Mitigation Starts With Design! Continues with Safe Operation, Mechanical Integrity and Training!

Last Unfortunately is When It Goes Wrong! The Failure! The Release! Loss of Product or Production and Injury or Death! How Do We Minimize The Negatives?

P.S.I.G.

- SMART DESIGN - REDUCE THE CHARGE AND CONTAIN IT TO ONE AREA!
- TRAINING
- SAFE AND SMART OPERATION

YES IT MAY REQUIRE SUBSTANTIAL INVESTMENT OF TIME AND FUNDS
THERE IS A PAYBACK
BEFORE
DURING
AFTER
AND EVERY DAY
THE BASICS

ODOR THRESHOLD

- **AMMONIA**: 5-15 PPM
- **CHLORINE**: .2 PPM
- **SULFUR DIOXIDE**: .5

APPEARANCE & COLOR

- **AMMONIA**: Colorless gas?
- **CHLORINE**: Greenish/Yellow gas?
- **SULFUR DIOXIDE**: Colorless gas?

PEL

- **AMMONIA**: 50 PPM
- **CHLORINE**: .5 PPM
- **SULFUR DIOXIDE**: 5 PPM

IDLH

- **AMMONIA**: 300 PPM
- **CHLORINE**: 10 PPM
- **SULFUR DIOXIDE**: 100 PPM

BOILING POINT

- **AMMONIA**: -28 degrees F
- **CHLORINE**: -29.3 degrees F
- **SULFUR DIOXIDE**: 14 degrees F
MITIGATION STARTS WITH INFORMATION AND UNDERSTANDING THE ERG USE IT

- Ammonia solution, with more than 50% Ammonia
- Chlorine
- Sulfur dioxide
AMMONIA AND SULFUR DIOXIDE
POTENTIAL HAZARDS

HEALTH
- TOXIC, may be fatal if inhaled, ingested or absorbed through skin.
- Vapors are extremely irritating and corrosive.
- Contact with gas or liquefied gas may cause burns, severe injury and/or frostbite.
- Fire will produce irritating, corrosive and/or toxic gases.
- Runoff from fire control may cause pollution.

FIRE OR EXPLOSION
- Some may burn but none ignite readily.
- Vapors from liquefied gas are initially heavier than air and spread along ground.
- Some of these materials may react violently with water.
- Cylinders exposed to fire may vent and release toxic and/or corrosive gas through pressure relief devices.
- Containers may explode when heated.
- Ruptured cylinders may rocket.

PUBLIC SAFETY
- CALL Emergency Response Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover.
- As an immediate precautionary measure, isolate spill or leak area for at least 100 meters (330 feet) in all directions.
- Keep unauthorized personnel away.
- Stay upwind.
- Many gases are heavier than air and will spread along ground and collect in low or confined areas (sewers, basements, tanks).
- Keep out of low areas.
- Ventilate closed spaces before entering.

PROTECTIVE CLOTHING
- Wear positive pressure self-contained breathing apparatus (SCBA).
- Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection.
- Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible.

EVACUATION
- Spill
  - See Table 1 - Initial Isolation and Protective Action Distances for highlighted materials. For non-highlighted materials, increase, in the downwind direction, as necessary, the isolation distance shown under "PUBLIC SAFETY".
- Fire
  - If tank, rail car or tank truck is involved in a fire, ISOLATE for 1600 meters (1 mile) in all directions; also, consider initial evacuation for 1600 meters (1 mile) in all directions.
EMERGENCY RESPONSE

FIRE
Small Fire
- Dry chemical or CO₂.
Large Fire
- Waterspray, fog or regular foam.
- Move containers from fire area if you can do it without risk.
- Do not get water inside containers.
- Damaged cylinders should be handled only by specialists.

Fire Involving Tanks
- Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.
- Cool containers with flooding quantities of water until well after fire is out.
- Do not direct water at source of leak or safety devices; icing may occur.
- Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. • ALWAYS stay away from tanks engulfed in fire.

SPILL OR LEAK
- Fully encapsulating vapor protective clothing should be worn for spills and leaks with no fire.
- Do not touch or walk through spilled material.
- Stop leak if you can do it without risk.
- If possible, turn leaking containers so that gas escapes rather than liquid.
- Prevent entry into waterways, sewers, basements or confined areas.
- Do not direct water at spill or source of leak.
- Use water spray to reduce vapors or divert vapor cloud drift. Avoid allowing water runoff to contact spilled material. • Isolate area until gas has dispersed.

FIRST AID
- Move victim to fresh air. • Call 911 or emergency medical service.
- Give artificial respiration if victim is not breathing.
- Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.
- Administer oxygen if breathing is difficult.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with liquefied gas, thaw frostied parts with lukewarm water.
- In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes.
- In case of contact with Hydrogen fluoride, anhydrous (UN1052), flush skin and eyes with water for 5 minutes; then, for skin exposures rub on a calcium/jelly combination; for eyes flush with a water/calcium solution for 15 minutes.
- Keep victim warm and quiet. • Keep victim under observation.
- Effects of contact or inhalation may be delayed.
- Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.
<table>
<thead>
<tr>
<th>ID No.</th>
<th>NAME OF MATERIAL</th>
<th>SMALL SPILLS</th>
<th>LARGE SPILLS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>First ISOLATE in all Directions</td>
<td>Then PROTECT persons Downwind during-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meters (Feet)</td>
<td>Kilometers (Miles)</td>
</tr>
<tr>
<td>1005</td>
<td>Ammonia, anhydrous</td>
<td>30 m (100 ft)</td>
<td>0.1 km (0.1 mi)</td>
</tr>
<tr>
<td>1005</td>
<td>Anhydrous ammonia</td>
<td>30 m (100 ft)</td>
<td>0.1 km (0.1 mi)</td>
</tr>
<tr>
<td>1076</td>
<td>Phosgene</td>
<td>100 m (300 ft)</td>
<td>0.7 km (0.4 mi)</td>
</tr>
<tr>
<td>1079</td>
<td>Sulfur dioxide</td>
<td>60 m (200 ft)</td>
<td>0.3 km (0.2 mi)</td>
</tr>
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<td>60 m (200 ft)</td>
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CHLORINE
POTENTIAL HAZARDS

HEALTH
• TOXIC; may be fatal if inhaled or absorbed through skin.
• Fire will produce irritating, corrosive and/or toxic gases.
• Contact with gas or liquefied gas may cause burns, severe injury and/or frostbite.
• Runoff from fire control may cause pollution.

FIRE OR EXPLOSION
• Substance does not burn but will support combustion.
• Vapors from liquefied gas are initially heavier than air and spread along ground.
• These are strong oxidizers and will react vigorously or explosively with many materials including fuels.
• May ignite combustibles (wood, paper, oil, clothing, etc.).
• Some will react violently with air, moist air and/or water.
• Cylinders exposed to fire may vent and release toxic and/or corrosive gas through pressure relief devices.
• Containers may explode when heated.
• Ruptured cylinders may rocket.

PUBLIC SAFETY
• CALL Emergency Response Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover.
• As an immediate precautionary measure, isolate spill or leak area for at least 100 meters (330 feet) in all directions.
• Keep unauthorized personnel away.
• Stay upwind.
• Many gases are heavier than air and will spread along ground and collect in low or confined areas (sewers, basements, tanks).
• Keep out of low areas.
• Ventilate closed spaces before entering.

PROTECTIVE CLOTHING
• Wear positive pressure self-contained breathing apparatus (SCBA).
• Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection.
• Structural firefighters’ protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible.

EVACUATION
Spill
• See Table 1 - Initial Isolation and Protective Action Distances.
Fire
• If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions.
EMERGENCY RESPONSE

FIRE
Small Fire: Water only; no dry chemical, CO₂, or Halon®.
- Contain fire and let burn. If fire must be fought, water spray or fog is recommended.
- Do not get water inside containers.
- Move containers from fire area if you can do it without risk.
- Damaged cylinders should be handled only by specialists.
Fire Involving Tanks
- Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.
- Cool containers with flooding quantities of water until well after fire is out.
- Do not direct water at source of leak or safety devices; icing may occur.
- Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.
- ALWAYS stay away from tanks engulfed in fire.
- For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

SPILL OR LEAK
- Fully encapsulating, vapor protective clothing should be worn for spills and leaks with no fire.
- Do not touch or walk through spilled material.
- Keep combustibles (wood, paper, oil, etc.) away from spilled material.
- Stop leak if you can do it without risk.
- Use water spray to reduce vapors or divert vapor cloud drift. Avoid allowing water runoff to contact spilled material.
- Do not direct water at spill or source of leak.
- If possible, turn leaking containers so that gas escapes rather than liquid.
- Prevent entry into waterways, sewers, basements or confined areas.
- Isolate area until gas has dispersed.
- Ventilate the area.

FIRST AID
- Move victim to fresh air. Call 911 or emergency medical service.
- Give artificial respiration if victim is not breathing.
- Do not use mouth-to-mouth method if victim ingested or inhaled the substance.
- Give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.
- Administer oxygen if breathing is difficult.
- Clothing frozen to the skin should be thawed before being removed.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes.
- Keep victim warm and quiet. Keep victim under observation.
- Effects of contact or inhalation may be delayed.
- Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.
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<td>Anhydrous ammonia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1008</td>
<td>Boron trifluoride</td>
<td>30 m (100 ft)</td>
<td>0.1 km (0.1 mi)</td>
</tr>
<tr>
<td>1008</td>
<td>Boron trifluoride, compressed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1016</td>
<td>Carbon monoxide</td>
<td>30 m (100 ft)</td>
<td>0.1 km (0.1 mi)</td>
</tr>
<tr>
<td>1016</td>
<td>Carbon monoxide, compressed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1017</td>
<td>Chlorine</td>
<td>60 m (200 ft)</td>
<td>0.4 km (0.3 mi)</td>
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DESIGN

AN EXAMPLE USING AMMONIA AS THE FOCUS
THE WRONG WAY

MODIFIED OR NEW DAIRY OR WINERY FACILITY BUILT

DIRECT AMMONIA REFRIGERATION SYSTEM - AMMONIA IN ALL AREAS

CHARGE 60,000 LBS - PERSONNEL EXPOSURE AND A 2.2 TO 4.4 MILE DEATH ZONE

AUTOMATED NOTIFICATION IN 26 AREAS - MONITORING COST $63,000.00
ANNUAL MAINTENANCE COST $6500.00
NOT INCLUDED - COST PROHIBITIVE

AUTOMATED ZONE ISOLATION - NOT INCLUDED - COST PROHIBITIVE
TO MANY ZONES AMMONIA EVERYWHERE

AUTOMATED ZONE PUMP DOWN - NOT INCLUDED - COST PROHIBITIVE
TO MANY ZONES AMMONIA EVERYWHERE!
2 HIGH PRESSURE RECEIVERS 7’ x 30’ Each

ANSWER!!
MITIGATE BEFORE IT HAPPENS
A CRITICAL CHARGE SYSTEM USING A SECONDARY COOLANT
ESTIMATED CHARGE 3600 POUNDS SECURED IN THE MACHINE ROOM
WHY DID WE DESIGN IT THIS WAY

THIS IS THE WAY WE ALWAYS DID IT!
THE RIGHT WAY-SMART DESIGN

- REDUCE THE CHARGE - CRITICAL CHARGE SYSTEMS
- KEEP THE CHEMICAL AWAY FROM PRODUCTION BY USING A SECONDARY COOLANT
- AUTOMATED NOTIFICATION - 1 ZONE
- AUTOMATED ZONE ISOLATION - 1 ZONE
- AUTOMATED ZONE PUMP DOWN - 1 ZONE
- SMALL VESSELS
- PROPER VENTILATION AND DIFFUSION OR SCRUBBING - 1 ZONE
- THE PRESSURE REDUCTION CONTROL SYSTEM - 1 ZONE
THE RIGHT WAY-SMART DESIGN CONTINUED

- Certified welders only needed in the engine room area
- Reduced controls
- Reduced area monitoring
- Worst case impact zone .8 miles
- Off the EPA radar
- Small diffusion tank
- No ammonia pumps to run or maintain
- Low suction pressure drop-run a higher suction pressure and save energy
- No ammonia in production or product areas – etc! etc! etc!
A major bottling facility is located along side an interstate and close to one of the busiest airports in the world.

The ammonia charge is 13,000 lbs.

Worst case impact – or circle of death 1.5 to 2.2 miles.

A major release – catastrophic.

Interstate closed.

Airport shut down.

38,330 people affected not counting the interstate or airport.

A release would cause:

- Lost production
- Lost product
- Media frenzy
- Fines
- Exposure

$\text{$$$$$$$$$$$$}$
SOLUTION COMPLETED!

- Reduced the charge to 1280 pounds of ammonia using a secondary coolant. All the ammonia is now in the engine room.
- Exposure reduced
- Energy saved
- Cost of controls, monitoring, maintenance and mitigation systems reduced
- No ammonia in production or product areas
CONTROL IS MITIGATION
DURING
BEFORE
AND
AFTER!
BE IN CONTROL
REMOTE MONITORING AND
CONTROL AWAY FROM THE
RELEASE

MANAGE YOUR PRESSURES

MONITOR NH3 PPM LEVELS

A CONTROL SYSTEM THAT’S NOT ACCESSIBLE DURING AN EMERGENCY IS NOT BEING IN CONTROL
SO MUCH FOR DESIGN
LETS MOVE ON
MECHANICAL INTEGRITY IS MITIGATION

INCREASE YOUR ODDS!

MINIMIZE THE POSSIBILITY!
IF YOU CAN’T TURN THE VALVE YOU CAN’T STOP THE LEAK OR SERVICE IT!

IF YOU TURN THE VALVE AND THE PACKING NUT IS SIEZED THE LEAK WILL NEVER STOP!

ITS REQUIRED!

ITS REQUIRED!
A Simple Obtainable Expectation
The General Duty Clause Requirements

The owners and operators of stationary sources producing, processing, handling or storing such nasty substances:

Have a general duty to identify hazards which may result from such releases using appropriate hazard assessment techniques.

To design and maintain a safe facility taking such steps as are necessary to prevent releases, and to minimize the consequences of accidental releases which do occur.

Therefore We Must Create Usable, Workable Safety, Mechanical Integrity and Training Programs!
General Duty Clause

Requirements

Elements of designing and maintaining a safe facility:

- Be in compliance with good engineering practices
- Comply with recognized industry standards
- Follow manufacturers’ recommendations for use and maintenance of equipment
- Basic theory and system specific operator training
Cylinder Liner and Piston Wear

- MAINTAIN YOUR SYSTEM AND EQUIPMENT
- FOLLOW MANUFACTURES RECOMMENDATIONS OR USE HISTORICAL DATA
Excessive Moisture

Test annually for moisture in the ammonia and in the oil.
**Oil Analysis Kit**

- The Oil Analysis Kit
- Remove oil sample from oil drain valve.
- Completely fill out label for bottle.
- Place in mailing tube and seal with preaddressed mailing label.
MAINTENANCE AND MECHANICAL INTEGRITY

INSULATION AND VAPOR BARRIERS
KEEP IT FROM SWEATING!
- STARTS WITH COATING THE PIPES BEFORE INSULATING
- USE THE CORRECT MATERIALS
- TWO OVERLAPPING LAYERS
- SEAL ALL SEAMS AND OPENINGS
- USE A VAPOR BARRIER-A METAL JACKET IS NOT A VAPOR BARRIER IT’S A PROTECTIVE COVERING!
- USE THE SARAN WRAP!
- PROTECTIVE COATING-PVC INSIDE AND ALUMINUM OR STAINLESS STEEL COVERING OUTSIDE
- KEEP DAMAGED AREAS REPAIRED AND KEEP THE WATER OUT!
THE CONDENSER

ITS WAY UP HIGH AND HARD TO MAINTAIN!

IF ITS HARD TO GET TO CHANCES ARE IT WON’T BE MAINTAINED

DO I HAVE TO WORK FROM A LADDER?
KEEP YOUR WORKERS SAFE
The corrosion of galvanized steel in Condensers is referred to as white rust.

PASSIVATE THE NEW CONDENSER

New Galvanized Steel  White Rust Corrosion  Passivated Galvanized Steel
INFORMATION IS MITIGATION
HURRY JOE CLOSE S204
IT’S A BAD ONE!
1111.8 **Identification.** Piping shall be identified in accordance with U.M.C. Standard No. 11-2. The type of refrigerant, function and pressure shall be indicated.
The Regulations
Must we Tag and Label?
INFORMATION SAVES TIME!
INFORMATION HELPS PREVENT MISTAKES!

1112.4 Identification. Stop valves shall be identified by tagging in accordance with U.M.C. Standard No. 11-2. A valve chart shall be mounted under glass at an approved location near the principal entrance to a refrigeration machinery room.
THE HIGH LEVEL FLOAT. LIQUID, PRESSURE, SHUT DOWN, VENTILATION AND MONITORING CONTROL. TEST IT!
WE HAVE FAILURES AND INCIDENTS AND WE WONDER WHY THEY VISIT!

29/06/2004
SO MUCH FOR DESIGN OR MODIFICATIONS! WE DON’T HAVE ANY MONEY FOR CAPITOL! WE ARE WORKING ON PENNIES HERE!

MAINTENANCE ARE YOU KIDDING!
YOU KNOW HOW MUCH THAT’S GONNA COST!

THE RELEASE!
WHAT CAN WE DO TO MINIMIZE IMPACT?
WE DID ALL WE COULD!

THE RELEASE STILL HAPPENED

SO!

What do we do?
PROTECT THE HAPPY COWS!

TARP AND COVER SHELBY!
CONTROL IT!

- CLOSE THE DOORS AND NEUTRALIZE
- TARPA AND COVER
- MANAGE THE PRESSURE MANUALLY OR REMOTELY
- TRANSFER IT TO A LOWER PRESSURE
- LAST- SEND IT TO DIFFUSION
- VENT SLOWLY - THINK ABOUT OFFSITE PRIOR TO POSITIVE PRESSURE VENTILATION
- HAVE A PLAN AND PRACTICE THE PLAN
DO WE RUN OR SHUT DOWN?
MANAGE YOUR PRESSURE!
STOP EXPOSURE DURING A RELEASE, MAINTENANCE OR SERVICE

- TRANSFER IT TO A LOWER PRESSURE
- PUMP IT DOWN AND PULL IT IN A VACUUM

TRANSFER:
- FROM HIGH TO INTERMEDIATE OR LOW
- FROM INTERMEDIATE TO LOW

CHANGE YOUR SETPOINTS TO HG

THE PRESSURE CONTROL BOX

LIQUID AND VAPOR
AMMONIA CLOUD CLOSE IT UP TIGHT AND TURN OFF IGNITION SOURCES!
TARP AND COVER LIQUID AMMONIA
VAPOR PRESSURE
NEUTRALIZE IT
CITRIC, VINEGAR OR CO2
WHAT TO USE?
AND
THE APPLICATOR
CITRIC
OUR FIRST CHOICE
Its just Orange Juice
OUR SECOND CHOICE VINEGAR
OUR LAST CHOICE CO2

CO2 CAN BE DANGEROUS
HANGS LOW
DISPLACES OXYGEN
CITRIC OUR FIRST CHOICE
FINDING THE RIGHT MIX
WE GOT THE RIGHT MIX
READY TO GO
SUCCESS STORY 6500 POUNDS ISOLATED AND NEUTRALIZED IN PLACE

CONCLUSION

CITRUS ACID WORKS

TWO DAYS NETTED

- 8 PPM IN ROOM B
- 12-20 PPM IN ROOM A
- BALANCE FOUND IN WOOD PALLET
- MINIMAL LOST PRODUCT
- ALL OUTSIDE AGENCIES SIGNED OFF

HAZMAT, COUNTY, FDA
STOP EXPOSURE DURING MAINTENANCE OR SERVICE

How do we perform tasks without odor?

OIL AND VAPOR

NH3 VAPOR

NH3 VAPOR VENT

System

Waste Oil Barrel
TRAINING IS MITIGATION
The Minimum Training Required

- Safe Work Practices
- Awareness
  - Ammonia Safety
  - Handling of NH3
  - Liquid Transfer etc.
  - Emergency Action/Response
  - Release Reporting and Release Monitoring
- Respiratory Protection In Depth
- Basic System Overview
- Basic Refrigeration academic and hands on
- P&ID/PHA Review-CalArp Elements
- System specific academic and hands on
- Certification (By the Company? Who is the Expert?) and or by an agency such as RETA CIRO CARO certifications or by an educator or other academic program.
Safety Training
Spill Prevention and Control
Emergency Response Plans

- Pre-emergency planning
- Personnel roles
- Lines of authority
- Training
- Communication
- Emergency recognition and prevention
- Safe refuge
Emergency Response Plans
(cont.)

- Site security
- Evacuation routes and procedures
- Decontamination
- Emergency medical treatment
- Emergency alerting
Emergency Response Personnel

- Incident Commander (IC)
- Project team leader
- Site safety officer
- Command post supervisor
- Rescue team
- Decontamination station officers
- 24-hour medical team
LAST BUT NOT LEAST HAVE A PLAN

OH WAIT THAT WAS FIRST! OPPS!