



SWEDISH
STANDARDS
INSTITUTE

SVENSK STANDARD SS-EN 14620-1:2006

Fastställd 2006-09-22

Utgåva 1

Konstruktion och tillverkning av stationära, vertikala, cylindriska stålcisterner med plan botten, för lagring av kylda, kondenserade gaser med arbetstemperatur mellan 0 °C och -165 °C – Del 1: Allmänt

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

ICS 23.020.10

Språk: engelska

Publicerad: november 2006

Europastandarden EN 14620-1:2006 gäller som svensk standard. Detta dokument innehåller den officiella engelska versionen av EN 14620-1:2006.

The European Standard EN 14620-1:2006 has the status of a Swedish Standard. This document contains the official English version of EN 14620-1:2006.

Uppllysningar om **sakinnehållet** i standarden lämnas av SIS, Swedish Standards Institute, telefon 08 - 555 520 00.

Standarder kan beställas hos SIS Förlag AB som även lämnar **allmänna uppllysningar** om svensk och utländsk standard.

Postadress: SIS Förlag AB, 118 80 STOCKHOLM
Telefon: 08 - 555 523 10. *Telefax:* 08 - 555 523 11
E-post: sis.sales@sis.se. *Internet:* www.sis.se

EUROPEAN STANDARD

EN 14620-1

NORME EUROPÉENNE

EUROPÄISCHE NORM

September 2006

ICS 23.020.10

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 1: General

Conception et fabrication de réservoirs en acier à fond plat, verticaux, cylindriques, construits sur site, destinés au stockage de gaz réfrigérés, liquéfiés, dont les températures de service sont comprises entre 0 °C et -165 °C - Partie 1: Généralités

Auslegung und Herstellung standortgefertigter, stehender, zylindrischer Flachboden-Stahl tanks für die Lagerung von tiefkalt verflüssigten Gasen bei Betriebstemperaturen zwischen 0 °C und -165 °C - Teil 1: Allgemeines

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.



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

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

Contents

	Page
Foreword.....	3
1 Scope.....	4
2 Normative references	4
3 Terms and definitions.....	5
4 Concept selection	9
4.1 Types of tank	9
Figure 1 — Examples of single containment tanks.....	11
Figure 2 — Examples of double containment tanks	12
Figure 3 — Examples of full containment tanks.....	13
Figure 4 — Example of membrane tank.....	14
4.2 Risk assessment.....	14
5 Quality assurance and quality control.....	17
6 Health, safety and environment plan	17
7 General design considerations	17
7.1 General.....	17
7.2 Protection systems	21
7.3 Actions (loadings).....	23
8 Inspection and maintenance.....	27
Annex A (informative) Physical properties of gases.....	28
Table A.1 — Physical properties of pure gases.....	28
Annex B (normative) Design information.....	29
Annex C (normative) Seismic analysis	31
Annex D (informative) Tank heating system	34
Bibliography	36

Foreword

This European Standard (EN 14620-1:2006) 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.

EN 14620-1:2006 (E)

1 Scope

This European Standard is a specification for vertical, cylindrical tanks, built on site, above ground and of which the primary liquid container is made of steel. The secondary container, if applicable, may be of steel or of concrete or a combination of both. An inner tank made only of pre-stressed concrete is excluded from the scope of this European Standard.

This European Standard specifies principles and application rules for the structural design of the “containment” during construction, testing, commissioning, operation (accidental included), and decommissioning. It does not address the requirements for ancillary equipment such as pumps, pumpwells, valves, piping, instrumentation, staircases etc. unless they can affect the structural design of the tank.

This European Standard applies to storage tanks designed to store products, having an atmospheric boiling point below ambient temperature, in a dual phase, i.e. liquid and vapour. The equilibrium between liquid and vapour phases being maintained by cooling down the product to a temperature equal to, or just below, its atmospheric boiling point in combination with a slight overpressure in the storage tank.

The maximum design pressure of the tanks covered by this European Standard is limited to 500 mbar. For higher pressures, reference can be made to EN 13445, Parts 1 to 5.

The operating range of the gasses to be stored is between 0 °C and –165 °C. The tanks for the storage of liquefied oxygen, nitrogen and argon are excluded.

The tanks are used to store large volumes of hydrocarbon products and ammonia with low temperature boiling points, generally called “Refrigerated Liquefied Gases” (RLG’s). Typical products stored in the tanks are: methane, ethane, propane, butane, ethylene, propylene, butadiene (this range includes the LNG’s and LPG’s).

NOTE Properties of the gases are given in Annex A.

The requirements of this European Standard cannot cover all details of design and construction because of the variety of sizes and configurations that may be employed. Where complete requirements for a specific design are not provided, the intention is for the designer, subject to approval of the purchaser’s authorized representative, to provide design and details that are as safe as those laid out in this European Standard.

This European Standard specifies general requirements for the tank concept, selection and general design considerations.

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 1991-1-4, *Eurocode 1: Actions on structures — Part 1-4: Wind actions*

EN 1991-1-6, *Eurocode 1: Actions on structures — Part 1-6: General actions — Actions during execution*

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

EN 1997-1:2004, *Eurocode 7: Geotechnical design — Part 1: General rules*

EN 1998-1:2004, *Eurocode 8: Design of structures for earthquake resistance — Part 1: General rules, seismic actions and rules for buildings*

ENV 1998-4:1998, *Eurocode 8: Design provisions for earthquake resistance of structures — Part 4: Silos, tanks and pipelines*

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*

EN 14620-3:2006, *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 3: Concrete components*

EN 14620-4, *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 4: Insulation components*

EN 14620-5, *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 5: Testing, drying, purging and cool-down*

3 Terms and definitions

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

3.1

action

a) set of forces (loads) applied to the structure (direct action)

b) set of imposed deformation or accelerations caused for example, by temperature changes, moisture variation, uneven settlement or earthquakes (indirect action)

3.2

annular space

space between the inner shell and outer shell or wall of self-supporting tanks

3.3

base slab

continuous concrete base supporting the tank (either on the ground or elevated)

3.4

boil-off

process of vaporization of refrigerated liquid by heat conducted through the insulation surrounding the storage tank

3.5

bund wall

low construction of earth or concrete surrounding the storage tank at a considerable distance to contain spilled liquid

3.6

polymeric vapour barrier

reinforced or un-reinforced polymeric layer applied to the concrete to function as a product vapour, water vapour and in some cases as liquid barrier

EN 14620-1:2006 (E)

3.7

contractor

company with which the purchaser agrees a proposal for the design, construction, testing and commissioning of a tank

3.8

design pressure

maximum permissible pressure

3.9

design negative pressure

maximum permissible negative pressure (vacuum)

3.10

design metal temperature

minimum temperature for which the metal component is designed

NOTE It may be the minimum design temperature (in the case of the primary container) or a higher calculated temperature.

3.11

double containment tank

see 4.1.2

3.12

foundations

elements of the construction that comprise the base slab, ring-wall or pile system required to support the tank and contents

3.13

full containment tank

see 4.1.3.

NOTE The secondary container contains the vapour in normal operation and ensures controlled venting in the case of a primary container leakage.

3.14

hazard

event having the potential to cause harm, including ill health and injury, damage to property, products or the environment, production losses or increased liabilities

3.15

inner tank

metallic self-supporting cylindrical primary container

3.16

insulation space

volume containing insulation material in the tank annular space, and between the tank bottoms or roofs

3.17

liner

metallic plate installed against the inside of the concrete outer tank, impervious to product vapour and water vapour

3.18

load bearing insulation

thermal insulation with special properties capable of transferring loads to the appropriate load bearing structures

3.19

lodmat

lowest one-day average ambient temperature.

Note The average temperature is half the sum of the maximum and minimum temperature

3.20

maximum design liquid level

maximum liquid level that will be maintained during operation of the tank used for the static shell thickness determination

3.21

maximum normal operating level

Maximum liquid level that will be maintained during normal operation of the tank. Normally the level at which the first high level alarm is set

3.22

membrane

thin metallic primary container of a membrane tank

3.23

membrane tank

containment whereby a membrane (primary container) together with load bearing thermal insulation and a concrete tank are forming jointly an integrated, composite tank structure

3.24

minimum design temperature

assumed temperature of the product, specified by the purchaser, for which the tank is designed

NOTE This temperature may be lower than the actual product temperature.

3.25

Operating Basis Earthquake (OBE)

maximum earthquake event for which no damage is sustained and restart and safe operation can continue

NOTE This event would result in no loss to the operational integrity and public safety is assured.

3.26

outer tank

self-supporting cylindrical secondary container made of steel or concrete

3.27

purchaser

company who gives an order to the contractor for the design, construction and testing of a tank

3.28

primary liquid container

part of a single, double, full containment or membrane tank that contains the liquid during normal operation

3.29

product vapour barrier

polymeric vapour barrier or a liner to prevent escape of product vapours from the tank

3.30

ringbeam

circular support under the shell of the tank

EN 14620-1:2006 (E)

3.31

roll-over

uncontrolled mass movement of stored liquid, correcting an unstable state of stratified liquids of different densities and resulting in a significant evolution of product vapour

3.32

roof

structure on top of a shell or wall containing the vapour pressure and sealing off the contents from the atmosphere

3.33

Safe Shutdown Earthquake (SSE)

maximum earthquake event for which the essential fail-safe functions and mechanisms are designed to be preserved

NOTE Permanent damage can be accepted, but without the loss of overall integrity and containment. The tank would not remain in operation without a detailed examination and structural assessment.

3.34

secondary liquid container

part of the outer container of a double, full containment or membrane tank that contains the liquid

3.35

self supporting tank

container designed to carry the hydrostatic forces of the stored liquid and the vapour pressure loads, if applicable

3.36

set pressure

pressure at which the pressure relief device first opens

3.37

shell

metallic vertical cylinder

3.38

single containment tank

see 4.1.1

NOTE The product vapour is contained by the primary container or by means of a metallic outer tank.

3.39

suspended roof

structure for supporting the internal insulation of the roof

3.40

test pressure

air pressure in the tank during testing

3.41

Thermal Protection System (TPS)

thermally insulating and liquid tight structure in order to protect the outer tank against low temperatures

NOTE Examples include bottom and bottom corner (see also 7.1.11).

3.42

vapour container

part of a single, double, full containment or membrane tank that contains the vapour during normal operation

3.43

wall

concrete vertical cylinder

3.44

vapour barrier

barrier to prevent entry of water vapour and other atmospheric gases into the insulation or into the outer tank

4 Concept selection

4.1 Types of tank

4.1.1 Single containment

A single containment tank shall consist of only one container to store the liquid product (primary liquid container). This primary liquid container shall be a self-supporting, steel, cylindrical tank.

The product vapours shall be contained by:

- either the steel dome roof of the container;
- or, when the primary liquid container is an open top cup, by a gas-tight metallic outer tank encompassing the primary liquid container, but being only designed to contain the product vapours and to hold and protect the thermal insulation.

NOTE 1 Depending on the options taken for vapour containment and thermal insulation; several types of single containment tanks exist.

A single containment tank shall be surrounded by a bund wall to contain possible product leakage.

NOTE 2 For examples of single containment tanks, see Figure 1.

4.1.2 Double containment

A double containment tank shall consist of a liquid and vapour tight primary container, which itself is a single containment tank, built inside a liquid-tight secondary container.

The secondary container shall be designed to hold all the liquid contents of the primary container in case it leaks. The annular space, between the primary and secondary containers, shall not be more than 6,0 m.

NOTE 1 The secondary container is open at the top and therefore cannot prevent the escape of product vapours. The space between primary and secondary container can be covered by a "rain shield" to prevent the entry of rain, snow, dirt etc.

NOTE 2 For examples of double containment tanks, see Figure 2.

4.1.3 Full containment

A full containment tank shall consist of a primary container and a secondary container, which together form an integrated storage tank. The primary container shall be a self-standing steel, single shell tank, holding the liquid product.

The primary container shall:

- either be open at the top, in which case it does not contain the product vapours