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Title: Draft BS EN 14015 Specification for the design and manufacture of site built, vertical, cylindrical, flat-bottomed, above ground, welded, steel tanks for the storage of liquids at ambient temperature and above.

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- iii) requires additional national guidance or information

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

English Version

Specification for the design and manufacture of site built,
vertical, cylindrical, flat-bottomed, above ground, welded,
steel tanks for the storage of liquids at ambient
temperature and above

Spécification pour la conception et la fabrication de
réservoirs en acier, soudés, aériens, à fond plat,
cylindriques, verticaux, construits sur site destinés au
stockage des liquides à la température ambiante ou
supérieure

Auslegung und Herstellung standortgefertigter,
oberirdischer, stehender, zylindrischer, geschweißter
Flachboden-Stahltanks für die Lagerung von
Flüssigkeiten bei Umgebungstemperatur und höheren
Temperaturen

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.

This draft European Standard was established by CEN 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-CENELEC Management Centre has the same status as the official versions.

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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 foreword

This document (prEN 14015:2025) 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 14015:2004.

Introduction

This document reflects current practice within the oil, petrochemical, chemical, food and general bulk liquid storage industry in regard to materials, design, fabrication, erection and testing. It is used in many parts of the world outside the EU.

In Europe, stress and stability requirements of storage tanks are covered by Eurocode 3 Design of steel structures, which includes EN 1993-4-2. Design in accordance with Eurocodes is based on the Limit State Theory (LST). The LST calculation uses safety factors which are defined nationally (NDPs) and selected for each specific application.

The calculation given in EN 14015 is based on design using allowable stresses. It is considered necessary to retain this method in this revision of EN 14015 for aspects not covered by Eurocode 3

This document covers many design items such as selection of type of tank based on characteristics of the stored medium (in Annex B), internal and external floating roofs (respectively in Annex C and D), rim seals (in Annex E), double bottoms (in Annex H) and specific other tank features which are not covered in any other European Standard. EN 14015 also covers aluminium dome roof structures in Annex S.

Changes in this edition include the following:

- wind loading has been brought in line with EN 1991-1-4 including wind suction over dome roofs. However, as wind suction over cone roofs is not covered in EN 1991-1-4 the theory on wind suction over these types of fixed roofs has been added.
- reduction factors for tanks design for elevated temperatures have been introduced.
- the section on wind loads on tanks (overturning stability) has been updated and expanded.
- Annex B – Operational and safety requirements has been added.
- Annex C – Requirements for Internal floating roofs extensively revised and updated.
- Annex D – Requirements for floating roofs extensively revised and updated.
- Annex E – Requirements for rim seals to floating roofs extensively revised and updated.
- Annex F – Selection of steel plate to alternative specifications revised and updated to include stainless steel.
- Annex G – Recommendations for seismic provisions for storage tanks has been completely revised to bring it in line with EN 1998-4.
- Annex I – Recommendations for tank foundations has been extensively revised and updated.
- Annex K – Design rules for tanks with frangible roof to shell joints is no longer be used to cover emergency venting but only possible explosion relief.
- Annex L has been removed as all venting calculations are now to be done to ISO 28300.
- Annex S – Self-Supporting aluminium roofs for storage tanks has been added.
- Annex T – Finite Element Analysis (FEA); Requirements regarding the use of FEA to support a tank design submission has been added.
- Annex U – Design by analysis; methods based on stress categories has been added.
- Annex V – Environmental impact has been added.

Tanks designed and built to EN 14015 do not require CE marking to EN 1090 or to the Pressure Equipment Directive. In addition the structures that are mounted on the tank and are fully supported by the tank structure are not to be CE marked to EN 1090. This includes the roof support structure, roof and shell platforms, inter tank walkways, access stairs and ladders.

1 Scope

This document specifies the requirements for the materials, design, fabrication, erection, testing and inspection of site built, vertical, cylindrical, flat bottomed, above ground, welded, steel tanks for the storage of liquids at ambient temperatures and above.

It is concerned with the structural design of the basic tank structure and does not provide requirements for considering process design, operational issues, safety and firefighting facilities, in-service inspection, maintenance, or repair.

This document is intended for use in conjunction with EN 1993-4-2 and so adheres the general principles and performance requirements for the structural design and serviceability limit states of those tank components. Specific requirements are addressed in EN 14015.

It is applicable to:

- closed-top tanks, with and without internal floating roofs;
- open-top tanks, with and without floating roofs;
- tanks for which:
 - a) the design pressure is not greater than 60 mbar;
 - b) the design internal negative pressure is not lower than 6,0 mbar;
 - c) the design metal temperature is between $-40\text{ }^{\circ}\text{C}$ and $+300\text{ }^{\circ}\text{C}$;
 - d) the maximum design liquid level is not higher than the top of the cylindrical shell;
 - e) the maximum allowable stress does not exceed 260 N/mm^2 .

The limits of application of this document terminate at the following locations:

- face of the first flange in a bolted flange connection;
- first threaded joint on the pipe or coupling outside of the tank shell, roof or bottom;
- first circumferential joint in a pipe not having a flange connection.

This document does not apply to tanks where the product is refrigerated to maintain it as a liquid at atmospheric pressure.

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 485 (all parts), *Aluminium and aluminium alloys — Sheet, strip and plate*

EN 754 (all parts), *Aluminium and aluminium alloys — Cold drawn rod/bar and tube*

EN 755 (all parts), *Aluminium and aluminium alloys — Extruded rod/bar, tube and profiles*

EN 1092-1, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 1: Steel flanges*

EN 1011-4, *Welding — Recommendations for welding of metallic materials — Part 4: Arc welding of aluminium and aluminium alloys*

EN 1593, *Non-destructive testing — Leak testing — Bubble emission techniques*

EN 1759-1, *Flanges and their joint — Circular flanges for pipes, valves, fittings and accessories, Class designated — Part 1: Steel flanges, NPS 1/2 to 24*

EN 1991-1-1:2002, *Eurocode 1: Actions on structures — Part 1-1: General actions — Densities, self-weight, imposed loads for buildings*

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

EN 1993-1-1, *Eurocode 3 Design of steel structures — Part 1-1: General rules and rules for buildings*

EN 1993-1-6:2007, *Eurocode 3 — Design of steel structures — Part 1-6: Strength and Stability of Shell Structures*

EN 1993-4-2, *Eurocode 3 — Design of steel structures — Part 4-2: Tanks*

EN 1999-1-1, *Eurocode 9 Design of aluminium structures — Part 1-1: General structural rules*

EN 1999-1-5, *Eurocode 9 — Design of aluminium structures — Part 1-5: Shell structures*

EN 10025 (all parts), *Hot rolled products of structural steel*

EN 10028-2, *Flat products made of steels for pressure purposes — Part 2: Non-alloy and alloy steels with specified elevated temperature properties*

EN 10028-3, *Flat products made of steels for pressure purposes — Part 3: Weldable fine grain steels, normalized*

EN 10029:2010, *Hot rolled steel plates 3 mm thick or above — Tolerances on dimensions and shape*

EN 10088-1 *Stainless steels — Part 1: List of stainless steels*

EN 10088-2 *Stainless steels — Part 2: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes*

EN 10088-3:2014, *Stainless steels — Part 3: Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes*

EN 10164, *Steel products with improved deformation properties perpendicular to the surface of the product — Technical delivery conditions*

EN 10204:2004, *Metallic products — Types of inspection documents*

EN 10216 (all parts), *Seamless steel tubes for pressure purposes — Technical delivery conditions*

EN 10217 (all parts), *Welded steel tubes for pressure purposes — Technical delivery conditions*

EN 10222 (all parts), *Steel forgings for pressure purposes*

EN 10250 (all parts), *Open steel die forgings for general engineering purposes*

EN 13445-3, *Unfired pressure vessels - Part 3: Design*

EN 13479, *Welding consumables — General product standard for filler metals and fluxes for fusion welding of metallic materials*

EN 13480 (all parts), *Metallic industrial piping*

EN ISO 148-1 *Metallic materials — Charpy pendulum impact test — Part 1: Test method (ISO 148-1:2016)*

EN ISO 898, *Mechanical properties of fasteners made of carbon steel and alloy steel (ISO 898)*

EN ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test methods (ISO 1461)*

EN ISO 2560, *Welding consumables — Covered electrodes for manual metal arc welding of non-alloy and fine grain steels — Classification (ISO 2560)*

EN ISO 3452-1 *Non-destructive testing — Penetrant testing - Part 1: General principles (ISO 3452-1)*

EN ISO 3581, *Welding consumables — Covered electrodes for manual metal arc welding of stainless and heat-resisting steels — Classification (ISO 3581)*

EN ISO 5579, *Non-destructive testing — Radiographic testing of metallic materials using film and X- or gamma rays - Basic rules (ISO 5579)*

EN ISO 6520-1, *Welding and allied processes — Classification of geometric imperfections in metallic materials — Part 1: Fusion welding (ISO 6520-1)*

EN ISO 9606-1, *Qualification testing of welders — Fusion welding — Part 1: Steels (ISO 9606-1)*

EN ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel (ISO 9712)*

EN ISO 14122 (all parts), *Safety of machinery — Permanent means of access to machinery — (ISO 14122 (all parts))*

EN ISO 14732, *Welding personnel — Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials (ISO 14732)*

EN ISO 15607:2003, *Specification and qualification of welding procedures for metallic materials — General rules (ISO 15607)*

EN ISO 15609-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding (ISO 15609-1)*

EN ISO 15614-1:2017, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1:2017)*

EN ISO 16828, *Non-destructive testing — Ultrasonic testing — Time-of-flight diffraction technique as a method for detection and sizing of discontinuities (ISO 16828)*

EN ISO/IEC 17020, *Conformity assessment — Requirements for the operation of various types of bodies performing inspection (ISO/IEC 17020)*

EN ISO 17636-1, *Non-destructive testing of welds — Radiographic testing — Part 1: X- and gamma-ray techniques with film (ISO 17636-1)*

EN ISO 17636-2, *Non-destructive testing of welds — Radiographic testing — Part 2: X- and gamma-ray techniques with digital detectors (ISO 17636-2)*

EN ISO 17637, *Non-destructive testing of welds — Visual testing of fusion-welded joints (ISO 17637)*

EN ISO 17638, *Non-destructive testing of welds — Magnetic particle testing (ISO 17638)*

EN ISO 17640, *Non-destructive testing of welds — Ultrasonic testing — Techniques, testing levels, and assessment (ISO 17640)*

EN ISO 19232-1, *Non-destructive testing - Image quality of radiographs — Part 1: Determination of the image quality value using wire-type image quality indicators (ISO 19232-1)*

EN ISO 19232-2, *Non-destructive testing - Image quality of radiographs — Part 2: Determination of the image quality value using step/hole-type image quality indicators (ISO 19232-2)*

3 Terms, definitions, symbols and abbreviations

3.1 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 <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1.1

design pressure

maximum permissible pressure in the space above the stored liquid

3.1.2

design internal negative pressure

maximum permissible negative pressure in the space above the stored liquid

3.1.3

set pressure

pressure at which the pressure relief device first opens

3.1.4

set vacuum

internal negative pressure at which a vacuum valve first opens

3.1.5

test pressure

pressure in the space above the test liquid during testing

3.1.6

maximum design metal temperature

temperature used for determining the maximum allowable stress for the material

3.1.7

minimum design metal temperature

temperature used for determining the material toughness requirements

3.1.8

LODMAT

lowest one day mean ambient temperature temperature based over any 24 hour period

3.1.9

purchaser

company or its agent which prepares and agrees a proposal with a contractor for the design, construction and testing of a storage tank

3.1.10

designer

person or organization carrying out the engineering design of the tank

3.1.11

contractor

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

3.1.12

manufacturer

organization carrying out the shop fabrication

3.1.13

erector

organization carrying out the construction on site

3.1.14

inspector

person or organization carrying out the inspection of the tank

3.1.15

independent NDE-unit or organization

NDE-unit or organization that has A-type B-type status

Note 1 to entry: A-type and B-type organizations are defined in EN ISO/IEC 17020.

3.1.16

supplier

company manufacturing and supplying sub-assemblies

3.1.17

static electricity

build-up of an electrical difference of potential or charge, through friction of dissimilar materials or substances e.g. product flow through a pipe

3.1.18

floating roof

metallic structure which floats on the surface of a liquid inside an open top tank shell, and in complete contact with this surface

3.1.19

internal floating roof

structure which floats on the surface of a liquid inside a fixed roof tank, primarily to reduce vapour loss

3.1.20

non-contact floating roof

roof which is supported by buoyancy chambers or pontoons on the liquid surface causing the floating roof to be raised above the liquid surface, thus creating a void between the underside of the floating roof and the liquid surface

3.1.21

full-contact floating roof

roof which floats in direct contact with the liquid with no space between the underside of the roof and the liquid surface

3.1.22

peripheral (rim) seal

seal mounted around the periphery of the floating roof which contacts the tank shell and seals the annular gap

3.1.23

floating suction device

mechanical device, sometimes articulated, installed in some tanks, which floats on the liquid surface and only permits product to be withdrawn from this point

Note 1 to entry: Commonly adopted for aviation fuel storage tanks.

3.1.24

bleeder vent

device incorporated in a floating roof to permit release of gas from under the floating roof during tank filling, and to allow air to pass back through the floating roof when draining product when the floating roof is stationary on its support legs

3.1.25

buoyancy

ability of a structure to float on liquid

3.1.26

inlet diffuser

component intended to join and extend the inlet pipe within the tank and disperses the incoming product

3.1.27**accumulation**

differential pressure between the set pressure of the valve and the tank pressure at which the required flow rate is reached or the set vacuum of the valve and the tank internal negative pressure at which the required flow rate is reached

3.1.28**emergency venting**

outbreathing in case of fire, or inbreathing and outbreathing in case of malfunction of tank equipment

3.1.29**empty tank**

tank with no liquid level

3.1.30**gross storage capacity**

for a fixed roof tank, the total capacity when the tank is filled to the level of the horizontal section of the top curb angle

for external and internal floating roof tank, the total capacity when the tank is filled to such an extent where the secondary rim seal is still 50 mm below the top curb angle when the floating roof is leaning as close as possible against the tank shell

3.2 Symbols

For the purpose of this document, the symbols given in Table 1 apply:

Table 1 — Symbols

Symbol	Description	Unit
C	Corrosion allowance	mm
C_{en}	carbon equivalent value from the ladle analysis for both traditional steels and low-carbon, low-alloy steels	
C_{ev}	carbon equivalent value from the ladle analysis for carbon and carbon-manganese steels	
D	Diameter of tank	m
d	Diameter of hole	mm
d_h	Diameter of hole in roof	mm
d_i	Diameter (inside) of nozzle	mm
d_n	Diameter (outside) of nozzle	mm
d_o	Diameter (outside) of manhole insert	mm
d_r	Diameter (outside) of reinforcement	mm
e	Nominal thickness of plate	mm

Symbol	Description	Unit
e_a	Thickness of annular plate	mm
e_b	Thickness of bottom plate	mm
$e_{b;asbuilt}$	nominal thickness of bottom plates increased by the corrosion allowance specified by the Purchaser	mm
e_{br}	Thickness of bottom reinforcing plate (flush type clean out door)	mm
e_c	Calculated minimum thickness of plate including corrosion allowance	mm
e_d	thickness of the floating roof deck plate through which the landing leg protrude in corroded conditions	mm
e_f	Thickness of flange	mm
e_i	Thickness of insert plate	mm
e_n	Thickness of nozzle	mm
e_p	Thickness of roof plate	mm
e_r	Thickness of reinforcement plate	mm
e_s	Thickness of any shell plate	mm
$e_{shell\ as\ built}$	as built thickness of shell plates	mm
e_t	Thickness of shell plate for test conditions	mm
e_1	Thickness of first shell course	mm
e_1	thickness of the landing leg in corroded condition	
F	Overstress factor	—
H	Design liquid height	m
H_c	Height from the bottom of the course under consideration to design liquid level	m
h_n	Height of nozzle	mm
J	Joint efficiency factor	
L_r	Effective roof length	mm
L_s	Effective shell length	mm
l_a	Width of the annular plate between the edge of the bottom plate and the inner surface of the shell	mm
l_d	Distance from the outer surface of the shell to the outer edge of the bottom plate or annular plate	mm
l_w	Lap of the bottom plates over the annular plate	mm
P	Design pressure	mbar

Symbol	Description	Unit
P_{cm}	carbon equivalent value from the ladle analysis for modern low-carbon, low alloy steels	
p_i	Internal pressure minus pressure exerted by roof	mbar
p_t	Test pressure	mbar
p_v	Design internal negative pressure	mbar
r	Radius of tank	m
$R_{0,2}$	0,2 % proof strength	N/mm ²
R_1	Radius of curvature of roof	m
r_i	Inside radius of nozzle	mm
r_m	Mean radius for nozzle	mm
r_o	Outside radius of nozzle	mm
S	Allowable design stress	N/mm ²
S_c	Allowable compressive stress	N/mm ²
S_t	Allowable test stress	N/mm ²
T	Total thickness tolerance	mm
T_{DM}	Design metal temperature	°C
V	Design wind speed	m/s
W	Density of contained liquid	kg/l
W_t	Density of test medium	kg/l
Z	Section modulus	cm ³

3.3 Abbreviations

For the purpose of this document, the following abbreviations in Table 2 apply:

Table 2 — Abbreviations

Abbreviations	Description
HAZ	Heat affected zone
LODMAT	Lowest one day mean ambient temperature
NDE	Non-destructive examination
NDT	Non-destructive test(ing)
pcd	Pitch circle diameter
PWHT	Post-weld heat treatment

4 Information and requirements to be specified

4.1 Information to be specified by the purchaser

The information to be specified by the purchaser, in accordance with A.1, shall be fully documented.
For this reason also a data sheet, covering the minimum design requirements should be documented.
A sample of a tank data sheet is shown in A.14.

4.2 Information to be agreed between the purchaser and the tank manufacturer

The information to be agreed between the purchaser and the tank manufacturer, in accordance with A.2, shall be fully documented.

4.3 Information to be supplied by the tank manufacturer

The information to be supplied by the tank manufacturer, in accordance with A.3, shall be fully documented.

4.4 Information to be supplied by the steel manufacturer

The information to be supplied by the steel manufacturer, in accordance with A.4, shall be fully documented.

4.5 Information to be agreed between the steel manufacturer and the tank manufacturer

The information to be agreed between the steel manufacturer and the tank manufacturer, in accordance with A.5, shall be fully documented.

4.6 Information to be agreed between the purchaser and the internal floating roof supplier

The information to be agreed between the purchaser and the internal floating roofs supplier, in accordance with A.6, shall be fully documented.

4.7 Information to be agreed between the tank manufacturer and the internal floating roof supplier

The information to be agreed between the tank manufacturer and the internal floating roof supplier, in accordance with A.7, shall be fully documented.

4.8 Information to be supplied by the internal floating roof supplier

The information to be supplied by the internal floating roof supplier, in accordance with A.8, shall be fully documented.

4.9 Information to be agreed between the purchaser and the supplier of the aluminium dome roof covering an open top steel tank

The information to be agreed between the purchaser and the supplier of the aluminium dome, in accordance with A.9 and EN 1999-1-5 (if needed), shall be fully documented.

4.10 Information to be agreed between the tank manufacturer and the supplier of the aluminium dome roof

The information to be agreed between the tank manufacturer and the supplier of the aluminium dome, in accordance with A.10, shall be fully documented.

4.11 Information to be supplied by the supplier of the aluminium dome roof

The information to be supplied by the supplier of the aluminium dome, in accordance with A.11, shall be fully documented.

5 Requirements

5.1 Design pressure

The design pressure and the design internal negative pressure shall be within the limits specified in Table 3, for the particular tank designation specified in 5.1 and A.1.

The set pressure of the relief device plus the accumulation to permit the required throughput to be achieved shall not exceed the design pressure as stated in Table 3.

The set vacuum of the relief device plus the accumulation to permit the required throughput to be achieved shall not exceed the design internal negative pressure.

Table 3 — Design pressure limits for tanks

Tank designation	Design pressure P mbar (g)	Design internal negative pressure p_v mbar (g)
Open top tanks or floating roof tanks	0	see D.3.5
Closed top tanks		
i) non-pressure tanks	$\leq 10^a$	$\leq 2,5^{b1}$
ii) low-pressure tanks	$\leq 25^a$	$\leq 6,0^{b2}$
iii) high-pressure tanks	$\leq 60^a$	$\leq 6,0^{b2}$
iv) self-supporting aluminium dome roofs on top of external floating roof tanks or fixed roofs equipped with peripheral vent openings in accordance with C.3.1.5.2.2 on top of internal floating roof tanks	c	d
^a The design pressures specified are those that give rise to load conditions stated in 7.2. and will be used in the calculation of shell thickness as in 9.2, shell stability as in 9.3, roof thickness as in 10.4), roof compression area as in 10.5, selection and sizing of vents as in 14, tank anchorage as in Clause 12, and selection of type of roof and its detailed design. ^b The vacuum to be used for the design of ring stiffeners on the tank shell shall take into account an additional safety margin of 2,5 mbar (g), i.e.: 1) 5 mbar (g) for non-pressure; 2) 8.5 mbar (g) for low and high pressure fixed roof tanks equipped with fixed roofs.		

^c in case these roofs are equipped with peripheral vent opening: use 0 mbar (g) for the internal pressure, otherwise use value mentioned for closed top non-pressure tanks

^d in case these roofs are equipped with peripheral vent opening: use 0 mbar (g) for the internal negative pressure, otherwise use values mentioned for closed top non-pressure tanks

5.2 Design metal temperature

5.2.1 Maximum design metal temperature

The maximum design metal temperature shall not exceed 300 °C.

5.2.2 Minimum design metal temperature

The minimum design metal temperature shall be the minimum temperature of the contents or the temperature given in Table 4, whichever is the lower. If the ambient temperature is lower than -40 °C, the minimum LODMAT shall be -40 °C.

The lowest one day mean ambient temperature LODMAT should be taken as the lowest recorded temperature averaged over any 24 hour period. Where insufficient complete records are available, this average temperature can be taken as the mean of the maximum and minimum temperatures. For more information see EN 1991-1-5.

Table 4 — Minimum design metal temperature based on LODMAT

Lowest one day mean ambient temperature (LODMAT)	Minimum design metal temperature	
	10 years data	30 years data
T_1 °C	°C	°C
≥ -10	+ 5	+ 10
≥ -25 < -10		+ 5
≤ -25 (see 5.2.2)	- 5	
For minimum design metal temperatures below 0 °C, the beneficial effect of insulation or heating shall be agreed but the design metal temperature should not be warmer than 0 °C. For more information see EN 1991-1-5.		

The minimum design metal temperature for the tank shall not take into account the beneficial effect of heating or insulation for design metal temperatures warmer than or equal to 0 °C.

5.3 Design density

The design density shall be the maximum specified density of the contents.

Where flexibility of operation in a tank or within a group of tanks is required, the design density should be the maximum envisaged density of the products.

5.4 Yield strength

The yield strength of the material shall be the minimum specified value of:

- room temperature minimum specified yield strength for carbon and carbon manganese steels;

- elevated temperature ($> 100\text{ }^{\circ}\text{C}$) yield strength for carbon and carbon manganese steels;
- room temperature 0,2 % proof strength for stainless steels;
- elevated temperature ($> 50\text{ }^{\circ}\text{C}$) 0,2 % proof strength for stainless steels.

5.5 Material compatibility between stored product and tank

The material compatibility between stored product and tank shall be proved. For the material compatibility between stored product and tank EN 12285-1 can be considered.

6 Materials

6.1 Carbon and carbon manganese steels

6.1.1 Plate materials

6.1.1.1 All carbon and carbon manganese steel plate used in the manufacture of tanks conforming to this document shall be in accordance with the minimum requirements of Tables 5 to 7 in conjunction with Table 9 and Figure 1, unless otherwise agreed (see A.2). When a steel grade other than those given in Tables 5 to 8 is to be used, it shall satisfy the requirements of Annex F.

Regarding the material specifications in table 5 to 8 the following additional requirements shall apply.

[A] Steelmaking process to be reported.

[B] CEV from ladle analysis $\leq 0,42$ for plates thicker than 20 mm.

[C] Inspection documentation shall be in accordance with EN 10204, Inspection certificate 3.1 except for nominal thickness plates where documentation may be in accordance with EN 10204, Test report 2.2 as a minimum.

[D] For flat products thicker than 20 mm out of each parent plate or coil the impact properties shall be verified.

[E] Cr, Cu, Mo, Nb, Ni, Ti and V to be recorded.

Table 5 — Hot rolled products $\leq 275\text{ N/mm}^2$ yield strength

Standard	Designation	Additional requirements	Steel type as given in Figure 1	Maximum thickness ^{a,b} mm
EN 10025-2	S235 JR	A, C	Type I	12
	S235 J0	A, B, C	Type II	30
	S235 J2	A, B, C	Type III	40
	S275 JR	A, C	Type I	12
	S275 J0	A, B, C	Type II	30
	S275 J2	A, B, C	Type III	40
EN 10025-3	S275 N	A, B, D	Type IV	40
	S275 NL	A, B, D	Type IV	40
EN 10025-4	S275 M	A, B, D	Type IV	40
	S275 ML	A, B, D	Type IV	40

- ^a The maximum thickness shall be the lower of that specified in this table and that derived from Figure 1.
- ^b The maximum thickness does apply only to shell plates (not insert plates); see also 9.1.6.

Table 6 — Hot rolled products > 275 N/mm² and ≤ 355 N/mm² yield strength

Standard	Designation	Additional requirements	Steel type as given in Figure 1	Maximum thickness ^{a,b} mm
EN10025-2	S355 JR	A, C, E	Type V	10
	S355 JO	A, C, E	Type VI	15
	S355 J2	A, B, C, D, E	Type VII	40
	S355 K2	A, B, C, D, E	Type VIII	40
EN 10025-3	S355 N	A, B, D	Type VIII	40
	S355 NL	A, B, D	Type IX	40
EN 10025-4	S355 M	A, B, D	Type VIII	40
	S355 ML	A, B, D	Type IX	40

^a The maximum thickness shall be the lower of that specified in this table and that derived from Figure 1.

^b The maximum thickness does apply only to shell plates (not insert plates); see also 9.1.6.

Table 7 — Hot rolled products > 355 N/mm² yield strength

Standard	Designation	Additional requirements	Steel type as given in Figure 1	Maximum thickness ^{a,b} mm
EN 10025-3	S420 N	A, B, D	Type X	40
	S420 NL	A, B, D	Type XI	40
EN 10025-4	S420 M	A, B, D	Type X	40
	S420 ML	A, B, D	Type XI	40

^a The maximum thickness shall be the lower of that specified in this table and that derived from Figure 1.

^b The allowed maximum thicknesses only apply to shell plates (not insert plates); see also 9.1.6.

Table 8 — Hot rolled products for use at elevated temperatures (< 100 °C)

Standard	Designation	Additional requirements	Steel type as given in Figure 1	Maximum thickness ^{a,b} mm
EN 10028-2	P235 GH	A, B	Type II A	30
	P265 GH	A, B	Type II A	30
	P295 GH	A, B	Type VI A	40
	P355 GH	A, B	Type VI A	40

EN 10028-3	P275 NH	A, B	Type IV	40
	P275 NL2	A, B	Type IV	40
	P355 NH	A, B	Type VIII	40
	P355 NL2	A, B	Type IX	40
^a The maximum thickness shall be the lower of that specified in this table and that derived from Figure 1. ^b The maximum thickness does apply only to shell plates (not insert plates); see also 9.1.6.				

Table 9 — Charpy V-notch impact energy for steel types

Steel type	Charpy V-notch impact energy
I	27 J at +20 °C
II	27 J at 0 °C
II A	27 J at -10 °C
III	27 J at -20 °C
IV	27 J at -30 °C
V	40 J at +30 °C ^a
VI	40 J at +10 °C ^b
VI A	40 J at 0 °C
VII	40 J at -10 °C ^c
VIII	40 J at -20 °C
IX	40 J at -30 °C
X	55 J at +20 °C
XI	55 J at 0 °C
NOTE 1 The impact energy requirements are longitudinal values of: 27 J for grade 235 and 275 steels 40 J for grade 355 steel 55 J for higher than grade 355 steel NOTE 2 There is no need under the atmospheric conditions in Europe to use steels with better toughness than line 6, of Figure 1.	
^a extrapolation from 27 J at +20 °C ^b extrapolation from 27 J at 0 °C ^c extrapolation from 27 J at -20 °C	

6.1.1.2 For Tables 5 to 9, above, the limited thickness of 40 mm of Types IV, VI A, VIII and IX materials can be increased to maximum of 45 mm for storing non-hydrocarbon and non-toxic materials, subject to agreements to be established between Purchaser and Contractor (see Annex A).

As a minimum the following additional requirements should be detailed:

- The reduction of the minimum specified yield strength or 0,2 % proof strength for plate thicknesses exceeding 40 mm shall be taken into account in conformity with the applicable material specifications, or as stipulated in EN 10025 and EN 10028;
- Additional NDT-tests to be agreed (see also 19.4.4), see Annex A;
- Additional number of test plates to be agreed (see Clause 17), see Annex A;
- Additional requirements to be specified in pWPS, WPS and WPQR (see Clause 17 and Annex A).

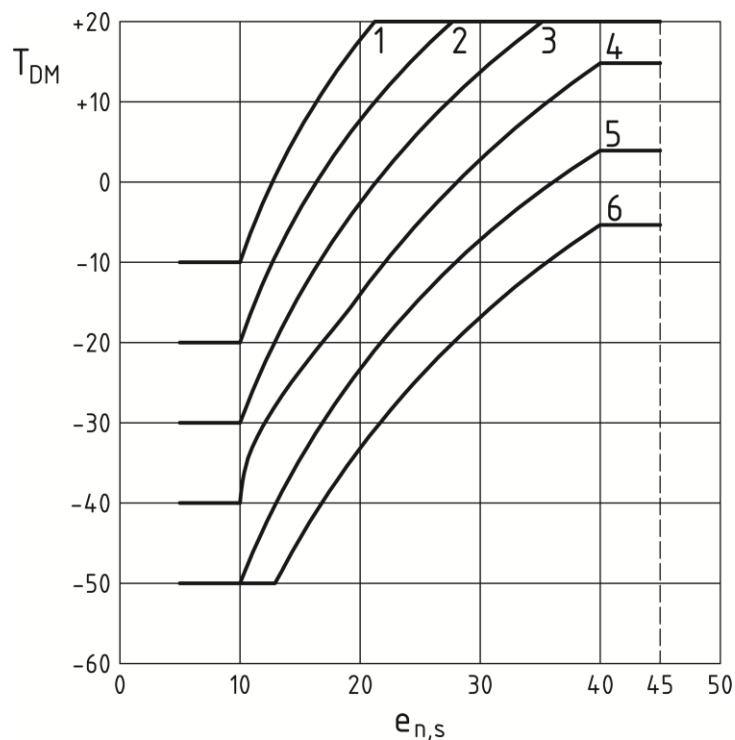
6.1.1.3 For design metal temperatures in excess of 100 °C, steel with elevated temperature yield strength values or 0.2% proof strength values can either be selected from Table 8, or the procedures as detailed in clause 9.4 shall be followed. See also 9.1.2, 9.3.3.7 and 9.3.3.9.

Other steel grades for which elevated temperature yield strength values are not specified in the material standard may also be used, provided:

- a) the actual value of each cast of the material delivered shall be certified by the steel manufacturer (see A.4) in accordance with EN 10025, or
- b) subject to approval by the appropriate authority, tensile tests at the elevated temperature of each cast are executed by an independent laboratory, providing the traceability is documented.

The test results shall be reported in an inspection document in accordance with EN 10204:2004, certificate 3.1.

6.1.1.4 When the maximum design metal temperature exceeds 250 °C, steels which are proven to be unaffected by ageing shall be used. The method of proof shall be subject to agreement (see A.5).



Key

T_{DM}	minimum design metal temperature	$e_{n,s}$	minimal thickness
1	steel types I, V and X (impact test at +20 °C)	4	steel types IIA and VII (impact test at -10 °C)
2	steel types VI (impact test at +10 °C)	5	steel types III and VIII (impact test at -20 °C)
3	steel types II, VIA and XI (impact test at 0 °C)	6	steel types IV and IX (impact test at -30 °C)

Figure 1 — Minimum design metal temperature at which each type of steel can be used

Figure 1 applies only to shell plates. For insert plates see 6.1.7.2.

6.1.2 Structural steel sections

6.1.2.1 All carbon and carbon manganese structural steel sections used in the manufacture of tanks conforming to this document shall be in accordance with Tables 5 to 7 or Table 10.

Table 10 — Structural steel products

Standard	Designation	Steel type
EN 10210-1 and EN 10210-2	S235 JRH	Type I
	S275 JOH	Type II
	S275 J2H	Type III
	S275 NH	Type IV
	S275 NLH	Type IV
	S355 JOH	Type VI
	S355 J2H	Type VII
	S355 NH	Type VIII
	S355 NLH	Type IX

6.1.2.2 Structural steel shall have inspection documentation in accordance with EN 10204:2004, Test report 2.2, except for steels S275 NH/NLH and S355 NH/NLH which shall have Inspection certificate 3.1.

6.1.2.3 Pads, gussets etc. shall be from steel in accordance with 6.1.1.

6.1.3 Forgings

6.1.3.1 Forgings shall be manufactured from steel products by open die forging or ring rolling in accordance with EN 10250 and EN 10222.

6.1.3.2 The mechanical properties of forgings shall also be in accordance with 6.1.6 and 6.1.7.

6.1.3.3 Flanges provided for shell nozzles shall be marked in accordance with the appropriate European Standard for flanges. Marking shall include the following information:

- manufacturer's name or mark;
- size and pressure rating;
- steel grade;
- identification number; and
- stamp of the manufacturer's inspector.

6.1.3.4 Inspection documentation in accordance with EN 10204:2004, certificate 3.1 shall be supplied with flanges used in nozzles attached to materials requiring inspection documentation in accordance with EN 10204:2004, certificate 3.1. This shall include the name of the producer of the initial material and the mechanical properties of the finished forging.

Inspection documentation in accordance with EN 10204:2004, Test report 2.2 shall be supplied with other flanges.

Flanges for roof nozzles, manholes and clean-out doors can be cut from plates. The quality of the cut flange should be guaranteed by the manufacturer of the flange, either by using plate with specified

transverse properties in accordance with Z15 of EN 10164, or by ultrasonic inspection to ensure the absence of laminations.

6.1.4 Pipes

6.1.4.1 Pipes used for nozzle bodies shall be either seamless tubes or longitudinal welded tubes in accordance with the appropriate parts of EN 10216 or EN 10217.

6.1.4.2 The mechanical properties of pipes shall also be in accordance with 6.1.6 and 6.1.7.

6.1.4.3 Pipes provided for piping connected to the shell shall be marked in accordance with the appropriate parts of EN 10216 or EN 10217.

6.1.4.4 Inspection documentation in accordance with EN 10204:2004, certificate 3.1 shall be supplied with pipes used in nozzles attached to materials requiring inspection documentation in accordance with EN 10204:2004, certificate 3.1. This shall include the name of the producer of the initial material and mechanical properties of the finished piping.

6.1.4.5 Inspection documentation in accordance with EN 10204:2004, Test report 2.2 shall be supplied with other piping.

6.1.4.6 Pipes provided for the manufacture of heating coils shall be in accordance with an appropriate European material standard and, if necessary, should conform to EN 13480.

6.1.5 Welding consumables

Welding consumables shall be in accordance with EN 13479, and, shall be used in the approval procedures in accordance with Clause 17. Inspection documentation in accordance with 20.1 shall be supplied.

The approval procedure test shall demonstrate that the yield strength and tensile strength of the welded joint exceeds the strength of the base materials being joined.

The welded joint shall also be chemically compatible with the materials being joined and the stored product.

6.1.6 Charpy V-notch impact energy requirements of carbon and carbon manganese steels

6.1.6.1 General

When specified in the relevant clause of this document, Charpy V-notch impact energy testing shall be carried out in accordance with EN ISO 148-1. The impact energy value shall be in accordance with the requirements of the relevant material specification or weld metals in accordance with 6.1.6.3.

The specified Charpy V-notch impact test values for plates, forgings, pipe and weld metal are determined from three specimens, the value taken shall be the average of the three results. The individual value of only one specimen shall be not less than 70 % of the specified minimum average value. When the material is less than 10 mm thick, 10 mm × 5 mm specimens shall be used and they shall demonstrate 50 % of the values specified for full size specimens.

6.1.6.2 Plates

The required impact test temperatures and levels of impact energy for the shell plates, bottom annular plates, plates of membrane roofs and roof compression areas shall conform to the requirements of the material specifications specified in 6.1.1. For shell plates and bottom annular plates purchased to an

alternative specification, then the impact test temperature and levels of impact energy shall conform to the requirements of Annex F.

Impact testing shall not be required for bottom plates other than annular plates.

Impact testing of bottom annular plates shall not be required when the shell plates attached to them are not required to be impact tested.

Impact testing shall not be required for shell plates, or materials attached to shell plates, less than 6 mm thick, nor when the minimum design metal temperature and the thickness are within the limits given in Table 11.

Table 11 — Conditions for waiving impact testing

Minimum design metal temperature °C	Thickness mm
$\geq +10$	≤ 20
$0 \geq +10$	≤ 13
$-10 \geq 0$	≤ 10
< -10	≤ 6

6.1.6.3 Weld metals

6.1.6.3.1 Weld metals for carbon and carbon manganese steels shall be impact tested when the materials they are joining are required to be impact tested at 0 °C or lower. Impact testing of weld metals shall not be required where plate materials are exempt from impact testing in accordance with 6.1.6.2. When impact testing is required, weld metal specimens shall be removed from the welding procedure test plates required by Clause 17 and shall meet the requirements of 6.1.6.3.2.

6.1.6.3.2 Shell welds shall be impact tested at the test temperature required for the plate material and shall show not less than the value required for the thicker plate material. When connections are made between materials of different thicknesses or different grades, then the impact requirements for the weld metal shall be the more stringent of the two.

6.1.7 Mountings

6.1.7.1 Unless otherwise agreed (see A.2), reinforcing plates, insert plates, nozzle bodies and flanges shall be of the same general type of material as the shell plates to which they are welded. They shall also conform to the impact energy requirements of 6.1.6. The nominal thickness, e , for use in Figure 1 shall be taken as the nominal thickness of the component except for the following:

a) Weld-neck flanges

The nominal thickness shall be taken as the thickness at the weld or 25 % of the flange thickness, whichever is greater.

b) Hubbed or plain slip-on flanges

The nominal thickness shall be taken as the nominal thickness of the branch, e_n , to which the flange is welded or 25 % of the flange thickness, whichever is greater.

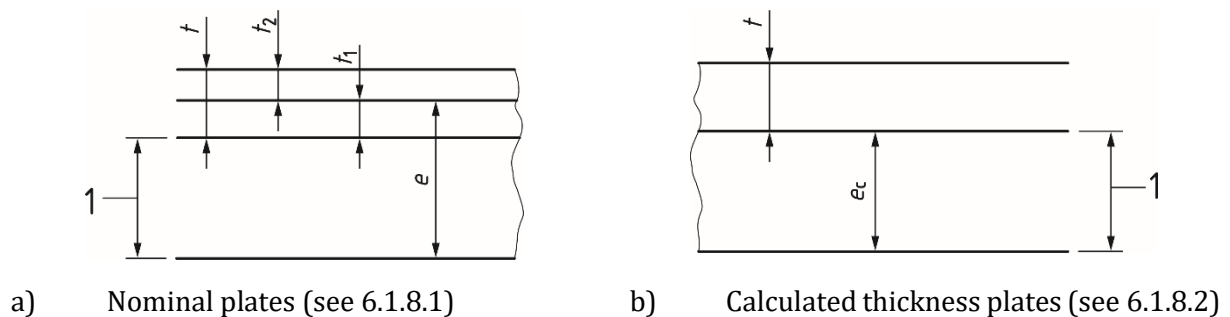
6.1.7.2 Insert plates of ferritic steel which exceed 40 mm thickness shall show Charpy V-notch impact energy values ≥ 27 J at -50 °C, irrespective of the design metal temperature.

6.1.7.3 Permanent attachment materials shall show the same Charpy V-notch impact energy values as the shell plates to which they are welded.

6.1.8 Thickness tolerances

6.1.8.1 The measured thickness at any point more than 25 mm from the edge of any nominal thickness of bottom, shell, roof or annular plate (e) shall be not less than the specified thickness less half the total thickness tolerance specified in EN 10029:2010, Table 1: class D (see Figure 2 a)).

6.1.8.2 The measured thickness at any point more than 25 mm from the edge of shell plates and roof plates whose thickness has been calculated shall not be less than the calculated minimum thickness (e_c), e.g. EN 10029:2010, Table 1: class C, i.e. only positive tolerances are permitted (see Figure 2 b)).



Key

- e nominal thickness (bottom, annular, shell or roof plates)
- e_c calculated minimum thickness of plate including any corrosion allowance
- t total thickness tolerance
- t_1 minus $\frac{1}{2}$ total thickness tolerance
- t_2 plus $\frac{1}{2}$ total thickness tolerance
- 1 minimum allowed thickness

Figure 2 — Plate thickness tolerances

6.2 Stainless steels

6.2.1 Selection of materials

All stainless steel plates and drawn products used in the manufacture of tanks conforming to this standard shall be in accordance with table 12.

Table 12 — Stainless steels for tank fabrication

Steel grade	
Steel name	Steel number
Austenitic	
X2CrNi18-9	1.4307
X2CrNi19-11	1.4306
X2CrNiN18-10	1.4311
X5CrNi18-10	1.4301
X6CrNiTi18-10	1.4541
X6CrNiNb18-10	1.4550
X1CrNi25-21	1.4335
X2CrNiMo17-12-2	1.4404
X2CrNiMoN17-11-2	1.4406
X2CrNiMoN20-8-1	1.4420
X5CrNiMo17-12-2	1.4401
X1CrNiMoN25-22-2	1.4466
X6CrNiMoTi17-12-2	1.4571
X6CrNiMoNb17-12-2	1.4580
X2CrNiMo17-12-3	1.4432
X2CrNiMoN17-13-3	1.4429
X3CrNiMo17-13-3	1.4436
X2CrNiMo18-14-3	1.4435
X2CrNiMoN18-12-4	1.4434
X2CrNiMo18-15-4	1.4438
X2CrNiMoN17-13-5	1.4439
X1NiCrMoCu31-27-4	1.4563
X1NiCrMoCu25-20-5	1.4539
X1CrNiMoCuN25-25-5	1.4537
X1CrNiMoCuN20-18-7	1.4547
X1NiCrMoCuN25-20-7	1.4529
Austenitic-ferritic	
X2CrNiN23-4	1.4362
X2CrMnNiN21-5-1	1.4162
X2CrNiN22-2	1.4062
X2CrNiMoN22-5-3	1.4462
X2CrNiMoCuN25-6-3	1.4507

Steel grade	
Steel name	Steel number
X2CrNiMoN25-7-4	1.4410
X2CrNiMoCuWN25-7-4	1.4501
X2CrNiMnMoCuN24-4-3-2	1.4662
Stainless steels selected from EN 10088-1	

Grades that are not listed in Table 12 are applicable when in accordance with F.3. For more detailed information regarding material selection in general see F.3.

Martensitic stainless steels shall not be used.

Ferritic stainless steels shall be limited to a maximum thickness of 10 mm.

6.2.2 Plates and drawn products

The following properties and requirements shall be in accordance with EN 10088-2 for plate materials and EN 10088-3 for drawn product materials.

- Chemical properties
- Mechanical properties
- Surface finish
- Marking of plates and drawn products

Depending on the stored product, all information which will allow the manufacturer to order the materials shall be specified (see A.1).

For tanks intended to operate at elevated temperatures, the required values of 0,2 % proof yield strength shall be determined by interpolation of the values specified in EN 10088-2 or EN 10088-3.

The materials shall be marked as required by the tank manufacturer (see A.5).

Inspection documentation in accordance with EN 10204, Inspection certificate 3.1 shall be supplied for plate materials and drawn products.

6.2.3 Forgings

6.2.3.1 Forgings shall be manufactured from stainless steel products by open die forging or ring rolling in accordance with EN 10222-5 and EN 10250-4.

6.2.3.2 The mechanical properties of forgings shall be equivalent to the properties used in the tank design.

6.2.3.3 Flanges provided for shell nozzles shall be marked by stamping or indelible paint. Marking shall include the following information:

- manufacturer's name or mark;
- size and pressure rating;

- steel grade;
- identification number; and
- stamp of the manufacturer's inspector.

6.2.4.4 Flanges shall be supplied with inspection documentation in accordance with EN 10204:2004, Inspection certificate 3.1, including the name of the producer of the initial material and mechanical properties of the finished flange.

NOTE Flanges for roof nozzles, manholes and clean-out doors can be cut from plate.

6.2.4 Pipes

6.2.5.1 Pipes used for nozzles shall be either stainless steel seamless tubes or longitudinal welded tubes in accordance with EN 10216-5 or EN 10217-7.

6.2.5.2 Mechanical properties of pipes shall be equivalent to the properties used in the tank design.

6.2.5.3 Pipes for piping connected to the shell shall be marked by stamping or indelible paint. Marking shall include the following information:

- manufacturer's name or mark;
- steel grade;
- identification number; and
- stamp of the manufacturer's inspector.

6.2.5.4 Pipes shall be supplied with inspection documentation in accordance with EN 10204:2004 Inspection certificate 3.1, including the name of the producer of the initial material.

6.2.5.5 Pipes provided for the manufacture of heating coils shall be in accordance with EN 10216-5 or EN 10217-7 and, if necessary (specified by the purchaser – see Annex. A.1) shall be designed and fabricated in accordance with EN 13480.

6.2.5 Welding consumables

Welding consumables shall be in accordance with EN ISO 3581, shall be supplied with the appropriate inspection documentation, and shall be used in the approval procedures in accordance with Clause 17.

The approval procedure tests shall demonstrate that the yield strength and tensile strength of the welded joint exceeds the strength of the base materials being joined.

The welded joint shall be chemically compatible with the materials being joined and the stored product.

6.3 Anchors and structural bolts

All anchors and structural bolts shall have metric threads in accordance with EN ISO 898 and, unless otherwise agreed between purchaser and contractor, carbon steel bolts should be hot dip galvanized according to EN ISO 1461 (see Annex A.2).

For accepted bolt materials see Table 12 and Table 14.

Table 13 — Accepted bolt materials

Standard	Designation	Max. Thickness
EN ISO 898-1	4.6	$M \leq 39$
	5.6	$M \leq 39$
	8.8	$M \leq 39$
EN 20898-2	5	$M \leq 39$
	8	$M \leq 39$
EN 10269	C35E	according to EN 10269
	C45E	
	35B2	
	20Mn5	
	25CrMo4	
	42CrMo4	
	42CrMo5-6	
	40CrMoV4-6	
	27NiCrMoV15-6	
	26 NiCrMo 14-6	
	21CrMoV5-7	
	20CrMoVTiB4-10	
	34CrNiMo6	
	30CrNiMo8	
	X12Ni5	
	X8Ni9	
	X15CrMo5-1	
	X22CrMoV12-1	
	X12CrNiMoV12-3	
	X19CrMoNbVN11-1	
	X2CrNi18-9	
	X5CrNi18-10	
	X4CrNi18-12	
	X2CrNiN18-10	
	X6CrNi25-20	
	X2CrNiMo17-12-2	
	X5CrNiMo17-12-2	
	X2CrNiMoN17-13-3	
	X3CrNiCu18-9-4	
	X6CrNi18-10	
	X10CrNiMoMnNbVB15-10-1	
	X3CrNiMoBN17-13-3	
	X6CrNiMoB17-12-2	
	X6CrNiTiB18-10	

EN ISO 3506-1	X6NiCrTiMoVB25-15-2	according to EN ISO 3506
	X7CrNiMoBNb16-16	
	A2-50	
	A4-50	
	A2-70	
	A4-70	

Table 14 — Characteristic values for 0.2% proof strength for bolts to EN ISO 3506-1

Group	Strength class	diameter	Characteristic values for 0,2 proof strength $R_{0.2}$ at			
			100 °C	200 °C	300 °C	400 °C
			MPa min.			
A2 and A4	50	≤M39	175	155	135	125
	70	≤M24	380	360	335	315
		>M24 to ≤M30	210	200	185	175

For carbon steel bolts material test report 2.2 according to EN 10204:2004 and for stainless steel bolt materials certificate 3.1 according to EN 10204:2004 is requested.

The proof strength values for elevated temperature according to Table 14 shall be proofed by material tests.

Allowable stresses of anchor materials shall be as given in 12.3.1.

7 Design loads

7.1 Loads

The design shall take account of the loads listed below and specified in 7.2.1 to 7.2.14:

- liquid induced loads during operation and testing;
- internal positive and negative pressure loads during operation and testing;
- thermally induced loads;
- dead loads;
- insulation loads;
- live loads;
- concentrated live loads;
- snow loads;
- rainfall induced loads;
- wind loads;
- seismic loads;
- loads resulting from connected piping and attachments;
- foundation settlement loads; and
- emergency loads.

7.2 Load values

7.2.1 Liquid induced loads

During operation, the load due to the contents shall be the design weight of the product to be stored from the maximum design liquid level to empty.

During test, the load due to the contents shall be the weight of the test medium from the maximum test liquid level to empty.

7.2.2 Internal pressure loads

During operation, the internal pressure load shall be the load due to the specified design pressure and design internal negative pressure.

During test, the internal pressure load shall be the load due to the specified test pressure and test internal negative pressure.

7.2.3 Thermally induced loads

When the stored product needs to be kept at an elevated temperature, the resulting thermal loads shall be evaluated.

NOTE For tanks designed to operate at 100 °C or less, loads resulting from temperature effects can be ignored.

7.2.4 Dead loads

The dead loads shall be considered as those resulting from the weight of all component parts of the tank and components permanently attached to the tank, for example ladders, platforms.

7.2.5 Insulation loads

The loads shall be those resulting from the self-weight of the insulation with its cladding.

7.2.6 Distributed live load

The distributed live load shall be taken from EN 1991-1-1 and shall be subject to agreement (see A.2) see also National normative annexes for applicable loads per country/region.

7.2.7 Concentrated live load

The concentrated live load shall be subject to agreement (see A.2).

7.2.8 Snow loads

The snow loads shall be in accordance with EN 1991-1-3.

The snow load shall be taken into account even at the highest stored liquid temperature in the case of tanks with an insulated roof.

The stability of the roof with the relevant strength characteristic value shall be proved both for snow load in the cold state and also without snow load at operating temperature in the case of tanks with a non-insulated roof an operating temperature > 50 °C.

7.2.9 Rainfall loads

The loads applied to floating roofs shall be in accordance with D.3.2.

7.2.10 Wind

7.2.10.1 Horizontal wind pressure

The 3 second wind gust velocity (V_w) to be used in the design shall be not less than 45 m/s. Where the 3 second wind gust velocities are expected to exceed 45 m/s and or the tank shell is higher than 30 m, national data shall be consulted to establish an appropriate value for the average 3 second wind gust velocity (V) which shall be subject to agreement (see A.2). The appropriate design 3 second wind gust velocity (V_w) shall be calculated according to the following formula:

$$V_w = V \times S_1 \times S_2 \times S_3 \times S_4 \quad (1)$$

where

- V_w is the design 3 second wind gust velocity
- V is the average 3 second wind gust velocity based on national data (see EN 1991-1-4)
- S_1 is the factor to take funnelling effect to exposed hill sides into account ($S_1 = 1,0$ for unexposed areas and $S_1 = 1,10$ for exposed hill sides)
- S_2 is the factor to take tank shell height into account:
 - $S_2 = 1,00$ for tank shell height ≤ 10 m;
 - $S_2 = 1,03$ for heights of tank shell $10 < H \leq 20$ m;
 - $S_2 = 1,07$ for heights of tank shell $20 < H \leq 30$ m;

For higher tanks use formula of curve: $y = 0,00005 X^2 + 0,0015 X + 0,98$, resulting is the following values of factor S_2

- $S_2 = 1,12$ for heights of tank shell $30 < H \leq 40$ m
- $S_2 = 1,18$ for heights of tank shell $40 < H \leq 50$ m
- $S_2 = 1,25$ for heights of tank shell ≤ 60 m.
- S_3 = statistical factor: use $S_3 = 1,0$ for cylindrical tanks having a design working life of 50 years. In case the design working life differs from the specified 50 years period as detailed in EN 1991-1-4 (wind loads), the S_3 factor shall be multiplied by a probability factor (C_{prob}) that is to be assessed from the formula:

$$C_{prob} = \left[\frac{1+K*\ln(T)}{(1+K*\ln(50))} \right]^n \quad (2)$$

where

- T = actual design working life.

The values for factors K and n can be found in the National Annexes to EN 1991-1-4, but the recommended values are $K = 0,2$ and $n = 0,5$ respectively.

When national data expresses the average wind gust velocity in other than the 3 second gust averaged value, a conversion factor S_4 shall be used to find the 3 second average wind gust velocity by using the formula: