SLOVENSKI STANDARD
SIST EN 12542:2002

01-november-2002

Stabilne, varjene, jeklene valjaste posode serijske proizvodnje za skladiščenje utekočinjenega naftnega plina (UNP) za nadzemno postavitev, katerih prostornina ni večja od 13 m3 - Konstruiranje in proizvodnja

Static welded steel cylindrical tanks, serially produced for the storage of Liquefied Petroleum Gas (LPG) having a volume not greater than 13m3 and for installation above ground - Design and manufacture

Ortsfeste, geschweisste zylindrische Behälter aus Stahl, die serienmäßig für die Lagerung von Flüssiggas (LPG) hergestellt werden, mit einem Fassungsvermögen bis 13 m3 für oberirdische Aufstellung - Gestaltung und Hertstellung

Conception and construction des réservoirs cylindriques fixes en acier soudés, aériens, pour le gaz de pétrole liquefié (GPL) ayant un volume inférieur ou égal a 13m3

Ta slovenski standard je istoveten z: EN 12542:2002

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23.020.10	Nepremične posode in rezervoarji	Stationary containers and tanks

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EUROPEAN STANDARD

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English version

Static welded steel cylindrical tanks, serially produced for the storage of Liquefied petroleum gas (LPG) having a volume not greater than 13m³ and for installation above ground - Design and manufacture

Réservoirs cylindriques fixes, aériens, en acier soudé, fabriqués en série pour le stockage de gaz de pétrole liquéfié (GPL) ayant un volume inférieur ou égal à 13 m³ - Conception et fabrication

Ortsfeste, geschweißte zylindrische Behälter aus Stahl, die serienmäßig für die Lagerung von Flüssiggas (LPG) hergestellt werden, mit einem Fassungsvermögen bis 13 m³ für oberirdische Aufstellung - Gestaltung und Herstellung

This European Standard was approved by CEN on 15 February 2002.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

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.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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

Management Centre: rue de Stassart, 36 B-1050 Brussels

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Contents

Foreword

This document (EN 12542:2002) 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 **October** 2002, and conflicting national standards shall be withdrawn at the latest by **October** 2002.

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.

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, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

NOTE The design formulae quoted in this document require the use of consistent units.

1 Scope

This European Standard specifies requirements for the design and manufacture of static welded steel cylindrical tanks, serially produced for the storage of liquefied petroleum gas (LPG) with a volume not greater than 13 m^3 and for installation above ground.

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 for fusion welding — Part 1: Steels*.

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

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

EN 288-8, *Specification and qualification of welding procedures for metallic materials — Part 8: Approval by a pre-production welding test*.

EN 462, *Non-destructive testing*.

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

EN 499, *Welding consumables— Covered electrodes for manual arc welding of non-alloy and fine grain steels — Classification*.

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

EN 756, *Welding consumables — Wire electrodes and wire-flux combinations for submerged arc welding of non alloy and fine grain steels — Classification*.

EN 758, *Welding consumables — Tubular card electrodes for metal arc welding with and without a gas shield of non-alloy and fine grain steels — Classification*.

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

EN 875, *Destructive tests on welds in metallic materials — Impact test*.

EN 876, *Destructive tests on welds in metallic materials — Longitudinal tensile test*.

EN 895, *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 testing of welds — Method*.

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

EN 1418, *Welding personnel — Approval testing of welding 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 1668, *Welding consumables — Rods, wires and deposits for tungsten inert gas welding of non-alloy and fine grain steels — Classification.*

EN 1708 –1, *Welding — Basic weld joints in steel — Part 1: Pressurized components.*

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

ISO 9162, *Petroleum products – Fuels (class F) – Liquefied petroleum gases – Specifications.*

EN 10025, *Hot rolled products of non-alloy structural steels; technical delivery conditions (includes amendment A1:1993).*

EN 10028-2, *Flat products made of steels for pressure purposes — Part 2: Non-alloy and alloy steels with specified elevated temperature properties.*

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

EN 10028-5, *Flat products made of steels for pressure purposes — Part 5: Weldable fine grain steels, thermomechanically rolled.*

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

EN 12062, *Non-destructive examination of welds — General rules for metallic materials.*

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

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

EN ISO 6520-1, *Welding and applied procedures — Classification of imperfections in metallic materials — Part 1: Fusion welding.*

3 Terms and definitions

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

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

NOTE These properties are equivalent to those specified by the symbol $R_{e/t}$, in the PED

3.2
serially produced tanks
more than one tank manufactured in the same factory to a common design using the same material and manufacturing procedure and produced with no major interruption within a given period of time

3.3
batch
group of pressure parts or finished tanks, made consecutively by the same manufacturer using the same manufacturing techniques to the same design, size and material specifications on the same production machinery and subject to the same heat treatment conditions

NOTE In this context consecutively need not imply continuous production

3.4
cold forming
forming at temperatures not less than 25 °C below the maximum permissible temperature for stress relieving in accordance with the material specification

3.5
hot forming
forming at temperatures above the maximum permissible temperature for stress relieving in accordance with the material specification

3.6
climatic area
geographic area agreed or defined by the relevant national authorities, or other bodies, responsible for defining the design conditions for LPG storage tanks, in the country(ies) where the tank is intended to be operated. The area is used to define the reference temperature for design pressure and filling

3.7
notified body
body notified to the Commission by Member States, appointed to perform the functions specified in the PED

3.8
design pressure
gauge pressure used in design formulae

NOTE For tanks made to this standard, the design pressure is equal to the “Maximum allowable pressure”, PS, in the PED

3.9
manufacturer
manufacturer of the tank unless otherwise specified

3.10
Ar_3
critical point, on the iron – iron carbide equilibrium diagram, representing the temperature at the beginning of transformation of austenite to ferrite on cooling of the steel

NOTE The actual temperature varies with composition of the steel.

4 Materials

4.1 Shells and ends

Materials for shells and ends shall be selected from the range of steels specified in EN 10028-2, EN 10028-3 or EN 10028-5. Alternatively, other equivalent material specifications which have either European materials approval or have been subjected to a particular material appraisal may be used.

In all cases the materials used shall comply with the following:

— the chemical composition and mechanical properties shall meet the requirements of either Group 1 or Group 2, as defined in Table 1;

— the minimum specified ultimate tensile strength shall not exceed 700 N/mm^2;

— the minimum elongation shall be 14 %;

— the impact properties shall be not less than 27 J at the minimum design temperature or shall meet the requirements for low temperature design as detailed in prEN 13445-2;

— steels in sub-group 2.2 shall have a carbon equivalent limited to 0,36%, maximum, when calculated in accordance with EN 10028-5.

Steels shall be grouped in accordance with Table 1.

Table 1 — Material grouping

Group	Sub-group	Type of steel
1		Steels with a specified minimum yield strength $R_{eH} \leq$ 460 N/mm² [a] and with analysis in % : C ≤ 0,25 Si ≤ 0,60 Mn ≤ 1,70 Mo ≤ 0,70 [b] S ≤ 0,045 P ≤ 0,045 Cu ≤ 0,40 [b] Ni ≤ 0,5[b] Cr ≤ 0,3 (0,4 for castings)[b] Nb ≤ 0,05 V ≤ 0,12 [b] Ti ≤ 0,05
	1.1	Steels with a specified minimum specified yield strength $R_{eH} \leq$ 275 N/mm²
	1.2	Steels with a specified minimum yield strength 275 N/mm² < $R_{eH} \leq$ 360 N/mm²
	1.3	Normalized fine grain steels with a specified minimum yield strength R_{eH} > 360 N/mm²
2		Thermomechanically treated fine grain steels and cast steels with a specified minimum yield strength R_{eH} > 360N/mm²
	2.1	Thermomechanically treated fine grain steels and cast steels with a specified minimum yield strength 360 N/mm² < $R_{eH} \leq$ 460 N/mm²
	2.2	Thermomechanically treated fine grain steels and cast steels with a specified minimum yield strength R_{eH} > 460 N/mm²

[a] In accordance with the specification of the steel product standards, R_{eH} may be replaced by $R_{p0,2}$.

[b] A higher value is accepted provided that Cr + Mo + Ni + Cu + V ≤ 0,75 %.

4.2 Pressure parts other than shells and ends

Materials for pressure parts other than shells and ends shall conform to the appropriate harmonised European Standard for the material or a similar specification which has European materials approval.

Materials shall also meet the requirements of 4.1.

4.3 Parts welded to the tank

Non-pressure retaining parts that are directly welded to the pressure retaining parts shall be made from suitable materials selected from EN 10025 or a material which is compatible with the pressure retaining part material.

NOTE It can be necessary for these materials to be subject to the alternative material approval requirements of the PED.

In all cases the material shall meet the requirements of 4.1.

4.4 Welding consumables

The welding consumables shall be such that they are capable of giving consistent welds with the properties at least equal to those specified for the parent materials of the finished tank.

The welding consumables shall be selected from EN 499, EN 756, EN 758, or EN 1668 as appropriate. Suitability of the chosen consumables shall be demonstrated in accordance with 7.6.3.

4.5 Certificates

The tank manufacturer shall obtain certificates showing the chemical analysis and details of the mechanical properties of the steel supplied for the construction of the pressure retaining parts of the tank. The certificates shall be in accordance with EN 10204, certificate Type 3.1B.

4.6 Non metallic materials (gaskets)

Non metallic materials shall be compatible with both phases of LPG over the full range of pressures and temperatures anticipated in service.

5 Design

5.1 General

Tank thicknesses shall be calculated in accordance with Annex E.

For tanks intended to contain LPG which complies with ISO 9162 supplied to a national or International Standard or other equivalent specification, no internal corrosion allowance is required.

For tanks protected against external corrosion in accordance with 10.1, no external corrosion allowance is required.

The appropriate weld joint factor for the material used and the level of non-destructive testing to be adopted shall be selected in accordance with Table 2.

The tank shall be designed to withstand the forces of pressure, vacuum conditions and liquid load in accordance with 5.3, 5.4 and 5.5.

Where necessary, attachments to the tank shall be welded using a backing plate.

5.2 Temperature

The design temperature range shall be –20 °C to 50 °C. However, where temperatures lower than –20 °C are envisaged, the manufacturer shall demonstrate that the material from which the pressure containing parts of the tank are constructed shall have properties suitable for a range of temperatures –40 °C to 50 °C in accordance with prEN 13445-2.

5.3 Pressure

The design pressure, *p* (see 3.9), shall not be less than the maximum pressure reached in service, in accordance with Annex A. It shall be selected taking into account the maximum pressure developed by the LPG.

5.4 Vacuum conditions

The tank shall be designed to withstand a minimum internal pressure of 0,1 bar absolute.

NOTE 1 This requirement can be satisfied by meeting the requirements of prEN 13445-3.

5.5 NOTE 2 This requirement should ensure that the tank will withstand vacuum conditions generated by the product during operation or normal maintenance.Support loadings

The tank and supports shall be designed to withstand the load when the tank is filled with water. This shall be demonstrated by calculation in accordance with prEN 13445-3 or by experimental testing.

5.6 Lifting lugs loadings

The lifting lugs shall be designed to accept the maximum loads anticipated during construction and handling. This shall be demonstrated by calculation in accordance with prEN 13445-3 or experimental testing.

5.7 Drawing

A fully dimensioned drawing including a material specification shall be produced.

6 Openings

6.1 General

Tanks shall be provided with an adequate number of openings to satisfy the need for fittings to meet service requirements.

6.2 Reinforcement

Each opening shall be reinforced by a boss, pad or compensating plate attached by welding and designed in accordance with E.3.

6.3 Position of welds and openings

The welds of opening reinforcements shall be clear of longitudinal and circumferential welds and welds of other opening reinforcements by a minimum of 40 mm between the weld edges.

7 Workmanship and manufacture

7.1 General

Tanks shall be manufactured according to drawings, specifications and procedures in accordance with the requirements of this standard and sound engineering practice.

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

Materials specified for the manufacture of the tanks shall be worked (subject to the working instructions of the material manufacturer if any) so that the finished tank shows both the properties necessary to meet the design intent and the requirements of this standard.

The manufacturer shall have a defined organization for the control of manufacturing operations, which includes special processes such as forming, welding and heat treatment.

7.2 Control and traceability of materials

The manufacturer shall maintain a system of identification for the material used in fabrication in order that all material for pressure parts in the completed tank can be traced to its origin. The system shall incorporate

procedures for verifying the identity of material as received from the supplier via the material manufacturer's test certificates and/ or acceptance tests.

The manufacturer shall ensure that the material used complies with that specified in the design and/or the drawings (see 5.7).

In laying out and cutting the material, the material identification mark shall be so located as to be:

a) clearly visible when the pressure part is completed; or

b) traceable by operation of a documented system which ensures material traceability for all materials in the completed tank.

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

NOTE Where the material identification mark is unavoidably cut out during manufacture of a pressure part, it should be transferred by the pressure part manufacturer, to another part of this component. The transfer of the mark should be carried out by a person designated by the manufacturer.

Records of applicable batches of the welding consumables used shall be retained.

7.3 Manufacturing tolerances

Tolerances on the shape of tanks shall be in accordance with Annex B.

7.4 Acceptable weld details

Basic weld details shall be in accordance with EN 1708-1. Recommended weld details are given in Annex G.

7.4.1 Longitudinal welds

Shell welds shall be either helical butt welds or longitudinal butt welds. Where a tank is made from more than one shell strake, the longitudinal weld seams of adjacent strakes shall be staggered by at least 100 mm. This spacing shall be measured between weld edges.

7.4.2 Joggle joints

7.4.2.1 Joggle joints shall meet the following requirements ;

a) the offset section which forms the weld backing shall be a close fit within its mating section round the entire circumference (machining of the spigot of the offset section is permissible providing that the thickness remaining as backing material is nowhere less than 75 % of the original thickness) ;

b) the profile of the offset shall be maintained, with a smooth radius without sharp corners throughout production;

c) on completion of the welding the weld shall have a smooth profile and shall fill the groove to the full thickness of the plate edge being joined.

NOTE Recommended arrangement for joggle joints is shown in Figure G.2.

7.4.2.2 When the flange section of the dished end is joggled, the joggle 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.

7.2.2.3 When a strake edge is joggled the longitudinal or helical weld shall be ground flush internally and externally for a distance of approximately 50 mm prior to joggling with no reduction of plate thickness. On completion of the joggling, the area of the weld shall be proven to be free of cracks by magnetic particle testing in accordance with EN 1290 or penetrant testing in accordance with EN 571-1.

7.5 Formed pressure parts

7.5.1 General

Formed pressure parts shall be either cold formed or hot formed.

They may comprise dished ends, cylindrical shells and other formed parts. Dished ends shall be made from one piece of plate.

Plates used for formed parts shall conform to 4.1.

The workpiece temperature during hot forming shall not exceed 1 050 ºC.

7.5.2 Heat treatment after forming

7.5.2.1 Heat treatment after cold forming of flat products

Cold formed dished ends shall be heat treated after forming, unless it can be demonstrated that the properties specified in 4.1 are met, or a burst test on a prototype tank demonstrates that the formed component is not the weakest point in the tank.

Where heat treatment is applied after cold forming, this shall be by normalising or another suitable procedure.

NOTE The base material manufacturer's test certificate can be taken as an indication or recommendation for the type of heat treatment required.

7.5.2.2 Heat treatment after hot forming

If no subsequent heat treatment is intended, the forming process shall be proven, controlled and meet the requirements of 7.5.1.

If the forming temperature is less than Ar_3 or the elongation of the steel, after forming, is less than that specified in 4.1, formed parts shall be heat treated by normalising or another qualified procedure after hot forming in order to restore the mechanical properties to comply with 4.1.

7.5.3 Testing of formed parts

For cold-formed parts not subject to heat treatment, no mechanical tests are required in respect of the forming operation except where required by 7.5.2.1 for dished ends

All other formed parts where the material thickness is greater than or equal to 5 mm, 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 piece formed by the same procedure. The test pieces, taken in accordance with the material specification, 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:

— 1 from the first 10 of each family, and then

— 1 from each 1 000 units produced, but not less than 1 per 2 years.

Ends belong to a family when they have the following characteristics in common :

— material specification,

— forming process,

— heat treatment, and

— geometrical similarity to ± 10 %.