TRANSCAER® Anhydrous Ammonia Training Instructor Guide

Special thanks is given to the following persons whom without their time, expertise and dedication this program would not be possible.

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David Finlayson - Canadian Fertilizer Institute, Ottawa
Donna Lepik, TRANSCAER® and CHEMTREC®

Instructional Materials

We've included several tools to help you present this material in a credible, dynamic and consistent manner. These include:

1. complete PowerPoint presentations of each of the four training blocks;
2. instructor notes embedded into the PowerPoint presentations;
3. complete video presentation of each block in DVD format, playable on both regular DVD players and on computers equipped with DVD drives;
4. student and instructor manuals;
5. a few extras we've thrown in (note: these could be extra videos, PDFs, handouts, etc. – to be determined prior to distribution)

The PowerPoint presentations and extras are accessible from a separate folder when the DVD is inserted into a computer.

All the materials were developed by our team of seasoned experts from across various industries. While they are intended to be used as a cohesive training package, we recognize that there may be local issues or unique circumstances that may lead you to change these presentations for your use. If that is the case, we ask that you contact us first – both TRANSCAER® and the Fertilizer Institute have designed and developed this training package in a fashion to promote safety and proper response to anhydrous ammonia incidents and do NOT endorse or support variations to the videos or PowerPoint presentations without review and approval.

As a lead field instructor, we recommend you prepare properly for the presentations as a whole. This includes having some familiarity with the ENTIRE program, not just your section. Watch the entire DVD and take a look at ALL the PowerPoint presentations – there may be elements that have some overlap, or complement another presentation. Being aware of what is in your session and how it relates to the entire program will only make for a more effective training opportunity. Of course, we don't expect you to just read the instructor notes verbatim – we certainly don't want "death by PowerPoint!" We recognize that you may have experiences and knowledge to bring to the table, but in order to deliver the cohesive message we've worked hard to design, we would not want you to inject opinions or advice that run counter to the training set forth by our development team.

The feedback we've received has been very positive. We're confident this training package will help you, your team and your community. If you have any questions, please do not hesitate to contact us. Good luck and be safe!

Methodology

This course uses lecture, discussion and hands on training when applicable.

Estimated Total Time: 4 Hours

Time	Section/Activity	IG Pages
10 min.	Introductions	Unit 1 Pg 4-6
60 min.	Section 1. Anhydrous Ammonia Properties	Unit 1 Pg 7-24
60 min.	Section 2: Cargo Trailers, Nurse Tanks, Straight Trucks	Unit 2 Pg 1-16
60 min.	Section 3: Railway Transportation	Unit 3 Pg 1-19
60 min.	Section 4: Emergency Response	Unit 4 Pg 1-27

Audiovisuals/Handouts

- Visuals - Section 1 31 slides
- Visuals - Section 2 43 slides
- Visuals - Section 3 31 slides
- Visuals - Section 4 32 slides
- Student Handout

Evaluation

- Course Evaluation

Introductions *10 min.*

I. INTRODUCTION TO TRANSCAER® AMMONIA TRAINING

Instructor Note: The purpose of this section is to welcome the students to the course and to review emergency and facility information. If possible, a representative from the host department should welcome the students and provide any pertinent information about the community, i.e. eating places, entertainment, etc. Welcome remarks should be no more than 10 minutes.

A. Welcome students

1. This course is being presented by _____.
2. The department that is hosting the training is _____.
3.

Instructor Note: You should provide some basic information for your introduction. After the introduction, thank the host for hosting the course and the students. Provide enough detailed information about yourself to answer for the students the following question, "What gives this person the credibility to deliver this block of instruction?"

B. **Emergency procedures**

Instructor Note: Emergency information should be gathered prior to the start of the course. Contact information should be listed on a whiteboard or easel pad.

1. Emergency exits
2. Fire alarm
3. Emergency contact phone numbers
4. Severe weather procedures and alarm sounds
5. Procedures for receiving an emergency call

C. **Facility information**

1. Restrooms
2. Parking areas
3. Telephones
4. Refreshment areas
5. Rules for refreshments in classroom

Ask Students: Are there any questions about the facility or emergency procedures? Answer any questions. If needed, refer the question to the host. Ensure all necessary forms have been completed by each student.

Student Introduction

Purpose: To learn about the background of each student.

Instructor Note: Depending on class size, (a guide would be 20 or less) if possible have all students introduce themselves. Ask them to mention if they have had any experience with ammonia in their jurisdiction. Keep this short and help to move the process along if someone starts to take too much time.

Directions to the Students:

Please introduce yourself, giving your name and agency that your work for. Please let us know if you have had any experience with anhydrous ammonia response in your agency.

Section 1: Properties of Anhydrous Ammonia 60 *min.*

Lesson Goal

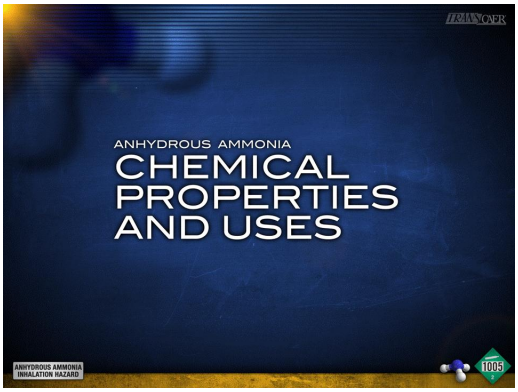
After completing this lesson, the student shall be familiar with ammonia properties.

Objectives

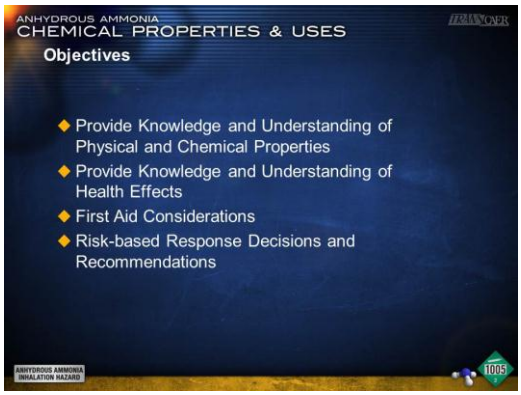
Upon successful completion of this section, the student shall be able to:

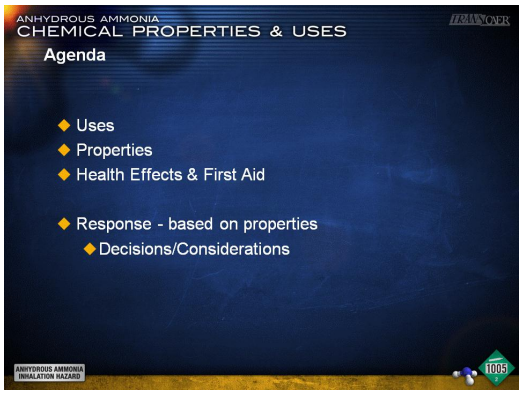
1. Obtain knowledge and understanding of the physical and chemical properties of anhydrous ammonia
2. Understand the properties and how that relates to actual, real life response to anhydrous ammonia
3. Understand and recognize the health effects of anhydrous ammonia exposure from both liquid and vapor phases
4. Understand the basic first aid for victims of ammonia exposures
5. Obtain knowledge to make risk based response decisions and recommendations involving an ammonia leak or incident, based on ammonia's properties and an assessment of the event

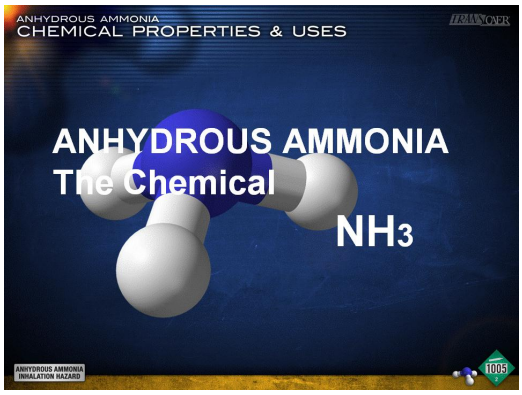
I. ANHYDROUS AMMONIA PROPERTIES



Instructor Note: The purpose of this section is to discuss the chemical properties of ammonia. This section should be given enough time to introduce the students to the material and give them some time to discuss any questions.

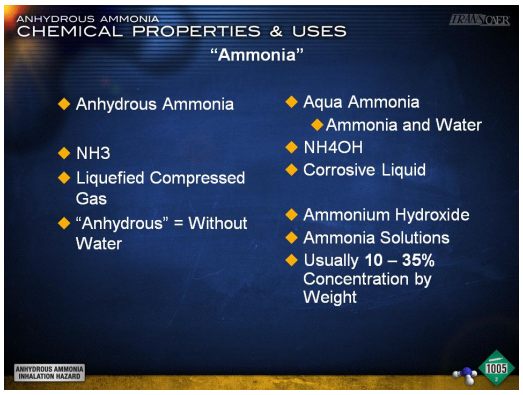


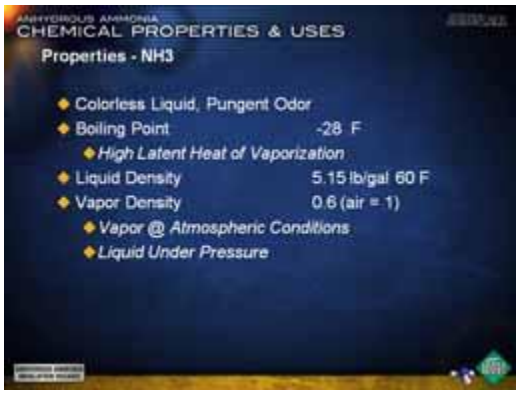




A. **Anhydrous Ammonia**

1. Pure liquefied compressed gas
2. It is 100% ammonia
3. Chemical formula is NH3
   a. One part nitrogen
   b. Three parts hydrogen
4. Anhydrous = without water
5. Anhydrous ammonia has higher toxicity than aqua ammonia- anhydrous ammonia is 100% ammonia.

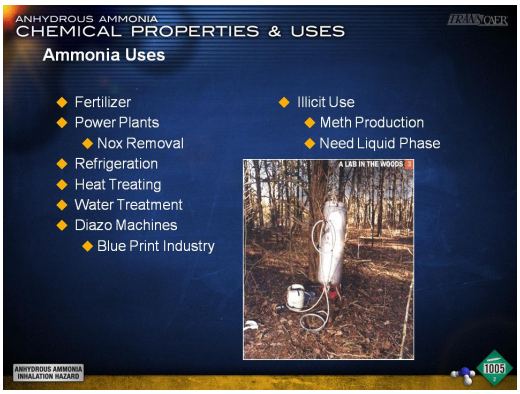




B. **Aqua Ammonia**

1. Ammonia and water
2. NH4OH
3. Corrosive liquid
4. Ammonium hydroxide
5. Ammonia solutions usually 10-35% concentration by weight
6. Usually either 19% or 30% by weight concentration

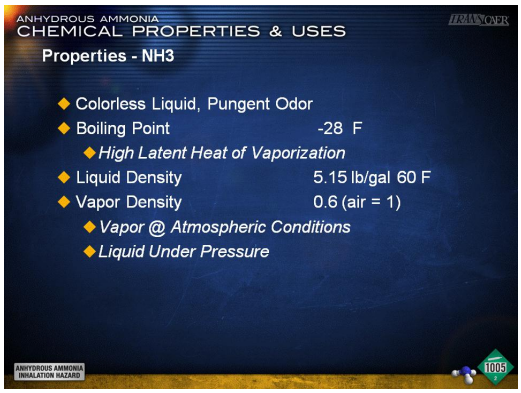
Instructor Note: We are covering anhydrous ammonia today - the liquefied compressed gas. You may have planning or response responsibilities to fixed facilities or a transportation incident and someone states "we have ammonia on site". Personnel may not distinguish between anhydrous ammonia and aqua ammonia – it is just ammonia to them since that is what they have on site or are transporting. Aqua ammonia is ammonia and water blended together – usually a 19% or 30% concentration. Anhydrous ammonia is pure 100% ammonia. It is important to know which product you are dealing with. Both are hazardous, but obviously anhydrous ammonia is more hazardous and response considerations will be different than with aqua ammonia. The type of storage or transport container will also be different.



C. Ammonia Uses

1. Fertilizer - 80% produced goes to agricultural purposes
    a. Used for high nitrogen content - 82% nitrogen by molecular weight
    b. Not put directly on plants because of corrosive nature
    c. By molecular weight anhydrous ammonia is 82% Nitrogen
2. Power Plants
    a. Used in coal and natural gas fired plants
    b. Used as a pollution control in a smoke stack scrubber system
    c. Ammonia will convert NOx to nitrogen and water
3. Refrigeration
    a. Ammonia has low boiling point
    b. Great heat absorption properties
4. Heat Treating
5. Water Treatment
6. Diazo Machines - Blue Print Industry

7. Illicit Use - Meth Labs
    a. Use of anhydrous ammonia is prevalent
    b. Used in liquid phase



D. **Properties**

1. Colorless liquid - looks like water
2. Has a pungent odor detectable at 2 ppm to 5ppm
    a. Federal OSHA Permissible Exposure Limit is 50 ppm
    b. This low odor threshold provides good early warning - the product will not sneak up on you
3. Boiling Point -28 F
    a. Low BP means most likely responders will deal with vapor phase
4. Anhydrous ammonia can form liquid pools near the point of the leak
5. High Latent Heat of Vaporization
    a. When ammonia boils it absorbs a tremendous amount of heat which is why it is used in refrigeration

b. Based on the low boiling point and this absorption of heat' there is potential for frost or freeze burns if the liquid phase contacts skin

6. Liquid Density - 5.15 lb/gal @ 60 deg F

7. Vapor Density - 0.6 (Air=1)
   a. Vapor may still hug the ground if there is high humidity in the release area
   b. Vapor @ atmospheric conditions
   c. Liquid under pressure

8. When ammonia boils it absorbs heat
   a. Used as a refrigerant
   b. You will see a white cloud

9. Even though anhydrous ammonia is lighter than air, it may exhibit heavier than air characteristics
   a. Weather impacts anhydrous ammonia's behavior
   b. Wet, misty, foggy weather will hold anhydrous ammonia closer to the ground. This slide is during a misty rainy day.

c. Cold temps will also hold anhydrous ammonia closer to the ground

10. Note in the slide that responders are in Level B PPE since this is a controlled drill. Would normally be in Level A PPE during an emergency response

11. This picture is during clearer weather. Note the V pattern of the cloud
    a. Ammonia will take this pattern whether in the air or hugging the ground
    b. Move laterally and upwind to get out of the cloud. The "side line" of the V is very well defined- something or nothing. This will happen with invisible vapor clouds and visible white clouds
    c. Ammonia clouds may hook back toward the ground in a horseshoe type effect. You can see in the picture the cloud is hooking over. Thus, even with good weather the cloud could bounce back if it is a more significant release (dense white cloud)

12. Wet Weather again- Note the V is wider and hanging closer to the ground due to moisture on the ground

13. Another wet weather day you can see the ammonia cloud hugging the ground and not going up and away

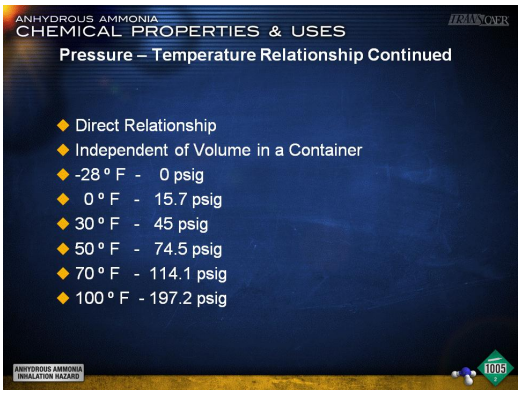
E. Properties- Pressure/ Temperature Relationship

1. High coefficient of expansion
2. 85% fill limit for storage containers
   a. This prevents a hydrostatic pressure buildup which could lead to a BLEVE
   b. There will always be a vapor space in a container provided it is not overfilled
   c. The fill limit allows for expansion and contraction as temperature changes

3. High Volumetric Expansion Ratio
   a. Expansion ratio of 850:1
   b. The vapor in the slide is probably 10-12lbs of liquid (approx 2 gallons)

4. Small cylinder was shipped out slightly overfilled
5. Was shipped out and put in a 70 degree room for storage and over expanded and ruptured

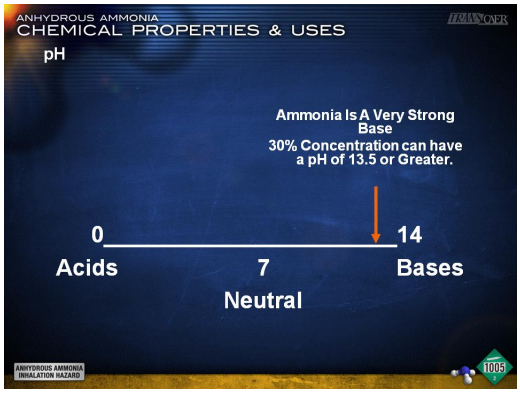
6. These small cylinders as well as the more typical larger cylinders often don't have pressure relief devices
7. When heated these cylinders can BLEVE



8. Pressure/Temperature Relationship
   a. As the temp of the material inside a container rises the vapor pressure on that container rises
   b. This relationship is independent of the volume amount in the container

c. A container showing 0 gauge pressure may not be empty. At times you could see a frost or sweat line which would be an indication that liquid ammonia is present in a container or a line

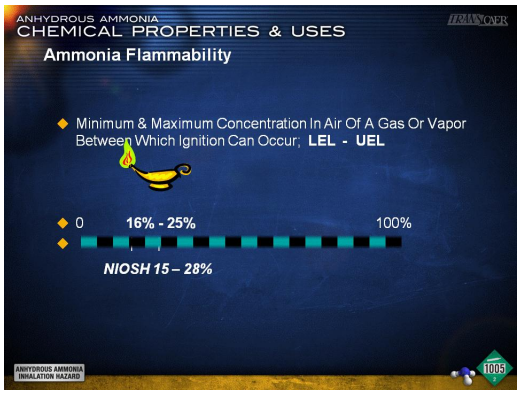
9. Discuss with students that given the different volumes and temperature of the tanks what would the pressure gauge read?
   a. Both tanks would be reading the same pressure if the tanks are at the same temperature



F. Additional Property Considerations

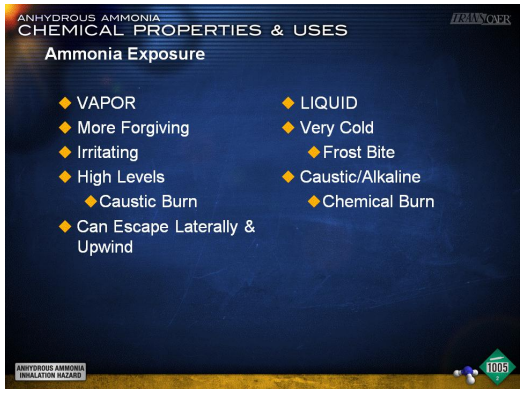
1. Ammonia is a very strong base
2. People who contact ammonia can get a caustic/alkaline burn
3. A 30% concentration in water can have a pH of 13.5 or greater

4. Ammonia is corrosive to copper and brass alloys
5. Refer to a Material Safety Data Sheet for all incompatibilities
6. You may see greenish corrosion as a sign of ammonia contacting an incompatible metal



G. **Flammability**

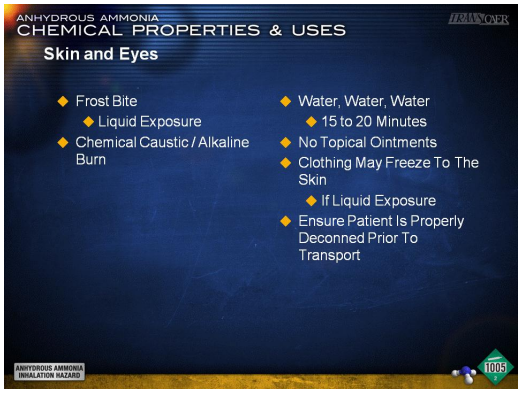
1. Ammonia does not have a Flash Point but does have a flammable range
2. Flammable range is typically 16-25%. The widest range referenced in NIOSH is 15-28%
3. Indoor releases should be treated with caution in regards to flammability
   a. Releases may reach the LEL
   b. In industrial refrigeration settings you may have other contaminants in the mix affecting the LEL/UEL range
   c. Control ignition sources and ventilate before entry
   d. Stay out of areas with visible clouds



H. **Ammonia Exposure**

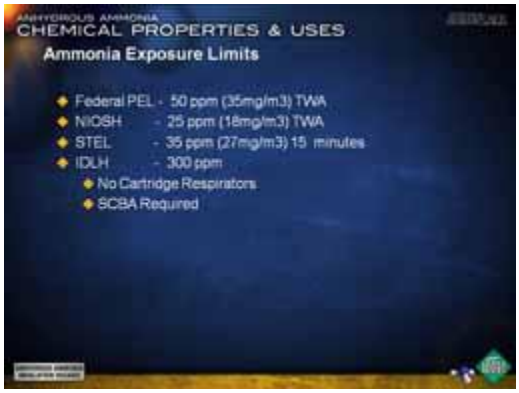
1. Vapor Exposure
   a. More forgiving
   b. Irritating
   c. High levels can cause a caustic burn
   d. Escape laterally and upwind from the release

2. Liquid Exposure
    a. Very Cold
    b. Can cause frost bite
    c. Caustic/Alkaline chemical burn

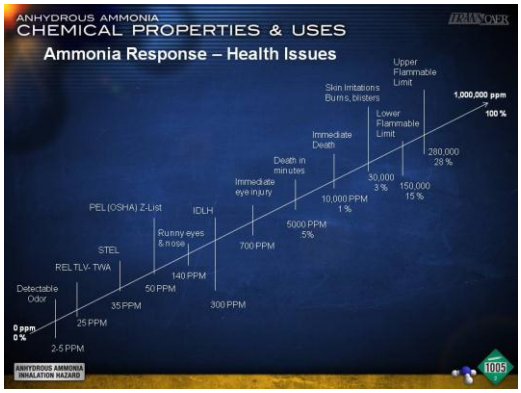


I. Health Effects and First Aid

1. First Aid
    a. Take the patient outside to fresh air and provide oxygen if needed
    b. Decontaminate with water for 15-20 minutes
    c. Do not use any topical ointments or treatments
    d. Clothing may freeze to the skin in liquid exposures
2. Ensure victims are decontaminated prior to transport by EMS



3. Permissible Limits
    a. Federal PEL= 50 ppm
    b. NIOSH REL = 25 ppm
    c. Short Term Exposure Limit (STEL) = 35 ppm for 15 minutes
    d. IDLH = 300 ppm
4. Cartridge respirators should not be used in IDLH atmospheres. Use Self Contained Breathing Apparatus when above IDLH values.



5. Health issues per dose vary
6. Length of time affects level of symptoms
    a. The greater the concentration the worse the health effects may be
        i. This may range from irritation to doses that are fatal
        ii. Ammonia is moisture seeking so you will feel it in mucous membranes such as the eyes, nose, and throat
        iii. Moist areas of the skin will sting
        iv. Higher doses can lead to bronchial spasm, and pulmonary edema
        v. Remember the low odor threshold provides good early warning of the presence of ammonia
    b. A person's level of health and pre-existing conditions can affect their response to exposures

J. Response Considerations

1. Indoor Response
   a. Flammability concerns are higher
   b. Level of PPE required
   c. Ventilation is needed
      i. Negative pressure in a non-flammable atmosphere
      ii. Positive pressure
   d. Do not enter an atmosphere where there is a visible cloud
2. Indoor ammonia releases can pose potential flammability concerns
3. Ventilate and control ignition sources prior to entry
4. This picture is an example of a release that sparked a fire
5. Outdoor Response
   a. Downwind threats assessed
      i. Public exposures
      ii. The type of release
      iii. Weather effects

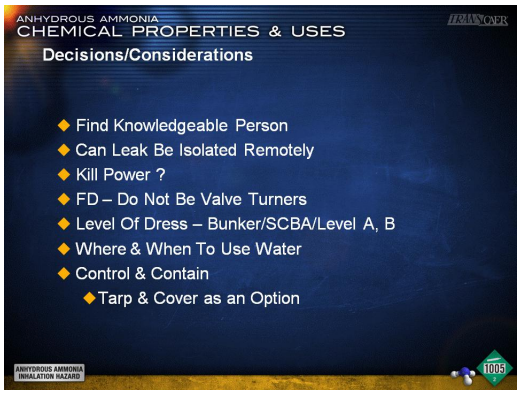
b. Where/when to use water
    i. Downwind to knockdown vapors; not on the leaking container or release point unless there is heat impingement
    ii. On containers to control flame impingement

6. Outdoor releases
    a. Note the V pattern in the release
    b. You may see liquid droplets in the air near the release point
    c. White dense gas cloud will be downwind
    d. The bottom cloud is from the aerosol droplets

7. Choose a good area for using water to protect downwind concerns
    a. Would be in the left side of the release outside of the aerosol cloud
    b. Be sure to control runoff as a little ammonia can drastically change the pH of water

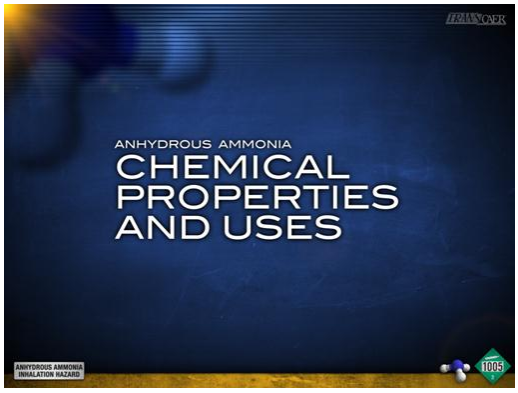
K. Control measures for outdoor releases

1. Tarp cover and containment may be used in some incidents
2. The release point is covered with a tarp
3. The tarp covers the release point and the escaping dense gas condenses to liquid phase and then will cool the release point; with ammonia if you drop temperature you will drop pressure- there is a direct relationship
4. Your downwind concerns are minimized in that the release is controlled/contained to the local release area
5. Not a cure all tactic- but an option to contain the release
6. Condensed ammonia under the tarp will hit the ground, vaporize but will get cold enough to form pooling liquid ammonia
7. Don't walk through any liquid pools



L. **Summary**

1. Find a knowledgeable person on ammonia response
2. Can the leak be isolated remotely?
3. Has Power been controlled to the structure?
4. Control any ignition sources
5. Do not turn valves unless instructed to do so
6. Use the proper level of PPE
7. Use water appropriately
8. Control and contain if appropriate



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