





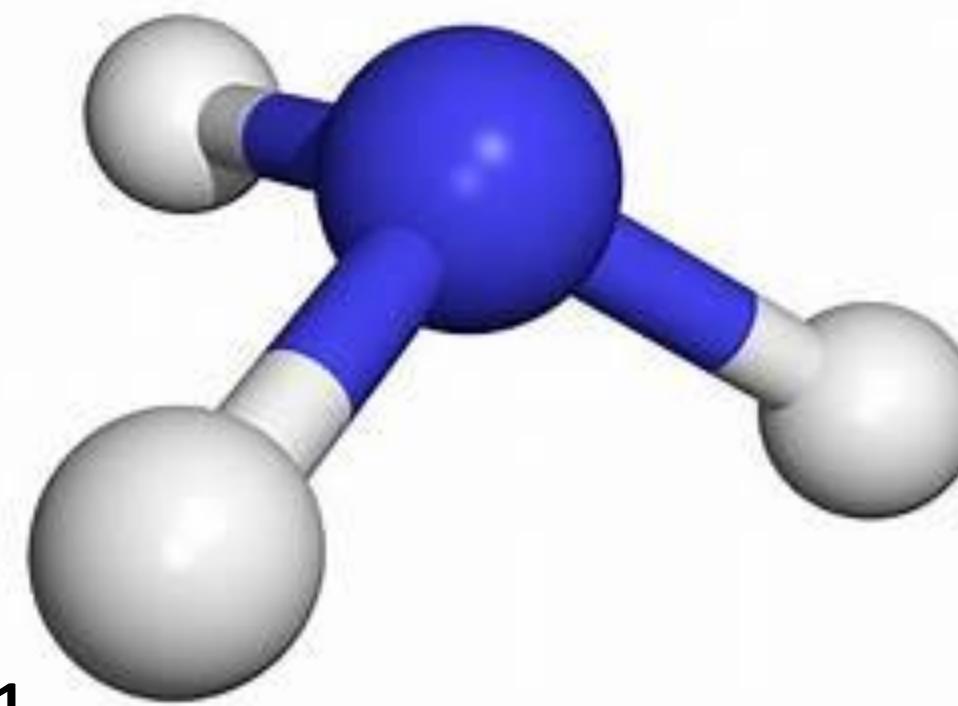
# Where does Ammonia naturally occur ?

**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.**



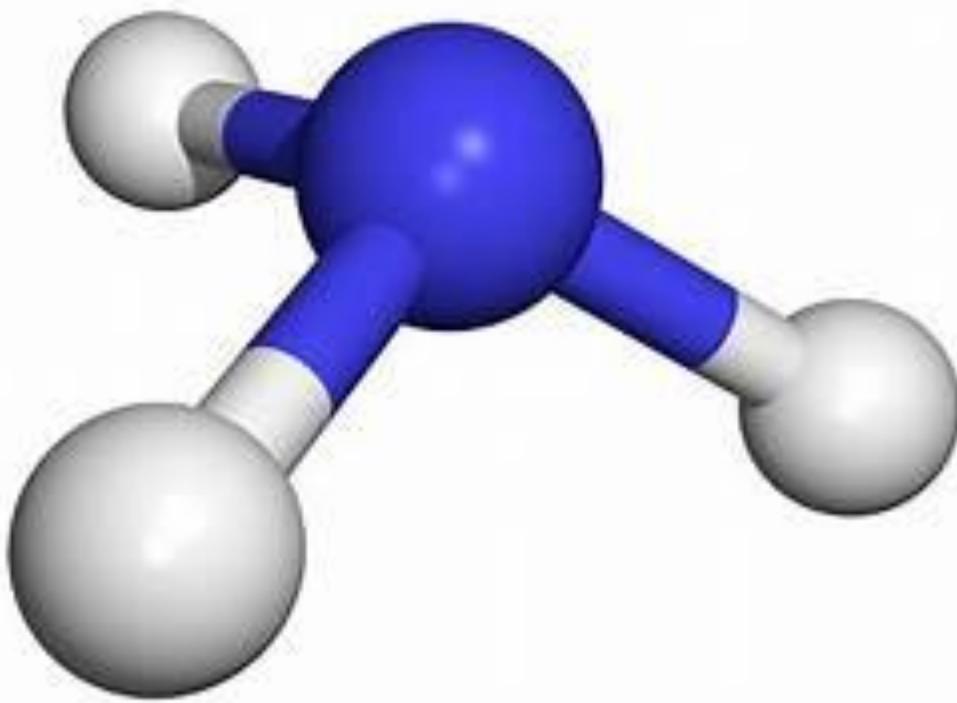
# Acute Exposure Guideline Levels

	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

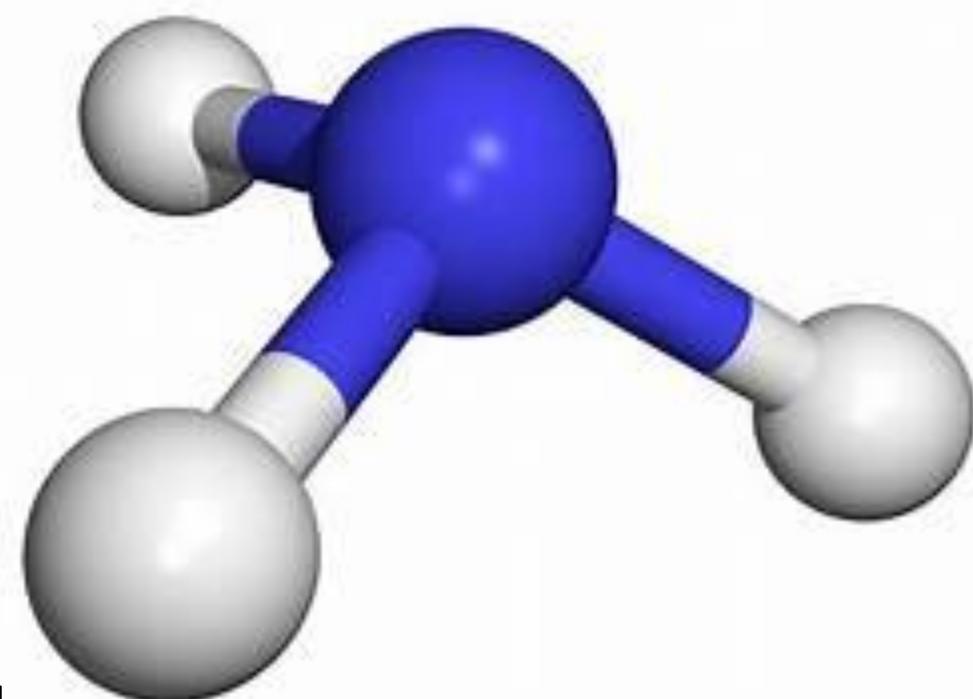
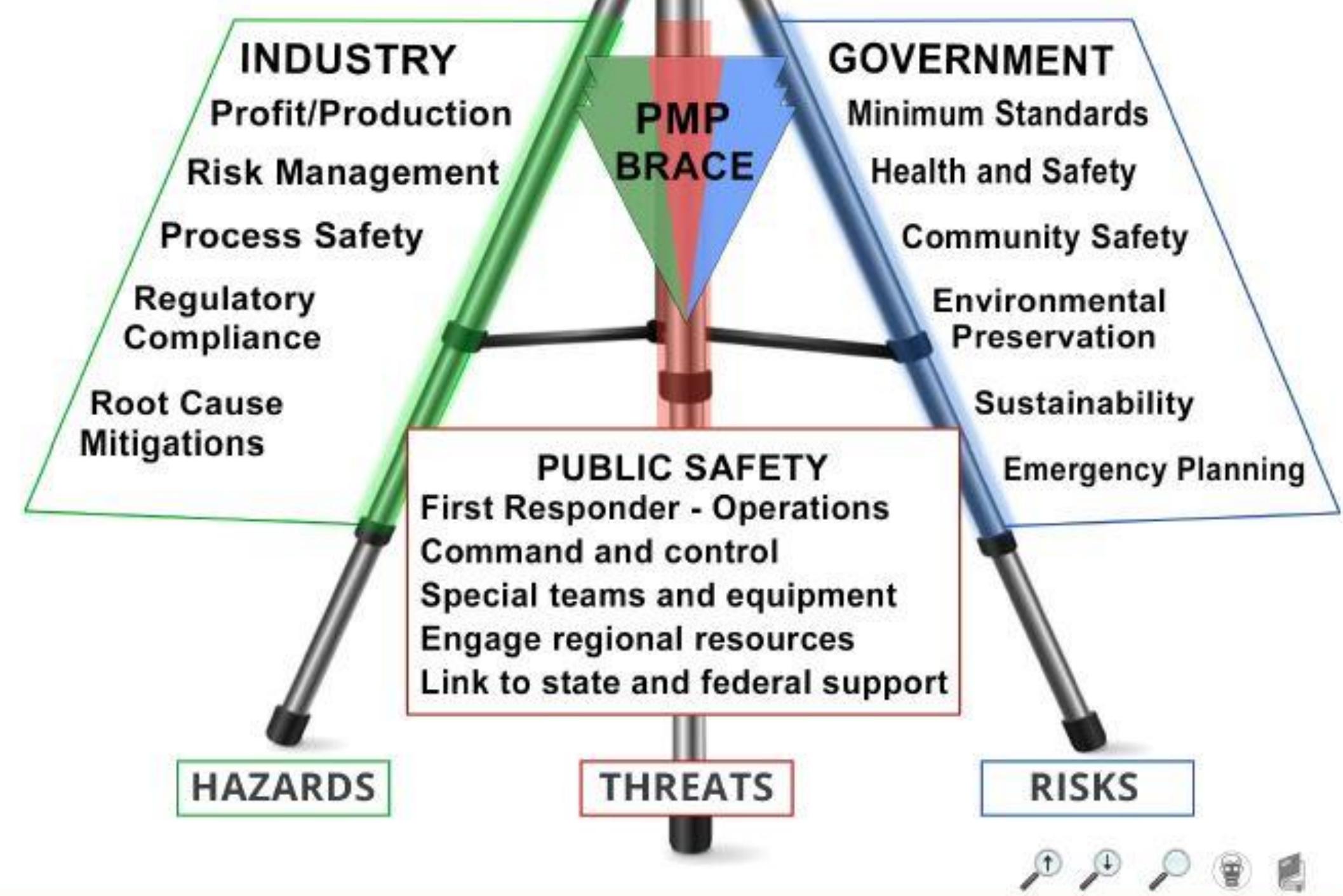
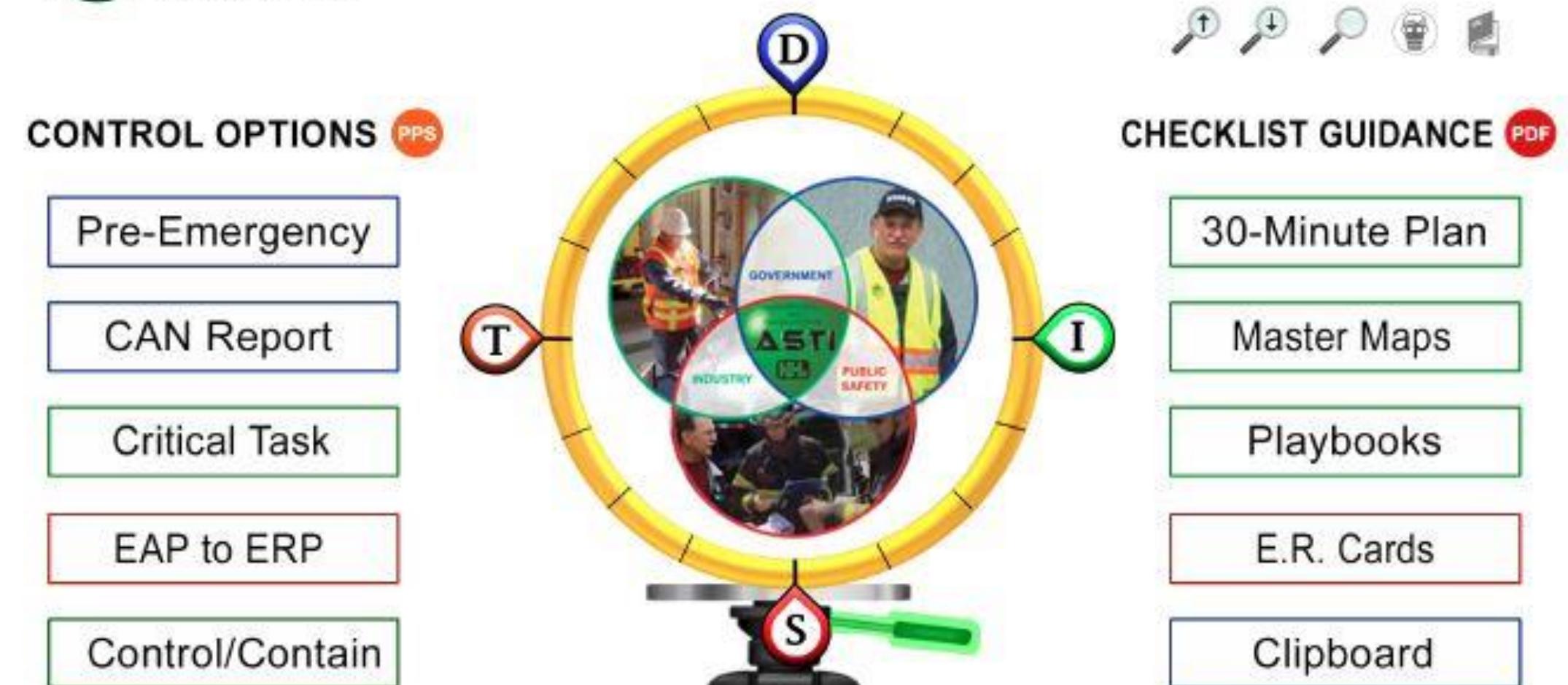
AEGL 1 Minor Exposure Low Exposure

AEGL 2 Moderate Exposure

AEGL 3 Acute Exposure



# THE FIRST 30 MINUTES





**Safety Days**

**Live Release Training**

**Table Top Exercises**

**Joint Training Exercises**

**Site Specific Emergency Response Plans**

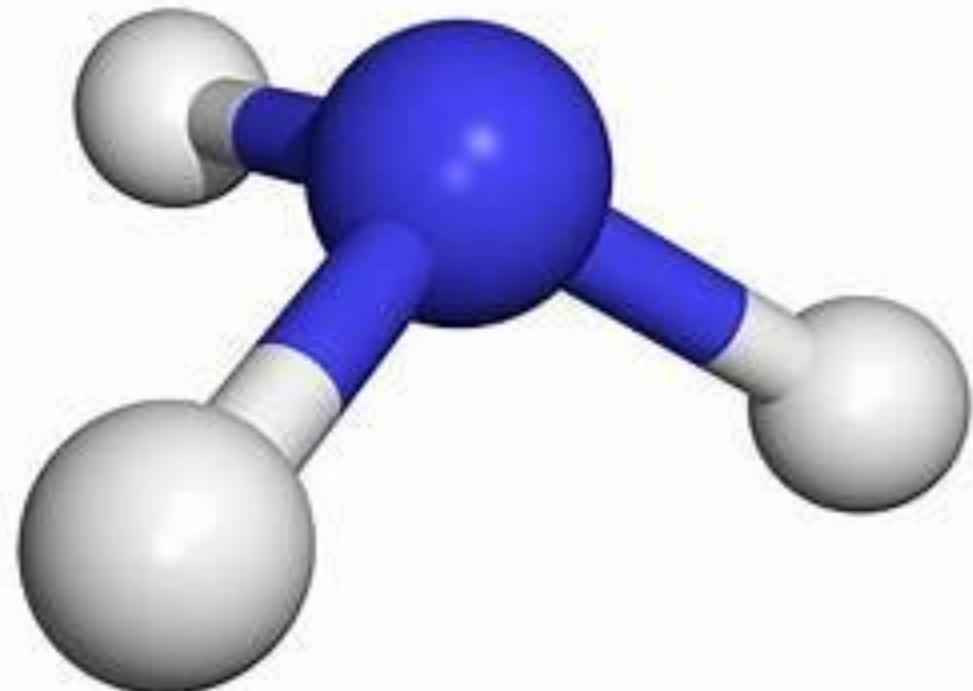
**Site Specific Technical and PPE Reviews**

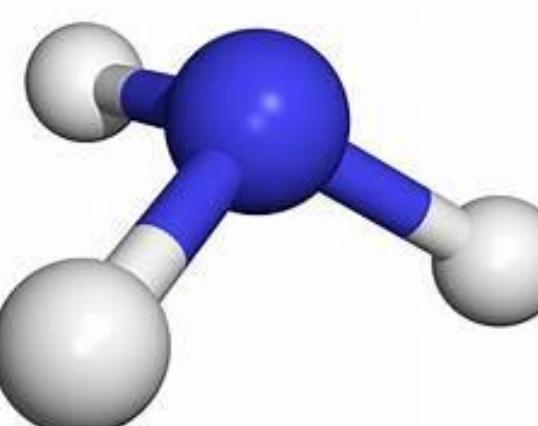
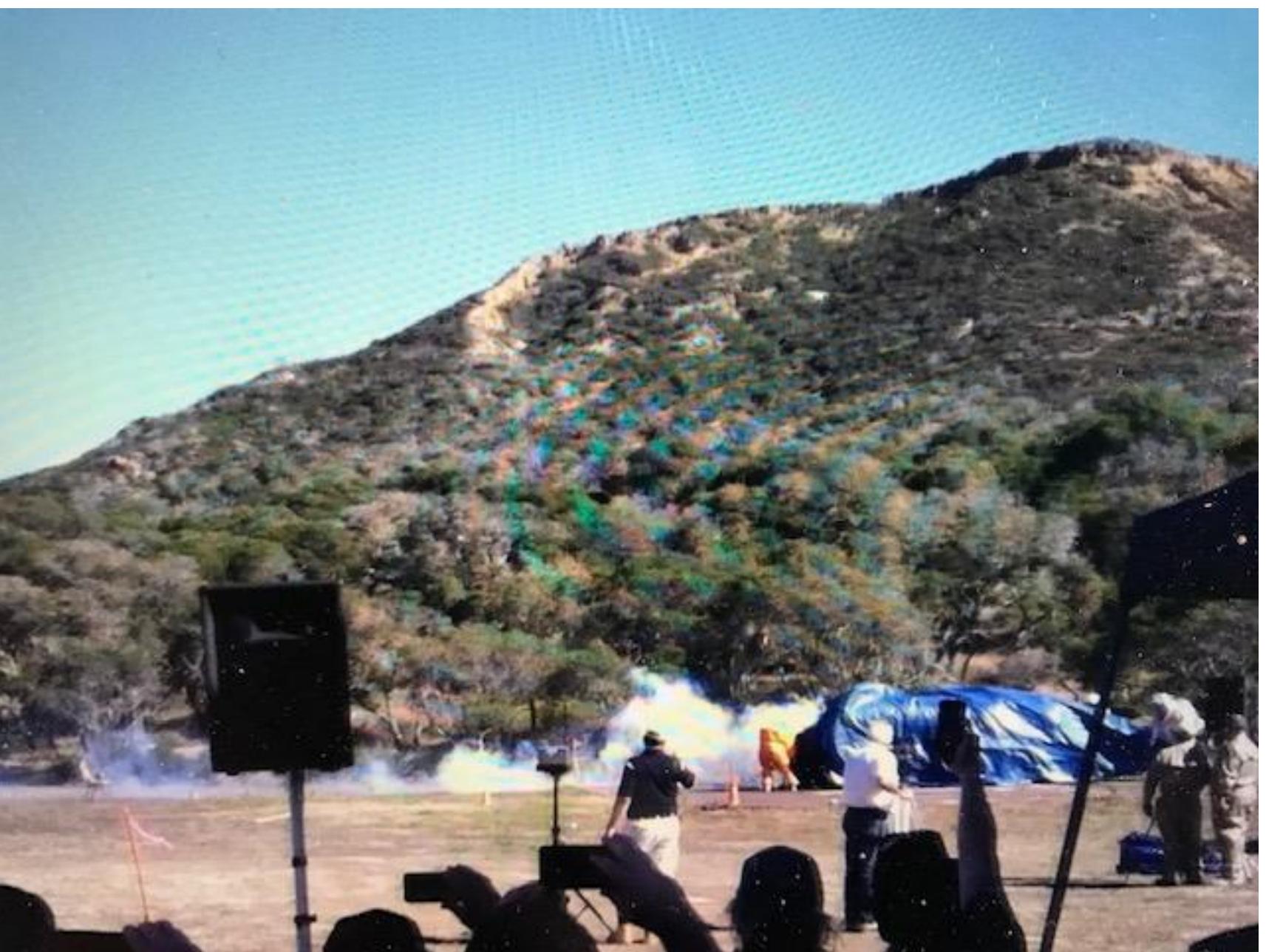
**Statutory code of practice development**

**One Plan Response**

**CRADA Dispersion Modelling**

**Literature for the General Public**





# Quick Guides and Playbooks



[\*\*Blue Playbook\*\*](#)

[\*\*Green Playbook\*\*](#)

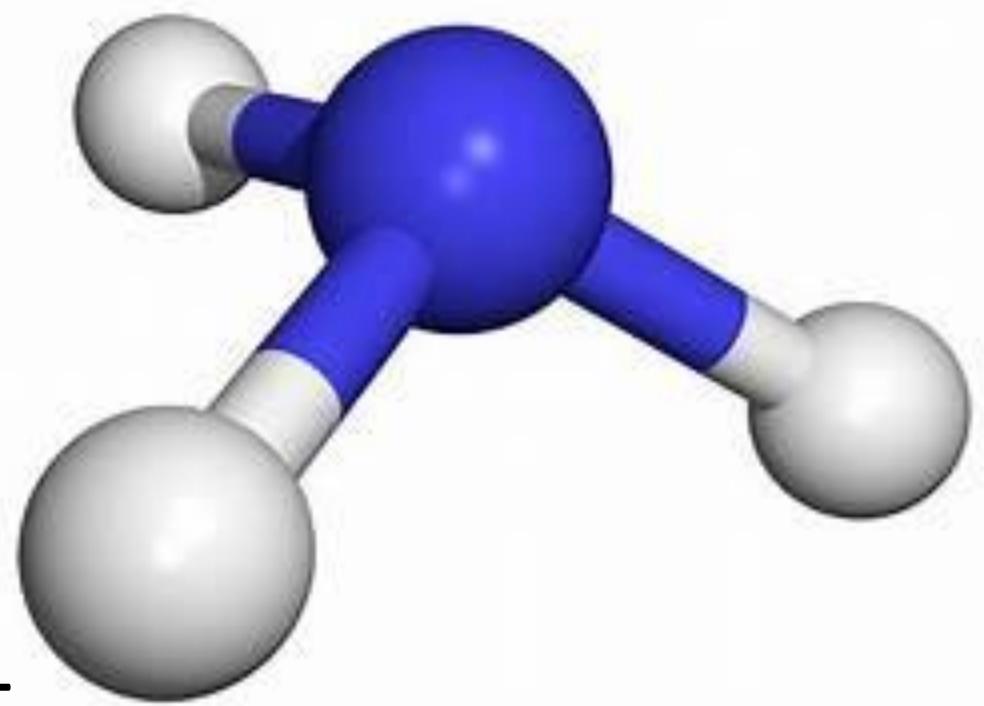
[\*\*Red Playbook\*\*](#)

[\*\*Orange Playbook\*\*](#)

[\*\*Hazard Analysis Quick Guide\*\*](#)

[\*\*Release Estimator Guide\*\*](#)

[\*\*30 Minute Plan\*\*](#)



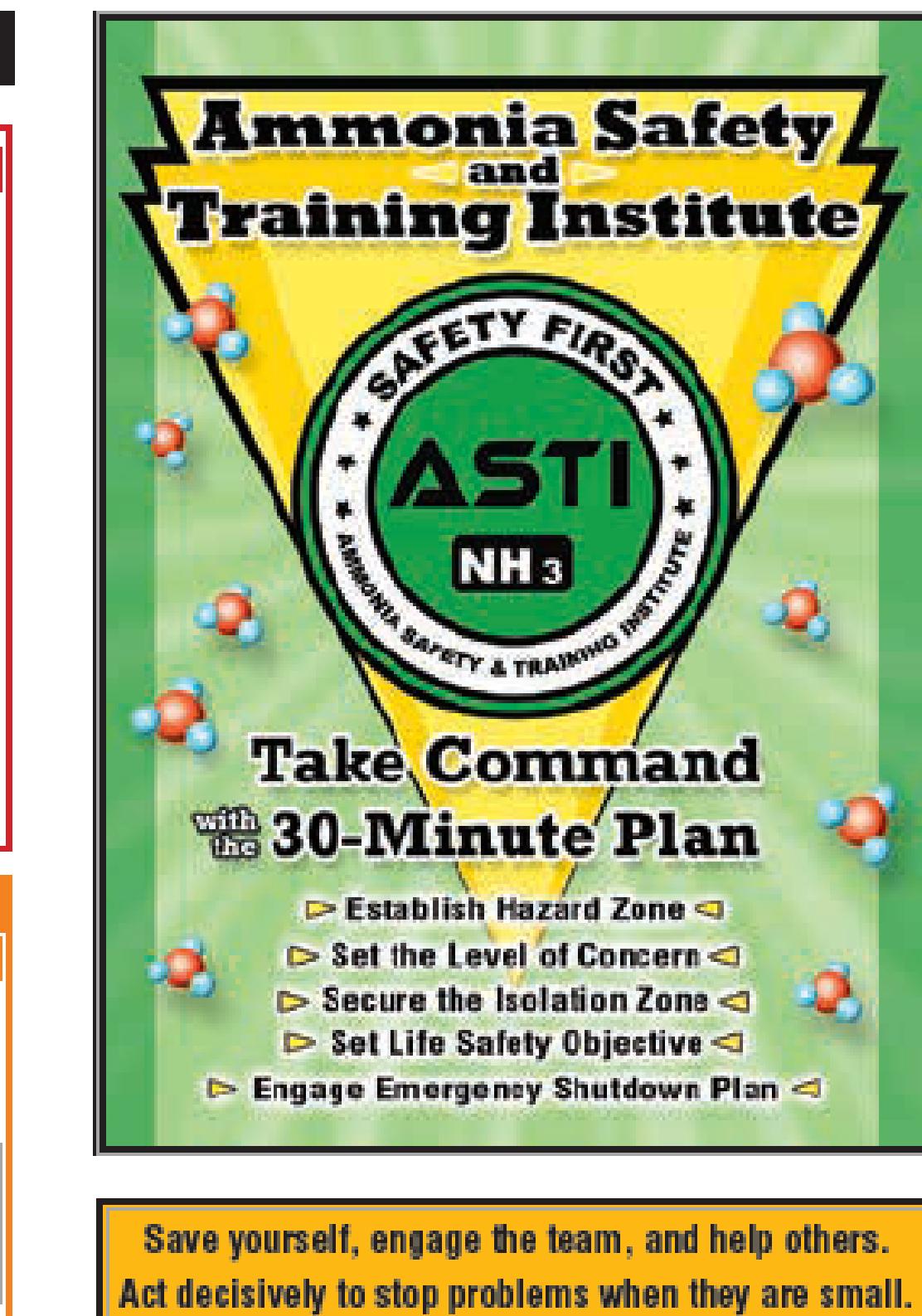
# 30-MINUTE PLAN EMERGENCY CONTROL GUIDE

<b>PHASE 1 DISCOVERY - LANCE</b>							
<b>Life Safety:</b> Clear the Isolation Zone (NH <sub>3</sub> = 100 ft. to 1,000 ft.) <ul style="list-style-type: none"> <li><input type="checkbox"/> Clear the Isolation Zone and escape laterally and upwind or SIP</li> <li><input type="checkbox"/> Set up for rapid entry rescue, decontamination, and medical care</li> </ul>							
<b>Alert:</b> Record Size-Up on Alert Form <ul style="list-style-type: none"> <li><input type="checkbox"/> Who? (your name)</li> <li><input type="checkbox"/> What? (casualties, rescue, medical, fire, or chemical release)</li> <li><input type="checkbox"/> Where? (specific location)</li> </ul>							
<b>Notification:</b> Coordinate Checklist Notifications with IC <ul style="list-style-type: none"> <li><input type="checkbox"/> 9-1-1; give response route and on-site meeting location</li> <li><input type="checkbox"/> LEPC: (____) SERC: (____)</li> <li><input type="checkbox"/> NRC: (800) 424-8802 OSHA: (____)</li> <li><input type="checkbox"/> Contractor: (____) CORP: (____)</li> </ul>							
<b>Command and Control</b> <ul style="list-style-type: none"> <li>Action: Identify Hazard Zone, Level of Concern, size of Isolation Zone, and location of the Incident Command Post (ICP)</li> <li>Plan: Engage the Command Team; set the Life Safety Objective</li> <li>Hazards (chemical/physical), Risks (life and environmental), Threats (fire, pressure, reactivity, slip/fall, structural integrity)</li> <li>Level of Concern: 1-Controlled and contained           <ul style="list-style-type: none"> <li>2-Controlled or contained</li> <li>3-Uncontrolled and uncontained</li> </ul> </li> </ul>							
<b>Isolation and Protective Action Distance (PAD) for ammonia:</b> <table border="1"> <tr> <td>Small 100 ft.</td> <td>PAD: 550 ft. (day and night)</td> </tr> <tr> <td>Large 500 ft.</td> <td>PAD: Day = .5 miles; Night = 1.3 miles</td> </tr> <tr> <td colspan="2">Catastrophic 1,000 ft. PAD: Track plume beyond 1.3 miles</td> </tr> </table>		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	
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<b>Acute Exposure Guideline Levels (AEGL):</b> <table border="1"> <tr> <td>10 Minutes: AEGL 2 = 220 PPM</td> <td>AEGL 3 = 2,700 PPM</td> </tr> <tr> <td>30 Minutes: AEGL 2 = 220 PPM</td> <td>AEGL 3 = 1,600 PPM</td> </tr> </table>		10 Minutes: AEGL 2 = 220 PPM	AEGL 3 = 2,700 PPM	30 Minutes: AEGL 2 = 220 PPM	AEGL 3 = 1,600 PPM		
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30 Minutes: AEGL 2 = 220 PPM	AEGL 3 = 1,600 PPM						
<b>Flammability of confined NH<sub>3</sub> vapor with a 1,204°F ignition source:</b> <p>Caution at 15,000 and high risk at 40,000 PPM</p>							
<b>Evacuation to Safe Refuge or SIP</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Movement Plan—move laterally and upwind to safe refuge</li> <li><input type="checkbox"/> Secure the safe refuge locations</li> <li><input type="checkbox"/> Setup Access Controls to and from the Plant</li> <li><input type="checkbox"/> Personnel accountability—check in/check out</li> </ul>							
<b>PHASE 2 INITIAL RESPONSE - SIMPLE</b>							
<b>Size-up: CAN report Conditions-Actions-Needs</b>							
<b>Conditions:</b> Hazard Zone Location? Status of emergency; Level 1, 2, or 3? Life Safety status? Controlled? Not Controlled? Contained?							
<b>Actions:</b> Incident Commander and Command Post location? Evacuation status and rescue in progress? Size of Isolation Zone? Status of emergency Shut-down?							
<b>Needs:</b> Rescue? Medical? Decon? Shut-down? Ventilation support? Downwind/downstream receptor management?							

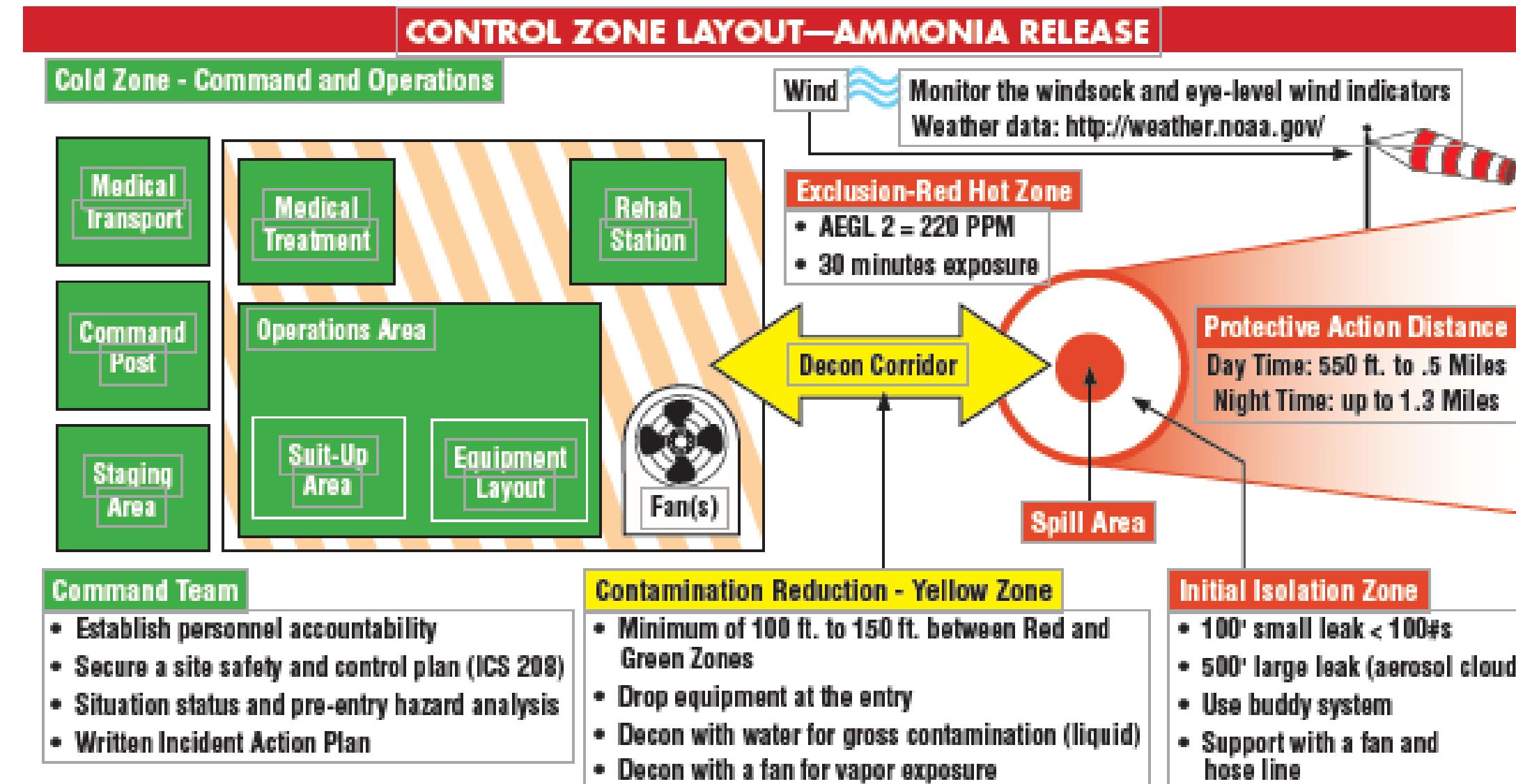
<b>Sources of ignition and fire suppression controls</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Control utilities, ventilation, and sources of ignition</li> <li><input type="checkbox"/> Access to hydrants and FDCs for fire sprinkler system</li> <li><input type="checkbox"/> Firewall integrity, containment of fire, exposure protection</li> </ul>	
<b>Isolate the source of the leak and pump down the liquid</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Identify upstream and downstream control points</li> <li><input type="checkbox"/> Avoid hydraulic shock caused by slamming a valve</li> <li><input type="checkbox"/> Avoid trapping liquid between valves with no relief valve</li> <li><input type="checkbox"/> Isolate the liquid flow to the leak site, and control defrost cycle</li> <li><input type="checkbox"/> Containment: tarp, and/or close doors</li> <li><input type="checkbox"/> Move liquid to safe location upstream or downstream of leak</li> </ul>	
<b>Manage energy flow to the high and low sides</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Release: High or low side? Status of emergency relief system?</li> <li><input type="checkbox"/> Manage liquid flow and system pressure</li> <li><input type="checkbox"/> Reduce incoming heat-disable evaporators and defrost</li> <li><input type="checkbox"/> Use diffuser and/or pressure equalizer</li> </ul>	
<b>Pressurized ventilation using system or portable fans</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Plan air flow—entry (upwind) and exhaust (downwind)</li> <li><input type="checkbox"/> Use fan to dilute or redirect vapor</li> <li><input type="checkbox"/> Engage portable fan to support rescue</li> </ul>	
<b>Life Safety and Engage Incident Action Plan</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Set up Control Zone Layout (see diagram below)</li> <li><input type="checkbox"/> Public Safety coordination of downwind receptors in the Protective Action Area</li> <li><input type="checkbox"/> Eye-level wind movement: CAUTION for wind changes, eddies, backflow, and turbulence</li> <li><input type="checkbox"/> Consider site access control and air monitoring</li> <li><input type="checkbox"/> Assure containment of downstream environmental threat</li> </ul>	

<b>Safety Plan: Pre-entry to Hot Zone</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Review the IAP objective(s) and task assignments</li> <li><input type="checkbox"/> Assure safety, rehab, decon, and medical evaluation</li> <li><input type="checkbox"/> Position hose line, ventilation and back-up team</li> <li><input type="checkbox"/> NO entry into IDLH without IC approval and a back-up</li> <li><input type="checkbox"/> Do a pre-entry review: use back-ups, proper PPE, entry/exit times, communications, and emergency alert signals</li> <li><input type="checkbox"/> Respirator &lt; IDLH (300 PPM) and SCBA &gt; IDLH (300 PPM)</li> <li><input type="checkbox"/> Vapor protection: Level B &lt; 5,000 PPM to 10,000 PPM and Level A &gt; 10,000 PPM</li> <li><input type="checkbox"/> Flammability = No entry &gt; 15,000 PPM without mitigations (for sources of ignition) and flash protection</li> <li><input type="checkbox"/> Aerosol Stream/Dense Gas: Level A with flashfire and cold temperature protection (avoid using water to absorb liquid or aerosol)</li> <li><input type="checkbox"/> Chemical monitoring (fixed and/or handheld) for monitoring control zones and for entry team</li> </ul>	
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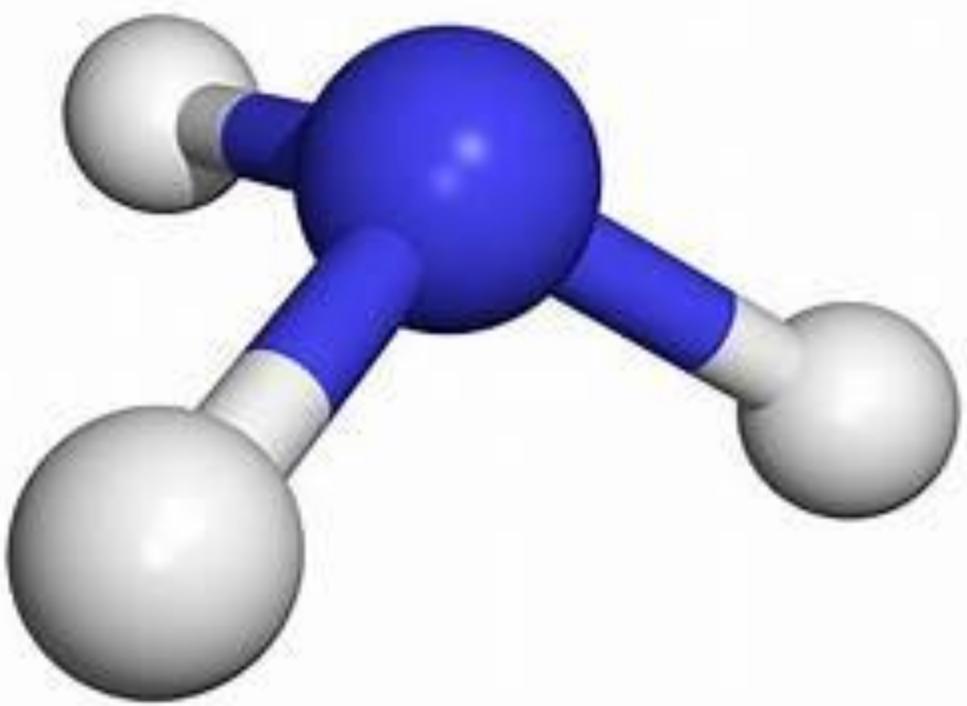
<b>PHASE 4 TERMINATION</b>	
<b>Termination of the Emergency</b> <ul style="list-style-type: none"> <li><b>Actions:</b> Hazard/threat mitigations completed and IC sign-off of Termination Proclamation</li> </ul>	
<b>Plan:</b> Communicate termination order to Command Team, shelter locations, regulators, and media <ul style="list-style-type: none"> <li><input type="checkbox"/> Plant IC engages Recovery, Restart, and Business Continuation IAP; maintain pre-emergency status (PPE and Command Team)</li> <li><input type="checkbox"/> Debrief and identify prevention and mitigation and preparedness improvements</li> </ul>	



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



# 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.

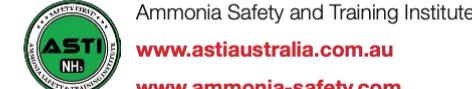
## Plan for Hazards Possible in Your Community

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



Materials Safety Data Sheet: Search MSDS for Anhydrous Ammonia.

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## Living near Anhydrous AMMONIA



## 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.

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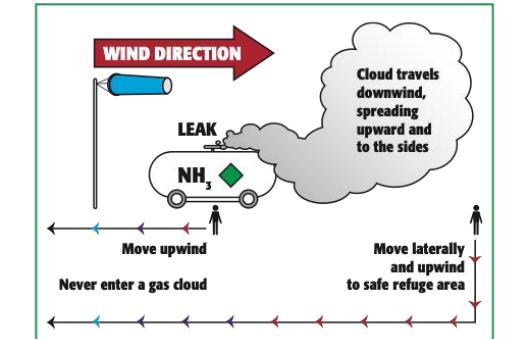
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## Escaping Ammonia Threats

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



Materials Safety Data Sheet: Search MSDS for Anhydrous Ammonia.

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## Working around Anhydrous AMMONIA



## Ammonia and Public Safety



## About Ammonia

**Product Name:** Anhydrous Ammonia.

**Chemical:** NH<sub>3</sub>, 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 NH<sub>3</sub> 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 (NH<sub>4</sub>OH) 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.

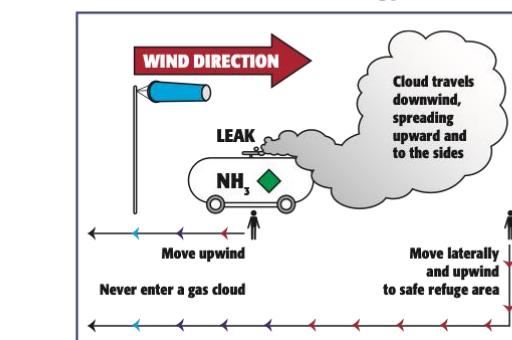
**Density:** 0.696 g/L @ 20°C.

**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



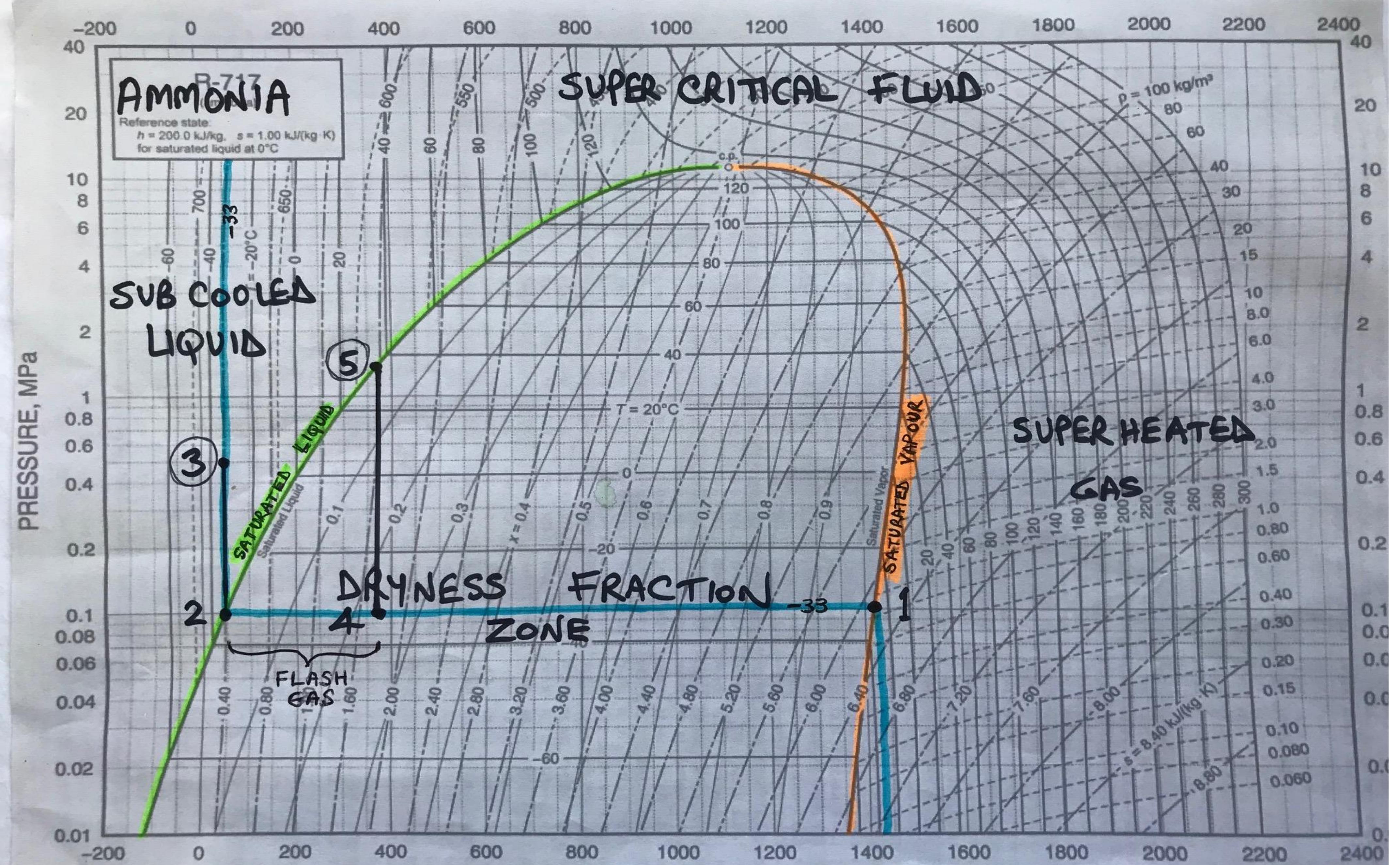
## For More Information



Agency for Toxic Substance and Disease Registry [www.atsdr.cdc.gov/](http://www.atsdr.cdc.gov/)

Materials Safety Data Sheet: Search MSDS for Anhydrous Ammonia.

© ASTI 2013



# 150 million tonnes p.a. distributed globally



**Rail Tank Cars**

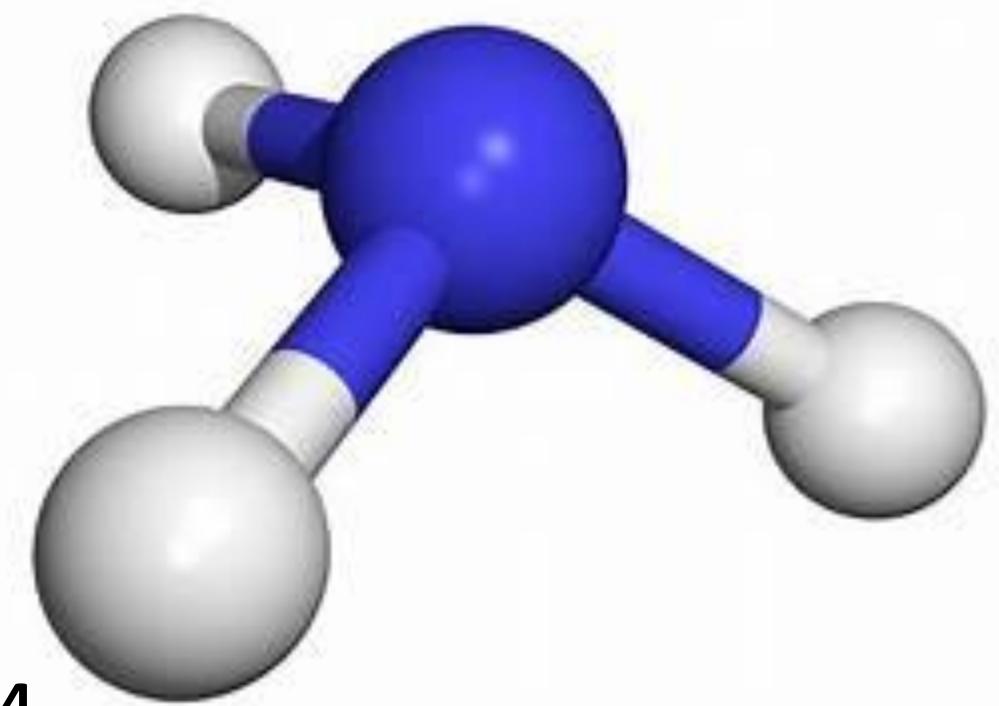
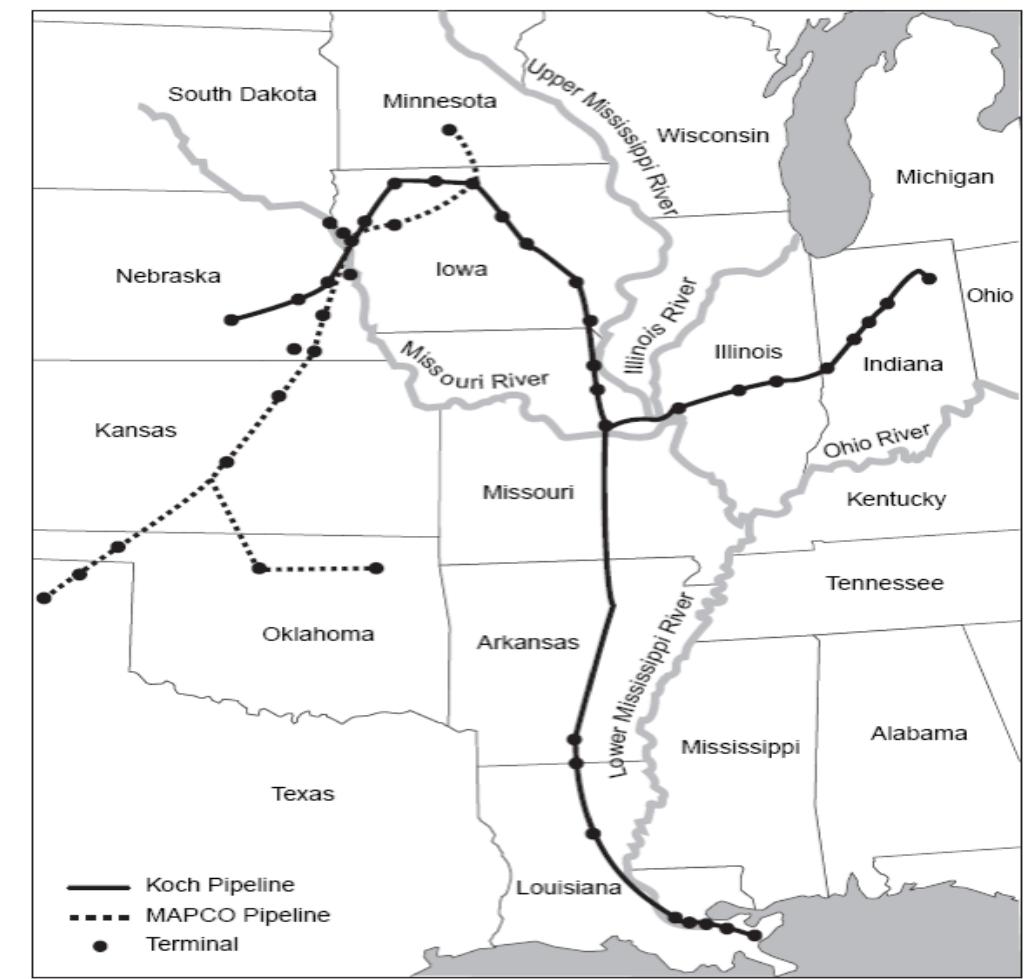


**Road Tankers**



**Barges**

**Pipelines**



**Nurse Tanks**

**Ships**



# Release of saturated liquid under pressure

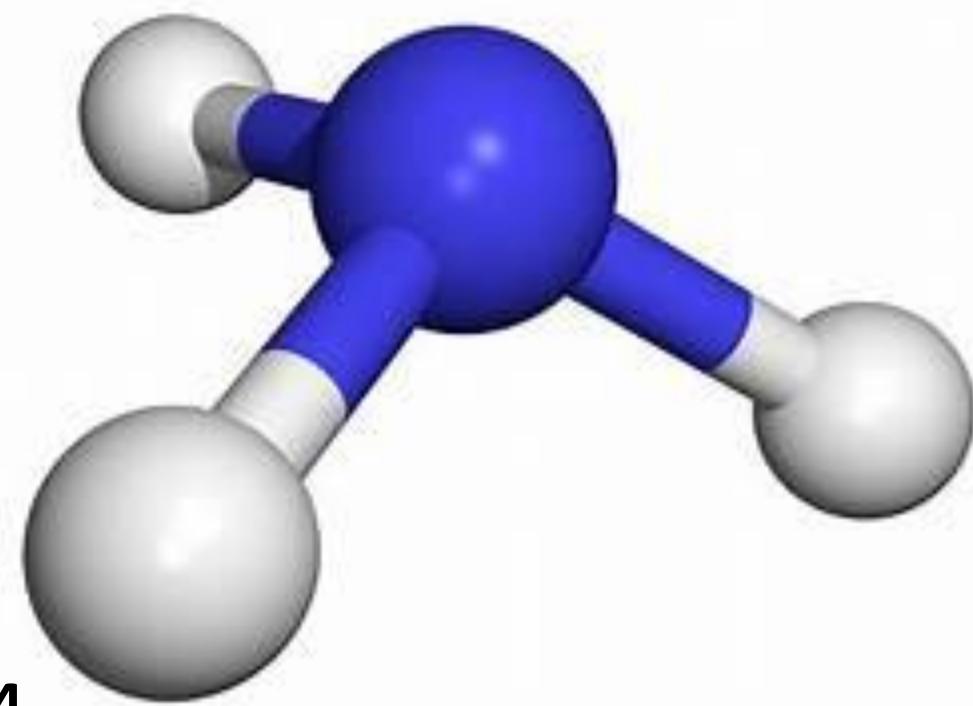


Release under pressure results in an aerosol and potentially a dense gas cloud which is usually heavier than air

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



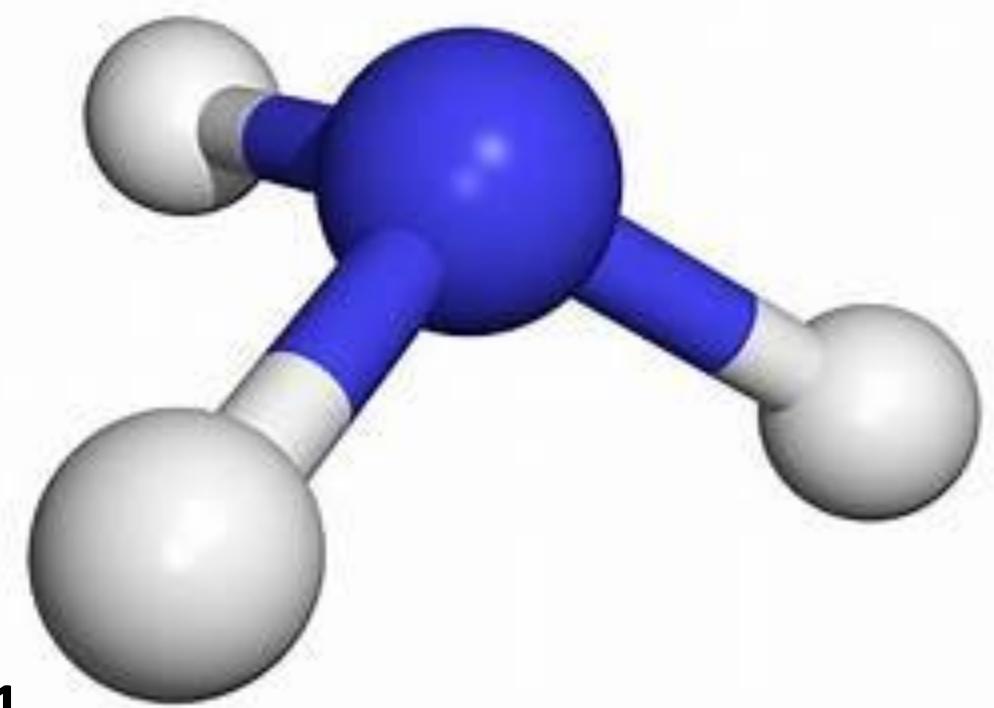
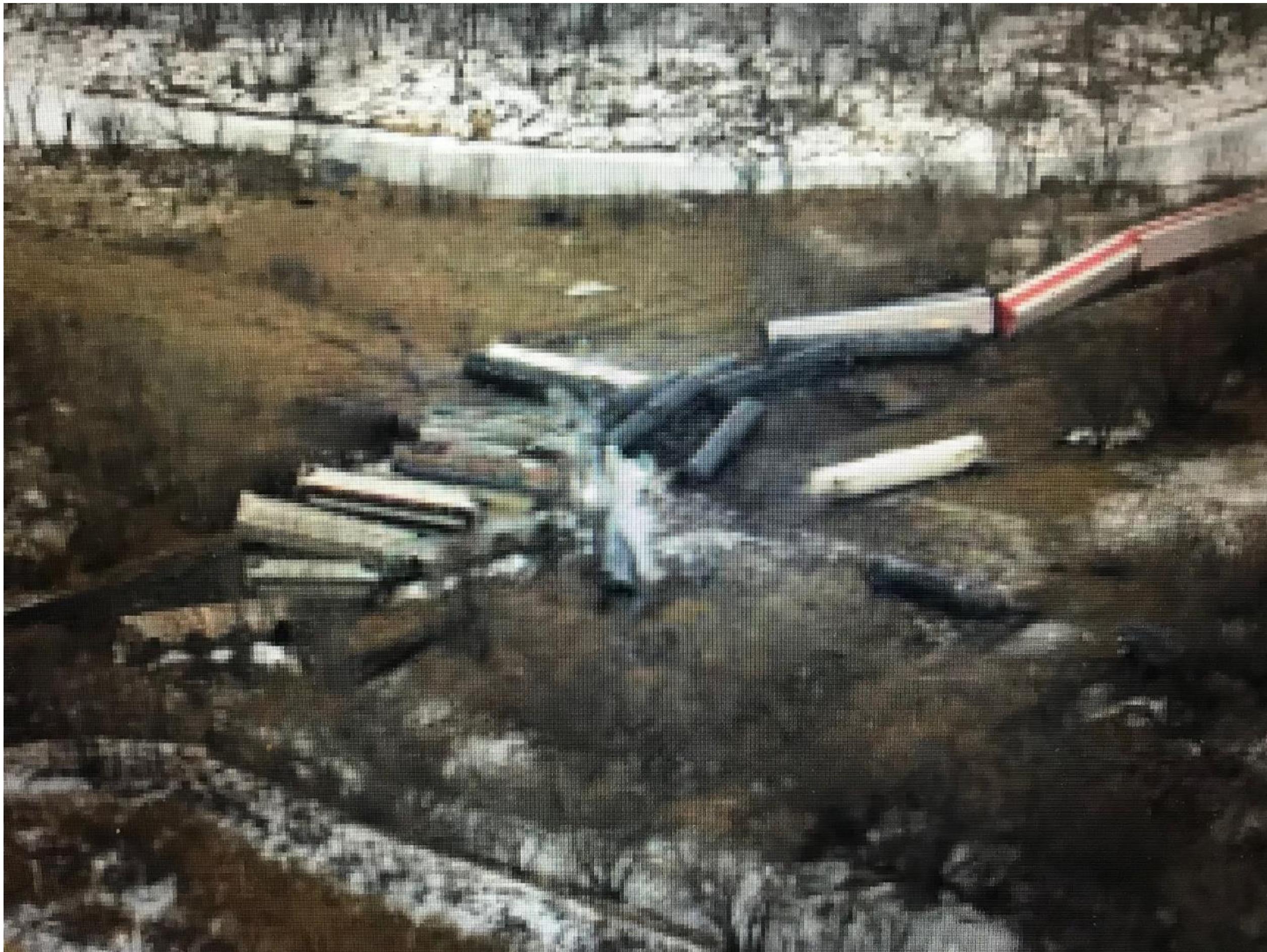
For example 1 litre/sec of liquid releasing will generate 168 litre/sec of flash gas which will violently propel an aerosol and then become a dense gas cloud which will be heavier than air.

This kind of release poses the highest risk.



# Case Study 1

Minot North Dakota 2002 Five rail tankers ruptured spilling ammonia



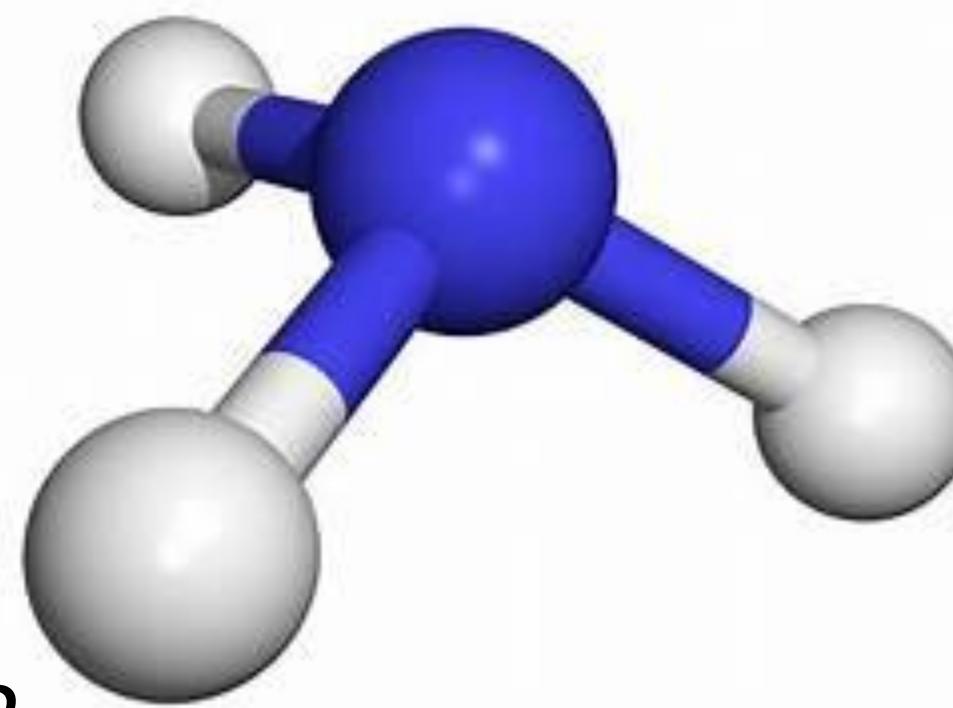
250 Tons were released. A cloud of ammonia lay over the city for several hours.

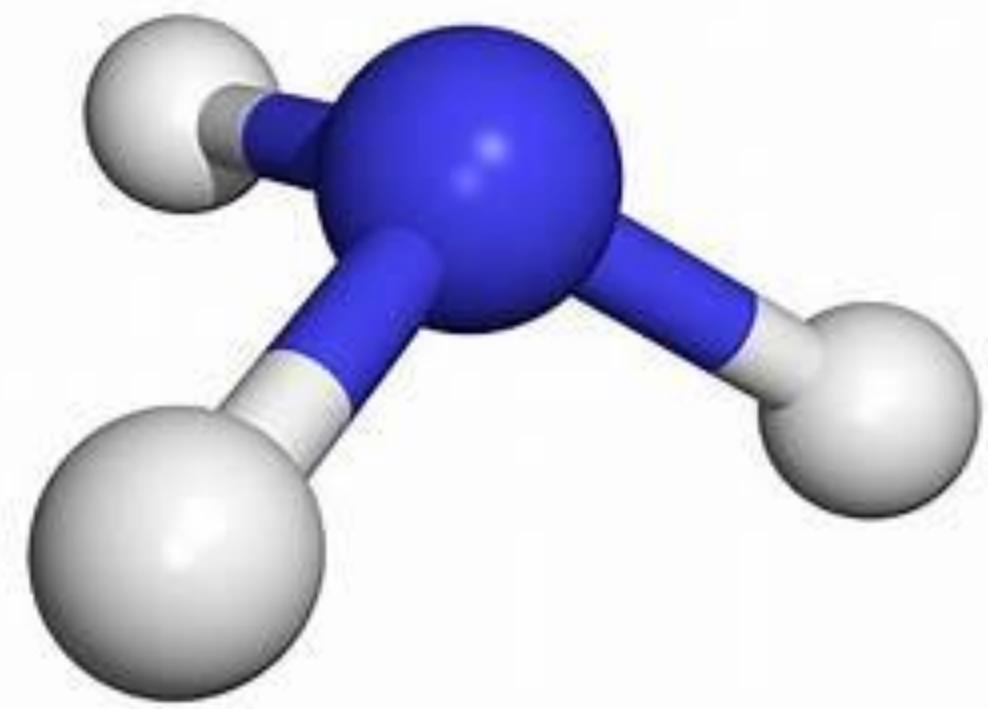


Dispatchers told residents to stay inside, close doors and windows, and cover their faces with wet cloths to counteract the ammonia.

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.



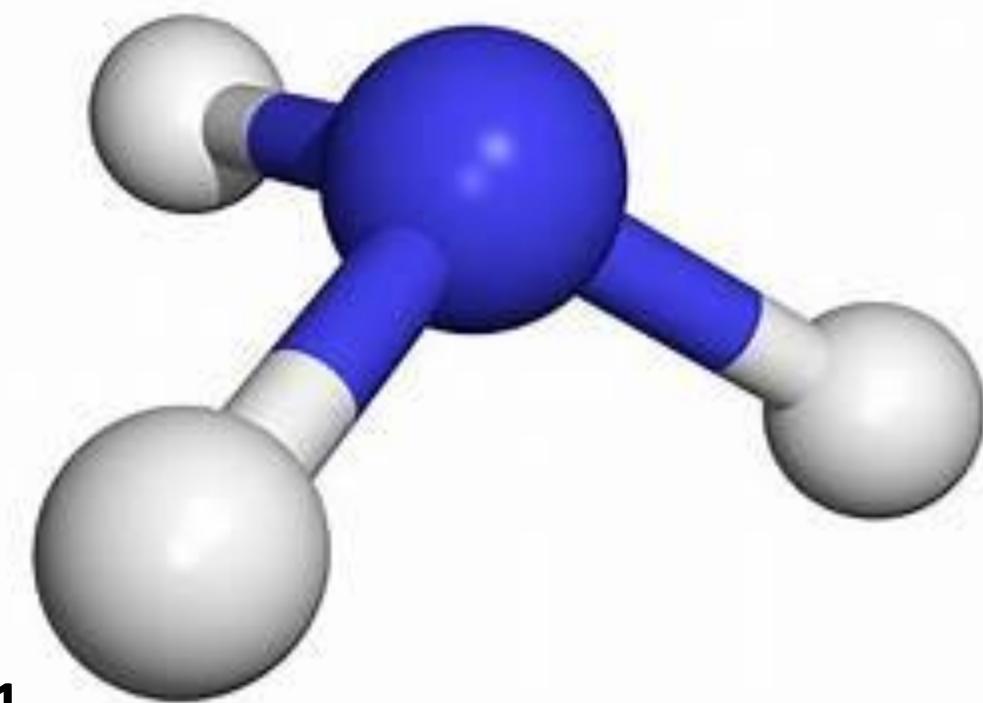


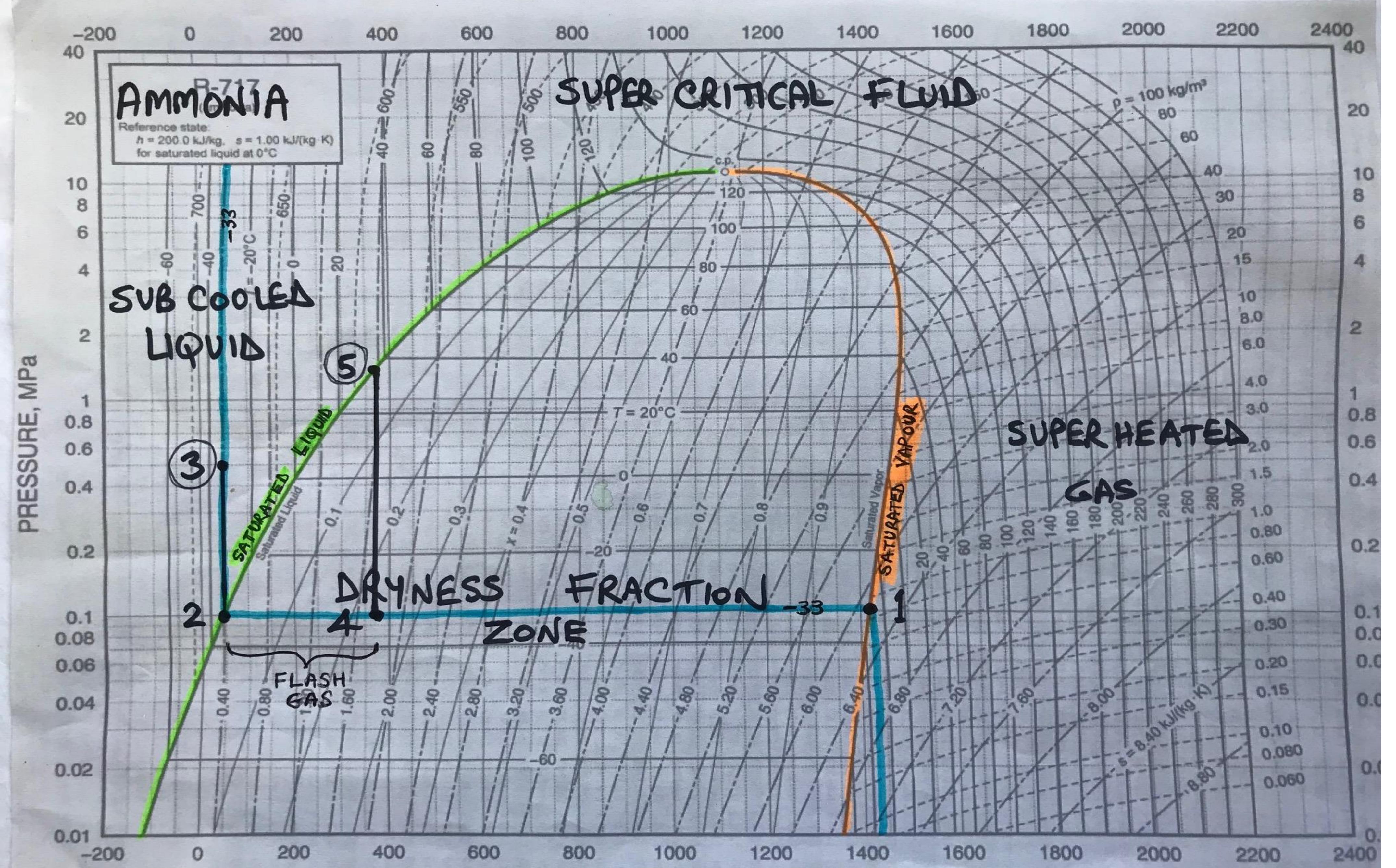
# Ammonia Transport Ship in Port Area



**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**

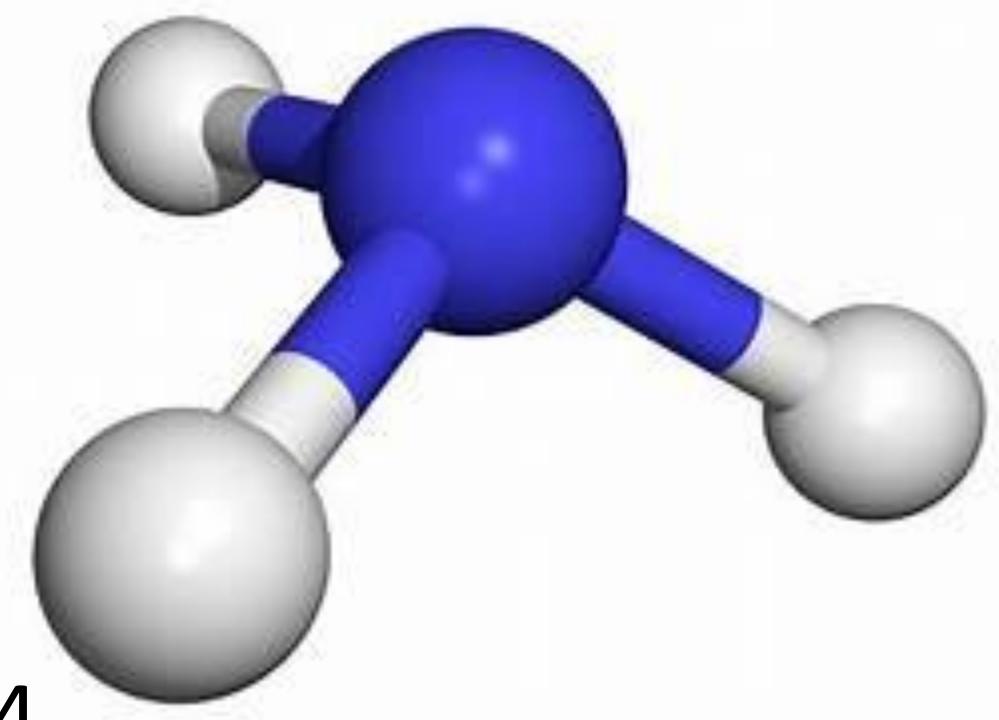
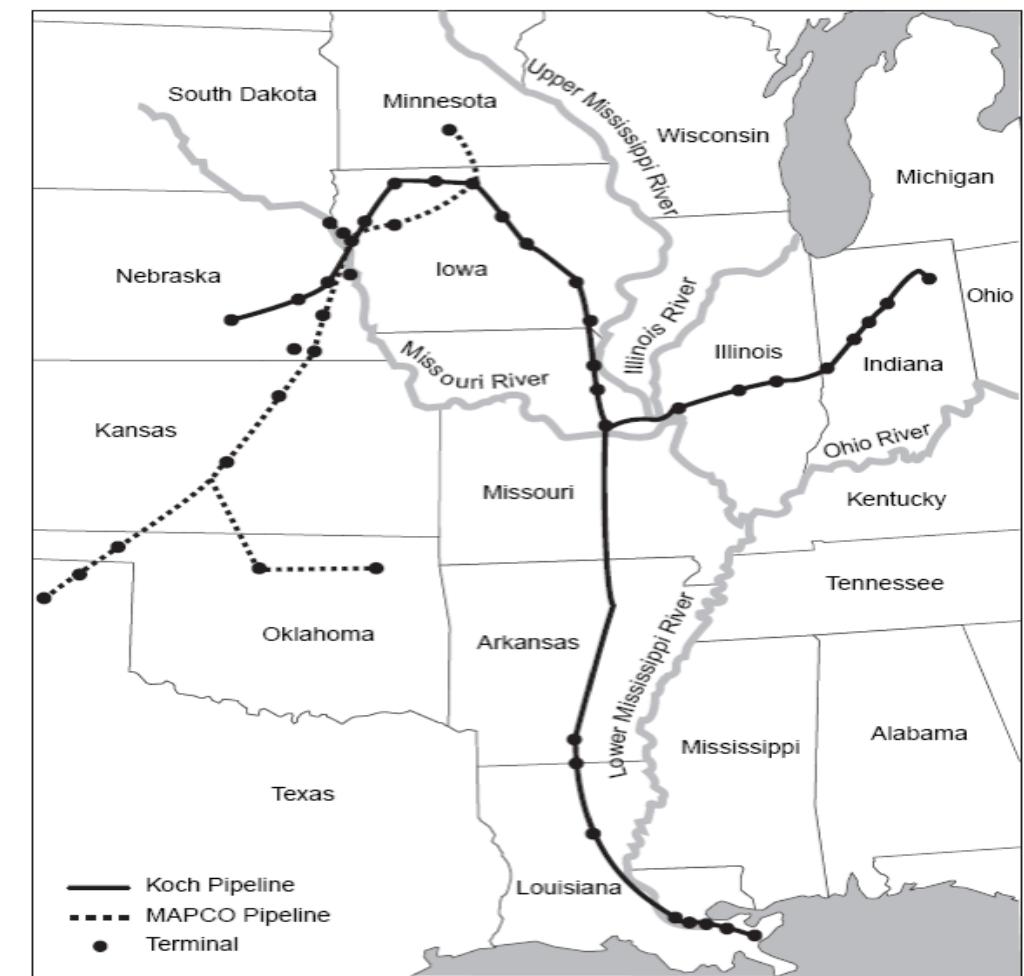


**Road Tankers**



**Barges**

**Pipelines**



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**Ships**



# Release of saturated liquid at atmospheric pressure

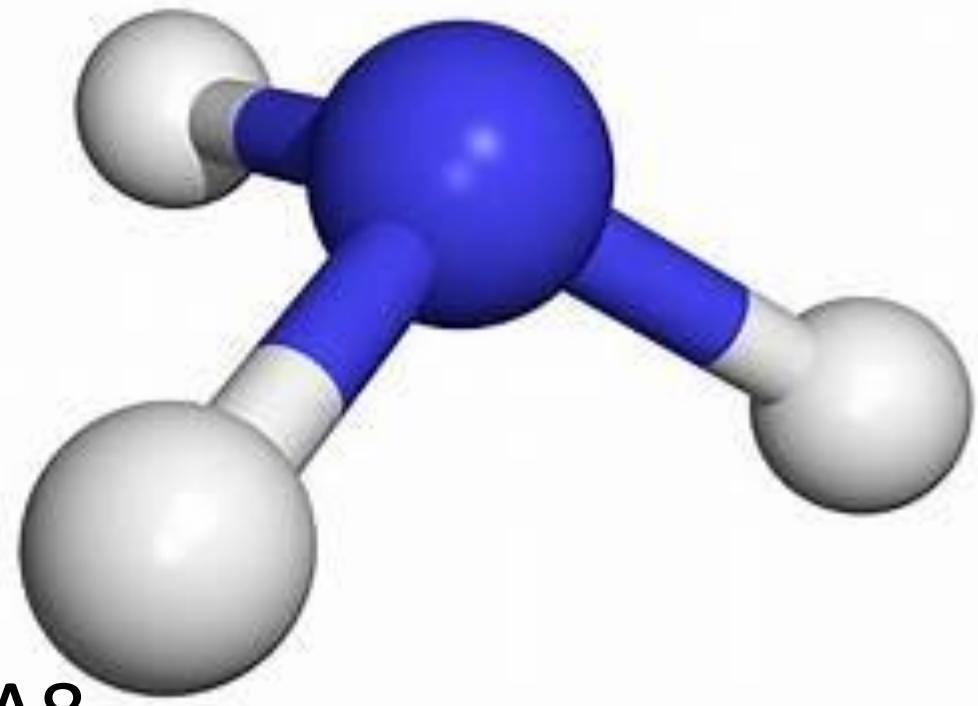


## Release from storage at atmospheric pressure (point 2)

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 whisping 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.

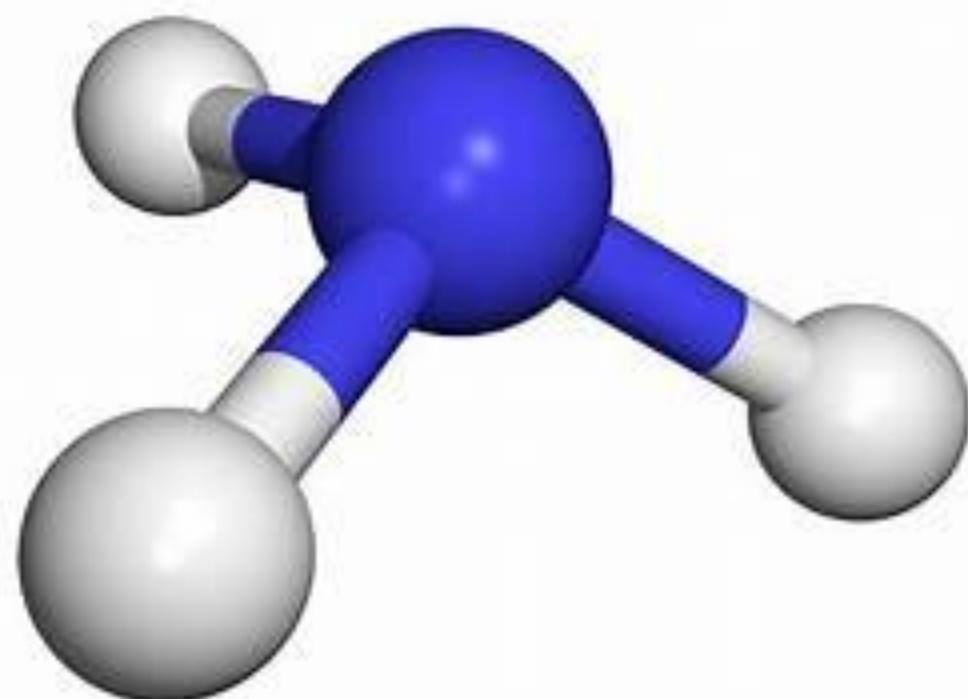


The amount of gas evaporating from the surface will be a function of the quantity of heat entering the pool from the surface below and the air above. Ammonia has a very high latent heat of evaporation , so the rate at which the ammonia evaporates will be very low.

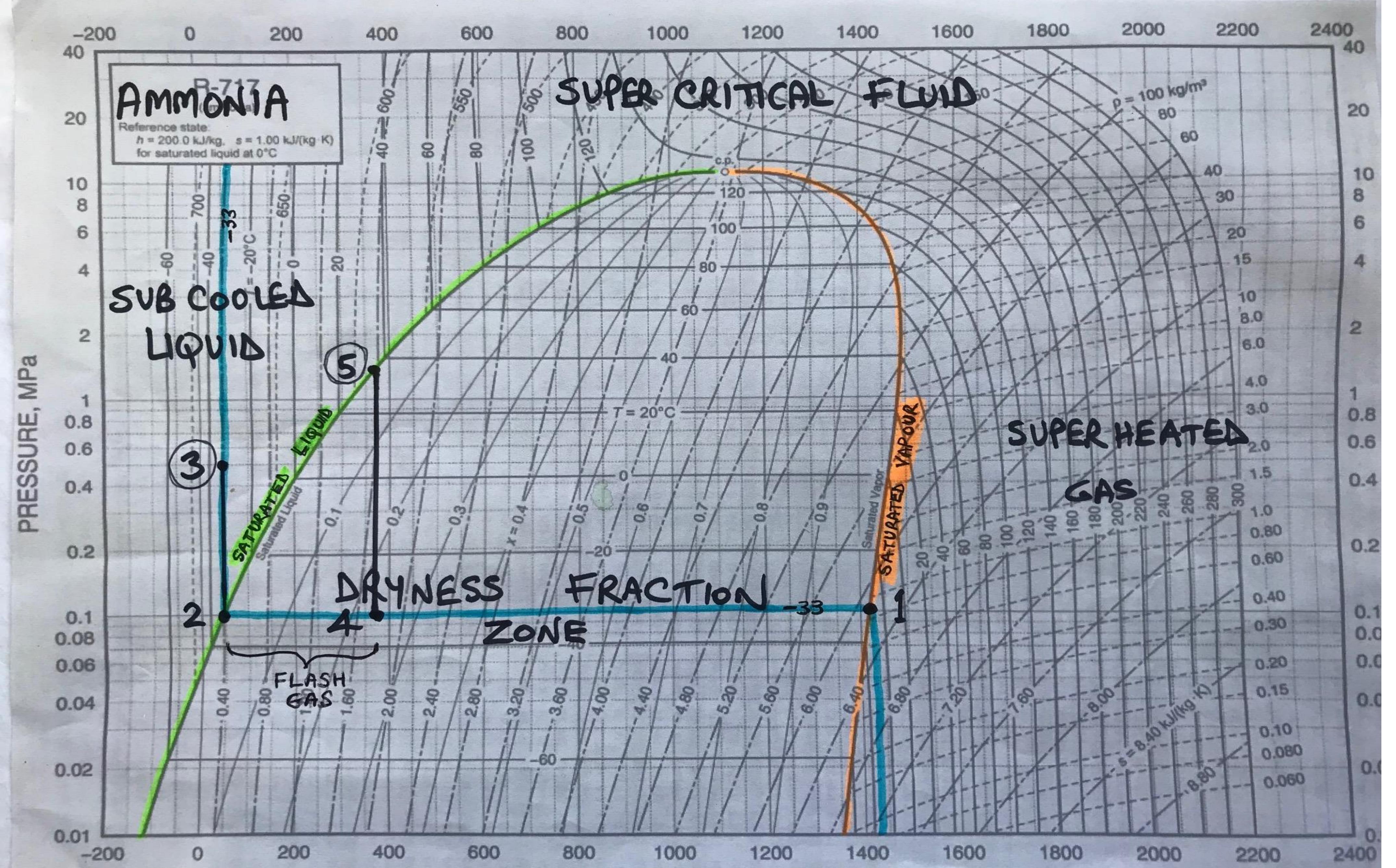


## Case Study 2

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.



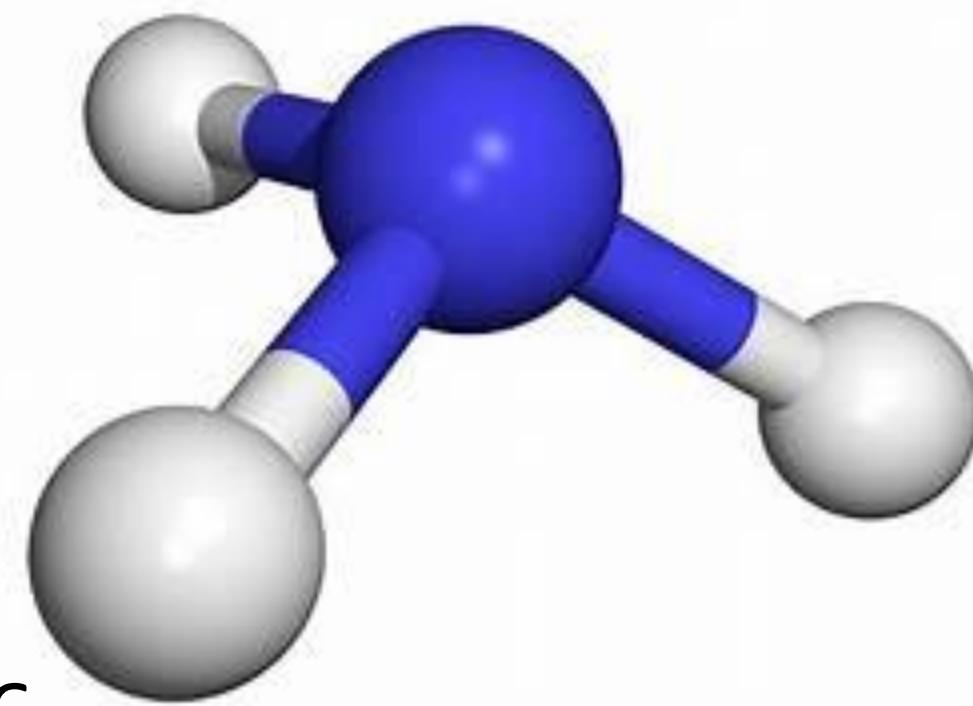
# Release of Subcooled liquid under pressure



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



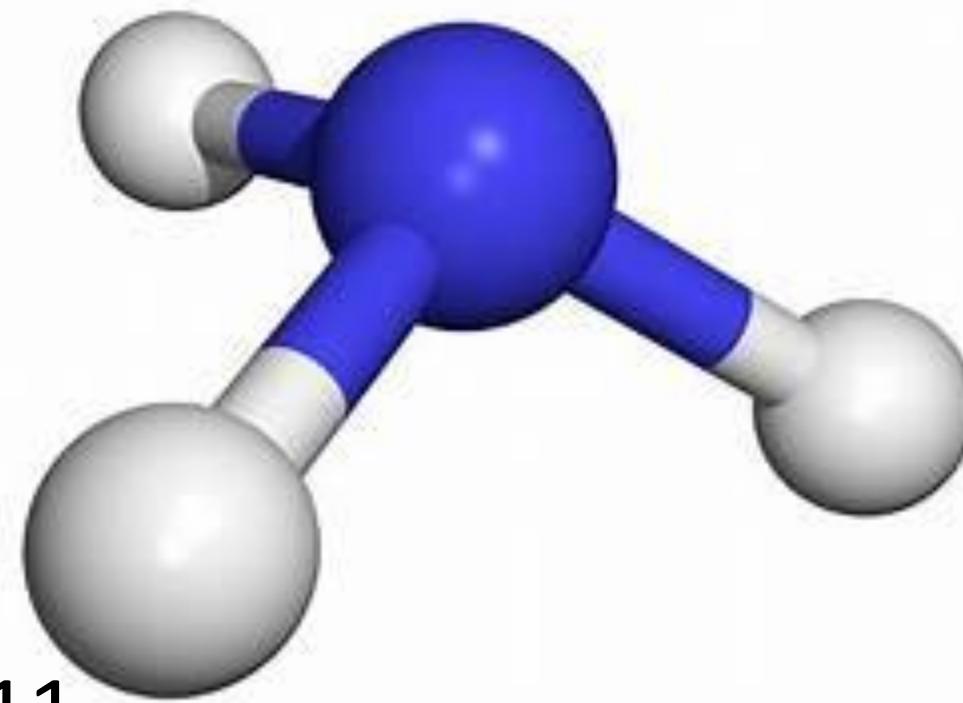
A subcooled liquid release should pose a lower risk than a saturated liquid release



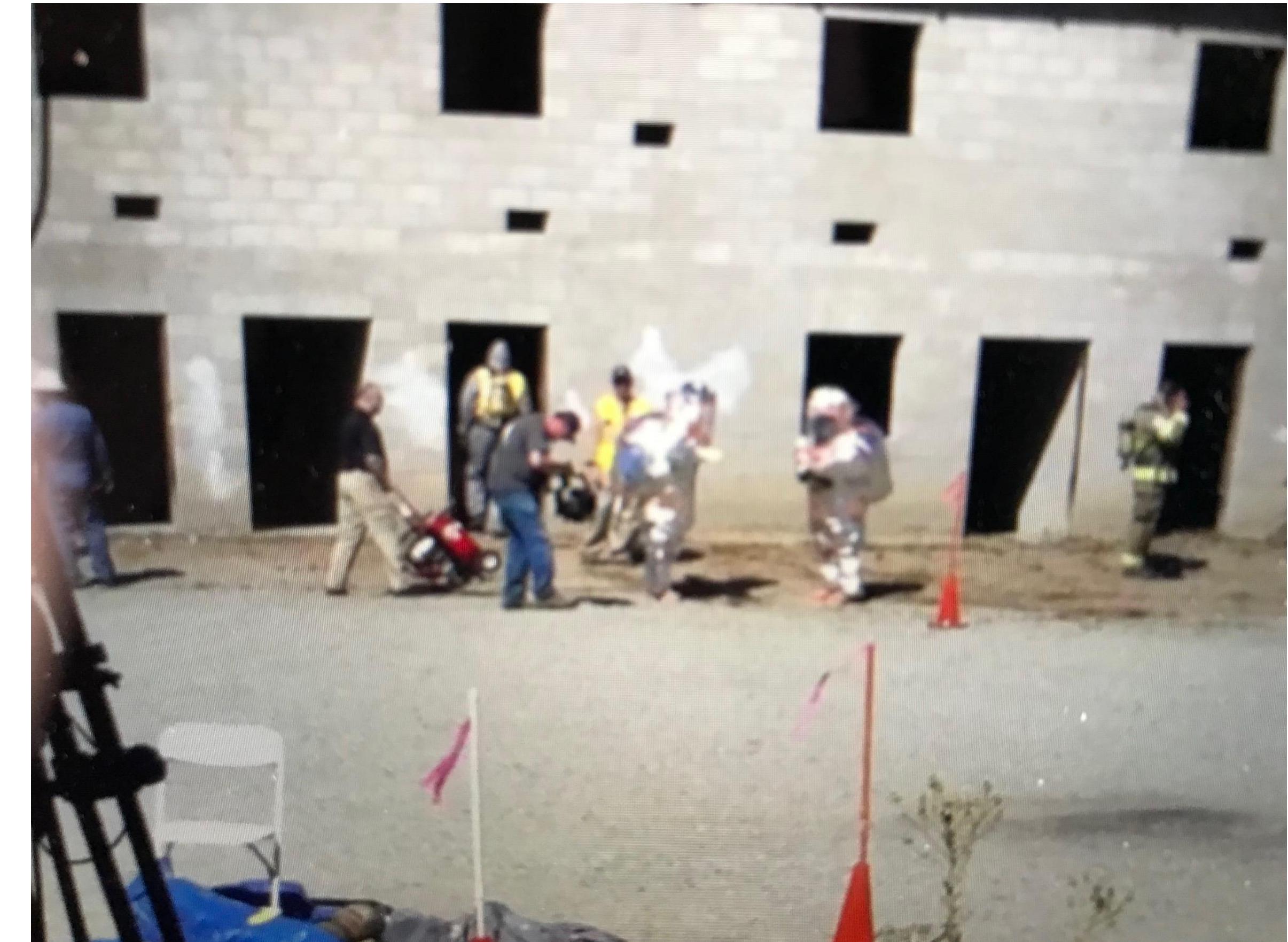
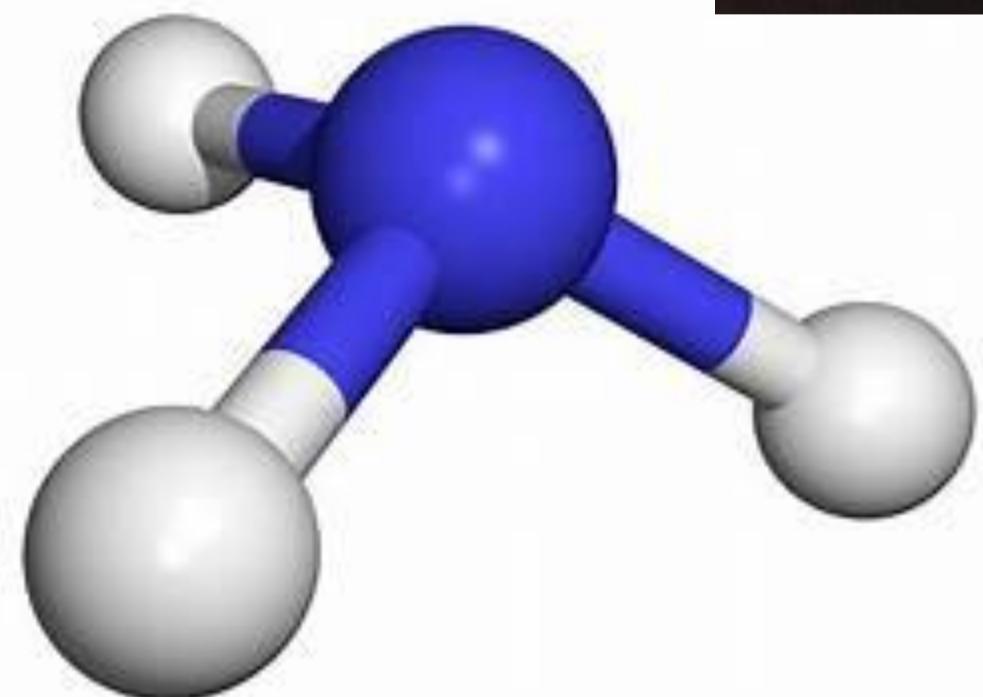
# Summary

**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**



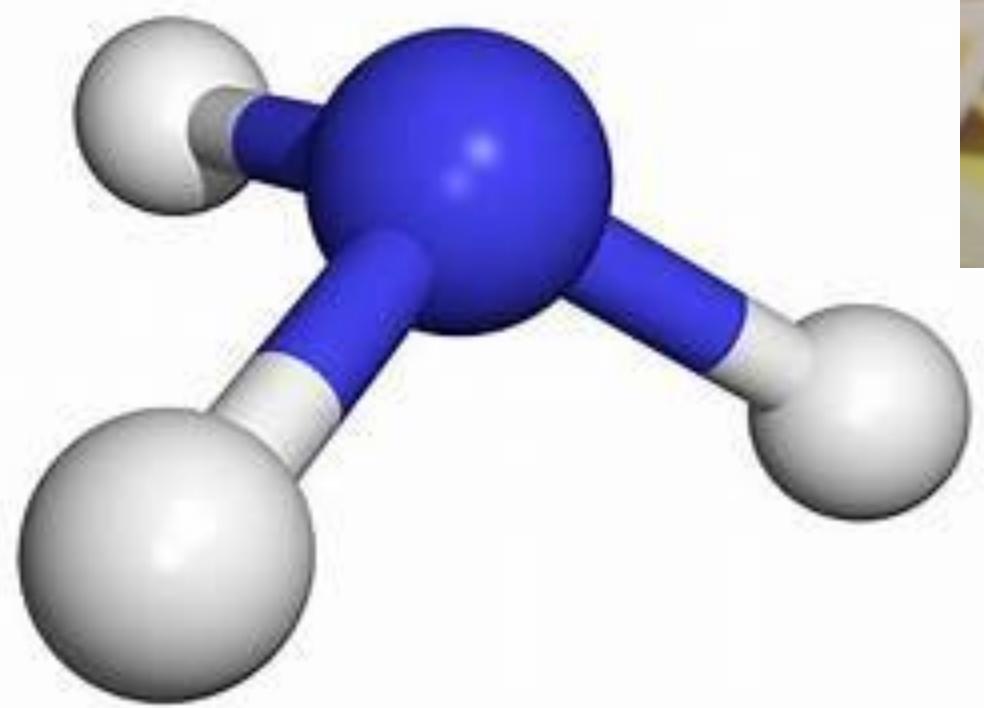
# Level A Using low temperature gas tight suit



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



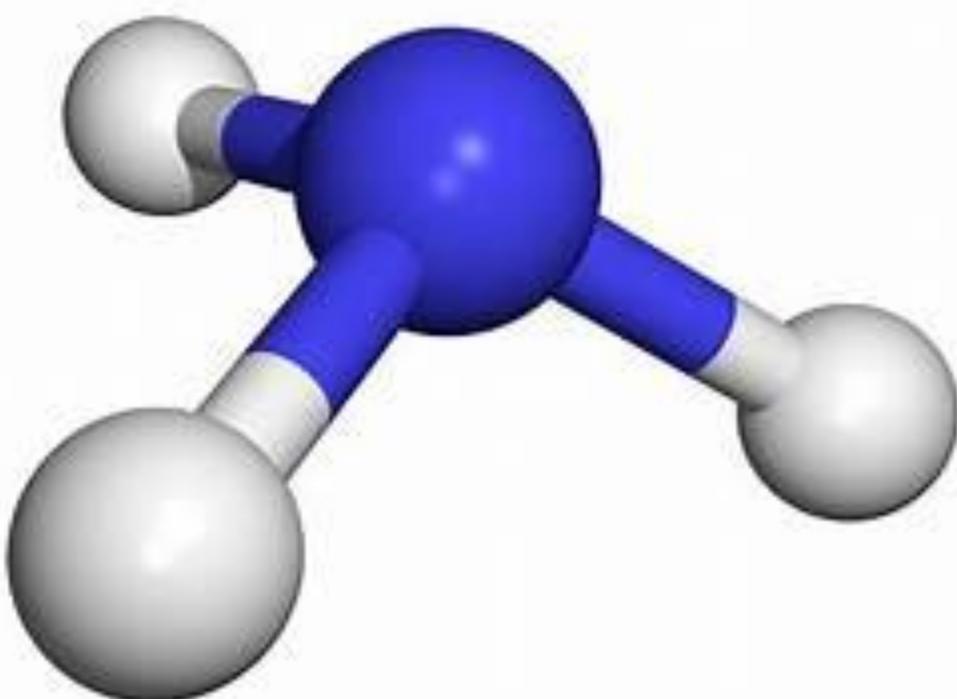
## Level B Disposable suit



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)**

## 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:

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