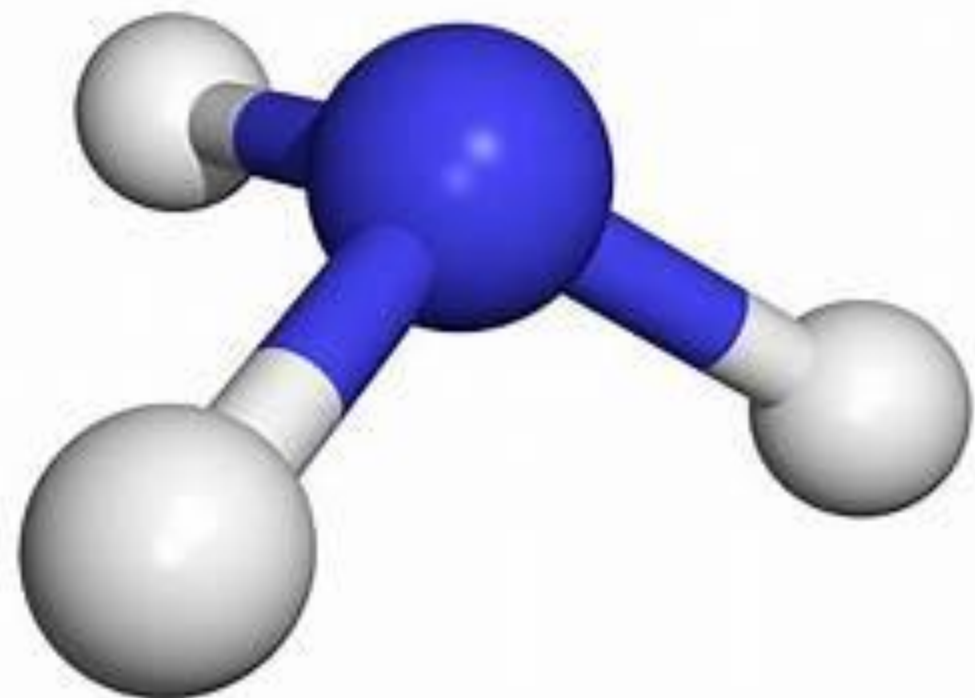
Site Specific Technical and PPE Reviews

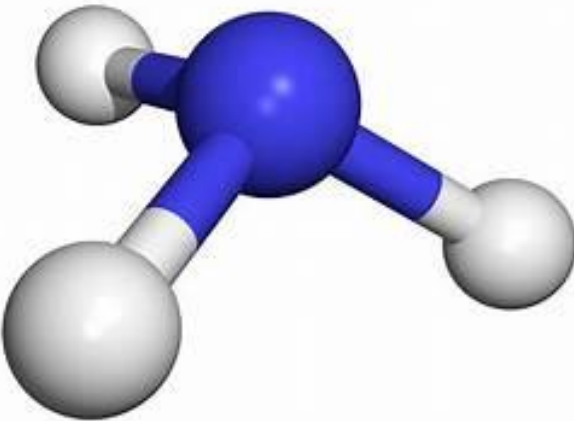
Statutory code of practice development

One Plan Response

CRADA Dispersion Modelling

Literature for the General Public





Quick Guides and Playbooks



Blue Playbook

Green Playbook

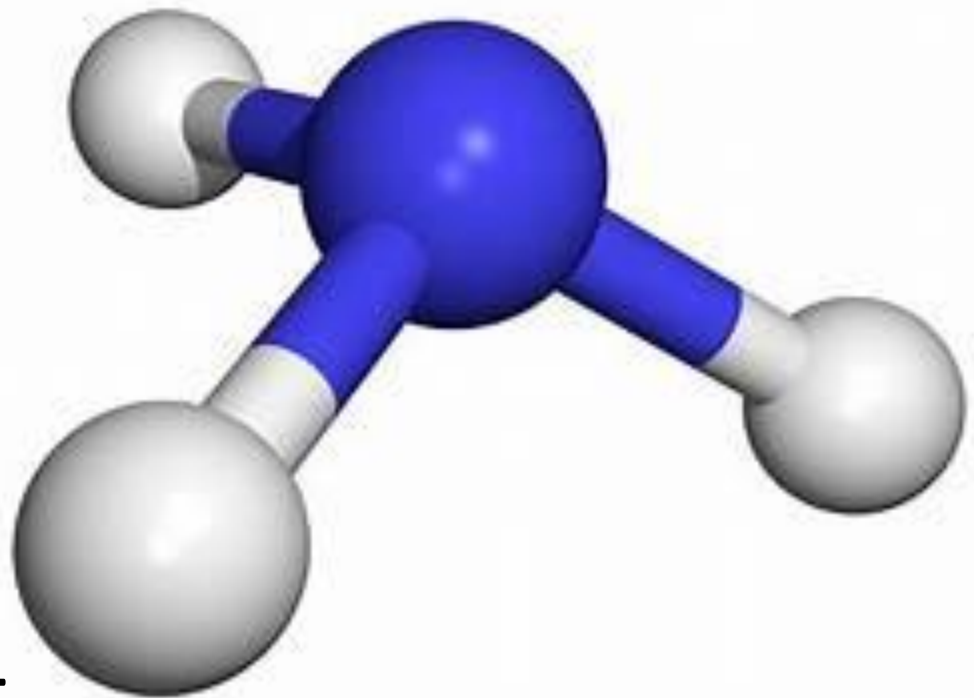
Red Playbook

Orange Playbook

Hazard Analysis Quick Guide

Release Estimator Guide

30 Minute Plan



30-MINUTE PLAN EMERGENCY CONTROL GUIDE

PHASE 1 DISCOVERY - LANCE

Life Safety: Clear the Isolation Zone (NH₃ = 100 ft. to 1,000 ft.)

- Clear the Isolation Zone and escape laterally and upwind or SIP
- Set up for rapid entry rescue, decontamination, and medical care

Alert: Record Size-Up on Alert Form

- Who? (your name)
- What? (casualties, rescue, medical, fire, or chemical release)
- Where? (specific location)

Notification: Coordinate Checklist Notifications with IC

- 9-1-1; give response route and on-site meeting location
- LEPC: () SERC: ()
- NRC: (800) 424-8802 OSHA: ()
- Contractor: () CORP: ()

Command and Control

Action: Identify Hazard Zone, Level of Concern, size of Isolation Zone, and location of the Incident Command Post (ICP)

Plan: Engage the Command Team; set the Life Safety Objective

Hazards (chemical/physical), **Risks** (life and environmental), **Threats** (fire, pressure, reactivity, slip/fall, structural integrity)

Level of Concern: 1-Controlled and contained
2-Controlled or contained
3-Uncontrolled and uncontained

Isolation and Protective Action Distance (PAD) for ammonia:

Small 100 ft.	PAD: 550 ft. (day and night)
Large 500 ft.	PAD: Day = .5 miles; Night = 1.3 miles
Catastrophic 1,000 ft.	PAD: Track plume beyond 1.3 miles

Acute Exposure Guideline Levels (AEGL):

10 Minutes: AEGL 2 = 220 PPM	AEGL 3 = 2,700 PPM
30 Minutes: AEGL 2 = 220 PPM	AEGL 3 = 1,600 PPM

Flammability of confined NH₃ vapor with a 1,204°F ignition source:
Caution at 15,000 and high risk at 40,000 PPM

Evacuation to Safe Refuge or SIP

- Movement Plan—move laterally and upwind to safe refuge
- Secure the safe refuge locations
- Setup Access Controls to and from the Plant
- Personnel accountability—check in/check out

PHASE 2 INITIAL RESPONSE - SIMPLE

Size-up: CAN report Conditions-Actions-Needs

Conditions: Hazard Zone Location? Status of emergency, Level 1, 2, or 3? Life Safety status? Controlled? Not Controlled? Contained?

Actions: Incident Commander and Command Post location? Evacuation status and rescue in progress? Size of Isolation Zone? Status of emergency Shut-down?

Needs: Rescue? Medical? Decon? Shut-down? Ventilation support? Downwind/downstream receptor management?

Sources of ignition and fire suppression controls

- Control utilities, ventilation, and sources of ignition
- Access to hydrants and FDCs for fire sprinkler system
- Firewall integrity, containment of fire, exposure protection

Isolate the source of the leak and pump down the liquid

- Identify upstream and downstream control points
- Avoid hydraulic shock caused by slamming a valve
- Avoid trapping liquid between valves with no relief valve
- Isolate the liquid flow to the leak site, and control defrost cycle
- Containment: tarp, and/or close doors
- Move liquid to safe location upstream or downstream of leak

Manage energy flow to the high and low sides

- Release: High or low side? Status of emergency relief system?
- Manage liquid flow and system pressure
- Reduce incoming heat—disable evaporators and defrost
- Use diffuser and/or pressure equalizer

Pressurized ventilation using system or portable fans

- Plan air flow—entry (upwind) and exhaust (downwind)
- Use fan to dilute or redirect vapor
- Engage portable fan to support rescue

Life Safety and Engage Incident Action Plan

- Set up Control Zone Layout (see diagram below)
- Public Safety coordination of downwind receptors in the Protective Action Area
- Eye-level wind movement: CAUTION for wind changes, eddies, backflow, and turbulence
- Consider site access control and air monitoring
- Assure containment of downstream environmental threat

PHASE 3 SUSTAINED RESPONSE

Sustained Response: Integrate and/or Unify Command

Actions: Assure personnel accountability and conduct a pre-entry site evaluation.

Plan: Write an IAP and Safety Plan (see back of 30-Minute Plan)

Hazmat Tech Team Engagement

- IC to review a Situation Status Report
- IC to integrate Command with Plant Liaison
- Safety Officer to update Site Safety and Control Plan (ICS 208)
- Conduct an IAP Command Team briefing
- Plans Section Chief updates situation status and proposes future IAP objectives
- Hazard assessment updates at least every 30 minutes and prior to engaging the next IAP
- Consider opening a Joint Information Center
- Consider opening an Emergency Command Center and assign a Public Information Officer and Plans Section Chief

Safety Plan: Pre-entry to Hot Zone

- Review the IAP objective(s) and task assignments
- Assure safety, rehab, decon, and medical evaluation
- Position hose line, ventilation and back-up team
- NO entry into IDLH without IC approval and a back-up
- Do a pre-entry review: use back-ups, proper PPE, entry/exit times, communications, and emergency alert signals
- Respirator < IDLH (300 PPM) and SCBA > IDLH (300 PPM)
- Vapor protection: Level B < 5,000 PPM to 10,000 PPM and Level A > 10,000 PPM
- Flammability = No entry > 15,000 PPM without mitigations (for sources of ignition) and flash protection
- Aerosol Stream/Dense Gas: Level A with flashfire and cold temperature protection (avoid using water to absorb liquid or aerosol)
- Chemical monitoring (fixed and/or handheld) for monitoring control zones and for entry team

PHASE 4 TERMINATION

Termination of the Emergency

Actions: Hazard/threat mitigations completed and IC sign-off of Termination Proclamation

Plan: Communicate termination order to Command Team, shelter locations, regulators, and media

- Plant IC engages Recovery, Restart, and Business Continuation IAP; maintain pre-emergency status (PPE and Command Team)
- Debrief and identify prevention and mitigation and preparedness improvements

Ammonia Safety and Training Institute

Take Command with the 30-Minute Plan

- Establish Hazard Zone
- Set the Level of Concern
- Secure the Isolation Zone
- Set Life Safety Objective
- Engage Emergency Shutdown Plan

Save yourself, engage the team, and help others. Act decisively to stop problems when they are small.

CONTROL ZONE LAYOUT—AMMONIA RELEASE

Cold Zone - Command and Operations

Medical Transport, Medical Treatment, Rehab Station, Command Post, Staging Area, Operations Area, Suit-Up Area, Equipment Layout, Fan(s)

Exclusion-Red Hot Zone
• AEGL 2 = 220 PPM
• 30 minutes exposure

Protective Action Distance
Day Time: 550 ft. to .5 Miles
Night Time: up to 1.3 Miles

Decon Corridor

Spill Area

Contamination Reduction - Yellow Zone

- Minimum of 100 ft. to 150 ft. between Red and Green Zones
- Drop equipment at the entry
- Decon with water for gross contamination (liquid)
- Decon with a fan for vapor exposure

Initial Isolation Zone

- 100' small leak < 100#s
- 500' large leak (aerosol cloud)
- Use buddy system
- Support with a fan and hose line

Command Team

- Establish personnel accountability
- Secure a site safety and control plan (ICS 208)
- Situation status and pre-entry hazard analysis
- Written Incident Action Plan

Wind Monitor the windsock and eye-level wind indicators
Weather data: <http://weather.noaa.gov/>

To order ASTI products, contact ASTI at astl@ammonia-safety.com, (831) 761-2935, or visit the ASTI website at www.ammonia-safety.com. ASTI products are distributed by ToucanEd - (888) 386-8226 www.ToucanEd.com

Tri-fold brochures



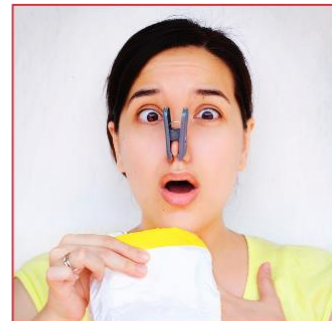
About Ammonia

Ammonia is a chemical that occurs naturally in the environment. It is an efficient and natural refrigerant used to support safe food storage, and as a fertilizer that is essential in growing crops. Ammonia is used as a household cleaner, and industrially to treat water and control air pollutants.

Ammonia is hazardous; however, people can live and work safely around it. Electricity, natural gas, and gasoline are examples of other hazardous materials that people have learned to live and work safely around.

Some basic things about ammonia:

- Ammonia is a colorless liquid or gas.
- Ammonia has a strong, pungent odour.



Wet baby diapers produce the ammonia odour.

- Initially a high concentration of ammonia may be visible as a white cloud. It will turn into invisible vapor as it travels downwind, away from the leak, and rise toward the upper atmosphere where it breaks down harmlessly.
- Ammonia does not cause damage to the ozone or contribute to climate change.

Plan for Hazards Possible in Your Community

Create the following emergency plans:

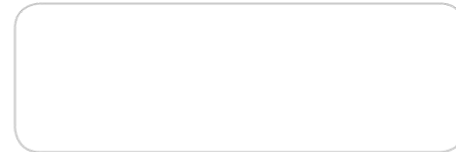
- Emergency Alert and 000 Notification Plan
- Fire Control and Escape Plan
- Shelter-in-Place Plan
- Medical Plan—CPR and First Aid
- Emergency Escape and Evacuation Plan
- Storm Mitigations and Shelter Plan



For More Information

Ammonia Safety and Training Institute
www.astiaustralia.com.au
www.ammonia-safety.com

Materials Safety Data Sheet: Search *MSDS* for Anhydrous Ammonia.
 © ASTI 2013



Living near Anhydrous AMMONIA



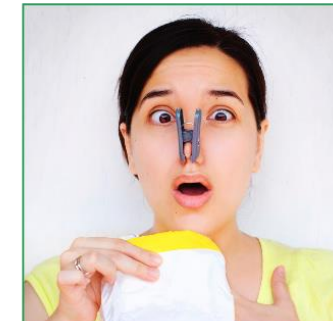
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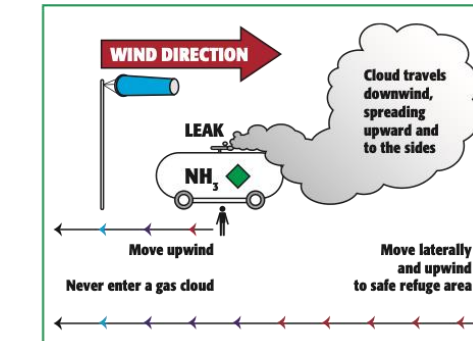
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Escaping Ammonia Threats

The Initial Isolation Zone around an ammonia release is 30 m. to 150 m. Escape by moving laterally and upwind or shelter-in-place. Follow your emergency plan as directed by the Plant Incident Commander.

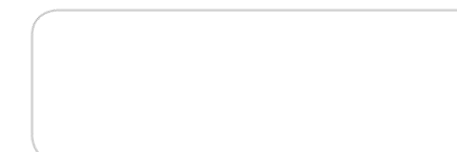
Evacuation Strategy



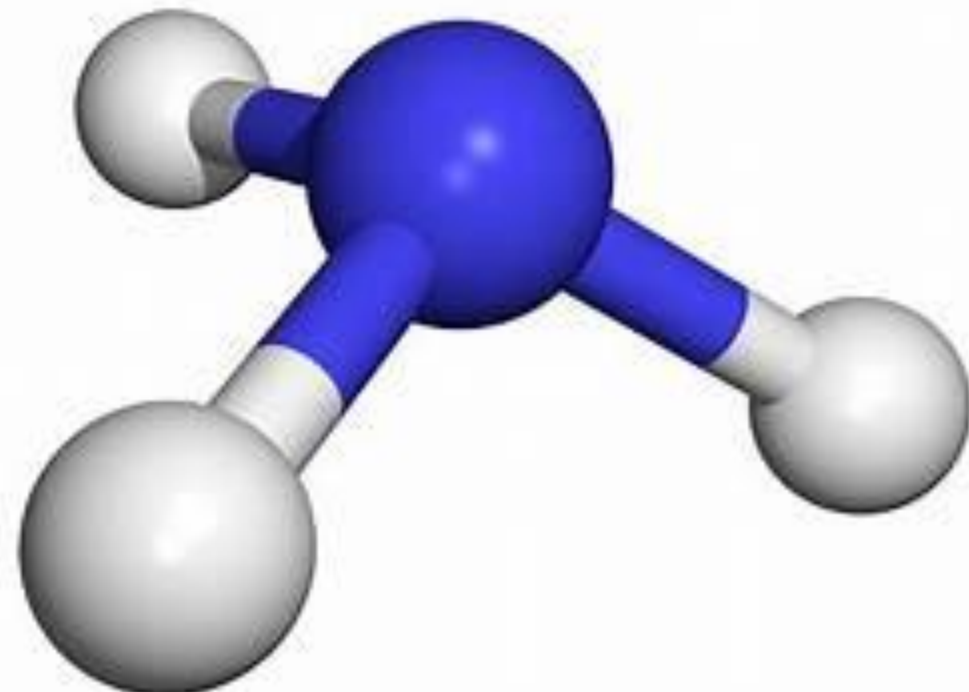
For More Information

Ammonia Safety and Training Institute
www.astiaustralia.com.au
www.ammonia-safety.com

Materials Safety Data Sheet: Search *MSDS* for Anhydrous Ammonia.
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Working around Anhydrous AMMONIA



About Ammonia

Product Name: Anhydrous Ammonia.

Chemical: NH₃, Inorganic, reactive with acids, halogens and chlorine.

Product Use: Fertilizers, Refrigeration, Fibers and Plastics, Explosives, NOx Control.

Physical Form, Color, and Odor: Colorless gas and liquid under pressure; forms white vapor in contact with moisture; strong, pungent, and penetrating odor.

Vaporization Rate: 865 NH₃ ammonia vapor to 1 volume of ammonia liquid at 21°C; the **absorption rate of ammonia vapor to water** is 1300 to 1.

Mixing Water with Ammonia: **Never add water to a dense gas, aerosol stream, or liquid. Contain all aqua ammonia** until it is determined to be safe to release to downstream environment or to a wastewater treatment facility.

Boiling Point: -33°C at 1 atm, freezes at -78°C.

Water Solubility: Very soluble with water, forms a pH of 11.6; a 29% aqueous ammonia (NH₄OH) pH of 13.8.

Specific Gravity: 0.6818 @ -33°C and 1 atm.

Vapor Density: 0.60 @ 15°C

Vapor Pressure: 7,600 mm Hg @ 25°C.

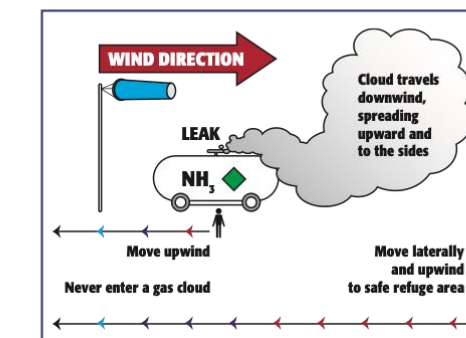
Density: 0.696 g/L @ 20°C.

Flammability: **Flash Point** 11°C; **Lower/Upper Flammable Limits:** 15% to 28% (150,000 to 280,000 PPM) Volume in Air; the **Lower Flammable Limit may drop** to as low as **12%** when combustible mineral oil is mixed with the ammonia cloud (normally found in a release in a machinery room); Auto-ignition Temperature is 651°C.

Escaping Ammonia Threats

The Initial Isolation Zone around an ammonia release is 30 m to 150 m. Escape by moving laterally and upwind, or shelter-in-place. Isolation Zone 30 m for small release, 150 m for large release, 300 m for catastrophic release.

Evacuation Strategy



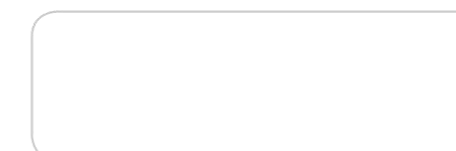
For More Information

Ammonia Safety and Training Institute
www.astiaustralia.com.au
www.ammonia-safety.com

Agency for Toxic Substance and Disease Registry
www.atsdr.cdc.gov/

Materials Safety Data Sheet: Search *MSDS* for Anhydrous Ammonia.

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Ammonia and Public Safety



150 million tonnes p.a. distributed globally



Rail Tank Cars



Road Tankers

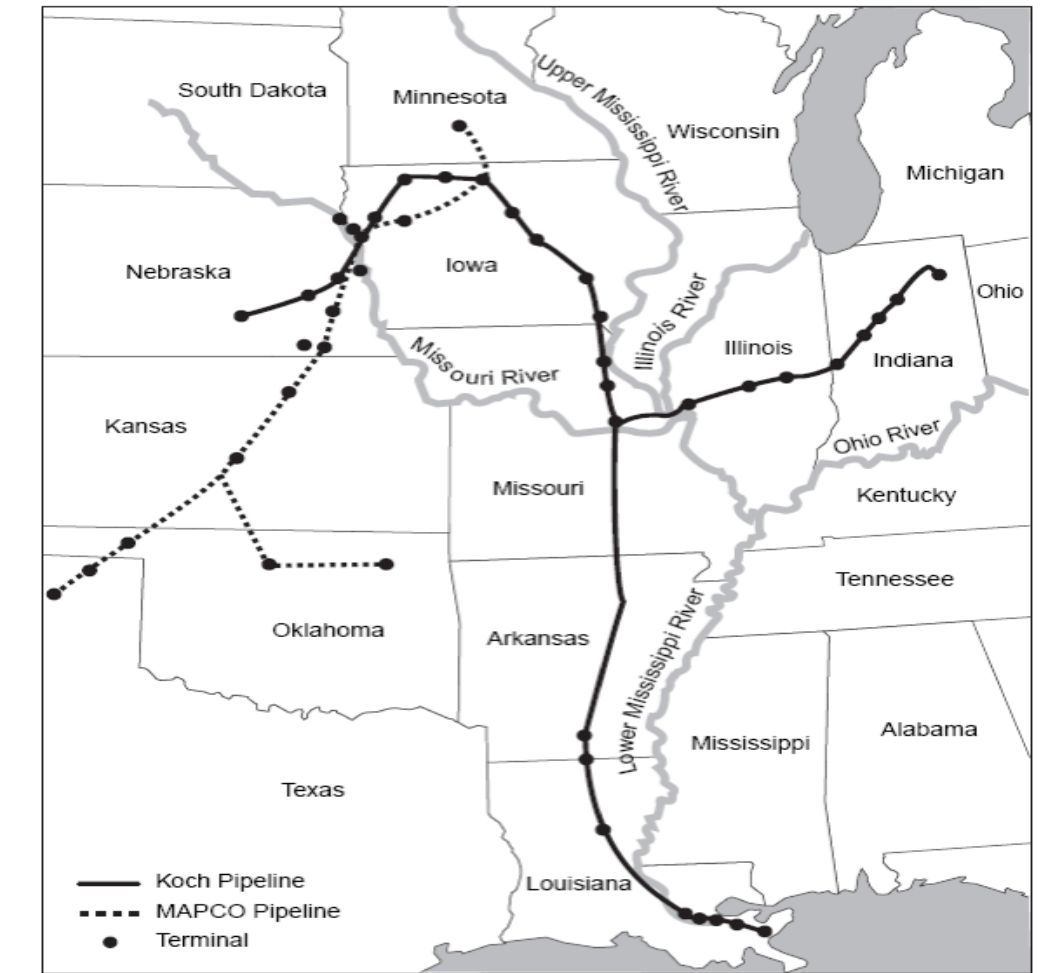


Barges

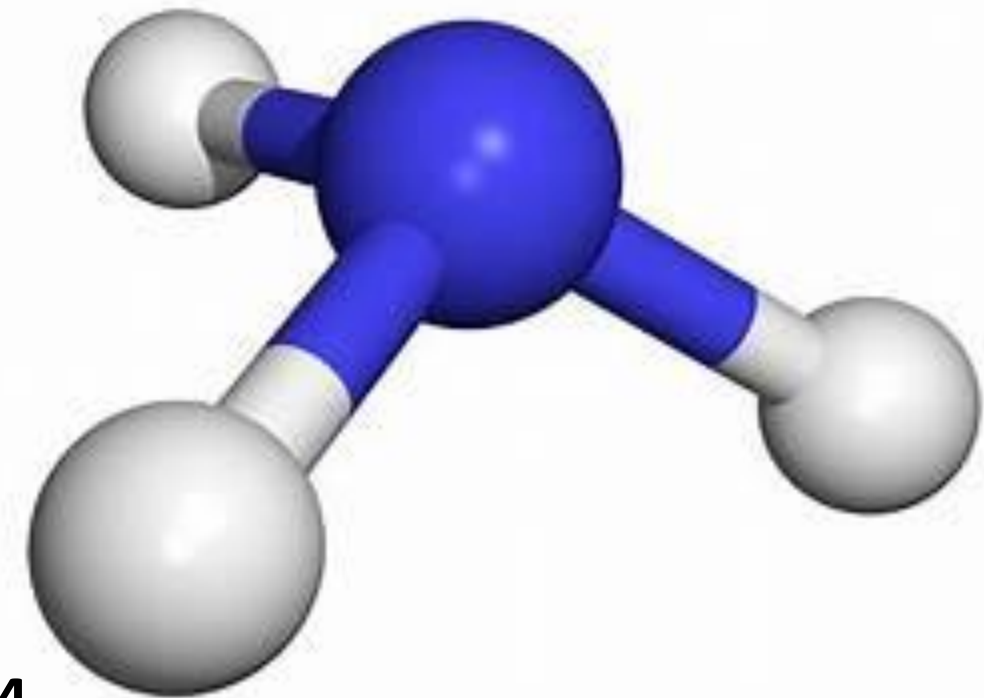


Nurse Tanks

Pipelines



Ships



Release of saturated liquid under pressure

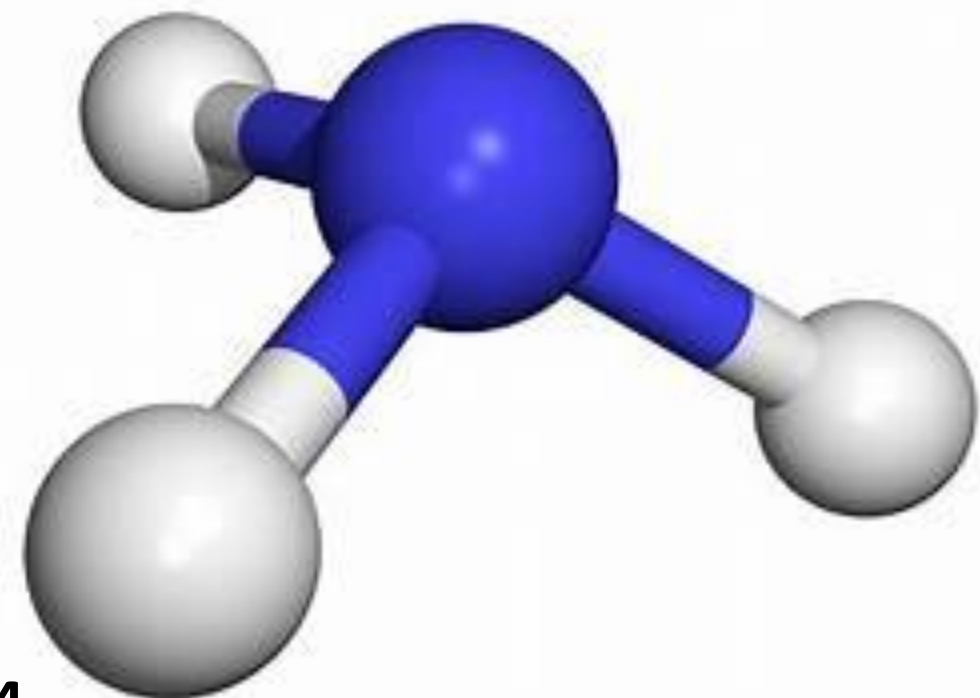


Release under pressure results in an aerosol and potentially a dense gas cloud which is usually heavier than air

The example shown involves a pressure reduction at the point of release vertically down the line from 5 to 4 arriving at atmospheric pressure and a dryness fraction of 0.22

We can therefore estimate that 22% of the mass flow of the release will instantaneously turn to flash gas at the breach

The volume ratio of gas to liquid at atmospheric pressure and -33C is a factor of 766

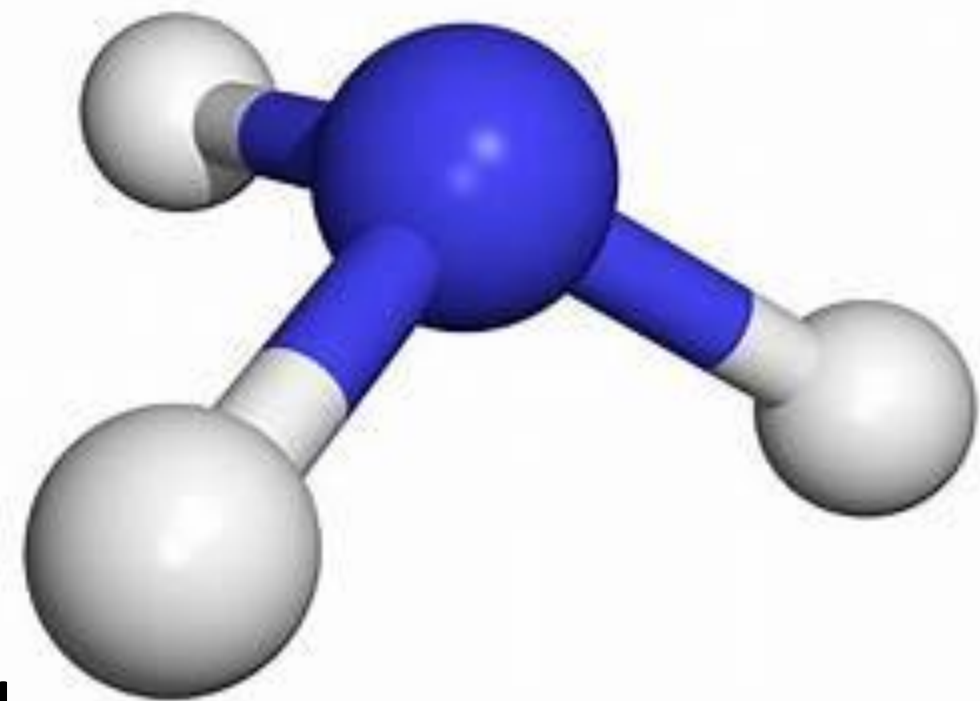


For example 1 litre/sec of liquid releasing will generate 168 litre/sec of flash gas which will violently propel an aerosol and then become a dense gas cloud which will be heavier than air.

This kind of release poses the highest risk.

Case Study 1

Minot North Dakota 2002 Five rail tankers ruptured spilling ammonia



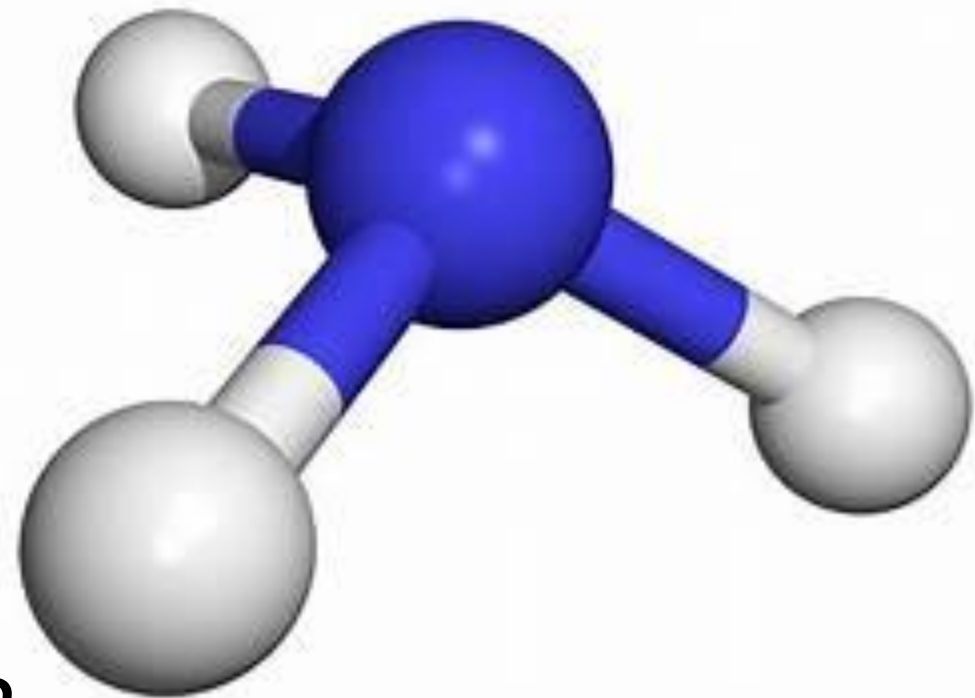
250 Tons were released. A cloud of ammonia lay over the city for several hours.

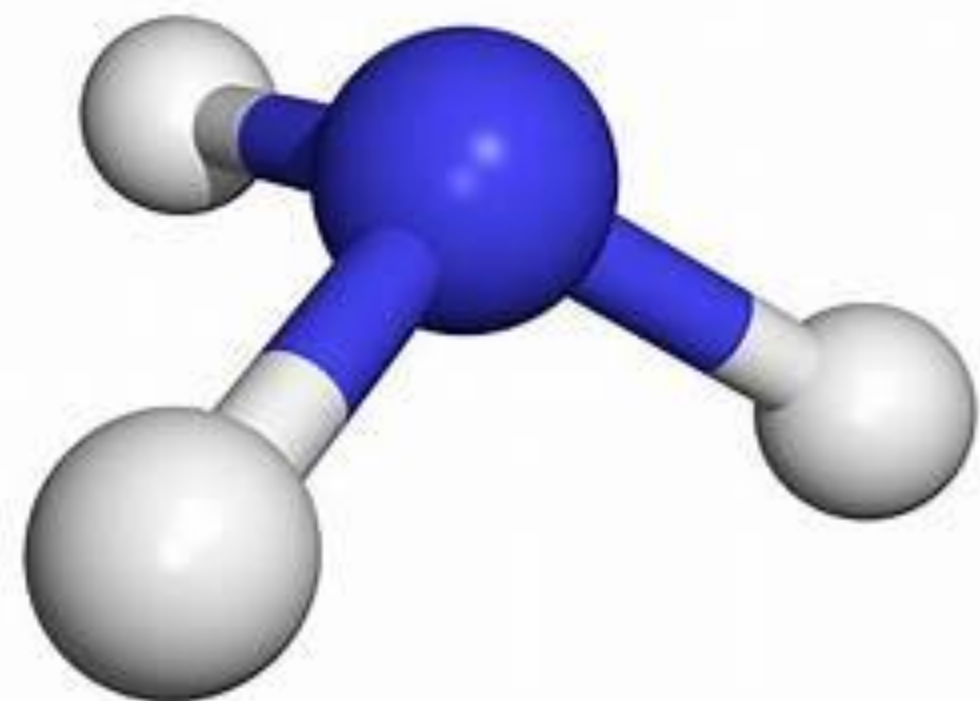


Dispatchers told residents to stay inside, close doors and windows, and cover their faces with wet cloths to counteract the ammonia.

Residents were also instructed to go into their bathroom and turn on the shower if the ammonia smell became too strong. The ammonia is absorbed into the shower water and carried down the drain which reduces the ammonia concentration.

This was one of the largest outdoor, pressurized ammonia releases in recent history, which tragically resulted in one death and fourteen serious injuries.



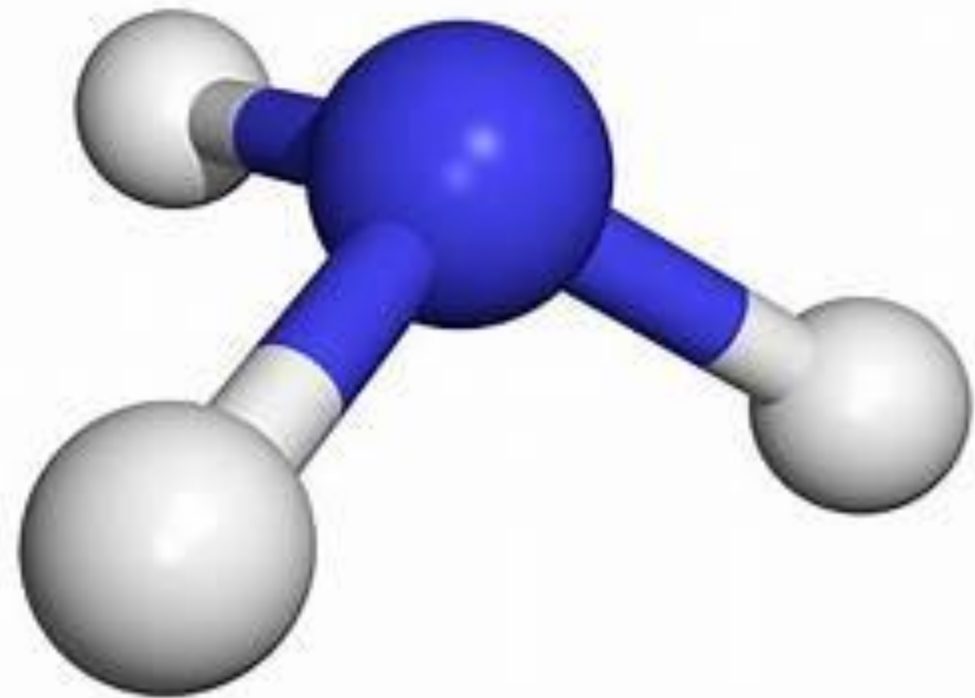


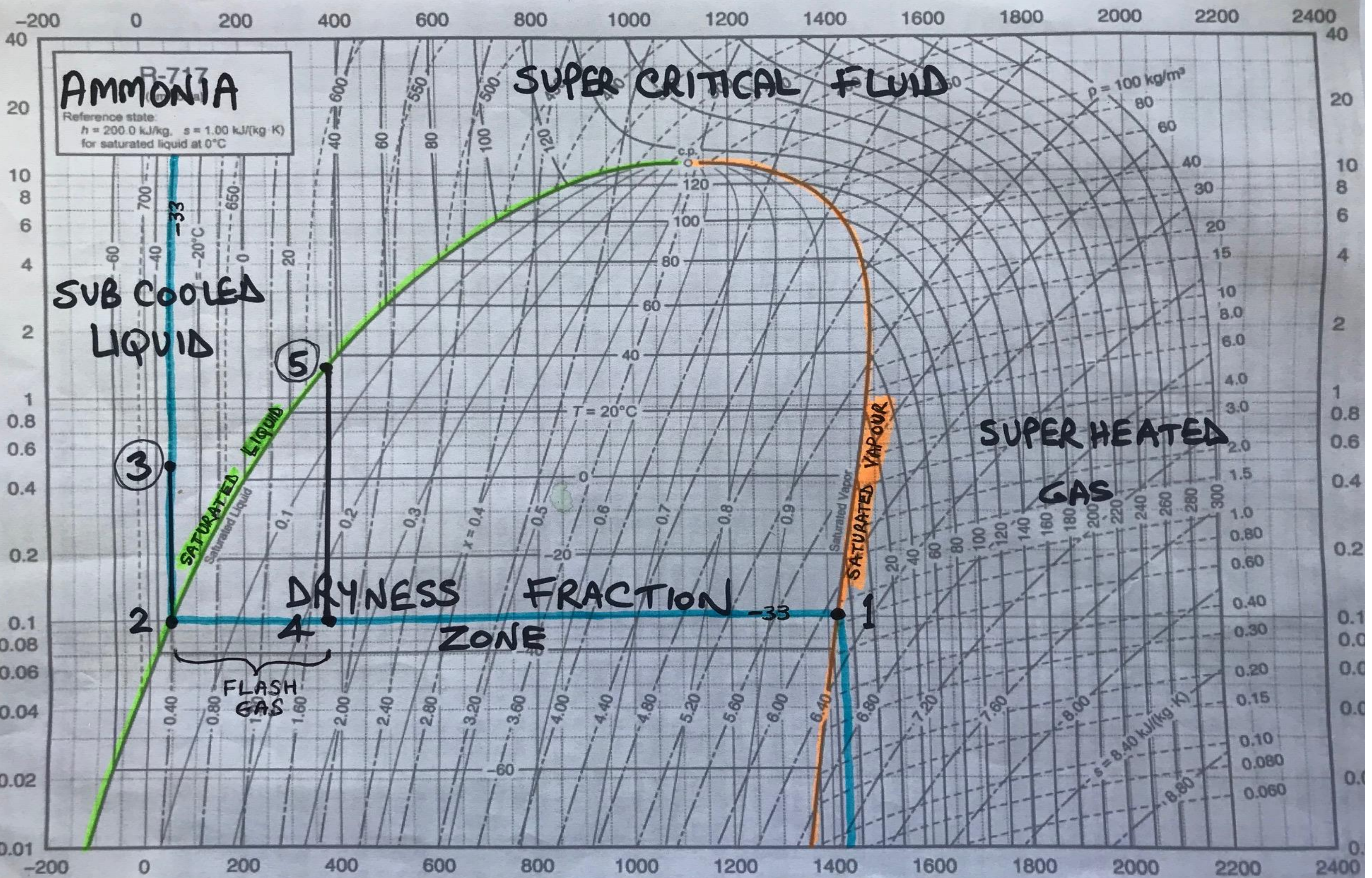
Ammonia Transport Ship in Port Area



It was reported that this release was because of a valve being opened by mistake as the ship was approaching the port. When the mistake was realized the valve was closed.

The release appears to be emanating from the freeboard area well above the water line.





150 million tonnes p.a. distributed globally



Rail Tank Cars



Road Tankers

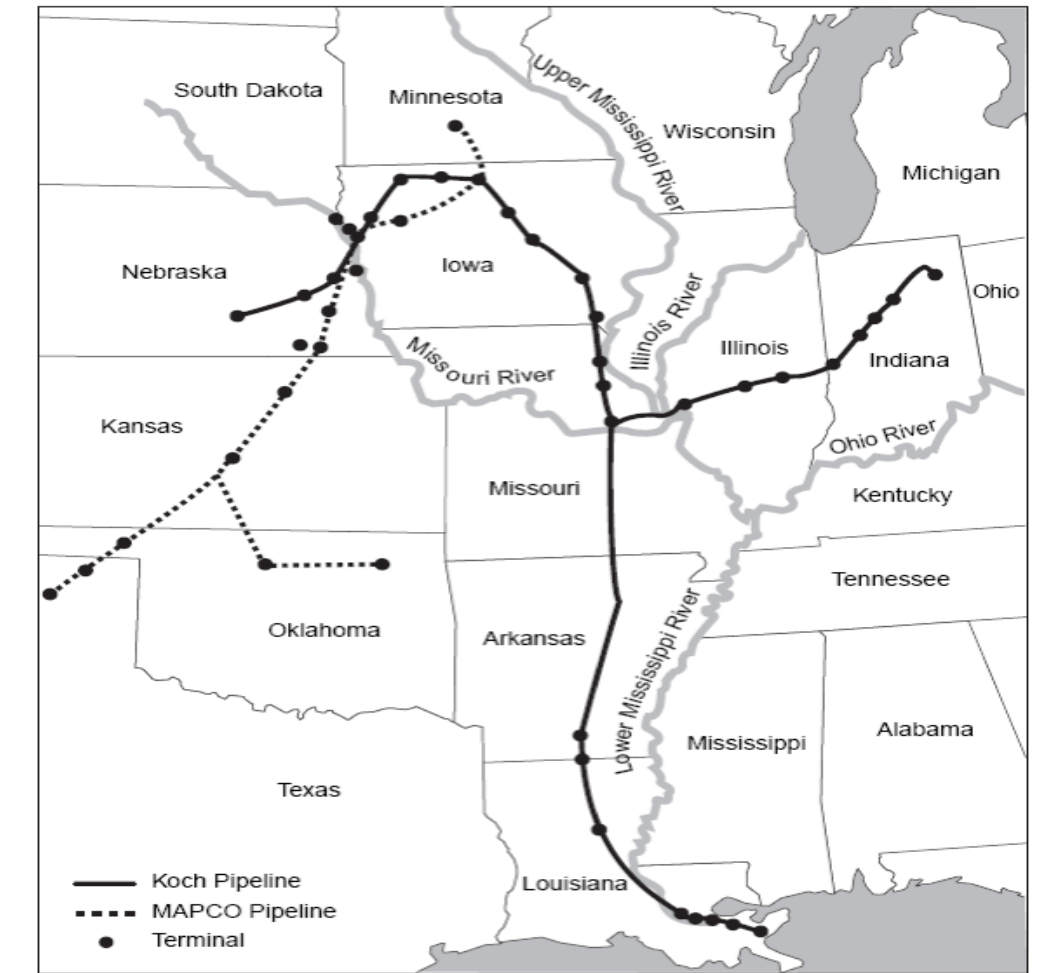


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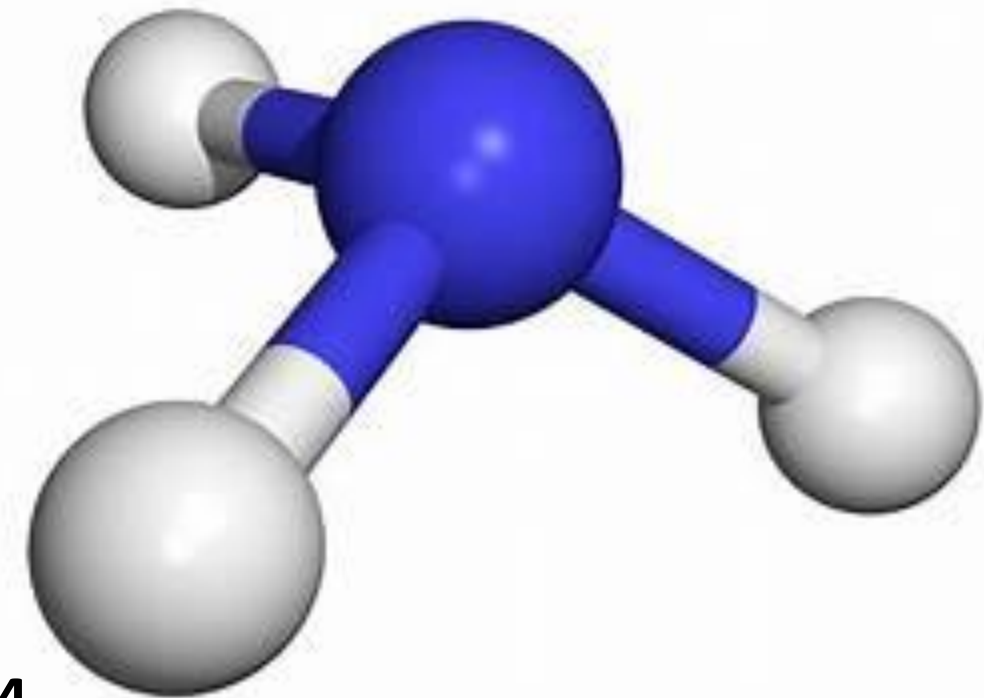


Nurse Tanks

Pipelines



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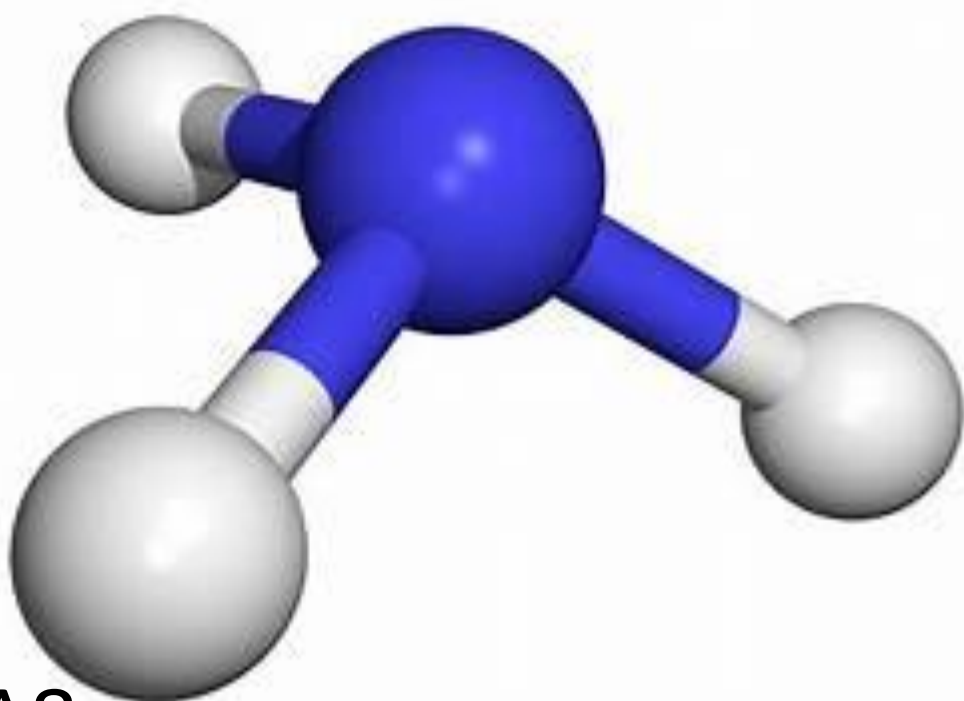
Release of saturated liquid at atmospheric pressure

Release from storage at atmospheric pressure (point 2)

The majority of the gas evaporating from the pool will be invisible pure gas which is about 60% of the density of air and will quickly rise into the atmosphere. There will be no aerosol or dense gas cloud and therefore the risk is low.

A little bit of water vapour may be visible whispering from the surface of the pool

Spraying water onto the pool will increase the evaporation rate and even cause a gas cloud which may be heavier than air so this should never be done.

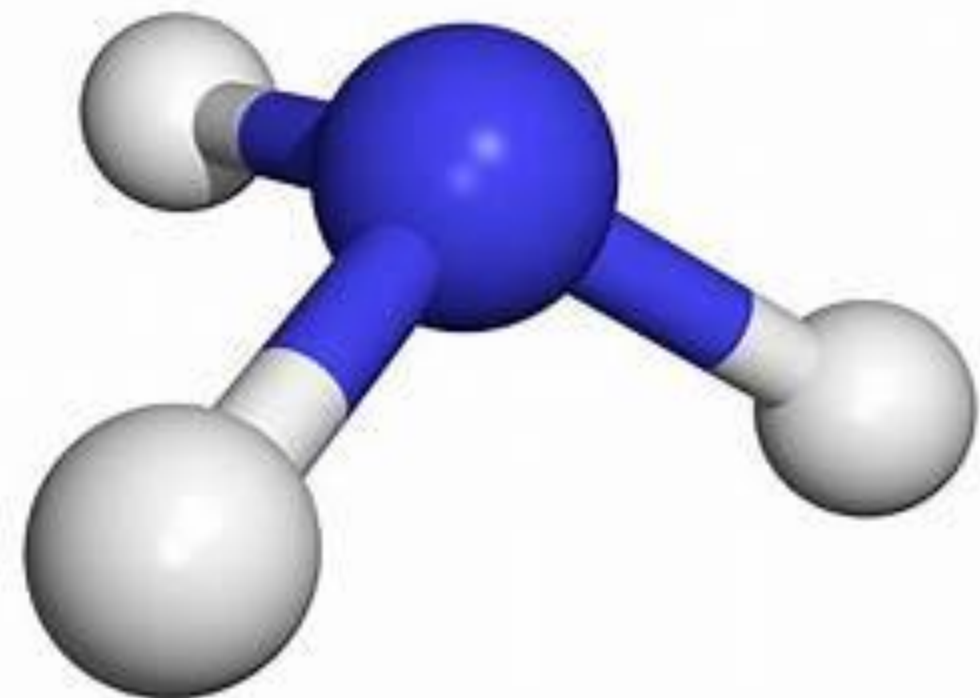


The amount of gas evaporating from the surface will be a function of the quantity of heat entering the pool from the surface below and the air above. Ammonia has a very high latent heat of evaporation, so the rate at which the ammonia evaporates will be very low.

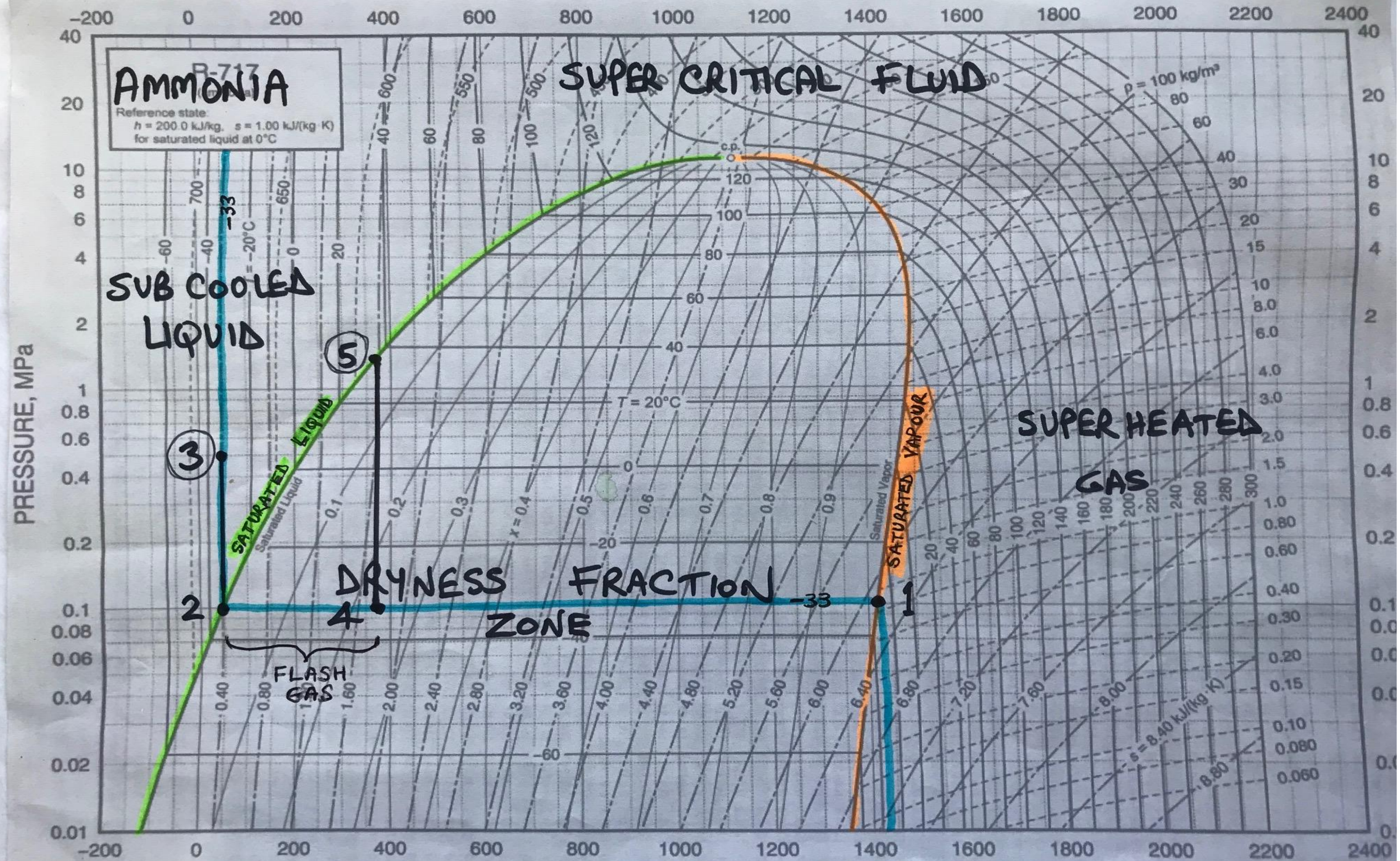
Case Study 2



In December 1994 there was an explosion in the Port Neal Iowa ammonium nitrate plant which ruptured nearby atmospheric pressure ammonia storage tanks allowing 5700 tons of liquid to escape into the bunded area. This was the largest ammonia release in US history.



1700 residents were evacuated from the surrounding area however there were no deaths or injuries as a result of the ammonia release.



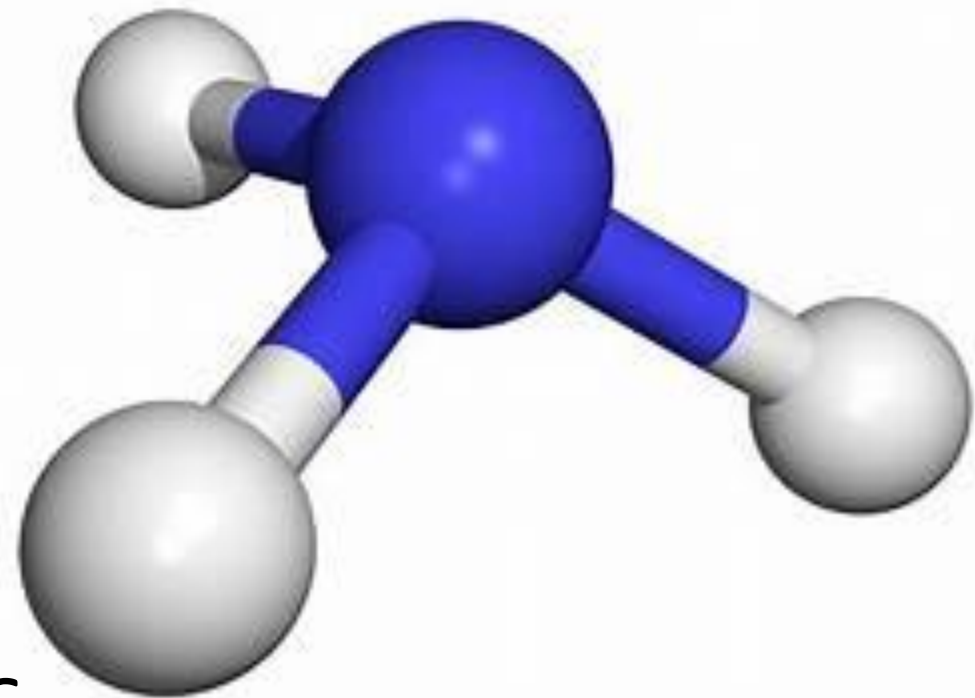
Release of Subcooled liquid under pressure



The example shown involves a pressure reduction at the point of release vertically down the line from 3 to 2 arriving at atmospheric pressure on the saturated liquid line

little or no flash gas will form at the breach and only liquid will be released some of which could be atomised

This example would be applicable for the relatively short insulated pipeline used to pump liquid ammonia to or from a -33C ammonia transport vessel and into an atmospheric pressure -33C terminal tank. The pump suction condition will be at point 2 and the discharge will be at point 3



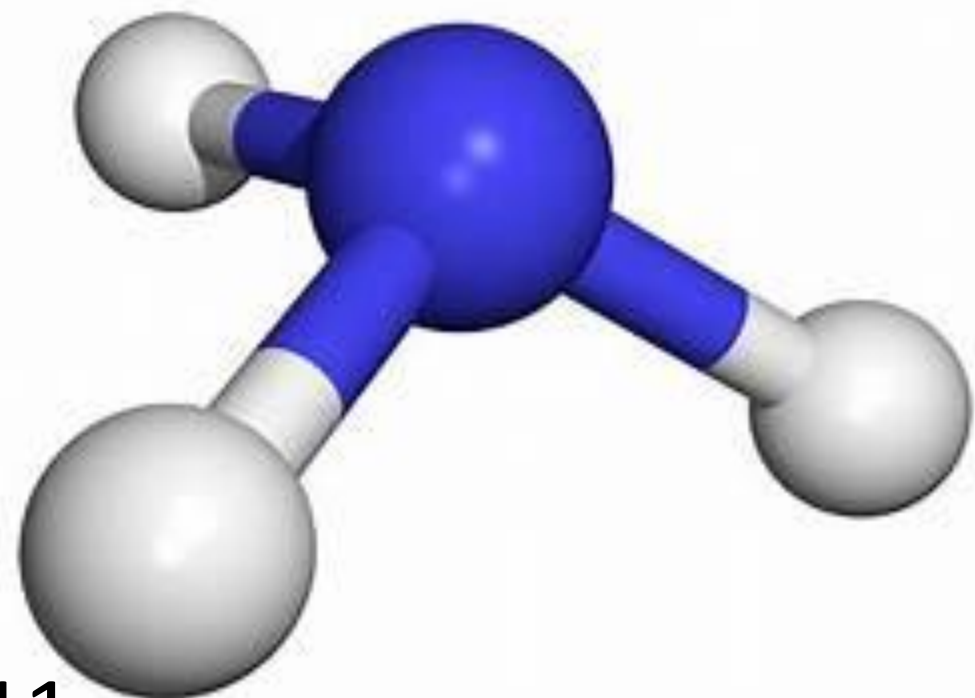
A subcooled liquid release should pose a lower risk than a saturated liquid release



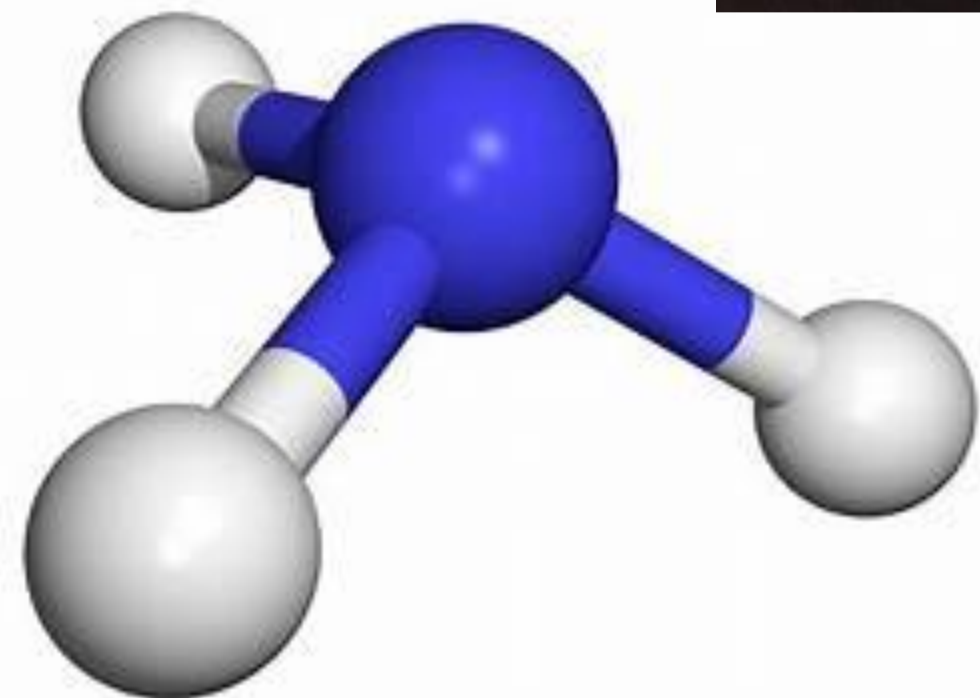
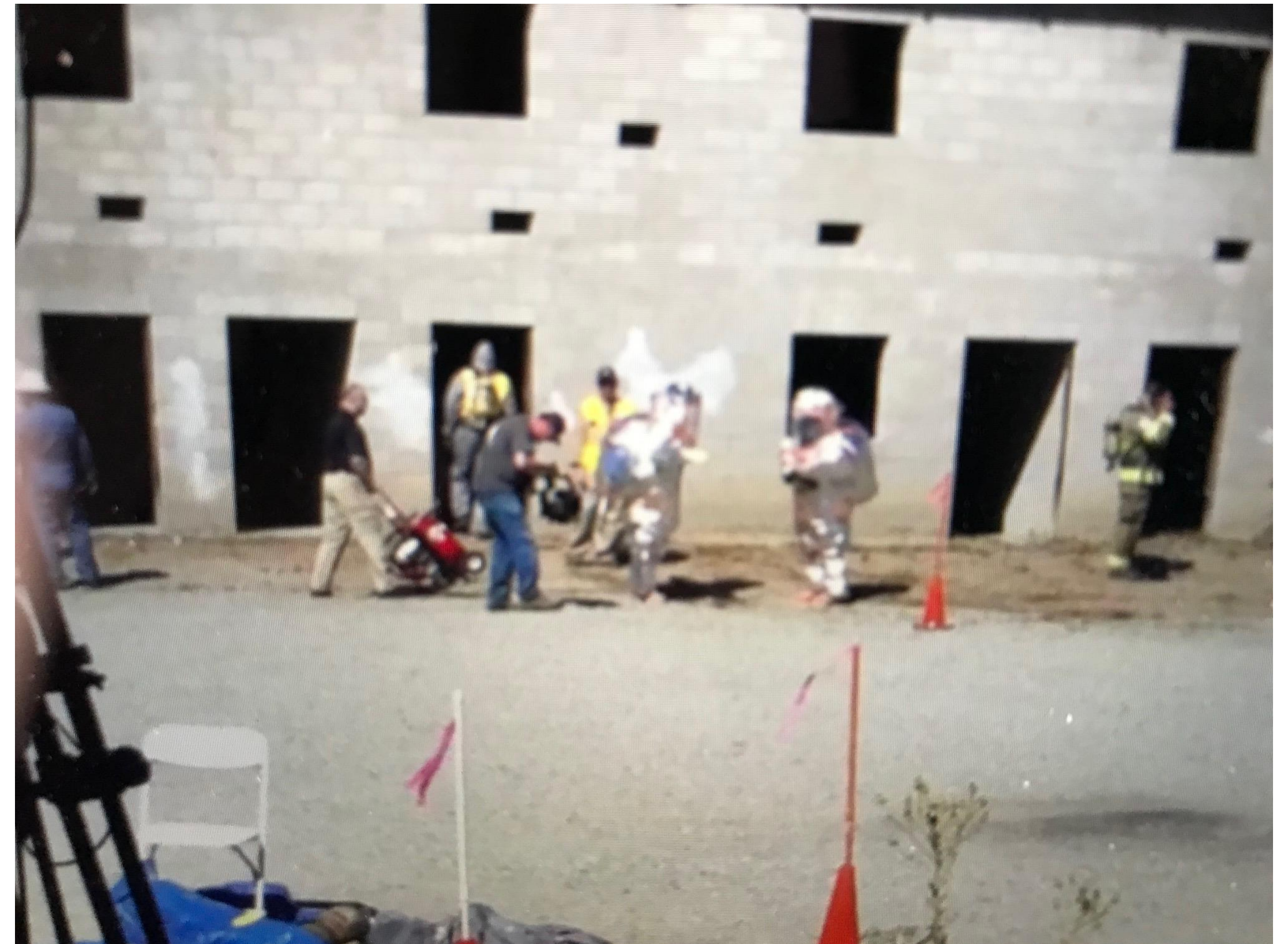
Summary

The highest risk and hazard profile will be from a pressurized saturated ammonia liquid release in an enclosed space

The lowest risk and hazard profile will be from an atmospheric pressure storage of saturated liquid ammonia in an outdoor area



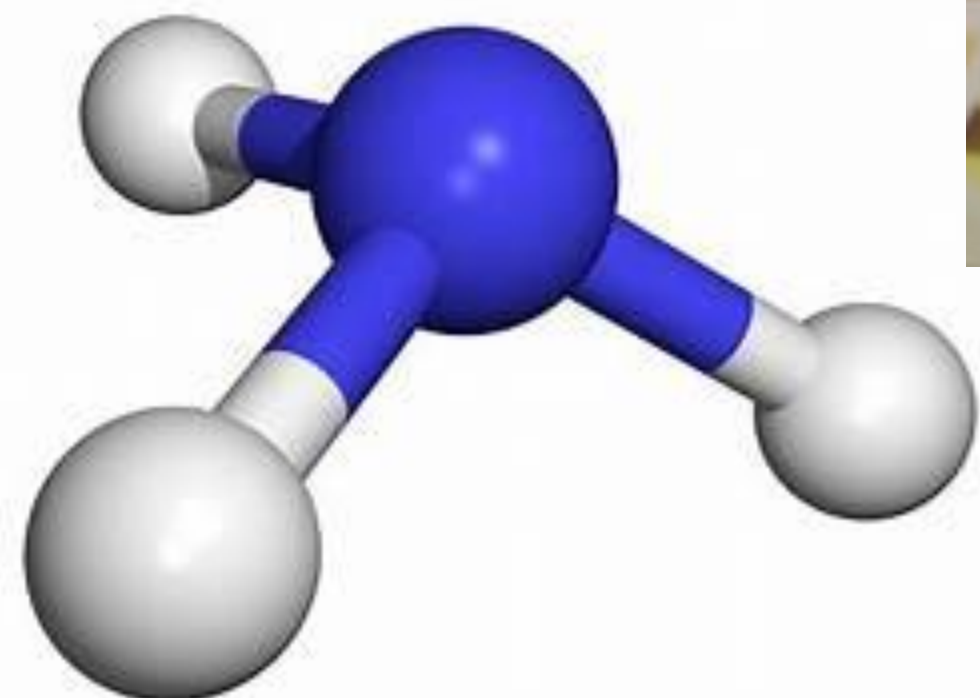
Level A Using low temperature gas tight suit



Recommended for concentrations above 5000 ppm and temperatures down to -40



Level B Disposable suit



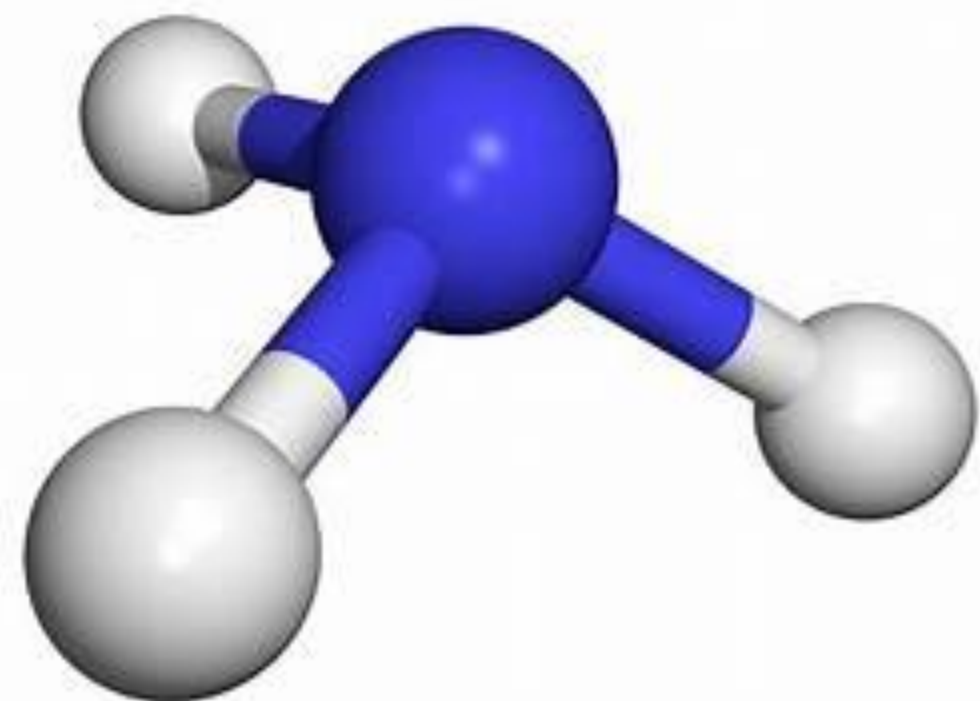
Recommended for 300 – 5000 ppm



Level C. ASTI Vest



- ASTI high visibility vest**
- Lapel mounted personal ammonia detector**
- Negative pressure, full face compact mask with replaceable K2 filter**
- White LED right angle flashlight**
- Ultravision anti fog goggles with forehead seal**
- Elbow length chemical safety gloves**
- Chemical break open eyewash**
- Anti-fogging agent to use on mask & goggles**
- ASTI 30 Minute Plan (*A3 folded*)**





**AMMONIA SAFETY &
TRAINING INSTITUTE**

ASTI is a 501(c)(3) Non-Profit

Call for Expressions of Interest

There is a lot of activity globally with the aim of introducing ammonia as a carbon free maritime bunker fuel in the near future.

The AMC and ASTI have been in discussions with a view to developing training courses for seafarers who will be crewing vessels and operators who will be carrying out bunkering activities at ports, all of which will be using ammonia bunker fuel.

It is envisaged that these courses, which will need to be AMSA approved, be added to the suite of approved short courses which are already delivered by the AMC in Launceston for the maritime community.

We are seeking expressions of interest and support for the development of these training courses

If you are interested please contact:

Hossein Enshaei AMC. hossein.enshaei@utas.edu.au

John Mott ASTI. johnniemott@hotmail.com

