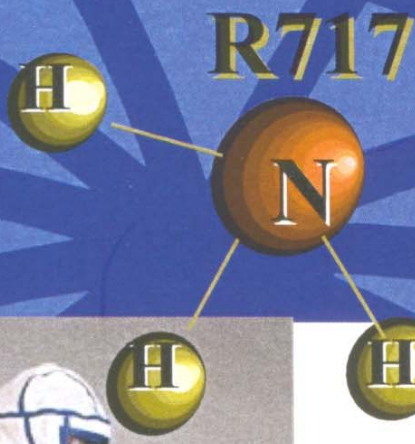
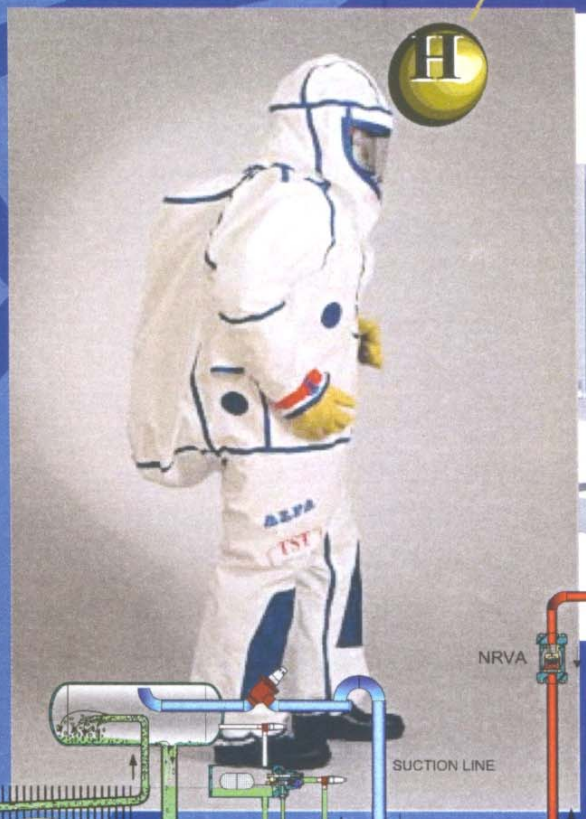
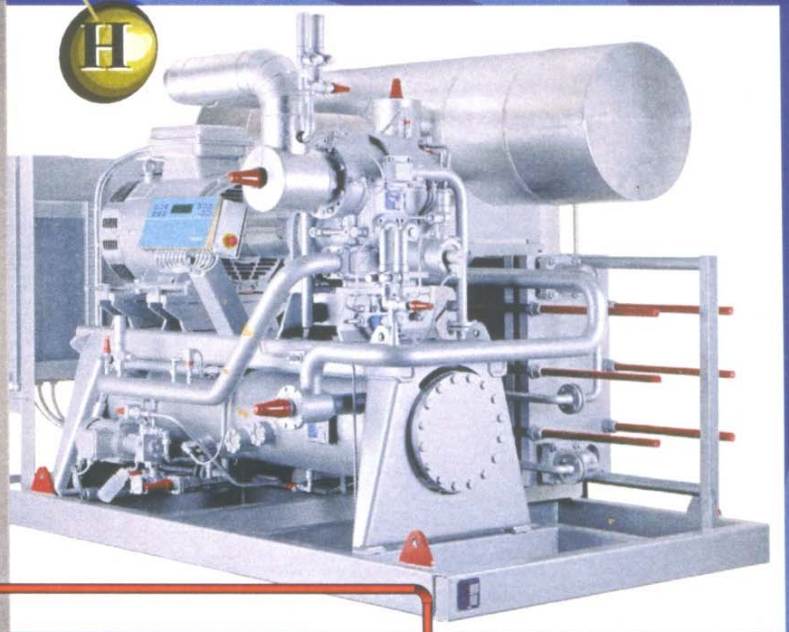
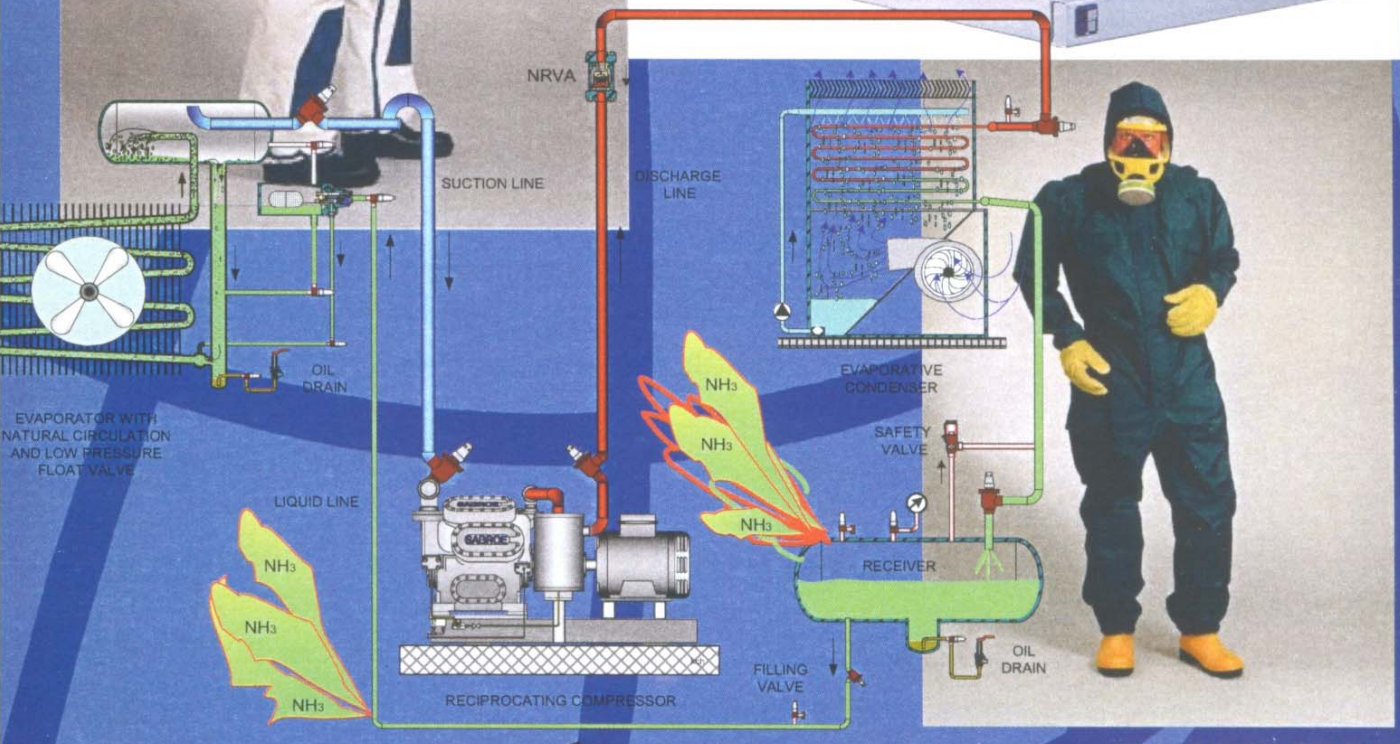
HANDBOOK OF AMMONIA SAFETY









Kurt C. Hilbrecht
YORK Service Training, DK

YORK® Refrigeration

Handbook of ammonia safety

Contents

Preface

The instructions in the handbook only provide general information. The owner of the refrigeration plant is responsible for ensuring that all codes, regulations and industry standards are complied with.

WARNING

No plant can ever be said to be too safe.
Safety is a way of life.

Kurt C. Hilbrecht
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Rule No 1:
Know your refrigeration plant!

You must:

- *Know the strengths and especially weaknesses of the plant.*
  (E.g. too small condenser, receiver, pump separator, missing valves etc.)
- *Know the **P&I** diagram.*
- *Know the location of the emergency stop.*
- *Know the location of the nearest first aid kit.*
- *Know the location of the nearest fire hose and shower station.*

Rule No 2:
Before starting the job you must:

- *Take the necessary safety precautions.* *(Eye wash, masks, gloves)*
- ***OBS! Never use contact lenses when you work with ammonia.In case of ammonia splash into your eyes,contact lenses can be glued to the cornea and gives you permanent eye damage.***
- *Always make sure that someone knows where you are.*
- *Know where you can get help.*

Rule No 3:
In case of a leak - never enter a room with ammonia vapours alone!

You must:

- *Take care of the security of others.*
  - Evacuation.
- *Contact persons according to emergency plan.*
- *In case of major leaks contact the relevant authorities.*
  - Police: 112.(911)

Rule No 4:
Quick and correct action reduces the damage!

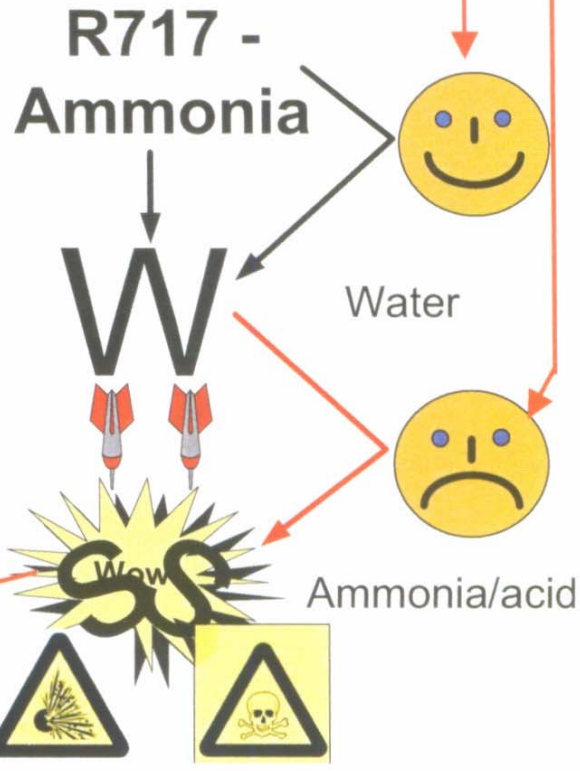
You must:

- *Remember, haste makes waste.*
- *Keep calm.*
- *Use common sense.*

Rule No 5:

Never poor or spray water directly into/at liquid ammonia!

But ammonia into water is OK!



Explosionlike boiling

Exotherm reaction!

Rule No 6:
A refrigeration plant is a plant at pressure!

You must:

- *Act with care when opening pipe connections, valve caps, flanges etc.*
- *Treat a refrigeration plant with respect and knowledge - not fear!*

It is very important that the service technician/ operator knows the refrigeration plant.

The service technician/operator must be trained in first aid.

- You must know your role in connection with a leak.
- You must be trained in the use of safety equipment.
- You must know where all the important main valves are located.
- You must know where switches for emergency stop and ventilation are located.
- You must know where the NH_3 masks, suits, rubber gloves and ventilation apparatus are located.
- Exercises in the use of masks, suits and ventilation apparatus must be held at regular intervals.

If an emergency/evacuation plan for leaks is available this must be known in details. If not, take initiative in preparing one.

Who to contact: Chief engineer/ or watchman
Doctor
Casualty ward
Internal emergency
Public authority/police
Emergency call centre
Authorised refrigeration company

First Aid for accidents with Ammonia

(Chemical formula: NH_3 - refrigerant no: R717)

Warning!

No plant can ever be said to be too safe. Safety is a way of life.

General

Ammonia is not a cumulative poison. It has a distinctive, pungent odour that even at very low, harmless concentrations is detectable by most persons.

Since ammonia is self-alarming, it serves at its own warning agent, so that no person will voluntarily remain in concentrations which are hazardous. Since ammonia is lighter than air, adequate ventilation is the best means of preventing an accumulation.

Experience has shown that ammonia is extremely hard to ignite and under normal conditions is a very stable compound. Under extremely high, though limited concentrations, ammonia can form ignitable mixtures with air and oxygen, and should be treated with respect.

Basic rules for first aid

1. **Call a doctor immediately.**

2. **Be prepared**: Keep an irrigation bottle available, containing a sterile isotonic (0.9%) NaCl-solution (salt water).

3. A shower bath or water tank should be available near all bulk installations with ammonia.

4. When applying first aid, the persons assisting should be duly protected to avoid further injury.

Inhalation

1. Move affected personnel into fresh air immediately, and loosen clothing restricting breathing.

2. **Call a doctor/ambulance with oxygen equipment immediately**

3. Keep the patient still and warmly wrapped in blankets.

4. If mouth and throat are burnt (freeze or acid burn), have the conscious patient drink water, taking small mouthfuls.

5. If conscious and the mouth is not burnt, give hot, sweet tea or coffee (never feed an unconscious person).

6. Oxygen may be administered, but **only** when authorized by a doctor.

7. If breathing fails, apply artificial respiration.

Eye injuries from liquid splashes or concentrated vapour

1. Force the eyelids open and rinse eyes immediately for at least 30 minutes with the salt water solution just mentioned.

2. **Call a doctor immediately.**

Skin burns from liquid splashes or concentrated vapour

1. Wash immediately with large quantities of water and continue for at least 15 minutes, remove contaminated clothing carefully while washing.
2. **Call a doctor immediately.**
3. After washing, apply wet compresses (wetted with a sterile isotonic (0.9%) NaCl-solution (salt water)) to affected areas until medical advice is available.

OBS! Point 1 - It is recommended to continue washing until medical treatment can begin.

Protecting the operator as well as the environment

Warning!

No plant can ever be said to be too safe.
Safety is a way of life.

Increasing industrialisation threatens our environment. It is therefore absolutely imperative that we protect nature against pollution.

To this end, many countries have passed legislation in an effort to reduce pollution and preserve the environment. These laws apply to all fields of industry, including refrigeration, and must be complied with.

Be especially careful with the following substances:

- refrigerants
- cooling media (brines etc)
- lubricating oils.

Refrigerants usually have a natural boiling point which lies a good deal below 0°C. This means that liquid refrigerants can be extremely harmful if they come into contact with skin or eyes.

High concentrations of refrigerant vapours are suffocating when they displace air; if high concentrations of refrigerant vapours are inhaled they attack the human nerve system.

When halogenated gasses come into contact with open flame or hot surfaces (over approx. 300°C) they decompose to produce poisonous chemicals, which have a very pungent odour, warning you of their presence.

In high concentrations, R717 causes respiratory problems, and when ammonia vapour and air mix 15 to 28 vol. %, the combination is explosive and can be ignited by an electric spark or open flame.

Oil vapour in the ammonia vapour increases this risk significantly as the point of ignition falls below that of the mixture ratio stated.

Usually the strong smell of ammonia will give ample warning of its presence before concentrations become dangerous.

The following table shows the values for refrigerant content in air, measured in volume %. Certain countries may, however, have an official limit which differs from those stated.

	Halogenated refrigerants							Ammonia
	HFC						HCFC	
		R134a	R404A	R407C	R410A	R507	R22	R717
	Unit							
TWA Time weighted average during a week	vol. %	0.1	0.1	0.1	0.1	0.1	0.1	0.005
Warning smell	vol. %					0.2		0.002

Drained ammonia must be collected in suitable containers, clearly marked with the contents, and sent to an approved incinerating plant.

Oil

Warning!

Avoid direct skin contact when charging oil. Direct skin contact with oil may develop allergic reactions in the long term. Therefore always use protection equipment - glasses and gloves - when charging oil.

Refrigeration compressors are lubricated by one of the following oil types, depending on the refrigerant, plant type and operating conditions.

- mineral oil
- semi-synthetic oil
- alkyl benzene-based synthetic oil
- polyalphaolefine-based synthetic oil
- glycol-based synthetic oil.
- Ester oil

When you change the oil in the compressor or drain oil from the refrigeration plant vessels, always collect the used oil in containers marked "waste oil" and send them to an approved incinerating plant.

NOTE

This instruction provides only general information. The owner of the refrigeration plant is responsible for ensuring that all codes, regulations and industry standards are complied with.

Safety signs

Safety signs are the traffic rules of the workplace.

Signs must be understandable and unambiguous so everybody are instructed in the best possible way and unnecessary risks are prevented.

With a minimum directive 92/58/EØF the EU has set out the guidelines.

In Denmark the guidelines are included in The Danish Working Environment Service's executive order no 518 of 17 June 1994 and in The Danish Energy Agency's executive order no 540 of 22 June 1994.

Warning

Warning is the mildest form of communication with the people in the working environment. The sign warns against an existing risk.

The sign is triangular with a black symbol on a yellow background.

11 035 00
Low temperature

11 028 00
Cauterization danger

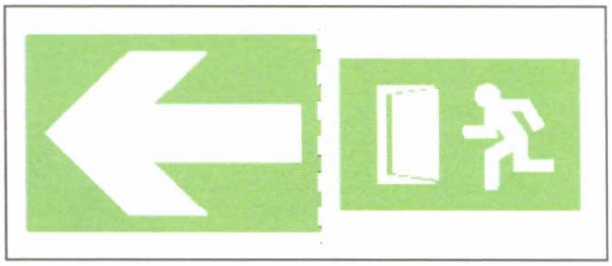
Mandatory signs

Mandatory signs indicate the safety equipment that ***must*** be used in the area. In some cases several levels of approval for the equipment exist, therefore it is possible to write or tape the classification level on the "undersign".

ArSiMa INDUSTRIAL SAFETY EQUIPMENT

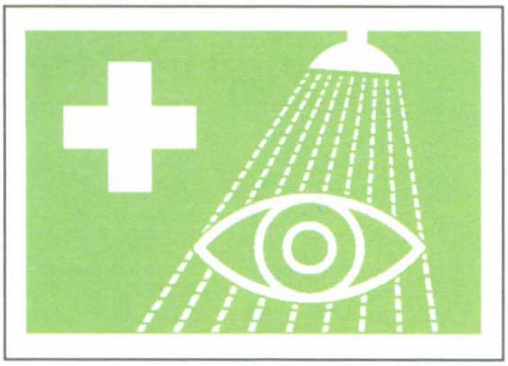
Reference

When the accident has happened it is important to keep calm and proceed in a systematic manner. Therefore it is important that the reference signs have been placed conspicuously and correctly so no time is wasted. The sign is quadrangular. If it refers to *fire* it is red/ white, if it refers to emergency it is green/ white.



Escape route

Location of breathing mask



Eye wash / shower

Prohibition

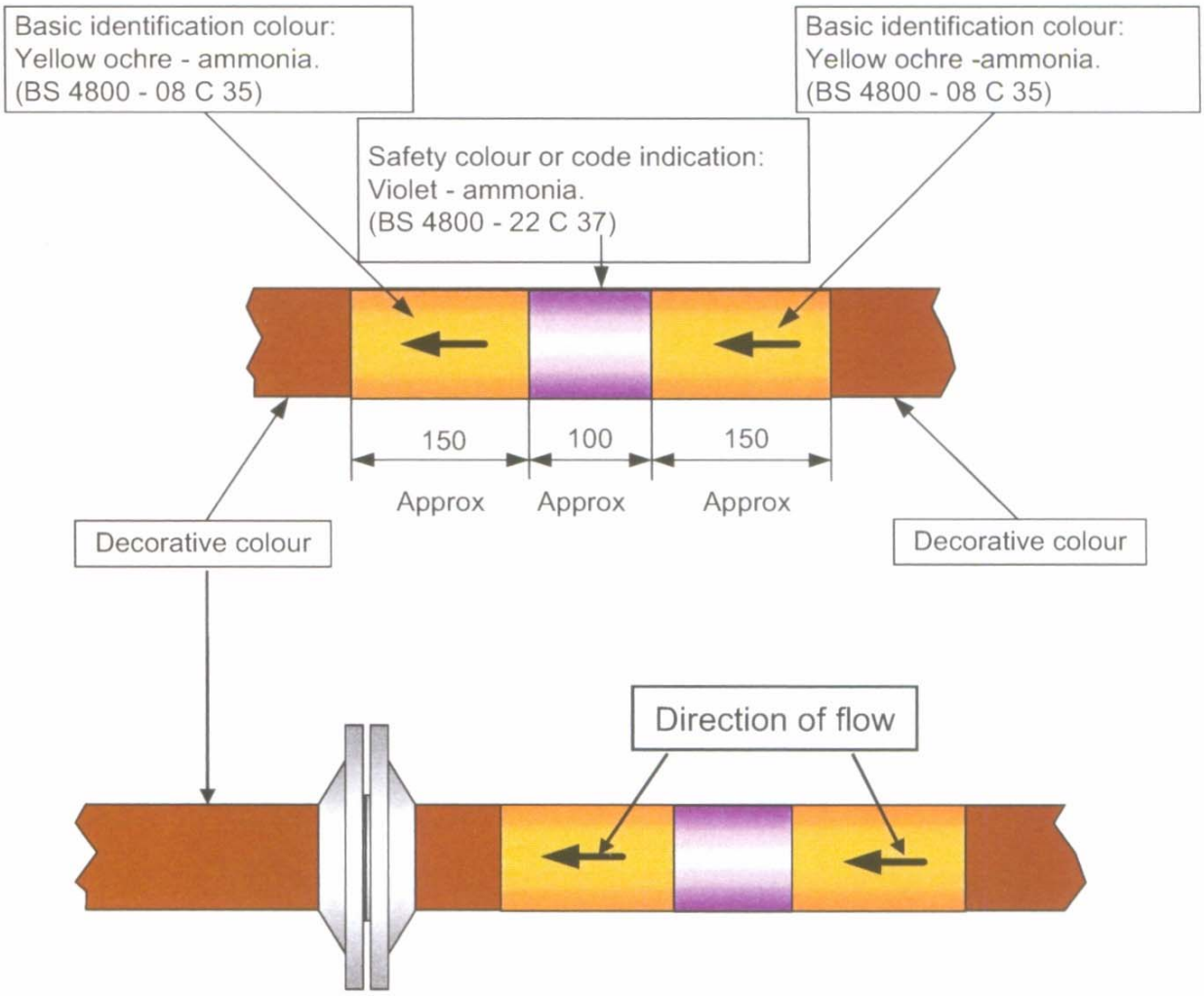
Some times prohibition is necessary. If the law prescribes it, the case is obvious. In other cases prohibition signs should only be used if it is possible to enforce the prohibition. The sign is round with a red edge and a black symbol on a white background.

Identification of pipelines

According to **EN 378-2 / 10.5.1** piping assembled and installed on site shall be marked by colour coding.
As a European Standard is not available, colour coding should be according to national codes.

The British Standard specifies the colour for the indification of pipes conveying fluids (ammonia).

British Standard Specification for
Identification of pipelines and services
BS 1710: 1984



Pipe labelling

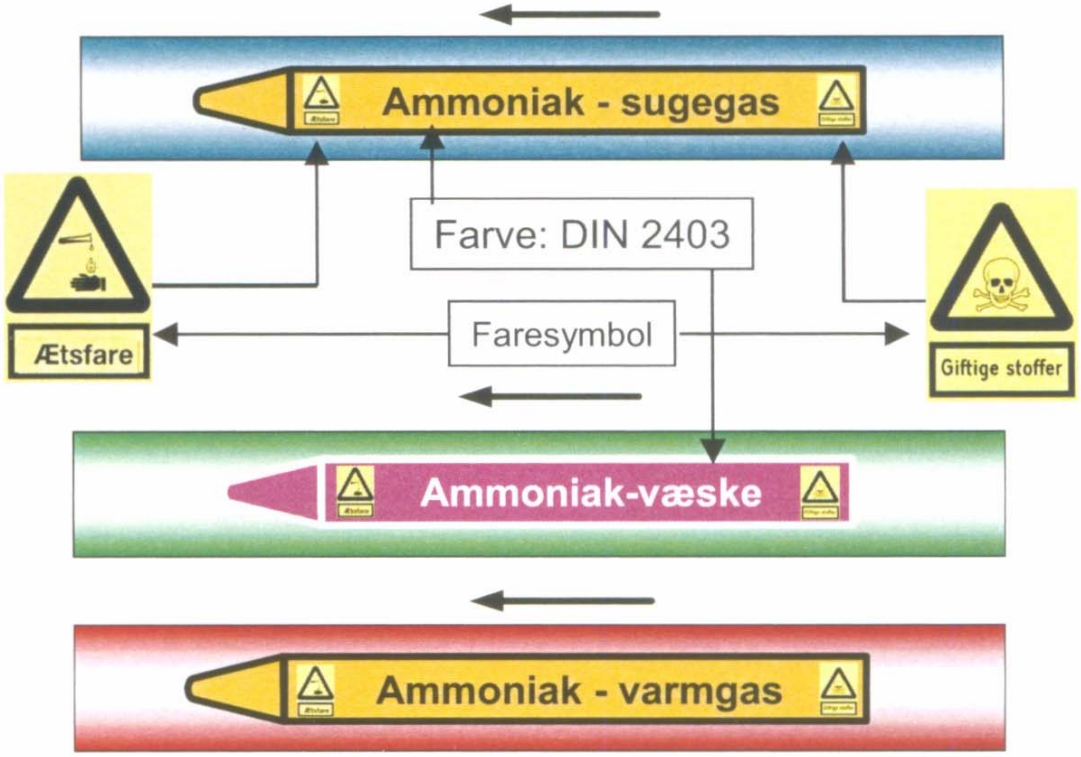
There are no common rules regarding pipe labelling within the **EU**.
Pipe labelling is carried out according to national legislation.

Danish legislation

According to Danish legislation, all visible piping systems containing or leading hazardous substances (eg ammonia) must be marked/labelled (with a pictogram or ground colour symbol) in accordance with the labelling legislation.

The labelling of pipes must be applied in visible places where the greatest dangers may occur such as close to valves and flanges.
A suitable number of labels must be applied.

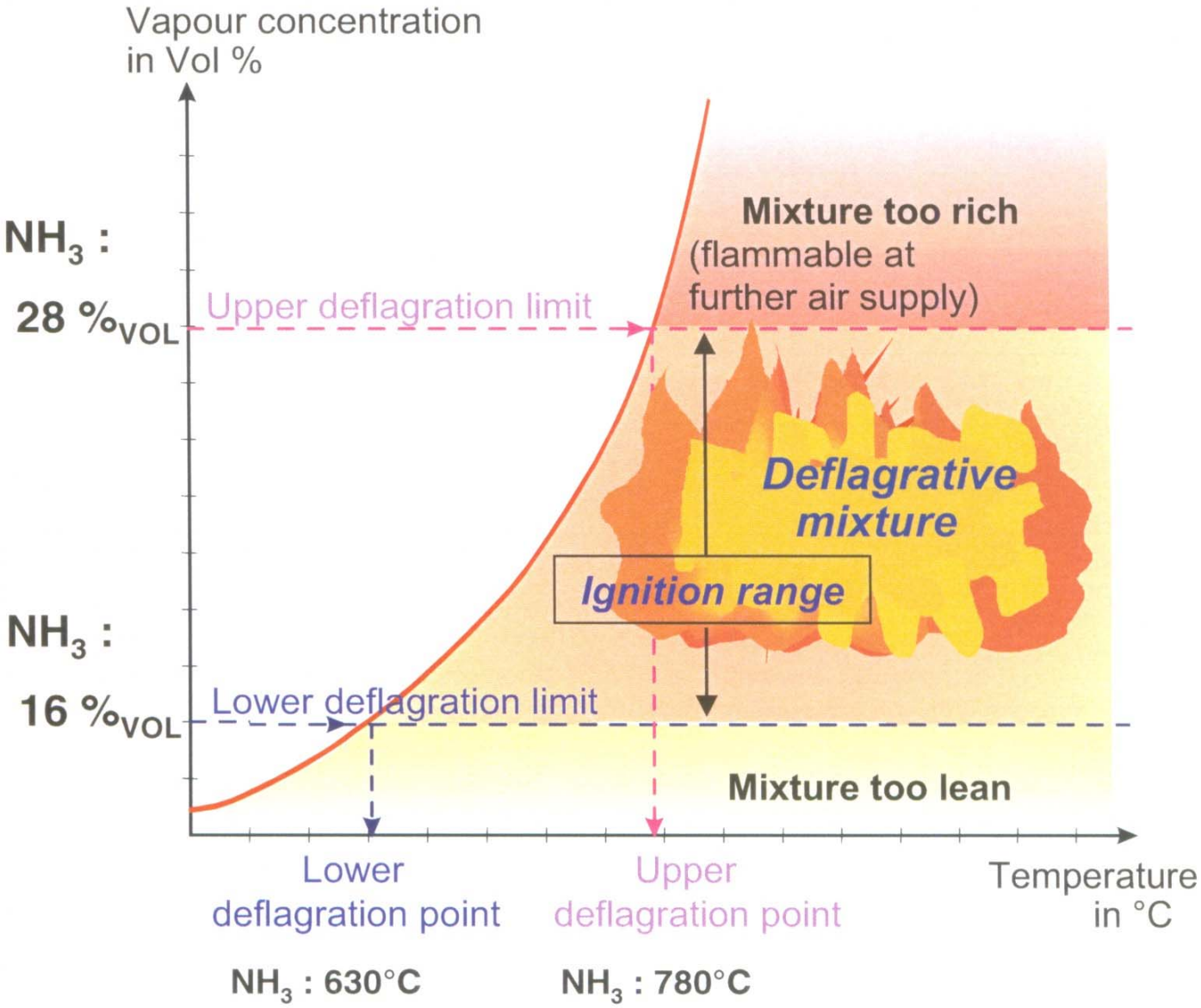
Furthermore, EN 378, 1-4 applies to all EU countries.



Physical properties of ammonia

Boiling point	-33.4ºC at 1.013 bar
Ignition temperature	651ºC (DIN 51794)
Explosive concentration in atmospheric air	16% - 28% volume
Dangerous reaction	Acid creates strong neutralisation and strong generation of heat
Other hazards 	Attacks copper and zinc as well as their alloys, and causes skin burns.

Deflagration area for ammonia



Evaporation capacity of ammonia

Evaporation from concrete floor with a starting temperature of +10°C				
Substance	Boiling point	Evaporation amount kg/m^2/min		
	°C	0-2 min.	2-10 min.	60-120 min.
Propane	-42	1.16	0.42	0.10
Chlorine	-34	1.10	0.53	0.12
SO_2	-10	0.37	0.17	0.04
NH_3 - R717	-33	0.23	0.11	0.03

In case of a major leak where ammonia (R717) is in the liquid phase the surroundings will be cooled down quickly and then evaporation will only proceed slowly.
In the above table R717 is compared to the evaporation of other substances from a concrete floor, and the table clearly shows that it takes a long time to remove only a few kg of R717 through an ordinary evaporation process.

(Safe use of ammonia refrigeration plants).

How is the human body affected?

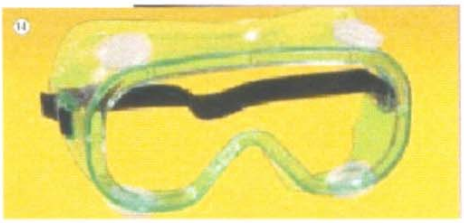
Gas concentration ppm	Effects on an unprotected human being	Time
20	The characteristic odour of ammonia can be detected. At low temperatures (below 0°C) small concentrations approx 5 ppm can be detected.	Unlimited. Hygienic limit in Denmark.
50	The smell is pronounced.	Do not stay longer than necessary.
100	No dangerous effects on healthy people. Uncomfortable. Inexperienced persons will leave.	Leave the area as quickly as possible.
400-700	Immediate irritation of the eyes, nose and respiratory organs.	Under normal circumstances no serious injuries
1700	Cough, convulsions and serious irritation of the nose, eyes and respiratory organs.	30 minutes can lead to severe injuries.
2000 – 5000	Cough, convulsions and serious irritation of the nose, eyes and respiratory organs	30 minutes or even less may cause death.
5000	Paralysis, suffocation	Lethal within few minutes

Tabel 3

Filter type	ARSIMA Gas concentration	"Tested" break-through time
K1	0.1 vol. % (1000 ppm)	50 minutes
K2	0.5 vol. % (5000 ppm)	40 minutes
K3	1.0 vol. % (10 000 ppm)	60 minutes

Personal protection equipment

Minimum protection when carrying out service work



Close-fitting protection goggle

Irrigation bottle in mini size to be kept in e.g. a breast pocket. Sodium chloride solution (0.9%)

Insulated chemical gloves

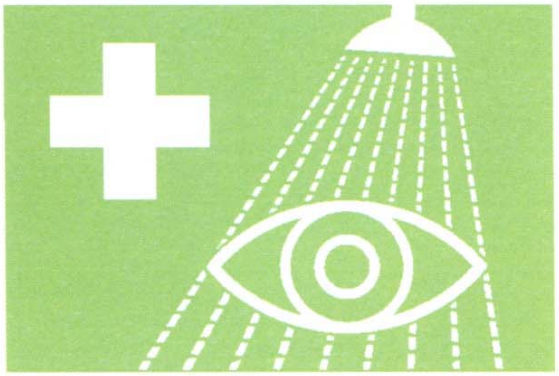
Breathing mask (Full mask with K2 filter)

When carrying out service work it is not always possible to stay within the safe distance of the fixed eye wash station. Therefore always carry an irrigation bottle in mini size and special chemical gloves, breathing mask and close-fitting protection glasses.

Note! The mini irrigation bottle is *only* an initial first aid and a supplement to the fixed eye wash, as the amount of water is not sufficient to rinse the eye clean in case of cauterisation.

Refrigeration order: (Danish)
§16 section 5
Breathing mask and eye protection glasses must be used at all jobs where leaks of refrigerants may occur.

Personal protection equipment



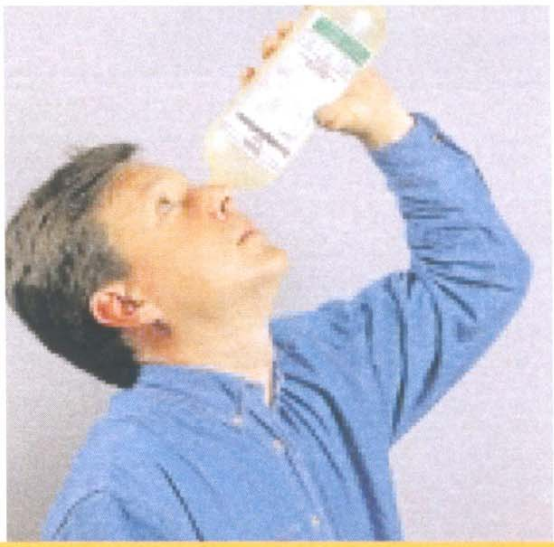
Reference sign for
eye wash and shower station

Eye wash station (irrigation bottles)
Sodium chloride solution (0.9%)

Alkaline injuries

Alkaline substances also called basic substances include lye, caustic soda, burnt lime and ammonia, products we have learned to handle with care. The basic substance *immediately* begins to cauterize the eye, and in contrast to acid, basic substances never stop cauterizing. *Consequently without treatment severe injury will occur,* as the basic substance continues to penetrate deeper and deeper. Certain basic substances such as ammonia have been detected in the interior of the eye already after 25 seconds!

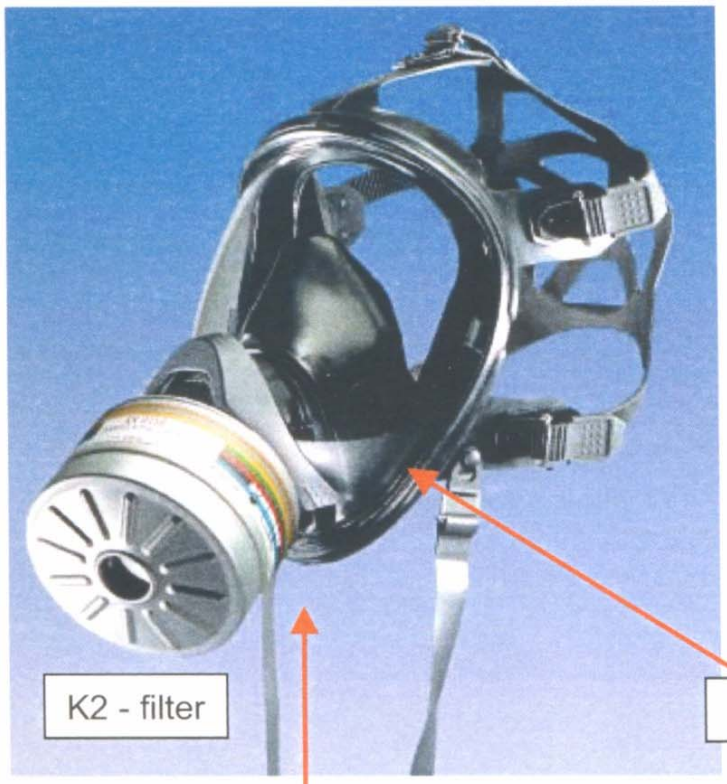
How to act: *Immediate treatment* and *sustained wash* is of great importance. An irrigation bottle must be within reach which can be used during transport to the hospital. Alkaline injuries should almost always be treated in hospital.



Don't stop washing the eye until the treatment has been taken over by a doctor/hospital!

•OBS! Never use contact lenses when you work with ammonia.In case of ammonia splash into your eyes,contact lenses can be glued to the cornea and gives you permanent eye damage.

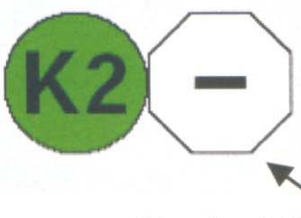
Personal protection equipment



"Breathing mask"

Safety equipment - set no 1

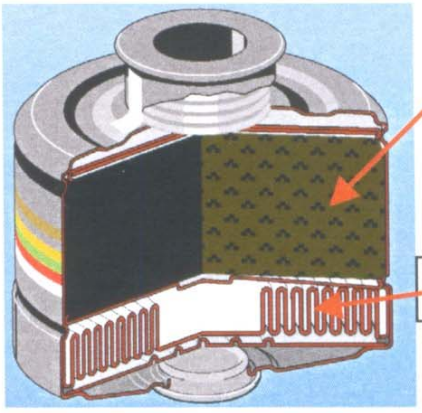
Choosing the correct filter type: (R717/NH_3/ammonia)



Ammonia (NH_3)

(No dust filter)

Filter type	ARSIMA Gas concentration	"Tested" break-through time
K1	0,1 vol. % (1000 ppm)	50 minutes
K2	0,5 vol. % (5000 ppm)	40 minutes
K3	1.0 vol. % (10 000 ppm)	60 minutes



Active carbon

Dust filter (optional)

Ammonia (NH_3)

(With dust filter)

Filters can normally be used against gasses that can be smelled and which are not directly dangerous to life or health.
Never use filter when there is a risk of oxygen displacement.

Personal protection equipment

Safety equipment is placed outside the engine room in containers/lockers made for the purpose. Location of equipment must be marked on layout drawings.

For refrigeration plants of 5,000 kcal/h (5.815 kW) - 50,000 kcal/h (58.15 kW) at least one breathing mask must be available.
For refrigeration plant of over 50,000 kcal/h at least 2 breathing masks must be available.
The breathing masks must be of an approved type.

The operator of the plant must be well trained in the use of the breathing masks. For plants over 50,000 kcal/h at least once a year, at the plant owner's request, an exercise in the use of the equipment must be arranged. The equipment must however be inspected every three months. There should be a "log book" with data of the latest inspection.

Refrigeration order: (Danish)

"Container" should always contain an extra new and sealed K2 - filter.

Fresh air supplied breathing mask

Fresh air apparatus

Example of belt fitted fresh air apparatus

Special container for keeping fresh air apparatus

SECOBA - Minikin 96 is a small pressure bottle apparatus which works independently of the ambient air. Suitable for tasks requiring immediate action and where the action time is short. E.g. when tightening leaking valves, closing of fire doors or rescuing people or things from polluted areas.

The staff must be trained in using fresh air apparatus.
At least once a year an exercise must be held in the use of all breathing protection apparatus.

Example of back fitted fresh air apparatus

Personal protection equipment
(Recommended by YORK)

Safety equipment - set no 1

YORK Refrigeration full mask

YORK Refrigeration suit
- protects against splashes

YORK Refrigeration special gloves - insulates against cold

YORK Refrigeration boots with steel insole

Life line

"Breathing mask`s"

"YORK Refrigeration Full Mask" gives you a good protection against ammonia splash

Note! Used filters must not be re-used - the remaining "break-through time" is unknown.

Safety equipment - set no 1

Protective Suit

Art No	Size	Body length	Chest width
45-2101	S	172-176	80-92
45-2102	M	176-182	92-104
45-2103	L	182-188	104-116
45-2104	XL	188-194	116-124
45-2105	XXL	194-200	124-132

Escape Hood, with K2 - filter	Art No 72 - 0203

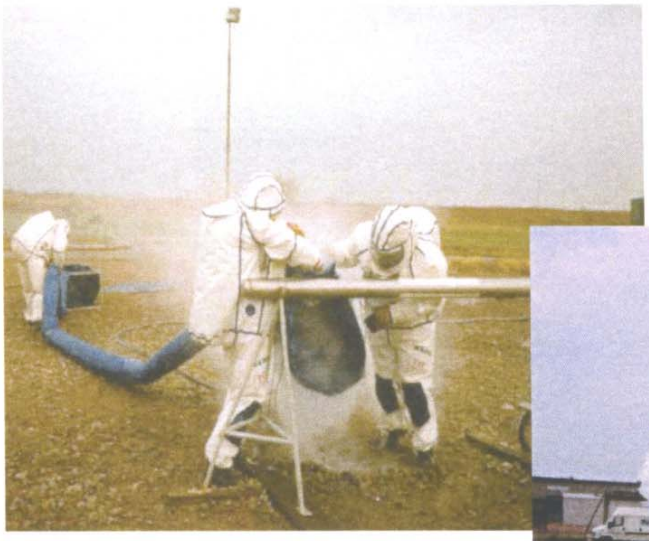
Isolation Gloves, pair (one size)	Art No 75 - 0030

65-20xx Safety Boots, pair (xx = Size EUR)

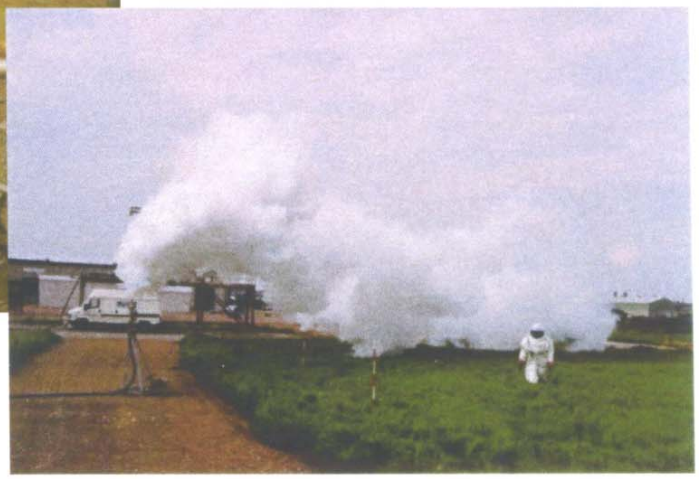
	EUR	US	UK	Quantity
65-2039	39	6 ½	6	
65-2040	40	7 ½	6 ½	
65-2041	41	8	7 ½	
65-2042	42	9	8	
65-2043	43	9 ½	9	
65-2044	44	10 ½	9 ½	
65-2045	45	11 ½	10 ½	
65-2046	46	12	11 ½	

Personal protection equipment

Safety equipment - set no. 2



Safety equipment must be placed outside engine room in containers/lockers made for the purpose.



LOW TEMPERATURE

Aerosol R717 sky

Due to very low temperatures (-74°C), at leaks of liquid ammonia this set is recommended.
The set consists of a special inner suit (7 layers), fresh air apparatus with mask, special insulated gloves, special boots and the special heat and cold resistant outer suit.

The staff must be trained in the use of fresh air apparatus/suits.

At least once a year an exercise **must** be held in the use of all breathing protection apparatuses.

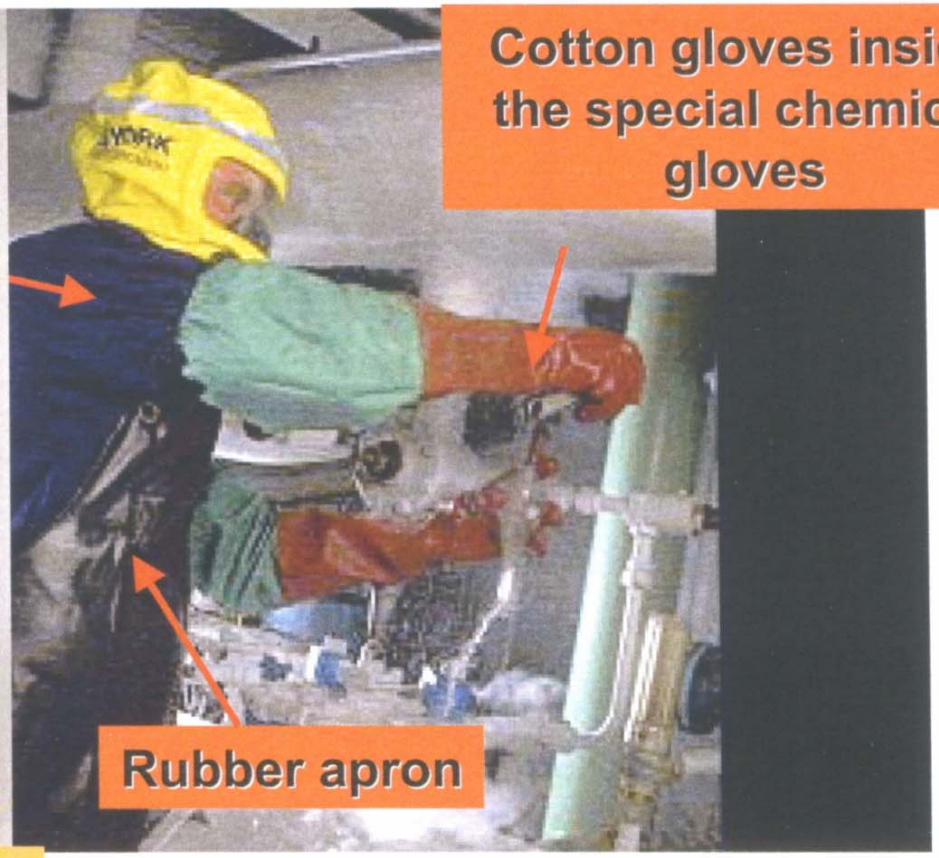
It takes two people to use the equipment.

75-000x Chemical Suit ALFA

Art No	Size	Body length	Quantity
75-0002	S-M	162-176	
75-0003	L	172-184	
75-0004	XL	184-200	

Personal protection equipment

Correct working gear



Example of draining an ammonia sample

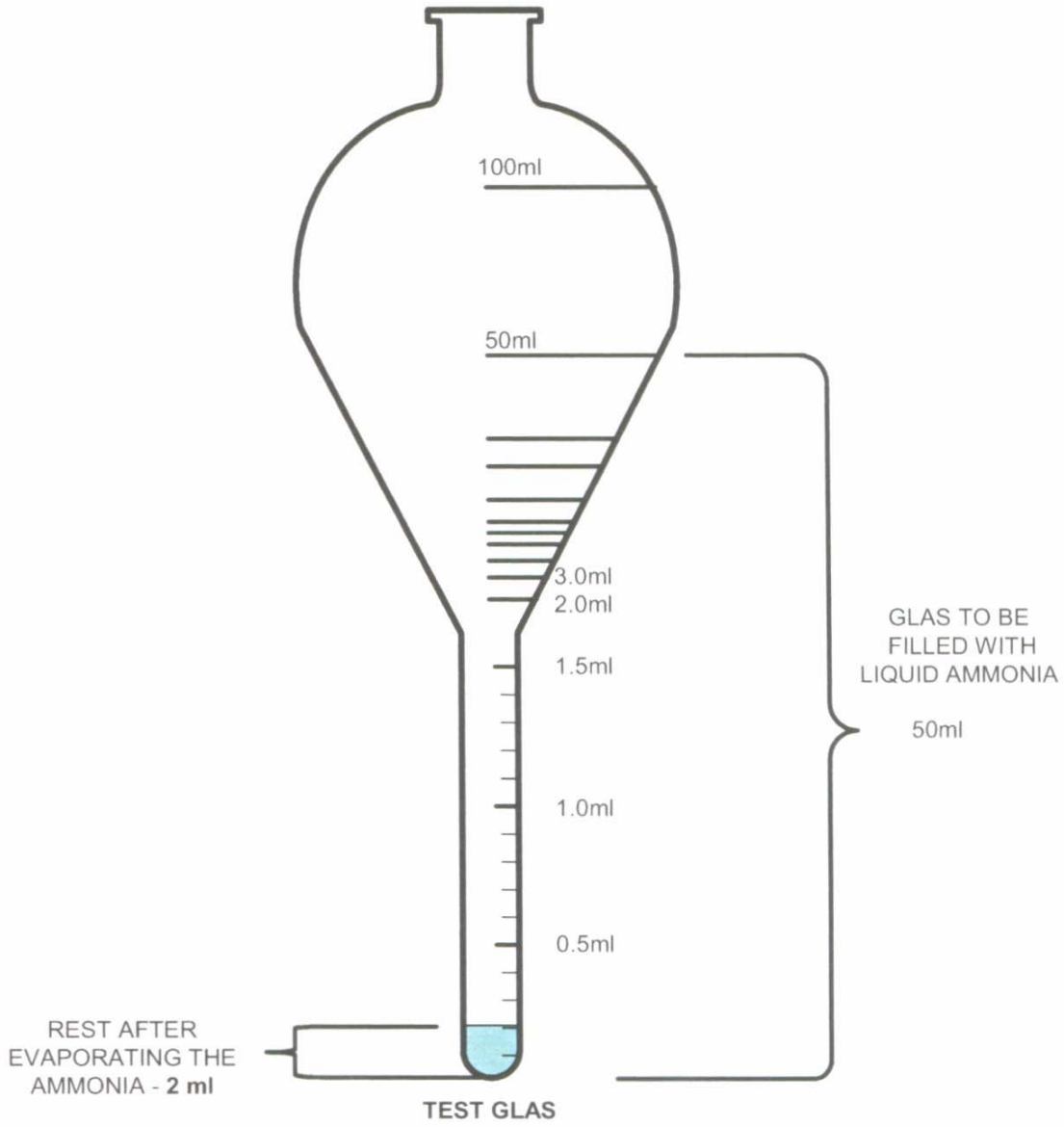
Mini irrigation bottle

Specially insulated chemical gloves

Full mask

ArSiMa INDUSTRIAL SAFETY EQUIPMENT

Determination of water content in ammonia



Example:

$$\frac{\text{Density of water (1) X Rest volume in the test glas (0.2 ml)}}{\text{Test volume X Density of ammonia (0.65)}} \text{ X 100 = ...\%}$$

$$\frac{1 \times 0{,}2}{50 \times 0{,}65} \times 100 = \underline{\underline{0{,}62\ \%}}$$

Ammonia injuries from **not** using correct gloves !

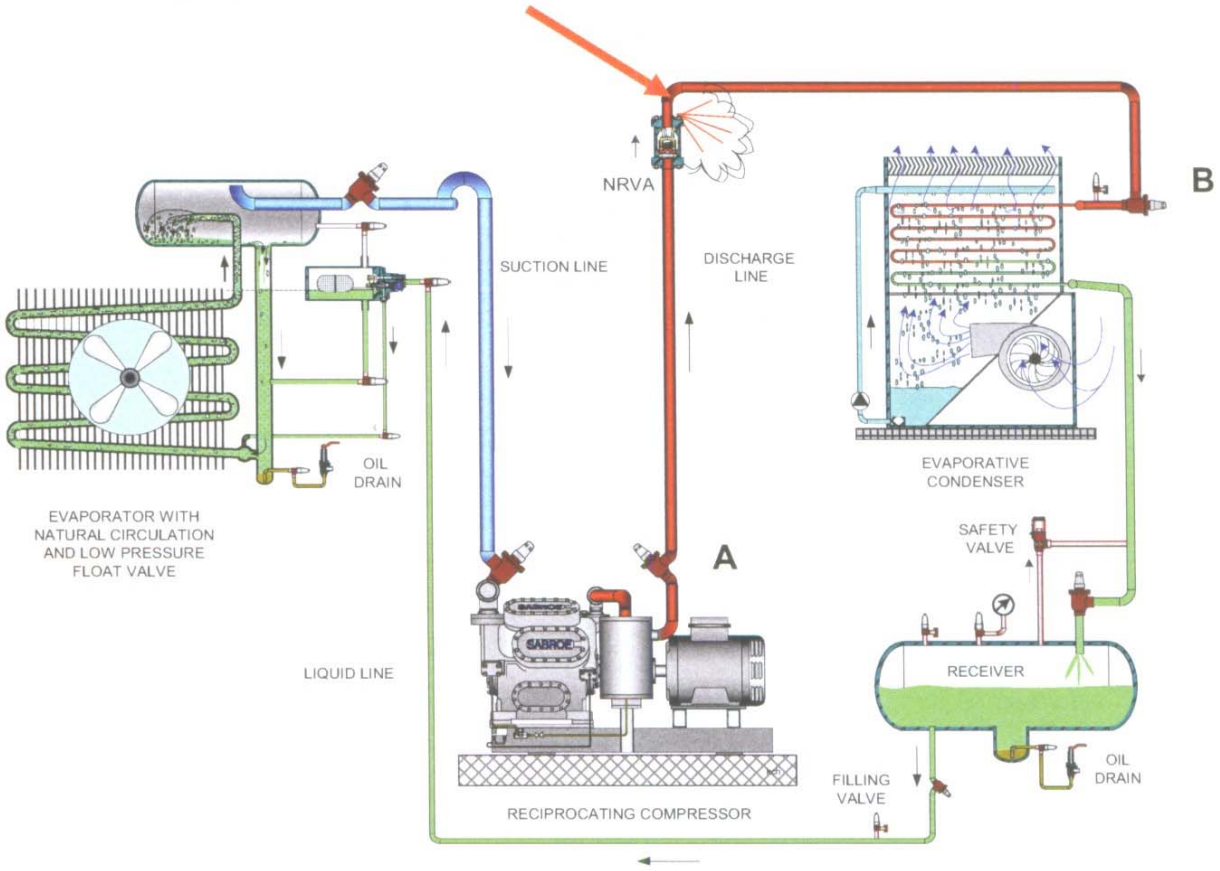
By using the correct protection equipment these injuries could have been prevented.

"Breathing mask" with **K2** filter

YORK Refrigeration helmaske

Correct working gear

Leak at high-pressure side - between compressor and condenser



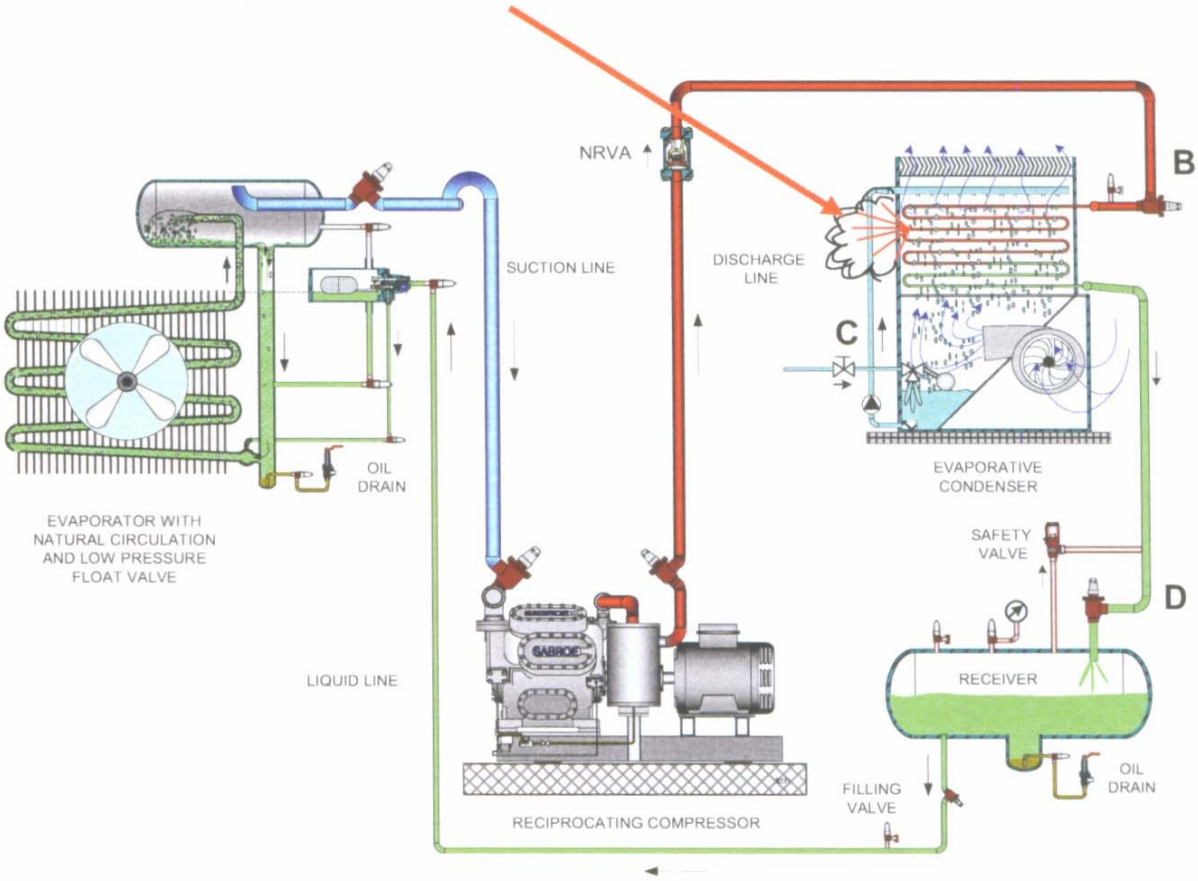
Ammonia leak on the high-pressure side takes place in the form of vapour at a temperature of between 80°C and 120°C. During the leak the vapours expand from max 16 bar to 1 bar and the temperature is cooled down approx 30° Kelvin to a temperature of 90°C to 50°C. Hereby the NH_3 vapours remain lighter than air and rise.

REMEMBER! Necessary safety equipment: Suit, gloves, mask, glasses and irrigation bottle.

Action:

1. **Stop the compressor**
2. **Shut the valves A and B**
3. **Start ventilation if the leak is inside an engine room**
4. **Call YORK Service for repair.**

Leak at high-pressure side - in condenser at water side



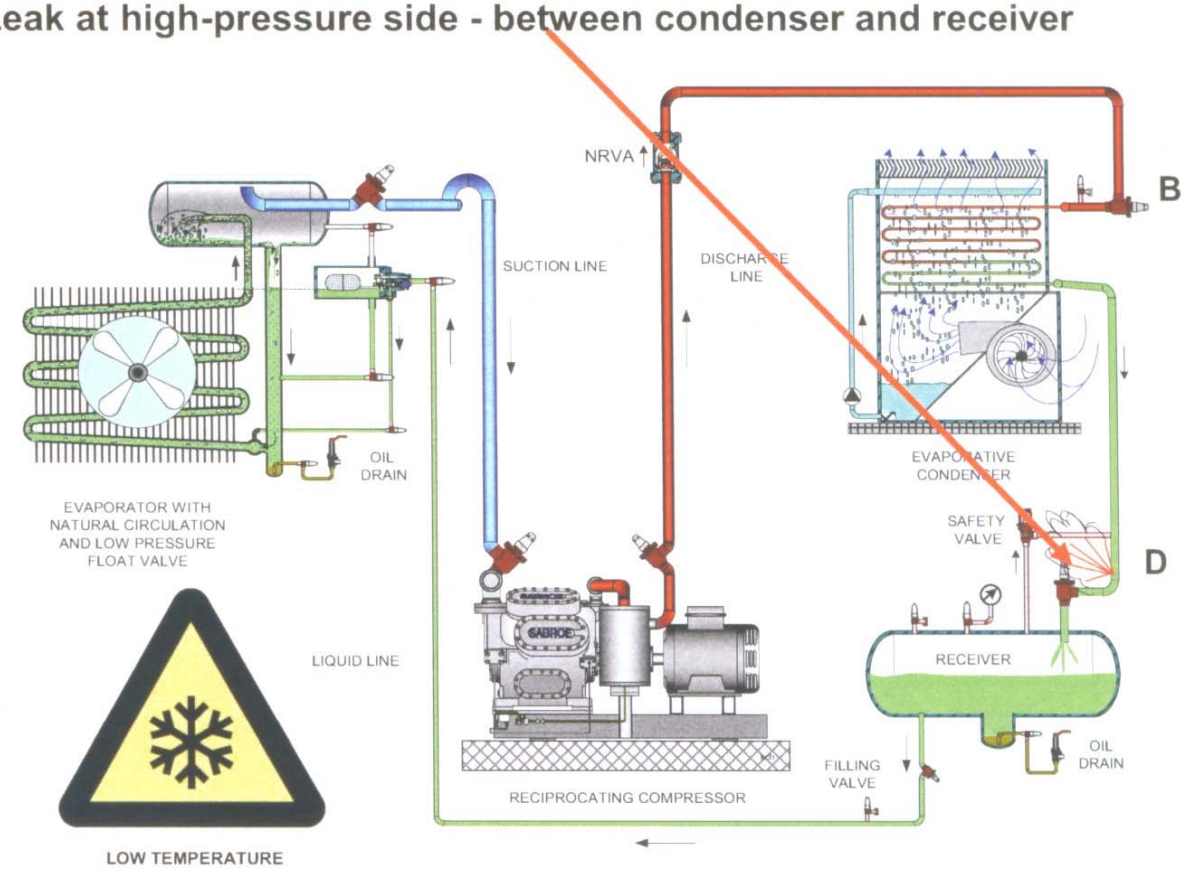
Due to higher pressure on the ammonia side than on the water side ammonia vapours will run into the water and be absorbed. As water and ammonia have large affinity (miscibility) water will also be led towards ammonia overpressure into the ammonia side, especially when the pressure drops below 1.0 bar/Ato. Consequently the water must be drained from the oil drain taps. It is recommended to install a Water-Dirt-Oil purifier (WDO).

REMEMBER! Necessary safety equipment: Suit, gloves, mask, glasses and irrigation bottle.

Action

1. **Stop the compressor if it cannot be connected to another condenser.**
2. **Shut the valves (B and D) on the ammonia side at in and out let on condenser.**
3. **Shut valve (C) for cooling water supply.**
4. **Call YORK Service for repair.**
5. **Collect cooling water.**
6. **Destroy the ammonia polluted cooling water according to current rules.**
7. **Check the ammonia side for water.**

Leak at high-pressure side - between condenser and receiver

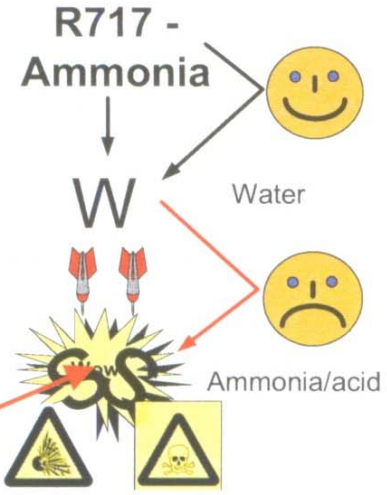


In this case liquid ammonia will escape from the leak. Due to the "Flash effect" the temperature in this area will be very low - temperatures down to -74°C have been measured.

REMEMBER! Necessary safety equipment: Suit, gloves, mask, glasses irrigation bottle.

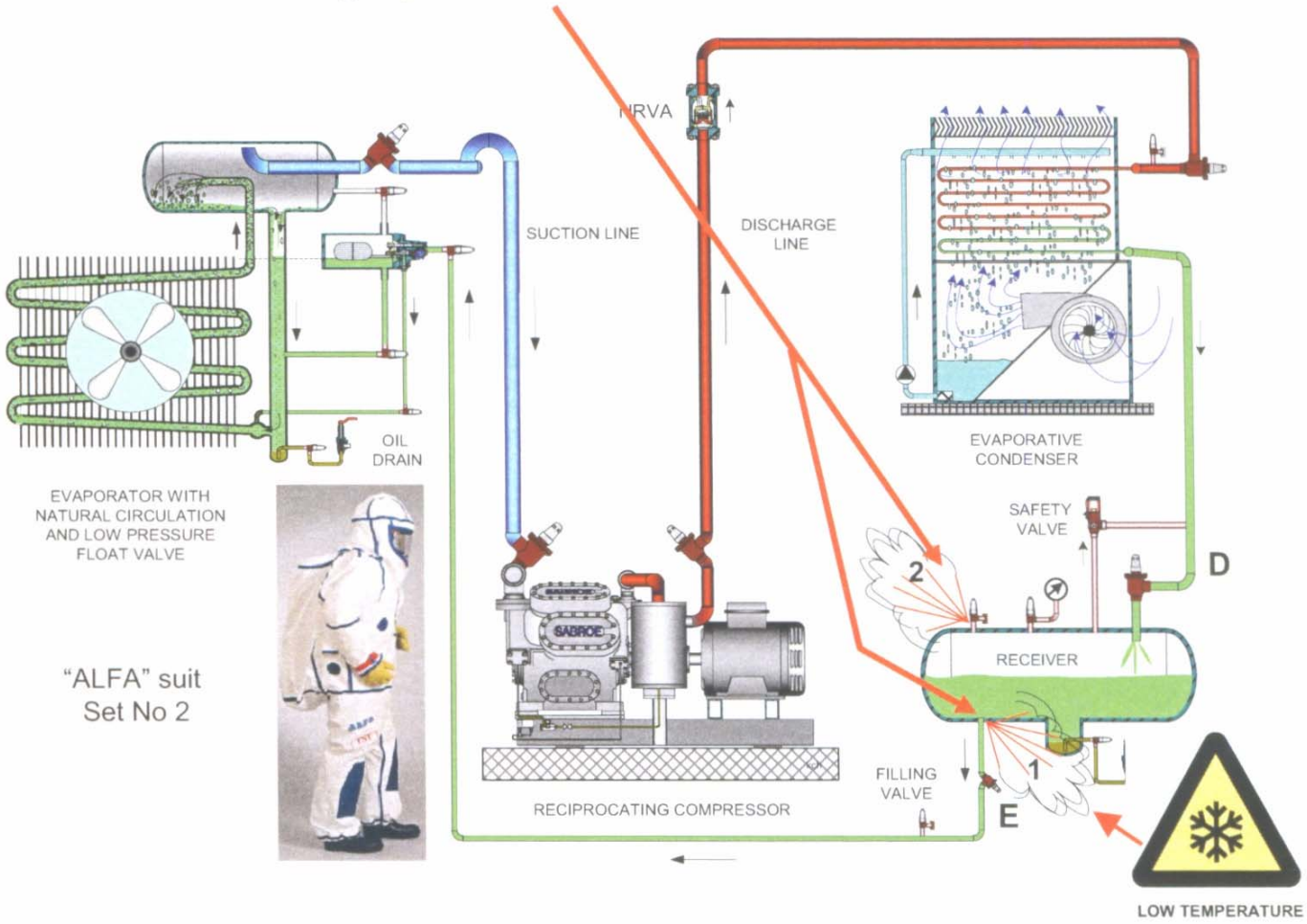
Action

1. **Stop the compressor.**
2. **Shut valves (B and D) before and after the leak.**
3. **Start ventilation.**
4. **The ammonia that has run out will subcool itself. Control the vapours with water mist.**
5. **Call YORK Service for repair.**



Important! Never spray water directly on/into liquid ammonia

Leak at high-pressure side - at receiver



1. If the leak is in liquid shape the out-flowing ammonia liquid will immediately be converted into aerosol i.e. small droplets forming a white cloud. In this cloud the temperature is very low (-74°C). The vessel will drain to the level where the liquid surface is at level with the leak.

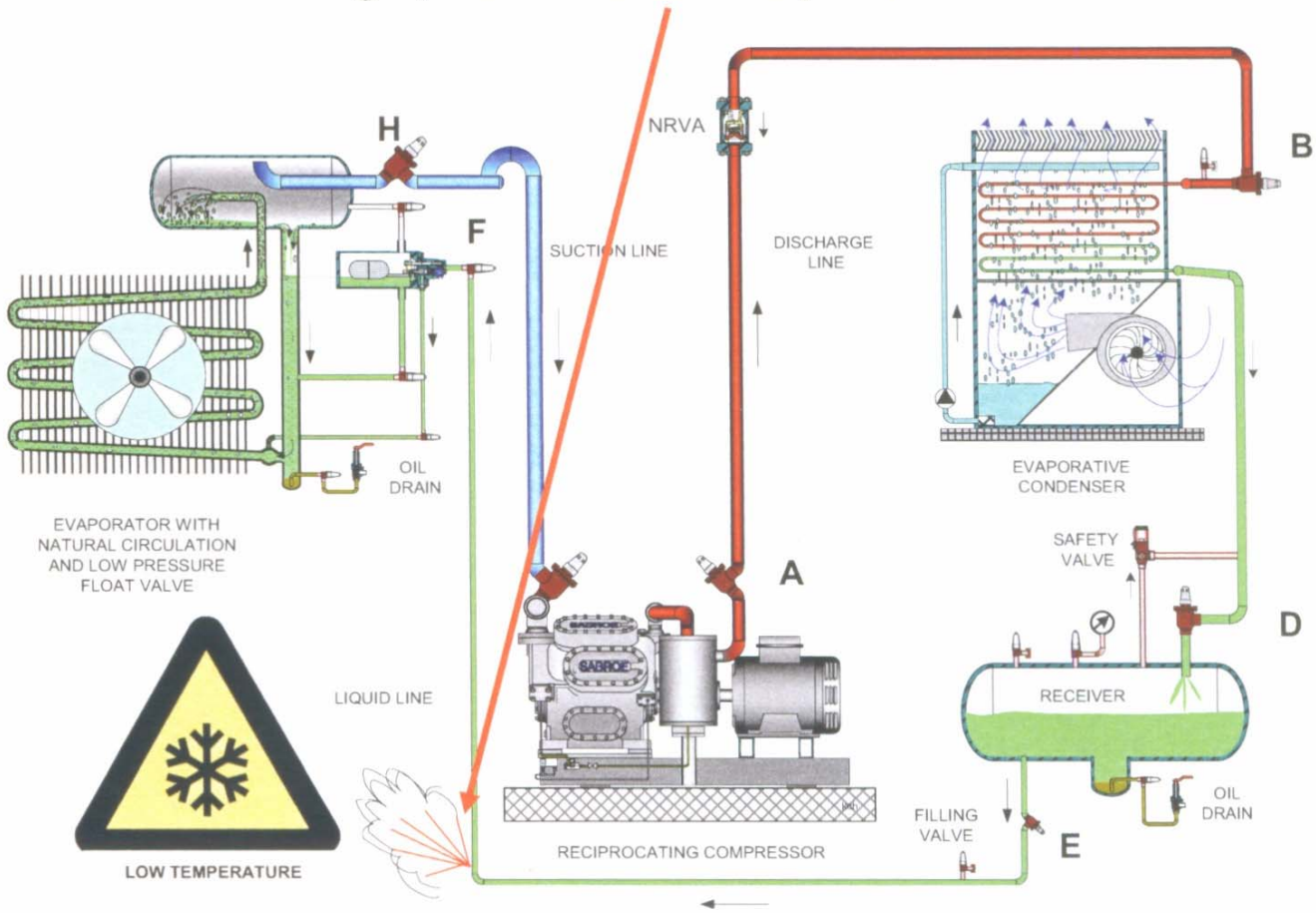
2. If the leak is in the gas phase the liquid will start to boil and gas will penetrate out through the leak and droplets from the liquid face may arise depending on the size of the leak. When the liquid boils and the temperature drops to -34°C (1 bar A) the gas flow from the leak will cease.

REMEMBER! Necessary safety equipment: Suit, gloves, mask, glasses irrigation bottle.

Action

1. **Start ventilation - if indoors.**
2. **Stop the compressor.**
3. **Shut valves (D and E) before and after the leak.**
4. **The ammonia that has run out will subcool itself.**
5. **Control the vapours with water mist.**
6. **At major leaks contact the relevant authorities.**
7. **Call YORK Service for repair.**

Leak at high-pressure side - in liquid line



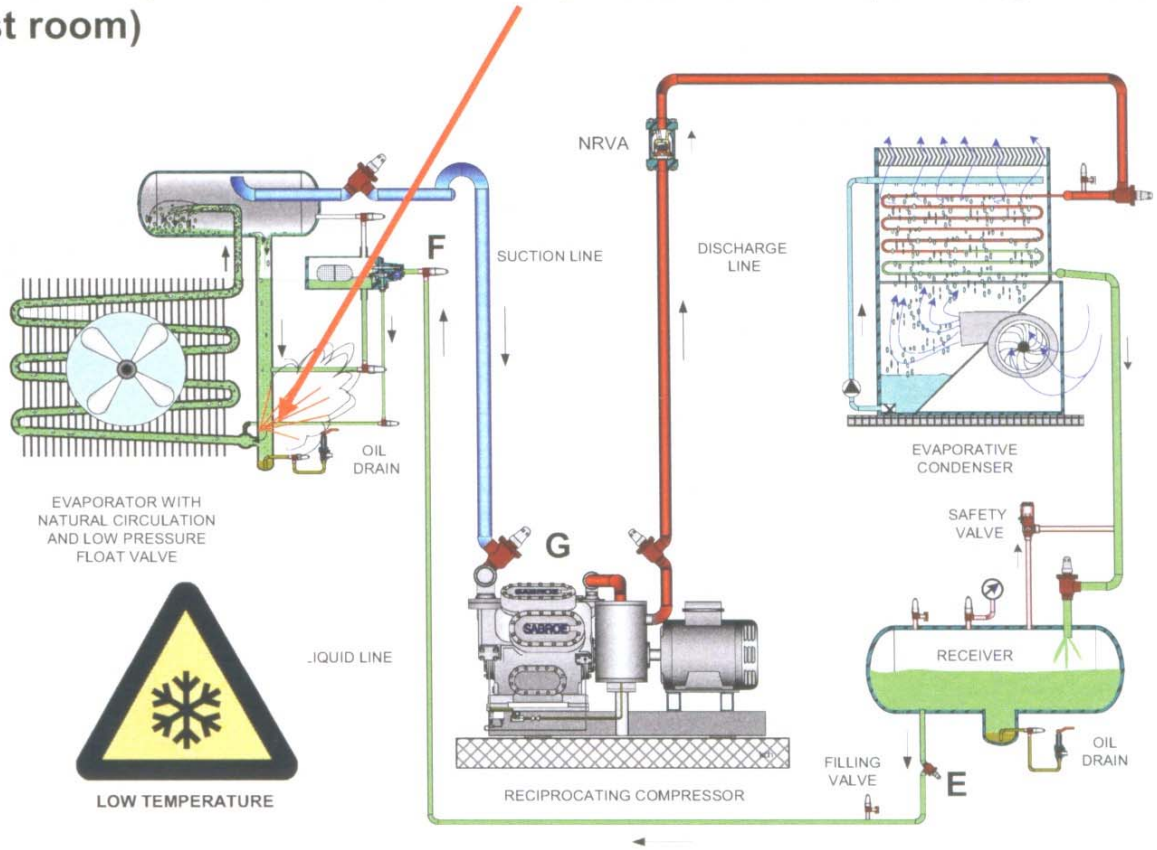
The liquid line between receiver and control valve/low-pressure float is always full of ammonia liquid at pressure (condensing pressure - max 16 bar). If the leak - as shown here - is below receiver level all liquid will flow out under high pressure. The leaking ammonia liquid will be converted to aerosol with very low temperature (-74°C).

REMEMBER! Necessary safety equipment: Suit, gloves, mask, glasses and irrigation bottle.

Action

1. **Shut valves (E and F) before and after the leak.**
2. **Start ventilation - if indoors.**
3. **Out-flowing liquid ammonia should subcool itself and the vapours should be controlled by water mist.**
4. **Stop the compressor.**
5. **At major leaks contact the relevant authorities.**
6. **Call YORK Service for repair.**

Leak at low-pressure side - at evaporator with evaporating below –33°C (frost room)



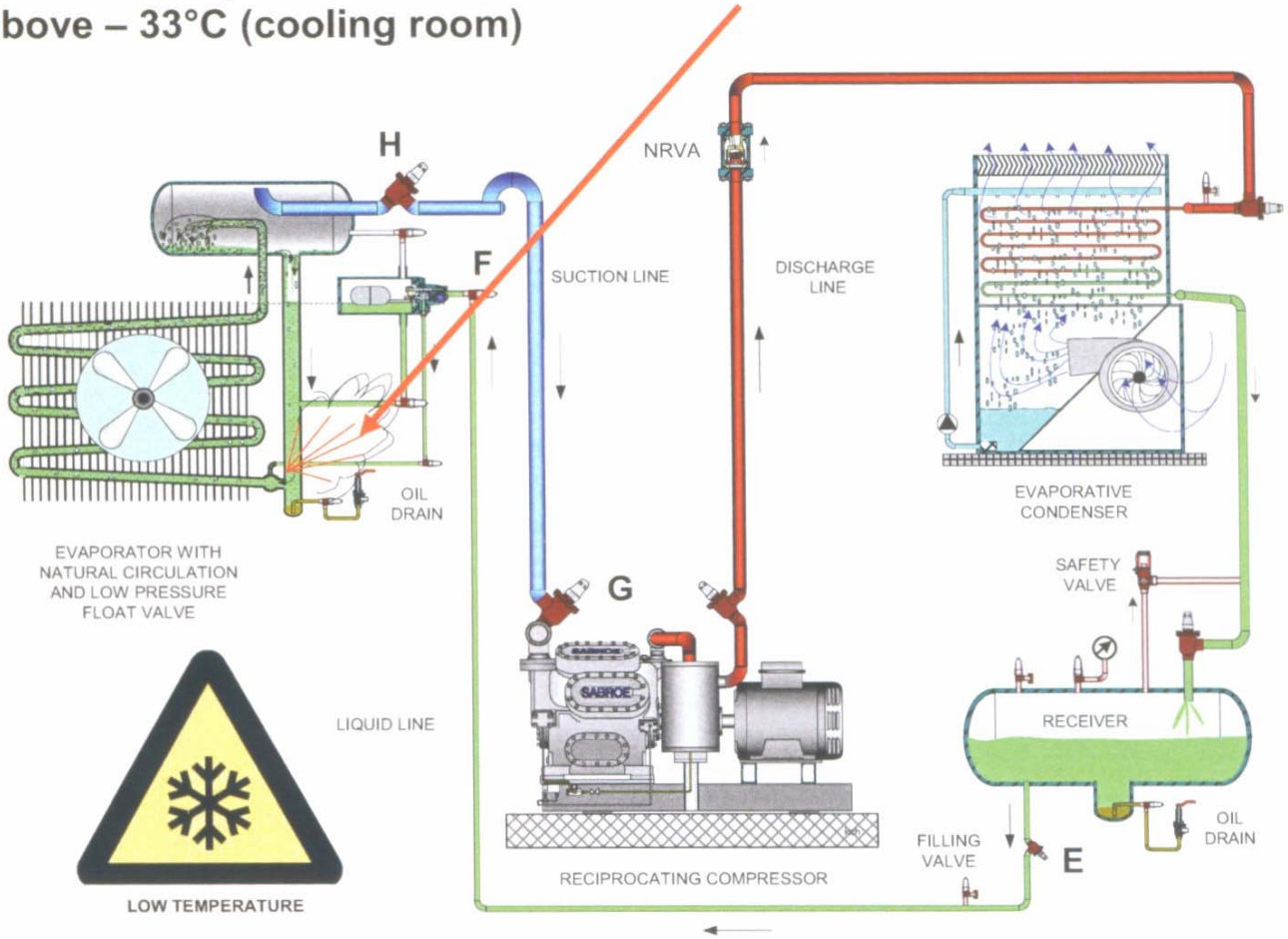
If the leak is below liquid level the ammonia will, due to the static pressure, run out. Due to the low pressure in the evaporator the liquid will not expand and there will only be a small amount of ammonia vapours. The surroundings will cool down more than if the leak had been in the gas phase. The content of ammonia in the air is high. The aerosol mist will slowly sink towards the floor.

REMEMBER! Necessary safety equipment: Suit, gloves, mask, glasses and irrigation bottle.

Action

1. **Shut valve (F) in liquid line - alternatively - shut valve (E) at receiver.**
2. **Leave the compressor running at minimum capacity as long as the pressure does not drop to below 0 bar overpressure. If the pressure drops valve (G) on the compressor can be throttled. If the situation is under control stop the compressor and shut valve (G).**
3. **Stop ventilator(s) at evaporator.**
4. **Establish strong ventilation.**
5. **If possible collect liquid ammonia in a vessel with water and cover with a tarpaulin.**
6. **Keep the evaporation pressure above 0 bar overpressure with compressor running on minimum capacity.**
7. **Call YORK Service for repair.**
8. **At major leaks contact the relevant authorities.**
9. **Collected ammonia water must be destroyed according to current rules.**
10. **Check the plant for air before restart.**

Leak on low-pressure side - at evaporator with evaporating temperature above – 33°C (cooling room)



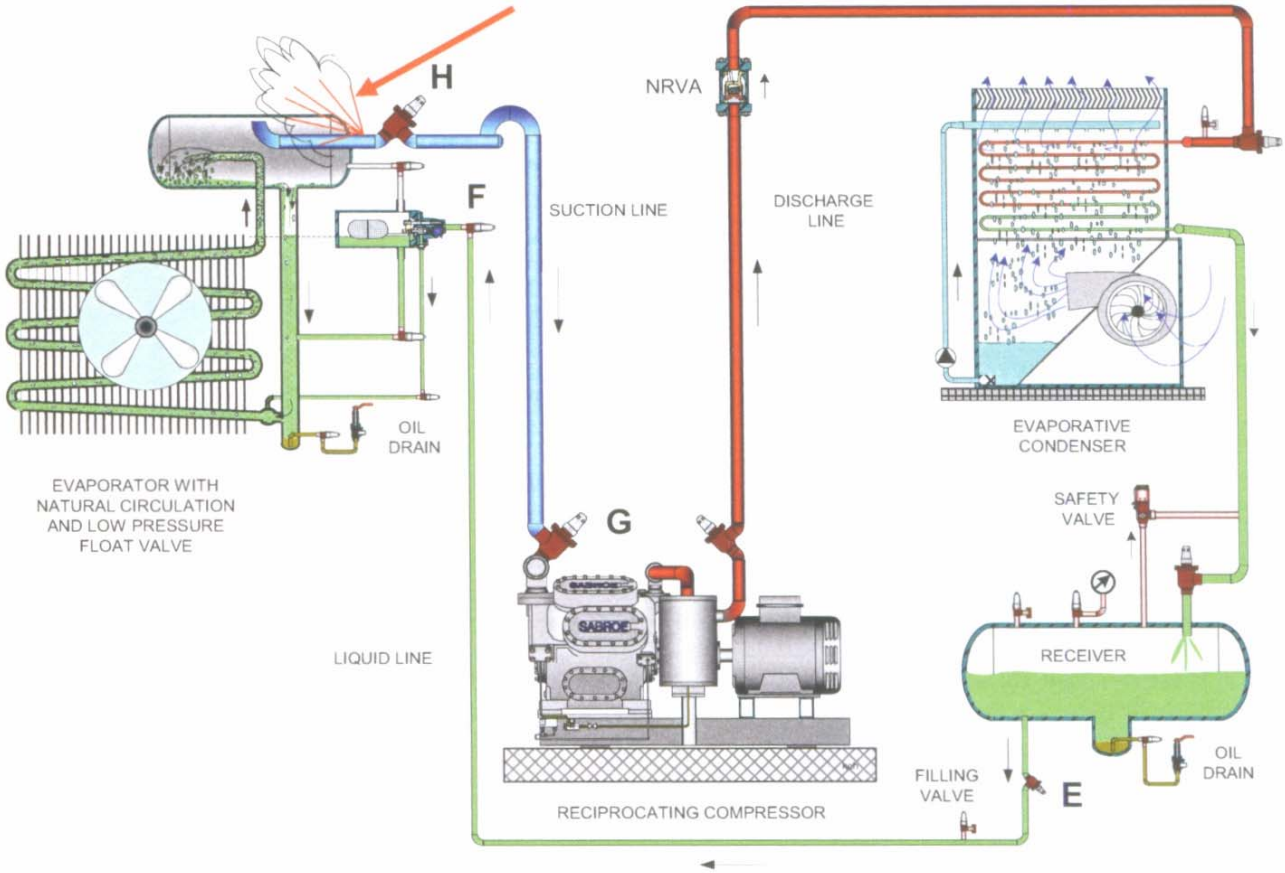
As the evaporation pressure is above the atmospheric pressure a certain amount of liquid and ammonia vapours will escape in connection with the pressure decline and the flash effect. The escaped liquid will collect in a "cold puddle" and cool down to below -33°C. It is recommended to leave the compressor running in order to move so much ammonia as possible to the high-pressure side until the evaporating pressure gets close to 0 bar positive pressure.

REMEMBER! Necessary safety equipment: Suit, gloves, mask, glasses and irrigation bottle.

Action

1. **Shut liquid inlet valve (F) - alternatively - valve (E) at receiver.**
2. **These should be stopped during pump operation.**
3. **Establish strong ventilation.**
4. **Leave the compressor running as long as possible at minimum capacity before it is stopped and valves (H and G) are shut.**
5. **If possible collect the liquid ammonia in a vessel with water and cover with a tarpaulin.**
6. **Collected ammonia water must be destroyed according to current rules.**
7. **At major leaks alarm the relevant authorities.**
8. **Call YORK Service for repair.**

Leak on low-pressure side above liquid level - at evaporators with evaporating temperature below -33°C (frost room)



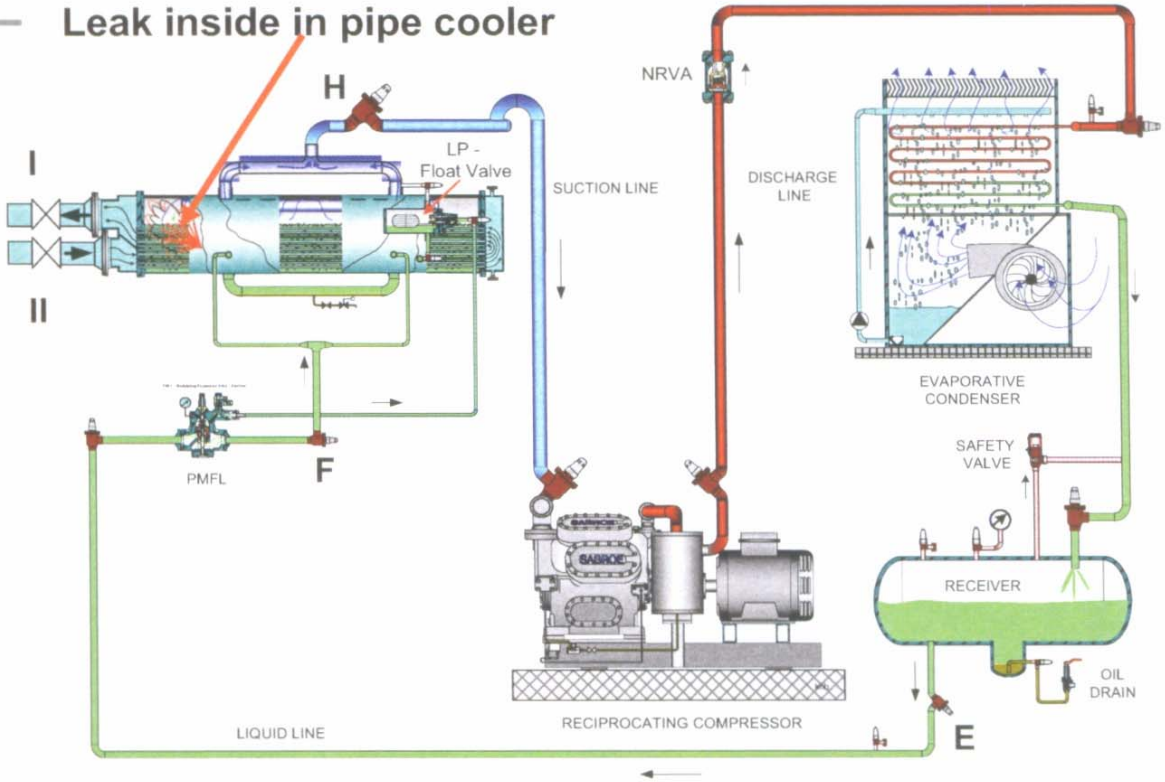
When the evaporating temperature is below -33°C the leak is relatively small due to the negative pressure.

REMEMBER! Necessary safety equipment: Suit, gloves, mask, glasses and irrigation bottle.

Action

1. **Shut the stop valve (F) in the liquid line - alternatively - valve (E) at receiver.**
2. **Stop compressor.**
3. **Stop ventilator(s) at evaporator.**
4. **If the evaporation pressure is above 0 bar overpressure leave the compressor running at minimum capacity as long as possible before stopping it.**
5. **Shut the stop valve (H) in the suction line - alternatively valve (G) at compressor.**
6. **Establish strong ventilation.**
7. **At major leaks contact the relevant authorities.**
8. **Call YORK Service for repair.**
9. **Check the plant for air.**

Leak inside in pipe cooler



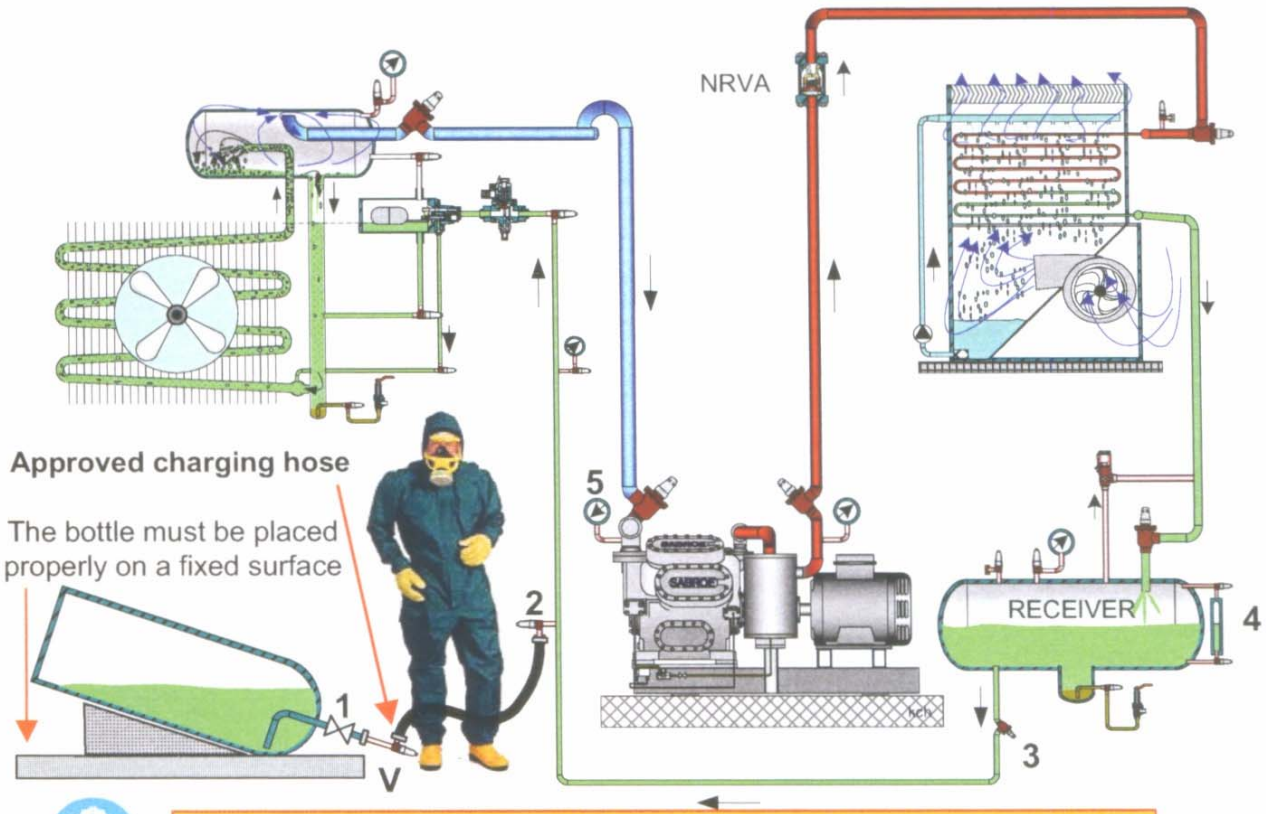
At leaks inside in pipe cooler towards brine side the ammonia will make it self noticeable in the brine. By monitoring the brine pH value even very small leaks will increase the brine pH value. Also by checking the oil sump in the cooler it can be established if brine should have leaked into the ammonia side. Be aware of too high and uncontrollable liquid level in the cooler due to penetrating brine.
This may cause slugging in the compressor

REMEMBER! Necessary safety equipment:
Suit, gloves, mask, glasses and irrigation bottle.

Action

1. **Stop the circulation pump.**
2. **Shut brine in and outlet - (valves I and II).**
3. **Stop compressor.**
4. **Shut valves (F and H) in in and out let on ammonia side.**
5. **Call YORK Service for repair.**
6. **Drain the brine side into special transport containers/vessels (be aware of ammonia vapours). To be destroyed according to current rules.**
7. **Drain the ammonia side into special transport containers/water tanks. To be destroyed according to current rules.**
8. **Check the brine pH value before restart. It may be necessary to replace the entire brine filling.**
9. **Check the water and brine content in the ammonia and oil before restart. The entire ammonia filling, compressor oil and oil filters may have to be replaced.**

Charging refrigerant



REMEMBER! Necessary safety equipment:
Suit, gloves, mask, glasses and irrigation bottle.

1. Check from the manufacturer's identification plate at the compressor that the correct refrigerant is charged.
2. Connect the liquid valve on the refrigerant bottle **(1)** to the charging valve **(2)** on the plant by means of a special charging hose made for the purpose.
3. Shut the stop valve **(3)** on the discharge side of the recipient. Leave the compressor working at lowest capacity level and now empty the liquid line for refrigerant.
4. After having reduced the pressure in the liquid line to the evaporating pressure (suction pressure) open the charging valve **(2+V)** and then the bottle valve **(1). NOTE!** The evaporating temperature must be lower than the surrounding temperature of the refrigerant bottle! Controlled use of warm water may be necessary in certain situations.
5. Observer the suction pressure **(5)** of the compressor and regulate, if possible, in order to prevent the compressor in being stopped by the low-pressure pressure control.
6. Check the liquid level in the sight glass **(4)** at recipient. As it is often necessary to charge more than one bottle it is an advantage to use the valve **(V).** When changing to the next bottle shut valve **(1)** and **(V),** in this way it is "only" necessary to empty the short piece for ammonia. Open the valves in the opposite order.
7. **Shut the bottle valve (1) w**hen the necessary amount of refrigerant has been charged to the plant. The charging hose will be partially emptied after this shut the charging valve **(2).**
8. Open the stop valve on the recipient **(3)** carefully and set the compressor at normal operation. Check that cooling system is functioning normally.
9. Normally the charging of refrigerant is not finished until the plant has been tested.
10. When the charging is completed dismantle the charging hose. NOTE! Be very careful as the hose may be under pressure. Seal the free end of the charging hose so that the hose remains clean until next charge.

Removing refrigerant

REMEMBER! Necessary safety equipment:
Suit, gloves, mask, glasses and irrigation bottle.

Overcharging of refrigerant on the plant results in filling up of refrigerant in the condenser and a corresponding reduction of the condenser heat transmission. This results in an inadmissibly high condenser pressure and consequently relatively high power consumption.

If a plant has been overcharged or if the refrigerant has to be removed from the plant the following procedure should be used (see also drawing/explanation on the next page):

1. Start the compressor and reduce the suction pressure to 0.2 bar_e (5), with the discharge valve (3) from the receiver closed. Then stop the compressor.

2. Shut the compressor pressure stop valve (7) and all liquid valves (6) to the evaporators.

3. Connect an empty approved refrigerant bottle and an approved charging hose to the charging valve (2). Before connecting the refrigerant bottle place it in ice water or cooled it down in some other way. It is an advantage to "vacuumize" the vessel first.
   OBS! Make sure that the bottle is big enough to take the charge without being overfilled and that it is designed for the refrigerant in question. All containers for return refrigerant must be filled according to weight i.e. the bottle must stand/hang on a weighing machine during charge. See the explanation next page.

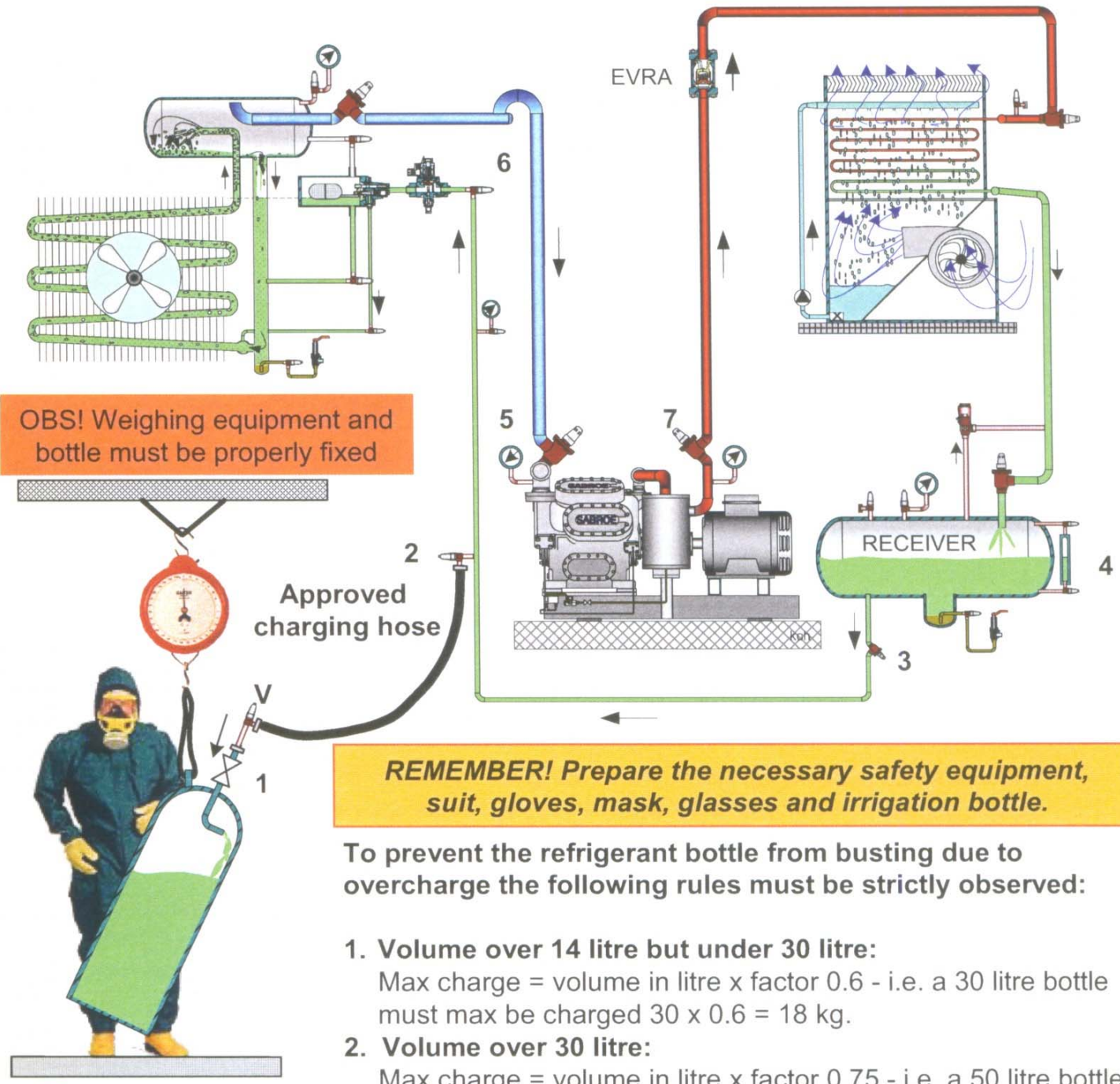
4. Open the charging valve (2) and the bottle valve (1). Then open the receiver discharge valve carefully after which the cooled/evacuated bottle will drain the refrigerant liquid from the receiver until the pressure in the bottle and system has been equalised. It may be necessary to use more bottles. The colder the bottle the smaller the amount of refrigerant left in the system.

5. During draining keep an eye on the receiver sight glass.

OBS! See drawing next page

Drained refrigerant must be regarded as chemical waste.
To be destroyed according to current rules.

Draining of refrigerant (NH_3) from liquid side



REMEMBER! Prepare the necessary safety equipment, suit, gloves, mask, glasses and irrigation bottle.

To prevent the refrigerant bottle from busting due to overcharge the following rules must be strictly observed:

1. **Volume over 14 litre but under 30 litre:**
   Max charge = volume in litre x factor 0.6 - i.e. a 30 litre bottle must max be charged 30 x 0.6 = 18 kg.
2. **Volume over 30 litre:**
   Max charge = volume in litre x factor 0.75 - i.e. a 50 litre bottle must max be charged 50 x 0.75 = 37.5 kg

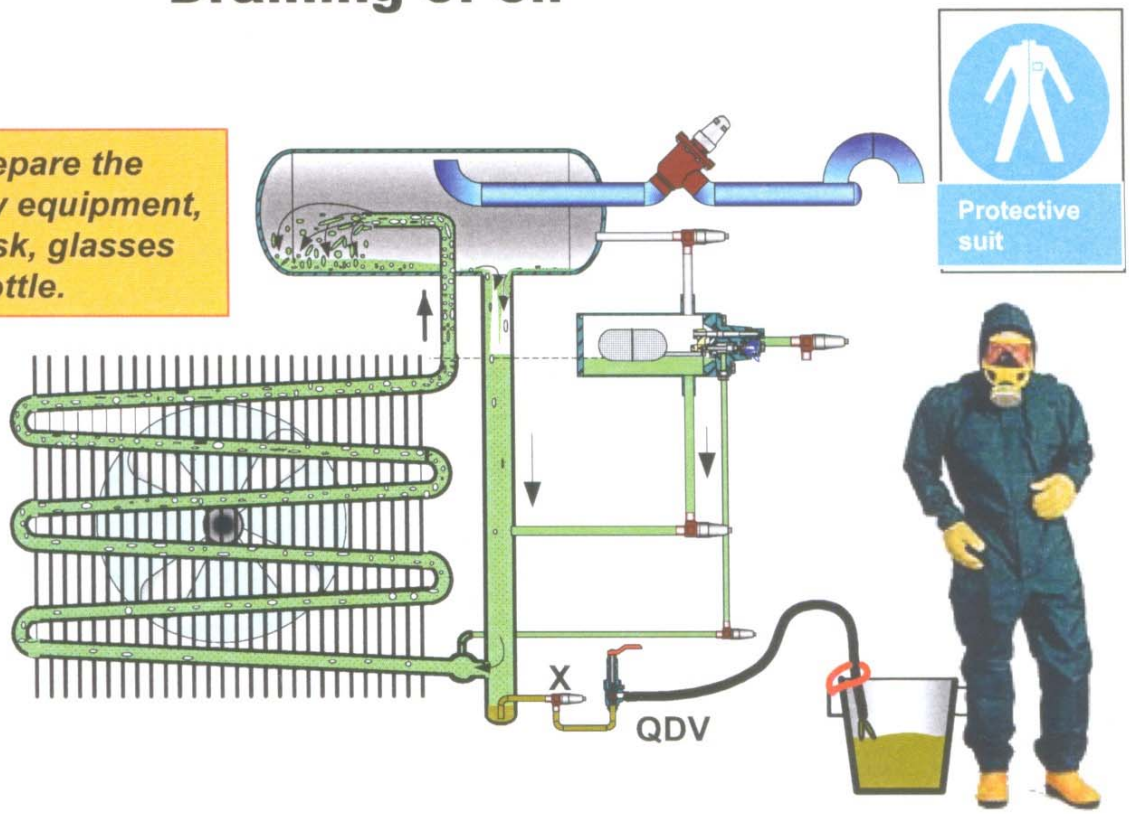
Drained ammonia must be collected in suitable containers, clearly marked with the contents, and sent to an approved incinerating plant.

Protective suit

Refrigerant bottles must be protected against damage such as jolts, collisions etc. Bottles must not be exposed to direct sun and must be kept in a locked room made for the purpose.

Draining of oil

REMEMBER! Prepare the necessary safety equipment, suit, gloves, mask, glasses and irrigation bottle.



Oil draining must be carried out by experienced staff and great vigilance must be exerted.

The pressure in the section from which the oil is drained must be above atmospheric pressure. Therefore the oil draining must be carried out in a defrosting period or when the plant is out of operation.

The drain valve (QDV) and the stop valve (X) must always be opened with great care in the mentioned order, as sludge or other impurities may have collected in a firm plug blocking the valve.

If oil is not running out of the valve when it is opened slightly it must be shut again immediately. The section must then be evacuated for ammonia and the valve dismantled for cleaning.

Sludge plugs can be prevented by draining the oil at regular intervals. At the same time it must be ensured that the evaporator is always working at the highest possible capacity.

OBS! The drained oil must not be reused in the compressor!

Leak detection

Leaks can be localised either by rubbing soapy water over the joints and note where bobbles appear or by using detectors that react to leaks in the refrigeration system.

Ammonia: To detect leaks on ammonia plant the following can be used:

1. A piece of burning sulphur tape as ammonia together with chlorine vapours or sulphur dioxide vapours produce white smoke.
2. Phenolphthalein- paper. The paper is wetted by water and moved over the joints. In case of leaks the paper will turn red.
3. Soapy water (bubbles).

HCFC,HFC (R 22, R 134a, R404 A): For these plants the following can be used:

1. Electronic leak detector.
2. Leak detection lamp - which is very sensitive.
3. "Spectro - line".
4. Soapy water.

Safety in connection with refrigerating machine oil

Tests have shown a certain connection between exposure to "Ester oils" and eczema. Therefore always avoid skin contact with "Ester oils".

Generally it is recommended always to protect oneself against direct contact with refrigeration machine oil.

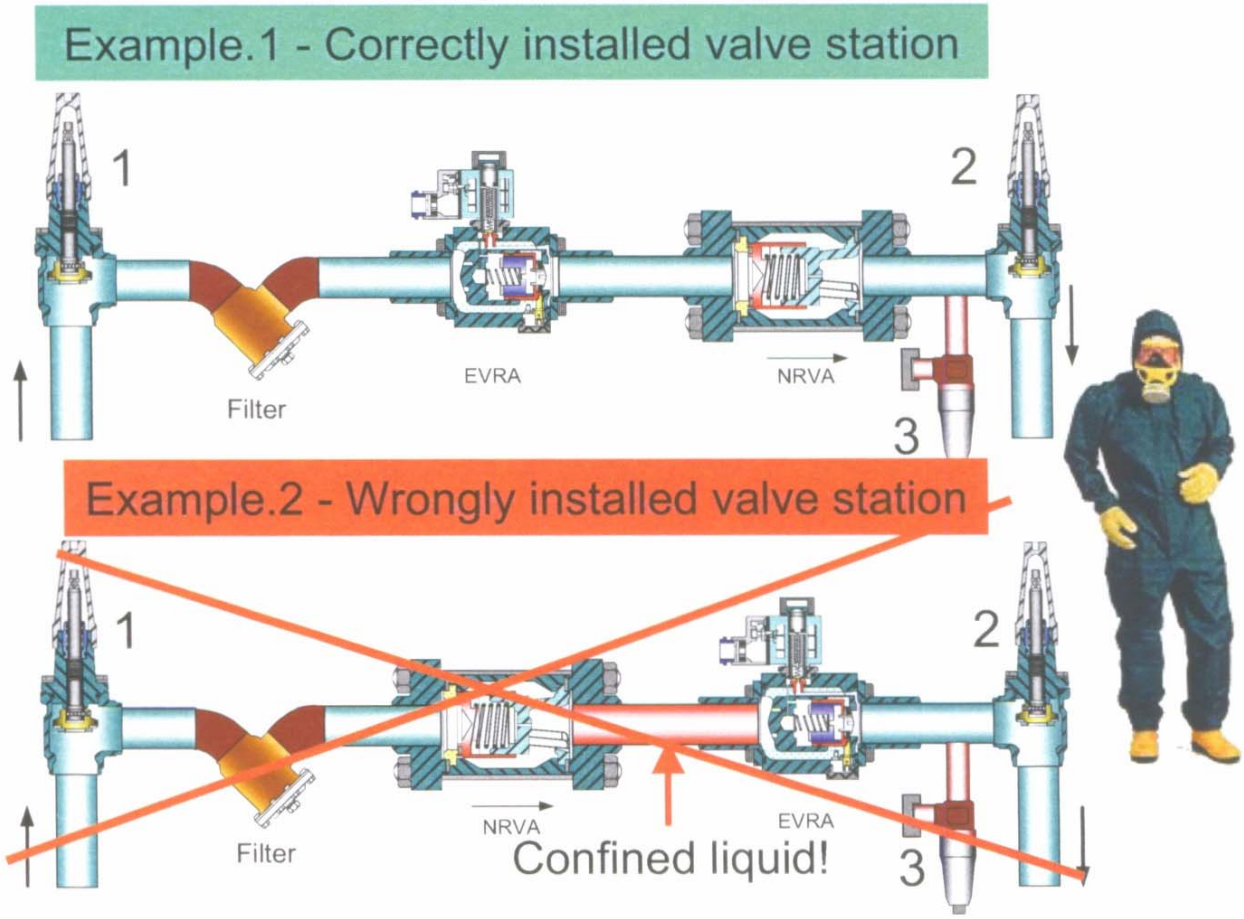
- When working with Ester oil or refrigerating machine oil nitrile gloves should be used (I.e. when changing oil or replacing filters).
- Make sure to keep your skin whole and in good condition.
- Wash your hands and use skin cream when you have been in contact with oil.
- Never use skin cream and protection gloves at the same time.
- Avoid oil soaked clothe.
- When there is a risk of contact with oil use protection suit or apron.

Nitrile - gloves

ArSiMa INDUSTRIAL SAFETY EQUIPMENT

Always protect yourself when working with oils!

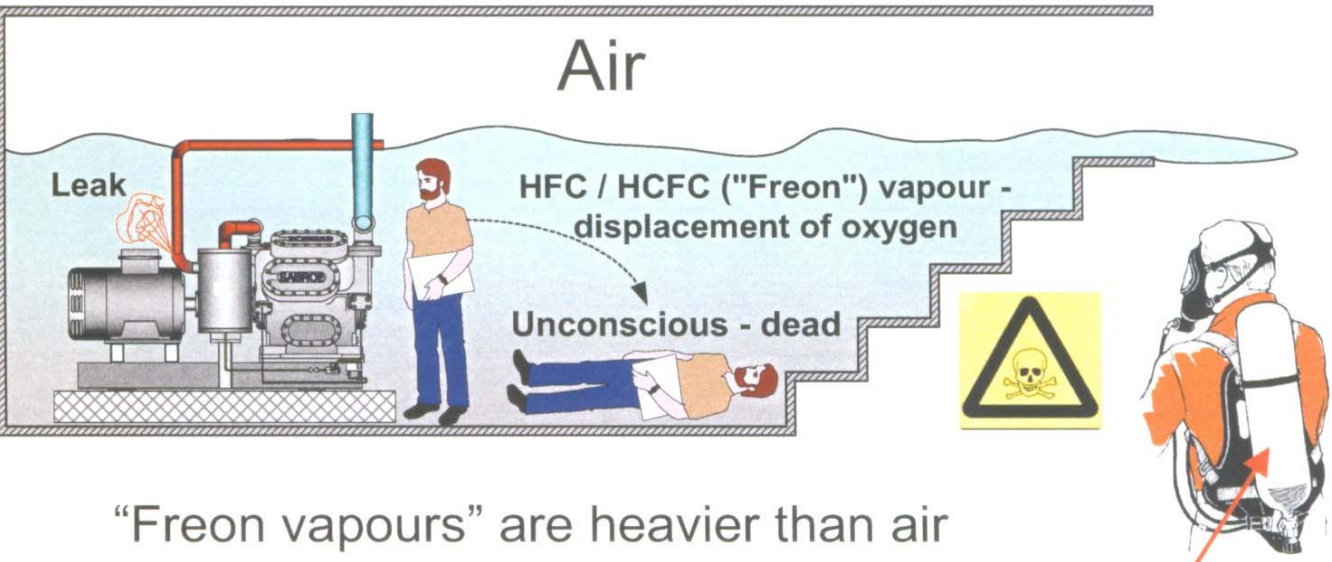
Confined liquid in liquid line



When carrying out service work, mantling or dismantling pipe systems and valve stations it must be ensured **not** to confine liquid. The below instruction must be used when e.g. cleaning filters:

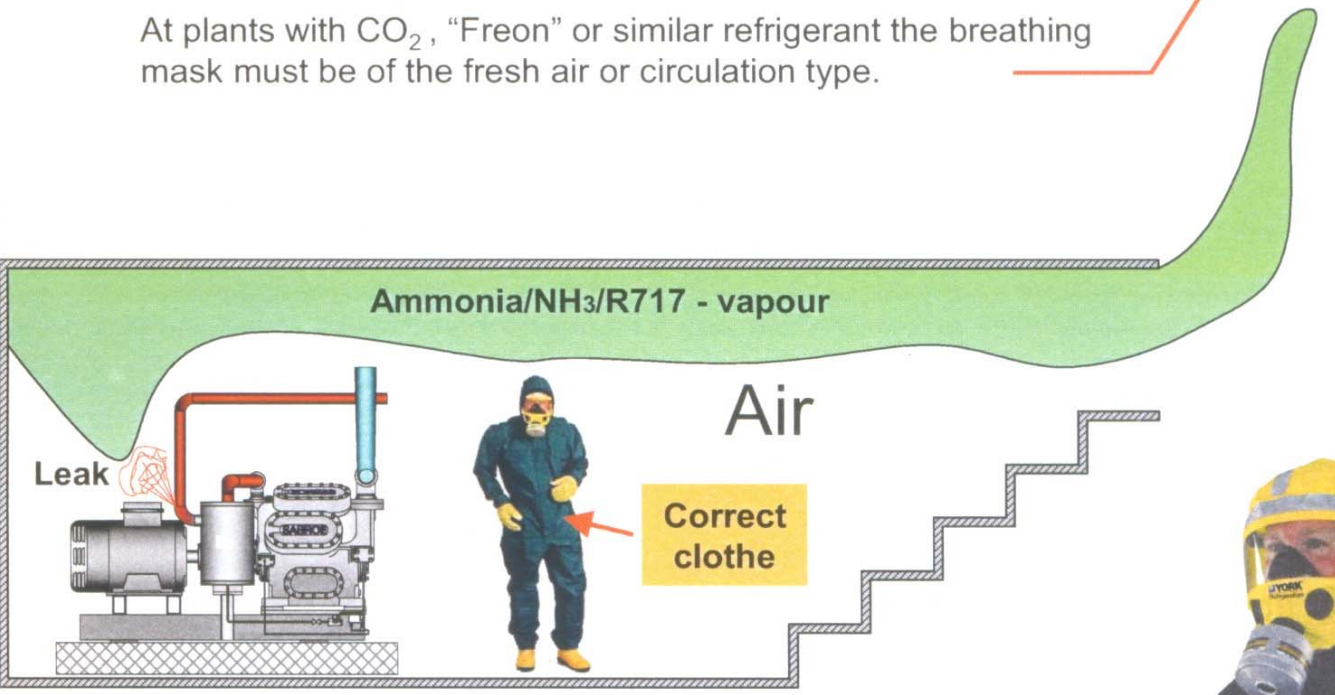
1. Shut stop valve **(1)**
2. Leave the pipe system to empty by normal pressure increase. A warm moist cloth may be used for heating the system (the temperature must not exceed 40°C).
   Obs! Never use a gas flame or the like!
3. Then shut stop valve **(2).** If a service valve **(3)** is available it possible with this to control/ empty the system.
4. Loosen the nuts on the flange at the non-return valve very carefully.
   REMEMBER necessary safety measures! There may be confined liquid/pressure in the system.
5. Loosen the bolts on the filter housing carefully.
6. When the service work has been finished close the filter housing and open the solenoid valve manually, a permanent magnet coil (Danfoss) may be used. Open stop valve (1) a little and close it in order to displace air from the system at the non-return valve. If service valve (3) is available use this for ventilation.
7. When all nuts and bolts have been tightened the system must be leak tested. This is done by opening the stop valve (1) a little. Paint the flanges with soapy water.
8. Open stop valve **(2)**. Open stop valve **(1)**.
   Remember to set solenoid valve at normal operation.

The specific gravity of refrigerants



"Freon vapours" are heavier than air

At plants with CO_2 , "Freon" or similar refrigerant the breathing mask must be of the fresh air or circulation type.

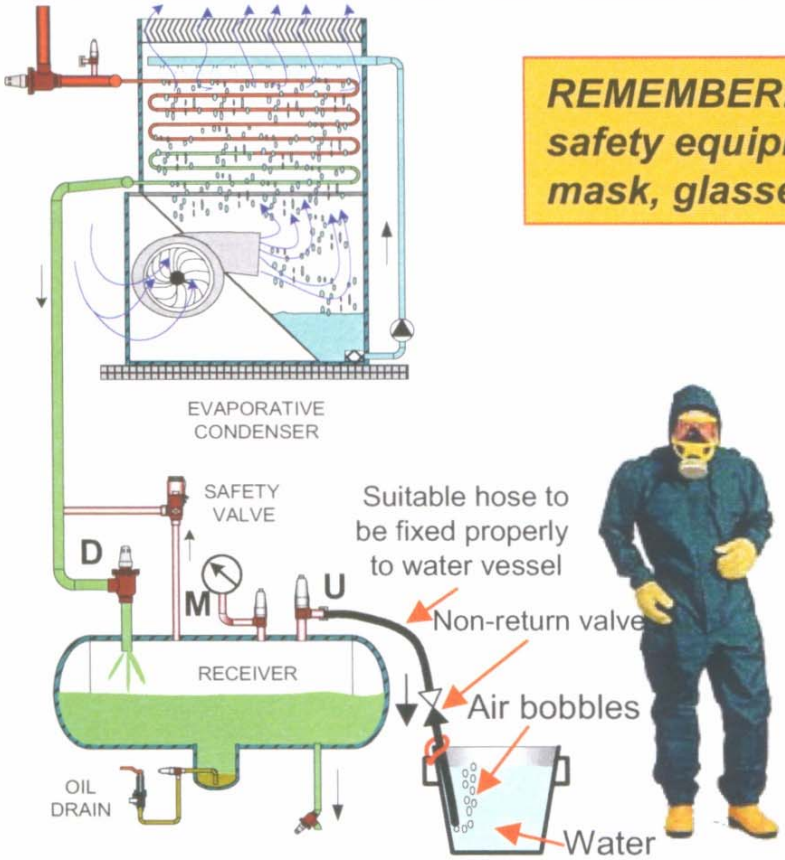


YORK Refrigeration helmaske

Escape mask
with K2 filter

Ammonia vapours are lighter than air

Manual blow-out of difficult condensable gasses



REMEMBER! Prepare the necessary safety equipment, suit, gloves, mask, glasses and irrigation bottle.

During the day-to-day operation it must be ensured that the system does not contain air as this will cause increasing condenser pressure and consequently increased power consumption.

As ammonia vapours are lighter than air they will, in an evaporative condenser, be above the liquid mirror in the receiver and partly in the condenser. Therefore it is an advantage to ventilate from the top of the receiver.

Checking for air is performed while the compressor is stopped. At double pipe condensers open the water inlet completely and measure the water temperature at inlet and outlet. When the inlet and outlet temperature has been equalised it is measured and compared to the pressure gauge (M) temperature. If the pressure gauge shows a higher temperature the plant contains air/uncondensable gasses. If the plant does not contain air/uncondensable gasses the ammonia will take on the pressure and temperature corresponding to the water temperature.
If however the plant contains air/uncondensable gasses the ammonia will probably taken on the pressure and the temperature corresponding to the water temperature but the air/uncondensable gasses will not change their pressure and as the combined pressure in the condenser is the sum of air/uncondensable gasses and the ammonia pressure the total pressure will be higher than the one corresponding to the water temperature.
At evaporative condensers the temperature shown by the pressure gauge is compared to the surrounding air temperature at the condenser, the pipes must however not be exposed to the sun and they must be completely dry.
It is easiest to remove air/uncondensable gasses after the compressor has been stopped for some time i.e. in the morning before start-up. As air/uncondensable gasses are heavier than ammonia vapours it is recommended to ventilate at the top of the receiver.

1. Shut the stop valve (D) between the condenser and receiver.
2. Connect a suitable hose to the blow-off valve (U) at the top of the receiver. Lead the hose down into a vessel with cold water and fix it properly.
3. Open the blow-out valve (U) carefully. The air/uncondensable gasses will now bubble up through the water. As soon as the bubbles stop (a special cracking sound will be heard) the valve must be shut. It may be necessary to carry out this procedure several times before all air/uncondensable gasses are out of the plant.

OBS! Do not leave the work during manual ventilation!

Optimum safety can only be obtained through knowledge and training.

SURVIVAL TRAINING CENTER ESBJERG supplies you with basic knowledge and skills regarding the safe handling of NH_3.

The pictures show some of the practical exercises of the course.


Action against NH_3 leak in machine room


Action against NH_3 leak in cold store


Practising the use of recondensing equipment


Action against NH_3 leak in machine room

For enrollment please contact
YORK Service Training, Denmark

Phone no: +45 87 36 75 28
Fax no: +45 87 36 75 32
E-mail: TrainingCentre@yorkref.com

YORK Refrigeration

Important telephone NO

Chief engineer/ or watchman.....telephone No _____

Doctor.....telephone No _____

Casualty ward ....telephone No _____

Internal emergency .....telephone No _____

Public authority/police ....telephone No _____

Emergency call centre ....telephone No _____

Authorised refrigeration company ..telephone No _____