SLOVENSKI STANDARD
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Konstruiranje 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 - 1. del: Splošno

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

Auslegung und Herstellung standortgefertigter, stehender, zylindrischer Flachboden-Stahltanks für die Lagerung von tiefkalt verflüssigten Gasen bei Betriebstemperaturen zwischen 0 °C und -196 °C - Teil 1: Allgemeines

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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

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

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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Contents

Page

European foreword

This document (prEN 14620-1:2022) has been prepared by Technical Committee CEN/TC 265 “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 14620-1:2006.

In comparison with the previous edition, the following technical modifications have been made:

— general editorial update;

— standard boundaries are defined in the scope statement and applicability extended to −196°C;

— terms and definitions adjusted;

— normative references updated;

— description of various tank system concepts updated;

— risk assessment requirements improved;

— liquid levels and capacities clarified;

— foundation requirements updated and allowable foundation settlement requirements added;

— secondary containment design requirements clarified;

— earthquake requirements clarified;

— new chapter on marking and documentation added;

— new informative annex with recommendation for geotechnical investigation and seismic hazard evaluation added.

EN 14620, *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*, 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;

— Part 6: Specific requirements for the design and construction of tank systems for the storage of liquefied oxygen (LOX), liquefied nitrogen (LIN) and liquefied argon (LAR); and

— Part 7: Specific requirements for the design and construction of tank systems for the storage of liquefied anhydrous ammonia.

1 Scope

This document is a specification for vertical, cylindrical tank systems, built on site, above ground and of which either the primary liquid container or the liquid tight barrier is made of steel. The secondary liquid container, if applicable, can be of steel or of concrete or a combination of both. A primary liquid container made of pre-stressed concrete is excluded from the scope of this document.

This document 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 systems. This document also does not address tank system operating procedures.

This document applies to all components located within, attached to and providing access to the tank system. It defines minimum performance requirements for the tank system, tank system foundation and protection systems. From a process piping standpoint, the scope of this document is limited to the following boundaries:

a) the face of the first flange outside of the tank in bolted flanged connection;

b) the first threaded joint outside of the tank in threaded connection;

c) the first circumferential pipe welded joint outside of the tank in welding-end pipe connection, which does not have a flange.

This document applies to storage tank systems 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 system.

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

The operating range of the gases to be stored is between 0 °C and −196°C.

The tank systems covered by this document are used to store large volumes of hydrocarbon products, ammonia and other non-hydrocarbon gases with low temperature boiling points, generally called "Refrigerated Liquefied Gases" (RLGs). Typical products stored in the tank systems are: methane, ethane, propane, butane, ethylene, propylene, butadiene (this range includes the Liquefied Natural Gas (LNG's) and Liquefied Petroleum Gas (LPG's)), ammonia, nitrogen, oxygen and argon.

NOTE Properties of the gases are given in Annex A.

The requirements of this document 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 document.

This document specifies general requirements for the tank system concept, selection and general design considerations.

The requirements specific for liquid nitrogen, liquid oxygen and liquid argon are covered in prEN 14620-6 and requirements specific to anhydrous ammonia are covered in EN 14620-7. In case of conflict between requirements of this Part and requirements on the same subject listed in prEN 14620-6 and EN 14620-7, the requirements set forth in prEN 14620-6 and EN 14620-7 take precedence.

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 1473:2021, *Installation and equipment for liquefied natural gas - Design of onshore installations*

EN 1990, *Eurocode - Basis of structural design*

EN 1991-1-3, *Eurocode 1 - Actions on structures - Part 1-3: General actions - Snow loads*

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

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

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

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

EN 1998-4:2006, *Eurocode 8 - Design of structures for earthquake resistance - Part 4: Silos, tanks and pipelines*

EN 1998-5, *Eurocode 8: Design of structures for earthquake resistance Part 5: Foundations, retaining structures and geotechnical aspects*

EN ISO 28300, *Petroleum, petrochemical and natural gas industries - Venting of atmospheric and low-pressure storage tanks (ISO 28300)*

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, *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*

prEN 14620-6, *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 6: Specific requirements for the design and construction of tank systems for the storage of liquefied oxygen (LOX), liquefied nitrogen (LIN) and liquefied argon (LAR)*

[1] As impacted by EN 1998 1:2004/A1:2013.

EN 14620-7, *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 7: Specific requirements for the design and construction of tank systems for the storage of liquefied anhydrous ammonia*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

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 primary liquid container and the outer tank

3.3
base slab
continuous concrete base supporting the tank system (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 system

3.5
bund wall
low construction of earth or concrete surrounding the storage tank system 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 barrier

3.7
contractor
company contracted to supply a tank system or services as defined by the purchaser

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 1 to entry: The minimum design temperature (in the case of the primary container) or a higher calculated temperature.

3.11
design working life
assumed period for which a structure or part of it is to be used for its intended purpose with anticipated maintenance

3.12
double containment tank system
liquid and vapour tight primary container, which itself is a single containment tank system, built inside a liquid tight secondary container

Note 1 to entry: See 4.1.3.

3.13
foundation
elements of the construction that comprise the base slab, ring-wall or pile system required to support the tank system and contents

3.14
freeboard
margin on tank system wall height to prevent the overfill, to allow for tilting settlements and to accommodate seismic sloshing wave

3.15
full containment tank system
primary liquid container and a secondary liquid container, which together form an integrated storage tank system

Note 1 to entry: See 4.1.4.

Note 2 to entry: The secondary container contains the vapour in normal operation and ensures controlled venting in the case of a primary container leakage.

3.16
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

3.17
insulation system
component of the tank system consisting of a complete package of insulation material and, when applicable, components for the insulation material fixing and protection to limit heat in-leak in the tank system and maintain RLG in the liquefied state at pressure close to atmospheric

3.18
insulation space
volume containing insulation material in the tank system annular space, and between the tank system bottoms or roofs

3.19
liner
metallic plate installed against the inside of the concrete outer tank, impervious to product vapour and water vapour

3.20
liquid barrier
parts of the tank system which prevents direct contact of refrigerated liquefied gas (RLG) with other components of the system but does not have structural capabilities to independently carry liquid load

3.21
load bearing insulation
thermal insulation with special properties capable of transferring loads to the appropriate load bearing structures

3.22
lodmat
lowest one-day average ambient temperature

Note 1 to entry: The average temperature is half the sum of the maximum and minimum temperature.

3.23
maximum design liquid level
maximum liquid level maintained during operation of the tank system used for the static shell thickness determination

3.24
maximum liquid capacity (gross capacity)
volume between the design liquid level and the tank bottom

3.25
maximum normal operating level
maximum liquid level maintained during normal operation of the tank system, typically the level at which the first high level alarm is set

3.26
membrane
part of a membrane containment tank system that, during normal operation, forms a liquid and vapour tight barrier

3.27
membrane containment tank system
metallic liquid barrier (membrane) together with load bearing thermal insulation and a self-supporting membrane tank outer container jointly forming an integrated, composite system

Note 1 to entry: See 4.1.5.

3.28
membrane tank outer container
the part of a membrane containment tank system that carries liquid and pressure loads during normal operation and may contain liquid in the event of liquid leakage from the membrane

3.29
minimum design temperature
assumed temperature of the product, specified by the purchaser, for which the tank system is designed

Note 1 to entry: This temperature can be lower than the actual product temperature.

3.30
minimum normal operating level
minimum liquid level maintained during normal operation of the tank system to meet the requirements specified by the purchaser

3.31
moisture barrier
layer to prevent entry of water vapour and other atmospheric gases into the insulation or into the outer tank

3.32
net capacity
working capacity
liquid volume between the maximum and the minimum normal operating levels

3.33
Operating Basis Earthquake
OBE
maximum earthquake event for which no damage is sustained and restart and safe operation can continue

3.34
outer tank
self-supporting cylindrical secondary liquid container, purge gas container or warm vapour container made of steel or concrete

3.35
pressure relief valve
valve designed to open and relieve excess pressure and to reclose and prevent the further flow of fluid out after normal conditions have been restored

3.36
purge gas container
parts of a tank system that contain only purge gas and are not expected to function after exposure to product temperature

3.37
purchaser
company who gives an order to the contractor for the supply a tank system or services

3.38
primary liquid container
part of a single, double, full containment tank systems that contains the liquid during normal operation

3.39
ringbeam
circular support under the shell of the tank

3.40
risk
measure of the combination (usually the product) of the probability or frequency of occurrence of a defined hazard and the magnitude of the consequences of the occurrence

3.41
rollover
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

3.42
roof
structure on top of a shell or wall containing the vapour pressure and sealing off the contents from the atmosphere

3.43
Safe Shutdown Earthquake
SSE
maximum earthquake event for which the essential fail-safe functions and mechanisms are designed to be preserved

Note 1 to entry: Permanent damage can be accepted, but without the loss of liquid and vapour containment. The tank system would not remain in operation without a detailed examination and structural assessment.

3.44
secondary liquid container
part a single, double and full containment tank systems that contains the liquid in the event of leakage from the primary liquid container

3.45
self-supporting tank
container designed to independently carry the liquid and the vapour pressure loads as well as the external loads, where applicable

3.46
set pressure
pressure at which the pressure relief device first opens

3.47
shell
metallic vertical cylinder

3.48
single containment tank system
one container to store the liquid product (primary liquid container) formed of a self-supporting, steel, cylindrical tank

Note 1 to entry: The product vapour is contained by the primary container or by means of a metallic outer tank. See also 4.1.2.

3.49
suspended roof
structure for supporting the internal insulation of the roof

3.50
tank system
equipment designed for the purpose of storing refrigerated liquefied gas (RLG) consisting of one or more containers together with all other necessary components within the scope of this document

3.51
pneumatic test pressure
air pressure in the tank system during testing

3.52
Thermal Protection System
TPS
thermally insulating and liquid tight systems to protect the concrete secondary liquid container or the membrane tank outer container against low temperatures in the event of leakage through primary liquid container or the membrane respectively

Note 1 to entry: Examples include bottom and bottom corner (see also 7.1.11).

3.53
vacuum relief valve
valve that designed to open and relieve negative pressure (vacuum) and then reclose to prevent further flow of fluid in after normal conditions have been restored

3.54
vapour container
part of a single, double, full containment or membrane tank systems that contains the vapour during normal operation

3.55
warm vapour container
parts of a tank system that contain product vapour, and prevent entry of water vapour and other atmospheric gases during normal operation but are not expected to function once exposed to refrigerated product temperature. (This includes roofs over suspended insulation deck and the outer container of a double wall, open top single containment tank system.)

4 Concept selection

4.1 Types of tank systems

4.1.1 General

Several different tank system concepts for RLG storage exist. The storage systems are differentiated based on the ability of each storage system to contain product liquid and/or vapour releases due to both internal and external hazards. Due to rapid boiling of refrigerated liquids when exposed to ambient conditions, a liquid release from a tank system to the surrounding ground generates a significant amount of uncontrolled cold vapours and results in a reduction in surface temperature of the surroundings. As a result, liquid releases are generally more dangerous than just vapour releases.

Four basic storage tank systems are described below which, due to a number of factors including materials of construction, configuration, and redundancy vary in their ability to resist hazards and contain product release.

While each storage system can ensure the safe RLG storage, selection of a storage system most suitable for the specific site and the project shall be determined via a detailed risk assessment. Subclause 4.2 provides basic requirements for the risk assessment process for the storage system selection.

The tank configurations described in 4.1.2 to 4.1.5 are provided in Figures 1 to 4 as examples only. Other configurations are acceptable providing that requirements toward the tank concepts described in 4.1.2 to 4.1.5 are satisfied.

4.1.2 Single containment system

A single containment tank system 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 tank systems exist.

A single containment tank system shall be surrounded by a bund wall to contain possible product leakage except for LIN/LOX/LAR storage addressed in prEN 14620-6.

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

4.1.3 Double containment system

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

The wall and the concrete foundation (or the liquid tight bottom) for the secondary liquid container shall be designed to hold all the liquid contents of the primary container in case it leaks.

NOTE 1 The secondary container is open at the top and, therefore, cannot prevent the escape of product vapours.