

Safety and refrigeration systems

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- You have the right to a safe workplace

Source: www.osha.gov

- Workers are entitled to working conditions that do not pose a risk of serious harm

Source: www.osha.gov

Why is the focus on safety?

- Accidents happen – but we can try to avoid them and minimize the risk
- Accidents are not a natural law
- By training and awareness you can learn to foresee potential risk
- Many accidents could have been avoided by better training
- Life long training should be mandatory

Træk billede til pladsholder, eller klik på symbol for at tilføje

Classification of refrigerants

- Refrigerants are classified in different categories
- New refrigerants are entering the market
- Old refrigerants are leaving the market
- Montreal Protocol
- Kyoto Protocol
- Kyoto gas will be dealt with under the Montreal Protocol

	Lower toxicity	Higher toxicity
Increasing flammability	A3	B3
	A2	B2
	A2L	B2L
	A1	B1

Ammonia deaths

- In the US there is 9,982 ammonia installations of many kinds.
- In the period from 1996 to 2011 the number of fatalities was 19
- In 2012 there was 4628 fatal work related accidents in the US
- 19 accidents over 15 years = 1.3/year in average
- 0,03% of accidents is with NH₃

- Traffic fatalities on US roads in 2011 fell to their lowest level since federal safety regulators started counting in 1949. Preliminary data estimates that 32,310 people died in motor vehicle crashes.

Træk billede til pladsholder, eller klik på symbol for at tilføje

Data can be difficult to find and compare

- Here we look at selected gases
- Exposure Guideline Comments:
 TLV® = Threshold Limit Value.
 TWA = Time-Weighted Average.
 STEL = Short-term Exposure
 Limit. C = Ceiling limit.

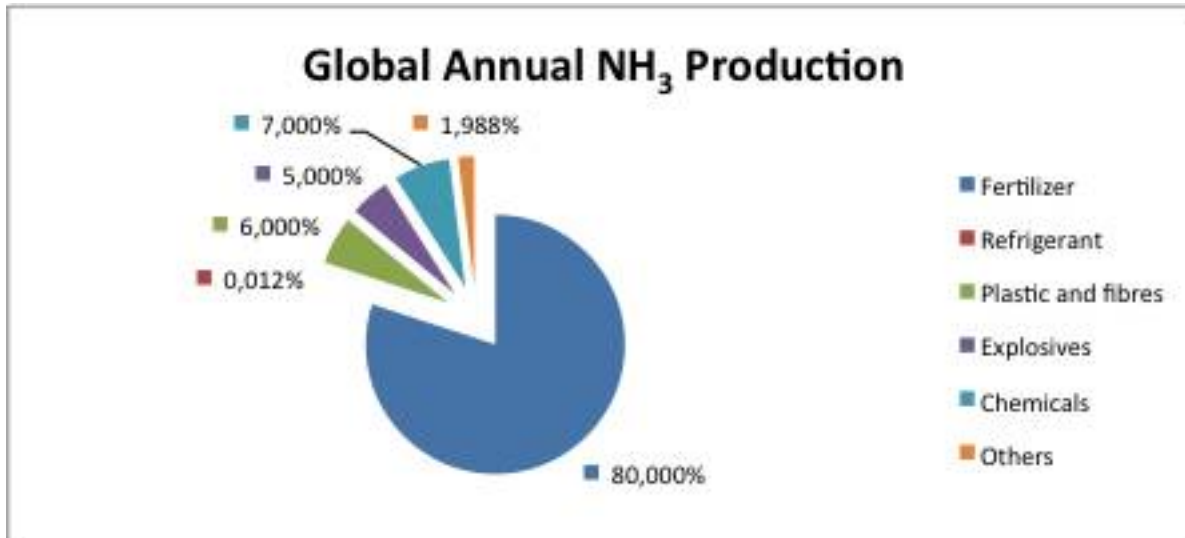
		Ammonia	Carbon Dioxide	Propane
CAS Registry No.		7664-41-7	124-38-9	74-98-6
REACH number		01-2119488876-14	1907/2006	01-2119486944-21
EC No (from EINECS)			204-696-9	200-827-9
ACGIH® TLV® - TWA	ppm	25	5000	1000
8 hour TWA				2500
ACGIH® TLV® - STEL [C]	ppm	35	30000	
OSHA PEL	ppm	50		
TLV-Stel IDLH	ppm	300		
GB -STEL	PPM	35	15000	
GB - LTEL	PPM	25	5000	
Solubilty in water		Solubility in water: 89.9 g/100 g water at 20 oC		

Hazardous substances

- Ammonia is classified as a hazardous substance
- Global annual production of ammonia is more than 200 million tons of ammonia
- Only a very little fraction of the production is used as refrigerant

Træk billede på symbol fo

Refrigerants		Global use 2006	
		(t)	(%)
CFC	R11	6331	0,9
	R12	20328	3,0
	R502	5579	0,8
HCFC	R22	376992	56,2
	R408A	3443	0,5
	R401A	772	0,1
	R123	6295	0,9
HFC	R134a	135569	20,2
	R404A	28279	4,2
	R407C	24607	3,6
	R410A	28922	4,3
	R507	3986	0,5
	R413A	143	0,0
Others	R717	26194	3,9
	R744		
	R600a	2869	0,4
Total		670309	100,0

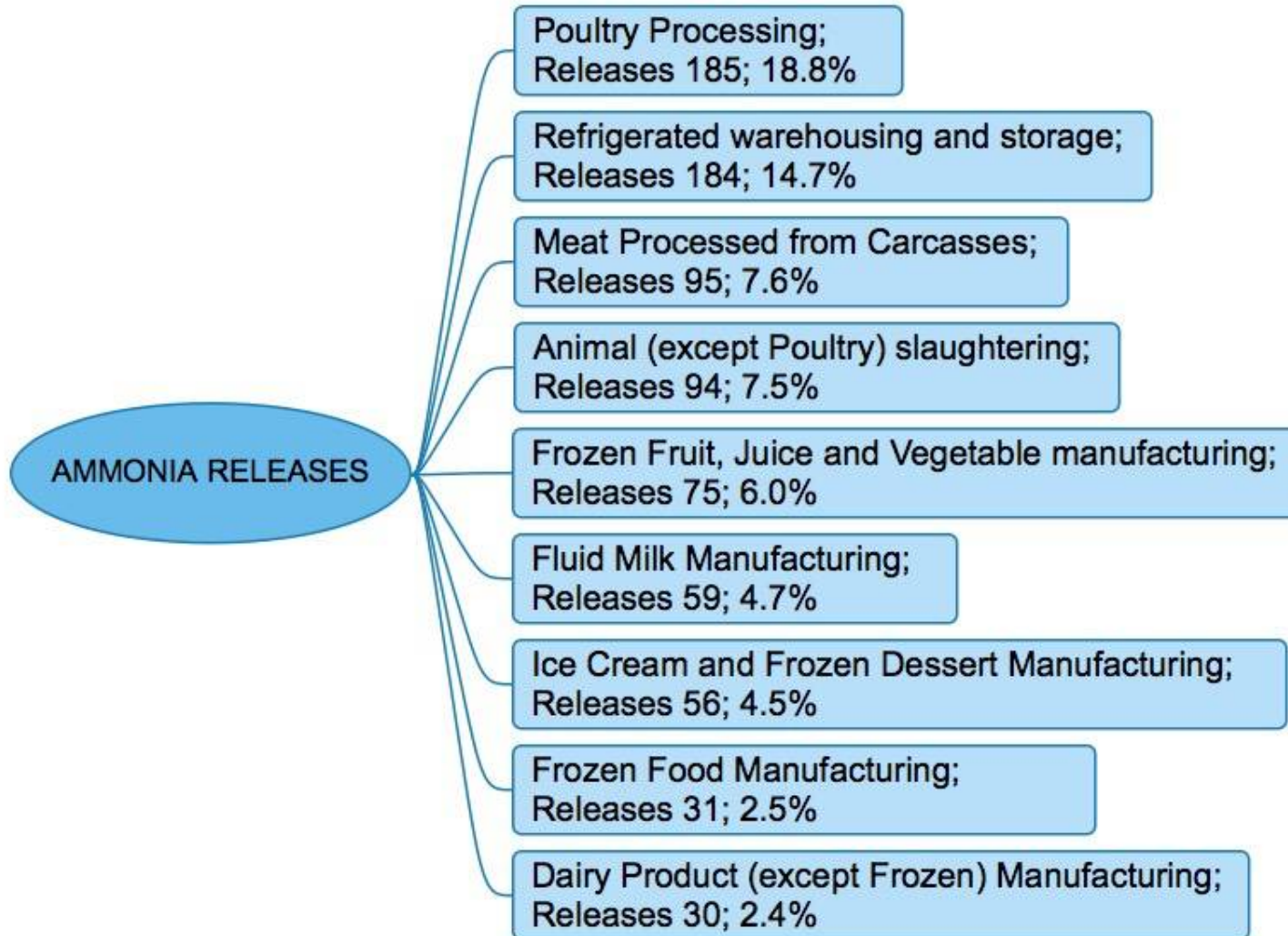


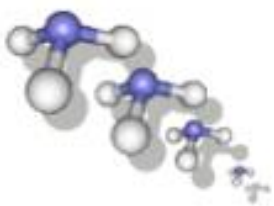
Dennis Clodic; 2010 UNEP RTOC report annex

Refrigeration accounts for to large part of releases

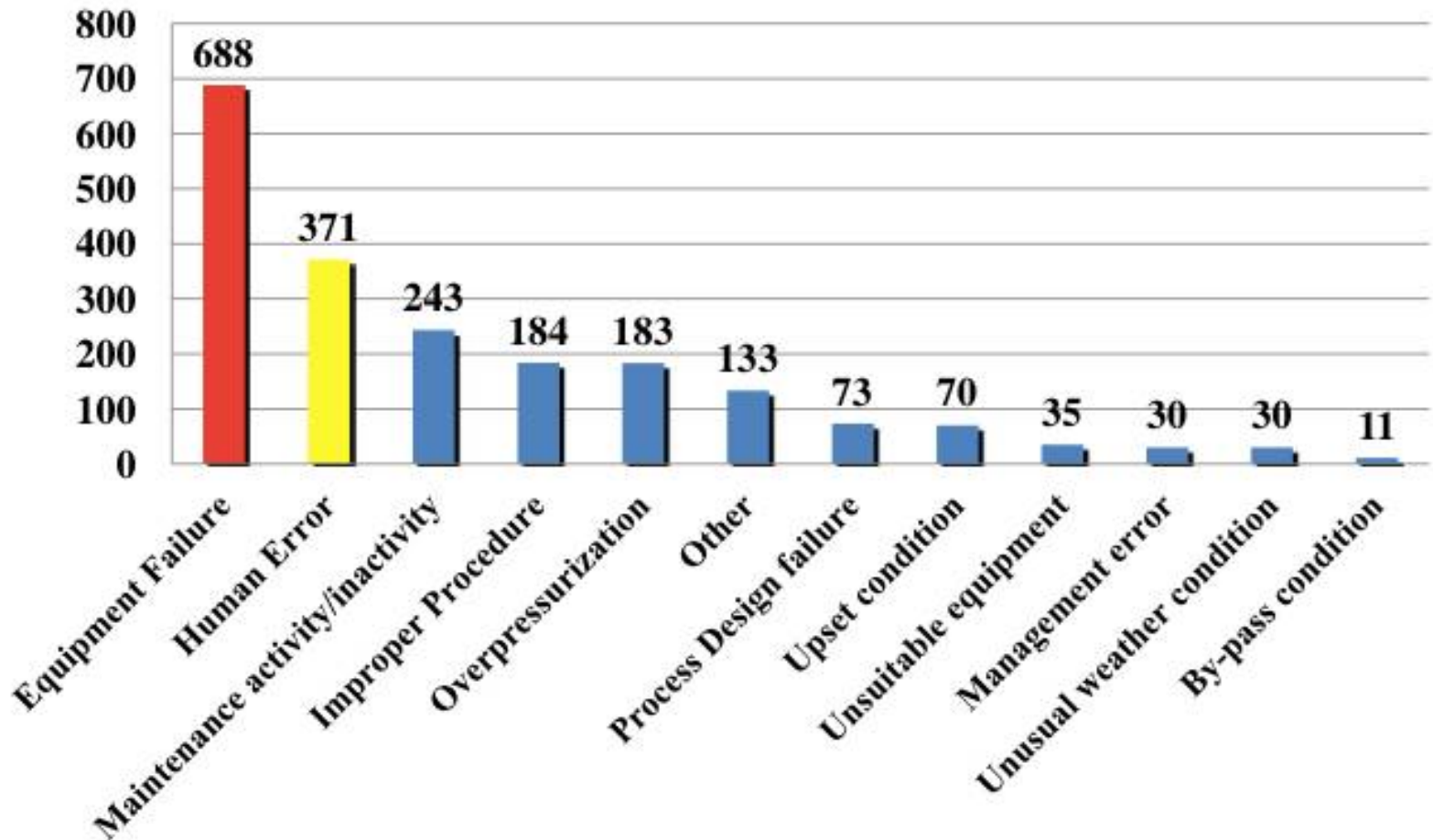
- Refrigeration accounted for 44% of all ammonia related accidents in the US
- From EU reports we know that refrigerant purposes is the 3rd most common accident involving NH₃
- Service and maintenance is the most common abnormality causing accidents
- 3 main types of releases account for 59,5% of all releases (644 in all)
- 1 release can cause more than one accident/incident

Releases in the US

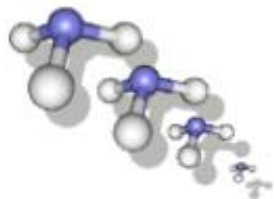




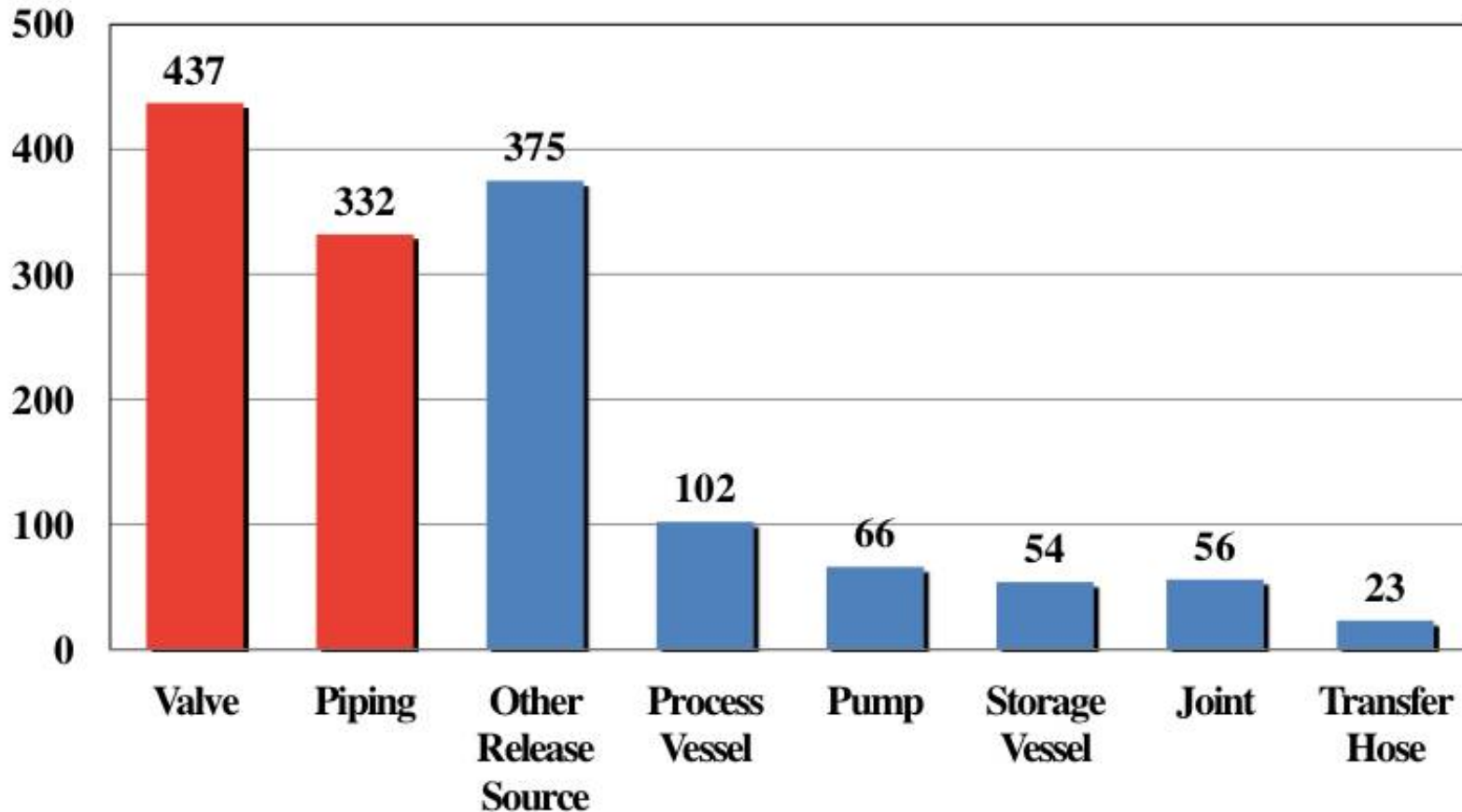
RMP Ammonia Refrigeration Reasons for Release (1994-2013)



1,253 Total Releases

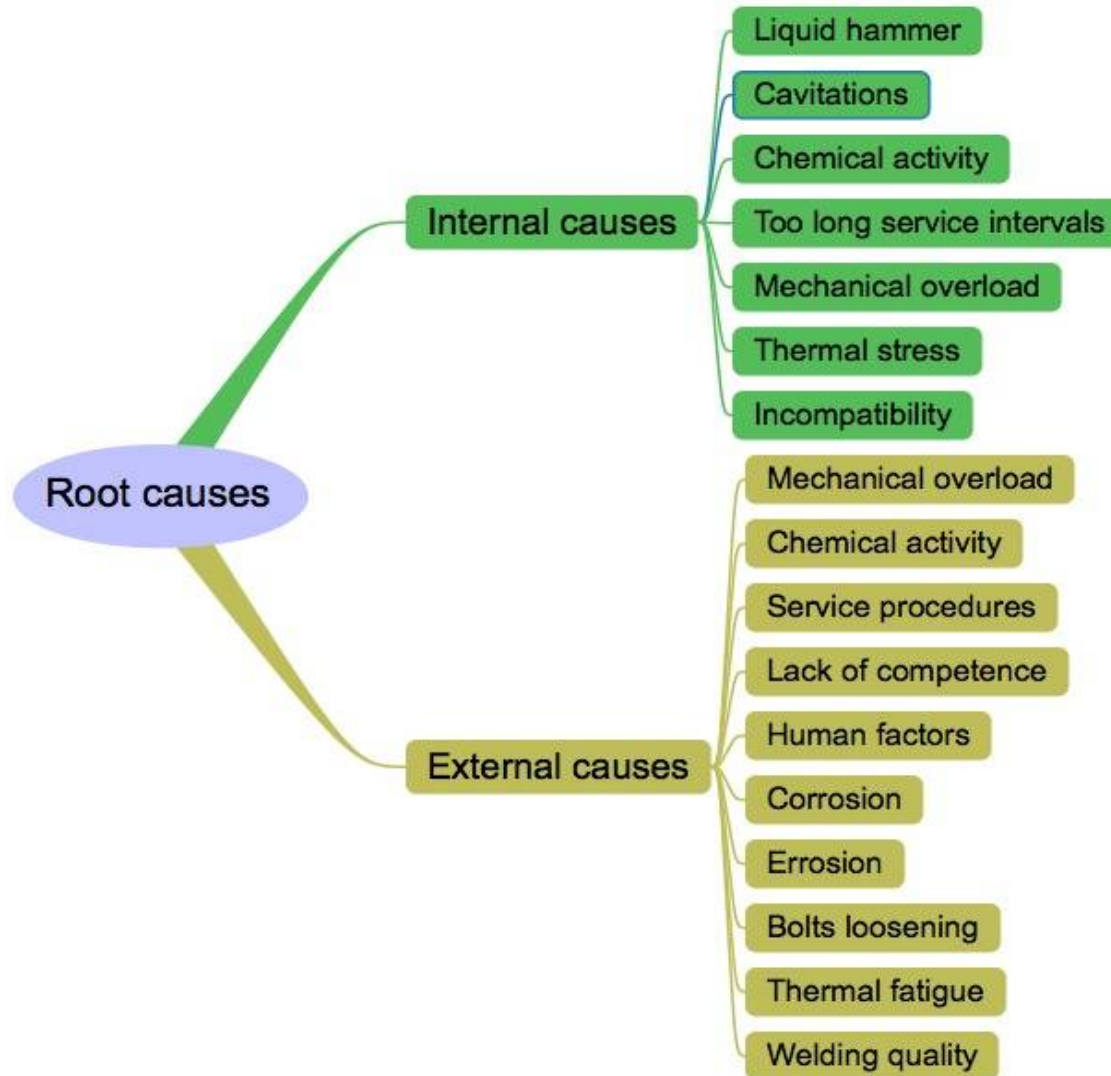


RMP Ammonia Refrigeration Release Sources (1994-2013)

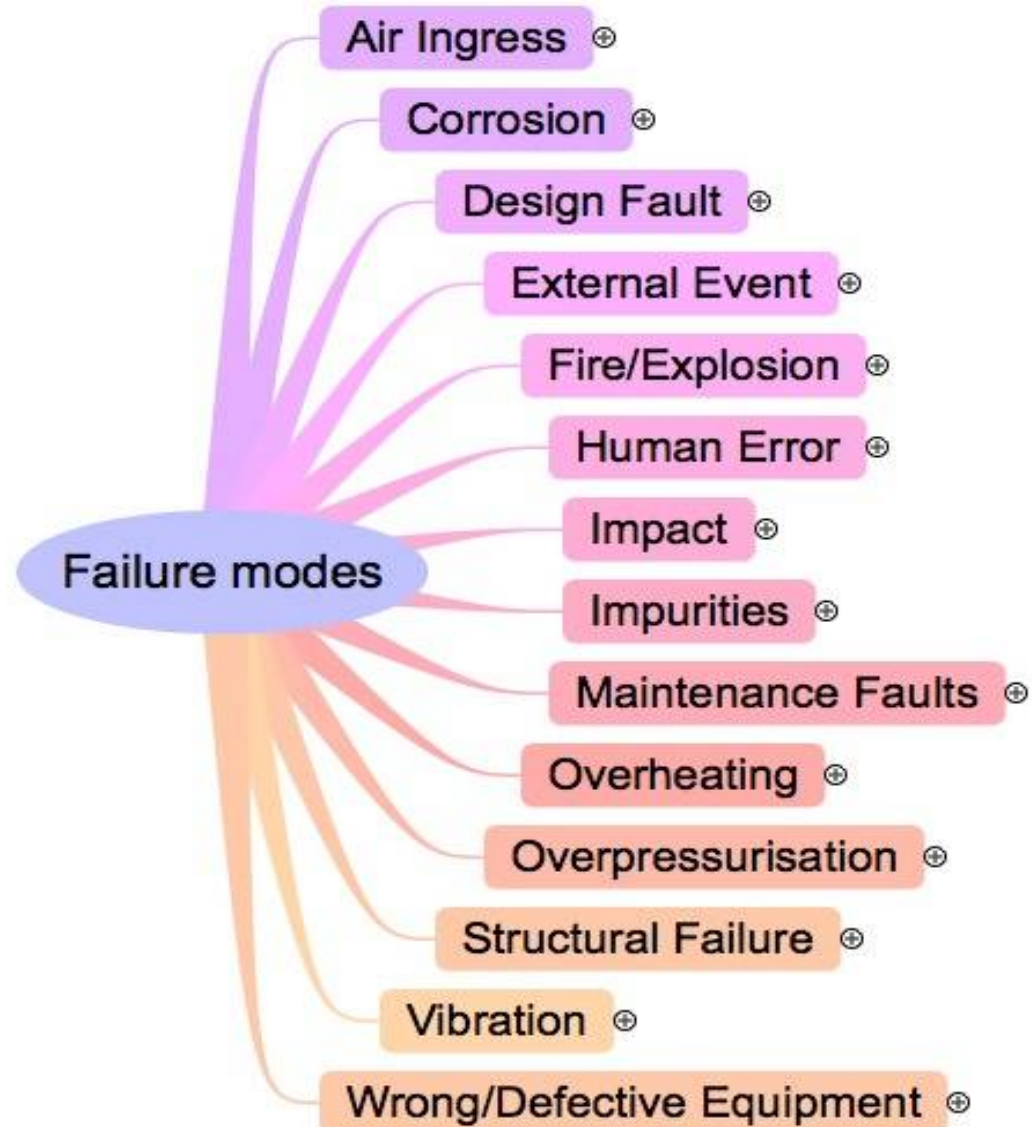


1,253 Total Releases

Internal and external root causes



Failures can have different paths and causes



Specifying the right quality refrigerant

Refrigerant	Contaminant	Refrigerant grade		Minimum Purity
		Max contamination (%)	Max contamination ppm	
Ammonia				99,98
R-717	water	0,015	150	
	Oil		0,3	
	Non-condensables	0.2 ml/g		
Propane				99,5
R-290	Water	10 mg kg ⁻¹	10	
	other gases	0,5		
	High boiling residue	0,01		
	Acidity		1	
Iso-Butane				
R-600a	Water	10 mg kg ⁻¹	10	
	other gases	0,5		
	High boiling residue	0,01		
	Acidity		1	
Carbon dioxide				99,9
R-744	Water	0,001		
	High boiling residue	0,0005		
	Non-condensables	1,5		

Refrigerant grade ammonia

		Ammonia Quality Specifications			
		Commercial grade		Refrigeration grade	
		USA	Europe	USA	Europe
Purity	Wt% Minimum	99,5	99,5	99,98	99,98
Water	Wt% Macimum	0,5	0,2	0,015	0,02
Inerts	mL/g maximum	c	c	0,1	0,08
Oil	ppm by weight	5	5	3	c

c Not specified

Ammonia purity and grades

	Purity (%)	Grade
Commercial grade	99,5	2,5
Agricultural grade	99,7	2,7
Refrigerant grade	99,98	3,8
Technical Grade	99,98	3,8
Metallurgical grade	99,995	4,5
Research grade	99,999	5,0
Semiconductor	99,9999	6,0
High grade	99,99999	7,0

Vibrations – an under estimated problem

- Vibrations can cause cavitation => You can work on a valve sitting on an internally damaged pipe and you have no chance to see it from outside
- It will in most cases be in the machine room
- Eliminations of vibrations are essential

Standards for safety

- The ventilation calculated is for normal service purpose
- The ventilation cannot handle a catastrophic leak
- Some gas can be absorbed by air scrubber systems
- For large capacity systems you have to consider dominating wind direction
- Water and CO₂ can help absorbing ammonia
- Other refrigerants can only be ventilated away

- There is only one refrigerant that we can inhale in unlimited amounts: clean atmospheric air at normal surface pressures

International Statistics

- A US survey, combining data from 2002 to 2006, found that an annual average of 593,000 teens aged 12 to 17 had used inhalants for the first time in the year before they took the survey.
- More than 22.9 million Americans have experimented with inhalants at some point in their lives.
- 22% of inhalant abusers who died of Sudden Sniffing Death Syndrome had no history of previous inhalant abuse – they were first time users.
- According to the European School Project on Alcohol and other drugs, 20% of youth in the 12 to 16 age group have tried inhalants.
- A US government study was done showing 52% of the treatment admissions that were inhalant related in 2008 were 18 to 29 years of age. 32% were aged 30 to 44 years old and 16% were 45 and older. Crack, LSD, Heroin and PCP use by adults were lower than inhalant abuse by adults.

- Safety is a never ending project

Kent Anderson, ASTI

In conclusion

All refrigerants must be handled with respect

- All refrigerants have to be dealt with taking in to account their properties
 - Some are toxic
 - Some are flammable
 - Some are both
- All HVAC&R systems have to be maintained for several reasons
 - Safety
 - Efficiency
 - Noise

Safety First!
Take Care

**And thank you for your
very kind attention**