

Super-Safe Large Anhydrous Ammonia Tanks

*Design Concepts for Ammonia Storage Safety
–Prevention Design for Populated Environments*

Mackinaw Associates

*Super Safe NH₃ Storage
Infrastructure*



Introduction



- Quick review of how ammonia is stored, large and small
- New safer tank designs are needed to insure public safety where large stationary urban tank farms/tanks exist.
- Materials and Regulations – Other industry examples...



Anhydrous Ammonia Storage

- Producing Plant & Large Distribution Terminals
 - Refrigerated Storage ~ 30,000 tons @ $< -28^{\circ}\text{F}$, 15 psi
- Local Distribution and Storage
 - Pressure Tank ~ 30,000 gal 265 psi minimum design
- Agriculture/Farm
 - Nurse Tank ~ 1,000 gal 265 psi minimum design



Authority Having Jurisdiction

- **Municipalities, counties, states, countries, and insurers - commonly referred to as the Authority Having Jurisdiction (AHJ), have adopted codes and standards to control hazardous materials and ensure public safety.**



Stationary Tank Requirements

- Tank Design ASME Boiler & Pressure Vessel Code Sec VII, Div 1, 250 psi minimum
- Tank Sizes 2,000 – 120,000 gallons
- Location, Design, Depart of Labor Requirement: Construction & Operation Conform to 29 F1910.111, American National Safety Institute, ANSI K61.1
- Location Local Code: Many municipalities now prevent the placement of ammonia storage tanks within city limits

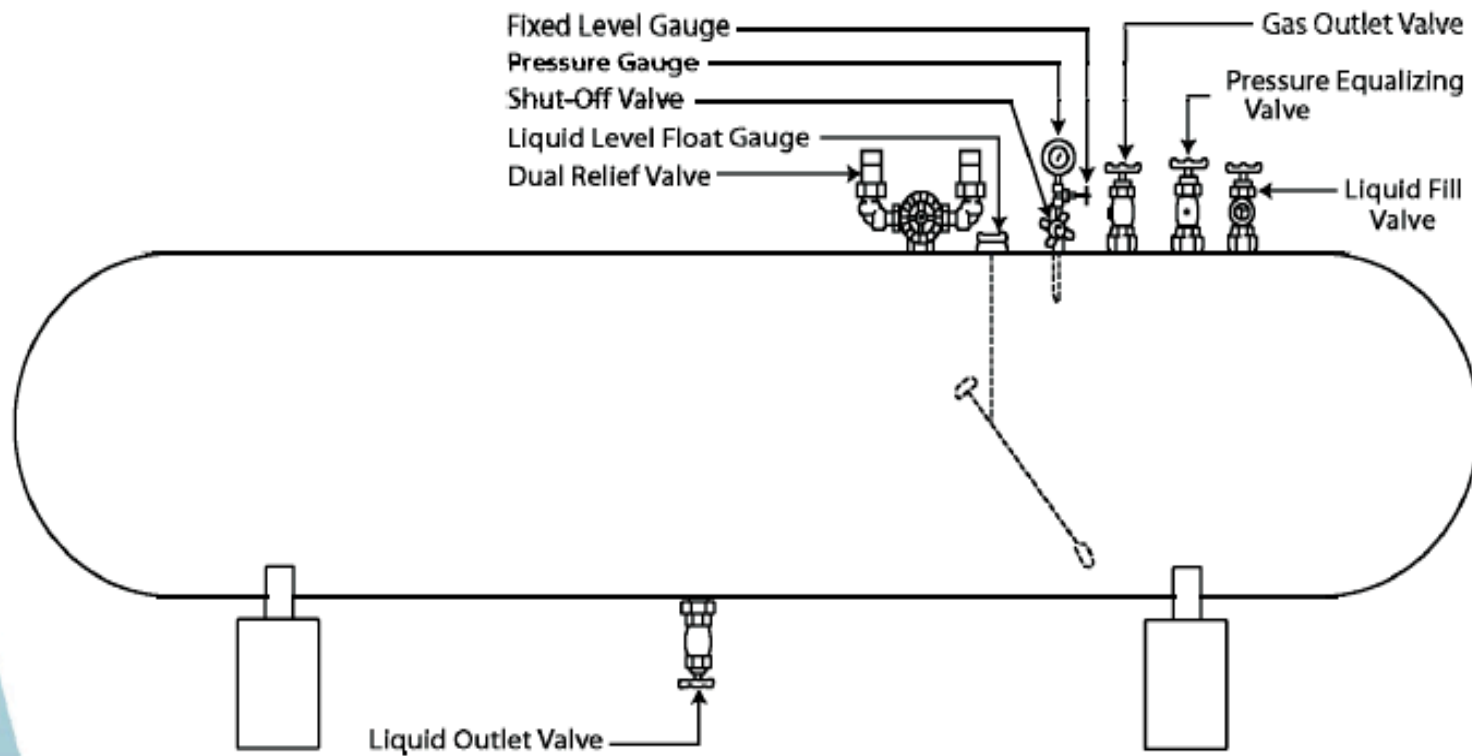


Anhydrous Ammonia Transportation Container Regulations

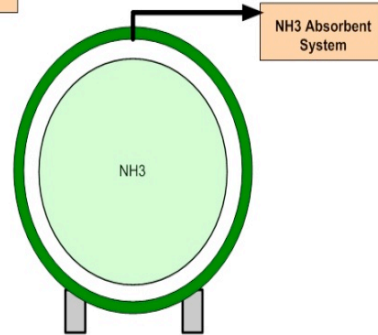
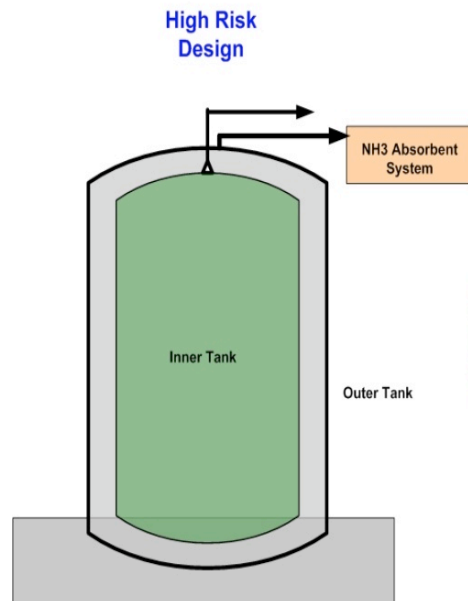
- Tank Truck: MC 331 – 11,500 gal 300 psi
- Rail Car: D.O.T. 112J340 – 33,500 gal 340 psi
- Most jurisdictions make it illegal to place or transport anhydrous ammonia in any container not designed, constructed, maintained or authorized for that purpose



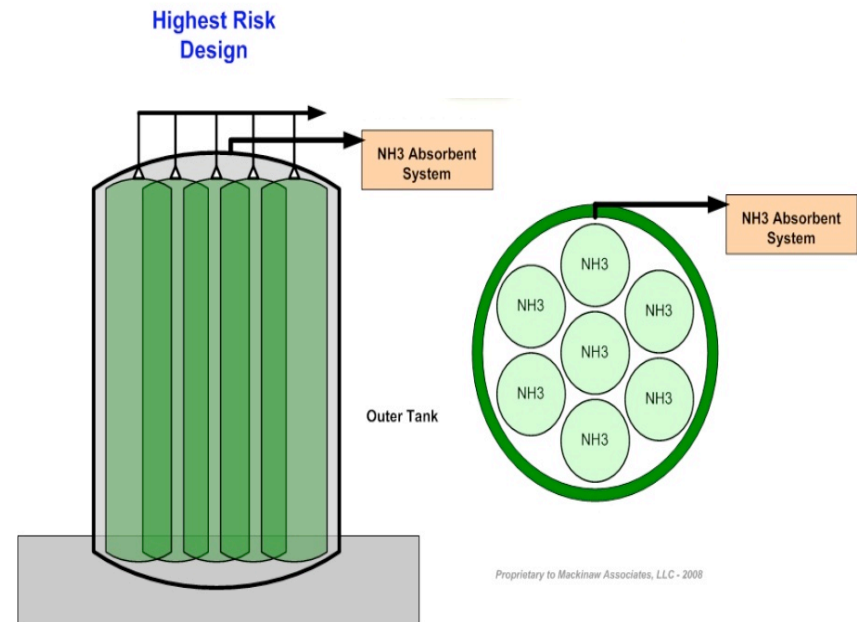
TYPICAL HORIZONTAL ANHYDROUS AMMONIA STORAGE TANK



Super Safe Storage Upright Tank Concepts



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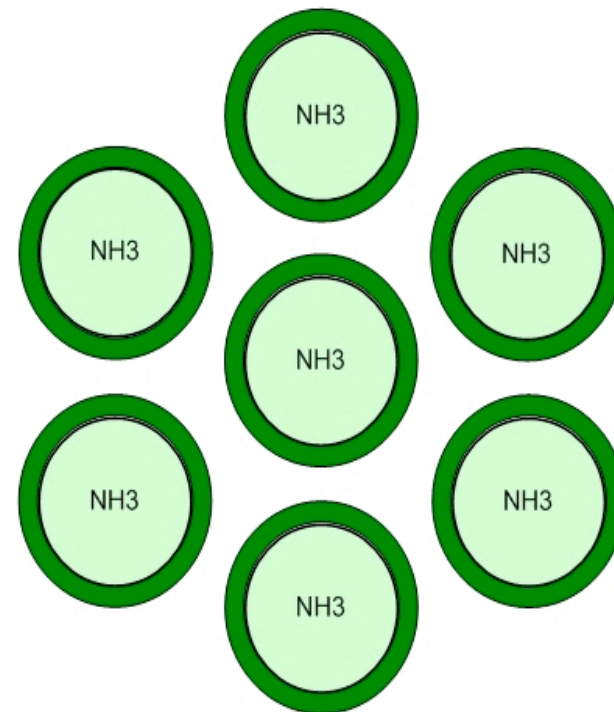
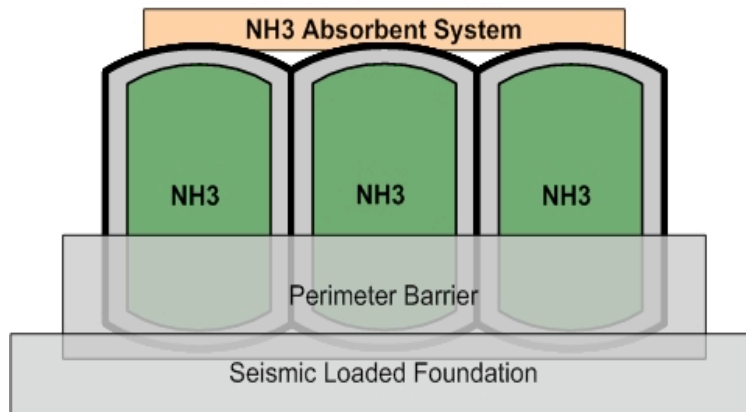


Super Safe Storage Urban Location - Tank Farm

Tank Farm

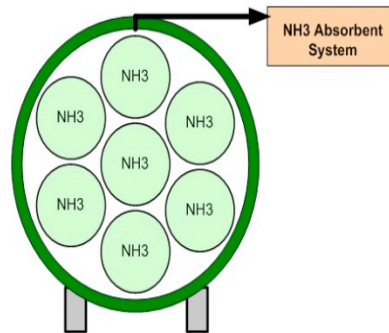
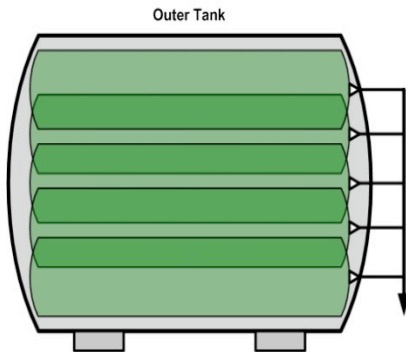


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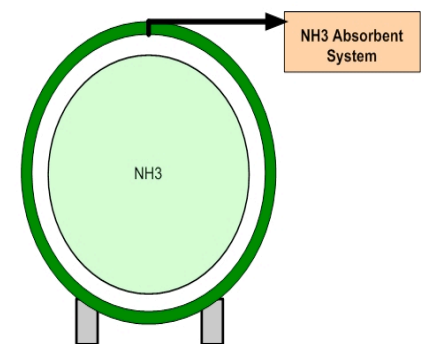
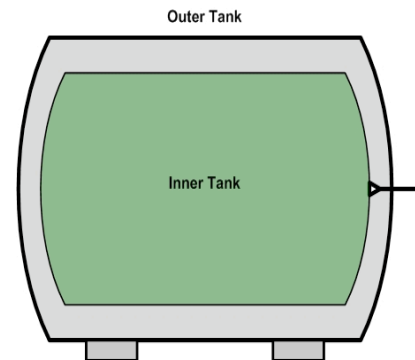
Super Safe Storage Horizontal Tank Concepts

Highest Risk
Design



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High Risk
Design



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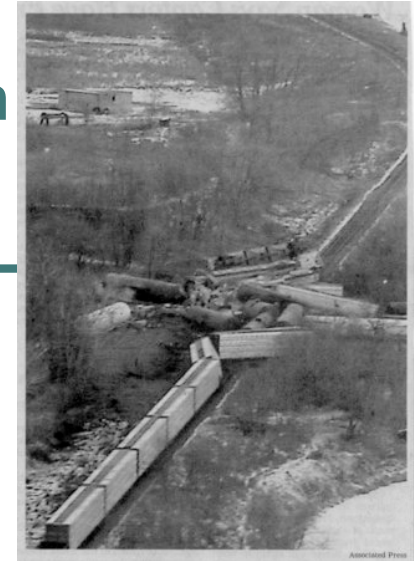


Super Safe Storage Multiple Tanks – Transport Application

Transport
Design



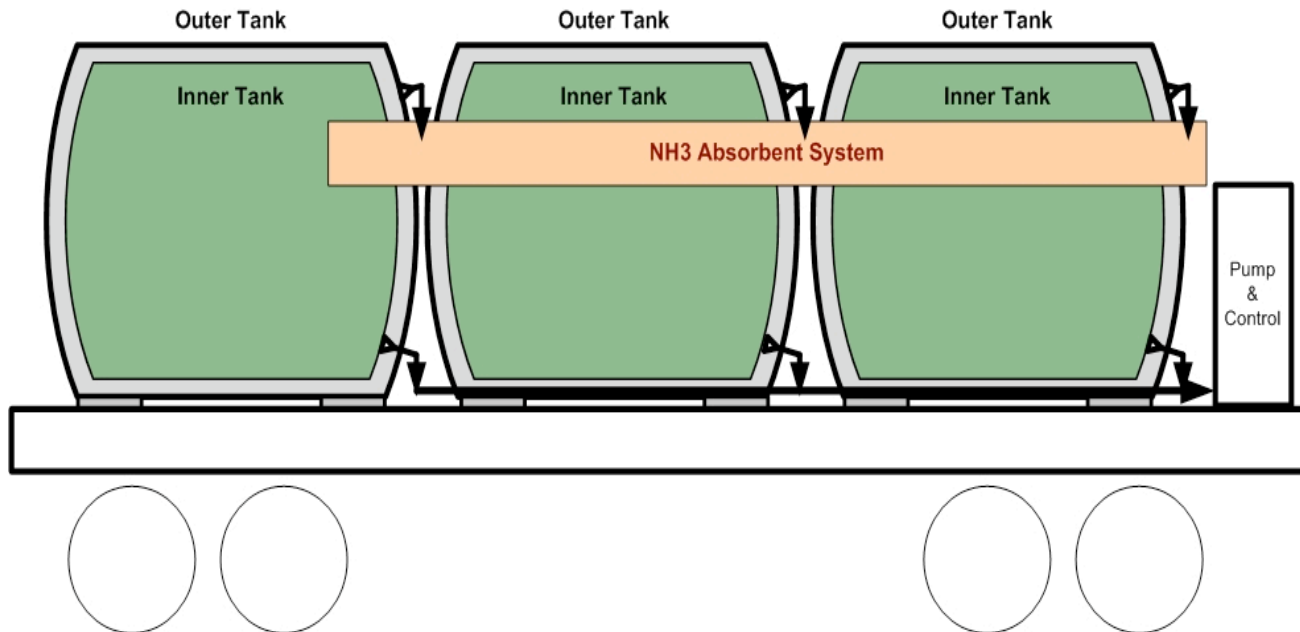
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Minot, North Dakota
January 2002

Typical current design:
33,800 gallons

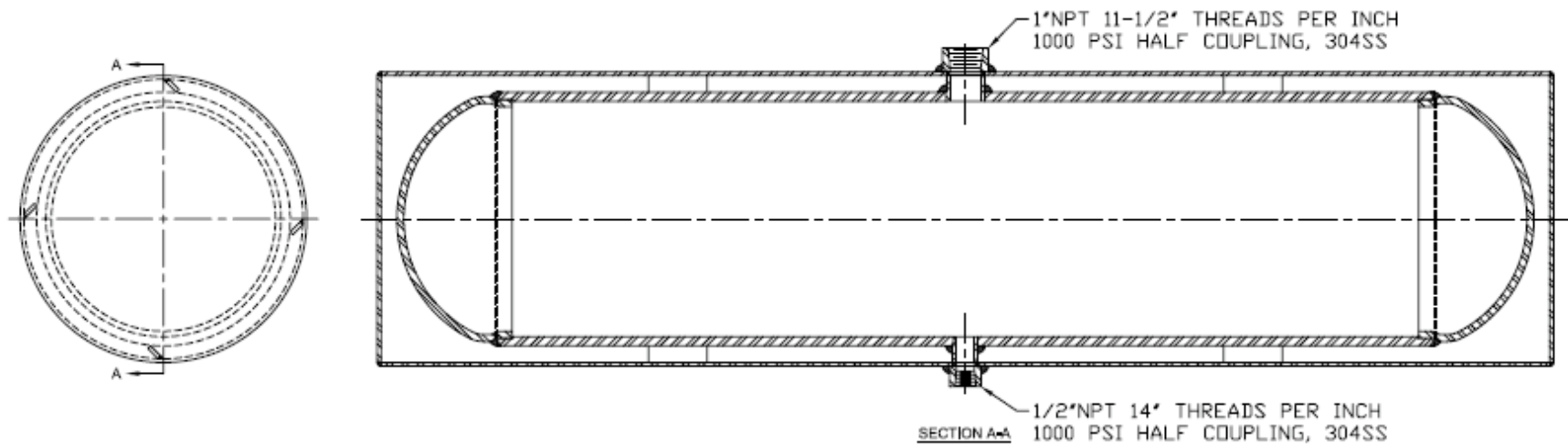
Union Tank Car Company



Proprietary to Mackinaw Associates, LLC - 2008



NH3 Hot Rod Fuel Tank

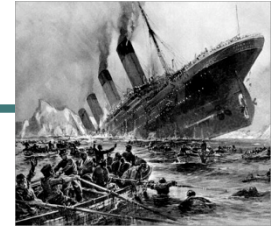


What is involved with super-safe storage: tanks, fittings/valves, hoses, sensors, active neutralization

- Large and small super safe concept designs
 - Smaller tanks vs. huge tanks ... (limit capacities of tanks stationed near communities)
 - Double hulled (tanks-with-a-tank or tank within a tank)
 - Neutralization of vented ammonia - designs to capture vented NH_3 and to neutralize same using automated method - sensors alert system)



Considerations



- Multiple Tanks vs. Monolithic Tank designs
- Double-Hull vs. Single-Tank
- Capture & Neutralization Systems
- Connection Systems Safety
- Seismic, Puncture, and Placement precautions
- Alerts & Monitoring - Training & Education



Issues

- Public acceptance of NH₃ fuel could hinge on fail-safe storage and delivery. Perceptions vs. Realities.
- Authority Having Jurisdiction (AHJ)
- Difficulties in storage
 - Corrosion, Reactions
 - Pressure issues (ambient temperature factors, ammonia venting, ammonia transfer issues, breakaway valves)



Conclusion

Future

- Regulations
- Public relations and compliance
- Materials - aluminum, composite, fiberglass, metal foam etc.



Questions? Contacts

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