BRITISH STANDARD

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12952-14:2004

Water-tube boilers and auxiliary installations —

Part 14: Requirements for flue gas DENOX-systems using liquified pressurized ammonia and ammonia water solution

The European Standard EN 12952-14:2004 has the status of a British Standard

ICS 27.040; 27.060.30

National foreword

This British Standard is the official English language version of EN 12952-14:2004.

The UK participation in its preparation was entrusted to Technical Committee PVE/2, Water-tube boilers, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

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Water-tube boilers and auxiliary installations - Part 14: Requirements for flue gas DENOX-systems using liquified pressurized ammonia and ammonia water solution

Chaudières à tubes d'eau et installations auxilaires - Partie 14: Exigences pour les sytèmes de dénitrification (DENOX) des fumées utilisant l'ammoniac liquéfié sous pression et l'ammoniaque liquide

Wasserrohrkessel und Anlagenkomponenten - Teil 14: Anforderungen an Rauchgas-DENOX-Anlagen die flüssiges Ammoniak und Ammoniakwasserlösung einsetzen

This European Standard was approved by CEN on 24 March 2004.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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Contents

Foreword

This document (EN 12952-14:2004) has been prepared by Technical Committee CEN/TC 269 “Shell and water-tube boilers”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2004, and conflicting national standards shall be withdrawn at the latest by December 2004.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

The European Standard EN 12952 concerning water-tube boilers and auxiliary installations consists of the following parts:

- *Part 1: General*
- *Part 2: Materials for pressure parts of boilers and accessories*
- *Part 3: Design and calculation for pressure parts*
- *Part 4: In-service boiler life expectancy calculations*
- *Part 5: Workmanship and construction of pressure parts of the boiler*
- *Part 6: Inspection during construction; documentation and marking of pressure parts of the boiler*
- *Part 7: Requirements for equipment for the boiler*
- *Part 8: Requirements for firing systems for liquid and gaseous fuels for the boiler*
- *Part 9: Requirements for firing systems for pulverized solid fuels for the boiler*
- *Part 10: Requirements for safeguards against excessive pressure*
- *Part 11: Requirements for limiting devices of the boiler and accessories*
- *Part 12: Requirements for boiler feedwater and boiler water quality*
- *Part 13: Requirements for flue gas cleaning systems*
- *Part 14: Requirements for flue gas DENOX-systems using liquified pressurized ammonia and ammonia water solution*
- *Part 15: Acceptance tests*
- *Part 16: Requirements for grate and fluidized-bed firing systems for solid fuels for the boiler*

CR 12952-17: Water-tube boilers and auxiliary installations – Part 17: Guideline for the involvement of an inspection body independent of the manufacturer

Although these Parts may be obtained separately, it should be recognized that the parts are interdependent. As such, the design and manufacture of boilers requires the application of more than one Part in order for the requirements of the standard to be satisfactorily fulfilled.

NOTE Part 4 and 15 are not applicable during the design, construction and installation stages.

The annex A of this European Standard is informative.

This document includes a Bibliography.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This draft European Standard covers the safety requirements regarding the storage and use of:

- liquefied pressurized ammonia for steam boiler plants;
- liquid ammonia water solution for the reduction of NOx in the flue gas from boiler plants.

Annex A summarizes the operational aspects.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 287-1, *Qualification test of welders — Fusion welding — Part 1: Steels.*

EN 764:1994, *Pressure equipment — Terminology and symbols — Pressure, temperature, volume.*

EN 764-7, *Pressure equipment —Part 7: Safety systems for unfired pressure equipment.*

EN 1011-1, *Welding — Recommendations for welding of metallic materials — Part 1: General guidance for arc welding.*

EN 1011-2, *Welding — Recommendations for welding of metallic materials — Part 2: Arc welding of ferritic steels.*

EN 1011-3, *Welding — Recommendations for welding of metallic materials — Part 3: Arc welding of stainless steels.*

EN 1043-1, *Destructive tests on welds in metallic materials — Hardness testing — Part 1: Hardness test on arc welded joints.*

EN 1043-2, *Destructive tests on welds in metal ic materials — Hardness testing — Part 2: Micro hardness testing on welded joints.*

EN 1563, *Founding — Spheroidal graphite cast irons.*

EN 1712, *Non-destructive examination of welds — Ultrasonic examination of welded joints — Acceptance levels.*

EN 1713, *Non-destructive examination of welds — Ultrasonic examination — Characterization of indications in welds.*

EN 1714, *Non-destructive examination of welds — Ultrasonic examination of welded joints.*

EN 10002-1, *Metallic materials — Tensile testing — Part 1: Method of test at ambient temperature.*

EN 10025, *Hot rolled products of non-al oy structural steels — Technical delivery conditions*

EN 10028-3, *Flat products made of steels for pressure purposes — Part 3: Weldable fine grain steels, normalized.*

EN 10028-7, *Flat products made of steels for pressure purposes — Part 7: Stainless steels.*

EN 10204:1991, *Metallic products — Types of inspection documents.*

EN 10213-2, *Technical delivery conditions for steel castings for pressure purposes — Part 2: Steel grades for use at room temperature and elevated temperatures.*

EN 10216-1, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 1: Non-alloy steel tubes with specified room temperature properties.*

EN 10216-2, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 2: Non-al oy and alloy steel tubes with specified elevated temperature properties.*

EN 10216-3, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 3: Al oy fine grain steel tubes.*

EN 10217-1, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 1: Non-al oy steel tubes with specified room temperature properties.*

EN 10222-4, *Steel forgings for pressure purposes — Part 4: Weldable fine grain steels with high proof strength.*

EN 10228-3, *Non-destructive testing of steel forgings — Part 3: Ultrasonic testing of ferritic or martensitic steel forgings.*

EN 12266-1:2003, *Industrial valves — Testing of valves — Part 1: Pressure tests, test procedures and acceptance criteria — Mandatory requirements.*

EN 12952-2, *Water-tube boilers and auxiliary instal ations — Part 2: Materials for pressure parts of boilers and accessories.*

EN 12952-3:2001, *Water-tube boilers and auxiliary installations — Part 3: Design and calculation for pressure parts.*

EN 12952-5, *Water-tube boilers and auxiliary installations — Part 5: Workmanship and construction of pressure parts of the boiler.*

EN 13445-1:2002, *Unfired pressure vessels — Part 1: General.*

EN 13445-2, *Unfired pressure vessels — Part 2: Materials.*

EN 13445-3, *Unfired pressure vessels — Part 3: Design.*

EN 13445-4, *Unfired pressure vessels — Part 4: Fabrication.*

EN 13445-5, *Unfired pressure vessels — Part 5: Inspection and testing.*

EN 13480-3, *Metallic industrial piping — Part 3: Design and calculation.*

EN 20898-2, *Mechanical properties of fasteners — Part 2: Nuts with specified proof load values — Coarse thread (ISO 898-2:1992).*

prEN 50156-1, *Electrical equipment for furnaces and ancil ary equipment — Part 1: Requirements for application design and installation.*

EN 60079-10, *Electrical apparatus for explosive gas atmospheres — Part 10: Classification of hazardous areas (IEC 60079-10:2002).*

EN ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs (ISO 898-1:1999).*

EN ISO 5817, *Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections (ISO 5817:2003).*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 764:1994 and EN 13445-1:2002 and the following apply.

3.1
liquefied pressurized ammonia
ammonia under a pressure of 10 bar to 15 bar, waterfree, flammable and with a boiling point of – 33°C

3.2
liquid ammonia
solution of water, with more the 10 % up to a maximum of 33 % ammonia (used between 15 % and 25 %), flammable, boiling point 37 °C

4 Installations for the storage of liquefied pressurized ammonia

4.1 Plant design

Stress corrosion is a hazard associated with the storage of liquid ammonia.

If required, protection against external mechanical and thermal effects shall be provided which shall be suitable for the required installation site.

NOTE This may include requirements for irrigation and fire protection systems, see relevant national law in the country of installation.

4.2 Materials

4.2.1 Liquefied pressurized ammonia storage vessel

4.2.1.1 The requirements for materials give in EN 13445-2 shall apply.

4.2.1.2 Plates shal be of fine-grained steels of the basic series or low temperature series in accordance with EN 10028-3 up to a minimum value of yield stress at room temperature of 355 N/mm^2. Limit values for chemical composition and for the measured yield stress at room temperature shall be in accordance with the requirements of 4.2.1.7.

4.2.1.3 Seamless tubes shal be of either:

a) fine-grained steels of the basic series or low temperature series in accordance with EN 10216-3 up to a minimum value of yield stress at room temperature of 355 N/mm^2. Limit values for chemical composition and for the measured yield stress at room temperature shall be in accordance with the requirements of 4.2.1.7 or;
b) P195 test category 2 and P235 test category 2 in accordance with EN 10216-2.

4.2.1.4 Flanges shal be made from S235JRG2 or S235J2G3 in accordance with EN 10025. Austenitic steel flanges shall be in accordance with EN 10028-7.

4.2.1.5 Forgings (rings, hollow parts, bars) shall be of either:

a) fine-grained steels of the basic series in accordance with EN 10222-4 up to a minimum value of yield stress at room temperature of 355 N/mm^2. Limit values for chemical composition and the measured yield stress at room temperature in accordance with the requirements of 4.2.1.7 or;
b) S235JRG2 and S235J2G3 in accordance with EN 10025.

4.2.1.6 Welded attachments shall be made from either of the following steel grades:

a) fine-grained steels in accordance with 4.2.1.2 or;

b) S35JRG2 and S235J2G3 in accordance with EN 10025.

4.2.1.7 Additional requirements for fine-grained steels in accordance with EN 10028-3, EN 10222-4 and EN 10216-3:

a) in the ladle analysis the percent by mass of molybdenum shall not exceed 0,04 % and of vanadium shall not exceed 0,02 %;

b) for the steel types with a minimum yield stress of 355 N/mm^2 the chemical composition shall be such that in the normalized condition the measured yield stress at room temperature shall not exceed the value of 440 N/mm^2;

c) for hot formed ends made from plates, which meet the requirements of b) a measured yield stress at room temperature of up to 470 N/mm^2 shall be permitted. Values exceeding 470 N/mm^2 shall be permitted if it is proved by means of an additional normalized specimen taken from the end, that the requirements of b) regarding the yield stress are met.

4.2.1.8 The suitability for the intended purpose and the quality characteristics for other normalised carbon steels which are not listed in 4.2.1.2 to 4.2.1.6 shall be proven. In which case the following general requirements shall be met for ferritic steels:

a) the minimum value of the elongation (A) characterizing the grade of steel shall not be less than 22 % on transverse specimen;

b) the minimum value of impact energy obtained on a transverse specimen (mean value obtained from three Charpy-V-notch impact test specimens), characterizing the grade of steel, shall not be less than 21 J at – 20 °C for fine-grained steels, and shall not be less than 27 J at 20 °C for other steel grades;

c) the weldability shall be proved by the material manufacturer. Preheating, welding heat input and type of heat treatment shall be stated by the material manufacturer.

In cases where steel impact properties are limited to 27 J at + 20 °C, the design values stated in this standard take account of the risk of brittle fracture by reducing the maximum permissible load in line with the published literature ([2] to [6]). Alternatively, the design must limit the lowest scheduled operating temperature of the plant to +20 °C and preclude loadings likely to lead to brittle fracture, not limited to operating instructions to that effect.

4.2.1.9 Weld filler metals and welding consumables shal be to the requirements in accordance with 4.4.1.5.

4.2.1.10 Stabilized austenitic stainless steels and stainless steels with a carbon content δ 0,03 % in accordance with EN 10028-7 may also be used as cladding material for roll claddings.

4.2.1.11 Copper, copper alloys and nickel alloys which contain copper shal not be used.

4.2.1.12 The steels covered by 4.2.1.2 to 4.2.1.6 shall be tested in accordance with the relevant European Standards.

a) in the case of fine-grained steels in accordance with EN 10028-3, EN 10222-4 and EN 10216-3, the impact energy shal be tested;

b) the plates shall be subjected to ultrasonic testing in accordance with EN 1712, EN 1713 and EN 1714 as follows;

- test grid δ 200 mm or in lines with a distance of δ 100 mm. Zones for longitudinal, circumferential and nozzle welds and for connection of support brackets and lifting lugs, on a width equal to plate thickness, but at least 50 mm;
- plates for ends (heads) shall be subject to ultrasonic surface area testing, and the ends shall be subjected to ultrasonic edge zone testing;

c) forgings in accordance with 4.2.1.5 greater than DN 100 shall be subjected to ultrasonic testing in accordance with EN 10228-3;

d) products made from steels in accordance with 4.2.1.10 shall be tested in accordance with the requirements in accordance with EN 10028-7.

4.2.1.13 Material certificates for pressure bearing parts shal be in accordance with inspection certificate 3.1.B in accordance with EN 10204:1991. For materials in accordance with EN 10025 test report 2.2 in accordance with EN 10204:1991 shall be sufficient.

4.2.2 Plant components

4.2.2.1 The requirements given in EN 13445-2 shal apply.

4.2.2.2 Copper, copper al oys and nickel alloys which contain copper, shal not be used for ammonia-containing plant parts. This shall also apply to pressure parts which may come into contact with ammonia due to leakage or diffusion, e.g. stem nuts, control air lines. Lammellar-graphite cast iron shall not be used.

4.2.2.3 The following materials shall be used for ammonia-containing components:

a) for piping, seamless pipes made from P195GH, P235GH or P265GH in accordance with EN 10216-2;

| Piping components which are part of pressure vessels (ammonia storage vessels or evaporators) shall comply with test category 2 in accordance with EN 10216-2.

b) for flanges, S235JRG2 and S235J2G3 in accordance with EN 10025. Austenitic steel flanges shal be in accordance with EN 10028-7;

c) for forgings, S235JRG2 and S235J2G3 in accordance with EN 10025;

d) for welded attachments, S235JRG2 and S235J2G3 in accordance with EN 10025;

e) for bolts and nuts shall be in accordance with EN ISO 898-1 and EN 20898-2;

f) for casings of pumps and compressors, spheroidal graphite cast iron JS1024, 1025, 1014, 1015 in accordance with EN 1563 or cast steel GP240GH/GR in accordance with EN 10213-2;

g) for valves, unalloyed forging steels to c). For special valves not made from forged steels, cast steel may be used in accordance with f).

4.2.2.4 The suitability for the intended purpose and the quality characteristics for other normalized carbon steels which are not listed in 4.2.2.3 shall be proven in which case the following general requirements shall be met for ferritic steels:

a) the minimum value of the elongation (A) characterizing the grade of steel shall not be less than 22 % on transverse specimen;

b) the minimum value of the impact energy (means value obtained on three Charpy-V-notch specimens in transverse direction) characterising the grade of steel shal not be less than 27 J for steels at 20 °C;

c) the weldability shall be proved by the manufacturer. Preheating, welding heat input and type of heat treatment shall be stated by the manufacturer.

In cases where steel impact properties are limited to 27 J at + 20 °C, the design values stated in this standard take account of the risk of brittle fracture by reducing the maximum permissible load in line with the published literature ([2] to [6]). Alternatively, the design must limit the lowest scheduled operating temperature of the plant to +20 °C and preclude loadings likely to lead to brittle fracture, not limited to operating instructions to that effect.

4.2.2.5 Stabilized austenitic stainless steels and stainless steels with a carbon content δ 0,03 % to EN 10028-7 may also be used as cladding material for roll cladding.

4.2.2.6 For evaporators and other pressure vessels with volumes > 100 l, the requirements of 4.2.1 shall apply.

4.2.2.7 The suitability for the intended use and the quality characteristics for other materials not covered by 4.2.2.1 to 4.2.2.5 shall be proved.

4.2.2.8 The following testing of materials shall be done:

a) the steels to 4.2.2.3 shall be tested in accordance with the relevant European Standards mentioned there;

b) forgings in accordance with 4.2.2.3 c) and 4.2.2.3 g) greater than DN 100 shall be subjected to ultrasonic testing in accordance with EN 10228-3;

c) products made from steels to 4.2.2.5 shall be tested in accordance with EN 10028-7.

4.2.2.9 Material certificates for pressure bearing parts shal be in accordance with inspection certificate 3.1.B in accordance with EN 10204:1991. For materials in accordance with EN 10025 test report 2.2 in accordance with EN 10204:1991 shall be sufficient.

4.3 Design of storage vessel

4.3.1 When designing the vessels local material and filler metal accumulations as well as abrupt wall thickness transitions, i.e. local changes in stiffness, shall be avoided. If practicable, the welds shal be positioned in zones subject to lower stresses, i.e. neither in the direct vicinity of transitions due to change in dimension or cross-section nor at points of load application. Irrespective of the design requirements to contain the internal pressure the vessel dimensions shall be selected so that no welded-on reinforcing rings are required for the purpose of vessel stability.

4.3.2 All nozzle and other connections shall be arranged in the gas space.

All nozzles shall have a minimum nominal diameter of DN 50.

Two access openings shal be provided. These openings shall be arranged in the vicinity of the vessel ends, and shall have a minimum nominal diameter of DN 800.

Where a manhole ring (dome) is provided for access openings and pipe connections it shall be high enough to ensure that all flange connections are located beneath its upper edge. The manhole ring need not be connected to the pressure vessel by means of welds. It shall be designed so as to keep constraints at the vessel shell as low as possible.

4.3.3 All nozzles shall be fully welded over their circumference to the vessel wall. Nozzles with a nominal diameter of up to and including DN 100 may be set on by welding. Set on nozzles shall have their roots ground. The drilled edges in the vessel shall be rounded.

All nozzles with an inside diameter δ 120 mm shall be designed so as to make external ultrasonic examination possible if required, to examine for cracking in the nozzle weld on the inside of the vessel. Rings for reinforcement of openings shall not be permitted.

The reduced area shal be compensated by adequately dimensioning the wall thickness of the nozzles.

Welded attachments shall be fixed by double-vee butt or double fillet welds. Unwelded residual gaps shal not be permitted.

4.3.4 Welded connections are preferred to flanged connections. When flanged connections are incorporated flanges rated at PN 40 and provided with form-fit gaskets, shall be used.

4.3.5 All welded joints on the vessel shall be capable of being non-destructively examined. Prior to stress-relief heat treatment, the weld surfaces shall be dressed as follows:

a) vessel inside (wetted by ammonia):

The longitudinal and circumferential welds shall be ground flush to the plate surface to make examinations possible. Inside nozzle welds and welds for attachments shall be ground notch-free to form smooth transitions.

b) vessel outside:

All welded joints shall be so laid as to make examinations possible.

4.3.6 The tensile strength R_m at 20 °C shall not be considered when determining the allowable stress for equation (6.3-1 of EN 12952-3:2001).

4.3.7 The wall thickness shall be designed for 24 bar. This design pressure is composed of the saturated vapour pressure ammonia at 50 °C (highest assumed temperature of fluid, 20 bar) and an al owance of 20 %. This allowance shall be omitted for austenitic steels.

4.3.8 Additional loadings on the vessel wall shal be taken into account in the calculation. This means, for horizontal ammonia vessels, additional forces arising from cradle supports or saddles, or those arising from the type of foundation1).

4.4 Manufacture

4.4.1 Liquefied pressurized ammonia storage vessels of ferritic steels

4.4.1.1 The general requirements of EN 12952-5 shall apply.

4.4.1.2 During manufacture including welding of normalized fine-grained structural steels with minimum yield stress values < 355 N/mm² the requirements of EN 1011-2 shall be taken into consideration.

4.4.1.3 Cold-formed ends shall be normalized.

4.4.1.4 The welded joints shall be made using the TIG welding, manual metal arc welding or submerged arc welding processes with a heat input suitable to obtain an as low as possible hardness. The weld-metal hardness in the component on the fluid-wetted side shall not exceed 230 HV 10 2) after stress relief heat treatment.

4.4.1.5 Only qualified basic filler metals and consumables shall be used. These shall not be alloyed with molybdenum or vanadium. Storage and drying of filler metals and consumables shall follow the requirements of EN 1011-1.

The filler metals and consumables shall be so selected and processed during welding that the yield stress at room temperature of the deposited filler metal and the hardness of the welded joint match the properties of the base metal. This shall be proved by mechanical testing on test pieces, see 4.4.1.6.

4.4.1.6 Mechanical testing on test pieces shal be in accordance with EN 13445-5.

Additional tests:

a) Tensile test in accordance with EN 10002-1 on weld metal specimen (round bar with L_0 = 5d) for thicknesses δ 10 mm for determining the mechanical properties of the weld metal. The yield stress at room temperature shall not exceed 500 N/mm².

   The tensile strength of the base metal in the all-weld metal specimen may be less than the minimum tensile strength by up to 10 % if the minimum tensile strength required in the base metal is obtained in the specimen transverse to the weld.

b) Hardness of the welded joint in accordance with EN 1043-1 and EN 1043-2. A weld metal hardness value of 230 HV 10 shal not be exceeded2) on the fluid-wetted side.

With regard to the additional tests on any welding procedure used for circumferential or longitudinal welds, all filler metals and consumables used, and each melt of the plate materials used, including those used for ends, shall be recorded.

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1) Moreover, additional forces occurring in double-walled vessels by constraints arising from the connection between the external and internal vessel walls, should be taken into account.

2) Conversion to other values may be made if other hardness test procedures are used.

Prior to cutting out the specimens the test pieces shall be subjected to the production stress-relief heat treatment in accordance with 4.4.1.11.

4.4.1.7 The preheating interpass temperatures for the welding of fine-grained structural steels shal be at least 100 °C. These preheating and interpass temperatures may also apply to other carbon steels. For all welds on the vessel temperatures in the upper range should be used over a large area of the material cross-section. These shall be monitored by a sufficient number of measuring points.

4.4.1.8 The welding conditions (filler metals and consumables, preheating and interpass temperatures, heat input, and stress relief treatment) shall be included in a welding procedure sheet. They shall be in conformance with the conditions laid down by the welding procedure qualification and shall be supervised by the manufacturer`s welding supervisor.

4.4.1.9 The weld shall be in accordance quality group B of EN ISO 5817. Peaking or flattening within the area of longitudinal welds, measured as deviation from normal roundness, shall not exceed 5 mm (template length 500 mm).

4.4.1.10 The surfaces of welded joints shall be ground in accordance with the requirements of 4.3.5 prior to stress relief heat treatment3). Surface damage on the inside of the vessel which is subject to cold or hot forming, shall be removed by grinding. When grinding, care shall be taken to ensure that no grinding cracks or annealing colours are produced by excessive heating4).

4.4.1.11 The following stress relief heat treatment shall be carried out:

a) the suitability of the heat treatment facility shall be proved prior to heat treatment with regard to the predetermined temperature tolerances;

b) upon completion the vessels shall be subjected to a stress relief heat treatment at a temperature of 570 ± 20 °C which shall include all welds and cold-formed base metal areas. The holding time shall be 2 min/mm wall thickness with a minimum of 30 min, but shal not exceed 90 min (with respect to possible repeated heat treatments). The measuring points shall be distributed in sufficient number over the length and circumference of the vessel and shall be monitored. For heating up the vessel to annealing temperature, a maximum heat-up rate of 50 K/h for the temperature range 300 °C δ J δ 570 °C shall apply. Cooling to a temperature below 300 °C will be in still air;

c) the whole vessel shall be subjected to stress relieving in the furnace;

d) after stress relieving no welding or grinding work or cold forming shall be performed on the vessel which may lead to tensile stresses on the inside of the vessel. Minor grinding work on the vessel outside shal be permitted. Deviations herefrom shall be at the responsibility of the manufacturer and shall be documented.

4.4.2 Plant components

4.4.2.1 The general requirements of EN 13445-4 shall apply.

4.4.2.2 The welded joints shall be made using the TIG welding, manual metal arc welding or submerged arc welding processes with a heat input suitable to obtain as low as possible hardness. The hardness of the weld metal and of cold-bent pipes shall not exceed 230 HV 102) and if required, stress relieving shal be performed. Root runs shall be exclusively welded by the TIG welding process.

4.4.2.3 Only qualified basic filler metals and consumables shall be used. These shall not be alloyed with molybdenum or vanadium. Storage drying of filler metals and consumable shall follow the requirements of EN 1011-1.

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3) Electrode arc burning beside the weld groove should be avoided. If present, arc burns should be eliminated prior to stress relieving by careful grinding (observing minimum wall thickness) to form smooth transitions.

4) In this respect carborundum or ceramic-bond disks show favourable behaviour. The disk should be continuously moved during grinding; excessive grinding pressure should be avoided.

The filler metals and consumables shall be so selected and processed during welding that the yield stress at room temperature of the deposited filler metal and the hardness of the welded joint match the properties of the base metal. This shall be proved by mechanical testing on test pieces, see 4.4.1.6.

4.4.2.4 The welding conditions (filler metals and consumables, preheating and interpass temperatures, heat input, and stress relief treatment) shall be included in a welding procedure sheet. They shall be in conformance with the conditions laid down by the welding procedure qualification and shall be supervised by the manufacturer`s welding supervisor.

4.4.2.5 The weld quality shall be to quality group B in accordance with EN ISO 5817.

4.4.2.6 The following stress relieving heat treatment shall be carried out:

a) for evaporators and other pressure vessels with volumes > 100 l, stress relieving of the welded joints and cold-bent pipes shall be carried out;

b) welded joints and cold-bent pipes between pressure vessels with volumes > 100 l and the first isolating valve, shall be stress relieved;

c) welded-joint and cold-bent tubes of the other pipework with hardness values > 230 H 10[2)] shall be stress-relieved;

d) the heat treatment facility shall be adequate for the predetermined temperature tolerances.

4.4.2.7 Plant components of stainless austenitic steel shall be welded in accordance with EN 1011-3.

4.5 Tests and inspections prior to commissioning

4.5.1 Liquefied pressurized ammonia storage vessel of ferritic steel

4.5.1.1 Random checks on specified parameters in 4.4.1.1 to 4.4.1.11 shal be performed and recorded.

4.5.1.2 Vessels made from ferritic steel shall be checked after stress relieving in accordance with Table 1.

4.5.1.3 Vessels made from materials in accordance with 4.2.1.10 shall be examined in accordance with the relevant standards.

4.5.1.4 At least 10 % of the length of all welds shall be subjected to ultrasonic testing or radiography and at least 25 % of their length to surface crack detection.

Table 4.5-1 — Testing after stress relieving

Weld	Side	Ultrasonic volume testing	Magnetic particle testing
Longitudinal and circumferential welds	ammonia-wetted side	100 %[a]	100 %
	vessel outside	—	all butted joints on a length of approx. 400 mm
Nozzle welds	both sides	100 %	100 %
Welded attachments	ammonia-wetted side	100 %	100 %
	vessel	—	100 %

a This test is suitably performed on the vessel outside.

4.5.1.5 The test results shall be recorded.

4.5.1.6 The vessel shall be subjected to a hydrostatic test. At the highest point of the vessel the minimum test pressure shall be

$$p_t = 1{,}43 \cdot p_d \qquad (4.5\text{-}1)$$

where the design pressure in accordance with 4.3.7 shall be taken for p_d. For the test pressure p_t the allowable stress

$$f = \frac{K'}{S'} \qquad (4.5\text{-}2)$$

shall not be exceeded.

The hydrostatic test shall be performed after final machining and heat treatment.

4.5.2 Plant equipment

4.5.2.1 Random checks on specified parameters in 4.4.1.1 to 4.4.1.11 shal be performed and recorded.

4.5.2.2 The welded joints between a vessel with a volume > 100 l and the first safety shut-off valve shall be fully tested. On the other ammonia-carrying pipes 25 % of the welded joint shall be radiographed, except for piping systems for ammonia gas mixtures with ammonia proportion δ 10 vol. %. By means of this radiography the joints welded by each individual welder shal be examined to a sufficient extent for to validate the welder's qualification.

4.5.2.3 The test results shall be recorded.

4.5.2.4 The pipes shall be subjected to a hydrostatic test in accordance with 4.5.1.6.

Where the hydrostatic pressure test is harmful or impractical, special tests shall be performed, to give an equivalent safety level e.g. non-destructive tests of all welds, leakage testing, special consideration of materials ductility and extended final inspection.

4.5.2.5 One leakage test shall suffice for piping systems carrying ammonia gas mixtures with an ammonia proportion δ 10 volume % and a working gauge pressure δ 1,0 bar.

4.6 Piping systems for ammonia

4.6.1 Piping systems for liquid ammonia shall be designed in accordance with EN 13480-3 for at least a nominal pressure of 25 bar. Pipework downstream of the pressure regulating station shal be designed for and safeguarded against the pressures which may occur.

4.6.2 Piping connections shall preferably be made by welding. Where detachable connections are required, flanged joints with male and female face or tongue and groove shal be provided. Alternatively gaskets that cannot be blown out shal be permissible.

4.6.3 Piping runs for ammonia in its liquid phase, which can be isolated, shall be safeguarded by relief or safety valves unless an inadmissible pressure rise due to fluid thermal expansion is prevented by other means. The safety valve shal relieve the pressure into a relief system or via an escape pipe to atmosphere set at a sufficient height to prevent danger.

4.6.4 The outdoor installation of pipes or installation on pipes racks shall be done in such a way that the pipes cannot be endangered by impinging vehicles or construction equipment.

4.6.5 Welded pipe connections shall be accessible for the first and periodic inspections to enable testing and inspection to be carried out.

For pipes installed in protective jackets an examination of the intermediate space shall be possible to check for leaks.

4.6.6 The pipes shall be protected against external corrosion.

Special attention shal be paid to corrosion protection between pipe supports (pipe clamps) and pipes. Supporting structures shall be protected against corrosion e.g. by the hot-dip galvanised type. When austenitic steels are used, contacts between ferritic and austenitic steels shall be avoided.

4.6.7 Valves for liquid ammonia shall be so designed that no inadmissible thermally induced fluid pressure is built up. For this purpose of safety, the position of the valves shal be clearly recognizable.

4.6.8 If practicable, valves shall be grouped together for emergency reasons.

4.6.9 Nozzles with sizes < DN 25 shall be protected against damage by external influences (e.g. by increasing the wall thickness).

4.6.10 The valves shall be subjected to strength and leakage testing in accordance with EN 12266-1 in the manufacturer's works.

a) strength testing of the body shall be carried out in accordance with EN 12266-1;

b) leakage testing of the seat shall be carried out in accordance with EN 12266-3:2003, A.4;

In both cases a) and b) the leakage rate shall be leakage rate A in accordance with EN 12266-1:2003, Table A.5.

c) Strengths and leakage tests shall be certified by acceptance test certificate 3.1.B to EN 10204:1991.

4.6.11 Monitoring and control devices shall be fitted to automatic switch off conveying devices (e.g. pumps, compressors) when the allowable filling height is reached or at the latest, if a pressure 10 % less than the allowable working gauge pressure of the vessel is achieved.

4.6.12 For piping systems containing ammonia gas mixtures with an ammonia proportion δ 10 volume %, the requirements in 4.4.2.2, 2nd sentence shall be omitted.

4.7 Electrical equipment

4.7.1 All safety circuits shall be designed in accordance with prEN 50156-1. Because the vapour of ammonia is flammable the electrical installation in this area shall be in accordance with EN 60079-10.

4.7.2 An emergency shutdown system shall be installed to act upon the respective drives and actuators. For the electrical components of the emergency shutdown system the requirements shall be met, e.g. if prEN 50156-1 has been taken into consideration. The fault assessment chart of prEN 50156-1 shall also be applied for faults in hydraulic, pneumatic and mechanical components.

For the manual actuation of the emergency shutdown system, emergency switches shall be installed at several readily accessible locations in the ammonia storage plant and the filling installations, and in addition to at a permanently manned position.

4.7.3 All safety-related electric control and monitoring devices shal be connected to the emergency power supply system or a safeguarded main. These safety-related devices include especially gas warning systems, emergency shutdown system, filling level and pressure measuring devices of the ammonia vessel, sprinkling systems, lighting and drives.

4.8 Equipment of storage vessels

4.8.1 Marking

The marking of storage vessels shall be in accordance with EN 13445-5.

4.8.2 lndication and relief of pressure

4.8.2.1 The devices for indicating and relieving the pressure shall be in accordance with EN 764-7.

4.8.2.2 The storage vessel shall be equipped with a continuously operating remote pressure indicator. The alarm signal released in the case of excess of pressure shall be transferred to a permanently manned location.

4.8.2.3 The storage vessel shal be equipped with two safety valves only one of which shall be permanently ready for operation. The change-over system shall ensure the required discharge area is maintained at all times. The system shall consist of one of the following:

- a two-way cock;

- a change-over valve; or

- an interlocking system.

Where one of the safety devices is disassembled, the two-way cock, the change-over valve or the interlocking system shall be safeguarded against actuation.

The safety valve shal safely discharge the maximum gas volume expelled during filling (as gas). In this case it shall be assumed that liquid ammonia will never be present at the safety valve.

4.8.2.4 The escape pipe shall be so instal ed as to discharge gaseous ammonia safely (e.g. at sufficient height or via the stack).

4.8.3 Measuring and limitation of the liquid level

4.8.3.1 Each storage vessel shall be equipped with a level indicator. The suitability of the level indicator shal be proved.

4.8.3.2 The indication image of the liquid level shall be transferred to the operating floor.

4.8.3.3 For each storage vessel two independent protective devices against overfilling (filling level limiters) shall be required. One of these devices may be integrated into the liquid level indicator to 4.8.3.1. The two protective devices against overfilling shall operate by different principles. Their suitability shal be proved. The control pulses shall actuate the safety shut-off devices of the filling system on the vessels and of the filling installation as well as the pumps (compressors) of the filling system.

If one of the protective devices against overfilling responds, the safety shut-off valves and the pumps (compressors) shall interrupt the supply flow, and at the same time an alarm signal shall sound at the location of filling. The allowable filling level shall be fixed for each individual plant.

4.8.4 Connections

4.8.4.1 All nozzles and pipe connections on the storage vessel shall be arranged within the area of the gas space as far as is technically feasible.

4.8.4.2 All pipe connections on the vessel with pipes leading away from it, which are only connected to the gas space (except for the connection for the safety valves) shall be equipped with at least two safety shut-off devices. One of these devices shal be a remote-controlled safety shut-off valve, the closing time of which is δ 10 s.

4.8.4.3 All pipes by which ammonia in its liquid phase can be taken from the pressure vessel during operation shall be equipped with two remote-controlled safety shut-off devices. In addition, it shal be possible to manually operate one of these safety shut-off valves.

4.8.4.4 When arranging pipe connections in the area of the liquid space, the first of the safety shut-off valves mentioned in 4.8.4.3 shall be arranged inside the vessel or shall be welded with a least a two-pass weld or shall be provided with a lip seal.

4.8.4.5 The suitability of the valves to 4.8.4.2 to 4.8.4.4 shall be proved.

4.8.4.6 Shut-off valves from which no pipes lead away shall be provided with a blind flange. Care shall be taken to ensure that no inadmissible pressure arises between the shut-off valve and the blind flange.

4.8.4.7 Valves on the vessel shall be as far as possible arranged in groups.

4.8.4.8 Adequate devices shall be provided for pressure relief and inerting of the pressure vessel.

4.9 Evaporator station

4.9.1 The evaporator station shal be instal ed as close as possible to the storage vessels in order to keep the pipes for liquid ammonia short. The requirements of automatic control for ammonia metering shall be taken into account. Installation in the boiler room shall not be permitted.

4.9.2 The equipment of the evaporator shal ensure its proper operation. The control and safety devices shall ensure that:

- the liquid phase can only enter the evaporator if the latter is ready to operate;
- the liquid phase cannot enter the piping system downstream of the evaporator;
- an excess of the al owable operating temperature and the al owable working pressure is reliably prevented.

4.9.3 Heat shall be supplied indirectly to the evaporators, e.g. via a heat exchanger with interconnected secondary circuits.

4.9.4 On the ammonia side the evaporator shall be designed for a gauge pressure of at least 25 bars.

4.9.5 It shal be possible to shut off the ammonia supply to the evaporator station. Shut-off shall be effected by the emergency shut-off, the overfilling protection and the gas warning system.

4.9.6 The evaporator station shall be equipped with gas detectors which shal be connected to the central gas warning system. 4.7.1 shal apply.

5 Installations for the storage of liquid ammonia

5.1 Plant design

If required, protection against external mechanical and thermal effects shall be provided which shall be suitable for the required installation site.

NOTE This may include requirements for irrigation and fire protection systems, see relevant national law in the country of installation.

5.2 Materials

5.2.1 Liquid ammonia storage vessel

5.2.1.1 Materials for liquid ammonia storage vessels shall meet the requirements regarding workmanship (e.g. weldability) and withstand the mechanical, chemical and thermal loadings to be expected in service.

5.2.1.2 Copper, zinc, copper-tin, copper-nickel, aluminium, and magnesium alloys as well as red brass and white metal shal not be used for fluid-wetted parts due to the corrosion risk.

5.2.1.3 For plates the following materials shall be used:

a) Weldable structural steels in accordance with EN 10025.

b) Fine-grained steels in accordance with EN 10028-3.

c) Stabilized stainless austenitic steels and stainless austenitic steels with a carbon content δ 0,03 % in accordance with EN 10028-7. They may be used as solid material and as cladding material.

d) Other metallic materials shall be examined for suitability.

5.2.1.4 For pipes, flanges, forgings, and welded attachments the following materials shall be used:

a) For pipes material in accordance with EN 10216-1 or in accordance with EN 10216-3 or in accordance with EN 10217-1 up to a minimum value of yield stress at room temperature of 355 N/mm^2 or P195, P235 and 16Mo3 in accordance with EN 10216-2.

b) For flanges material S235JRG2 and S235J2G3 in accordance with EN 10025.

c) For forgings material S235JRG2 and S235J2G3 in accordance with EN 10025 or steels in accordance with EN 10222-4 up to a minimum value of yield stress at room temperature of 355 N/mm^2.

d) For welded attachments material S235JRG2 and S235J2G3 in accordance with EN 10025 and the steel types in accordance with EN 10028-3.

5.2.1.5 Non-metallic materials shall be suitable for the storage of liquid ammonia and to withstand the maximum allowable working pressure of the vessel.

5.2.1.6 Material certificates for metallic materials for pressure bearing parts shal be in accordance with inspection certificate 3.1.B of EN 10204:1991. For materials to EN 10025 test report 2.2 of EN 10204:1991 shall be sufficient.

Non-metallic materials shall be proven that the materials are suitable to withstand the maximum allowable working pressure.

5.2.2 Plant components

5.2.2.1 The basic requirements for materials in accordance with EN 12952-2 shall apply.

5.2.2.2 Copper and Copper alloys as well as nickel alloys which contain copper shall not be used for ammonia containing plant parts. Lamellar-graphite cast iron shal not be used.

5.2.2.3 For liquid ammonia and its gaseous phase the following materials shall be used:

a) For pipe steels material in accordance with EN 10216-1 or in accordance with EN 10216-3 or in accordance with EN 10217-1 up to a minimum value of yield stress at room temperature of 355 N/mm^2 or P195, P235 and 16Mo3 in accordance with EN 10216-2.

b) For flanges material to S235JRG2 and S235J2G3 in accordance with EN 10025.

c) For forgings material to S235JRG2 and S235J2G3 in accordance with EN 10025 or steels in accordance with EN 10222-4 up to a minimum value of yield stress at room temperature of 355 N/mm^2.

d) For welded attachments material to S235JRG2 and S235J2G3 in accordance with EN 10025 and the steel types in accordance with EN 10028-3.

e) For bolts and nuts material in accordance with EN ISO 898-1 and EN 20898-2.

f) For casings of pumps and compressors, spheroidal graphite cast iron JS1024, JS1025, JS1014, JS1015 in accordance with EN 1563 or cast steel GP240GH/GR in accordance with EN 10213-2.

g) For valves, lamellar graphite cast iron shal not be used.

h) For evaporators and other pressure vessels, the requirements of EN 13445-2 shal apply.

5.2.2.4 Other unalloyed steels in the normalized condition, which are not covered by 5.2.2.3 may be used if their suitability for the intended use and their quality have been proved.

5.2.2.5 Stabilized stainless austenitic steels as well as stainless austenitic steels with a carbon content δ 0.03 % in accordance with EN 10028-7 may be used.

5.2.2.6 Other metal ic materials not covered by 5.2.2.1 to 5.2.2.5 may be used if the suitability for the intended use and the quality characteristics are proved.

5.2.2.7 The materials shall be suitable for the storage of liquid ammonia and shal withstand the maximum allowable working pressure of the tank. Reference shal be made to the respective national environmental law of the country of instal ation.

5.2.2.8 The following test shal be carried out:

a) Unalloyed steels in accordance with 5.2.2.3 shal be tested in accordance with the relevant European Standards.

b) Other unalloyed steels in accordance with 5.2.2.4 and other metallic materials in accordance with 5.2.2.6 shall be tested as agreed between the parties concerned.

c) Stabilized stainless austenitic steels and stainless austenitic steels with a carbon content δ 0.03 % shall be tested in accordance with EN 10028-7.

d) The quality characteristics of the non-metallic materials used shal be controlled and certified.

5.2.2.9 Material certificates for pressure bearing parts shal be in accordance with inspection certificate 3.1.B of EN 10204:1991. For materials to EN 10025 test report 2.2 of EN 10204:1991 shall be sufficient.

For non-metallic materials the requirements of 5.2.2.8 d) apply.

5.3 Design of storage vessel

5.3.1 The vessels shall be able to withstand the mechanical, thermal and chemical loadings to be expected and shall be stable as well as leak-light.

An access opening shall be provided, if permitted by the design, which shal have a minimum nominal width of DN 800.

5.3.2 The requirements in accordance with EN 13445-3 shall be used for vessels made of metallic materials.

In addition, the following shall be taken into account for double-walled vessels:

a) No more openings than actually required should be provided.

b) Flanges may be fabricated, welded, rolled without seam, or made of rolled material joined by welding. They shall have a pressure rating of at least PN 10.

c) The faces of flanged joints shall be constructed as follows: with spigot and recess, tongue and groove, or flat face. In the latter case gaskets shall be used that cannot be blown out.

d) All fluid wetted welds shall be accessible for the purpose of non-destructive examination.

5.3.3 It shal be proved that non-metallic materials are suitable for the intended maximum allowable working pressure.

5.4 Manufacture

5.4.1 Liquid ammonia storage vessel

5.4.1.1 Vessels made of metallic materials shall fulfil the following requirements:

a) Vessel welds shall be designed to ensure proper weldment by using suitable means and filler metals upon careful preparation of the parts to be welded such that residual stresses are minimized.

b) Welding filler metals shal be compatible with to the material of the vessel and form a ductile weld metal.

c) When fabricating vessel only such procedures shall be used for which the manufacturer can furnish the proof to be fully able to apply. The manufacturers of vessel shall demonstrate that they have suitable facilities at their disposal to perform proper welding work.

d) Any manual welding work shall only be done by welders approved to EN 287-1.

e) Vessel welds may be single-sided if they are full-penetration welds. Internal parts attached with fillet welds shall be welded over the full circumference of the attachment.

f) The weld quality shall correspond at least to quality level C of EN ISO 5817.

5.4.1.2 Vessels made of non-metallic materials.

The quality characteristics of the non-metallic materials used shal be controlled and certified.

5.4.2 Plant components

5.4.2.1 The welding of welded joints shall only be done by using approved welding procedures qualified in a welding procedure approval test. For pipe welds the root run shall be welded using the TIG welding procedure.

5.4.2.2 Welding filler metals shall be compatible with to the component base metal and form a ductile weld metal.

5.4.2.3 Only welders approved to EN 287-1 shall be employed for welding work.

5.4.2.4 The weld quality shall correspond at least to quality level C of EN ISO 5817.

5.5 Testing and inspection prior to commissioning

5.5.1 Liquid ammonia storage vessel

5.5.1.1 The vessel shall be subject to design approval, final inspection and pressure testing, see 4.5.1.6.

5.5.1.2 Vessels made from metallic materials shall be tested in accordance with EN 13445-5.

5.5.1.3 Each vessel made from non-metallic materials shall be subjected to a final inspection. The dimensions, wall thickness and shape shall be checked. Surfaces and joints shal be visually inspected.

5.5.2 Plant equipment

5.5.2.1 Random checks shall be carried out to determine whether the requirements for manufacture and heat treatment have been met.

5.5.2.2 The welded joints between a storage vessel made of metallic materials and the first shut-off valve for pipe connections within the area of liquid phase shall be fully radiographed.

On all other pipes conducting liquid ammonia, 10 % of the welds shal be radiographed except for piping systems for the vapour phase of liquid ammonia with an ammonia proportion δ 10 volume %. All welders employed shall be covered by the extent of testing.

5.5.2.3 The test results shal be recorded.

5.5.2.4 The pipes shall be subjected to a hydrostatic test in accordance with 4.5.1.6. Where the hydrostatic pressure test is harmful or impractical 5.5.2.5 shall apply.

5.5.2.5 One leakage test shal suffice for piping systems carrying the vapour phase of liquid ammonia with an ammonia proportion of δ 10 volume % and a working gauge pressure δ 1,0 bar.

5.6 Pipe systems for ammonia

5.6.1 Pipe systems for conducting liquid ammonia and its vapour phases shall be rated for a nominal pressure of at least PN 10. The downstream piping systems conducting an ammonia proportion of δ 10 volume % shall be designed for and safeguarded against the pressures possibly occurring.

5.6.2 Piping connections shall preferably be made by welding. For detachable connections, flanged joints with gaskets confined by male and female face or tongue and groove shall be provided. For detachable connections δ DN 32 screwed type connections may be used. Screwed type connections shal be provided with metallic seals or be gasketed with suitable materials, e.g. PTFE.

Compression-type fittings and ferrules may be used up to DN 32 if they are not required to be detached for maintenance purposes.

5.6.3 Pipe runs conducting ammonia in its liquid phase, which can be isolated, shal be safeguarded by relief or safety valves, unless an inadmissible pressure rise due to fluid thermal expansion is prevented by other means. The expanded fluid shal be safety discharged.

5.6.4 The outdoor installation of pipes or installation on pipe racks shal be arranged in such a way that the pipes cannot be endangered by impinging vehicles or construction equipment.

5.6.5 Pipes should be laid above the ground to enable their inclusion in scheduled inspections. Welded pipe connections shal be accessible for the first and periodic inspections and be designed to make testing and inspection possible.

5.6.6 The pipes shall be suitably protected against external corrosion. Special attention shall be paid to corrosion protection between pipe supports (pipe clamps) and pipes. When using austenitic steels, contact between ferritic and austenitic steels shall be avoided.

5.6.7 The operating position of safety-relevant valves shall be clearly recognizable.

5.6.8 If practicable, for emergency reasons, valves shal be grouped together in specified areas of the plant.

5.6.9 Nozzles with sizes < DN 25 shall be protected against damage from external influences (e.g. by increasing the wall thickness).

5.6.10 The conveying devices (e.g. pumps) shall be shut down when the allowable filling level of the tank is reached.

5.6.11 For piping systems containing vapour phases of liquid ammonia with an ammonia proportion δ 10 volume % the requirements of 5.6.2, 5.6.3, 5.6.5 and 5.6.8 can be omitted.

5.7 Electrical equipment

5.7.1 All safety circuits shal be designed in accordance with prEN 50156-1.

5.7.2 An emergency shutdown system shall be installed to act upon the respective drives and actuators. For the electrical components of the emergency shutdown system the requirements are e.g. met if prEN 50156-1 has been applied. This applies accordingly to non electrical components.

For the manual actuation of the emergency shutdown system emergency switches shall be installed at several readily accessible locations of the ammonia storage plant and the filling installations as well as at a permanently manned location.

5.7.3 All safety-related electric control and monitoring devices shall be connected to the emergency power supply system or a safeguarded main. These devices are especially the emergency shutdown system, lighting as well as drives, which shal be maintained in the case of failure of the power supply.

5.7.4 Electrical equipment outside the storage vessel is not subject to explosion protection.

5.8 Equipment

5.8.1 Marking

For the marking of pressure vessels EN 13445-5 applies.

5.8.2 Indication and relief of pressure

5.8.2.1 For the storage of liquid ammonia under pressure, the storage vessel shall be provided with a pressure monitoring device to trip an alarm signal to a permanently manned location if the minimum or maximum pressure is exceeded.

5.8.2.2 The storage vessel shall be provided with a venting valve to prevent vacuum conditions arising.

5.8.2.3 Venting and discharge pipes of the storage vessel shall be provided with flame arrestors.

5.8.2.4 Venting and discharge pipes of the storage vessel shall be equipped either with a syphon seal or another safety pressure relief device.

The syphon seal shall be protected against freezing.

5.8.2.5 Where the minimum or maximum filling level of a syphon seal is reached, an alarm signal shal be transferred to a permanently manned location.

5.8.2.6 Discharge pipes shall be so arranged that gaseous ammonia can be discharged safely.

5.8.3 Measuring and limitation of filling level

5.8.3.1 Each pressure vessel shal be equipped with a level indicator. The suitability of the level indicator shall be proved. The indication of the liquid level shall be transferred to the operating floor.

5.8.3.2 For each storage vessel two independent protective devices against overfilling (filling level limiters) shall be required. One of these devices may be integrated into the liquid level indicator (5.8.3.1). Their suitability shall be proved. The control pulses shall actuate the safety shut-off devices of the filling system.

If one of the protective devices against overfilling responds, the safety valves shal interrupt the supply flow, and at the same time an alarm signal shall sound at the location of filling. The trip points shall be set individually for each system.

5.8.3.3 Liquid level indicators and limiters, as well as other operational devices within the vessel, shal be permitted for safety zone 0 in accordance with EN 60079-10 unless other measures, e.g. inerting, are provided.

5.8.3.4 The set points of the protective devices against overfilling shal be checked.

5.8.4 Connections

5.8.4.1 The liquid drain nozzles on the storage vessel should be arranged at the lowest point of the liquid space.

All other nozzles and pipe connections shall be arranged, where technically feasible and purposeful, at the gas space.

5.8.4.2 All pipe connections on the vessel with pipes leading away from the vessel, which are only connected with the gas space (except for connections for venting and ventilation) shal be equipped with at least one shut-off valve.

5.8.4.3 All pipes by which liquid ammonia can be taken from the vessel during operation shall be equipped with two shut-off valves. One of these valves shall be a remote-controlled safety shut-off valve.

5.8.4.4 Shut-off valves from which no pipes lead away shal be provided with a blind flange.

5.8.4.4 Valves on the vessel shall be arranged as groups, if possible.

5.8.4.6 Adequate devices for draining the vessel shall be provided.

5.9 Production of ammonia vapour

5.9.1 Evaporators and columns should be installed as close as possible to the point of injection to keep gas lines short with respect to condensation. Columns, preheaters, direct evaporators should be installed, preferably outdoors, or in a separate room. Where gas accumulation is possible in this room ammonia gas sensors shall be installed.

5.9.2 Devices for indicating and relieving the pressure shall be in accordance with EN 764-7. Each pressure vessel shall be provided with a safety relief system, e.g. safety valve. Pressure limiters shall be provided on evapora-

tors and other systems containing liquid ammonia in which the operating pressure may exceed the al owable working pressure. In such a case the limiters shall directly cut off the heat supply and the supply of liquid ammonia.

Liquid-ammonia containing systems shall not be fitted with 3-way test cocks.

5.9.3 Flooding of evaporators or columns shall be prevented by suitable measures, e.g. level monitoring.

5.9.4 Systems containing vapour phases of liquid ammonia or mixtures with air shall be protected against condensation by suitable measures such as:

- monitoring of minimum temperatures;
- trace heating;
- monitoring of concentrations.

5.9.5 Pipes conducting vapour phases shal be protected against flooding. Suitable measures e.g. are separators and level monitors in the evaporator.

5.9.6 Safety valve escape pipes leading into the atmosphere, which are capable of discharging two-phase mixtures shall be connected.

Annex A
(informative)

Operational aspects

A.1 The manufacturer of the plant shal provide operating procedures at the latest when the plant is taken into operation. The procedures shall contain emergency procedures to be followed in the case of upset conditions.

A.2 The user shall establish and make available operating instructions. During operation the plant shal be regularly inspected by trained personnel. The frequency of inspection shal be laid down in the operating instructions.
During inspection the plant shall be checked for orderly condition and proper operational performance.

A.3 Prior to the first filling or after inspections the pressure vessel shall be evacuated by filling the vessel fully with water and expelling the air with nitrogen. Purged gases shall be discharged safely.

A.4 The connection and disconnection of the mobile tank shall be effected by at least two trained persons.

The filling operation shall be permanently supervised by trained personnel.

A.5 Within the area of the filling installations and the ammonia storage plant wind direction indicators (e.g. wind cones) which can be il uminated, shall be installed.

A.6 Within the plant area an escape room shall be provided where protective clothing and respirators shall be permanently available. In the escape room an overpressure in excess of the atmospheric pressure shall prevail, and the room shall be equipped with emergency lighting, telephone, emergency switch and emergency showers.

A.7 Draining of pressure vessels and piping systems should be effected by carrying away the ammonia during boiler plant operation via the DENOX system. If this is not possible, draining of the respective plant parts should be effected safely via other systems.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive for Pressure Equipment

This European Standard has been prepared under a mandate given to CEN by the European Commission to provide a means of conforming to Essential Requirements of the New Approach Directive for Pressure Equipment 97/23/EC.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in table ZA confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA – Correspondence between this European Standard and Directive for pressure equipment 97/23/EC

Clause(s)/sub-clause(s) of this EN 12952-14	Essential Requirements (ERs) of Pressure Equipment Directive 97/23/EC Annex I	Qualifying remarks/Notes
4.3, 5.3	2.2	Design for adequate strength
4.8, 5.8	2.3	Provisions to ensure safe handling and operation
4.7, 4.8, 5.7, 5.8	2.10	Protection against exceeding the allowable limits of pressure equipment
4.4, 5.4	3.1	Manufacturing procedures
4.5, 5.5	3.2	Final assessment
4.2, 5.2	4	Materials

WARNING: Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

[1] Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment OJEC, L181.

[2] CEN/TC 54/267 JWG B N 400: CASE Proposal to prEN UFPV-2, doc TC 54/267 JWG B N 277 Clause 4.1.7 and Annex D.3.2 (prepared by SG - LT to Mr. Crooks comments); Basis of national regulations and standards and common standpoint:

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