BRITISH STANDARD

BS EN
14879-1:2005

Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media —

Part 1: Terminology, design and preparation of substrate

The European Standard EN 14879-1:2005 has the status of a British Standard

ICS 01.040.25; 25.220.60

National foreword

This British Standard is the official English language version of EN 14879-1:2005. The UK voted against ratification of EN 14879-1 for the following reasons:

- omission of any reference to the EN ISO 8501 series of standards for the preparation of steel substrates before the application of coatings;
- exclusion of surface preparation methods other than abrasive blast cleaning;
- exclusion of coating methods on inaccessible components other than spreading, flooding or dipping;
- omission of an explanation of the limitations of the use of laminate and trowelled coatings for straight pipes and pipe fittings;
- omission from Table 2 of coatings applied by brush or spray techniques.

The UK participation in its preparation was entrusted to Technical Committee ISE/16, Protective coatings and linings of metal pipes and fittings, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

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Summary of pages

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 14879-1

September 2005

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English Version

Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media - Part 1: Terminology, design and preparation of substrate

Systèmes de revêtements organiques de peinture et autres revêtements rapportés pour la protection des appareils et installations industriels contre la corrosion par des milieux agressifs - Partie 1 : Terminologie, conception et préparation des subjectiles

Beschichtungen und Auskleidungen aus organischen Werkstoffen zum Schutz von industriellen Anlagen gegen Korrosion durch aggressive Medien - Teil 1: Terminologie, Konstruktion und Vorbereitung des Untergrundes

This European Standard was approved by CEN on 22 July 2005.

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 Central Secretariat 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 Central Secretariat has the same status as the official versions.

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

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

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Contents

Foreword

This European Standard (EN 14879-1:2005) has been prepared by Working Group CEN/BT/TF 130 "Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media", 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 March 2006, and conflicting national standards shall be withdrawn at the latest by March 2006.

EN 14879 "Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media" consists of the following parts:

— *Part 1: Terminology, design and preparation of substrate*

— *Part 2: Coatings on metallic components*

— *Part 3: Coatings on concrete components*

— *Part 4: Linings on metallic components*

— *Part 5: Linings on concrete components*

— *Part 6: Combined lining with tile and brick layers*

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This European Standard describes the terminology, the design and the preparation of the substrate of industrial apparatus for the protection against corrosion caused by aggressive media. These industrial apparatus include, for example, reaction tanks, storage tanks, floors in industrial plants, in general for production and handling of chemicals.

The protection is applicable to metallic and concrete structures.

Beside the protection of the apparatus, the protection of the media itself against pollution is also considered in this series of European Standards EN 14879.

A protection against corrosion caused by atmospheric exposure (as for example according to EN ISO 12944-4) is not included in the scope of this series of European Standards EN 14879.

Corrosion protection systems according to this series of European Standards EN 14879 are:

1) Thick coatings normally of 1 mm or more thick.

2) Linings made of pre-fabricated sheets respectively plate materials.

3) Combined linings with tile and brick layers.

2 Normative references

The following referenced documents are indispensable for the application of this European Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 206-1, *Concrete — Part 1: Specification, performance, production and conformity*

EN 1504-1, *Products and systems for the protection and repair of concrete structures — Definitions, requirements, quality control and evaluation of conformity — Part 1: Definitions*

EN 1504-2, *Products and systems for the protection and repair of concrete structures — Definitions, requirements, quality control and evaluation of conformity — Part 2: Surface protection systems for concrete*

EN 1504-3, *Products and systems for the protection and repair of concrete structures — Definitions, requirements, quality control and evaluation of conformity — Part 3: Structural and non-structural repair*

EN 1504-4, *Products and systems for the protection and repair of concrete structures — Definitions, requirements, quality control and evaluation of conformity — Part 4: Structural bonding*

EN 1504-5, *Products and systems for the protection and repair of concrete structures — Definitions, requirements, quality control and evaluation of conformity — Part 5: Concrete injection*

EN 1504-8, *Products and systems for the protection and repair of concrete structures — Definitions, requirements, quality control and evaluation of conformity — Part 8: Quality control and evaluation of conformity*

ENV 1504-9, *Products and systems for the protection and repair of concrete structures — Definitions, requirements, quality control and evaluation of conformity — Part 9: General principles for the use of products and systems*

EN 1504-10, *Products and systems for the protection and repair of concrete structures — Definitions, requirements, quality control and evaluation of conformity — Part 10: Site application of products and systems and quality control of the works*

EN 1559-1:1997, *Founding — Technical conditions of delivery — Part 1: General*

EN 1990, *Eurocode — Basis of structural design*

EN 1992-1-1, *Eurocode 2: Design of concrete structures — Part 1-1: General rules and rules for buildings*

EN 10025 (all parts), *Hot rolled products of non-alloy structural steels — General technical delivery conditions*

EN 10028-1, *Flat products made of steels for pressure purposes — Part 1: General requirements*

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

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

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

EN 10130+A1, *Cold rolled low carbon steel flat products for cold forming — Technical delivery conditions*

EN 10139, *Cold rolled uncoated mild steel narrow steel strip for cold forming — Technical delivery conditions*

EN 10208-1, *Steel pipes for pipelines for combustible fluids — Technical delivery conditions — Part 1: Pipes of requirement class A*

EN 10216-2, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 2: Non-alloy and alloy steel tubes with specified elevated temperature properties*

EN 10217-1, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 1: Non-alloy steel tubes with specified room temperature properties*

EN 10217-2, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 2: Electric welded non-alloy and alloy steel tubes with specified elevated temperature properties*

EN 10217-7, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 7: Stainless steel tubes*

EN 10293, *Steel castings for general engineering uses*prEN 10296-2, *Welded circular steel tubes for mechanical and general engineering purposes — Technical delivery conditions — Part 2: Stainless steel*

prEN 10340, *Steel castings for structural uses*

EN 10297-2, *Seamless circular steel tubes for mechanical and general engineering purposes — Technical delivery conditions — Part 2: Stainless steel*

EN 13813, *Screed material and floor screeds — Screed materials — Properties and requirements*

prEN 14879-3, *Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media — Part 3: Coatings on concrete components*

prEN 14879-5, *Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media — Part 5: Linings on concrete components*

EN ISO 4617:2000, *Paints and varnishes — List of equivalent terms (ISO 4617:2000)*

EN ISO 4618-2:1999, *Paints and varnishes — Terms and definitions for coating materials — Part 2: Special terms relating to paint characteristics and properties (ISO 4618-2:1999)*

EN ISO 4618-3:1999, *Paints and varnishes — Terms and definitions for coating materials — Part 3: Surface preparation and methods of application (ISO 4618-3:1999)*

EN ISO 6520-1, *Welding and allied processes — Classification of geometric imperfections in metallic materials — Part 1: Fusion welding (ISO 6520-1:1998)*

EN ISO 7093-1, *Plain washers — Large series — Part 1: Product grade A (ISO 7093-1:2000)*

EN ISO 12944-4, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 4: Types of surface and surface preparation (ISO 12944-4:1998)*

ISO 4997, *Cold-reduced steel sheet of structural quality*

ISO 9329 (all parts), *Seamless steel tubes for pressure purposes — Technical delivery conditions*

ISO 9330-1, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 1: Unalloyed steel tubes with specified room temperatures properties*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN ISO 4617:2000, EN ISO 4618-2:1999, EN ISO 4618-3:1999 and the following apply.

3.1
surface protection system
consists of the materials and material combinations listed in the standards of the series EN 14879, which protect and seal concrete parts or metallic components in process plants

3.2
coating
produced by applying an organic coating material to protect steel or concrete parts against corrosion

3.3
coating material
liquid to paste like materials applied mainly by means of trowel, brushing, rolling or spraying.

3.4
lining
thermoplastics, duroplastic or rubber applied as sheets or plates which may or may not (thermoplastics) be bonded to the substrate

3.5
corrosion
reaction of a metallic material or concrete with its environment which produces a measurable change in the material and can result in an impairment of the function of a component or a complete system

3.6
corrosion protection
corrosion protection means the isolation of the metallic or concrete material from the attacking medium by applying coatings or linings

3.7
medium, corrosive medium
environment containing components (chemicals, gases, vapours, etc.) that react with the material during corrosion

3.8
construction joint
joint in a building or building element caused by interruption during the casting of the concrete

3.9
movement joint
joint that accommodates movement of structural concrete parts caused by the expansion or contraction of the structure

3.10
dummy joint
joint formed by cutting the concrete surface, thereby determining the location of arising cracks that may form

3.11
tensile strength
for the purposes of this European Standard, the tensile strength is a measure based on the maximum load which a concrete structure can accommodate when subjected to uniaxial tension

3.12
blast cleaning, abrasive blast cleaning
impingement of a high-kinetic-energy stream of blast cleaning abrasive on to the surface to be prepared

3.13
abrasive, blast cleaning abrasive
solid material intended to be used for abrasive blast-cleaning

3.14
dew point
temperature at which moisture in the air will condense out on to a solid surface

3.15
duroplastic
plastic which, when cured by heat or other means, changes into a substantially infusible and insoluble product. Contrary to thermoplastics, duroplastic materials remain hard when heated

4 Design and preparation of substrate

4.1 Metallic components

4.1.1 Design of metallic components

4.1.1.1 General

Components to be protected shall be designed and manufactured so that after abrasive blast cleaning the surface protection can be applied without further treatment or modification.

For this reason, the following particulars shall be established beforehand:

a) coating or lining material;

b) mode of application and thickness of protective layer;

c) site at which coating or lining shall take place.

This results in various requirements for the design which are taken into account in Table 3. The examples given are partly taken from EN 1708-1.

The design requirements concerning type and thickness of the lining or coating are based on experience gained in the chemical industry and need not be taken as definitive. Since other designs are equally acceptable, it is recommended that the component manufacturer and the manufacturer of the surface protection reach agreement on the most suitable design to be used.

Where components are to receive a new lining or coating, it should be borne in mind that removal of the existing lining or coating may subject them to stresses.

Metallic base materials and semi-finished products see 4.1.2.

4.1.1.2 Dimensions of components

The dimensions and masses of the components shall be suitable for the intended surface protection process and shall be selected as a function of the place of manufacture (e.g. construction site), available facilities (e.g. blast-cleaning equipment, immersion vessels, ovens, autoclaves) as well as transportation and lifting facilities.

4.1.1.3 Surfaces

Component surfaces to be protected shall comply with the requirements specified in 4.1.2.

4.1.1.4 Design criteria

4.1.1.4.1 Rigidity

Components shall be sufficiently rigid so as to preclude any deformation which would result in damage to the intended surface protection, particularly in the case of rigid linings and coatings. Should bracing be required, this shall be fitted to the unlined or uncoated side of the component. It is, however, preferable to select appropriate wall thickness. The permissible deviation is to be agreed upon with the manufacturer of the surface protection. Deformations may also be caused by handling and machining, e.g. during blast cleaning, as well as by storage, transportation and installation.

4.1.1.4.2 Accessibility

Surfaces to be protected shall be accessible to hand tools and be readily visible with the exception of components which are to be lined or coated by such techniques as spreading, flooding or dipping, where adequate protection and assessment are ensured.

Manholes shall be in accordance with national regulations. For vessels, manholes shall be at least of size DN 600, see EN ISO 12944-3. Additional air supply and exhaust openings of at least DN 250 should also be provided. Other larger erection openings, e.g. for scaffolding, may also be required.

4.1.1.4.3 Rotating components

Rotating components, e.g. fan wheels, centrifugal drums shall be balanced prior to the application of the surface protection.

Counter weights shall be mounted so that the coating or lining can be applied properly.

4.1.1.4.4 Cavities

Cavities shall be avoided or they shall be adequately vented by spot-drilling of the unlined or uncoated side. Closing of cavities by welding to make them gas-tight is permitted, provided they will be able to withstand the occurring mechanical stresses (e.g. during vulcanisation) or thermal stresses (e.g. during the removal of the existing coating or lining).

4.1.1.4.5 Dimensional accuracy

The design of the component shall take into account the thickness of the surface protection to be applied as well as of possible deviations of thickness and multiple layers of the surface protection. Particular requirements for the dimensional accuracy of surface protected components, where specified, can only be fulfilled if the components comply with analogous requirements prior to the application of the surface protection. Dimensional corrections by means of the surface protection itself and/or its mechanical treatment shall be permitted to a limited extent with due

consideration given to the material of the surface protection, the coating or lining thickness and the thickness tolerances specified.

4.1.1.4.6 Protective layer/transition areas

Surfaces subject to stresses under service conditions should be fully lined or coated without any interruption. However, if in particular cases it is necessary to interrupt the protective layer, suitable design shall be agreed upon with the manufacturer of the surface protection.

4.1.1.4.7 Joints

4.1.1.4.7.1 Welded joints

Welds shall be continuous on surfaces to be protected. Spot welding shall not be permitted. The surface finish of welds shall be in accordance with 4.1.2.6.

Welding shall not be permitted after the application of the surface protection.

4.1.1.4.7.2 Bolted connections

Bolted connections shall be avoided in zones which are in contact with the corrosive media. Where this is not possible, the following solutions can be applied among others:

a) Bolts, screws, nuts and washers shall be of suitable corrosion-resistant materials. An additional soft washer may be provided to prevent any damage to the surface protection (see Table 3, item 2.1).

b) Where bolts, screws and nuts are to be protected, they may be provided with screw-on caps with gasket (see Table 3, item 2.3).

c) Where the permissible load of the gasket or surface protection in the joint area is too low, pressure relief shall be provided and the gasket shall be located in a secondary non-positive connection (see Table 3, item 2.3).

d) Countersunk bolts and screws with applied surface protection.

e) The size of the bolt holes shall be selected as a function of the type and thickness of the surface protection to be applied. Edges and radii shall be in accordance with 4.1.1.4.9.

4.1.1.4.7.3 Rivet assemblies

Rivet assemblies shall not be permitted.

4.1.1.4.7.4 Flanged connections

The specifications of 4.1.1.4.7.2 shall apply analogously to flanged connections. Threaded flanges shall not be permitted. Fitting dimensions shall be selected as a function of the thickness of the surface protection, also see 4.1.1.4.5. Edges and radii shall be in accordance with 4.1.1.4.9. Examples of flanged connections are given in Table 3, items 3.1 to 3.13.

Type, material and permissible surface pressure of the gasket shall be selected as a function of the surface protection. Soft gaskets should be used for rigid surface protection materials, e.g. hard rubber linings or duroplastic linings, and rigid gaskets should be used for soft materials.

The design of the gasket shall be such that the sealing pressure can act only on that part of the gasket which is supported by the component. Where high surface pressure is given, the gasket shall be located in the secondary non-positive connection. Ring-joint gaskets shall be used for high pressures. For examples of the design see Table 3.

4.1.1.4.7.5 Other joints

Other continuous joints without gap on the surface to be protected, e.g. soldered or bonded joints, are permissible as a function of the method of application of the surface protection (e.g. temperature influence).

4.1.1.4.8 Nozzles and outlets

Nozzles, outlets, connections etc. may be designed as set-in, set-on, butt-welded types or may be extruded with the limitations as given in Table 3, items 4.1 to 4.9. Their lengths should not exceed the nominal size in mm + 100 mm. A nominal size of at least DN 100 shall be provided for trowelled and laminate coatings. Where due to the technical process smaller nominal sizes are required it is allowed to use sleeves instead of the intended coating. In the case of thermoplastic linings of small nominal sizes (≤ DN 200), the tube inside diameters shall be selected to suit the respective thermoplastic semi-finished products.

Threaded nozzles are not permitted.

Set-through and weld-in nozzles as well as nozzles with weld-on bends are not permitted (see Table 3, items 4.4, 4.6 and 4.8).

4.1.1.4.9 Edges, fillets and corners

Edges, fillets and corners shall be smoothly finished to the minimum radii specified in Table 1. Flange radii shall be designed so as not to impair the performance of the flange facings.

Examples of the design are given in Table 3, items 5.1 to 5.6.

The transition from shell to vessel end shall be considered as special design of the fillet. Examples of the design are given in Table 3, items 6.1 and 6.7.

4.1.1.4.10 Supports and welding attachments

End support rings, holding devices and the like shall be fixed by welding prior to the application of the surface protection. Attention shall be paid to ensure a uniform load distribution and that the permissible surface pressure is not exceeded. Also see 4.1.1.4.5, 4.1.1.4.6, 4.1.1.4.7.2 and 4.1.1.4.9. Examples of design see Table 3, items 7.1 and 7.2.

Table 1 — Minimum radii

Surface protection Material	Minimum radius in mm	
	Edges	Fillets
Powder coatings	2	3
Coatings applied by spraying or brush application	3	6
Trowelled coatings	10	15
Laminate coatings	10	10
Duroplastic linings	5	10
Rubber linings	3	3 + lining thickness [a]
Thermoplastic linings	3[b]	3 + lining thickness [b]

[a] Fillets shall be formed in the base material. In particular cases, it is permissible upon agreement with the manufacturer of the surface protection system, to form the minimum radius by further measures, e.g. luting, trowelling.

[b] For manufacturing reasons, some thermoplastics may require an edges design.

4.1.1.4.11 Pipe components

4.1.1.4.11.1 Straight pipes and pipe fittings

The maximum pipe lengths specified in Table 2 should not be exceeded as a function of nominal size, surface protection material, surface preparation, method of application and test procedure.

Laminate and trowelled coatings as well as permanently bonded thermoplastic linings can be used with considerable limitations, but they are not suitable as equivalent plastic pipes can be used instead. Details are to be agreed upon with the manufacturer of the surface protection.

Pipe fittings, e.g. bends, tees, reducers shall preferably be short separate elements for example in accordance with DIN 2848 which are accessible from all sides. Bends > 90° shall normally be subdivided.

4.1.1.4.11.2 Heat exchanger tubes

For weld-in heat exchanger tubes see Table 3, items 8.1 and 8.2.

For partition plates in heat exchangers see Table 3, item 8.3.

4.1.1.4.12 Barrier devices

The protective treatment presupposes that the barrier devices are accessible and can be disassembled to suit the method of application of the surface protection. Particular attention shall be paid to the sealing faces of the barrier devices, also see 4.1.1.4.5.

Table 2 — Recommended maximum lengths of straight pipes and flanged pipe fittings with internal lining

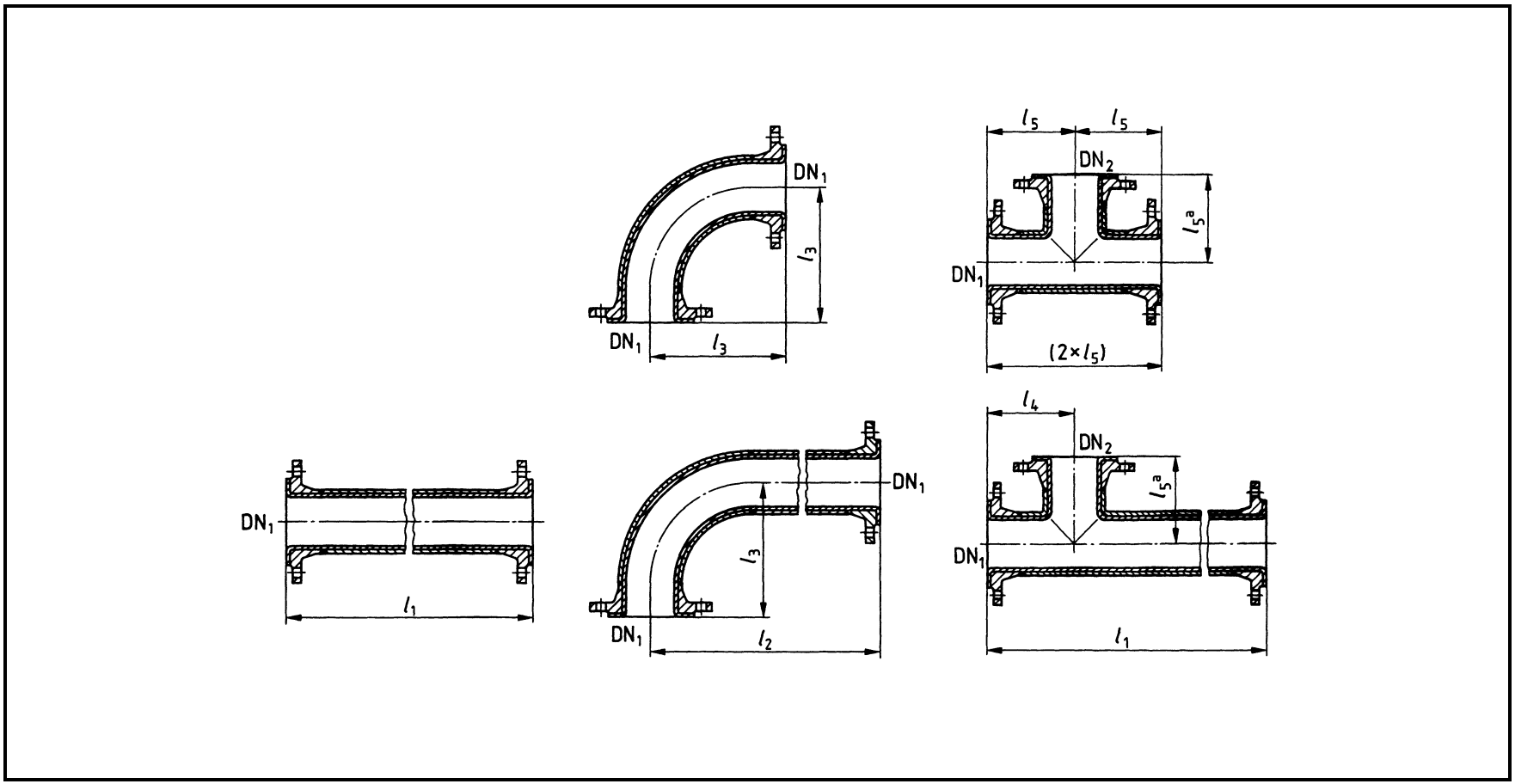


Table 2 (*concluded*)

Surface protection			Maximum length l in mm for DN														
			25	32	40	50	65	80	100	125	150	200	250	300	350	400	500 [b]
Coatings applied by flooding or dipping		l_1 for DN_1	6 000														
Powder coatings		l_1 for DN_1	4 000							5 000							
Laminate and trowelled coatings		l_1 for DN_1	see 4.1.1.4.11.1											1 200			
Thermoplastic linings		l_1 for DN_1	see 4.1.1.4.11.1													1 200	
Duroplastic linings		l_1 for DN_1	—		2 000							2 500	3 000				
Rubber linings		l_1 for DN_1	2 500	3 000	4 000	5 000		6 000									
Coating or lining (for laminate and trowelled coating as well as thermoplastic lining, see 4.1.1.4.11.1)	Duroplastic lining	l_2 for DN_1	—								1 000	2 000					
	Optional	l_2 for DN_1	2 000		3 000												
	Duroplastic lining	l_3 for DN_1	Flanged bends														
			—	—	150	180	220	255	320	385	440	570	710	830	910	1 030	1 300
	Optional	l_3 for DN_1	110	130	150	180	220	255	320	385	440	570	710	830	910	1 030	1 300
	Duroplastic lining	l_4 for DN_2	Tees														
			—	—	150	180	140	165	205	245	285	365	450	525	600	680	830
	Optional	l_4 for DN_2	110	130	150	180	220	255	320	optional							
	Duroplastic lining [a]	l_5 for DN_2	Tees														
			—	—	150	180	140	165	205	245	285	365	450	525	600	680	830
	Optional[a]	l_5 for DN_2	Tees														
			110	130	150	180	220	255	320	385	440	570	710	830	910	1 030	1 300

[a] The values specified apply to nozzles (or branches) $DN_2 = DN_1$; where $DN_2 < DN_1$, values specified for example in DIN 2848, Table 2 may be applied. For footnote a see also figure above.

[b] Pipes > DN 500 shall be treated as part of the vessel.

Table 3 — Design requirements

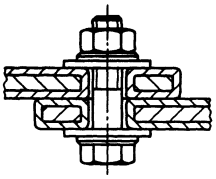
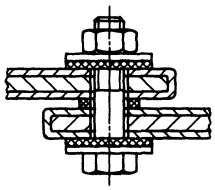
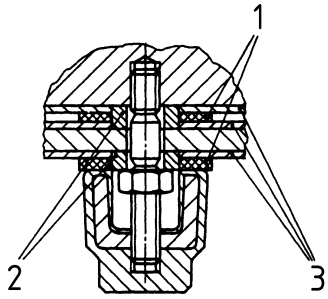
1	2	3	4
Item no	Illustration	Other details	Restrictions on protective system used
1	**Butt welded joints**		
1.1	Butt weld 	Weld upset shall be flattened and be free from notches	Permitted, except for thermoplastic linings
1.2	Change in wall thickness 	—	Permitted, except for thermoplastic linings
2	**Bolted connections in contact with the media**		
2.1	With corrosion-resistant bolt materials 	Washers according to EN ISO 7093-1	Permitted, but should be avoided for laminate and trowelled coatings and thermoplastic linings
2.2	With bore sealing 	Washers according to EN ISO 7093-1	Permitted, but not recommended
2.3	Surface protection relieved from pressure  **Key** 1 Gaskets 2 Disks, resistant to pressure 3 Surface protection	—	Permitted, but not recommended

Table 3 (*continued*)

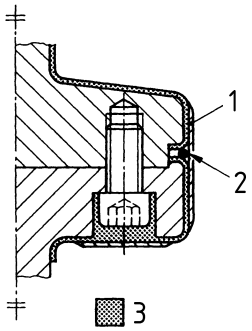
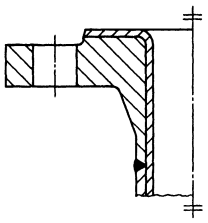
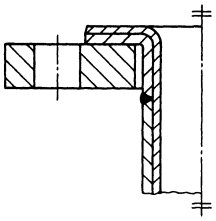
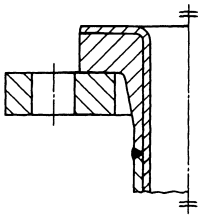
1	2	3	4
Item no	Illustration	Other details	Restrictions on protective system used
2.4	With countersunk screws  **Key** 1 Soft rubber lining 2 O-ring 3 Repair paste	—	Permitted for rubber linings
3	**Flanged designs**		
3.1	Welding neck flange 	Edges shall be rounded	Permitted; some thermoplastic linings may require an edged design
3.2	Lapped pipe end with loose flange 	Stiffness to be considered.	Permitted, but not recommended in the case of duroplastic linings and rubber coatings
3.3	Weld-neck collar with loose flange 	Edges shall be rounded	Permitted; some thermoplastic linings may require an edged design

Table 3 (*continued*)

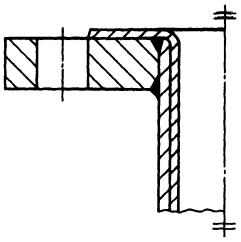
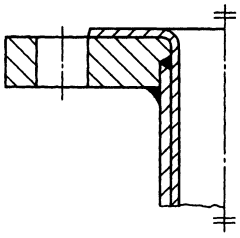
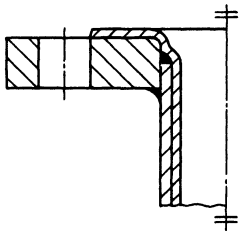
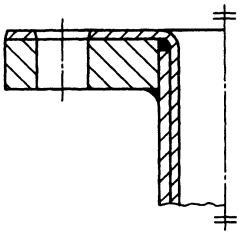
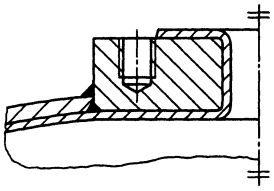
1	2	3	4
Item no	Illustration	Other details	Restrictions on protective system used
3.4	Type A weld-on flange 	Edges shall be rounded	Permitted; some thermoplastic linings may require an edged design
3.5	Type B weld-on flange 	Edges shall be rounded	Permitted; some thermoplastic linings may require an edged design
3.6	Type C weld-on flange 	—	Not permitted
3.7	Type D weld-on flange 	Edges shall be rounded	Permitted; some thermoplastic linings may require an edged design
3.8	Set-in block flange 	Edges shall be rounded	Permitted; some thermoplastic linings may require an edged design

Table 3 (*continued*)

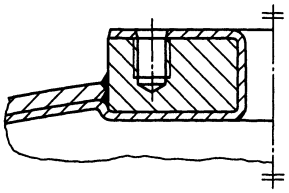
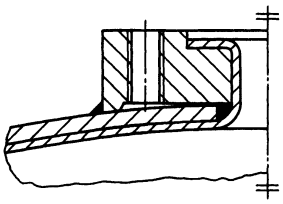
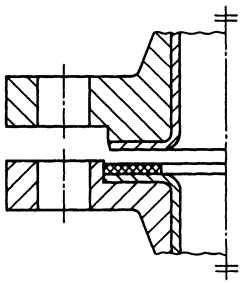
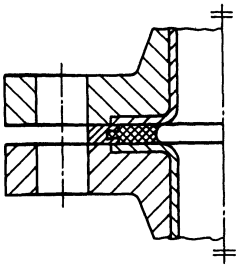
1	2	3	4
Item no	Illustration	Other details	Restrictions on protective system used
3.9	Set-in block flange with internal projection 	—	Permitted, except for duroplastic and thermoplastic linings
3.10	Set-on block flange with recessed raised face 	Edges shall be rounded	Permitted; some thermoplastic linings may require an edged design
3.11	Flat gasket for male and female face flanges 	Suitable for high internal pressures; as a function of geometry, also suitable for sealing in secondary non-positive connection	Permitted
3.12	Example for sealing in secondary non-positive connection 	Suitable for high internal pressures and high secondary pipe loads	Permitted

Table 3 (*continued*)

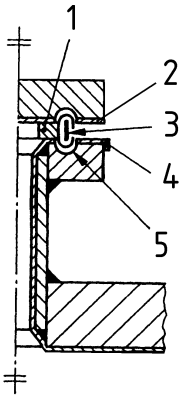
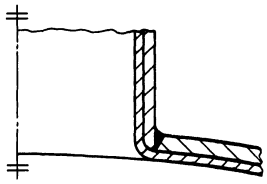
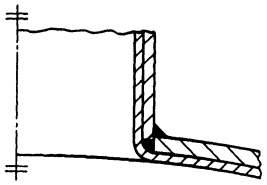
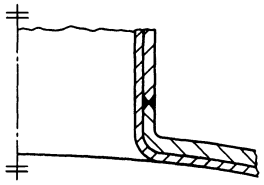
1	2	3	4
Item no	Illustration	Other details	Restrictions on protective system used
3.13	Ring-joint gasket  **Key** 1 PTFE-Ring 2 System internal coating 3 Soft-iron ring 4 End of internal coating 5 Ring groove not to be coated	For high internal pressures	Permitted only for coatings applied by spraying or powder coatings
4	**Nozzles and outlets**		
4.1	Set-in nozzle 	Edges shall be rounded	Permitted; some thermoplastic linings may require an edged design
4.2	Set-in nozzle 	Edges shall be rounded	Permitted; some thermoplastic linings may require an edged design
4.3	Extruded nozzle 	—	Permitted, except for some thermoplastic linings

Table 3 (*continued*)

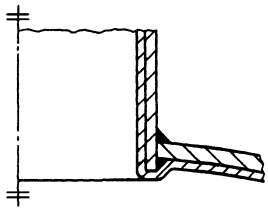
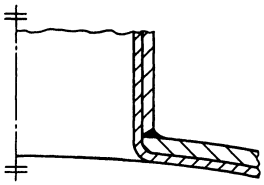
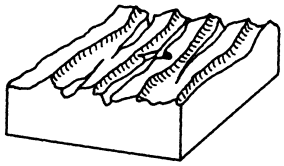
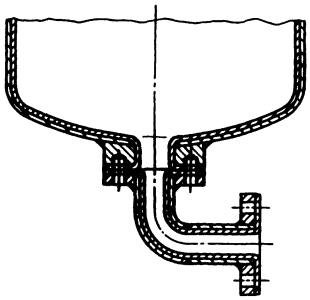
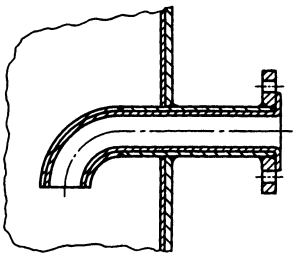
1	2	3	4
Item no	Illustration	Other details	Restrictions on protective system used
4.4	Set-through nozzle 	—	Not permitted
4.5	Set-on nozzle 	Edges shall be rounded	Permitted; some thermoplastic linings may require an edged design
4.6	Weld-on bend 	—	Not permitted
4.7	Flanged-on bend 	—	Permitted
4.8	Weld-in inlet pipe 	—	Not permitted

Table 3 (*continued*)

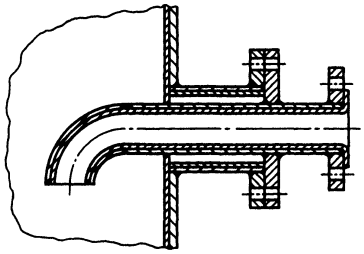
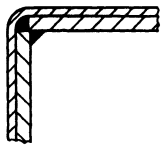
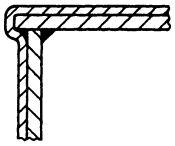
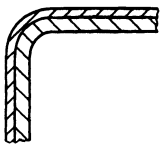
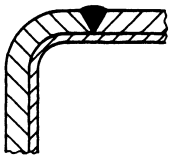
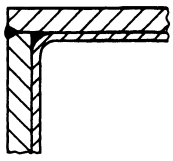
1	2	3	4
Item no	Illustration	Other details	Restrictions on protective system used
4.9	Flanged-in inlet pipe 	—	Permitted
5	**Edges and fillets**		
5.1	Edge with weld (type A) 	Weld shall be rounded	Permitted; some thermoplastic linings require an edged design
5.2	Edge with projection 	—	Not permitted
5.3	Rounded edge 	—	Permitted, except for some thermoplastic linings
5.4	Rounded fillet 	—	Permitted, except for some thermoplastic linings
5.5	Welded fillet 	Weld shall be rounded	Permitted, except for some thermoplastic linings

Table 3 (*continued*)

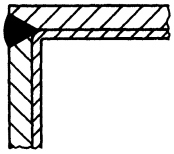
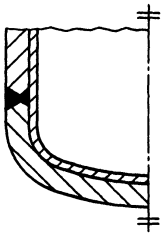
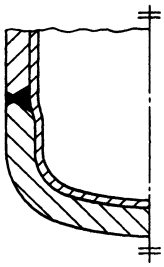
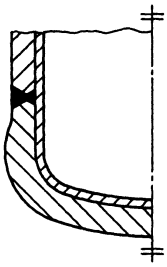
1	2	3	4
Item no	Illustration	Other details	Restrictions on protective system used
5.6	Fillet 	—	Required in the case of some thermoplastic linings; otherwise, not permitted
6	**Shell/end transitions**		
6.1	Dished end 	—	Permitted
6.2	Dished end with change in wall thickness on the inside 	—	Permitted, but not for thermo-plastic linings
6.3	Dished end with change in wall thickness on the outside 	—	Permitted

Table 3 (*continued*)

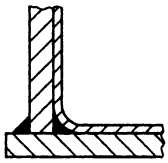
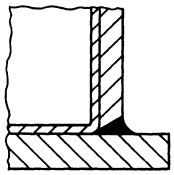
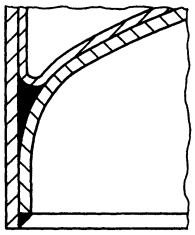
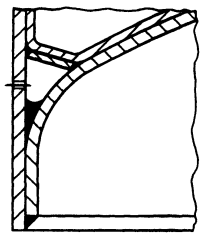
1	2	3	4
Item no	Illustration	Other details	Restrictions on protective system used
6.4	Flat end 	Weld shall be rounded	Permitted, except for some thermoplastic linings
6.5	Flat end 	—	Required in the case of some thermoplastic linings; otherwise, not permitted
6.6	Weld-in dished end 	—	Not permitted
6.7	Torispherical end with inclined plate 	—	Permitted

Table 3 (*continued*)

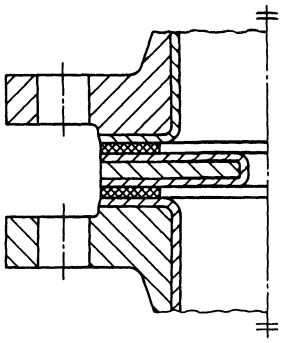
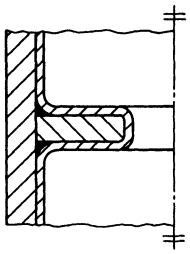
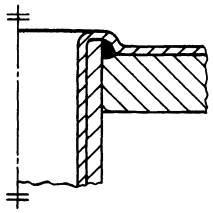
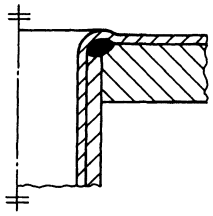
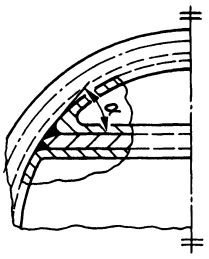
1	2	3	4
Item no	Illustration	Other details	Restrictions on protective system used
7	**Supports and weld-on components**		
7.1	Flanged ring 	Edges shall be rounded	Permitted; some thermoplastic linings may require an edged design
7.2	Support ring 	Welds shall be rounded	Permitted, but not recommended
8	**Heat exchangers**		
8.1	Weld-in tubes 	—	Not permitted
8.2	Weld-in tubes 	Edges shall be rounded	Permitted, for cold and hot-curing coatings

Table 3 (*concluded*)

1	2	3	4
Item no	Illustration	Other details	Restrictions on protective system used
8.3	Partition plate 	—	Permitted where $a \geq 45°$; Not permitted in the case of thermoplastic linings

4.1.2 Requirements for metallic substrates

4.1.2.1 General

The following materials and semi-finished products are suitable for use as metallic substrates.

4.1.2.2 Steel

4.1.2.2.1 Flat products and sections

Strip as specified in EN 10139.

Cold-rolled sheet and strip as in EN 10130+A1, with a surface appearance as specified in ISO 4997.

Sheet and strip (for pressure purposes) as in EN 10028-1 and EN 10028-2.

Hot-rolled flat products and sections as in EN 10025.

4.1.2.2.2 Tubes

4.1.2.2.2.1 Seamless tubes

Seamless tubes as in EN 10208-1 and EN 10216-2.

4.1.2.2.2.2 Welded tubes

Welded tubes according to ISO 9330-1, EN 10217-1 and EN 10217-2.

Any weld upset shall be removed. The use of welded tubes having a nominal size lower than DN 500 shall be agreed upon with the coating or lining applicator.

4.1.2.3 Stainless steel

4.1.2.3.1 Flat products and sections

Flat products and sections according to EN 10088-2 and EN 10088-3.

4.1.2.3.2 Tubes

4.1.2.3.2.1 Seamless tubes

Seamless tubes according to EN 10297-2 and ISO 9329.

4.1.2.3.2.2 Welded tubes

Welded tubes according to EN 10296-2 and EN 10217-7.

Any weld upset shall be removed. The use of welded tubes having a nominal size lower than 500 mm shall be agreed upon with the coating or lining applicator.

4.1.2.4 Cast materials

Cast steel and iron according to EN 10293, prEN 10340 and EN 1559-1 with a surface appearance as specified in 4.4 of EN 1559-1:1997, with the following exception:

Minor surface imperfections such as small patches of sand or slag, flashes, small shrink holes, localized porosity or small cold laps or scabs shall be removed by grinding and smoothing. Filling defects with putty is not permitted. Weld zones and brazed areas shall be pit-free and smooth.

These requirements apply by analogy to cast materials not listed here.

4.1.2.5 Other metallic materials and products

Other metals such as copper, aluminium and their alloys, and nickel and products other than those listed in this European Standard may be used if so agreed with the coating/lining manufacturer. The requirements of this European Standard are analogously valid.

4.1.2.6 Substrate requirements

Tables 4 and 5 specify requirements for the substrate and welds according to the type and thickness of the coating/lining. Prior to abrasive blast cleaning, a person with normal vision shall make a preliminary assessment as to whether the substrate will be suitable for the intended coating/lining after it has been blasted. A final assessment of the surface condition shall be made after blast cleaning, with due consideration being given to the coating or lining material and application process used. In Table 4, substrate imperfections have been characterized analogous to EN ISO 8785, and in Table 5 weld imperfections described analogous to EN ISO 6520-1 and EN ISO 5817.

Substrates and welds which do not meet the requirements of Tables 4 and 5 have to be reworked in agreement with the coating/lining manufacturer.

Substrates that are soiled by oil, grease or provisional protective coatings, or are chemically contaminated (e.g. by exposure to a corrosive environment, the effects of salt or chemical loading) have to be removed before the coating or lining is applied. Any special measures taken shall be agreed between the plant operator, component manufacturer and coating or lining applicator.

Table 4 — Substrate imperfections

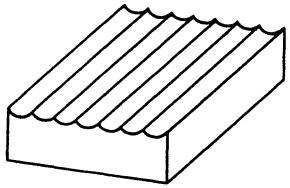
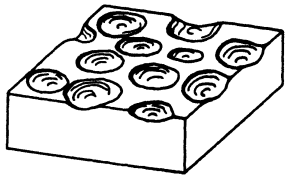
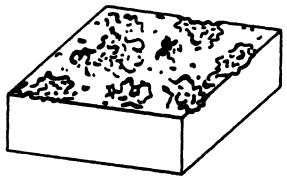
No.	Type of imperfection (illustration not to scale)		Substrate requirements (requirement class)				
			A1	A2	A3	A4	A5
			For a nominal coating thickness of 50 µm up to 200 µm	For a nominal coating thickness over 200 µm up to 1 000 µm	For a nominal coating thickness over 1 000 µm	For a nominal lining thickness (natural or synthetic rubber or phenol-formaldehyde resin sheeting) over 1 000 µm	For a nominal lining thickness (thermoplastic sheeting) over 1 000 µm
1	Grooves 	Regular or irregular indentations or tracks with relatively sharp edges. They can occur singly or in groups, either in parallel or criss-crossing. They can be produced even when properly carrying out machining processes such as turning, grinding or planing.	Permitted where $R_z \leq 50$ µm.	Permitted where $R_z \leq 100$ µm.	Permitted where $R_z \leq 160$ µm.	For autoclave vulcanised rubber, permitted where $R_z \leq 160$ µm; otherwise, permitted where $R_z \leq 100$ µm.	With contact adhesives, permitted where $R_z \leq 100$ µm; with reactive adhesives permitted where $R_z \leq 160$ µm.
For R_z see EN ISO 1302							
2	Pits 	Localized, more or less defined irregular depressions in the surface, being round or square, single or clustered. They can be caused by mechanical action or result from wide pitting.	Single, localized shallow pits with a smooth surface are permitted.	Shallow pits with a smooth surface are permitted.	Shallow pits are permitted.	Shallow pits with a width/depth ratio of 30 or higher are permitted.	Not permitted.
3	Localized corrosion 	Localized concentration of corrosion products.	Permitted when the initial condition of the substrate does not correspond to a rust grade higher than B as in EN ISO 12944-4.	Permitted when the initial condition of the substrate does not correspond to a rust grade higher than C as in EN ISO 12944-4.	Permitted when the initial condition of the substrate does not correspond to a rust grade higher than C as in EN ISO 12944-4.	Permitted when the initial condition of the substrate does not correspond to a rust grade higher than C as in EN ISO 12944-4.	Permitted when the initial condition of the substrate does not correspond to a rust grade higher than C as in EN ISO 12944-4.

Table 4 (*continued*)

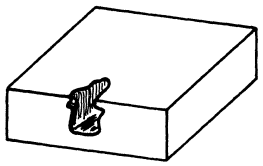
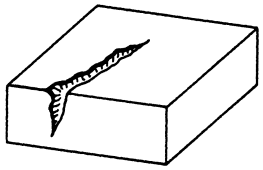
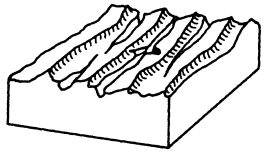
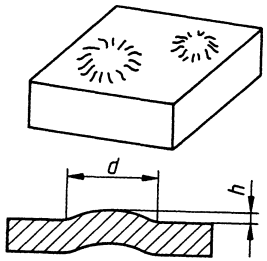
			A1	A2	A3	A4	A5
4	Shrinkage cavities and pores 	Sharply defined point-like depressions with a depth much larger than their diameter. They can be single or clustered and may also occur in welds.	Not permitted.	Not permitted.	Not permitted.	Not permitted.	Not permitted.
5	Cracks 	Localized discontinuities in the material structure, of minor width but often of considerable length and depth; also occur in welds. Cracking can result from internal or external stresses or from corrosion.	Not permitted.	Not permitted.	Not permitted.	Not permitted.	Not permitted.
6	Scores and scratches 	Trough-like irregular tracks that are clearly visible and tangible. They can be produced by improper handling such as incorrect freehand grinding or during transport.	Permitted where $R_z \leq 50$ µm.	Permitted where $R_z \leq 100$ µm.	Permitted where $R_z \leq 160$ µm.	For autoclave vulcanised rubber, permitted where $R_z \leq 160$ µm, otherwise permitted where $R_z \leq 100$ µm.	With contact adhesives, permitted where $R_z \leq 100$ µm, with reactive adhesives permitted where $R_z \leq 160$ µm.
7	Projections 	Localized raised areas (e.g. defects on castings due to defects in the mould surface).	Permitted for flat sections.	Permitted for flat sections.	Permitted for flat sections.	Permitted for flat sections if $d/h \geq 10$.	Not permitted.

Table 4 (*continued*)

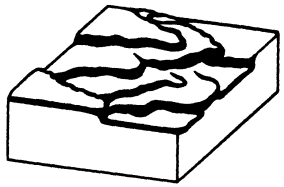
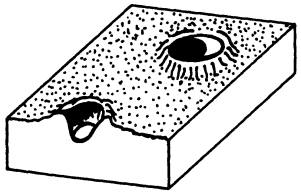
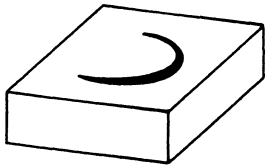
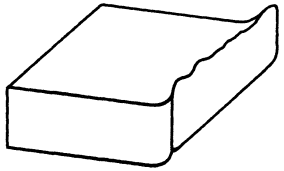
			A1	A2	A3	A4	A5
8	Stepped surface 	Lamellar, flaky and veined surface, which can be produced by lamellar corrosion or rolling defects.	Not permitted.	Not permitted.	Not permitted.	Not permitted.	Not permitted.
9	Dents 	Crater-like localized depressions, usually with a bulged edge. They can be produced by impacts, blows, when blast cleaning or as centring marks.	Not permitted.	Permitted if the dents are not too deep, the edges are ground down, and the coating/lining material will completely fill the dent without forming bubbles.	Permitted if the dents are not too deep, the edges are ground down, and the coating/lining material will completely fill the dent without forming bubbles.	Permitted if the dents are not too deep, the edges are ground down, and the coating/lining material will completely fill the dent without forming bubbles.	Permitted if the dents are not too deep, the edges are ground down, and the coating/lining material will completely fill the dent without forming bubbles.
10	Scales 	Localized laminations of the material. They are due to imperfections in the material or result from the manufacturing process.	Not permitted.	Not permitted.	Not permitted.	Not permitted.	Not permitted.
11	Burrs 	Sharp raised edges produced by machining or due to mechanical damage.	Not permitted.	Not permitted.	Not permitted.	Not permitted.	Not permitted.

Table 5 — Weld imperfections

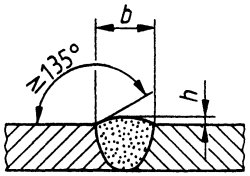
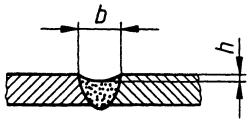
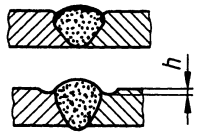
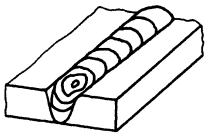
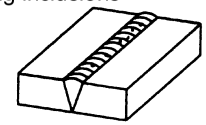
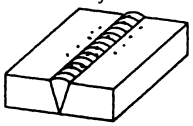
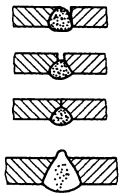
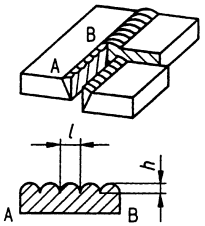
No.	Type of imperfection (illustration not to scale)		Substrate requirements (requirement class)				
			A1	A2	A3	A4	A5
			For a nominal coating thickness of 50 µm up to 200 µm	For a nominal coating thickness over 200 µm up to 1 000 µm	For a nominal coating thickness over 1 000 µm	For a nominal lining thickness (natural or synthetic rubber or phenol-formaldehyde resin sheeting) over 1 000 µm	For a nominal lining thickness (thermoplastic sheeting) over 1 000 µm
1	Excess weld metal and overlap 	Excessive cover run, but with smooth transition to parent metal.	Permitted if the weld has a regular shape.	Permitted.	Permitted where $b/h \geq 4$ (for laminate coatings, only in some cases). Not permitted for trowelled coatings or fillet welds.	Permitted where $b/h \geq 10$. Not permitted for fillet welds or tubes with a nominal size of DN 500 or lower.	Not permitted.
2	Incompletely filled groove 	Intermittent or continuous channel in the surface of a weld.	Permitted if channel is not too deep, its edges are rounded and $b/h \geq 4$.	Permitted if channel is not too deep, its edges are rounded and $b/h \geq 4$.	Permitted if channel is not too deep, its edges are rounded and $b/h \geq 4$. For laminate coatings, permitted only in some cases.	Permitted where $b/h \geq 10$. Not permitted for tubes with a nominal size of DN 500 or lower.	Not permitted.
3	Undercuts 	Continuous or intermittent irregular groove in the parent metal caused by welding.	Not permitted.	Permitted if edges can be smoothed by blast cleaning.	Permitted if edges can be smoothed by blast cleaning.	Permitted where h is not greater than 0,1 mm if edges can be smoothed by blast cleaning.	Permitted if edges can be smoothed by blast cleaning.

Table 5 (*concluded*)

			A1	A2	A3	A4	A5
4	End crater pipe 	Depression due to shrinkage at the end of a weld run.	Not permitted.	Not permitted.	Not permitted.	Not permitted.	Not permitted.
5	Slag inclusions 	Slag entrapped in the weld metal.	Not permitted.	Not permitted.	Not permitted.	Not permitted.	Not permitted.
6	Spatter or stray flash 	Weld spatters expelled during welding; damage of the parent metal resulting from the accidental striking of an arc away from the weld (stray flash).	Not permitted.	Not permitted.	Not permitted.	Not permitted.	Not permitted.
7	Open joints or excess penetration bead 	Open joints or excess weld metal protruding through the root of weld made from one side only.	Not permitted.	Not permitted.	Not permitted.	Not permitted.	Not permitted.
8	Rippled weld 	Weld with rippled surface (e.g. in vertical welds, or manual electrode welding).	Not permitted.	Permitted where $l/h \geq 4$.	Permitted where $l/h \geq 4$. Permitted only in some cases for laminate coatings. Not permitted for trowelled coatings.	Permitted where $h \leq 0{,}3$ mm, if $l/h \geq 30$.	Not permitted.
NOTE For Rz see EN ISO 1302.							

4.2 Concrete structures

4.2.1 Design of concrete structures

4.2.1.1 General

4.2.1 specifies requirements for the design of concrete parts used in process plant units to which a protective coating in compliance with prEN 14879-3 and/or a protective lining in compliance with prEN 14879-5 is to be applied, and provides recommendations with regard to the preparatory treatment of concrete, screed or plaster substrates. In addition to the standard load cases (for an example according to the series of standards EN 1991), the following factors shall be considered:

— restraint caused by deformation as a result of thermal movement;

— restraint caused by differential settlement;

— restraint caused by shrinkage, hydration heat or changes in moisture content.

Plain and reinforced concrete has to be rated according to the exposure classes according to EN 206-1.

The inner side of the coating shall be protected from the adverse effects of water, water vapour pressure and hydrostatic pressure. Water vapour is deemed deleterious if it is likely to cause the protective coating to debond under service conditions.

Debonding may also be caused by frost, moisture accumulating under the coating, capillary forces or water-soluble substances creating osmotic pressure. If the structure is exposed to groundwater infiltration, waterproofing is to be provided.

4.2.1.2 Defining limit states of cracking

Care shall be taken to minimize cracking, as the performance of the protective coating may be impaired by the formation of cracks in the concrete surface. All limit states resulting from the erection of a process plant and its subsequent operation shall be considered in the analysis.

In addition to deformation as a result of static or dynamic loads, deformation may also be caused by unstable bearing conditions, shrinkage, creep or thermal movement. Such stresses may be accidental or permanent.

The risk of crack formation shall be minimized by choosing the appropriate design. The cross section of concrete parts shall be continuous throughout, i.e. it shall have no notches. When specifying the maximum crack width, the expansion characteristics of the coating or lining system selected shall be considered.

Detailed calculation has to be carried out according to EN 1992-1-1 under consideration of the additional statements according to ENV 1504-9.

In certain cases, pre-stressing should be considered.

For the planning of new concrete parts or the assessment of existing concrete parts, the following grouping can be used.

A: Substrates with very narrow cracks

Discontinuous cracks of a width less than 0,1 mm (crazing) are permissible. New cracks or existing cracks that have widened after the coating system has been applied shall not exceed a width of 0,1 mm.

Group A includes pre-stressed and reinforced concrete members in state I as specified in EN 206-1 as well as reinforced floor slabs in full contact with their support and the upper surface of single-span, non-projecting slabs.

B: Substrates with narrow cracks

The width of cracks shall not exceed 0,3 mm. This also applies to new cracks or to existing cracks that have widened after the coating system has been applied and where the coating system is to cover the tension side of reinforced concrete members.

Group B includes reinforced concrete parts as specified in EN 206-1.

C: Substrates with wide cracks

The width of cracks shall not exceed 0,5 mm.

This group includes cracks of widths exceeding those specified for group B, regardless of whether such cracks have been allowed for in the analysis or have accidentally occurred in service.

The application of a coating system to concrete parts belonging to this group requires particular care.

Specifications given for groups A to C apply to cracks caused by tension or flexure as the result of mechanical or thermal loading. Cracks that have been caused by shear shall not be bridged by a protective coating.

4.2.1.3 Joints

As joints generally present a risk to the water tightness of the concrete structure and coating system, the number of joints designed to accommodate the expansion and contraction movements should be limited.

Joints should be straight, located at the upper end of slopes and detailed so as to suit the coating system selected.

4.2.1.4 Inclined surfaces

Inclined concrete surfaces that are exposed to liquids shall be laid to a fall of not less than 1,5 %. In order to allow for tolerances, a further 0,5 %, up to a maximum of 30 mm should be added. The slope should be directed away from main girders and tank foundations, walls and expansion joints, thus providing adequate drainage.

4.2.1.5 Flatness

Point deviations from flatness of the substrate shall not exceed

- 2 mm on a length of 0,1 m;
- 4 mm on a length of 1 m;
- 10 mm on a length of 4 m;
- 12 mm on a length of 10 m;
- 15 mm on a length of 15 m.

Intermediate values shall be interpolated and rounded to the nearest mm.

4.2.1.6 Gutters and trenches

Gutters and trenches shall not be run over surfaces which may be subject to deformation and subsequent cracking. Their slope shall generally be of 1 %, however, not less than 0,5 %. As joints in gutters and trenches present a risk to water tightness, their number should be limited. They require a particular design.

The trench width shall be designed as a function of the maximum depth to ensure appropriate lining of the bottom.

4.2.1.7 Pits and tanks

Pits and tanks partly installed in ground shall be insulated against the ingress of moisture.

4.2.1.8 Components

Components such as sockets, drainage outlets, ties and penetration sleeves shall be fastened to the concrete part so that the function of the protection system to be applied later is secured also during loading. Influence caused by movements resulting from temperature changes, vibration, traffic etc., have to be considered during the design of the construction.

When selecting materials for components, the type of coating system to be used shall be taken into account. If ties are to be fixed to concrete parts, ceramic sockets or bonded anchors may be provided.

4.2.1.9 Concrete/screed on inclined surfaces or levelling layers

The risk of cracking in inclined concrete and/or screed surfaces shall be minimized by providing additional reinforcement. It shall be ensured that all movements resulting from temperature changes, vibration, traffic etc. are accommodated.

Cementitious screed shall be at least of class CT 30 in compliance with EN 13813.

In case a levelling layer has to be applied to the substrate or in case of repair, sufficient bond strength and surface hardness are requisite features.

A protective coating may also be applied to masonry, providing it has been given a permanently adhesive layer of plaster.

4.2.2 Requirements for concrete substrates

4.2.2.1 General

For the planned application the concrete has to meet the respective requirements according to EN 206-1, EN 1990 and EN 1992-1-1. In addition the series of standards EN 1504 shall be taken into account.

4.2.2.2 Construction materials

The requirements for the working of concrete, screed and plaster shall be stated in the specifications of work, in compliance with relevant standards. Concrete admixtures and curing aids shall be compatible with the coating system.

4.2.2.3 Concrete surfaces

4.2.2.3.1 Casting

Structural concrete should be cast so that its surface is even and free from imperfections, thus rendering the application of additional levelling layers superfluous.

If a protective coating is to be applied to structural concrete, curing as specified in EN 206-1 is indispensable.

Concrete members shall be cast according to the specified surface profile. The surface to be given a protective coating shall not be smoothed. If shall have an almost even, uniform texture providing an adequate key as is obtained by finishing the surface with a wooden float.

Concrete surfaces that have been compacted and smoothed by machines shall be roughened. The hardened surface shall be even and free from flash, clusters, laitance, as well as flaky or brittle layers.

Sharp edges shall be rounded. Depending on the type of the protective coating used, the fillets shall be hollowed to permit adequate adhesion of the coating.

4.2.2.3.2 Preparation

4.2.2.3.2.1 General

Roughening of the concrete surface is generally required. Any cementitious grout, brittle or flaky layers, as well as residues of separating agents shall be removed by appropriate means such as blast-cleaning, grinding, flame cleaning, milling and shot-peening. The degree of roughness required largely depends on the type of coating system to be used. If curing aids have been used, the contractor applying the protective coating shall be notified so that any additional measures required may be taken.

Surface irregularities (e.g. flash, gravel clusters) shall be removed by levelling the surface using a filling mortar that provides a sufficient bond and is suitable for the subsequent application of a protective coating.

Distance pieces and binding wire susceptible to corrosion shall be cut at a depth of at least 20 mm below the surface and the holes filled as prescribed. Preference shall be given to distance pieces with detachable cones.

Concrete surfaces that have been attacked in depth by acids, alkaline solutions, oils or other deteriorating substances shall be stripped down to the sound substrate, and fresh concrete placed. Where only the upper layer has been affected, blast-cleaning or emulsifying may be deemed a satisfactory means of preparing the concrete parts to receive the protective coating. Appropriate measures shall be taken to neutralize any residues in order to prevent subsequent deterioration of the coating (e.g. by sulphur scum).

4.2.2.3.2.2 Blast-cleaning and grinding

A conventional means of removing thin layers such as cementitious grout, cement, paint and soiling is blast-cleaning and grinding. However, the removal of brittle concrete layers requires more appropriate means, such as pressurized water blast-cleaning or shot peening.

Shot peening is a dust-free method of blast-cleaning in which an encapsulated self-propelling machine is run over a horizontal or inclined surface directing a stream of metallic shot or grit onto the deteriorated surface which is loosened while the ensuing debris is simultaneously vacuumed.

Given the design of shot peening machines, the edges of concrete members and the areas surrounding components that have been fitted into the concrete will require subsequent manual or mechanical cleaning.

4.2.2.3.2.3 Flame cleaning

When flame cleaning is used, the concrete surface is momentarily exposed to an oxygen-acetylene flame at about 1 500 °C, thus causing flaking and fusion in the upper 5 mm layer. The surface is thus cleansed of oil stains and of any residues of bitumen, paint, coatings and rubber.

As a certain extent of spalling and softening of the underlying layer cannot be avoided, mechanical cleaning as described in 4.2.2.3.2.2 is essential. As a consequence, this method is not recommended for cleaning reinforced concrete with a thin cover, fragile members or elements, or screed and other lightweight aggregate surfaces.

4.2.2.3.2.4 Chipping and cutting

In order to cut away thicker layers, a wide chipping or milling cutter should be used.

As a certain extent of spalling and softening of the underlying layer cannot be avoided mechanical cleaning as described in 4.2.2.3.2.2 is essential. As a consequence, this method is not recommended for cleaning reinforced concrete with a thin cover, fragile members or elements, or screed and other lightweight aggregate surfaces.

4.2.2.4 Drying

The concrete surface shall be dry throughout before the protective coating is applied. The contractor in charge of applying the protective coating shall assess the degree of residual moisture and ensure that the relevant limit values specified by the manufacturer of the coating manufacturer material are complied with. The moisture content,

which is to be measured with an appropriate device, shall not exceed 4 % at a depth of 20 mm (see EN 1504-10). Coating systems tolerating a higher moisture content do, however, exist.

Accelerated drying should be avoided. Where it is indispensable, it should begin no earlier than seven days after the concrete has been cast. Adequate ventilation shall be ensured as the temperature is gradually increased. The temperature of the concrete surface shall not exceed 50 °C. Over-rapid drying may cause damage to the concrete, screed or plaster.

4.2.2.5 Tensile strength

The substrate shall have a tensile strength in accordance with the specifications in Table 6. The number of tensile tests required depends on the evenness and size of the surfaces to be coated.

Table 6 — Tensile strength to the substrates

Protective and repair measures: Local repair or planar coating with	Tensile strength, in N/mm^2	
	Average	Minimum
Cement/mortar (modified or unmodified)	> 1,5	> 1,0
Polymer concrete or mortar (for surfaces not exposed to traffic loads)	> 1,5	> 1,0
Resin coatings up to 1 mm thick	> 1,5	> 1,0
Resin coatings thicker than 1 mm, for mechanical load grade 2 loading or more, as in prEN 14879-3 and prEN 14879-5	> 2,0	> 1,5

4.2.2.6 Temperature

Specifications regarding the temperature conditions required for coating are given in other Parts of this European Standard.

Bibliography

[1] EN 1708-1, *Welding — Basic weld joint details in steel — Part 1: Pressurized components*

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

[3] EN 1991-1-2, *Eurocode 1: Actions on structures — Part 1-2: General actions — Actions on structures exposed to fire*

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

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

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

[7] prEN 1991-4, *Eurocode 1 - Actions on structures — Part 4: Silos and tanks*

[8] EN ISO 1302, *Geometrical product specifications (GPS) — Indication of surface texture in technical product documentation (ISO 1302:2002)*

[9] EN ISO 5817, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Guidance on quality levels for imperfections (ISO 5817:2003)*

[10] EN ISO 8785, *Geometrical product specifications (GPS) — Surface imperfections — Terms, definitions and parameters (ISO 8785:1998)*

[11] EN ISO 12944-3, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 3: Design considerations (ISO 12944-3:1998)*

[12] DIN 2848, *Flanged steel pipes and flanged steel or cast iron fittings with lining — PN 10, PN 25 and PN 40*

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