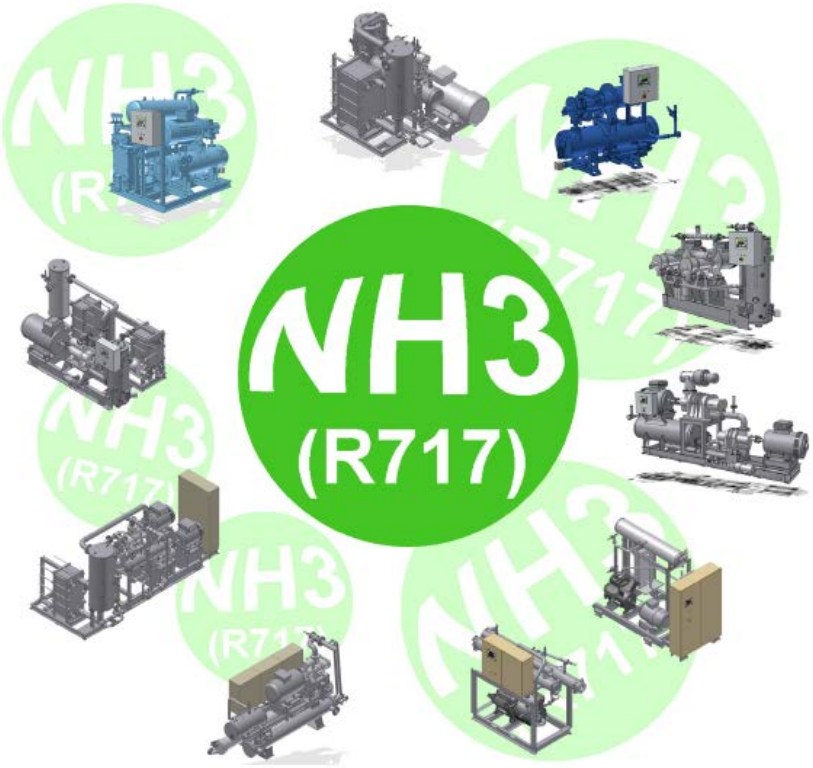
SAFETY MANUAL



NH 3

Refrigerant

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LEGAL NOTICE

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SYMBOLS USED

⚠ Danger

Stands for an immediate danger leading to severe physical injuries or death.

► Description for avoiding the danger.

⚠ Warning!

Stands for a potentially dangerous situation leading to severe physical injuries or death.

► Description for avoiding the dangerous situation.

⚠ Caution!

Stands for a potentially dangerous situation which could lead to minor physical injuries or damage to property.

► Description for avoiding the dangerous situation.

Notice

Stands for important information that must be observed for the intended use and function of the product.

► Description of the required action for the intended function of the product.

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1 Safety Instructions NH_3 (ammonia)

1.1 Legal regulations (Germany)

Notice

Ensuring the safety and functioning of the ***GEA Grasso compressor packages*** and ***GEA Grasso chillers***.

► The following EC directives, laws, regulations, standards and ordinances must be observed:

- **EC Pressure Equipment Directive 2014/68/EC**

  Implementation in Germany:

  Devices and Product Safety Act (DPSA)

  Pressure Equipment Ordinance (14. GPSGV)

- **EC Machinery Directive 2006/42/EC**

  Implementation in Germany:

  Devices and Product Safety Act (DPSA)

  Machinery Ordinance (9. GPSGV)

- **Federal Immission Control Act** (BImSchG), 4. BimSchV

  Devices and Product Safety Act (DPSA)

- **Water Resources Act** (WHG), VawS
- **Closed Substance Cycle Waste Management Act** (KrW-AbfG)
- **Industrial Safety Ordinance** (BetrSichV)

  regarding safety and health protection when supplying working fluids and their use during work

  regarding operational safety of systems which need supervision and regarding the organisation of operational industrial safety

  Pressure Equipment Ordinance (14. GPSGV)

  Machinery Ordinance (9. GPSGV)

- **Ordinance on Failures**(12. BImSchV)

  Twelfth ordinance for the enforcement of the Federal Emissions Control Act including 1st failure VwV

- **Ordinance on Hazardous Substances** (GefStoffV)
- **DIN 2405** Pipes in refrigeration plants, marking
- **DIN EN 378** Refrigerating systems and heat pumps - safety and environmental requirements

  Part 1 Basic requirements, definitions, classification and selection criteria

  Part 2 Design, construction, testing, marking and documentation

  Part 3 Installation site and personal protection

Part 4 Operation, maintenance, repair and recovery

- **DIN EN 14276** Pressure equipment for refrigerating systems and heat pumps

  Part 1 Vessels - General requirements

  Part 2 Piping - General requirements

- **DIN EN 12284** Refrigerating systems and heatpumps – Valves – Requirements, testing and marking
- **Accident-Prevention & Insurance Association Rule** (BGR 500, Chapter 2.35) for refrigeration plants, heat pumps and cooling equipment
- **VDMA Directives**

  VDMA 24243-1,-2,-3 Refrigerating machine and refrigeration plants - leak-proofness of refrigeration plants and heat-pumps - leak detection / leak test

  VDMA 24020-1 Operational requirements for refrigeration plants - Part 1: Ammonia refrigeration plants

- **VDI Guidelines**

  VDI rules are considered to be recommendations. Everyone is at liberty to use them, i.e., you can use them and are also at liberty to use other methods to ensure the maintenance of the state of the art. The use of a VDI recommendation does not relieve the user of the responsibility for his/her own acts and it is thus used at the user's own risk.

- **Accident prevention information** BGI 595 handling irritant and corrosive materials
- **Safety sheet for ammonia:**

The list of rules and standards has been taken from Status Report No. 5 of Deutscher Kälte- und Klimatechnischer Verein “Sicherheit und Umweltschutz bei Ammoniak-Kälteanlagen (Safety and environmental protection in ammonia refrigeration plants)”, November 1990.

1.1.1 Hints for the technically safe operation of an NH_3 system

Notice

Fill only anhydrous ammonia into the plant (maximum water content in NH_3 at delivery 0.3 %).

► When operating the NH_3 plant, take appropriate technical measures to ensure that the water content of the plant does not exceed 1 % of the total NH_3 filling quantity.

1.2 Legal regulations (Europe)

Notice

Ensuring the safety and functioning of the ***GEA Grasso compressor packages*** and ***GEA Grasso chillers***.

► The following EC directives, European standards, and international regulations must be observed:

- **EC Pressure Equipment Directive 2014/68/EC**
- **EC Machinery Directive 2006/42/EC**
- **DIN EN 378-1, -2,-3, -4**
- **DIN EN 12284**
- **DIN EN 14276-1, -2**
- **Country specific laws and rules**

1.3 Basic principles

⚠ Warning!

When operating, servicing and maintaining GEA Grasso screw compressor packages and GEA Grasso chillers, adhere **in particular** to the following instructions taken from the EC Directives, laws, ordinances, standards, and rules, listed in legal regulations mentioned under point 1.1:

► It is forbidden to weld or use open flames unless special safety instructions are observed.
► Smoking is not allowed in the refrigeration machinery room.
► Escape routes must be free from obstacles.
► Store suitable personnel protective equipment and respirators at an accessible point of the refrigeration machinery room (acc. to EN 378-3, appendix A).
► Store fire extinguishers at an accessible point of the refrigeration machinery room (acc. to EN 378-3, 5.1.j).
► Any work on units and chillers may only be carried out by appropriately trained and instructed staff.
► Intimate knowledge of the complete delivered documentation is a prerequisite for operating the equipment correctly and safely.
► The packages and chillers must not be operated unless full functional and operational safety and reliability of all components, safety devices and circuits (refrigerant and oil circuits, secondary refrigerant and cooling water circuit) and of the electrical switchgear is ensured.
► The elements of the safety chain, sensors and controllers must be adjusted according to the designed values and must not be deactivated, or even partly deactivated.

1.4 NH_3 - safety

Strict safety provisions have been defined to protect human beings and facilities.

In the following paragraphs, reference is made to some important measures to ensure the safety With regard to their operation, the detailed operating manuals of the plant manufacturers shall be taken into account as well.

The texts cited refer to the National Rule "Refrigerating Plants, Heat Pumps, and Cooling Equipment" (BGR 500. Chapter 2.35, Germany) and to EN 378, parts 1 to 4 "Safety- and environmental requirements".

1.4.1 Installation of NH_3 refrigerating plants

Refrigerating plants must be positioned so as to prevent their being damaged by site traffic and transport activities.

In areas which are used for traffic, pipes with refrigerants (e.g., NH_3) may be installed only without detachable connectors and fittings.

Refrigerant pipelines must be protected from mechanical damage.

Mechanical damage may be caused by vehicles or heavy loads. Protection can be achieved, e.g., through the following measures:

- Laying above the vehicle height with a given profile limitation
- Mounting of protective bars or driving limitation rails
- Bumpers mounted on pipeline supports
- Laying in pipeline ducts

Refrigerating plants must be positioned so as to allow inspection from all sides and to provide sufficient space for maintenance work.

For pollution control, NH_3 and oil must be prevented from entering the sewerage network. Therefore, the installation area of the NH_3 refrigerating plant must be free of drains, or existing drains must be closed.

Rescue routes (escape routes) from an installation room to safe rooms must not be longer than 20 m and must be properly marked.

A sufficient number of fire extinguishers must be available.

1.4.2 Installation site

Machinery rooms must be designed so as to allow exhausting of escaping NH_3 avoiding it being transferred into adjacent rooms, staircases, narrow yards and corridors.

This requirement is met if:

- in case of natural ventilation, the cross section area to be open to the outside is at least **"A"** m² and air change must take place at least four times per hour

or

- in case of mechanical ventilation, an air flow from outside the endangered area of at least **"V"** m³/s can be switched on

and

- the doors of the machinery room not leading directly to the outside are self-locking.

"A" = 0.14 x m $^{1/2}$ (m²)

"V" = 14 x 10^{-3} x m $^{2/3}$ (m³/s)

“G" = weight of the refrigerant filling quantity in kg.

Where several plants are installed, this parameter is derived from the plant with the larger filling weight.

Air exhaust openings (windows, outlets, channels) must be arranged to prevent human beings from being harmed by the refrigerants carried by the exhaust air.

A mechanical ventilation is provided if natural ventilation through windows or doors is impossible or insufficient. An effective air exchange can be accomplished only if a sufficient quantity of outside air can flow in.

As NH_3 is lighter than air, the polluted air must be evacuated near the ceiling while fresh air must be supplied near the floor.

The machinery room may also be provided as a gas-tight machine housing being vented to the outside.

An absorption system to dissolve the escaping NH_3 can be used. (See Item 1.4.5.2.)

Machinery rooms must allow quick escape in case of danger.

Depending upon the size of the machinery room and the refrigerant filling weight, an emergency exit directly to the outside is recommended.

Doors must open towards the escape direction and must be able to be opened at any time from the inside, e.g., by installing a panic lock.

Refrigerating plants installed in machinery rooms must allow switchoff from outside the machinery room. Control devices must be clearly marked.

Facilities for refrigerant discharge must allow actuation from a non-hazardous position.

1.4.3 Personal protection

The plant operator shall provide personal safety equipment against exposure to refrigerant. This equipment shall be stored ready-for-use outside the hazardous areas in an easily accessible manner.

Safety equipment for at least two persons should be available.

Safety equipment for ammonia:

- Safety gloves
- Safety goggles
- Respiratory equipment with filter

1.4.4 Explosion protection

NH_3 is explosive if mixed with air at ratios between 15 and 28% although the reaction energy is very low, and a ventilation system is operating.

NH_3 is a hardly inflammable gas which does not continue to burn without a supporting flame as its ignition temperature is very high (630 °C). Therefore, no explosion protection is prescribed (except for special cases for fans, fan motors and associated electrical equipment: see EN 378-3, 5.17.1.2 and 6.3)

Open flames and smoking are not permissible in the installation area.

1.4.5 Safety systems

In order to provide a high degree of safety against ammonia leaks, ammonia warning systems can be used.

Detecting devices and warning systems are required according to EN 378-3, section 8.

For refrigerant filling amounts exceeding 500 kg, additional measures are to be taken to check all the connected water circuits or liquid circuits for the presence of refrigerant.

1.4.6 Testing the entire plant prior to start-up

Testing of the entire plant has to be performed according to EN 378-2, section 6.3, prior to start-up.

Renewal tests of the entire plant have to be carried out with due regard to EN 378-4, appendix D.

The plant operator shall ensure that flexible refrigerant lines which are moved actively be tested for leaks by an expert at least every 6 months.

"Notified bodies" (e.g. TÜV) are the competent authorities for testing of pressure equipment and piping subject to the EC Pressure Equipment Directive.

1.5 Properties of NH_3

Physical material data

NH_3:

- is oil-free, water-free, gaseous, liquid, dissolved in water, colourless
- Odour characteristically pungent
- Molecular weight is 17 kg/kmol
- Density 0.7 kg/m^3 as a gas at 1 bar and 20 °C
- is lighter than air

Safety relevant data

NH_3:

- belongs to the safety group B2 according to EN 378-1
- Fluid group 1 according to ES Directive 97/23/EC
- after an accident it is dissolved in water by using an absorption device. Fire-extinguishing systems with sprinklers (and water spraying devices) are not allowed in machinery rooms for refrigeranting plants with NH_3.

Danger for people and environment

Fig.1: "Toxic"

NH_3:

- is toxic when inhaled (GefStoffV)
- has a pungent odour causing eye irritation and tears and is clearly detectable even at 25 ppm
- as gas causes strong irritation or damage to eyes
- in liquid form, as concentrated aqueous solution and gaseous form has strong caustic effect on skin, mucous membranes and eyes in high concentrations
- Liquid ammonia can cause frostbite, if it gets in contact with the skin.
- Ammonia and air produce an explosive mixture between 15...28 Vol.-%.

1.6 Rules of conduct when handling NH_3

- The compressor unit/liquid chiller must be operated only by trained and qualified staff.
- Interventions in the ammonia-circuit must be carried out only by experts in this field.
- Only persons confirmed by the plant operator are permitted to handle NH_3.
- Regular instruction must be given on the handling of ammonia (with documented evidence).
- A proper machinery room ventilation must be guaranteed. If there is ammonia odour in the machinery room, do not eat, drink or smoke there!
- Skin contact with liquid ammonia must be avoided at all times.
- Respiratory protection apparatus with an ammonia filter must always be worn when working on the refrigerating plant.

1.7 Behaviour in case of danger

- Leave the working area immediately and actuate the alarm if ammonia escapes from the refrigerating plant.
- If need be, put on a respiratory protection apparatus with ammonia filter (colour: green).
- Rubber gloves, protection apron and protection boots must be used.
- Start-up of the absorption device.
- Do not drain NH_3 containing water into the sewerage system or public waters.

1.8 First aid

Fig.2: "First aid"

- The casualty/casualties must be removed from the contaminated atmosphere into the open air.
- Clothes contaminated with ammonia must be removed.
- Irritated parts of the body - mouth and eyes too - must be sufficiently rinsed with water for about 20 minutes.
- The affected skin areas must not be covered with dressings, oil, etc., but must be protected from cold.
- The casualty/casualties must be taken to hospital or to a doctor as soon as possible after the affected parts of the body have been rinsed.

- Medical treatment is immediately necessary, if NH_3 was inhaled in large quantities and in case of irritations – especially of the eyes.

1.9 Appropriate disposal

Danger

Ammonia including its watery solution must be disposed of as waste requiring special supervision!

► National regulations (e.g., EN 378.4, Section 6) must be observed for the disposal of refrigerants.

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