German Safety Regulations
for Using Ammonia as a Refrigerant

Preliminary Remark:
The term “safety regulation” will be used in the following as a collective term for all kinds of regulations which have to be observed. In the Federal Republic of Germany, safety requirements for the protection of human beings, animals and objects are included in laws, decrees, guidelines, sets of rules, and standards. Laws and decrees are passed by the Federal Government or the German states (as for example the Law for Safety of Appliances [Geräte-Sicherheitsgesetz] or the Federal Clean Air Act [Bundes-Immissionsschutzgesetz] with the accompanying contingency decree [Störfallverordnung]).

In addition there are regulations by public corporations, e.g. by the trade associations. Laws, decrees and regulations can in their implementation requirements refer to standards and instructions of non-public standardizing institutions as for example DIN (German Standards Institution), VDE (Association of German Electrical Engineers), VDMA (German Machinery and Plant Manufacturers' Association). Their standards are drawn up with public participation.
Due to the progressing development, safety regulations are subject to change. Therefore only an information about the current state is possible. This leaflet is intended to inform about the existing safety regulations for refrigerating systems using the refrigerant ammonia, in order to give interested parties--or operators of such refrigeration systems--a first general idea of the extent and the quality of the existing safety regulations. Only the essential regulations will be mentioned and briefly commented on, over and above that there are further regulations.


DIN 8975 is valid for all kinds of refrigerating systems, not only for ammonia systems. According to Part 1, a pressure of 12 bars is permitted for the low-pressure side and 16/23 bars for the high-pressure side for the layout of system components--depending on whether the system is operated with water or air cooling. For aggravated conditions, a pressure of 28 bars is permitted.

Part 2 of this standard contains details for the selection of materials. It is not allowed to use the materials copper and zinc with ammonia, copper alloys may be used with ammonia after proving their compatibility.

Part 6 of this standard summarizes the state-of-the-art for refrigerant piping. The pipes and fittings on the high-pressure side have to be designed for 25 bars. On the low-pressure side the same nominal pressure is used as on the high-pressure side, which offers among other things more protection against corrosion.
The manufacturers of pipes and fittings have to subject the parts to an inspection. After installation of the pipe system, a first inspection is carried out by competent experts or personnel. For this a pressure test is performed on site; additionally a part of the welded joints of the piping is subjected to an X-ray examination.

Parts 7, 8 and 9 describe safety devices against excessive pressure load, level indicators and flexible parts of the piping.

Part 10 (draft) deals with recommendations for the reduction of refrigerant emissions from refrigerating systems. Here, it is recommended to use for example ammonia instead of fully-halogenated refrigerants.

2. Pressure Vessel Decree and Technical Rules for Pressure Vessels TRB (Druckbehälterverordnung und Technische Regeln TRB)

Pressure vessels and piping in the sense of this decree are vessels and piping with an existing or possible excess operating pressure of > 0.1 bar. Among the piping are also such pipes which connect the pressure vessels with each other, for example refrigerant pipes.

Among other things, the Pressure Vessel Decree regulates the inspection of pressure vessels and piping. According to the decree, pressure vessels have to be tested before commissioning. The extent of the test depends on the classification of the respective vessels, in groups I and II (product of pressure in bar x content in l < 200) a pressure test is performed by the manufacturer and an acceptance inspection by a competent inspector.
For groups III and IV (product of pressure in bar x content in l > 200) a first test and acceptance inspection is performed by an authorized expert.

Repeated inspections of refrigerant piping are performed every 5 years--provided the connected pressure vessels have been shut down for maintenance purposes during this period.

The realization of this requirement is included in the Technical Rules for Pressure Vessels (TRB), the AD Instructions and further documents cited in these places. Here, in the first place the TRB 801 (pressure vessels in refrigerating systems, plate heat exchangers) and the TRR 512 for first inspections of piping according to the Pressure Vessel Decree are concerned.

3. Accident Prevention Regulation (UVV [Unfallverhütungsvorschrift])
“Refrigerating Systems, Heat Pumps and Cooling Systems” (VBG 20)
This UVV contains the specific safety-related requirements for building, equipment, installation, inspection, and operation of refrigerating systems. The instructions list measures on how the requirements of the regulation can be fulfilled. The solutions mentioned there reflect the technological safety level. The latest version of the VBG 20 in force is dated January 1, 1993 (supplemented in 1995).

3.1 Classification of Refrigerants
Ammonia is classified in refrigerant group 2 which contains toxic and caustic refrigerants, and such, whose blends with air have a lower explosion limit of at least
3.5 vol. %. By the conspicuous odour with a threshold of perception clearly below the MAK (maximum allowable concentration) value, \( \text{NH}_3 \) leakages become noticeable before larger contaminations or caustic effects occur. As the explosive area comprises only a very narrow and high range of concentrations, ammonia was granted special favourable regulations.

### 3.2 Design Regulations

Shutoff devices, which may not be activated during operation, have to be protected against abuse.

Drain pipes in refrigerating systems, which can be opened during operation have to be equipped with fast-closing valves in addition to the check and control valves. When installing refrigerating systems, it has to be taken into consideration that in areas, which serve for traffic purposes, piping with ammonia may only be installed with inseparable coupling pieces and fittings. Emergency paths from an operation room to unendangered rooms may not be longer than 20 m.

Machinery rooms have to be equipped in a way that leaking ammonia is drawn off so that a crossing of the gas into adjoining rooms, staircases etc. is prevented.

### 3.3 Protective Gear

Personal protective gear against refrigerant exposure has to be available in the same room and has to be worn when refrigerant is leaking out or when in the case of repairs a leakage has to be expected.
This gear includes protective gloves, eye protectors, and respiratory protective equipment (full face mask with filter). The protective gear has to be provided for at least 2 persons.

3.4 Installation and Charge
There are maximum refrigerant charges depending on the system and the location and type of installation. The most important specifications are as follows:

Area 0 (only for authorized persons), without machinery room, charge limit: 10 kg, with a staff of less than 1 person per 10 m² and with marked emergency paths shorter than 20 m: 50 kg ammonia.

If compressors and accumulators are installed in the machinery room, the 50 kg limit in open rooms is also applicable with a staff of less than 1 person per 10 m². For closed machinery rooms no charge limits exist. For refrigerant-containing parts in the machinery room or outside, there are no charge limits.

In the other areas, which are marked with “M”, the limit of 2.5 kg charge applies, there are, however, special regulations depending on the type of system.

4. Federal Clean Air Act (BImSchG), Ambient Air Emission Decree (Immissionsschutzverordnung), and Accident Decree (Störfallverordnung)
Effective June 1, 1993, ammonia systems with a charge of more than 3 t have been included in the BImSchV and thus belong to the systems requiring official approval.
For systems with a charge of between 3 t and 30 t only a simplified approval process is required, for systems with more than 30 t all steps of the approval process have to be complied with. As a consequence, the Accident Decree applies and thus it is necessary to examine the problem of system safety more closely.

The following paragraphs are contained in the Accident Decree:

Areas of application--definitions--safety requirements--requirements for the prevention of accidents--requirements for damage control--additional requirements--safety analysis--extrapolation of the safety analysis--availability of the safety analysis--exceptions--reporting requirements--information about safety precautions--transition regulations--infringements--entry into force.

The requirements for ammonia refrigerating systems are complied with as a rule if they have been built and are operated in accordance with the respective accident prevention regulation VBG 20, DIN 8975 and the pressure vessel decree. In addition to the approval by the authority in charge (in most German states these are the factory inspectorates) according to the aspects of system safety, there are already a number of additional requirements, which unfortunately have not been included in regulations yet. Therefore the approving authorities at present still have freedom for additional requirements--depending on the location of installation and the degree of experience of the respective authority or the appointed authorized expert.
Since 1994 technological safety recommendations have been discussed in the Technical Committee for System Safety (TAA [Technischer Ausschuß für Anlagensicherheit]) of the BMU (Federal Ministry for the Environment, Nature Conservancy and Reactor Safety [Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit]).

Due to the varying requirements with regard to system safety, industry hopes for a speedy clarification in order to end the existing uncertainties among manufacturers and operators of refrigerating systems. It should be achieved that a good system safety is ensured but unnecessary demands and distortions of competition should be ruled out.

Within the framework of this leaflet, the working group eurammon demands that the respective institutions create and publish binding regulations as soon as possible.

Final Remarks:
It can be recognized that the existing safety regulations offer a high degree of system safety.

Ammonia refrigerating systems can be controlled, they are safe, require relatively little energy and are environmentally friendly.

In case of doubt, the German-language original should be consulted as the authoritative text.