

Butt-welding pipe fittings —

Part 2: Non alloy and ferritic alloy steels with specific inspection requirements

The European Standard EN 10253-2:2007 has the status of a
British Standard

ICS 23.040.40

National foreword

This British Standard is the UK implementation of EN 10253-2:2007. Together with BS EN 10253-1:1999 it supersedes BS 1965-1:1963, which is withdrawn. It partially supersedes BS 1640-1:1962, and BS 1640-3:1968, which will be withdrawn upon publication of BS EN 10253-3 and BS EN 10253-4.

The UK participation in its preparation was entrusted to Technical Committee ISE/19, Pipe fittings (other than cast iron).

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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Formstücke zum Einschweißen - Teil 2: Unlegierte und legierte ferritische Stähle mit besonderen Prüfanforderungen

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Management Centre: rue de Stassart, 36 B-1050 Brussels

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Foreword

This document (EN 10253-2:2007) has been prepared by Technical Committee ECISS/TC 29 "Steel tubes and fittings for steel tubes", the secretariat of which is held by UNI/UNSIDER.

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of an identical text or by endorsement, at the latest by May 2008, and conflicting national standards shall be withdrawn at the latest by May 2008.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive (97/23/EC).

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

EN 10253 comprises a series of European Standards about *Butt-welding pipe fittings*, namely:

- *Part 1 : Wrought carbon steel for general use and without specific inspection requirements*
- *Part 2 : Non alloy and ferritic alloy steels with specific inspection requirements*
- *Part 3 : Wrought austenitic and austenitic-ferritic (duplex) stainless steels without specific inspection requirements*
- *Part 4 : Wrought austenitic and austenitic-ferritic (duplex) stainless steels with specific inspection requirements*

In writing this European Standard the competent committee recognized that there are two broad types of products commonly used, and decided to reflect these in the standard by differentiating between two parts.

EN 10253-1 describes fittings without formal reference to the pressure resistance, which are not intended to be used in applications covered by the Pressure Equipment Directive (97/23/EC).

EN 10253-2 defines two types of fittings : Type A fittings have the same wall thickness at the welding ends and at the body of the fitting than a pipe having the same specified wall thickness. Their resistance to internal pressure is, in general, less than that of a straight pipe with the same dimensions. Type B fittings showing increased wall thickness at the body of the fitting are designed to resist the same internal pressure as a straight pipe with same dimensions. These two types of fittings are intended to be used in applications covered by the EU Directive 97/23/EC. According to this Directive and further interpretation guidelines (e.g. guideline 7/19), seamless fittings are considered as materials whereas welded fittings are considered as components. Therefore, in some areas of this European Standard, provisions for seamless and welded fittings are different.

The selection of steel type and requirement level depend on many factors; the properties of the fluid to be conveyed, the service conditions, the design code and any statutory requirements should all be taken into consideration. Therefore this standard gives no detailed guidelines for the application of different parts. It is the ultimate responsibility of the user to select the appropriate part for the intended application.

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

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

1 Scope

This Part of EN 10253 specifies the technical delivery requirements for seamless and welded butt-welding fittings (elbows, concentric and eccentric reducers, equal and reducing tees, caps) made of carbon and alloy steel which are intended for pressure purposes at room temperature, at low temperature or at elevated temperatures, and for the transmission and distribution of fluids and gases.

It specifies:

- type of fittings ;
 - type A : Butt-welding fittings with reduced pressure factor ;
 - type B : Butt-welding fittings for use at full service pressure ;
- steel grades ;
- mechanical properties ;
- dimensions and tolerances ;
- requirements for inspection and testing ;
- inspection documents ;
- marking ;
- protection and packaging.

NOTE In the case of a harmonised supporting standard for materials, presumption of conformity to the ESRs is limited to technical data of materials in the standard and does not presume adequacy of the material to a specific item of equipment. Consequently it is essential that the technical data stated in the material standard be assessed against the design requirements of this specific item of equipment to verify that the ESRs of the PED are satisfied.

2 Normative references

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

EN 287-1, *Qualification test of welders — Fusion welding — Part 1: Steels*

EN 910, *Destructive tests on welds in metallic materials — Bend tests*

EN 1418, *Welding personnel — Approval testing of welding operators for fusion welding and resistance weld setters for fully mechanized and automatic welding of metallic materials*

EN 10002-1, *Metallic materials — Tensile testing — Part 1: Method of test at ambient temperature*

EN 10002-5, *Metallic materials — Tensile testing — Part 5: Method of testing at elevated temperature*

EN 10020:2000, *Definition and classification of grades of steel*

EN 10021:2006, *General technical delivery conditions for steel products*

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EN 10027-1, *Designation systems for steels — Part 1: Steel names*

EN 10027-2, *Designation systems for steels — Part 2: Numerical system*

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

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

EN 10028-4, *Flat products made of steels for pressure purposes — Part 4: Nickel alloy steels with specified low temperature properties*

EN 10045-1, *Metallic materials - Charpy impact test — Part 1: Test method*

EN 10052:1993, *Vocabulary of heat treatment terms for ferrous products*

EN 10168, *Steel products — Inspection documents — List of information and description*

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

EN 10217-1, *Welded steel tubes for pressure purposes — 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 10217-3, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 3: Alloy fine grain steel tubes*

EN 10217-4, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 4: Electric welded non-alloy steel tubes with specified low temperature properties*

EN 10217-5, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 5: Submerged arc welded non-alloy and alloy steel tubes with specified elevated temperature properties*

EN 10217-6, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 6: Submerged arc welded non-alloy steel tubes with specified low temperature properties*

EN 10246-10, *Non-destructive testing of steel tubes — Part 10: Radiographic testing of the weld seam of automatic fusion arc welded steel tubes for the detection of imperfections*

EN 10246-11, *Non-destructive testing of steel tubes — Part 11: Liquid penetrant testing of seamless and welded steel tubes for the detection of surface imperfections*

EN 10246-12, *Non-destructive testing of steel tubes — Part 12: Magnetic particle inspection of seamless and welded ferromagnetic steel tubes for the detection of surface imperfections*

EN 10266:2003, *Steel tubes, fittings and structural hollow sections — Symbols and definitions of terms for use in product standards*

EN 10273, *Hot rolled weldable steel bars for pressure purposes with specified elevated temperature properties*

EN 13480-3:2002, *Metallic industrial piping — Part 3: Design and calculation*

EN ISO 377:1997, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing (ISO 377:1997)*

EN ISO 2566-1, *Steel — Conversion of elongation values — Part 1: Carbon and low alloy steels (ISO 2566-1:1984)*.

EN ISO 3166-1, *Codes for the representation of names of countries and their subdivisions — Part 1: Country codes (ISO 3166-1:2006)*

EN ISO 6708, *Pipe work components — Definition and selection of DN (nominal size) (ISO 6708:1995)*

EN ISO 14284, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition (ISO 14284:1996)*

EN ISO 15614-1, *Specification and qualification of welding procedures for metallic materials - Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1:2004)*

ISO 1027, *Radiographic image quality indicators for non-destructive testing — Principles and identification*

3 Terms and definitions

For the purposes of this document, the relevant definitions in EN 10020:2000, EN 10021:2006, EN 10052:1993 and EN ISO 377:1997 apply, except as defined below.

3.1

carbon steel grade

in this part of EN 10253, the following grades :

P235TR2 - P265TR2 - P235GH - P265GH - P355N - P355NH - P355NL1 - P215NL - P265NL

3.2

employer

organisation for which a person works on a regular basis

NOTE The employer may be either the fitting manufacturer or supplier or a third party organisation providing a service, e.g. NDT.

3.3

model

for elbows and return bends, the model defines the bending radius of the piece

3.4

purchaser

person or organisation that orders products in accordance with this European Standard

NOTE 1 The purchaser is not necessarily, but may be, a manufacturer of pressure equipment in accordance with the EU Directive listed in Annex ZA.

NOTE 2 Where a purchaser has responsibilities under this EU Directive, this standard will provide a presumption of conformity with the essential requirements of the Directive so identified in Annex ZA.

3.5

weld during manufacture

weld made for obtaining a fitting

NOTE This term does not include the tube welds when a tube is used as starting material.

3.6

seamless fitting

fitting manufactured without welding from starting material which is not welded

3.7

welded fitting

3.7.1

fitting made from welded tubes

3.7.2

fitting made from sheet/plate or strip where welding is a part of the manufacturing process

4 Symbols

For the purposes of this document, the symbols defined in EN 10266:2003 and the following apply:

| | |
|------------|--|
| DN, DN_1 | Conventional dimension used in piping ; non measurable value (See EN ISO 6708) ; |
| D | Specified outside diameter for elbows, return ends, equal tees, caps and the major outside diameter for reducers and reducing tees, expressed in millimetres ; |
| D_1 | Specified minor outside diameter for reducers and reducing tees, expressed in millimetres ; |
| T | Specified wall thickness at the welding ends for elbows, return bends, equal tees and bends or on the D end for reducers and reducing tees, expressed in millimetres ; |
| T_1 | Specified wall thickness on the D_1 welding end of reducers and reducing tees, expressed in millimetres ; |
| ID | Internal diameter at the welding ends of elbows, return bends, equal tees and at the major welding end of reducers and reducing tees ($ID = D - 2T$) ; |
| ID_1 | Internal diameter at the minor welding end of reducers and reducing tees ($ID_1 = D_1 - 2T_1$) ; |
| C | Centre to centre distance for return bends ($C \approx 2R$), expressed in millimetres ; |
| B | Back to face distance for return bends, expressed in millimetres ; |
| F | Distance from the axis of the branch outlet to the face of the centre body of tees, expressed in millimetres ; |
| G | Distance from the axis of the centre line to the face of the branch outlet of reducing tees, expressed in millimetres ; |
| k | Total height for caps, expressed in millimetres ; |
| L | Face to face distance for reducers, expressed in millimetres ; |
| X | Tolerance on the form of fittings ; |
| r | Inside knuckle radius of cap ; |
| R | Bending radius of elbows and return bends, expressed in millimetres ; |
| $R1$ | Inside spherical radius of cap ; |
| P | Tolerance on the form of elbows ; |
| W | Distance from the extrados to the centre of a 90° elbow at the welding ends ; |

| | |
|------------|--|
| Z | Distance from the extrados to the centre of a 45° elbow at the welding ends ; |
| R_m | Tensile strength at room temperature, expressed in megapascals ; |
| $R_{p0,2}$ | Minimum 0,2 % proof strength at room temperature, expressed in megapascals ; |
| A | Percentage of elongation at rupture, with reference to gauge length of $5,65 \sqrt{S_0}$. |

5 Designations

5.1 Designation of steel grades

For fittings covered by this European Standard the designation shall consist of :

— number of this European Standard (EN 10253-2) ;

plus either :

— steel name in accordance with EN 10027-1 ;

or

— steel number allocated in accordance with EN 10027-2.

5.2 Designation of fittings

Elbows and return bends are designated by the model (2D, 3D or 5D), the angle, the outside diameter D .

Reducers are designated by the model (concentric or eccentric), the major diameter D , the minor diameter D_1 .

Equal tees are designated by the outside diameter D .

Reducing tees are designated by the major diameter D , the minor diameter D_1 .

Caps are designated by the outside diameter D .

6 Information to be supplied by the purchaser

6.1 Mandatory information

The following information shall be supplied by the purchaser at the time of enquiry and order:

- a) quantity required (number of pieces) ;
- b) reference to this European Standard ;
- c) type of fitting, A or B ;
- d) designation of fittings (see 5.2) and the wall thickness $T(T_1)$;
- e) designation of the steel grade (see 5.1) ;

6.2 Options

A number of options are specified in this European Standard and these are listed below. In the event that the purchaser does not indicate a wish to implement any of these options at the time of enquiry and order, the fittings shall be supplied in accordance with the basic specification (see 6.1).

- 1) Steelmaking process (see 8.1) ;
- 2) method of manufacture of the fitting (see 8.2) ;
- 3) starting product form and /or delivery condition (see 8.2.1) ;
- 4) information about the product-making process (see 8.2.1) ;
- 5) type of heat treatment (see 8.2.3) ;
- 6) other grades as specified on the purchase order (see 9.2.1) ;
- 7) product analysis (see 9.2.2) ;
- 8) verification of the proof strength at elevated temperature (see 9.3) ;
- 9) tolerance to be applied to the outside diameter (see 11.2.1.1) ;
- 10) special ID tolerances for pigging (see 11.2.1.2) ;
- 11) plus tolerances on the body of the fitting (see 11.2.2) ;
- 12) end finishing (see 11.3) ;
- 13) inspection document 3.2 (see 12.2.1) ;
- 14) mechanical properties determined on the finished product (see 9.2) ;
- 15) hardness testing of each fitting (see Table 20) ;
- 16) impact testing for grades listed in footnote ^e of Table 20 (see Table 20) ;
- 17) registration records of the heat treatment temperatures (see 13.1.1) ;
- 18) size of the test unit per Table 21 (see 13.1.1) ;
- 19) size of the test unit per Table 22 (see 13.1.1) ;
- 20) special test unit size (see 13.1.1) ;
- 21) impact test of the heat affected zone (see 13.2.6) ;
- 22) NDT of welds after forming (see 14.9.2.1) ;
- 23) NDT of welds mandatory after forming (see 14.9.2.1) ;

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- 24) NDT of the starting material for the detection of laminar imperfections (see 14.9.4) ;
- 25) method of marking to be applied (see 15.2) ;
- 26) special provisions concerning marking (see 15.2) ;
- 27) protection to be applied (see Clause 16).

6.3 Examples of an order

6.3.1 Example 1

1 000 elbows in accordance with this European Standard, of type A (not having an increased wall thickness for the body of the fitting) and model 3D, with angle 90°, having an outside diameter 114, and a wall thickness 6,3, made of steel grade P265GH.

1000 elbows - EN 10253-2 - Type A – Model 3D - 90° - 114,3 X 6,3 - P265GH

6.3.2 Example 2

500 reducing tees in accordance with this European Standard of type B (having an increased wall thickness for the body of the fitting), with dimensions 114,3 X 6,3 - 88,9 X 4,0 and made of steel grade P265GH.

500 reducing tees - EN 10253-2 – Type B - 114, 3X6,3 - 88,9 X 4,0 - P265GH

7 Resistance to internal pressure

7.1 General

The Pressure Equipment Directive (EU Directive 97/23/EC — Annex I — subclause 2.2.2) imposes that the design for adequate strength shall be based on a calculation method or, with restrictions, on an experimental method.

The resistance to internal pressure of a fitting conforming to this European Standard shall be determined according to the relevant design rules laid down in e.g. EN 13480-3.

The selection of the appropriate fitting (material, thickness) is the ultimate responsibility of the manufacturer of the pressure equipment (See Annex ZA for presumption of conformity of the material to the ESR's of Directive 97/23/EC).

For fittings of type A in carbon steel grades, when the manufacturer is able to guarantee that the minimum yield strength of the delivered products is higher than the specified minimum yield strength, the wall thickness may be reduced such as the product of the reduced thickness times the minimum product yield strength shall at least equal the product of the specified wall thickness times the specified minimum yield strength of the specified grade. For such products the mechanical properties shall be determined on the finished product and they shall be clearly identified on the inspection documents and by specific marking. See 12.2 for relevant documents, 12.3 for testing and Clause 15 for relevant information on marking.

7.2 Fittings of type A

Type A fitting have the same wall thickness at the welding ends and at the body of the fitting than a pipe having the same specified wall thickness. Their resistance to internal pressure is less than that of a pipe with the same specified diameter, wall thickness and of the same steel grade. The determination of the reducing pressure factor is given in Annex A and tables of pressure factors are given in Annex B.

For reducers the wall thickness at the conical section shall be the specified wall thickness at the major end.

7.3 Fittings of type B

Fittings of type B have increased wall thickness at the body of the fitting. They will, in general, withstand the same pressure than a pipe having the same specified diameter, wall thickness and the same steel grade.

Wall thickness requirements for this type of fittings are defined by the calculation procedures given in Annex A. For some preferred, specified wall thicknesses the resulting wall thicknesses at the body of the fitting are listed in the tables given in Annex C.

8 Manufacturing process

8.1 Steelmaking process

The steelmaking process is left at the discretion of the manufacturer and shall be reported. The steels shall be fully killed.

Option 1 : *The steelmaking process shall be as specified on the purchase order.*

8.2 Product making process for fittings and heat treatment

8.2.1 Product making process

The different allowed processes and the relevant starting product forms are listed in Table 1. Differing starting materials and production routes are associated with variations in the types of controls applied. The method of manufacturing is left at the discretion of the manufacturer. When choosing the method the manufacturer shall take suitable precautions to prevent the occurrence of ageing problems in the final product form.

Where tubes are used as starting material, following conditions shall apply:

- unless otherwise specified, the choice of the tubes (seamless or welded) is left at the discretion of the manufacturer ;
- when manufacturing fittings from welded tubes, only tubes according to EN 10217, Parts 1 to 6 shall be used. Tubes marked "C1" and/or " C2" are not allowed ;
- helical SAW tubes are not permitted ;
- after forming, repair of the pipe weld seam is only permitted for weld seams made with filler metal. These repairs shall be carried out as described in 8.2.2.

Where plate/strip are used as starting material for welded fittings, the following condition shall apply :

- only plate / strip according to EN 10028-2 to -4 shall be used.

Where bars are used as starting material for welded or machined fittings, the following condition shall apply :

- only bars according to EN 10273 shall be used.

Table 1 — Product making process – Starting product forms ^a

| Process | Hot deformation | | | Cold deformation | | Machining from round bars (DN < 50) ^d |
|----------|----------------------|-----------------------------|--------------------------------------|----------------------|-----------------------------|---|
| | Bending ^b | Pressed in die ^c | Rolled, forged followed by machining | Bending ^b | Pressed in die ^c | |
| Elbows | 1, 2, 4, 5 | 1, 2, 3, 4, 5 | - | 1, 2, 4, 5 | 1, 2, 3, 4, 5 | - |
| Tees | - | 1, 2, 3, 4, 5 | 4, 5 | - | 1, 2, 3, 4, 5 | - |
| Reducers | - | 1, 2, 3, 4, 5 | 4, 5 | - | 1, 2, 3, 4, 5 | 5 |
| Caps | - | 1, 2, 3, 4, 5 | 4, 5 | - | 1, 2, 3, 4, 5 | 5 |

^a Starting material :

- 1 seamless pipe ;
- 2 welded pipe ;
- 3 plate and strip ;
- 4 forging ;
- 5 bar.

^b When producing elbows from welded pipe, the position of the weld is at the discretion of the manufacturer.

^c For these processes welding with or without filler metal may be used (see 8.2.2.1). When filler metal is used it shall be compatible with the parent metal.

^d The method of manufacture shall be reported.

Option 2 : *The method of manufacturing and/or details of the manufacturing process, e.g. welding operations or position of the weld before forming shall be as specified on the purchase order.*

Option 3 : *The starting product form to be used and/or its delivery condition shall be as specified on the purchase order.*

Option 4 : *The method of manufacture shall be reported.*

8.2.2 Welding as part of the manufacturing process of the fitting

8.2.2.1 General

When producing fittings from plate or strip, welding is considered being a part of the manufacturing of fittings, and :

- welding process/procedures shall be qualified in accordance with EN ISO 15614-1 ;
- welders and/or welding operators shall be qualified in accordance with EN 287-1 and/or EN 1418.

For pressure equipment in categories II, III, and IV, (of Directive 97/23 EC) the operating procedures and the personnel shall be approved by a competent third-party.

All welds carried out during the manufacture of the fitting shall be fusion weld type. All welds shall have complete penetration.

Local repair of weld seam which have been made with filler metal is permitted provided that the repair procedure/welders are qualified in accordance with the relevant part of the above mentioned standards and the repaired area is heat treated and non destructively tested in the same way as the original weld.

All joints welded with filler metal shall be finished in accordance with the requirements in 8.2.2.1 and 8.2.2.2.

When taking into account the conditions specified for the manufacture of fittings and for the testing of the welds, a weld efficiency factor of 1,0 can be used in design calculations.

8.2.2.2 Alignment tolerances

Alignments of sections at edges to be butt-welded shall be such that the maximum offset does not cause the effective wall thickness to be less than the specified minimum and is not greater than :

$$t / 20 + 1 \text{ mm}$$

where:

t is the nominal wall thickness of the thinner section to be joined.

8.2.2.3 Finished joint requirement

As welded surfaces are permitted provided the surface imperfections permit proper interpretation of radiographic or other non-destructive examination. If there is a question regarding the surface condition of the weld when interpreting the radiographic film, the film shall be compared to the actual weld surface for determination of acceptability.

A reduction in thickness due to the welding process is acceptable provided that the material of the joining surfaces shall not be reduced at any point below the minimum required thickness.

Concavity due to the welding process on the root side of a single welded joint is permitted when the resulting thickness of the weld is at least equal to the minimum thickness of the thinner part of the parts being joined and the contour of the concavity is smooth.

To assure that the weld grooves are completely filled the reinforcement on each face of the weld is permitted provided that it does not exceed the values specified in Table 2.

Table 2 — Height of reinforcement

Dimensions in millimetres

| Base metal thickness (T) | Reinforcement |
|------------------------------|---------------------------|
| $T < 5$ | 1,0 |
| $5 \leq T \leq 10$ | 0,2t |
| $10 < T \leq 25$ | 3,0 |
| $25 < T \leq 50$ | 3,0 inside 5,0 outside |
| $50 < T$ | 5,0 inside 6,0 outside |

The finished joint criteria for the fittings made from welded pipe without filler metal shall be governed by the standard defining the starting material.

8.2.3 Heat treatment condition

The fittings shall be delivered in one of the final heat-treated conditions given in Table 3. Recommended heat treatment temperatures are given in Annex D.

In case of hot deformation fittings in carbon steel grades (see Clause 3) and steel grade 16Mo3 may be delivered without heat treatment if hot deformation produces a technically equivalent metallurgical structure with the corresponding mechanical characteristics.

This condition is regarded as satisfied when the final forming operation is completed at a temperature between 750 °C and 980 °C.

When welding is part of the manufacturing process of the fitting, the final heat treatment shall be carried out after welding.

Option 5 : *The heat treatment to be applied shall be as specified on the purchase order.*

Table 3 — Steel grades — Heat treatment conditions

| Steel grade | Heat treatment condition ^a |
|---------------|---------------------------------------|
| P235TR2 | N |
| P265TR2 | N |
| P235GH | N |
| P265GH | N |
| 16Mo3 | N |
| 10CrMo5-5 | NT ^b |
| 13CrMo4-5 | NT ^b |
| 10CrMo9-10 | NT ^b |
| X11CrMo5 | I or NT |
| X11CrMo9-1 | I or NT |
| X10CrMoVNb9-1 | NT ^b |
| P355N | N |
| P355NH | N |
| P355NL1 | N |
| P215NL | N |
| P265NL | N |
| 12Ni14 | NT or QT |
| X10Ni9 | NT or QT |
| L290NB | N |
| L360NB | N |
| L360QB | QT |
| L415NB | N |
| L415QB | QT |
| L450QB | QT |

N = Normalized or normalized formed ; NT = Normalized and tempered.
 QT = Quenched and tempered ; I = Isothermal annealing.

^a These heat treatments are identical to those described in the corresponding tube standards.

^b For these steel grades it may be necessary in the case of wall thickness T above 25 mm or T/D > 0,15 to apply quenching and tempering in order to achieve the intended structure and material properties. The decision shall be left to the discretion of the manufacturer but shall be stated to the customer at the time of enquiry and order. Steel tubes treated in such a way shall be designated by the steel name supplemented by the symbol "+QT".

9 Technical requirements

9.1 General

Fittings supplied and inspected in accordance with Clauses 8, 11 and 12, shall comply with the requirements of this Part of EN 10253.

In addition to the requirements of this Part of EN 10253, the general technical delivery requirements specified in EN 10021 shall apply.

The requirements for the base material of the seamless fittings are left at the discretion of the manufacturer provided the requirements defined in Clauses 8 and 9 are fulfilled.

9.2 Chemical composition

9.2.1 Cast analysis

The cast analysis reported by the steel manufacturer shall apply and comply with the requirements of Table 4.

Option 6 : *Other grades, as specified on the purchase order, may be agreed.*

9.2.2 Product analysis

Option 7 : *A product analysis shall be supplied.*

Table 5 specifies the permissible deviations of the product analysis from the specified cast analysis given in Table 4.

Table 4 — Chemical composition (cast analysis), in % by mass ^a

| Steel name | Steel number | C | Si | Mn | P | S | Al tot | Cr | Cu | Mo | Nb | Ni | Ti | V | Others |
|-------------------|------------------|------------------------|-----------|-----------|-------|-------|----------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|---|
| P235TR2 | 1.0255 | 0,16 | 0,35 | 1,20 | 0,025 | 0,020 | ≥ 0,020 ^c | 0,30 ^b | 0,30 ^b | 0,08 ^b | 0,01 ^b | 0,30 ^b | 0,04 ^b | 0,02 ^b | Cr+Cu+Mo+Ni ≤ 0,70 |
| P265TR2 | 1.0259 | 0,20 | 0,40 | 1,40 | 0,025 | 0,020 | ≥ 0,020 ^c | 0,30 ^b | 0,30 ^b | 0,08 ^b | 0,01 ^b | 0,30 ^b | 0,04 ^b | 0,02 ^b | « |
| P235GH | 1.0345 | 0,16 | 0,35 | 1,20 | 0,025 | 0,020 | ≥ 0,020 ^c | 0,30 | 0,30 | 0,08 | 0,01 ^b | 0,30 | 0,04 ^b | 0,02 ^b | « |
| P265GH | 1.0425 | 0,20 | 0,40 | 1,40 | 0,025 | 0,020 | ≥ 0,020 ^c | 0,30 | 0,30 | 0,08 | 0,01 ^b | 0,30 | 0,04 ^b | 0,02 ^b | « |
| 16Mo3 | 1.5415 | 0,12-0,20 ^d | 0,35 | 0,40-0,90 | 0,025 | 0,020 | ≤ 0,040 | 0,30 | 0,30 | 0,25-0,35 | - | 0,30 | - | - | - |
| 10CrMo5-5 | 1.7338 | 0,15 | 0,50-1,00 | 0,30-0,60 | 0,025 | 0,020 | ≤ 0,040 | 1,00-1,50 | 0,30 | 0,45-0,65 | - | 0,30 | - | - | - |
| 13CrMo4-5 | 1.7335 | 0,10-0,17 ^d | 0,35 | 0,40-0,70 | 0,025 | 0,020 | ≤ 0,040 | 0,70-1,15 | 0,30 | 0,40-0,60 | - | 0,30 | - | - | - |
| 10CrMo9-10 | 1.7380 | 0,08-0,14 | 0,50 | 0,30-0,70 | 0,025 | 0,020 | ≤ 0,040 | 2,00-2,50 | 0,30 | 0,90-1,10 | - | 0,30 | - | - | - |
| X11CrMo5 | 1.7362 | 0,08-0,15 | 0,15-0,50 | 0,30-0,60 | 0,025 | 0,020 | ≤ 0,040 | 4,00-6,00 | 0,30 | 0,45-0,65 | - | - | - | - | - |
| X11CrMo9-1 | 1.7386 | 0,08-0,15 | 0,25-1,00 | 0,30-0,60 | 0,025 | 0,020 | ≤ 0,040 | 8,00-10,00 | 0,30 | 0,90-1,10 | - | - | - | - | - |
| X10CrMoV Nb9-1 | 1.4903 | 0,08-0,12 | 0,20-0,50 | 0,30-0,60 | 0,020 | 0,010 | ≤ 0,040 | 8,00-9,50 | 0,30 | 0,85-1,05 | 0,06-0,10 | 0,40 | - | 0,18-0,25 | N : 0,030-0,070 |
| P355N P355 NH | 1.0562 1.0565 | 0,20 | 0,50 | 0,90-1,70 | 0,025 | 0,020 | ≥ 0,020 ^c | 0,30 ^b | 0,30 ^e | 0,08 ^e | 0,05 | 0,50 | 0,04 | 0,10 | N ≤ 0,02 Nb+Ti+V ≤ 0,12 |
| P355NL1 | 1.0566 | 0,18 | 0,50 | 0,90-1,70 | 0,025 | 0,020 | ≥ 0,020 ^c | 0,30 ^b | 0,30 ^e | 0,08 ^e | 0,05 | 0,50 | 0,04 | 0,10 | N ≤ 0,02 Nb+Ti+V ≤ 0,12 |
| P215NL | 1.0451 | 0,15 | 0,35 | 0,40-1,20 | 0,025 | 0,020 | ≥ 0,020 ^c | 0,30 | 0,30 | 0,08 | 0,10 | 0,30 | 0,04 | 0,02 | - |
| P265NL | 1.0453 | 0,20 | 0,40 | 0,60-1,40 | 0,025 | 0,020 | ≥ 0,020 ^c | 0,30 | 0,30 | 0,08 | 0,10 | 0,30 | 0,04 | 0,02 | - |
| 12Ni14 | 1.5637 | 0,15 | 0,15-0,35 | 0,30-0,80 | 0,025 | 0,010 | - | - | 0,30 | - | - | 3,25-3,75 | - | 0,05 | - |
| X10Ni9 | 1.5682 | 0,13 | 0,15-0,35 | 0,30-0,80 | 0,020 | 0,010 | - | - | 0,30 | 0,10 | - | 8,50-9,50 | - | 0,05 | - |
| L290NB | 1.0484 | 0,17 | 0,40 | 1,20 | 0,025 | 0,020 | 0,015-0,060 | 0,30 | 0,25 | 0,10 ^f | 0,05 | 0,30 | 0,04 | 0,05 | N ≤ 0,012 CEV ≤ 0,42 |
| L360NB | 1.0582 | 0,20 | 0,45 | 1,60 | 0,025 | 0,020 | 0,015-0,060 | 0,30 | 0,25 | 0,10 ^f | 0,05 | 0,30 | 0,04 | 0,15 | N ≤ 0,012 V+Nb+Ti ≤ 0,15 CEV ≤ 0,45 |
| L360QB | 1.8948 | 0,16 | 0,45 | 1,40 | 0,025 | 0,020 | 0,015-0,060 | 0,30 | 0,25 | 0,10 ^f | 0,05 | 0,30 | 0,04 | 0,05 | N ≤ 0,012 CEV ≤ 0,42 |
| L415NB | 1.8972 | 0,21 | 0,45 | 1,60 | 0,025 | 0,020 | 0,015-0,060 | 0,30 | 0,25 | 0,10 ^f | 0,05 | 0,30 | 0,04 | 0,15 | N ≤ 0,012 V+Nb+Ti ≤ 0,15 |
| L415QB | 1.8947 | 0,16 | 0,45 | 1,60 | 0,025 | 0,020 | 0,015-0,060 | 0,30 | 0,25 | 0,10 ^f | 0,05 | 0,30 | 0,04 | 0,08 | N ≤ 0,012 V+Nb+Ti ≤ 0,15 CEV ≤ 0,43 |
| L450QB | 1.8952 | 0,16 | 0,45 | 1,60 | 0,025 | 0,020 | 0,015-0,060 | 0,30 | 0,25 | 0,10 ^f | 0,05 | 0,30 | 0,06 | 0,09 | N ≤ 0,012 V+Nb+Ti ≤ 0,15 CEV ≤ 0,45 |

Elements not included in this table shall not be intentionally added to the steel without the agreement of the purchaser, except for elements which may be added for finishing the cast. All appropriate measures shall be taken to prevent the addition of undesirable elements from scrap or other materials used in the steelmaking process.

^a For elements where only one value is indicated without further information, this value shall be regarded as a maximum.

^b The content of these elements need not be reported unless intentionally added to the cast.

^c This requirement is not applicable provided the steel contains a sufficient amount of other nitrogen binding elements which shall be reported.

^d For wall thicknesses greater than 30 mm, the carbon content may be increased by 0,02% for cast and product analysis.

^e The sum of the percentage by mass of the three elements chromium, copper and molybdenum shall not exceed 0,45 %.

^f Al / N ≤ 2.

Table 5 — Permissible deviations of the product analysis from specified limits on cast analysis given in Table 4

| Element | Limiting value for the cast analysis in accordance with Table 4 % by mass | Permissible deviation of the product analysis % by mass |
|---------|--|--|
| C | ≤ 0,21 | ± 0,02 |
| Si | ≤ 0,40 | ± 0,05 |
| | > 0,40 to ≤ 1,00 | ± 0,06 |
| Mn | ≤ 1,00 | ± 0,05 |
| | > 1,00 to ≤ 1,70 | ± 0,10 |
| P | ≤ 0,025 | + 0,005 |
| S | ≤ 0,010 | + 0,003 |
| | > 0,010 ≤ 0,020 | + 0,005 |
| Al | ≤ 0,060 | ± 0,005 |
| Cr | ≤ 1,00 | ± 0,05 |
| | > 1,00 to ≤ 10,00 | ± 0,10 |
| Cu | ≤ 0,30 | ± 0,05 |
| Mo | ≤ 0,35 | ± 0,03 |
| | > 0,35 to ≤ 1,10 | ± 0,04 |
| N | ≤ 0,012 | ± 0,01 |
| Nb | ≤ 0,10 | ± 0,005 |
| Ni | ≤ 0,35 | ± 0,05 |
| | > 0,35 to ≤ 9,50 | ± 0,07 |
| Ti | ≤ 0,060 | + 0,010 |
| V | ≤ 0,10 | + 0,01 |
| | > 0,10 to ≤ 0,25 | ± 0,03 |

^a If several product analyses are carried out on one cast, and the contents of an individual element determined lie outside the permissible range of the chemical composition specified for the cast analysis, then it is only allowed to exceed the permissible maximum

9.3 Mechanical properties

The mechanical properties of the finished product shall conform to the requirements given in Tables 6 to 9. For the impact properties in the weld (where applicable), the values of the relevant grade in the transverse direction shall apply.

Option 8 : For the grades listed in Table 7, the proof strength at elevated temperature shall be verified. The test temperature shall be specified at the time of enquiry and order.

Table 6 — Mechanical properties

| Steel grade | | Upper yield strength or proof strength ReH or R _{p0,2} min. for wall thicknesses T in mm N/mm ² | | | | Tensile strength R _m for wall thicknesses T in mm N/mm ² | | | Elongation A min. % | |
|-------------------|------------------|---|------------------|-------------|--------------|--|-------------|--------------|------------------------|------------|
| Name | Number | T ≤ 16 | 16 < T ≤ 40 | 40 < T ≤ 60 | 60 < T ≤ 100 | T ≤ 16 | 16 < T ≤ 60 | 60 < T ≤ 100 | Longitudinal | Transverse |
| P235TR2 | 1.0255 | 235 | 225 | 215 | - | 360-500 | 360-500 | - | 25 | 23 |
| P265TR2 | 1.0259 | 265 | 255 | 245 | - | 410-570 | 410-570 | - | 21 | 19 |
| P235GH | 1.0345 | 235 | 225 | 215 | - | 360-500 | 360-500 | - | 25 | 23 |
| P265GH | 1.0425 | 265 | 255 | 245 | - | 410-570 | 410-570 | - | 23 | 21 |
| 16Mo3 | 1.5415 | 280 | 270 | 260 | - | 450-600 | 450-600 | - | 22 | 20 |
| 10CrMo5-5 | 1.7338 | 275 | 275 | 265 | - | 410-560 | 410-560 | - | 22 | 20 |
| 13CrMo4-5 | 1.7335 | 290 | 290 | 280 | - | 440-590 | 440-590 | - | 22 | 20 |
| 10CrMo9-10 | 1.7380 | 280 | 280 | 270 | - | 480-630 | 480-630 | - | 22 | 20 |
| X11CrMo5+I | 1.7362 | 175 | 175 | 175 | 175 | 430-580 | 430-580 | 430-580 | 22 | 20 |
| X11CrMo5+NT1 | 1.7362 | 280 | 280 | 280 | 280 | 480-640 | 480-640 | 480-640 | 20 | 18 |
| X11CrMo5+NT2 | 1.7362 | 390 | 390 | 390 | 390 | 570-740 | 570-740 | 570-740 | 18 | 16 |
| X11CrMo9-1+ I | 1.7386 | 210 | 210 | 210 | - | 460-640 | 460-640 | - | 20 | 18 |
| X11CrMo9-1+NT | 1.7386 | 390 | 390 | 390 | - | 590-740 | 590-740 | - | 18 | 16 |
| X10CrMoV Nb9-1 | 1.4903 | 450 | 450 | 450 | 450 | 630-830 | 630-830 | 630-830 | 19 | 17 |
| P355N P355NH | 1.0562 1.0562 | 355 | 345 | 325 | 305 | 490-650 | 490-630 | 450-590 | 22 | 20 |
| P355NL1 | 1.0566 | 355 | 345 | 325 | 305 | 490-650 | 490-630 | 450-590 | 22 | 20 |
| P215NL | 1.0451 | 215 ^a | - | - | - | 360-480 | 360-480 | - | 25 | 23 |
| P265NL | 1.0453 | 265 | 265 ^b | - | - | 410-570 | 410-570 | - | 24 | 22 |
| 12Ni14 | 1.5637 | 345 | 345 | - | - | 440-590 | 440-590 | - | 22 | 20 |
| X10Ni9 | 1.5682 | 510 | 510 | - | - | 690-840 | 690-840 | - | 20 | 18 |
| L290NB | 1.0484 | 290-440 | 290-440 | - | - | ≥ 415 | - | - | 23 | 21 |
| L360NB | 1.0582 | 360-510 | 360-510 | - | - | ≥ 460 | - | - | 22 | 20 |
| L360QB | 1.8948 | 360-510 | 360-510 | - | - | ≥ 460 | - | - | 22 | 20 |
| L415NB | 1.8972 | 415-565 | 415-565 | - | - | ≥ 520 | ≥ 520 | - | 20 | 18 |
| L415QB | 1.8947 | 415-565 | 415-565 | - | - | ≥ 520 | ≥ 520 | - | 20 | 18 |
| L450QB | 1.8952 | 450-570 | 450-570 | - | - | ≥ 535 | ≥ 535 | - | 20 | 18 |

^a For wall thicknesses equal to or smaller than 10 mm.
^b For wall thicknesses equal to or smaller than 25 mm.

Table 7 — Minimum proof strength $R_{p0,2}$ at elevated temperature

| Grade | Minimum proof strength $R_{p0,2}$ N/mm ² at temperature of (°C) | | | | | | | | | | |
|----------------|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 | 550 | 600 |
| P235GH | 198 | 187 | 170 | 150 | 132 | 120 | 112 | 108 | - | - | - |
| P265GH | 226 | 213 | 192 | 171 | 154 | 141 | 134 | 128 | - | - | - |
| 16Mo3 | 243 | 237 | 224 | 205 | 173 | 159 | 156 | 150 | 146 | - | - |
| 10CrMo5-5 | 240 | 228 | 219 | 208 | 165 | 156 | 148 | 144 | 143 | - | - |
| 13CrMo4-5 | 264 | 253 | 245 | 236 | 192 | 182 | 174 | 168 | 166 | - | - |
| 10CrMo9-10 | 249 | 241 | 234 | 224 | 219 | 212 | 207 | 193 | 180 | - | - |
| X11CrMo5+I | 156 | 150 | 148 | 147 | 145 | 142 | 137 | 129 | 116 | - | - |
| X11CrMo5+NT1 | 245 | 237 | 230 | 223 | 216 | 206 | 196 | 181 | 167 | - | - |
| X11CrMo5+NT2 | 366 | 350 | 334 | 332 | 309 | 299 | 289 | 280 | 265 | - | - |
| X11CrMo9-1+I | 187 | 186 | 178 | 177 | 175 | 171 | 164 | 153 | 142 | 120 | - |
| X11CrMo9-1+NT | 363 | 348 | 334 | 330 | 326 | 322 | 316 | 311 | 290 | 235 | - |
| X10CrMoV Nb9-1 | 410 | 395 | 380 | 370 | 360 | 350 | 340 | 320 | 300 | 270 | 215 |
| P355NH | $T \leq 16$ | 304 | 284 | 255 | 235 | 216 | 196 | 167 | - | - | - |
| | $16 < T \leq 40$ | 294 | 275 | 255 | 235 | 216 | 196 | 167 | - | - | - |
| | $40 < T \leq 60$ | 284 | 265 | 245 | 226 | 206 | 186 | 157 | - | - | - |
| | $60 < T \leq 100$ | 265 | 245 | 226 | 206 | 186 | 167 | 137 | - | - | - |

Table 8 — Minimum tensile strength values at elevated temperature for grade P355NH

| Temperature in °C | Rm for wall thickness T in mm | | | |
|-------------------|-------------------------------|-------------|-------------|--------------|
| | T ≤ 30 | 30 < T ≤ 50 | 50 < T ≤ 80 | 80 < T ≤ 100 |
| 100 | 440 | 420 | 400 | 390 |
| 150 | 430 | 410 | 390 | 380 |
| 200 | 410 | 390 | 370 | 360 |
| 250 | 410 | 390 | 370 | 360 |
| 300 | 410 | 390 | 370 | 360 |
| 350 | 400 | 380 | 360 | 350 |
| 400 | 390 | 370 | 350 | 340 |

Table 9 — Impact properties

| Grade | Minimum average absorbed energy KV, in J | | | | | | | | | | | |
|---------------------|--|-----|-----|-----|----|----|----------------------|-----|-----|-----|----|----|
| | longitudinal direction | | | | | | transverse direction | | | | | |
| | at a temperature of (°C) | | | | | | | | | | | |
| | -50 | -40 | -20 | -10 | 0 | 20 | -50 | -40 | -20 | -10 | 0 | 20 |
| P235TR2 | - | - | - | - | 40 | - | - | - | - | - | 27 | - |
| P265TR2 | - | - | - | - | 40 | - | - | - | - | - | 27 | - |
| P235GH | - | - | - | - | 40 | - | - | - | - | - | 27 | - |
| P265GH | - | - | - | - | 40 | - | - | - | - | - | 27 | - |
| 16Mo3 | - | - | - | - | - | 40 | - | - | - | - | - | 27 |
| 10CrMo5-5 | - | - | - | - | - | 40 | - | - | - | - | - | 27 |
| 13CrMo4-5 | - | - | - | - | - | 40 | - | - | - | - | - | 27 |
| 10CrMo9-10 | - | - | - | - | - | 40 | - | - | - | - | - | 27 |
| X11CrMo5 | - | - | - | - | - | 40 | - | - | - | - | - | 27 |
| X11CrMo9-1 | - | - | - | - | - | 40 | - | - | - | - | - | 27 |
| X10CrMoVNb9-1 | - | - | - | - | - | 40 | - | - | - | - | - | 27 |
| P355N P355NH | - | - | 40 | 43 | 47 | 55 | - | - | 27 | 31 | 35 | 39 |
| P355NL1 | - | 40 | 53 | 60 | 65 | 70 | - | 27 | 35 | 39 | 43 | 47 |
| P215NL | - | 40 | 45 | - | - | 55 | - | - | - | - | - | - |
| P265NL | - | 40 | 45 | - | - | 50 | - | 27 | 30 | - | - | 35 |
| 12Ni14 ^a | T ≤ 25 | 55 | 55 | 60 | - | 65 | 35 | 40 | 45 | 45 | 45 | 45 |
| | 25 < T ≤ 40 | 50 | 50 | 55 | - | 65 | 30 | 35 | 40 | 40 | 45 | 45 |
| X10Ni9 ^a | 70 | 70 | 70 | - | - | 70 | 50 | 50 | 50 | 50 | 50 | 50 |
| L290NB | - | - | - | - | 60 | - | - | - | - | - | 40 | - |
| L360NB | - | - | - | - | 60 | - | - | - | - | - | 40 | - |
| L360QB | - | - | - | - | 60 | - | - | - | - | - | 40 | - |
| L415NB | - | - | - | - | 60 | - | - | - | - | - | 40 | - |
| L415QB | - | - | - | - | 60 | - | - | - | - | - | 40 | - |
| L450QB | - | - | - | - | 60 | - | - | - | - | - | 40 | - |

^a For lower temperatures, the applicable values are those of the corresponding grade in EN 10216-4.

9.4 Weldability

Fittings covered by this European Standard are weldable ; however account should be taken of the fact that the behaviour of the steel during and after welding is dependent not only on the steel, but also essentially on the conditions of preparing and carrying out the welding.

10 Appearance and internal soundness

10.1 The fittings shall be free from surface defects as can be established by visual inspection in accordance with this European Standard.

10.2 The fittings shall have a finish and internal and external surface condition typical of the manufacturing process and, where applicable, the heat treated condition. The finish and surface condition shall permit surface imperfections or marks requiring dressing to be identified.

10.3 It shall be permissible to dress by grinding or machining surface marks or imperfections provided that the wall thickness of the fitting after dressing does not fall below the minimum permitted wall thickness.

10.4 All dressed areas shall blend smoothly into the contour of the fitting.

10.5 Surface imperfections which encroach on the minimum wall thickness shall be considered defects and shall be deemed not to comply with this European Standard.

10.6 The manufacturer shall explore by grinding a sufficient number of surface marks and imperfections identified during visual inspection to provide assurance that these have been evaluated to ensure compliance with 10.7.

10.7 The manufacturer shall, subject to the limitations given in 10.8 and 10.10, dress surface marks and imperfections found by exploration in accordance with 10.6 to be deeper than 5 % of the specified wall thickness or 3 mm, whichever is the lesser, but not less than 0,5 mm.

10.8 If surface imperfections acceptable under 10.7 are not scattered and appear over a large area in excess of what is considered to be an acceptable surface condition then fittings shall be rejected or alternatively subjected to dressing as agreed between purchaser and manufacturer.

10.9 Repairs to fittings shall only be carried out by grinding or machining, and hammering is not permitted. Welding as a mean of repair may be only be carried out in specific instances agreed between manufacturer and purchaser.

10.10 Score marks (linear mechanical scratches) shall not have a depth greater than 1,6 mm or 12,5 % of the nominal wall thickness, whichever is the smaller, provided that the bottom of the marks are rounded and not sharp. Excessive numbers of score marks, even within these limits, may constitute an unacceptable condition, and is dependent upon agreement between manufacturer and purchaser.

Sharp bottom scores shall be considered as defects and treated in accordance with 10.7.

10.11 Localised or generalised scale up to 0,8 mm thick is permissible provided the scale is tightly adherent to the fitting and does not readily flake off.

11 Dimensions and tolerances

11.1 Dimensions

11.1.1 General

For reducers and tees it is not mandatory that the produced pieces correspond to the exact representation in the figures. Only the dimensions given in the relevant tables shall be respected.

11.1.2 Elbows

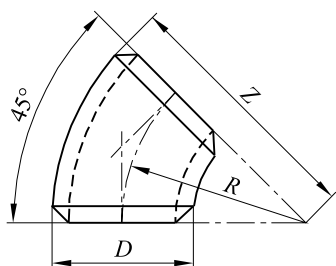


Figure 1 — 45° elbow

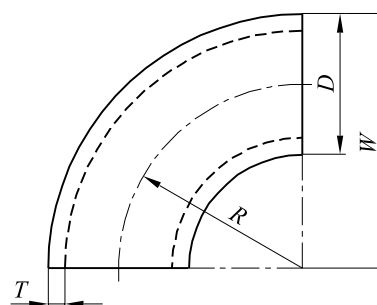


Figure 2 — 90° elbow

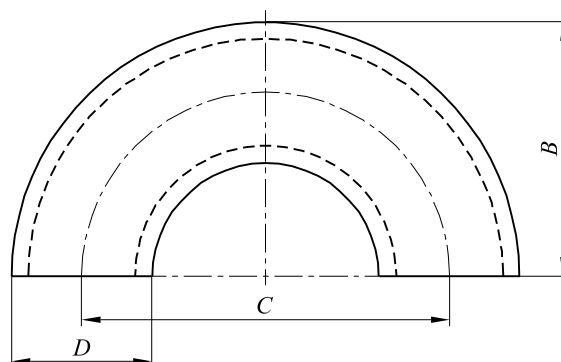


Figure 3 — Return bend

Elbows and return bends are produced according to Figures 1, 2 and 3 (45° - 90° - 180°). Specific dimensions are listed in Tables 10, 11 and 12.

The values given for W and Z in addition to those for R have been calculated from the values of R and shall be used to verify conformance of the elbow because measurement of R is not possible in practice.

Table 10 — Elbows model 2D — Dimensions

Dimensions in millimetres

| <i>DN</i> | <i>D</i> | <i>R</i> | <i>C</i> | <i>B - W</i> |
|-----------|----------|----------|----------|--------------|
| 15 | 21,3 | 25 | 50 | 36 |
| 20 | 26,9 | 25 | 50 | 39 |
| 25 | 33,7 | 25 | 50 | 42 |
| 32 | 42,4 | 32 | 64 | 53 |
| 40 | 48,3 | 38 | 76 | 62 |
| 50 | 60,3 | 51 | 102 | 81 |
| 65 | 76,1 | 63 | 127 | 102 |
| 80 | 88,9 | 76 | 152 | 121 |
| 100 | 114,3 | 102 | 203 | 159 |
| 125 | 139,7 | 127 | 254 | 197 |
| 150 | 168,3 | 152 | 305 | 237 |
| 200 | 219,1 | 203 | 406 | 313 |
| 250 | 273 | 254 | 508 | 391 |
| 300 | 323,9 | 305 | 610 | 467 |
| 350 | 355,6 | 356 | 711 | 533 |
| 400 | 406,4 | 406 | 813 | 610 |
| 450 | 457 | 457 | 914 | 686 |
| 500 | 508 | 508 | 1 016 | 762 |
| 550 | 559 | 559 | 1 118 | 838 |
| 600 | 610 | 610 | 1 220 | 914 |
| 650 | 660 | 660 | 1 320 | 990 |
| 700 | 711 | 711 | 1 422 | 1 066 |
| 750 | 762 | 762 | 1 524 | 1 143 |
| 800 | 813 | 813 | 1 626 | 1 220 |
| 850 | 864 | 864 | 1 728 | 1 296 |
| 900 | 914 | 914 | 1 828 | 1 371 |
| 1 000 | 1 016 | 1 016 | 2 032 | 1 524 |
| 1 050 | 1 067 | 1 067 | 2 134 | 1 600 |
| 1 100 | 1 118 | 1 118 | 2 236 | 1 677 |
| 1 150 | 1 166 | 1 166 | 2 332 | 1 749 |
| 1 200 | 1 219 | 1 219 | 2 438 | 1 830 |

Table 11 — Elbows model 3D — Dimensions

Dimensions in millimetres

| <i>DN</i> | <i>D</i> | <i>R</i> | <i>C</i> | <i>B - W - Z</i> |
|-----------|----------|----------|----------|------------------|
| 15 | 21,3 | 38 | 76 | 49 |
| 20 | 26,9 | 38 | 76 | 51 |
| 25 | 33,7 | 38 | 76 | 56 |
| | 38 | 45 | 90 | 64 |
| 32 | 42,4 | 48 | 96 | 69 |
| 40 | 48,3 | 57 | 114 | 82 |
| | 51 | 63 | 126 | 88 |
| | 57 | 72 | 144 | 100 |
| 50 | 60,3 | 76 | 152 | 106 |
| | 70 | 92 | 184 | 127 |
| 65 | 76,1 | 95 | 190 | 133 |
| 80 | 88,9 | 114 | 228 | 159 |
| | 101,6 | 133 | 267 | 184 |
| | 108 | 142,5 | 285 | 196 |
| 100 | 114,3 | 152 | 304 | 210 |
| | 133 | 181 | 362 | 247 |
| 125 | 139,7 | 190 | 380 | 260 |
| | 159 | 216 | 432 | 295 |
| 150 | 168,3 | 229 | 457 | 313 |
| | 193,7 | 270 | 540 | 367 |
| 200 | 219,1 | 305 | 610 | 414 |
| | 244,5 | 340 | 680 | 462 |
| 250 | 273 | 381 | 762 | 518 |
| 300 | 323,9 | 457 | 914 | 619 |
| 350 | 355,6 | 533 | 1 066 | 711 |
| 400 | 406,4 | 610 | 1 220 | 813 |
| 450 | 457 | 686 | 1 372 | 914 |
| 500 | 508 | 762 | 1 524 | 1 016 |
| 550 | 559 | 838 | 1 676 | 1 118 |
| 600 | 610 | 914 | 1 828 | 1 219 |
| 650 | 660 | 990 | 1 980 | 1 320 |
| 700 | 711 | 1 067 | 2 134 | 1 422 |
| 750 | 762 | 1 143 | 2 286 | 1 524 |
| 800 | 813 | 1 219 | 2 438 | 1 626 |
| 850 | 864 | 1 296 | 2 592 | 1 728 |
| 900 | 914 | 1 372 | 2 744 | 1 829 |
| 1 000 | 1 016 | 1 524 | 3 048 | 2 032 |
| 1 050 | 1 067 | 1 600 | 3 201 | 2 134 |
| 1 100 | 1 118 | 1 677 | 3 354 | 2 236 |
| 1 150 | 1 168 | 1 752 | 3 504 | 2 336 |
| 1 200 | 1 219 | 1 829 | 3 658 | 2 438 |

Table 12 — Elbows model 5D — Dimensions

Dimensions in millimetres

| <i>DN</i> | <i>D</i> | <i>R</i> | <i>C</i> | <i>B - W - Z</i> |
|-----------|----------|----------|----------|------------------|
| 15 | 21,3 | 42,5 | 85 | 53 |
| 20 | 26,9 | 57,5 | 115 | 71 |
| 25 | 33,7 | 72,5 | 145 | 89 |
| | 38 | 82,5 | 165 | 101 |
| 32 | 42,4 | 92,5 | 185 | 114 |
| 40 | 48,3 | 109,5 | 219 | 134 |
| | 51 | 122,5 | 245 | 149 |
| | 57 | 130 | 260 | 158 |
| 50 | 60,3 | 137,5 | 275 | 168 |
| | 70 | 160 | 320 | 195 |
| 65 | 76,1 | 175 | 350 | 213 |
| 80 | 88,9 | 207,5 | 415 | 252 |
| | 101,6 | 235 | 470 | 286 |
| | 108 | 253 | 506 | 306 |
| 100 | 114,3 | 270 | 540 | 327 |
| | 133 | 311,5 | 623 | 378 |
| 125 | 139,7 | 330 | 660 | 400 |
| | 159 | 375 | 750 | 454 |
| 150 | 168,3 | 390 | 780 | 474 |
| 200 | 219,1 | 515 | 1030 | 624 |
| | 244,5 | 580 | 1160 | 702 |
| 250 | 273 | 650 | 1300 | 786 |
| 300 | 323,9 | 770 | 1540 | 932 |
| 350 | 355,6 | 850 | 1700 | 1 028 |
| 400 | 406,4 | 970 | 1940 | 1 173 |
| 450 | 457 | 1 122 | 2 244 | 1 350 |
| 500 | 508 | 1 245 | 2 490 | 1 500 |
| 550 | 559 | 1 398 | 2 796 | 1 677 |
| 600 | 610 | 1 525 | 3 050 | 1 830 |
| 650 | 660 | 1 650 | 3 300 | 1 980 |
| 700 | 711 | 1 778 | 3 556 | 2 133 |
| 750 | 762 | 1 905 | 3 810 | 2 286 |
| 800 | 813 | 2 033 | 4 066 | 2 439 |
| 850 | 864 | 2 155 | 4 310 | 2 587 |
| 900 | 914 | 2 285 | 4 570 | 2 742 |
| 1 000 | 1 016 | 2 540 | 5 080 | 3 048 |
| 1 050 | 1 067 | 2 665 | 5 335 | 3 201 |
| 1 100 | 1 118 | 2 790 | 5 580 | 3 354 |
| 1 150 | 1 168 | 2 915 | 5 830 | 3 504 |
| 1 200 | 1 219 | 3 050 | 6 100 | 3 657 |

11.1.3 Tees

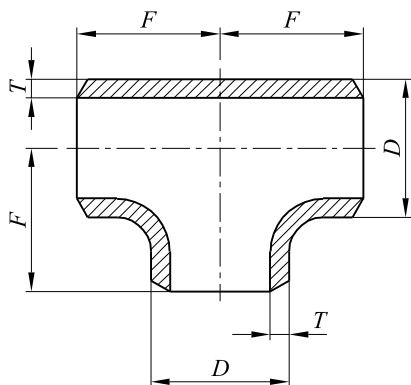


Figure 4 — Equal tee

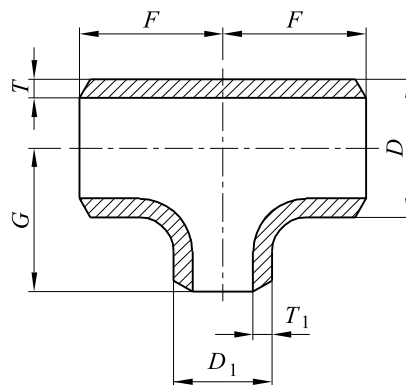


Figure 5 — Reducing tee

Equal tees are produced in accordance with Figure 4. Specific dimensions are listed in Table 13.

Reducing tees are produced in accordance with Figure 5. Specific dimensions are listed in Table 14.

Table 13 — Equal Tees — Dimensions

Dimensions in millimetres

| <i>DN</i> | <i>D</i> | <i>F</i> |
|-----------|----------|------------------|
| 15 | 21,3 | 25 |
| 20 | 26,9 | 29 |
| 25 | 33,7 | 38 |
| 32 | 42,4 | 48 |
| 40 | 48,3 | 57 |
| 50 | 60,3 | 64 |
| 65 | 76,1 | 76 |
| 80 | 88,9 | 86 |
| 90 | 101,6 | 95 |
| 100 | 114,3 | 105 |
| 125 | 139,7 | 124 |
| 150 | 168,3 | 143 |
| 200 | 219,1 | 178 |
| 250 | 273 | 216 |
| 300 | 323,9 | 254 |
| 350 | 355,6 | 279 |
| 400 | 406,4 | 305 |
| 450 | 457 | 343 |
| 500 | 508 | 381 |
| 550 | 559 | 419 |
| 600 | 610 | 432 |
| 650 | 660 | 495 |
| 700 | 711 | 521 |
| 750 | 762 | 559 |
| 800 | 813 | 597 |
| 850 | 864 | 635 |
| 900 | 914 | 673 |
| 1 000 | 1 016 | 749 |
| 1 050 | 1 067 | 762 ^a |
| 1 100 | 1 118 | 813 ^a |
| 1 150 | 1 166 | 851 ^a |
| 1 200 | 1 219 | 889 ^a |

^a For these dimensions, the length of the outlet branch is not equal to the length of the run F. The applicable values for the length of the outlet branch are respectively : 711 for *DN* 1050, 762 for *DN* 1100, 800 for *DN* 1150 and 838 for *DN* 1200.

Table 14 — Reducing Tees — Dimensions

Dimensions in millimetres

| Side <i>D</i> | | Side <i>D</i> ₁ | | | |
|---------------|----------|----------------------------|-----------------------|----------|----------|
| <i>DN</i> | <i>D</i> | <i>DN</i> ₁ | <i>D</i> ₁ | <i>F</i> | <i>G</i> |
| 20 | 26,9 | 15 | 21,3 | 29 | 29 |
| 25 | 33,7 | 15 | 21,3 | 38 | 38 |
| | | 20 | 26,9 | | |
| 32 | 42,4 | 15 | 21,3 | 48 | 48 |
| | | 20 | 26,9 | | |
| | | 25 | 33,7 | | |
| 40 | 48,3 | 15 | 21,3 | 57 | 57 |
| | | 20 | 26,9 | | |
| | | 25 | 33,7 | | |
| | | 32 | 42,4 | | |
| 50 | 60,3 | 20 | 26,9 | 64 | 44 |
| | | 25 | 33,7 | | 51 |
| | | 32 | 42,4 | | 57 |
| | | 40 | 48,3 | | 60 |
| 65 | 76,1 | 25 | 33,7 | 76 | 57 |
| | | 32 | 42,4 | | 64 |
| | | 40 | 48,3 | | 67 |
| | | 50 | 60,3 | | 70 |
| 80 | 88,9 | 32 | 42,4 | 86 | 70 |
| | | 40 | 48,4 | | 73 |
| | | 50 | 60,3 | | 76 |
| | | 65 | 76,1 | | 83 |
| 100 | 114,3 | 40 | 48,3 | 105 | 86 |
| | | 50 | 60,3 | | 89 |
| | | 65 | 76,1 | | 95 |
| | | 80 | 88,9 | | 98 |
| 125 | 139,7 | 50 | 60,3 | 124 | 105 |
| | | 65 | 76,1 | | 108 |
| | | 80 | 88,9 | | 111 |
| | | 100 | 114,3 | | 117 |
| 150 | 168,3 | 65 | 76,1 | 143 | 121 |
| | | 80 | 88,9 | | 124 |
| | | 100 | 114,3 | | 130 |
| | | 125 | 139,7 | | 137 |
| 200 | 219,1 | 100 | 114,3 | 178 | 156 |
| | | 125 | 139,7 | | 162 |
| | | 150 | 168,3 | | 168 |
| 250 | 273,1 | 100 | 114,3 | 216 | 184 |
| | | 125 | 139,7 | | 191 |
| | | 150 | 168,3 | | 194 |
| | | 200 | 219,1 | | 203 |
| 300 | 323,9 | 150 | 168,3 | 254 | 219 |
| | | 200 | 219,1 | | 229 |
| | | 250 | 273 | | 241 |

Table 14 (continued)

| Side <i>D</i> | | Side <i>D</i> ₁ | | <i>F</i> | <i>G</i> |
|---------------|----------|----------------------------|-----------------------|----------|----------|
| <i>DN</i> | <i>D</i> | <i>DN</i> ₁ | <i>D</i> ₁ | | |
| 350 | 355,6 | 150 | 168,3 | 279 | 238 |
| | | 200 | 219,1 | | 248 |
| | | 250 | 273 | | 257 |
| | | 300 | 323,9 | | 270 |
| 400 | 406,4 | 150 | 168,3 | 305 | 264 |
| | | 200 | 219,1 | | 273 |
| | | 250 | 273 | | 283 |
| | | 300 | 323,9 | | 295 |
| | | 350 | 355,6 | | 305 |
| 450 | 457 | 200 | 219,1 | 343 | 298 |
| | | 250 | 273 | | 308 |
| | | 300 | 323,9 | | 321 |
| | | 350 | 355,6 | | 330 |
| | | 400 | 406,4 | | 330 |
| 500 | 508 | 250 | 273 | 381 | 333 |
| | | 300 | 323,9 | | 346 |
| | | 400 | 406,4 | | 356 |
| | | 450 | 457,0 | | 368 |
| 550 | 559 | 250 | 273 | 419 | 359 |
| | | 300 | 323,9 | | 371 |
| | | 400 | 406,4 | | 381 |
| | | 500 | 508,0 | | 406 |
| 600 | 610 | 250 | 273 | 432 | 384 |
| | | 300 | 323,9 | | 397 |
| | | 400 | 406,4 | | 406 |
| | | 500 | 508,0 | | 432 |
| 650 | 660 | 300 | 323,9 | 495 | 422 |
| | | 350 | 355,6 | | 432 |
| | | 400 | 406,4 | | 432 |
| | | 500 | 508 | | 457 |
| 700 | 711 | 300 | 323,9 | 521 | 448 |
| | | 400 | 406,4 | | 457 |
| | | 500 | 508,0 | | 483 |
| | | 600 | 610,0 | | 508 |
| 750 | 762 | 400 | 406,4 | 559 | 483 |
| | | 500 | 508,0 | | 508 |
| | | 600 | 610,0 | | 533 |
| 800 | 813 | 400 | 406,4 | 602 | 508 |
| | | 500 | 508,0 | | 533 |
| | | 600 | 610,0 | | 559 |
| | | 700 | 711,0 | | 572 |
| 850 | 864 | 400 | 406,4 | 635 | 533 |
| | | 500 | 508,0 | | 559 |
| | | 600 | 610,0 | | 584 |
| | | 700 | 711,0 | | 597 |

Table 14 (continued)

| Side D | | Side D_1 | | F | G |
|----------|-------|------------|---------|-----|-----|
| DN | D | DN_1 | D_1 | | |
| 900 | 914 | 400 | 406,4 | 673 | 559 |
| | | 500 | 508,0 | | |
| | | 600 | 610,0 | | |
| | | 700 | 711,0 | | |
| | | 800 | 813,0 | | |
| 1 000 | 1 016 | 600 | 610,0 | 749 | 660 |
| | | 700 | 711,0 | | |
| | | 800 | 813,0 | | |
| | | 900 | 914,0 | | |
| 1 050 | 1 067 | 600 | 610,0 | 762 | 660 |
| | | 700 | 711,0 | | |
| | | 800 | 813,0 | | |
| | | 900 | 914,0 | | |
| 1 100 | 1 118 | 600 | 610,0 | 813 | 698 |
| | | 700 | 711,0 | | |
| | | 800 | 813,0 | | |
| | | 900 | 914 | | |
| 1 200 | 1 219 | 700 | 711,0 | 889 | 762 |
| | | 800 | 813,0 | | |
| | | 900 | 914,0 | | |
| | | 1 000 | 1 016,0 | | |

11.1.4 Reducers

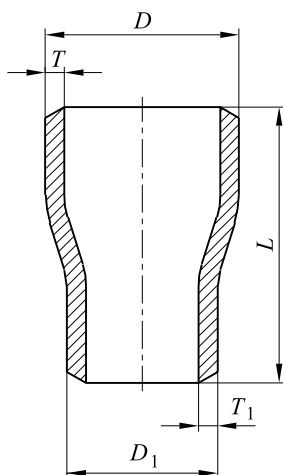


Figure 6 — Concentric reducer

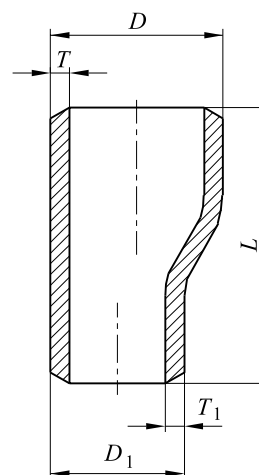


Figure 7 — Eccentric reducer

Concentric and eccentric reducers are produced in accordance respectively with Figures 6 and 7. Specific dimensions are listed in Table 15.

Table 15 — Reducers — Dimensions

Dimensions in millimetres

| Side D | | Side D_1 | | Length L |
|----------|-------|------------|-------|------------|
| DN | D | DN_1 | D_1 | |
| 20 | 26,9 | 15 | 21,3 | 38 |
| 25 | 33,7 | 20 | 26,9 | 51 |
| | | 15 | 21,3 | 51 |
| 32 | 42,4 | 25 | 33,7 | 51 |
| | | 20 | 26,9 | 51 |
| | | 15 | 21,3 | 51 |
| 40 | 48,3 | 32 | 42,4 | 64 |
| | | 25 | 33,7 | 64 |
| | | 20 | 26,9 | 64 |
| 50 | 60,3 | 40 | 48,3 | 76 |
| | | 32 | 42,4 | 76 |
| | | 25 | 33,7 | 76 |
| | | 20 | 26,9 | 76 |
| 65 | 76,1 | 50 | 60,3 | 89 |
| | | 40 | 48,3 | 89 |
| | | 32 | 42,4 | 89 |
| | | 25 | 33,7 | 89 |
| 80 | 88,9 | 65 | 76,1 | 89 |
| | | 50 | 60,3 | 89 |
| | | 40 | 48,3 | 89 |
| | | 32 | 42,4 | 89 |
| 100 | 114,3 | 80 | 88,9 | 102 |
| | | 65 | 76,1 | 102 |
| | | 50 | 60,3 | 102 |
| | | 40 | 48,3 | 102 |
| 125 | 139,7 | 100 | 114,3 | 127 |
| | | 80 | 88,9 | 127 |
| | | 65 | 76,1 | 127 |
| | | 50 | 60,3 | 127 |
| 150 | 168,3 | 125 | 139,7 | 140 |
| | | 100 | 114,3 | 140 |
| | | 80 | 88,9 | 140 |
| | | 65 | 76,1 | 140 |
| 200 | 219,1 | 150 | 168,3 | 152 |
| | | 125 | 139,7 | 152 |
| | | 100 | 114,3 | 152 |
| | | 80 | 88,9 | 152 |

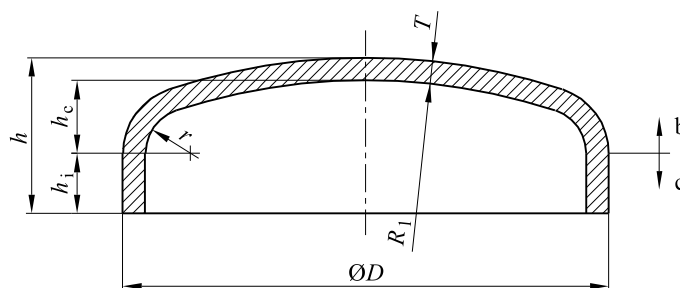
Table 15 (continued)

| Side D | | Side D_1 | | Length L |
|----------|-------|------------|-------|------------|
| DN | D | DN_1 | D_1 | |
| 250 | 273 | 200 | 219,1 | 178 |
| | | 150 | 168,3 | 178 |
| | | 125 | 139,7 | 178 |
| | | 100 | 114,3 | 178 |
| 300 | 323,9 | 250 | 273 | 203 |
| | | 200 | 219,1 | 203 |
| | | 150 | 168,3 | 203 |
| | | 125 | 139,7 | 203 |
| 350 | 355,6 | 300 | 323,9 | 330 |
| | | 250 | 273 | 330 |
| | | 200 | 219,1 | 330 |
| | | 150 | 168,3 | 330 |
| 400 | 406,4 | 350 | 355,6 | 356 |
| | | 300 | 323,9 | 356 |
| | | 250 | 273 | 356 |
| | | 200 | 219,1 | 356 |
| 450 | 457 | 400 | 406,4 | 381 |
| | | 350 | 355,6 | 381 |
| | | 300 | 323,9 | 381 |
| | | 250 | 273 | 381 |
| 500 | 508 | 450 | 457 | 508 |
| | | 400 | 406,4 | 508 |
| | | 350 | 355,6 | 508 |
| | | 300 | 323,9 | 508 |
| 550 | 559 | 500 | 508 | 508 |
| | | 450 | 457 | 508 |
| | | 400 | 406,4 | 508 |
| | | 350 | 355,6 | 508 |
| 600 | 610 | 550 | 559 | 508 |
| | | 500 | 508 | 508 |
| | | 450 | 457 | 508 |
| | | 400 | 406,4 | 508 |
| 700 | 711 | 600 | 610 | 610 |
| | | 500 | 508 | 610 |
| | | 450 | 457 | 610 |
| 800 | 813 | 700 | 711 | 610 |
| | | 600 | 610 | 610 |
| | | 550 | 559 | 610 |
| | | 500 | 508 | 610 |

Table 15 (continued)

| Side D | | Side D_1 | | Length L |
|----------|-------|------------|-------|------------|
| DN | D | DN_1 | D_1 | |
| 900 | 914 | 800 | 813 | 610 |
| | | 700 | 711 | 610 |
| | | 600 | 610 | 610 |
| 1 000 | 1 016 | 900 | 914 | 610 |
| | | 800 | 813 | 610 |
| | | 700 | 711 | 610 |
| 1 200 | 1 219 | 1 000 | 1 016 | 711 |
| | | 900 | 914 | 711 |
| | | 800 | 813 | 711 |

11.1.5 Caps



Key

- R_1 approximately equal to $0,8 D$
- r approximately equal to $0,15 D$

Figure 8 — Cap

NOTE Some of the listed dimensions don't comply with all technical regulations, e.g. according to EN 13480-3 (see B.5). Nevertheless they are standard on the market. In these cases, it is essential that the dimensions be agreed.

Table 16 — Caps — Dimensions

Dimensions in millimetres

| <i>DN</i> | <i>D</i> | <i>k</i> |
|-----------|----------|-----------------------|
| 15 | 21,3 | 25 |
| 20 | 26,9 | 25 |
| 25 | 33,7 | 25 |
| 32 | 42,4 | 38 |
| 40 | 48,3 | 38 |
| 50 | 60,3 | 38 |
| 65 | 76,1 | 38 |
| 80 | 88,9 | 51 |
| | 101,6 | 64 |
| 100 | 114,3 | 64 |
| 125 | 139,7 | 76 |
| 150 | 168,3 | 89 |
| 200 | 219,1 | 102 |
| 250 | 273,1 | 127 |
| 300 | 323,9 | 152 |
| 350 | 355,6 | 165 |
| 400 | 406,4 | 178 |
| 450 | 457 | 203 |
| 500 | 508 | 229 |
| 550 | 559 | 254 |
| 600 | 610 | 267 |
| 650 | 660 | 267 |
| 700 | 711 | 267 for $T \leq 25$ |
| | | 290 |
| 750 | 762 | 267 for $T \leq 20$ |
| | | 310 |
| 800 | 813 | 267 for $T \leq 17,5$ |
| | | 330 |
| 850 | 864 | 267 for $T \leq 14$ |
| | | 350 |
| 900 | 914 | 267 for $T \leq 10$ |
| | | 370 |
| 1 000 | 1 016 | 305 for $T \leq 14,2$ |
| | | 420 |
| 1 050 | 1 067 | 305 for $T \leq 13$ |
| | | 405 |
| 1 100 | 1 118 | 343 for $T \leq 12$ |
| | | 390 |
| 1 150 | 1 166 | 343 for $T \leq 11$ |
| | | 375 |
| 1 200 | 1 219 | 343 for $T \leq 10$ |
| | | 360 |

11.1.6 Preferred diameters and wall thicknesses

Preferred diameters and wall thicknesses have been selected to match with tube dimensions described in EN 10220 and are listed in Table 17.

NOTE Dimensions which are different from those in Table 17 may be agreed.

Table 17 — Preferred diameter and wall thicknesses

| Diameter | | | Wall thickness series | | | | | | | |
|-----------|----------|----------|-----------------------|-----|-----|-----|------|------|------|------|
| <i>DN</i> | <i>D</i> | <i>D</i> | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 15 | 21,3 | | | 2,0 | 2,6 | 3,2 | 4,0 | | 5 | 7,1 |
| | | 25 | | 2,0 | 2,3 | | | | | |
| 20 | 26,9 | | | 2,3 | 2,6 | 3,2 | 4,0 | 4,5 | 5,6 | 8,0 |
| | | 31,8 | | 2,6 | | | | | | |
| 25 | 33,7 | | | 2,6 | 3,2 | 4,0 | 4,5 | 5,6 | 6,3 | 8,8 |
| | | 38 | | 2,6 | | | | | | |
| 32 | 42,4 | | | 2,6 | 3,6 | 4,0 | 5,0 | 6,3 | 8,0 | 10,0 |
| 40 | 48,3 | | | 2,6 | 3,6 | 4,0 | 5,0 | 6,3 | 8,0 | 10,0 |
| | | 51 | | 2,6 | | | | | | |
| | | 57 | | 2,9 | | | | | | |
| 50 | 60,3 | | | 2,9 | 3,6 | 4,0 | 5,6 | 7,1 | 8,8 | 11,0 |
| | | 63,5 | | 2,9 | | | | | | |
| | | 70 | | 2,9 | | | | | | |
| | | 73 | | 2,9 | 3,6 | 4,5 | 7,1 | | | 14,2 |
| 65 | 76,1 | | | 2,9 | 3,6 | 5,6 | 7,1 | 8,0 | 10,0 | 14,2 |
| | | 82,5 | | 3,2 | | | | | | |
| 80 | 88,9 | | | 3,2 | 4,0 | 5,6 | 8,0 | 8,8 | 11,0 | 16,0 |
| | | 101,6 | | 3,6 | 4,0 | 5,6 | 8,0 | | | |
| | | 108 | | 3,6 | | | | | | |
| 100 | 114,3 | | | 3,6 | 4,5 | 6,3 | 8,8 | 11,0 | 14,2 | 17,5 |
| | | 127 | | 4,0 | | | | | | |
| | | 133 | | 4,0 | | | | | | |
| 125 | 139,7 | | | 4,0 | 5,0 | 6,3 | 10,0 | 12,5 | 16,0 | 20,0 |
| | | 141,3 | | 4,0 | 5,4 | 6,3 | 10,0 | | 16,0 | 20,0 |
| | | 152,4 | | 4,5 | | | | | | |
| | | 159 | | 4,5 | | | | | | |
| | | 165,1 | | 4,5 | 5,4 | | | | | |
| 150 | 168,3 | | 4,0 | 4,5 | 5,6 | 7,1 | 11,0 | 14,2 | 17,5 | 22,2 |
| | | 177,8 | | 5,0 | | | | | | |
| | | 193,7 | | 5,6 | 6,3 | 7,1 | | | | |
| 200 | 219,1 | | 4,5 | 6,3 | 7,1 | 8,0 | 12,5 | 16,0 | 17,5 | 22,2 |
| | | 244,5 | | 6,3 | | | | | | |

Table 17 (continued)

| Diameter | | | Wall thickness series | | | | | | | |
|----------|-------|-------|-----------------------|------|------|------|------|------|------|------|
| DN | D | D | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 250 | 273 | | 5 | 6,3 | 8,8 | 10,0 | 12,5 | 16,0 | 22,2 | 30,0 |
| 300 | 323,9 | | 5,6 | 7,1 | 8,8 | 10,0 | 12,5 | 17,5 | 25,0 | 32,0 |
| 350 | 355,6 | | 5,6 | 8,0 | 10,0 | 12,5 | 16,0 | 20,0 | 28,0 | 36,0 |
| 400 | 406,4 | | 6,3 | 8,8 | 10,0 | 12,5 | 17,5 | 22,2 | 30,0 | 40,0 |
| 450 | 457 | | 6,3 | 10,0 | 11,0 | 12,5 | 17,5 | 22,2 | 32,0 | 45,0 |
| 500 | 508 | | 6,3 | 10,0 | 11,0 | 12,5 | 17,5 | 25,0 | 36,0 | 50,0 |
| 550 | | 559 | 6,3 | 10,0 | | 12,5 | 20,0 | 28,0 | | |
| 600 | 610 | | 6,3 | 10,0 | 12,5 | 17,5 | 25,0 | 30,0 | 45,0 | 60,0 |
| 650 | 660 | | | 10,0 | 12,5 | 17,5 | | | | |
| 700 | 711 | | 7,1 | 10,0 | 12,5 | 25,0 | | | | |
| 750 | | 762 | | 10,0 | 12,5 | 25,0 | | | | |
| 800 | 813 | | 8,0 | 10,0 | 12,5 | 25,0 | | | | |
| 850 | | 864 | | 10,0 | 12,5 | 25,0 | | | | |
| 900 | 914 | | 10,0 | 12,5 | 20,0 | 25,0 | | | | |
| 1 000 | 1 016 | | 10,0 | 12,5 | 20,0 | 25,0 | | | | |
| 1 050 | | 1 067 | 10,0 | 12,5 | 20,0 | 25,0 | | | | |
| 1 100 | | 1 118 | 10,0 | 12,5 | 20,0 | 25,0 | | | | |
| 1 150 | | 1 168 | 10,0 | 12,5 | 20,0 | 25,0 | | | | |
| 1 200 | 1 219 | | 10,0 | 12,5 | 20,0 | 25,0 | | | | |

11.2 Dimensional tolerances

11.2.1 Inside diameter (ID-ID1)

11.2.1.1 The relevant diameters shall be measured at the welding ends of the fittings. The tolerance is as follows :

$\pm 1\%$ or $\pm 0,5$ mm, whichever is the greater, but maximum ± 5 mm

Option 9 : *The tolerance on diameter shall apply to the outside diameter instead of the inside diameter.*

11.2.1.2 In order to guarantee the regular flow of the fluid through the fitting, the internal diameter in any section of the fitting (not applicable to caps) shall be above 80 % (for tees 70 %) of the internal diameter *ID* at the welding ends.

Option 10 : *Special tolerances may be agreed when pigging shall be applied.*

11.2.1.3 Tolerances for ovality are following:

At the welding ends:

- $D \leq 273,0$ Included in the diameter tolerance ;
- $273,0 < D \leq 610$ 2 % ;
- $D > 610$ 1 % ;

On the body for elbows and return bends : 4 %.

The ovality shall be calculated as follows :

$$Ov = 100 (D_{max} - D_{min}) / D \text{ in } \%$$

Where:

D_{max} is the bigger diameter in one section, expressed in millimetres ;

D_{min} is the smaller diameter in the same section, expressed in millimetres ;

D is the specified diameter, expressed in millimetres.

11.2.2 Wall thickness tolerances at the welding ends

Wall thickness tolerances are indicated in Table 18. For fittings type B, the minus tolerances on T apply also for the other values of the wall thickness as defined in Annex A.

Table 18 — Wall thickness tolerances at the welding ends

| D mm | T mm | Wall thickness tolerance | |
|------------|-----------|--------------------------|--------|
| | | Minus | Plus |
| ≤ 610 | ≤ 4 | - 12,5 % | + 20 % |
| | > 4 | | |
| > 610 | Seamless | - 12,5 % | + 20 % |
| | Welded | | |
| | ≤ 10 | - 0,35 mm | + 20 % |
| | > 10 | - 0,5 mm | |

The minus tolerances apply also for the body of the fitting.

Option 11 : Plus tolerances on the body of the fitting shall be as specified on the purchase order.

11.2.3 Tolerances on specific dimensions

For the dimensions specific to fittings, the tolerances are given in Table 19.

Table 19 — Tolerances on specific dimensions and form

| Dimensions in millimetres | | | | | |
|---------------------------|----------------|------------|----------|----------|----------|
| <i>D</i> | <i>F-G-L-W</i> | <i>B-Z</i> | <i>C</i> | <i>h</i> | <i>P</i> |
| $\leq 114,3$ | ± 2 | ± 7 | ± 7 | ± 4 | 2 |
| $114,3 < D \leq 219,1$ | ± 2 | ± 7 | ± 7 | ± 7 | 4 |
| $219,1 < D \leq 406,4$ | ± 3 | ± 7 | ± 10 | ± 7 | 6 |
| $406,4 < D \leq 762$ | ± 3 | ± 10 | ± 10 | ± 7 | 7 |
| $762 < D$ | ± 5 | ± 12 | ± 10 | ± 10 | 9 |

11.2.4 Tolerances on the form of fittings

The tolerance on the form of every type of fitting (out-of-squareness, alignment) is following:

$X \leq 1$ % of the outside diameter at the point measured or 1 mm, whichever is the greater (see Figure 9).

For P, the tolerance is given in Table 19.

All tolerances on the form shall be verified with the fitting remaining in the same position.

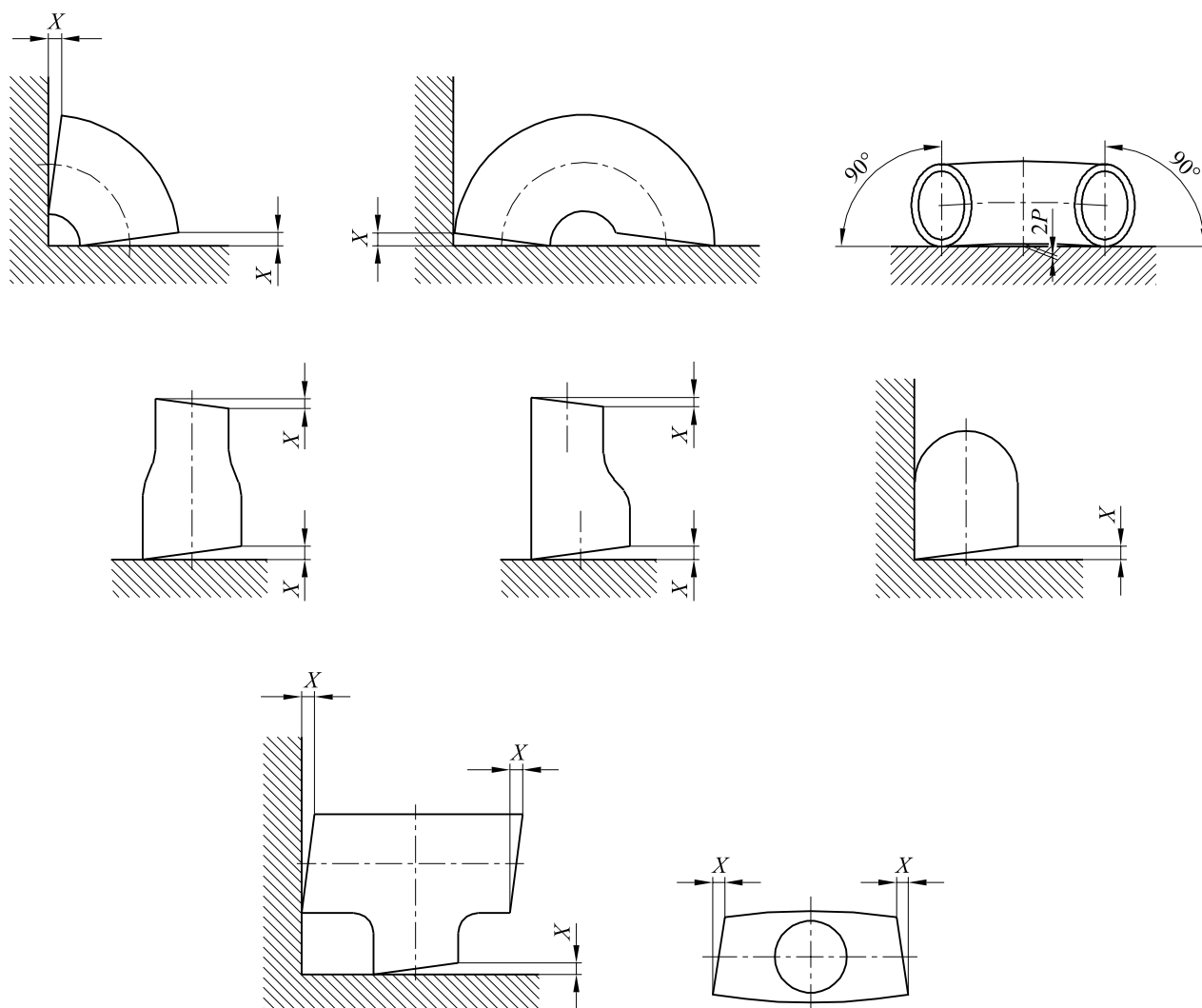


Figure 9 — Determination of the tolerance on the form of fittings

11.2.5 Corrugation

Corrugation (see Figure 10) is permitted within following limits:

- a) for elbows and return bends :
- hm not exceeding 3 % D or 25 mm, whichever is lesser ;
 - $LE \geq 15 \cdot hm$.
- b) for tees and reducers :
- hm not exceeding 3 % D or 25 mm, whichever is lesser ;
 - $LE \geq 5 \cdot hm$;
 - there shall be no sharp edges associated with the corrugation.

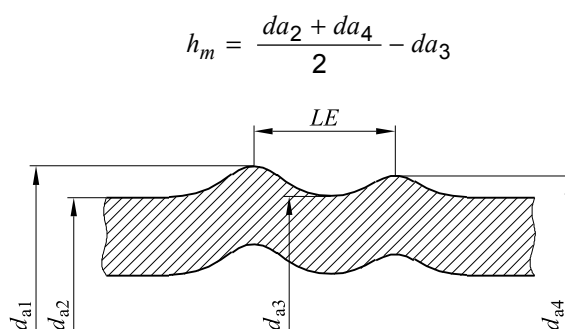


Figure 10 — Determination of corrugation

11.3 End finishing

At the manufacturer's option, for specified wall thicknesses below 3 mm, the ends may be square cut or slightly chamfered. For wall thicknesses between 3 mm and 22 mm, the ends shall be bevelled with an angle of $30^\circ - 0 + 5^\circ$ with a root face of $1,6 \text{ mm} \pm 0,8 \text{ mm}$.

For wall thicknesses above 22 mm the type of bevel shall be agreed.

For wall thicknesses above 3 mm, where machining at the welding ends is necessary, the wall thickness may be reduced by taper boring, the taper being not larger than:

- external : 30° ;
- internal : 18° .

The fitting ends shall be free from harmful burrs.

Option 12: *The end finishing shall be as specified.*

12 Inspection

12.1 Type of inspection

Conformity to the requirements of the order, for fittings in accordance with this Part of EN 10253, shall be checked by specific inspection.

When an inspection document 3.1 is specified, the manufacturer shall state in the confirmation of the order whether he is operating according to a “quality assurance system”, certified by a competent body established within the community, and having undergone a specific assessment for materials and processes relevant to manufacture of fittings, including, if applicable, welding procedure approvals, welder/weld operator approval and NDT operator approval.

NOTE See Directive 97/23/EC Annex I section 4.3 third paragraph.

12.2 Inspection documents

12.2.1 Type of inspection documents

Unless Option 13 is specified an inspection certificate 3.1 in accordance with EN 10204 shall be issued.

Option 13 : *An inspection document 3.2 in accordance with EN 10204 shall be issued.*

If an inspection document 3.2 is specified, the purchaser shall notify the manufacturer of the name and address of the organisation or person who is to carry out the inspection and to produce the inspection document.

For welded fittings and fittings machined from bars, the manufacturer shall join to the inspection document the relevant inspection document concerning the starting material (welded tube or plate/strip or bar).

12.2.2 Content of inspection documents

The content of the inspection document shall be in accordance with EN 10168.

In all types of inspection documents a statement on the conformity of the products delivered with the requirements of this standard and the order shall be included.

The inspection document shall contain the following codes and/or information:

A – commercial transactions and parties involved ;

B – description of products to which the inspection document applies ;

C01-C02 – location of the test sample where applicable ;

C10-C13 – tensile test where applicable ;

C40-C43 – impact test where applicable ;

C50 – bend test where applicable ;

C71-C92 – chemical composition on cast analysis (product analysis where applicable) ;

D01 – marking and identification, surface appearance and dimensional properties ;

D02-D99 – non destructive inspection where applicable ;

Z - authentication.

When welding is part of the manufacturing process, the inspection document shall also contain :

- reference to welding procedure approval ;
- reference to welder and or welding operator approval ;
- reference to non-destructive testing operators approval ;
- information on the forming process and the applied heat treatment.

When fittings are produced from welded tubes, the inspection document shall also contain :

- Information on the forming process and the applied heat treatment.

When fittings are marked “Y” (see 7.1), the inspection document shall also contain :

- reduced wall thickness used instead of the specified one ;
- attested minimum yield strength.

In addition, for inspection document 3.1, the manufacturer shall state the references to the certificate (see 12.1) of the appropriate “quality assurance system”, if applicable.

12.3 Summary of inspection and testing

Inspection and testing to be carried out are summarised in Table 20. Unless option 14 is specified, the tensile test may be waived for carbon steels provided the four following conditions are simultaneously fulfilled:

- manufacturer does not attest a higher yield strength than the specified minimum (see 7.1) ;
- tensile test results used to determine compliance with the standard are the results of the starting material as reported by the material manufacturer ;
- producer can demonstrate that the fittings are in the equivalent metallurgical condition as that of the starting material as a result of the heating or heat treatment carried out during manufacture ;
- thardness results (see Table 20) are in compliance with the criteria defined in this standard.

If the tensile test is waived the manufacturer shall join the relevant inspection documents concerning the starting material (tube, plate/strip or bar).

Option 14 : *The mechanical properties shall be determined on the finished product in accordance with Table 20.*

Table 20 — Inspections and tests

| Type of inspection and testing | Conditions for realisation | Number of tests |
|---|--|--------------------------------------|
| Cast analysis (14.1) | Base material | 1 per cast |
| Mandatory tests | | |
| Tensile test at room temperature (14.2.1) | $D \geq 114,3$ mm | 1 per test unit |
| Tensile test transverse to the weld (14.3) | Welded fittings ^a with $D \geq 219,1$ mm | 1 per test unit |
| Hardness test (14.4) | $D < 114,3$ mm $D \geq 114,3$ mm ^b | 10 per test unit 10 per test unit |
| Impact test (14.6) ^c | $D \geq 114,3$ mm | 1 per test unit |
| Impact test transverse to the weld (14.6) | Welded fittings ^a with $D \geq 219,1$ mm | 1 per test unit |
| Bend test transverse to the weld (14.5) | Welded fittings ^a | 1 per test unit |
| Material identification (14.10) | Alloy steels | Each fitting |
| Dimensional inspection (14.7) | | Manufacturer's procedure |
| Visual inspection (14.8) | | Each fitting |
| NDT of the weld (14.9.2) | Welded fittings | Each fitting |
| NDT of the tee (14.9.3) | Cold formed tees | Each fitting |
| Optional tests | | |
| Product analysis (14.1) | | 1 per cast |
| Tensile test at elevated temperature(14.2.2) | | 1 per cast |
| Hardness test (14.4) ^d | | Each fitting |
| Impact test (14.6) ^e | $D \geq 114,3$ mm | 1 per test unit |
| Impact test of the heat affected zone (14.6) | To be agreed | To be agreed |
| NDT of the starting material for laminar imperfections (14.9.4) | To be agreed | To be agreed |
| ^a In this table welded fittings are fittings for which a weld is made during the manufacture of the fitting. ^b To be carried out when the tube results are used for the inspection document. ^c The test is not mandatory for grades P235GH, P265GH, 16Mo3, 10CrMo5-5, 13CrMo4-5, 10 CrMo9-10, X11CrMo5, X11CrMo9-1, X10CrMoVNb9-1. ^d Option 15 : Each fitting shall be hardness tested according to 14.4. ^e Option 16 : This option applies only for grades P235GH, P265GH, 16Mo3, 10CrMo5-5, 13CrMo4-5, 10 CrMo9-10, X11CrMo5, X11CrMo9-1, X10CrMoVNb9-1. | | |

13 Sampling

13.1 Frequency of tests

13.1.1 Test unit

A test unit shall consist of fittings of the same type, same specified dimension, same manufacturing process (for welded fittings, same welding process), from the same cast and the same heat treatment.

NOTE If the fitting dimensions are so large or the test unit so numerous that the furnace capacity leads to multiple heat treatment, it may be regarded as one test unit provided that the temperature can be guaranteed in a range of ± 15 °C and that the cooling conditions are similar.

Option 17 : *The registration records of the temperatures shall be transmitted to the purchaser.*

The purchaser may indicate in his enquiry and order that the test unit size shall be limited ; in this case he shall select one of the following options and following conditions apply :

For test unit size determination, equal or reducing tees as well as concentric or eccentric reducers with the same large diameter D and different reducing ratios are considered the same type.

Option 18 : *The test unit size shall be as indicated in Table 21.*

Table 21

| Diameter mm | Maximum number of pieces in a test unit |
|---------------------------|---|
| $D < 114,3$ | 500 |
| $114,3 \leq D \leq 219,1$ | 200 |
| $219,1 < D \leq 323,9$ | 100 |
| $323,9 < D \leq 610$ | 50 |
| $610 < D \leq 1219$ | 25 |
| $1219 < D$ | 10 |

Option 19 : *The test unit size shall be as indicated in Table 22.*

Table 22

| Diameter mm | Maximum number of pieces in a test unit |
|---------------------------|---|
| $D < 114,3$ | 200 |
| $114,3 \leq D \leq 219,1$ | 100 |
| $219,1 < D \leq 323,9$ | 50 |
| $323,9 < D \leq 610$ | 25 |
| $610 < D \leq 1219$ | 10 |
| $1219 < D$ | 10 |

Option 20: *The test unit size shall be as specified on the purchase order.*

13.1.2 Number of sample fittings per test unit

One sample fitting shall be taken from each test unit.

13.2 Preparation of samples and test pieces

13.2.1 Samples for product analysis

Samples for product analysis shall be taken from the test piece or samples for mechanical testing or from the whole thickness of the fitting at same location as for the mechanical test samples, in accordance with EN ISO 14284.

13.2.2 Samples and test pieces for mechanical tests

The samples for the mechanical testing shall be taken and the corresponding test pieces prepared in accordance with the general conditions of EN ISO 377, as far as applicable. The test pieces may be taken from the fitting itself or from an over length of the fitting or from an accompanying test piece which is produced from the same semi-finished product and has undergone the same heat treatment as the fitting.

13.2.3 Test piece for the tensile test on the base material

The test piece for the tensile test on the base material at room temperature shall consist of segment, over length of the fitting or representative sample. The test shall be according to EN 10002-1.

13.2.4 Test piece for the tensile test on the weld

The test piece for the tensile test on the weld shall be taken transverse to the weld with the weld at the centre of the test piece.

13.2.5 Test piece for the weld bend test

The test pieces for the weld bend test at the root and face shall be taken and prepared in accordance with EN 910.

13.2.6 Test piece for the impact test

Three standard Charpy V-notch test pieces in accordance with EN 10045-1 shall be prepared. If the specified thickness is such that standard test pieces cannot be produced from the fitting without flattening of the section, then test pieces of width less than 10 mm, but not less than 5 mm shall be prepared, the largest obtainable width shall be used. Where test pieces of least 5 mm width cannot be obtained, the fittings shall not be subjected to impact testing ; in this case, the impact test results on the starting material shall be used and reported.

The test pieces shall be taken transverse (where possible) to the fitting axis unless D_{min} , as calculated by the following equation, is greater than the specified outside diameter, in which case longitudinal test pieces shall be used :

$$D_{min} = (T - 5) + [756,25/(T-5)]$$

where:

T is the specified wall thickness, in millimetres.

It is the responsibility of the purchaser to specify the location of the impacting testing e.g. base material, HAZ, weld.

Option 21 : *Impact test transverse to the weld in the HAZ or in the weld shall be specified.*

14 Test methods

14.1 Chemical analysis

The chemical composition shall be determined by the manufacturer of the starting material.

The elements to be determined and reported shall be those in Table 4 in accordance with the steel grade concerned.

14.2 Tensile test on the base material

14.2.1 At room temperature

Unless the starting material characteristics are used, the test shall be carried out for fittings with $D \geq 114,3$ mm at room temperature in accordance with EN 10002-1, and the following shall be determined :

- the tensile strength (R_m) ;
- the 0,2 % proof strength ($R_{p0,2}$) and where applicable, the 1,0 % proof strength ($R_{p1,0}$) ;
- the percentage elongation after fracture with a reference to a gauge length (L_0) of $5,65 \sqrt{S_0}$; if a non proportional test piece is used, the percentage elongation value shall be converted to the value for a gauge length $L_0 = 5,65 \sqrt{S_0}$ using the conversion tables in EN ISO 2566-1.

14.2.2 At elevated temperature

The test shall be carried out in accordance with EN 10002-5 at the temperature agreed in the order, and the 0,2 % proof strength ($R_{p0,2}$) shall be determined.

14.3 Transverse tensile test on the weld

The test shall be carried out in accordance with EN 10002-1 at room temperature and the tensile strength (R_m) shall be determined.

14.4 Hardness test

The test is carried out for fittings with $D < 114,3$ mm. It shall also be carried out for fittings with $D \geq 114,3$ mm under the conditions in 12.3.

The test pieces shall be selected at random in the test unit provided they are representative of the test unit.

One measurement shall be carried out on the external wall of the fitting in accordance with EN ISO 6506-1 or with any other suitable method where the results can be converted to Brinell hardness numbers.

The measured hardness values shall be converted into tensile strength values in accordance with EN ISO 2566-1 to determine compliance.

14.5 Weld bend test

The test shall be carried out in accordance with EN 910 using a mandrel of a diameter of 3T. After testing the test piece shall show no cracks or flaws but slight premature failure at its edges shall not be regarded as a justification for rejection.

NOTE This test is only applicable for fittings made from sheet/plate or strip where welding is a part of the production.

14.6 Impact testing

14.6.1 The test shall be carried out for fittings with $D \geq 114,3$ mm in accordance with EN 10045-1. The test temperature shall be the lowest specified in Table 9 for the relevant grade.

14.6.2 The mean value of the three test pieces shall meet the specified minimum average value given in Table 5 or 6 for the steel grade concerned. One individual value may be below the specified value, provided that it is not less than 70 % of that value.

14.6.3 If the width (W) of the test piece is less than 10 mm, the measured impact energy (KV_p) shall be converted to impact energy (KV_c) using the equation :

$$KV_c = 10 \times KV_p / W$$

where:

KV_c is the calculated impact energy, in joules ;

KV_p is the measured impact energy, in joules ;

W is the width of the test piece.

The calculated impact energy KV_c shall comply with the requirements given in 14.6.2.

14.6.4 If the requirement of 14.6.2 is not met, then an additional set of three test pieces may be taken at the discretion of the manufacturer from the same sample and tested. To consider the test unit as complying, after testing the second test, following conditions shall be satisfied :

- average value of six test shall be equal to or greater than the specified minimum average value ;
- not more than two of six individual values may be lower than the specified minimum average value ;
- not more than one of six values may be lower than 70 % of the specified minimum average value.

14.6.5 The measured energy values and the resulting average value shall be reported.

14.7 Dimensional testing

The fittings shall be checked at a frequency fixed by the manufacturer in order to verify statistically that the dimensions conform to the requirements in Clause 11.

For elbows, the dimension R cannot be measured directly. Conformity with the requirements is verified by measurements of W and Z , for which relevant tolerances are given in Table 19.

14.8 Visual inspection

The fittings shall be submitted individually to a visual inspection in order to detect the imperfections on external and internal surfaces.

The fittings are inspected after final deformation without being protected with any coating.

The requirements in Clause 10 shall be complied with.

14.9 Non destructive testing

14.9.1 Personnel

All NDT activities shall be carried out by qualified and competent level 1, 2 and/or 3 personnel authorised to operate by the employer.

The qualification shall comply with EN 10256 or an equal specification.

It is recommended that the level 3 personnel be certified in accordance with EN 473 or, at least, an equivalent to it.

The operating authorisation issued by the employer shall be in accordance with a written procedure.

NDT operations shall be authorised by level 3 NDT individual approved by the employer.

For pressure equipment in categories III and IV (of Directive 97/23-EC) the personnel shall be approved by a recognised third-party organisation.

NOTE The definition of level 1, 2 and 3 can be found in appropriate standards, e.g. EN 473 and EN 10256

14.9.2 NDT of the weld

14.9.2.1 The NDT of welds in grades P235GH, P265GH, P355GH, 16 Mo3, 10CrMo5-5 and 13CrMo4-5 may be performed either prior or after forming and heat treatment. If fittings in such grades are produced from welded tubes not marked with C2, no additional NDT of the weld is necessary.

For all other grades, the NDT of welds shall be performed after forming and heat treatment.

Option 22 : *If NDT of the weld of fittings in grades P235, P265, P355, 16 Mo3, 10CrMo5-5 and 13CrMo4-5 is performed prior to forming and heat treatment, 10 % of the welds shall be tested after forming and heat treatment again. If one or more fitting among the 10 % has to be rejected for defect in the weld, then NDT of 100 % of the fittings shall be carried out.*

Option 23 : *The NDT of welds in grades P235, P265, P355, 16 Mo3, 10CrMo5-5 and 13CrMo4-5 shall be performed after forming and heat treatment.*

14.9.2.2 Except as mentioned in 14.9.2.3 and 14.9.2.4, all welds shall be radiographically examined throughout their entire length in accordance with EN 10246-10 to image quality R1, with the conditions given in 1) to 3) below :

- 1) sensitivity requirements, given in Table 23 established on the base material, shall be verified by use of the ISO wire penetrometer according to ISO 1027 or, if so agreed, by use of an equivalent hole penetrometer ;
- 2) only X-Ray radiation, using fine-grain, high-contrast direct film with lead screen, or gamma-ray, shall be used unless precluded by the thickness of the weld ; in such cases, other methods may be agreed ;
- 3) density of the radiograph shall not be less than 2,0 and shall be chosen so that the density through the thickest portion of the weld seam is not less than 1,5 and that maximum contrast for the type of film used is achieved.

Table 23 — Sensitivity requirements for the radiographic inspection, image quality R1

| Wall thickness mm | | Visibility required | |
|----------------------|-------|--------------------------------------|--------------------------------------|
| above | up to | of the hole with a diameter mm | of the wire with a diameter mm |
| 4,5 | 10 | 0,40 | 0,16 |
| 10 | 16 | 0,50 | 0,20 |
| 16 | 25 | 0,63 | 0,25 |
| 25 | 32 | 0,80 | 0,32 |
| 32 | 40 | 1,00 | 0,40 |

The acceptance limits for the radiographic inspection of the weld seam shall be as given in a) to f) below :

- a) cracks, incomplete penetration and lack of fusion are not acceptable ;
- b) individual circular slag inclusions and gas pockets up to 3,0 mm or T/3 in diameter, whichever is the smaller, are acceptable ;

The sum of the diameters of all such permitted individual imperfections in any 150 mm or $12T$ of weld length, whichever is the smaller, shall not exceed 6,0 mm or $0,5T$, whichever is the smaller, where the separation between individual inclusions is less than $4T$;

- c) individual elongated slag inclusions up to 12,0 mm or $1T$ in length, whichever is the smaller, or up to 1,6 mm in width, are acceptable. The maximum accumulated length of such permitted individual imperfections in any 150 mm or $12T$ of weld length, whichever is the smaller, shall not exceed 12,0 mm, where the separation between individual inclusions is less than $4T$;
- d) individual undercuts of any length having a maximum depth of 0,4 mm are acceptable.

Individual undercuts of a maximum length of $T/2$ having a maximum depth of 0,8 mm and not exceeding 10 % of the specified wall thickness are acceptable provided that there are not more than two such undercuts in any 300 mm of the weld length, and that all such undercuts are dressed out ;

- e) undercuts exceeding the above limits shall be repaired or the suspect area shall be cropped off or the fitting shall be rejected ;
- f) undercuts on the inside and outside weld of any length and depth which are coincident in the longitudinal direction on the same side of the weld are not acceptable.

14.9.2.3 Instead of radiographic examination and with the agreement of the purchaser, welds made by the fitting manufacturer, may be ultrasonically tested throughout their entire length in accordance with EN 10246-9 with acceptance level U2.

14.9.2.4 For fittings made from welded tubes, instead of radiographic examination, ultrasonic testing in accordance with EN 10246-8 with acceptance level U3 or EN 10246-9 with acceptance level U3 is permitted.

14.9.3 NDT of cold formed tees

Each cold formed tee shall be liquid penetrant or magnetic particle inspected in accordance with EN 10246-11 or EN 10246-12. This examination shall be carried out after final heat treatment.

Only the side wall areas of the tees shall be examined. This area is defined by a circle which covers the area from the weld bevel of the branch outlet to the centre of the body of run (see Figure 11). Internal and external surfaces shall be examined when size permits accessibility.

No cracks shall be permitted. Other imperfections shall be treated in accordance with 10.5 to 10.9. After removal of any imperfections the tee shall be re-examined by the original method.

If the manufacturer can demonstrate by testing history (relevant to the particular fitting size) that the results are consistent with the definition of a test unit, then the manufacturer can agree a percentage test with the purchaser provided always that a minimum of 10 % of any test unit is tested ; in the event of a single crack being found on this sample, then 100 % testing is carried out.

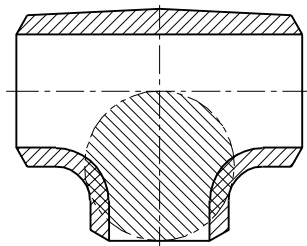


Figure 11 — Area of cold formed tee to be examined

14.9.4 Detection of laminar imperfections

Option 24 : *The starting material shall be ultrasonically tested for the detection of laminar imperfections.*

14.10 Material identification

Each fitting in alloy steel shall be tested by an appropriate method to assure that the correct grade is being supplied.

15 Marking

15.1 Marking to be applied

The marking shall include the following minimum information:

- manufacturer's mark or logo ;
- country of manufacture or the ISO code (in accordance with EN ISO 3166-1) representing it ;

NOTE When individual manufacturing/production operations are performed at different locations, country of manufacture means country where the forming operation is performed.

- letters "EN2" used as reference to this standard ;
- letter "B" for fittings of type B ;
- steel name or steel number (see 5.1) ;
- letter W (for welded fittings or fittings made from welded tubes) ;
- letter "Y" when increased yield strength is used (see 7.1) ;
- cast number or a code number which permits the correlation with the inspection document ;
- mark of the inspection representative (for third party when applicable) ;
- outside diameter D ;
- wall thickness T ;
- category conformity indicator C1 or C2, if applicable (see 8.2.2.1 and 14.9.1).

At the manufacturer's discretion, for fittings of type A, the letter "A" is marked after the letters "EN2".

For the meaning of deformation, see Table 1. A code number may be used for correspondence between the fitting and the inspection document. For reducing tees or reducers, the marking of dimensions shall include D_1 and T_1 (in addition to D and T) in the following order : $D \times T/D_1 \times T_1$.

For the outside diameter, the value to be marked may be rounded, i.e. 42 instead of 42,4 or 89 instead of 88,9.

Additional markings may be added at the manufacturer's discretion.

For fittings with $D < 88,9$ mm, markings may be omitted in the following order when the shape or size of the product does not permit the inclusion of all required markings :

- outside diameter ;

— wall thickness.

In this case the full marking shall be reported on the packaging or the attached tag.

15.2 Methods

The marking shall be die stamped. As far as possible the die stamping should not be applied in the weld area.

Option 25 : *Cold die stamping shall not be used ; the method of marking shall be as specified on the purchase order.*

Option 26 : *Any requirements for additional markings or for special locations shall be as specified on the purchase order.*

16 Protection and packaging

At the manufacturer's discretion the fittings are delivered without protection or with the normal manufacturer's mill protection.

For $D \leq 60,3$ the fittings are delivered packaged.

Option 27 : *The protection shall be as specified on the purchase order.*

Annex A (informative)

Determination of pressure factors and wall thickness

A.1 General

Annex A defines pressure factors for fittings of type A and wall thickness requirements of fittings of type B. This is done by laying down appropriate calculation procedures in detail.

The pressure factor of a fitting of type A gives the percentage of internal pressure which may, in general, be applied to the fitting relative to the pressure which may be applied to a straight pipe with the same dimensions (diameter, wall thickness, wall thickness tolerance) and material. The wall thickness tolerance of this pipe is assumed to be the same as the wall thickness tolerances at the welding ends of the fitting.

The wall thicknesses of fittings type B are laid down so that the fittings will, in general, withstand the same internal pressure as a straight pipe with the same dimensions (diameter, wall thickness, wall thickness tolerance) and material. Wall thickness tolerance of this corresponding straight pipe is assumed to be the same as the wall thickness tolerances at the welding ends of the fitting.

NOTE The calculation procedures are based on the design rules laid down in EN 13480-3:2002. Most of the formulas may be applied in case of time-independent and time-dependent loads. Where the formulas are valid only for time-independent loads appropriate notes are made in Annex A.

A.2 Symbols and units

For the purposes of Annex A, B and C, the symbols given in Table A.1 shall apply in addition to those given in Clause 4.

Table A.1 — Additional symbols for the purposes of Annexes A, B and C

| Symbol | Description |
|------------------------------------|---|
| A_f | Stress loaded cross sectional area (calculation of tees) |
| $A_{fs}, A_{fsc}, A_{fbc}, A_{fb}$ | Partial Areas of A_f (calculation of tees) |
| A_p | Pressure loaded area (calculation of tees) |
| A_{pbc}, A_{psc} | Areas used in the determination of A_p (calculation of tees) |
| c_0 | Corrosion or erosion allowance |
| D_b | Outside diameter at the body of the branch of tees type B |
| D_s | Outside diameter at the body of the run of tees type B |
| L_2 | Length at the major end of reducers |
| L'_2 | Length of cylindrical part at the major end of reducers |
| $L_{2,min}$ | Minimum length at the major end of reducers |
| $L'_{2,min}$ | Minimum length of cylindrical part at the major end of reducers |
| L_4 | Length at the minor end of reducers |

Table A.1 (continued)

| Symbol | Description |
|----------------|---|
| $L_{4,min}$ | Minimum length at the minor end of reducers |
| l_b | Reinforcing length of branch (calculation of tees) |
| l'_b | Modified reinforcing length of branch (calculation of tees) |
| l_s | Reinforcing length of run (calculation of tees) |
| l'_s | Modified reinforcing length of run (calculation of tees) |
| R | Bending radius of elbows and return bends relating to the internal diameter |
| r_c | Crotch radius of tees |
| $T_{1,min}$ | Minimum wall thickness at the minor welding end of reducers and at the welding end of the branch of reducing tees (D_1) Minimum wall thickness of the branch of reducing tees type A Minimum wall thickness of the cylindrical part at the minor end of reducers type A |
| $T_{1,X}$ | Wall thickness of a straight pipe with the same resistance to pressure as a fitting type A (equivalent wall thickness) with the diameter D_1 (minor end of a reducer) |
| T_2 | Wall thickness of the cylindrical part of reducers type B at their major end |
| $T_{2,min}$ | Minimum wall thickness of the cylindrical part of reducers type B at their major end |
| $T^*_{2,min}$ | Minimum wall thickness of a cylindrical part with modified length of reducers type B at their major end |
| T_3 | Wall thickness of the conical part of reducers type B |
| $T_{3,min}$ | Minimum wall thickness of the conical part of reducers type B |
| T_4 | Wall thickness of the cylindrical part of reducers type B at their minor end |
| $T_{4,min}$ | Minimum wall thickness of the cylindrical part of reducers type B at their minor end |
| $T^*_{4,min}$ | Minimum wall thickness of a cylindrical part with modified length of reducers type B at their minor end |
| T_b | Wall thickness on the branch of tees type B |
| $T_{b,min}$ | Minimum wall thickness on the branch of tees type B |
| $T_{bc,min}$ | Intermediate result (calculation of tees) |
| T_c | Wall thickness of caps type B |
| $T_{c,min}$ | Minimum wall thickness of caps type B Minimum wall thickness on the crotch zone of tees |
| $T_{co,min}$ | Intermediate result (calculation of reducers type B) |
| T_{ext} | Wall thickness on the extrados of elbows type B |
| $T_{ext,min}$ | Minimum wall thickness on the extrados of elbows type B |
| T_{int} | Wall thickness on the intrados of elbows type B |
| $T_{int,min}$ | Minimum wall thickness on the intrados of elbows type B |
| $T_{j,min}$ | Intermediate result (calculation of reducers type B) |
| $T_{kn y,min}$ | Intermediate result (calculation of caps type B) |

Table A.1 (continued)

| Symbol | Description |
|---|---|
| T_{\min} | Minimum wall thickness at the welding ends of elbows, return bends, caps and equal tees, at the welding ends of the run of reducing tees or at the major welding end of reducers Minimum wall thickness at the body of elbows, return bends, equal tees and caps of type A Minimum wall thickness of the run of reducing tees type A Minimum wall thickness of the cylindrical part at the major end of reducers type A and of the conical part of reducers type A |
| T_s | Wall thickness at the run of tees type B |
| $T_{s,\min}$ | Minimum wall thickness at the run of tees type B Intermediate result (calculation of caps type B) |
| $T_{sc,\min}$ | Intermediate result (calculation of tees) |
| T_X | Wall thickness of a straight pipe with the same pressure resistance as a fitting of type A (equivalent wall thickness) |
| $T_{X,23}, T_{X,3},$ $T_{X,34}, T_{X,4}, T_{L2},$ $T_{L2}, T_{L4}, T_{L4},$ | Intermediate results (calculation of reducers type A) |
| $T_{X,s}, T_{X,ky}$ | Intermediate results (calculation of caps type A) |
| $T_{a,\min}$ | Minimum wall thickness at the body of elbows type B (between intrados and the crown) |
| X | Pressure factor : ratio of the pressure a fitting of type A will resist to the pressure a straight pipe (with same dimensions and material) will resist |
| α | Semi angle of reducer Angle at the perimeter of elbows (for the evaluation of the wall thickness at the body of the elbow) |
| α_b, α_s | Angle (intermediate result in the calculation of tees) |
| $\beta, \beta_{0,06}, \beta_{0,1},$ $\beta_{0,2}, N, W, Y, Z$ | Factors (calculation of caps) |
| β, β_H, s, τ | Factors (calculation of reducers) |

A.3 Minimal and nominal wall thickness

The design rules given in EN 13480-3:2002 are based on minimal required wall thicknesses. Therefore, in a first step, these minimal wall thicknesses have to be derived from the nominal wall thickness of the fitting. Taking into account the negative tolerances given in Table 18 and the corrosion or erosion allowance c_0 the minimal wall thickness is calculated :

$$T_{\min} = \begin{cases} T \cdot (100 - 12.5) / 100 - c_0 & \text{if } D \leq 610 \text{ mm or fitting is seamless} \\ T - 0,35 \text{ mm} - c_0 & \text{if } D > 610 \text{ mm and } T \leq 10 \text{ mm and fitting is welded (A-1)} \\ T - 0,5 \text{ mm} - c_0 & \text{if } D > 610 \text{ mm and } T > 10 \text{ mm and fitting is welded} \end{cases}$$

To obtain a wall thickness including wall thickness tolerances and corrosion or erosion allowance from a minimal wall thickness the following equation is used:

$$T = \begin{cases} (T_{\min} + c_0) \cdot 100 / (100 - 12.5) & \text{if } D \leq 610 \text{ mm or fitting is seamless} \\ T_{\min} + c_0 + 0, < 35 \text{ mm} & \text{if } D > 610 \text{ mm and } T_{\min} + c_0 \leq 9,65 \text{ mm and fitting is welded} \\ T_{\min} + c_0 + 0,5 \text{ mm} & \text{if } D > 610 \text{ mm and } T_{\min} + c_0 > 9,65 \text{ mm and fitting is welded} \end{cases} \quad (\text{A-2})$$

If other tolerances are specified for the fitting, these values have to be used in above formulas.

For fittings of type B the corrosion or erosion allowance c_0 shall be 0.

NOTE In general, $c_0 = 0$ has the consequence that elbows, tees and reducers will withstand at least the same pressure as the corresponding straight pipe for all corrosion or erosion allowances.

A.4 Pressure factors of fittings of type A

A.4.1 Pressure factor

In general, fittings of type A will not withstand the same internal pressure as a straight pipe with the same dimensions (diameter, wall thickness, wall thickness tolerance) and material. To support the designer of a piping system a pressure factor X is calculated. This pressure factor X gives the ratio of the pressure the fitting will resist to the pressure the pipe will resist :

$$X = \frac{\text{pressure resistance of fitting}}{\text{pressure resistance of pipe}} \cdot 100 \% \quad (\text{A-3})$$

In many cases the design formulas for fittings are based on the wall thickness of a straight pipe. Therefore, in a first step, the wall thickness T_X of a pipe with the same outside diameter, which will resist to the same pressure as the given fitting, (equivalent wall thickness) will be determined. The pressure factor X is calculated afterwards:

$$X = \frac{\frac{T_X}{D} \cdot 1 - \frac{T_{\min}}{D}}{\frac{T_{\min}}{D} \cdot 1 - \frac{T_X}{D}} \cdot 100 \% \quad (\text{A-4})$$

NOTE Formula (A-4) is derived from (6.1-1) from EN 13480-3:2002.

For fittings with two different ends (reducers and reducing tees) the pressure factor shall be calculated:

$$X = \frac{\frac{T_X}{D} \cdot 1 - \min\left(\frac{T_{\min}}{D}, \frac{T_{1,\min}}{D_1}\right)}{\min\left(\frac{T_{\min}}{D}, \frac{T_{1,\min}}{D_1}\right) \cdot 1 - \frac{T_X}{D}} \cdot 100 \% \quad (\text{A-5})$$

A.4.2 Elbows

For elbows, the equivalent wall thickness is given by :

$$T_x = \frac{4 \cdot R - 2 \cdot D + 2 \cdot T_{\min}}{4 \cdot R - D} \cdot T_{\min} \quad (\text{A-6})$$

NOTE Formula (A-6) is derived from (B.4.1-11) from EN 13480-3:2002 by setting $B = e_f/e$ and solving the equation for e .

EXAMPLE

Pressure factor of an elbow (welded) model 2D - 711 x 7.1, corrosion or erosion allowance 1 mm :

Table 10 : $R = 711 \text{ mm}$

(A-1) : $T_{\min} = 7,1 \text{ mm} - 0,35 \text{ mm} - 1 \text{ mm} = 5,75 \text{ mm}$

(A-6) : $T_x = 3,864 \text{ mm}$

(A-4) : $X = 67,0 \%$

A.4.3 Tees

The calculation procedure for tees is based on the design rules in EN 13480-3:2002. It includes the determination of the stress loaded cross sectional area A_f and the pressure loaded cross sectional area A_p , which are shown in Figure A.1.

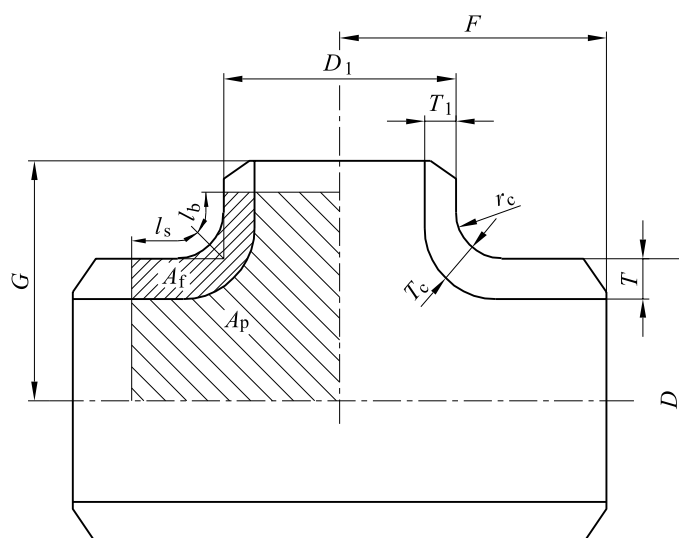


Figure A.1 — Tee type A

With these areas A_p and A_f the wall thickness of a pipe with the same resistance to internal pressure as the tee is given by :

$$T_x = \frac{D}{2 \cdot \left(\frac{A_p}{A_f} + 1 \right)} \quad (\text{A-7})$$

The reinforcing lengths are calculated :

$$l_s = \min\left(\sqrt{(D - T_{\min}) \cdot T_{\min}}, F - \frac{D_1}{2} - \left(1 - \frac{\pi}{4}\right) \cdot r_c\right) \quad (\text{A-8})$$

$$l_b = \min\left(\sqrt{(D_1 - T_{1,\min}) \cdot T_{1,\min}}, G - \frac{D}{2} - \left(1 - \frac{\pi}{4}\right) \cdot r_c\right) \quad (\text{A-9})$$

At the transition of run and branch (crotch zone) the inside and outside surfaces shall merge smoothly.

NOTE 1 Formula (A-7) is only applicable if $T_{1,\min}$ is less equal T_{\min} .

NOTE 2 Formula (A-7) is derived from (8.4.3-3) and (6.1-1) from EN 13480-3:2002, Formulas (A-8) and (A-9) are based on (8.4.1-2) and (8.4.3-1) from EN 13480-3:2002. The requirement $T_{1,\min} \leq T_{\min}$ is more restrictive than the stipulation in EN 13480-3:2002, Figure 8.3.1-1.

NOTE 3 In EN 13480-3:2002 the design is limited to $D_1 - 2 T_{1,\min} \leq 0,8 (D - 2 \cdot T_{\min})$ for materials others than austenitic steels. For applications within the creep range it is limited to $D_1 - 2 T_{1,\min} \leq 0,7 (D - 2 \cdot T_{\min})$ and the pressure factor is multiplied by 0,9.

EXAMPLE :

Pressure factor of a reducing tee 813 x 8 – 508 x 6.3,

$c_0 = 0$ mm, $r_c = 95$ mm and $T_{c,\min} = (T_{s,\min} + T_{b,\min}) / 2$:

Table 14 : $F = 597$ mm, $G = 533$ mm.

(A-1) : $T_{\min} = 8 \text{ mm} - 0,35 \text{ mm} - 0 \text{ mm} = 7,650 \text{ mm}$

$$T_{1,\min} = 6,3 \text{ mm} (100 - 12.5) / 100 - 0 \text{ mm} = 5,513 \text{ mm}$$

$$T_{c,\min} = (7,65 \text{ mm} + 5,513 \text{ mm}) / 2 = 6,581 \text{ mm}$$

(A-8) : $l_s = 78,49 \text{ mm}$

(A-9) : $l_b = 52,63 \text{ mm}$

For the calculation of areas A_f and A_p see Figure A.2.

$$\alpha_s = 45^\circ \cdot \max\left(1 - \frac{l_s}{\frac{\pi}{4} \cdot r_c}, 0\right) = 0,00^\circ$$

$$\alpha_b = 45^\circ \cdot \max\left(1 - \frac{l_b}{\frac{\pi}{4} \cdot r_c}, 0\right) = 13,26^\circ$$

$$l'_s = r_c - r_c \cdot \sin(\alpha_s) + \max\left(l_s - r_c \cdot \frac{\pi}{4}, 0\right) = 98,88 \text{ mm}$$

$$l'_b = r_c - r_c \cdot \sin(\alpha_b) + \max\left(l_b - r_c \cdot \frac{\pi}{4}, 0\right) = 73,21 \text{ mm}$$

$$T_{sc,min} = \frac{45^\circ - \alpha_s}{45^\circ} \cdot T_{min} + \frac{\alpha_s}{45^\circ} \cdot T_{c,min} = 7,650 \text{ mm}$$

$$T_{bc,min} = \frac{45^\circ - \alpha_b}{45^\circ} \cdot T_{1,min} + \frac{\alpha_b}{45^\circ} \cdot T_{c,min} = 5,827 \text{ mm}$$

$$A_{fs} = \max(l'_s - r_c, 0) \cdot T_{min} = 29,7 \text{ mm}^2$$

$$A_{fsc} = \left(\left(r_c + \frac{T_{sc,min} + T_{c,min}}{2} \right)^2 - r_c^2 \right) \cdot \pi \cdot \frac{45^\circ - \alpha_s}{360^\circ} + T_{sc,min}^2 \cdot \frac{\tan(\alpha_s)}{2} = 550,8 \text{ mm}^2$$

$$A_{fbc} = \left(\left(r_c + \frac{T_{bc,min} + T_{c,min}}{2} \right)^2 - r_c^2 \right) \cdot \pi \cdot \frac{45^\circ - \alpha_b}{360^\circ} + T_{bc,min}^2 \cdot \frac{\tan(\alpha_b)}{2} = 341,2 \text{ mm}^2$$

$$A_{fb} = \max(l'_b - r_c, 0) \cdot T_{1,min} = 0,0 \text{ mm}^2$$

$$A_f = A_{fs} + A_{fsc} + A_{fbc} + A_{fb} = 921,7 \text{ mm}^2$$

$$A_{psc} = r_c^2 \cdot \left(\frac{1}{2} \cdot (1 - \sin(\alpha_s))^2 - \pi \cdot \frac{45^\circ - \alpha_s}{360^\circ} + \frac{1}{2} \cdot \sin(\alpha_s) \cdot (\cos(\alpha_s) - \sin(\alpha_s)) \right) = 968 \text{ mm}^2$$

$$A_{pbc} = r_c^2 \cdot \left(\frac{1}{2} \cdot (1 - \sin(\alpha_b))^2 - \pi \cdot \frac{45^\circ - \alpha_b}{360^\circ} + \frac{1}{2} \cdot \sin(\alpha_b) \cdot (\cos(\alpha_b) - \sin(\alpha_b)) \right) = 950 \text{ mm}^2$$

$$A_p = \left(\frac{D1}{2} + l'_s \right) \cdot \left(\frac{D}{2} + l'_b \right) - l'_s \cdot l'_b + A_{psc} + A_{psb} - A_f = 163038 \text{ mm}^2$$

$$\frac{A_p}{A_f} = 176,89$$

(A-7) : TX = 2,285 mm

(A-5) : X = 29,7 %

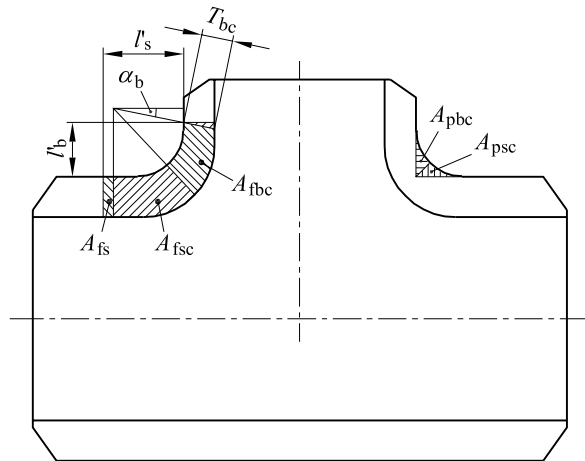


Figure A.2 — Additional dimensions and areas used in the calculation A_p and A_f of a tee

A.4.4 Reducers

For the determination of the pressure resistance of reducers several aspects have to be taken into consideration. The calculations are based on the following preconditions:

- wall thickness in the conical section is at least the wall thickness at the major end of the reducer ;
- reducer has cylindrical sections on both ends of the reducer. In some cases minimal lengths of these sections are required ;
- at the transition of cylindrical sections and conical sections the inside and outside surfaces shall merge smoothly ;
- transition between the cylindrical sections and the conical section at the major end may be curved. In this case the distance between the knuckle and the end of the reducer shall be at least :

$$L'_{2,min} = 0,5 \cdot \sqrt{(D - T_{L2}) \cdot T_{L2}} \quad (A-10)$$

- transition between the cylindrical sections and the conical section at the minor end may be curved too. The wall thickness of the knuckle shall be the same as of the conical section.

Figure A.3 shows wall thicknesses, minimal lengths at the ends and the semi angle for both concentric and eccentric reducers.

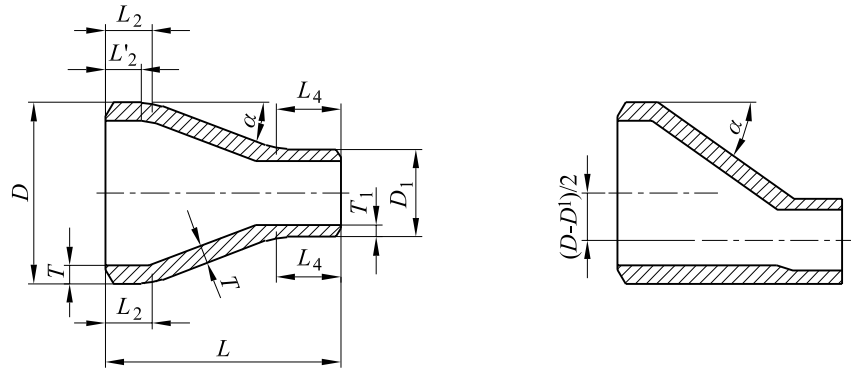


Figure A.3 — Concentric and eccentric reducer type A

The design of a reducer comprises the determination of the wall thickness at the cylindrical sections, the wall thickness at the conical section and the wall thicknesses at the transitions between cylindrical and conical sections. Therefore, first the equivalent wall thickness at different sections of the reducer has to be calculated. In the next step the overall equivalent wall thickness of the reducer is determined.

$$T_{X,23} = T_{\min} \cdot \frac{D}{\beta \cdot (D - T_{\min}) + T_{\min}} \quad (\text{A-11})$$

$$T_{X,3} = T_{\min} \cdot \cos(\alpha) \cdot \frac{D}{D - 2 \cdot T_{\min} - \sqrt{\frac{(D - T_{\min}) \cdot T_{\min}}{\cos(\alpha)} \cdot \sin(\alpha)} + T_{\min} \cdot \cos(\alpha)} \quad (\text{A-12})$$

$$T_{X,34} = T_{\min} \cdot \frac{D}{\beta_H \cdot (D_1 - T_{1,\min}) \cdot \frac{T_{\min}}{T_{1,\min}} + T_{\min}} \quad (\text{A-13})$$

$$T_{X,4} = T_{1,\min} \cdot \frac{D}{D_1} \quad (\text{A-14})$$

$$T_X = \min(T_{X,23}, T_{X,3}, T_{X,34}, T_{X,4}) \quad (\text{A-15})$$

$$T_{1,X} = T_X \cdot \frac{D_1}{D} \quad (\text{A-16})$$

with the factors β and β_H :

$$\beta = \max \left(\frac{1}{3} \cdot \sqrt{\frac{D - T_{\min}}{T_{\min}}} \cdot \frac{\tan(\alpha)}{1 + \frac{1}{\sqrt{\cos(\alpha)}}} - 0,15, 1 \right) \quad (\text{A-17})$$

$$s = \frac{T_{\min}}{T_{1,\min}} \quad (\text{A-18})$$

$$\tau = \begin{cases} s \cdot \sqrt{\frac{s}{\cos(\alpha)}} + \sqrt{\frac{1+s^2}{2}} & \text{if } s < 1 \\ 1 + \sqrt{s \cdot \frac{1+s^2}{2 \cdot \cos(\alpha)}} & \text{if } s \geq 1 \end{cases} \quad (\text{A-19})$$

$$\beta_H = 0,4 \cdot \sqrt{\frac{D_1 - T_{1,\min}}{T_{1,\min}}} \cdot \frac{\tan(\alpha)}{\tau} + 0,5 \quad (\text{A-20})$$

Afterwards, the minimal lengths at the ends have to be calculated. In a first step, the wall thicknesses T_{L2} and T_{L4} are determined. These wall thicknesses are required at the cylindrical sections so that the reducer is able to resist the pressure expressed by the pressure factor X . The following equations have to be solved by iteration :

$$T'_{L2} = \beta \cdot T_X \cdot \frac{D}{D + (\beta - 1) \cdot T_X} \quad (\text{A-21})$$

$$T_{L2} = \max(T_X, T'_{L2}) \quad (\text{A-22})$$

$$T'_{L4} = \beta_H \cdot T_{1,X} \cdot \frac{D}{D + (\beta_H - 1) \cdot T_X} \quad (\text{A-23})$$

$$T_{L4} = \max(T_{1,X}, T'_{L4}) \quad (\text{A-24})$$

with the factors β and β_H :

$$\beta = \frac{1}{3} \cdot \sqrt{\frac{D - T'_{L2}}{T'_{L2}}} \cdot \frac{\tan(\alpha)}{1 + \frac{1}{\sqrt{\cos(\alpha)}}} - 0,15 \quad (\text{A-25})$$

$$s = \frac{T_{\min}}{T'_{L4}} \quad (\text{A-26})$$

$$\tau = \begin{cases} s \cdot \sqrt{\frac{s}{\cos(\alpha)}} + \sqrt{\frac{1+s^2}{2}} & \text{if } s < 1 \\ 1 + \sqrt{s \cdot \frac{1+s^2}{2 \cdot \cos(\alpha)}} & \text{if } s \geq 1 \end{cases} \quad (\text{A-27})$$

$$\beta_H = 0,4 \cdot \sqrt{\frac{D_1 - T'_{L4}}{T'_{L4}}} \cdot \frac{\tan(\alpha)}{\tau} + 0,5 \quad (\text{A-28})$$

With these wall thicknesses the minimal lengths are calculated :

$$L_{2,\min} = \frac{T_{L2} - T_X}{T_{\min} - T_X} \cdot 1,4 \cdot \sqrt{(D - T_{L2}) \cdot T_{L2}} \quad (\text{A-29})$$

$$L_{4,\min} = \frac{T_{L4} - T_{1,X}}{T_{1,\min} - T_{1,X}} \cdot \sqrt{(D_1 - T_{L4}) \cdot T_{L4}} \quad (\text{A-30})$$

The length $L_{2,\min}$ is applicable only if T_X is less than T_{\min} , $L_{4,\min}$ is applicable if $T_{1,X}$ is less than $T_{1,\min}$. If the reducer is located between pipes with minimal wall thicknesses larger than T_{L2} and T_{L4} , respectively, the minimal lengths do not apply, too.

NOTE 1 Formula (A-12) to (A-28) are applicable only for semi angle α less equal 75° and ratios of $T_{\min} \cos(\alpha)$ to D not smaller than 0,001.

NOTE 2 The calculation of reducers is based on the following sections/equations in EN 13480-3:2002:

Formula (A-10) is based on the stipulations in 6.4.7.2 ;

Formula (A-11) takes into account 6.4.6.3 a) and 6.4.6.3 g) ;

Formula (A-12) takes into account 6.4.6.3 b) and 6.4.6.3e) ;

Formula (A-13) takes into account 6.4.8.3 ;

Formula (A-14) takes into account the pressure resistance of the cylindrical part at the minor end ;

Formulas (A-17) and (A-25) are based on (6.4.6-1) ;

Formulas (A-18) and (A-26) are given as (6.4.8-1) ;

Formulas (A-19) and (A-27) are based on (6.4.8-2) and (6.4.8-3) ;

Formulas (A-20) and (A-28) are given as (6.4.8-4) ;

Formula (A-21) is derived from (6.4.6-2) and (6.1-1) ;

Formula (A-23) is derived from (6.4.8-6) and (6.1-1).

The calculation of the minimal length at the ends of the reducers (A-29) and (A-30) takes into account that the wall thickness near the junction may be increased and the wall thickness further away may be reduced provided that the cross-sectional area remains constant (see last paragraph of 6.4.6.2 and last paragraph of 6.4.8.2 of in EN 13480-3:2002) and that the reducer will be located between pipes with minimal wall thicknesses of at least T_X and $T_{1,X}$.

No additional calculation of the wall thickness of the knuckle at the major end is required. The formulas in EN 13480-3:2002 (6.4.7-1) to (6.4.7-4) give wall thicknesses which are not larger than for junctions without a knuckle.

The rules for a knuckle at the minor end differs from the stipulations in EN 13480-3:2002.

EXAMPLE

Pressure factor of a concentric reducer 323,9 x 7,1 – 168,3 x 4,5,

$c_0 = 0$ mm, semi angle $\alpha = 35^\circ$:

Table 15 : $L = 203$ mm.

(A-1) : $T_{\min} = 7,1 \text{ mm } (100 - 12,5) / 100 - 0 \text{ mm} = 6,213 \text{ mm}$

$T_{1,\min} = 4,5 \text{ mm } (100 - 12,5) / 100 - 0 \text{ mm} = 3,938 \text{ mm}$

(A-17) : $\beta = 1,000$

(A-18) : $s = 1,578$

(A-19) : $\tau = 2,833$

(A-20) : $\beta_H = 1,139$

(A-11) : $T_{X,23} = 6,213 \text{ mm}$

(A-12) : $T_{X,3} = 5,715 \text{ mm}$

(A-13) : $T_{X,34} = 6,674 \text{ mm}$

(A-14) : $T_{X,4} = 7,578 \text{ mm}$

(A-15) : $T_X = 5,715 \text{ mm}$

(A-16) : $T_{1,X} = 2,970 \text{ mm}$

(A-5) : $X = 91,9 \%$

The calculation of the minimal lengths at the ends of the cylinders :

Result of solving (A-21) and (A-25) by iteration : $T_{L2}^* = 4,499 \text{ mm}$, $\beta = 0,784$

Result of solving (A-23) with (A-26), (A-27) and (A-28) by iteration : $T_{L4}^* = 3,261 \text{ mm}$, $s = 1,905$, $\tau = 3,320$, $\beta_H = 1,100$

(A-22) : $T_{L2} = 5,715 \text{ mm}$

(A-24) : $T_{L4} = 3,261 \text{ mm}$

(A-29) : $L_{2,\min} = 0,00 \text{ mm}$ (no specific length required)

(A-10) : $L'_{2,\min} = 21,32 \text{ mm}$

(A-30) : $L_{4,\min} = 6,99 \text{ mm}$

A.4.5 Caps

The design of a cap comprises the determination of the wall thickness of the ellipsoidal end, the wall thickness of the knuckle and the wall thickness of the cylindrical part. Therefore, first the equivalent wall thickness at different sections of the cap has to be calculated. In the next step the overall equivalent wall thickness of the cap is determined :

$$T_{X,s} = T_{\min} \cdot \frac{D}{R1 + 1,5 \cdot T_{\min}} \quad (\text{A-31})$$

$$T_{X,ky} = T_{\min} \cdot \frac{D}{2 \cdot \beta \cdot (0,75 \cdot R1 + 0,2 \cdot (D - 2 \cdot T_{\min})) + T_{\min}} \quad (\text{A-32})$$

$$T_X = \min(T_{X,s}, T_{X,ky}, T_{\min}) \quad (\text{A-33})$$

The factors β is calculated :

$$Y = \min\left(\frac{T_{\min}}{R1}, 0,04\right) \quad (\text{A-34})$$

$$Z = \log\left(\frac{1}{Y}\right) \quad (\text{A-35})$$

$$W = \frac{r}{D - 2 \cdot T_{\min}} \quad (\text{A-36})$$

$$N = 1,006 - \frac{1}{6,2 + (90 \cdot Y)^4} \quad (\text{A-37})$$

$$\beta_{0,06} = (-0,3635 \cdot Z^3 + 2,2124 \cdot Z^2 - 3,2937 \cdot Z + 1,8873) \cdot N \quad (\text{A-38})$$

$$\beta_{0,1} = (-0,1833 \cdot Z^3 + 1,0383 \cdot Z^2 - 1,2943 \cdot Z + 0,837) \cdot N \quad (\text{A-39})$$

$$\beta_{0,2} = 0,5 \quad (\text{A-40})$$

$$\beta = \begin{cases} 25 \cdot ((0,1 - W) \cdot \beta_{0,06} + (W - 0,06) \cdot \beta_{0,1}) & \text{if } 0,06 \leq W \leq 0,1 \\ 10 \cdot ((0,2 - W) \cdot \beta_{0,1} + (W - 0,1) \cdot \beta_{0,2}) & \text{if } 0,1 < W \leq 0,2 \end{cases} \quad (\text{A-41})$$

The heights of the curved and cylindrical parts of the cap shall be :

$$h_i = 0,255 \cdot D - 0,635 \cdot T$$

$$h_c \geq 3 \cdot T$$

NOTE 1 Formulas (A-31) to (A-41) are applicable provided that the following conditions are simultaneously fulfilled :

$$r \geq 0,06 (D - 2 T_{\min})$$

$$r \geq 3 T_{\min}$$

$$0,004 (D - 2 T_{\min}) < T_{\min} \leq 0,08 (D - 2 T_{\min})$$

$$R1 \leq D$$

NOTE 2 The calculation of caps is based on the following formulas in EN 13480-3:2002:

Formula (A-31) is derived from (7.1.3-1) and (6.1-1) ;

Formula (A-32) is derived from (7.1.3-2) and (6.1-1) ;

Formula (A-34) is given as (7.1.5-1) ;

Formula (A-35) is given as (7.1.5-2) ;

Formula (A-36) is given as (7.1.5-3) ;

Formula (A-37) is given as (7.1.5-4) ;

Formula (A-38) is given as (7.1.5-6) ;

Formula (A-39) is given as (7.1.5-5) ;

Formula (A-40) is read from Figure 7.1.5-1 ;

Formula (A-41) is given as (7.1.5-8) and (7.1.5-7).

EXAMPLE

Pressure factor of a seamless cap 1219x10,

$$c_0 = 0 \text{ mm}, r = 0,15 \cdot D, R1 = 0,8 \cdot D :$$

$$r = 0,15 \cdot 1219 = 183 \text{ mm}$$

$$R1 = 0,8 \cdot 1219 = 975 \text{ mm}$$

$$(\text{A-1}) : T_{\min} = 10 \text{ mm} \cdot (100 - 12,5) / 100 - 0 \text{ mm} = 8,75 \text{ mm}$$

- (A-31) : $T_{X,s} = 10,792 \text{ mm}$
- (A-34) : $Y = 0,00897$
- (A-35) : $Z = 2,047$
- (A-36) : $W = 0,152$
- (A-37) : $N = 0,855$
- (A-38) : $\beta_{0,06} = 1,110$
- (A-39) : $\beta_{0,1} = 0,826$
- (A-41) : $\beta = 0,656$
- (A-32) : $T_{X, kn y} = 8,311 \text{ mm}$
- (A-33) : $T_X = 8,311 \text{ mm}$
- (A-4) : $X = 94,9 \%$

A.5 Wall thicknesses of fittings of type B

A.5.1 Elbows

Wall thicknesses and other dimension of an elbow type B are illustrated in Figure A.4.

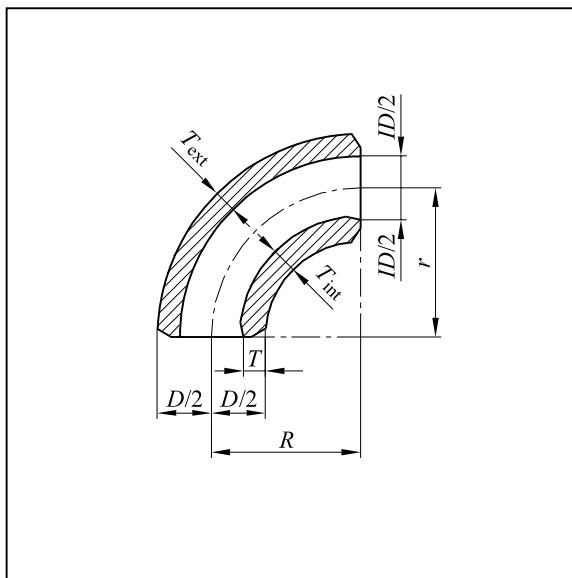


Figure A.4 — Elbow type B

The wall thickness on the intrados of the elbow shall be calculated:

$$T_{\text{int,min}} = T_{\text{min}} \cdot \left(\frac{D}{2 \cdot T_{\text{min}}} + \frac{r}{T_{\text{min}}} - \left(\frac{D}{2 \cdot T_{\text{min}}} + \frac{r}{T_{\text{min}}} - 1 \right) \cdot \sqrt{\frac{\left(\frac{r}{T_{\text{min}}} \right)^2 - \left(\frac{D}{2 \cdot T_{\text{min}}} \right)^2}{\left(\frac{r}{T_{\text{min}}} \right)^2 - 2 \cdot \frac{D}{T_{\text{min}}} \cdot \left(\frac{D}{2 \cdot T_{\text{min}}} - 1 \right)}} \right) \quad (\text{A-42})$$

where:

$$\frac{r}{T_{\text{min}}} = \sqrt{\frac{1}{2} \cdot \left\{ \left(\frac{D}{2 \cdot T_{\text{min}}} \right)^2 + \left(\frac{R}{T_{\text{min}}} \right)^2 \right\}} + \sqrt{\frac{1}{4} \cdot \left(\left(\frac{D}{2 \cdot T_{\text{min}}} \right)^2 + \left(\frac{R}{T_{\text{min}}} \right)^2 \right)^2 - \frac{D}{2 \cdot T_{\text{min}}} \cdot \left(\frac{D}{2 \cdot T_{\text{min}}} - 1 \right) \cdot \left(\frac{R}{T_{\text{min}}} \right)^2} \quad (\text{A-43})$$

The wall thickness on the extrados of an elbow shall be equal to the wall thickness of the corresponding straight pipe :

$$T_{\text{ext,min}} = T_{\text{min}} \quad (\text{A-44})$$

Between intrados ($\alpha = 0^\circ$) and crown ($\alpha = 90^\circ$) of the elbow the wall thickness shall be :

$$T_{\alpha,\text{min}} = T_{\text{min}} + (T_{\text{int,min}} - T_{\text{min}}) \cdot \cos(\alpha) \quad (\text{A-45})$$

Between the crown of the elbow ($\alpha = 90^\circ$) and extrados ($\alpha = 180^\circ$) the wall thickness shall be T_{min} .

NOTE 1 Setting $T_{\text{ext,min}} = T_{\text{min}}$ ensures that the design requirements of EN 13480-3 are met for all corrosion or erosion allowances.

NOTE 2 Formulas (A-42) and (A-43) are given in EN 13480-3:2002 as (B.4.1-3) and (B.4.1-4).

EXAMPLE

Wall thicknesses of an elbow (welded) model 2D - 711 x 7,1.

$R = 711 \text{ mm}$

$$(\text{A-1}) : \quad T_{\text{min}} = 7,1 \text{ mm} - 0,35 \text{ mm} = 6,75 \text{ mm}$$

$$(\text{A-43}) : \quad r / T_{\text{min}} = 105,66$$

$$(\text{A-42}) : \quad T_{\text{int,min}} = 10,067 \text{ mm}$$

$$(\text{A-44}) : \quad T_{\text{int,min}} = 6,75 \text{ mm}$$

Wall thicknesses including tolerances are :

$$(\text{A-2}) : \quad T_{\text{int}} = 10,07 \text{ mm} + 0,5 \text{ mm} = 10,57 \text{ mm},$$

$$T_{\text{ext}} = 6,75 + 0,35 \text{ mm} = 7,1 \text{ mm}$$

A.5.2 Tees

The wall thickness of tees cannot be calculated directly, but shall be assumed in a first step. This assumption shall then be verified by means of the described method. This method leads to a relation between the pressure loaded

area A_p and the stress loaded cross section area A_f shown in Figure A.5. Under certain circumstances, the calculation may need to be repeated using an improved assumption of the wall thickness.

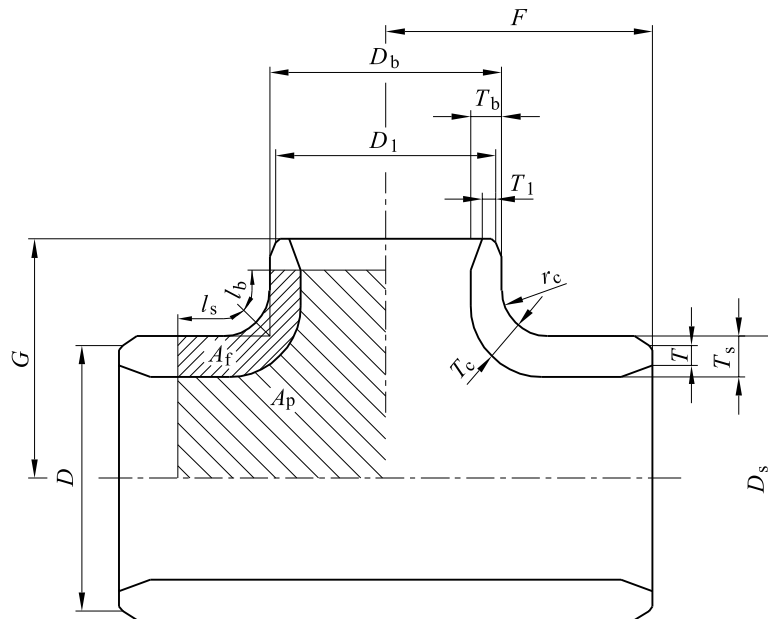


Figure A.5 — Dimensions and areas A_p and A_f of a tee

For the tee the following condition shall apply :

$$\frac{A_p}{A_f} \leq \max\left(\frac{D - 2 \cdot T_{s,\min}}{2 \cdot T_{s,\min}}, \frac{D_1 - 2 \cdot T_{1,\min}}{2 \cdot T_{1,\min}}\right) \quad (\text{A-46})$$

The reinforcing lengths are calculated :

$$l_s = \min\left(\sqrt{(D_s - T_{s,\min}) \cdot T_{s,\min}}, F - \frac{D_b}{2} - \left(1 - \frac{\pi}{4}\right) \cdot r_c - T_{\min}\right) \quad (\text{A-47})$$

$$l_b = \min\left(\sqrt{(D_b - T_{b,\min}) \cdot T_{b,\min}}, G - \frac{D_s}{2} - \left(1 - \frac{\pi}{4}\right) \cdot r_c - T_{1,\min}\right) \quad (\text{A-48})$$

The wall thickness $T_{s,\min}$ and $T_{b,\min}$ apply to the whole perimeter of the run and the branch, respectively. At the transitions between the run and the branch (crotch zone) the inside and outside surfaces shall merge smoothly.

The minimum wall thickness at the branch $T_{b,\min}$ shall not be larger than the minimum wall thickness at the run $T_{s,\min}$.

NOTE 1 Formula (A-46) is derived from (8.4.3-3) and (6.1-1) from EN 13480-3:2002,

formulas (A-47) and (A-48) are based on (8.4.1-2) and (8.4.3-1) from EN 13480-3:2002.

The requirement $T_{b,\min} \leq T_{s,\min}$ is more restrictive than the stipulations in EN 13480-3:2002, Figure 8.3.1-1.

NOTE 2 The subtraction of T_{\min} and $T_{1,\min}$ in (A-47) and (A-48), respectively, approximately considers the taper borings at the ends.

NOTE 3 In EN 13480-3:2002 the design is limited to $D_b - 2 \cdot T_{b,\min} \leq 0,8 (D_s - 2 \cdot T_{s,\min})$ for materials others than austenitic steels. For applications within the creep range it is limited to $D_b - 2 \cdot T_{b,\min} \leq 0,7 (D_s - 2 \cdot T_{b,\min})$ and the design stress is multiplied by 0,9.

EXAMPLE

Wall thicknesses of a reducing tee (welded) 813 x 8,0 – 508 x 6,3

with the geometry $D_s = D$, $D_b = D_1$, $r_c = 95$ mm and $T_{c,\min} = (T_{s,\min} + T_{b,\min}) / 2$.

Table 14 : $F = 597$ mm, $G = 533$ mm.

Assumed wall thicknesses to be checked : $T_s = 19,0$ mm, $T_b = 15,5$ mm

$$\begin{aligned} \text{(A-1)} : \quad T_{\min} &= 8 \text{ mm} - 0,35 \text{ mm} - 0 \text{ mm} = 7,650 \text{ mm} \\ T_{1,\min} &= 6,3 \text{ mm} \cdot (100 - 12,5) / 100 - 0 \text{ mm} = 5,513 \text{ mm} \\ T_{s,\min} &= 19,0 \text{ mm} - 0,5 \text{ mm} = 18,5 \text{ mm}, \\ T_{b,\min} &= 15,5 \text{ mm} (100 - 12,5) / 100 = 13,563 \text{ mm} \\ T_{c,\min} &= (18,5 \text{ mm} + 13,563 \text{ mm}) / 2 = 16,031 \text{ mm} \end{aligned}$$

$$\text{(A-47)} : \quad l_s = 121,24 \text{ mm}$$

$$\text{(A-48)} : \quad l_b = 81,89 \text{ mm}$$

For the calculation of areas A_f and A_p see Figure A.2.

$$\alpha_s = 45^\circ \cdot \max \left(1 - \frac{l_s}{\frac{\pi}{4} \cdot r_c}, 0 \right) = 0,00^\circ$$

$$\alpha_b = 45^\circ \cdot \max \left(1 - \frac{l_b}{\frac{\pi}{4} \cdot r_c}, 0 \right) = 0,00^\circ$$

$$l'_s = r_c - r_c \cdot \sin(\alpha_s) + \max \left(l_s - r_c \cdot \frac{\pi}{4}, 0 \right) = 141,62 \text{ mm}$$

$$l'_b = r_c - r_c \cdot \sin(\alpha_b) + \max \left(l_b - r_c \cdot \frac{\pi}{4}, 0 \right) = 102,28 \text{ mm}$$

$$T_{sc,\min} = \frac{45^\circ - \alpha_s}{45^\circ} \cdot T_{s,\min} + \frac{\alpha_s}{45^\circ} \cdot T_{c,\min} = 18,500 \text{ mm}$$

$$T_{bc,\min} = \frac{45^\circ - \alpha_b}{45^\circ} \cdot T_{b,\min} + \frac{\alpha_b}{45^\circ} \cdot T_{c,\min} = 13,563 \text{ mm}$$

$$A_{fs} = \max(l'_s - r_c, 0) \cdot T_{s,\min} = 862,5 \text{ mm}^2$$

$$A_{fsc} = \left(\left(r_c + \frac{T_{sc,\min} + T_{c,\min}}{2} \right)^2 - r_c^2 \right) \cdot \pi \cdot \frac{45^\circ - \alpha_s}{360^\circ} + T_{sc,\min}^2 \cdot \frac{\tan(\alpha_s)}{2} = 1405,3 \text{ mm}^2$$

$$A_{fbc} = \left(\left(r_c + \frac{T_{bc,\min} + T_{c,\min}}{2} \right)^2 - r_c^2 \right) \cdot \pi \cdot \frac{45^\circ - \alpha_b}{360^\circ} + T_{bc,\min}^2 \cdot \frac{\tan(\alpha_b)}{2} = 1190,0 \text{ mm}^2$$

$$A_{fb} = \max(l'_b - r_c, 0) \cdot T_{b,\min} = 98,7 \text{ mm}^2$$

$$A_f = A_{fs} + A_{fsc} + A_{fbc} + A_{fb} = 3556,5 \text{ mm}^2$$

$$A_{psc} = r_c^2 \cdot \left(\frac{1}{2} \cdot (1 - \sin(\alpha_s))^2 - \pi \cdot \frac{45^\circ - \alpha_s}{360^\circ} + \frac{1}{2} \cdot \sin(\alpha_s) \cdot (\cos(\alpha_s) - \sin(\alpha_s)) \right) = 968 \text{ mm}^2$$

$$A_{pbc} = r_c^2 \cdot \left(\frac{1}{2} \cdot (1 - \sin(\alpha_b))^2 - \pi \cdot \frac{45^\circ - \alpha_b}{360^\circ} + \frac{1}{2} \cdot \sin(\alpha_b) \cdot (\cos(\alpha_b) - \sin(\alpha_b)) \right) = 968 \text{ mm}^2$$

$$A_p = \left(\frac{D_b}{2} + l'_s \right) \cdot \left(\frac{D_s}{2} + l'_b \right) - l'_s \cdot l'_b + A_{psc} + A_{psb} - A_f = 185179 \text{ mm}^2$$

$$\frac{A_p}{A_f} = 52,07$$

$$\max \left(\frac{D - 2 \cdot T_{\min}}{2 \cdot T_{\min}}, \frac{D_1 - 2 \cdot T_{1,\min}}{2 \cdot T_{1,\min}} \right) = 52,14$$

Inequation (A-46) is satisfied ($52,07 \leq 52,14$) and therefore the assumed wall thicknesses T_s and T_b are acceptable.

A.5.3 Reducers

For the design of reducers several aspects have to be taken into account. The calculations are based on the following preconditions:

- reducer has cylindrical sections on both ends of the reducer. In some cases minimal lengths of these sections are required ;
- at the transition of cylindrical sections and the conical sections the inside and outside surfaces shall merge smoothly ;
- transition between the cylindrical sections and the conical section at the major end may be curved. In this case the wall thickness of the knuckle shall be at least T_2 and the distance between the knuckle and the end of the reducer shall be at least :

$$L'_{2,\min} = 0,5 \cdot \sqrt{(D - T_{2,\min}) \cdot T_{2,\min}} \quad (\text{A-49})$$

- transition between the cylindrical sections and the conical section at the minor end may be curved too. The wall thickness of the knuckle shall be at least the maximum of $T_{3,\min}$ and $T_{4,\min}$.

Wall thicknesses and other dimension of a reducer are illustrated in Figure A.6, both for concentric and eccentric type.

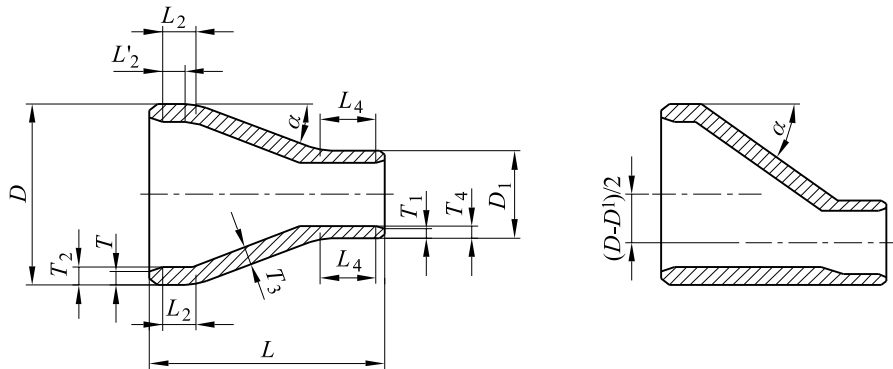


Figure A.6 - Wall thicknesses and dimensions of reducers type B

NOTE 1 The lengths L_2 , L'_2 and L_4 are not measured from the ends of the reducer, but from the location where the wall thickness reaches $T_{2,\min}$ or $T_{4,\min}$, respectively.

The reinforced wall thickness at the major end of the reducer is calculated:

$$T_{j,\min} = \frac{\beta \cdot D \cdot \min\left(\frac{T_{\min}}{D - T_{\min}}, \frac{T_{1,\min}}{D_1 - T_{1,\min}}\right)}{1 + \beta \cdot \min\left(\frac{T_{\min}}{D - T_{\min}}, \frac{T_{1,\min}}{D_1 - T_{1,\min}}\right)} \quad (\text{A-50})$$

with

$$\beta = \frac{1}{3} \cdot \sqrt{\frac{D - T_{j,\min}}{T_{j,\min}}} \cdot \frac{\tan(\alpha)}{1 + \frac{1}{\sqrt{\cos(\alpha)}}} - 0,15 \quad (\text{A-51})$$

NOTE 2 Formulas (A-50) and (A-51) cannot be evaluated directly but are solved by iteration.

The wall thickness of the cylindrical part at the major end of the reducer shall be:

$$T_{2,\min} = \max(T_{\min}, T_{j,\min}) \quad (\text{A-52})$$

The wall thickness of a cone with the given half angle α is calculated:

$$T_{co,min} = \frac{\left(\sqrt{\frac{D - T_{2,min}}{\cos(\alpha)} \cdot \sin^2(\alpha) + 4 \cdot \left(\frac{1}{\min\left(\frac{T_{min}}{D - T_{min}}, \frac{T_{1,min}}{D_1 - T_{1,min}}\right)} - 1\right) \cdot \cos(\alpha) \cdot (D - 2 \cdot T_{2,min})} - \sqrt{\frac{D - T_{2,min}}{\cos(\alpha)} \cdot \sin(\alpha)} \right)^2}{4 \cdot \cos^2(\alpha) \cdot \left(\frac{1}{\min\left(\frac{T_{min}}{D - T_{min}}, \frac{T_{1,min}}{D_1 - T_{1,min}}\right)} - 1\right)^2} \quad (A-53)$$

The wall thickness of the conical part of a reducer shall be :

$$T_{3,min} = \max(T_{co,min}, T_{j,min}) \quad (A-54)$$

The wall thickness of the cylindrical part at the minor end of the reducer shall be determined using the following formulas:

$$s = \frac{T_{3,min}}{T_{4,min}} \quad (A-55)$$

$$\tau = \begin{cases} s \cdot \sqrt{\frac{s}{\cos(\alpha)}} + \sqrt{\frac{1+s^2}{2}} & \text{if } s < 1 \\ 1 + \sqrt{s \cdot \frac{1+s^2}{2 \cdot \cos(\alpha)}} & \text{if } s \geq 1 \end{cases} \quad (A-56)$$

$$\beta_H = 0,4 \cdot \sqrt{\frac{D_1 - T_{4,min}}{T_{4,min}}} \cdot \frac{\tan(\alpha)}{\tau} + 0,5 \quad (A-57)$$

If

$$\min\left(\frac{T_{min}}{D - T_{min}}, \frac{T_{1,min}}{D_1 - T_{1,min}}\right) \leq \frac{T_{4,min}}{(D_1 - T_{4,min}) \cdot \beta_H} \quad (A-58)$$

and

$$T_{4,min} \geq T_{1,min} \quad (A-59)$$

$T_{4,min}$ is acceptable. If not, the calculation shall be repeated with a larger value of $T_{4,min}$. In order to satisfy (A-58) it is also allowed to increase value of $T_{3,min}$.

If the wall thickness of the cylindrical part at the major end of the reducer has to be reinforced, a minimal length of this part shall be assured:

$$L_{2,\min} = \begin{cases} 1,4 \cdot \sqrt{(D - T_{2,\min}) \cdot T_{2,\min}} & \text{if } T_{2,\min} > T_{\min} \\ 0 & \text{if } T_{2,\min} \leq T_{\min} \end{cases} \quad (\text{A-60})$$

If the wall thickness of the cylindrical part at the minor end of the reducer has to be reinforced, a minimal length of this part shall be assured:

$$L_{4,\min} = \begin{cases} \sqrt{(D_1 - T_{4,\min}) \cdot T_{4,\min}} & \text{if } T_{4,\min} > T_{1,\min} \\ 0 & \text{if } T_{4,\min} \leq T_{1,\min} \end{cases} \quad (\text{A-61})$$

If smaller lengths for L_2 and/or L_4 than calculated above are desired it is possible to increase the wall thickness and reduce the lengths :

$$T'_{2,\min} = \frac{T_{2,\min} \cdot L_{2,\min} - T_{\min} \cdot (L_{2,\min} - L_2)}{L_2} \quad (\text{A-62})$$

$$T'_{4,\min} = \frac{T_{4,\min} \cdot L_{4,\min} - T_{1,\min} \cdot (L_{4,\min} - L_4)}{L_4} \quad (\text{A-63})$$

NOTE 1 Formulas (A-50) to (A-59) are applicable only for semi angle α less equal 75° and ratios of $T_{3,\min} \cos(\alpha)$ to D not smaller than 0,001.

NOTE 2 The design of reducers is based on the following sections/formulas in EN 13480-3:2002:

Formula (A-49) is based on the stipulations in 6.4.7.2 ;

Formula (A-50) is derived from (6.4.6-2) and (6.1-1) ;

Formula (A-51) is given as (6.4.6-1) ;

Formula (A-52) is based on the stipulations in 6.4.6.2 ;

Formula (A-53) is derived from (6.4.4-3) and (6.1-1) using (6.4.4-4), (6.4.4-5), (6.4.4-6), (6.4.4-7) and (6.4.5-2), setting $r = 0$ and solving for e_{con} ;

Formula (A-54) is based on the stipulations in 6.4.6.2 ;

Formula (A-55) is given in EN 13480-3 as (6.4.8-1) ;

Formula (A-56) is based on (6.4.8-2) and (6.4.8-3) ;

Formula (A-57) is given in EN 13480-3 as (6.4.8-4) ;

Formula (A-58) is derived from (6.4.8-5) and (6.1-1) ;

Formula (A-59) is based on the stipulations in 6.4.8.1 b) ;

Formula (A-60) is based on (6.4.5-1) and the provisions in 6.4.6.2 ;

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Formula (A-61) is based on the stipulations in 6.4.8.1 a) ;

Formula (A-62) is based on the stipulations in 6.4.6.2 ;

Formula (A-63) is based on the stipulations in 6.4.8.2.

No additional calculation of the wall thickness of the knuckle at the major end is required. The formulas in EN 13480-3:2002 (6.4.7-1) to (6.4.7-4) give wall thicknesses which are not larger than for junctions without a knuckle.

The rules for a knuckle at the minor end differs from the stipulations in EN 13480-3:2002.

EXAMPLE

Design of an eccentric reducer of type B 323,9 x 7,1 – 168,3 x 4,5,

$c_0 = 0$ mm, semi angle $\alpha = 55^\circ$:

Table 15 : $L = 203$ mm.

$$(A-1) : T_{\min} = 7,1 \text{ mm} \cdot (100 - 12,5) / 100 - 0 \text{ mm} = 6,213 \text{ mm}$$

$$T_{1,\min} = 4,5 \text{ mm} \cdot (100 - 12,5) / 100 - 0 \text{ mm} = 3,938 \text{ mm}$$

Result of solving (A-50) and (A-51) by iteration : $T_{j,\min} = 7,385$ mm, $\beta = 1,193$

$$(A-52) : T_{2,\min} = 7,385 \text{ mm}$$

$$(A-53) : T_{\text{co},\min} = 8,768 \text{ mm}$$

$$(A-54) : T_{3,\min} = 8,768 \text{ mm}$$

Result of solving (A-55) to (A-59) by iteration : $T_{4,\min} = 4,454$ mm, $s = 1,969$, $\tau = 3,893$, $\beta_H = 1,390$

$$(A-60) : L_{2,\min} = 67,69 \text{ mm}$$

$$(A-61) : L_{4,\min} = 27,01 \text{ mm}$$

$$(A-49) : L'_{2,\min} = 24,17 \text{ mm}$$

$$(A-2) : T_2 = (7,385 \text{ mm} + 0 \text{ mm}) / (100 - 12,5) \cdot 100 = 8,44 \text{ mm}$$

$$T_3 = (8,768 \text{ mm} + 0 \text{ mm}) / (100 - 12,5) \cdot 100 = 10,02 \text{ mm}$$

$$T_4 = (4,45 \text{ mm} + 0 \text{ mm}) / (100 - 12,5) \cdot 100 = 5,09 \text{ mm}$$

The results of the design are :

$$T_2 = 8,44 \text{ mm}, L_2 = 67,7 \text{ mm}, L'_2 \geq 24,2 \text{ mm}, T_3 = 10,02 \text{ mm}, T_4 = 5,09 \text{ mm}, L_4 \geq 27,0 \text{ mm}$$

The length L_2 and L_4 are quite long compared to the total length of the reducer L . Therefore, an alternative design with lengths $L_2 = 30$ mm and $L_4 = 20$ is made :

$$(A-62) : T'_{2,\min} = 8,858 \text{ mm}$$

$$(A-63) : T'_{4,\min} = 4,635 \text{ mm}$$

$$(A-2) : T_2 = (8,86 \text{ mm} + 0 \text{ mm}) / (100 - 12,5) \cdot 100 = 10,12 \text{ mm}$$

$$T_4 = (4,64 \text{ mm} + 0 \text{ mm}) / (100 - 12,5) \cdot 100 = 5,30 \text{ mm}$$

The results of the alternative design are :

$$T_2 = 10,12 \text{ mm}, L_2 \geq 30 \text{ mm}, L'_2 \geq 24,2 \text{ mm}, T_3 = 10,02 \text{ mm}, T_4 = 5,29 \text{ mm}, L_4 \geq 20 \text{ mm}$$

A.5.4 Caps

The design of an ellipsoidal end comprises the determination of the wall thickness of the ellipsoidal end and the wall thickness of the knuckle. For the wall thickness of a cap the wall thickness requirements of the cylindrical part have also to be taken into consideration too :

$$T_{s,\min} = T_{\min} \cdot \frac{R1}{D - 1,5 \cdot T_{\min}} \quad (A-64)$$

$$T_{\text{kn y},\min} = T_{\min} \frac{\beta \cdot (0,75 \cdot R1 + 0,2 D)}{0,5 \cdot D - (0,5 - 0,4 \cdot \beta) \cdot T_{\min}} \quad (A-65)$$

$$T_{c,\min} = \max(T_{s,\min}, T_{\text{kn y},\min}, T_{\min}) \quad (A-66)$$

The factor β is calculated :

$$Y = \min\left(\frac{T_{\text{kn y},\min}}{R1}, 0,04\right) \quad (A-67)$$

$$Z = \log\left(\frac{1}{Y}\right) \quad (A-68)$$

$$W = \frac{r}{D - 2 \cdot T_{\text{kn y},\min}} \quad (A-69)$$

$$N = 1,006 - \frac{1}{6,2 + (90 \cdot Y)^4} \quad (A-70)$$

$$\beta_{0,06} = (-0,3635 \cdot Z^3 + 2,2124 \cdot Z^2 - 3,2937 \cdot Z + 1,8873) \cdot N \quad (A-71)$$

$$\beta_{0,1} = (-0,1833 \cdot Z^3 + 1,0383 \cdot Z^2 - 1,2943 \cdot Z + 0,837) \cdot N \quad (A-72)$$

$$\beta_{0,2} = 0,5 \quad (A-73)$$

$$\beta = \begin{cases} 25 \cdot ((0,1 - W) \cdot \beta_{0,06} + (W - 0,06) \cdot \beta_{0,1}) & \text{if } 0,06 \leq W \leq 0,1 \\ 10 \cdot ((0,2 - W) \cdot \beta_{0,1} + (W - 0,1) \cdot \beta_{0,2}) & \text{if } 0,1 < W \leq 0,2 \end{cases} \quad (A-74)$$

NOTE 1 Formula (A-65) with β from formulas (A-67) to (A-74) cannot be evaluated directly but are solved by iteration.

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NOTE 2 Formulas (A-64) to (A-74) are applicable provided that the following conditions are simultaneously fulfilled :

$$r \geq 0,06 \cdot (D - 2 \cdot T_{c,\min})$$

$$r \geq 3 \cdot T_{c,\min}$$

$$0,004 \cdot (D - 2 \cdot T_{c,\min}) < T_{c,\min} \leq 0,08 \cdot (D - 2 \cdot T_{c,\min})$$

$$R1 \leq D$$

NOTE 3 The calculation of caps is based on the following formulas in EN 13480-3:2002:

Formula (A-64) is derived from (7.1.3-1) and (6.1-1) ;

Formula (A-65) is derived from (7.1.3-2) and (6.1-1) ;

Formula (A-67) is given as (7.1.5-1) ;

Formula (A-68) is given as (7.1.5-2) ;

Formula (A-69) is given as (7.1.5-3) ;

Formula (A-70) is given as (7.1.5-4) ;

Formula (A-71) is given as (7.1.5-6) ;

Formula (A-72) is given as (7.1.5-5) ;

Formula (A-73) is read from figure 7.1.5-1 ;

Formula (A-74) is given as (7.1.5-8) and (7.1.5-7).

EXAMPLE

Wall thickness of a seamless cap 1219x10,

$$c_0 = 0 \text{ mm}, r = 0,15 \cdot D, R1 = 0,8 \cdot D :$$

$$r = 0,15 \cdot 1219 = 183 \text{ mm}$$

$$R1 = 0,8 \cdot 1219 = 975 \text{ mm}$$

$$(A-1) : T_{\min} = 10 \text{ mm} \cdot (100 - 12,5) / 100 - 0 \text{ mm} = 8,75 \text{ mm}$$

$$(A-64) : T_{s,\min} = 7,076 \text{ mm}$$

Result of solving (A-65) with (A-67) to (A-74) by iteration :

$$T_{\text{kn y},\min} = 9,149, Y = 0,00938, Z = 2,028, W = 0,152, N = 0,857, \beta_{0,06} = 1,092, \beta_{0,1} = 0,817, \beta = 0,651$$

$$(A-66) : T_{c,\min} = 9,149 \text{ mm}$$

$$(A-2) : T_c = 10,46 \text{ mm}$$

Annex B (informative)

Pressure factor tables for Fittings of type A

B.1 General

This annex lists pressure factors of elbows, tees, reducers and caps for the 8 wall thickness series listed in Table 17.

These pressure factors are calculated using the procedures given in Annex A and tolerances listed in Table 18. For fittings with diameters larger than 610 mm, where seamless and welded fittings have different wall thickness tolerances, the smaller of the two pressure factors is listed. For the corrosion allowance 0 mm is used.

NOTE 1 In general, welded elbows, tees and reducers with diameters larger than 610 mm have larger pressure factors than the seamless fittings.

NOTE 2 In general, corrosion allowances larger than 0 mm lead to smaller pressure factors.

For the definition of symbols see A.1 and the figures in Annex A.

The pressure factor of fittings with nominal dimensions not listed in the tables of this annex, with a corrosion allowance larger than 0 mm or with other tolerances (e.g. welded fitting with diameter larger than 610 mm) may be calculated in accordance with Annex A.

B.2 Elbows

Table B.1 shows the pressure factors of elbows of model 2D, 3D and 5D (indicated in second line of table) whose bending radii are given in Table 10, Table 11 and Table 12, respectively.

Table B.1 — Pressure factors of elbows type A

| Model | | 1 | | | | 2 | | | | 3 | | | | 4 | | | | 5 | | | | 6 | | | | 7 | | | | 8 | | | |
|-------|-------|-----|---------|---------|---------|------|---------|---------|---------|------|---------|---------|---------|------|---------|---------|---------|------|---------|---------|---------|------|---------|---------|---------|------|---------|---------|---------|------|---------|---------|---------|
| | | T | 2D X | 3D X | 5D X | T | 2D X | 3D X | 5D X | T | 2D X | 3D X | 5D X | T | 2D X | 3D X | 5D X | T | 2D X | 3D X | 5D X | T | 2D X | 3D X | 5D X | T | 2D X | 3D X | 5D X | T | 2D X | 3D X | 5D X |
| 15 | 21,3 | - | - | - | - | 2 | 75 | 85 | 87 | 2,6 | 76 | 85 | 87 | 3,2 | 77 | 86 | 88 | 4 | 79 | 87 | 88 | - | - | - | - | 5 | 80 | 88 | 89 | 7,1 | 84 | 90 | 91 |
| 20 | 26,9 | - | - | - | - | 2,3 | 67 | 80 | 87 | 2,6 | 67 | 80 | 88 | 3,2 | 68 | 81 | 88 | 4 | 69 | 82 | 88 | 4,5 | 70 | 82 | 89 | 5,6 | 72 | 83 | 89 | 8 | 77 | 86 | 91 |
| 25 | 33,7 | - | - | - | - | 2,6 | 54 | 74 | 87 | 3,2 | 55 | 74 | 88 | 4 | 57 | 75 | 88 | 4,5 | 58 | 75 | 88 | 5,6 | 60 | 77 | 89 | 6,3 | 61 | 77 | 89 | 8,8 | 66 | 80 | 90 |
| 32 | 42,4 | - | - | - | - | 2,6 | 54 | 73 | 87 | 3,6 | 55 | 74 | 88 | 4 | 56 | 74 | 88 | 5 | 58 | 75 | 88 | 6,3 | 60 | 76 | 89 | 8 | 62 | 78 | 89 | 10 | 65 | 79 | 90 |
| 40 | 48,3 | - | - | - | - | 2,6 | 56 | 74 | 88 | 3,6 | 57 | 75 | 88 | 4 | 58 | 75 | 88 | 5 | 59 | 76 | 88 | 6,3 | 61 | 77 | 89 | 8 | 63 | 78 | 89 | 10 | 65 | 79 | 90 |
| 50 | 60,3 | - | - | - | - | 2,9 | 60 | 76 | 88 | 3,6 | 61 | 76 | 88 | 4 | 61 | 77 | 88 | 5,6 | 62 | 77 | 88 | 7,1 | 64 | 78 | 89 | 8,8 | 65 | 79 | 89 | 11 | 67 | 80 | 90 |
| 65 | 76,1 | - | - | - | - | 2,9 | 58 | 76 | 88 | 3,6 | 59 | 76 | 88 | 5,6 | 60 | 77 | 88 | 7,1 | 61 | 77 | 88 | 8 | 62 | 77 | 89 | 10 | 63 | 78 | 89 | 14,2 | 67 | 80 | 90 |
| 80 | 88,9 | - | - | - | - | 3,2 | 60 | 76 | 88 | 4 | 60 | 76 | 88 | 5,6 | 61 | 77 | 88 | 8 | 63 | 78 | 89 | 8,8 | 63 | 78 | 89 | 11 | 65 | 79 | 89 | 16 | 68 | 80 | 90 |
| 100 | 114,3 | - | - | - | - | 3,6 | 62 | 77 | 88 | 4,5 | 62 | 77 | 88 | 6,3 | 63 | 78 | 88 | 8,8 | 64 | 78 | 89 | 11 | 65 | 79 | 89 | 14,2 | 67 | 80 | 89 | 17,5 | 68 | 80 | 90 |
| 125 | 139,7 | - | - | - | - | 4 | 63 | 78 | 88 | 5 | 63 | 78 | 88 | 6,3 | 64 | 78 | 88 | 10 | 65 | 79 | 89 | 12,5 | 66 | 79 | 89 | 16 | 67 | 80 | 89 | 20 | 68 | 81 | 89 |
| 150 | 168,3 | 4 | 62 | 78 | 88 | 4,5 | 62 | 78 | 88 | 5,6 | 63 | 78 | 88 | 7,1 | 63 | 78 | 88 | 11 | 64 | 79 | 88 | 14,2 | 65 | 79 | 88 | 17,5 | 66 | 80 | 89 | 22,2 | 67 | 80 | 89 |
| 200 | 219,1 | 4,5 | 63 | 78 | 88 | 6,3 | 64 | 78 | 88 | 7,1 | 64 | 78 | 88 | 8 | 64 | 78 | 88 | 12,5 | 65 | 79 | 88 | 16 | 66 | 79 | 88 | 17,5 | 66 | 80 | 89 | 22,2 | 67 | 80 | 89 |
| 250 | 273 | 5 | 64 | 78 | 88 | 6,3 | 64 | 78 | 88 | 8,8 | 64 | 78 | 88 | 10 | 64 | 79 | 88 | 12,5 | 65 | 79 | 88 | 16 | 65 | 79 | 88 | 22,2 | 66 | 80 | 89 | 30 | 68 | 80 | 89 |
| 300 | 323,9 | 5,6 | 64 | 78 | 88 | 7,1 | 64 | 78 | 88 | 8,8 | 65 | 79 | 88 | 10 | 65 | 79 | 88 | 12,5 | 65 | 79 | 88 | 17,5 | 66 | 79 | 88 | 25 | 67 | 80 | 89 | 32 | 68 | 80 | 89 |
| 350 | 355,6 | 5,6 | 67 | 80 | 88 | 8 | 67 | 80 | 88 | 10 | 67 | 80 | 88 | 12,5 | 68 | 80 | 88 | 16 | 68 | 80 | 88 | 20 | 68 | 81 | 88 | 28 | 69 | 81 | 89 | 36 | 70 | 82 | 89 |
| 400 | 406,4 | 6,3 | 67 | 80 | 88 | 8,8 | 67 | 80 | 88 | 10 | 67 | 80 | 88 | 12,5 | 67 | 80 | 88 | 17,5 | 68 | 80 | 88 | 22,2 | 68 | 81 | 88 | 30 | 69 | 81 | 89 | 40 | 70 | 82 | 89 |
| 450 | 457 | 6,3 | 67 | 80 | 88 | 10 | 67 | 80 | 88 | 11 | 67 | 80 | 88 | 12,5 | 67 | 80 | 88 | 17,5 | 68 | 80 | 89 | 22,2 | 68 | 81 | 89 | 32 | 69 | 81 | 89 | 45 | 70 | 82 | 89 |
| 500 | 508 | 6,3 | 67 | 80 | 88 | 10 | 67 | 80 | 88 | 11 | 67 | 80 | 88 | 12,5 | 67 | 80 | 88 | 17,5 | 68 | 80 | 89 | 25 | 68 | 81 | 89 | 36 | 69 | 81 | 89 | 50 | 70 | 82 | 89 |
| 600 | 610 | 6,3 | 67 | 80 | 89 | 10 | 67 | 80 | 89 | 12,5 | 67 | 80 | 89 | 17,5 | 67 | 80 | 89 | 25 | 68 | 80 | 89 | 30 | 68 | 81 | 89 | 45 | 69 | 81 | 89 | 60 | 70 | 82 | 90 |
| 700 | 711 | 7,1 | 67 | 80 | 89 | 10 | 67 | 80 | 89 | 12,5 | 67 | 80 | 89 | 25 | 68 | 80 | 89 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 800 | 813 | 8 | 67 | 80 | 88 | 10 | 67 | 80 | 89 | 12,5 | 67 | 80 | 89 | 25 | 67 | 80 | 89 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 900 | 914 | 10 | 67 | 80 | 89 | 12,5 | 67 | 80 | 89 | 20 | 67 | 80 | 89 | 25 | 67 | 80 | 89 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1 000 | 1 016 | 10 | 67 | 80 | 88 | 12,5 | 67 | 80 | 89 | 20 | 67 | 80 | 89 | 25 | 67 | 80 | 89 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1 200 | 1 219 | 10 | 66 | 80 | 88 | 12,5 | 67 | 80 | 89 | 20 | 67 | 80 | 89 | 25 | 67 | 80 | 89 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

B.3 Tees

Table B.2 shows the pressure factors of equal tees and reducing tees.

The data listed is applicable if the following conditions apply:

- crotch radius is less equal to 3/4 of the height of the branch ($r_c \leq 0,75 \cdot (G - D/2)$) and
- wall thickness at the crotch zone is at least the mean of the wall thicknesses of run and branch ($T_{c,min} \geq (T_{min} + T_{1,min}) / 2$) and
- dimensions F and G are as listed in Table 13 or 14.

In all other cases the pressure factor may be calculated in accordance with Annex A.

Table B.2 — Pressure factors of tees type A

| DN | D | DN ₁ | D ₁ | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | |
|----|------|-----------------|----------------|---|----------------|---|-----|----------------|----|-----|----------------|----|-----|----------------|----|-----|----------------|----|-----|----------------|----|-----|----------------|----|------|----------------|----|
| | | | | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X |
| 15 | 21,3 | 15 | 21,3 | - | - | - | 2 | 2 | 42 | 2,6 | 2,6 | 45 | 3,2 | 3,2 | 48 | 4 | 4 | 51 | - | - | - | 5 | 5 | 53 | 7,1 | 7,1 | 57 |
| 20 | 26,9 | 20 | 26,9 | - | - | - | 2,3 | 2,3 | 43 | 2,6 | 2,6 | 44 | 3,2 | 3,2 | 47 | 4 | 4 | 50 | 4,5 | 4,5 | 51 | 5,6 | 5,6 | 54 | 8 | 8 | 58 |
| | | 15 | 21,3 | - | - | - | 2,3 | 2 | 44 | 2,6 | 2,6 | 50 | 3,2 | 3,2 | 53 | 4 | 4 | 57 | - | - | - | 5,6 | 5 | 57 | 8 | 7,1 | 61 |
| 25 | 33,7 | 25 | 33,7 | - | - | - | 2,6 | 2,6 | 41 | 3,2 | 3,2 | 43 | 4 | 4 | 46 | 4,5 | 4,5 | 47 | 5,6 | 5,6 | 50 | 6,3 | 6,3 | 52 | 8,8 | 8,8 | 56 |
| | | 20 | 26,9 | - | - | - | 2,6 | 2,3 | 42 | 3,2 | 2,6 | 42 | 4 | 3,2 | 45 | 4,5 | 4 | 49 | 5,6 | 4,5 | 49 | 6,3 | 5,6 | 54 | 8,8 | 8 | 59 |
| | | 15 | 21,3 | - | - | - | 2,6 | 2 | 43 | 3,2 | 2,6 | 47 | 4 | 3,2 | 50 | 4,5 | 4 | 55 | - | - | - | 6,3 | 5 | 56 | 8,8 | 7,1 | 61 |
| 32 | 42,4 | 32 | 42,4 | - | - | - | 2,6 | 2,6 | 38 | 3,6 | 3,6 | 42 | 4 | 4 | 43 | 5 | 5 | 46 | 6,3 | 6,3 | 49 | 8 | 8 | 52 | 10 | 10 | 54 |
| | | 25 | 33,7 | - | - | - | 2,6 | 2,6 | 42 | 3,6 | 3,2 | 43 | 4 | 4 | 48 | 5 | 4,5 | 48 | 6,3 | 5,6 | 51 | 8 | 6,3 | 51 | 10 | 8,8 | 56 |
| | | 20 | 26,9 | - | - | - | 2,6 | 2,3 | 43 | 3,6 | 2,6 | 43 | 4 | 3,2 | 47 | 5 | 4 | 50 | 6,3 | 4,5 | 50 | 8 | 5,6 | 52 | 10 | 8 | 59 |
| | | 15 | 21,3 | - | - | - | 2,6 | 2 | 44 | 3,6 | 2,6 | 47 | 4 | 3,2 | 51 | 5 | 4 | 54 | - | - | - | 8 | 5 | 55 | 10 | 7,1 | 61 |
| 40 | 48,3 | 40 | 48,3 | - | - | - | 2,6 | 2,6 | 35 | 3,6 | 3,6 | 39 | 4 | 4 | 40 | 5 | 5 | 43 | 6,3 | 6,3 | 46 | 8 | 8 | 49 | 10 | 10 | 52 |
| | | 32 | 42,4 | - | - | - | 2,6 | 2,6 | 38 | 3,6 | 3,6 | 42 | 4 | 4 | 43 | 5 | 5 | 46 | 6,3 | 6,3 | 49 | 8 | 8 | 52 | 10 | 10 | 55 |
| | | 25 | 33,7 | - | - | - | 2,6 | 2,6 | 42 | 3,6 | 3,2 | 43 | 4 | 4 | 48 | 5 | 4,5 | 48 | 6,3 | 5,6 | 51 | 8 | 6,3 | 50 | 10 | 8,8 | 57 |
| | | 20 | 26,9 | - | - | - | 2,6 | 2,3 | 42 | 3,6 | 2,6 | 42 | 4 | 3,2 | 46 | 5 | 4 | 49 | 6,3 | 4,5 | 49 | 8 | 5,6 | 52 | 10 | 8 | 59 |
| | | 15 | 21,3 | - | - | - | 2,6 | 2 | 42 | 3,6 | 2,6 | 46 | 4 | 3,2 | 50 | 5 | 4 | 53 | - | - | - | 8 | 5 | 54 | 10 | 7,1 | 60 |
| 50 | 60,3 | 50 | 60,3 | - | - | - | 2,9 | 2,9 | 36 | 3,6 | 3,6 | 39 | 4 | 4 | 40 | 5,6 | 5,6 | 44 | 7,1 | 7,1 | 47 | 8,8 | 8,8 | 50 | 11 | 11 | 53 |
| | | 40 | 48,3 | - | - | - | 2,9 | 2,6 | 39 | 3,6 | 3,6 | 45 | 4 | 4 | 47 | 5,6 | 5 | 48 | 7,1 | 6,3 | 51 | 8,8 | 8 | 55 | 11 | 10 | 58 |
| | | 32 | 42,4 | - | - | - | 2,9 | 2,6 | 43 | 3,6 | 3,6 | 49 | 4 | 4 | 51 | 5,6 | 5 | 53 | 7,1 | 6,3 | 56 | 8,8 | 8 | 60 | 11 | 10 | 64 |
| | | 25 | 33,7 | - | - | - | 2,9 | 2,6 | 51 | 3,6 | 3,2 | 54 | 4 | 4 | 60 | 5,6 | 4,5 | 59 | 7,1 | 5,6 | 62 | 8,8 | 6,3 | 62 | 11 | 8,8 | 69 |
| | | 20 | 26,9 | - | - | - | 2,9 | 2,3 | 58 | 3,6 | 2,6 | 59 | 4 | 3,2 | 63 | 5,6 | 4 | 66 | 7,1 | 4,5 | 66 | 8,8 | 5,6 | 70 | 11 | 8 | 78 |
| 65 | 76,1 | 65 | 76,1 | - | - | - | 2,9 | 2,9 | 34 | 3,6 | 3,6 | 37 | 5,6 | 5,6 | 43 | 7,1 | 7,1 | 46 | 8 | 8 | 47 | 10 | 10 | 50 | 14,2 | 14,2 | 55 |
| | | 50 | 60,3 | - | - | - | 2,9 | 2,9 | 41 | 3,6 | 3,6 | 44 | 5,6 | 4 | 46 | 7,1 | 5,6 | 47 | 8 | 7,1 | 52 | 10 | 8,8 | 55 | 14,2 | 11 | 57 |
| | | 40 | 48,3 | - | - | - | 2,9 | 2,6 | 44 | 3,6 | 3,6 | 50 | 5,6 | 4 | 48 | 7,1 | 5 | 51 | 8 | 6,3 | 55 | 10 | 8 | 59 | 14,2 | 10 | 60 |
| | | 32 | 42,4 | - | - | - | 2,9 | 2,6 | 48 | 3,6 | 3,6 | 55 | 5,6 | 4 | 52 | 7,1 | 5 | 55 | 8 | 6,3 | 60 | 10 | 8 | 64 | 14,2 | 10 | 66 |
| | | 25 | 33,7 | - | - | - | 2,9 | 2,6 | 57 | 3,6 | 3,2 | 60 | 5,6 | 4 | 61 | 7,1 | 4,5 | 62 | 8 | 5,6 | 67 | 10 | 6,3 | 67 | 14,2 | 8,8 | 73 |

Table B.2 (continued)

| DN | D | DN ₁ | D ₁ | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | |
|-----|-------|-----------------|----------------|-----|----------------|----|-----|----------------|----|-----|----------------|----|-----|----------------|----|------|----------------|----|------|----------------|----|------|----------------|----|------|----------------|----|
| | | | | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X |
| 80 | 88,9 | 80 | 88,9 | - | - | - | 3,2 | 3,2 | 34 | 4 | 4 | 37 | 5,6 | 5,6 | 41 | 8 | 8 | 46 | 8,8 | 8,8 | 47 | 11 | 11 | 50 | 16 | 16 | 55 |
| | | 65 | 76,1 | - | - | - | 3,2 | 2,9 | 36 | 4 | 3,6 | 38 | 5,6 | 5,6 | 46 | 8 | 7,1 | 47 | 8,8 | 8 | 49 | 11 | 10 | 52 | 16 | 14,2 | 56 |
| | | 50 | 60,3 | - | - | - | 3,2 | 2,9 | 42 | 4 | 3,6 | 45 | 5,6 | 4 | 45 | 8 | 5,6 | 49 | 8,8 | 7,1 | 54 | 11 | 8,8 | 57 | 16 | 11 | 58 |
| | | 40 | 48,3 | - | - | - | 3,2 | 2,6 | 46 | 4 | 3,6 | 52 | 5,6 | 4 | 51 | 8 | 5 | 53 | 8,8 | 6,3 | 58 | 11 | 8 | 62 | 16 | 10 | 63 |
| | | 32 | 42,4 | - | - | - | 3,2 | 2,6 | 50 | 4 | 3,6 | 56 | 5,6 | 4 | 55 | 8 | 5 | 58 | 8,8 | 6,3 | 63 | 11 | 8 | 67 | 16 | 10 | 68 |
| 100 | 114,3 | 100 | 114,3 | - | - | - | 3,6 | 3,6 | 34 | 4,5 | 4,5 | 36 | 6,3 | 6,3 | 40 | 8,8 | 8,8 | 45 | 11 | 11 | 48 | 14,2 | 14,2 | 51 | 17,5 | 17,5 | 54 |
| | | 80 | 88,9 | - | - | - | 3,6 | 3,2 | 37 | 4,5 | 4 | 40 | 6,3 | 5,6 | 45 | 8,8 | 8 | 50 | 11 | 8,8 | 50 | 14,2 | 11 | 52 | 17,5 | 16 | 60 |
| | | 65 | 76,1 | - | - | - | 3,6 | 2,9 | 39 | 4,5 | 3,6 | 42 | 6,3 | 5,6 | 49 | 8,8 | 7,1 | 52 | 11 | 8 | 52 | 14,2 | 10 | 55 | 17,5 | 14,2 | 62 |
| | | 50 | 60,3 | - | - | - | 3,6 | 2,9 | 45 | 4,5 | 3,6 | 49 | 6,3 | 4 | 49 | 8,8 | 5,6 | 54 | 11 | 7,1 | 57 | 14,2 | 8,8 | 60 | 17,5 | 11 | 63 |
| | | 40 | 48,3 | - | - | - | 3,6 | 2,6 | 49 | 4,5 | 3,6 | 55 | 6,3 | 4 | 55 | 8,8 | 5 | 58 | 11 | 6,3 | 61 | 14,2 | 8 | 65 | 17,5 | 10 | 69 |
| 125 | 139,7 | 125 | 139,7 | - | - | - | 4 | 4 | 33 | 5 | 5 | 36 | 6,3 | 6,3 | 39 | 10 | 10 | 44 | 12,5 | 12,5 | 47 | 16 | 16 | 51 | 20 | 20 | 53 |
| | | 100 | 114,3 | - | - | - | 4 | 3,6 | 36 | 5 | 4,5 | 38 | 6,3 | 6,3 | 44 | 10 | 8,8 | 47 | 12,5 | 11 | 50 | 16 | 14,2 | 54 | 20 | 17,5 | 57 |
| | | 80 | 88,9 | - | - | - | 4 | 3,2 | 39 | 5 | 4 | 42 | 6,3 | 5,6 | 48 | 10 | 8 | 52 | 12,5 | 8,8 | 52 | 16 | 11 | 55 | 20 | 16 | 63 |
| | | 65 | 76,1 | - | - | - | 4 | 2,9 | 41 | 5 | 3,6 | 44 | 6,3 | 5,6 | 53 | 10 | 7,1 | 54 | 12,5 | 8 | 55 | 16 | 10 | 58 | 20 | 14,2 | 65 |
| | | 50 | 60,3 | - | - | - | 4 | 2,9 | 47 | 5 | 3,6 | 50 | 6,3 | 4 | 51 | 10 | 5,6 | 56 | 12,5 | 7,1 | 60 | 16 | 8,8 | 63 | 20 | 11 | 66 |
| 150 | 168,3 | 150 | 168,3 | 4 | 4 | 32 | 4,5 | 4,5 | 33 | 5,6 | 5,6 | 36 | 7,1 | 7,1 | 38 | 11 | 11 | 44 | 14,2 | 14,2 | 47 | 17,5 | 17,5 | 50 | 22,2 | 22,2 | 52 |
| | | 125 | 139,7 | - | - | - | 4,5 | 4 | 35 | 5,6 | 5 | 38 | 7,1 | 6,3 | 40 | 11 | 10 | 47 | 14,2 | 12,5 | 50 | 17,5 | 16 | 54 | 22,2 | 20 | 56 |
| | | 100 | 114,3 | - | - | - | 4,5 | 3,6 | 38 | 5,6 | 4,5 | 41 | 7,1 | 6,3 | 46 | 11 | 8,8 | 50 | 14,2 | 11 | 53 | 17,5 | 14,2 | 57 | 22,2 | 17,5 | 60 |
| | | 80 | 88,9 | - | - | - | 4,5 | 3,2 | 42 | 5,6 | 4 | 45 | 7,1 | 5,6 | 51 | 11 | 8 | 55 | 14,2 | 8,8 | 56 | 17,5 | 11 | 59 | 22,2 | 16 | 66 |
| | | 65 | 76,1 | - | - | - | 4,5 | 2,9 | 44 | 5,6 | 3,6 | 47 | 7,1 | 5,6 | 55 | 11 | 7,1 | 57 | 14,2 | 8 | 59 | 17,5 | 10 | 62 | 22,2 | 14,2 | 68 |
| 200 | 219,1 | 200 | 219,1 | 4,5 | 4,5 | 31 | 6,3 | 6,3 | 34 | 7,1 | 7,1 | 36 | 8 | 8 | 37 | 12,5 | 12,5 | 43 | 16 | 16 | 46 | 17,5 | 17,5 | 47 | 22,2 | 22,2 | 49 |
| | | 150 | 168,3 | 4,5 | 4 | 34 | 6,3 | 4,5 | 37 | 7,1 | 5,6 | 37 | 8 | 7,1 | 41 | 12,5 | 11 | 47 | 16 | 14,2 | 51 | 17,5 | 17,5 | 57 | 22,2 | 22,2 | 59 |
| | | 125 | 139,7 | - | - | - | 6,3 | 4 | 37 | 7,1 | 5 | 40 | 8 | 6,3 | 44 | 12,5 | 10 | 51 | 16 | 12,5 | 54 | 17,5 | 16 | 60 | 22,2 | 20 | 63 |
| | | 100 | 114,3 | - | - | - | 6,3 | 3,6 | 40 | 7,1 | 4,5 | 43 | 8 | 6,3 | 50 | 12,5 | 8,8 | 54 | 16 | 11 | 57 | 17,5 | 14,2 | 63 | 22,2 | 17,5 | 66 |

Table B.2 (continued)

| DN | D | DN ₁ | D ₁ | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | |
|-----|-------|-----------------|----------------|-----|----------------|----|-----|----------------|----|-----|----------------|----|------|----------------|----|------|----------------|----|------|----------------|----|------|----------------|----|----|----------------|----|
| | | | | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X |
| 250 | 273 | 250 | 273 | 5 | 5 | 30 | 6,3 | 6,3 | 32 | 8,8 | 8,8 | 36 | 10 | 10 | 38 | 12,5 | 12,5 | 41 | 16 | 16 | 44 | 22,2 | 22,2 | 47 | 30 | 30 | 48 |
| | | 200 | 219,1 | 5 | 4,5 | 33 | 6,3 | 6,3 | 38 | 8,8 | 7,1 | 37 | 10 | 8 | 39 | 12,5 | 12,5 | 47 | 16 | 16 | 51 | 22,2 | 17,5 | 50 | 30 | 22,2 | 55 |
| | | 150 | 168,3 | 5 | 4 | 36 | 6,3 | 4,5 | 37 | 8,8 | 5,6 | 40 | 10 | 7,1 | 43 | 12,5 | 11 | 52 | 16 | 14,2 | 56 | 22,2 | 17,5 | 57 | 30 | 22,2 | 59 |
| | | 125 | 139,7 | - | - | - | 6,3 | 4 | 40 | 8,8 | 5 | 42 | 10 | 6,3 | 46 | 12,5 | 10 | 54 | 16 | 12,5 | 58 | 22,2 | 16 | 61 | 30 | 20 | 63 |
| | | 100 | 114,3 | - | - | - | 6,3 | 3,6 | 43 | 8,8 | 4,5 | 47 | 10 | 6,3 | 52 | 12,5 | 8,8 | 58 | 16 | 11 | 61 | 22,2 | 14,2 | 64 | 30 | 17,5 | 67 |
| 300 | 323,9 | 300 | 323,9 | 5,6 | 5,6 | 29 | 7,1 | 7,1 | 32 | 8,8 | 8,8 | 34 | 10 | 10 | 36 | 12,5 | 12,5 | 39 | 17,5 | 17,5 | 43 | 25 | 25 | 46 | 32 | 32 | 47 |
| | | 250 | 273 | 5,6 | 5 | 31 | 7,1 | 6,3 | 33 | 8,8 | 8,8 | 39 | 10 | 10 | 41 | 12,5 | 12,5 | 44 | 17,5 | 16 | 46 | 25 | 22,2 | 49 | 32 | 30 | 53 |
| | | 200 | 219,1 | 5,6 | 4,5 | 34 | 7,1 | 6,3 | 39 | 8,8 | 7,1 | 40 | 10 | 8 | 41 | 12,5 | 12,5 | 50 | 17,5 | 16 | 53 | 25 | 17,5 | 51 | 32 | 22,2 | 53 |
| | | 150 | 168,3 | 5,6 | 4 | 38 | 7,1 | 4,5 | 39 | 8,8 | 5,6 | 42 | 10 | 7,1 | 46 | 12,5 | 11 | 55 | 17,5 | 14,2 | 58 | 25 | 17,5 | 59 | 32 | 22,2 | 62 |
| 350 | 355,6 | 350 | 355,6 | 5,6 | 5,6 | 28 | 8 | 8 | 32 | 10 | 10 | 35 | 12,5 | 12,5 | 37 | 16 | 16 | 41 | 20 | 20 | 43 | 28 | 28 | 47 | 36 | 36 | 47 |
| | | 300 | 323,9 | 5,6 | 5,6 | 30 | 8 | 7,1 | 33 | 10 | 8,8 | 35 | 12,5 | 10 | 40 | 16 | 12,5 | 44 | 20 | 17,5 | 45 | 28 | 25 | 48 | 36 | 32 | 51 |
| | | 250 | 273 | 5,6 | 5 | 32 | 8 | 6,3 | 34 | 10 | 8,8 | 39 | 12,5 | 10 | 40 | 16 | 12,5 | 42 | 20 | 16 | 46 | 28 | 22,2 | 50 | 36 | 30 | 53 |
| | | 200 | 219,1 | 5,6 | 4,5 | 35 | 8 | 6,3 | 39 | 10 | 7,1 | 40 | 12,5 | 8 | 41 | 16 | 12,5 | 49 | 20 | 16 | 53 | 28 | 17,5 | 52 | 36 | 22,2 | 54 |
| | | 150 | 168,3 | 5,6 | 4 | 39 | 8 | 4,5 | 40 | 10 | 5,6 | 43 | 12,5 | 7,1 | 47 | 16 | 11 | 54 | 20 | 14,2 | 58 | 28 | 17,5 | 60 | 36 | 22,2 | 63 |
| 400 | 406,4 | 400 | 406,4 | 6,3 | 6,3 | 28 | 8,8 | 8,8 | 32 | 10 | 10 | 34 | 12,5 | 12,5 | 36 | 17,5 | 17,5 | 41 | 22,2 | 22,2 | 43 | 30 | 30 | 44 | 40 | 40 | 45 |
| | | 350 | 355,6 | 6,3 | 5,6 | 29 | 8,8 | 8 | 33 | 10 | 10 | 37 | 12,5 | 12,5 | 39 | 17,5 | 16 | 42 | 22,2 | 20 | 44 | 30 | 28 | 49 | 40 | 36 | 50 |
| | | 300 | 323,9 | 6,3 | 5,6 | 31 | 8,8 | 7,1 | 33 | 10 | 8,8 | 36 | 12,5 | 10 | 37 | 17,5 | 12,5 | 44 | 22,2 | 17,5 | 45 | 30 | 25 | 49 | 40 | 32 | 51 |
| | | 250 | 273 | 6,3 | 5 | 33 | 8,8 | 6,3 | 35 | 10 | 8,8 | 41 | 12,5 | 10 | 42 | 17,5 | 12,5 | 44 | 22,2 | 16 | 47 | 30 | 22,2 | 52 | 40 | 30 | 55 |
| | | 200 | 219,1 | 6,3 | 4,5 | 36 | 8,8 | 6,3 | 40 | 10 | 7,1 | 42 | 12,5 | 8 | 43 | 17,5 | 12,5 | 50 | 22,2 | 16 | 54 | 30 | 17,5 | 54 | 40 | 22,2 | 57 |
| | | 150 | 168,3 | 6,3 | 4 | 40 | 8,8 | 4,5 | 42 | 10 | 5,6 | 45 | 12,5 | 7,1 | 49 | 17,5 | 11 | 55 | 22,2 | 14,2 | 59 | 30 | 17,5 | 62 | 40 | 22,2 | 65 |
| 450 | 457 | 450 | 457 | 6,3 | 6,3 | 27 | 10 | 10 | 32 | 11 | 11 | 33 | 12,5 | 12,5 | 35 | 17,5 | 17,5 | 39 | 22,2 | 22,2 | 42 | 32 | 32 | 44 | 45 | 45 | 45 |
| | | 400 | 406,4 | 6,3 | 6,3 | 30 | 10 | 8,8 | 33 | 11 | 10 | 34 | 12,5 | 12,5 | 38 | 17,5 | 17,5 | 43 | 22,2 | 22,2 | 46 | 32 | 30 | 47 | 45 | 40 | 49 |
| | | 350 | 355,6 | 6,3 | 5,6 | 30 | 10 | 8 | 33 | 11 | 10 | 37 | 12,5 | 12,5 | 41 | 17,5 | 16 | 44 | 22,2 | 20 | 47 | 32 | 28 | 50 | 45 | 36 | 52 |
| | | 300 | 323,9 | 6,3 | 5,6 | 32 | 10 | 7,1 | 34 | 11 | 8,8 | 37 | 12,5 | 10 | 39 | 17,5 | 12,5 | 41 | 22,2 | 17,5 | 46 | 32 | 25 | 51 | 45 | 32 | 52 |
| | | 250 | 273 | 6,3 | 5 | 34 | 10 | 6,3 | 36 | 11 | 8,8 | 42 | 12,5 | 10 | 43 | 17,5 | 12,5 | 46 | 22,2 | 16 | 49 | 32 | 22,2 | 53 | 45 | 30 | 57 |
| | | 200 | 219,1 | 6,3 | 4,5 | 37 | 10 | 6,3 | 42 | 11 | 7,1 | 43 | 12,5 | 8 | 45 | 17,5 | 12,5 | 52 | 22,2 | 16 | 56 | 32 | 17,5 | 56 | 45 | 22,2 | 59 |

Table B.2 (continued)

| DN | D | DN ₁ | D ₁ | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | |
|-----|-----|-----------------|----------------|-----|----------------|----|------|----------------|----|------|----------------|----|------|----------------|----|------|----------------|----|----|----------------|----|----|----------------|----|----|----------------|----|
| | | | | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X |
| 500 | 508 | 500 | 508 | 6,3 | 6,3 | 26 | 10 | 10 | 31 | 11 | 11 | 32 | 12,5 | 12,5 | 34 | 17,5 | 17,5 | 38 | 25 | 25 | 42 | 36 | 36 | 44 | 50 | 50 | 45 |
| | | 450 | 457 | 6,3 | 6,3 | 28 | 10 | 10 | 34 | 11 | 11 | 35 | 12,5 | 12,5 | 36 | 17,5 | 17,5 | 41 | 25 | 22,2 | 43 | 36 | 32 | 47 | 50 | 45 | 49 |
| | | 400 | 406,4 | 6,3 | 6,3 | 31 | 10 | 8,8 | 34 | 11 | 10 | 36 | 12,5 | 12,5 | 40 | 17,5 | 17,5 | 44 | 25 | 22,2 | 46 | 36 | 30 | 48 | 50 | 40 | 50 |
| | | 300 | 323,9 | 6,3 | 5,6 | 33 | 10 | 7,1 | 35 | 11 | 8,8 | 39 | 12,5 | 10 | 40 | 17,5 | 12,5 | 42 | 25 | 17,5 | 47 | 36 | 25 | 52 | 50 | 32 | 54 |
| | | 250 | 273 | 6,3 | 5 | 35 | 10 | 6,3 | 38 | 11 | 8,8 | 43 | 12,5 | 10 | 45 | 17,5 | 12,5 | 48 | 25 | 16 | 50 | 36 | 22,2 | 55 | 50 | 30 | 58 |
| 600 | 610 | 600 | 610 | 6,3 | 6,3 | 25 | 10 | 10 | 30 | 12,5 | 12,5 | 32 | 17,5 | 17,5 | 36 | 25 | 25 | 39 | 30 | 30 | 40 | 45 | 45 | 41 | 60 | 60 | 42 |
| | | 500 | 508 | 6,3 | 6,3 | 28 | 10 | 10 | 33 | 12,5 | 11 | 33 | 17,5 | 12,5 | 39 | 25 | 17,5 | 45 | 30 | 25 | 43 | 45 | 36 | 48 | 60 | 50 | 49 |
| | | 400 | 406,4 | 6,3 | 6,3 | 33 | 10 | 8,8 | 36 | 12,5 | 10 | 37 | 17,5 | 12,5 | 39 | 25 | 17,5 | 44 | 30 | 22,2 | 47 | 45 | 30 | 50 | 60 | 40 | 53 |
| | | 300 | 323,9 | 6,3 | 5,6 | 36 | 10 | 7,1 | 38 | 12,5 | 8,8 | 40 | 17,5 | 10 | 42 | 25 | 12,5 | 47 | 30 | 17,5 | 49 | 45 | 25 | 54 | 60 | 32 | 57 |
| | | 250 | 273 | 6,3 | 5 | 38 | 10 | 6,3 | 40 | 12,5 | 8,8 | 45 | 17,5 | 10 | 46 | 25 | 12,5 | 50 | 30 | 16 | 53 | 45 | 22,2 | 57 | 60 | 30 | 61 |
| 700 | 711 | 700 | 711 | 7,1 | 7,1 | 24 | 10 | 10 | 28 | 12,5 | 12,5 | 30 | 25 | 25 | 38 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 600 | 610 | 7,1 | 6,3 | 25 | 10 | 10 | 30 | 12,5 | 12,5 | 33 | 25 | 17,5 | 43 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 500 | 508 | 7,1 | 6,3 | 28 | 10 | 10 | 34 | 12,5 | 11 | 35 | 25 | 12,5 | 50 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 400 | 406,4 | 7,1 | 6,3 | 33 | 10 | 8,8 | 37 | 12,5 | 10 | 39 | 25 | 12,5 | 47 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 300 | 323,9 | 7,1 | 5,6 | 36 | 10 | 7,1 | 39 | 12,5 | 8,8 | 42 | 25 | 10 | 51 | - | - | - | - | - | - | - | - | - | - | - | - |
| 800 | 813 | 800 | 813 | 8 | 8 | 24 | 10 | 10 | 26 | 12,5 | 12,5 | 29 | 25 | 25 | 37 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 700 | 711 | 8 | 7,1 | 25 | 10 | 10 | 29 | 12,5 | 12,5 | 32 | 25 | 25 | 40 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 600 | 610 | 8 | 6,3 | 26 | 10 | 10 | 32 | 12,5 | 12,5 | 34 | 25 | 17,5 | 39 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 500 | 508 | 8 | 6,3 | 29 | 10 | 10 | 36 | 12,5 | 11 | 36 | 25 | 12,5 | 46 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 400 | 406,4 | 8 | 6,3 | 34 | 10 | 8,8 | 39 | 12,5 | 10 | 40 | 25 | 12,5 | 43 | - | - | - | - | - | - | - | - | - | - | - | - |
| 900 | 914 | 900 | 914 | 10 | 10 | 25 | 12,5 | 12,5 | 27 | 20 | 20 | 33 | 25 | 25 | 35 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 800 | 813 | 10 | 8 | 27 | 12,5 | 10 | 29 | 20 | 12,5 | 39 | 25 | 25 | 38 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 700 | 711 | 10 | 7,1 | 27 | 12,5 | 10 | 29 | 20 | 12,5 | 38 | 25 | 25 | 42 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 600 | 610 | 10 | 6,3 | 28 | 12,5 | 10 | 32 | 20 | 12,5 | 36 | 25 | 17,5 | 38 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 500 | 508 | 10 | 6,3 | 30 | 12,5 | 10 | 36 | 20 | 11 | 37 | 25 | 12,5 | 43 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 400 | 406,4 | 10 | 6,3 | 36 | 12,5 | 8,8 | 40 | 20 | 10 | 42 | 25 | 12,5 | 45 | - | - | - | - | - | - | - | - | - | - | - | - |

Table B.2 (continued)

| DN | D | DN ₁ | D ₁ | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | |
|-------|-------|-----------------|----------------|----|----------------|----|------|----------------|----|----|----------------|----|----|----------------|----|---|----------------|---|---|----------------|---|---|----------------|---|---|----------------|---|
| | | | | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X |
| 1 000 | 1 016 | 1 000 | 1016 | 10 | 10 | 24 | 12,5 | 12,5 | 26 | 20 | 20 | 31 | 25 | 25 | 34 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 900 | 914 | 10 | 10 | 26 | 12,5 | 12,5 | 28 | 20 | 20 | 34 | 25 | 25 | 36 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 800 | 813 | 10 | 8 | 25 | 12,5 | 10 | 27 | 20 | 12,5 | 37 | 25 | 25 | 40 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 700 | 711 | 10 | 7,1 | 26 | 12,5 | 10 | 30 | 20 | 12,5 | 36 | 25 | 25 | 44 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 600 | 610 | 10 | 6,3 | 27 | 12,5 | 10 | 33 | 20 | 12,5 | 35 | 25 | 17,5 | 39 | - | - | - | - | - | - | - | - | - | - | - | - |
| 1 200 | 1 219 | 1 200 | 1 219 | 10 | 10 | 23 | 12,5 | 12,5 | 25 | 20 | 20 | 30 | 25 | 25 | 33 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 1 000 | 1 016 | 10 | 10 | 26 | 12,5 | 12,5 | 29 | 20 | 20 | 34 | 25 | 25 | 37 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 900 | 914 | 10 | 10 | 28 | 12,5 | 12,5 | 31 | 20 | 20 | 37 | 25 | 25 | 40 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 800 | 813 | 10 | 8 | 27 | 12,5 | 10 | 29 | 20 | 12,5 | 33 | 25 | 25 | 43 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 700 | 711 | 10 | 7,1 | 28 | 12,5 | 10 | 32 | 20 | 12,5 | 34 | 25 | 25 | 47 | - | - | - | - | - | - | - | - | - | - | - | - |

B.4 Reducers

Table B.3 and Table B.4 show the pressure factors of concentric and eccentric reducers, respectively.

The data listed is applicable if all of the following conditions apply :

- semi angle of the reducer is not larger than the values listed in Table B.3 and B.4 ;
- wall thickness of the conical part is at least the wall thickness at the major end ;
- each of the lengths L_2 and L_4 at the ends of the reducer is at least 10 % of the total length L listed in Table 15 ;
- at the transitions between the cylindrical sections and the conical sections the inside and outside surfaces shall merge smoothly ;
- length L'_2 between a knuckle and the major end of a reducer is at least ;

$$L'_2 \geq 0.5 \cdot \sqrt{(D - T) \cdot T} \quad (\text{B-1})$$

or, alternatively, at least $L_{2,\min}$ given by formula (A-10).

- transition between the cylindrical sections and the conical section at the minor end may be curved too. The wall thickness of the knuckle shall be the same as the wall thickness of the conical part.

In all other cases the pressure factor may be calculated in accordance with Annex A.

If the pressure factor is shown in brackets the lengths required at the ends of the reducer are larger than 10 % of the total length L listed in Table 15. In this case the pressure factor is applicable only if the lengths L_2 and L_4 are at least $L_{2,\min}$ and $L_{4,\min}$ given by formulas (A-29) and (A-30) or if the reducer is situated between tubes with wall thicknesses of T and T_1 , respectively.

Table B.3 — Pressure factors of concentric reducers type A

| DN | D | DN ₁ | D ₁ | α _{max} | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | |
|-----|-------|-----------------|----------------|------------------|---|----------------|---|-----|----------------|-----|-----|----------------|-----|-----|----------------|-----|-----|----------------|-----|-----|----------------|-----|------|----------------|-----|------|----------------|-----|
| | | | | | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X |
| 20 | 26,9 | 15 | 21,3 | 8 | - | - | - | 2,3 | 2 | 100 | 2,6 | 2,6 | 100 | 3,2 | 3,2 | 100 | 4 | 4 | 100 | - | - | - | 5,6 | 5 | 100 | 8 | 7,1 | 100 |
| 25 | 33,7 | 20 | 26,9 | 7 | - | - | - | 2,6 | 2,3 | 100 | 3,2 | 2,6 | 100 | 4 | 3,2 | 100 | 4,5 | 4 | 100 | 5,6 | 4,5 | 100 | 6,3 | 5,6 | 100 | 8,8 | 8 | 100 |
| | | 15 | 21,3 | 12 | - | - | - | 2,6 | 2 | 100 | 3,2 | 2,6 | 100 | 4 | 3,2 | 100 | 4,5 | 4 | 100 | - | - | - | 6,3 | 5 | 100 | 8,8 | 7,1 | 100 |
| 32 | 42,4 | 25 | 33,7 | 9 | - | - | - | 2,6 | 2,6 | 100 | 3,6 | 3,2 | 100 | 4 | 4 | 100 | 5 | 4,5 | 100 | 6,3 | 5,6 | 100 | 8 | 6,3 | 100 | 10 | 8,8 | 100 |
| | | 20 | 26,9 | 15 | - | - | - | 2,6 | 2,3 | 100 | 3,6 | 2,6 | 100 | 4 | 3,2 | 100 | 5 | 4 | 100 | 6,3 | 4,5 | 100 | 8 | 5,6 | 100 | 10 | 8 | 100 |
| | | 15 | 21,3 | 19 | - | - | - | 2,6 | 2 | 100 | 3,6 | 2,6 | 100 | 4 | 3,2 | 100 | 5 | 4 | 100 | - | - | - | 8 | 5 | 100 | 10 | 7,1 | 100 |
| 40 | 48,3 | 32 | 42,4 | 6 | - | - | - | 2,6 | 2,6 | 100 | 3,6 | 3,6 | 100 | 4 | 4 | 100 | 5 | 5 | 100 | 6,3 | 6,3 | 100 | 8 | 8 | 100 | 10 | 10 | 100 |
| | | 25 | 33,7 | 10 | - | - | - | 2,6 | 2,6 | 100 | 3,6 | 3,2 | 100 | 4 | 4 | 100 | 5 | 4,5 | 100 | 6,3 | 5,6 | 100 | 8 | 6,3 | 100 | 10 | 8,8 | 100 |
| | | 20 | 26,9 | 16 | - | - | - | 2,6 | 2,3 | 100 | 3,6 | 2,6 | 100 | 4 | 3,2 | 100 | 5 | 4 | 100 | 6,3 | 4,5 | 100 | 8 | 5,6 | 100 | 10 | 8 | 100 |
| 50 | 60,3 | 40 | 48,3 | 7 | - | - | - | 2,9 | 2,6 | 100 | 3,6 | 3,6 | 100 | 4 | 4 | 100 | 5,6 | 5 | 100 | 7,1 | 6,3 | 100 | 8,8 | 8 | 100 | 11 | 10 | 100 |
| | | 32 | 42,4 | 11 | - | - | - | 2,9 | 2,6 | 100 | 3,6 | 3,6 | 100 | 4 | 4 | 100 | 5,6 | 5 | 100 | 7,1 | 6,3 | 100 | 8,8 | 8 | 100 | 11 | 10 | 100 |
| | | 25 | 33,7 | 16 | - | - | - | 2,9 | 2,6 | 100 | 3,6 | 3,2 | 100 | 4 | 4 | 100 | 5,6 | 4,5 | 100 | 7,1 | 5,6 | 100 | 8,8 | 6,3 | 100 | 11 | 8,8 | 100 |
| | | 20 | 26,9 | 21 | - | - | - | 2,9 | 2,3 | 100 | 3,6 | 2,6 | 100 | 4 | 3,2 | 100 | 5,6 | 4 | 100 | 7,1 | 4,5 | 100 | 8,8 | 5,6 | 100 | 11 | 8 | 100 |
| 65 | 76,1 | 50 | 60,3 | 9 | - | - | - | 2,9 | 2,9 | 100 | 3,6 | 3,6 | 100 | 5,6 | 4 | 100 | 7,1 | 5,6 | 100 | 8 | 7,1 | 100 | 10 | 8,8 | 100 | 14,2 | 11 | 100 |
| | | 40 | 48,3 | 15 | - | - | - | 2,9 | 2,6 | 100 | 3,6 | 3,6 | 100 | 5,6 | 4 | 100 | 7,1 | 5 | 100 | 8 | 6,3 | 100 | 10 | 8 | 100 | 14,2 | 10 | 100 |
| | | 32 | 42,4 | 18 | - | - | - | 2,9 | 2,6 | 100 | 3,6 | 3,6 | 100 | 5,6 | 4 | 100 | 7,1 | 5 | 100 | 8 | 6,3 | 100 | 10 | 8 | 100 | 14,2 | 10 | 100 |
| | | 25 | 33,7 | 23 | - | - | - | 2,9 | 2,6 | 100 | 3,6 | 3,2 | 100 | 5,6 | 4 | 100 | 7,1 | 4,5 | 100 | 8 | 5,6 | 100 | 10 | 6,3 | 100 | 14,2 | 8,8 | 100 |
| 80 | 88,9 | 65 | 76,1 | 7 | - | - | - | 3,2 | 2,9 | 100 | 4 | 3,6 | 100 | 5,6 | 5,6 | 100 | 8 | 7,1 | 100 | 8,8 | 8 | 100 | 11 | 10 | 100 | 16 | 14,2 | 100 |
| | | 50 | 60,3 | 16 | - | - | - | 3,2 | 2,9 | 100 | 4 | 3,6 | 100 | 5,6 | 4 | 100 | 8 | 5,6 | 100 | 8,8 | 7,1 | 100 | 11 | 8,8 | 100 | 16 | 11 | 100 |
| | | 40 | 48,3 | 22 | - | - | - | 3,2 | 2,6 | 100 | 4 | 3,6 | 100 | 5,6 | 4 | 100 | 8 | 5 | 100 | 8,8 | 6,3 | 100 | 11 | 8 | 100 | 16 | 10 | 100 |
| | | 32 | 42,4 | 26 | - | - | - | 3,2 | 2,6 | 100 | 4 | 3,6 | 100 | 5,6 | 4 | 100 | 8 | 5 | 100 | 8,8 | 6,3 | 100 | 11 | 8 | 100 | 16 | 10 | 100 |
| 100 | 114,3 | 80 | 88,9 | 13 | - | - | - | 3,6 | 3,2 | 100 | 4,5 | 4 | 100 | 6,3 | 5,6 | 100 | 8,8 | 8 | 100 | 11 | 8,8 | 100 | 14,2 | 11 | 100 | 17,5 | 16 | 100 |
| | | 65 | 76,1 | 18 | - | - | - | 3,6 | 2,9 | 100 | 4,5 | 3,6 | 100 | 6,3 | 5,6 | 100 | 8,8 | 7,1 | 100 | 11 | 8 | 100 | 14,2 | 10 | 100 | 17,5 | 14,2 | 100 |
| | | 50 | 60,3 | 26 | - | - | - | 3,6 | 2,9 | 100 | 4,5 | 3,6 | 100 | 6,3 | 4 | 100 | 8,8 | 5,6 | 100 | 11 | 7,1 | 100 | 14,2 | 8,8 | 100 | 17,5 | 11 | 100 |
| | | 40 | 48,3 | 31 | - | - | - | 3,6 | 2,6 | 97 | 4,5 | 3,6 | 99 | 6,3 | 4 | 100 | 8,8 | 5 | 100 | 11 | 6,3 | 100 | 14,2 | 8 | 100 | 17,5 | 10 | 100 |

Table B.3 (continued)

| DN | D | DN ₁ | D ₁ | α _{max} | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | |
|-----|-------|-----------------|----------------|------------------|-----|----------------|-----|-----|----------------|-----|-----|----------------|-----|------|----------------|-----|------|----------------|-----|------|----------------|-----|------|----------------|-----|------|----------------|-----|
| | | | | | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X |
| 125 | 139,7 | 100 | 114,3 | 10 | - | - | - | 4 | 3,6 | 100 | 5 | 4,5 | 100 | 6,3 | 6,3 | 100 | 10 | 8,8 | 100 | 12,5 | 11 | 100 | 16 | 14,2 | 100 | 20 | 17,5 | 100 |
| | | 80 | 88,9 | 20 | - | - | - | 4 | 3,2 | 100 | 5 | 4 | 100 | 6,3 | 5,6 | 100 | 10 | 8 | 100 | 12,5 | 8,8 | 100 | 16 | 11 | 100 | 20 | 16 | 100 |
| | | 65 | 76,1 | 25 | - | - | - | 4 | 2,9 | 100 | 5 | 3,6 | 100 | 6,3 | 5,6 | 100 | 10 | 7,1 | 100 | 12,5 | 8 | 100 | 16 | 10 | 100 | 20 | 14,2 | 100 |
| | | 50 | 60,3 | 30 | - | - | - | 4 | 2,9 | 97 | 5 | 3,6 | 99 | 6,3 | 4 | 100 | 10 | 5,6 | 100 | 12,5 | 7,1 | 100 | 16 | 8,8 | 100 | 20 | 11 | 100 |
| 150 | 168,3 | 125 | 139,7 | 9 | - | - | - | 4,5 | 4 | 100 | 5,6 | 5 | 100 | 7,1 | 6,3 | 100 | 11 | 10 | 100 | 14,2 | 12,5 | 100 | 17,5 | 16 | 100 | 22,2 | 20 | 100 |
| | | 100 | 114,3 | 19 | - | - | - | 4,5 | 3,6 | 100 | 5,6 | 4,5 | 100 | 7,1 | 6,3 | 100 | 11 | 8,8 | 100 | 14,2 | 11 | 100 | 17,5 | 14,2 | 100 | 22,2 | 17,5 | 100 |
| | | 80 | 88,9 | 27 | - | - | - | 4,5 | 3,2 | 98 | 5,6 | 4 | 100 | 7,1 | 5,6 | 100 | 11 | 8 | 100 | 14,2 | 8,8 | 100 | 17,5 | 11 | 100 | 22,2 | 16 | 100 |
| | | 65 | 76,1 | 31 | - | - | - | 4,5 | 2,9 | 96 | 5,6 | 3,6 | 98 | 7,1 | 5,6 | 100 | 11 | 7,1 | 100 | 14,2 | 8 | 100 | 17,5 | 10 | 100 | 22,2 | 14,2 | 100 |
| 200 | 219,1 | 150 | 168,3 | 18 | 4,5 | 4 | 100 | 6,3 | 4,5 | 100 | 7,1 | 5,6 | 100 | 8 | 7,1 | 100 | 12,5 | 11 | 100 | 16 | 14,2 | 100 | 17,5 | 17,5 | 100 | 22,2 | 22,2 | 100 |
| | | 125 | 139,7 | 27 | - | - | - | 6,3 | 4 | 99 | 7,1 | 5 | 100 | 8 | 6,3 | 100 | 12,5 | 10 | 100 | 16 | 12,5 | 100 | 17,5 | 16 | 100 | 22,2 | 20 | 100 |
| | | 100 | 114,3 | 33 | - | - | - | 6,3 | 3,6 | 95 | 7,1 | 4,5 | 96 | 8 | 6,3 | 97 | 12,5 | 8,8 | 100 | 16 | 11 | 100 | 17,5 | 14,2 | 100 | 22,2 | 17,5 | 100 |
| | | 80 | 88,9 | 39 | - | - | - | 6,3 | 3,2 | 90 | 7,1 | 4 | 91 | 8 | 5,6 | 92 | 12,5 | 8 | 99 | 16 | 8,8 | 100 | 17,5 | 11 | 100 | 22,2 | 16 | 100 |
| 250 | 273 | 200 | 219,1 | 16 | 5 | 4,5 | 100 | 6,3 | 6,3 | 100 | 8,8 | 7,1 | 100 | 10 | 8 | 100 | 12,5 | 12,5 | 100 | 16 | 16 | 100 | 22,2 | 17,5 | 100 | 30 | 22,2 | 100 |
| | | 150 | 168,3 | 30 | 5 | 4 | 94 | 6,3 | 4,5 | 95 | 8,8 | 5,6 | 98 | 10 | 7,1 | 99 | 12,5 | 11 | 100 | 16 | 14,2 | 100 | 22,2 | 17,5 | 100 | 30 | 22,2 | 100 |
| | | 125 | 139,7 | 36 | - | - | - | 6,3 | 4 | 91 | 8,8 | 5 | 94 | 10 | 6,3 | 95 | 12,5 | 10 | 98 | 16 | 12,5 | 100 | 22,2 | 16 | 100 | 30 | 20 | 100 |
| | | 100 | 114,3 | 40 | - | - | - | 6,3 | 3,6 | 87 | 8,8 | 4,5 | 90 | 10 | 6,3 | 91 | 12,5 | 8,8 | 94 | 16 | 11 | 98 | 22,2 | 14,2 | 100 | 30 | 17,5 | 100 |
| 300 | 323,9 | 250 | 273 | 12 | 5,6 | 5 | 100 | 7,1 | 6,3 | 100 | 8,8 | 8,8 | 100 | 10 | 10 | 100 | 12,5 | 12,5 | 100 | 17,5 | 16 | 100 | 25 | 22,2 | 100 | 32 | 30 | 100 |
| | | 200 | 219,1 | 24 | 5,6 | 4,5 | 98 | 7,1 | 6,3 | 99 | 8,8 | 7,1 | 100 | 10 | 8 | 100 | 12,5 | 12,5 | 100 | 17,5 | 16 | 100 | 25 | 17,5 | 100 | 32 | 22,2 | 100 |
| | | 150 | 168,3 | 35 | 5,6 | 4 | 90 | 7,1 | 4,5 | 91 | 8,8 | 5,6 | 93 | 10 | 7,1 | 94 | 12,5 | 11 | 96 | 17,5 | 14,2 | 100 | 25 | 17,5 | 100 | 32 | 22,2 | 100 |
| | | 125 | 139,7 | 40 | - | - | - | 7,1 | 4 | 87 | 8,8 | 5 | 88 | 10 | 6,3 | 90 | 12,5 | 10 | 92 | 17,5 | 12,5 | 97 | 25 | 16 | 100 | 32 | 20 | 100 |
| 350 | 355,6 | 300 | 323,9 | 6 | 5,6 | 5,6 | 100 | 8 | 7,1 | 100 | 10 | 8,8 | 100 | 12,5 | 10 | 100 | 16 | 12,5 | 100 | 20 | 17,5 | 100 | 28 | 25 | 100 | 36 | 32 | 100 |
| | | 250 | 273 | 14 | 5,6 | 5 | 100 | 8 | 6,3 | 100 | 10 | 8,8 | 100 | 12,5 | 10 | 100 | 16 | 12,5 | 100 | 20 | 16 | 100 | 28 | 22,2 | 100 | 36 | 30 | 100 |
| | | 200 | 219,1 | 22 | 5,6 | 4,5 | 98 | 8 | 6,3 | 100 | 10 | 7,1 | 100 | 12,5 | 8 | 100 | 16 | 12,5 | 100 | 20 | 16 | 100 | 28 | 17,5 | 100 | 36 | 22,2 | 100 |
| | | 150 | 168,3 | 29 | 5,6 | 4 | 94 | 8 | 4,5 | 96 | 10 | 5,6 | 98 | 12,5 | 7,1 | 99 | 16 | 11 | 100 | 20 | 14,2 | 100 | 28 | 17,5 | 100 | 36 | 22,2 | 100 |

Table B.3 (continued)

| DN | D | DN ₁ | D ₁ | α _{max} | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | |
|-----|-------|-----------------|----------------|------------------|-----|----------------|-----|------|----------------|-----|------|----------------|-----|------|----------------|-----|------|----------------|-----|------|----------------|-----|----|----------------|-----|----|----------------|-----|
| | | | | | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X |
| 400 | 406,4 | 350 | 355,6 | 8 | 6,3 | 5,6 | 100 | 8,8 | 8 | 100 | 10 | 10 | 100 | 12,5 | 12,5 | 100 | 17,5 | 16 | 100 | 22,2 | 20 | 100 | 30 | 28 | 100 | 40 | 36 | 100 |
| | | 300 | 323,9 | 13 | 6,3 | 5,6 | 100 | 8,8 | 7,1 | 100 | 10 | 8,8 | 100 | 12,5 | 10 | 100 | 17,5 | 12,5 | 100 | 22,2 | 17,5 | 100 | 30 | 25 | 100 | 40 | 32 | 100 |
| | | 250 | 273 | 21 | 6,3 | 5 | 99 | 8,8 | 6,3 | 100 | 10 | 8,8 | 100 | 12,5 | 10 | 100 | 17,5 | 12,5 | 100 | 22,2 | 16 | 100 | 30 | 22,2 | 100 | 40 | 30 | 100 |
| | | 200 | 219,1 | 28 | 6,3 | 4,5 | 95 | 8,8 | 6,3 | 96 | 10 | 7,1 | 97 | 12,5 | 8 | 99 | 17,5 | 12,5 | 100 | 22,2 | 16 | 100 | 30 | 17,5 | 100 | 40 | 22,2 | 100 |
| 450 | 457 | 400 | 406,4 | 7 | 6,3 | 6,3 | 100 | 10 | 8,8 | 100 | 11 | 10 | 100 | 12,5 | 12,5 | 100 | 17,5 | 17,5 | 100 | 22,2 | 22,2 | 100 | 32 | 30 | 100 | 45 | 40 | 100 |
| | | 350 | 355,6 | 14 | 6,3 | 5,6 | 100 | 10 | 8 | 100 | 11 | 10 | 100 | 12,5 | 12,5 | 100 | 17,5 | 16 | 100 | 22,2 | 20 | 100 | 32 | 28 | 100 | 45 | 36 | 100 |
| | | 300 | 323,9 | 18 | 6,3 | 5,6 | 99 | 10 | 7,1 | 100 | 11 | 8,8 | 100 | 12,5 | 10 | 100 | 17,5 | 12,5 | 100 | 22,2 | 17,5 | 100 | 32 | 25 | 100 | 45 | 32 | 100 |
| | | 250 | 273 | 25 | 6,3 | 5 | 96 | 10 | 6,3 | 98 | 11 | 8,8 | 99 | 12,5 | 10 | 100 | 17,5 | 12,5 | 100 | 22,2 | 16 | 100 | 32 | 22,2 | 100 | 45 | 30 | 100 |
| 500 | 508 | 450 | 457 | 4 | 6,3 | 6,3 | 100 | 10 | 10 | 100 | 11 | 11 | 100 | 12,5 | 12,5 | 100 | 17,5 | 17,5 | 100 | 25 | 22,2 | 100 | 36 | 32 | 100 | 50 | 45 | 100 |
| | | 400 | 406,4 | 10 | 6,3 | 6,3 | 100 | 10 | 8,8 | 100 | 11 | 10 | 100 | 12,5 | 12,5 | 100 | 17,5 | 17,5 | 100 | 25 | 22,2 | 100 | 36 | 30 | 100 | 50 | 40 | 100 |
| | | 350 | 355,6 | 17 | 6,3 | 5,6 | 99 | 10 | 8 | 100 | 11 | 10 | 100 | 12,5 | 12,5 | 100 | 17,5 | 16 | 100 | 25 | 20 | 100 | 36 | 28 | 100 | 50 | 36 | 100 |
| | | 300 | 323,9 | 20 | 6,3 | 5,6 | 98 | 10 | 7,1 | 100 | 11 | 8,8 | 100 | 12,5 | 10 | 100 | 17,5 | 12,5 | 100 | 25 | 17,5 | 100 | 36 | 25 | 100 | 50 | 32 | 100 |
| 600 | 610 | 500 | 508 | 10 | 6,3 | 6,3 | 100 | 10 | 10 | 100 | 12,5 | 11 | 100 | 17,5 | 12,5 | 100 | 25 | 17,5 | 100 | 30 | 25 | 100 | 45 | 36 | 100 | 60 | 50 | 100 |
| | | 450 | 457 | 15 | 6,3 | 6,3 | 100 | 10 | 10 | 100 | 12,5 | 11 | 100 | 17,5 | 12,5 | 100 | 25 | 17,5 | 100 | 30 | 22,2 | 100 | 45 | 32 | 100 | 60 | 45 | 100 |
| | | 400 | 406,4 | 21 | 6,3 | 6,3 | 97 | 10 | 8,8 | 99 | 12,5 | 10 | 100 | 17,5 | 12,5 | 100 | 25 | 17,5 | 100 | 30 | 22,2 | 100 | 45 | 30 | 100 | 60 | 40 | 100 |
| 700 | 711 | 600 | 610 | 10 | 7,1 | 6,3 | 100 | 10 | 10 | 100 | 12,5 | 12,5 | 100 | 25 | 17,5 | 100 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 500 | 508 | 15 | 7,1 | 6,3 | 99 | 10 | 10 | 100 | 12,5 | 11 | 100 | 25 | 12,5 | 100 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 400 | 406,4 | 25 | 7,1 | 6,3 | 95 | 10 | 8,8 | 96 | 12,5 | 10 | 97 | 25 | 12,5 | 100 | - | - | - | - | - | - | - | - | - | - | - | - |
| 800 | 813 | 700 | 711 | 10 | 8 | 7,1 | 100 | 10 | 10 | 100 | 12,5 | 12,5 | 100 | 25 | 25 | 100 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 600 | 610 | 15 | 8 | 6,3 | 99 | 10 | 10 | 100 | 12,5 | 12,5 | 100 | 25 | 17,5 | 100 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 500 | 508 | 20 | 8 | 6,3 | 98 | 10 | 10 | 98 | 12,5 | 11 | 99 | 25 | 12,5 | 100 | - | - | - | - | - | - | - | - | - | - | - | - |
| 900 | 914 | 800 | 813 | 10 | 10 | 8 | 100 | 12,5 | 10 | 100 | 20 | 12,5 | 100 | 25 | 25 | 100 | - | - | - | - | - | - | - | - | - | - | - | |
| | | 700 | 711 | 15 | 10 | 7,1 | 100 | 12,5 | 10 | 100 | 20 | 12,5 | 100 | 25 | 25 | 100 | - | - | - | - | - | - | - | - | - | - | - | |
| | | 600 | 610 | 20 | 10 | 6,3 | 94 | 12,5 | 10 | 99 | 20 | 12,5 | 100 | 25 | 17,5 | 100 | - | - | - | - | - | - | - | - | - | - | - | |

Table B.3 (continued)

| DN | D | DN ₁ | D ₁ | α_{\max} | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | |
|-------|-------|-----------------|----------------|-----------------|----|----------------|------|------|----------------|-----|----|----------------|-----|----|----------------|-----|---|----------------|---|---|----------------|---|---|----------------|---|---|----------------|---|
| | | | | | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X |
| 1 000 | 1 016 | 900 | 914 | 10 | 10 | 10 | 100 | 12,5 | 12,5 | 100 | 20 | 20 | 100 | 25 | 25 | 100 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 800 | 813 | 15 | 10 | 8 | (99) | 12,5 | 10 | 100 | 20 | 12,5 | 100 | 25 | 25 | 100 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 700 | 711 | 20 | 10 | 7,1 | (90) | 12,5 | 10 | 98 | 20 | 12,5 | 100 | 25 | 25 | 100 | - | - | - | - | - | - | - | - | - | - | - | |
| 1 200 | 1 219 | 1 000 | 1 016 | 11 | 10 | 10 | 100 | 12,5 | 12,5 | 100 | 20 | 20 | 100 | 25 | 25 | 100 | - | - | - | - | - | - | - | - | - | - | - | |
| | | 900 | 914 | 16 | 10 | 10 | 99 | 12,5 | 12,5 | 99 | 20 | 20 | 100 | 25 | 25 | 100 | - | - | - | - | - | - | - | - | - | - | - | |
| | | 800 | 813 | 20 | 10 | 8 | 97 | 12,5 | 10 | 98 | 20 | 12,5 | 100 | 25 | 25 | 100 | - | - | - | - | - | - | - | - | - | - | - | |

Table B.4 — Pressure factors of eccentric reducers type A

| DN | D | DN ₁ | D ₁ | α _{max} | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | |
|-----|-------|-----------------|----------------|------------------|---|----------------|---|-----|----------------|------|-----|----------------|------|-----|----------------|-----|-----|----------------|-----|-----|----------------|-----|------|----------------|-----|------|----------------|-----|
| | | | | | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X |
| 20 | 26,9 | 15 | 21,3 | 15 | - | - | - | 2,3 | 2 | 100 | 2,6 | 2,6 | 100 | 3,2 | 3,2 | 100 | 4 | 4 | 100 | - | - | - | 5,6 | 5 | 100 | 8 | 7,1 | 100 |
| 25 | 33,7 | 20 | 26,9 | 13 | - | - | - | 2,6 | 2,3 | 100 | 3,2 | 2,6 | 100 | 4 | 3,2 | 100 | 4,5 | 4 | 100 | 5,6 | 4,5 | 100 | 6,3 | 5,6 | 100 | 8,8 | 8 | 100 |
| | | 15 | 21,3 | 24 | - | - | - | 2,6 | 2 | 100 | 3,2 | 2,6 | 100 | 4 | 3,2 | 100 | 4,5 | 4 | 100 | - | - | - | 6,3 | 5 | 100 | 8,8 | 7,1 | 100 |
| 32 | 42,4 | 25 | 33,7 | 16 | - | - | - | 2,6 | 2,6 | 100 | 3,6 | 3,2 | 100 | 4 | 4 | 100 | 5 | 4,5 | 100 | 6,3 | 5,6 | 100 | 8 | 6,3 | 100 | 10 | 8,8 | 100 |
| | | 20 | 26,9 | 30 | - | - | - | 2,6 | 2,3 | 100 | 3,6 | 2,6 | 100 | 4 | 3,2 | 100 | 5 | 4 | 100 | 6,3 | 4,5 | 100 | 8 | 5,6 | 100 | 10 | 8 | 100 |
| | | 15 | 21,3 | 42 | - | - | - | 2,6 | 2 | 97 | 3,6 | 2,6 | 100 | 4 | 3,2 | 100 | 5 | 4 | 100 | - | - | - | 8 | 5 | 100 | 10 | 7,1 | 100 |
| 40 | 48,3 | 32 | 42,4 | 8 | - | - | - | 2,6 | 2,6 | 100 | 3,6 | 3,6 | 100 | 4 | 4 | 100 | 5 | 5 | 100 | 6,3 | 6,3 | 100 | 8 | 8 | 100 | 10 | 10 | 100 |
| | | 25 | 33,7 | 19 | - | - | - | 2,6 | 2,6 | 100 | 3,6 | 3,2 | 100 | 4 | 4 | 100 | 5 | 4,5 | 100 | 6,3 | 5,6 | 100 | 8 | 6,3 | 100 | 10 | 8,8 | 100 |
| | | 20 | 26,9 | 28 | - | - | - | 2,6 | 2,3 | 100 | 3,6 | 2,6 | 100 | 4 | 3,2 | 100 | 5 | 4 | 100 | 6,3 | 4,5 | 100 | 8 | 5,6 | 100 | 10 | 8 | 100 |
| 50 | 60,3 | 40 | 48,3 | 13 | - | - | - | 2,9 | 2,6 | 100 | 3,6 | 3,6 | 100 | 4 | 4 | 100 | 5,6 | 5 | 100 | 7,1 | 6,3 | 100 | 8,8 | 8 | 100 | 11 | 10 | 100 |
| | | 32 | 42,4 | 20 | - | - | - | 2,9 | 2,6 | 100 | 3,6 | 3,6 | 100 | 4 | 4 | 100 | 5,6 | 5 | 100 | 7,1 | 6,3 | 100 | 8,8 | 8 | 100 | 11 | 10 | 100 |
| | | 25 | 33,7 | 29 | - | - | - | 2,9 | 2,6 | 100 | 3,6 | 3,2 | 100 | 4 | 4 | 100 | 5,6 | 4,5 | 100 | 7,1 | 5,6 | 100 | 8,8 | 6,3 | 100 | 11 | 8,8 | 100 |
| | | 20 | 26,9 | 36 | - | - | - | 2,9 | 2,3 | 98 | 3,6 | 2,6 | 100 | 4 | 3,2 | 100 | 5,6 | 4 | 100 | 7,1 | 4,5 | 100 | 8,8 | 5,6 | 100 | 11 | 8 | 100 |
| 65 | 76,1 | 50 | 60,3 | 15 | - | - | - | 2,9 | 2,9 | 100 | 3,6 | 3,6 | 100 | 5,6 | 4 | 100 | 7,1 | 5,6 | 100 | 8 | 7,1 | 100 | 10 | 8,8 | 100 | 14,2 | 11 | 100 |
| | | 40 | 48,3 | 27 | - | - | - | 2,9 | 2,6 | 100 | 3,6 | 3,6 | 100 | 5,6 | 4 | 100 | 7,1 | 5 | 100 | 8 | 6,3 | 100 | 10 | 8 | 100 | 14,2 | 10 | 100 |
| | | 32 | 42,4 | 34 | - | - | - | 2,9 | 2,6 | 97 | 3,6 | 3,6 | 99 | 5,6 | 4 | 100 | 7,1 | 5 | 100 | 8 | 6,3 | 100 | 10 | 8 | 100 | 14,2 | 10 | 100 |
| | | 25 | 33,7 | 42 | - | - | - | 2,9 | 2,6 | 90 | 3,6 | 3,2 | 93 | 5,6 | 4 | 100 | 7,1 | 4,5 | 100 | 8 | 5,6 | 100 | 10 | 6,3 | 100 | 14,2 | 8,8 | 100 |
| 80 | 88,9 | 65 | 76,1 | 13 | - | - | - | 3,2 | 2,9 | 100 | 4 | 3,6 | 100 | 5,6 | 5,6 | 100 | 8 | 7,1 | 100 | 8,8 | 8 | 100 | 11 | 10 | 100 | 16 | 14,2 | 100 |
| | | 50 | 60,3 | 30 | - | - | - | 3,2 | 2,9 | 99 | 4 | 3,6 | 100 | 5,6 | 4 | 100 | 8 | 5,6 | 100 | 8,8 | 7,1 | 100 | 11 | 8,8 | 100 | 16 | 11 | 100 |
| | | 40 | 48,3 | 44 | - | - | - | 3,2 | 2,6 | 87 | 4 | 3,6 | 90 | 5,6 | 4 | 96 | 8 | 5 | 100 | 8,8 | 6,3 | 100 | 11 | 8 | 100 | 16 | 10 | 100 |
| | | 32 | 42,4 | 50 | - | - | - | 3,2 | 2,6 | 80 | 4 | 3,6 | 83 | 5,6 | 4 | 90 | 8 | 5 | 100 | 8,8 | 6,3 | 100 | 11 | 8 | 100 | 16 | 10 | 100 |
| 100 | 114,3 | 80 | 88,9 | 24 | - | - | - | 3,6 | 3,2 | 100 | 4,5 | 4 | 100 | 6,3 | 5,6 | 100 | 8,8 | 8 | 100 | 11 | 8,8 | 100 | 14,2 | 11 | 100 | 17,5 | 16 | 100 |
| | | 65 | 76,1 | 37 | - | - | - | 3,6 | 2,9 | 93 | 4,5 | 3,6 | 95 | 6,3 | 5,6 | 100 | 8,8 | 7,1 | 100 | 11 | 8 | 100 | 14,2 | 10 | 100 | 17,5 | 14,2 | 100 |
| | | 50 | 60,3 | 51 | - | - | - | 3,6 | 2,9 | 78 | 4,5 | 3,6 | 80 | 6,3 | 4 | 86 | 8,8 | 5,6 | 94 | 11 | 7,1 | 100 | 14,2 | 8,8 | 100 | 17,5 | 11 | 100 |
| | | 40 | 48,3 | 60 | - | - | - | 3,6 | 2,6 | (65) | 4,5 | 3,6 | (68) | 6,3 | 4 | 74 | 8,8 | 5 | 83 | 11 | 6,3 | 93 | 14,2 | 8 | 100 | 17,5 | 10 | 100 |

Table B.4 (continued)

| DN | D | DN ₁ | D ₁ | α _{max} | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | |
|-----|-------|-----------------|----------------|------------------|-----|----------------|------|-----|----------------|------|-----|----------------|------|------|----------------|------|------|----------------|------|------|----------------|-----|------|----------------|-----|------|----------------|-----|
| | | | | | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X |
| 125 | 139,7 | 100 | 114,3 | 18 | - | - | - | 4 | 3,6 | 100 | 5 | 4,5 | 100 | 6,3 | 6,3 | 100 | 10 | 8,8 | 100 | 12,5 | 11 | 100 | 16 | 14,2 | 100 | 20 | 17,5 | 100 |
| | | 80 | 88,9 | 35 | - | - | - | 4 | 3,2 | 93 | 5 | 4 | 95 | 6,3 | 5,6 | 98 | 10 | 8 | 100 | 12,5 | 8,8 | 100 | 16 | 11 | 100 | 20 | 16 | 100 |
| | | 65 | 76,1 | 43 | - | - | - | 4 | 2,9 | 86 | 5 | 3,6 | 88 | 6,3 | 5,6 | 91 | 10 | 7,1 | 100 | 12,5 | 8 | 100 | 16 | 10 | 100 | 20 | 14,2 | 100 |
| | | 50 | 60,3 | 51 | - | - | - | 4 | 2,9 | 77 | 5 | 3,6 | 79 | 6,3 | 4 | 82 | 10 | 5,6 | 92 | 12,5 | 7,1 | 99 | 16 | 8,8 | 100 | 20 | 11 | 100 |
| 150 | 168,3 | 125 | 139,7 | 18 | - | - | - | 4,5 | 4 | 100 | 5,6 | 5 | 100 | 7,1 | 6,3 | 100 | 11 | 10 | 100 | 14,2 | 12,5 | 100 | 17,5 | 16 | 100 | 22,2 | 20 | 100 |
| | | 100 | 114,3 | 34 | - | - | - | 4,5 | 3,6 | 94 | 5,6 | 4,5 | 95 | 7,1 | 6,3 | 98 | 11 | 8,8 | 100 | 14,2 | 11 | 100 | 17,5 | 14,2 | 100 | 22,2 | 17,5 | 100 |
| | | 80 | 88,9 | 48 | - | - | - | 4,5 | 3,2 | 80 | 5,6 | 4 | 82 | 7,1 | 5,6 | 85 | 11 | 8 | 93 | 14,2 | 8,8 | 100 | 17,5 | 11 | 100 | 22,2 | 16 | 100 |
| | | 65 | 76,1 | 52 | - | - | - | 4,5 | 2,9 | (75) | 5,6 | 3,6 | 77 | 7,1 | 5,6 | 80 | 11 | 7,1 | 88 | 14,2 | 8 | 96 | 17,5 | 10 | 100 | 22,2 | 14,2 | 100 |
| 200 | 219,1 | 150 | 168,3 | 31 | 4,5 | 4 | (93) | 6,3 | 4,5 | (90) | 7,1 | 5,6 | (95) | 8 | 7,1 | 98 | 12,5 | 11 | 100 | 16 | 14,2 | 100 | 17,5 | 17,5 | 100 | 22,2 | 22,2 | 100 |
| | | 125 | 139,7 | 45 | - | - | - | 6,3 | 4 | (74) | 7,1 | 5 | (84) | 8 | 6,3 | (86) | 12,5 | 10 | 93 | 16 | 12,5 | 99 | 17,5 | 16 | 100 | 22,2 | 20 | 100 |
| | | 100 | 114,3 | 55 | - | - | - | 6,3 | 3,6 | (71) | 7,1 | 4,5 | (72) | 8 | 6,3 | 74 | 12,5 | 8,8 | 81 | 16 | 11 | 88 | 17,5 | 14,2 | 91 | 22,2 | 17,5 | 100 |
| | | 80 | 88,9 | 60 | - | - | - | 6,3 | 3,2 | (64) | 7,1 | 4 | (65) | 8 | 5,6 | (67) | 12,5 | 8 | 74 | 16 | 8,8 | 81 | 17,5 | 11 | 84 | 22,2 | 16 | 96 |
| 250 | 273 | 200 | 219,1 | 28 | 5 | 4,5 | (92) | 6,3 | 6,3 | 97 | 8,8 | 7,1 | (97) | 10 | 8 | 100 | 12,5 | 12,5 | 100 | 16 | 16 | 100 | 22,2 | 17,5 | 100 | 30 | 22,2 | 100 |
| | | 150 | 168,3 | 48 | 5 | 4 | (76) | 6,3 | 4,5 | (75) | 8,8 | 5,6 | (76) | 10 | 7,1 | (83) | 12,5 | 11 | 86 | 16 | 14,2 | 91 | 22,2 | 17,5 | 99 | 30 | 22,2 | 100 |
| | | 125 | 139,7 | 55 | - | - | - | 6,3 | 4 | (69) | 8,8 | 5 | (72) | 10 | 6,3 | 74 | 12,5 | 10 | 77 | 16 | 12,5 | 82 | 22,2 | 16 | 91 | 30 | 20 | 100 |
| | | 100 | 114,3 | 60 | - | - | - | 6,3 | 3,6 | (62) | 8,8 | 4,5 | (65) | 10 | 6,3 | (67) | 12,5 | 8,8 | (70) | 16 | 11 | 75 | 22,2 | 14,2 | 85 | 30 | 17,5 | 100 |
| 300 | 323,9 | 250 | 273 | 23 | 5,6 | 5 | (95) | 7,1 | 6,3 | (99) | 8,8 | 8,8 | 100 | 10 | 10 | 100 | 12,5 | 12,5 | 100 | 17,5 | 16 | 100 | 25 | 22,2 | 100 | 32 | 30 | 100 |
| | | 200 | 219,1 | 44 | 5,6 | 4,5 | (72) | 7,1 | 6,3 | (83) | 8,8 | 7,1 | (84) | 10 | 8 | (86) | 12,5 | 12,5 | 88 | 17,5 | 16 | 93 | 25 | 17,5 | 100 | 32 | 22,2 | 100 |
| | | 150 | 168,3 | 55 | 5,6 | 4 | (66) | 7,1 | 4,5 | (69) | 8,8 | 5,6 | (71) | 10 | 7,1 | (72) | 12,5 | 11 | 75 | 17,5 | 14,2 | 80 | 25 | 17,5 | 90 | 32 | 22,2 | 100 |
| | | 125 | 139,7 | 60 | - | - | - | 7,1 | 4 | (61) | 8,8 | 5 | (63) | 10 | 6,3 | (65) | 12,5 | 10 | (67) | 17,5 | 12,5 | 73 | 25 | 16 | 83 | 32 | 20 | 94 |
| 350 | 355,6 | 300 | 323,9 | 8 | 5,6 | 5,6 | 100 | 8 | 7,1 | 100 | 10 | 8,8 | 100 | 12,5 | 10 | 100 | 16 | 12,5 | 100 | 20 | 17,5 | 100 | 28 | 25 | 100 | 36 | 32 | 100 |
| | | 250 | 273 | 25 | 5,6 | 5 | 97 | 8 | 6,3 | (97) | 10 | 8,8 | 100 | 12,5 | 10 | 100 | 16 | 12,5 | 100 | 20 | 16 | 100 | 28 | 22,2 | 100 | 36 | 30 | 100 |
| | | 200 | 219,1 | 37 | 5,6 | 4,5 | 88 | 8 | 6,3 | 90 | 10 | 7,1 | 92 | 12,5 | 8 | 94 | 16 | 12,5 | 97 | 20 | 16 | 100 | 28 | 17,5 | 100 | 36 | 22,2 | 100 |
| | | 150 | 168,3 | 47 | 5,6 | 4 | (77) | 8 | 4,5 | 79 | 10 | 5,6 | 81 | 12,5 | 7,1 | 84 | 16 | 11 | 87 | 20 | 14,2 | 91 | 28 | 17,5 | 99 | 36 | 22,2 | 100 |

Table B.4 (continued)

| DN | D | DN ₁ | D ₁ | α _{max} | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | |
|-----|-------|-----------------|----------------|------------------|-----|----------------|------|------|----------------|------|------|----------------|------|------|----------------|------|------|----------------|-----|------|----------------|-----|----|----------------|-----|----|----------------|-----|
| | | | | | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X |
| 400 | 406,4 | 350 | 355,6 | 15 | 6,3 | 5,6 | 100 | 8,8 | 8 | 100 | 10 | 10 | 100 | 12,5 | 12,5 | 100 | 17,5 | 16 | 100 | 22,2 | 20 | 100 | 30 | 28 | 100 | 40 | 36 | 100 |
| | | 300 | 323,9 | 24 | 6,3 | 5,6 | (96) | 8,8 | 7,1 | (96) | 10 | 8,8 | 99 | 12,5 | 10 | 100 | 17,5 | 12,5 | 100 | 22,2 | 17,5 | 100 | 30 | 25 | 100 | 40 | 32 | 100 |
| | | 250 | 273 | 36 | 6,3 | 5 | 82 | 8,8 | 6,3 | (83) | 10 | 8,8 | 91 | 12,5 | 10 | 93 | 17,5 | 12,5 | 97 | 22,2 | 16 | 100 | 30 | 22,2 | 100 | 40 | 30 | 100 |
| | | 200 | 219,1 | 46 | 6,3 | 4,5 | (78) | 8,8 | 6,3 | 80 | 10 | 7,1 | 81 | 12,5 | 8 | 83 | 17,5 | 12,5 | 87 | 22,2 | 16 | 91 | 30 | 17,5 | 98 | 40 | 22,2 | 100 |
| 450 | 457 | 400 | 406,4 | 11 | 6,3 | 6,3 | 100 | 10 | 8,8 | 100 | 11 | 10 | 100 | 12,5 | 12,5 | 100 | 17,5 | 17,5 | 100 | 22,2 | 22,2 | 100 | 32 | 30 | 100 | 45 | 40 | 100 |
| | | 350 | 355,6 | 24 | 6,3 | 5,6 | (96) | 10 | 8 | (98) | 11 | 10 | 99 | 12,5 | 12,5 | 100 | 17,5 | 16 | 100 | 22,2 | 20 | 100 | 32 | 28 | 100 | 45 | 36 | 100 |
| | | 300 | 323,9 | 31 | 6,3 | 5,6 | (91) | 10 | 7,1 | (85) | 11 | 8,8 | (95) | 12,5 | 10 | 96 | 17,5 | 12,5 | 99 | 22,2 | 17,5 | 100 | 32 | 25 | 100 | 45 | 32 | 100 |
| | | 250 | 273 | 41 | 6,3 | 5 | (83) | 10 | 6,3 | (79) | 11 | 8,8 | 86 | 12,5 | 10 | 88 | 17,5 | 12,5 | 91 | 22,2 | 16 | 94 | 32 | 22,2 | 100 | 45 | 30 | 100 |
| 500 | 508 | 450 | 457 | 8 | 6,3 | 6,3 | 100 | 10 | 10 | 100 | 11 | 11 | 100 | 12,5 | 12,5 | 100 | 17,5 | 17,5 | 100 | 25 | 22,2 | 100 | 36 | 32 | 100 | 50 | 45 | 100 |
| | | 400 | 406,4 | 18 | 6,3 | 6,3 | 99 | 10 | 8,8 | 100 | 11 | 10 | 100 | 12,5 | 12,5 | 100 | 17,5 | 17,5 | 100 | 25 | 22,2 | 100 | 36 | 30 | 100 | 50 | 40 | 100 |
| | | 350 | 355,6 | 27 | 6,3 | 5,6 | 94 | 10 | 8 | 96 | 11 | 10 | 97 | 12,5 | 12,5 | 98 | 17,5 | 16 | 100 | 25 | 20 | 100 | 36 | 28 | 100 | 50 | 36 | 100 |
| | | 300 | 323,9 | 32 | 6,3 | 5,6 | 91 | 10 | 7,1 | 93 | 11 | 8,8 | 94 | 12,5 | 10 | 95 | 17,5 | 12,5 | 97 | 25 | 17,5 | 100 | 36 | 25 | 100 | 50 | 32 | 100 |
| 600 | 610 | 500 | 508 | 17 | 6,3 | 6,3 | 99 | 10 | 10 | 100 | 12,5 | 11 | 100 | 17,5 | 12,5 | 100 | 25 | 17,5 | 100 | 30 | 25 | 100 | 45 | 36 | 100 | 60 | 50 | 100 |
| | | 450 | 457 | 27 | 6,3 | 6,3 | 94 | 10 | 10 | 96 | 12,5 | 11 | 97 | 17,5 | 12,5 | (98) | 25 | 17,5 | 100 | 30 | 22,2 | 100 | 45 | 32 | 100 | 60 | 45 | 100 |
| | | 400 | 406,4 | 35 | 6,3 | 6,3 | 88 | 10 | 8,8 | 90 | 12,5 | 10 | (91) | 17,5 | 12,5 | (93) | 25 | 17,5 | 97 | 30 | 22,2 | 99 | 45 | 30 | 100 | 60 | 40 | 100 |
| 700 | 711 | 600 | 610 | 19 | 7,1 | 6,3 | 88 | 10 | 10 | 99 | 12,5 | 12,5 | 100 | 25 | 17,5 | 100 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 500 | 508 | 34 | 7,1 | 6,3 | 71 | 10 | 10 | (89) | 12,5 | 11 | (85) | 25 | 12,5 | (97) | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 400 | 406,4 | 45 | 7,1 | 6,3 | (67) | 10 | 8,8 | (79) | 12,5 | 10 | (80) | 25 | 12,5 | (86) | - | - | - | - | - | - | - | - | - | - | - | - |
| 800 | 813 | 700 | 711 | 19 | 8 | 7,1 | (86) | 10 | 10 | 99 | 12,5 | 12,5 | 99 | 25 | 25 | 100 | - | - | - | - | - | - | - | - | - | - | - | |
| | | 600 | 610 | 34 | 8 | 6,3 | 62 | 10 | 10 | (80) | 12,5 | 12,5 | (86) | 25 | 17,5 | (87) | - | - | - | - | - | - | - | - | - | - | - | |
| | | 500 | 508 | 45 | 8 | 6,3 | (60) | 10 | 10 | (76) | 12,5 | 11 | (78) | 25 | 12,5 | (80) | - | - | - | - | - | - | - | - | - | - | - | |
| 900 | 914 | 800 | 813 | 19 | 10 | 8 | (87) | 12,5 | 10 | (93) | 20 | 12,5 | 100 | 25 | 25 | 100 | - | - | - | - | - | - | - | - | - | - | | |
| | | 700 | 711 | 34 | 10 | 7,1 | (62) | 12,5 | 10 | (68) | 20 | 12,5 | (79) | 25 | 25 | (94) | - | - | - | - | - | - | - | - | - | - | | |
| | | 600 | 610 | 45 | 10 | 6,3 | (52) | 12,5 | 10 | (62) | 20 | 12,5 | (67) | 25 | 17,5 | (74) | - | - | - | - | - | - | - | - | - | - | | |

Table B.4 (continued)

| DN | D | DN ₁ | D ₁ | α_{\max} | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | | |
|------|------|-----------------|----------------|-----------------|----|----------------|------|------|----------------|------|----|----------------|------|----|----------------|------|---|----------------|---|---|----------------|---|---|----------------|---|---|----------------|---|---|
| | | | | | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | T | T ₁ | X | |
| 1000 | 1016 | 900 | 914 | 19 | 10 | 10 | (93) | 12,5 | 12,5 | (99) | 20 | 20 | 100 | 25 | 25 | 100 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 800 | 813 | 34 | 10 | 8 | (58) | 12,5 | 10 | (63) | 20 | 12,5 | (76) | 25 | 25 | (93) | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 700 | 711 | 45 | 10 | 7,1 | (49) | 12,5 | 10 | (59) | 20 | 12,5 | (63) | 25 | 25 | (82) | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1200 | 1219 | 1000 | 1016 | 30 | 10 | 10 | (70) | 12,5 | 12,5 | (76) | 20 | 20 | (89) | 25 | 25 | (95) | - | - | - | - | - | - | - | - | - | - | - | - | |
| | | 900 | 914 | 41 | 10 | 10 | (62) | 12,5 | 12,5 | (67) | 20 | 20 | (80) | 25 | 25 | (85) | - | - | - | - | - | - | - | - | - | - | - | - | |
| | | 800 | 813 | 49 | 10 | 8 | (49) | 12,5 | 10 | (54) | 20 | 12,5 | (56) | 25 | 25 | (76) | - | - | - | - | - | - | - | - | - | - | - | - | |

B.5 Caps

Table B.5 shows pressure factors of caps.

The calculation was done for an inside knuckle radius $r = 0,15 D$ and an inside spherical radius $R1 = 0,8 D$. Smaller inside knuckle radii ($r < 0,15 \cdot D$) or larger inside spherical radii ($R1 > 0,8 D$) of the ellipsoidal end may result in lower pressure factors, especially for small ratios of wall thickness to diameter with pressure factors less than 100 %.

For some dimensions no pressure factors are listed. In these cases the dimensions of the cap are outside the range of validity of the calculation procedures given in Annex A ; the usability has to be checked for each case.

Table B.5 — Pressure factors of caps type A

| DN | D | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | |
|------|-------|-----|-----|------|-----|------|-----|------|-----|------|-----|------|-----|------|---|------|---|
| | | T | X | T | X | T | X | T | X | T | X | T | X | T | X | T | X |
| 15 | 21,3 | | - | 2 | - | 2,6 | - | 3,2 | - | 4 | - | | - | 5 | - | 7,1 | - |
| 20 | 26,9 | | - | 2,3 | - | 2,6 | - | 3,2 | - | 4 | - | 4,5 | - | 5,6 | - | 8 | - |
| 25 | 33,7 | | - | 2,6 | - | 3,2 | - | 4 | - | 4,5 | - | 5,6 | - | 6,3 | - | 8,8 | - |
| 32 | 42,4 | | - | 2,6 | - | 3,6 | - | 4 | - | 5 | - | 6,3 | - | 8 | - | 10 | - |
| 40 | 48,3 | | - | 2,6 | 100 | 3,6 | - | 4 | - | 5 | - | 6,3 | - | 8 | - | 10 | - |
| 50 | 60,3 | | - | 2,9 | 100 | 3,6 | - | 4 | - | 5,6 | - | 7,1 | - | 8,8 | - | 11 | - |
| 65 | 76,1 | | - | 2,9 | 100 | 3,6 | 100 | 5,6 | - | 7,1 | - | 8 | - | 10 | - | 14,2 | - |
| 80 | 88,9 | | - | 3,2 | 100 | 4 | 100 | 5,6 | - | 8 | - | 8,8 | - | 11 | - | 16 | - |
| 100 | 114,3 | | - | 3,6 | 100 | 4,5 | 100 | 6,3 | 100 | 8,8 | - | 11 | - | 14,2 | - | 17,5 | - |
| 125 | 139,7 | | - | 4 | 100 | 5 | 100 | 6,3 | 100 | 10 | - | 12,5 | - | 16 | - | 20 | - |
| 150 | 168,3 | 4 | 100 | 4,5 | 100 | 5,6 | 100 | 7,1 | 100 | 11 | - | 14,2 | - | 17,5 | - | 22,2 | - |
| 200 | 219,1 | 4,5 | 100 | 6,3 | 100 | 7,1 | 100 | 8 | 100 | 12,5 | 100 | 16 | - | 17,5 | - | 22,2 | - |
| 250 | 273 | 5 | 100 | 6,3 | 100 | 8,8 | 100 | 10 | 100 | 12,5 | 100 | 16 | - | 22,2 | - | 30 | - |
| 300 | 323,9 | 5,6 | 100 | 7,1 | 100 | 8,8 | 100 | 10 | 100 | 12,5 | 100 | 17,5 | 100 | 25 | - | 32 | - |
| 350 | 355,6 | 5,6 | 100 | 8 | 100 | 10 | 100 | 12,5 | 100 | 16 | 100 | 20 | 100 | 28 | - | 36 | - |
| 400 | 406,4 | 6,3 | 100 | 8,8 | 100 | 10 | 100 | 12,5 | 100 | 17,5 | 100 | 22,2 | 100 | 30 | - | 40 | - |
| 450 | 457 | 6,3 | 100 | 10 | 100 | 11 | 100 | 12,5 | 100 | 17,5 | 100 | 22,2 | 100 | 32 | - | 45 | - |
| 500 | 508 | 6,3 | 100 | 10 | 100 | 11 | 100 | 12,5 | 100 | 17,5 | 100 | 25 | 100 | 36 | - | 50 | - |
| 600 | 610 | 6,3 | 98 | 10 | 100 | 12,5 | 100 | 17,5 | 100 | 25 | 100 | 30 | 100 | 45 | - | 60 | - |
| 700 | 711 | 7,1 | 97 | 10 | 100 | 12,5 | 100 | 25 | 100 | - | - | - | - | - | - | - | - |
| 800 | 813 | 8 | 97 | 10 | 100 | 12,5 | 100 | 25 | 100 | - | - | - | - | - | - | - | - |
| 900 | 914 | 10 | 99 | 12,5 | 100 | 20 | 100 | 25 | 100 | - | - | - | - | - | - | - | - |
| 1000 | 1016 | 10 | 97 | 12,5 | 100 | 20 | 100 | 25 | 100 | - | - | - | - | - | - | - | - |
| 1200 | 1219 | 10 | 94 | 12,5 | 98 | 20 | 100 | 25 | 100 | - | - | - | - | - | - | - | - |

Annex C (informative)

Wall thickness tables for Fittings of type B

C.1 General

This annex lists wall thicknesses at the body of the fitting of elbows, tees, reducers and caps for the wall thickness series listed in Table 17 and with the tolerances given in Table 18.

These wall thicknesses are calculated using the procedures given in Annex A. For fittings with diameters larger than 610 mm, where seamless and welded fittings have different wall thickness tolerances, the larger of the resulting wall thicknesses is listed. For the corrosion allowance 0 mm is used.

NOTE In general, corrosion allowances larger than 0 mm lead to smaller wall thicknesses at the body of elbows, tees and reducers.

For the definition of symbols see A.2 and the figures in Annex A.

Fittings with dimensions not listed in the tables of this annex, with a corrosion allowance larger than 0 mm or with other tolerances shall be designed in accordance with Annex A. Smaller wall thicknesses than listed in the tables are acceptable provided that they are calculated in accordance with Annex A, e.g. for welded elbows with diameters larger than 610 mm.

C.2 Elbows

Table C.1 shows the wall thickness on the intrados of elbows of model 2D, 3D and 5D (indicated in second line of table) whose bending radii are given in Table 10, Table 11 and Table 12, respectively.

The wall thickness on the extrados of the elbows shall be the same as at the welding ends.

Table C.1 — Wall thickness on the intrados of elbows type B

| Model | | 1 | | | | 2 | | | | 3 | | | | 4 | | | | 5 | | | | 6 | | | | 7 | | | | 8 | | | |
|-----------|----------|----------|------------------------------|------------------------------|------------------------------|----------|------------------------------|------------------------------|------------------------------|----------|------------------------------|------------------------------|------------------------------|----------|------------------------------|------------------------------|------------------------------|----------|------------------------------|------------------------------|------------------------------|----------|------------------------------|------------------------------|------------------------------|----------|------------------------------|------------------------------|------------------------------|----------|------------------------------|------------------------------|------------------------------|
| | | <i>T</i> | 2D <i>T_{int}</i> | 3D <i>T_{int}</i> | 5D <i>T_{int}</i> | <i>T</i> | 2D <i>T_{int}</i> | 3D <i>T_{int}</i> | 5D <i>T_{int}</i> | <i>T</i> | 2D <i>T_{int}</i> | 3D <i>T_{int}</i> | 5D <i>T_{int}</i> | <i>T</i> | 2D <i>T_{int}</i> | 3D <i>T_{int}</i> | 5D <i>T_{int}</i> | <i>T</i> | 2D <i>T_{int}</i> | 3D <i>T_{int}</i> | 5D <i>T_{int}</i> | <i>T</i> | 2D <i>T_{int}</i> | 3D <i>T_{int}</i> | 5D <i>T_{int}</i> | <i>T</i> | 2D <i>T_{int}</i> | 3D <i>T_{int}</i> | 5D <i>T_{int}</i> | <i>T</i> | 2D <i>T_{int}</i> | 3D <i>T_{int}</i> | 5D <i>T_{int}</i> |
| <i>DN</i> | <i>D</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | 21,3 | - | - | - | - | 2 | 2,7 | 2,4 | 2,4 | 2,6 | 3,5 | 3,1 | 3,1 | 3,2 | 4,3 | 3,8 | 3,7 | 4 | 5,3 | 4,7 | 4,7 | - | - | - | - | 5 | 6,5 | 5,9 | 5,8 | 7,1 | 9,0 | 8,3 | 8,1 |
| 20 | 26,9 | - | - | - | - | 2,3 | 3,5 | 2,9 | 2,7 | 2,6 | 3,9 | 3,3 | 3,0 | 3,2 | 4,8 | 4,0 | 3,7 | 4 | 5,9 | 5,0 | 4,6 | 4,5 | 6,5 | 5,6 | 5,2 | 5,6 | 8,0 | 6,9 | 6,4 | 8 | 11,0 | 9,8 | 9,1 |
| 25 | 33,7 | - | - | - | - | 2,6 | 4,7 | 3,6 | 3,0 | 3,2 | 5,7 | 4,4 | 3,7 | 4 | 6,9 | 5,4 | 4,6 | 4,5 | 7,7 | 6,1 | 5,2 | 5,6 | 9,2 | 7,5 | 6,4 | 6,3 | 10,2 | 8,4 | 7,2 | 8,8 | 13,5 | 11,4 | 10,0 |
| 32 | 42,4 | - | - | - | - | 2,6 | 4,7 | 3,6 | 3,0 | 3,6 | 6,4 | 4,9 | 4,2 | 4 | 7,0 | 5,5 | 4,6 | 5 | 8,5 | 6,8 | 5,8 | 6,3 | 10,4 | 8,4 | 7,2 | 8 | 12,8 | 10,6 | 9,1 | 10 | 15,4 | 13,1 | 11,4 |
| 40 | 48,3 | - | - | - | - | 2,6 | 4,6 | 3,5 | 3,0 | 3,6 | 6,2 | 4,9 | 4,1 | 4 | 6,8 | 5,4 | 4,6 | 5 | 8,4 | 6,7 | 5,7 | 6,3 | 10,3 | 8,4 | 7,2 | 8 | 12,7 | 10,5 | 9,1 | 10 | 15,4 | 13,0 | 11,3 |
| 50 | 60,3 | - | - | - | - | 2,9 | 4,8 | 3,9 | 3,3 | 3,6 | 5,9 | 4,8 | 4,1 | 4 | 6,5 | 5,3 | 4,6 | 5,6 | 8,9 | 7,3 | 6,4 | 7,1 | 11,1 | 9,2 | 8,1 | 8,8 | 13,5 | 11,4 | 10,0 | 11 | 16,5 | 14,1 | 12,5 |
| 65 | 76,1 | - | - | - | - | 2,9 | 5,0 | 3,9 | 3,3 | 3,6 | 6,1 | 4,8 | 4,1 | 5,6 | 9,2 | 7,4 | 6,4 | 7,1 | 11,5 | 9,3 | 8,1 | 8 | 12,8 | 10,5 | 9,1 | 10 | 15,7 | 13,0 | 11,4 | 14,2 | 21,5 | 18,2 | 16,1 |
| 80 | 88,9 | - | - | - | - | 3,2 | 5,3 | 4,2 | 3,7 | 4 | 6,6 | 5,3 | 4,6 | 5,6 | 9,1 | 7,3 | 6,4 | 8 | 12,7 | 10,4 | 9,1 | 8,8 | 13,9 | 11,4 | 10,0 | 11 | 17,0 | 14,2 | 12,5 | 16 | 23,9 | 20,4 | 18,1 |
| 100 | 114,3 | - | - | - | - | 3,6 | 5,8 | 4,7 | 4,1 | 4,5 | 7,2 | 5,9 | 5,1 | 6,3 | 9,9 | 8,2 | 7,2 | 8,8 | 13,7 | 11,3 | 10,0 | 11 | 16,9 | 14,1 | 12,5 | 14,2 | 21,4 | 18,1 | 16,1 | 17,5 | 25,9 | 22,1 | 19,8 |
| 125 | 139,7 | - | - | - | - | 4 | 6,4 | 5,2 | 4,6 | 5 | 7,9 | 6,5 | 5,7 | 6,3 | 9,9 | 8,1 | 7,2 | 10 | 15,4 | 12,8 | 11,4 | 12,5 | 19,0 | 15,9 | 14,2 | 16 | 24,0 | 20,3 | 18,1 | 20 | 29,5 | 25,2 | 22,6 |
| 150 | 168,3 | 4 | 6,4 | 5,2 | 4,6 | 4,5 | 7,2 | 5,8 | 5,2 | 5,6 | 8,9 | 7,2 | 6,4 | 7,1 | 11,2 | 9,1 | 8,1 | 11 | 17,1 | 14,1 | 12,5 | 14,2 | 21,7 | 18,1 | 16,1 | 17,5 | 26,5 | 22,2 | 19,9 | 22,2 | 33,0 | 28,0 | 25,1 |
| 200 | 219,1 | 4,5 | 7,1 | 5,8 | 5,2 | 6,3 | 9,8 | 8,1 | 7,2 | 7,1 | 11,1 | 9,1 | 8,1 | 8 | 12,4 | 10,2 | 9,1 | 12,5 | 19,1 | 15,9 | 14,2 | 16 | 24,3 | 20,3 | 18,1 | 17,5 | 26,4 | 22,1 | 19,8 | 22,2 | 33,1 | 28,0 | 25,1 |
| 250 | 273 | 5 | 7,9 | 6,4 | 5,7 | 6,3 | 9,9 | 8,1 | 7,2 | 8,8 | 13,7 | 11,2 | 10,0 | 10 | 15,5 | 12,8 | 11,4 | 12,5 | 19,2 | 15,9 | 14,2 | 16 | 24,4 | 20,3 | 18,1 | 22,2 | 33,4 | 28,0 | 25,1 | 30 | 44,4 | 37,7 | 33,9 |
| 300 | 323,9 | 5,6 | 8,7 | 7,2 | 6,4 | 7,1 | 11,0 | 9,1 | 8,1 | 8,8 | 13,6 | 11,2 | 10,0 | 10 | 15,4 | 12,7 | 11,4 | 12,5 | 19,2 | 15,9 | 14,2 | 17,5 | 26,6 | 22,1 | 19,8 | 25 | 37,4 | 31,5 | 28,3 | 32 | 47,3 | 40,1 | 36,1 |
| 350 | 355,6 | 5,6 | 8,4 | 7,0 | 6,4 | 8 | 11,9 | 10,0 | 9,1 | 10 | 14,8 | 12,5 | 11,4 | 12,5 | 18,5 | 15,6 | 14,2 | 16 | 23,5 | 19,9 | 18,1 | 20 | 29,2 | 24,8 | 22,6 | 28 | 40,4 | 34,6 | 31,6 | 36 | 51,5 | 44,4 | 40,6 |
| 400 | 406,4 | 6,3 | 9,4 | 7,9 | 7,2 | 8,8 | 13,1 | 11,0 | 10,0 | 10 | 14,9 | 12,5 | 11,4 | 12,5 | 18,5 | 15,6 | 14,2 | 17,5 | 25,7 | 21,8 | 19,8 | 22,2 | 32,5 | 27,6 | 25,1 | 30 | 43,5 | 37,1 | 33,9 | 40 | 57,3 | 49,3 | 45,1 |
| 450 | 457 | 6,3 | 9,4 | 7,9 | 7,2 | 10 | 14,9 | 12,5 | 11,3 | 11 | 16,3 | 13,7 | 12,4 | 12,5 | 18,5 | 15,6 | 14,1 | 17,5 | 25,8 | 21,8 | 19,8 | 22,2 | 32,5 | 27,6 | 25,0 | 32 | 46,4 | 39,6 | 36,0 | 45 | 64,4 | 55,5 | 50,6 |
| 500 | 508 | 6,3 | 9,4 | 7,9 | 7,2 | 10 | 14,9 | 12,5 | 11,3 | 11 | 16,4 | 13,8 | 12,4 | 12,5 | 18,6 | 15,6 | 14,1 | 17,5 | 25,8 | 21,8 | 19,8 | 25 | 36,6 | 31,1 | 28,2 | 36 | 52,2 | 44,6 | 40,5 | 50 | 71,6 | 61,6 | 56,2 |
| 600 | 610 | 6,3 | 9,4 | 7,9 | 7,1 | 10 | 14,9 | 12,5 | 11,3 | 12,5 | 18,6 | 15,6 | 14,1 | 17,5 | 25,9 | 21,8 | 19,7 | 25 | 36,8 | 31,1 | 28,1 | 30 | 43,9 | 37,3 | 33,7 | 45 | 65,1 | 55,7 | 50,5 | 60 | 85,9 | 74,0 | 67,3 |
| 700 | 711 | 7,1 | 10,6 | 8,9 | 8,0 | 10 | 14,9 | 12,6 | 11,4 | 12,5 | 18,6 | 15,6 | 14,1 | 25 | 36,9 | 31,1 | 28,1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 800 | 813 | 8 | 12,0 | 10,0 | 9,0 | 10 | 15,0 | 12,6 | 11,4 | 12,5 | 18,6 | 15,6 | 14,1 | 25 | 37,0 | 31,2 | 28,1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 900 | 914 | 10 | 15,0 | 12,6 | 11,4 | 12,5 | 18,7 | 15,6 | 14,1 | 20 | 29,7 | 25,0 | 22,5 | 25 | 37,0 | 31,2 | 28,1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1000 | 1016 | 10 | 15,0 | 12,6 | 11,4 | 12,5 | 18,7 | 15,6 | 14,1 | 20 | 29,7 | 25,0 | 22,5 | 25 | 37,1 | 31,2 | 28,1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1200 | 1219 | 10 | 15,0 | 12,6 | 11,4 | 12,5 | 18,7 | 15,6 | 14,1 | 20 | 29,8 | 25,0 | 22,5 | 25 | 37,2 | 31,2 | 28,1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

C.3 Tees

Table C.2 shows the wall thickness at the body of equal tees and reducing tees. This data is applicable if one of the following two conditions applies :

- 1) reinforcement is interior ($D_s = D, D_b = D_1$) and the crotch radius is less equal to 3/4 of the height of the branch ($r_c \leq 0.75 (G - D/2)$) and the wall thickness at the crotch zone is at least the mean of the wall thicknesses of run and branch ($T_{c,min} \geq (T_{s,min} + T_{b,min}) / 2$) and dimensions F and G are as listed in Table 13 and 14 ;
- 2) reinforcement is at maximum half to the external ($D_s \leq D + (T_{s,min} - T), D_b \leq D_1 + (T_{b,min} - T_1)$) and the crotch radius is less equal to 1/2 of the height of the branch ($r_c \leq 0.5 (G - D_s/2)$) and the wall thickness at the crotch zone is at least the mean of the wall thicknesses of run and branch ($T_{c,min} \geq (T_{s,min} + T_{b,min}) / 2$) and dimensions F and G are as listed in Table 13 and 14.

In all other cases, e.g. when the reinforcement is completely to the external, the wall thicknesses shall be calculated in accordance with Annex A.

Smaller wall thicknesses than listed in Tables C.2 are acceptable provided that they are calculated in accordance with Annex A, e.g. for smaller crotch radii or other ratios of the wall thicknesses of branch to run.

Table C.2 — Wall thickness of tees type B

| DN | D | DN ₁ | D ₁ | 1 | | | | 2 | | | | 3 | | | | 4 | | | | 5 | | | | 6 | | | | 7 | | | | 8 | | | |
|----|------|-----------------|----------------|---|----------------|----------------|----------------|-----|----------------|----------------|----------------|-----|----------------|----------------|----------------|-----|----------------|----------------|----------------|-----|----------------|----------------|----------------|-----|----------------|----------------|----------------|-----|----------------|----------------|----------------|-----|----------------|----------------|----------------|
| | | | | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b |
| 15 | 21,3 | 15 | 21,3 | - | - | - | - | 2 | 2 | 4,2 | 3,2 | 2,6 | 2,6 | 5,2 | 3,9 | 3,2 | 3,2 | 6,1 | 4,6 | 4 | 4 | 7,4 | 5,6 | - | - | - | - | 5 | 5 | 9,1 | 6,9 | 7,1 | 7,1 | 12,8 | 9,6 |
| 20 | 26,9 | 20 | 26,9 | - | - | - | - | 2,3 | 2,3 | 4,8 | 3,6 | 2,6 | 2,6 | 5,3 | 4,0 | 3,2 | 3,2 | 6,3 | 4,7 | 4 | 4 | 7,7 | 5,8 | 4,5 | 4,5 | 8,6 | 6,5 | 5,6 | 5,6 | 10,7 | 8,1 | 8 | 8 | 15,2 | 11,4 |
| | | 15 | 21,3 | - | - | - | - | 2,3 | 2 | 4,4 | 3,3 | 2,6 | 2,6 | 4,8 | 3,6 | 3,2 | 3,2 | 5,7 | 4,3 | 4 | 4 | 6,7 | 5,1 | - | - | - | - | 5,6 | 5 | 8,9 | 6,7 | 8 | 7,1 | 12,4 | 9,3 |
| 25 | 33,7 | 25 | 33,7 | - | - | - | - | 2,6 | 2,6 | 5,7 | 4,3 | 3,2 | 3,2 | 6,7 | 5,0 | 4 | 4 | 7,9 | 5,9 | 4,5 | 4,5 | 8,7 | 6,5 | 5,6 | 5,6 | 10,5 | 7,9 | 6,3 | 6,3 | 11,8 | 8,8 | 8,8 | 8,8 | 16,4 | 12,3 |
| | | 20 | 26,9 | - | - | - | - | 2,6 | 2,3 | 5,2 | 3,9 | 3,2 | 2,6 | 6,1 | 4,6 | 4 | 3,2 | 7,2 | 5,4 | 4,5 | 4 | 7,9 | 5,9 | 5,6 | 4,5 | 9,4 | 7,0 | 6,3 | 5,6 | 10,3 | 7,7 | 8,8 | 8 | 13,8 | 10,3 |
| | | 15 | 21,3 | - | - | - | - | 2,6 | 2 | 4,8 | 3,6 | 3,2 | 2,6 | 5,6 | 4,2 | 4 | 3,2 | 6,7 | 5,0 | 4,5 | 4 | 7,3 | 5,5 | - | - | - | - | 6,3 | 5 | 9,5 | 7,1 | 8,8 | 7,1 | 12,3 | 9,2 |
| 32 | 42,4 | 32 | 42,4 | - | - | - | - | 2,6 | 2,6 | 6,0 | 4,5 | 3,6 | 3,6 | 7,7 | 5,8 | 4 | 4 | 8,3 | 6,3 | 5 | 5 | 9,9 | 7,4 | 6,3 | 6,3 | 12,0 | 9,0 | 8 | 8 | 14,9 | 11,2 | 10 | 10 | 18,6 | 13,9 |
| | | 25 | 33,7 | - | - | - | - | 2,6 | 2,6 | 5,5 | 4,1 | 3,6 | 3,2 | 7,0 | 5,3 | 4 | 4 | 7,6 | 5,7 | 5 | 4,5 | 9,0 | 6,8 | 6,3 | 5,6 | 10,8 | 8,1 | 8 | 6,3 | 12,9 | 9,7 | 10 | 8,8 | 15,7 | 11,8 |
| | | 20 | 26,9 | - | - | - | - | 2,6 | 2,3 | 5,1 | 3,8 | 3,6 | 2,6 | 6,5 | 4,9 | 4 | 3,2 | 7,1 | 5,3 | 5 | 4 | 8,4 | 6,3 | 6,3 | 4,5 | 10,0 | 7,5 | 8 | 5,6 | 12,0 | 9,0 | 10 | 8 | 14,3 | 10,8 |
| | | 15 | 21,3 | - | - | - | - | 2,6 | 2 | 4,8 | 3,6 | 3,6 | 2,6 | 6,1 | 4,6 | 4 | 3,2 | 6,6 | 5,0 | 5 | 4 | 7,9 | 5,9 | - | - | - | - | 8 | 5 | 11,3 | 8,5 | 10 | 7,1 | 13,5 | 10,1 |
| 40 | 48,3 | 40 | 48,3 | - | - | - | - | 2,6 | 2,6 | 6,3 | 4,7 | 3,6 | 3,6 | 8,0 | 6,0 | 4 | 4 | 8,7 | 6,6 | 5 | 5 | 10,3 | 7,8 | 6,3 | 6,3 | 12,3 | 9,3 | 8 | 8 | 15,0 | 11,2 | 10 | 10 | 18,3 | 13,7 |
| | | 32 | 42,4 | - | - | - | - | 2,6 | 2,6 | 6,0 | 4,5 | 3,6 | 3,6 | 7,7 | 5,8 | 4 | 4 | 8,3 | 6,2 | 5 | 5 | 9,8 | 7,4 | 6,3 | 6,3 | 11,7 | 8,8 | 8 | 8 | 14,1 | 10,6 | 10 | 10 | 16,8 | 12,6 |
| | | 25 | 33,7 | - | - | - | - | 2,6 | 2,6 | 5,5 | 4,2 | 3,6 | 3,2 | 7,1 | 5,3 | 4 | 4 | 7,7 | 5,8 | 5 | 4,5 | 9,1 | 6,8 | 6,3 | 5,6 | 10,8 | 8,1 | 8 | 6,3 | 13,0 | 9,8 | 10 | 8,8 | 15,4 | 11,6 |
| | | 20 | 26,9 | - | - | - | - | 2,6 | 2,3 | 5,2 | 3,9 | 3,6 | 2,6 | 6,6 | 5,0 | 4 | 3,2 | 7,2 | 5,4 | 5 | 4 | 8,5 | 6,4 | 6,3 | 4,5 | 10,1 | 7,6 | 8 | 5,6 | 12,2 | 9,1 | 10 | 8 | 14,5 | 10,9 |
| | | 15 | 21,3 | - | - | - | - | 2,6 | 2 | 4,9 | 3,7 | 3,6 | 2,6 | 6,3 | 4,7 | 4 | 3,2 | 6,8 | 5,1 | 5 | 4 | 8,0 | 6,0 | - | - | - | - | 8 | 5 | 11,5 | 8,7 | 10 | 7,1 | 13,7 | 10,3 |
| 50 | 60,3 | 50 | 60,3 | - | - | - | - | 2,9 | 2,9 | 6,9 | 5,2 | 3,6 | 3,6 | 8,2 | 6,1 | 4 | 4 | 8,8 | 6,6 | 5,6 | 5,6 | 11,4 | 8,6 | 7,1 | 7,1 | 13,9 | 10,5 | 8,8 | 8,8 | 17,0 | 12,8 | 11 | 11 | 21,3 | 16,0 |
| | | 40 | 48,3 | - | - | - | - | 2,9 | 2,6 | 6,2 | 4,6 | 3,6 | 3,6 | 7,3 | 5,5 | 4 | 4 | 7,9 | 5,9 | 5,6 | 5 | 10,2 | 7,7 | 7,1 | 6,3 | 12,2 | 9,2 | 8,8 | 8 | 14,5 | 10,9 | 11 | 10 | 17,6 | 13,2 |
| | | 32 | 42,4 | - | - | - | - | 2,9 | 2,6 | 5,8 | 4,3 | 3,6 | 3,6 | 6,8 | 5,1 | 4 | 4 | 7,4 | 5,5 | 5,6 | 5 | 9,5 | 7,2 | 7,1 | 6,3 | 11,5 | 8,6 | 8,8 | 8 | 13,7 | 10,3 | 11 | 10 | 16,5 | 12,4 |
| | | 25 | 33,7 | - | - | - | - | 2,9 | 2,6 | 5,1 | 3,8 | 3,6 | 3,2 | 6,0 | 4,5 | 4 | 4 | 6,5 | 4,9 | 5,6 | 4,5 | 8,5 | 6,4 | 7,1 | 5,6 | 10,3 | 7,7 | 8,8 | 6,3 | 12,3 | 9,2 | 11 | 8,8 | 14,9 | 11,2 |
| | | 20 | 26,9 | - | - | - | - | 2,9 | 2,3 | 4,5 | 3,4 | 3,6 | 2,6 | 5,3 | 4,0 | 4 | 3,2 | 5,8 | 4,4 | 5,6 | 4 | 7,7 | 5,8 | 7,1 | 4,5 | 9,4 | 7,1 | 8,8 | 5,6 | 11,3 | 8,5 | 11 | 8 | 13,8 | 10,4 |

Table C.2 (continued)

| DN | D | DN ₁ | D ₁ | 1 | | | | 2 | | | | 3 | | | | 4 | | | | 5 | | | | 6 | | | | 7 | | | | 8 | | | |
|-----|-------|-----------------|----------------|---|----------------|----------------|----------------|-----|----------------|----------------|----------------|-----|----------------|----------------|----------------|-----|----------------|----------------|----------------|-----|----------------|----------------|----------------|------|----------------|----------------|----------------|------|----------------|----------------|----------------|------|----------------|----------------|----------------|
| | | | | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b |
| 65 | 76,1 | 65 | 76,1 | - | - | - | - | 2,9 | 2,9 | 7,2 | 5,4 | 3,6 | 3,6 | 8,4 | 6,3 | 5,6 | 5,6 | 11,8 | 8,9 | 7,1 | 7,1 | 14,4 | 10,8 | 8 | 8 | 16,1 | 12,1 | 10 | 10 | 20,1 | 15,1 | 14,2 | 14,2 | 28,7 | 21,5 |
| | | 50 | 60,3 | - | - | - | - | 2,9 | 2,9 | 6,3 | 4,8 | 3,6 | 3,6 | 7,4 | 5,6 | 5,6 | 4 | 9,6 | 7,2 | 7,1 | 5,6 | 12,5 | 9,4 | 8 | 7,1 | 13,8 | 10,4 | 10 | 8,8 | 16,6 | 12,5 | 14,2 | 11 | 22,7 | 17,0 |
| | | 40 | 48,3 | - | - | - | - | 2,9 | 2,6 | 5,7 | 4,3 | 3,6 | 3,6 | 6,7 | 5,1 | 5,6 | 4 | 9,4 | 7,1 | 7,1 | 5 | 11,4 | 8,5 | 8 | 6,3 | 12,5 | 9,4 | 10 | 8 | 15,0 | 11,3 | 14,2 | 10 | 20,1 | 15,1 |
| | | 32 | 42,4 | - | - | - | - | 2,9 | 2,6 | 5,4 | 4,0 | 3,6 | 3,6 | 6,3 | 4,8 | 5,6 | 4 | 8,9 | 6,7 | 7,1 | 5 | 10,7 | 8,0 | 8 | 6,3 | 11,8 | 8,8 | 10 | 8 | 14,2 | 10,7 | 14,2 | 10 | 19,0 | 14,3 |
| | | 25 | 33,7 | - | - | - | - | 2,9 | 2,6 | 4,8 | 3,6 | 3,6 | 3,2 | 5,6 | 4,2 | 5,6 | 4 | 8,0 | 6,0 | 7,1 | 4,5 | 9,7 | 7,3 | 8 | 5,6 | 10,8 | 8,1 | 10 | 6,3 | 13,0 | 9,8 | 14,2 | 8,8 | 17,5 | 13,2 |
| 80 | 88,9 | 80 | 88,9 | - | - | - | - | 3,2 | 3,2 | 7,9 | 6,0 | 4 | 4 | 9,4 | 7,0 | 5,6 | 5,6 | 12,1 | 9,1 | 8 | 8 | 16,5 | 12,4 | 8,8 | 8,8 | 18,1 | 13,6 | 11 | 11 | 22,6 | 17,0 | 16 | 16 | 33,2 | 24,9 |
| | | 65 | 76,1 | - | - | - | - | 3,2 | 2,9 | 7,3 | 5,5 | 4 | 3,6 | 8,7 | 6,5 | 5,6 | 5,6 | 11,2 | 8,4 | 8 | 7,1 | 14,7 | 11,1 | 8,8 | 8 | 15,9 | 11,9 | 11 | 10 | 19,4 | 14,6 | 16 | 14,2 | 28,4 | 21,3 |
| | | 50 | 60,3 | - | - | - | - | 3,2 | 2,9 | 6,5 | 4,9 | 4 | 3,6 | 7,7 | 5,8 | 5,6 | 4 | 9,9 | 7,5 | 8 | 5,6 | 13,1 | 9,8 | 8,8 | 7,1 | 14,2 | 10,7 | 11 | 8,8 | 17,1 | 12,8 | 16 | 11 | 23,9 | 17,9 |
| | | 40 | 48,3 | - | - | - | - | 3,2 | 2,6 | 5,9 | 4,4 | 4 | 3,6 | 7,0 | 5,3 | 5,6 | 4 | 9,0 | 6,8 | 8 | 5 | 11,9 | 9,0 | 8,8 | 6,3 | 12,9 | 9,7 | 11 | 8 | 15,6 | 11,7 | 16 | 10 | 21,4 | 16,0 |
| | | 32 | 42,4 | - | - | - | - | 3,2 | 2,6 | 5,6 | 4,2 | 4 | 3,6 | 6,6 | 5,0 | 5,6 | 4 | 8,5 | 6,4 | 8 | 5 | 11,3 | 8,5 | 8,8 | 6,3 | 12,2 | 9,2 | 11 | 8 | 14,8 | 11,1 | 16 | 10 | 20,3 | 15,2 |
| 100 | 114,3 | 100 | 114,3 | - | - | - | - | 3,6 | 3,6 | 9,0 | 6,8 | 4,5 | 4,5 | 10,7 | 8,0 | 6,3 | 6,3 | 13,9 | 10,4 | 8,8 | 8,8 | 18,8 | 14,1 | 11 | 11 | 23,6 | 17,7 | 14,2 | 14,2 | 30,6 | 23,0 | 17,5 | 17,5 | 38,0 | 28,5 |
| | | 80 | 88,9 | - | - | - | - | 3,6 | 3,2 | 7,9 | 6,0 | 4,5 | 4 | 9,4 | 7,1 | 6,3 | 5,6 | 12,2 | 9,1 | 8,8 | 8 | 15,8 | 11,9 | 11 | 8,8 | 19,0 | 14,2 | 14,2 | 11 | 23,9 | 18,0 | 17,5 | 16 | 29,3 | 22,0 |
| | | 65 | 76,1 | - | - | - | - | 3,6 | 2,9 | 7,4 | 5,6 | 4,5 | 3,6 | 8,8 | 6,6 | 6,3 | 5,6 | 11,3 | 8,5 | 8,8 | 7,1 | 14,7 | 11,0 | 11 | 8 | 17,6 | 13,2 | 14,2 | 10 | 21,9 | 16,4 | 17,5 | 14,2 | 26,1 | 19,6 |
| | | 50 | 60,3 | - | - | - | - | 3,6 | 2,9 | 6,6 | 5,0 | 4,5 | 3,6 | 7,9 | 5,9 | 6,3 | 4 | 10,2 | 7,7 | 8,8 | 5,6 | 13,2 | 9,9 | 11 | 7,1 | 15,9 | 12,0 | 14,2 | 8,8 | 19,8 | 14,9 | 17,5 | 11 | 23,8 | 17,8 |
| | | 40 | 48,3 | - | - | - | - | 3,6 | 2,6 | 6,1 | 4,6 | 4,5 | 3,6 | 7,2 | 5,4 | 6,3 | 4 | 9,4 | 7,0 | 8,8 | 5 | 12,2 | 9,2 | 11 | 6,3 | 14,6 | 11,0 | 14,2 | 8 | 18,2 | 13,7 | 17,5 | 10 | 21,8 | 16,4 |
| 125 | 139,7 | 125 | 139,7 | - | - | - | - | 4 | 4 | 10,2 | 7,6 | 5 | 5 | 12,0 | 9,0 | 6,3 | 6,3 | 14,3 | 10,8 | 10 | 10 | 22,0 | 16,5 | 12,5 | 12,5 | 27,6 | 20,7 | 16 | 16 | 35,6 | 26,7 | 20 | 20 | 44,9 | 33,7 |
| | | 100 | 114,3 | - | - | - | - | 4 | 3,6 | 9,1 | 6,9 | 5 | 4,5 | 10,8 | 8,1 | 6,3 | 6,3 | 12,9 | 9,7 | 10 | 8,8 | 18,6 | 14,0 | 12,5 | 11 | 22,4 | 16,8 | 16 | 14,2 | 28,8 | 21,6 | 20 | 17,5 | 36,1 | 27,1 |
| | | 80 | 88,9 | - | - | - | - | 4 | 3,2 | 8,1 | 6,1 | 5 | 4 | 9,6 | 7,2 | 6,3 | 5,6 | 11,5 | 8,6 | 10 | 8 | 16,5 | 12,4 | 12,5 | 8,8 | 19,8 | 14,9 | 16 | 11 | 24,6 | 18,4 | 20 | 16 | 29,6 | 22,2 |
| | | 65 | 76,1 | - | - | - | - | 4 | 2,9 | 7,6 | 5,7 | 5 | 3,6 | 9,0 | 6,8 | 6,3 | 5,6 | 10,7 | 8,1 | 10 | 7,1 | 15,4 | 11,6 | 12,5 | 8 | 18,5 | 13,9 | 16 | 10 | 23,0 | 17,2 | 20 | 14,2 | 27,7 | 20,8 |
| | | 50 | 60,3 | - | - | - | - | 4 | 2,9 | 6,9 | 5,2 | 5 | 3,6 | 8,2 | 6,2 | 6,3 | 4 | 9,9 | 7,4 | 10 | 5,6 | 14,2 | 10,6 | 12,5 | 7,1 | 16,9 | 12,7 | 16 | 8,8 | 20,9 | 15,7 | 20 | 11 | 25,4 | 19,0 |
| 150 | 168,3 | 150 | 168,3 | 4 | 4 | 10,5 | 7,9 | 4,5 | 4,5 | 11,5 | 8,6 | 5,6 | 5,6 | 13,5 | 10,2 | 7,1 | 7,1 | 16,5 | 12,4 | 11 | 11 | 25,2 | 18,9 | 14,2 | 14,2 | 32,9 | 24,7 | 17,5 | 17,5 | 40,8 | 30,6 | 22,2 | 22,2 | 52,4 | 39,3 |
| | | 125 | 139,7 | - | - | - | - | 4,5 | 4 | 10,4 | 7,8 | 5,6 | 5 | 12,3 | 9,2 | 7,1 | 6,3 | 14,7 | 11,1 | 11 | 10 | 21,0 | 15,7 | 14,2 | 12,5 | 26,7 | 20,0 | 17,5 | 16 | 32,9 | 24,7 | 22,2 | 20 | 42,0 | 31,5 |
| | | 100 | 114,3 | - | - | - | - | 4,5 | 3,6 | 9,4 | 7,1 | 5,6 | 4,5 | 11,1 | 8,4 | 7,1 | 6,3 | 13,4 | 10,0 | 11 | 8,8 | 19,0 | 14,3 | 14,2 | 11 | 23,6 | 17,7 | 17,5 | 14,2 | 28,1 | 21,1 | 22,2 | 17,5 | 35,4 | 26,5 |
| | | 80 | 88,9 | - | - | - | - | 4,5 | 3,2 | 8,4 | 6,3 | 5,6 | 4 | 10,0 | 7,5 | 7,1 | 5,6 | 12,0 | 9,0 | 11 | 8 | 17,0 | 12,8 | 14,2 | 8,8 | 21,1 | 15,9 | 17,5 | 11 | 25,3 | 19,0 | 22,2 | 16 | 31,0 | 23,2 |
| | | 65 | 76,1 | - | - | - | - | 4,5 | 2,9 | 7,9 | 5,9 | 5,6 | 3,6 | 9,4 | 7,0 | 7,1 | 5,6 | 11,3 | 8,5 | 11 | 7,1 | 16,0 | 12,0 | 14,2 | 8 | 19,8 | 14,9 | 17,5 | 10 | 23,8 | 17,9 | 22,2 | 14,2 | 29,2 | 21,9 |

Table C.2 (continued)

| DN | D | DN ₁ | D ₁ | 1 | | | | 2 | | | | 3 | | | | 4 | | | | 5 | | | | 6 | | | | 7 | | | | 8 | | | |
|-----|-------|-----------------|----------------|-----|----------------|----------------|----------------|-----|----------------|----------------|----------------|-----|----------------|----------------|----------------|------|----------------|----------------|----------------|------|----------------|----------------|----------------|------|----------------|----------------|----------------|------|----------------|----------------|----------------|------|----------------|----------------|----------------|
| | | | | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b |
| 200 | 219,1 | 200 | 219,1 | 4,5 | 4,5 | 12,1 | 9,1 | 6,3 | 6,3 | 15,7 | 11,8 | 7,1 | 7,1 | 17,4 | 13,1 | 8 | 8 | 19,4 | 14,5 | 12,5 | 12,5 | 30,2 | 22,6 | 16 | 16 | 39,0 | 29,2 | 17,5 | 17,5 | 42,8 | 32,1 | 22,2 | 22,2 | 55,0 | 41,2 |
| | | 150 | 168,3 | 4,5 | 4 | 10,6 | 7,9 | 6,3 | 4,5 | 12,9 | 9,7 | 7,1 | 5,6 | 14,9 | 11,2 | 8 | 7,1 | 16,3 | 12,3 | 12,5 | 11 | 23,5 | 17,7 | 16 | 14,2 | 28,9 | 21,7 | 17,5 | 17,5 | 31,5 | 23,6 | 22,2 | 22,2 | 40,0 | 30,0 |
| | | 125 | 139,7 | - | - | - | - | 6,3 | 4 | 12,4 | 9,3 | 7,1 | 5 | 13,7 | 10,3 | 8 | 6,3 | 15,0 | 11,2 | 12,5 | 10 | 21,5 | 16,2 | 16 | 12,5 | 26,5 | 19,9 | 17,5 | 16 | 28,7 | 21,5 | 22,2 | 20 | 34,9 | 26,2 |
| | | 100 | 114,3 | - | - | - | - | 6,3 | 3,6 | 11,4 | 8,6 | 7,1 | 4,5 | 12,5 | 9,4 | 8 | 6,3 | 13,7 | 10,3 | 12,5 | 8,8 | 19,7 | 14,8 | 16 | 11 | 24,3 | 18,3 | 17,5 | 14,2 | 26,4 | 19,8 | 22,2 | 17,5 | 32,2 | 24,2 |
| 250 | 273 | 250 | 273 | 5 | 5 | 13,7 | 10,3 | 6,3 | 6,3 | 16,3 | 12,2 | 8,8 | 8,8 | 21,9 | 16,5 | 10 | 10 | 24,8 | 18,6 | 12,5 | 12,5 | 31,0 | 23,3 | 16 | 16 | 40,1 | 30,1 | 22,2 | 22,2 | 56,5 | 42,4 | 30 | 30 | 77,8 | 58,4 |
| | | 200 | 219,1 | 5 | 4,5 | 12,2 | 9,2 | 6,3 | 6,3 | 14,5 | 10,9 | 8,8 | 7,1 | 18,7 | 14,1 | 10 | 8 | 20,8 | 15,6 | 12,5 | 12,5 | 25,1 | 18,9 | 16 | 16 | 30,8 | 23,1 | 22,2 | 17,5 | 42,5 | 31,9 | 30 | 22,2 | 54,4 | 40,8 |
| | | 150 | 168,3 | 5 | 4 | 10,8 | 8,1 | 6,3 | 4,5 | 12,8 | 9,6 | 8,8 | 5,6 | 16,5 | 12,4 | 10 | 7,1 | 18,3 | 13,7 | 12,5 | 11 | 22,2 | 16,6 | 16 | 14,2 | 27,3 | 20,5 | 22,2 | 17,5 | 35,9 | 27,0 | 30 | 22,2 | 46,8 | 35,1 |
| | | 125 | 139,7 | - | - | - | - | 6,3 | 4 | 11,9 | 8,9 | 8,8 | 5 | 15,3 | 11,5 | 10 | 6,3 | 16,9 | 12,7 | 12,5 | 10 | 20,4 | 15,3 | 16 | 12,5 | 25,1 | 18,8 | 22,2 | 16 | 33,1 | 24,8 | 30 | 20 | 42,9 | 32,2 |
| | | 100 | 114,3 | - | - | - | - | 6,3 | 3,6 | 10,9 | 8,2 | 8,8 | 4,5 | 14,1 | 10,6 | 10 | 6,3 | 15,6 | 11,7 | 12,5 | 8,8 | 18,8 | 14,1 | 16 | 11 | 23,2 | 17,4 | 22,2 | 14,2 | 30,7 | 23,1 | 30 | 17,5 | 40,0 | 30,0 |
| 300 | 323,9 | 300 | 323,9 | 5,6 | 5,6 | 15,5 | 11,7 | 7,1 | 7,1 | 18,6 | 13,9 | 8,8 | 8,8 | 22,4 | 16,8 | 10 | 10 | 25,2 | 18,9 | 12,5 | 12,5 | 31,3 | 23,5 | 17,5 | 17,5 | 44,2 | 33,2 | 25 | 25 | 64,3 | 48,2 | 32 | 32 | 83,6 | 62,7 |
| | | 250 | 273 | 5,6 | 5 | 14,2 | 10,6 | 7,1 | 6,3 | 16,9 | 12,7 | 8,8 | 8,8 | 19,9 | 14,9 | 10 | 10 | 22,1 | 16,6 | 12,5 | 12,5 | 26,5 | 19,9 | 17,5 | 16 | 35,8 | 26,8 | 25 | 22,2 | 51,7 | 38,8 | 32 | 30 | 66,5 | 49,9 |
| | | 200 | 219,1 | 5,6 | 4,5 | 12,7 | 9,5 | 7,1 | 6,3 | 15,1 | 11,4 | 8,8 | 7,1 | 17,8 | 13,4 | 10 | 8 | 19,8 | 14,8 | 12,5 | 12,5 | 23,9 | 18,0 | 17,5 | 16 | 31,6 | 23,7 | 25 | 17,5 | 42,8 | 32,1 | 32 | 22,2 | 54,3 | 40,7 |
| | | 150 | 168,3 | 5,6 | 4 | 11,2 | 8,4 | 7,1 | 4,5 | 13,4 | 10,1 | 8,8 | 5,6 | 15,8 | 11,9 | 10 | 7,1 | 17,5 | 13,2 | 12,5 | 11 | 21,3 | 16,0 | 17,5 | 14,2 | 28,2 | 21,2 | 25 | 17,5 | 38,2 | 28,7 | 32 | 22,2 | 47,2 | 35,4 |
| 350 | 355,6 | 350 | 355,6 | 5,6 | 5,6 | 15,9 | 11,9 | 8 | 8 | 20,8 | 15,6 | 10 | 10 | 25,3 | 19,0 | 12,5 | 12,5 | 31,3 | 23,5 | 16 | 16 | 40,2 | 30,1 | 20 | 20 | 50,6 | 38,0 | 28 | 28 | 72,0 | 54,0 | 36 | 36 | 94,1 | 70,6 |
| | | 300 | 323,9 | 5,6 | 5,6 | 15,1 | 11,3 | 8 | 7,1 | 19,3 | 14,5 | 10 | 8,8 | 22,7 | 17,1 | 12,5 | 10 | 25,2 | 18,9 | 16 | 12,5 | 30,7 | 23,1 | 20 | 17,5 | 43,0 | 32,3 | 28 | 25 | 62,3 | 46,7 | 36 | 32 | 80,7 | 60,5 |
| | | 250 | 273 | 5,6 | 5 | 13,8 | 10,3 | 8 | 6,3 | 18,0 | 13,5 | 10 | 8,8 | 21,4 | 16,1 | 12,5 | 10 | 25,7 | 19,3 | 16 | 12,5 | 31,6 | 23,7 | 20 | 16 | 38,1 | 28,6 | 28 | 22,2 | 52,7 | 39,6 | 36 | 30 | 68,1 | 51,1 |
| | | 200 | 219,1 | 5,6 | 4,5 | 12,4 | 9,3 | 8 | 6,3 | 16,3 | 12,2 | 10 | 7,1 | 19,3 | 14,5 | 12,5 | 8 | 23,1 | 17,3 | 16 | 12,5 | 28,4 | 21,3 | 20 | 16 | 34,4 | 25,8 | 28 | 17,5 | 45,8 | 34,4 | 36 | 22,2 | 57,0 | 42,8 |
| | | 150 | 168,3 | 5,6 | 4 | 11,0 | 8,3 | 8 | 4,5 | 14,5 | 10,9 | 10 | 5,6 | 17,2 | 12,9 | 12,5 | 7,1 | 20,5 | 15,4 | 16 | 11 | 25,4 | 19,1 | 20 | 14,2 | 30,7 | 23,1 | 28 | 17,5 | 41,1 | 30,8 | 36 | 22,2 | 51,1 | 38,3 |

Table C.2 (continued)

| DN | D | DN ₁ | D ₁ | 1 | | | | 2 | | | | 3 | | | | 4 | | | | 5 | | | | 6 | | | | 7 | | | | 8 | | | |
|-----|-------|-----------------|----------------|-----|----------------|----------------|----------------|-----|----------------|----------------|----------------|------|----------------|----------------|----------------|------|----------------|----------------|----------------|------|----------------|----------------|----------------|------|----------------|----------------|----------------|----|----------------|----------------|----------------|----|----------------|----------------|----------------|
| | | | | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b |
| 400 | 406,4 | 400 | 406,4 | 6,3 | 6,3 | 17,8 | 13,3 | 8,8 | 8,8 | 23,6 | 17,7 | 10 | 10 | 26,7 | 20,1 | 12,5 | 12,5 | 33,2 | 24,9 | 17,5 | 17,5 | 47,0 | 35,3 | 22,2 | 22,2 | 60,3 | 45,2 | 30 | 30 | 83,0 | 62,3 | 40 | 40 | 114 | 85,1 |
| | | 350 | 355,6 | 6,3 | 5,6 | 16,7 | 12,5 | 8,8 | 8 | 21,4 | 16,1 | 10 | 10 | 23,6 | 17,7 | 12,5 | 12,5 | 28,1 | 21,1 | 17,5 | 16 | 38,7 | 29,1 | 22,2 | 20 | 49,5 | 37,1 | 30 | 28 | 67,5 | 50,7 | 40 | 36 | 91,6 | 68,7 |
| | | 300 | 323,9 | 6,3 | 5,6 | 15,8 | 11,9 | 8,8 | 7,1 | 20,4 | 15,3 | 10 | 8,8 | 22,4 | 16,8 | 12,5 | 10 | 26,8 | 20,1 | 17,5 | 12,5 | 32,3 | 24,2 | 22,2 | 17,5 | 44,2 | 33,2 | 30 | 25 | 60,9 | 45,7 | 40 | 32 | 82,3 | 61,7 |
| | | 250 | 273 | 6,3 | 5 | 14,5 | 10,9 | 8,8 | 6,3 | 18,7 | 14,0 | 10 | 8,8 | 20,6 | 15,5 | 12,5 | 10 | 24,7 | 18,6 | 17,5 | 12,5 | 32,7 | 24,6 | 22,2 | 16 | 40,0 | 30,0 | 30 | 22,2 | 51,8 | 38,9 | 40 | 30 | 69,5 | 52,2 |
| | | 200 | 219,1 | 6,3 | 4,5 | 13,1 | 9,9 | 8,8 | 6,3 | 16,9 | 12,7 | 10 | 7,1 | 18,6 | 14,0 | 12,5 | 8 | 22,3 | 16,7 | 17,5 | 12,5 | 29,6 | 22,2 | 22,2 | 16 | 36,3 | 27,3 | 30 | 17,5 | 47,1 | 35,3 | 40 | 22,2 | 60,2 | 45,2 |
| | | 150 | 168,3 | 6,3 | 4 | 11,7 | 8,8 | 8,8 | 4,5 | 15,2 | 11,4 | 10 | 5,6 | 16,7 | 12,6 | 12,5 | 7,1 | 19,9 | 15,0 | 17,5 | 11 | 26,6 | 20,0 | 22,2 | 14,2 | 32,7 | 24,5 | 30 | 17,5 | 42,5 | 31,9 | 40 | 22,2 | 54,5 | 40,9 |
| 450 | 457 | 450 | 457 | 6,3 | 6,3 | 18,3 | 13,7 | 10 | 10 | 26,8 | 20,1 | 11 | 11 | 29,4 | 22,1 | 12,5 | 12,5 | 33,3 | 25,0 | 17,5 | 17,5 | 46,8 | 35,1 | 22,2 | 22,2 | 59,9 | 45,0 | 32 | 32 | 88,2 | 66,2 | 45 | 45 | 128 | 95,7 |
| | | 400 | 406,4 | 6,3 | 6,3 | 17,1 | 12,9 | 10 | 8,8 | 24,1 | 18,1 | 11 | 10 | 26,3 | 19,7 | 12,5 | 12,5 | 29,2 | 21,9 | 17,5 | 17,5 | 39,7 | 29,8 | 22,2 | 22,2 | 50,7 | 38,0 | 32 | 30 | 74,3 | 55,7 | 45 | 40 | 107 | 80,1 |
| | | 350 | 355,6 | 6,3 | 5,6 | 16,1 | 12,1 | 10 | 8 | 22,8 | 17,1 | 11 | 10 | 24,5 | 18,4 | 12,5 | 12,5 | 27,1 | 20,4 | 17,5 | 16 | 35,8 | 26,8 | 22,2 | 20 | 43,6 | 32,7 | 32 | 28 | 63,0 | 47,3 | 45 | 36 | 90,1 | 67,6 |
| | | 300 | 323,9 | 6,3 | 5,6 | 15,3 | 11,5 | 10 | 7,1 | 21,7 | 16,3 | 11 | 8,8 | 23,3 | 17,5 | 12,5 | 10 | 25,9 | 19,4 | 17,5 | 12,5 | 34,2 | 25,7 | 22,2 | 17,5 | 41,8 | 31,4 | 32 | 25 | 57,8 | 43,4 | 45 | 32 | 82,4 | 61,8 |
| | | 250 | 273 | 6,3 | 5 | 14,1 | 10,6 | 10 | 6,3 | 20,0 | 15,0 | 11 | 8,8 | 21,6 | 16,2 | 12,5 | 10 | 24,0 | 18,0 | 17,5 | 12,5 | 31,7 | 23,8 | 22,2 | 16 | 38,8 | 29,1 | 32 | 22,2 | 53,0 | 39,7 | 45 | 30 | 71,7 | 53,8 |
| | | 200 | 219,1 | 6,3 | 4,5 | 12,8 | 9,6 | 10 | 6,3 | 18,2 | 13,6 | 11 | 7,1 | 19,5 | 14,7 | 12,5 | 8 | 21,7 | 16,3 | 17,5 | 12,5 | 28,9 | 21,7 | 22,2 | 16 | 35,4 | 26,5 | 32 | 17,5 | 48,5 | 36,4 | 45 | 22,2 | 65,0 | 48,8 |
| 500 | 508 | 500 | 508 | 6,3 | 6,3 | 18,8 | 14,1 | 10 | 10 | 27,2 | 20,4 | 11 | 11 | 29,5 | 22,2 | 12,5 | 12,5 | 33,4 | 25,1 | 17,5 | 17,5 | 46,7 | 35,0 | 25 | 25 | 67,6 | 50,7 | 36 | 36 | 99,4 | 74,6 | 50 | 50 | 142 | 107 |
| | | 450 | 457 | 6,3 | 6,3 | 17,7 | 13,3 | 10 | 10 | 25,0 | 18,8 | 11 | 11 | 26,9 | 20,2 | 12,5 | 12,5 | 29,9 | 22,5 | 17,5 | 17,5 | 40,3 | 30,2 | 25 | 22,2 | 57,5 | 43,1 | 36 | 32 | 84,2 | 63,1 | 50 | 45 | 121 | 90,6 |
| | | 400 | 406,4 | 6,3 | 6,3 | 16,6 | 12,5 | 10 | 8,8 | 23,5 | 17,6 | 11 | 10 | 25,4 | 19,1 | 12,5 | 12,5 | 28,3 | 21,2 | 17,5 | 17,5 | 37,3 | 28,0 | 25 | 22,2 | 50,7 | 38,0 | 36 | 30 | 73,9 | 55,5 | 50 | 40 | 105 | 78,3 |
| | | 300 | 323,9 | 6,3 | 5,6 | 14,9 | 11,2 | 10 | 7,1 | 21,1 | 15,8 | 11 | 8,8 | 22,7 | 17,0 | 12,5 | 10 | 25,1 | 18,9 | 17,5 | 12,5 | 33,2 | 24,9 | 25 | 17,5 | 44,9 | 33,7 | 36 | 25 | 61,2 | 45,9 | 50 | 32 | 84,0 | 63,0 |
| | | 250 | 273 | 6,3 | 5 | 13,7 | 10,3 | 10 | 6,3 | 19,5 | 14,6 | 11 | 8,8 | 21,0 | 15,8 | 12,5 | 10 | 23,4 | 17,5 | 17,5 | 12,5 | 30,9 | 23,2 | 25 | 16 | 41,9 | 31,4 | 36 | 22,2 | 57,1 | 42,9 | 50 | 30 | 75,6 | 56,7 |
| 600 | 610 | 600 | 610 | 6,3 | 6,3 | 19,4 | 14,6 | 10 | 10 | 29,4 | 22,1 | 12,5 | 12,5 | 36,5 | 27,4 | 17,5 | 17,5 | 51,5 | 38,7 | 25 | 25 | 74,9 | 56,2 | 30 | 30 | 90,9 | 68,2 | 45 | 45 | 142 | 106 | 60 | 60 | 192 | 144 |
| | | 500 | 508 | 6,3 | 6,3 | 17,8 | 13,3 | 10 | 10 | 25,1 | 18,8 | 12,5 | 11 | 29,7 | 22,3 | 17,5 | 12,5 | 34,5 | 25,9 | 25 | 17,5 | 46,9 | 35,2 | 30 | 25 | 67,6 | 50,7 | 45 | 36 | 99,1 | 74,4 | 60 | 50 | 141 | 106 |
| | | 400 | 406,4 | 6,3 | 6,3 | 15,8 | 11,9 | 10 | 8,8 | 22,3 | 16,8 | 12,5 | 10 | 26,8 | 20,1 | 17,5 | 12,5 | 35,3 | 26,5 | 25 | 17,5 | 47,6 | 35,7 | 30 | 22,2 | 55,5 | 41,6 | 45 | 30 | 81,7 | 61,3 | 60 | 40 | 111 | 82,6 |
| | | 300 | 323,9 | 6,3 | 5,6 | 14,3 | 10,7 | 10 | 7,1 | 20,2 | 15,2 | 12,5 | 8,8 | 23,9 | 18,0 | 17,5 | 10 | 31,6 | 23,7 | 25 | 12,5 | 40,6 | 30,5 | 30 | 17,5 | 50,1 | 37,6 | 45 | 25 | 70,8 | 53,1 | 60 | 32 | 92,0 | 69,0 |
| | | 250 | 273 | 6,3 | 5 | 13,2 | 9,9 | 10 | 6,3 | 18,7 | 14,0 | 12,5 | 8,8 | 22,4 | 16,8 | 17,5 | 10 | 29,6 | 22,2 | 25 | 12,5 | 40,1 | 30,1 | 30 | 16 | 47,0 | 35,2 | 45 | 22,2 | 66,6 | 49,9 | 60 | 30 | 85,2 | 63,9 |

Table C.2 (continued)

| DN | D | DN ₁ | D ₁ | 1 | | | | 2 | | | | 3 | | | | 4 | | | | 5 | | | | 6 | | | | 7 | | | | 8 | | | | | | | |
|-----|-----|-----------------|----------------|-----|----------------|----------------|----------------|------|----------------|----------------|----------------|------|----------------|----------------|----------------|----|----------------|----------------|----------------|---|----------------|----------------|----------------|---|----------------|----------------|----------------|---|----------------|----------------|----------------|---|----------------|----------------|----------------|---|---|---|---|
| | | | | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | | | | |
| 700 | 711 | 700 | 711 | 7,1 | 7,1 | 22,2 | 16,7 | 10 | 10 | 28,7 | 21,6 | 12,5 | 12,5 | 34,9 | 26,2 | 25 | 25 | 69,7 | 52,4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| | | 600 | 610 | 7,1 | 6,3 | 20,5 | 15,8 | 10 | 10 | 26,5 | 21,4 | 12,5 | 12,5 | 31,3 | 25,2 | 25 | 17,5 | 46,3 | 34,7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| | | 500 | 508 | 7,1 | 6,3 | 18,6 | 14,9 | 10 | 10 | 24,1 | 19,4 | 12,5 | 11 | 28,4 | 22,9 | 25 | 12,5 | 37,3 | 28,0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 400 | 406,4 | 7,1 | 6,3 | 16,6 | 13,3 | 10 | 8,8 | 21,5 | 17,4 | 12,5 | 10 | 25,7 | 20,8 | 25 | 12,5 | 40,7 | 30,5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 300 | 323,9 | 7,1 | 5,6 | 15,1 | 12,0 | 10 | 7,1 | 19,5 | 15,8 | 12,5 | 8,8 | 23,2 | 18,7 | 25 | 10 | 36,8 | 27,6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 800 | 813 | 800 | 813 | 8 | 8 | 25,2 | 18,9 | 10 | 10 | 29,7 | 22,3 | 12,5 | 12,5 | 35,5 | 26,6 | 25 | 25 | 68,9 | 51,8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| | | 700 | 711 | 8 | 7,1 | 23,3 | 17,5 | 10 | 10 | 27,5 | 20,7 | 12,5 | 12,5 | 32,5 | 24,4 | 25 | 25 | 57,1 | 42,9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 600 | 610 | 8 | 6,3 | 21,6 | 16,8 | 10 | 10 | 25,5 | 20,6 | 12,5 | 12,5 | 30,1 | 24,3 | 25 | 17,5 | 49,5 | 37,2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 500 | 508 | 8 | 6,3 | 19,7 | 15,8 | 10 | 10 | 23,2 | 18,8 | 12,5 | 11 | 27,5 | 22,1 | 25 | 12,5 | 40,1 | 30,1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 400 | 406,4 | 8 | 6,3 | 17,6 | 14,2 | 10 | 8,8 | 20,9 | 16,9 | 12,5 | 10 | 24,9 | 20,1 | 25 | 12,5 | 44,3 | 33,2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 900 | 914 | 900 | 914 | 10 | 10 | 30,6 | 23,0 | 12,5 | 12,5 | 36,1 | 27,1 | 20 | 20 | 55,0 | 41,2 | 25 | 25 | 68,3 | 51,3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| | | 800 | 813 | 10 | 8 | 26,5 | 19,9 | 12,5 | 10 | 31,3 | 23,5 | 20 | 12,5 | 36,9 | 27,7 | 25 | 25 | 58,6 | 43,9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| | | 700 | 711 | 10 | 7,1 | 24,9 | 18,7 | 12,5 | 10 | 31,5 | 23,6 | 20 | 12,5 | 38,1 | 28,6 | 25 | 25 | 55,0 | 41,3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 600 | 610 | 10 | 6,3 | 23,7 | 17,8 | 12,5 | 10 | 29,2 | 23,5 | 20 | 12,5 | 40,0 | 30,0 | 25 | 17,5 | 50,7 | 39,7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 500 | 508 | 10 | 6,3 | 22,6 | 18,2 | 12,5 | 10 | 26,7 | 21,5 | 20 | 11 | 38,6 | 28,9 | 25 | 12,5 | 42,9 | 32,2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 400 | 406,4 | 10 | 6,3 | 20,3 | 16,4 | 12,5 | 8,8 | 24,1 | 19,5 | 20 | 10 | 35,6 | 29,4 | 25 | 12,5 | 43,1 | 35,7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

Table C.2 (continued)

| DN | D | DN ₁ | D ₁ | 1 | | | | 2 | | | | 3 | | | | 4 | | | | 5 | | | | 6 | | | | 7 | | | | 8 | | | | |
|------|------|-----------------|----------------|----|----------------|----------------|----------------|------|----------------|----------------|----------------|----|----------------|----------------|----------------|----|----------------|----------------|----------------|---|----------------|----------------|----------------|---|----------------|----------------|----------------|---|----------------|----------------|----------------|---|----------------|----------------|----------------|---|
| | | | | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | T | T ₁ | T _s | T _b | |
| 1000 | 1016 | 1000 | 1016 | 10 | 10 | 31,5 | 23,6 | 12,5 | 12,5 | 37,1 | 27,9 | 20 | 20 | 55,0 | 41,3 | 25 | 25 | 68,3 | 51,2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| | | 900 | 914 | 10 | 10 | 29,8 | 22,4 | 12,5 | 12,5 | 35,2 | 26,4 | 20 | 20 | 50,0 | 37,5 | 25 | 25 | 59,8 | 44,9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| | | 800 | 813 | 10 | 8 | 27,9 | 21,0 | 12,5 | 10 | 33,0 | 24,7 | 20 | 12,5 | 39,0 | 29,2 | 25 | 25 | 56,5 | 42,4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 700 | 711 | 10 | 7,1 | 25,9 | 19,4 | 12,5 | 10 | 30,6 | 22,9 | 20 | 12,5 | 40,3 | 30,2 | 25 | 25 | 53,4 | 40,1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 600 | 610 | 10 | 6,3 | 24,1 | 18,7 | 12,5 | 10 | 28,5 | 22,9 | 20 | 12,5 | 41 | 31,8 | 25 | 17,5 | 49,4 | 40,8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1200 | 1219 | 1200 | 1219 | 10 | 10 | 32,4 | 24,3 | 12,5 | 12,5 | 38,2 | 28,7 | 20 | 20 | 56,7 | 42,5 | 25 | 25 | 70,6 | 52,9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| | | 1000 | 1016 | 10 | 10 | 29,5 | 22,1 | 12,5 | 12,5 | 34,8 | 26,1 | 20 | 20 | 50,5 | 37,9 | 25 | 25 | 60,5 | 45,4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 900 | 914 | 10 | 10 | 27,8 | 20,9 | 12,5 | 12,5 | 32,8 | 24,6 | 20 | 20 | 48,2 | 36,2 | 25 | 25 | 57,8 | 43,3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 800 | 813 | 10 | 8 | 26,4 | 19,8 | 12,5 | 10 | 31,1 | 23,4 | 20 | 12,5 | 42,6 | 32,0 | 25 | 25 | 54,3 | 40,7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 700 | 711 | 10 | 7,1 | 24,6 | 18,5 | 12,5 | 10 | 29,1 | 21,8 | 20 | 12,5 | 42,4 | 31,8 | 25 | 25 | 51,4 | 38,5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

C.4 Reducers

Tables C.3 to C.6 show the wall thicknesses of concentric and eccentric reducers of type B.

The data listed is applicable if all of the following conditions apply:

- semi angle of the reducer is not larger than the values listed in Tables C.3 to C.6 ;
- each of the lengths L_2 and L_4 at the ends of the reducer is at least 10 % of the total length L listed in Table 15 ;
- at the transitions between the cylindrical sections and the conical sections the inside and outside surfaces shall merge smoothly ;
- the length L'_2 between a knuckle and the major end of a reducer is at least :

$$L'_2 \geq 0,5 \cdot \sqrt{(D - T_2) \cdot T_2} \quad (C-1)$$

or, alternatively, at least $L'_{2,\min}$ given by formula (A-49). The wall thickness of such a knuckle shall be at least T_2 ;

- transition between the cylindrical sections and the conical section at the minor end may be curved too. The wall thickness of the knuckle shall be at least the maximum of $T_{3,\min}$ and $T_{4,\min}$.

If a wall thickness is shown in brackets the length required at the end of the reducer is larger than 10 % of the total length L listed in Table 15. In this case the length shall be at least $L_{2,\min}$ or $L_{4,\min}$ given by (A-60) or (A-61) or the wall thickness shall be increased in accordance with (A-62) or (A-63).

Smaller wall thicknesses than listed in Tables C.3 to C.6 are acceptable provided that they are calculated in accordance with Annex A. e.g. for smaller semi angles α .

NOTE For the calculation of the wall thickness tolerances of T , T_2 and T_3 the diameter D should be used. For the calculation of the wall thickness tolerance of T_1 and T_4 the diameter D_1 should be used.

Table C.3 — Wall thickness of concentric reducers type B – wall thickness series 1 to 4

| DN | D | DN ₁ | D ₁ | α _{max} | 1 | | | | | 2 | | | | | 3 | | | | | 4 | | | | |
|-----|-------|-----------------|----------------|------------------|---|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|
| | | | | | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ |
| 20 | 26,9 | 15 | 21,3 | 8 | - | - | - | - | - | 2,3 | 2 | 2,3 | 2,3 | 2,0 | 2,6 | 2,6 | 2,6 | 2,6 | 2,6 | 3,2 | 3,2 | 3,2 | 3,1 | 3,2 |
| 25 | 33,7 | 20 | 26,9 | 7 | - | - | - | - | - | 2,6 | 2,3 | 2,6 | 2,6 | 2,3 | 3,2 | 2,6 | 3,2 | 3,1 | 2,6 | 4 | 3,2 | 4,0 | 3,9 | 3,2 |
| | | 15 | 21,3 | 12 | - | - | - | - | - | 2,6 | 2 | 2,6 | 2,5 | 2,0 | 3,2 | 2,6 | 3,2 | 3,1 | 2,6 | 4 | 3,2 | 4,0 | 3,8 | 3,2 |
| 32 | 42,4 | 25 | 33,7 | 9 | - | - | - | - | - | 2,6 | 2,6 | 2,6 | 2,6 | 2,6 | 3,6 | 3,2 | 3,6 | 3,5 | 3,2 | 4 | 4 | 4,0 | 3,9 | 4,0 |
| | | 20 | 26,9 | 15 | - | - | - | - | - | 2,6 | 2,3 | 2,6 | 2,6 | 2,3 | 3,6 | 2,6 | 3,6 | 3,5 | 2,6 | 4 | 3,2 | 4,0 | 3,8 | 3,2 |
| | | 15 | 21,3 | 19 | - | - | - | - | - | 2,6 | 2 | 2,6 | 2,6 | 2,0 | 3,6 | 2,6 | 3,6 | 3,5 | 2,6 | 4 | 3,2 | 4,0 | 3,8 | 3,2 |
| 40 | 48,3 | 32 | 42,4 | 6 | - | - | - | - | - | 2,6 | 2,6 | 2,6 | 2,6 | 2,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 4 | 4 | 4,0 | 3,9 | 4,0 |
| | | 25 | 33,7 | 10 | - | - | - | - | - | 2,6 | 2,6 | 2,6 | 2,6 | 2,6 | 3,6 | 3,2 | 3,6 | 3,5 | 3,2 | 4 | 4 | 4,0 | 3,9 | 4,0 |
| | | 20 | 26,9 | 16 | - | - | - | - | - | 2,6 | 2,3 | 2,6 | 2,6 | 2,3 | 3,6 | 2,6 | 3,6 | 3,5 | 2,6 | 4 | 3,2 | 4,0 | 3,9 | 3,2 |
| 50 | 60,3 | 40 | 48,3 | 7 | - | - | - | - | - | 2,9 | 2,6 | 2,9 | 2,9 | 2,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 4 | 4 | 4,0 | 4,0 | 4,0 |
| | | 32 | 42,4 | 11 | - | - | - | - | - | 2,9 | 2,6 | 2,9 | 2,9 | 2,6 | 3,6 | 3,6 | 3,6 | 3,5 | 3,6 | 4 | 4 | 4,0 | 3,9 | 4,0 |
| | | 25 | 33,7 | 16 | - | - | - | - | - | 2,9 | 2,6 | 2,9 | 2,9 | 2,6 | 3,6 | 3,2 | 3,6 | 3,5 | 3,2 | 4 | 4 | 4,0 | 3,9 | 4,0 |
| | | 20 | 26,9 | 21 | - | - | - | - | - | 2,9 | 2,3 | 2,9 | 2,9 | 2,3 | 3,6 | 2,6 | 3,6 | 3,6 | 2,6 | 4 | 3,2 | 4,0 | 3,9 | 3,2 |
| 65 | 76,1 | 50 | 60,3 | 9 | - | - | - | - | - | 2,9 | 2,9 | 2,9 | 2,9 | 2,9 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 5,6 | 4 | 5,6 | 4,9 | 4,0 |
| | | 40 | 48,3 | 15 | - | - | - | - | - | 2,9 | 2,6 | 2,9 | 2,9 | 2,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 5,6 | 4 | 5,6 | 5,4 | 4,0 |
| | | 32 | 42,4 | 18 | - | - | - | - | - | 2,9 | 2,6 | 2,9 | 2,9 | 2,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 5,6 | 4 | 5,6 | 5,4 | 4,0 |
| | | 25 | 33,7 | 23 | - | - | - | - | - | 2,9 | 2,6 | 2,9 | 3,0 | 2,6 | 3,6 | 3,2 | 3,6 | 3,6 | 3,2 | 5,6 | 4 | 5,6 | 5,4 | 4,0 |
| 80 | 88,9 | 65 | 76,1 | 7 | - | - | - | - | - | 3,2 | 2,9 | 3,2 | 3,2 | 2,9 | 4 | 3,6 | 4,0 | 4,0 | 3,6 | 5,6 | 5,6 | 5,6 | 5,5 | 5,6 |
| | | 50 | 60,3 | 16 | - | - | - | - | - | 3,2 | 2,9 | 3,2 | 3,2 | 2,9 | 4 | 3,6 | 4,0 | 4,0 | 3,6 | 5,6 | 4 | 5,6 | 5,5 | 4,0 |
| | | 40 | 48,3 | 22 | - | - | - | - | - | 3,2 | 2,6 | 3,2 | 3,3 | 2,6 | 4 | 3,6 | 4,0 | 4,0 | 3,6 | 5,6 | 4 | 5,6 | 5,5 | 4,0 |
| | | 32 | 42,4 | 26 | - | - | - | - | - | 3,2 | 2,6 | 3,2 | 3,3 | 2,6 | 4 | 3,6 | 4,0 | 4,1 | 3,6 | 5,6 | 4 | 5,6 | 5,5 | 4,0 |
| 100 | 114,3 | 80 | 88,9 | 13 | - | - | - | - | - | 3,6 | 3,2 | 3,6 | 3,6 | 3,2 | 4,5 | 4 | 4,5 | 4,5 | 4,0 | 6,3 | 5,6 | 6,3 | 6,2 | 5,6 |
| | | 65 | 76,1 | 18 | - | - | - | - | - | 3,6 | 2,9 | 3,6 | 3,6 | 2,9 | 4,5 | 3,6 | 4,5 | 4,5 | 3,6 | 6,3 | 5,6 | 6,3 | 6,2 | 5,6 |
| | | 50 | 60,3 | 26 | - | - | - | - | - | 3,6 | 2,9 | 3,6 | 3,7 | 2,9 | 4,5 | 3,6 | 4,5 | 4,6 | 3,6 | 6,3 | 4 | 6,3 | 6,3 | 4,0 |
| | | 40 | 48,3 | 31 | - | - | - | - | - | 3,6 | 2,6 | 3,6 | 3,8 | 2,6 | 4,5 | 3,6 | 4,5 | 4,7 | 3,6 | 6,3 | 4 | 6,3 | 6,4 | 4,0 |

Table C.3 (continued)

| DN | D | DN ₁ | D ₁ | α _{max} | 1 | | | | | 2 | | | | | 3 | | | | | 4 | | | | |
|-----|-------|-----------------|----------------|------------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|
| | | | | | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ |
| 125 | 139,7 | 100 | 114,3 | 10 | - | - | - | - | - | 4 | 3,6 | 4,0 | 4,0 | 3,6 | 5 | 4,5 | 5,0 | 5,0 | 4,5 | 6,3 | 6,3 | 6,3 | 6,2 | 6,3 |
| | | 80 | 88,9 | 20 | - | - | - | - | - | 4 | 3,2 | 4,0 | 4,1 | 3,2 | 5 | 4 | 5,0 | 5,0 | 4,0 | 6,3 | 5,6 | 6,3 | 6,3 | 5,6 |
| | | 65 | 76,1 | 25 | - | - | - | - | - | 4 | 2,9 | 4,0 | 4,1 | 2,9 | 5 | 3,6 | 5,0 | 5,1 | 3,6 | 6,3 | 5,6 | 6,3 | 6,3 | 5,6 |
| | | 50 | 60,3 | 30 | - | - | - | - | - | 4 | 2,9 | 4,0 | 4,3 | 2,9 | 5 | 3,6 | 5,0 | 5,2 | 3,6 | 6,3 | 4 | 6,3 | 6,5 | 4,0 |
| 150 | 168,3 | 125 | 139,7 | 9 | - | - | - | - | - | 4,5 | 4 | 4,5 | 4,5 | 4,0 | 5,6 | 5 | 5,6 | 5,6 | 5,0 | 7,1 | 6,3 | 7,1 | 7,0 | 6,3 |
| | | 100 | 114,3 | 19 | - | - | - | - | - | 4,5 | 3,6 | 4,5 | 4,6 | 3,6 | 5,6 | 4,5 | 5,6 | 5,6 | 4,5 | 7,1 | 6,3 | 7,1 | 7,1 | 6,3 |
| | | 80 | 88,9 | 27 | - | - | - | - | - | 4,5 | 3,2 | 4,5 | 4,7 | 3,2 | 5,6 | 4 | 5,6 | 5,8 | 4,0 | 7,1 | 5,6 | 7,1 | 7,2 | 5,6 |
| | | 65 | 76,1 | 31 | - | - | - | - | - | 4,5 | 2,9 | 4,5 | 4,8 | 2,9 | 5,6 | 3,6 | 5,6 | 5,9 | 3,6 | 7,1 | 5,6 | 7,1 | 7,4 | 5,6 |
| 200 | 219,1 | 150 | 168,3 | 18 | 4,5 | 4 | 4,5 | 4,6 | 4,0 | 6,3 | 4,5 | 6,3 | 5,9 | 4,5 | 7,1 | 5,6 | 7,1 | 7,1 | 5,6 | 8 | 7,1 | 8,0 | 8,0 | 7,1 |
| | | 125 | 139,7 | 27 | - | - | - | - | - | 6,3 | 4 | 6,3 | 6,5 | 4,0 | 7,1 | 5 | 7,1 | 7,3 | 5,0 | 8 | 6,3 | 8,0 | 8,2 | 6,3 |
| | | 100 | 114,3 | 33 | - | - | - | - | - | 6,3 | 3,6 | 6,3 | 6,8 | 3,6 | 7,1 | 4,5 | 7,1 | 7,6 | 4,5 | 8 | 6,3 | 8,0 | 8,5 | 6,3 |
| | | 80 | 88,9 | 39 | - | - | - | - | - | 6,3 | 3,2 | 6,3 | 7,1 | 3,2 | 7,1 | 4 | 7,1 | 8,0 | 4,0 | 8 | 5,6 | 8,0 | 8,9 | 5,6 |
| 250 | 273 | 200 | 219,1 | 16 | 5 | 4,5 | 5,0 | 5,1 | 4,5 | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 | 8,8 | 7,1 | 8,8 | 8,8 | 7,1 | 10 | 8 | 10,0 | 9,9 | 8,0 |
| | | 150 | 168,3 | 30 | 5 | 4 | 5,0 | 5,4 | 4,0 | 6,3 | 4,5 | 6,3 | 6,7 | 4,5 | 8,8 | 5,6 | 8,8 | 9,2 | 5,6 | 10 | 7,1 | 10,0 | 10,4 | 7,1 |
| | | 125 | 139,7 | 36 | - | - | - | - | - | 6,3 | 4 | 6,3 | 7,1 | 4,0 | 8,8 | 5 | 8,8 | 9,6 | 5,0 | 10 | 6,3 | 10,0 | 10,8 | 6,3 |
| | | 100 | 114,3 | 40 | - | - | - | - | - | 6,3 | 3,6 | 6,3 | 7,3 | 3,6 | 8,8 | 4,5 | 8,8 | 10,0 | 4,5 | 10 | 6,3 | 10,0 | 11,2 | 6,3 |
| 300 | 323,9 | 250 | 273 | 12 | 5,6 | 5 | 5,6 | 5,6 | 5,0 | 7,1 | 6,3 | 7,1 | 7,1 | 6,3 | 8,8 | 8,8 | 8,8 | 8,7 | 8,8 | 10 | 10 | 10,0 | 9,9 | 10,0 |
| | | 200 | 219,1 | 24 | 5,6 | 4,5 | 5,6 | 5,8 | 4,5 | 7,1 | 6,3 | 7,1 | 7,3 | 6,3 | 8,8 | 7,1 | 8,8 | 9,0 | 7,1 | 10 | 8 | 10,0 | 10,2 | 8,0 |
| | | 150 | 168,3 | 35 | 5,6 | 4 | 5,6 | 6,3 | 4,0 | 7,1 | 4,5 | 7,1 | 7,9 | 4,5 | 8,8 | 5,6 | 8,8 | 9,7 | 5,6 | 10 | 7,1 | 10,0 | 10,9 | 7,1 |
| | | 125 | 139,7 | 40 | - | - | - | - | - | 7,1 | 4 | 7,1 | 8,3 | 4,0 | 8,8 | 5 | 8,8 | 10,1 | 5,0 | 10 | 6,3 | 10,0 | 11,4 | 6,3 |

Table C.3 (continued)

| DN | D | DN ₁ | D ₁ | α_{\max} | 1 | | | | | 2 | | | | | 3 | | | | | 4 | | | | |
|-----|-------|-----------------|----------------|-----------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|
| | | | | | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ |
| 350 | 355,6 | 300 | 323,9 | 6 | 5,6 | 5,6 | 5,6 | 5,6 | 5,6 | 8 | 7,1 | 8,0 | 7,8 | 7,1 | 10 | 8,8 | 10,0 | 9,6 | 8,8 | 12,5 | 10 | 12,5 | 10,8 | 10,0 |
| | | 250 | 273 | 14 | 5,6 | 5 | 5,6 | 5,7 | 5,0 | 8 | 6,3 | 8,0 | 8,0 | 6,3 | 10 | 8,8 | 10,0 | 9,9 | 8,8 | 12,5 | 10 | 12,5 | 12,4 | 10,0 |
| | | 200 | 219,1 | 22 | 5,6 | 4,5 | 5,6 | 5,8 | 4,5 | 8 | 6,3 | 8,0 | 8,2 | 6,3 | 10 | 7,1 | 10,0 | 10,1 | 7,1 | 12,5 | 8 | 12,5 | 12,6 | 8,0 |
| | | 150 | 168,3 | 29 | 5,6 | 4 | 5,6 | 6,0 | 4,0 | 8 | 4,5 | 8,0 | 8,5 | 4,5 | 10 | 5,6 | 10,0 | 10,5 | 5,6 | 12,5 | 7,1 | 12,5 | 13,0 | 7,1 |
| 400 | 406,4 | 350 | 355,6 | 8 | 6,3 | 5,6 | 6,3 | 6,3 | 5,6 | 8,8 | 8 | 8,8 | 8,8 | 8,0 | 10 | 10 | 10,0 | 9,9 | 10,0 | 12,5 | 12,5 | 12,5 | 12,4 | 12,5 |
| | | 300 | 323,9 | 13 | 6,3 | 5,6 | 6,3 | 6,3 | 5,6 | 8,8 | 7,1 | 8,8 | 8,8 | 7,1 | 10 | 8,8 | 10,0 | 10,0 | 8,8 | 12,5 | 10 | 12,5 | 12,4 | 10,0 |
| | | 250 | 273 | 21 | 6,3 | 5 | 6,3 | 6,5 | 5,0 | 8,8 | 6,3 | 8,8 | 9,0 | 6,3 | 10 | 8,8 | 10,0 | 10,2 | 8,8 | 12,5 | 10 | 12,5 | 12,6 | 10,0 |
| | | 200 | 219,1 | 28 | 6,3 | 4,5 | 6,3 | 6,7 | 4,5 | 8,8 | 6,3 | 8,8 | 9,3 | 6,3 | 10 | 7,1 | 10,0 | 10,5 | 7,1 | 12,5 | 8 | 12,5 | 13,0 | 8,0 |
| 450 | 457 | 400 | 406,4 | 7 | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 | 10 | 8,8 | 10,0 | 9,8 | 8,8 | 11 | 10 | 11,0 | 10,9 | 10,0 | 12,5 | 12,5 | 12,5 | 12,4 | 12,5 |
| | | 350 | 355,6 | 14 | 6,3 | 5,6 | 6,3 | 6,4 | 5,6 | 10 | 8 | 10,0 | 10,0 | 8,0 | 11 | 10 | 11,0 | 11,0 | 10,0 | 12,5 | 12,5 | 12,5 | 12,4 | 12,5 |
| | | 300 | 323,9 | 18 | 6,3 | 5,6 | 6,3 | 6,4 | 5,6 | 10 | 7,1 | 10,0 | 10,1 | 7,1 | 11 | 8,8 | 11,0 | 11,1 | 8,8 | 12,5 | 10 | 12,5 | 12,5 | 10,0 |
| | | 250 | 273 | 25 | 6,3 | 5 | 6,3 | 6,6 | 5,0 | 10 | 6,3 | 10,0 | 10,4 | 6,3 | 11 | 8,8 | 11,0 | 11,4 | 8,8 | 12,5 | 10 | 12,5 | 12,8 | 10,0 |
| 500 | 508 | 450 | 457 | 4 | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 | 10 | 10 | 10,0 | 10,0 | 10,0 | 11 | 11 | 11,0 | 11,0 | 11,0 | 12,5 | 12,5 | 12,5 | 12,4 | 12,5 |
| | | 400 | 406,4 | 10 | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 | 10 | 8,8 | 10,0 | 10,0 | 8,8 | 11 | 10 | 11,0 | 10,9 | 10,0 | 12,5 | 12,5 | 12,5 | 12,4 | 12,5 |
| | | 350 | 355,6 | 17 | 6,3 | 5,6 | 6,3 | 6,4 | 5,6 | 10 | 8 | 10,0 | 10,1 | 8,0 | 11 | 10 | 11,0 | 11,1 | 10,0 | 12,5 | 12,5 | 12,5 | 12,5 | 12,5 |
| | | 300 | 323,9 | 20 | 6,3 | 5,6 | 6,3 | 6,5 | 5,6 | 10 | 7,1 | 10,0 | 10,2 | 7,1 | 11 | 8,8 | 11,0 | 11,2 | 8,8 | 12,5 | 10 | 12,5 | 12,6 | 10,0 |
| 600 | 610 | 500 | 508 | 10 | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 | 10 | 10 | 10,0 | 10,0 | 10,0 | 12,5 | 11 | 12,5 | 12,4 | 11,0 | 17,5 | 12,5 | 17,5 | 14,8 | 12,5 |
| | | 450 | 457 | 15 | 6,3 | 6,3 | 6,3 | 6,4 | 6,3 | 10 | 10 | 10,0 | 10,1 | 10,0 | 12,5 | 11 | 12,5 | 12,5 | 11,0 | 17,5 | 12,5 | 17,5 | 16,6 | 12,5 |
| | | 400 | 406,4 | 21 | 6,3 | 6,3 | 6,3 | 6,6 | 6,3 | 10 | 8,8 | 10,0 | 10,3 | 8,8 | 12,5 | 10 | 12,5 | 12,8 | 10,0 | 17,5 | 12,5 | 17,5 | 17,6 | 12,5 |
| 700 | 711 | 600 | 610 | 10 | 7,1 | 6,3 | 7,1 | 7,1 | 6,3 | 10 | 10 | 10,0 | 10,0 | 10,0 | 12,5 | 12,5 | 12,5 | 12,5 | 12,5 | 25 | 17,5 | 25,0 | 19,9 | 17,5 |
| | | 500 | 508 | 15 | 7,1 | 6,3 | 7,1 | 7,2 | 6,3 | 10 | 10 | 10,0 | 10,2 | 10,0 | 12,5 | 11 | 12,5 | 12,6 | 11,0 | 25 | 12,5 | 25,0 | 17,1 | 12,5 |
| | | 400 | 406,4 | 25 | 7,1 | 6,3 | 7,1 | 7,5 | 6,3 | 10 | 8,8 | 10,0 | 10,6 | 8,8 | 12,5 | 10 | 12,5 | 13,0 | 10,0 | 25 | 12,5 | 25,0 | 22,1 | 12,5 |
| 800 | 813 | 700 | 711 | 10 | 8 | 7,1 | 8,0 | 8,0 | 7,1 | 10 | 10 | 10,0 | 10,0 | 10,0 | 12,5 | 12,5 | 12,5 | 12,5 | 12,5 | 25 | 25 | 25,0 | 24,7 | 25,0 |
| | | 600 | 610 | 15 | 8 | 6,3 | 8,0 | 8,1 | 6,3 | 10 | 10 | 10,0 | 10,2 | 10,0 | 12,5 | 12,5 | 12,5 | 12,6 | 12,5 | 25 | 17,5 | 25,0 | 23,1 | 17,5 |
| | | 500 | 508 | 20 | 8 | 6,3 | 8,0 | 8,3 | 6,3 | 10 | 10 | 10,0 | 10,4 | 10,0 | 12,5 | 11 | 12,5 | 12,8 | 11,0 | 25 | 12,5 | 25,0 | 20,0 | 12,5 |

Table C.3 — Wall thickness of concentric reducers type B – wall thickness series 1 to 4

| DN | D | DN ₁ | D ₁ | α _{max} | 1 | | | | | 2 | | | | | 3 | | | | | 4 | | | | |
|-----|-------|-----------------|----------------|------------------|---|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|
| | | | | | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ |
| 20 | 26,9 | 15 | 21,3 | 8 | - | - | - | - | - | 2,3 | 2 | 2,3 | 2,3 | 2,0 | 2,6 | 2,6 | 2,6 | 2,6 | 2,6 | 3,2 | 3,2 | 3,2 | 3,1 | 3,2 |
| 25 | 33,7 | 20 | 26,9 | 7 | - | - | - | - | - | 2,6 | 2,3 | 2,6 | 2,6 | 2,3 | 3,2 | 2,6 | 3,2 | 3,1 | 2,6 | 4 | 3,2 | 4,0 | 3,9 | 3,2 |
| | | 15 | 21,3 | 12 | - | - | - | - | - | 2,6 | 2 | 2,6 | 2,5 | 2,0 | 3,2 | 2,6 | 3,2 | 3,1 | 2,6 | 4 | 3,2 | 4,0 | 3,8 | 3,2 |
| 32 | 42,4 | 25 | 33,7 | 9 | - | - | - | - | - | 2,6 | 2,6 | 2,6 | 2,6 | 2,6 | 3,6 | 3,2 | 3,6 | 3,5 | 3,2 | 4 | 4 | 4,0 | 3,9 | 4,0 |
| | | 20 | 26,9 | 15 | - | - | - | - | - | 2,6 | 2,3 | 2,6 | 2,6 | 2,3 | 3,6 | 2,6 | 3,6 | 3,5 | 2,6 | 4 | 3,2 | 4,0 | 3,8 | 3,2 |
| | | 15 | 21,3 | 19 | - | - | - | - | - | 2,6 | 2 | 2,6 | 2,6 | 2,0 | 3,6 | 2,6 | 3,6 | 3,5 | 2,6 | 4 | 3,2 | 4,0 | 3,8 | 3,2 |
| 40 | 48,3 | 32 | 42,4 | 6 | - | - | - | - | - | 2,6 | 2,6 | 2,6 | 2,6 | 2,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 4 | 4 | 4,0 | 3,9 | 4,0 |
| | | 25 | 33,7 | 10 | - | - | - | - | - | 2,6 | 2,6 | 2,6 | 2,6 | 2,6 | 3,6 | 3,2 | 3,6 | 3,5 | 3,2 | 4 | 4 | 4,0 | 3,9 | 4,0 |
| | | 20 | 26,9 | 16 | - | - | - | - | - | 2,6 | 2,3 | 2,6 | 2,6 | 2,3 | 3,6 | 2,6 | 3,6 | 3,5 | 2,6 | 4 | 3,2 | 4,0 | 3,9 | 3,2 |
| 50 | 60,3 | 40 | 48,3 | 7 | - | - | - | - | - | 2,9 | 2,6 | 2,9 | 2,9 | 2,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 4 | 4 | 4,0 | 4,0 | 4,0 |
| | | 32 | 42,4 | 11 | - | - | - | - | - | 2,9 | 2,6 | 2,9 | 2,9 | 2,6 | 3,6 | 3,6 | 3,6 | 3,5 | 3,6 | 4 | 4 | 4,0 | 3,9 | 4,0 |
| | | 25 | 33,7 | 16 | - | - | - | - | - | 2,9 | 2,6 | 2,9 | 2,9 | 2,6 | 3,6 | 3,2 | 3,6 | 3,5 | 3,2 | 4 | 4 | 4,0 | 3,9 | 4,0 |
| | | 20 | 26,9 | 21 | - | - | - | - | - | 2,9 | 2,3 | 2,9 | 2,9 | 2,3 | 3,6 | 2,6 | 3,6 | 3,6 | 2,6 | 4 | 3,2 | 4,0 | 3,9 | 3,2 |
| 65 | 76,1 | 50 | 60,3 | 9 | - | - | - | - | - | 2,9 | 2,9 | 2,9 | 2,9 | 2,9 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 5,6 | 4 | 5,6 | 4,9 | 4,0 |
| | | 40 | 48,3 | 15 | - | - | - | - | - | 2,9 | 2,6 | 2,9 | 2,9 | 2,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 5,6 | 4 | 5,6 | 5,4 | 4,0 |
| | | 32 | 42,4 | 18 | - | - | - | - | - | 2,9 | 2,6 | 2,9 | 2,9 | 2,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 5,6 | 4 | 5,6 | 5,4 | 4,0 |
| | | 25 | 33,7 | 23 | - | - | - | - | - | 2,9 | 2,6 | 2,9 | 3,0 | 2,6 | 3,6 | 3,2 | 3,6 | 3,6 | 3,2 | 5,6 | 4 | 5,6 | 5,4 | 4,0 |
| 80 | 88,9 | 65 | 76,1 | 7 | - | - | - | - | - | 3,2 | 2,9 | 3,2 | 3,2 | 2,9 | 4 | 3,6 | 4,0 | 4,0 | 3,6 | 5,6 | 5,6 | 5,6 | 5,5 | 5,6 |
| | | 50 | 60,3 | 16 | - | - | - | - | - | 3,2 | 2,9 | 3,2 | 3,2 | 2,9 | 4 | 3,6 | 4,0 | 4,0 | 3,6 | 5,6 | 4 | 5,6 | 5,5 | 4,0 |
| | | 40 | 48,3 | 22 | - | - | - | - | - | 3,2 | 2,6 | 3,2 | 3,3 | 2,6 | 4 | 3,6 | 4,0 | 4,0 | 3,6 | 5,6 | 4 | 5,6 | 5,5 | 4,0 |
| | | 32 | 42,4 | 26 | - | - | - | - | - | 3,2 | 2,6 | 3,2 | 3,3 | 2,6 | 4 | 3,6 | 4,0 | 4,1 | 3,6 | 5,6 | 4 | 5,6 | 5,5 | 4,0 |
| 100 | 114,3 | 80 | 88,9 | 13 | - | - | - | - | - | 3,6 | 3,2 | 3,6 | 3,6 | 3,2 | 4,5 | 4 | 4,5 | 4,5 | 4,0 | 6,3 | 5,6 | 6,3 | 6,2 | 5,6 |
| | | 65 | 76,1 | 18 | - | - | - | - | - | 3,6 | 2,9 | 3,6 | 3,6 | 2,9 | 4,5 | 3,6 | 4,5 | 4,5 | 3,6 | 6,3 | 5,6 | 6,3 | 6,2 | 5,6 |
| | | 50 | 60,3 | 26 | - | - | - | - | - | 3,6 | 2,9 | 3,6 | 3,7 | 2,9 | 4,5 | 3,6 | 4,5 | 4,6 | 3,6 | 6,3 | 4 | 6,3 | 6,3 | 4,0 |
| | | 40 | 48,3 | 31 | - | - | - | - | - | 3,6 | 2,6 | 3,6 | 3,8 | 2,6 | 4,5 | 3,6 | 4,5 | 4,7 | 3,6 | 6,3 | 4 | 6,3 | 6,4 | 4,0 |

Table C.3 (continued)

| DN | D | DN ₁ | D ₁ | α _{max} | 1 | | | | | 2 | | | | | 3 | | | | | 4 | | | | |
|-----|-------|-----------------|----------------|------------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|
| | | | | | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ |
| 125 | 139,7 | 100 | 114,3 | 10 | - | - | - | - | - | 4 | 3,6 | 4,0 | 4,0 | 3,6 | 5 | 4,5 | 5,0 | 5,0 | 4,5 | 6,3 | 6,3 | 6,3 | 6,2 | 6,3 |
| | | 80 | 88,9 | 20 | - | - | - | - | - | 4 | 3,2 | 4,0 | 4,1 | 3,2 | 5 | 4 | 5,0 | 5,0 | 4,0 | 6,3 | 5,6 | 6,3 | 6,3 | 5,6 |
| | | 65 | 76,1 | 25 | - | - | - | - | - | 4 | 2,9 | 4,0 | 4,1 | 2,9 | 5 | 3,6 | 5,0 | 5,1 | 3,6 | 6,3 | 5,6 | 6,3 | 6,3 | 5,6 |
| | | 50 | 60,3 | 30 | - | - | - | - | - | 4 | 2,9 | 4,0 | 4,3 | 2,9 | 5 | 3,6 | 5,0 | 5,2 | 3,6 | 6,3 | 4 | 6,3 | 6,5 | 4,0 |
| 150 | 168,3 | 125 | 139,7 | 9 | - | - | - | - | - | 4,5 | 4 | 4,5 | 4,5 | 4,0 | 5,6 | 5 | 5,6 | 5,6 | 5,0 | 7,1 | 6,3 | 7,1 | 7,0 | 6,3 |
| | | 100 | 114,3 | 19 | - | - | - | - | - | 4,5 | 3,6 | 4,5 | 4,6 | 3,6 | 5,6 | 4,5 | 5,6 | 5,6 | 4,5 | 7,1 | 6,3 | 7,1 | 7,1 | 6,3 |
| | | 80 | 88,9 | 27 | - | - | - | - | - | 4,5 | 3,2 | 4,5 | 4,7 | 3,2 | 5,6 | 4 | 5,6 | 5,8 | 4,0 | 7,1 | 5,6 | 7,1 | 7,2 | 5,6 |
| | | 65 | 76,1 | 31 | - | - | - | - | - | 4,5 | 2,9 | 4,5 | 4,8 | 2,9 | 5,6 | 3,6 | 5,6 | 5,9 | 3,6 | 7,1 | 5,6 | 7,1 | 7,4 | 5,6 |
| 200 | 219,1 | 150 | 168,3 | 18 | 4,5 | 4 | 4,5 | 4,6 | 4,0 | 6,3 | 4,5 | 6,3 | 5,9 | 4,5 | 7,1 | 5,6 | 7,1 | 7,1 | 5,6 | 8 | 7,1 | 8,0 | 8,0 | 7,1 |
| | | 125 | 139,7 | 27 | - | - | - | - | - | 6,3 | 4 | 6,3 | 6,5 | 4,0 | 7,1 | 5 | 7,1 | 7,3 | 5,0 | 8 | 6,3 | 8,0 | 8,2 | 6,3 |
| | | 100 | 114,3 | 33 | - | - | - | - | - | 6,3 | 3,6 | 6,3 | 6,8 | 3,6 | 7,1 | 4,5 | 7,1 | 7,6 | 4,5 | 8 | 6,3 | 8,0 | 8,5 | 6,3 |
| | | 80 | 88,9 | 39 | - | - | - | - | - | 6,3 | 3,2 | 6,3 | 7,1 | 3,2 | 7,1 | 4 | 7,1 | 8,0 | 4,0 | 8 | 5,6 | 8,0 | 8,9 | 5,6 |
| 250 | 273 | 200 | 219,1 | 16 | 5 | 4,5 | 5,0 | 5,1 | 4,5 | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 | 8,8 | 7,1 | 8,8 | 8,8 | 7,1 | 10 | 8 | 10,0 | 9,9 | 8,0 |
| | | 150 | 168,3 | 30 | 5 | 4 | 5,0 | 5,4 | 4,0 | 6,3 | 4,5 | 6,3 | 6,7 | 4,5 | 8,8 | 5,6 | 8,8 | 9,2 | 5,6 | 10 | 7,1 | 10,0 | 10,4 | 7,1 |
| | | 125 | 139,7 | 36 | - | - | - | - | - | 6,3 | 4 | 6,3 | 7,1 | 4,0 | 8,8 | 5 | 8,8 | 9,6 | 5,0 | 10 | 6,3 | 10,0 | 10,8 | 6,3 |
| | | 100 | 114,3 | 40 | - | - | - | - | - | 6,3 | 3,6 | 6,3 | 7,3 | 3,6 | 8,8 | 4,5 | 8,8 | 10,0 | 4,5 | 10 | 6,3 | 10,0 | 11,2 | 6,3 |
| 300 | 323,9 | 250 | 273 | 12 | 5,6 | 5 | 5,6 | 5,6 | 5,0 | 7,1 | 6,3 | 7,1 | 7,1 | 6,3 | 8,8 | 8,8 | 8,8 | 8,7 | 8,8 | 10 | 10 | 10,0 | 9,9 | 10,0 |
| | | 200 | 219,1 | 24 | 5,6 | 4,5 | 5,6 | 5,8 | 4,5 | 7,1 | 6,3 | 7,1 | 7,3 | 6,3 | 8,8 | 7,1 | 8,8 | 9,0 | 7,1 | 10 | 8 | 10,0 | 10,2 | 8,0 |
| | | 150 | 168,3 | 35 | 5,6 | 4 | 5,6 | 6,3 | 4,0 | 7,1 | 4,5 | 7,1 | 7,9 | 4,5 | 8,8 | 5,6 | 8,8 | 9,7 | 5,6 | 10 | 7,1 | 10,0 | 10,9 | 7,1 |
| | | 125 | 139,7 | 40 | - | - | - | - | - | 7,1 | 4 | 7,1 | 8,3 | 4,0 | 8,8 | 5 | 8,8 | 10,1 | 5,0 | 10 | 6,3 | 10,0 | 11,4 | 6,3 |

Table C.3 (continued)

| DN | D | DN ₁ | D ₁ | α _{max} | 1 | | | | | 2 | | | | | 3 | | | | | 4 | | | | |
|-----|-------|-----------------|----------------|------------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|
| | | | | | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ |
| 350 | 355,6 | 300 | 323,9 | 6 | 5,6 | 5,6 | 5,6 | 5,6 | 5,6 | 8 | 7,1 | 8,0 | 7,8 | 7,1 | 10 | 8,8 | 10,0 | 9,6 | 8,8 | 12,5 | 10 | 12,5 | 10,8 | 10,0 |
| | | 250 | 273 | 14 | 5,6 | 5 | 5,6 | 5,7 | 5,0 | 8 | 6,3 | 8,0 | 8,0 | 6,3 | 10 | 8,8 | 10,0 | 9,9 | 8,8 | 12,5 | 10 | 12,5 | 12,4 | 10,0 |
| | | 200 | 219,1 | 22 | 5,6 | 4,5 | 5,6 | 5,8 | 4,5 | 8 | 6,3 | 8,0 | 8,2 | 6,3 | 10 | 7,1 | 10,0 | 10,1 | 7,1 | 12,5 | 8 | 12,5 | 12,6 | 8,0 |
| | | 150 | 168,3 | 29 | 5,6 | 4 | 5,6 | 6,0 | 4,0 | 8 | 4,5 | 8,0 | 8,5 | 4,5 | 10 | 5,6 | 10,0 | 10,5 | 5,6 | 12,5 | 7,1 | 12,5 | 13,0 | 7,1 |
| 400 | 406,4 | 350 | 355,6 | 8 | 6,3 | 5,6 | 6,3 | 6,3 | 5,6 | 8,8 | 8 | 8,8 | 8,8 | 8,0 | 10 | 10 | 10,0 | 9,9 | 10,0 | 12,5 | 12,5 | 12,5 | 12,4 | 12,5 |
| | | 300 | 323,9 | 13 | 6,3 | 5,6 | 6,3 | 6,3 | 5,6 | 8,8 | 7,1 | 8,8 | 8,8 | 7,1 | 10 | 8,8 | 10,0 | 10,0 | 8,8 | 12,5 | 10 | 12,5 | 12,4 | 10,0 |
| | | 250 | 273 | 21 | 6,3 | 5 | 6,3 | 6,5 | 5,0 | 8,8 | 6,3 | 8,8 | 9,0 | 6,3 | 10 | 8,8 | 10,0 | 10,2 | 8,8 | 12,5 | 10 | 12,5 | 12,6 | 10,0 |
| | | 200 | 219,1 | 28 | 6,3 | 4,5 | 6,3 | 6,7 | 4,5 | 8,8 | 6,3 | 8,8 | 9,3 | 6,3 | 10 | 7,1 | 10,0 | 10,5 | 7,1 | 12,5 | 8 | 12,5 | 13,0 | 8,0 |
| 450 | 457 | 400 | 406,4 | 7 | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 | 10 | 8,8 | 10,0 | 9,8 | 8,8 | 11 | 10 | 11,0 | 10,9 | 10,0 | 12,5 | 12,5 | 12,5 | 12,4 | 12,5 |
| | | 350 | 355,6 | 14 | 6,3 | 5,6 | 6,3 | 6,4 | 5,6 | 10 | 8 | 10,0 | 10,0 | 8,0 | 11 | 10 | 11,0 | 11,0 | 10,0 | 12,5 | 12,5 | 12,5 | 12,4 | 12,5 |
| | | 300 | 323,9 | 18 | 6,3 | 5,6 | 6,3 | 6,4 | 5,6 | 10 | 7,1 | 10,0 | 10,1 | 7,1 | 11 | 8,8 | 11,0 | 11,1 | 8,8 | 12,5 | 10 | 12,5 | 12,5 | 10,0 |
| | | 250 | 273 | 25 | 6,3 | 5 | 6,3 | 6,6 | 5,0 | 10 | 6,3 | 10,0 | 10,4 | 6,3 | 11 | 8,8 | 11,0 | 11,4 | 8,8 | 12,5 | 10 | 12,5 | 12,8 | 10,0 |
| 500 | 508 | 450 | 457 | 4 | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 | 10 | 10 | 10,0 | 10,0 | 10,0 | 11 | 11 | 11,0 | 11,0 | 11,0 | 12,5 | 12,5 | 12,5 | 12,4 | 12,5 |
| | | 400 | 406,4 | 10 | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 | 10 | 8,8 | 10,0 | 10,0 | 8,8 | 11 | 10 | 11,0 | 10,9 | 10,0 | 12,5 | 12,5 | 12,5 | 12,4 | 12,5 |
| | | 350 | 355,6 | 17 | 6,3 | 5,6 | 6,3 | 6,4 | 5,6 | 10 | 8 | 10,0 | 10,1 | 8,0 | 11 | 10 | 11,0 | 11,1 | 10,0 | 12,5 | 12,5 | 12,5 | 12,5 | 12,5 |
| | | 300 | 323,9 | 20 | 6,3 | 5,6 | 6,3 | 6,5 | 5,6 | 10 | 7,1 | 10,0 | 10,2 | 7,1 | 11 | 8,8 | 11,0 | 11,2 | 8,8 | 12,5 | 10 | 12,5 | 12,6 | 10,0 |
| 600 | 610 | 500 | 508 | 10 | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 | 10 | 10 | 10,0 | 10,0 | 10,0 | 12,5 | 11 | 12,5 | 12,4 | 11,0 | 17,5 | 12,5 | 17,5 | 14,8 | 12,5 |
| | | 450 | 457 | 15 | 6,3 | 6,3 | 6,3 | 6,4 | 6,3 | 10 | 10 | 10,0 | 10,1 | 10,0 | 12,5 | 11 | 12,5 | 12,5 | 11,0 | 17,5 | 12,5 | 17,5 | 16,6 | 12,5 |
| | | 400 | 406,4 | 21 | 6,3 | 6,3 | 6,3 | 6,6 | 6,3 | 10 | 8,8 | 10,0 | 10,3 | 8,8 | 12,5 | 10 | 12,5 | 12,8 | 10,0 | 17,5 | 12,5 | 17,5 | 17,6 | 12,5 |
| 700 | 711 | 600 | 610 | 10 | 7,1 | 6,3 | 7,1 | 7,1 | 6,3 | 10 | 10 | 10,0 | 10,0 | 10,0 | 12,5 | 12,5 | 12,5 | 12,5 | 12,5 | 25 | 17,5 | 25,0 | 19,9 | 17,5 |
| | | 500 | 508 | 15 | 7,1 | 6,3 | 7,1 | 7,2 | 6,3 | 10 | 10 | 10,0 | 10,2 | 10,0 | 12,5 | 11 | 12,5 | 12,6 | 11,0 | 25 | 12,5 | 25,0 | 17,1 | 12,5 |
| | | 400 | 406,4 | 25 | 7,1 | 6,3 | 7,1 | 7,5 | 6,3 | 10 | 8,8 | 10,0 | 10,6 | 8,8 | 12,5 | 10 | 12,5 | 13,0 | 10,0 | 25 | 12,5 | 25,0 | 22,1 | 12,5 |
| 800 | 813 | 700 | 711 | 10 | 8 | 7,1 | 8,0 | 8,0 | 7,1 | 10 | 10 | 10,0 | 10,0 | 10,0 | 12,5 | 12,5 | 12,5 | 12,5 | 12,5 | 25 | 25 | 25,0 | 24,7 | 25,0 |
| | | 600 | 610 | 15 | 8 | 6,3 | 8,0 | 8,1 | 6,3 | 10 | 10 | 10,0 | 10,2 | 10,0 | 12,5 | 12,5 | 12,5 | 12,6 | 12,5 | 25 | 17,5 | 25,0 | 23,1 | 17,5 |
| | | 500 | 508 | 20 | 8 | 6,3 | 8,0 | 8,3 | 6,3 | 10 | 10 | 10,0 | 10,4 | 10,0 | 12,5 | 11 | 12,5 | 12,8 | 11,0 | 25 | 12,5 | 25,0 | 20,0 | 12,5 |

Table C.3 (continued)

| DN | D | DN ₁ | D ₁ | α _{max} | 1 | | | | | 2 | | | | | 3 | | | | | 4 | | | | |
|------|------|-----------------|----------------|------------------|----|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|----|----------------|----------------|----------------|----------------|----|----------------|----------------|----------------|----------------|
| | | | | | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ |
| 900 | 914 | 800 | 813 | 10 | 10 | 8 | 10,0 | 9,0 | 8,0 | 12,5 | 10 | 12,5 | 11,3 | 10,0 | 20 | 12,5 | 20,0 | 13,9 | 12,5 | 25 | 25 | 25,0 | 24,7 | 25,0 |
| | | 700 | 711 | 15 | 10 | 7,1 | 10,0 | 9,2 | 7,1 | 12,5 | 10 | 12,5 | 12,6 | 10,0 | 20 | 12,5 | 20,0 | 16,0 | 12,5 | 25 | 25 | 25,0 | 24,8 | 25,0 |
| | | 600 | 610 | 20 | 10 | 6,3 | 10,0 | 9,7 | 6,9 | 12,5 | 10 | 12,5 | 12,8 | 10,0 | 20 | 12,5 | 20,0 | 19,0 | 12,5 | 25 | 17,5 | 25,0 | 25,1 | 17,5 |
| 1000 | 1016 | 900 | 914 | 10 | 10 | 10 | 10,0 | 10,0 | 10,0 | 12,5 | 12,5 | 12,5 | 12,5 | 12,5 | 20 | 20 | 20,0 | 19,9 | 20,0 | 25 | 25 | 25,0 | 24,8 | 25,0 |
| | | 800 | 813 | 15 | 10 | 8 | 10,0 | 10,1 | 8,0 | 12,5 | 10 | 12,5 | 12,6 | 10,0 | 20 | 12,5 | 20,0 | 15,6 | 12,5 | 25 | 25 | 25,0 | 24,9 | 25,0 |
| | | 700 | 711 | 20 | 10 | 7,1 | 10,0 | 10,5 | (7,9) | 12,5 | 10 | 12,5 | 12,9 | 10,0 | 20 | 12,5 | 20,0 | 18,1 | 12,5 | 25 | 25 | 25,0 | 25,2 | 25,0 |
| 1200 | 1219 | 1000 | 1016 | 11 | 10 | 10 | 10,0 | 10,2 | 10,0 | 12,5 | 12,5 | 12,5 | 12,5 | 12,5 | 20 | 20 | 20,0 | 19,9 | 20,0 | 25 | 25 | 25,0 | 24,8 | 25,0 |
| | | 900 | 914 | 16 | 10 | 10 | 10,0 | 10,3 | 10,0 | 12,5 | 12,5 | 12,5 | 12,7 | 12,5 | 20 | 20 | 20,0 | 20,1 | 20,0 | 25 | 25 | 25,0 | 25,1 | 25,0 |
| | | 800 | 813 | 20 | 10 | 8 | 10,0 | 10,5 | 8,0 | 12,5 | 10 | 12,5 | 12,9 | 10,0 | 20 | 12,5 | 20,0 | 19,1 | 12,5 | 25 | 25 | 25,0 | 25,4 | 25,0 |

Table C.4 — Wall thickness of concentric reducers type B – wall thickness series 5 to 8

| DN | D | DN ₁ | D ₁ | α _{max} | 5 | | | | | 6 | | | | | 7 | | | | | 8 | | | | |
|-----|-------|-----------------|----------------|------------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|
| | | | | | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ |
| 20 | 26,9 | 15 | 21,3 | 8 | 4 | 4 | 4,0 | 3,8 | 4,0 | - | - | - | - | - | 5,6 | 5 | 5,6 | 5,2 | 5,0 | 8 | 7,1 | 8,0 | 7,2 | 7,1 |
| 25 | 33,7 | 20 | 26,9 | 7 | 4,5 | 4 | 4,5 | 4,4 | 4,0 | 5,6 | 4,5 | 5,6 | 5,4 | 4,5 | 6,3 | 5,6 | 6,3 | 6,0 | 5,6 | 8,8 | 8 | 8,8 | 8,1 | 8,0 |
| | | 15 | 21,3 | 12 | 4,5 | 4 | 4,5 | 4,3 | 4,0 | - | - | - | - | - | 6,3 | 5 | 6,3 | 5,8 | 5,0 | 8,8 | 7,1 | 8,8 | 7,7 | 7,1 |
| 32 | 42,4 | 25 | 33,7 | 9 | 5 | 4,5 | 5,0 | 4,8 | 4,5 | 6,3 | 5,6 | 6,3 | 6,0 | 5,6 | 8 | 6,3 | 8,0 | 7,4 | 6,3 | 10 | 8,8 | 10,0 | 9,1 | 8,8 |
| | | 20 | 26,9 | 15 | 5 | 4 | 5,0 | 4,7 | 4,0 | 6,3 | 4,5 | 6,3 | 5,8 | 4,5 | 8 | 5,6 | 8,0 | 7,2 | 5,6 | 10 | 8 | 10,0 | 8,7 | 8,0 |
| | | 15 | 21,3 | 19 | 5 | 4 | 5,0 | 4,7 | 4,0 | - | - | - | - | - | 8 | 5 | 8,0 | 7,0 | 5,0 | 10 | 7,1 | 10,0 | 8,4 | 7,1 |
| 40 | 48,3 | 32 | 42,4 | 6 | 5 | 5 | 5,0 | 4,9 | 5,0 | 6,3 | 6,3 | 6,3 | 6,1 | 6,3 | 8 | 8 | 8,0 | 7,7 | 8,0 | 10 | 10 | 10,0 | 9,5 | 10,0 |
| | | 25 | 33,7 | 10 | 5 | 4,5 | 5,0 | 4,8 | 4,5 | 6,3 | 5,6 | 6,3 | 6,0 | 5,6 | 8 | 6,3 | 8,0 | 7,5 | 6,3 | 10 | 8,8 | 10,0 | 9,2 | 8,8 |
| | | 20 | 26,9 | 16 | 5 | 4 | 5,0 | 4,8 | 4,0 | 6,3 | 4,5 | 6,3 | 5,9 | 4,5 | 8 | 5,6 | 8,0 | 7,3 | 5,6 | 10 | 8 | 10,0 | 8,8 | 8,0 |
| 50 | 60,3 | 40 | 48,3 | 7 | 5,6 | 5 | 5,6 | 5,5 | 5,0 | 7,1 | 6,3 | 7,1 | 6,9 | 6,3 | 8,8 | 8 | 8,8 | 8,4 | 8,0 | 11 | 10 | 11,0 | 10,4 | 10,0 |
| | | 32 | 42,4 | 11 | 5,6 | 5 | 5,6 | 5,4 | 5,0 | 7,1 | 6,3 | 7,1 | 6,8 | 6,3 | 8,8 | 8 | 8,8 | 8,3 | 8,0 | 11 | 10 | 11,0 | 10,1 | 10,0 |
| | | 25 | 33,7 | 16 | 5,6 | 4,5 | 5,6 | 5,4 | 4,5 | 7,1 | 5,6 | 7,1 | 6,7 | 5,6 | 8,8 | 6,3 | 8,8 | 8,1 | 6,3 | 11 | 8,8 | 11,0 | 9,9 | 8,8 |
| | | 20 | 26,9 | 21 | 5,6 | 4 | 5,6 | 5,3 | 4,0 | 7,1 | 4,5 | 7,1 | 6,6 | 4,5 | 8,8 | 5,6 | 8,8 | 8,0 | 5,6 | 11 | 8 | 11,0 | 9,6 | 8,0 |
| 65 | 76,1 | 50 | 60,3 | 9 | 7,1 | 5,6 | 7,1 | 6,8 | 5,6 | 8 | 7,1 | 8,0 | 7,7 | 7,1 | 10 | 8,8 | 10,0 | 9,5 | 8,8 | 14,2 | 11 | 14,2 | 12,8 | 11,0 |
| | | 40 | 48,3 | 15 | 7,1 | 5 | 7,1 | 6,8 | 5,0 | 8 | 6,3 | 8,0 | 7,6 | 6,3 | 10 | 8 | 10,0 | 9,3 | 8,0 | 14,2 | 10 | 14,2 | 12,7 | 10,0 |
| | | 32 | 42,4 | 18 | 7,1 | 5 | 7,1 | 6,8 | 5,0 | 8 | 6,3 | 8,0 | 7,5 | 6,3 | 10 | 8 | 10,0 | 9,2 | 8,0 | 14,2 | 10 | 14,2 | 12,5 | 10,0 |
| | | 25 | 33,7 | 23 | 7,1 | 4,5 | 7,1 | 6,8 | 4,5 | 8 | 5,6 | 8,0 | 7,5 | 5,6 | 10 | 6,3 | 10,0 | 9,2 | 6,3 | 14,2 | 8,8 | 14,2 | 12,3 | 8,8 |
| 80 | 88,9 | 65 | 76,1 | 7 | 8 | 7,1 | 8,0 | 7,8 | 7,1 | 8,8 | 8 | 8,8 | 8,6 | 8,0 | 11 | 10 | 11,0 | 10,6 | 10,0 | 16 | 14,2 | 16,0 | 15,2 | 14,2 |
| | | 50 | 60,3 | 16 | 8 | 5,6 | 8,0 | 7,6 | 5,6 | 8,8 | 7,1 | 8,8 | 8,4 | 7,1 | 11 | 8,8 | 11,0 | 10,3 | 8,8 | 16 | 11 | 16,0 | 14,3 | 11,0 |
| | | 40 | 48,3 | 22 | 8 | 5 | 8,0 | 7,6 | 5,0 | 8,8 | 6,3 | 8,8 | 8,3 | 6,3 | 11 | 8 | 11,0 | 10,2 | 8,0 | 16 | 10 | 16,0 | 14,0 | 10,0 |
| | | 32 | 42,4 | 26 | 8 | 5 | 8,0 | 7,7 | 5,0 | 8,8 | 6,3 | 8,8 | 8,3 | 6,3 | 11 | 8 | 11,0 | 10,1 | 8,0 | 16 | 10 | 16,0 | 13,8 | 10,0 |
| 100 | 114,3 | 80 | 88,9 | 13 | 8,8 | 8 | 8,8 | 8,5 | 8,0 | 11 | 8,8 | 11,0 | 10,5 | 8,8 | 14,2 | 11 | 14,2 | 13,3 | 11,0 | 17,5 | 16 | 17,5 | 16,2 | 16,0 |
| | | 65 | 76,1 | 18 | 8,8 | 7,1 | 8,8 | 8,5 | 7,1 | 11 | 8 | 11,0 | 10,4 | 8,0 | 14,2 | 10 | 14,2 | 13,2 | 10,0 | 17,5 | 14,2 | 17,5 | 15,9 | 14,2 |
| | | 50 | 60,3 | 26 | 8,8 | 5,6 | 8,8 | 8,6 | 5,6 | 11 | 7,1 | 11,0 | 10,5 | 7,1 | 14,2 | 8,8 | 14,2 | 13,1 | 8,8 | 17,5 | 11 | 17,5 | 15,6 | 11,0 |
| | | 40 | 48,3 | 31 | 8,8 | 5 | 8,8 | 8,7 | 5,0 | 11 | 6,3 | 11,0 | 10,6 | 6,3 | 14,2 | 8 | 14,2 | 13,1 | 8,0 | 17,5 | 10 | 17,5 | 15,5 | 10,0 |

Table C.4 (continued)

| DN | D | DN ₁ | D ₁ | α _{max} | 5 | | | | | 6 | | | | | 7 | | | | | 8 | | | | |
|-----|-------|-----------------|----------------|------------------|------|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|
| | | | | | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ |
| 125 | 139,7 | 100 | 114,3 | 10 | 10 | 8,8 | 10,0 | 9,7 | 8,8 | 12,5 | 11 | 12,5 | 12,0 | 11,0 | 16 | 14,2 | 16,0 | 15,3 | 14,2 | 20 | 17,5 | 20,0 | 18,8 | 17,5 |
| | | 80 | 88,9 | 20 | 10 | 8 | 10,0 | 9,7 | 8,0 | 12,5 | 8,8 | 12,5 | 11,9 | 8,8 | 16 | 11 | 16,0 | 14,9 | 11,0 | 20 | 16 | 20,0 | 18,2 | 16,0 |
| | | 65 | 76,1 | 25 | 10 | 7,1 | 10,0 | 9,7 | 7,1 | 12,5 | 8 | 12,5 | 11,9 | 8,0 | 16 | 10 | 16,0 | 14,9 | 10,0 | 20 | 14,2 | 20,0 | 18,0 | 14,2 |
| | | 50 | 60,3 | 30 | 10 | 5,6 | 10,0 | 9,9 | 5,6 | 12,5 | 7,1 | 12,5 | 12,1 | 7,1 | 16 | 8,8 | 16,0 | 14,9 | 8,8 | 20 | 11 | 20,0 | 18,0 | 11,0 |
| 150 | 168,3 | 125 | 139,7 | 9 | 11 | 10 | 11,0 | 10,7 | 10,0 | 14,2 | 12,5 | 14,2 | 13,7 | 12,5 | 17,5 | 16 | 17,5 | 16,8 | 16,0 | 22,2 | 20 | 22,2 | 21,1 | 20,0 |
| | | 100 | 114,3 | 19 | 11 | 8,8 | 11,0 | 10,7 | 8,8 | 14,2 | 11 | 14,2 | 13,6 | 11,0 | 17,5 | 14,2 | 17,5 | 16,4 | 14,2 | 22,2 | 17,5 | 22,2 | 20,4 | 17,5 |
| | | 80 | 88,9 | 27 | 11 | 8 | 11,0 | 10,9 | 8,0 | 14,2 | 8,8 | 14,2 | 13,7 | 8,8 | 17,5 | 11 | 17,5 | 16,5 | 11,0 | 22,2 | 16 | 22,2 | 20,2 | 16,0 |
| | | 65 | 76,1 | 31 | 11 | 7,1 | 11,0 | 11,0 | 7,1 | 14,2 | 8 | 14,2 | 13,8 | 8,0 | 17,5 | 10 | 17,5 | 16,6 | 10,0 | 22,2 | 14,2 | 22,2 | 20,2 | 14,2 |
| 200 | 219,1 | 150 | 168,3 | 18 | 12,5 | 11 | 12,5 | 12,2 | 11,0 | 16 | 14,2 | 16,0 | 15,4 | 14,2 | 17,5 | 17,5 | 17,5 | 16,8 | 17,5 | 22,2 | 22,2 | 22,2 | 20,9 | 22,2 |
| | | 125 | 139,7 | 27 | 12,5 | 10 | 12,5 | 12,5 | 10,0 | 16 | 12,5 | 16,0 | 15,6 | 12,5 | 17,5 | 16 | 17,5 | 16,9 | 16,0 | 22,2 | 20 | 22,2 | 20,9 | 20,0 |
| | | 100 | 114,3 | 33 | 12,5 | 8,8 | 12,5 | 12,8 | 8,8 | 16 | 11 | 16,0 | 16,0 | 11,0 | 17,5 | 14,2 | 17,5 | 17,3 | 14,2 | 22,2 | 17,5 | 22,2 | 21,2 | 17,5 |
| | | 80 | 88,9 | 39 | 12,5 | 8 | 12,5 | 13,3 | 8,0 | 16 | 8,8 | 16,0 | 16,5 | 8,8 | 17,5 | 11 | 17,5 | 17,8 | 11,0 | 22,2 | 16 | 22,2 | 21,7 | 16,0 |
| 250 | 273 | 200 | 219,1 | 16 | 12,5 | 12,5 | 12,5 | 12,3 | 12,5 | 16 | 16 | 16,0 | 15,6 | 16,0 | 22,2 | 17,5 | 22,2 | 20,8 | 17,5 | 30 | 22,2 | 30,0 | 25,6 | 22,2 |
| | | 150 | 168,3 | 30 | 12,5 | 11 | 12,5 | 12,8 | 11,0 | 16 | 14,2 | 16,0 | 16,1 | 14,2 | 22,2 | 17,5 | 22,2 | 21,6 | 17,5 | 30 | 22,2 | 30,0 | 28,1 | 22,2 |
| | | 125 | 139,7 | 36 | 12,5 | 10 | 12,5 | 13,3 | 10,0 | 16 | 12,5 | 16,0 | 16,6 | 12,5 | 22,2 | 16 | 22,2 | 22,1 | 16,0 | 30 | 20 | 30,0 | 28,5 | 20,0 |
| | | 100 | 114,3 | 40 | 12,5 | 8,8 | 12,5 | 13,7 | 8,8 | 16 | 11 | 16,0 | 17,1 | 11,0 | 22,2 | 14,2 | 22,2 | 22,6 | 14,2 | 30 | 17,5 | 30,0 | 28,9 | 17,5 |
| 300 | 323,9 | 250 | 273 | 12 | 12,5 | 12,5 | 12,5 | 12,3 | 12,5 | 17,5 | 16 | 17,5 | 17,1 | 16,0 | 25 | 22,2 | 25,0 | 24,1 | 22,2 | 32 | 30 | 32,0 | 30,5 | 30,0 |
| | | 200 | 219,1 | 24 | 12,5 | 12,5 | 12,5 | 12,6 | 12,5 | 17,5 | 16 | 17,5 | 17,3 | 16,0 | 25 | 17,5 | 25,0 | 24,1 | 17,5 | 32 | 22,2 | 32,0 | 30,2 | 22,2 |
| | | 150 | 168,3 | 35 | 12,5 | 11 | 12,5 | 13,4 | 11,0 | 17,5 | 14,2 | 17,5 | 18,2 | 14,2 | 25 | 17,5 | 25,0 | 25,0 | 17,5 | 32 | 22,2 | 32,0 | 30,9 | 22,2 |
| | | 125 | 139,7 | 40 | 12,5 | 10 | 12,5 | 13,9 | 10,0 | 17,5 | 12,5 | 17,5 | 18,8 | 12,5 | 25 | 16 | 25,0 | 25,6 | 16,0 | 32 | 20 | 32,0 | 31,5 | 20,0 |

Table C.4 (continued)

| DN | D | DN ₁ | D ₁ | α _{max} | 5 | | | | | 6 | | | | | 7 | | | | | 8 | | | | |
|-----|-------|-----------------|----------------|------------------|------|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|----|----------------|----------------|----------------|----------------|----|----------------|----------------|----------------|----------------|
| | | | | | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ |
| 350 | 355,6 | 300 | 323,9 | 6 | 16 | 12,5 | 16,0 | 13,4 | 12,5 | 20 | 17,5 | 20,0 | 18,8 | 17,5 | 28 | 25 | 28,0 | 26,7 | 25,0 | 36 | 32 | 36,0 | 34,0 | 32,0 |
| | | 250 | 273 | 14 | 16 | 12,5 | 16,0 | 15,7 | 12,5 | 20 | 16 | 20,0 | 19,5 | 16,0 | 28 | 22,2 | 28,0 | 26,9 | 22,2 | 36 | 30 | 36,0 | 34,1 | 30,0 |
| | | 200 | 219,1 | 22 | 16 | 12,5 | 16,0 | 15,9 | 12,5 | 20 | 16 | 20,0 | 19,6 | 16,0 | 28 | 17,5 | 28,0 | 26,9 | 17,5 | 36 | 22,2 | 36,0 | 33,8 | 22,2 |
| | | 150 | 168,3 | 29 | 16 | 11 | 16,0 | 16,3 | 11,0 | 20 | 14,2 | 20,0 | 20,1 | 14,2 | 28 | 17,5 | 28,0 | 27,3 | 17,5 | 36 | 22,2 | 36,0 | 34,1 | 22,2 |
| 400 | 406,4 | 350 | 355,6 | 8 | 17,5 | 16 | 17,5 | 17,2 | 16,0 | 22,2 | 20 | 22,2 | 21,7 | 20,0 | 30 | 28 | 30,0 | 29,2 | 28,0 | 40 | 36 | 40,0 | 38,6 | 36,0 |
| | | 300 | 323,9 | 13 | 17,5 | 12,5 | 17,5 | 15,3 | 12,5 | 22,2 | 17,5 | 22,2 | 21,4 | 17,5 | 30 | 25 | 30,0 | 28,9 | 25,0 | 40 | 32 | 40,0 | 38,0 | 32,0 |
| | | 250 | 273 | 21 | 17,5 | 12,5 | 17,5 | 17,4 | 12,5 | 22,2 | 16 | 22,2 | 21,8 | 16,0 | 30 | 22,2 | 30,0 | 28,9 | 22,2 | 40 | 30 | 40,0 | 37,7 | 30,0 |
| | | 200 | 219,1 | 28 | 17,5 | 12,5 | 17,5 | 17,8 | 12,5 | 22,2 | 16 | 22,2 | 22,2 | 16,0 | 30 | 17,5 | 30,0 | 29,3 | 17,5 | 40 | 22,2 | 40,0 | 37,9 | 22,2 |
| 450 | 457 | 400 | 406,4 | 7 | 17,5 | 17,5 | 17,5 | 17,3 | 17,5 | 22,2 | 22,2 | 22,2 | 21,8 | 22,2 | 32 | 30 | 32,0 | 31,2 | 30,0 | 45 | 40 | 45,0 | 43,5 | 40,0 |
| | | 350 | 355,6 | 14 | 17,5 | 16 | 17,5 | 17,2 | 16,0 | 22,2 | 20 | 22,2 | 21,7 | 20,0 | 32 | 28 | 32,0 | 30,9 | 28,0 | 45 | 36 | 45,0 | 42,7 | 36,0 |
| | | 300 | 323,9 | 18 | 17,5 | 12,5 | 17,5 | 17,3 | 12,5 | 22,2 | 17,5 | 22,2 | 21,8 | 17,5 | 32 | 25 | 32,0 | 30,8 | 25,0 | 45 | 32 | 45,0 | 42,4 | 32,0 |
| | | 250 | 273 | 25 | 17,5 | 12,5 | 17,5 | 17,7 | 12,5 | 22,2 | 16 | 22,2 | 22,2 | 16,0 | 32 | 22,2 | 32,0 | 31,1 | 22,2 | 45 | 30 | 45,0 | 42,4 | 30,0 |
| 500 | 508 | 450 | 457 | 4 | 17,5 | 17,5 | 17,5 | 17,4 | 17,5 | 25 | 22,2 | 25,0 | 24,4 | 22,2 | 36 | 32 | 36,0 | 35,0 | 32,0 | 50 | 45 | 50,0 | 49,0 | 45,0 |
| | | 400 | 406,4 | 10 | 17,5 | 17,5 | 17,5 | 17,3 | 17,5 | 25 | 22,2 | 25,0 | 24,5 | 22,2 | 36 | 30 | 36,0 | 34,9 | 30,0 | 50 | 40 | 50,0 | 47,9 | 40,0 |
| | | 350 | 355,6 | 17 | 17,5 | 16 | 17,5 | 17,4 | 16,0 | 25 | 20 | 25,0 | 24,5 | 20,0 | 36 | 28 | 36,0 | 34,7 | 28,0 | 50 | 36 | 50,0 | 47,2 | 36,0 |
| | | 300 | 323,9 | 20 | 17,5 | 12,5 | 17,5 | 17,5 | 12,5 | 25 | 17,5 | 25,0 | 24,6 | 17,5 | 36 | 25 | 36,0 | 34,7 | 25,0 | 50 | 32 | 50,0 | 47,1 | 32,0 |
| 600 | 610 | 500 | 508 | 10 | 25 | 17,5 | 25,0 | 20,5 | 17,5 | 30 | 25 | 30,0 | 29,3 | 25,0 | 45 | 36 | 45,0 | 41,6 | 36,0 | 60 | 50 | 60,0 | 57,4 | 50,0 |
| | | 450 | 457 | 15 | 25 | 17,5 | 25,0 | 22,9 | 17,5 | 30 | 22,2 | 30,0 | 28,9 | 22,2 | 45 | 32 | 45,0 | 40,8 | 32,0 | 60 | 45 | 60,0 | 56,8 | 45,0 |
| | | 400 | 406,4 | 21 | 25 | 17,5 | 25,0 | 24,8 | 17,5 | 30 | 22,2 | 30,0 | 29,6 | 22,2 | 45 | 30 | 45,0 | 43,3 | 30,0 | 60 | 40 | 60,0 | 56,5 | 40,0 |

Table C.5 — Wall thickness of eccentric reducers type B – wall thickness series 1 to 4

| DN | D | DN ₁ | D ₁ | α _{max} | 1 | | | | | 2 | | | | | 3 | | | | | 4 | | | | |
|----|------|-----------------|----------------|------------------|---|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|
| | | | | | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ |
| 20 | 26,9 | 15 | 21,3 | 15 | - | - | - | - | - | 2,3 | 2 | 2,3 | 2,2 | 2,0 | 2,6 | 2,6 | 2,6 | 2,5 | 2,6 | 3,2 | 3,2 | 3,2 | 3,0 | 3,2 |
| 25 | 33,7 | 20 | 26,9 | 13 | - | - | - | - | - | 2,6 | 2,3 | 2,6 | 2,5 | 2,3 | 3,2 | 2,6 | 3,2 | 3,1 | 2,6 | 4 | 3,2 | 4,0 | 3,8 | 3,2 |
| | | 15 | 21,3 | 24 | - | - | - | - | - | 2,6 | 2 | 2,6 | 2,6 | 2,0 | 3,2 | 2,6 | 3,2 | 3,1 | 2,6 | 4 | 3,2 | 4,0 | 3,7 | 3,2 |
| 32 | 42,4 | 25 | 33,7 | 16 | - | - | - | - | - | 2,6 | 2,6 | 2,6 | 2,6 | 2,6 | 3,6 | 3,2 | 3,6 | 3,5 | 3,2 | 4 | 4 | 4,0 | 3,8 | 4,0 |
| | | 20 | 26,9 | 30 | - | - | - | - | - | 2,6 | 2,3 | 2,6 | 2,6 | 2,3 | 3,6 | 2,6 | 3,6 | 3,5 | 2,6 | 4 | 3,2 | 4,0 | 3,9 | 3,2 |
| | | 15 | 21,3 | 42 | - | - | - | - | - | 2,6 | 2 | 2,6 | 2,8 | 2,0 | 3,6 | 2,6 | 3,6 | 3,7 | 2,6 | 4 | 3,2 | 4,0 | 4,1 | 3,2 |
| 40 | 48,3 | 32 | 42,4 | 8 | - | - | - | - | - | 2,6 | 2,6 | 2,6 | 2,6 | 2,6 | 3,6 | 3,6 | 3,6 | 3,5 | 3,6 | 4 | 4 | 4,0 | 3,9 | 4,0 |
| | | 25 | 33,7 | 19 | - | - | - | - | - | 2,6 | 2,6 | 2,6 | 2,6 | 2,6 | 3,6 | 3,2 | 3,6 | 3,5 | 3,2 | 4 | 4 | 4,0 | 3,9 | 4,0 |
| | | 20 | 26,9 | 28 | - | - | - | - | - | 2,6 | 2,3 | 2,6 | 2,7 | 2,3 | 3,6 | 2,6 | 3,6 | 3,6 | 2,6 | 4 | 3,2 | 4,0 | 3,9 | 3,2 |
| 50 | 60,3 | 40 | 48,3 | 13 | - | - | - | - | - | 2,9 | 2,6 | 2,9 | 2,9 | 2,6 | 3,6 | 3,6 | 3,6 | 3,5 | 3,6 | 4 | 4 | 4,0 | 3,9 | 4,0 |
| | | 32 | 42,4 | 20 | - | - | - | - | - | 2,9 | 2,6 | 2,9 | 2,9 | 2,6 | 3,6 | 3,6 | 3,6 | 3,5 | 3,6 | 4 | 4 | 4,0 | 3,9 | 4,0 |
| | | 25 | 33,7 | 29 | - | - | - | - | - | 2,9 | 2,6 | 2,9 | 3,0 | 2,6 | 3,6 | 3,2 | 3,6 | 3,6 | 3,2 | 4 | 4 | 4,0 | 4,0 | 4,0 |
| | | 20 | 26,9 | 36 | - | - | - | - | - | 2,9 | 2,3 | 2,9 | 3,1 | 2,3 | 3,6 | 2,6 | 3,6 | 3,8 | 2,6 | 4 | 3,2 | 4,0 | 4,1 | 3,2 |
| 65 | 76,1 | 50 | 60,3 | 15 | - | - | - | - | - | 2,9 | 2,9 | 2,9 | 2,9 | 2,9 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 5,6 | 4 | 5,6 | 4,8 | 4,0 |
| | | 40 | 48,3 | 27 | - | - | - | - | - | 2,9 | 2,6 | 2,9 | 3,0 | 2,6 | 3,6 | 3,6 | 3,6 | 3,7 | 3,6 | 5,6 | 4 | 5,6 | 5,5 | 4,0 |
| | | 32 | 42,4 | 34 | - | - | - | - | - | 2,9 | 2,6 | 2,9 | 3,1 | 2,6 | 3,6 | 3,6 | 3,6 | 3,8 | 3,6 | 5,6 | 4 | 5,6 | 5,6 | 4,0 |
| | | 25 | 33,7 | 42 | - | - | - | - | - | 2,9 | 2,6 | 2,9 | 3,3 | 2,6 | 3,6 | 3,2 | 3,6 | 4,0 | 3,2 | 5,6 | 4 | 5,6 | 5,9 | 4,0 |
| 80 | 88,9 | 65 | 76,1 | 13 | - | - | - | - | - | 3,2 | 2,9 | 3,2 | 3,2 | 2,9 | 4 | 3,6 | 4,0 | 4,0 | 3,6 | 5,6 | 5,6 | 5,6 | 5,5 | 5,6 |
| | | 50 | 60,3 | 30 | - | - | - | - | - | 3,2 | 2,9 | 3,2 | 3,4 | 2,9 | 4 | 3,6 | 4,0 | 4,1 | 3,6 | 5,6 | 4 | 5,6 | 5,6 | 4,0 |
| | | 40 | 48,3 | 44 | - | - | - | - | - | 3,2 | 2,6 | 3,2 | 3,8 | 2,6 | 4 | 3,6 | 4,0 | 4,6 | 3,6 | 5,6 | 4 | 5,6 | 6,1 | 4,0 |
| | | 32 | 42,4 | 50 | - | - | - | - | - | 3,2 | 2,6 | 3,2 | 4,0 | 2,6 | 4 | 3,6 | 4,0 | 4,9 | 3,6 | 5,6 | 4 | 5,6 | 6,5 | 4,0 |

Table C.5 (continued)

| DN | D | DN ₁ | D ₁ | α _{max} | 1 | | | | | 2 | | | | | 3 | | | | | 4 | | | | |
|-----|-------|-----------------|----------------|------------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|
| | | | | | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ |
| 100 | 114,3 | 80 | 88,9 | 24 | - | - | - | - | - | 3,6 | 3,2 | 3,6 | 3,7 | 3,2 | 4,5 | 4 | 4,5 | 4,6 | 4,0 | 6,3 | 5,6 | 6,3 | 6,3 | 5,6 |
| | | 65 | 76,1 | 37 | - | - | - | - | - | 3,6 | 2,9 | 3,6 | 4,0 | 2,9 | 4,5 | 3,6 | 4,5 | 4,9 | 3,6 | 6,3 | 5,6 | 6,3 | 6,6 | 5,6 |
| | | 50 | 60,3 | 51 | - | - | - | - | - | 3,6 | 2,9 | 3,6 | 4,7 | 2,9 | 4,5 | 3,6 | 4,5 | 5,7 | 3,6 | 6,3 | 4 | 6,3 | 7,5 | 4,0 |
| | | 40 | 48,3 | 60 | - | - | - | - | - | 3,6 | 2,6 | (4,2) | 5,3 | 2,6 | 4,5 | 3,6 | (4,9) | 6,4 | 3,6 | 6,3 | 4 | 6,3 | 8,4 | 4,0 |
| 125 | 139,7 | 100 | 114,3 | 18 | - | - | - | - | - | 4 | 3,6 | 4,0 | 4,0 | 3,6 | 5 | 4,5 | 5,0 | 5,0 | 4,5 | 6,3 | 6,3 | 6,3 | 6,2 | 6,3 |
| | | 80 | 88,9 | 35 | - | - | - | - | - | 4 | 3,2 | 4,0 | 4,4 | 3,2 | 5 | 4 | 5,0 | 5,4 | 4,0 | 6,3 | 5,6 | 6,3 | 6,7 | 5,6 |
| | | 65 | 76,1 | 43 | - | - | - | - | - | 4 | 2,9 | 4,0 | 4,7 | 2,9 | 5 | 3,6 | 5,0 | 5,8 | 3,6 | 6,3 | 5,6 | 6,3 | 7,1 | 5,6 |
| | | 50 | 60,3 | 51 | - | - | - | - | - | 4 | 2,9 | 4,0 | 5,2 | 2,9 | 5 | 3,6 | 5,0 | 6,4 | 3,6 | 6,3 | 4 | 6,3 | 7,8 | 4,0 |
| 150 | 168,3 | 125 | 139,7 | 18 | - | - | - | - | - | 4,5 | 4 | 4,5 | 4,5 | 4,0 | 5,6 | 5 | 5,6 | 5,6 | 5,0 | 7,1 | 6,3 | 7,1 | 7,0 | 6,3 |
| | | 100 | 114,3 | 34 | - | - | - | - | - | 4,5 | 3,6 | 4,5 | 4,9 | 3,6 | 5,6 | 4,5 | 5,6 | 6,0 | 4,5 | 7,1 | 6,3 | 7,1 | 7,5 | 6,3 |
| | | 80 | 88,9 | 48 | - | - | - | - | - | 4,5 | 3,2 | 4,5 | 5,7 | 3,2 | 5,6 | 4 | 5,6 | 6,9 | 4,0 | 7,1 | 5,6 | 7,1 | 8,5 | 5,6 |
| | | 65 | 76,1 | 52 | - | - | - | - | - | 4,5 | 2,9 | (4,7) | 6,0 | 2,9 | 5,6 | 3,6 | 5,6 | 7,3 | 3,6 | 7,1 | 5,6 | 7,1 | 8,9 | 5,6 |
| 200 | 219,1 | 150 | 168,3 | 31 | 4,5 | 4 | 4,5 | 4,9 | (4,2) | 6,3 | 4,5 | 6,3 | 6,2 | (5,1) | 7,1 | 5,6 | 7,1 | 7,5 | (5,9) | 8 | 7,1 | 8,0 | 8,4 | 7,1 |
| | | 125 | 139,7 | 45 | - | - | - | - | - | 6,3 | 4 | 6,3 | 7,6 | (5,1) | 7,1 | 5 | 7,1 | 8,5 | (5,6) | 8 | 6,3 | 8,0 | 9,4 | 6,3 |
| | | 100 | 114,3 | 55 | - | - | - | - | - | 6,3 | 3,6 | (6,8) | 8,7 | (4,2) | 7,1 | 4,5 | (7,4) | 9,7 | 4,5 | 8 | 6,3 | 8,0 | 10,7 | 6,3 |
| | | 80 | 88,9 | 60 | - | - | - | - | - | 6,3 | 3,2 | (7,6) | 9,4 | 3,2 | 7,1 | 4 | (8,2) | 10,4 | 4,0 | 8 | 5,6 | (8,8) | 11,5 | 5,6 |
| 250 | 273 | 200 | 219,1 | 28 | 5 | 4,5 | 5,0 | 5,3 | (4,8) | 6,3 | 6,3 | 6,3 | 6,7 | 6,3 | 8,8 | 7,1 | 8,8 | 9,1 | (7,3) | 10 | 8 | 10,0 | 10,3 | 8,0 |
| | | 150 | 168,3 | 48 | 5 | 4 | (5,5) | 6,5 | (4,7) | 6,3 | 4,5 | (6,4) | 8,0 | (5,5) | 8,8 | 5,6 | 8,8 | 10,9 | (6,8) | 10 | 7,1 | 10,0 | 12,2 | (7,5) |
| | | 125 | 139,7 | 55 | - | - | - | - | - | 6,3 | 4 | (7,4) | 8,9 | (4,4) | 8,8 | 5 | (9,1) | 12,0 | (5,4) | 10 | 6,3 | 10,0 | 13,4 | 6,3 |
| | | 100 | 114,3 | 60 | - | - | - | - | - | 6,3 | 3,6 | (8,2) | 9,7 | 3,6 | 8,8 | 4,5 | (10,2) | 12,9 | 4,5 | 10 | 6,3 | (11,0) | 14,4 | 6,3 |
| 300 | 323,9 | 250 | 273 | 23 | 5,6 | 5 | 5,6 | 5,8 | (5,3) | 7,1 | 6,3 | 7,1 | 7,3 | 6,3 | 8,8 | 8,8 | 8,8 | 9,0 | 8,8 | 10 | 10 | 10,0 | 10,2 | 10,0 |
| | | 200 | 219,1 | 44 | 5,6 | 4,5 | (5,8) | 6,9 | (5,8) | 7,1 | 6,3 | 7,1 | 8,7 | (6,8) | 8,8 | 7,1 | 8,8 | 10,5 | (7,9) | 10 | 8 | 10,0 | 11,8 | (8,6) |
| | | 150 | 168,3 | 55 | 5,6 | 4 | (7,3) | 8,1 | (4,4) | 7,1 | 4,5 | (8,5) | 10,1 | (5,1) | 8,8 | 5,6 | (9,7) | 12,2 | (5,9) | 10 | 7,1 | (10,5) | 13,7 | 7,1 |
| | | 125 | 139,7 | 60 | - | - | - | - | - | 7,1 | 4 | (9,4) | 11,0 | 4,0 | 8,8 | 5 | (10,8) | 13,2 | 5,0 | 10 | 6,3 | (11,7) | 14,8 | 6,3 |

Table C.5 (continued)

| DN | D | DN ₁ | D ₁ | α _{max} | 1 | | | | | 2 | | | | | 3 | | | | | 4 | | | | |
|-----|-------|-----------------|----------------|------------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|
| | | | | | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ |
| 350 | 355,6 | 300 | 323,9 | 8 | 5,6 | 5,6 | 5,6 | 5,6 | 5,6 | 8 | 7,1 | 8,0 | 7,8 | 7,1 | 10 | 8,8 | 10,0 | 9,6 | 8,8 | 12,5 | 10 | 12,5 | 10,8 | 10,0 |
| | | 250 | 273 | 25 | 5,6 | 5 | 5,6 | 5,9 | 5,0 | 8 | 6,3 | 8,0 | 8,3 | (6,4) | 10 | 8,8 | 10,0 | 10,3 | 8,8 | 12,5 | 10 | 12,5 | 12,7 | 10,0 |
| | | 200 | 219,1 | 37 | 5,6 | 4,5 | 5,6 | 6,5 | 4,7 | 8 | 6,3 | 8,0 | 9,0 | 6,3 | 10 | 7,1 | 10,0 | 11,1 | 7,1 | 12,5 | 8 | 12,5 | 13,7 | (8,1) |
| | | 150 | 168,3 | 47 | 5,6 | 4 | (6,4) | 7,2 | 4,0 | 8 | 4,5 | 8,0 | 10,1 | 4,5 | 10 | 5,6 | 10,0 | 12,4 | 5,6 | 12,5 | 7,1 | 12,5 | 15,1 | 7,1 |
| 400 | 406,4 | 350 | 355,6 | 15 | 6,3 | 5,6 | 6,3 | 6,4 | 5,6 | 8,8 | 8 | 8,8 | 8,8 | 8,0 | 10 | 10 | 10,0 | 10,0 | 10,0 | 12,5 | 12,5 | 12,5 | 12,4 | 12,5 |
| | | 300 | 323,9 | 24 | 6,3 | 5,6 | 6,3 | 6,6 | (5,8) | 8,8 | 7,1 | 8,8 | 9,1 | (7,4) | 10 | 8,8 | 10,0 | 10,3 | 8,8 | 12,5 | 10 | 12,5 | 12,7 | 10,0 |
| | | 250 | 273 | 36 | 6,3 | 5 | 6,3 | 7,2 | (5,9) | 8,8 | 6,3 | 8,8 | 9,9 | (7,4) | 10 | 8,8 | 10,0 | 11,1 | 8,8 | 12,5 | 10 | 12,5 | 13,7 | 10,0 |
| | | 200 | 219,1 | 46 | 6,3 | 4,5 | (7,1) | 8,0 | 5,0 | 8,8 | 6,3 | 8,8 | 11,0 | 6,3 | 10 | 7,1 | 10,0 | 12,4 | 7,1 | 12,5 | 8 | 12,5 | 15,1 | 8,0 |
| 450 | 457 | 400 | 406,4 | 11 | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 | 10 | 8,8 | 10,0 | 9,9 | 8,8 | 11 | 10 | 11,0 | 10,9 | 10,0 | 12,5 | 12,5 | 12,5 | 12,4 | 12,5 |
| | | 350 | 355,6 | 24 | 6,3 | 5,6 | 6,3 | 6,6 | (5,8) | 10 | 8 | 10,0 | 10,3 | (8,1) | 11 | 10 | 11,0 | 11,3 | 10,0 | 12,5 | 12,5 | 12,5 | 12,8 | 12,5 |
| | | 300 | 323,9 | 31 | 6,3 | 5,6 | 6,3 | 6,9 | (6,0) | 10 | 7,1 | 10,0 | 10,8 | (8,2) | 11 | 8,8 | 11,0 | 11,8 | 8,8 | 12,5 | 10 | 12,5 | 13,3 | 10,0 |
| | | 250 | 273 | 41 | 6,3 | 5 | (6,6) | 7,6 | 5,6 | 10 | 6,3 | 10,0 | 11,8 | (7,6) | 11 | 8,8 | 11,0 | 12,8 | 8,8 | 12,5 | 10 | 12,5 | 14,5 | 10,0 |
| 500 | 508 | 450 | 457 | 8 | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 | 10 | 10 | 10,0 | 10,0 | 10,0 | 11 | 11 | 11,0 | 10,9 | 11,0 | 12,5 | 12,5 | 12,5 | 12,4 | 12,5 |
| | | 400 | 406,4 | 18 | 6,3 | 6,3 | 6,3 | 6,5 | 6,3 | 10 | 8,8 | 10,0 | 10,1 | 8,8 | 11 | 10 | 11,0 | 11,1 | 10,0 | 12,5 | 12,5 | 12,5 | 12,6 | 12,5 |
| | | 350 | 355,6 | 27 | 6,3 | 5,6 | 6,3 | 6,7 | 5,6 | 10 | 8 | 10,0 | 10,5 | 8,0 | 11 | 10 | 11,0 | 11,5 | 10,0 | 12,5 | 12,5 | 12,5 | 13,0 | 12,5 |
| | | 300 | 323,9 | 32 | 6,3 | 5,6 | 6,3 | 7,0 | 5,6 | 10 | 7,1 | 10,0 | 10,9 | 7,4 | 11 | 8,8 | 11,0 | 11,9 | 8,8 | 12,5 | 10 | 12,5 | 13,5 | 10,0 |
| 600 | 610 | 500 | 508 | 17 | 6,3 | 6,3 | 6,3 | 6,4 | 6,3 | 10 | 10 | 10,0 | 10,1 | 10,0 | 12,5 | 11 | 12,5 | 12,6 | 11,0 | 17,5 | 12,5 | 17,5 | 14,9 | 12,5 |
| | | 450 | 457 | 27 | 6,3 | 6,3 | 6,3 | 6,8 | 6,5 | 10 | 10 | 10,0 | 10,6 | 10,0 | 12,5 | 11 | 12,5 | 13,1 | 11,0 | 17,5 | 12,5 | 17,5 | 17,3 | (12,8) |
| | | 400 | 406,4 | 35 | 6,3 | 6,3 | (6,4) | 7,2 | 6,6 | 10 | 8,8 | 10,0 | 11,3 | (8,9) | 12,5 | 10 | 12,5 | 13,9 | (10,3) | 17,5 | 12,5 | 17,5 | 19,1 | (13,0) |
| 700 | 711 | 600 | 610 | 19 | 7,1 | 6,3 | 7,1 | 7,3 | (7,3) | 10 | 10 | 10,0 | 10,3 | 10,0 | 12,5 | 12,5 | 12,5 | 12,7 | 12,5 | 25 | 17,5 | 25,0 | 20,2 | 17,5 |
| | | 500 | 508 | 34 | 7,1 | 6,3 | 7,1 | 8,1 | 8,5 | 10 | 10 | 10,0 | 11,3 | (10,8) | 12,5 | 11 | 12,5 | 13,9 | (12,5) | 25 | 12,5 | 25,0 | 18,7 | (15,0) |
| | | 400 | 406,4 | 45 | 7,1 | 6,3 | (9,1) | 9,1 | 7,5 | 10 | 8,8 | (11,4) | 12,6 | 9,4 | 12,5 | 10 | (13,1) | 15,6 | 10,7 | 25 | 12,5 | 25,0 | 25,9 | (14,8) |

Table C.5 (continued)

| DN | D | DN ₁ | D ₁ | α_{\max} | 1 | | | | | 2 | | | | | 3 | | | | | 4 | | | | |
|------|------|-----------------|----------------|-----------------|----|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|----|----------------|----------------|----------------|----------------|
| | | | | | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ |
| 800 | 813 | 700 | 711 | 19 | 8 | 7,1 | 8,0 | 8,2 | (8,2) | 10 | 10 | 10,0 | 10,4 | 10,0 | 12,5 | 12,5 | 12,5 | 12,7 | 12,5 | 25 | 25 | 25,0 | 25,0 | 25,0 |
| | | 600 | 610 | 34 | 8 | 6,3 | 8,0 | 9,1 | (10,3) | 10 | 10 | 10,0 | 11,4 | (12,0) | 12,5 | 12,5 | 12,5 | 14,0 | (14,0) | 25 | 17,5 | 25,0 | 25,1 | (20,3) |
| | | 500 | 508 | 45 | 8 | 6,3 | (10,3) | 10,3 | (9,8) | 10 | 10 | (11,9) | 12,7 | (11,3) | 12,5 | 11 | (13,7) | 15,7 | (13,0) | 25 | 12,5 | 25,0 | 24,1 | (16,7) |
| 900 | 914 | 800 | 813 | 19 | 10 | 8 | 10,0 | 9,2 | (9,6) | 12,5 | 10 | 12,5 | 11,6 | (11,1) | 20 | 12,5 | 20,0 | 14,2 | (13,1) | 25 | 25 | 25,0 | 25,1 | 25,0 |
| | | 700 | 711 | 34 | 10 | 7,1 | 10,0 | 10,4 | (12,2) | 12,5 | 10 | 12,5 | 14,0 | (14,4) | 20 | 12,5 | 20,0 | 17,7 | (17,0) | 25 | 25 | 25,0 | 27,1 | 25,0 |
| | | 600 | 610 | 45 | 10 | 6,3 | (12,0) | 12,1 | (11,8) | 12,5 | 10 | (14,3) | 15,8 | (14,9) | 20 | 12,5 | 20,0 | 23,1 | (18,3) | 25 | 17,5 | 25,0 | 30,2 | (22,8) |
| 1000 | 1016 | 900 | 914 | 19 | 10 | 10 | 10,0 | 10,4 | (10,8) | 12,5 | 12,5 | 12,5 | 12,8 | 12,5 | 20 | 20 | 20,0 | 20,2 | 20,0 | 25 | 25 | 25,0 | 25,1 | 25,0 |
| | | 800 | 813 | 34 | 10 | 8 | 10,0 | 11,4 | (14,2) | 12,5 | 10 | 12,5 | 14,1 | (16,0) | 20 | 12,5 | 20,0 | 17,3 | (18,2) | 25 | 25 | 25,0 | 27,3 | 25,0 |
| | | 700 | 711 | 45 | 10 | 7,1 | (12,9) | 12,9 | (13,9) | 12,5 | 10 | (14,9) | 15,9 | (15,6) | 20 | 12,5 | 20,0 | 22,2 | (19,7) | 25 | 25 | 25,0 | 30,4 | 25,0 |
| 1200 | 1219 | 1000 | 1016 | 30 | 10 | 10 | 10,0 | 11,1 | (15,0) | 12,5 | 12,5 | 12,5 | 13,7 | (16,9) | 20 | 20 | 20,0 | 21,6 | (21,9) | 25 | 25 | 25,0 | 26,7 | (25,5) |
| | | 900 | 914 | 41 | 10 | 10 | (12,6) | 12,6 | (15,9) | 12,5 | 12,5 | (14,6) | 15,2 | (18,2) | 20 | 20 | 20,0 | 23,9 | (23,2) | 25 | 25 | 25,0 | 29,4 | (26,9) |
| | | 800 | 813 | 49 | 10 | 8 | (15,0) | 15,0 | (14,0) | 12,5 | 10 | (17,3) | 17,3 | (16,5) | 20 | 12,5 | (22,4) | 24,8 | (21,5) | 25 | 25 | (26,9) | 32,5 | (25,8) |

Table C.6 — Wall thickness of eccentric reducers type B – wall thickness series 5 to 8

| DN | D | DN ₁ | D ₁ | α _{max} | 5 | | | | | 6 | | | | | 7 | | | | | 8 | | | | |
|----|------|-----------------|----------------|------------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|
| | | | | | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ |
| 20 | 26,9 | 15 | 21,3 | 15 | 4 | 4 | 4,0 | 3,7 | 4,0 | - | - | - | - | - | 5,6 | 5 | 5,6 | 5,0 | 5,0 | 8 | 7,1 | 8,0 | 6,5 | 7,1 |
| 25 | 33,7 | 20 | 26,9 | 13 | 4,5 | 4 | 4,5 | 4,2 | 4,0 | 5,6 | 4,5 | 5,6 | 5,2 | 4,5 | 6,3 | 5,6 | 6,3 | 5,7 | 5,6 | 8,8 | 8 | 8,8 | 7,6 | 8,0 |
| | | 15 | 21,3 | 24 | 4,5 | 4 | 4,5 | 4,1 | 4,0 | - | - | - | - | - | 6,3 | 5 | 6,3 | 5,5 | 5,0 | 8,8 | 7,1 | 8,8 | 6,9 | 7,1 |
| 32 | 42,4 | 25 | 33,7 | 16 | 5 | 4,5 | 5,0 | 4,7 | 4,5 | 6,3 | 5,6 | 6,3 | 5,8 | 5,6 | 8 | 6,3 | 8,0 | 7,1 | 6,3 | 10 | 8,8 | 10,0 | 8,6 | 8,8 |
| | | 20 | 26,9 | 30 | 5 | 4 | 5,0 | 4,7 | 4,0 | 6,3 | 4,5 | 6,3 | 5,6 | 4,5 | 8 | 5,6 | 8,0 | 6,8 | 5,6 | 10 | 8 | 10,0 | 7,8 | 8,0 |
| | | 15 | 21,3 | 42 | 5 | 4 | 5,0 | 4,8 | 4,0 | - | - | - | - | - | 8 | 5 | 8,0 | 6,6 | 5,0 | 10 | 7,1 | 10,0 | 7,4 | 7,1 |
| 40 | 48,3 | 32 | 42,4 | 8 | 5 | 5 | 5,0 | 4,9 | 5,0 | 6,3 | 6,3 | 6,3 | 6,1 | 6,3 | 8 | 8 | 8,0 | 7,6 | 8,0 | 10 | 10 | 10,0 | 9,3 | 10,0 |
| | | 25 | 33,7 | 19 | 5 | 4,5 | 5,0 | 4,7 | 4,5 | 6,3 | 5,6 | 6,3 | 5,8 | 5,6 | 8 | 6,3 | 8,0 | 7,2 | 6,3 | 10 | 8,8 | 10,0 | 8,6 | 8,8 |
| | | 20 | 26,9 | 28 | 5 | 4 | 5,0 | 4,8 | 4,0 | 6,3 | 4,5 | 6,3 | 5,8 | 4,5 | 8 | 5,6 | 8,0 | 7,0 | 5,6 | 10 | 8 | 10,0 | 8,3 | 8,0 |
| 50 | 60,3 | 40 | 48,3 | 13 | 5,6 | 5 | 5,6 | 5,4 | 5,0 | 7,1 | 6,3 | 7,1 | 6,7 | 6,3 | 8,8 | 8 | 8,8 | 8,2 | 8,0 | 11 | 10 | 11,0 | 10,0 | 10,0 |
| | | 32 | 42,4 | 20 | 5,6 | 5 | 5,6 | 5,3 | 5,0 | 7,1 | 6,3 | 7,1 | 6,6 | 6,3 | 8,8 | 8 | 8,8 | 8,0 | 8,0 | 11 | 10 | 11,0 | 9,7 | 10,0 |
| | | 25 | 33,7 | 29 | 5,6 | 4,5 | 5,6 | 5,4 | 4,5 | 7,1 | 5,6 | 7,1 | 6,6 | 5,6 | 8,8 | 6,3 | 8,8 | 7,9 | 6,3 | 11 | 8,8 | 11,0 | 9,4 | 8,8 |
| | | 20 | 26,9 | 36 | 5,6 | 4 | 5,6 | 5,5 | 4,0 | 7,1 | 4,5 | 7,1 | 6,7 | 4,5 | 8,8 | 5,6 | 8,8 | 7,9 | 5,6 | 11 | 8 | 11,0 | 9,3 | 8,0 |
| 65 | 76,1 | 50 | 60,3 | 15 | 7,1 | 5,6 | 7,1 | 6,7 | 5,6 | 8 | 7,1 | 8,0 | 7,6 | 7,1 | 10 | 8,8 | 10,0 | 9,3 | 8,8 | 14,2 | 11 | 14,2 | 12,4 | 11,0 |
| | | 40 | 48,3 | 27 | 7,1 | 5 | 7,1 | 6,8 | 5,0 | 8 | 6,3 | 8,0 | 7,5 | 6,3 | 10 | 8 | 10,0 | 9,1 | 8,0 | 14,2 | 10 | 14,2 | 12,1 | 10,0 |
| | | 32 | 42,4 | 34 | 7,1 | 5 | 7,1 | 6,9 | 5,0 | 8 | 6,3 | 8,0 | 7,7 | 6,3 | 10 | 8 | 10,0 | 9,2 | 8,0 | 14,2 | 10 | 14,2 | 11,9 | 10,0 |
| | | 25 | 33,7 | 42 | 7,1 | 4,5 | 7,1 | 7,2 | 4,5 | 8 | 5,6 | 8,0 | 7,9 | 5,6 | 10 | 6,3 | 10,0 | 9,3 | 6,3 | 14,2 | 8,8 | 14,2 | 11,8 | 8,8 |
| 80 | 88,9 | 65 | 76,1 | 13 | 8 | 7,1 | 8,0 | 7,7 | 7,1 | 8,8 | 8 | 8,8 | 8,4 | 8,0 | 11 | 10 | 11,0 | 10,4 | 10,0 | 16 | 14,2 | 16,0 | 14,6 | 14,2 |
| | | 50 | 60,3 | 30 | 8 | 5,6 | 8,0 | 7,7 | 5,6 | 8,8 | 7,1 | 8,8 | 8,4 | 7,1 | 11 | 8,8 | 11,0 | 10,2 | 8,8 | 16 | 11 | 16,0 | 13,7 | 11,0 |
| | | 40 | 48,3 | 44 | 8 | 5 | 8,0 | 8,2 | 5,0 | 8,8 | 6,3 | 8,8 | 8,9 | 6,3 | 11 | 8 | 11,0 | 10,5 | 8,0 | 16 | 10 | 16,0 | 13,4 | 10,0 |
| | | 32 | 42,4 | 50 | 8 | 5 | 8,0 | 8,6 | 5,0 | 8,8 | 6,3 | 8,8 | 9,2 | 6,3 | 11 | 8 | 11,0 | 10,8 | 8,0 | 16 | 10 | 16,0 | 13,4 | 10,0 |

Table C.6 (continued)

| DN | D | DN ₁ | D ₁ | α _{max} | 5 | | | | | 6 | | | | | 7 | | | | | 8 | | | | |
|-----|-------|-----------------|----------------|------------------|------|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|
| | | | | | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ |
| 100 | 114,3 | 80 | 88,9 | 24 | 8,8 | 8 | 8,8 | 8,5 | 8,0 | 11 | 8,8 | 11,0 | 10,4 | 8,8 | 14,2 | 11 | 14,2 | 13,0 | 11,0 | 17,5 | 16 | 17,5 | 15,6 | 16,0 |
| | | 65 | 76,1 | 37 | 8,8 | 7,1 | 8,8 | 8,9 | 7,1 | 11 | 8 | 11,0 | 10,8 | 8,0 | 14,2 | 10 | 14,2 | 13,2 | 10,0 | 17,5 | 14,2 | 17,5 | 15,5 | 14,2 |
| | | 50 | 60,3 | 51 | 8,8 | 5,6 | 8,8 | 9,8 | 5,6 | 11 | 7,1 | 11,0 | 11,7 | 7,1 | 14,2 | 8,8 | 14,2 | 13,9 | 8,8 | 17,5 | 11 | 17,5 | 15,8 | 11,0 |
| | | 40 | 48,3 | 60 | 8,8 | 5 | 8,8 | 10,8 | 5,0 | 11 | 6,3 | 11,0 | 12,5 | 6,3 | 14,2 | 8 | 14,2 | 14,5 | 8,0 | 17,5 | 10 | 17,5 | 16,0 | 10,0 |
| 125 | 139,7 | 100 | 114,3 | 18 | 10 | 8,8 | 10,0 | 9,7 | 8,8 | 12,5 | 11 | 12,5 | 11,9 | 11,0 | 16 | 14,2 | 16,0 | 14,9 | 14,2 | 20 | 17,5 | 20,0 | 18,3 | 17,5 |
| | | 80 | 88,9 | 35 | 10 | 8 | 10,0 | 10,1 | 8,0 | 12,5 | 8,8 | 12,5 | 12,3 | 8,8 | 16 | 11 | 16,0 | 15,1 | 11,0 | 20 | 16 | 20,0 | 18,0 | 16,0 |
| | | 65 | 76,1 | 43 | 10 | 7,1 | 10,0 | 10,6 | 7,1 | 12,5 | 8 | 12,5 | 12,8 | 8,0 | 16 | 10 | 16,0 | 15,5 | 10,0 | 20 | 14,2 | 20,0 | 18,2 | 14,2 |
| | | 50 | 60,3 | 51 | 10 | 5,6 | 10,0 | 11,4 | 5,6 | 12,5 | 7,1 | 12,5 | 13,5 | 7,1 | 16 | 8,8 | 16,0 | 16,1 | 8,8 | 20 | 11 | 20,0 | 18,6 | 11,0 |
| 150 | 168,3 | 125 | 139,7 | 18 | 11 | 10 | 11,0 | 10,7 | 10,0 | 14,2 | 12,5 | 14,2 | 13,6 | 12,5 | 17,5 | 16 | 17,5 | 16,5 | 16,0 | 22,2 | 20 | 22,2 | 20,4 | 20,0 |
| | | 100 | 114,3 | 34 | 11 | 8,8 | 11,0 | 11,2 | 8,8 | 14,2 | 11 | 14,2 | 14,0 | 11,0 | 17,5 | 14,2 | 17,5 | 16,7 | 14,2 | 22,2 | 17,5 | 22,2 | 20,3 | 17,5 |
| | | 80 | 88,9 | 48 | 11 | 8 | 11,0 | 12,3 | 8,0 | 14,2 | 8,8 | 14,2 | 15,2 | 8,8 | 17,5 | 11 | 17,5 | 17,8 | 11,0 | 22,2 | 16 | 22,2 | 21,0 | 16,0 |
| | | 65 | 76,1 | 52 | 11 | 7,1 | 11,0 | 12,8 | 7,1 | 14,2 | 8 | 14,2 | 15,7 | 8,0 | 17,5 | 10 | 17,5 | 18,2 | 10,0 | 22,2 | 14,2 | 22,2 | 21,4 | 14,2 |
| 200 | 219,1 | 150 | 168,3 | 31 | 12,5 | 11 | 12,5 | 12,7 | 11,0 | 16 | 14,2 | 16,0 | 15,8 | 14,2 | 17,5 | 17,5 | 17,5 | 17,1 | 17,5 | 22,2 | 22,2 | 22,2 | 21,1 | 22,2 |
| | | 125 | 139,7 | 45 | 12,5 | 10 | 12,5 | 13,9 | 10,0 | 16 | 12,5 | 16,0 | 17,2 | 12,5 | 17,5 | 16 | 17,5 | 18,5 | 16,0 | 22,2 | 20 | 22,2 | 22,3 | 20,0 |
| | | 100 | 114,3 | 55 | 12,5 | 8,8 | 12,5 | 15,5 | 8,8 | 16 | 11 | 16,0 | 18,8 | 11,0 | 17,5 | 14,2 | 17,5 | 20,1 | 14,2 | 22,2 | 17,5 | 22,2 | 23,8 | 17,5 |
| | | 80 | 88,9 | 60 | 12,5 | 8 | 12,5 | 16,5 | 8,0 | 16 | 8,8 | 16,0 | 19,8 | 8,8 | 17,5 | 11 | 17,5 | 21,1 | 11,0 | 22,2 | 16 | 22,2 | 24,7 | 16,0 |
| 250 | 273 | 200 | 219,1 | 28 | 12,5 | 12,5 | 12,5 | 12,7 | 12,5 | 16 | 16 | 16,0 | 16,0 | 16,0 | 22,2 | 17,5 | 22,2 | 21,1 | 17,5 | 30 | 22,2 | 30,0 | 25,6 | 22,2 |
| | | 150 | 168,3 | 48 | 12,5 | 11 | 12,5 | 14,8 | 11,0 | 16 | 14,2 | 16,0 | 18,3 | 14,2 | 22,2 | 17,5 | 22,2 | 23,9 | 17,5 | 30 | 22,2 | 30,0 | 30,0 | 22,2 |
| | | 125 | 139,7 | 55 | 12,5 | 10 | 12,5 | 16,1 | 10,0 | 16 | 12,5 | 16,0 | 19,7 | 12,5 | 22,2 | 16 | 22,2 | 25,4 | 16,0 | 30 | 20 | 30,0 | 31,3 | 20,0 |
| | | 100 | 114,3 | 60 | 12,5 | 8,8 | (12,7) | 17,3 | 8,8 | 16 | 11 | 16,0 | 21,0 | 11,0 | 22,2 | 14,2 | 22,2 | 26,6 | 14,2 | 30 | 17,5 | 30,0 | 32,3 | 17,5 |
| 300 | 323,9 | 250 | 273 | 23 | 12,5 | 12,5 | 12,5 | 12,6 | 12,5 | 17,5 | 16 | 17,5 | 17,3 | 16,0 | 25 | 22,2 | 25,0 | 24,1 | 22,2 | 32 | 30 | 32,0 | 30,1 | 30,0 |
| | | 200 | 219,1 | 44 | 12,5 | 12,5 | 12,5 | 14,5 | 12,5 | 17,5 | 16 | 17,5 | 19,5 | 16,0 | 25 | 17,5 | 25,0 | 26,3 | 17,5 | 32 | 22,2 | 32,0 | 32,1 | 22,2 |
| | | 150 | 168,3 | 55 | 12,5 | 11 | 12,5 | 16,6 | 11,0 | 17,5 | 14,2 | 17,5 | 21,9 | 14,2 | 25 | 17,5 | 25,0 | 28,9 | 17,5 | 32 | 22,2 | 32,0 | 34,6 | 22,2 |
| | | 125 | 139,7 | 60 | 12,5 | 10 | (13,5) | 17,8 | 10,0 | 17,5 | 12,5 | 17,5 | 23,4 | 12,5 | 25 | 16 | 25,0 | 30,5 | 16,0 | 32 | 20 | 32,0 | 35,9 | 20,0 |

Table C.6 (continued)

| DN | D | DN ₁ | D ₁ | α _{max} | 5 | | | | | 6 | | | | | 7 | | | | | 8 | | | | |
|-----|-------|-----------------|----------------|------------------|------|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|----|----------------|----------------|----------------|----------------|----|----------------|----------------|----------------|----------------|
| | | | | | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ | T | T ₁ | T ₂ | T ₃ | T ₄ |
| 350 | 355,6 | 300 | 323,9 | 8 | 16 | 12,5 | 16,0 | 13,4 | 12,5 | 20 | 17,5 | 20,0 | 18,7 | 17,5 | 28 | 25 | 28,0 | 26,6 | 25,0 | 36 | 32 | 36,0 | 33,7 | 32,0 |
| | | 250 | 273 | 25 | 16 | 12,5 | 16,0 | 16,0 | 12,5 | 20 | 16 | 20,0 | 19,8 | 16,0 | 28 | 22,2 | 28,0 | 27,0 | 22,2 | 36 | 30 | 36,0 | 33,9 | 30,0 |
| | | 200 | 219,1 | 37 | 16 | 12,5 | 16,0 | 17,1 | 12,5 | 20 | 16 | 20,0 | 21,0 | 16,0 | 28 | 17,5 | 28,0 | 28,2 | 17,5 | 36 | 22,2 | 36,0 | 34,8 | 22,2 |
| | | 150 | 168,3 | 47 | 16 | 11 | 16,0 | 18,8 | 11,0 | 20 | 14,2 | 20,0 | 22,7 | 14,2 | 28 | 17,5 | 28,0 | 30,1 | 17,5 | 36 | 22,2 | 36,0 | 36,6 | 22,2 |
| 400 | 406,4 | 350 | 355,6 | 15 | 17,5 | 16 | 17,5 | 17,2 | 16,0 | 22,2 | 20 | 22,2 | 21,6 | 20,0 | 30 | 28 | 30,0 | 28,8 | 28,0 | 40 | 36 | 40,0 | 37,9 | 36,0 |
| | | 300 | 323,9 | 24 | 17,5 | 12,5 | 17,5 | 15,7 | 12,5 | 22,2 | 17,5 | 22,2 | 21,7 | 17,5 | 30 | 25 | 30,0 | 29,0 | 25,0 | 40 | 32 | 40,0 | 37,7 | 32,0 |
| | | 250 | 273 | 36 | 17,5 | 12,5 | 17,5 | 18,7 | 12,5 | 22,2 | 16 | 22,2 | 23,2 | 16,0 | 30 | 22,2 | 30,0 | 30,3 | 22,2 | 40 | 30 | 40,0 | 38,7 | 30,0 |
| | | 200 | 219,1 | 46 | 17,5 | 12,5 | 17,5 | 20,4 | 12,5 | 22,2 | 16 | 22,2 | 25,1 | 16,0 | 30 | 17,5 | 30,0 | 32,3 | 17,5 | 40 | 22,2 | 40,0 | 40,7 | 22,2 |
| 450 | 457 | 400 | 406,4 | 11 | 17,5 | 17,5 | 17,5 | 17,2 | 17,5 | 22,2 | 22,2 | 22,2 | 21,7 | 22,2 | 32 | 30 | 32,0 | 31,0 | 30,0 | 45 | 40 | 45,0 | 42,9 | 40,0 |
| | | 350 | 355,6 | 24 | 17,5 | 16 | 17,5 | 17,6 | 16,0 | 22,2 | 20 | 22,2 | 22,1 | 20,0 | 32 | 28 | 32,0 | 31,1 | 28,0 | 45 | 36 | 45,0 | 42,4 | 36,0 |
| | | 300 | 323,9 | 31 | 17,5 | 12,5 | 17,5 | 18,2 | 12,5 | 22,2 | 17,5 | 22,2 | 22,7 | 17,5 | 32 | 25 | 32,0 | 31,7 | 25,0 | 45 | 32 | 45,0 | 42,9 | 32,0 |
| | | 250 | 273 | 41 | 17,5 | 12,5 | 17,5 | 19,7 | 12,5 | 22,2 | 16 | 22,2 | 24,3 | 16,0 | 32 | 22,2 | 32,0 | 33,5 | 22,2 | 45 | 30 | 45,0 | 44,5 | 30,0 |
| 500 | 508 | 450 | 457 | 8 | 17,5 | 17,5 | 17,5 | 17,3 | 17,5 | 25 | 22,2 | 25,0 | 24,2 | 22,2 | 36 | 32 | 36,0 | 34,6 | 32,0 | 50 | 45 | 50,0 | 48,2 | 45,0 |
| | | 400 | 406,4 | 18 | 17,5 | 17,5 | 17,5 | 17,4 | 17,5 | 25 | 22,2 | 25,0 | 24,5 | 22,2 | 36 | 30 | 36,0 | 34,7 | 30,0 | 50 | 40 | 50,0 | 47,1 | 40,0 |
| | | 350 | 355,6 | 27 | 17,5 | 16 | 17,5 | 18,0 | 16,0 | 25 | 20 | 25,0 | 25,1 | 20,0 | 36 | 28 | 36,0 | 35,2 | 28,0 | 50 | 36 | 50,0 | 47,3 | 36,0 |
| | | 300 | 323,9 | 32 | 17,5 | 12,5 | 17,5 | 18,5 | 12,5 | 25 | 17,5 | 25,0 | 25,7 | 17,5 | 36 | 25 | 36,0 | 35,8 | 25,0 | 50 | 32 | 50,0 | 47,8 | 32,0 |
| 600 | 610 | 500 | 508 | 17 | 25 | 17,5 | 25,0 | 20,6 | 17,5 | 30 | 25 | 30,0 | 29,4 | 25,0 | 45 | 36 | 45,0 | 41,4 | 36,0 | 60 | 50 | 60,0 | 56,6 | 50,0 |
| | | 450 | 457 | 27 | 25 | 17,5 | 25,0 | 23,7 | 17,5 | 30 | 22,2 | 30,0 | 29,7 | 22,2 | 45 | 32 | 45,0 | 41,4 | 32,0 | 60 | 45 | 60,0 | 56,7 | 45,0 |
| | | 400 | 406,4 | 35 | 25 | 17,5 | 25,0 | 26,6 | 17,5 | 30 | 22,2 | 30,0 | 31,4 | 22,2 | 45 | 30 | 45,0 | 45,2 | 30,0 | 60 | 40 | 60,0 | 57,9 | 40,0 |

C.5 Caps

Table C.7 shows wall thicknesses at the body of caps of type B.

The calculation was done for an inside knuckle radius $r = 0,15 D$ and an inside spherical radius $R1 = 0,8 D$. Smaller inside knuckle radii ($r < 0,15 D$) or larger inside spherical radii ($R1 > 0,8 D$) of the ellipsoidal end may result in larger wall thicknesses, especially for small ratios of wall thickness to diameter showing increased wall thicknesses at the body of the cap.

For caps with an inside knuckle radius $r < 0,15 D$ or with an inside spherical radius $R > 0,8 D$ the wall thickness at the body of the cap shall be calculated in accordance with Annex A.

For some dimensions no wall thicknesses at the body of the cap are listed. In these cases the dimensions of the cap are outside the range of validity of the calculation procedures given in Annex A.

Smaller wall thicknesses than listed in Table C.7 are acceptable provided that they are calculated in accordance with Annex A.

Table C.7 — Wall thickness of caps

| DN | D | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | |
|-------|-------|-----|----------------|------|----------------|------|----------------|------|----------------|------|----------------|------|----------------|------|----------------|------|----------------|
| | | T | T _c | T | T _c | T | T _c | T | T _c | T | T _c | T | T _c | T | T _c | T | T _c |
| 15 | 21,3 | - | - | 2 | - | 2,6 | - | 3,2 | - | 4 | - | - | - | 5 | - | 7,1 | - |
| 20 | 26,9 | - | - | 2,3 | - | 2,6 | - | 3,2 | - | 4 | - | 4,5 | - | 5,6 | - | 8 | - |
| 25 | 33,7 | - | - | 2,6 | - | 3,2 | - | 4 | - | 4,5 | - | 5,6 | - | 6,3 | - | 8,8 | - |
| 32 | 42,4 | - | - | 2,6 | - | 3,6 | - | 4 | - | 5 | - | 6,3 | - | 8 | - | 10 | - |
| 40 | 48,3 | - | - | 2,6 | 2,6 | 3,6 | - | 4 | - | 5 | - | 6,3 | - | 8 | - | 10 | - |
| 50 | 60,3 | - | - | 2,9 | 2,9 | 3,6 | - | 4 | - | 5,6 | - | 7,1 | - | 8,8 | - | 11 | - |
| 65 | 76,1 | - | - | 2,9 | 2,9 | 3,6 | 3,6 | 5,6 | - | 7,1 | - | 8 | - | 10 | - | 14,2 | - |
| 80 | 88,9 | - | - | 3,2 | 3,2 | 4 | 4,0 | 5,6 | - | 8 | - | 8,8 | - | 11 | - | 16 | - |
| 100 | 114,3 | - | - | 3,6 | 3,6 | 4,5 | 4,5 | 6,3 | 6,3 | 8,8 | - | 11 | - | 14,2 | - | 17,5 | - |
| 125 | 139,7 | - | - | 4 | 4,0 | 5 | 5,0 | 6,3 | 6,3 | 10 | - | 12,5 | - | 16 | - | 20 | - |
| 150 | 168,3 | 4 | 4,0 | 4,5 | 4,5 | 5,6 | 5,6 | 7,1 | 7,1 | 11 | - | 14,2 | - | 17,5 | - | 22,2 | - |
| 200 | 219,1 | 4,5 | 4,5 | 6,3 | 6,3 | 7,1 | 7,1 | 8 | 8,0 | 12,5 | 12,5 | 16 | - | 17,5 | - | 22,2 | - |
| 250 | 273 | 5 | 5,0 | 6,3 | 6,3 | 8,8 | 8,8 | 10 | 10,0 | 12,5 | 12,5 | 16 | - | 22,2 | - | 30 | - |
| 300 | 323,9 | 5,6 | 5,6 | 7,1 | 7,1 | 8,8 | 8,8 | 10 | 10,0 | 12,5 | 12,5 | 17,5 | 17,5 | 25 | - | 32 | - |
| 350 | 355,6 | 5,6 | 5,6 | 8 | 8,0 | 10 | 10,0 | 12,5 | 12,5 | 16 | 16,0 | 20 | 20,0 | 28 | - | 36 | - |
| 400 | 406,4 | 6,3 | 6,3 | 8,8 | 8,8 | 10 | 10,0 | 12,5 | 12,5 | 17,5 | 17,5 | 22,2 | 22,2 | 30 | - | 40 | - |
| 450 | 457 | 6,3 | 6,3 | 10 | 10,0 | 11 | 11,0 | 12,5 | 12,5 | 17,5 | 17,5 | 22,2 | 22,2 | 32 | - | 45 | - |
| 500 | 508 | 6,3 | 6,3 | 10 | 10,0 | 11 | 11,0 | 12,5 | 12,5 | 17,5 | 17,5 | 25 | 25,0 | 36 | - | 50 | - |
| 600 | 610 | 6,3 | 6,4 | 10 | 10,0 | 12,5 | 12,5 | 17,5 | 17,5 | 25 | 25,0 | 30 | 30,0 | 45 | - | 60 | - |
| 700 | 711 | 7,1 | 7,3 | 10 | 10,0 | 12,5 | 12,5 | 25 | 25,0 | - | - | - | - | - | - | - | - |
| 800 | 813 | 8 | 8,2 | 10 | 10,0 | 12,5 | 12,5 | 25 | 25,0 | - | - | - | - | - | - | - | - |
| 900 | 914 | 10 | 10,1 | 12,5 | 12,5 | 20 | 20,0 | 25 | 25,0 | - | - | - | - | - | - | - | - |
| 1 000 | 1 016 | 10 | 10,3 | 12,5 | 12,5 | 20 | 20,0 | 25 | 25,0 | - | - | - | - | - | - | - | - |
| 1 200 | 1 219 | 10 | 10,5 | 12,5 | 12,8 | 20 | 20,0 | 25 | 25,0 | - | - | - | - | - | - | - | - |

Annex D (informative)

Recommended heat treatment temperatures

Table D.1

| Steel grade | Reference heat treatment | Austenitizing temperature | Cooling medium | Tempering temperature | Cooling medium |
|---------------|--------------------------|---------------------------|--------------------|-----------------------|----------------|
| P235TR2 | N | 880-940 | air | | |
| P265TR2 | N | 880-940 | air | | |
| P235GH | N | 880-940 | air | | |
| P265GH | N | 880-940 | air | | |
| 16Mo3 | N | 890-950 | air | | |
| 10CrMo5-5 | NT | 900-960 | air | 650-750 | air |
| 13CrMo4-5 | NT | 900-960 | air | 660-730 | air |
| 10CrMo9-10 | NT | 900-960 | air | 680-750 | air |
| X11CrMo5 | I | 890-950 | furnace atmosphere | | |
| X11CrMo5 | NT1 | 930-980 | air | 710-770 | air |
| X11CrMo5 | NT2 | 930-980 | air | 710-750 | air |
| X11CrMo9-1 | I | 950-980 | furnace atmosphere | | |
| X11CrMo9-1 | NT | 890-950 | air | 720-800 | air |
| X10CrMoVNb9-1 | NT | 1040-1090 | air | 730-830 | air |
| P355N | N | - | - | | |
| P355NH | N | - | - | | |
| P355NL1 | N | - | - | | |
| P215NL | N | 900-940 | | | |
| P265NL | N | 880-940 | | | |
| 12Ni14 | QT | 820-880 | water or oil | 580-660 | air |
| X10Ni9 | QT | 770-820 | water or oil | 540-660 | air |

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 97/23/EC

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 97/23/EC.

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in the four divisions of Table ZA-1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA-1 — Correspondence between this European Standard and Directive 97/23/EC

Table ZA-1 a) - Seamless fittings (except fittings machined from bars)

| Clauses/sub clauses of this EN | Pressure Equipment Directive 97/23/EC Annex I | Content |
|---------------------------------------|--|--|
| 9.3 | Annex I, 4.1a | Appropriate material properties |
| 8.1 and 9.2 Table 4 and Table 7 | Annex I, 4.1c | Ageing |
| 8.2 and 10 | Annex I, 4.1d | Suitable for the processing procedures |
| 12 | Annex I, 4.3 | Documentation |

Table ZA-1 b) - Fittings produced from welded pipe

| Clauses/sub-clauses of this EN | Pressure Equipment Directive 97/23/EC Annex I | Content |
|---------------------------------------|--|--|
| 8.2.1 | 3.1.1 | Forming |
| 8.2.1 | 3.1.2 | Welding |
| 8.2.1, 14.9.1 | 3.1.3 | NDT personnel |
| 8.2.3 | 3.1.4 | Heat treatment |
| 8.2.1, 9.3 | Annex I, 4.1a | Appropriate material properties |
| 8.1 and 9.2 Table 4 and Table 7 | Annex I, 4.1c | Ageing |
| 8.2 and 10 | Annex I, 4.1d | Suitable for the processing procedures |
| 12 | Annex I, 4.3 | Documentation |

Table ZA-1 c) - Fittings where welding is part of the production process

| Clauses/sub-clauses of this EN | Pressure Equipment Directive 97/23/EC Annex I | Content |
|------------------------------------|---|--|
| 8.2.1 | 3.1.1 | Forming |
| 8.2.2 | 3.1.2 | Welding |
| 14.9.1 | 3.1.3 | NDT personnel |
| 8.2.3 | 3.1.4 | Heat treatment |
| 8.2.1, 9.3 | Annex I, 4.1a | Appropriate material properties |
| 8.1 and 9.2 Table 4 and Table 7 | Annex I, 4.1c | Ageing |
| 8.2 and 10 | Annex I, 4.1d | Suitable for the processing procedures |
| 12 | Annex I, 4.3 | Documentation |

Table ZA-1 d) - Fittings machined from bars

| Clauses/sub-clauses of this EN | Pressure Equipment Directive 97/23/EC Annex I | Content |
|------------------------------------|---|--|
| 8.2.1, 9.3 | Annex I, 4.1a | Appropriate material properties |
| 8.1 and 9.2 Table 4 and Table 7 | Annex I, 4.1c | Ageing |
| 8.2 and 10 | Annex I, 4.1d | Suitable for the processing procedures |
| 12 | Annex I, 4.3 | Documentation |

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

- [1] EN 473, *Non-destructive testing — Qualification and certification of NDT personnel — General principles*
- [2] EN 10216 (all parts), *Seamless steel tubes for pressure purposes — Technical delivery conditions*
- [3] EN 10208-2, *Steel pipes for pipelines for combustible fluids — Technical delivery conditions — Part 2: Pipes of requirement class B*
- [4] EN 10246-8, *Non-destructive testing of steel tubes — Part 8: Automatic ultrasonic testing of the weld seam of electric welded steel tubes for the detection of longitudinal imperfections*
- [5] EN 10246-9, *Non-destructive testing of steel tubes — Part 9: Automatic ultrasonic testing of the weld seam of submerged arc welded steel tubes for the detection of longitudinal and/or transverse imperfections*
- [6] EN 10220, *Seamless and welded steel tubes — Dimensions and masses per unit length*
- [7] EN 10256, *Non-destructive testing of steel tubes — Qualification and competence of level 1 and 2 non-destructive testing personnel*
- [8] EN ISO 6506-1, *Metallic materials — Brinell hardness test - Part 1: Test method (ISO 6506-1:2005)*

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