

Australian Standard<sup>®</sup>

**Plastics piping systems—Glass-reinforced thermoplastics (GRP) systems based on unsaturated polyester (UP) resin**

**Part 1: Pressure and non-pressure drainage and sewerage (ISO 10467:2004, MOD)**



This Australian Standard® was prepared by Committee PL-044, Reinforced Plastics Pipe Systems, Tanks and Vessels. It was approved on behalf of the Council of Standards Australia on 3 April 2009.

This Standard was published on 27 April 2009.

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The following are represented on Committee PL-044:

- Australian Chamber of Commerce and Industry
  - Business New Zealand
  - Certification Interests, Australia
  - Composites Australia
  - Engineers Australia
  - Plastics Industry Pipe Association of Australia
  - Water Industry Alliance
  - Water Services Association of Australia
- 

This Standard was issued in draft form for comment as DR 06736.

Standards Australia wishes to acknowledge the participation of the expert individuals that contributed to the development of this Standard through their representation on the Committee and through the public comment period.

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**Part 1: Pressure and non-pressure drainage and sewerage (ISO 10467:2004, MOD)**

Originated as part of AS 3571—1989.  
Revised in part and redesignated as AS 3571.1—2009.  
Reissued incorporating Amendment No. 1 (November 2009).

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Published by Standards Australia GPO Box 476, Sydney, NSW 2001, Australia  
ISBN 0 7337 9135 2

## PREFACE

This Standard was prepared by the Standards Australia Committee PL-044, Reinforced Plastics Pipe Systems, Tanks and Vessels to supersede (in part) AS 3571—1989, *Glass filament reinforced thermosetting plastics (GRP)—Polyester based—Water supply, sewerage and drainage applications*.

*This Standard incorporates Amendment No. 1 (November 2009). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.*

The objective of this Standard is to provide designers, manufacturers, operators and regulating authorities of pressure and non-pressure drainage and sewerage systems with the requirements for glass-reinforced thermoplastics (GRP) systems.

This Standard is an adoption with national modifications and has been reproduced from, ISO 10467:2004, *Plastics piping systems for pressure and non-pressure drainage and sewerage—Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin*.

The Australian modifications are listed in Appendix ZZ.

Methods for demonstrating compliance with this Standard are specified in Appendix ZA.

Enquiry, tendering and ordering guidelines for purchasers and suppliers are given in Appendix ZB.

Guidance on acceptable levels of surface defects is given in Appendix ZC.

The terms ‘normative’ and ‘informative’ are used to define the application of the Annex or Appendix to which it applies. A normative Annex or appendix is an integral part of a Standard, whereas an informative Annex or Appendix is only for information and guidance.

As this Standard is reproduced from an international standard, the following applies:

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References to International Standards should be replaced by references to Australian or Australian/New Zealand Standards, as follows:

| <i>Reference to International Standard</i> |                                                                                          | <i>Australian or Australian/New Zealand Standard</i> |                                                                     |
|--------------------------------------------|------------------------------------------------------------------------------------------|------------------------------------------------------|---------------------------------------------------------------------|
| ISO                                        |                                                                                          | AS/NZS                                               |                                                                     |
| 2531                                       | Ductile iron pipes, fittings, accessories and their joints for water or gas applications | 2280                                                 | Ductile iron pipes and fittings                                     |
| 3126                                       | Plastics piping systems—Plastics components—Determination of dimensions                  | 1477                                                 | PVC pipes and fittings for pressure applications; or                |
|                                            |                                                                                          | 4765                                                 | Modified PVC (PVC-M) pipes for pressure applications; or            |
|                                            |                                                                                          | 4441                                                 | Oriented PVC (PVC-O) pipes for pressure applications, as applicable |

| ISO          |                                                                                                    | AS/NZS |                                                                     |
|--------------|----------------------------------------------------------------------------------------------------|--------|---------------------------------------------------------------------|
| 11922        | Thermoplastics pipes for the conveyance of fluids—Dimensions and tolerances                        | 1477   | PVC pipes and fittings for pressure applications; or                |
| 11922-1      | Part 1: Metric series                                                                              | 4765   | Modified PVC (PVC-M) pipes for pressure applications; or            |
|              |                                                                                                    | 4441   | Oriented PVC (PVC-O) pipes for pressure applications, as applicable |
|              |                                                                                                    | AS     |                                                                     |
| 4200         | Plain end steel tubes, welded and seamless—General tables of dimensions and masses per unit length | 1579   | Arc welded steel pipes and fittings for water and waste water       |
|              |                                                                                                    | AS/NZS |                                                                     |
| ISO/TR 10465 | Underground installation of flexible glass-reinforced thermosetting resin (GRP) pipes              | 2566   | Buried flexible pipelines                                           |
| 10465-3      | Part 3: Installation parameters and application limits                                             | 2566.1 | Part 1: Structural design; and                                      |
|              |                                                                                                    | 2566.2 | Part 2: Installation                                                |

The following documents are referred to in Appendices ZZ and ZA:

AS

1199 Sampling procedures for inspection by attributes  
 1199.1 Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection

1646 Elastomeric seals for waterworks purposes

3572 Plastics—Glass filament reinforced plastics (GRP)—Methods of test

3572.4 Part 4: Determination of the dimensions of glass filament reinforced plastics pipes

HB 18.28 Conformity assessment—Guidance on a third-party certification system for products

AS/NZS

4020 Testing of products for use in contact with drinking water

Statements expressed in mandatory notes to tables and figures are deemed to be requirements of this Standard. Other notes are for information and guidance only.

## CONTENTS

|                                                                                                                                                      | <i>Page</i> |
|------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| 1 Scope.....                                                                                                                                         | 1           |
| 2 Normative references .....                                                                                                                         | 2           |
| 3 Terms and definitions .....                                                                                                                        | 4           |
| 4 General .....                                                                                                                                      | 14          |
| 4.1 Classification .....                                                                                                                             | 14          |
| 4.2 Materials .....                                                                                                                                  | 15          |
| 4.3 Wall construction .....                                                                                                                          | 16          |
| 4.4 Appearance .....                                                                                                                                 | 17          |
| 4.5 Reference conditions for testing .....                                                                                                           | 17          |
| 4.6 Elapsed time, $x$ , for determination of long-term properties .....                                                                              | 17          |
| 4.7 Joints .....                                                                                                                                     | 17          |
| 5 Pipes.....                                                                                                                                         | 18          |
| 5.1 Geometrical characteristics .....                                                                                                                | 18          |
| 5.2 Mechanical characteristics.....                                                                                                                  | 26          |
| 5.3 Resistance to pressure pipes to cyclic internal pressure .....                                                                                   | 36          |
| 5.4 Resistance to strain corrosion .....                                                                                                             | 36          |
| 5.5 Marking .....                                                                                                                                    | 39          |
| 6 Fittings .....                                                                                                                                     | 39          |
| 6.1 All types .....                                                                                                                                  | 39          |
| 6.2 Bends.....                                                                                                                                       | 41          |
| 6.3 Branches.....                                                                                                                                    | 45          |
| 6.4 Reducers.....                                                                                                                                    | 48          |
| 6.5 Saddles .....                                                                                                                                    | 52          |
| 6.6 Flanged adaptors .....                                                                                                                           | 53          |
| 6.7 Marking .....                                                                                                                                    | 56          |
| 7 Joint performance .....                                                                                                                            | 57          |
| 7.1 General .....                                                                                                                                    | 57          |
| 7.2 Flexible joints .....                                                                                                                            | 57          |
| 7.3 Rigid joints .....                                                                                                                               | 60          |
| Annex A Principles used to establish the design requirements based on regression testing<br>and consideration of the variability of the product..... | 66          |
| Annex B Guidance on leaktightness testing .....                                                                                                      | 74          |
| <br>APPENDICES                                                                                                                                       |             |
| ZZ VARIATIONS TO ISO 10467:2004 FOR APPLICATION IN AUSTRALIA .....                                                                                   | 76          |
| ZA COMPLIANCE REQUIREMENTS.....                                                                                                                      | 79          |
| ZB ENQUIRY, TENDERING AND ORDERING INFORMATION.....                                                                                                  | 82          |
| ZC SURFACE DEFECTS ACCEPTABILITY .....                                                                                                               | 84          |

A1

## AUSTRALIAN STANDARD

# Plastics piping systems—Glass-reinforced thermoplastics (GRP) systems based on unsaturated polyester (UP) resin

## Part 1: Pressure and non-pressure drainage and sewerage (ISO 10467:2004, MOD)

### 1 Scope

This International Standard specifies the properties of piping system components made from glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP) for drainage or sewerage with or without pressure, as well as the properties of the system itself.

This International Standard is applicable to GRP-UP piping systems, with flexible or rigid joints with or without end thrust load-bearing capability, primarily intended for use in buried installations.

**NOTE** Piping systems conforming to this International Standard can also be used for non-buried applications provided the influence of the environment and the supports are considered in the design of the pipes, fittings and joints.

This International Standard is applicable to pipes, fittings and their joints of nominal sizes from DN 50 to DN 4000 which are intended to be used for the conveyance of drainage or sewerage at temperatures up to 50 °C, with or without pressure. In a pipework system, pipes and fittings of different nominal pressure and stiffness ratings may be used together.

Clause 4 specifies the general aspects of GRP-UP piping systems intended to be used in the field of drainage or sewerage with or without pressure.

Clause 5 specifies the characteristics of pipes made from GRP-UP with or without aggregates and/or fillers. The pipes may have a thermoplastics or thermosetting resin liner. Clause 5 also specifies the test parameters for the test methods referred to in this International Standard.

Clause 6 specifies the characteristics of fittings made from GRP-UP, with or without a thermoplastics or thermosetting resin liner, intended to be used in the field of drainage or sewerage. Clause 6 specifies the dimensional and performance requirements for bends, branches, reducers, saddles and flanged adaptors. Clause 6 is applicable to fittings made using any of the following techniques:

- a) fabrication from straight pipes;
- b) moulding by
  - 1) filament winding,
  - 2) tape winding,
  - 3) contact moulding,
  - 4) hot or cold compression moulding.

Clause 7 is applicable to the joints to be used in GRP-UP piping systems to be used for the conveyance of surface water or sewerage, both buried and non-buried. It covers requirements to prove the design of the joint. Clause 7 specifies type test performance requirements for the following joints as a function of the declared nominal pressure rating of the pipeline or system:

- a) socket-and-spigot (including double-socket) joints or mechanical joints;
- b) locked socket-and-spigot joints;
- c) cemented or wrapped joints;
- d) bolted flange joints.

## 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.

ISO 75-2:2003, *Plastics — Determination of temperature of deflection under load — Part 2: Plastics and ebonite*

ISO 161-1, *Thermoplastics pipes for the conveyance of fluids — Nominal outside diameters and nominal pressures — Part 1: Metric series*

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

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

ISO 2078, *Textile glass — Yarns — Designation*

ISO 2531, *Ductile iron pipes, fittings, accessories and their joints for water or gas applications*

ISO 3126, *Plastics piping systems — Plastics components — Determination of dimensions*

ISO 4200, *Plain end steel tubes, welded and seamless — General tables of dimensions and masses per unit length*

ISO 7432:2002, *Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Test methods to prove the design of locked socket-and-spigot joints, including double-socket joints, with elastomeric seals*

ISO 7509, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Determination of time to failure under sustained internal pressure*

ISO 7511:1999, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Test methods to prove the leaktightness of the wall under short-term internal pressure*

ISO 7685, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Determination of initial specific ring stiffness*

ISO 8483:2003, *Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Test methods to prove the design of bolted flange joints*

ISO 8513:2000, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Determination of longitudinal tensile properties*

ISO 8521:1998, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Determination of the apparent initial circumferential tensile strength*

ISO 8533:2003, *Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Test methods to prove the design of cemented or wrapped joints*

ISO 8639:2000, *Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Test methods for leaktightness of flexible joints*

ISO/TR 10465-3, *Underground installation of flexible glass-reinforced thermosetting resin (GRP) pipes — Part 3: Installation parameters and application limits*

ISO 10466, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Test method to prove the resistance to initial ring deflection*

ISO 10468, *Glass-reinforced thermosetting plastics (GRP) pipes — Determination of the long-term specific ring creep stiffness under wet conditions and calculation of the wet creep factor*

ISO 10471, *Glass-reinforced thermosetting plastics (GRP) pipes — Determination of the long-term ultimate bending strain and the long-term ultimate relative ring deflection under wet conditions*

ISO 10928:1997, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Methods for regression analysis and their use*

ISO 10952, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Determination of the resistance to chemical attack from the inside of a section in a deflected condition*

ISO 11922-1, *Thermoplastics pipes for the conveyance of fluids — Dimensions and tolerances — Part 1: Metric series*

ISO 14828, *Glass-reinforced thermosetting plastics (GRP) pipes — Determination of the long-term specific ring relaxation stiffness under wet conditions and calculation of the wet relaxation factor*

ISO 15306, *Glass-reinforced thermosetting plastics (GRP) pipes — Determination of the resistance to cyclic internal pressure*

EN 681-1, *Elastomeric seals — Materials requirements for pipe joint seals used in water and drainage applications — Part 1: Vulcanized rubber*

EN 681-2, *Elastomeric seals — Materials requirements for pipe joint seals used in water and drainage applications — Part 2: Thermoplastic elastomers*

JIS A 5350, *Fibreglass reinforced plastic mortar pipes*

### 3 Terms and definitions

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

#### 3.1

##### **nominal size**

##### **DN**

alphanumeric designation of size, which is common to all components in a piping system, which is a convenient round number for reference purposes and is related to the internal diameter in millimetres

NOTE The designation for reference or marking purposes consists of the letters DN plus a number.

#### 3.2

##### **declared diameter**

diameter which a manufacturer states to be the mean internal or external diameter produced in respect of a particular nominal size (DN)

#### 3.3

##### **nominal stiffness**

##### **SN**

alphanumeric designation of stiffness classification purposes, which has the same numerical value as the minimum initial value required, when expressed in newtons per square metre (N/m<sup>2</sup>) (see 4.1.3)

NOTE The designation for reference or marking purposes consists of the letters SN plus a number.

#### 3.4

##### **specific ring stiffness**

##### **S**

measure of the resistance, in newtons per square metre, of a pipe to ring deflection per metre length under external load as defined by Equation (1):

$$S = \frac{E \times I}{d_m^3} \quad (1)$$

where

*E* is the apparent modulus of elasticity as determined in a ring stiffness test, in newtons per square metre (N/m<sup>2</sup>);

*I* is the second moment of area in the longitudinal direction per metre length, in metres to the fourth power per metre (m<sup>4</sup>/m), i.e.

$$I = \frac{e^3}{12} \quad (2)$$

*e* being the wall thickness, in metres (m);

*d<sub>m</sub>* is the mean diameter of the pipe, in metres (m) (see 3.5)

#### 3.5

##### **mean diameter**

##### ***d<sub>m</sub>***

diameter of the circle corresponding to the middle of the pipe wall cross-section and given, in metres (m), by either Equation (3) or (4)

$$d_m = d_i + e \quad (3)$$

$$d_m = d_e - e \quad (4)$$

where

$d_i$  is the internal diameter, in metres (m);

$d_e$  is the external diameter, in metres (m);

$e$  is the wall thickness of the pipe, in metres (m)

### 3.6

#### initial specific ring stiffness

$S_0$

value of  $S$  obtained when determined in accordance with ISO 7685, in newtons per square metre (N/m<sup>2</sup>)

### 3.7

#### wet creep factor

$\alpha_{x, \text{wet, creep}}$

ratio of the long-term specific ring stiffness,  $S_{x, \text{wet}}$ , at  $x$  years (see 4.6), determined under sustained loading in wet conditions in accordance with ISO 10468, to the initial specific ring stiffness,  $S_0$ , both measured at the same position referred to as reference position 1

NOTE It is given by Equation (5):

$$\alpha_{x, \text{wet, creep}} = \frac{S_{x, 1, \text{wet}}}{S_{0, 1}} \quad (5)$$

### 3.8

#### wet relaxation factor

$\alpha_{x, \text{wet, relax}}$

ratio of the long-term specific ring stiffness,  $S_{x, \text{wet}}$ , at  $x$  years (see 4.6), determined under sustained deflection in wet conditions in accordance with ISO 14828, to the initial specific ring stiffness,  $S_0$ , both measured at the same position, referred to as reference position 1

NOTE It is given by Equation (6):

$$\alpha_{x, \text{wet, relax}} = \frac{S_{x, 1, \text{wet}}}{S_{0, 1}} \quad (6)$$

### 3.9

#### calculated long-term specific ring stiffness

$S_{x, \text{wet}}$

calculated value of  $S$  (see 4.6) at  $x$  years, obtained by Equation (7):

$$S_{x, \text{wet}} = S_0 \times \alpha_{x, \text{wet}} \quad (7)$$

where

$x$  is the elapsed time, in years, specified in this International Standard (see 4.6);

$\alpha_{x, \text{wet}}$  is either the wet creep factor (see 3.7) or the wet relaxation factor (see 3.8);

$S_0$  is the initial specific ring stiffness, in newtons per square metre (N/m<sup>2</sup>) (see 3.6).

### 3.10

#### rating factor

$R_{RF}$

multiplication factor that quantifies the relation between a mechanical, physical or chemical property under the service conditions compared to the respective value at 23 °C and 50 % relative humidity (R.H.)

### 3.11 nominal pressure PN

alphanumeric designation for pressure classification purposes which is numerically equal to the resistance of a component of a piping system to internal pressure, expressed in bars<sup>1)</sup>

NOTE The designation for reference or marking purposes consists of the letters PN plus a number.

### 3.12 type test

test carried out in order to assess the fitness for purpose of a product or assembly of components to fulfil its or their function(s) in accordance with the product specification

### 3.13 nominal length

numerical designation of pipe length which is equal to the laying length (see 3.15), expressed in metres (m), rounded to the nearest whole number

### 3.14 total length

distance between two planes normal to the pipe axis and passing through the extreme end points of the pipe, expressed in metres (m)

### 3.15 laying length

total length of a pipe minus, where applicable, the manufacturer's recommended insertion depth of the spigot(s) in the socket

### 3.16 normal service conditions

conveyance of surface water or sewage in the temperature range 2 °C to 50 °C, with or without pressure, for 50 years

NOTE At temperatures above 35 °C, it may be necessary to rerate the pipe.

### 3.17 working pressure

$p_w$   
internal pressure, excluding surge, at which a system is to be continuously operated, expressed in bars

### 3.18 maximum working pressure

maximum internal pressure, excluding surge, at which a system can be continuously operated, expressed in bars

### 3.19 surge

rapid change in internal pressure, either positive or negative, caused by a change in the flow velocity

NOTE It is expressed in bars.

### 3.20 surge allowance

value, expressed in bars or as a percentage of the maximum working pressure of a pipe, that can be added to the maximum working pressure to allow for occasional fluctuations in pressure

NOTE The value may vary depending upon the anticipated frequency of the surge conditions.

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1) 1 bar = 10<sup>5</sup> N/m<sup>2</sup> = 100 kPa (or = 0,1 MPa)

**3.21****static design pressure**

maximum working pressure of a system, taking into account current and future use, fixed by the designer

NOTE It is expressed in bars.

**3.22****maximum design pressure**

maximum working pressure, including surge, that the designer anticipates in a system

NOTE It is expressed in bars.

**3.23****non-pressure pipe or fitting**

pipe or fitting subjected to an internal pressure not greater than 1 bar

**3.24****pressure pipe or fitting**

pipe or fitting having a nominal pressure classification, expressed in bars, greater than 1 bar and which is intended to be used at internal pressures up to its nominal pressure in bars

**3.25****buried pipeline**

pipeline which is subjected to the external pressure transmitted from soil loading, including traffic and superimposed loads and possibly the pressure of a head of water

**3.26****non-buried pipeline**

pipeline which is subjected to negative and positive pressure, forces resulting from its supports, environmental conditions, e.g. snow and wind, and possibly the pressure of a head of water

**3.27****sub-aqueous pipeline**

pipeline which is subjected to an external pressure arising from a head of water and conditions such as drag and lift caused by current and wave action

**3.28****design service temperature**

maximum sustained temperature at which a system is expected to operate, expressed in degrees Celsius (°C)

**3.29****variance**

measure of dispersion based on the mean square deviation from the arithmetic mean

**3.30****standard deviation**

$\sigma$

positive square root of the variance

**3.31****coefficient of variation**

$Y$

ratio of the standard deviation to the absolute value of the arithmetic mean [see Equation (8)]:

$$Y = \frac{\text{Standard deviation of the population}}{\text{Mean of the population}} \quad (8)$$

NOTE In this International Standard, it is expressed as a percentage.

### 3.32 acceptable quality level AQL

quality level which, for the purposes of sampling inspection of a continuous series of lots, is the limit of a satisfactory process-average percent nonconforming

### 3.33 projected failure pressure at 6 min

$p_6$   
value at 6 min derived from the pressure regression line obtained from long-term pressure tests performed in accordance with ISO 7509 and analysed in accordance with ISO 10928

### 3.34 projected failure pressure at 50 years

$p_{50}$   
value at 50 years derived from the pressure regression line obtained from long-term pressure tests performed in accordance with ISO 7509 and analysed in accordance with ISO 10928

### 3.35 pressure regression ratio

$R_{R,p}$   
ratio of the projected failure pressure at 50 years,  $p_{50}$ , to the projected failure pressure at 6 min,  $p_6$ , obtained from long-term pressure tests performed in accordance with ISO 7509 [see Equation (9)] and analysed in accordance with ISO 10928

$$R_{R,p} = \frac{p_{50}}{p_6} \quad (9)$$

### 3.36 initial failure pressure

$p_0$   
pressure at which failure occurs with specimens subjected to short-term tests performed in accordance with ISO 8521

### 3.37 minimum failure pressure at 50 years

$p_{50, 97,5 \% \text{ LCL, min}}$   
failure pressure at 50 years which 97,5 % of products are required to exceed [see Equation (10)]:

$$p_{50, 97,5 \% \text{ LCL, min}} = P_N \times \eta_{t, P_N, 97,5 \% \text{ LCL, min}} \quad (10)$$

### 3.38 minimum failure pressure at 6 min

$p_{6, \text{ min}}$   
failure pressure at 6 min which 97,5 % of products are required to exceed [see Equation (11)]:

$$p_{6, \text{ min}} = \frac{p_{50, 97,5 \% \text{ LCL, min}}}{R_{R,p}} \quad (11)$$

### 3.39 correction factor for initial failure pressure

$C$   
factor used to convert projected 6-min values,  $p_6$ , to initial failure pressure values,  $p_0$  [see Equation (12)]:

$$C = \frac{p_0}{p_6} \quad (12)$$

### 3.40 minimum initial failure pressure

$p_{0, \min}$   
initial failure pressure, determined in accordance with ISO 8521, which 97,5 % of products are required to exceed [see Equation (13)]:

$$P_{0, \min} = P_{6, \min} \times C \quad (13)$$

### 3.41 minimum design pressure

$p_{0, d}$   
design initial failure pressure to ensure 97,5 % of products will exceed  $p_{0, \min}$  [see Equation (14)]:

$$p_{0, d} = p_{0, \min} \times \frac{1}{(1 - Y \times 0,01 \times 1,96)} \quad (14)$$

### 3.42 minimum mean failure pressure at 50 years

$p_{50, \text{mean}, \min}$   
failure pressure at 50 years which 50 % of products are required to exceed [see Equation (15)]:

$$p_{50, \text{mean}, \min} = PN \times \eta_t, PN, \text{mean} \quad (15)$$

where PN is expressed in bars

### 3.43 AQL multiplier

$MPL_{\text{test}}$   
multiplier, whose value is dependent upon the specified AQL (see 3.32), that is used with the coefficient of variation (see 3.31)

EXAMPLES If the AQL = 6,5 %, then  $MPL_{\text{test}} = 1,51$ . If the AQL = 2,5 %, then  $MPL_{\text{test}} = 1,96$ .

### 3.44 tensile safety factor

$\eta_t$   
safety factor which is applied to the tensile strength of a product

### 3.45 tensile safety factor related to $p_{50, 97,5 \% \text{ LCL}, \min}$

$\eta_t, PN, 97,5 \%, \min$   
safety factor which is applied to the nominal pressure (PN) to ensure that 97,5 % of products when installed in the ground can operate at a working pressure,  $p_w$  (see 3.17), equal to PN without failure for at least 50 years

NOTE For further information, see ISO/TR 10465-3.

### 3.46 relative ring deflection

$y/d_m$   
ratio of the change in diameter of a pipe,  $y$ , in metres, to its mean diameter,  $d_m$  (see 3.5)

NOTE It is derived as a percentage from Equation (16):

$$\text{Relative ring deflection} = \frac{y}{d_m} \times 100 \quad (16)$$

**3.47****projected initial relative ultimate ring deflection** $y_2/d_m$ 

projected deflection value at 2 min derived from the ultimate deflection regression line obtained from long-term ultimate deflection tests performed in accordance with ISO 10471 and analysed in accordance with ISO 10928

NOTE It is expressed as a percentage by multiplying by 100.

**3.48****minimum initial relative specific ring deflection before bore cracking occurs** $(y_2, \text{bore}/d_m)_{\min}$ 

initial relative deflection at 2 min which a test piece is required to pass without bore cracking when tested in accordance with ISO 10466

NOTE It is expressed as a percentage by multiplying by 100.

**3.49****minimum initial relative specific ring deflection before structural failure occurs** $(y_2, \text{struct}/d_m)_{\min}$ 

initial relative deflection at 2 min which a test piece is required to pass without structural failure when tested in accordance with ISO 10466

NOTE It is expressed as a percentage by multiplying by 100.

**3.50****extrapolated long-term relative ultimate ring deflection** $y_{u, \text{wet}, x}/d_m$ 

deflection value at  $x$  years (see 4.6) derived from the ultimate deflection regression line obtained from long-term deflection tests performed under wet conditions in accordance with ISO 10471 and analysed in accordance with ISO 10928

NOTE It is expressed as a percentage by multiplying by 100.

**3.51****minimum long-term relative ultimate ring deflection** $(y_{u, \text{wet}, x}/d_m)_{\min}$ 

required minimum extrapolated value at  $x$  years (see 4.6) derived from the ultimate deflection regression line obtained from long-term deflection tests performed under wet conditions in accordance with ISO 10471

NOTE It is expressed as a percentage by multiplying by 100.

**3.52****extrapolated long-term relative ring deflection in a corrosive environment** $y_{\text{corr}, x}/d_m$ 

deflection value at  $x$  years (see 4.6) derived from the deflection regression line obtained from long-term deflection tests performed in a corrosive environment in accordance with ISO 10952

NOTE It is expressed as a percentage by multiplying by 100.

**3.53****relative ring deflection for a test lasting  $t$  hours** $y_{\text{test}, t}/d_m$ 

relative ring deflection required for test pieces to resist for  $t$  h in a test performed in accordance with ISO 10952 in a corrosive environment

NOTE It is expressed as a percentage by multiplying by 100.

### 3.54 deflection constant

$K_t$

value used for the calculation of the percentage ring deflection required for test pieces to resist for  $t$  h in a test performed in accordance with ISO 10952 in a corrosive environment

NOTE It is expressed as a percentage by multiplying by 100.

### 3.55 ultimate deflection regression ratio

$R_{R, dv}$

ratio of the extrapolated long-term relative ultimate ring deflection at  $x$  years (see 4.6),  $y_{u, wet, x}/d_m$  (see 3.50), to the projected initial ultimate ring deflection,  $y_2/d_m$  (see 3.47), obtained from long-term ultimate ring deflection tests performed in accordance with ISO 10471 [see Equation (17)] and analysed in accordance with ISO 10928

$$R_{R, dv} = \frac{y_{u, wet, x}/d_m}{y_2/d_m} \quad (17)$$

### 3.56 angular deflection

$\delta$

angle between the axes of two consecutive pipes (see Figure 1), expressed in degrees (°)

### 3.57 draw

$D$

longitudinal movement of a joint (see Figure 1), expressed in millimetres (mm)

### 3.58 total draw

$T$

sum of the draw,  $D$ , and the additional longitudinal movement,  $J$ , of joint components due to the presence of angular deflection (see Figure 1), expressed in millimetres (mm)

### 3.59 misalignment

$M$

amount by which the centrelines of consecutive components fail to coincide (see Figure 1), expressed in millimetres (mm)

### 3.60 flexible joint

joint which allows relative movement between the components being joined

NOTE Flexible joints which have resistance to axial loading are classified as end-load-bearing.

Examples of this type of joint are:

- a) socket-and-spigot joints with an elastomeric sealing element (including double-socket designs);
- b) locked socket-and-spigot joints with an elastomeric sealing element (including double-socket designs);
- c) mechanically clamped joints, e.g. bolted couplings including components made of materials other than GRP.

### 3.61 rigid joint

joint which does not allow relative movement between the components being joined

NOTE Rigid joints which do not have resistance to axial loading are classified as non-end-load-bearing.

Examples of this type of joint are:

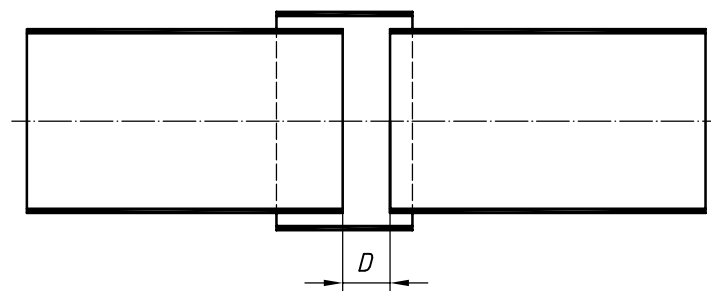
- a) flanged joints including integral or loose flanges;
- b) wrapped or cemented joints.

**3.62  
break**

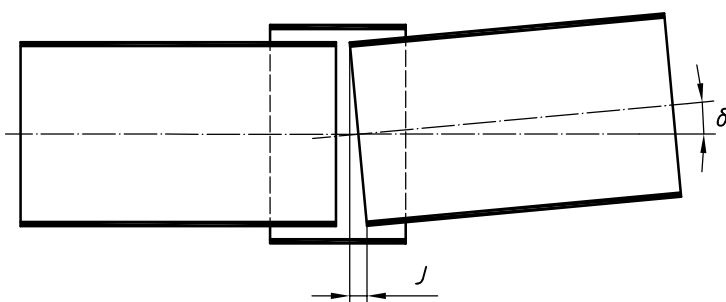
condition where the test piece can no longer carry the load to which it is being subjected

**3.63  
combined tensile safety factor**

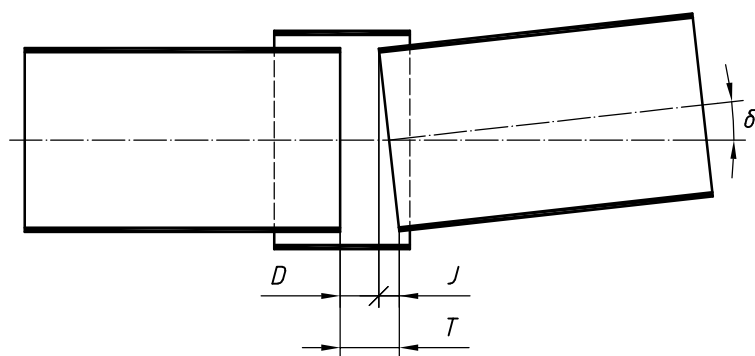
$\eta_{\text{hat}}$   
safety factor for combined circumferential tensile loading arising from internal pressure and flexure



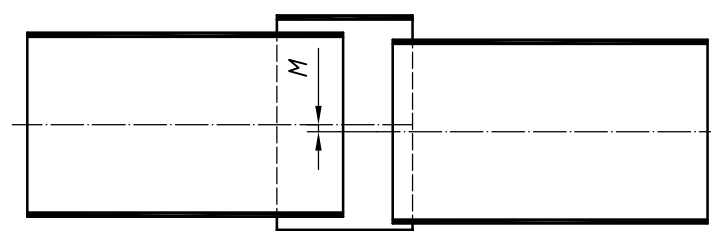
a)



b)



c)



d)

**Key**

- $D$  draw
- $J$  longitudinal movement arising from angular deflection of the joint
- $\delta$  angular deflection of the joint
- $T$  total draw
- $M$  misalignment

**Figure 1 — Joint movements**

## 4 General

### 4.1 Classification

#### 4.1.1 Categories

Pipes and fittings shall be classified according to nominal size (DN) (see 3.1), nominal pressure (PN) (see 3.11) and joint type.

In addition, pipes shall include nominal stiffness (SN) (see 3.3) in their classification.

#### 4.1.2 Nominal size

The nominal size (DN) of pipes and fittings in the range DN 50 to DN 4000 shall conform to the appropriate Tables in Clause 5 of this International Standard. If a thermoplastics liner is present, its internal diameter shall be declared by the manufacturer. The tolerance on the diameter shall be as specified in Clause 5 of this International Standard.

#### 4.1.3 Nominal stiffness

The nominal stiffness (SN) shall conform to one of those given in Table 1 (see Notes 1 to 3 to Table 1).

**Table 1 — Nominal stiffness (SN)**

| Nominal stiffness                                                                                                                                                                                                                                                                                                                                                                                                                            |           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Series S1                                                                                                                                                                                                                                                                                                                                                                                                                                    | Series S2 |
| 630                                                                                                                                                                                                                                                                                                                                                                                                                                          | 500       |
| 1250                                                                                                                                                                                                                                                                                                                                                                                                                                         | 1000      |
| 2500                                                                                                                                                                                                                                                                                                                                                                                                                                         | 2000      |
| 5000                                                                                                                                                                                                                                                                                                                                                                                                                                         | 4000      |
| 10000                                                                                                                                                                                                                                                                                                                                                                                                                                        | 8000      |
| <p>NOTE 1 Series S1 is the preferred series for GRP-UP pipes and series S2 is an alternative series.</p> <p>NOTE 2 These nominal stiffnesses correspond to the values specified in Clause 5 of this International Standard for the minimum initial specific ring stiffness in newtons per square metre (N/m<sup>2</sup>).</p> <p>NOTE 3 Pipes of nominal stiffness less than SN 1000 are not intended for laying directly in the ground.</p> |           |

Where special applications require the use of pipes having a higher nominal stiffness than those given in Table 1, the pipe shall be marked SN *X*, where *X* is the nominal stiffness of the pipe.

#### 4.1.4 Nominal pressure

The nominal pressure (PN) shall conform to one of those given in Table 2.

Where pressures other than the nominal values in Table 2 are to be supplied by agreement between the manufacturer and the purchaser the pressure marking shall be PN *X*, where *X* is the value.

**Table 2 — Nominal pressure (PN)**

| Nominal pressure                                                  |
|-------------------------------------------------------------------|
| 1                                                                 |
| (2,5)                                                             |
| (4)                                                               |
| 6                                                                 |
| (9)                                                               |
| 10                                                                |
| (12)                                                              |
| (15)                                                              |
| 16                                                                |
| (18)                                                              |
| (20)                                                              |
| 25                                                                |
| 32                                                                |
| NOTE 1 Values in parentheses are non-preferred nominal pressures. |
| NOTE 2 Pipes marked PN 1 are non-pressure (gravity) pipes.        |

## 4.2 Materials

### 4.2.1 General

The pipe or fitting shall be constructed using chopped and/or continuous glass filaments, strands or rovings, mats or fabric, and polyester resin with or without fillers and, if applicable, with those additives necessary to impart specific properties to the resin. The pipe or fitting may also incorporate aggregates and, if required, a thermoplastics liner.

### 4.2.2 Reinforcement

The glass used for the manufacture of the reinforcement shall be of one of the following types:

- type E, comprising primarily either oxides of silicon, aluminium and calcium (alumino-calcosilicate glass) or silicon, aluminium and boron (alumino-borosilicate glass);
- type C, comprising primarily oxides of silicon, sodium, potassium, calcium and boron (alkali-metal calcium glass with an increased boron trioxide content) which is intended for applications requiring enhanced chemical resistance.

In either of these types of glass, small amounts of oxides of other metals will be present.

NOTE These descriptions for type C glass and type E glass are consistent with, but more specific than, those given in ISO 2078.

The reinforcement shall be made from continuously drawn filaments of type E or type C glass, and shall have a surface finish compatible with the resin to be used. It may be used in any form, e.g. as continuous or chopped filaments, strands or rovings, mat or fabric. Surface mats or veils of synthetic (organic) fibres may be used on the surfaces of the components.

#### 4.2.3 Resin

The resin used in the structural layer (see 4.3.2) shall have a temperature of deflection of at least 70 °C when tested in accordance with method A of ISO 75-2:2004 with the test specimen in the edgewise position.

#### 4.2.4 Aggregates and fillers

The particle size of aggregates and fillers shall not exceed 1/5 of the total wall thickness of the pipe or fitting or 2,5 mm, whichever is the smaller.

#### 4.2.5 Thermoplastics liners

When using a thermoplastics liner that requires a bonding material, care shall be taken to ensure that the bonding material is compatible with all other materials used in the pipe construction.

#### 4.2.6 Elastomers

The elastomeric material(s) of the seal shall conform to the applicable part of EN 681 or, if available, a similar national standard that is acceptable to both the purchaser and supplier.

#### 4.2.7 Metals

Metallic components may be used in the system.

### 4.3 Wall construction

#### 4.3.1 Inner layer

The inner layer shall comprise one of the following:

- a) a thermosetting resin layer with or without aggregates and fillers and with or without a reinforcement;
- b) a thermoplastics liner.

The resin used in this inner layer need not conform to the temperature of deflection requirements given in 4.2.3.

#### 4.3.2 Structural layer

The structural layer shall consist of glass reinforcement and a thermosetting resin, with or without aggregates or fillers.

#### 4.3.3 Outer layer

The construction of the outer layer of the pipe shall take into account the environment in which the pipe is to be used. This layer shall be formed of a thermosetting resin with or without aggregates and fillers and with or without a reinforcement made of glass or synthetic filaments.

**NOTE** Special constructions may be necessary where the pipe is exposed to extreme climatic, environmental or ground conditions. For example, provision may be made for the inclusion of pigments or inhibitors for extreme climatic conditions or to give fire-retarding properties.

The resin used in this outer layer need not conform to the temperature of deflection requirements in 4.2.3.

## 4.4 Appearance

Both the internal and the external surfaces shall be free from irregularities which would impair the ability of the component to conform to the requirements of this International Standard.

## 4.5 Reference conditions for testing

### 4.5.1 Temperature

The mechanical, physical and chemical properties specified in this International Standard shall, unless otherwise specified, be determined at  $(23 \pm 5) ^\circ\text{C}$ .

For service temperatures over  $35 ^\circ\text{C}$ , type tests shall be carried out at least at the design service temperature (see 3.28) to establish rating factors for all long-term properties of relevance to the design of pipes and fittings.

### 4.5.2 Properties of water for testing

The water used for the tests referred to in this International Standard shall be tap water having a pH of  $7 \pm 2$ .

### 4.5.3 Loading conditions

Unless otherwise specified, the mechanical, physical and chemical properties specified in this International Standard shall be determined using circumferential and/or longitudinal loading conditions, as applicable.

### 4.5.4 Conditioning

Unless otherwise specified, in cases of dispute store the test piece(s) in air at the test temperature specified in 4.5.1 for at least 24 h prior to testing.

### 4.5.5 Measurement of dimensions

In cases of dispute, determine the dimensions of GRP components at the temperature specified in 4.5.1. Make all measurements in accordance with ISO 3126 or using any other method of sufficient accuracy to determine conformity or non-conformity with the applicable limits. Make all routine measurements at the prevailing temperature or, if the manufacturer prefers, at the temperature specified in 4.5.1.

## 4.6 Elapsed time, $x$ , for determination of long-term properties

The subscript  $x$  in, for example,  $S_{x, \text{wet}}$  (see 3.8) denotes the time at which the long-term property is to be determined. Unless otherwise specified, the long-term properties shall be determined at 50 years (438 000 h).

## 4.7 Joints

### 4.7.1 General

If requested, the manufacturer shall declare the length and the maximum external diameter of the assembled joint.

### 4.7.2 Types of joint

A joint shall be classified as either flexible (see 3.60) or rigid (see 3.61), and in either case the manufacturer shall declare whether or not it is capable of resisting end loads.

### 4.7.3 Flexibility of the joint

#### 4.7.3.1 Allowable angular deflection

The manufacturer shall declare the allowable angular deflection (see 3.56) for which each joint is designed.

Flexible joints, i.e. those which are not locked, shall have a maximum allowable angular deflection that is not less than the applicable value given below:

- 3° for pipes and/or fittings with a nominal size equal to or less than DN 500;
- 2° for pipes and/or fittings with a nominal size greater than DN 500 but equal to or less than DN 900;
- 1° for pipes and/or fittings with a nominal size greater than DN 900 but equal to or less than DN 1800;
- 0,5° for pipes and/or fittings with a nominal size greater than DN 1800.

For locked joints, the manufacturer shall declare the maximum allowable angular deflection.

By agreement between the manufacturer and the purchaser, flexible joints intended to be used at pressures greater than 16 bar may have lower allowable angular deflections than those given in this subclause.

#### 4.7.3.2 Allowable draw

The manufacturer shall declare the maximum allowable draw (see 3.57) for which each joint is designed.

For flexible joints, the maximum allowable draw, which includes Poisson contraction and temperature effects, shall not be less than 0,3 % of the laying length of the longest pipe which it is intended to use in the case of pressure pipes and 0,2 % in the case of non-pressure pipes. For locked joints, the manufacturer shall declare the maximum allowable draw.

### 4.7.4 Sealing ring

The sealing ring shall not have any detrimental effect on the properties of the components with which it is used and shall not cause the test assembly to fail the performance requirements specified in Clause 7 of this International Standard.

### 4.7.5 Adhesives

Adhesives, if required for jointing, shall be as specified by the manufacturer of the joint. The joint manufacturer shall ensure that the adhesives do not have any detrimental effects on the components with which they are used and shall not cause the test assembly to fail the performance requirements specified in Clause 7 of this International Standard.

## 5 Pipes

### 5.1 Geometrical characteristics

#### 5.1.1 Diameter

##### 5.1.1.1 Diameter series

**NOTE** In standardizing the diameters of GRP pipes, difficulties are encountered because of the various methods used to manufacture them (e.g. filament winding, centrifugal casting or contact moulding). Typically, GRP pipes are produced by controlling either the internal diameter or the external diameter to a fixed value.

Unless otherwise agreed between the manufacturer and the purchaser, GRP pipes shall be designated by nominal size in accordance with one of the following two series:

- **series A**, which specifies the internal diameter as being equal to the nominal size in millimetres;
- **series B**, which specifies the external diameter in millimetres.

#### 5.1.1.2 Nominal size

Unless otherwise agreed between the manufacturer and the purchaser, the nominal size (DN) shall be chosen from the values given in Table 3.

**Table 3 — Nominal size (DN)**

| Nominal size                                          |        |        |        |
|-------------------------------------------------------|--------|--------|--------|
| 50                                                    | 600    | (1650) | (2900) |
| 75                                                    | 700    | (1700) | 3000   |
| 100                                                   | (750)  | 1800   | (3100) |
| 125                                                   | 800    | (1900) | 3200   |
| 150                                                   | 900    | 2000   | (3300) |
| 200                                                   | 1000   | (2100) | 3400   |
| 250                                                   | (1100) | 2200   | (3500) |
| 300                                                   | 1200   | (2300) | 3600   |
| 350                                                   | (1300) | 2400   | (3700) |
| (375)                                                 | (1350) | (2500) | 3800   |
| 400                                                   | 1400   | 2600   | (3900) |
| 450                                                   | (1500) | (2700) | 4000   |
| 500                                                   | 1600   | 2800   |        |
| NOTE Figures in parentheses are non-preferred values. |        |        |        |

#### 5.1.1.3 Specified diameters

##### 5.1.1.3.1 General

Pipes may be supplied conforming to 5.1.1.3.2 (series A), 5.1.1.3.3 (series B) or, by agreement between the manufacturer and the purchaser, another diameter series.

Pipes having other diameters may be supplied by agreement between the manufacturer and the purchaser.

##### 5.1.1.3.2 Series A (internal diameter specified)

The internal diameter, in millimetres, shall conform to the applicable values relative to the nominal size given in Table 4.

**Table 4 — Series A — Specified pipe internal diameters and tolerances**

Dimensions in millimetres

| Column 1          | Column 2                                  | Column 3 | Column 4                                              |
|-------------------|-------------------------------------------|----------|-------------------------------------------------------|
| Nominal size (DN) | Range of declared pipe internal diameters |          | Permissible deviation from declared internal diameter |
|                   | min.                                      | max.     |                                                       |
| 100               | 97                                        | 103      | ± 1,5                                                 |
| 110               | 107                                       | 113      | ± 1,5                                                 |
| 125               | 122                                       | 128      | ± 1,5                                                 |
| 150               | 147                                       | 153      | ± 1,5                                                 |
| 200               | 196                                       | 204      | ± 1,5                                                 |
| 225               | 221                                       | 229      | ± 1,5                                                 |
| 250               | 246                                       | 255      | ± 1,5                                                 |
| 300               | 296                                       | 306      | ± 1,8                                                 |
| 350               | 346                                       | 357      | ± 2,1                                                 |
| 400               | 396                                       | 408      | ± 2,4                                                 |
| 450               | 446                                       | 459      | ± 2,7                                                 |
| 500               | 496                                       | 510      | ± 3,0                                                 |
| 600               | 595                                       | 612      | ± 3,6                                                 |
| 700               | 695                                       | 714      | ± 4,2                                                 |
| 800               | 795                                       | 816      | ± 4,2                                                 |
| 900               | 895                                       | 918      | ± 4,2                                                 |
| 1000              | 1 195                                     | 1 220    | ± 5,0                                                 |
| 1200              | 1 395                                     | 1 420    | ± 5,0                                                 |
| 1400              | 1 595                                     | 1 620    | ± 5,0                                                 |
| 1600              | 1 795                                     | 1 820    | ± 5,0                                                 |
| 1800              | 1 995                                     | 2 020    | ± 5,0                                                 |
| 2000              | 2 195                                     | 2 220    | ± 5,0                                                 |
| 2200              | 2 395                                     | 2 420    | ± 5,0                                                 |
| 2400              | 2 595                                     | 2 620    | ± 6,0                                                 |
| 2600              | 2 795                                     | 2 820    | ± 6,0                                                 |
| 2800              | 2 995                                     | 3 020    | ± 6,0                                                 |
| 3000              | 3 195                                     | 3 220    | ± 6,0                                                 |
| 3200              | 3 395                                     | 3 420    | ± 6,0                                                 |
| 3400              | 3 595                                     | 3 620    | ± 6,0                                                 |
| 3600              | 3 795                                     | 3 820    | ± 6,0                                                 |
| 3800              | 3 995                                     | 4 020    | ± 7,0                                                 |
| 4000              | 1 195                                     | 1 220    | ± 7,0                                                 |

NOTE 1 When a non-preferred size is selected from Table 3, the range of diameters and the permissible deviations shall be interpolated between the preferred sizes immediately above and below the non-preferred size.

NOTE 2 When a manufacturer supplies pipes with a definable change in diameter from one end to the other, then the manufacturer may declare the diameters at each end and it is these declared values which will be subject to the tolerances given in column 4.

#### 5.1.1.3.3 Series B (external diameter specified)

The external diameter, in millimetres, shall conform to the applicable value relative to the nominal size given in Table 5, Table 6 or Table 7.

The dimensions of pipes with nominal sizes between DN 300 and DN 4000 to be used with GRP fittings conforming to Clause 6 of this International Standard shall conform to those given for series B1.

The dimensions of pipes with nominal sizes between DN 100 and DN 600 to be used with either GRP fittings conforming to Clause 6 of this International Standard or with ductile-iron fittings conforming to ISO 2531 shall conform to those given for series B2.

**NOTE** When specifying the use of ductile-iron fittings with GRP pipes, care should be taken to ensure their dimensional compatibility with the GRP pipe.

The dimensions of pipes with nominal sizes between DN 100 and DN 600 to be used with either GRP fittings conforming to Clause 6 of this International Standard or with PVC fittings conforming to ISO 161-1 and the tolerances to ISO 11922-1 shall conform to those given for series B3.

The dimensions of pipes with nominal sizes between DN 100 and DN 300 to be used with either GRP fittings conforming to Clause 6 of this International Standard or steel pipes conforming to ISO 4200 shall conform to those given for series B4.

The dimensions of pipes with nominal sizes between DN 50 and DN 800 to be used with either GRP fittings conforming to Clause 6 of this International Standard or with metallic pipes conforming to standards not covered by series B2 or B4 shall conform to those given for series B5.

The dimensions of pipes with nominal sizes between DN 200 and DN 2400 to be used with either GRP fittings conforming to Clause 6 of this International Standard or with GRP pipes conforming to Japanese standard JIS A 5350 shall conform to those given for series B6.

#### 5.1.1.3.4 Minimum internal diameters for pipes with a prefabricated thermoplastics liner

The internal diameter of the thermoplastics liner shall not be less than 96,5 % of the nominal size of the pipe.

#### 5.1.1.4 Tolerances

**NOTE** Where interchangeability is required, see Clause 7 of this International Standard for further information.

##### 5.1.1.4.1 Series A — Tolerances on internal diameter

The declared internal diameter of a pipe shall be between the minimum and maximum values given in columns 2 and 3 of Table 4. The average internal diameter at any point along the length of the pipe shall not deviate from the declared internal diameter by more than the permissible deviation given in column 4 of Table 4.

For GRP pipes which have a liner made from thermoplastics pipes, the tolerances on the internal diameter shall be as specified in the relevant thermoplastics pipe standard. The internal diameter of GRP pipes which have a liner fabricated from thermoplastics sheet shall conform to the applicable value in Table 4 and its tolerances.

#### 5.1.1.4.2 Series B1 — Tolerances on external diameter

The external diameter of a pipe at the spigot shall be as given in Table 5. The manufacturer shall declare the actual maximum and minimum external diameters of the pipe at the spigot.

**Table 5 — Series B1 — Specified pipe external diameters and tolerances**

Dimensions in millimetres

| Nominal size<br>(DN) | External<br>diameter of<br>pipe | Permissible deviation |             |
|----------------------|---------------------------------|-----------------------|-------------|
|                      |                                 | Upper limit           | Lower limit |
| 300                  | 310                             | +1,0                  | −1,0        |
| 350                  | 361                             |                       | −1,2        |
| 400                  | 412                             |                       | −1,4        |
| 450                  | 463                             |                       | −1,6        |
| 500                  | 514                             |                       | −1,8        |
| 600                  | 616                             |                       | −2,0        |
| 700                  | 718                             |                       | −2,2        |
| 800                  | 820                             |                       | −2,4        |
| 900                  | 924                             |                       | −2,6        |
| 1000                 | 1 026                           | +2,0                  | −2,6        |
| 1200                 | 1 229                           |                       | −2,6        |
| 1400                 | 1 434                           |                       | −2,8        |
| 1600                 | 1 638                           |                       | −2,8        |
| 1800                 | 1 842                           |                       | −3,0        |
| 2000                 | 2 046                           | +2,0                  | −3,0        |
| 2200                 | 2 250                           |                       | −3,2        |
| 2400                 | 2 453                           |                       | −3,4        |
| 2600                 | 2 658                           |                       | −3,6        |
| 2800                 | 2 861                           |                       | −3,8        |
| 3000                 | 3 066                           |                       | −4,0        |
| 3200                 | 3 270                           |                       | −4,2        |
| 3400                 | 3 474                           |                       | −4,4        |
| 3600                 | 3 678                           |                       | −4,6        |
| 3800                 | 3 882                           |                       | −4,8        |
| 4000                 | 4 086                           |                       | −5,0        |

NOTE When a non-preferred size is selected from Table 3, the range of diameters and the permissible deviations shall be interpolated between the preferred sizes immediately above and below the non-preferred size.

### 5.1.1.4.3 Series B2, B3 and B4 — Tolerances on external diameter

The tolerances on the external diameter, at the spigot, for series B2, B3 and B4 pipes shall be as given in Table 6.

**Table 6 — Series B2, B3 and B4 — Specified pipe external diameters and tolerances**

Dimensions in millimetres

| Nominal size (DN)                                                                                                     | Series B2         |                       |             | Series B3         |                       |             | Series B4         |                       |             |
|-----------------------------------------------------------------------------------------------------------------------|-------------------|-----------------------|-------------|-------------------|-----------------------|-------------|-------------------|-----------------------|-------------|
|                                                                                                                       | External diameter | Permissible deviation |             | External diameter | Permissible deviation |             | External diameter | Permissible deviation |             |
|                                                                                                                       |                   | Upper limit           | Lower limit |                   | Upper limit           | Lower limit |                   | Upper limit           | Lower limit |
| 100                                                                                                                   | 115,0             | +1,5                  | +0,3        | 110               | +0,4                  | 0           | 114,3             | +1,5                  | −0,2        |
| 125                                                                                                                   | 141,0             |                       | +0,2        | 125               | +0,4                  |             | 139,7             |                       |             |
| 150                                                                                                                   | 167,0             |                       | +0,1        | 160               | +0,5                  |             | 168,3             |                       |             |
| 200                                                                                                                   | 220,0             |                       | 0,0         | 200               | +0,6                  |             | 219,1             |                       |             |
| 225                                                                                                                   | —                 |                       | —           | 225               | +0,7                  |             | —                 |                       |             |
| 250                                                                                                                   | 271,8             |                       | −0,2        | 250               | +0,8                  |             | 273,0             |                       |             |
| 300                                                                                                                   | 323,8             |                       | −0,3        | 315               | +1,0                  |             | 323,9             |                       |             |
| 350                                                                                                                   | 375,7             |                       | −0,3        | 355               | +1,1                  |             | —                 |                       |             |
| 400                                                                                                                   | 426,6             |                       | −0,3        | 400               | +1,2                  |             | —                 |                       |             |
| 450                                                                                                                   | 477,6             |                       | −0,4        | 450               | +1,4                  |             | —                 |                       |             |
| 500                                                                                                                   | 529,5             |                       | −0,4        | 500               | +1,5                  |             | —                 |                       |             |
| 600                                                                                                                   | 632,5             |                       | −0,5        | 630               | +1,9                  |             | —                 |                       |             |
| NOTE When a non-preferred size is selected from Table 3, use the nearest relevant size from the appropriate standard. |                   |                       |             |                   |                       |             |                   |                       |             |

#### 5.1.1.4.4 Series B5 — Tolerances on external diameter

The declared external diameter for series B5 shall be between the values given in Table 7 for the applicable nominal size and be subject to the tolerances for the metallic pipes with which they are to be used.

The tolerances applicable to these dimensions depend on the joint. Upon request by the purchaser, the manufacturer shall provide detailed toleranced dimensions of the pipes used for particular joints.

**Table 7 — Series B5 — Specified external diameters**

Dimensions in millimetres

| Column 1          | Column 2                                  | Column 3 |
|-------------------|-------------------------------------------|----------|
| Nominal size (DN) | Range of declared pipe external diameters |          |
|                   | min.                                      | max.     |
| 50                | 63                                        | 64       |
| 75                | 100                                       | 101      |
| 100               | 121                                       | 122      |
| 150               | 175                                       | 177      |
| 200               | 229                                       | 232      |
| 250               | 281                                       | 286      |
| 300               | 335                                       | 345      |
| 350               | 388                                       | 399      |
| 400               | 426                                       | 453      |
| 450               | 495                                       | 507      |
| 500               | 548                                       | 587      |
| 700               | 655                                       | 747      |
| 800               | 812                                       | 826      |