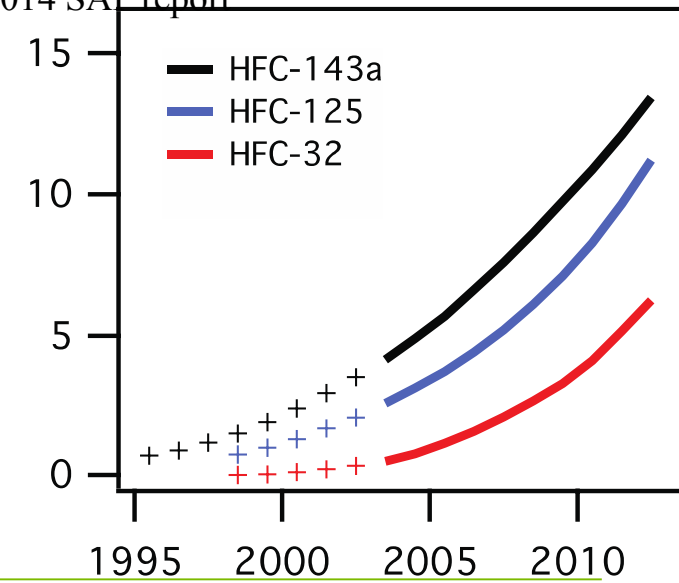
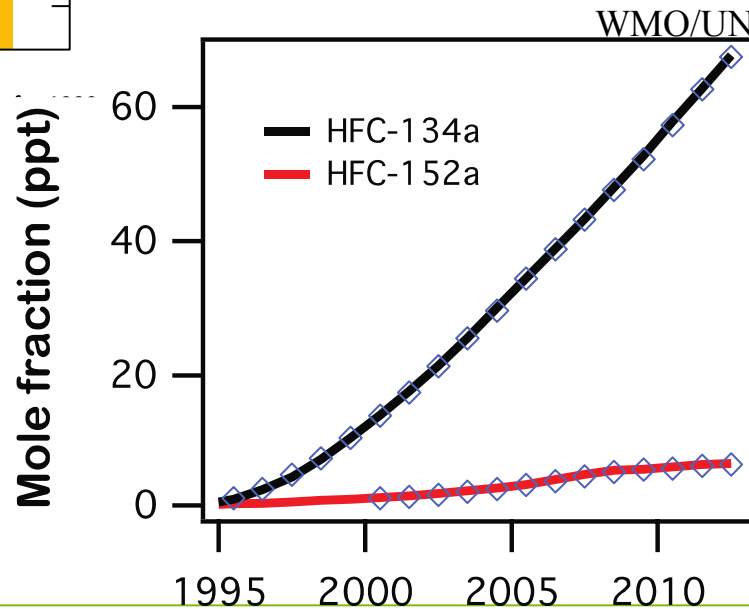
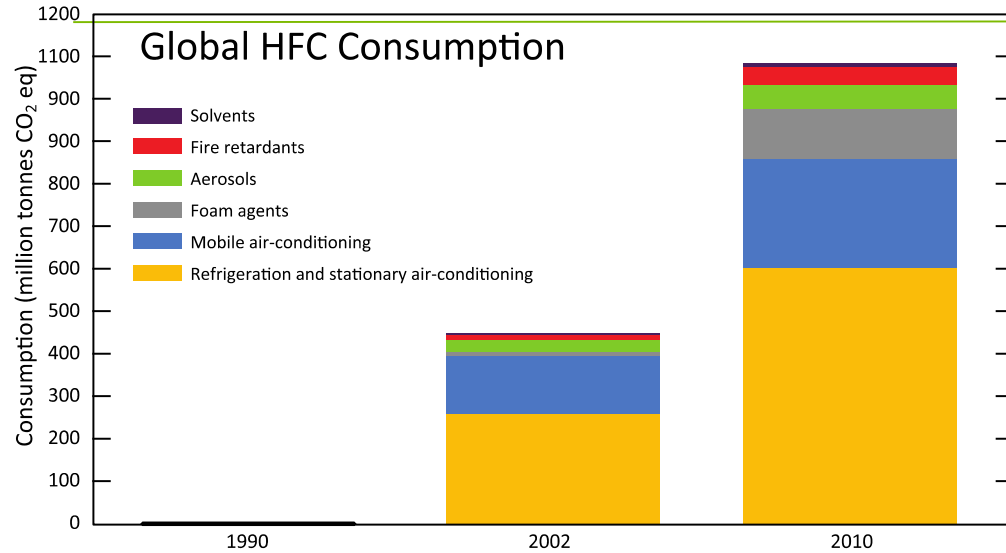


# Safe handling of natural refrigerants



# The global warming has been linked to the consumption of HFC



# Natural refrigerants



Current refrigerants	Alternatives
R134a	R290/R600a
	R600a
R404A R507A R22	R717
	R723
	R290
	R1270
R23	R170
Various	R744

Natural refrigerants are defined as:  
Naturally occurring in nature  
That they are naturally degraded in atmosphere  
without creating toxic breakdown product

## Accidents happen:



# Inquiry into the Explosion and Fire at Icepak Coolstores, Tamahere, on 5 April 2008

## Freon leak at Durham Marketplace 'sounded like an explosion'

By Alexis Macarchuk  
[news@seacoastonline.com](mailto:news@seacoastonline.com)  
Photographer Deb Gram contributed to this report.

April 02, 2010 10:02 AM



DURHAM — Emergency responders were dispatched to the Durham Marketplace Friday morning after a burst pipe caused a freon gas leak, leading to the evacuation of employees and customers from the food market.

Store manager Perry Shaw said there were no injuries and everyone made it out of the building within two minutes. The Durham fire and police departments responded to the scene shortly after Shaw placed a call at around 9:30 a.m.

Produce manager Susan Partington said she heard a loud pop that "sounded like an explosion." After the pop, Partington said she saw what looked like smoke coming from the compressor room and summonsed Perry, who knew it was Freon.

"I got on the intercom system and said 'everyone out of the store,'" he said.

Store owner Chuck Cressy credits Perry with saving patrons from the harmful effects of the gas. Exposure sucks up oxygen in the atmosphere and can cause people to lose consciousness.

Cressy said he didn't anticipate losing any produce because of the leak and while Freon leaks are rare, they happen often enough that management and refrigeration companies know what to do.

"I've been in the business since 1973 and it's only happened one other time," he said.

F128045

## The Human Body and Freon Exposure

If you are exposed to Freon on the job place, you should keep in mind that the chemical is not completely harmless to your body. So, it is important that you have regular checkups at least once a year. All medical exams should give due consideration to the possibility that Freon might be affecting your heart. In most cases, Freon exposure is in small quantities, for example, in case of leaks from the refrigerator or the air conditioner. However, if you have known heart problems, you need to be very careful with Freon because it can cause irregular heartbeat, i.e. cardiac arrhythmia.

When Freon gases are in very high concentration, they can cause dizziness, asphyxia and loss of coordination and concentration. They may cause irritation, particularly with regard to sensitive skin (skin rashes, dermatitis, etc.), but the good news is that Freon has no long term effects on health. Freon is not a mutagen, teratogen or carcinogen, and it does not affect the liver.

Read more: <http://www.doityourself.com/stry/3-health-effects-of-freon-exposure#b#ixzz34YBWqDgw>

## R134a leak sends eight to hospital



Posted on Sunday, January 19, 2014

GERMANY: Eight people were taken to hospital on Wednesday following a refrigerant leak at a factory outlet store in Metzingen, south west Germany.

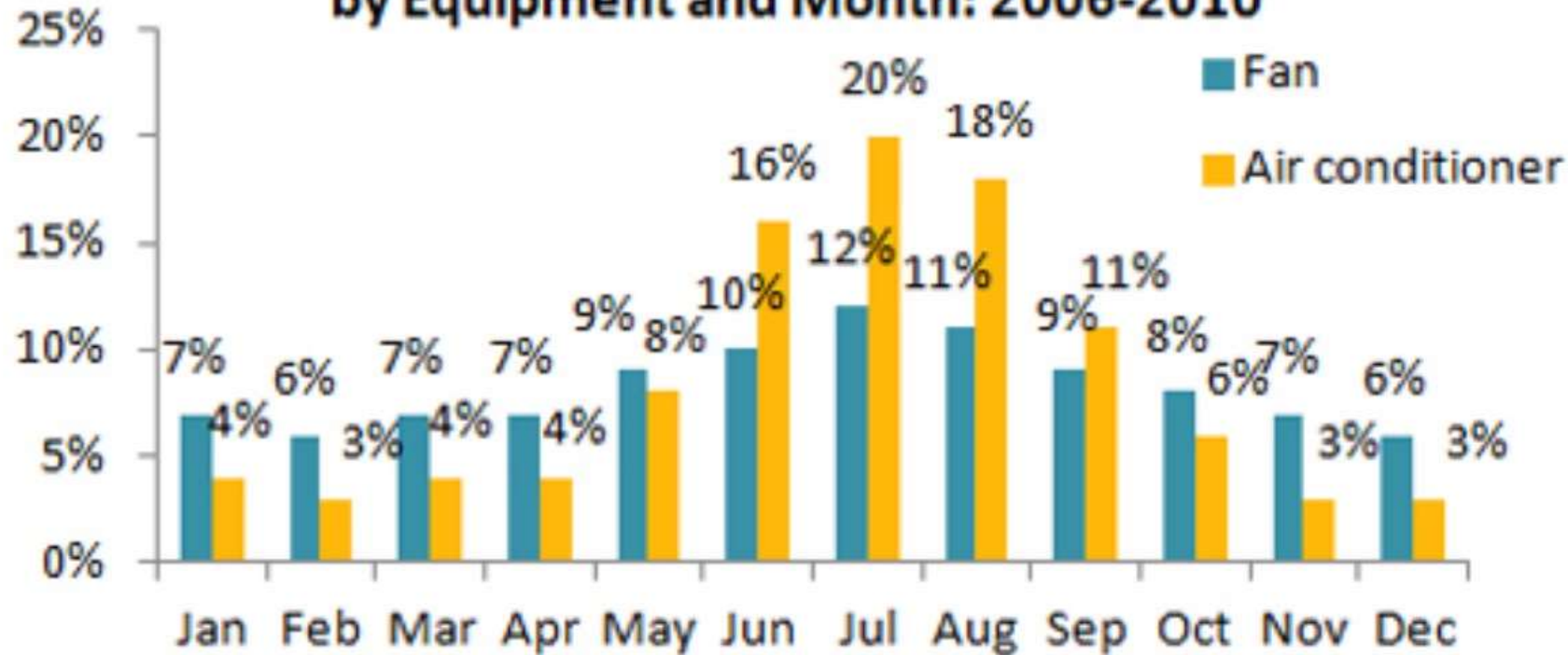
The fire service was summoned to the store after an automatic smoke detector was triggered by the leak. According to the local fire service report a pressure relief valve leaked a large amount of R134a during maintenance work on the air conditioning system.

The store was evacuated and 32 people treated at the scene. Eight were taken to hospital for further observation.

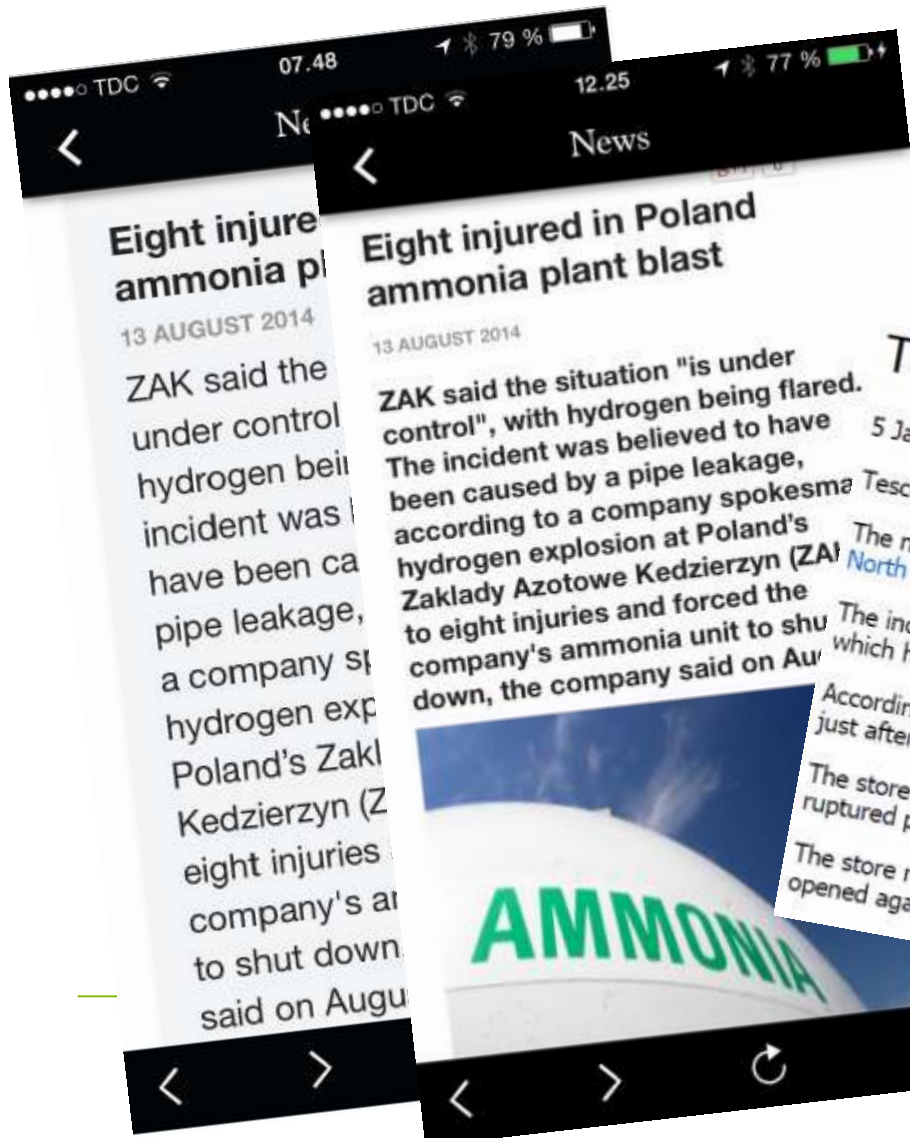
We are not here discussing the everyday occurring accidents



### Home Fires Involving Air Conditioning, Fans or Related Equipment by Equipment and Month: 2006-2010



With modern technology information is out seconds after the accident happen



---

The press only tells you a little

It is not always the true story

Often important details are missing

**TABLE A-1. Fatal occupational injuries by industry and event or exposure, all United States, 2013**

Industry <sup>1</sup>	NAICS code <sup>1</sup>	Total fatal injuries (number)	Event or exposure <sup>2</sup>					
			Violence and other injuries by persons or animals <sup>3</sup>	Transportation incidents <sup>4</sup>	Fires and explosions	Falls, slips, trips	Exposure to harmful substances or environments	Contact with objects and equipment
Boiler, tank, and shipping container manufacturing	3324	3	--	1	--	--	--	--
Metal can, box, and other metal container (light gauge) manufacturing	33243	1	--	1	--	--	--	--
Spring and wire product manufacturing	3326	3	--	--	--	--	--	--
Spring and wire product manufacturing	33261	3	--	--	--	--	--	--
Machine shops; turned product; and screw, nut, and bolt manufacturing	3327	9	--	--	--	--	--	6
Machine shops	33271	8	--	--	--	--	--	6
Coating, engraving, heat treating, and allied activities	3328	8	--	--	--	--	--	4
Coating, engraving, heat treating, and allied activities	33281	8	--	--	--	--	--	4
Electroplating, plating, polishing, anodizing, and coloring	332813	6	--	--	--	--	--	3
Machinery manufacturing	333	26	3	6	--	3	4	10
Agriculture, construction, and mining machinery manufacturing	3331	9	1	3	--	1	--	3
Agricultural implement manufacturing	33311	2	--	--	--	--	--	--
Farm machinery and equipment manufacturing	333111	2	--	--	--	--	--	--
Construction machinery manufacturing	33312	6	1	--	--	1	--	3
Commercial and service industry machinery manufacturing	3333	1	--	--	--	--	--	1
Commercial and service industry machinery manufacturing	33331	1	--	--	--	--	--	1
Ventilation, heating, air-conditioning, and commercial refrigeration equipment manufacturing	3334	1	--	--	--	1	--	--
Ventilation, heating, air-conditioning, and commercial refrigeration equipment manufacturing	33341	1	--	--	--	1	--	--
Air-conditioning and warm air heating eqp. and commercial and industrial refrigeration eqp. mfg.	333415	1	--	--	--	1	--	--



Fatal occupational injuries, total hours worked, and rates of fatal occupational injuries by selected worker characteristics, occupations, and industries, civilian workers, 2013 - continued



Characteristic	Total fatal injuries	Total hours worked <sup>1</sup> (millions)	Fatal injury rate <sup>2</sup>
Janitors and building cleaners	45	3,837	2.2
Grounds maintenance workers	151	2,264	13.1
Personal care and service occupations	48	8,851	1.0
<b>Sales and office occupations</b>	<b>295</b>	<b>59,770</b>	<b>1.0</b>
Sales and related occupations	220	28,102	1.6
First-line supervisors/managers of retail sales workers	84	6,729	2.5
First-line supervisors/managers of non-retail sales workers	20	2,557	1.6
Cashiers	34	4,653	1.5
Retail salespersons	32	5,307	1.2
Office and administrative support occupations	75	31,695	0.5
<b>Natural resources, construction, and maintenance occupations</b>	<b>1,447</b>	<b>25,679</b>	<b>11.1</b>
Farming, fishing, and forestry occupations	232	1,886	23.9
Miscellaneous agricultural workers	125	1,335	17.8
Fishers and related fishing workers	27	72	75.0
Logging workers	59	127	91.3
Construction and extraction occupations	845	13,706	12.2
First-line supervisors/managers of construction trades and extraction workers	122	1,450	16.6
Carpenters	77	2,173	6.9
Construction laborers	220	2,410	18.1
Operating engineers and other construction equipment operators	25	745	6.7
Electricians	64	1,502	8.5
Painters, construction and maintenance	40	851	9.4
Pipelayers, plumbers, pipefitters, and steamfitters	38	1,035	7.3
Roofers	72	346	40.5
Mining machine operators	16	119	26.9
Other extraction workers	19	81	46.9
Installation, maintenance, and repair occupations	370	10,078	7.2
First-line supervisors/managers of mechanics, installers, and repairers	32	583	11.0
Automotive service technicians and mechanics	32	1,742	3.6
Bus and truck mechanics and diesel engine specialists	28	653	8.6
Heating, air conditioning, and refrigeration mechanics and installers	29	762	7.6

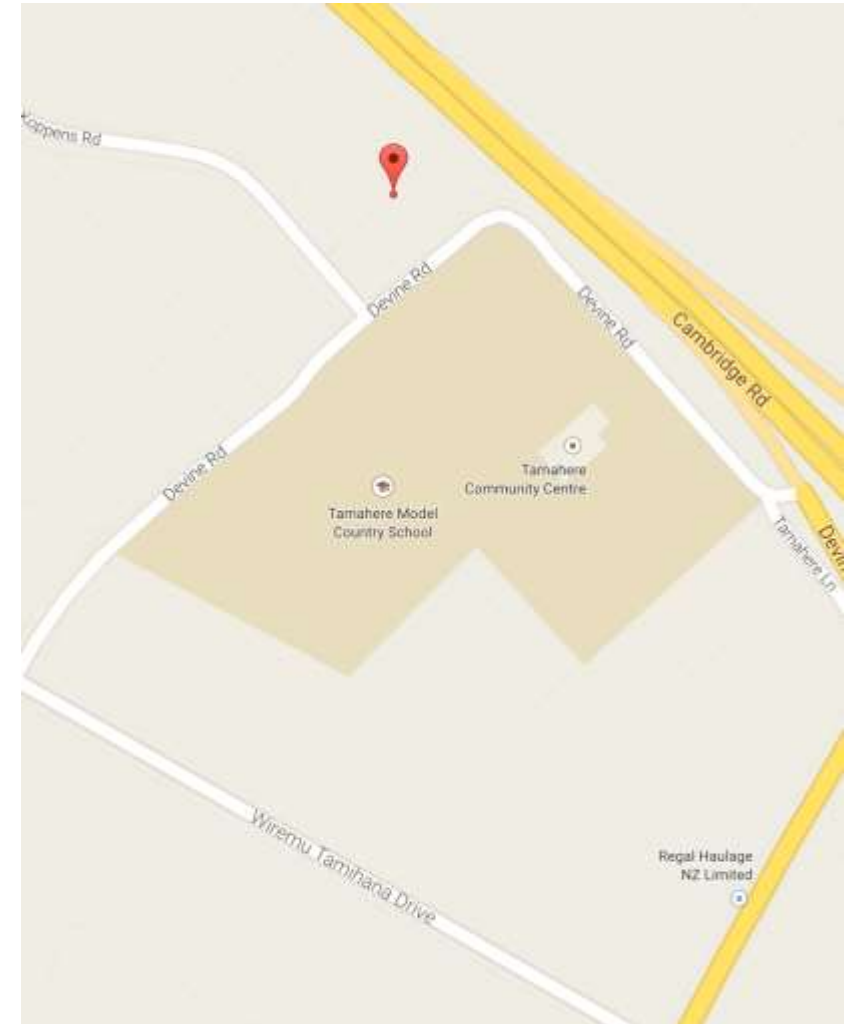
# Icepak Coldstores, Tamahere, New Zealand



8 April 2008  
One firefighter killed  
Seven injured  
A new fire engine burned out

A leaking R-22 system was retrofitted in to a HC solution without upgrading the site or the system

Non of the recommendations from industry leaders or standards were followed



## Melting butter and cheese



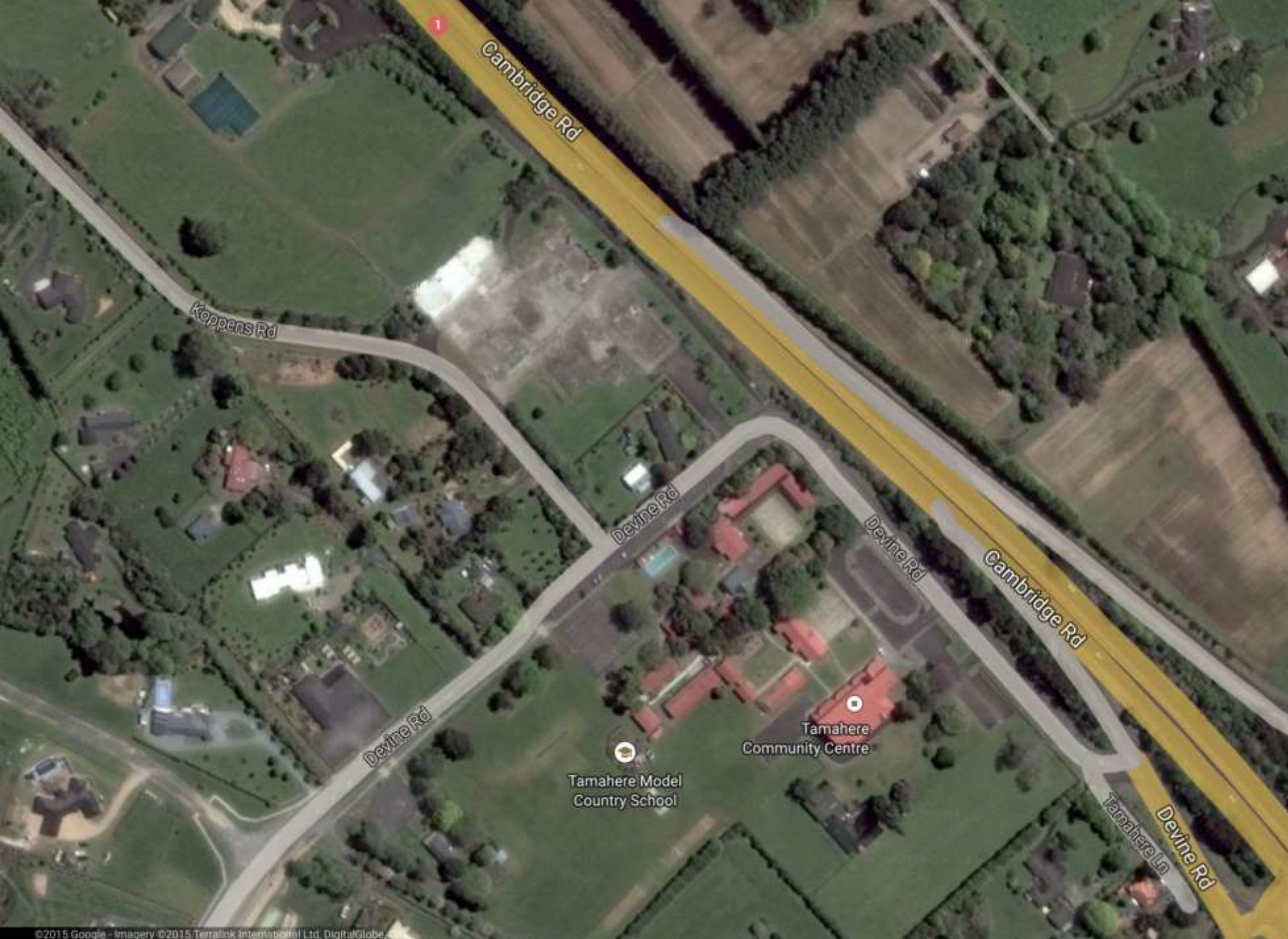
The number of fatalities became less because of quick and competent aid

After the blast the fire fuelled it self and burnt down the building

Minor part of the buildings were saved by competent fire service







## What made it go so wrong?

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A leaking R-22 system had been converted in to a HC solution

No machine room ventilation

No proper gas detection system in place

Parking of gas driven trucks in plant room

The doors were locked in a way that prevented entrance without cutting tools

The conversion should have been done by a qualified company

The normal standards would have prevented the accident

Fix leaks before you convert a system – to any other gas

# AC technician injured after explosion at Kendall home

*Posted: Aug 26, 2014 3:27 PM RDT*

*Updated: Oct 21, 2014 3:27 PM RDT*

SOUTHWEST MIAMI-DADE, Fla. (WSVN) -- An air conditioning technician was injured after an explosion occurred while he was working at a South Florida home, Monday.

Officials said the explosion happened just after 8 a.m., when a worker was servicing an AC unit near Southwest 144th Court and 85th Street in Kendall.

The homeowners said they were able to get help quickly from a police officer who lives next door. "My wife heard the explosion," said homeowner Luis. "She called 911 right away, and we have our next door neighbor, he's an officer. He gave me the first aid."

The technician suffered injuries to his hands.

Officials are investigating the cause of the blast.



## Gas explosion kills one person in Binh Duong

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Gas explosion kills one person in Binh Duong

Police investigate the cause of a gas explosion in Thu Dau Mot City. — VNA/VNS Photo Duong Chi Tuong

BINH DUONG (VNS) — One person was killed and two others were seriously injured in a gas explosion this morning in the southern province of Binh Duong.

The explosion happened at 8am in Thanh Nha Trade Ltd Company in Phu Tho district of Thu Dau Mot City.

The two seriously injured persons were admitted to Binh Duong General Hospital.

A resident living near the company said the blast was huge, with debris falling everywhere, creating panic among the residents.

One inspector said the cause of the blast could be the company workers' negligence while filling gas in the gas holder of an air conditioner. — VNS

Latest update,  
Vietnam case:

The explosion happened due to unsafe service of technicians when brazing, using LPG. There was no either explosion of the R-22 cylinder nor compressor.



Another

# Two die in reported ac explosion

Posted on Monday, May 4, 2015 - Leave a Comment



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CAMBODIA: Two ac engineers are said to have been killed after an air conditioner they were fixing reportedly exploded.

According to newspaper website reports, the two victims in their 20s were called to the Thai-owned Pailin Flamingo Casino Hotel & Entertainment Complex on Saturday to fix a number of faulty floor-standing air conditioners.

Both employees of a Phnom-Penh-based air conditioner repair company, the *Cambodia Daily* reports that the men were at work on one of the machines in a covered courtyard at the casino when it exploded. Both men are said to have suffered severe burns. One died at the scene, the other succumbed to his injuries on the way to a hospital.





And another

1 KILLED, 2 INJURED IN GULSHAN AC BLAST



# 1 killed, 2 injured in Gulshan AC blast



*Fire fighters recover the body of the victim who dies in an air conditioner blast of a 14-story hotel in Gulshan-2 of Dhaka on Friday afternoon. Photo: Palash Khan*

One person died and two others sustained serious injuries in an air conditioner blast of a 14-story hotel in Gulshan-2 of Dhaka this afternoon.

The deceased was identified as Anwar Hossain, 25. The other injured could not be known immediately.

The blast took place around 3:15pm when the victim was working with a chiller of the air conditioner at 14-floor of the hotel, our reporter said quoting Al Amin reservation in-charge of the hotel.

The injured were taken to Dhaka Medical College and Hospital.

Two co-workers were also sustained serious injured in the blast.

On information, police and fire fighters rushed to spot.

The AC exploded with huge cracking sound and destroyed windowpanes of a nearby house owned by the former communication Syed Abul Hossain.

Talking to The Daily Star, Abul Hossain thought some miscreant for attacking his house with bomb.

He said the 14-story hotel has been built in the residential area illegally.

# Mystery surrounds ac explosions

Posted on Sunday, May 10, 2015 · Leave a Comment



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ASIA: Mystery surrounds a spate of fatal air-conditioning "explosions" in South and South East Asia in recent days.

Following *Cooling Post* reports of the deaths of two workers carrying out repairs on air conditioners at a hotel in Cambodia on Sunday May 3, reports reach us from neighbouring Vietnam of one death and two serious injuries from an explosion at an air conditioning repair shop three days later in Thu Dau Mot City.

Reports from this more recent incident on May 6 are confused but locals report a loud explosion. There is no definitive indication as to any link between this incident and the "explosion". The victims in Cambodia were said to have suffered serious burns, something not mentioned in the Vietnam incident.



Stock photo

However, a day later on Thursday May 7 in Bangladesh, another "explosion" involving an air conditioner in the city of Dhaka resulted in the death of one engineer and serious burns to another. One worker at the air conditioning workshop in the Kazipara area of the city died in hospital on Friday morning after sustaining 80% burns in what has been described as "an air conditioner gas cylinder explosion". The dead man's colleague who was helping him with the air conditioner at the time sustained 25% burns. Another engineer in the workshop told *TheReport24.com* that "the gas cylinder suddenly burst into flames with a bang" while the two victims were working on it.

A little over two weeks earlier up to five workers (some reports say four, some say five) were admitted to Dhaka Medical College Hospital with 7%-30% burns after another air conditioner was said to have exploded in the Moghbazar area of the city. The incident on April 20 was said to have occurred while an air conditioning compressor was being brazed.

The *Cooling Post* is aware of other similar, sometimes fatal, incidents – some in China . Many reports are confused and, sometimes, contradictory and it is unclear whether there is any causal link between the incidents.

## Latest update, Vietnam case:

The explosion happened due to unsafe service of technicians when brazing, using LPG. There was no either explosion of the R-22 cylinder nor compressor.

It happens in Europe as well



## Another engineer injured in ac “explosion”

Posted on Wednesday, May 13, 2015 · Leave a Comment

SHARE THIS ARTICLE

JOIN OUR NEWSLETTER

SPAIN: Another worker has been injured after a reported air conditioning explosion, this time in Spain.

An engineer working on an air conditioning unit on the roof of a commercial office building in Los Bermejales, Seville, suffered burns after the unit reportedly exploded.

According to the *Diario de Sevilla*, emergency services were called to the Centro Indotorre on avenida del Reino Unido at around 10.00 local time.

The injuries were not reported to be serious, the engineer suffering burns and injuries as a result of the impact of pieces of the air conditioner.



There were also unconfirmed reports some pieces of the air conditioner fell on and injured a pedestrian in the street below.

One person died and two were seriously injured in Vietnam last Wednesday (May 6) following a reported air conditioning explosion. Just three days earlier, two workers had died after an air conditioner they were working on “exploded” in Cambodia. The *Cooling Post* later uncovered reports that one man had died and one received serious burns after a similar incident on May 7 in Bangladesh.

There is currently nothing to link the incidents.

## Training is the key to success

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More than once it has happened that the technicians use O<sub>2</sub> for pressure test because it is at hand

Too many accidents happen because of risky behaviour; seems to be the case in the Vietnam case

A great portion of accidents are fall from height

Explosions have occurred with both R22, R134a and R407C because there was sufficient air in the system to reach the LFL at elevated pressure and temperature

Most common reason for fire in AC systems is lack of proper maintenance and cleaning

# Unsafe working conditions



## Other accidents

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### Wrong reaction

- pulling out electrical plugs when refrigerant leaks in the machine room
- only qualified persons are allowed in the machine room – exactly like for machine room for elevator systems
- machine room is not a storage room or parking room for fork lifts or other machines
- machine room and AC ventilation system must not be mixed
- detection system must be in place



## Accidents with ammonia

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Accidents with ammonia are generally rare

Ammonia has been in use for more than 150 years and trained staff are available in most parts of the world

Training requirements are well integrated and accepted in the industry

Standards and procedures are in place and under constant improvement when new methods become known

Safety requirements and personal protection gear is on the market

Qualified engineers and welders can be hired when needed

# Ammonia Leakage in A Food Refrigeration Factory, Shanghai, China



## Description of Injury:

- 15 people were killed , 7 people seriously injured.

Date of Incident : 13 Aug  
2013

## Incident Description:

- An operator conducted a defrost of an IQF freezer in an ammonia compressor room to increase the refrigeration efficiency.
- The hot ammonia gas mixed with the cold liquid ammonia resulting in a sudden increase in a liquid hammer.
- Several tons of ammonia leaked and killed the workers in the production area near the compressor room who could not escape quick enough.

## Root Cause:

- Wrong defrosting procedure (did not discharge the cold ammonia in the pipe).
- Poor welding quality of the cap with the header pipe.
- Poor design of the factory layout.
- Poor awareness and training of the temporary worker

## Lesson Leaned:

- To require the qualified worker and supplier to do the pressurized pipe welding.
- Training of the operators.



Damaged Header



The Cap off from the header

# A very important message!

---



You cannot and should not make rules or regulate on basis of accidents that happen when people go against standards and regulations

This kind of accidents are more a matter of view of human nature

When money becomes the #1 priority common sense is often neglected

## CO<sub>2</sub> releases causing no fatalities

---



In 2010 and 2011 a couple of incidents were reported in the UK

Components were the root cause to these incidents

Manufacturer admitted that there had been a quality problem

Since then many hundreds of systems have been installed with no further problems

## Huffing any gas is a deadly addiction



A 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



[http://www.addictionsearch.com/treatment\\_blog/huffing-freon-is-a-deadly-addiction\\_81.html](http://www.addictionsearch.com/treatment_blog/huffing-freon-is-a-deadly-addiction_81.html)



## Accidents will happen – but we can try to avoid them

---



EN 13313 describes the education level and what topics to be knowledgeable in

Training centres and institutes around the world can approve the skills achieved

Technicians need to be trained at least in handling the refrigerants they are to work with

Service technicians that are on call need to know more than installation only technicians

For doing leak check only you can be trained for this

Table A.1 — Basic thermodynamics

Basic thermodynamics	Tasks												
Description of tasks, see Clause 3 Terms and definitions	Design 3.8	Pre-assembling 3.9	Installation 3.10	Putting into Operation 3.11	Commissioning 3.12	Operating 3.13	In-service Inspection 3.14	Leakage checking 3.15	General Maintenance 3.16	Circuit Maintenance 3.17	Decommissioning 3.18	Removing Refrigerant 3.19	Dismantling 3.20
Skills to assess													

N. DS/EN 13313:2010

# An example

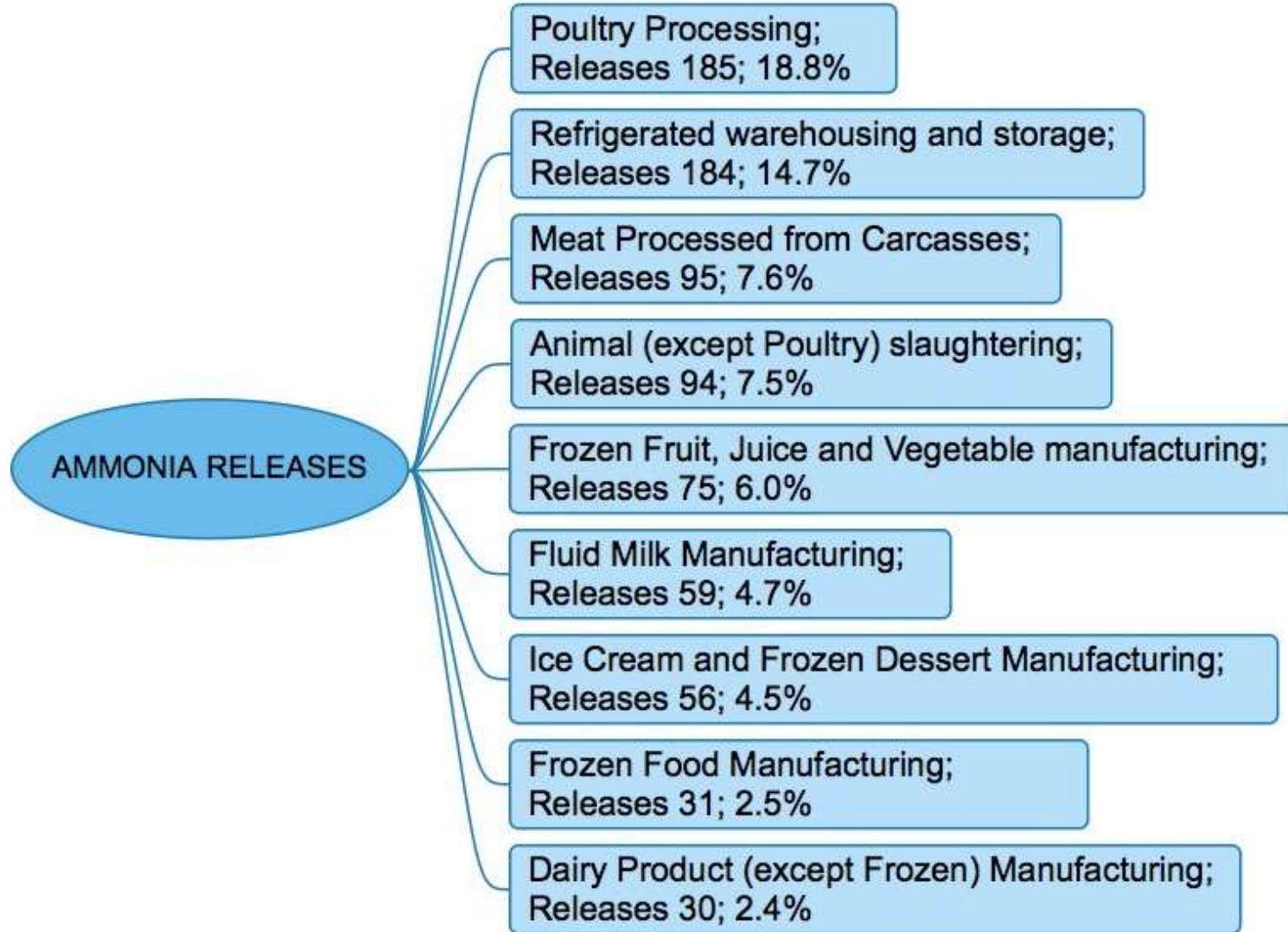


**Table A.3 — Piping, joints and valves**

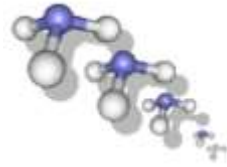
Piping, joints and valves	Tasks												
Description of tasks, see Clause 3 Terms and definitions	Design	Pre-assembling	Installation	Putting into Operation	Commissioning	Operating	In-service Inspection	Leakage checking	General Maintenance	Circuit Maintenance	Decommissioning	Removing Refrigerant	Dismantling
	3.8	3.9	3.10	3.11	3.12	3.13	3.14	3.15	3.16	3.17	3.18	3.19	3.20
Skills to assess													
Piping	FO	FO	FO	WK	WK	WK	WK	WK	WK	FO	WK	BA	FO
Joints	FO	FO	FO	WK	WK	WK	WK	WK	WK	FO	WK	FO	FO
Valves	FO	FO	FO	FO	WK	WK	WK	WK	WK	FO	WK	FO	FO
Thermal insulation	FO	FO	FO	WK	WK	WK	WK	WK	WK	WK	WK		
Pipe supports	FO	FO	FO	WK	WK	WK	WK	WK	WK	WK	WK		



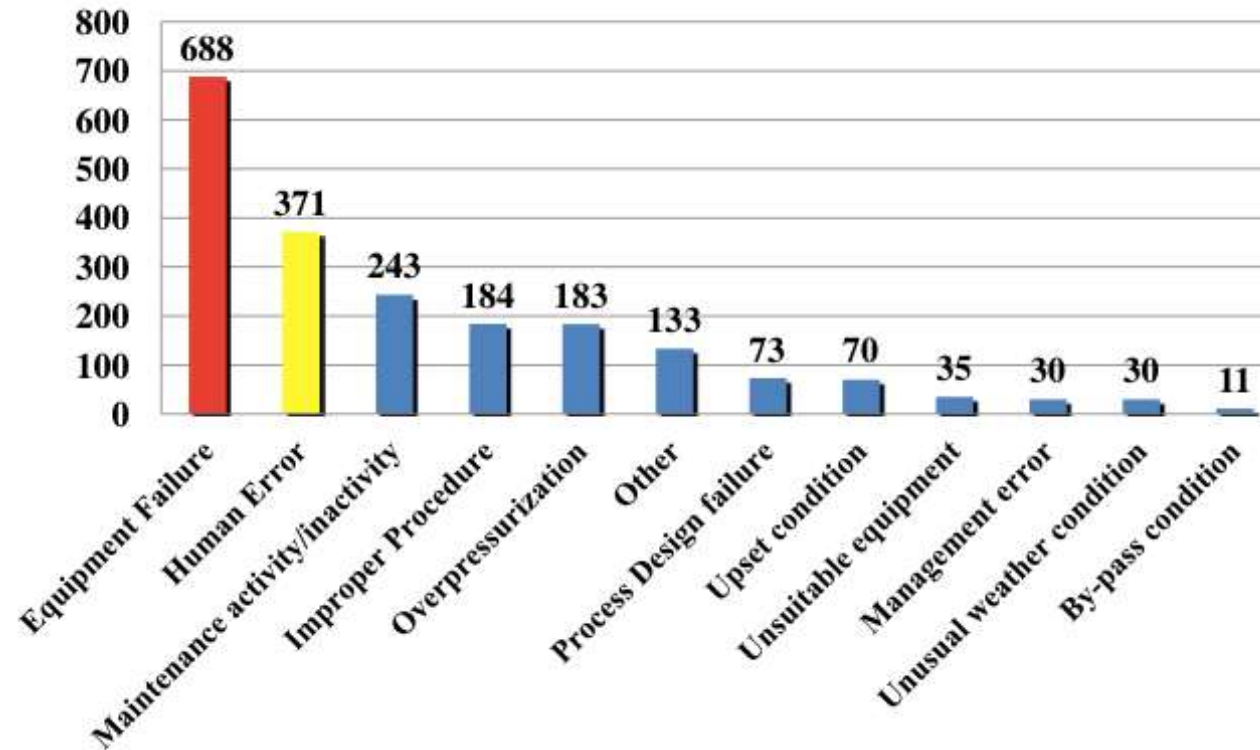
# NH<sub>3</sub> releases in the US



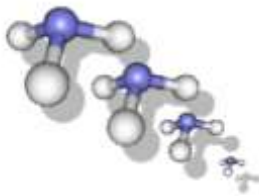
# Main contributions to ammonia releases



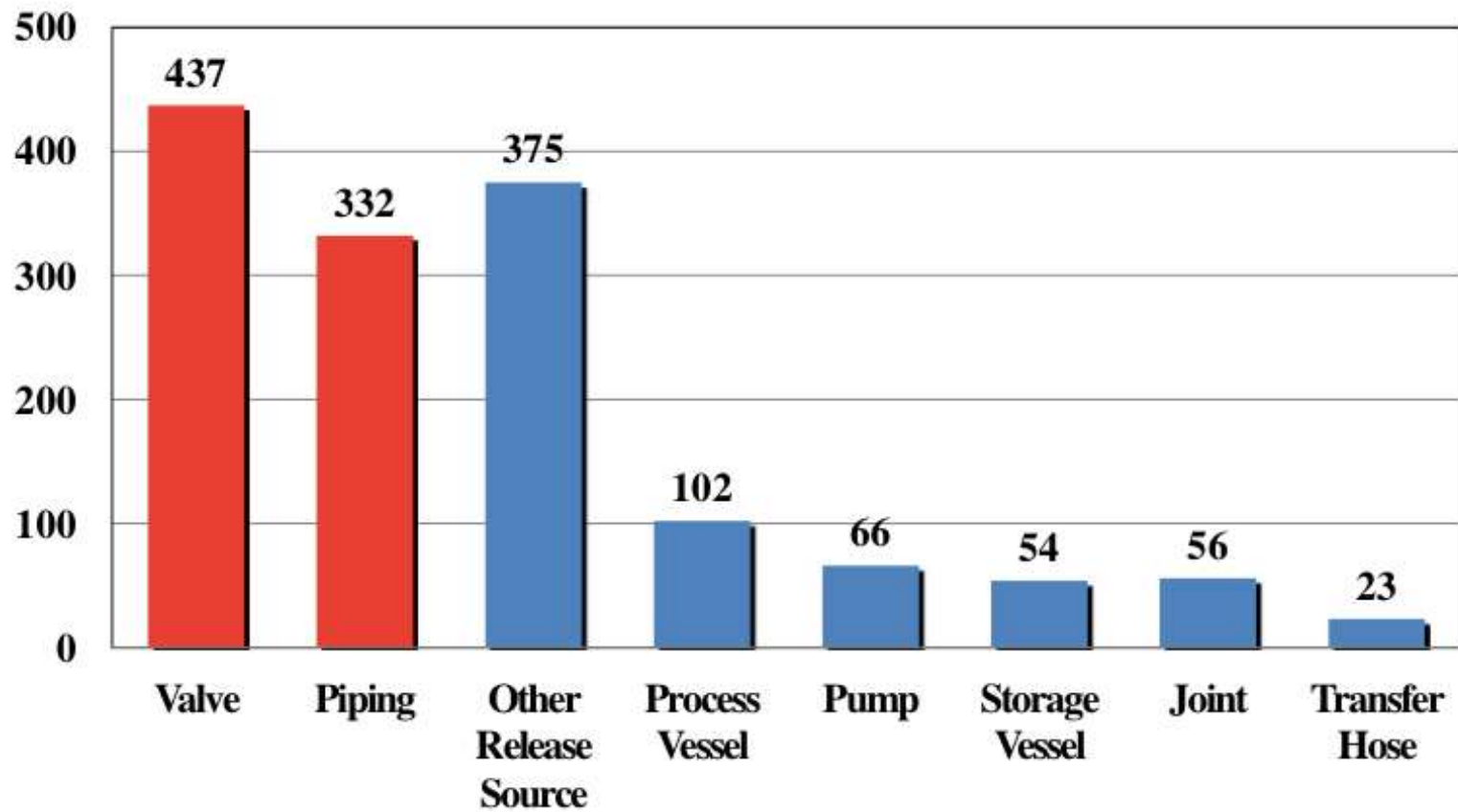
## RMP Ammonia Refrigeration Reasons for Release (1994-2013)



1,253 Total Releases

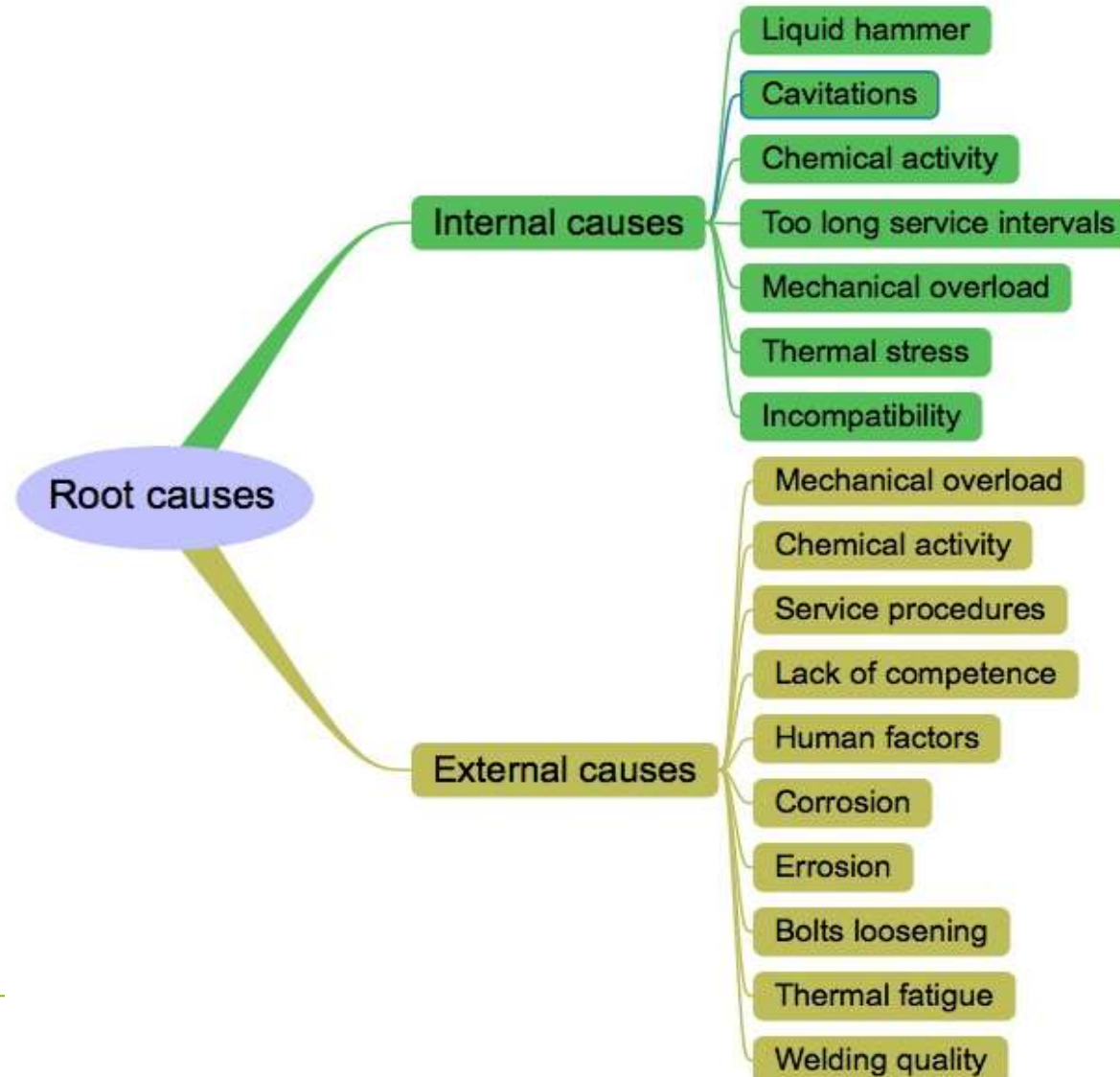


## RMP Ammonia Refrigeration Release Sources (1994-2013)

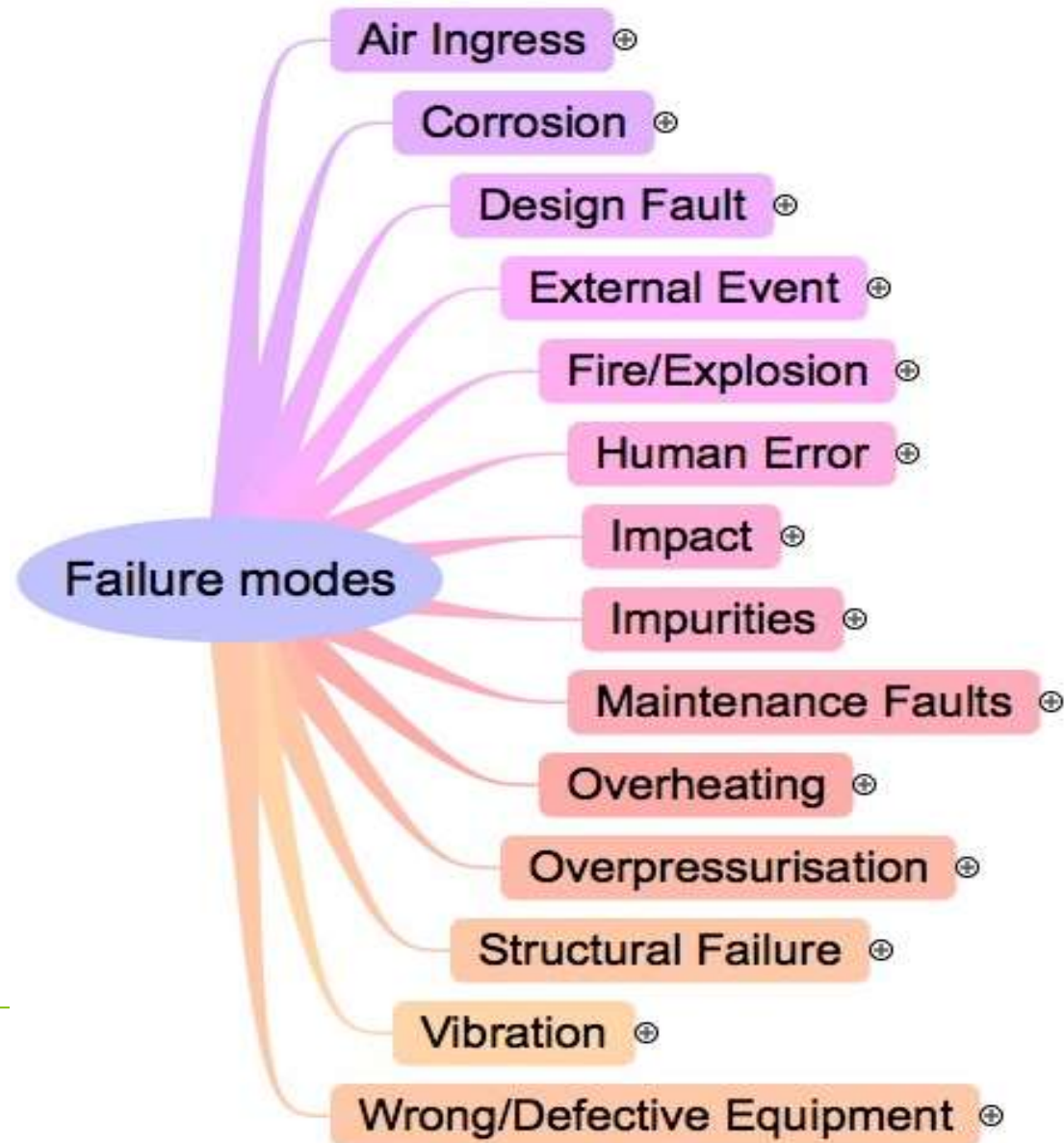


1,253 Total Releases

# 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 <sup>-1</sup>	10	
	other gases	0,5		
	High boiling residue	0,01		
	Acidity		1	
Iso-Butane				
R-600a	Water	10 mg kg <sup>-1</sup>	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



# There has been fake refrigerants in the market for a while



**Table 1A. Single Component Fluorocarbon Refrigerants and their Maximum Allowable Levels of Contaminants (continued)**

	Reporting Units	Reference Section	R-115	R-116	R-123	R-124	R-125	R-134a	R-141b
<i>CHARACTERISTICS:</i>									
Boiling Point <sup>1</sup>	°C @ 101.3 kPa	N/A	-38.9	-78.2	27.8	-12	-48.1	-26.1	32
Boiling Point Range <sup>1</sup>	K	N/A	± 0.3	± 0.3	± 0.3	± 0.3	± 0.3	± 0.3	± 0.3
Critical Temperature <sup>1</sup>	°C	N/A	80	19.9	183.7	122.3	66	101.1	206.8
Isomer Content Isomer	% by weight	N/A	N/A	N/A	0-8 R-123a+ R-123b	0-5 R-124a	N/A	0-0.5 R-134	0-0.1ea R-141, R-141a
<i>VAPOR PHASE CONTAMINANTS:</i>									
Air and Other Non-condensables	% by volume @ 25.0°C	5.1	1.5	1.5	N/A <sup>2</sup>	1.5	1.5	1.5	N/A <sup>2</sup>
<i>LIQUID PHASE CONTAMINANTS:</i>									
Water	ppm by weight	5.4	10	10	20	10	10	10	100
All Other Volatile Impurities	% by weight	5.11	0.5	0.5	0.5	0.5	0.5	0.5	0.9
Halogenated Unsaturated Volatile Impurities	ppm by weight	5.11.2.1	40	40	40	40	40	See footnote <sup>4</sup>	40
High Boiling Residue	% by volume or % by weight	5.8	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Particulates/Solids	Pass or Fail	5.9	Visually clean	Visually clean	Visually clean	Visually clean	Visually clean	Visually clean	Visually clean
Acidity	ppm by weight (as HCl)	5.7	1	1	1	1	1	1	1
Chloride <sup>3</sup>	Pass or Fail	5.6	No visible turbidity	No visible turbidity	No visible turbidity	No visible turbidity	No visible turbidity	No visible turbidity	No visible turbidity
Notes:									
1. Boiling points, boiling point ranges and critical temperatures, although not required, are provided for informational purposes. Refrigerant data compiled from Refprop 9.1.									
2. Since R-11, R-113, R-123, R-141b, R-245fa, and R-1233zd(E) have normal boiling points near or above room temperature, non-condensable determinations are not required for these refrigerants.									
3. Recognized chloride level for pass/fail is about 3 ppm.									
4. Up to 5000 ppm R-1234yf is acceptable as a halogenated unsaturated volatile impurity in R-134a									
N/A Not Applicable									

A/HRI STANDARD 700-2014

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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 CO<sub>2</sub> can help absorbing ammonia

Other refrigerants can only be ventilated away

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

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## What happens if the ammonia is contaminated?



Chemical reactions will influence the efficiency and reliability and reduce the expected operational lifetime of the system dramatically

In ammonia systems you get a different polymers that obstruct the functions of valves and block the refrigerant flow to pressure transmitters and temperature sensors

**New**



**Used  
(1)**

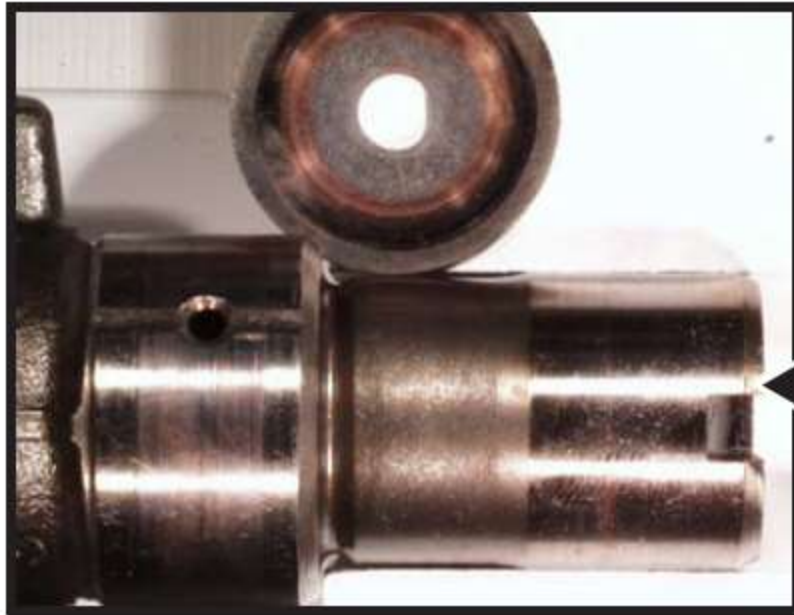


# What happens if the HFC is contaminated?



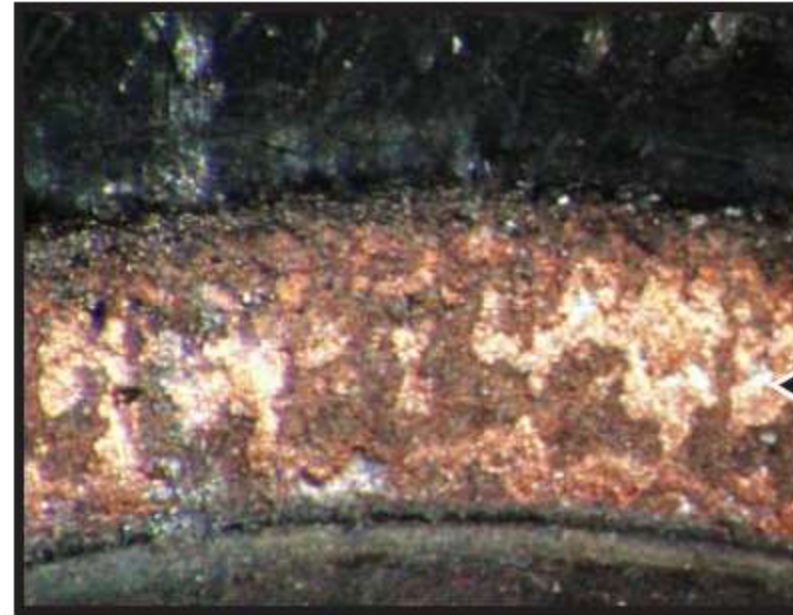
High temperatures and water increase the reaction and the formation of HF which is the dominating acid in HFC systems

The typical result is copper plating of valves and bearings



**Crank Shaft (loaded)**

Scored/Copper Plated



**Suction Reed (micro)**


Corrosion/Copper Plating

# New Refrigerants coming up




DuPont	new	ASHRAE
R404A	XP40	R449A
R134a	XP10	R513A
	Opteon yf	R1234yf
R410A	XL41	R454B
R22	DR-91	N/A
<b>Honeywell</b>		
R404A	Performax	R407F
	N40	R448A
R134a	N13	R450A
	Solstice ze	R1234ze
R410A	L41	R447A
R123/R245fa	Solstice zd	R1233zd
R22	N-20	N/A


**Solstice® family**



**Solstice® yf**



**Solstice® ze**



**Solstice® zd**

## A little flash back from the introduction of the first HFC's



	R134a	R404A	other ref.	Soldering	others, e.eg. POE
<b>Dizziness</b>	11	9	4	13	
<b>Diarrhoea</b>	6	5	1	5	1
<b>Vomiting</b>	2	7	1	6	
<b>Cardiac irregularities</b>	2	4	0	6	
<b>Eczema, itching</b>	3	2	0	3	3
<b>other, e.g. Headache</b>	2	2	0	3	

169 questionnaires answered in Denmark 1998

## About HFC and others

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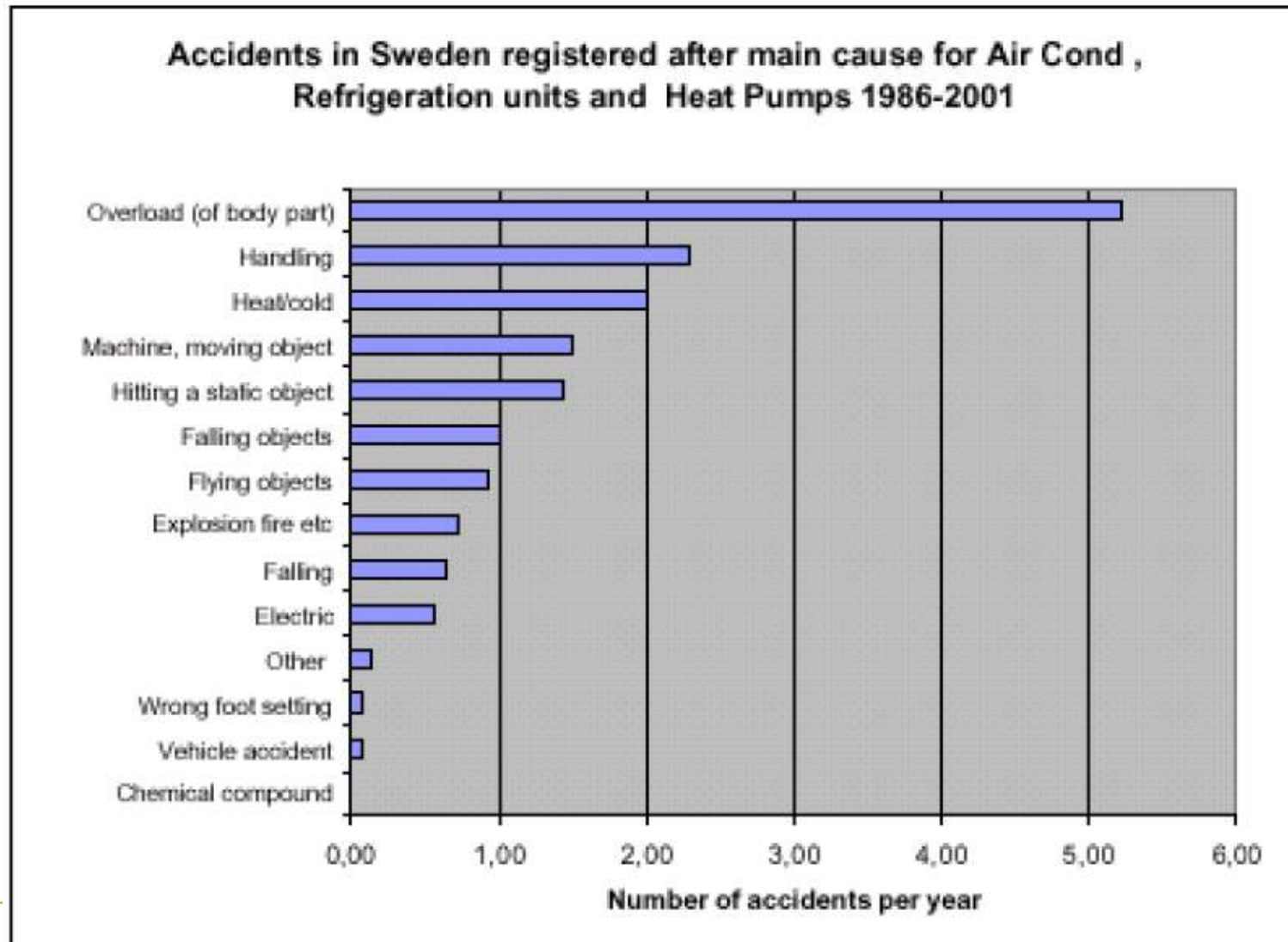
There are no statistics that show how many accidents happen with HFC because only death are registered  
Incidents with HFC are very often classified under other class of accidents such as fall from height  
Many papers have been produced on the topic over the years not getting closer to a picture

We know about fatalities

We know it happens but we cannot learn from them

We read about fatalities in the press without getting the full picture of what happened

## From Sweden we know a little





## Inferior counterfeit refrigerants cause three fatalities

Tuesday, 20 March 2012 09:12 | Kaabelsoe Matshediso

A recent spate of exploding refrigerated containers has been reported in Brazil, China and Vietnam. These explosions have caused the deaths of several port workers and the accidents have forced the grounding of thousands of refrigerated containers by international shipping lines.

Pure R134a containing methyl chloride (R40), in a cocktail refrigerant may be responsible for the explosions and the deaths of the workers. According to reports, the methyl chloride contained in the counterfeit refrigerant blend, reacted with the aluminium in the system, producing highly inflammable gases which are self-igniting and explosive on contact with air.



Besides the obvious safety risks, R40 has the following negative effects:

- Attacks plastics and damages compressor hoses
- Synthetic Polyol ester oil is emulsified by the reaction and splits into its component materials
- It is not compatible with metals and can cause pit corrosion.

A leading international compressor manufacturer has named methyl chloride as a constituent in fake refrigerants which has been responsible for an increasing number of compressor breakdowns. Unsure whether there is a link between the fatalities and the compressor breakdowns, they have identified the bogus R134a refrigerant consists mainly of R22, R30, R40 (methyl chloride) and R142b.

A-GAS once again urges all refrigerant users to purchase from reputable suppliers and insist on certificates of analysis /conformance with these purchases, so as to ensure first and foremost their safety and secondly that the products are indeed what is being paid for!

This should go a long way in minimising any local incidents such as those which have occurred elsewhere in the world. We are aware that this dangerous cocktail has surfaced locally so we caution all refrigerant users to be extremely careful when sourcing refrigerant.

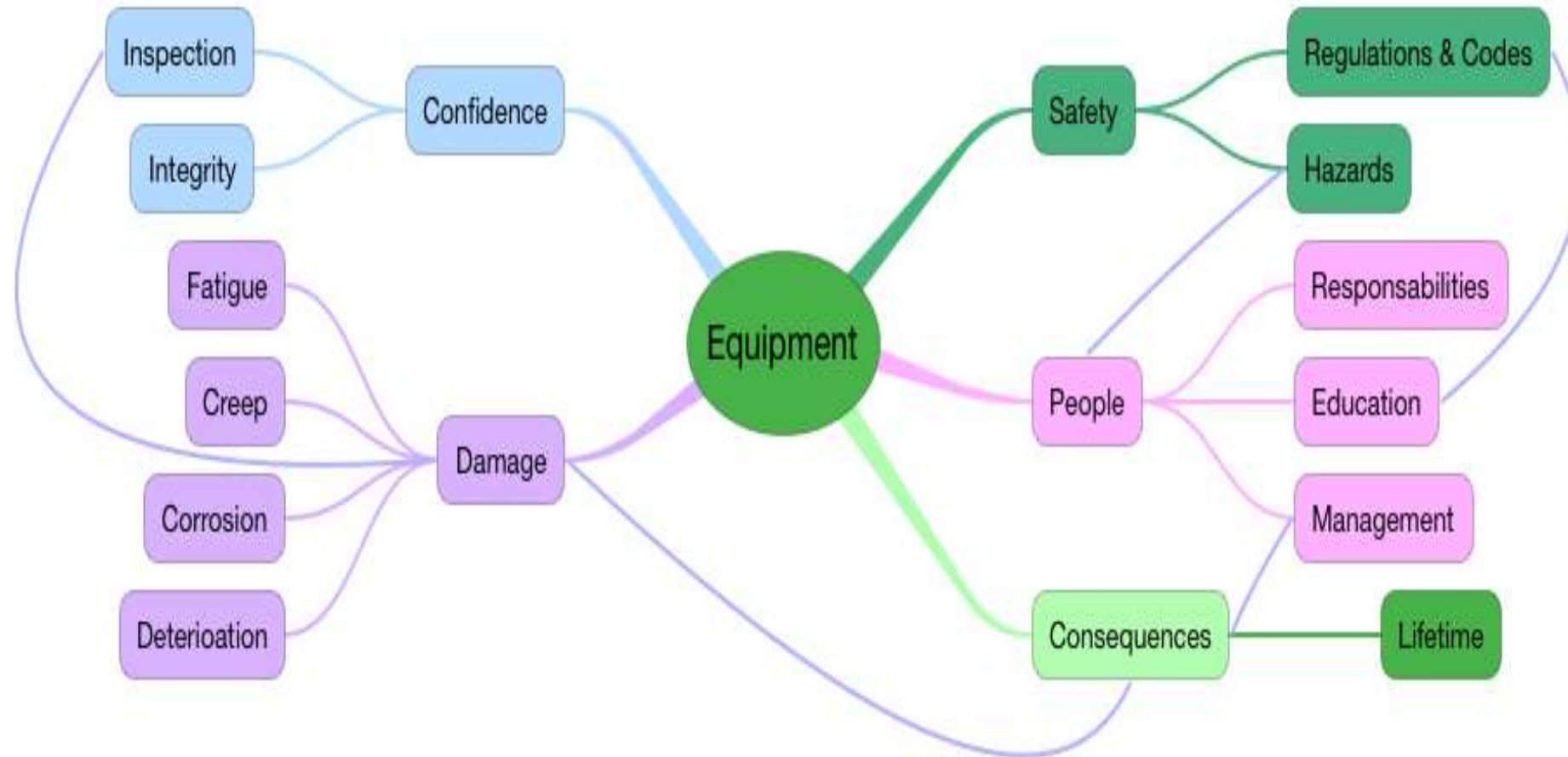
Some accidents and fatalities have been caused by blends containing methyl chloride (R-40)

These blends have been sold on all markets and for all types of systems

In large systems with few aluminium parts you get a white powder in the system

In mobile systems with a lot of aluminium parts you can get violent explosions

# Keep the equipment in good shape – it is a good investment



**”The analyses of accident databases indicate that the proportion of accidents occurring when the plant is in some abnormal state may be 40% or more. Maintenance appears to be a particularly important abnormal state”**

Ref: “Det Norske Veritas Ltd for  
The Health and Safety  
Executive”

# Safety is a lifestyle and a way of thinking

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Safety has to be part of the company policy from top to bottom

Management needs to focus keeping up safety on all levels

Safety has to be rooted in everything you do and think

ISO-18000 part 1&2 is a good place to start

# Conclusions

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All refrigerants have to be dealt with taking in to account their properties

- Some are toxic
- Some are flammable
- Some are both
- Some produce toxic break down product when heated

All HVAC&R systems have to be maintained for several reasons

- Safety
- Efficiency
- Noise

## Conclusions

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- No refrigerant is more safe than others
- Safety is a life long process
- Accidents will happen but we can make sure the consequences are as small as possible
- Training and updating is essential to ensure the use of correct habits and procedures
- Safety starts from the top in the company, without the managements focus is will not work
- There are standards, guide lines and regulations in place that will help preventing the worst accidents
- Enforcement from the authorities will ensure compliance
- Local safety systems and organisation will help the culture change together with the management

Although maintenance can cause accidents the lack of maintenance is much more common reason for fire and other accidents

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You have the right to a safe workplace

Source: [www.osha.gov](http://www.osha.gov)

Thank you for your kind attention