Ammonia Fuels Network

10th Annual NH_3 Conference, September 23, 2013

Understand the Hazards and Manage Risks and Threats

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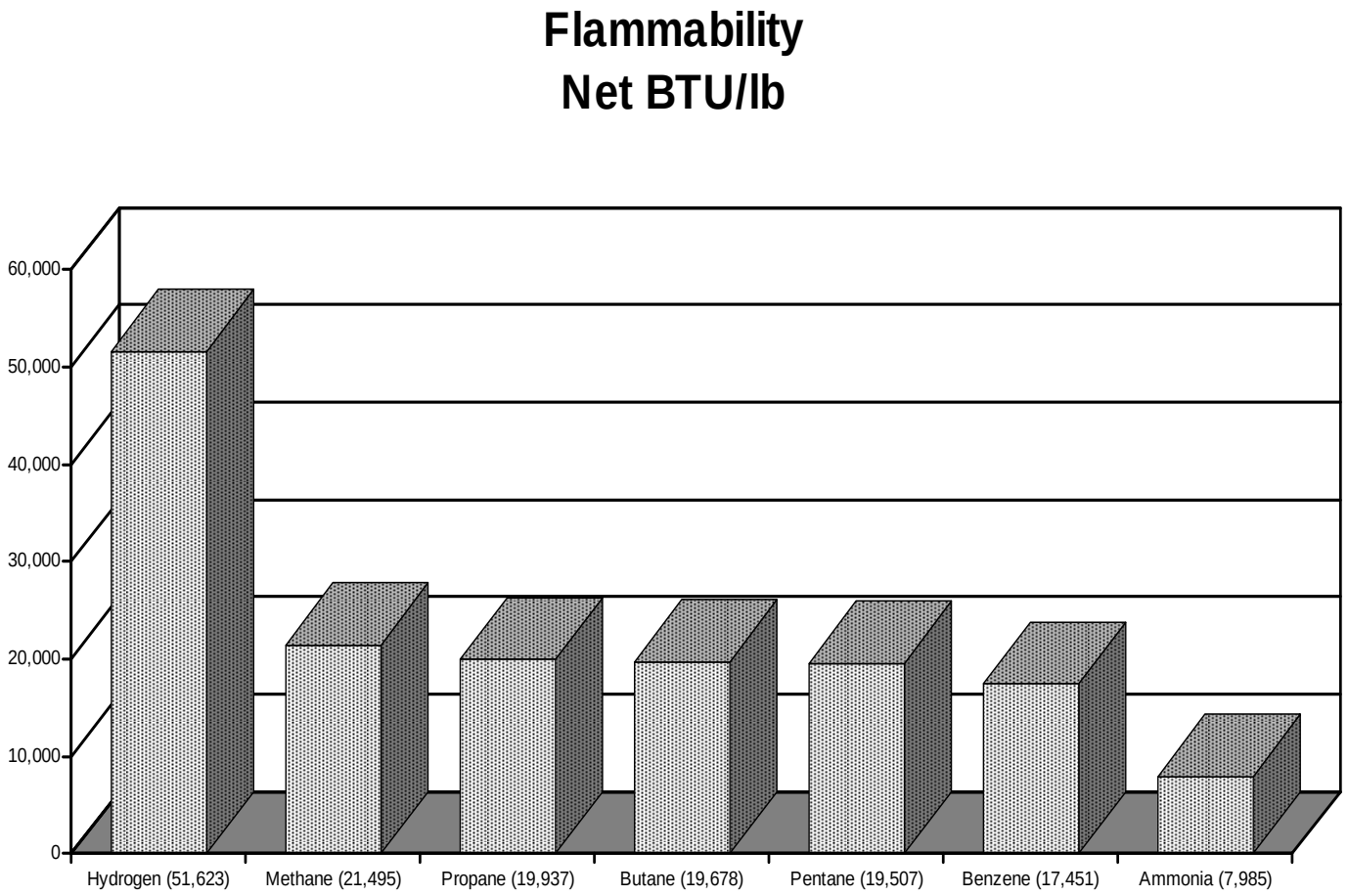
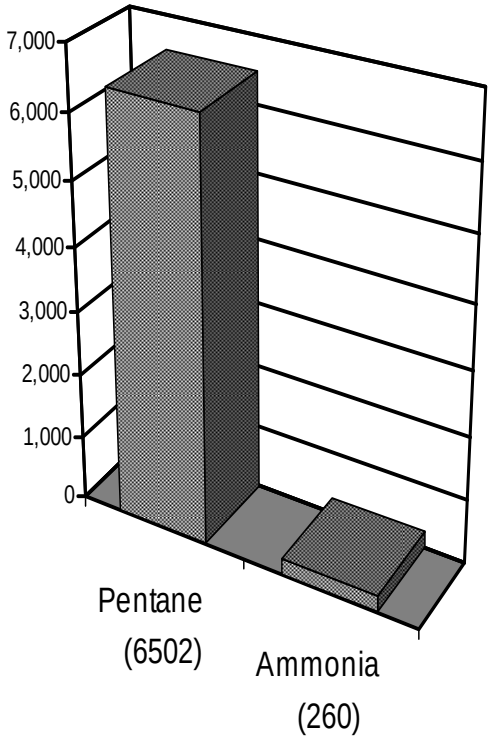
Flammability

Ammonia vapor confined within a building may ignite similar to a smoke explosion or backdraft: ammonia vapor may ignite as a powerful deflagration if concentrations reach its lower flammable limit (16% to 25%) with a source of ignition of 1204°F. Oil contamination may lower the LFL to 8% (80,000 ppm). Caution for flammability concerns start at ¼ of the LFL. The flash point of NH_3 is 50°F (gasoline is -45°F).

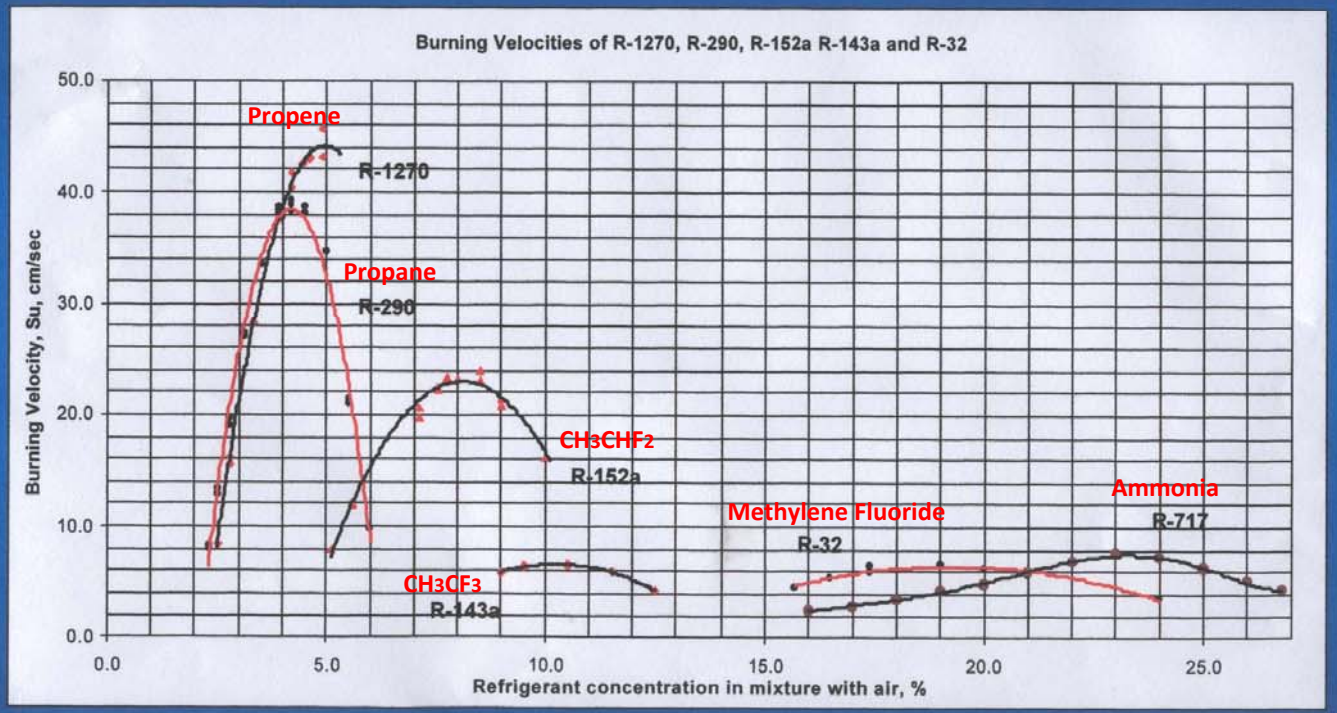
Energy of gases



Rate of Pressure Rise
PSI/Sec



Classification



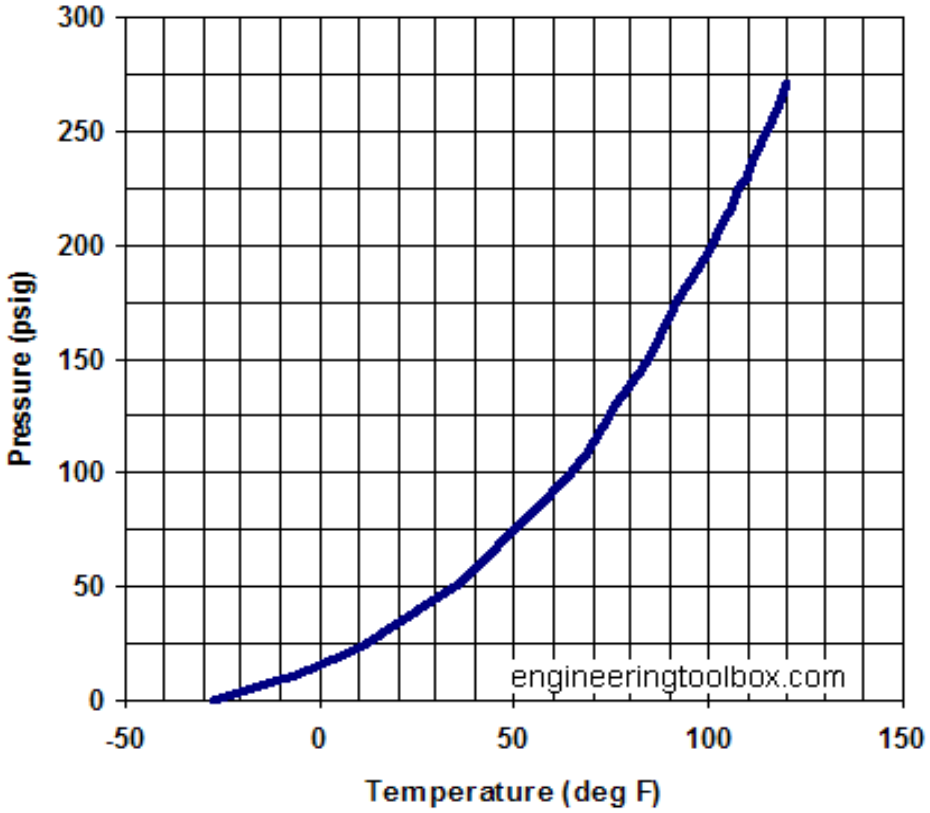
NH3 Flammability

- Dense Gas Flash
- Outside Fire
- Phillips 66 Test
- Shreveport
- Borden's Fire

Thermal Dynamics

Thermal-dynamics: heat builds pressure and cooling reduces pressure exponentially. The temperature of an aerosol stream will reduce to as low as -80°F when released into the open air (law of Partial Pressures). Vapor released from a vessel will reduce pressure and auto-refrigerate the liquid; a liquid release has little effect on pressure. Ammonia liquid will cool to below its boiling point -28°F and 0 psig.

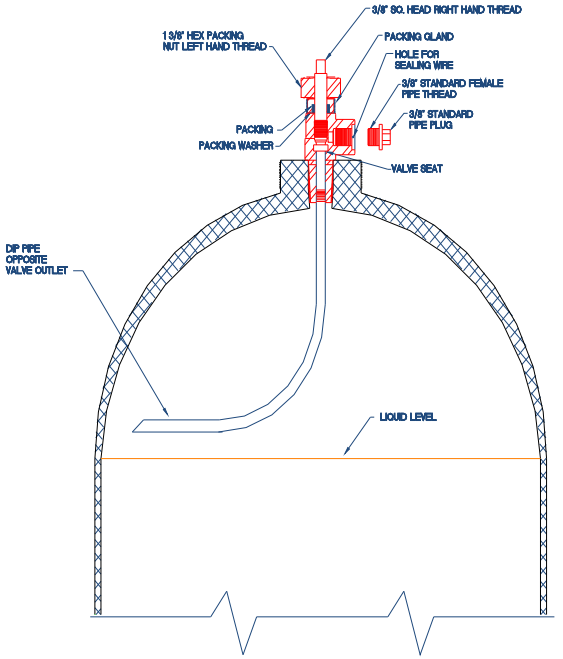
Pressure/Temperature



Pressure Management

- Hydrostatic Pressure
- Pressure Challenges
  - Hydraulic Shock
  - Trapped Liquid
  - Slug of Ammonia

Pressure Problems



Pressure Problems

Overfilled Cylinders

Fire: Ammonia cylinders

Liquid or vapor?

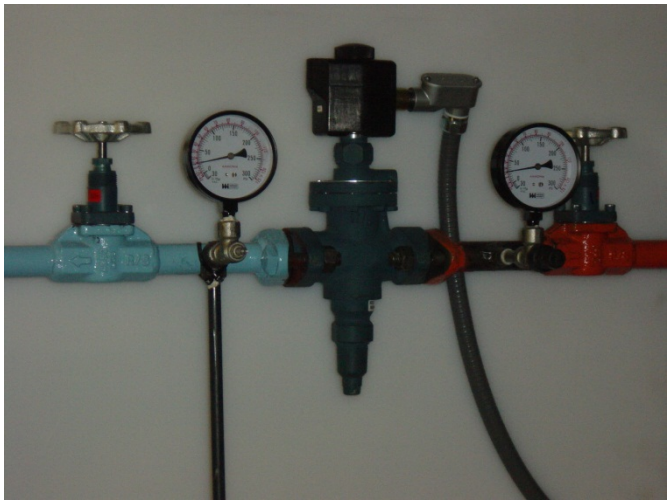
Pressure Management

- Pressure Relieve Valve
- Auto-Refrigeration
- Equalizing Pressure-High to Low
- Defusing Vapor
- Low Pressure Release

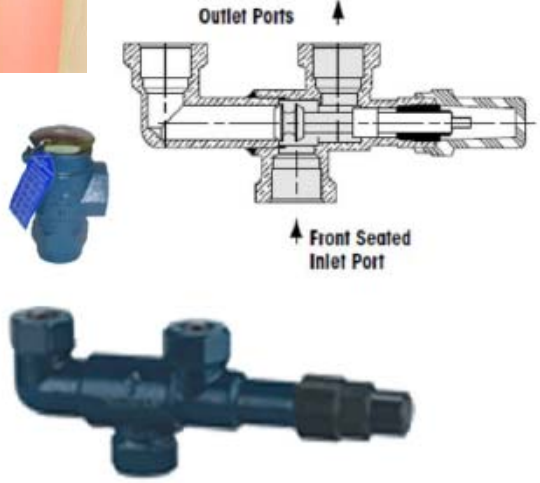
Pressure Management

Diffuser

Emergency Pressure Control



Relief Valves



Physical Characteristics

Ammonia spreads in a V-Pattern and will track with the wind (be especially mindful of eye-level wind movement); moisture and vegetation will cause ammonia to become more turbulent, rolling rather than laying out in a defined v-pattern. Dry, windy, and warm weather diffuses ammonia to the atmosphere faster than humid, cool, and low wind conditions. High pressure inversions and humidity may cause the vapor to bounce and return to ground level before completely diffusing.

Release Diagram

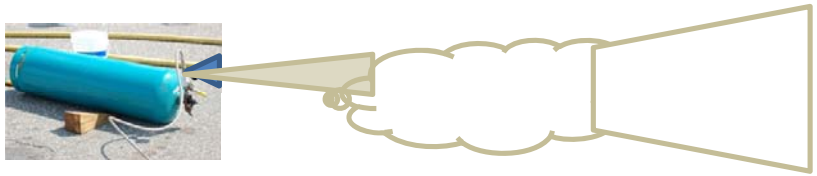
Aerosol stream =

Dense Gas Cloud =

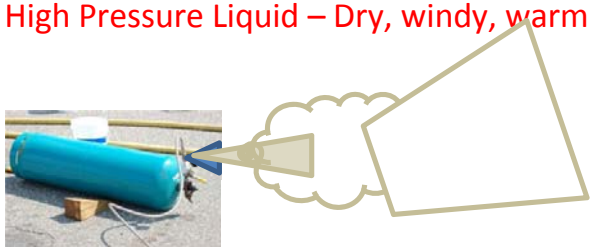
Invisible Vapor =

NOTE: Pressure, volume, wind, topography, and environment cause variations in release characteristics

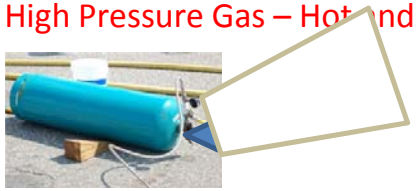
High Pressure Liquid – Wet , low wind, cold day:



High Pressure Liquid – Dry, windy, warm day:



High Pressure Gas – Hot and dry day:



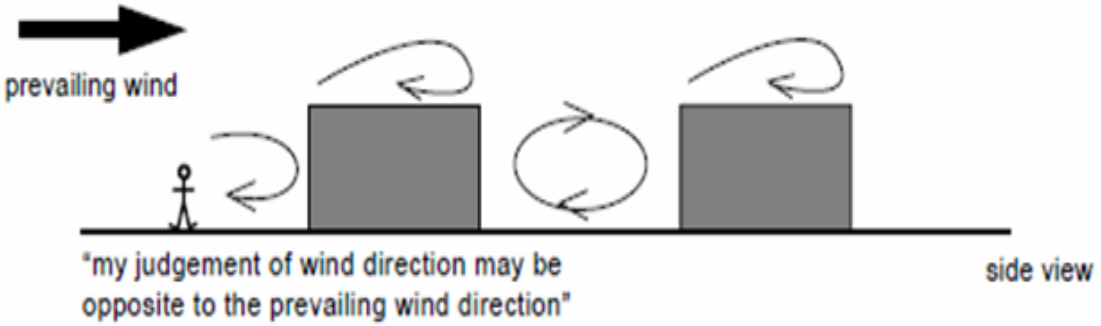
Invisible Vapor!

- Three types of ammonia
- Invisible vapor – small release
- Moving behind the release
- Invisible vapor – large release

Eye Level Wind

APPARENT WIND ANOMALIES

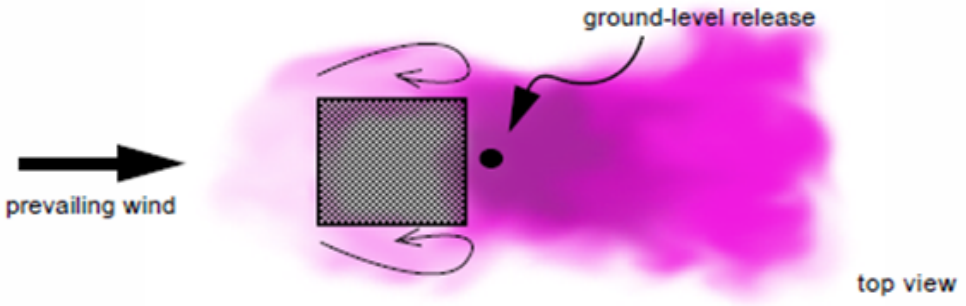
The locally-measured wind may not match the large-scale wind due to building-induced circulations.



Lesson: because of the complicated flows that develop around buildings, a measurement of wind made at ground-level may not be indicative of the upper-level prevailing wind. Evacuation zones far downwind must be determined by the larger-scale plume transport which follows the prevailing wind, not the local wind.

EDDY TRANSPORT OF AGENT

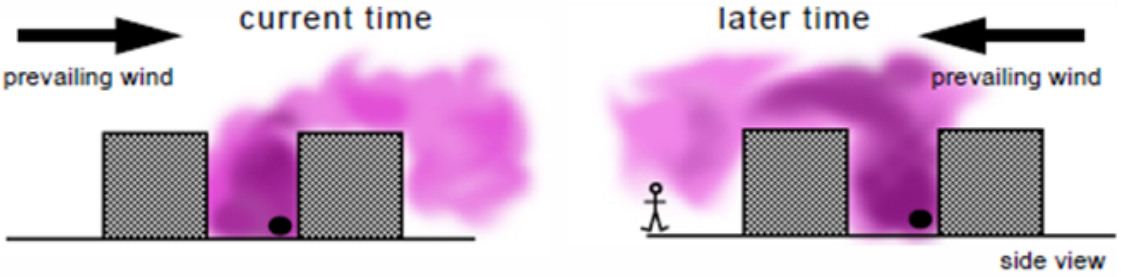
The air contaminant can move short distances against the prevailing wind direction in recirculation zones along the sides and top of the building.



Lesson: even if the source is determined to be downwind of you, be careful at locations near the building upstream of the source, as the plume can travel short distances in the opposite direction to the prevailing wind.

LARGE-SCALE WIND VARIABILITY

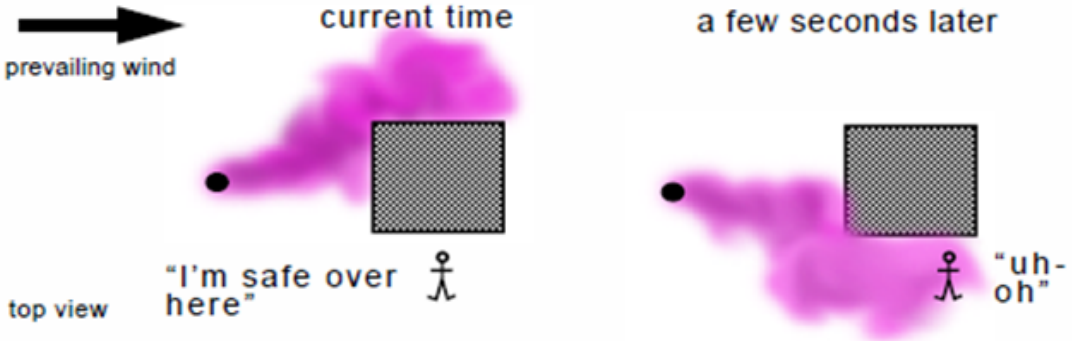
The prevailing wind switches direction occasionally, so that the upwind safe zone may now be downwind.



Lesson: the prevailing wind is not fixed and under some circumstances can change direction quickly; thus, monitor the prevailing wind direction so that safe zones can be maintained.

SMALL-SCALE WIND VARIABILITY

The local wind can switch direction very rapidly, so that the plume may switch from one side of the building to the other in a matter of seconds.



Lesson: due to the turbulent nature of the wind, it is very common for a plume to bounce from one side of the building to the other; hence, don't assume that you are safe on one side of the building just because the plume is currently on the other side.

Ammonia is Corrosive

- **Ammonia is corrosive** when mixed with water a pH of 11.6 occurs rather rapidly. The corrosiveness of ammonia will mix with body fluids like sweat and respiratory tract moisture to cause irritation; skin burns begin to occur at 10,000 ppm.
- Environmental threat is increased when NH_3 goes into a live body of water
- NH_3 is corrosive to copper, brass, zinc alloys – forms greenish/blue color
- Avoid mixing of NH_3 with bromine, chlorine, iodine, calcium hypochlorite; NH_3 is an alkaline reducing agent (react with acids, halogens, and oxidizing agents).

Corrosiveness and Affinity for Water

- Fire Hose - Aerosol Cloud
- Ammonia vapor into water
- Ammonia Liquid into water
- Water into Ammonia
- Fish kill due to ammonia

Copper, Zinc and Alloys

Exposure to Ammonia

Acute Exposure Guideline Levels (AEGL): The EPA recommends that the AEGL levels by used by emergency responders when judging the human exposure threats of NH_3. This is especially valuable when judging the risks and threats of shelter-in-place versus evacuation, and for judging if a rapid extrication rescue is warranted.

Occupational Exposure Guidelines

- **ACGIH TLV** (Threshold Limit Values): 25 PPM - TWA (8-hour Time Weighted Average)
- **STEL** (15-minute Short Term Exposure Limit): 35 PPM
- **OSHA PEL** (Permissible Exposure Limit): 25 to 50 PPM - TWA (8-hour Time Weighted Average)
- **NIOSH IDLH** (Immediately Dangerous to Life and Health): 300 PPM
- **Ammonia's pungent odor must be taken seriously.** The early warning provided by ammonia's odor at 0-25 PPM is the signal to move upwind, put on personal protective equipment, or move to a room or building equipped as a safe refuge.

Acute Exposure Guideline Levels

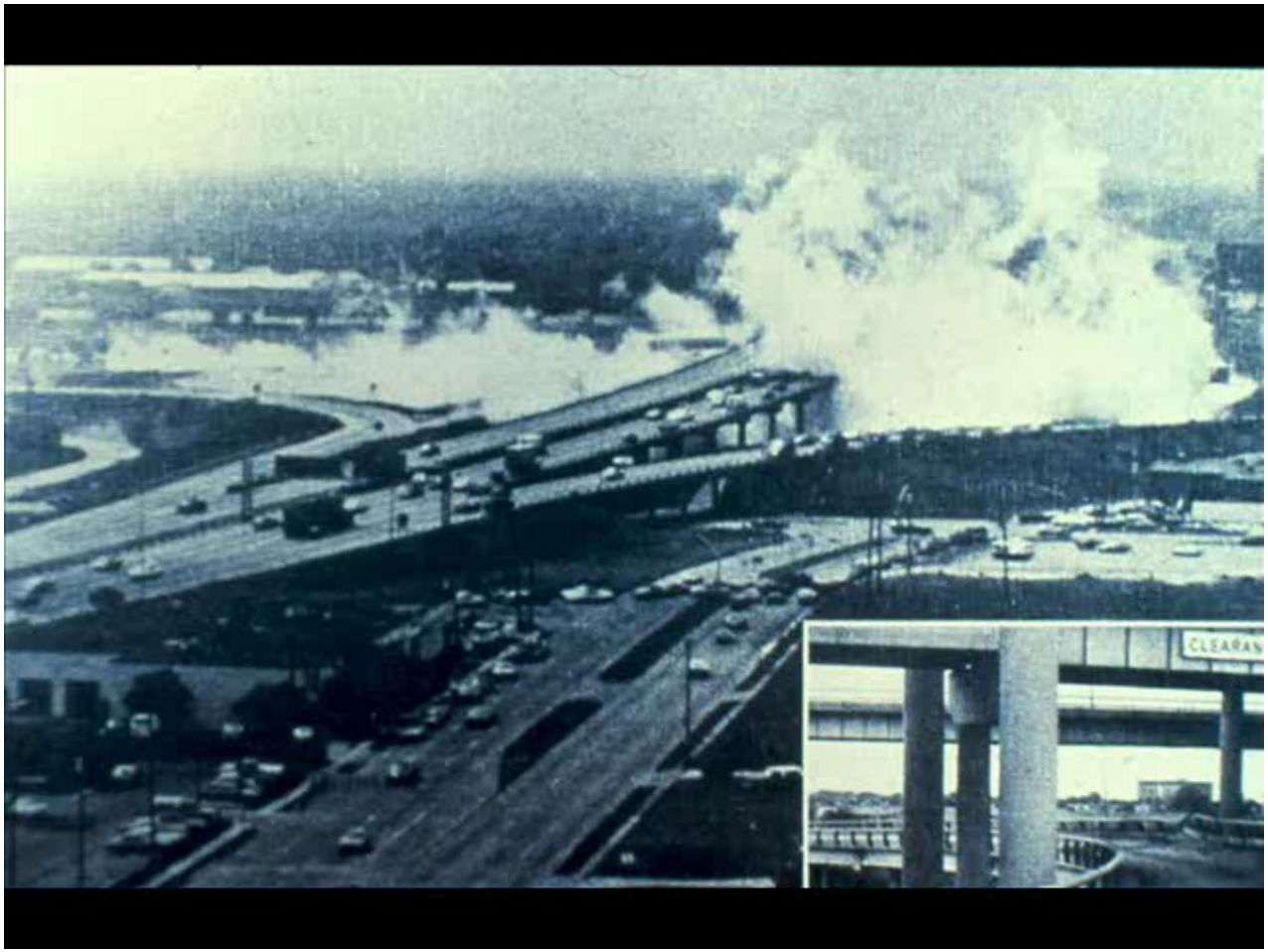
Ammonia 7664-41-7 (Final) - Expressed in PPM					
	10 min	30 min	60 min	4 hr	8 hr
AEGL 1	30	30	30	30	30
AEGL 2	220	220	160	110	110
AEGL 3	2,700	1,600	1,100	550	390

AEGL-1 is the airborne concentration above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

AEGL-2 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

AEGL-3 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

Surviving an NH_3 Cloud



Isolation Zones

The DOT – ERG recommends Isolation Zones (circles) for high life threat downwind and dangerous levels upwind: small release = 100’, large = 500’, and catastrophic = 1,000’; and a Protective Action Zone downwind distances measured as a (v-pattern).

LIFE SAFETY: 100’ and 500’ I-Zones

Map #1

Incident Command Post ICP 1 and ICP 2

1. 100’ Zone

Penny Savor

2. 500’ Zone

Maytag

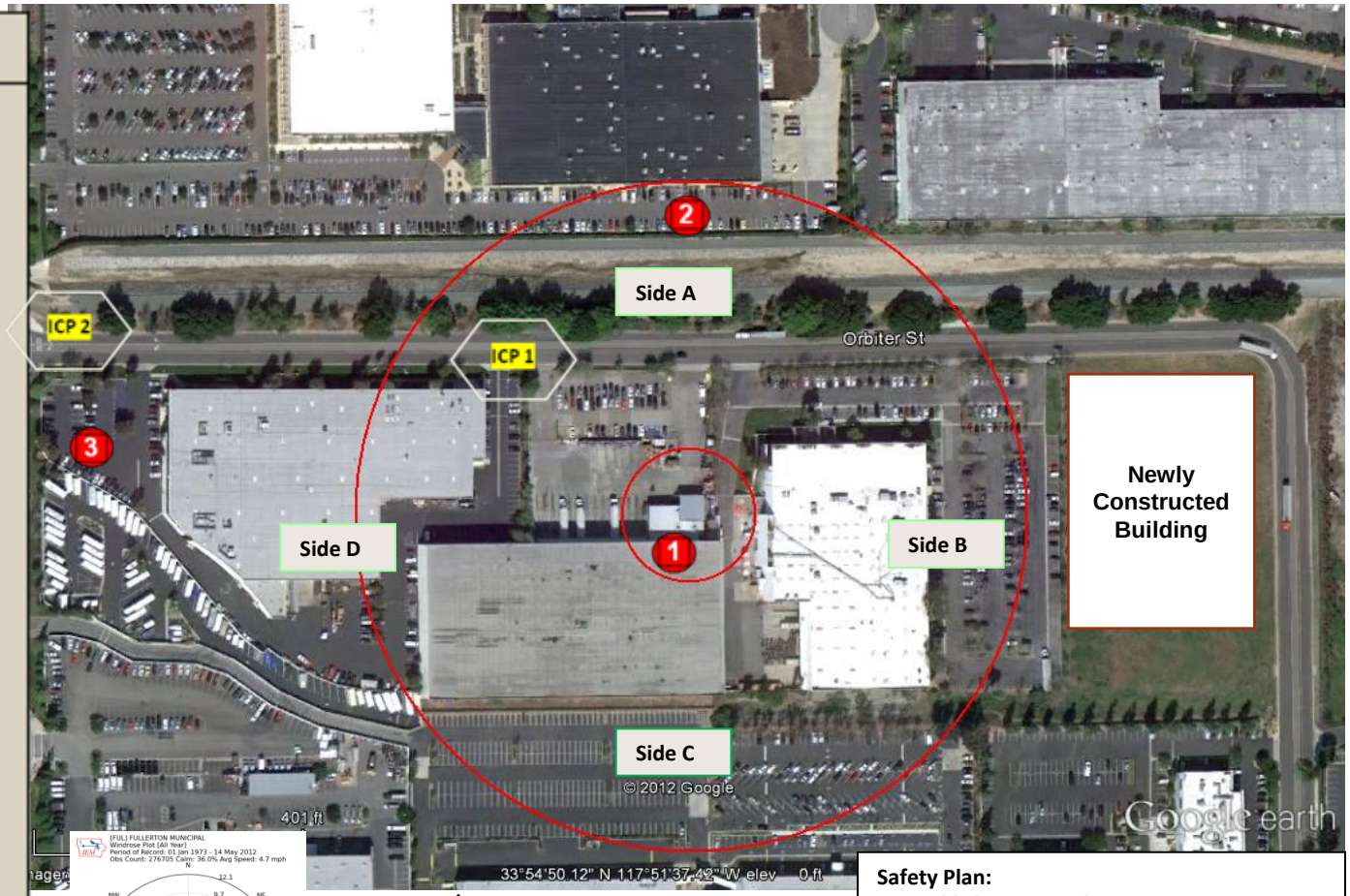
3. Rally Point: Orbiter and Kramer

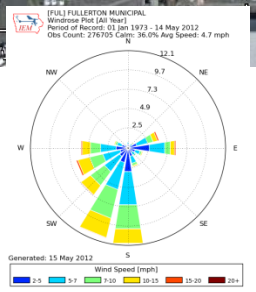
Sides of the building

Side - A, B, C, D

Off-site gathering points:

1. Civic Center
2. Anaheim Americold





Prevailing Wind

Safety Plan:

1. Establish command team
2. Define Isolation Zone
3. Eye level wind indicators/Zone controls
4. Access control and zone control
5. Eyewash/Shower location
6. PPE, Buddy system/back-up, monitoring
7. Emergency Alert alarm signal
8. Review IAP and Safety Plan

Hazard Zones and Safe Refuge Area

Location Index

Hazard Zones

Refrig: Motor Room and outside receiver/condenser

Cold Rooms: **CR#3, CR#2,** and **CR#1**

1. Dock Area

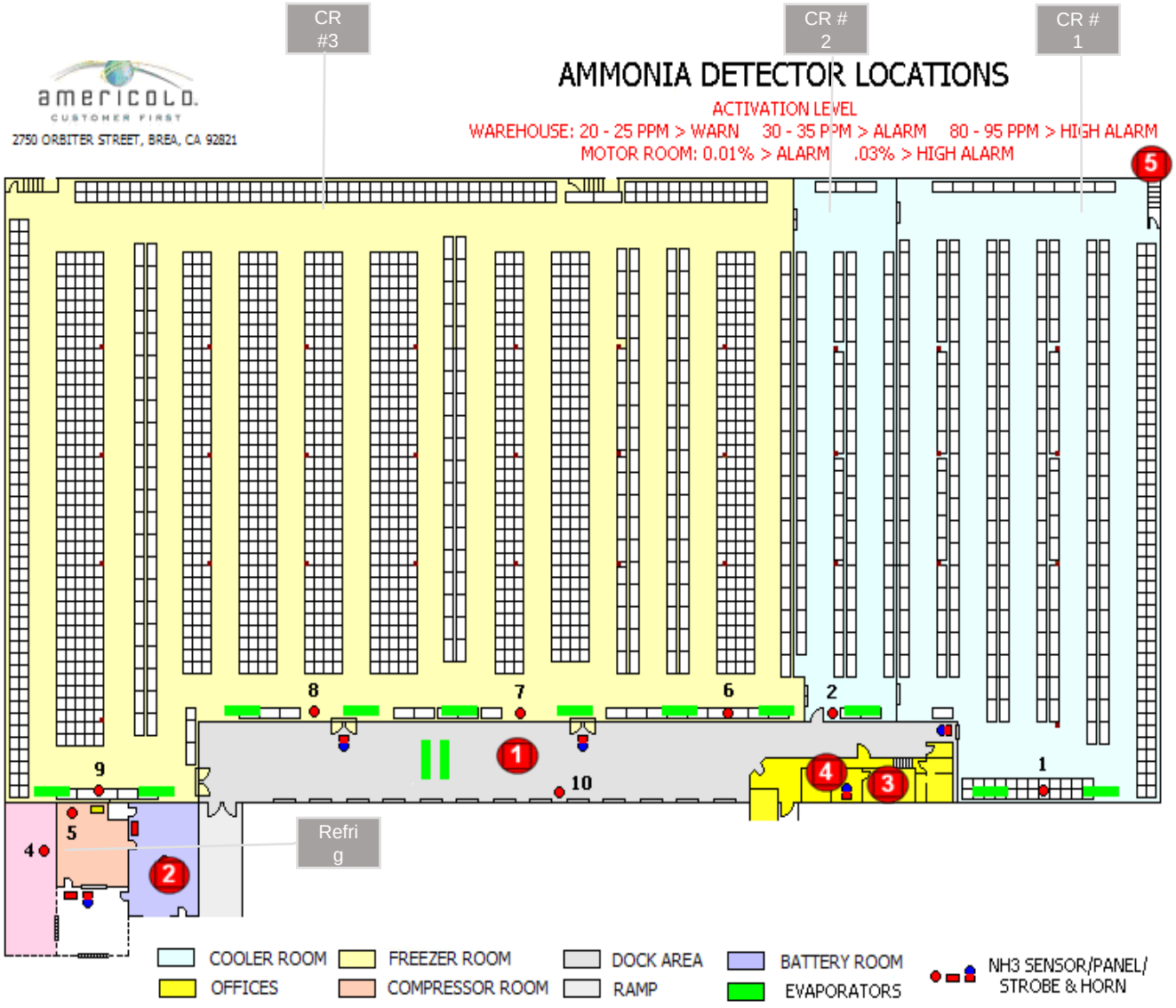
2. Battery Room

Safe Refuge Area

3. Office Refuge: Primary Refuge (upstairs lunch room)

4. Emergency Command Center (ECC) in Upstairs Office Area

5. Emergency Exit through Cold Room #1 and exit out of Door #2



LIFE SAFETY: Catastrophic – 1,000’

Map #2

Incident Command Post
ICP 2

1. Isolation Zone #1- 100’
2. Isolation Zone #2- 500’
3. Isolation Zone #3 – 1,000’
4. Rally Point: Orbiter and Kramer

Sides of the building
Side - A, B, C, D

Off-site gathering points:

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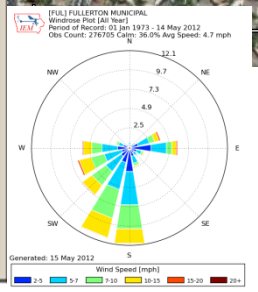

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LIFE SAFETY: Protective Action Zone

Map #3

High Risk Receptors:

1. Inner circle: 0.5 miles

2. Outer two circles: 1.0 mile to 1.3 miles

Off-site gathering points:

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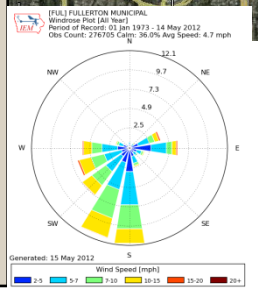
2. Anaheim Americold



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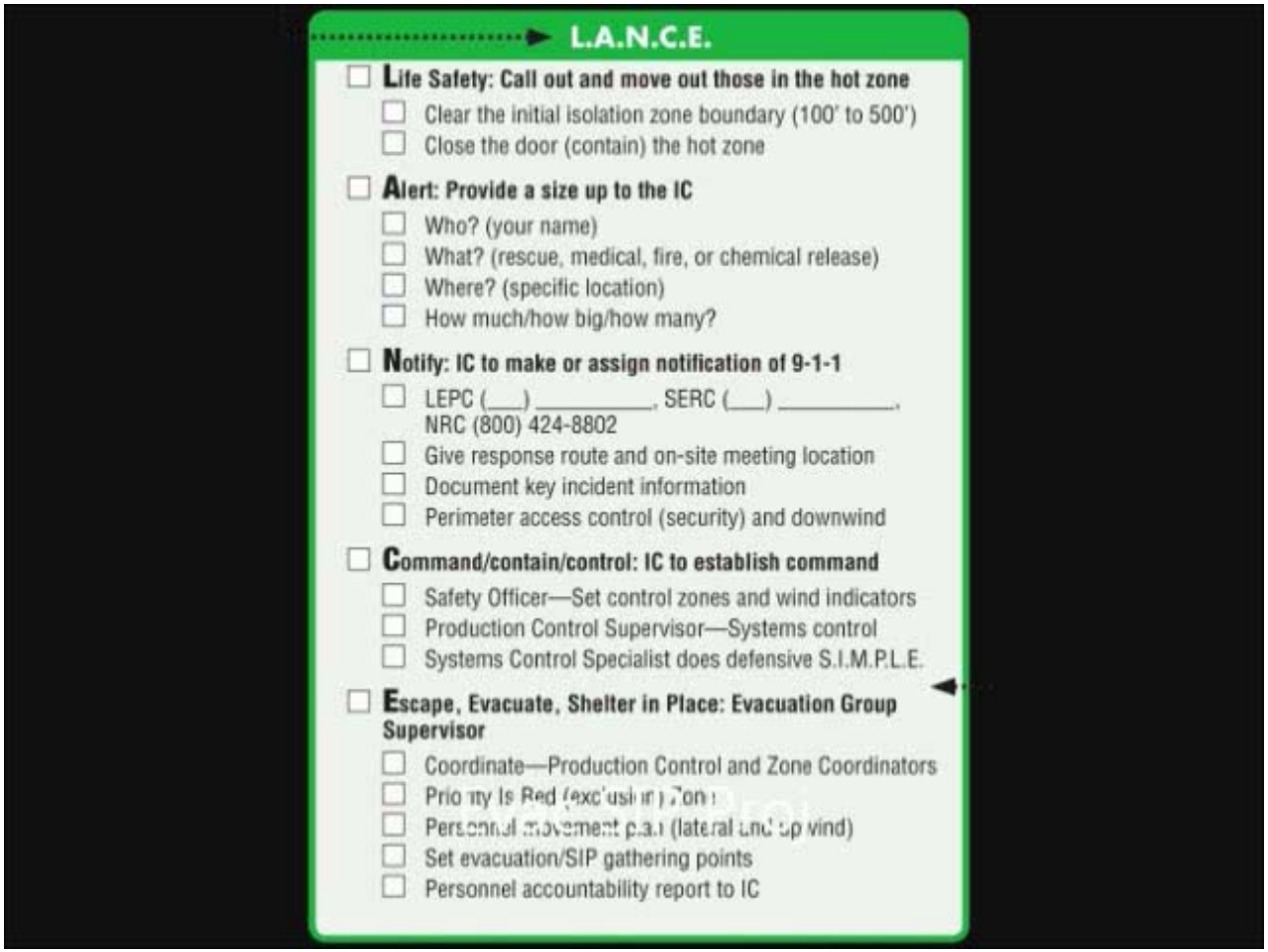
Evacuation


L.A.N.C.E.
Life Safety: Call out and move out those in the hot zone
Clear the initial isolation zone boundary (100' to 500')
Close the door (contain) the hot zone
Alert: Provide a size up to the IC
Who? (your name)
What? (rescue, medical, fire, or chemical release)
Where? (specific location)
How much/how big/how many?
Notify: IC to make or assign notification of 9-1-1
LEPC (___) _____, SERC (___) _____, NRC (800) 424-8802
Give response route and on-site meeting location
Document key incident information
Perimeter access control (security) and downwind
Command/contain/control: IC to establish command
Safety Officer—Set control zones and wind indicators
Production Control Supervisor—Systems control
Systems Control Specialist does defensive S.I.M.P.L.E.
Escape, Evacuate, Shelter in Place: Evacuation Group Supervisor
Coordinate—Production Control and Zone Coordinators
Personnel accountability report to IC

Emergency Response Preparedness

Pre-Emergency

Discovery

Initial Response

Sustained Response

Terminating the Emergency