Eurokoodeks 3 - Teraskonstruktsioonide projekteerimine. Osa 4-2: Vedelikumahutid.

Eurocode 3 - Design of steel structures - Part 4-2: Tanks.

EESTI STANDARDI EESSÕNA **NATIONAL FOREWORD**

Käesolev Eesti standard EVS-EN 1993-4-2:2007 sisaldab Euroopa standardi EN 1993-4-2: 2007 ingliskeelset teksti. Käesolev dokument on jõustatud 30.03.2007 ja selle kohta on avaldatud teade Eesti standardiorganisatsiooni ametlikus väljaandes. Standard on kättesaadav Eesti standardiorganisatsioonist.	This Estonian standard EVS-EN 1993-4-2:2007 consists of the English text of the European standard EN 1993-4-2: 2007. This document is endorsed on 30.03.2007 with the notification being published in the official publication of the Estonian national standardisation organisation. The standard is available from Estonian standardisation organisation.

Käsitlusala: Eurokoodeks 3 osa 4-2 esitab põhimõtted ja rakendusreeglid vedelike hoidmiseks ette nähtud vertikaalsete silindriliste maapealsete terasmahutite projekteerimiseks.	**Scope:** Part 4.2 of Eurocode 3 provides principles and application rules for the structural design of vertical cylindrical above ground steel tanks for the storage of liquid products

ICS 23.020.01, 91.010.30, 91.080.10

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Eurocode 3 - Design of steel structures - Part 4-2: Tanks

Eurocode 3 - Calcul des structures en acier - Partie 4-2: Réservoirs

Eurocode 3 - Bemessung und Konstruktion von Stahlbauten - Teil 4-2: Silos,Tankbauwerke und Rohrleitungen - Tankbauwerke

This European Standard was approved by CEN on 12 June 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 CEN 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 CEN Management Centre has the same status as the official versions.

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Foreword

This European Standard EN 1993-4-2, Eurocode 3: Design of steel structures: "Design of Steel Structures – Part 4-2: Tanks", has been prepared by Technical Committee CEN/TC250 « Structural Eurocodes », the Secretariat of which is held by BSI. CEN/TC250 is responsible for all Structural Eurocodes.

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 August 2007, and conflicting National Standards shall be withdrawn at latest by March 2010.

This Eurocode supersedes ENV1993-4-2: 1999.

According to the CEN-CENELEC Internal Regulations, the National Standard Organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, 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.

Background of the Eurocode programme

In 1975, the Commission of the European Community decided on an action programme in the field of construction, based on article 95 of the Treaty. The objective of the programme was the elimination of technical obstacles to trade and the harmonisation of technical specifications.

Within this action programme, the Commission took the initiative to establish a set of harmonised technical rules for the design of construction works which, in a first stage, would serve as an alternative to the national rules in force in the Member States and, ultimately, would replace them.

For fifteen years, the Commission, with the help of a Steering Committee with Representatives of Member States, conducted the development of the Eurocodes programme, which led to the first generation of European codes in the 1980's.

In 1989, the Commission and the Member States of the EU and EFTA decided, on the basis of an agreement[1)] between the Commission and CEN, to transfer the preparation and the publication of the Eurocodes to the CEN through a series of Mandates, in order to provide them with a future status of European Standard (EN). This links de facto the Eurocodes with the provisions of all the Council's Directives and/or Commission's Decisions dealing with European standards (e.g. the Council Directive 89/106/EEC on construction products - CPD - and Council Directives 93/37/EEC, 92/50/EEC and 89/440/EEC on public works and services and equivalent EFTA Directives initiated in pursuit of setting up the internal market).

The Structural Eurocode programme comprises the following standards generally consisting of a number of Parts:

EN1990	Eurocode 0: Basis of structural design
EN1991	Eurocode 1: Actions on structures
EN1992	Eurocode 2: Design of concrete structures

1) Agreement between the Commission of the European Communities and the European Committee for Standardisation (CEN) concerning the work on EUROCODES for the design of building and civil engineering works (BC/CEN/03/89).

EN1993	Eurocode 3: Design of steel structures
EN1994	Eurocode 4: Design of composite steel and concrete structures
EN1995	Eurocode 5: Design of timber structures
EN1996	Eurocode 6: Design of masonry structures
EN1997	Eurocode 7: Geotechnical design
EN1998	Eurocode 8: Design of structures for earthquake resistance
EN1999	Eurocode 9: Design of aluminium structures

Eurocode standards recognise the responsibility of regulatory authorities in each Member State and have safeguarded their right to determine values related to regulatory safety matters at national level where these continue to vary from State to State.

Status and field of application of Eurocodes

The Member States of the EU and EFTA recognise that EUROCODES serve as reference documents for the following purposes:

- as a means to prove compliance of building and civil engineering works with the essential requirements of Council Directive 89/106/EEC, particularly Essential Requirement N°1 - Mechanical resistance and stability - and Essential Requirement N°2 - Safety in case of fire ;
- as a basis for specifying contracts for construction works and related engineering services ;
- as a framework for drawing up harmonised technical specifications for construction products (ENs and ETAs)

The Eurocodes, as far as they concern the construction works themselves, have a direct relationship with the Interpretative Documents[2)] referred to in Article 12 of the CPD, although they are of a different nature from harmonised product standards[3)]. Therefore, technical aspects arising from the Eurocodes work need to be adequately considered by CEN Technical Committees and/or EOTA Working Groups working on product standards with a view to achieving full compatibility of these technical specifications with the Eurocodes.

The Eurocode standards provide common structural design rules for everyday use for the design of whole structures and component products of both a traditional and an innovative nature. Unusual forms of construction or design conditions are not specifically covered and additional expert consideration will be required by the designer in such cases.

National Standards implementing Eurocodes

The National Standards implementing Eurocodes will comprise the full text of the Eurocode (including any annexes), as published by CEN, which may be preceded by a National title page and National foreword, and may be followed by a National Annex.

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2) According to Art. 3.3 of the CPD, the essential requirements (ERs) shall be given concrete form in interpretative documents for the creation of the necessary links between the essential requirements and the mandates for harmonised ENs and ETAGs/ETAs.

3) According to Art. 12 of the CPD the interpretative documents shall :

a) give concrete form to the essential requirements by harmonising the terminology and the technical bases and indicating classes or levels for each requirement where necessary ;

b) indicate methods of correlating these classes or levels of requirement with the technical specifications, e.g. methods of calculation and of proof, technical rules for project design, etc. ;

c) serve as a reference for the establishment of harmonised standards and guidelines for European technical approvals.

The Eurocodes, de facto, play a similar role in the field of the ER 1 and a part of ER 2.

The National Annex may only contain information on those parameters which are left open in the Eurocode for national choice, known as Nationally Determined Parameters, to be used for the design of buildings and civil engineering works to be constructed in the country concerned, i.e. :

- values and/or classes where alternatives are given in the Eurocode,
- values to be used where a symbol only is given in the Eurocode,
- country specific data (geographical, climatic, etc), e.g. snow map,
- the procedure to be used where alternative procedures are given in the Eurocode.

It may also contain:

- decisions on the application of informative annexes,
- references to non-contradictory complementary information to assist the user to apply the Eurocode.

Links between Eurocodes and harmonised technical specifications (ENs and ETAs) for products

There is a need for consistency between the harmonised technical specifications for construction products and the technical rules for works[4)]. Furthermore, all the information accompanying the CE Marking of the construction products which refer to Eurocodes should clearly mention which Nationally Determined Parameters have been taken into account.

Additional information specific to EN1993-4-2

EN 1993-4-2 gives design guidance for the structural design of tanks.

EN 1993-4-2 gives design rules that supplement the generic rules in the many parts of EN 1993-1.

EN 1993-4-2 is intended for clients, designers, contractors and relevant authorities.

EN 1993-4-2 is intended to be used in conjunction with EN 1990, with EN 1991-4, with the other Parts of EN 1991, with EN 1993-1-6 and EN 1993-4-1, with the other Parts of EN 1993, with EN 1992 and with the other Parts of EN 1994 to EN 1999 relevant to the design of tanks. Matters that are already covered in those documents are not repeated.

Numerical values for partial factors and other reliability parameters are recommended as basic values that provide an acceptable level of reliability. They have been selected assuming that an appropriate level of workmanship and quality management applies.

Safety factors for ‘product type’ tanks (factory production) can be specified by the appropriate authorities. When applied to ‘product type’ tanks, the factors in 2.9 are for guidance purposes only. They are provided to show the likely levels needed to achieve consistent reliability with other designs.

National Annex for EN1993-4-2

This standard gives alternative procedures, values and recommendations for classes with notes indicating where national choices may have to be made. Therefore the National Standard implementing EN 1993-4-2 should have a National Annex containing all Nationally Determined Parameters to be used for the design of buildings and civil engineering works to be constructed in the relevant country.

National choice is allowed in EN 1993-4-2 through:

– 2.2 (1)
– 2.2 (3)

4) see Art.3.3 and Art.12 of the CPD, as well as clauses 4.2, 4.3.1, 4.3.2 and 5.2 of ID 1.

- 2.9.2.1 (1)P
- 2.9.2.1 (2)P
- 2.9.2.1 (3)P
- 2.9.2.2 (3) P
- 2.9.3 (2)
- 3.3 (3)
- 4.1.4 (3)
- 4.3.1 (6)
- 4.3.1 (8)

1 General

1.1 Scope

(1) Part 4.2 of Eurocode 3 provides principles and application rules for the structural design of vertical cylindrical above ground steel tanks for the storage of liquid products with the following characteristics

a) characteristic internal pressures above the liquid level not less than −100mbar and not more than 500mbar [1)];

b) design metal temperature in the range of −50ºC to +300ºC. For tanks constructed using austenitic stainless steels, the design metal temperature may be in the range of −165ºC to +300ºC. For fatigue loaded tanks, the temperature should be limited to T < 150ºC;

c) maximum design liquid level not higher than the top of the cylindrical shell.

(2) This Part 4.2 is concerned only with the requirements for resistance and stability of steel tanks. Other design requirements are covered by EN 14015 for ambient temperature tanks and by EN 14620 for cryogenic tanks, and by EN 1090 for fabrication and erection considerations. These other requirements include foundations and settlement, fabrication, erection and testing, functional performance, and details like man-holes, flanges, and filling devices.

(3) Provisions concerning the special requirements of seismic design are provided in EN 1998-4 (Eurocode 8 Part 4 “Design of structures for earthquake resistance: Silos, tanks and pipelines”), which complements the provisions of Eurocode 3 specifically for this purpose.

(4) The design of a supporting structure for a tank is dealt with in EN 1993-1-1.

(5) The design of an aluminium roof structure on a steel tank is dealt with in EN 1999-1-5.

(6) Foundations in reinforced concrete for steel tanks are dealt with in EN 1992 and EN 1997.

(7) Numerical values of the specific actions on steel tanks to be taken into account in the design are given in EN 1991-4 "Actions on Silos and Tanks". Additional provisions for tank actions are given in annex A to this Part 4.2 of Eurocode 3.

(8) This Part 4.2 does not cover:

- floating roofs and floating covers;
- resistance to fire (refer to EN 1993-1-2).

(9) The circular planform tanks covered by this standard are restricted to axisymmetric structures, though they can be subject to unsymmetrical actions, and can be unsymmetrically supported.

1.2 Normative references

This European Standard incorporates, by dated and undated reference, provisions from other standards. 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 the European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1)] All pressures are in mbar gauge unless otherwise specified

EN 1090-2 *Execution of steel and aluminium structures – Technical requirements for steel structures*

EN 1990 *Eurocode: Basis of structural design;*

EN 1991 *Eurocode 1: Actions on structures;*

Part 1.1: *Actions on Structures - Densities, self weight and imposed loads for buildings;*

Part 1.2: *Actions on structures - Actions on structures exposed to fire;*

Part 1.3: *Actions on structures - Snow loads;*

Part 1.4: *Actions on structures - Wind loads;*

Part 4: *Actions on silos and tanks;*

EN 1992 *Eurocode 2 : Design of concrete structures ;*

EN 1993 *Eurocode 3: Design of steel structures;*

Part 1.1: *General rules and rules for buildings;*

Part 1.3: *General rules - Supplementary rules for cold formed members and sheeting;*

Part 1.4: *General rules – Supplementary rules for stainless steels;*

Part 1.6: *General rules - Supplementary rules for the strength and stability of shell structures;*

Part 1.7: *General rules - Supplementary rules for planar plated structures loaded transversely;*

Part 1.10: *Material toughness and through thickness properties;*

Part 4.1: *Silos;*

EN 1997 *Eurocode 7: Geotechnical design;*

EN 1998 *Eurocode 8: Design of structures for earthquake resistance;*

Part 4: *Silos, tanks and pipelines;*

EN 1999 *Eurocode 9: Design of aluminium structures;*

Part 1.5: *Shell structures;*

EN 10025 *Hot rolled products of non-alloy structural steels – technical delivery conditions*;

EN 10028 *Flat products made of steel for pressure purposes;*

EN 10088 *Stainless steels*

EN 10149 *Specification for hot-rolled flat products made of high yield strength steels for cold forming.*

Part 1: *General delivery conditions*

Part 2: *Delivery conditions for thermomechanically rolled steels*

Part 3: *Delivery conditions for normalized or normalized rolled steels*

EN 13084 *Freestanding industrial chimneys*

Part 7: *Product specification of cylindrical steel fabrications for use in single wall steel chimneys and steel liners*

EN 14015 *Specification for the design and manufacture of site built, vertical, cylindrical, flat bottomed, above ground, welded, metallic tanks for the storage of liquids at ambient temperatures*

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 –5°C and –165°C;*
ISO 1000	*SI Units;*
ISO 3898	*Bases for design of structures – Notation – General symbols;*
ISO 8930	*General principles on reliability for structures - List of equivalent terms.*

1.3 Assumptions

(1) In addition to the general assumptions of EN 1990 the following assumption applies:

- fabrication and erection complies with EN 1090, EN 14015 and 14620 as appropriate

1.4 Distinction between principles and application rules

(1) See 1.4 in EN 1990.

1.5 Terms and definitions

(1) The terms that are defined in 1.5 in EN 1990 for common use in the Structural Eurocodes and the definitions given in ISO 8930 apply to this Part 4.2 of EN 1993, unless otherwise stated, but for the purposes of this Part 4.2 the following supplementary definitions are given:

1.5.1 shell. A structure formed from a curved thin plate. This term also has a special meaning for tanks: see 1.7.2.

1.5.2 axisymmetric shell. A shell structure whose geometry is defined by rotation of a meridional line about a central axis.

1.5.3 box. A structure formed from an assembly of flat plates into a three-dimensional enclosed form. For the purposes of this standard, the box has dimensions that are generally comparable in all directions.

1.5.4 meridional direction. The tangent to the tank wall at any point in a plane that passes through the axis of the tank. It varies according to the structural element being considered.

1.5.5 circumferential direction. The horizontal tangent to the tank wall at any point. It varies around the tank, lies in the horizontal plane and is tangential to the tank wall irrespective of whether the tank is circular or rectangular in plan.

1.5.6 middle surface. This term is used to refer to both the stress-free middle surface when a shell is in pure bending and the middle plane of a flat plate that forms part of a box.

1.5.7 separation of stiffeners. The centre to centre distance between the longitudinal axes of two adjacent parallel stiffeners.

Supplementary to Part 1 of EN 1993 (and Part 4 of EN 1991), for the purposes of this Part 4.2, the following terminology applies: