SLOVENSKI STANDARD

SIST EN 14620-3:2007

01-januar-2007

Naļ rtovanje in proizvodnja na mestu postavitve grajenih navpiļ nih, valjastih jeklenih posod z ravnim dnom za shranjevanje hlajenih utekoļ injenih plinov z delovnimi temperaturami med 0 ÁC in ï 165 ÁC - 3. del: Betonski deli

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 3: Concrete components

Auslegung und Herstellung standortgefertigter, stehender, zylindrischer Flachboden-Stahltanks für die Lagerung von tiefkalt verflüssigten Gasen bei Betriebstemperaturen zwischen 0 °C und -165 °C - Teil 3: Bauteile aus Beton

Conception et fabrication de réservoirs en acier a 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 -165 °C - Partie 3: Constituants béton

Ta slovenski standard je istoveten z: **EN 14620-3:2006**

ICS:

23.020.10	Nepremiļ ne posode in rezervoarji	Stationary containers and tanks

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EUROPEAN STANDARD

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English Version

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 3: Concrete components

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This European Standard was approved by CEN on 20 February 2006.

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 Central Secretariat 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 Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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Contents

Foreword

This European Standard (EN 14620-3:2006) 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 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 March 2007, and conflicting national standards shall be withdrawn at the latest by March 2007.

EN 14620 *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* consists of the following parts:

— Part 1: General;

— Part 2: Metallic components;

— Part 3: Concrete components;

— Part 4: Insulation components;

— Part 5: Testing, drying, purging and cool down.

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, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This European Standard specifies general requirements for materials, design and construction of the concrete components of the refrigerated liquefied gas storage tanks.

This European Standard deals with the 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.

2 Normative references

The following referenced documents are indispensable for the application of this European Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 206-1, *Concrete — Part 1: Specification, performance, production and conformity*

EN 1992-1-1:2004, *Eurocode 2: Design of concrete structures — Part 1-1: General rules and rules for buildings*

EN 1992-1-2:2004, *Eurocode 2: Design of concrete structures — Part 1-2: General rules — Structural fire design*

EN 14620-1:2006, *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 1: General*

EN 14620-2, *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 European Standard, the terms and definitions given in EN 14620-1:2006 and the following apply.

3.1
low temperature
temperature lower than –20 °C

4 General

For material selection and design of normal reinforced concrete and/or pre-stressed concrete structures, reference is made to EN 1992-1-1.

5 Vapour tightness

To ensure vapour tightness of the outer tank (e.g. in a full containment tank) metallic liners or polymeric coatings shall be used.

6 Materials

6.1 General

Material properties of concrete and components change at low temperature. Some changes are beneficial, some non-beneficial. The appropriate material properties shall be used to ensure that the structural integrity is not impaired for all temperature ranges for the components. This shall include both steady state and transient conditions.

NOTE Low temperature resistant material requirements, as given in 6.2 to 6.3, are needed only as far as they are required to guarantee the structural integrity and to fulfil the liquid tightness and where applicable vapour tightness requirements.

6.2 Concrete

For normal and low temperature conditions, the concrete material requirements shall be in accordance with EN 1992-1-1.

For the concrete performance, production, placing and compliance criteria, reference shall be made to EN 206-1.

NOTE Further information about the low temperature performance of concrete components is given in Annex A.

6.3 Pre-stressing and reinforcing steel

6.3.1 Pre-stressing steel and anchors

Pre-stressing steel, anchors, ducts etc. shall be in accordance with EN 1992-1-1.

In addition, it shall be demonstrated that the pre-stressing steel and anchors are suitable for the cold temperatures to which it may be exposed.

NOTE Further information about the low temperature performance of pre-stressing concrete is given in Annex A.

6.3.2 Reinforcing steel

For the design of reinforced concrete structure where the design temperature during a normal operating or emergency condition does not fall below –20 °C, the reinforcing steel shall comply with EN 1992-1-1.

For elements under tension, where the design temperature during a normal operating or emergency condition falls below –20 °C, additional low temperature requirements shall be implemented.

NOTE Guidance is given in Annex A.

It shall also be demonstrated that reinforcement connectors, used at ambient temperature, are suitable for the intended application.

For low temperature, the connectors shall be subjected to the same tests at design metal temperature and the results of these tests shall be compared to those at ambient temperature. The connectors shall be considered suitable if the low temperature results are within 5 % of those specified at ambient temperature. The contractor shall carry out appropriate tests, which shall include, as a minimum, tests for tensile strength and ductility. The results of these tests shall meet appropriate criteria set by the designer.

7 Design

7.1 General

Actions to be considered shall be in accordance with EN 14620-1:2006.

The reliability of the concrete components, according to the limit state theory, shall be achieved by application of the partial factor method.

The design values of actions, the effects of actions, material properties, geometric data and the design resistance shall be determined in accordance with EN 1992-1-1. In case heat radiation is involved, reference shall be made to EN 1992-1-2.

7.2 Partial factors for actions and combinations of actions

Table 1 provides partial load factors for accidental actions. They shall be used in addition to the partial load factors mentioned in the EN 1991-1-1.

Table 1 — Partial load factors for accidental actions

Load combinations	Load factors					
	Dead		Imposed		Abnormal load	Wind
	Adverse	Beneficial	Adverse	Beneficial		
Normal action plus one accidental action	1,05	1,0	1,05	0	1,0	0,3
Accidental actions being, earthquake (SSE), blast overpressure, external impact, fire or leakage from inner tank.						

7.3 Liquid tightness

For liquid tightness, the following shall be considered:

a) **In case of a non-liquid tight liner/coating**

For concrete outer containers without a liquid tight liner or coating, the liquid tightness of the concrete shall be ensured by means of the minimum compression zone of 100 mm.

b) **In case of a liquid tight liner/coating**

Where a liquid tight liner/coating is applied (to ensure full tightness of the secondary container) then cracking of the concrete section shall be permitted within the limits specified by EN 1992-1-1.

In such cases the crack width shall be calculated and the liner/coating shall be proven to be capable of ‘bridging’ a gap equal to 120 % of the crack width.

8 Detailing provisions

8.1 General

For general information on pre-stressed concrete tanks, reference should be made to Annex B.

8.2 Pre-stressing

For the pre-stressed concrete wall, horizontal pre-stressing shall be applied.

NOTE Vertical pre-stressing is not required. It can be combined with horizontal pre-stressing. The need for vertical pre-stressing depends on the tank design pressure, tank diameter, and associated permanent and transitional stresses within the concrete section.

8.3 Wall design

The minimum wall thickness shall be determined so that:

— adequate cover to all reinforcement and pre-stressing tendons shall be available;

— space between the reinforcement and pre-stressing tendons shall be sufficient to ensure that a homogeneous, liquid tight concrete structure is obtained.

8.4 Steel roof liner

The steel roof liner shall be anchored adequately to the concrete roof.

NOTE The liner may act as formwork for the concrete and may also act compositely with the use of shear studs. The concrete may be built up in layers to prevent overstress of the liner (see also B.6)

8.5 Construction joints

Attention shall be paid to the design and execution of the construction joints. The location and necessity shall be carefully planned to minimize the risk of poor jointing. For the areas where liquid tightness is to be assured, the contractor shall provide method statements based on proven working practices and where necessary, due to lack of evidence, the contractor shall carry out tests to demonstrate that the construction joint is liquid tight.

8.6 Position of tendons and wires

For internal pre-stressing systems using buttresses and grouted tendons, due account of the emergency conditions, e.g. fire scenarios, shall be taken to determine the position of the pre-stressing system.

NOTE 1 Tendons should be preferably placed, in the centre of the concrete wall for protection against external fires.

The tendons shall be well protected from corrosion during the life of the tank. Grouting procedures shall be provided and agreed between the designer and contractor to provide adequate protection to the tendons.

NOTE 2 In very aggressive environments, where additional protection is required, for the tendons, non-ferrous pre-stressing ducts may be considered. Reference is made to ‘Durable bonded post-tensioned bridges’ Concrete Society Report TR47 [12]. For non-bonded tendons, reference should be made to FIP recommendation 91 [13].

NOTE 3 Where wire-winding systems are used the wire should be placed on the outer face of the wall in a continuous helix with vertical spacing between wires of not less than 8 mm. Each layer of wire should be coated with shotcrete to provide a minimum of 6 mm thickness over the wire. After all the wires have been placed and coated, a final coating of shotcrete should be applied to provide a minimum thickness of 25 mm over the last wire.

8.7 Concrete cover

The concrete cover selection of reinforcement shall take into account the exposure classification, soil conditions and emergency design conditions e.g. fire protection.

Minimum requirements shall be in accordance with EN 1992-1-1.

8.8 Minimum reinforcement

The minimum area of reinforcement shall be in accordance with EN 1992-1-1.

8.9 Reinforced concrete bund walls

Bund walls constructed in reinforced concrete shall be permitted. The bund wall shall be designed to the requirements specified in this European Standard.

NOTE Bund walls are required with a single containment tank. They can be applied in combination with an earth embankment for structural reasons.

9 Construction and workmanship

9.1 General

In principle, the construction and workmanship requirements shall be in accordance with EN 1992-1-1.

Special attention shall be paid to the concrete composition, production, quality control, placement, compaction, curing etc. of the concrete to ensure liquid tightness of the structure, which shall be in accordance with EN 206-1.

In addition, the following requirements shall apply.

9.2 Crack control

The contractor shall investigate the heat of hydration and the effects of drying and thermal shrinkage in the concrete structure. The composition of the mix, the cement type, and the intended execution method shall be adapted accordingly so that cracking of the concrete is minimized.

Temperature differences between new and old constructions and the environment shall be considered in the construction plan.

9.3 Formwork and tie-rods

The formwork shall be tightly sealed at all joints. Calculations of the formwork shall be made to ensure sufficient strength and stiffness.

Special arrangements shall be applied at tie-rods to prevent leakage.

All cone openings shall be sealed such that liquid tightness shall be ensured.