
SAFETY FIRST
ASTI
NH3
AMMONIA SAFETY & TRAINING INSTITUTE
MODELING
RISK MITIGATION &
INCIDENT RESPONSE

AMMONIA H.R.Ts

Understand Hazards – Aerosol, Vapor, Dense Gas

Invisible Gas & Liquid.

Manage Risks – Prevent, Mitigate & Control

Prepare for Threats – PPE, Plan, & Prepare – Life,

Environment & Property

Chemical Research & Development Agreement

Chemical Security Analysis Center & ASTI

1. **Tripod – Bow Tie – Profitable Safety**

2. **Ammonia Hazards, Risks & Threats**

3. **Life and Health Concerns**

4. **PPE and PPV Fans**

ASTI – Nanyang Tech University Live Ammonia Releases at Fort Ord CA.

Nanyang Technological University - NTU Singapore
https://www.ntu.edu.sg › mesd-coe

Maritime Energy and Sustainable Development Centre of ...

... **MESD** works closely with key stakeholders within the maritime cluster to ... Institute (SMI) and **Nanyang Technological University** (**NTU**). As the first ...

Viper Imaging
https://www.viperimaging.com

FLIR Thermal Imaging Systems | Viper Camera Imaging

Your Leading Supplier of Thermal & Infrared Imaging Cameras & Systems. Early Detection

Sub-Cooled Releases

2 Bar (30 PSI) Sub-Cooled

8 Bar (120 PSI Sub-cooled

NH_3 CONOPS

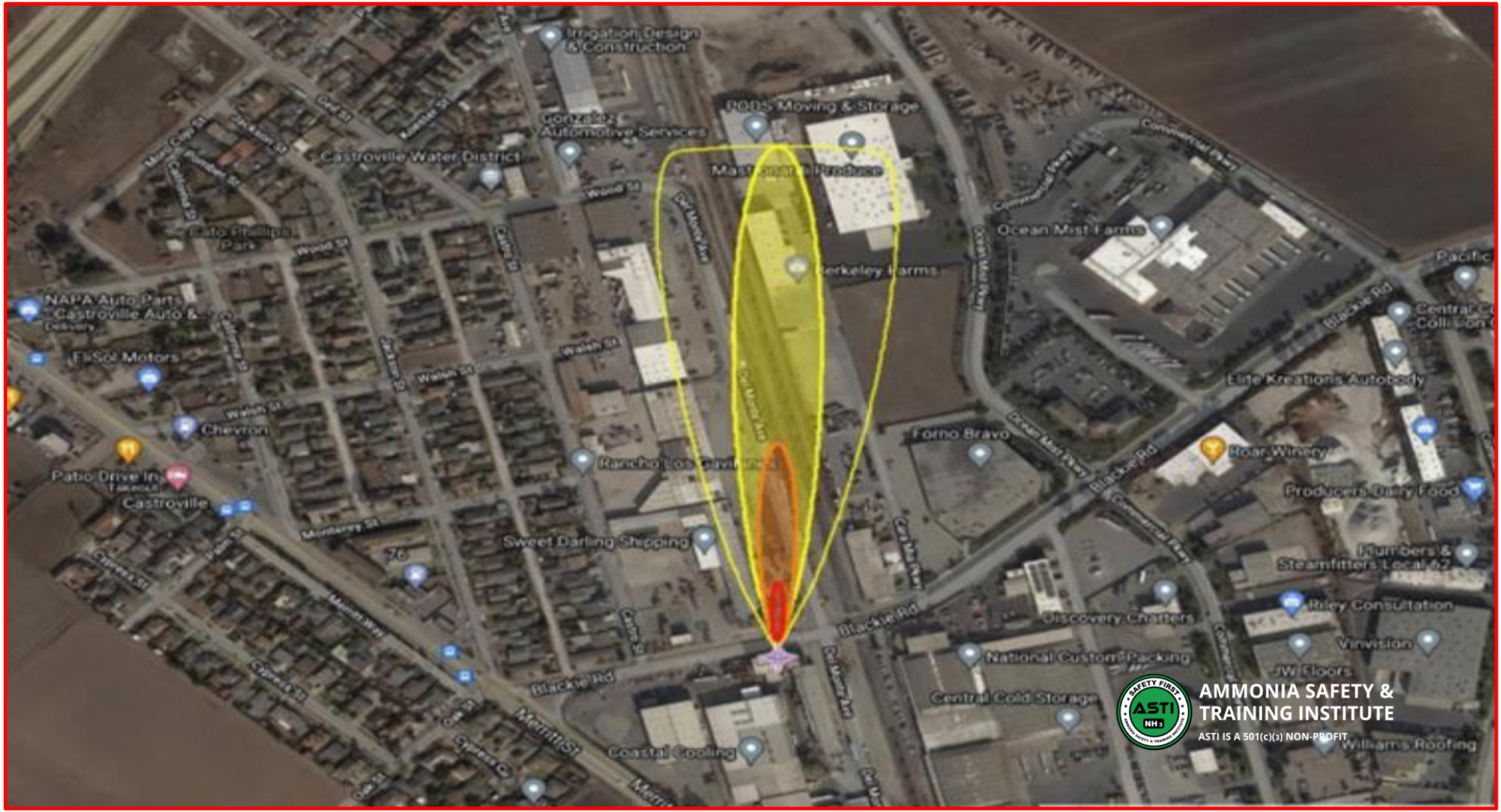
- Vortex Swirl

- FAN Mitigation

Ammonia Release & Response

High Pressure Aerosol - 2015

High Pressure Aerosol - 2016

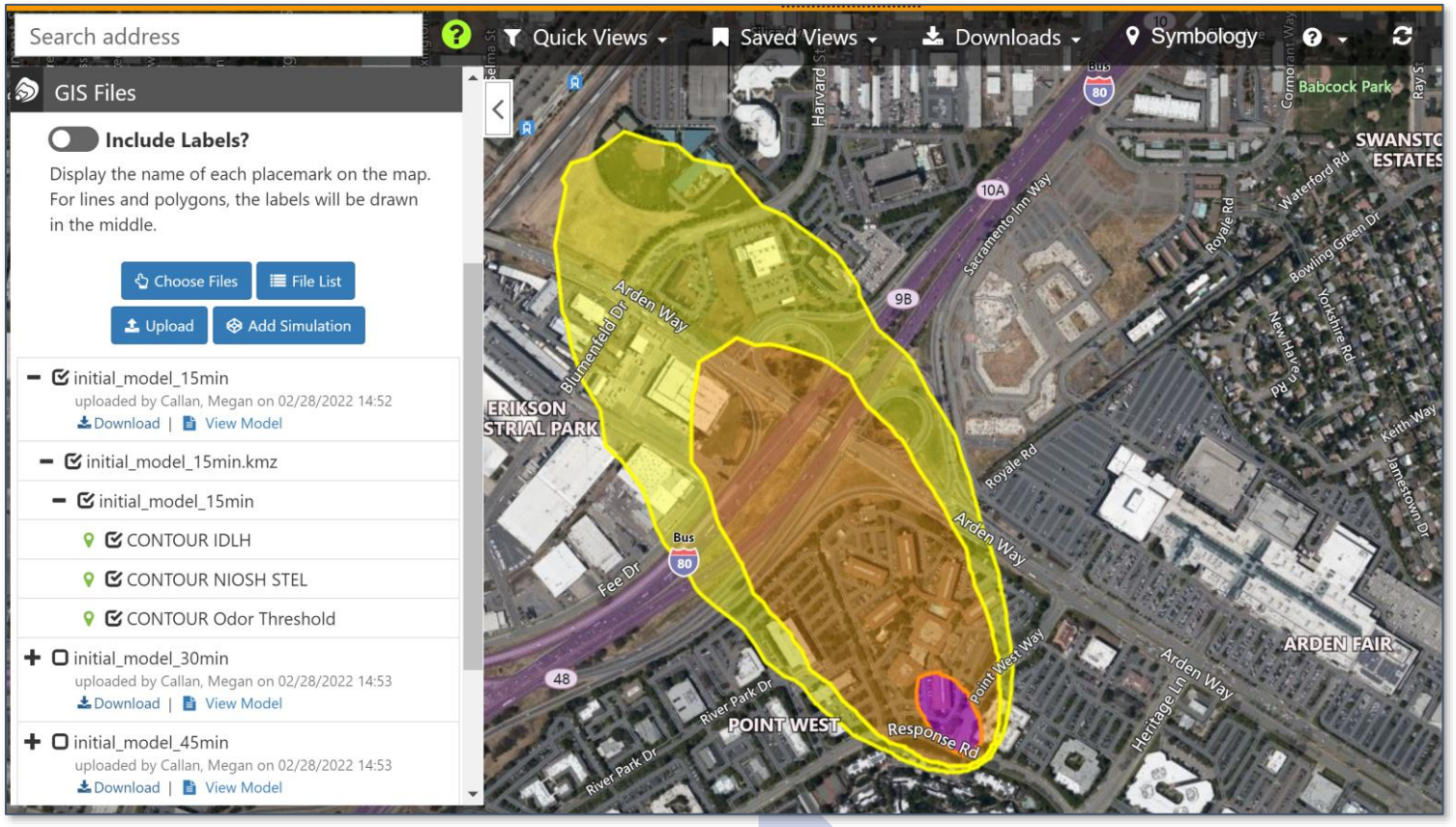


AMMONIA SAFETY & TRAINING INSTITUTE

ASTI IS A 501(c)(3) NON-PROFIT

ChemResponder Action 7 – View your IMAAC Products

- Modeling files are pushed directly to the event map
- The user can customize the layering for their model viewing



Discovery | Initial Response | Sustained Response | Termination

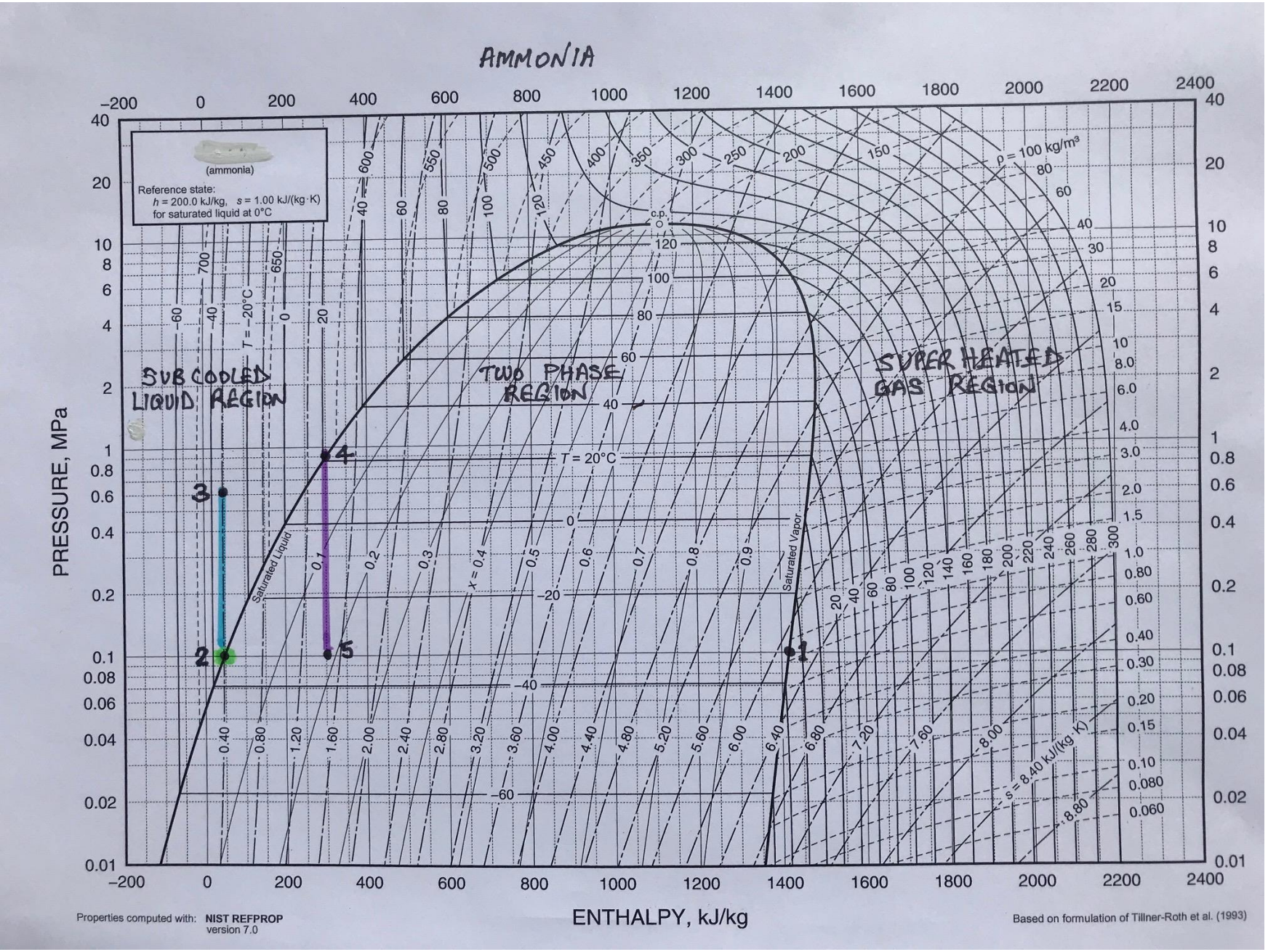
AMMONIA SAFETY & TRAINING INSTITUTE

ASTI IS A 501(c)(3) NON-PROFIT

Case Studies

Types of Accidental Ammonia Liquid Releases

1. Saturated Liquid Under Pressure onto Dry Land
2. Sub-Cooled Liquid Under Pressure onto Dry Land
3. Saturated Liquid at Atmospheric Pressure onto Dry Land
4. Puff Cloud over Water
5. Cold Liquid onto the Surface of Water
6. Pressurised Liquid Released Below the Water Surface



Saturated Liquid Under Pressure

Sub-Cooled Liquid Under Pressure

Saturated Liquid at Atmospheric Pressure

1. Saturated Liquid Under Pressure

Rail Tank Cars

Road Tankers

Barges

Nurse Tanks

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 4 to 5 arriving at atmospheric pressure and a dryness fraction of 0.18

We can therefore estimate that 18% of the mass flow of the release will instantaneously turn to flash gas in 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 138 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 a very high hazard and risk profile.

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 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, pressurised ammonia releases in recent history, which tragically resulted in one death and fourteen serious injuries.

2. Sub-Cooled Liquid Under Pressure

Release of sub-cooled liquid under pressure

When ammonia liquid is pumped from one atmospheric pressure -33C (-28F) storage tank to another, the pump will pressurise the liquid from the saturation line (point 2) straight up to point 3 with very little enthalpy gain, and into the transfer line.

The example shows typically what could be expected should there be an accidental release of ammonia liquid from a pumped transfer line onto a dry surface. This release involves a pressure reduction at the point of release from point 3 down to point 2.

Given that point 2 is on the saturation line, there will be very little or no flash gas formed in the breach however there may be atomised aerosols generated depending on the nature of the breach and how high the line pressure is.

The propensity of a sub-cooled release to generate a dense gas cloud should be less than that of a saturated release.

Sub-Cooled Liquid under 2bar (30psig) pressure

Saturated Liquid under pressure

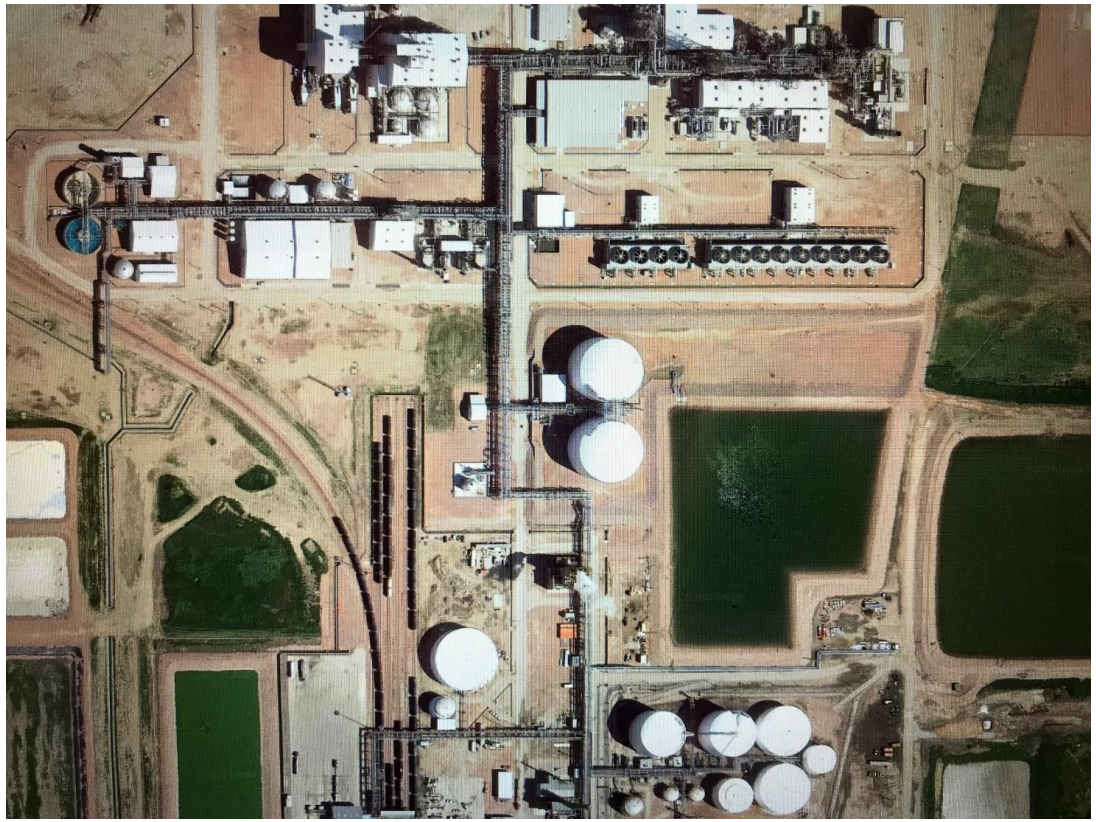
October 2024 testing for NTU Singapore MESD

3. Saturated Liquid at Atmospheric Pressure

Release of -33C (-28F) liquid at atmospheric pressure (at point 2 Green) results in the liquid running out into a pool which then slowly boils off into clear light gas which rises 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 should never be done as it will increase the evaporation rate and may even cause a gas cloud which could be heavier than air.

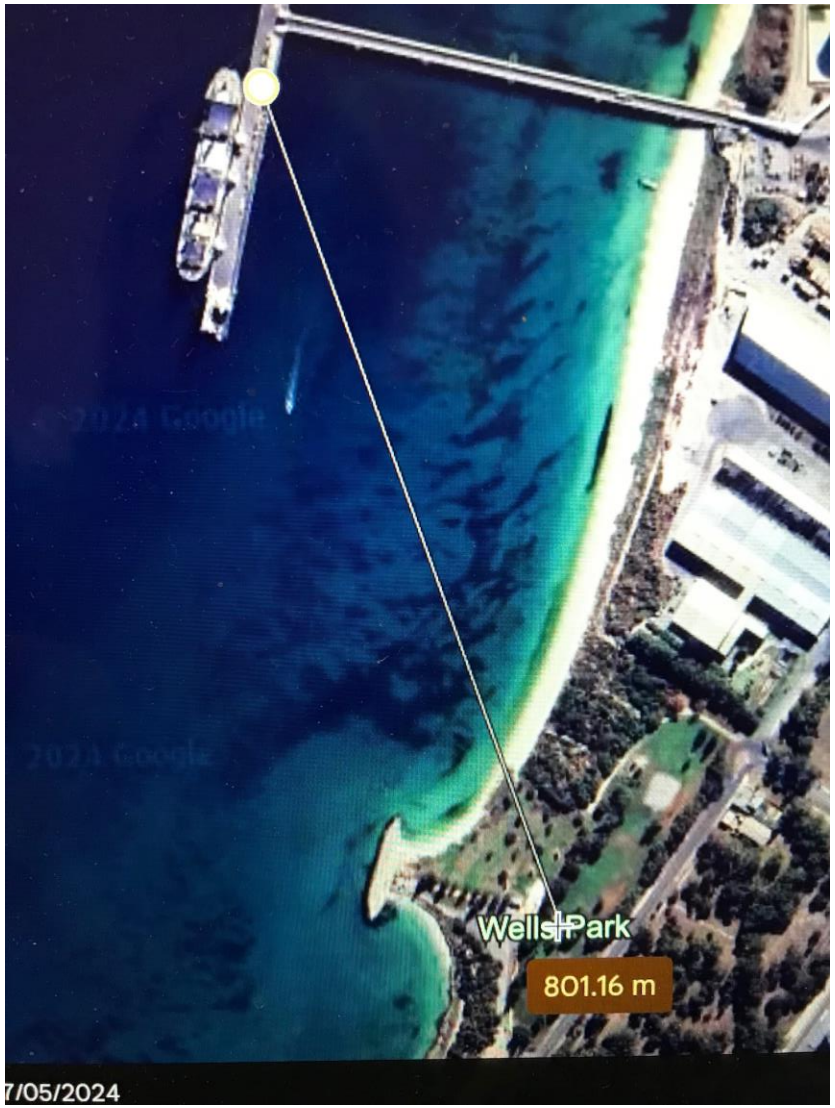


In December 1994 there was an explosion at the Port Neal Iowa ammonium nitrate plant which ruptured a nearby atmospheric pressure ammonia storage tank allowing 5700 tons of liquid to escape into the bunded area. This was the largest ammonia release in US history.

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

4. Puff Cloud over Water

A puff cloud can be created by an hydraulic shock event where a high velocity slug of liquid slams into a blind end and dislodges a gasket, flange or fitting, or splits a pipe allowing an instantaneous jet of liquid, under extreme pressure, to atomise into a cloud



Kwinana Western Australia July 2018, an ammonia release occurred on the Kwinana Beach Jetty during a ship to shore unloading procedure. A puff cloud occurred from the loading arm, as a result of hydraulic shock.

The cloud drifted about 800 metres across the water to Wells Park where it was smelled by a person sitting in his car.

Five people from the ship and facility were taken to hospital as a precaution and it was reported that their exposure to the chemical was not life-threatening.

This incident highlights the need to ensure that all system designs and procedures include the elimination of hydraulic shock potential, particularly during initiation and final purging of the liquid transfer pipeline.

5. Cold Liquid onto the Surface of Water

When a significant quantity of cold ammonia liquid hits the water, there are immediate thermal and chemical reactions which will cause a dense gas cloud to form. If the water temperature was +17C then the temperature difference between that and the -33C ammonia would be 50C (90F)

Puerto Mejillones, Chile in November 2016 liquid ammonia spilled from a ship into the sea.

It was reported that this release was because of a valve being opened by mistake and when the mistake was realized the valve was closed. It was suggested that the duration of the spill was 5 min.

The visible dense gas cloud did not reach the shore and there were no injuries on board. There were mussel beds in the proximity of the release and these were monitored after the spill and to date have shown no sign of negative impact.

6. Pressurised Liquid Release Below the Water Surface

It is likely that even a significant volume of ammonia liquid released below the surface would be overwhelmingly diluted in water depending on factors like the current and depth.

For example, a 55 ton release to be diluted to 100 : 1 would need a water sphere of radius 11m (35') and to be diluted to 1000 : 1 would need a sphere of radius 23m (75') Even so, the marine life within that radius may be seriously affected.

New Hampton , Iowa in august 2021 a train derailed due to the failure of a railway trestle during a major flood. One of the railcars was carrying 55 tons of liquid ammonia, all of which leaked into the floodwater when that railcar ruptured.

Responders were unable to detect any evidence of residual ammonia