SLOVENSKI STANDARD
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Načrtovanje in proizvodnja na mestu postavitve grajenih navpičnih, valjastih jeklenih posod z ravnim dnom za shranjevanje hlajenih utekočinjenih plinov z delovnimi temperaturami med 0 °C in –196 °C - 5. del: Preskušanje, sušenje, čiščenje in ohlajanje

Design and manufacture of site built, vertical, cylindrical, flat-bottomed tank systems for the storage of refrigerated, liquefied gases with operating temperatures between 0 °C and -196 °C - Part 5: Testing, drying, purging and cool-down

Auslegung und Herstellung standortgefertigter, stehender, zylindrischer Flachboden-Stahltanks für die Lagerung von tiefkalt verflüssigten Gasen bei Betriebstemperaturen zwischen 0 °C und -165 °C - Teil 5: Prüfen, Trocknen, Inertisieren und Kaltfahren

Conception et fabrication de réservoirs à fond plat, verticaux, cylindriques, construits sur site, destinés au stockage des gaz réfrigérés, liquéfiés, dont les températures de service sont comprises entre 0 °C et -196 °C - Partie 5 : Essais, séchage, inertage et mise en froid

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This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 265.

If this draft becomes a European Standard, 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.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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

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European foreword

This document (prEN 14620-5:2023) has been prepared by Technical Committee CEN/TC 265 “Site built metallic tanks for the storage of liquids”, the secretariat of which is held by BSI.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 14620-5:2006.

prEN 14620-5:2023 includes the following significant technical changes with respect to EN 14620-5:2006:

— Table 1 ‘Hydrostatic test requirements’ updated and adjusted to relate to product temperature;

— permitted use of small temporary safety opening in primary steel liquid container after hydrostatic test added;

— requirements for inspection of concrete surfaces during pressure test added;

— negative pressure test details clarified;

— negative pressure test requirements for double wall double roof tanks clarified;

— purging of bottom insulation space clarified;

— decommissioning guidance improved.

— new informative annex for global test for membrane tanks added.

A list of all parts in the EN 14620 series can be found on the CEN website.

1 Scope

This document specifies the requirements for testing, drying, purging, cool-down and decommissioning of refrigerated liquefied gas storage tanks.

This document deals with the design and manufacture of site built, vertical, cylindrical, flat-bottomed tank systems for the storage of refrigerated, liquefied gases with operating temperatures between 0 °C and –196°C.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 14620-1:—,[1] *Design and manufacture of site built, vertical, cylindrical, flat-bottomed tank systems for the storage of refrigerated, liquefied gases with operating temperatures between 0°C and –196 °C — Part 1: General*

EN 14620-2:2006, *Design and manufacture of site built, vertical, cylindrical, flat-bottomed steel tanks for the storage of refrigerated, liquefied gases with operating temperatures between 0 °C and -165 °C - Part 2: Metallic components*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14620-1:— apply.

4 Hydrostatic and pneumatic testing

4.1 Hydrostatic test

4.1.1 General

A hydrostatic test shall be carried out. The hydrostatic test shall demonstrate that:

— the tank system is designed and constructed to contain the product;

— the foundation is able to support the tank contents.

NOTE A hydrostatic test also aids the relief of residual stresses for steel tanks.

4.1.2 Test requirements for each type of tank

For the various tank types, the hydrostatic test shall be carried out in accordance with Table 1.

A specification shall be prepared with all the actions to be taken. The test results shall be documented.

NOTE See Annex C.

[1] Under preparation. Current stage: prEN 14620-1:2023.

Table 1 — Hydrostatic test requirements

Contents	Single containment	Double containment	Full containment	Membrane tank
Tank system design temperature ≥ −50 °C	**Primary liquid container - steel** FH	**Primary liquid container - steel** FH	**Primary liquid container – steel** FH	**Membrane barrier** No test (see NOTE 2)
		Secondary liquid container - steel FH (see NOTE 3)	**Secondary liquid container - steel** FH (see NOTE 3)	**Outer container - steel** FH
		Secondary liquid container - pre-stressed concrete No test	**Secondary liquid container – pre-stressed concrete** No test	**Outer container - pre-stressed concrete** PH (see NOTE 2)
Tank system design temperature < −50 °C	**Primary liquid container - steel** PH	**Primary liquid container - steel** PH	**Primary liquid container - steel** PH	**Membrane barrier** No test (see NOTE 2)
		Secondary liquid container - steel PH (see NOTE 3)	**Secondary liquid container - steel** PH (see NOTE 3)	**Outer container - steel** PH
		Secondary liquid container – pre-stressed concrete No test	**Secondary liquid container – pre-stressed concrete** No test	**Outer container – pre-stressed concrete** PH (see NOTE 2)

NOTE 1 FH means Full height hydrostatic test, PH means Partial height hydrostatic test.

NOTE 2 In the case of a membrane tank, there is no requirement for the membrane barrier to be hydrostatically tested. Refer to cl 4.3 for hydrotesting of membrane tank outer container

NOTE 3 The requirement to conduct a full or partial height hydrotest of steel secondary liquid container can be waived by written agreement by the purchaser.

4.1.3 Additional requirements

The following additional requirements shall apply:

— Leak testing shall be completed by means of the welding examination and inspection requirements described in EN 14620-2:2006.

— For a full height hydrostatic test, the primary liquid container shall be filled to the maximum design liquid level. The same quantity of water shall be used when testing the outer tank;

— For a partial height hydrostatic test of the primary liquid container, the test pressure applied by hydrotest water to the tank bottom shall be equal to 1,25 times the pressure applied to the tank bottom by the product at the height of the maximum design liquid level. The same quantity of water contained shall be used when testing the secondary liquid container.

— When secondary liquid containers are hydrostatically tested, a suitable water barrier shall be provided to prevent test water ingress in to the bottom insulation.

— Care shall be taken during filling of the annular space that water levels are controlled and regulated to prevent differential levels between the inner tank and annular spaces.

— The hydrostatic test shall not be carried out until all welded accessories to the shell and the bottom of the tank are in place. Welding shall not generally be allowed after completion of the hydrostatic test. The exception is when approved by the Purchaser, to assist quick emergency evacuation of construction personnel for tank systems without wall penetrations. A single circular temporary opening, not smaller than 600mm and not larger than 1000mm in diameter, may be allowed in the tank after hydrotest. The opening shall be permanently closed by the welding of a closure plate after personnel access into the hydrotested container is no longer necessary.

— The circular opening shall be positioned so that it does not cross any shell seams. It should also be at least the greater of 300mm or 10 times the shell thickness from any other weld in the shell. This includes shell to bottom weld, shell seams or welds to attachments.

— The butt weld around the perimeter of the closure plate shall be examined over the entirety of its length. Examination shall comprise liquid penetrant method and radiographic method. The liquid penetrant inspection is needed on the root pass, on the back gouged surface and on the inside and outside surfaces of the finished weld. The whole weld shall also be vacuum box leak tested. The welding and testing procedures shall be in accordance with EN 14620-2:2006.

— For tanks which are to be insulated with expanded perlite, the hydrostatic test shall be carried out before installation of the expanded perlite and resilient layer (if applicable).

— Test level of a membrane tank shall be based on the partial hydrostatic test requirement indicated above.

— The water shall be of a quality such that no damage to the steel/concrete can occur.

NOTE See Annex C.

4.1.4 Quality of the water

The suitability of the water for hydrostatic testing shall be demonstrated. Special attention shall be paid to possible corrosion.

The following types of corrosion shall be considered:

— general corrosion;

— galvanic corrosion; and

— localized corrosion (pitting, under deposit corrosion, bacterial corrosion).

NOTE 1 galvanic corrosion (fresh and seawater) is an electrochemical form of corrosion. It can occur when a metal or alloy is electrically connected to another metal or alloy with a different electrochemical potential and the metals (alloys) are exposed to a common electrolyte and electrical path. Welding of metals can lead to dissimilar metal compositions between the weld, Heat Affected Zone (HAZ) and the plate material. The most anodic material area will corrode because of the galvanic effect with the cathodic material areas.

NOTE 2 Localized corrosion can occur under the following circumstances in the presence of deposits and or solids:

a) presence of sulphate reducing bacteria;

b) locations where a low oxygen content is present.

Deposits or solids, present in the seawater, might settle down on the steel surface during hydrostatic testing and localized corrosion cells might develop. This can lead to high corrosion penetration rates.

NOTE 3 The main corrosion concerns, when using seawater during hydrostatic testing of 9 % nickel steel tanks, are:

a) galvanic activity between plate material, weld and HAZ;

b) when soils/deposits are present in the seawater, localized corrosion when cells can develop;

c) effect of sulphate reducing bacteria resulting in sour “corrosive” environment and possible formation of hydrogen;

d) the need for protection of stainless-steel internal components and exposed flange gasket surfaces;

e) the need for removal/prevention of dried mineral deposits resulting from draining of sea water.

The need for cathodic protection should be investigated to avoid galvanic corrosion and to reduce general corrosion. Cathodic protection promotes the cathodic reaction, which in de-aerated conditions (under deposits) generates hydrogen and therefore increases the risk of hydrogen stress cracking, if H2S is present at the same time.

The cathodic protection system (when required) shall be designed so that the risk of hydrogen embrittlement is avoided.

If the required water quality cannot be achieved then alternative methods utilizing filters or suitable inhibitors shall be considered.

Before discharging any test water from the Tank System, the environmental impact shall be investigated.

4.1.5 Conditions of implementation

Before the start of the test, the tank shall be cleaned. Any spatter and slag shall be removed from the welds, and all materials, objects or temporary installations used during its construction, shall also be removed.

Provisions should be taken in order to ensure that potential settlement during the hydrotest will not put unacceptable loads on the piping or any structural component connected to the tank.

Hydrostatic test of the tank systems shall be conducted with roof manhole (manholes) open to atmosphere.

4.1.6 Examination during filling

4.1.6.1 Peripheral level check

Before filling, permanent markers shall be installed equidistantly around the perimeter of the foundation of the tank, with a maximum spacing of 10 m around the circumference with a minimum of 4 markers.

Markers shall also be installed on the primary liquid container, in double and full containment tank systems, so that settlement of the inner tank can be monitored simultaneously with that of the secondary liquid container.

The markers shall be of such a type that they remain visible/usable after the tank is painted and shall be referenced to a remote benchmark.

A baseline measurement shall be conducted when the tank is empty and before the start of the hydrostatic test.

The settlement of the tank shall be monitored during the filling and emptying of the tank. As a minimum, this shall be done when the tank is a quarter full, half full, three-quarters full, full and after emptying. The

monitoring results shall be permanently recorded. The “after emptying” results shall form the start point of an annual settlement monitoring programme for the tank foundation.

4.1.6.2 Bottom surface level check

For tanks, where bottom differential settlements of more than 30 mm can be expected, or where the owner specifies, provisions shall be provided so that the settlement profile of the tank base can be monitored. The minimum requirement would be to provide monitoring across two orthogonal tank diameters.

For elevated tanks, this may be by means of taking a series of levels on the soffit of the tank base at permanently marked locations ≤ 5 m spacing. For ground supported or elevated tanks, an inclinometer or suitable measurement system, permanently cast into the tank base slab can be used.

4.1.7 Filling

The rate of filling shall be determined based on water/equipment availability and subsoil conditions.

The full water load shall be maintained for at least 24 h. During the test, a visual inspection of the shell welds for possible leakage shall be carried out.

The tightness of all welded joints above the test water level of an open top tank shall be inspected by vacuum box testing.

The anchor bolts, or straps, if present, shall be tightened during the emptying phase, when the water is at a constant height. (not less than 70 % of the maximum hydrostatic test liquid level).

During the work, the observed settlements shall be compared with the predicted values. If differences occur, the geotechnical expert, involved in the foundation design, shall be consulted (see EN 14620-1:—) and the purchaser shall be informed.

4.2 Pneumatic test

4.2.1 General

A pneumatic test shall be carried out. The purpose of the tank system pneumatic testing is as follows:

— to demonstrate the ability of the tank system and its components to resist design internal positive and negative pressure loads without any failures or damage;

— to perform leak tightness testing for the tank components not previously tested for leak tightness in accordance with EN 14620-2:2006; and

— to verify that pressure and vacuum relief vents operate properly and open at the specified setting pressures.

Specific requirements for pneumatic testing are provided in the following paragraphs 4.2.2 to 4.2.5.

During pneumatic testing, visual inspection of accessible external surfaces of the roof and walls may be considered. This is to ensure the structure behaves as predicted by the design. Any concrete surface cracking in excess of that allowed for in the design, abnormal deformation of steel plates, leakage, or other defects, shall be reported to the Contractor. If necessary, the test shall be suspended and investigation carried out.

Trigonometric levelling of the roof structure may also be considered, to check predicted deflections are not exceeded, where appropriate, or specified by the owner.

For safety reasons, inspection shall only be undertaken at pressures at, or below 1,0 times the design pressure.

4.2.2 Pressure test

A pressure test shall be carried out at a test pressure equal to 1,25 times the design pressure of the tank.

For hydrotested fixed roof containers, the test pressure shall be applied to the vapour space above the test water.

For double wall tanks with open-top inner tank, the inner tank may be completely or partially emptied of water before the pressure test, in the case where an outer tank hydrotest is not required. (See Note 3 in Table 1)

The following actions shall be considered:

— pressure relief valves shall be adjusted to open at the test pressure. Alternatively, a temporary pressure relief system shall be provided to prevent the pressure exceeding the test pressure. The test pressure, when reached, shall be held for at least 30 min. Thereafter the test pressure shall be reduced to the design pressure;

— soap solution test of all accessible welded joints, subjected to the pressure test, shall be performed at design pressure;

— Soap solution test for accessible welds can be substituted by visual inspection, if the joint has previously been vacuum-box tested. However, this relaxation does not apply to the following welds of steel roofs:

  — single sided roof plate welds to the compression ring; and

  — welds of roof nozzles and piping.

— repairs shall not be made while the tank is under pressure;

NOTE Repairs can be made later and individually vacuum box tested.

— pressure shall be reduced and pressure relief valves shall be adjusted to open at the design pressure. The set pressure of the pressure relief valve shall be verified by pumping air into the vapour space.

4.2.3 Negative pressure test

A negative pressure test shall be carried out in two stages, stage 1 to test the tank and stage 2 the vacuum relief valves.

The negative pressure test should be carried out while there is still water in the tank. This will prevent possible uplift of the bottom and the thermal protection system (TPS). For tanks with TPS, a provision to equalize pressure above and below secondary bottom /TPS shall be considered in the design.

Stage 1 – The tank shall be tested at a pressure equal to the internal negative design pressure of the tank.

Negative pressure testing of low-pressure tanks is a delicate operation. Utmost care shall be taken not to exceed the tank design limits. When approaching the test pressure levels, the air/water withdrawal is to be exercised carefully and at slow rate. Any further vacuum generation shall be terminated once the required pressure levels have been reached.

A minimum holding time is not required. The test may be finished as soon as the design internal negative pressure has been reached.

Stage 2 – The vacuum relief valves installed on the tank, shall be individually tested to verify that they open at their set pressure.