

STN	GRP (sklolaminátové) nádrže a nádoby na používanie nad zemou. Časť 3: Navrhovanie a výroba.	STN EN 13121-3 69 8120
------------	--	--

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

Táto norma obsahuje anglickú verziu európskej normy.
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 08/16

Obsahuje: EN 13121-3:2016

Oznámením tejto normy sa od 31.10.2016 ruší
STN EN 13121-3+A1 (69 8120) z júna 2010

123414

EUROPEAN STANDARD

EN 13121-3

NORME EUROPÉENNE

EUROPÄISCHE NORM

April 2016

ICS 23.020.10

Supersedes EN 13121-3:2008+A1:2010

English Version

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

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 10 January 2016.

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-CENELEC 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-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



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

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Contents		Page
European foreword		8
Introduction		9
1	Scope	10
2	Normative references	10
3	Terms and definitions	12
4	Symbols and abbreviations	13
5	Information and requirements to be supplied and documented	16
5.1	General	16
5.2	Information to be obtained by the manufacturer	16
5.3	Information to be prepared by the manufacturer	17
5.4	Final documentation	18
6	Material	18
6.1	General	18
6.2	Chemical protective barrier	18
6.2.1	General	18
6.2.2	Thermoplastics linings	18
6.2.3	Resin based linings	18
6.3	Flammability	18
6.4	Electrical resistivity	19
7	Mechanical properties	19
7.1	General	19
7.2	Heat deflection temperature	19
7.3	Laminate construction	19
7.4	Laminate thickness	21
7.5	Laminate properties	21
7.6	Inter-laminar shear strength	21
7.6.1	Laminate	21
7.6.2	Thermoplastics linings	21
7.7	Peel strength of laminates	22
7.8	Pull-off strength of laminates and thermoplastic liner	22
7.9	Selection of physical properties of materials and allowable design factors	22
7.9.1	General	22
7.9.2	Basic design	22
7.9.3	Advanced design	23
7.9.4	Design factors	24
7.9.5	Overall design factors K and F	24
8	Determination of design strain and loadings	27
8.1	General	27
8.2	Limit design strains	28
8.2.1	General	28
8.2.2	Limit resin strain ε_{ar}	28
8.2.3	Limit strain for laminate or lamina ε_{lim}	28
8.2.4	Limit test strain ε_{test}	29
8.3	Limit design laminate loadings	29
8.4	Determination of the mechanical values from laminates	29

8.4.1	General	29
8.4.2	Calculation of laminate values without experimental test data	29
8.4.3	Laminate with experimental data	30
8.5	Laminate thickness	30
9	Design	30
9.1	Introduction.....	30
9.2	Determination of external loads	31
9.2.1	Snow loads.....	31
9.2.2	Wind loads.....	31
9.2.3	Seismic loads	32
9.2.4	Insulation loads.....	33
9.2.5	Loads resulting from connections	33
9.2.6	Agitation.....	34
9.2.7	Pressure due to inadequate venting.....	34
9.2.8	Personnel loading.....	34
9.2.9	Internal stresses in vessels and tanks due temperatures.....	34
9.3	Verification by the partial factor method	34
9.3.1	General	34
9.3.2	Dimensioning by using ($A_5 \cdot \gamma$)-factored loads.....	40
9.4	Drawings and design calculations	41
9.5	Design details.....	41
9.5.1	Design temperature TS	41
9.5.2	Pressure	41
10	Design analysis	42
10.1	Symbols and units.....	42
10.2	Vertical vessels or tanks, cylinders under loads ($t < 0,01 \cdot D$)	44
10.2.1	Circumferential loadings	44
10.2.2	Combined axial loading.....	45
10.3	Cylindrical shells subject to compressive loadings — critical buckling criteria	46
10.3.1	General	46
10.3.2	Critical axial buckling load.....	46
10.3.3	Critical circumferential buckling pressure	47
10.3.4	Combined axial and radial compressive loadings	48
10.3.5	Critical buckling pressure for cylindrical shell stiffened with external or internal rings	49
10.4	Conical shells.....	50
10.4.1	General requirements.....	50
10.4.2	Shallow conical ends.....	52
10.4.3	Conical ends subject to internal pressure	52
10.4.4	Conical ends subject to external pressure.....	54
10.4.5	Shell conical covers.....	56
10.5	Dished end.....	57
10.5.1	General requirements.....	57
10.5.2	Dished ends subject to internal pressure	58
10.5.3	Stability for dished ends subject to external pressure	59
10.6	Design of flat bottoms and skirts for vertical tanks and vessels	60
10.6.1	Definitions.....	60
10.6.2	Fully supported, flat bottom tanks.....	60
10.6.3	Vessels with flat bases subjected to pressure	67
10.6.4	Dished bottom and conical bottom configurations.....	67
10.7	Circumferential seams for cylindrical joints	77
10.7.1	General	77
10.7.2	Construction without thermoplastics liner.....	79
10.7.3	Construction with thermoplastics liner	79

10.8	Openings, branches and compensating laminate	79
10.8.1	General	79
10.8.2	Symbols	80
10.8.3	Compensation requirements for openings	80
10.8.4	Pull out load from nozzles	87
10.8.5	Prevention of failure in peel.....	87
10.8.6	Pad connections	87
10.8.7	Screwed connections.....	89
10.8.8	Access and inspecting openings	89
10.8.9	Gusset on branches	89
10.9	Flat Panels or Blind flanges.....	89
10.9.1	General	89
10.9.2	Symbols	90
10.9.3	Circular panels.....	90
10.10	Horizontal tanks and vessels.....	93
10.10.1	Types of supports.....	93
10.10.2	Symbols.....	95
10.10.3	Unit loads of the cylindrical shell	96
10.10.4	Unit loads on saddle position.....	103
10.10.5	Unit loads for horizontal loads at the vessel	109
10.11	Large diameter pipes and pipe fittings.....	110
10.11.1	General.....	110
10.11.2	Joints	111
10.11.3	Elbows	112
10.11.4	Large cut-outs and Tees.....	112
11	Bolted flange connections	115
11.1	General	115
11.2	Full face flanges design.....	121
11.2.1	General	121
11.2.2	Symbols	122
11.2.3	Pipe loads on flanges.....	124
11.2.4	Gasket load and bolt torque.....	124
11.2.5	Summary of loads	125
11.2.6	Total bending moment	125
11.2.7	Flange design.....	125
11.2.8	Flange slope.....	127
11.3	Stub flange design with backing ring	133
11.3.1	General	133
11.3.2	Loads, bending moment and design for backing ring made of steel or GRP	134
11.3.3	Stub flange loadings.....	135
11.3.4	Stub shear interface design.....	135
11.3.5	Stub end or flange design.....	135
11.3.6	Seating stress	136
11.4	Butt and strap jointed flanges at vessels or tanks	138
12	Supports for vessels and tanks	138
12.1	General	138
12.2	Supports and mountings for tanks and vessels	139
12.2.1	General considerations for supports.....	139
12.2.2	Supports for vertical vessels	139
13	Seismic loading.....	145
14	Design calculation for tank and vessel anchorage	145
14.1	General	145
14.2	Design for uplift.....	145

14.3	Design for anchor bolts.....	145
15	Structures and fittings	149
15.1	General	149
15.2	Internal structures and fittings	149
15.3	External structures and fittings.....	149
15.4	Lifting devices	149
16	Local load analysis	154
17	Quality Control.....	154
17.1	General	154
17.2	Works requirements	154
17.2.1	General	154
17.2.2	Raw materials storage	154
17.2.3	Manufacturing area.....	154
17.2.4	Conditions for laminating.....	154
17.3	Documentation to be prepared by the manufacturer	155
17.3.1	Technical documentation	155
17.3.2	Records and documentation requirements for raw materials	155
17.3.3	Manufacturing documentation requirements	156
17.3.4	Quality control documentation requirements.....	156
17.4	Manufacture.....	161
17.4.1	General	161
17.4.2	Fabrication of thermoplastics liners	162
17.4.3	Fabrication of laminates	162
17.4.4	Imperfections in laminates	163
17.4.5	Curing.....	163
17.5	Inspection and testing after completion of fabrication	163
17.5.1	Visual and dimensional inspection	163
17.5.2	Physical test to be carried out.....	164
17.5.3	Coupon testing	164
17.6	Experimental Design Verification Method for pressure vessel	165
17.6.1	General	165
17.6.2	Manufacture of the prototype vessel.....	165
17.6.3	Tests to be applied to prototype vessels.....	166
18	Marking	166
Annex A	(informative) Product testing for serial or batch production process	168
A.1	Initial type testing (ITT).....	168
A.2	Testing of samples.....	168
A.2.1	General	168
A.2.2	Batch release tests (BRT).....	168
A.2.3	Process control tests.....	169
A.3	Inspection and test records	170
A.3.1	General	170
A.3.2	Marking	170
A.3.3	Delivery, installation, maintenance.....	170
Annex B	(informative) Derivation of laminate properties from laminate properties	171
B.1	General	171
B.2	Lamina/laminate thickness	171
B.3	Laminate modulus.....	172
B.4	Determination of laminate flexural stiffness	173
B.5	Determination of laminate strains from load resultants.....	173
Annex C	(normative) Pressure and leak testing.....	175

C.1	General	175
C.2	Open top tanks.....	175
C.3	Static head test of closed tanks and vessels.....	176
C.3.1	Contents having a specific gravity up to 1,0.....	176
C.3.2	Contents having a specific gravity greater than 1,0	176
C.4	Hydraulic pressure test.....	176
C.4.1	Test done in the working attitude	176
C.4.2	Tests done in other than the working attitudes	176
C.4.3	Pneumatic testing.....	177
C.4.4	Vacuum test	177
Annex D	(normative) Methods of tests	178
D.1	General	178
D.1.1	Tests	178
D.1.2	Accuracy of test equipment.....	178
D.2	Loss on ignition	179
D.3	Tensile strength of thermoplastics welds	179
D.4	Bend test for thermoplastics welds	179
D.4.1	Introduction	179
D.4.2	Test arrangement.....	179
D.4.3	Test pieces.....	180
D.4.4	Method of test	180
D.4.5	Requirements from flexural test.....	180
D.4.6	Test report	180
D.5	Ultimate tensile unit strength of laminates	181
D.5.1	Test pieces and procedure	181
D.5.2	Simple laminates	181
D.5.3	Combined laminates.....	181
D.6	Unit tensile modulus of laminates.....	182
D.7	Inter laminar shear strength of laminates	184
D.7.1	Form of test specimen.....	184
D.7.2	Number of test specimens	184
D.7.3	Procedure	184
D.7.4	Results	184
D.7.5	Report.....	184
D.8	Lap shear strength of bond between thermoplastics lining and laminate or between laminates	185
D.8.1	Form of the test specimen	185
D.8.2	Number of test specimens	185
D.8.3	Procedure	185
D.8.4	Report.....	186
D.9	Peel strength of bond between laminate layers.....	186
D.9.1	Form of the specimen.....	186
D.9.2	Number of specimens.....	186
D.9.3	Procedure	187
D.9.4	Report.....	187
D.10	Flexural short-term creep test (flexural modulus E_{1h} and E_{24h} test).....	189
D.10.1	General	189
D.10.2	Definitions.....	189
D.10.3	Test device	189
D.10.4	Test pieces.....	190
D.10.5	Procedure	190
D.10.6	Calculation	190
D.11	Barcol hardness	191
D.12	Determination of electrical resistivity.....	191

D.13	Glass transition temperature by DSC of cured resin.....	191
D.14	Spark testing of thermoplastics welds.....	191
D.14.1	General	191
D.14.2	Apparatus	192
D.14.3	Procedure.....	192
D.15	Long term flexural creep test.....	192
D.15.1	General	192
D.15.2	Definitions.....	192
D.15.3	Test device	192
D.15.4	Test pieces.....	193
D.15.5	Procedure	193
D.15.6	Calculation.....	193
D.16	Hardness of rubber	194
D.17	Flash point test	194
D.18	Heat deflection temperature test.....	194
D.19	Flexural strength of laminate.....	194
D.20	Pull-off strength from laminates.....	194
Annex E	(normative) Approval testing of laminators	196
E.1	General	196
E.2	Assessment of the laminator	196
E.3	Procedure	196
E.4	Theory exam.....	197
E.5	Test pieces.....	197
E.6	Evaluation of test pieces.....	197
E.6.1	General	197
E.6.2	Test procedure 1.....	198
E.6.3	Test procedure 2.....	198
E.6.4	Test procedure 3.....	198
E.7	Minimum requirements for acceptance	198
E.8	Test certificate	199
E.9	Validity and renewal	199
E.10	Range of approval.....	199
Annex F	(informative) Design by stress analysis	201
F.1	General	201
F.2	Typical methods.....	201
F.3	General requirements.....	201
F.4	Important determination results	201
F.5	Design factors.....	201
Annex G	(normative) Environmental aspects	202
G.1	Principle.....	202
G.2	Design and Manufacturing	202
G.3	Effects of materials on water	202
G.4	Effects of materials on food.....	203
G.5	Recycling.....	203
G.6	Storage of substances hazardous to water	203
Annex ZA	(informative) Relationship between this European Standard and the essential requirements of Directive 2014/68/EU aimed to be covered	204
Bibliography	206

European foreword

This document (EN 13121-3:2016) has been prepared by Technical Committee CEN/TC 210 "GRP tanks and vessels", the secretariat of which is held by SFS.

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 October 2016, and conflicting national standards shall be withdrawn at the latest by October 2016.

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 supersedes EN 13121-3:2008+A1:2010.

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.

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

The following changes were made in this new edition of EN 13121-3:

- the standard was totally revised so as to make it comply with EN 1990; and
- sections covering "Flat panels" and "Loading from local loads" removed from the standard.

EN 13121, *GRP tanks and vessels for use above ground*, is currently composed of the following parts:

- *Part 1: Raw materials — Specification conditions and acceptance conditions;*
- *Part 2: Composite materials — Chemical resistance;*
- *Part 3: Design and workmanship;*
- *Part 4: Delivery, installation and maintenance;*
- *Part 5: Example of calculation* (CEN/TR 13121-5; in preparation).

A European Standard does not purport to include all the necessary provisions of a contract. Users of European Standards are responsible for their correct application.

Compliance with a European Standard does not of itself confer immunity from legal obligations.

It has been assumed in the drafting of this European Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people.

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, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

The five parts of EN 13121 together define the responsibilities of the tank or vessel manufacturer and the materials to be used in their manufacture.

EN 13121-1 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 EN 13121-2 and the mechanical, thermal and design properties determined in this part of EN 13121. Together with the workmanship principles determined in this Part 3, requirements and acceptance conditions for raw materials ensure that the tank or vessel will be able to meet its design requirements. EN 13121-4 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 vessels and tanks covered by this standard are made only by manufacturers who are competent and suitably equipped to comply with all the requirements of this standard, using materials manufactured by competent and experienced material manufacturers.

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.

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 wish to take advantage of such developments then all other requirements of this standard will be maintained and such tanks and vessels will only be designed in accordance with the advanced design method given in 7.9.3.

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.

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-pressurized or pressurized up to 10 bar, for use above ground. Further requirements are presented in normative Annex G.

The terms vessels and tanks as used in this part of EN 13121 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.

This part of EN 13121 covers vessels and tanks subject to temperatures between $-40\text{ }^{\circ}\text{C}$ and $120\text{ }^{\circ}\text{C}$.

Excluded from this part of EN 13121 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 where the double wall is considered structural;
- 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).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 — Determination of indentation hardness by means of a Barcol hardness tester*

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

EN 1990, *Eurocode — Basis of structural design*

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

EN 1991-1-5, *Eurocode 1: Actions on structures — Part 1-5: General actions - Thermal actions*

EN 1991-4, *Eurocode 1 — Actions on structures — Part 4: Silos and tanks*

EN 1993 (all parts), *Eurocode 3: Design of steel structures*

- 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 1998 (all parts), *Eurocode 8 — Design of structures for earthquake resistance*
- EN 1998-1, *Eurocode 8: Design of structures for earthquake resistance — Part 1: General rules, seismic actions and rules for buildings*
- EN 1998-4:2006, *Eurocode 8 — Design of structures for earthquake resistance — Part 4: Silos, tanks and pipelines*
- EN 10025-2, *Hot rolled products of structural steels — Part 2: Technical delivery conditions for non-alloy structural steels*
- EN 13067, *Plastics welding personnel — Qualification testing of welders — Thermoplastics welded assemblies*
- EN 13121-1:2003, *GRP tanks and vessels for use above ground — Part 1: Raw materials — Specification 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, *GRP tanks and vessels for use above ground — Part 4: Delivery, installation and maintenance*
- EN 13445-3:2014, *Unfired pressure vessels — Part 3: Design*
- EN 13555, *Flanges and their joints — Gasket parameters and test procedures relevant to the design rules for gasketed circular flange connections*
- 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 and ebonite (ISO 75-2)*
- EN ISO 291, *Plastics — Standard atmospheres for conditioning and testing (ISO 291)*
- EN ISO 527-4, *Plastics — Determination of tensile properties — Part 4: Test conditions for isotropic and orthotropic fibre-reinforced plastic composites (ISO 527-4)*
- EN ISO 899-1, *Plastics — Determination of creep behaviour — Part 1: Tensile creep (ISO 899-1)*
- EN ISO 899-2, *Plastics — Determination of creep behaviour — Part 2: Flexural creep by three-point loading (ISO 899-2)*
- 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)*
- EN ISO 2592, *Determination of flash and fire points — Cleveland open cup method (ISO 2592)*
- EN ISO 3915, *Plastics — Measurement of resistivity of conductive plastics (ISO 3915)*

EN 13121-3:2016 (E)

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

EN ISO 9513, *Metallic materials — Calibration of extensometer systems used in uniaxial testing (ISO 9513)*

EN ISO 11357-2, *Plastics — Differential scanning calorimetry (DSC) — Part 2: Determination of glass transition temperature and glass transition step height (ISO 11357-2)*

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

EN ISO 14692-3:2002, *Petroleum and natural gas industries — Glass-reinforced plastics (GRP) piping — Part 3: System design (ISO 14692-3:2002)*

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

ASTM D4541-09, *Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers*

ASME B16.5/16.47, *Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard*

koniec náhľadu – text ďalej pokračuje v platenej verzii STN