

Internal and/or external protective coatings for steel tubes
Specification for hot dip galvanized coatings applied
in automatic plants
English version of DIN EN 10240

DIN
EN 10240

ICS 23.040.10; 25.220.40; 77.140.75

Supersedes DIN 2444,
January 1984 edition.

Descriptors: Coatings, steel pipes.

Innere und/oder äußere Schutzüberzüge für Stahlrohre –
Festlegungen für durch Schmelztauchverzinken in automatisierten
Anlagen hergestellte Überzüge

European Standard EN 10240 : 1997 has the status of a DIN Standard.

A comma is used as the decimal marker.

National foreword

This standard has been prepared by ECISS/TC 29.

The responsible German body involved in its preparation was the *Normenausschuß Rohre, Rohrverbindungen und Rohrleitungen* (Pipes, Pipe Joints and Pipelines Standards Committee).

Amendments

DIN 2444, January 1984 edition, has been superseded by the specifications of EN 10240.

Previous editions

DIN 2444: 1963-03, 1972-08, 1978-07, 1984-01.

EN comprises 17 pages.

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Revêtements intérieurs et/ou
extérieurs des tubes en acier –
Spécifications pour revêtements à
chaud sur des lignes automatiques

Innere und/oder äußere Schutzüber-
züge für Stahlrohre – Festlegungen
für durch Schmelztauchverzinken in
automatisierten Anlagen hergestellte
Überzüge

This European Standard was approved by CEN on 1997-08-09.

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.

The European Standards exist 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.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Contents

Foreword.....	3
1 Scope	4
2 Normative references	4
3 Definitions	5
4 Designation of coating quality	6
5 Information to be supplied by the purchaser.....	6
6 Hot dip galvanizing process.....	7
7 General requirements of the coating	7
8 Special requirements of the coating	8
9 Inspection.....	10
10 Sampling	10
11 Inspection and test methods	11
12 Post galvanizing treatment	13
13 Marking.....	14
Annex A (normative) Condition of the tube to be coated	14
Annex B (normative) Method of determination of the local coating thickness using the magnetic method (ISO 2178)	14
Annex C (normative) Method of determination of the mass of the coating per unit area using the gravimetric method (EN ISO 1460)	15
Annex D (informative) Guidelines for the galvanizer's procedure for non-specific inspection and testing of coating quality A.1 in accordance with EN 10021 - Frequency of inspection and testing.....	17

Foreword

This European Standard has been prepared by Technical Committee ECISS/TC 29 "Steel tubes and fittings for steel tubes", the secretariat of which is held by UNI.

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 June 1998, and conflicting national standards shall be withdrawn at the latest by June 1998.

The European Committee for Iron and Steel Standardization (ECISS) instructed the Technical Committee ECISS/TC 29 to draw up a European Standard for hot dip galvanized coatings for steel tubes.

This task has been undertaken by the sub-committee ECISS/TC 29/SC 4, the secretariat of which is held by the Association Française de Normalisation (AFNOR). The sub-committee has recognised that the quality required of a hot dip galvanized coating depends on the intended application of the steel tubes and it must relate to the capabilities of the process by which the coating is applied. Consequently this standard specifies a number of coating qualities each with different coating requirements for hot dip galvanized coatings applied to steel tubes in automatic plants. The purchaser is required to specify one of these coating qualities in his enquiry and order.

In respect of potential adverse effects on the quality of water intended for human consumption, caused by the product covered by this standard :

- 1) this standard provides no information as to whether the product may be used without restriction in any of the Member States of the EU or EFTA ;
- 2) it should be noted that, while awaiting the adoption of verifiable European criteria, existing national regulations concerning the use and/or the characteristics of this product remain in force.

No EURONORM is replaced by this European Standard.

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

1 Scope

1.1 This European Standard specifies the requirements and tests for hot dip galvanized coatings applied to steel tubes hot dip galvanized in automatic plants (see 3.9) for the following :

- a) gas and water installations, including water intended for human consumption ;
- b) other applications e.g. scaffold tubes, structural hollow sections.

NOTE 1 : Subsequently in this European Standard, the term "tube" includes "hollow section".

NOTE 2 : Hot dip galvanized coatings for steel tubes fabricated (see 3.10) subsequent to manufacture or hot dip galvanized in non-automatic plants are specified in prEN ISO 1461. Hot dip galvanized coatings for steel tube fittings and accessories are within the scope of sub-committee ECISS/TC 29/SC 3.

1.2 In addition to the requirements of this European Standard the general technical delivery requirements specified in EN 10021 apply.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 1179	Zinc and zinc alloys - Primary zinc
EN 10021	General technical delivery requirements for steel and iron products
EN 10204	Metallic products - Types of inspection documents (including amendment A1:1995)
EN 10232	Metallic materials - Tube (in full section) - Bend test
EN 10233	Metallic materials - Tube - Flattening test
prEN 10266 ¹⁾	Steel tubes, fittings and structural hollow sections - Definitions and symbols for use in product standards
EN ISO 1460	Metallic coatings - Hot dip galvanized coatings on ferrous materials - Gravimetric determination of the mass per unit area
prEN ISO 1461 ¹⁾	Hot dip galvanized coatings on fabricated ferrous products - Specification

¹⁾ In preparation ; until this document is published as a European Standard, a corresponding national standard should be agreed at the time of enquiry and order.

EN ISO 1463	Metallic and oxide coatings - Measurement of coating thickness - Microscopical method
EN ISO 9001	Quality systems - Model for quality assurance in design, development, production, installation and servicing
EN ISO 9002	Quality systems - Model for quality assurance in production, installation and servicing
ISO 2178	Non-magnetic coatings on magnetic substrates - Measurement of coating thickness - Magnetic method

3 Definitions

For the purpose of this European Standard, the following definitions apply , in addition to those of prEN 10266 :

3.1 hot dip galvanizing

Formation of a coating of zinc and/or zinc-iron alloys produced by dipping prepared steel in molten zinc.

3.2 hot dip galvanized coating (subsequently referred to as "the coating")

The coating consisting of zinc-iron alloys usually covered by zinc, obtained by hot dip galvanizing.

3.3 coating mass

The total mass of zinc and/or zinc-iron alloys per unit area of surface (expressed in grammes per square metre, g/m²).

3.4 coating thickness

The total thickness of zinc and/or zinc-iron alloys (expressed in micrometers, μm).

3.5 local coating thickness

The mean value of coating thickness obtained from the specified number of measurements within a reference area for a magnetic test or determined from the single value from a gravimetric test.

3.6 local coating mass

The value of coating mass obtained from a single gravimetric test.

3.7 significant surface

The whole of the inside and/or outside surfaces of the tube depending upon the application, but excluding the end faces.

3.8 reference area

An area of significant surface within which a specified number of single measurements of coating thickness is to be made.

3.9 automatic plant

A plant in which tubes are hot dip galvanized and mechanically handled individually at withdrawal from the hot dip galvanizing bath.

3.10 fabricated

Manipulated e.g. welded, bent, assembled.

4 Designation of coating quality

For the coatings specified in this European Standard, the quality designation shall consist of one of the following to identify the intended application of the tube :

- a) A for gas and water installations, including water intended for human consumption ;
- b) B for other applications ;

followed by a full stop and a number to identify the special requirements for that application (see 8.2.1 and table 1), e.g. A.3.

5 Information to be supplied by the purchaser

5.1 Mandatory information

The following information, when appropriate, shall be supplied by the purchaser to the galvanizer at the time of enquiry and order :

- a) the number of this European standard ;
- b) the designation of coating quality (see clause 4) ;
- c) the product standard to which the tubes to be galvanized were manufactured.

5.2 Options

A number of options are permitted by this European Standard, and they are listed below with the appropriate clause references. Where the purchaser identifies an option he shall include it in his enquiry and order. In the event that the purchaser does not indicate his wish to implement an option, the galvanizer shall supply in accordance with the base specification :

- 1) the minimum local coating thickness on the outside surface is specified. This option applies to coating qualities A.1, A.2 and A.3 only, and the purchaser shall indicate the minimum local coating thickness required (see 8.2.1c) ;
- 2) the chemical composition of the coating shall comply with 8.2.1f. This option applies to coating qualities A.2 and A.3 only ;
- 3) the minimum local coating thickness required is in excess of 55 μm . This option applies to coating quality B.1 only and the purchaser shall indicate the minimum coating thickness required (see 8.2.2), e.g. as specified in prEN ISO 1461 ;
- 4) the type of post galvanizing treatment is specified. The purchaser shall indicate the type of post galvanizing treatment required (see clause 12) ;
- 5) a post galvanizing treatment is precluded (see clause 12).

6 Hot dip galvanizing process

6.1 The galvanizer and the stockist, where products are supplied through a stockist, shall operate a quality system in accordance with EN ISO 9002.

NOTE : This requirement is also fulfilled by a quality system in accordance with EN ISO 9001.

6.2 The zinc added to the galvanizing bath shall contain a total of impurities (other than iron and tin) specified in EN 1179 not exceeding 1,5 %.

7 General requirements of the coating

NOTE : The surface quality, thickness and adhesion of the coating may be influenced by the surface condition of the tubes to be coated (see annex A).

7.1 Surface

The coating on both the inside and outside surfaces shall be continuous, smooth and free from flux residues on the significant surface.

NOTE : White marks on the surface of the coating (commonly known as "wet storage stain") are permitted if the requirements for the coating thickness are met.

7.2 Thickness

The coating thickness on the significant surface (inside and/or outside as applicable) shall comply with the requirements of the coating quality specified (see 8.2).

NOTE : Service life increases with increase in coating thickness, but thicker coatings are more susceptible to mechanical damage.

7.3 Adhesion

When tested in accordance with 11.4.2 or 11.4.3 the coating shall show no evidence of flaking on the significant surface. In addition the coating shall show no evidence of cracking on the significant surface when subjected to the bend test. Flaking adjacent to cut faces or at the corners of square or rectangular tubes shall not be cause for rejection.

8 Special requirements of the coating

8.1 All coatings have special requirements which are related to the application of the tube. These are detailed in the coating qualities specified in 8.2 one of which shall be specified by the purchaser in his enquiry and order (see 5.1).

8.2 Requirements of coating quality

8.2.1 Coating qualities, A.1, A.2 and A.3

a) the surface of the coating on the inside surface shall be as smooth as can be achieved by steam blowing.

NOTE 1 : Steam blowing produces a smoother surface on tubes of outside diameter 21,3 mm up to and including 88,9 mm than on tubes of other sizes.

NOTE 2 : Some variations may occur in the surface condition of the coating at the points where the tube is held whilst steam blowing and within 50 mm of the tube ends ;

b) the minimum local coating thickness on the inside surface shall be as specified in table 1 ;

c) unless otherwise specified by the purchaser, the minimum local coating thickness on the outside surface is not controlled.

Option 1 (see 5.2) : The minimum local coating thickness on the outside surface is specified ;

d) for coating quality A.1 the local coating thickness shall be as specified in table 1 at any point of the weld bead on the inside surface of welded tubes (see annex A) ;

e) the product of any post galvanizing treatment e.g. phosphating, shall be water soluble to such a degree that its removal is ensured and no toxic elements remain on the inside surface after flushing ;

f) for coating quality A.1, and for coating qualities A.2 and A.3 when Option 2 is specified, the chemical composition of the coating shall not exceed the following :

Antimony	0,01 % ;
Arsenic	0,02 % ;
Lead	0,8 % ;
Cadmium	0,01 % ;
Bismuth	0,01 %.

For antimony, arsenic, cadmium and bismuth the above requirements can alternatively, at the galvanizer's option, be met by analysing a sample from the galvanizing bath or by a certificate issued by the supplier of the zinc showing conformity with the maximum value specified for each element.

Option 2 (see 5.2) : The chemical composition of the coating shall for coating qualities A.2 and A.3 not exceed the limits given above.

Table 1 : Minimum local coating thickness and chemical composition requirements for coating qualities A.1, A.2 and A.3

Requirements		Coating quality		
		A.1	A.2	A.3
Mandatory	Minimum local coating thickness on the inside surface except at the weld bead	55 µm	55 µm	45 µm
	Minimum local coating thickness on the inside surface at the weld bead	28 µm	1)	1)
	Chemical composition of the coating	see 8.2.1f	1)	1)
Options	Minimum local coating thickness on the outside surface	2)	2)	2)
	Chemical composition of the coating	1)	3)	3)
1) This requirement does not apply. 2) This requirement applies when the purchaser specifies Option 1. 3) This requirement applies when the purchaser specifies Option 2 and a value.				

8.2.2 Coating qualities B.1, B.2 and B.3

The minimum local coating thickness on the outside surface of the tube shall be as specified in table 2. Thicker coatings than 55 μm minimum may be achieved on some steels, and when required they shall be specified by the purchaser in the enquiry and order (see Option 3).

Table 2 : Minimum local coating thickness for coating qualities B.1, B.2 and B.3

Requirements		Coating quality		
		B.1	B.2	B.3
Mandatory	Minimum local coating thickness on the outside surface	55 μm	40 μm	25 μm

Option 3 (see 5.2) : For the coating quality B.1, a minimum local coating thickness in excess of 55 μm is specified (see note in 7.2).

9 Inspection

9.1 General

The coating shall be supplied with non-specific inspection and testing in accordance with EN 10021. A guideline for the frequency of inspection and testing of coating quality A.1 is given in annex D.

9.2 Inspection document

The coating shall be supplied with a certificate of compliance, 2.1, in accordance with EN 10204.

10 Sampling

10.1 Types of inspection and tests

Samples are required for the following inspection and tests :

- visual examination (see 10.2.1 and 11.1) ;
- examination of the inside surface for coating quality A.1 for tubes with outside diameters 21,3 mm up to and including 88,9 mm (see 10.2.2 and 11.2) ;
- local coating thickness (see 10.2.3 and 11.3) ;
- adhesion test (see 10.2.4 and 11.4) ;
- chemical analysis of the coating when coating quality A.1 or option 2 is specified (see 10.2.5 and 11.5).

10.2 Preparation of samples and testpieces

10.2.1 Visual examination

The sample shall be the full length of the tube.

10.2.2 Examination of the inside surface for coating quality A.1

Two testpieces each 1 metre in length shall be taken from the middle of the sample tube.

10.2.3 Local coating thickness

10.2.3.1 Testpieces for the magnetic method (see 11.3.1 a)) shall be selected in accordance with B.1.2.

10.2.3.2 Two testpieces for the gravimetric method, (see 11.3.1 b)) shall be taken from the tube. Each testpiece shall have a significant surface of at least 0,3 dm² but not greater than 6,0 dm² with a length of at least 50 mm but not greater than 150 mm, and shall be cut at random but at least 600 mm from a tube end.

NOTE : The testpieces need not be full tube sections.

10.2.3.3 Testpieces for the metallographic verification of coating thickness at the welding seam (see 11.3.2) shall be cut transverse to the longitudinal direction of the tube and include the welding seam.

10.2.4 Adhesion test

10.2.4.1 Testpieces for the flattening test (see 11.4.2) shall be full tube sections not less than 40 mm in length, cut at random, but at least 50 mm from a tube end.

10.2.4.2 Testpieces for the bend test shall be full tube sections and of a length sufficient to produce a 90° bend when tested in accordance with 11.4.3.

10.2.5 Chemical analysis

The testpiece size shall be at the discretion of the galvanizer but suitable for analysis.

11 Inspection and test methods

11.1 Visual examination

The coating shall be visually inspected using only normal or corrected vision in good lighting.

NOTE 1 : Special lighting devices may be needed to inspect the inside surface.

NOTE 2 : An illuminance of 500 lux or greater is normally considered to be good lighting.

11.2 Examination of the inside surface for coating quality A.1

Each testpiece shall be divided into sections so that accurate assessment of the coating on the inside surface under the conditions described in 11.1, is possible to ensure conformity with 8.2.1a.

11.3 Local coating thickness

11.3.1 The local coating thickness shall be determined separately for the outside and/or inside surface as required by the specified coating quality (see 8.2) by one of the following :

a) the magnetic method of measurement according to ISO 2178, which shall be applied in accordance with annex B ;

b) the determination of the local coating mass per unit area by the gravimetric method according to EN ISO 1460, which shall be applied in accordance with annex C.

NOTE : The appropriate local coating thickness can be calculated using the equation :

$$S = \frac{M_a}{7,2}$$

where :

S is the local coating thickness, in micrometers ;

M_a is the local coating mass per unit area, in grammes per square metre.

In cases of dispute the gravimetric method shall be used.

11.3.2 The metallographic examination shall be carried out in accordance with EN ISO 1463. This examination shall only be used when considered necessary e.g. to confirm conformity with 8.2.1d.

11.4 Adhesion

11.4.1 The adhesion of the coating shall be tested using one of the following :

a) a cold flattening test in accordance with EN 10233 and 11.4.2 ;

b) for circular tubes with outside diameter up to and including 60,3 mm, a cold bend test in accordance with EN 10232 and 11.4.3.

11.4.2 For the flattening test, the testpiece shall be flattened between parallel flat platens :

- a) for circular tubes, to the degree of flattening given in table 3 ;
- b) for square and rectangular tubes, with two of the sides (the shorter sides of rectangular tubes) in contact with the platens, until the distance between the platens is 75 % of the original outside dimension (the larger side of rectangular tubes).

Table 3 : Degree of flattening for circular tubes

Outside diameter mm	Distance between platens % of outside diameter
≤ 21,3	85
> 21,3 ≤ 48,3	80
> 48,3 ≤ 76,1	75
> 76,1 ≤ 114,3	70
>114,3	65

11.4.3 The bend test shall be carried out using a tube bending machine, and the testpiece shall be bent through 90° round a former having a radius at the bottom of the groove equal to eight times the outside diameter of the tube.

11.5 Chemical analysis

11.5.1 The method of chemical analysis is at the discretion of the galvanizer. In cases of dispute wet chemical analysis shall be used.

11.5.2 The quantity of coating required for wet analysis shall be dissolved from the testpiece using 12 % - 18 % hydrochloric acid solution to which an organic pickling inhibitor has been added.

12 Post galvanizing treatment

12.1 Unless otherwise specified by the purchaser any post galvanizing treatment is at the discretion of the galvanizer.

12.2 If the purchaser requires a specific post galvanizing treatment such as phosphating etc., or requires that the coating shall not be specially treated after galvanizing, this shall be stated in the enquiry and order.

Option 4 (see 5.2) : The type of post galvanizing treatment is specified.

Option 5 (see 5.2) : A post galvanizing treatment is precluded.

13 Marking

Tubes hot dip galvanized in accordance with this European Standard shall be marked in accordance with the standard to which they were manufactured and with the number of this standard and the appropriate coating quality.

The marking shall include the identification of the producer of the galvanized tube.

Annex A (normative)

Condition of the tube to be coated

This annex of this European Standard is mandatory if the requirements for the condition of the tube to be coated are not specified in the product standard to which the tubes are manufactured.

A.1 The tubes to be coated shall have smooth surfaces consistent with the method of manufacture and shall be free from the following :

- a) contaminants which cannot be removed by pretreatment prior to the galvanizing bath, e.g. some oils, some greases ;
- b) imperfections such as laps, seams, slivers, scabs and rolled-in impurities.

A.2 When coating quality A.1 (see 8.2.1) is specified the internal weld bead of welded tubes shall be such that the requirement of 8.2.1d can be met.

NOTE : Compliance with this requirement may depend upon the internal weld bead condition and especially upon the extent of any sharp corners from treatment of the bead.

Annex B (normative)

Method of determination of the local coating thickness using the magnetic method (ISO 2178)

B.1 Procedure

B.1.1 Calculate the area of significant surface of, where applicable, the outside and independently, the inside of the tube.

B.1.2 For significant surface in excess of 2 m² select three reference areas, each of at least 1 000 mm². For significant surface 2 m² and below, select one reference area of at least 1 000 mm².

B.1.3 Take five thickness measurements within each reference area. When necessary, cut tubes to enable the thickness measurements to be taken on the inside surface.

B.2 Results

Determine the local coating thickness by calculating the mean value of the thickness measurements taken within each reference area.

Annex C (normative)

Method of determination of the mass of the coating per unit area using the gravimetric method (EN ISO 1460)

C.1 Stripping solution

The stripping solution shall consist of 3,6 g of hexamethylene tetramine (hexamine) dissolved in 500 ml of concentrated hydrochloric acid (specific gravity = 1,19) and diluted to 1 000 ml with distilled water.

C.2 Preparation of testpieces

Degrease the testpieces with a suitable organic solvent e.g. trichlorethylene, and wipe dry with a clean soft cloth.

C.3 Procedure

Carry out the following for outside and/or inside surfaces as applicable :

- a) determine the mass of the testpiece (m_1) ;
- b) protect the coating on the inside surface of the tube with a substance resistant to chemical attack by the stripping solution, e.g. rubber plugs for full tube sections ;
- c) immerse, at room temperature, the testpiece in a volume of stripping solution of at least 10 ml for every 1 cm² of the area of the testpiece ;
- d) keep the testpiece immersed until the external coating has completely dissolved i.e. until the vigorous chemical reaction has ceased ;
- e) rinse the testpiece in running water and if necessary brush to remove any loose substances ;
- f) remove the coating protection on the inside surface of the testpiece and dip the testpiece in alcohol ;
- g) dry the testpiece and determine its mass (m_2) ;
- h) repeat stages c), d), e) and g) for the internal coating and determine the new mass (m_3) ;
- i) determine the areas of the stripped surfaces (inner and outer surfaces separately) to a degree of uncertainty less than 1 %.

Masses m_1 , m_2 , and m_3 shall be determined to a degree of uncertainty less than 1 % of the total coating mass of the sample calculated using the minimum coating thickness specified.

C.4 Results

Calculate the mass of coating per unit area for the outside and/or inside surfaces of the testpiece as applicable independently as follows :

$$M_e = \frac{(m_1 - m_2)}{S_e}$$

$$M_b = \frac{(m_2 - m_3)}{S_b}$$

where :

M_e is the mass of coating per unit area, in grams per square metre, on the outside surface ;

M_b is the mass of coating per unit area, in grams per square metre, on the inside surface ;

m_1 is the mass of the testpiece, in grams ;

m_2 is the mass of the testpiece, in grams, after dissolution of the coating on the outside surface ;

m_3 is the mass of the testpiece, in grams, after dissolution of the coating on both the outside surface and inside surfaces ;

S_e is the area of the outside surface of the testpiece, in square metres ;

S_b is the area of the inside surface of the testpiece, in square metres.

Annex D (informative)

Guidelines for the galvanizer's procedure for non-specific inspection and testing of coating quality A.1 in accordance with EN 10021 - Frequency of inspection and testing

D.1 Inspection

Each tube should be inspected for conformity with 7.1.

D.2 Testing

The tests in 10.1 should be carried out on one tube per test unit. The test unit should be in accordance with D.3.

D.3 Test unit

D.3.1 When the sequence of galvanizing can be assured, the test unit should consist of :

- for all tests except chemical analysis, up to the first 500 consecutively galvanized tubes of the same outside diameter and thickness and thereafter up to 2 000 tubes for outside diameters up to and including 21,3 mm and up to 1 000 tubes for larger outside diameters, galvanized consecutively ;
- for chemical analysis, up to the first 500 tubes galvanized consecutively and thereafter the remainder of one week's production of consecutively galvanized tubes from a bath.

D.3.2 When the sequence of galvanizing cannot be assured, the test unit should be in accordance with table 4.

Table 4 : Test unit where the sequence of galvanizing cannot be assured

Outside diameter mm	Test unit tonnes
≤ 17,2	≤ 2
> 17,2 ≤ 26,9	≤ 5
> 26,9 ≤ 48,3	≤ 10
> 48,3 ≤ 88,9	≤ 20
> 88,9 ≤ 139,7	≤ 40
> 139,7	≤ 60