LARGE SCALE AMMONIA STORAGE AND HANDLING

DAN WEBB

MGR., ENG. & TECH. SVCS.

CF INDUSTRIES, INC.

LONG GROVE, IL

Presentation Overview

- Why are these facilities needed?
- Why is refrigeration needed?
- What are the major components?
- How is ammonia transported to and from the facilities?
- What are special challenges and opportunities?

Why are these facilities needed?

- Ammonia is a very concentrated form of nitrogen fertilizer for agricultural crops
- Shipping demands to local supply centers and farms is short duration and high volume
- Ammonia is produced continually and must be stored until needed
- Physical properties of ammonia demand high pressure storage vessels or refrigeration

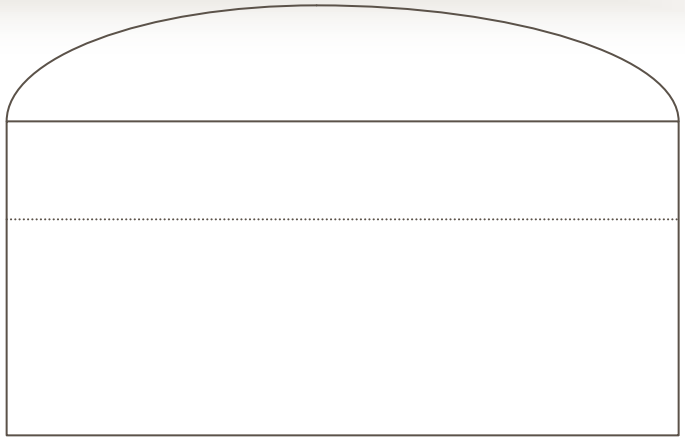
Why is refrigeration needed?

- A typical facility stores from 15,000 to 60,000 tons of ammonia to meet shipping needs
- Full pressure, shop fabricated, storage vessels are practical to about 300 tons (you would need 50 to 200 per site)
- By storing ammonia in a refrigerated state, very large tanks are practical (as high as 17.5 million gallons)

Why is refrigeration needed? (cont.)

- Ammonia, in addition to being a good fertilizer, is a good refrigerant
- By keeping the stored product temperature low, the pressure stays low
- By keeping the stored product pressure low, the temperature stays low (-28F at 0 psig.)

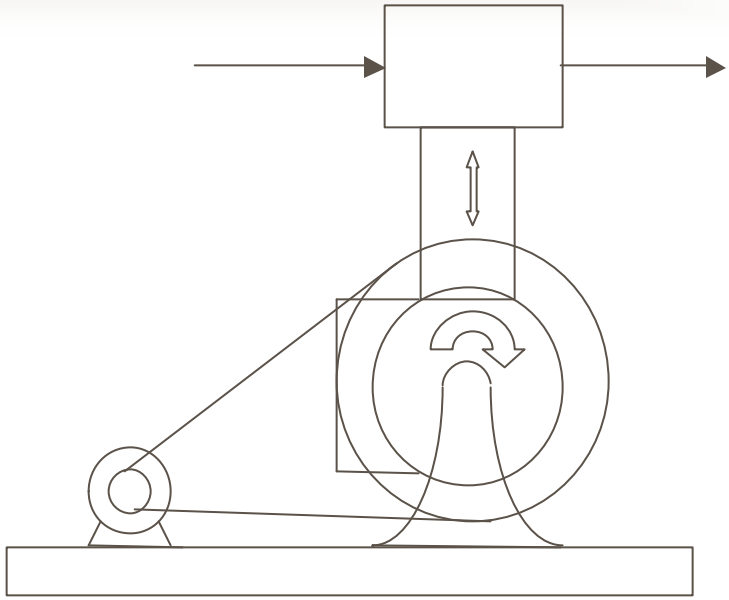
Major Components



Low Pressure Storage Tank (LPST)

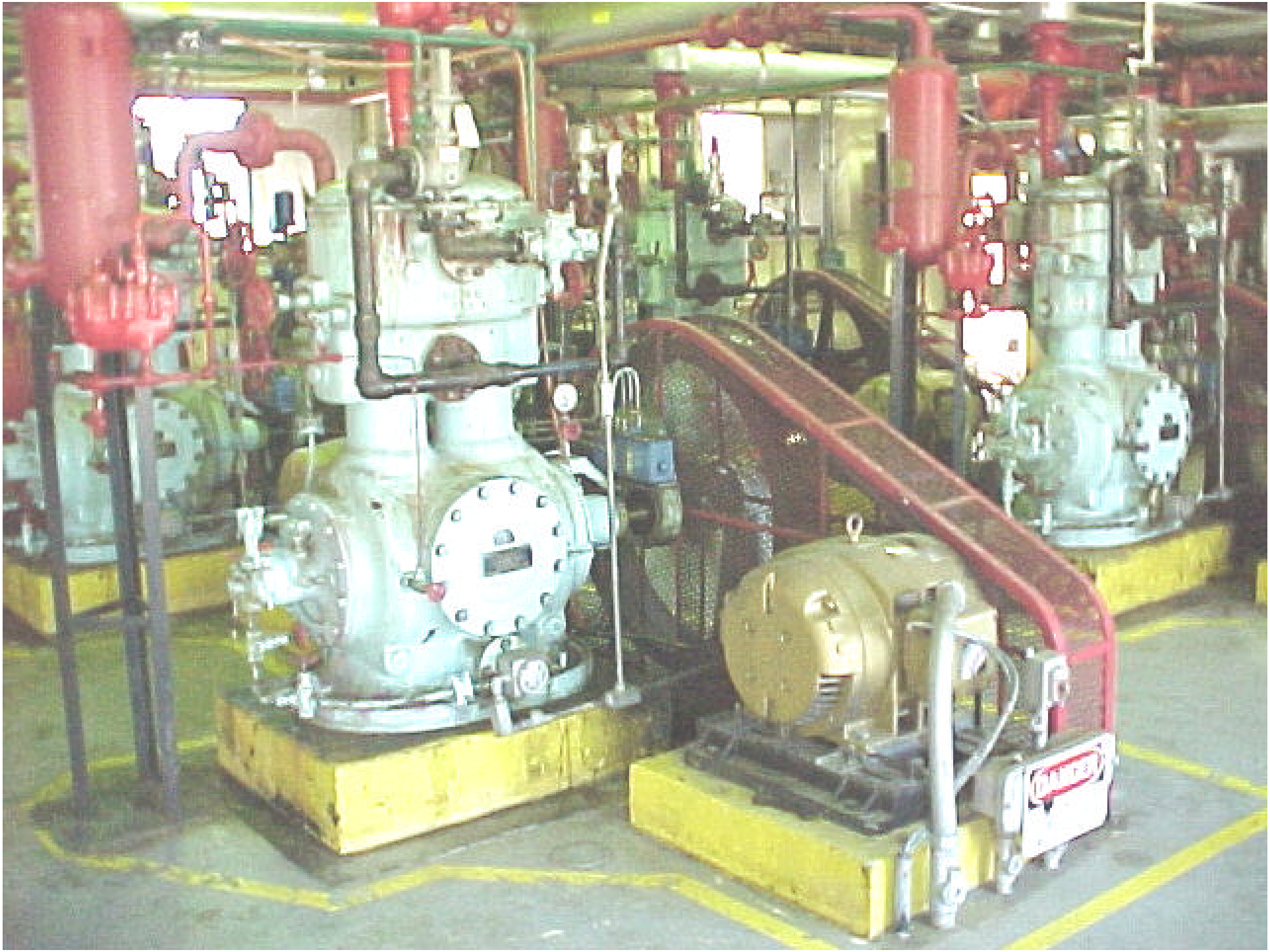
- 126 to 170 ft. in diameter
- 60 to 105 ft. high
- 6 to 12 million gallon capacity (15-30,000 tons)
- usually 1 psig max. internal pressure (~-28F)
- heat leaks in from environment

Major Components (cont.)



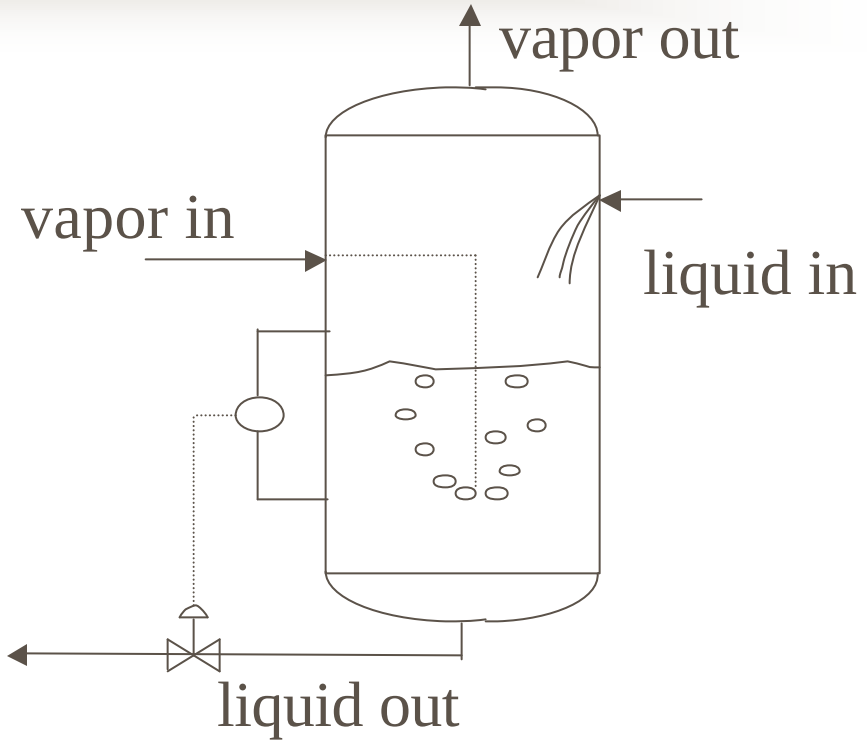
Compressor

- moves vapor, increases pressure
- reciprocating, rotary screw, rotary vane, etc
- 10 to 300 horsepower each (75 to 1200 hp total)
- compression ratio dependent on type
- required capacity dependent on inbound type
- compression causes temperature increase



Major Components (cont.)

- can be vertical or horizontal vessel
- usually designed for 250 psig.
- provides direct contact cooling
- removes superheat from vapor

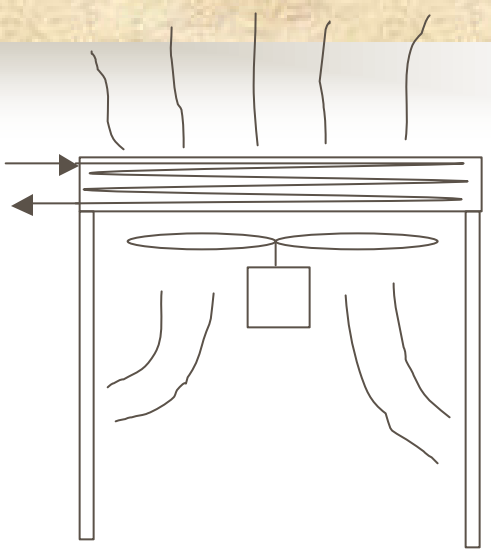


Flash Tank or Intercooler

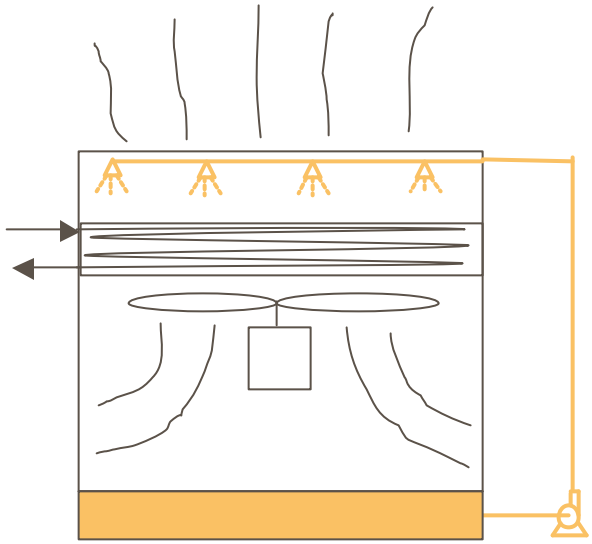

flash tank

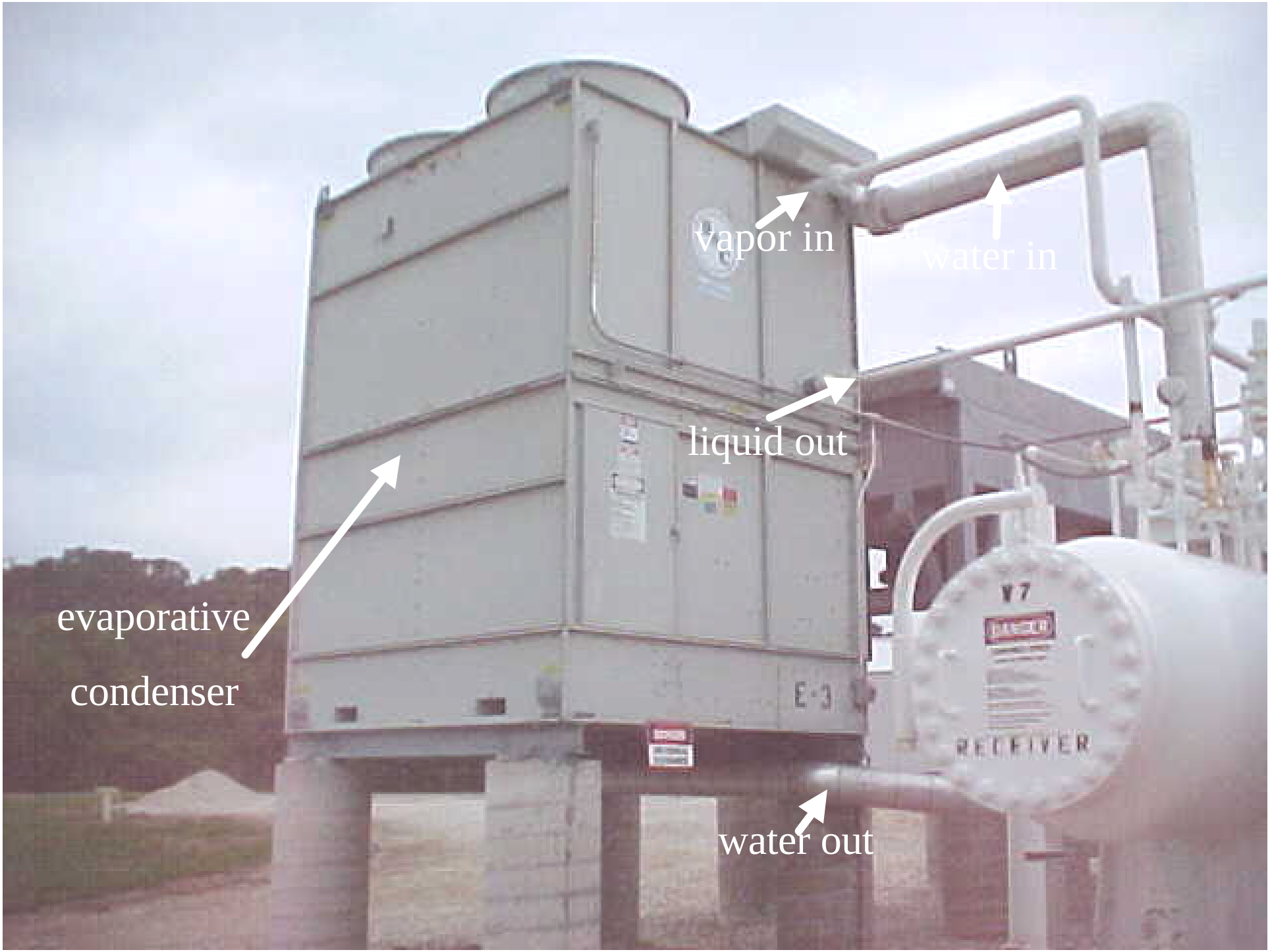
Major Components (cont.)

- can be air-cooled, evaporative, or shell-and-tube
- usually designed for 250 psig.
- removes superheat and latent heat
- changes vapor to liquid

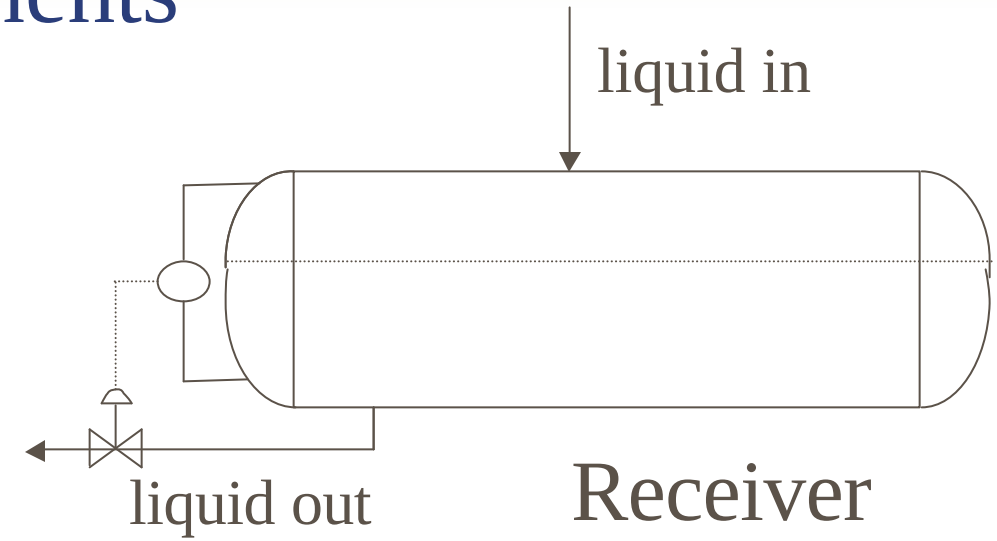


Condensers



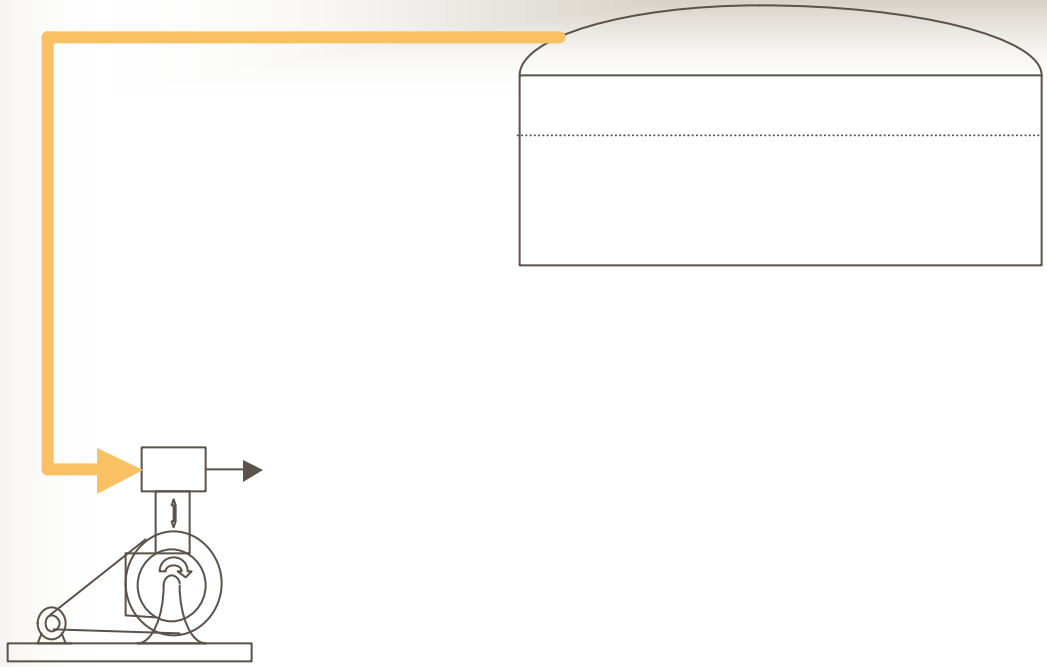

vapor in
water in
liquid out
evaporative
condenser
water out
E-3
RECEIVER

Major Components (cont.)

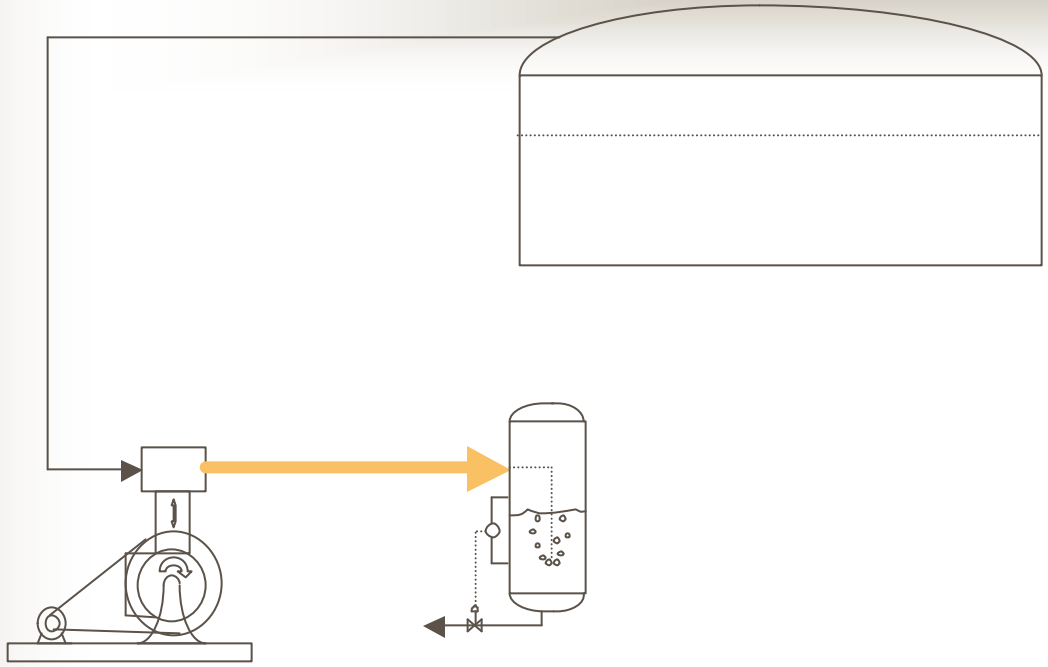


- usually a horizontal vessel
- usually designed for >= 250 psig.
- provides liquid seal
- provides surge capacity

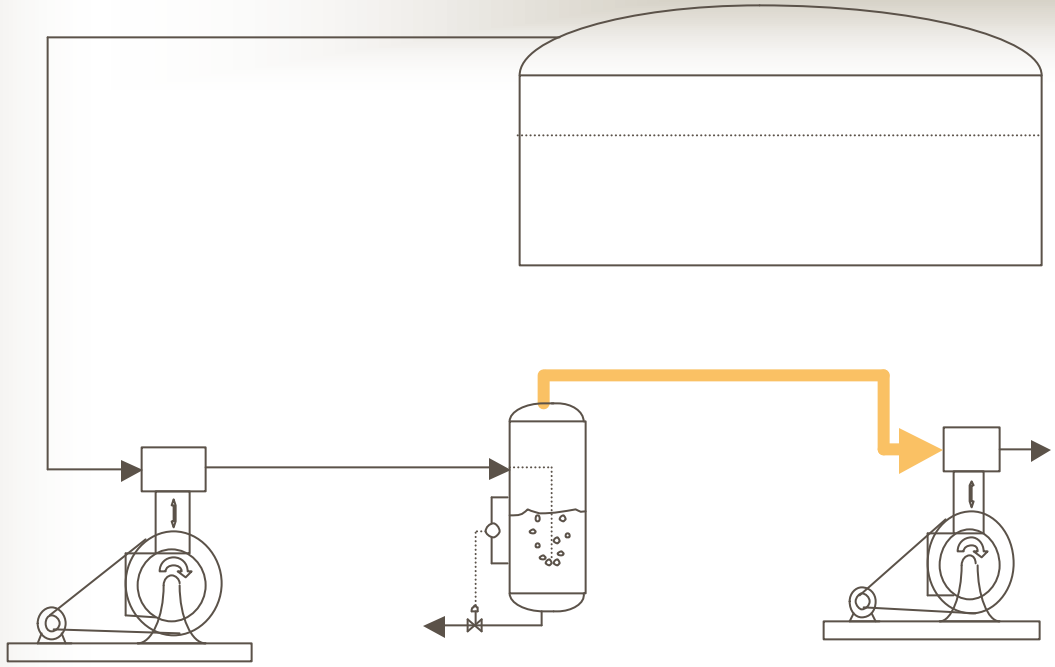
Refrigeration in an Ammonia Storage Facility



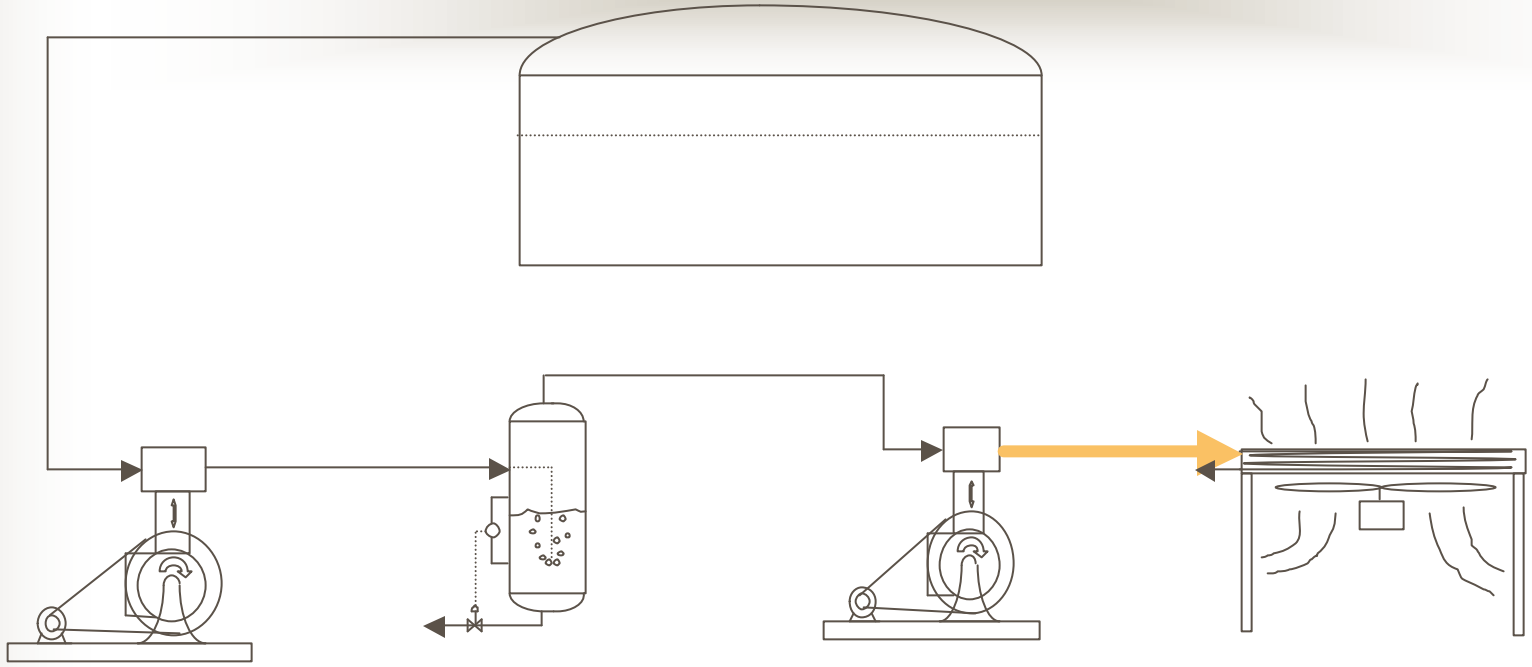
Superheated vapor passes from the storage tank to the 1st stage of compression. Vapor is compressed from less than 1 psig. up to 30-60 psig.



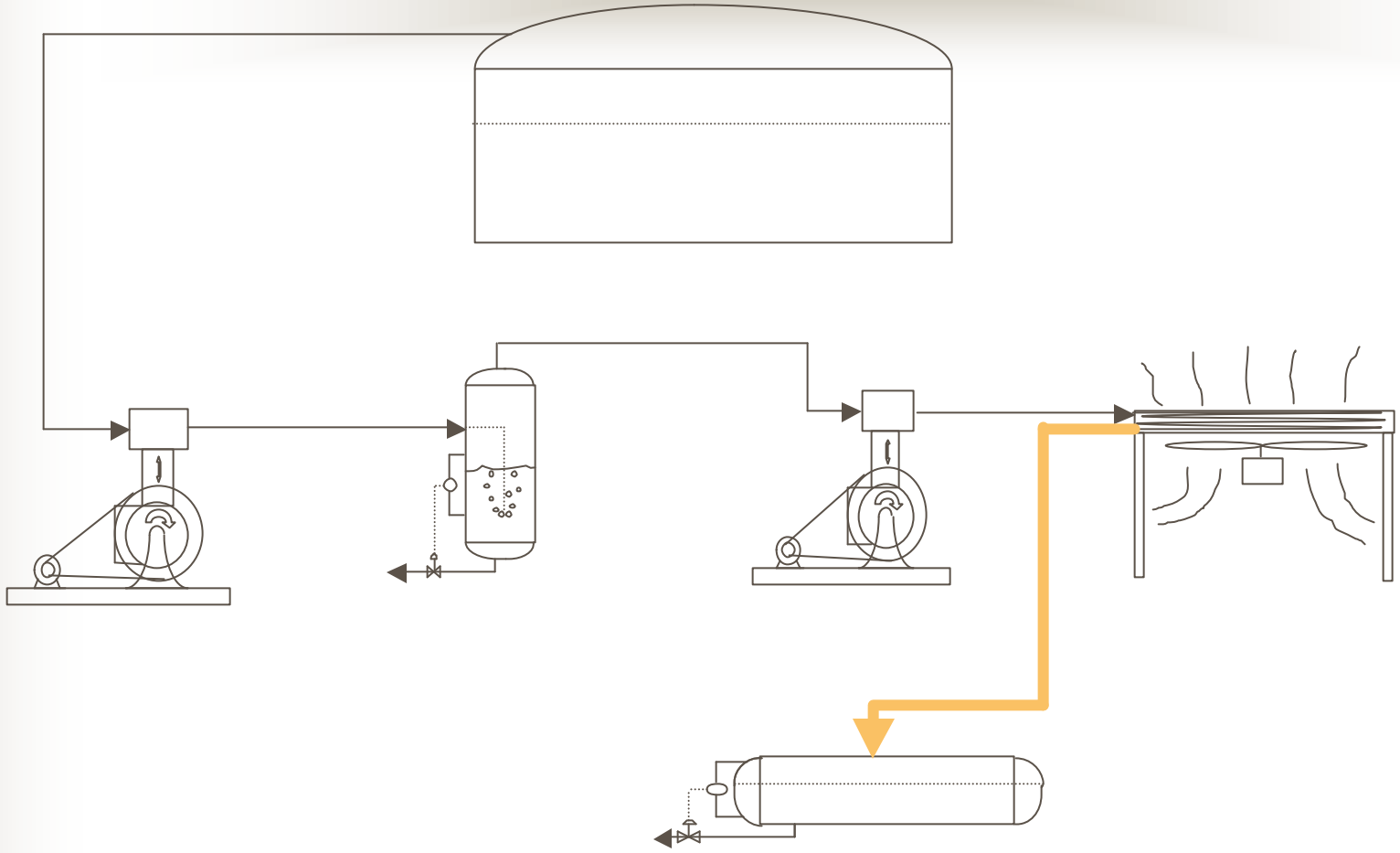
Hot vapor from 1st stage compression is cooled in the flash tank in preparation for 2nd stage compression.



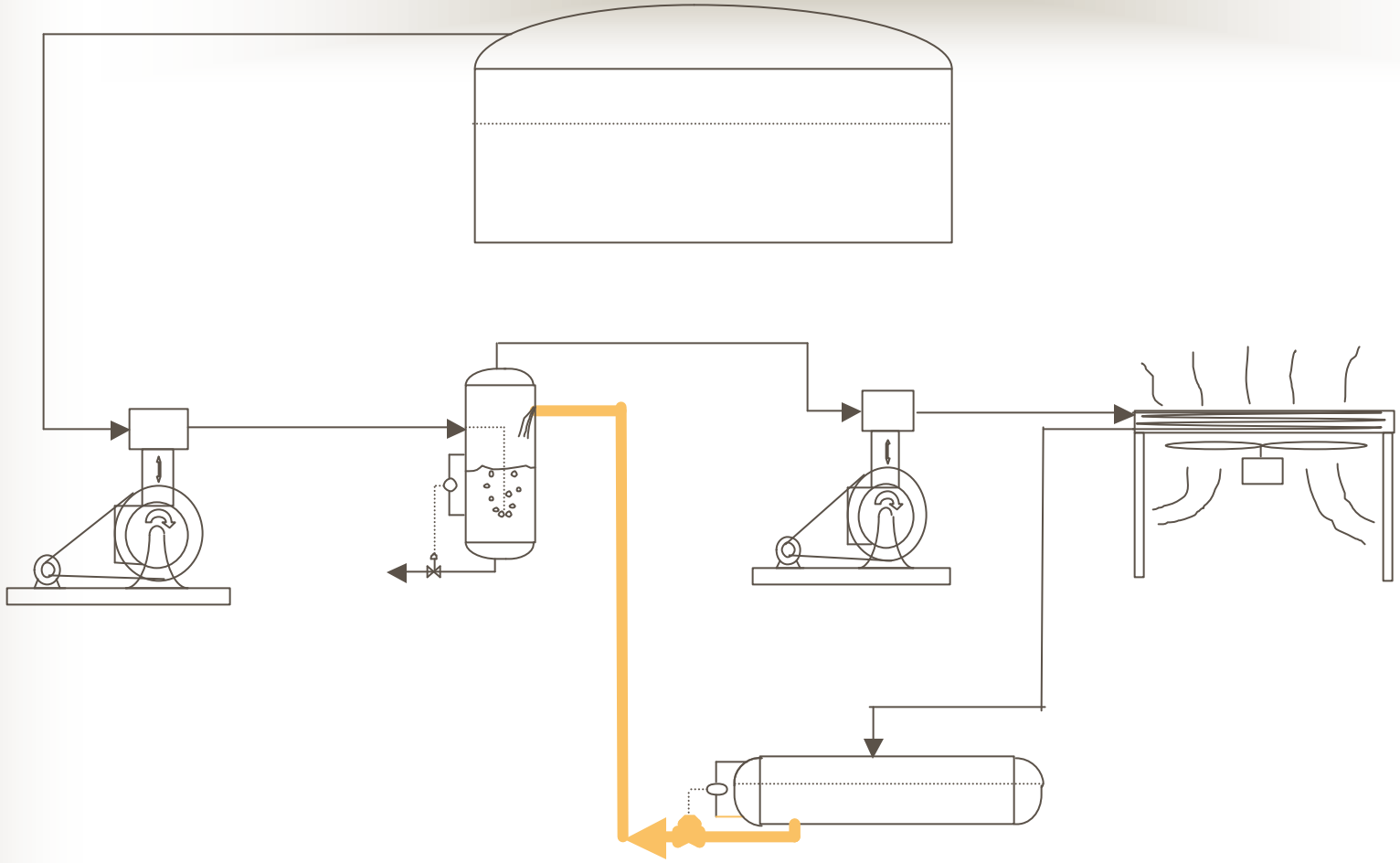
Vapor near its saturation temperature passes to 2nd stage compression. Vapor is compressed from 30-60 psig up to condensing pressure of 150 to 225 psig.



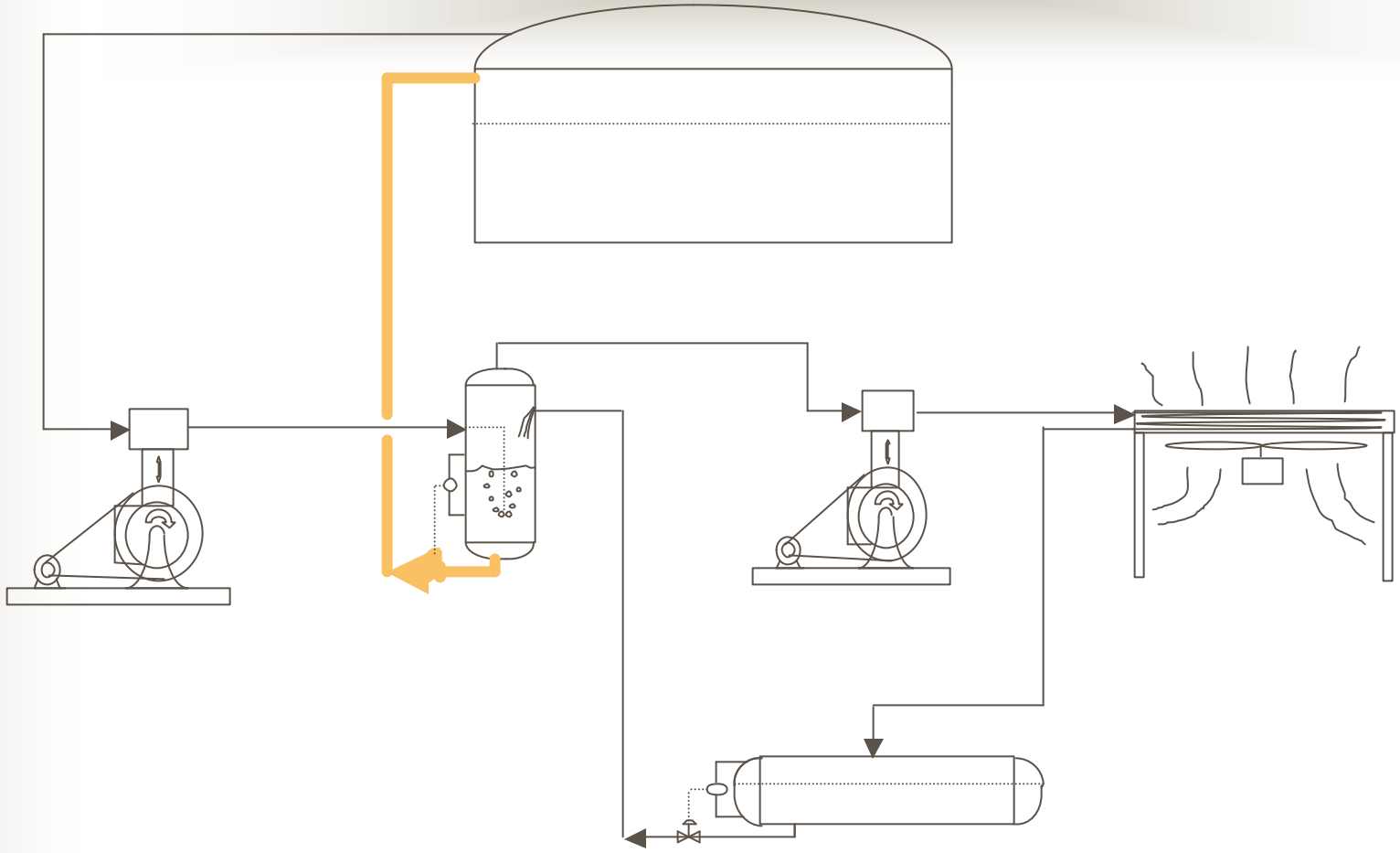
Hot vapor passes to the condenser, where heat is rejected to the environment.



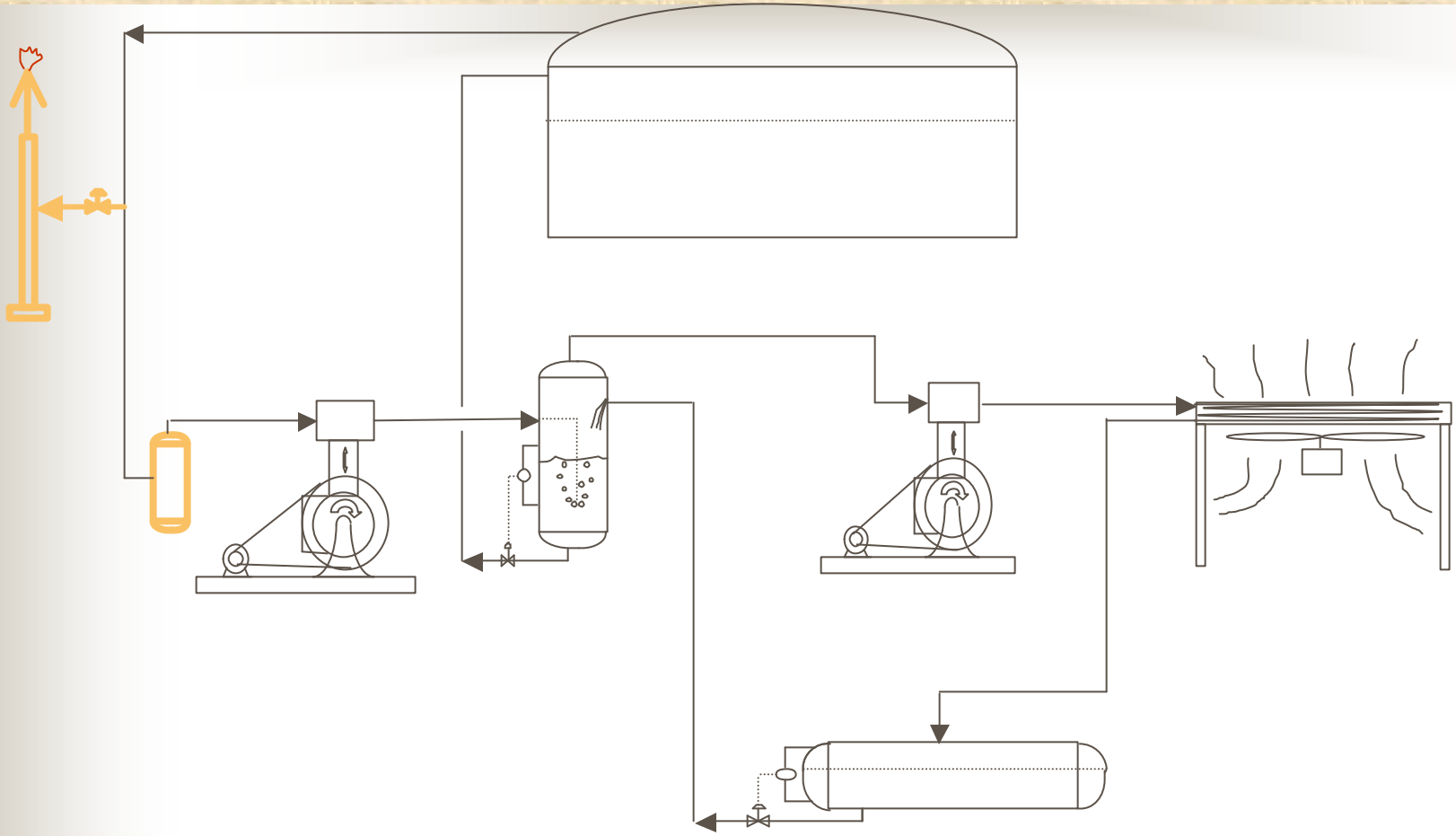
Condensed ammonia gravity drains into the receiver.



Receiver level control sends liquid to flash tank for an intermediate flash on its way back to the storage tank.



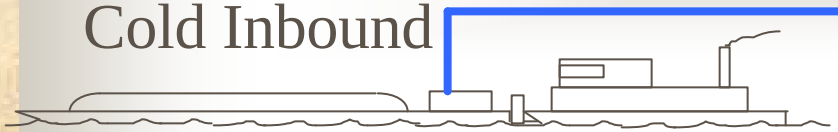
Flash tank level control sends liquid, at intermediate pressure, to the storage tank.



A flare for burning of ammonia vapor during a refrigeration system interruption and a knockout pot to protect the compressors from damaging liquid entry are also utilized. This completes the holding refrigeration system.

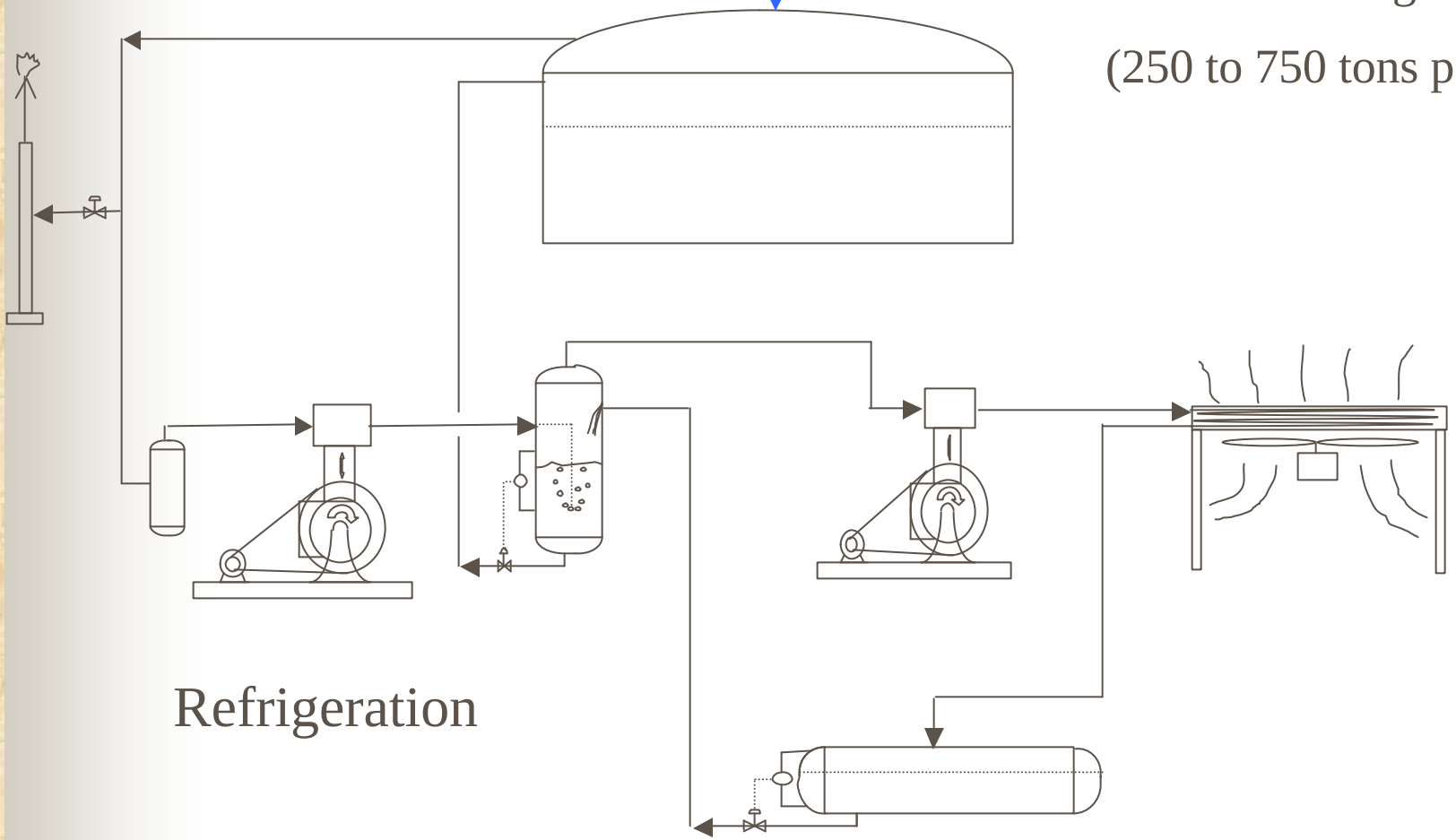
Ammonia Inbound to a Storage Facility

Cold Inbound



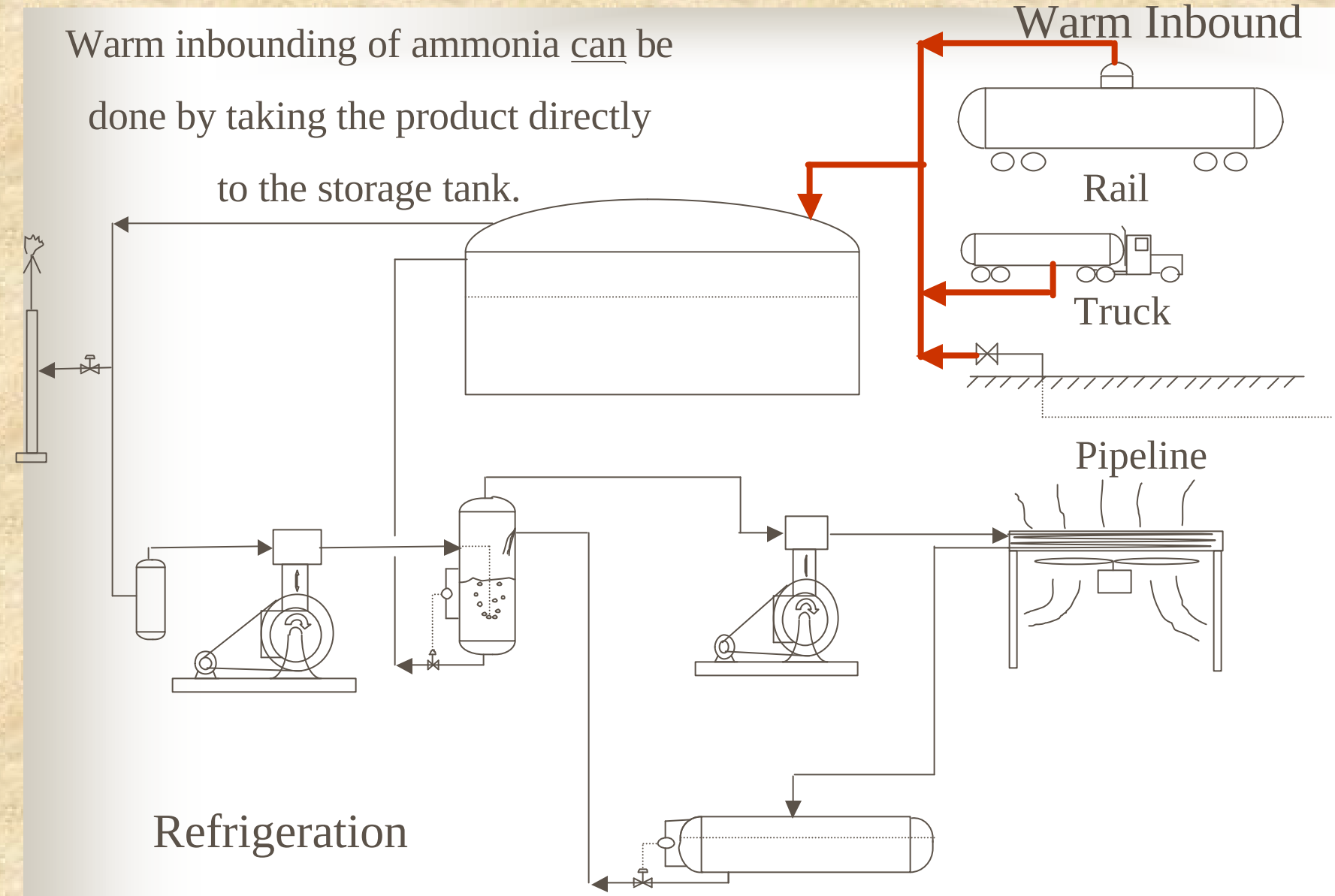
Refrigerated Barge/Ship

Cold inbounding of ammonia is done by pumping directly to the storage tank (250 to 750 tons per hour)

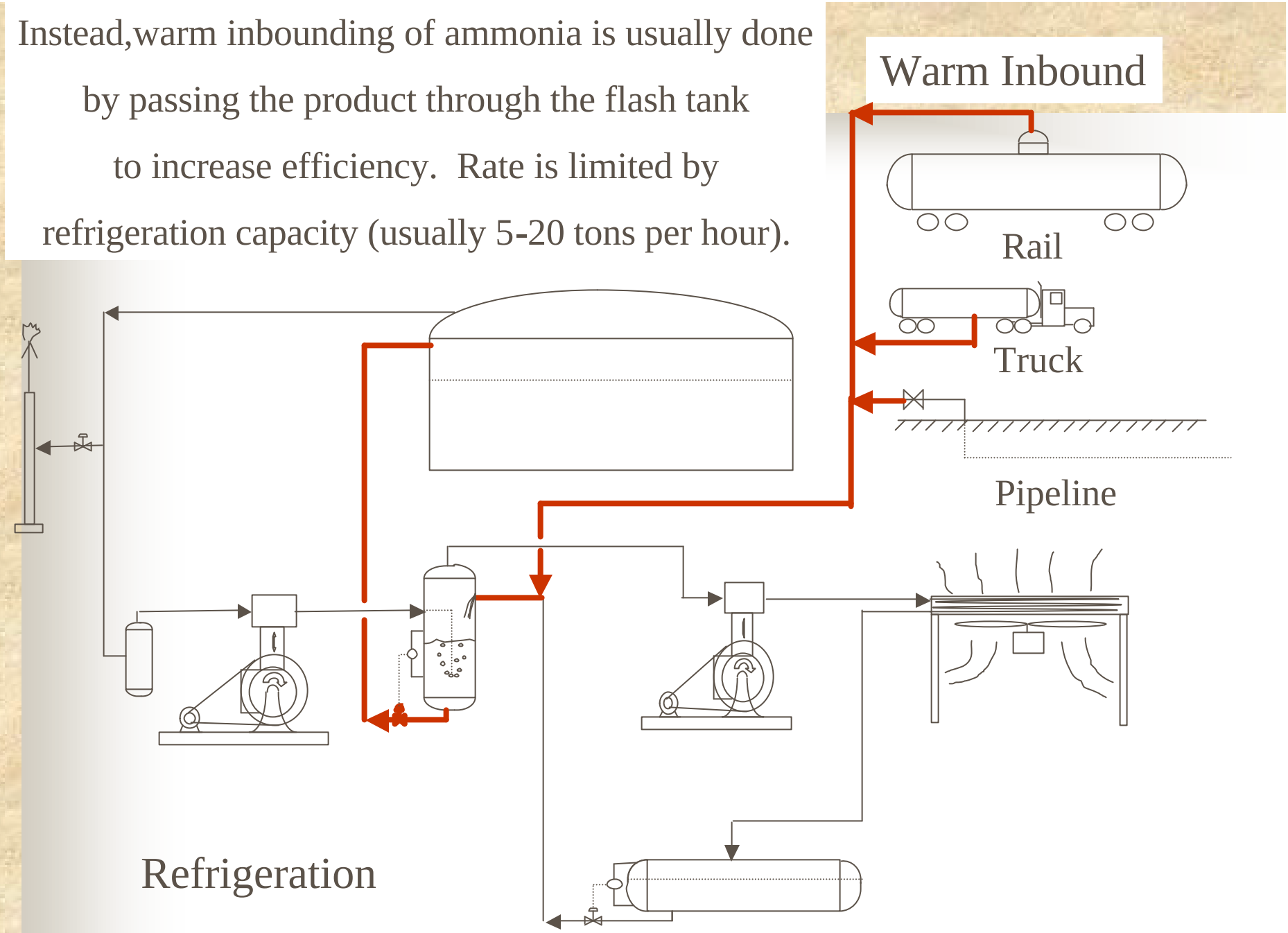


Refrigeration

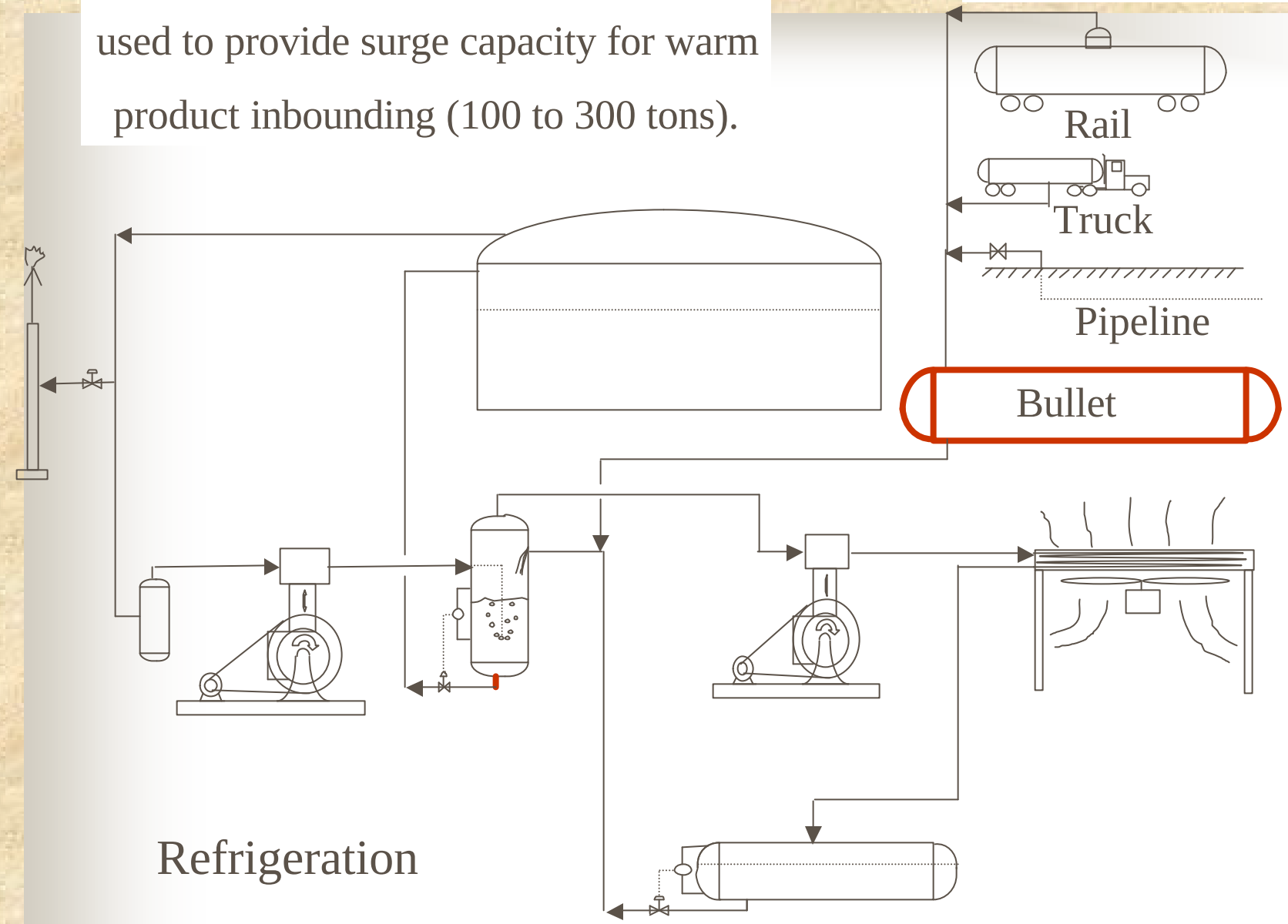
Warm inbounding of ammonia can be done by taking the product directly to the storage tank.

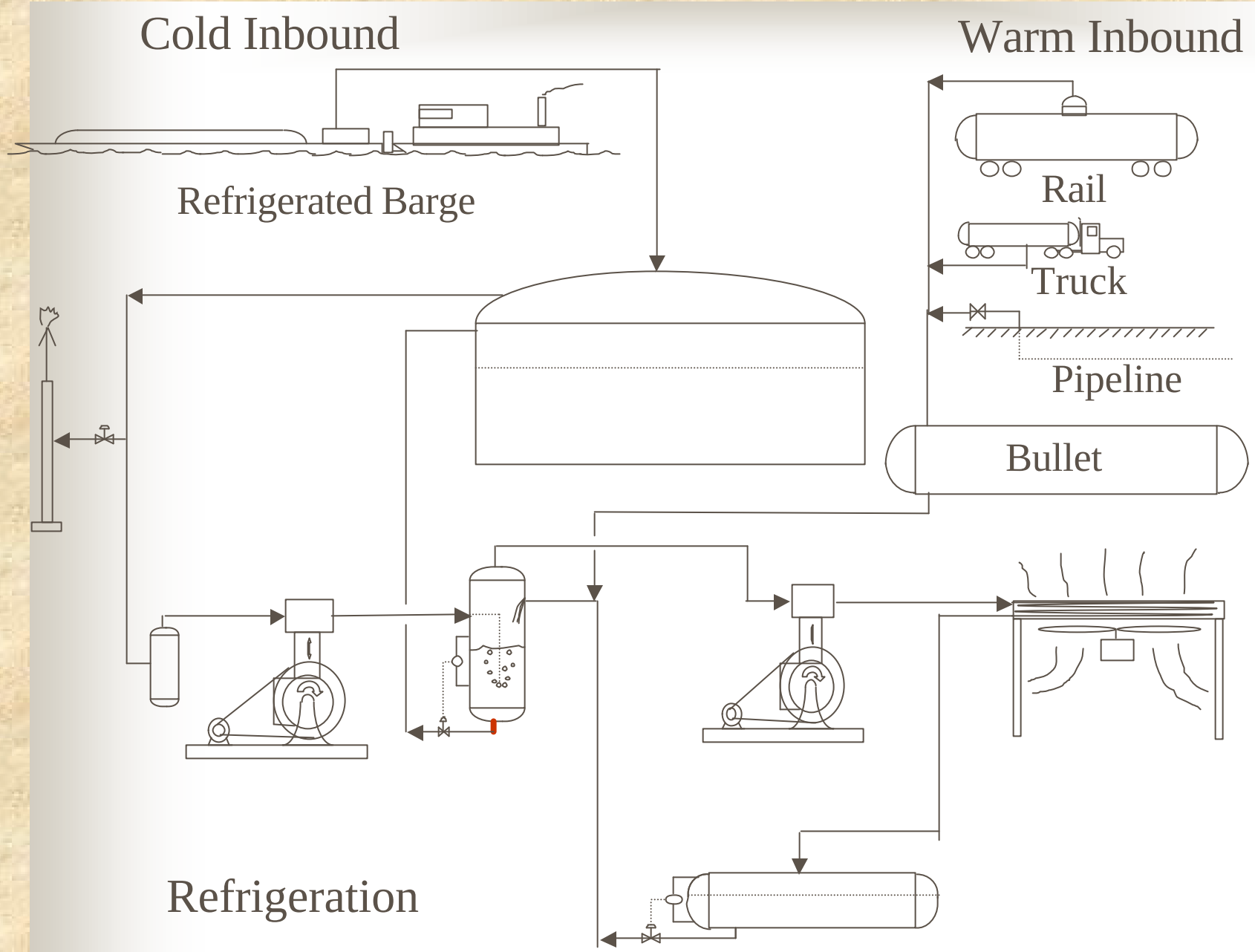


Instead,warm inbounding of ammonia is usually done by passing the product through the flash tank to increase efficiency. Rate is limited by refrigeration capacity (usually 5-20 tons per hour).

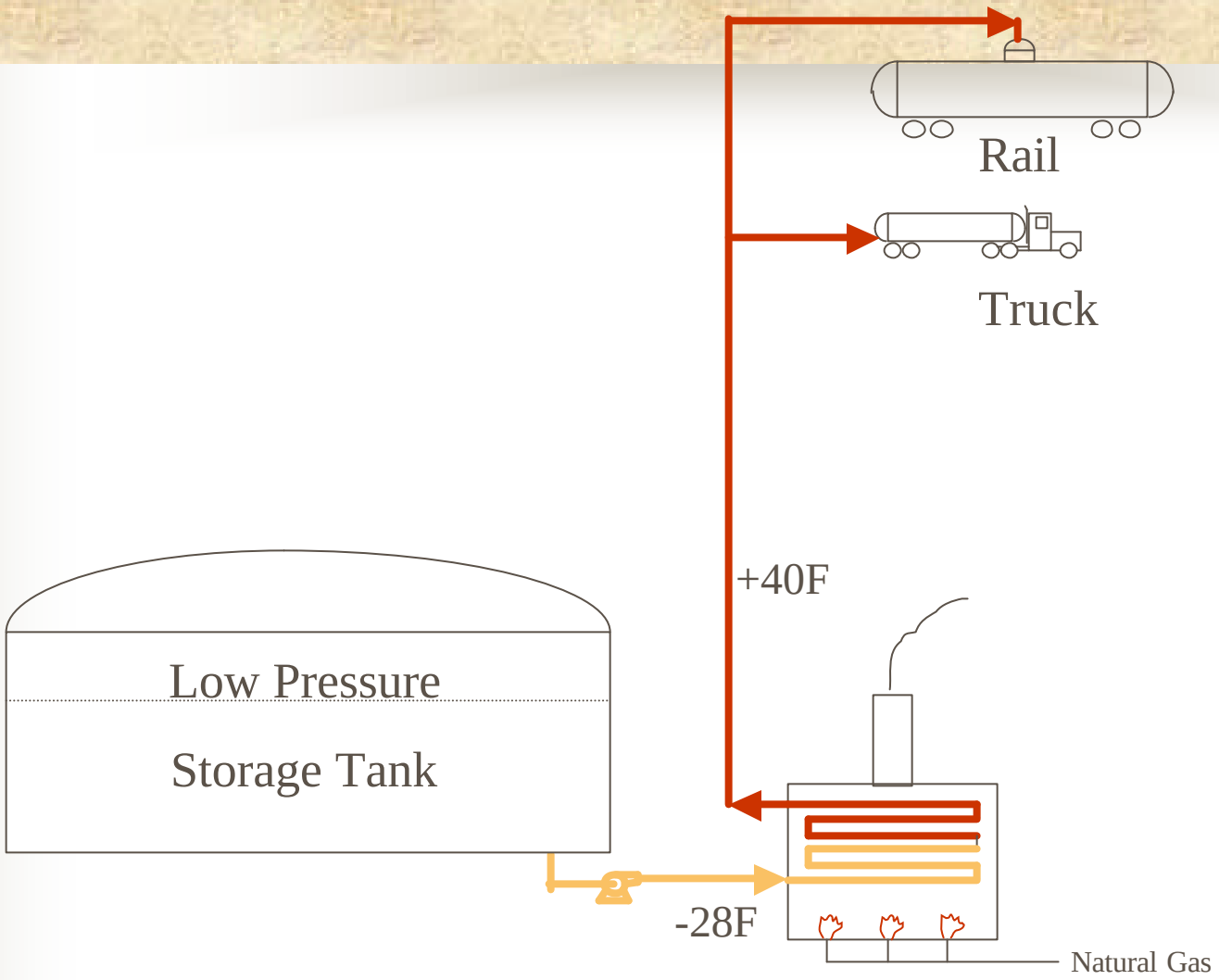


A high pressure “bullet” is typically used to provide surge capacity for warm product inbounding (100 to 300 tons).

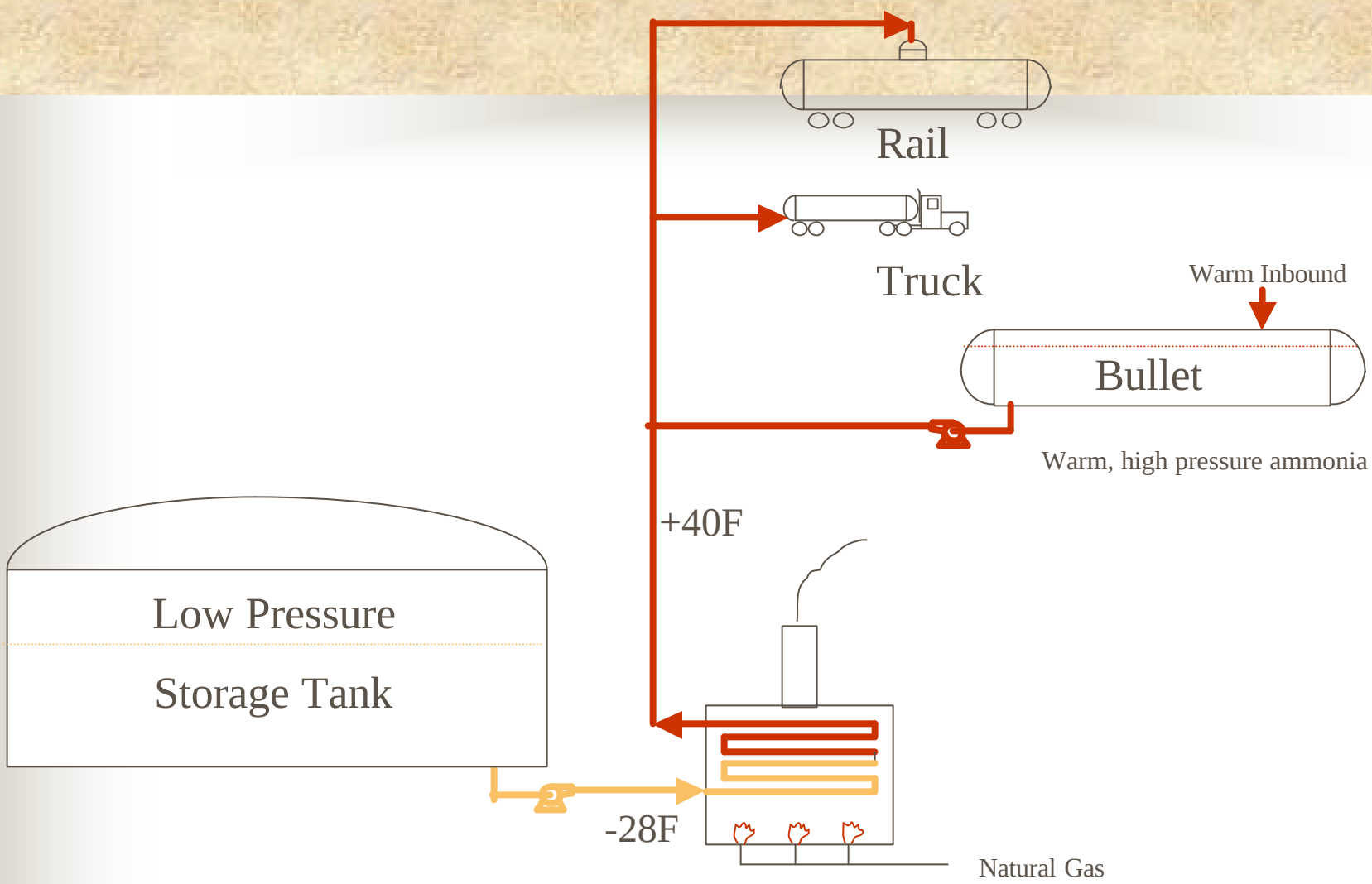



Cold Inbound
Warm Inbound
Refrigerated Barge
Rail
Truck
Pipeline
Bullet
Refrigeration

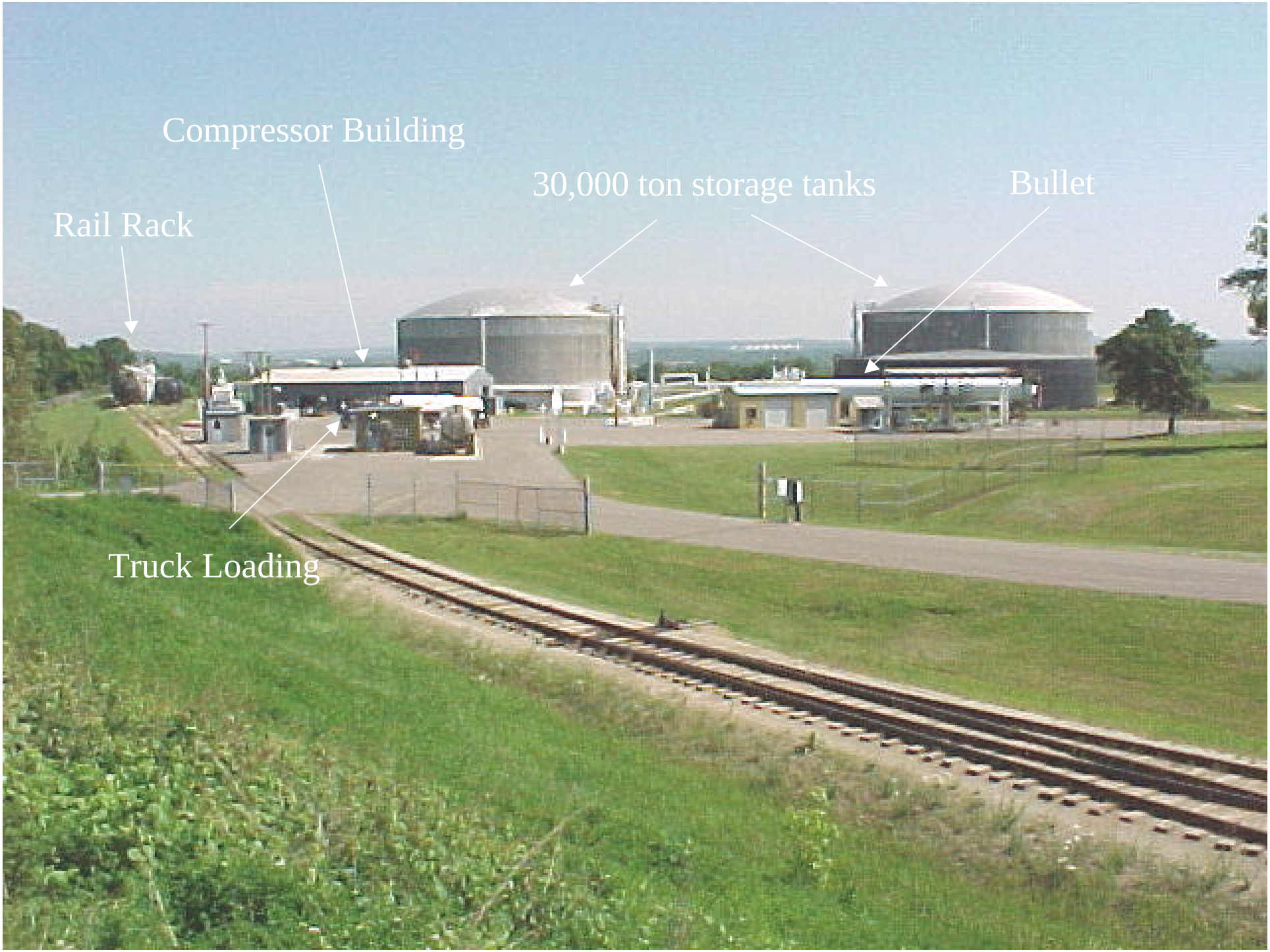
Ammonia Shipping



Cold ammonia must be heated before loading onto trucks or rail cars.



Warm ammonia from inbound can be loaded directly onto outbound vehicles or mixed with heated product for shipping. "Direct transfer" saves refrigeration and heating energy if the facility has a bullet.


Compressor Building
30,000 ton storage tanks
Bullet
Rail Rack
Truck Loading

Challenges and Opportunities

- Ammonia stinks! (that's good and bad)
- Storing millions of gallons of ammonia presents environmental, health, and safety concerns.
- PSM and RMP very much affect this industry.
- Ammonia handling is very energy intensive and competitive.

Challenges and Opportunities (cont.)

- Energy prices are hitting ammonia manufacturing and handling very hard!
- Many of the facilities were built in the 60's and 70's and need to be upgraded to newer technology.

Questions/Comments?