



SLOVENSKI STANDARD
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SIST EN 13121-3:2008

**Nadzemni rezervoarji iz armiranega poliestra - 3. del: Konstruiranje in izdelava
(vključno z dopolnilom A1)**

GRP tanks and vessels for use above ground - Part 3: Design and workmanship

Oberirdische GFK-Tanks und -Behälter - Teil 3: Auslegung und Herstellung

Réservoirs et récipients en PRV pour applications hors sol - Partie 3: Conception et fabrication

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ICS:

23.020.10	Nepremične posode in rezervoarji	Stationary containers and tanks
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Réservoirs et récipients en PRV pour applications hors sol -
Partie 3: Conception et fabrication

Oberirdische GFK-Tanks und -Behälter - Teil 3: Auslegung
und Herstellung

This European Standard was approved by CEN on 21 April 2008 and includes Amendment 1 approved by CEN on 11 January 2010.

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Contents

	Page
Foreword.....	6
Introduction	7
1 Scope	8
2 Normative references	8
3 Terms and definitions	10
4 Symbols and abbreviations	11
5 Information and requirements to be supplied and to be documented.....	14
5.1 General.....	14
5.2 Information to be obtained by the manufacturer.....	14
5.3 Information to be prepared by the manufacturer	14
5.4 Final documentation.....	15
6 Material	15
6.1 General.....	15
6.2 Chemical protective barrier	15
6.3 Flammability.....	16
6.4 Electrical resistivity	16
7 Mechanical properties	17
7.1 General.....	17
7.2 Heat deflection temperature	17
7.3 Laminate construction	17
7.4 Lamina thickness.....	19
7.5 Laminate properties	19
7.6 Inter-laminar shear strength.....	19
7.7 Peel strength	20
7.8 Selection of physical properties of materials and allowable design factors	20
8 Determination of design strain and loadings	25
8.1 General.....	25
8.2 Allowable design strains.....	25
8.3 Laminate design loadings.....	26
8.4 Laminate design.....	26
8.5 Laminate thickness.....	27
9 Design	28
9.1 Introduction	28
9.2 Determination of external loads	29
9.3 Drawings and design calculations.....	30
9.4 Design details.....	30
10 Design analysis.....	31
10.1 Symbols and units	31
10.2 Vertical vessels or tanks, cylinders under loads ($t < 0,01 D$)	32
10.3 Cylindrical shells subject to compressive loadings — critical buckling criteria.....	34
10.4 Conical shells.....	39
10.5 Dished end.....	45
10.6 Flat circular ends	47
10.7 Circumferential seams	58
10.8 Openings, branches and compensating laminate.....	61
10.9 Flat panels	70

10.10	Rectangular tanks	81
10.11	Horizontal vessels	83
11	Bolted flange connections.....	99
11.1	General	99
11.2	Full faced flanges (with full faced gaskets) design	106
11.3	Stub flange design with metallic backing ring	110
11.4	Prefomed flanges	113
11.5	Butt and strap jointed flanges.....	114
11.6	Stub flange design with non-metallic backing ring	114
12	Supports	115
12.1	General	115
12.2	Vertical tanks	115
12.3	Supports and mountings for vessels	115
12.4	Seismic loading	121
12.5	Design calculation for tank and vessel anchorage.....	121
13	Structures and fittings	123
13.1	General	123
13.2	Internal structures and fittings	123
13.3	External structures and fittings	123
13.4	Lifting devices	123
14	Local load analysis.....	124
14.1	General	124
14.2	Symbols.....	124
14.3	Calculation of force and moment resultants	124
14.4	Calculation of laminate strains	124
15	Quality control	125
15.1	General	125
15.2	Works requirements	125
15.3	Documentation to be prepared by the manufacturer	126
15.4	Manufacture	133
15.5	Inspection and testing after completion of fabrication	135
15.6	Experimental design verification method	136
16	Site built tanks and vessels	138
16.1	General	138
16.2	Design.....	138
16.3	Manufacture	139
16.4	Inspection.....	139
17	Marking.....	139
Annex A	(informative) Product testing for volume or batch production process	141
A.1	Initial type testing (ITT)	141
A.2	Testing of samples	141
A.3	Inspection and test records.....	143
Annex B	(informative) Derivation of laminate properties from lamina properties	144
B.1	General	144
B.2	Lamina/laminate thickness.....	144
B.3	Lamina modulus.....	145
B.4	Determination of laminate flexural stiffness.....	146
B.5	Determination of laminate strains from load resultants.....	146
Annex C	(normative) Pressure and leak testing	148
C.1	General	148
C.2	Open top tanks and containers.....	148
C.3	Closed tanks and vessels.....	149
C.4	Hydraulic pressure test.....	149
Annex D	(normative) Methods of tests	150

EN 13121-3:2008+A1:2010 (E)

D.1	General.....	150
D.2	Loss on ignition	151
D.3	Tensile strength of thermoplastics welds	151
D.4	Bend tests for welds in thermoplastics.....	151
D.5	Ultimate tensile unit strength of laminates	153
D.6	Unit tensile modulus of laminates	154
D.7	Inter laminar shear strength of laminates.....	156
D.8	Lap shear strength of bond between thermoplastics lining and laminate or between laminates	157
D.9	Peel strength of bond between laminate layers	160
D.10	Flexural short term creep test	160
D.11	Barcol hardness.....	163
D.12	Determination of electrical resistivity.....	163
D.13	Residual styrene polyester resins	163
D.14	Acetone test polyester resins.....	163
D.15	Spark testing of thermoplastics welds.....	163
D.16	Long term flexural creep test	164
D.17	Hardness of rubber.....	166
D.18	Flash point test	166
D.19	Heat deflection temperature test.....	166
D.20	Flexural strength of laminate.....	166
Annex E	(normative) Approval testing of laminators	167
E.1	General.....	167
E.2	Assessment of the laminator.....	167
E.3	Procedure	167
E.4	Test pieces	168
E.5	Evaluation of test pieces.....	168
E.6	Minimum requirements for acceptance.....	169
E.7	Test certificate.....	169
E.8	Validity and renewal	169
E.9	Range of approval.....	170
Annex F	(normative) Approval testing of welders	171
F.1	General.....	171
F.2	Test requirements.....	172
F.3	Procedure	172
F.4	Test pieces	173
F.5	Evaluation of test pieces.....	173
F.6	Minimum requirements for acceptance.....	174
F.7	Test certificate.....	174
F.8	Validity and renewal	174
F.9	Range of approval.....	174
Annex G	(informative) Loading from local loads - Methods of calculation.....	176
G.1	General.....	176
G.2	Local loads on pressure vessel shells	176
Annex H	(informative) Design method for filament wound laminates	203
H.1	General.....	203
H.2	Filament wound laminate properties	204
H.3	Design methods	206
H.4	Axial instability.....	209
Annex I	(normative) Pre-moulded flanges technical requirements	215
I.1	General.....	215
Annex J	(informative) Shells subjected to wind loading value from metallic codes	217
J.1	Symbols	217
Annex K	(informative) Horizontal vessel design.....	222
K.1	General.....	222
K.2	Strain modification for vessels on rigid saddle support.....	222

K.3	Horizontal vessels supported on two longitudinal continuous beams	226
Annex ZA (informative)	Relationship between this European Standard and the Essential Requirements of EU Directive 97/23/EC.....	231
Bibliography.....		232

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[SIST EN 13121-3:2008+A1:2010](https://standards.iteh.ai/catalog/standards/sist/3d1db288-3ffb-4b20-8cbf-f96f0e4c9484/sist-en-13121-3-2008a1-2010)

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EN 13121-3:2008+A1:2010 (E)**Foreword**

This document (EN 13121-3:2008+A1:2010) has been prepared by Technical Committee CEN/TC 210 “GRP tanks and vessels”, the secretariat of which is held by DIN.

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 2010, and conflicting national standards shall be withdrawn at the latest by August 2010.

This document includes Amendment 1, approved by CEN on 2010-01-11.

This document supersedes EN 13121-3:2008.

The start and finish of text introduced or altered by amendment is indicated in the text by tags **A1** **A1**.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, 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 the United Kingdom.

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Introduction

EN 13121 consists of the following parts under the general title "*GRP tanks and vessels for use above ground*":

- Part 1: Raw materials — Specification conditions and acceptance conditions
- Part 2: Composite materials — Chemical resistance
- Part 3: Design and workmanship (this standard)
- Part 4: Delivery, installation and maintenance

These four parts together define the responsibilities of the tank or vessel manufacturer and the materials to be used in their manufacture.

Part 1 of this standard specifies the requirements and acceptance conditions for the raw materials - resins, curing agents, Thermoplastics linings, reinforcing materials and additives. These requirements are necessary in order to establish the chemical resistance properties determined in Part 2 and the mechanical, thermal and design properties determined in Part 3. Together with the workmanship principles determined in Part 3, requirements and acceptance conditions for raw materials ensure that the tank or vessel will be able to meet its design requirements. Part 4 of this standard specifies recommendations for delivery, handling, installation and maintenance of GRP tanks and vessels.

The design and manufacture of GRP tanks and vessels involve a number of different materials such as resins, thermoplastics and reinforcing fibres and a number of different manufacturing methods. It is implicit that tanks and vessels conforming to this standard should be made only by manufacturers who are competent and suitably equipped to fulfil all requirements, using materials manufactured by competent and experienced material manufacturers.

SIST EN 13121-3:2008+A1:2010

Metallic vessels, and those manufactured from other isotropic, homogeneous materials, are conveniently designed by calculating permissible loads based on measured tensile and ductility properties. GRP, on the other hand, is a laminar material, manufactured through the successive application of individual layers of reinforcement. As a result there are many possible combinations of reinforcement type that will meet the structural requirement of any one-design case. This allows the designer to select the laminate construction best suited to the available manufacturing facilities and hence be most cost effective.

In considering a layered GRP structure it is assumed that it is the glass reinforcement that provides the stiffness and strength required to resist mechanical loadings. Also, since the quantity of glass reinforcement is most readily assessed by weight, the weight of glass per unit area (m) is used instead of thickness in determining mechanical properties, thus the concepts of load and modulus are replaced by unit strength (U) and unit modulus (X), these being defined in Table 1.

NOTE To convert a unit load, or a unit modulus to a load and a modulus respectively, U and X may be simply divided by t , where t is the thickness per weight of glass per unit area of the lamina, or laminate under consideration.

EN 13121-3:2008+A1:2010 (E)**1 Scope**

This European Standard gives requirements for the design, fabrication, inspection, testing and verification of GRP tanks and vessels with or without Thermoplastics lining for storage or processing of fluids, factory made or site built, non pressurised or pressurised up to 10 bar, for use above ground.

The terms vessels and tanks as used in this European Standard include branches up to the point of connection to pipe work or other equipment by bolting and supports, brackets or other attachments bonded directly to the shell. In addition to the definitive requirements, this European Standard also requires the items in Clause 5 to be fully documented.

This European Standard covers vessels and tanks subject to temperatures between – 40 °C and + 120 °C.

NOTE It is possible that future advances in resin technology would allow tanks and vessels to be considered for operating temperatures above + 120 °C. Should such a situation arise and a manufacturer wishes to take advantage of such developments, then all other requirements of the standard shall be maintained and such tanks and vessels shall only be designed in accordance with the advanced design method given in 7.8.3.

Excluded from this European Standard are:

- tanks and vessels for the transport of fluids;
- underground storage tanks;
- spherical vessels;
- vessels and tanks of irregular shape;
- tanks and vessels with double containment;
- tanks and vessels which are subject to the risk of explosion, or failure of which may cause an emission of radioactivity;
- specification for fibre reinforced cisterns of one piece and sectional construction for the storage, above ground, of cold water (see EN 13280:2001).

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<https://standards.iteh.ai/catalog/standards/sist/3d1db288-3ffb-4b20-8cbf-9b0049931000/sist-en-13121-3-2008-a1-2010>**2 Normative references**

The following referenced documents are indispensable for the application 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 59, *Glass reinforced plastics — Measurement of hardness by means of a Barcol impressor*

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

EN 1993-1-2, *Eurocode 3: Design of steel structures — Part 1-2: General rules — Structural fire design*

EN 1993-1-3, *Eurocode 3 — Design of steel structures — Part 1-3: General rules — Supplementary rules for cold-formed members and sheeting*

EN 13121-1:2003, *GRP tanks and vessels for use above ground — Part 1: Raw materials — Specifications conditions and acceptance conditions*

EN 13121-2:2003, *GRP tanks and vessels for use above ground — Part 2: Composite materials — Chemical resistance*

EN 13121-4:2005, *GRP tanks and vessels for use above ground — Part 4: Delivery, installation and maintenance*

EN 13923, *Filament-wound FRP pressure vessels — Materials, design, manufacturing and testing*

EN ISO 75-2, *Plastics — Determination of temperature of deflection under load — Part 2: Plastics, ebonite and long-fibre-reinforced composites (ISO 75-2:2004)*

EN ISO 291, *Plastics — Standard atmospheres for conditioning and testing (ISO 291:2005)*

EN ISO 527-4, *Plastics — Determination of tensile properties — Part 4: Test conditions for isotropic and orthotropic fibre-reinforced plastic composites (ISO 527-4:1997)*

EN ISO 527-5, *Plastics — Determination of tensile properties — Part 5: Test conditions for unidirectional fibre-reinforced plastic composites (ISO 527-5:1997)*

EN ISO 899-1, *Plastics — Determination of creep behaviour — Part 1: Tensile creep (ISO 899-1:2003)*

EN ISO 899-2, *Plastics — Determination of creep behaviour — Part 2: Flexural creep by three-point loading (ISO 899-2:2003)*

EN ISO 1172, *Textile-glass-reinforced plastics — Prepregs, moulding compounds and laminates — Determination of the textile-glass and mineral-filler content — Calcination methods (ISO 1172:1996)*

EN ISO 2592, *Determination of flash and fire points - Cleveland open cup method (ISO 2592:2000)*

EN ISO 3915, *Plastics — Measurement of resistivity of conductive plastics (ISO 3915:1981)*

EN ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system (ISO 7500-1:2004)*

EN ISO 9513, *Metallic materials — Calibration of extensometers used in uniaxial testing (ISO 9513:1999)*

EN ISO 14125:1998, *Fibre-reinforced plastic composites — Determination of flexural properties (ISO 14125: 1998)*

ISO 48, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

ISO 4901, *Reinforced plastics based on unsaturated polyester resins — Determination of residual styrene monomer content*

EN 13121-3:2008+A1:2010 (E)**3 Terms and definitions**

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

- 3.1 manufacturer**
the organisation that designs, manufactures and tests the vessel or tank in accordance with this European Standard
- 3.2 purchaser**
the organisation or individual that buys the finished vessel or tank and specifies the process requirements
- 3.3 authorised inspecting authority**
the body or organisation that may be required to check that the design, materials and construction comply with this European Standard when $PS \leq 0,5$ bar
- 3.4 vessel**
a closed container subject to applied pressure or vacuum, with or without hydrostatic head, including branches up to the first flanged connection
- 3.5 tank**
a container for the storage of fluids subject only to the fluid hydrostatic head and freely vented to atmosphere, including branches up to the first flanged connection
- 3.6 laminate**
resin reinforced with glass fibre
- 3.7 gel coat**
a thin layer of resin on the surface of a laminate that may or not be reinforced with a glass or a synthetic fibre tissue
- 3.8 cure**
the chemical reaction resulting in the polymerised laminate
- 3.9 post cure**
the application of heat to take the polymerisation to a final stage
- 3.10 maximum allowable pressure (PS)**
the maximum pressure for which the equipment is designed, as decided by the manufacturer
- 3.11 differential pressure**
the difference of pressure on both sides of a component
- 3.12 design pressure (p_D)**
the design pressure used in the calculations for a component

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3.13**maximum/minimum allowable temperature (*TS*)**

the maximum or minimum temperature for which the equipment is designed, decided by the manufacturer

3.14**test temperature**

the temperature at which the pressure test of the equipment is carried out

3.15**test pressure (*TP*)**

the pressure to which the tank or vessel is tested

4 Symbols and abbreviations

For the purposes of this standard, the symbols and abbreviations common to all clauses and annexes are given in Table 1.

Further symbols are defined in the relevant clauses as required.

Table 1 — Standard symbols and abbreviations

Symbol	Unit	Definition
<i>A</i>	mm	Distance
<i>a</i>	mm	Dimension
<i>b</i>	mm	Dimension
<i>d</i>	mm	Diameter
<i>D</i>	mm	Internal diameter of tank, vessel
Δ	-	Difference or additional
<i>E</i>	N/mm ²	Modulus of elasticity = $\frac{X}{t}$
ϵ	%	Strain
<i>F</i>	-	Buckling design factor
ϕ	°	Half the angle at the apex of the cone
Θ	°	Support saddle angle
<i>g</i>	m/s ²	Gravity
<i>h</i>	mm	Height of dished end
<i>H</i>	mm	Height of cone
<i>I</i>	mm ⁴	Second moment of area
<i>k</i>	-	Correction factor
<i>K</i>	-	Overall design factor
<i>l</i>	mm	Length
<i>L</i>	mm	Overall length

Table 1 (continued)

Symbol	Unit	Definition
m	kg/m ²	Mass per unit area
M	Nmm	Bending moment
u	N/mm	Unit load = load/width
ν	–	Poissons ratio
P	N	Direct load
p	N/mm ²	Pressure
Q	N	Shear load
r	mm	Knuckle radius
R	mm	Radius
ρ	kg/m ³	Density of liquid
σ	N/mm ²	Load = $\frac{U}{t}$ and $\frac{q}{t}$
t	mm	Thickness
τ	N/mm ²	Shear load
T	°C	Temperature
TS	°C	Design temperature
all. U_{lam}	N/mm	allowable unit load for the laminate
U	N/mm per kg/m ² glass	Ultimate tensile unit strength of the laminate (UTUS)
V	m ³	Volume
W	kg	Weight
χ	–	Coordinate in axial direction
X	N/mm	Unit modulus = Load/width x strain
X_i	N/mm per kg/m ² glass	Unit tensile-modulus of the lamina per kg/m ² glass
q	N/mm	Applied unit load

Table 1 (continued)

Abbreviations		
CSM	-	Chopped strand mat
ECTFE	-	Ethylene-chlorotrifluoroethylene copolymer
all.	-	Allowable
FEP	-	Fluorinated ethylene-propylene copolymer
FU	-	Furane
FW	-	Filament winding
HDT	°C	Heat deflection temperature
IRHD	°	International rubber hardness
ln		Natural logarithm
PF	-	Phenolic
PFA	-	Perfluoro-alkoxy copolymer
PP-B	-	Polypropylene, block polymer
PP-H	-	Polypropylene, homopolymer
PP-R	-	Polypropylene, random polymer
PVC-U	-	Polyvinyl chloride, unplasticised
PVDF	-	Polyvinylidene fluoride
UP	-	Unsaturated polyester
VE	-	Vinyl ester
WR	-	Woven rovings
CRL	-	Chemical Resistant Layer, see EN 13121-2
VL	-	Veil Layer, see EN 13121-2
TPL	-	Thermoplastics Liner, see EN 13121-2
Supp.	-	Support
lam	-	Laminate
S.G	-	Specific Gravity (Relative Density)
O.D	-	Outside Diameter
I.D	-	Inside Diameter