SLOVENSKI STANDARD
SIST EN 12493:2002

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Varjenje jeklenih rezervoarjev za utekočinjeni naftni plin (UNP) - Rezervoarji za cestni prevoz - Konstrukcija in izdelava

Welded steel tanks for liquefied petroleum gas (LPG) - Road tankers - Design and manufacture

Geschweißte Druckbehälter aus Stahl für Flüssiggas (LPG) - Straßentankfahrzeuge - Konstruktion und Herstellung

Citernes en acier soudées pour gaz de pétrole liquéfiés (GPL) - Véhicules citernes routiers - Conception et construction

Ta slovenski standard je istoveten z: **EN 12493:2001**

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This European Standard was approved by CEN on 9 May 2001.

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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 Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 286 "Liquefied petroleum gas equipment and accessories", the secretariat of which is held by NSAI.

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of an identical text or by endorsement, at the latest by December 2001, and conflicting national standards shall be withdrawn at the latest by December 2001.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports the framework Directives on the Transport of Dangerous Goods.

This European Standard has been submitted for reference into the technical annexes of the European Agreement concerning the international carriage of dangerous goods by road (ADR).

The standards listed in the normative references and covering the basic requirements of the ADR not addressed within the present standard are normative only if the standards themselves are referred to in the technical annexes of ADR.

The annexes A, B, D, F, G, I, K and L are normative.

The annexes C, E, H and J are informative.

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

Introduction

This European Standard calls for the use of substances and procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

It has been assumed in the drafting of this European Standard that execution of its provisions is entrusted to appropriately qualified and experienced people.

1 Scope

This European Standard specifies minimum requirements for materials, design, construction and workmanship procedures, and tests for welded LPG road tanker tanks and their welded attachments manufactured from carbon, carbon/manganese and micro alloy steels.

There is no upper size limit as this is determined by the gross vehicle weight limitation.

This standard does not cover tanks for ISO type containers.

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, *Approval and testing of welders — Fusion welding — Part 1: Steels.*

EN 288-2, *Specification and approval of welding procedures for metallic materials — Part 2: Welding procedure specification for arc welding.*

EN 288-3, *Specification and approval of welding procedures for metallic materials — Part 3: Welding procedure tests for the arc welding of steels.*

EN 444, *Non-destructive testing — General principles for radiographic examination of metallic materials by X- and gamma rays.*

EN 462-1, *Non-destructive testing — Image quality of radiographs — Part 1: Image quality indicators (wire type) — Determination of image quality value.*

EN 462-2, *Non-destructive testing — Image quality of radiographs — Part 2: Image quality indicators (step/hole type) — Determination of image quality value.*

EN 473, *Qualification and certification of NDT personnel — General principles.*

EN 571-1, *Non-destructive testing — Penetrant testing — Part 1: General principles.*

EN 729-2, *Quality requirements for welding — Fusion welding of metallic materials — Part 2: Comprehensive quality requirements.*

EN 837-2, *Pressure gauges — Part 2: Selection and installation recommendations for pressure gauges.*

EN 875, *Destructive tests on welds in metallic materials — Impact tests — Test specimen location notch orientation and examination.*

EN 876, *Destructive tests on welds in metallic materials — Longitudinal tensile test on weld metal in fusion welded joints.*

EN 895, *Destructive tests on welds in metallic materials — Transverse tensile test.*

EN 910, *Destructive tests on welds in metallic materials — Bend tests.*

EN 970, *Non-destructive examination of fusion welds — Visual examination.*

EN 1290, *Non-destructive examination of welds — Magnetic particle examination of welds.*

EN 1321, *Destructive tests on welds in metallic materials — Macroscopic and microscopic examination of welds.*

EN 1418, *Welding personnel — Approval testing of operators for fusion welding and resistance weld setters for fully mechanized and automatic welding of metallic materials.*

EN 1435, *Non-destructive examination of welds — Radiographic examination of welded joints.*

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

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

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

EN 10028, *Flat products made of steels for pressure purposes : (all parts).*

EN 10045-1, *Metallic materials — Charpy impact test — Part 1: Test method.*

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

EN 12252, *Equipping of Liquified Petroleum Gas (LPG) road tankers.*

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

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

EN 25817:1997, *Arc-welded joints in steel — Guidance on quality levels for inspections (ISO 5817:1992).*

EN ISO 6520-1:1998, *Welding and allied processes - Classification of geometric imperfections in metallic materials – Part 1: Fusion welding (ISO 6520-1:1998).*

prEN ISO 6520-2:1999, *Welding and allied processes - Classification of geometric imperfections in metallic materials – Part 2: Welding with pressure (ISO/FDIS 6520-2:1999).*

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply:

3.1
yield strength
upper yield stress R_{eH} or, for steels that do not exhibit a definite yield (non-proportional elongation), the 0,2 % proof stress

3.2
cold forming
forming at temperatures not less than 25 °C below the maximum permissible temperature for stress relieving, in accordance with the applicable material specifications

3.3
hot forming
forming at temperatures above the temperature for stress relieving as stated in the material specifications

3.4
sun shield
shield covering not less than the upper third but not more than the upper half of the shell surface, separated from the shell by an air gap of at least 40 mm

3.5
tank
assembly of the shell (the pressure-retaining enclosure including the openings and their closures) and non-pressure-retaining parts welded directly to the shell

3.6
competent authority
authority designated as such in each country its government

3.7
notified/designated body
testing and certifying body approved by a competent authority

3.8
competent person
person who, by qualifications, training, experience and resources, is able to make objective judgements

4 Materials

4.1 Suitability

Unless otherwise specified by the design documents, the design temperature range shall be – 20 °C to + 50 °C. The materials of construction shall be suitable for operating within the envisaged temperature range. If the tank could be subjected to more severe ambient or product temperatures, the design temperature range shall be – 40 °C to + 50 °C.

Guidance on selection of material grades is given in annex A.

If additional impact testing is required, it shall be carried out in accordance with EN 10045-1 to achieve the impact values specified in 10.2.5.4.

4.2 Pressure retaining parts

Pressure-retaining materials shall be of appropriate steels conforming to EN 10028 or shall conform to specifications agreed with the competent authority. All materials shall conform to 10.2.5.4 and the ratio of the specified yield strength (R_{eH}) to minimum tensile strength (R_m) shall not exceed 0,85 (i.e. $R_{eH}/R_m \leq 0,85$). The percentage elongation at fracture shall be not less than 10 000 divided by the actual tensile strength in N/mm^2, and in any case shall be not less than 16 % for fine grained steels and not less than 20 % for other steels.

4.3 Non-pressure retaining parts

Non-pressure retaining parts that are directly welded to pressure retaining parts shall be of suitable materials conforming to EN 10025 or materials with characteristics approved by a competent authority. All materials used for non-pressure retaining parts shall be compatible with the material of pressure retaining parts, and shall conform to the impact requirements of 10.2.5.4, tested in accordance with the method specified in EN 10045-1.

4.4 Welding consumables

Welding consumables shall be able to provide consistent welds with properties at least equal to those specified for the parent materials in the finished tank.

4.5 Non-metallic materials (gaskets)

Non-metallic materials (gaskets) shall be compatible with both phases of LPG over the range of pressures and temperatures for which the tanker is designed (see 4.1 and annexes B and C).

4.6 Certification of materials

Pressure retaining parts and non-pressure retaining parts directly welded to the tank shall be provided with the material manufacturers' certificates conforming to EN 10204 certificate type 3.1B. Other parts shall have certificates conforming to EN 10204 certificate type 2.2.

5 Tank design

5.1 Design conditions

Reference temperatures shall conform to annex B.

Design calculations shall be carried out in accordance with annex D.

Account shall be taken of the fatigue loading on all component parts of the tank and its attachments by conducting an assessment or through proven operating experience.

5.2 Surge plates

To reduce the dynamic loadings of the liquid content due to accelerations of the vehicle, tanks longer than 4 m shall be fitted with transverse surge plates at a maximum spacing of 4 m, and shall be designed to permit full internal inspection of the tank. The area of each plate shall be at least 70 % of the cross-sectional area of the tank in which the plates are fitted.

Surge plates shall be able to withstand the load imposed by a full capacity liquid content of the section between the plates in either direction. Surge plates shall be at least 2 mm thick.

Provision shall be made for communication and drainage between sections.

For tanks over 1,8 m diameter, having a wall thickness less than 6 mm and for tanks up to 1,8 m diameter, having a wall thickness less than 5 mm, the surge plates shall have the same thickness as the shell and the volume between any two plates shall not exceed 7 500 litres.

5.3 Doubler plates

To reduce stress concentration on the tank, load-carrying attachments shall incorporate a doubler plate between the attachment and the tank.

Non-circular doubler plates shall be designed with as generous as practicable corner radii, with a minimum of 25 mm to reduce stress concentrations.

If doubler plates are provided with test sockets they shall be closed with threaded plugs after testing.

5.4 Stresses due to motion

Tanks and their permanent attachments shall be able to absorb, under maximum permissible load, forces exerted by the design pressure, and the following dynamic forces:

— in the direction of travel: twice the total mass times gravity;

— at right-angles to the direction of travel: the total mass times gravity;

— vertically upwards: the total mass times gravity;

— vertically downwards: twice the total mass times gravity.

Under the forces defined above, the stresses in the tank and its fastenings shall not exceed the following:

a) general membrane stress in the shell, remote from the supports:

   — the normal design stress as defined in D.1;

b) stresses local to the supports, determined either by experimental analysis or calculation/special analysis:

   — the limits specified in prEN 13445-3.

5.5 Self-supporting tanks

Self-supporting tanks shall be designed to carry bending stresses that would otherwise be carried by the chassis or frame.

5.6 Vacuum conditions

Tanks shall be designed to withstand vacuum conditions generated by the product during operation or other operational conditions, but as a minimum, this shall be equivalent to an external pressure of at least 40 kPa (0,4 bar) gauge pressure.

NOTE 1 Some liquefied petroleum gases have vapour pressures below atmospheric pressure at temperatures that could occur during normal operations in winter, and this could create partial vacuum conditions within the carrying tank.

NOTE 2 Suitable design methods may be applied from prEN 13445-3.

5.7 Tank mountings

5.7.1 Mounting structures shall be fabricated in steel and designed to limit movement of the tank in relation to the chassis.

5.7.2 Tank mountings and their method of attachment to the shell shall be of sufficient strength to support the tank when full of water.

5.7.3 The design of the tank mountings shall be co-ordinated with the design of the vehicle chassis. The designer shall assess the effect of the tank and its mountings, including the additional loadings given in 5.4.

NOTE The chassis manufacturer should be notified at the tank design stage that the tank, while on the chassis, could be subjected to a hydraulic test, during which the tank can contain twice the normal weight of carrying capacity.

5.7.4 Tank mountings designed as an integral attachment to the shell shall be fitted with doubler plates as specified in 5.3. Stitch welding shall not be used.

5.8 Internal pipework

The mechanical strength of internal pipework and supports shall be sufficient to withstand the service conditions, including dynamic load.

NOTE Internal pipework may be attached directly to a tank boss.

Pipework shall be located so as to avoid inadvertent entry of liquid LPG from the liquid inlet line into other pipework terminating in the vapour space.

6 Openings

6.1 General

For the equipping of LPG road tankers, see EN 12252.

Valves and other accessories shall be protected against damage by external impact either by their positioning on the tank, when mounted on the vehicle, or by specific tank design. Provision in tank design shall be either by mounting and fitting valves and other accessories in a recess within the contour of the tank shell or end, or by use of a guard able to withstand a collision with another vehicle and the forces experienced in a tank roll-over.

6.2 Reinforcement of openings

Openings shall be reinforced and designed in accordance with D.4.

6.3 Threaded connections

The maximum nominal diameter of threaded connections shall be 80 mm.

6.4 Manhole

Tanks over 1,5 m diameter shall be fitted with a manhole either:

— at least 500 mm in diameter; or

— at least 420 mm in diameter, if acceptable to the notified/designated body.

NOTE Smaller tanks may be fitted with inspection openings instead of a manhole, with dimensions conforming to EN 286-1.

Manholes shall be of forged construction, machined from plate, or fabricated from pipe and standard flanges of the appropriate temperature and pressure rating. If plate is used for pad type manholes, it shall be ultrasonically tested for lamellar defects.

The manhole shall be positioned for ease of access.

7 Non-pressure retaining parts

7.1 Attachment welds

Attachment welds shall be continuous.

7.2 Position of attachment welds

Attachments shall be designed not to trap water and to permit inspection of the weld. Wherever possible, attachment welds shall be clear of vessel welds (longitudinal, circumferential and opening welds), by a minimum distance of 40 mm. Where this is not possible, attachment welds shall fully cross the main welds.

8 Workmanship and construction

8.1 General

Road tanker tanks shall be manufactured in accordance with drawings and specifications approved by a notified/designated body.

The manufacturer shall be responsible for the competence, training and supervision of their staff.

The manufacturer shall ensure, taking into account any instructions from the material supplier, that the materials of the finished tank conform to this European Standard.

The manufacturer shall have defined procedures for manufacturing operations, including processes such as forming, welding and heat treatment.

8.2 Control of materials

The manufacturer of the tank shall maintain a system of identification for the material used in the fabrication so that all material for pressure-retaining parts and non-pressure-retaining parts directly welded to pressure-retaining parts in the completed work can be traced to origin. The system shall incorporate appropriate procedures for verifying the identity of material received from the supplier.

Verifying procedures shall be based on the material manufacturers' certificates and/or acceptance tests. The system shall ensure that before cutting and forming parts of the tank, the original identification mark of the material is transferred to any parts of the tank that could be without markings after the process. The manufacturer shall ensure that the material conforms to the design and/or drawings specification.

In laying out and cutting the material:

— the material identification mark shall be clearly visible when the pressure part is complete; or

— the manufacturer shall operate a documented system that ensures material traceability for all materials in the completed tanks.

If the material identification mark is unavoidably cut out during manufacture of a pressure part, it shall be transferred by the pressure part manufacturer to another part of the component. Transfer of the mark shall be carried out by a person designated by the manufacturer.

When identification on materials is transferred, the method of marking shall not have any detrimental effect on the specified material properties.

Details of welding consumables shall be retained.

8.3 Acceptable weld details

8.3.1 The manufacturer, in selecting an appropriate weld detail, shall consider:

— the method of manufacture;

— the service conditions;

— the ability to carry out necessary non-destructive testing.

NOTE 1 Recommended weld details are given in EN 1708-1.

The root faces of welding preparations shall be aligned within the tolerances given in the welding procedure specification.

NOTE 2 Examples of typical welded joints used on the tank are given in annex E.

8.3.2 If a tank is made from more than one shell strake, the longitudinal weld of adjacent strakes shall be staggered by at least 100 mm between weld edges.

8.3.3 Where the tank diameter is less than 1,5 m and no internal access is provided, joggle joints are permitted for end to shell joints. Only dished ends shall be joggled.

Joggles shall be sufficiently clear of the knuckle radius to ensure that the edge of the circumferential weld is at least 12 mm clear of the knuckle.

NOTE A typical joggle joint detail is shown in Figure E.2.

8.4 Heat treatment and forming

8.4.1 Cold forming

Heat treatment of cold formed cylindrical shells is not required.

Cold formed dished ends shall be heat treated unless the manufacturer can demonstrate that the properties of the finished products conform to the original design.

Cold formed dished ends that have not been heat treated shall not be welded or heated locally in the knuckle area to temperatures above 550 °C without subsequent heat treatment.

8.4.2 Hot forming

For normalised steels, because of the danger of excessive grain growth, the workpiece temperature during hot forming shall not exceed 1 050 °C. Before the final stage of hot forming, or if hot forming is performed only once, the workpiece shall not be heated above 980 °C.

NOTE The duration of hot forming should be kept to a minimum to avoid grain growth.

If no subsequent heat treatment is applied, hot forming shall be completed above 750 °C, or above 700 °C if the degree of forming in the final stage does not exceed 5 %.

Cooling shall be carried out in still air.

If hot forming is carried out in conditions other than those specified in this subclause, normalising as specified by the steel manufacturer or supplier shall be carried out after hot forming.

A competent person shall specify the heat treatment procedure to ensure that the properties of the finished product conform to the original design.

8.4.3 Testing of formed parts

For cold-formed parts not subject to heat treatment, no mechanical tests are required in respect of the forming operation.

All other formed parts shall have tests carried out after the last forming operation or any heat treatment to demonstrate conformity to the material specification. Test pieces shall be taken from an excess length or a redundant piece of the formed part, or from a separate test piece formed to same procedure. The test pieces shall consist of one tensile and three impact specimens.

In the case of formed ends, the test pieces shall be taken from sample ends selected as follows :

— from initial production: 1 from 10 of each family; and

— from production formed ends: 1 formed part in 1 000 production units, but not less than one per 2 years.

Ends with the following characteristics are considered to be a family of ends:

— same material specification;

— same forming process;

— same heat treatment;

— geometrical similarity to ± 10 %.

8.4.4 Visual examination and control of dimensions

Bought-in formed parts that require acceptance certificates conforming to EN 10204 shall be submitted by the tank manufacturer to visual examination and dimensional check in the delivery condition, and the results shall be included in the tank acceptance certificate.

8.4.5 Marking

Formed parts of pressure tanks shall be marked so that the material and the manufacturer of the part can be identified as specified in 8.2. For batch testing the relationship to the batch shall be evident.

8.5 Welding

8.5.1 General

Welding of the joints of the component parts of a tank shall conform to EN 729-2 and shall only be carried out if all the following apply:

— a welding procedure specification is compiled by the manufacturer;

— the welding procedures selected by the manufacturer are qualified for the field of application. If the design is based on material specifications agreed by a competent authority, the welding procedure shall be qualified using material with the higher properties;

— the welders and welding operators are qualified for the work and their approval is valid (see 8.5.5);

— the quality level of welded joints is quality level B of EN 25817:1992, except as modified in annex F, for shell longitudinal and circumferential welds or if the design specification or drawing has more stringent requirements.

8.5.2 Longitudinal welds

There shall be not more than one longitudinal weld on any strake. Longitudinal welds shall be full penetration butt welds.