No.33 (1992) (1992/Corr.) Guidelines for the Construction of Pressure Vessel Type Tanks Intended for the Transportation of Anhydrous Ammonia at Ambient Temperatures

1. Scope

1.1 These Guidelines complement the requirements of the UR-W1, Materials and Welding for Gas Tankers, where the tanks are to be constructed for the carriage of anhydrous Ammonia at ambient temperatures. The measures listed in these guidelines with respect to material selection, tank fabrication and inspection will be regarded as being necessary to reduce the risk of ammonia stress corrosion cracking to a minimum.

1.2 Tanks subject to these Guidelines are designed for service temperatured **not** lower than 0°C.

1.3 These Guidelines deal with tanks to be constructed of Carbon-Manganese Steels. Materials having characteristics differing from those specified in these guidelines may be used by special agreement with the Classification Society.

2. Approved Materials

2.1 Plates are to be manufactured from fine grain treated steels and are to be normalized. The nominal yield strength of the steel is to be not more than 355 N/mm^2 and the actual yield strength should not exceed 440 N/mm^2.

The chemical composition is to be within the limits as given in Table 1.

2.2 Internal piping and nozzles are to be manufactured from mild steels in accordance with an approved national standard and are to be normalized.

The nominal yield strength of the steel is to be not more than 355 N/mm^2.

The actual yield strength should not exceed 440 N/mm^2 and the elongation A_5 must be at least 22%. Furthermore, the limitations for carbon, molybdenum and vanadium as given in Table 1 are applicable.

2.3 Forgings are to be manufactured from mild steels in accordance with an approved national standard and are to be normalized.

The nominal yield strength of the steel is to be not more than 355 N/mm^2.

The actual yield strength should not exceed 440 N/mm^2 and the elongation A_5 must be at least 22%. Furthermore, the limitations for carbon, molybdenum and vanadium as given in Table 1 are applicable.

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Table 1 Chemical composition for fine grain Steels, Ladle Analysis[1)]

% maximum (if not otherwise indicated)										
C	Si	Mn	P	S	Al	Cr	Cu	Mo	Ni[2)]	V
0,18	0,10 to 0,50	1,65	0,030	0,025	min. 0,020	0,20	0,35	0,08	0,40	0,10

1) For steels with a nominal yield point of 355 N/mm^2 the chemical composition is to be adjusted in such a way as to limit the actual yield point to 440 N/mm^2.

2) If nickle will intentionally be alloyed, the maximum may be 0,85%.

2.4 Dished Ends

The dished ends are to be made from plate material as given under 2.1 and Table 1, preferably by hot forming process.

Cold pressed dished ends are to be normalized.

2.5 Impact Energy Requirements

All materials of the pressure containment must fulfill the impact energy requirements of Table 2.

Table 2 Impact Energy Requirements in ISO-V-Notch Specimens

Type of product	Test temp. [°C]	Impact Energy[1)] Joule min.	
		long.	transv.
Plates	–20	–	27
Pipes		41	–
Forgings		41	27

[1)] Average value. One value may be below the average value, but not lower than 70% of this value.

2.6 The scope of the inspection is to be in accordance with Table 3.

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Table 3 Scope of Mechanical Tests and NDT Inspections

Type of product	Tensile and notched bar impact tests	Ultrasonic inspection
Plates	each rolled length at one side	Surface with a grid of 200 mm and edges acc. to an approved Standard
Pipes	batch testing acc. to an approved Standard (same heat)	each length on the whole circumference acc. to an approved Standard
Forgings	batch testing acc. to an approved Standard (same heat)	to an approved Standard
Pressed Bottoms	one piece from the same mother plate	edges acc. to an approved Standard

3. Tank Design

3.1 The tanks are to be of a cylindrical or spherical shape.

If bilobe tanks are proposed, special considerations will be necessary.

Internal stiffening and bearing rings are to be kept to the minimum number necessary. The same applies to all other parts to be welded to the inside of the tank shell.

3.2 All socket pieces, nozzles and other pipe connections are to be assembled at the tank dome. The connections with the dome are to be prepared as full penetration welds.

3.3 Parts to be welded to the tank shell like stiffening and bearing rings, clips, brackets and bearings are to be connected with the tank shell by using K-preparation or double fillet welds. Unwelded gaps open to the tank contents are not allowed.

4. Welding Requirements

4.1 Welding is to be carried out using approved welding consumables of low hydrogen type. Only consumables reasonably free from molybdenum and vanadium are permitted, c.f. Table 1. The strength of the deposited material shall as little as possible overmatch the strength of the base material.

4.2 In order to keep the welding stresses and the hardness of the weld to a minimum preheating is to be applied. The preheating and interpass temperatures should not be less than 100°C and all welding work is to be carried out using multirun technic.

4.3 The hardness of the weld including the heat affected zone must not exceed 230 HV. This is to be verified by the procedure approval and workmanship test.

4.4 Irregularities of the tank construction which may cause local stresses, like misalignments of the welding edges, "peaking" of the weld seams, etc., are to be avoided. For this purpose the tank fabricator must submit tank specifications to the Society for approval giving the allowable manufacturing tolerances.

4.5 Welding defects as well as welding spatter and ignition spots on the base material are to be removed by careful grinding. ▶

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4.6 All butt and full penetration welds of the tank shell must be in a condition enabling proper ultrasonic inspection to be carried out on them. If necessary the surfaces of the welds are to be ground.

4.7 To allow ultrasonic inspections the following measurments are to be taken:

- Both sides of the welds of crossing joints are to be ground flush with the surrounding plate surface on a length of at least 500 mm starting from the crossing point.
- The full penetration welds of domes and sumps with the tank shell are to be ground on both sides.

4.8 The quality of the welds must comply with an approval pressure vessel standard.

5. Stress Relieving

5.1 Tanks, with the exception of those described under item 5.2, are to be subjected to a stress relieving heat treatment. The temperature is to be 570 + 20°C, the holding time 60 min/ 25 mm wall thickness.

5.2 If the furnace dimensions or the heat treatment equipment do not allow to heat treat the tank as a whole, the following procedure may be applied subject to the consent of the society:

- Separate stress relieving heat treatment of the domes, sumps, manholes together with the surrounding parts of the tank shell before mounting them into the tank. Nozzles and socket pieces are to be welded into the dome prior to the heat treatment, and then
- Mechanical stress relieving of the finished tank.

5.3 After stress relieving no welding work is to be carried out at the inner side of the tank. Slight grinding may be permitted.

5.4 After mechanical stress relieving the weld crossings at the side of the tanks are to be hardness tested. If the hardness values as given under item 4.3 are exceeded, special considerations must be given to remedial actions.

6.1 Tank Inspection by NDT Procedures

6.1 All butt welds and full penetration welds of the tank shell are to be 100% tested by ultrasonic procedures (longitudinal and transverse defects). The testing for transverse defects in the area of the weld crossings are to be carried out from the ground surfaces of the welds. At the discretion of the Society the ultrasonic test may partly be replaced by radiographic inspections.

6.2 All butt and fillet welds are to be 100% magnetic particle tested at the inside of the tank.

At the outside of the tank the weld crossings (500 mm at each direction) and the fillet welds are to be magnetic particle tested 100%.

6.3 At least 10% of the tests described under items 6.1 and 6.2 are to be repeated in the presence of the Society's Surveyor after the stress relieving and hydraulic test. These inspections must contain all weld crossings and penetration welds of dome and sumps.

6.4 The testing procedures are to be approved by the Society.

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7. Repeated Inspection by NDT Procedures

7.1 In connection with the class renewal survey the following additional NDT inspections are to be carried out:

- Ultrasonic inspection on all weld crossings and on all full penetration welds of domes and sumps.
- Magnetic particle inspection on at least 10% of the inside butt and fillet welds.

  This inspection must cover at least all penetration welds and all weld crossings as well as a part of the bearing ring fillet welds. If defects will be found, the scope of tests is to be increased in accordance with the Surveyor's instructions.

7.2 Shorter inspection periods may be required by the individual Society if cargos have been transported which may cause stress corrosion cracking, e.g., anhydrous Ammonia.

8. Reports

All inspections are to be documented by the NDT personnel.

The reports are to be presented to the Society's Surveyor for review and endorsement.

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