

# General Technical Specification

## SUBOR GRP PIPES

Glass Fiber Reinforced Polyester (GRP)

Pipe systems for pressure and  
non-pressure water supply

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## 1 SCOPE

This document specifies the required properties of the piping system and its components made from based on unsaturated polyester resin (UP) intended to be used for **pressure and non-pressure WATER supply**.

Likewise applies to the provision supply of all works, materials and services related to the manufacture, testing, delivery and buried installation of glass-reinforced thermosetting plastics (GRP) pipe, joints, accessories and special parts as specified in drawings and technical documents.

The pipeline system may accommodate together pipes and fittings of different nominal pressure and stiffness, according to the needs identified in the project.

## 2 REFERENCE STANDARDS

All pipes, joints and fittings supplied under this specification are made according to international recognized standards, using unsaturated polyester resins, glass fiber reinforcements and aggregates of sand. The SUBOR GRP pipes shall comply with minimum requirements established by reference to the following standards.

- **EN 1796:** *Plastics piping systems for water supply with or without pressure. Fiberglass reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP).*
- **AWWA C950:** *AWWA standard for Fiberglass reinforced pipes with pressure.*
- **ASTM D3517:** *Standard Specification for Pressure Fiberglass Pipes (Reinforced Thermosetting Resin Fiberglass).*
- **ISO 10639:** *International Standard for Plastics piping systems for water supply with or without pressure. Fiberglass reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP).*
- **CEN/TS 14632:** *Plastics piping systems for drainage, sewerage and water supply, pressure and non-pressure - Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP) - Guidance for the assessment of conformity.*

### 3 GENERAL POINTS

#### 3.1 GRP pipe design

GRP pipes and fittings comply with **EN 1796** or **ISO 10639** and must be classified according to nominal size (DN), series, nominal pressure (PN) and type of joint. The pipes are further classified by nominal stiffness (SN).

#### 3.2 Nominal size

The nominal size (DN) of the pipes and fittings must conform to Table 1. The nominal diameter corresponds to the inner diameter of the pipe. Expressed in millimetres (mm).

Nominal Size (DN)			
100	800	2000	3200
125	900	2100	3300
150	1000	2200	3400
200	1100	2300	3500
250	1200	2400	3600
300	1300	2500	3700
350	1400	2600	3800
400	1500	2700	3900
450	1600	2800	4000
500	1700	2900	
600	1800	3000	
700	1900	3100	

Table 1. Nominal Size (DN)

#### 3.3 Nominal stiffness

The nominal stiffness, SN, is the specific circumferential stiffness ( $S_0$ ), expressed in N/m<sup>2</sup>. The normalized nominal stiffness values for **EN 1796** or **ISO 10639** are the ones specified in the table:

Nominal Stiffness (SN)	
630	5000
1250	10000
2500	

Table 2. Nominal Stiffness (SN)

The choice of pipe stiffness must be made according to the calculations performed according to the AWWA M-45 Manual, based on the load supported, the backfill materials, the natural soil, the type of installation and the capacity of vacuum resistance.

### 3.4 Nominal Pressure

It is the closest value to the DP (Design Pressure) in continuous use for 50 years (long term) at a maximum service temperature of 35 °C.

The nominal pressure (PN) must conform to one of those indicated in Table 3.

Nominal Pressure (PN)	
1	12,5
2,5	16
4	20
6	25
10	32

Table 3. Nominal Pressure (PN)

### 3.5 Joints

The connection of the pipes is sleeve-pipe-sleeve type.

The connection between pipes and fittings shall be carried out by a coupling joint equipped with a separate sealing gasket by element to be connected and with a central mounting rubber stopper.

### 3.6 Adjustment pipes

The adjustment pipes comply with all specifications specified in the present document for GRP pipes and, in addition, they comply with the specified outside diameter for Series B1 and B2 pipes shown in Tables 5 and 6 respectively of the Standard EN 1796.

The minimum number of adjustment pipes supplied shall be 15% per diameter, identified with an inscription easily appreciable with the naked eye.

### 3.7 Rocker Pipes

The GRP short pipes comply with everything specified in this sheet for GRP pipes. These will be used as a flexible element in rigid connections between the GRP pipeline and concrete thrust blocks, concrete walls or any type of rigid transition.

The length of the short pipes will vary depending on the diameter, according to the following Table 4:

DN	L (mm)
DN300 – DN1400	1500
DN1500 – DN3000	3000
DN3000 – DN4000	4000

Table 4. MINIMUM length, L (mm), of the rocker pipes depending on the diameter.

### 3.8 Diameter Series

The GRP pipes will be produced within Series B1 and B2 depending on the nominal diameter according to the standard **EN 1796** or **ISO 10639**.

- *For DN>500 the series will be the B1*
- *For DN≤500 the series will be the B2 or B1*

## 4 GRP PIPES PRODUCTION AND RAW MATERIALS

### 4.1 Product Overview

The pipe or fitting should be manufactured using cut and continuous glass filaments, felts or veils of glass fabrics, and polyester resin with or without fillers. Only the additives necessary to promote the polymerization reaction of the resin or to improve its properties may be used.

Both the resin and the fiber must be homologated by the manufacturer according to the use of which allows to obtain a final product that exceeds the approval tests by accredited laboratory.

In applications where there is a risk of contact with corrosive fluids and/or high temperatures, by themselves or by the use of mixed chemical additives, resins with high chemical resistance, 'vinylester' type or equivalent, must be used in the barrier inside and/or in all layers of the pipe. In such cases, the resin to be used in the 3 layers of the pipe must be studied, depending on the fluid properties and operating conditions of the project.

The pipe or fitting may also incorporate loads of aggregates. The use of aggregates in the structure of the pipe will not be allowed if it does not incorporate both continuous and cut glass fiber simultaneously.

Calcium carbonate (CaCO<sub>3</sub>) will not be used as an inert filler under any circumstances.

### 4.2 Reinforcement

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

- *Glass type ECR or CR comprising primarily either oxides of silicon, aluminium and calcium (aluminium-calcosilicates glass) or silicon, aluminium and boron (aluminium-borosilicate glass).*

The reinforcement shall be made of continuously drawn filaments of a glass, and shall have a surface treatment compatible with the resin to be used.

In the structural layer, it shall be used in form of continuous and chopped filaments.

The fiberglass reinforcements to be used in the manufacture must be of the highest quality grade glass wires, conveniently treated to make them compatible with the resins to be used. The different types of reinforcement that can be used in manufacturing will be:

- *Surface Mat (veil)*
- *Continuous thread (direct roving)*

- *Cut thread (chop)*

### **4.3 Resin**

Approved and validated polyester resins will be used, of which we will be able to provide documentation on their suitability for the application of each project. In no case, once curing or polymerization of the resin has taken place, the materials constituting the pipe will have elements that may be soluble in the water, or others capable of giving it flavour or odour that may modify its characteristics.

The resin used must have the following properties:

- *Temperature of deflection (HDT) of at least 70 °C, according to EN ISO 75-2.*
- *Elongation at break by minimum longitudinal traction of 3%. For its determination, the test must be carried out in accordance with the methodology indicated in EN ISO 527-2*

During the manufacture of the pipes, curing of the resin must be carried out by means of the supply of internal and external heat, the heat input derived from the exothermic reaction of the polymerization process of the resin itself being accepted as the only curing medium.

When manufacturing the pipes, the resin cross-linking must be done by internal and external to the pipe heating systems. It is not accepted as only mean of curing the heat derivate from the exothermic reaction of resin polymerization.

Routine monitoring of manufacturing will take place by Barcol hardness test according to ASTM D2583 or UNE 53270.

The minimum hardness value shall be not less than **38**.

### **4.4 Aggregates**

As a general rule, inert loads of a siliceous nature will be used to improve the mechanical properties, more specifically the modulus to circumferential bending.

The size particle in aggregates shall not exceed 1 mm. The aggregates shall be placed in a single layer of the pipe to form a core layer.

### **4.5 Synthetic veils**

The GRP pipes may have a synthetic veil or not, according to the following indications.

Synthetic veils are similar to glass veils but made with synthetic fibers. They can be made exclusively of synthetic fibers or with a combination of synthetic and glass fibers.

Synthetic veils can only be used in the liner of the pipe and only if a mechanical and chemical advantage is demonstrated against traditional fiberglass veils.

#### 4.6 Elastomeric sealing gasket

The elastomeric materials of the gaskets will be EPDM, and must be supplied by suppliers of recognized quality.

The elastomeric material(s) of the sealing component shall conform to the applicable requirements of EN 681-1 which are qualified to comply with the required quality level. The manufacturer shall provide the corresponding compliance tests in accordance with the aforementioned regulations.

In addition, the special GRP flanged fittings will have a suitable sealing gasket, preferably with metal reinforcement, which will also comply with the specifications of EN 1796.

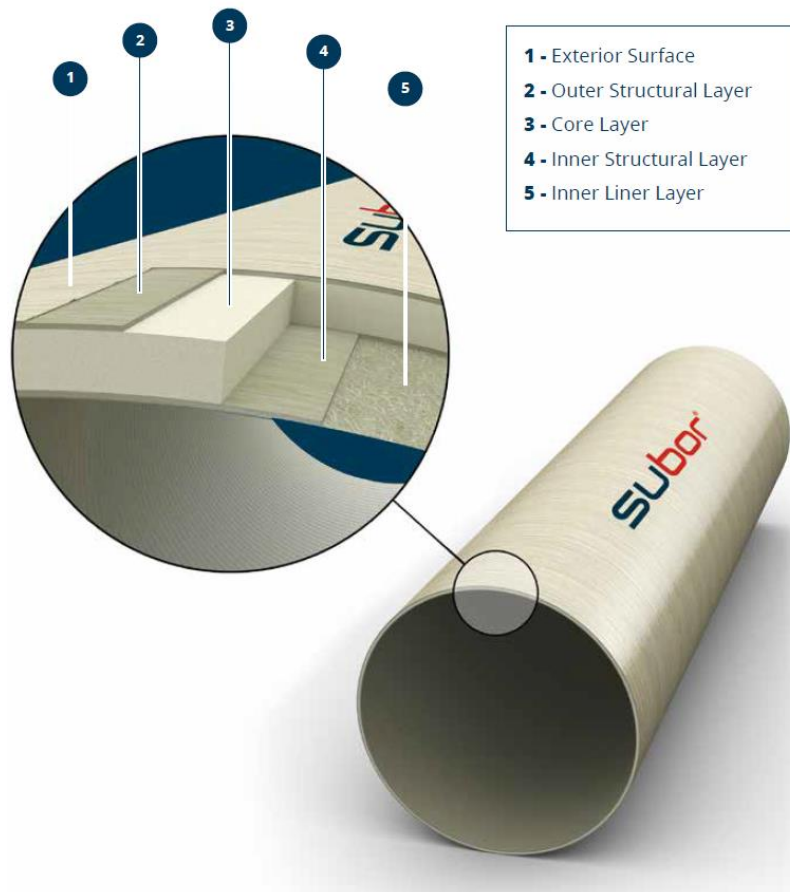
#### 4.7 Additives

It is allowed the use of additives (viscosity control, curing, etc.) and pigments or other colouring agents in the resin, but they cannot decrease the final mechanical and chemical outcome of the product.

### 5 MAIN TECHNICAL SPECIFICATIONS

#### 5.1 Pipe wall composition

The wall of the SUBOR GRP pipe is made up of several structural and non-structural layers that provide the final properties to the pipe.



### 5.1.1 Internal layer (liner)

The inner layer is made of a first layer of 0.2 mm of pure resin, reinforced with glass fiber veil, and a second layer of 0.8 mm reinforced with chopped glass fiber. The liners cannot be made only with pure resin (100%).

This layer must have total thickness not less than 1 mm, do not present delaminated areas, shortage of resin or reinforcement, in order to offer the maximum chemical resistance and water tightness with respect to the fluid to be contained.

### 5.1.2 Structural layers

The structural layer must consist of a glass reinforcement and a thermosetting resin with inert loads. The glass reinforcements will be both continuous and chopped. The use of inert aggregates in the central structural layer will only be allowed and when both chopped and continuous fiberglass reinforcements are included and mixed into it.

The inert loads contribute to provide specific properties or to increase the stiffness of the pipe. Once this layer has been polymerized, it must be free of obvious defects of lack of reinforcing glass or of thickness. In the structures formed with inert loads different colour shades will be allowed, as long as the thickness in the area is within the tolerances allowed.

### 5.1.3 External layer

This layer will be composed of a fiberglass veil impregnated with a thermosetting resin with the necessary additives to eliminate external aggressions.

This layer must be formed of a thermosetting polyester resin with glass reinforcements and without inert aggregates.

## 5.2 Marking

The details of the marking must be printed or made directly on the fitting in such a way that the marking does not initiate cracks or other kind of breaks. If the marking is printed with ink, the colour of the printed information should differ from the basic colour of the product in such a way that the marking should be readable to the naked eye.

On the outer face of each accessory must be the following marking:

- *Number of the reference standard. Standard EN 1796*
- *Nominal size DN and diameter series*
- *Stiffness class (SN)*
- *Pressure value (PN)*
- *"P" if suitable for drinking water*
- *Manufacturer's name or brand*

- *Serial number of the pipe or fitting*
- *Date and manufacturing code*
- *if applicable, standard quality mark*
- *Angle in special pieces (bends, branches and grafts)*
- *Standard of drilling in the flanges*
- *Type of joint, flexible or rigid and whether it is resistant or not to axial stresses*

## **6 JOINING SYSTEMS**

### **6.1 Overview**

The manufacturer must declare the length and maximum outer diameter of the coupling to be supplied.

In general, the connection between pipes and fittings will be made by using a coupling equipped with separate sealing gaskets and with a central rubber mounting stopper.

The joints will be designed to meet the following conditions:

- *Resist mechanical stresses without weakening the resistance of the pipes.*
- *There will be no appreciable alterations in the hydraulic system of the pipe.*
- *The elements that compose the coupling will be durable against external and internal actions.*
- *The joint will be tight to the test of hydrostatic pressure of the pipes and throughout its useful life.*

Bends, extensions or reducers and T, will be joined to the pipe by coupling. The secondary branch of the T-fitting can be plane or flanged end as determined by the Job Manager.

The couplings will normally be supplied mounted one per pipe. The rubber gasket exposed to the outside will be protected with a suitable and resistant blue protective adhesive strip. This protective band performs a triple function:

- *Protection against UV of the rubber gasket.*
- *Protection against dirt on the rubber seal and the groove. Keeping the system clean until the its assembly.*
- *Prevents the detachment of the rubber gasket during transport.*

This band must be removed before mounting the pipe.



## 6.2 Types of joint

### 6.2.1 Flexible coupling joint

The connection between pipes and fittings will be made by using a coupling equipped with separate sealing gaskets and with a central rubber mounting stopper.



#### 6.2.1.1 Maximum angular deflection.

The connection by flexible GRP REKA coupling allows some angular deflection between the pipes to be joined. Angular deflection for standard SUBOR pressure coupling is given below:

Nom. Pipe Diameter (mm)	Nom. Pressure Class (bar)			
	Up to 16	20	25	32
		Max. Angle of Deflection (deg)		
DN ≤ 500	3.0	2.5	2.0	1.5
500 < DN ≤ 900	2.0	1.5	1.3	1.0
900 < DN ≤ 1800	1.0	0.8	0.5	0.5
1800 < DN	0.5	0.4	0.3	NA

If required, a joint system with an angular capacity of 3° can be supplied in the whole diameter range.

### 6.2.1.2 Gaskets

The gasket must not have a detrimental effect on the properties of the components with which it is used.

### 6.2.1.3 Lubricants

The lubricants used for the assembly of the pipes, will ensure that they do not have negative effects on the components in which they will be used: EPDM joints, the GRP pipe itself, or harmful effects on the fluid to be transported. In the case of humidity installation conditions, special lubricants must be used.

### 6.2.1.4 Retraction

The manufacturer shall declare the maximum retraction for which each joint and the maximum unit length of the unit pipe to be supplied is designed.

For flexible joints, maximum retraction, including Poisson shrinkage and temperature effects, must not be less than 0.3% (for pressure pipes) of the effective length of the longest. And 0.2% for non-pressure pipes.

Maximum Retraction depending on the length of the pipe (3%)		
Pipes 3m	Pipes 6m	Pipes 12m
9mm	18mm	36mm

Table 5. Maximum pipe retraction.

This maximum retraction value must comply with the required validation tests according to EN 1796, following EN 1119 test procedures.

To comply with the above requirement, the minimum width of the pressure connection couplings must be:

DN (mm) – Pressure pipes	Coupling length (mm)
300-500	270
600-2500	330
2600-3000	370
>3000	390

Table 6. Coupling length (mm) – Pressure pipes.

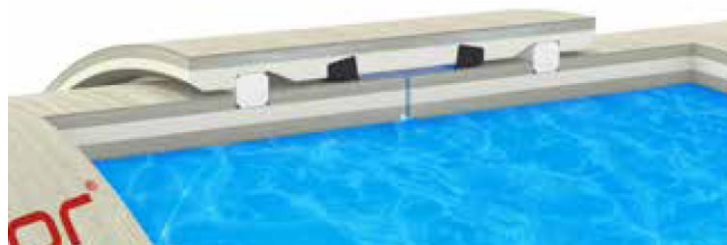
DN (mm) – Sewer gravity pipes (*)	Coupling length (mm)
300-1100	240
1200-2500	270
2600-3000	300

Table 7. Coupling length (mm) – Sewer gravity pipes.

(\*) For sewer gravity pipes, it will be allowed to supply couplings with larger length than those indicated, but never less.

### 6.2.2 Locked coupling joint

This joining system is mainly used to join GRP pipes in which a locking system is required to avoid unplugging. They are used in areas with fittings (mainly bends) where it is not allowed to be supported by thrust blocks. When these types of joints are used, the pipe must be biaxial.

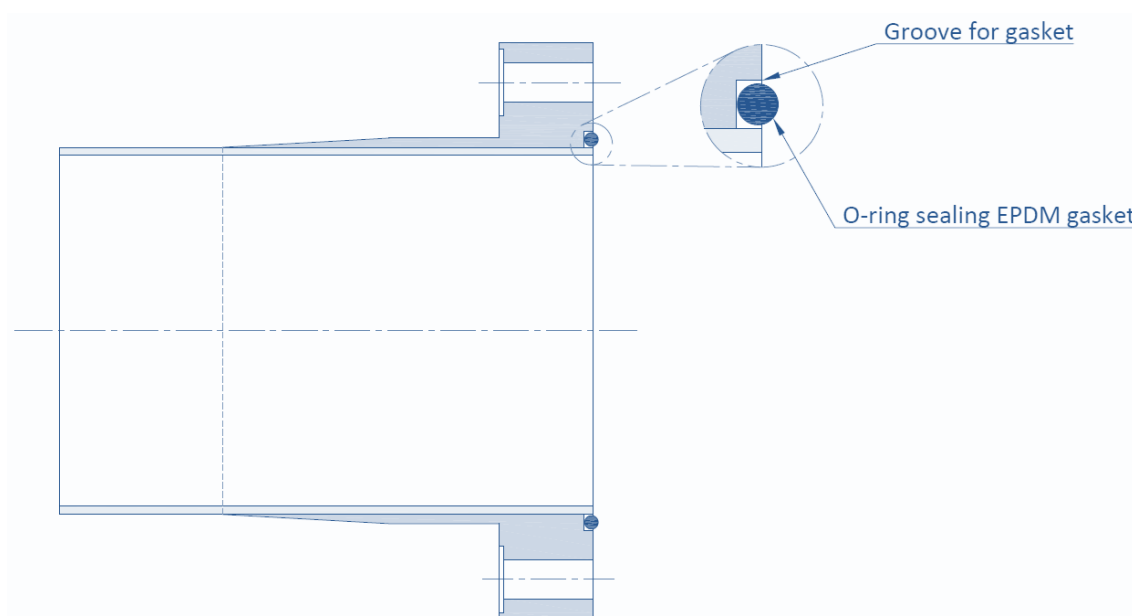


### 6.2.3 Flanged joints

It is only used for connections with line devices (valves, flowmeter, etc.) or with special fittings. These joints are obtained by fixing with a torque wrench and in a determined sequence the two flanged ends using bolts or screws with nut and placing an elastomeric joint between them. The use of a sealing gasket with an O-ring section is recommended to guarantee total tightness at both high and low pressures.

The dimensions of the GRP flanges (number and diameter of the holes) are those provided for in the DIN, AWWA, ASA, etc. international standards.

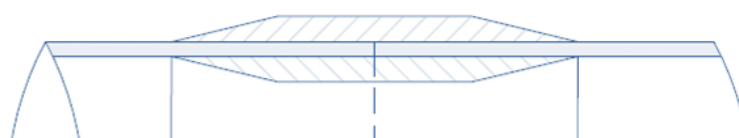
To ensure complete water tightness at the “GRP-Metal” flange connection, a flexible gasket-type element made of elastomeric material must be installed. Gaskets made of EPDM material and with O-ring geometry are recommended, since they require a lower tightening torque, thus reducing the stresses induced by the tightening of the screws. Flanges with flat face can also be supplied on request.



#### 6.2.4 Lay-up joint – Rigid joint by butt-wrapped lamination

The manufacturing process of this joint is based on the application of different glass fabric types impregnated with polyester resin. The number and width of layers will depend on the mechanical requirements of the project, mainly the pipe diameter and nominal pressure.

This method requires special designs, clean and skilled and trained personnel.



## 7 GEOMETRIC CHARACTERISTICS OF THE PIPES

All geometric characteristics must be determined in accordance with section 5.1 of the standard EN 1796.

### 7.1 Diameter

The GRP pipes and joints must be fabricated according to Series **B1** and **B2**, which are related to the external diameter according to the requirement of EN 1796 and ISO standards.

Pipes and fittings must be supplied according to the nominal diameters detailed in the project (DN1, DN2, etc).

The diameter series shall allow the direct interconnection of pipes and fittings with different stiffnesses and nominal pressures.

A technical data sheet of each pipe type with the inside diameter of the pipes shall be supplied. The average of the inner diameters at any point along the length of the pipe shall not deviate from the declared inner diameter by more than is permitted by the deviations given in the table to be supplied.

### 7.2 Wall thickness

Wall thicknesses for pipes according to their stiffness expressed in mm.

### 7.3 Pipe length

GRP pipes will have a nominal length of 3, 5, 6, 10, or 12 meters and the rocker pipes will be between 1,5-3 meters length.

### 7.4 Effective length

The tolerance on laying length is  $\pm 60$  mm.

Of the total number of pipes supplied in each diameter, the manufacturer can supply up to 10 % in lengths shorter than the effective length unless a higher percentage of such pipes is to be supplied by agreement between the manufacturer and the customer.

## 8 MECHANICAL CHARACTERISTICS OF THE PIPES

Calculations of the pipes used in each project may be required, according to the AWWA M45 Design Manual for GRP pipes.

The mechanical characteristics, as well as the design and qualification tests of pipes and fittings, required by the reference standard, are detailed below:

### 8.1 Initial specific circumferential stiffness

Alphanumeric designation to classify stiffness, which has the same numerical value as the minimum required value of the initial specific circumferential stiffness ( $S_0$ ), it is expressed in Newton per square meter ( $N/m^2$ ) and it is obtained according to ISO 7685.

It is the physical characteristic of a pipe expressing the resistance to circumferential deflection per meter of length under external load, defined by equation (1):

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

Where:

$E$  is the modulus of apparent elasticity,

$d_m$  is the average pipe diameter, in meters (m),

$I$  is the quadratic moment of inertia of the area in the longitudinal direction per meter in length, in meters to the fourth power per meter ( $m^4/m$ ), see equation (2):

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

Where:

$e$  is the wall thickness, in meters (m).

This test shall be carried out in accordance with the methodology described in ISO 7685 and in the test conditions indicated in standard -EN 1796 (section 5.2.1) to obtain initial circumferential stiffness values ( $S_0$ ).

#### 8.1.1 Frequency

This test shall be made as Release Test (BRT) test, and the recommended minimum frequency shall be as follows, in each case:

- BRT 1 batch test of equal DN-PN-SN every 600 meters of manufactured pipe

## 8.2 Long-term specific circumferential stiffness in wet conditions

The manufacturer must declare the value corresponding to the specific circumferential stiffness of his products. To do this, it must have the long-term results according to the test criteria established by ISO 10468.

For this determination will be used the method of creep with which will obtain the value of the coefficient of creep.

This test shall be carried out in accordance with the methodology described in ISO 10468 and the test conditions indicated in Standard EN 1796 (section 5.2.2) to obtain the value of the wet creep factor ( $\alpha_{x, \text{creep, wet}}$ ).

From the value of the wet creep factor ( $\alpha_{x, \text{creep, wet}}$ ) the specific circumferential stiffness calculated in the long term ( $S_{x, \text{wet}}$ ) will be determined:

$$S_{x, \text{wet}} = S_0 \times \alpha_{x, \text{creep, wet}}$$

$x$  time elapsed, in years. 50, according to the Standard EN 1796.

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

$S_0$  initial specific circumferential stiffness (N/m<sup>2</sup>)

The minimum creep factor required shall be:  $\alpha_{x, \text{creep, wet}} \geq 0,6$ .

This test must be performed by an accredited laboratory.

### 8.2.1 Frequency

This test shall be made as a type test (TT), and the minimum frequency recommended shall be as follows, in each case:

- TT 1 LTT trial (10,000 hours) per group

## 8.3 Resistance to initial circumferential deflection

The initial resistance to flexion failure shall be determined using the method specified in ISO 10466. The test shall be performed using diametrical deformations appropriate to the nominal stiffness (SN) of the pipe.

This test shall be carried out in accordance with the methodology described in ISO Standard 10466 and the test conditions indicated in Standard EN 1796 (section 5.2.3).

During the trial, the test piece shall conform to the following requirements (as described in section 5.2.3.2 of Standard EN 1796):

1. At the first deflection level the test pieces should not show internal cracks.  
At the first deflection level, penetrating liquids will be applied to the areas where they may appear in order to perform the visual inspection and in order to increase the reliability in the detection of cracks.
2. At the second deflection level, the specimen shall not exhibit apparent structural failure in any of the following forms:

- Delamination
- Fractional breakage of fiberglass reinforcement
- Deflection of the pipe wall
- Separation of the thermoplastic lining from the wall structure, if appropriate

It will be verified that the values obtained in the test, before surface cracking of the inner surface of the specimen  $(y_{2,inner}/D_m)_{min}$ , and the one obtained in the test, before structural failure  $(y_{2,estructural}/D_m)_{min}$  are in accordance with the values established in sections 5.2.3.3.1 and 5.2.3.3.2 of Standard EN 1796.

### **8.3.1 Frequency**

This test shall be conducted as Batch Release Test (BRT), and the minimum frequency recommended shall be as follows, in each case:

- BRT 1 batch test of equal DN-PN-SN every 600 meters of manufactured pipe

## **8.4 Failure resistance, long-term, at the ultimate load under bending conditions**

This test shall be carried out following the procedure indicated in the ISO 10471 or ASTM D5365 standards, whose purpose is to obtain the value of the elongation of the pipe wall at break and under humidity conditions under circumferential deflection.

The value  $S_b$  will be obtained in each sample from a regression curve formed by a cloud of at least 18 points. The duration of this test for each specimen, depending on the applied load, can vary between 10 and 10,000 hours (14 months).

### **8.4.1 Frequency**

This test shall be carried out as a test type (TT).

- TT 1 LTT test in each of the three mediums per group

## **8.5 Initial specific strength in longitudinal strength**

The initial specific strength in longitudinal traction shall be determined in accordance with Method A of ISO 8513.

This test shall be carried out in accordance with the methodology described on ISO standard 8513 (methods A, B or C), and in the test conditions indicated on standard EN 1796 (section 5.2.5). The results shall be double checked against the values indicated on the reference standard.

The manufacturer shall declare the average value of the initial specific resistance in longitudinal traction.

The average value of the elongation shall be not less than 0,25%.

### **8.5.1 Frequency**

This test shall be conducted as a Batch Release Test (BRT), and the minimum frequency recommended shall be as follows, in each case:

- BRT 1 batch test of equal DN-PN-SN every 600 meters of manufactured pipe

## 8.6 Initial failure pressure

For pressure pipes, the initial failure pressure shall be determined according to one of the B or D methods of ISO 8521. It shall comply with that specified in section 5.2.6 of the standard EN 1796.

Using test pieces conforming to ISO 8521, the value of the initial failure pressure shall correspond to the values given in Table 10-B of the AWWA C-950 standard.

The dimensions of the specimen must conform to ISO 8521.

In any case, the Nominal Pressure (PN) of the pipe must guarantee at least a safety factor of 1.8 against the long-term failure pressure of 50 years ( $P_{50}$ ) and a safety factor of 4.0 against the failure pressure ( $P_0$ ).

$$P_{50} > 1.8 * PN$$

$$P_0 > 4.0 * PN$$

### 8.6.1 Frequency

This test shall be conducted as a Batch Release Test (BRT), and the minimum frequency recommended shall be as follows, on each case:

- BRT 1 batch test of equal DN-PN-SN every 600 meters of manufactured pipe

## 8.7 Long-term failure pressure

For pressure pipes, the long-term failure pressure must be determined according to EN 1447 or ASTM D2992 procedure B, using an analysis method based on unit elongations.

This test, or its equivalent according to ASTM D2992, must be supplied by the manufacturer by means of an accredited laboratory.

The declared value will be used by the calculation method proposed in the AWWA M-45 manual, decreasing it by a minimum safety factor of 1.8.

The manufacturer must carry out the test and declare the design value of his products.

### 8.7.1 Frequency

This test shall be conducted as a Type Test (TT), and the minimum frequency recommended shall be as follows, on each case:

- TT 1 LTT trial (10,000 hours) per group

## 9 FITTINGS. MECHANICAL CHARACTERISTICS AND QUALIFICATION

### 9.1 General points

Fittings (bends, flanges, reducers, branches, etc.) shall be made with suitable resin impregnated fabrics by one of the following procedures:

- *Contact Molding*
- *Machining Molding*

### - Chemical lamination of pipe sections

Other procedures can be used to ensure the homogeneity and quality of the finished product.

The geometrical characteristics of the fittings will be according to: thicknesses to the pressure design calculation and by diameters to the pipe of corresponding nominal diameter.

The manufacturer must ensure the functionality of the installed piping with pipes and special GRP fittings for the particular conditions required of the project.

Particularly, concerning the bend design, it will have a radius of curvature of one 1.5 times the nominal diameter of the piece. Bends can be produced with continuous radio (moulded) or segmented, by joining different pipe sections through chemical lamination.

The characteristics of these kind of bends are:

Angle (°)	Number of miters
0-30	1
31-60	2
61-90	3

The manufacturer must specify the dimensions of the chemical joints (length and thickness), both external and if necessary internal, for each type of pipe (DN and PN).

## 9.2 Diameter series

The diameter series of the fitting must be the same as the diameter series of the pipes straight length(s) to which it is going to be connected in the pipeline.

## 9.3 Nominal pressure (PN)

The value of the nominal pressure (PN) of the fitting must be selected from the values indicated above in the general section and will not be less than that of the straight pipes to be connected in the piping system.

## 9.4 Nominal stiffness (SN)

Any fitting shall have the nominal stiffness equal to or higher than that of the pipe. This is due to the geometry of the fitting itself. Therefore, it will not be necessary to subject these fittings to initial stiffness or deflection testing. Due to this characteristic, it will be possible to provide fittings with pipes of a lower stiffness than those that make the straight pipes.

## 9.5 Type of joint

The type of joint used on fittings will be the same as the one used to connect the pipes.

## 9.6 Characteristics of the laminates

The joints between the sections of the pipe to produce the fittings, will be made by chemical lamination, using layers of glass fiber impregnated with polyester resin.

The fiberglass fabric shall have the following characteristics:

- *Woven Roving, with the orientations of the fibers suitable to be able to withstand the mechanical stresses for which they have been designed.*
- *The fiberglass layers must be accurately cut using any mechanical system controlled by a central computer that acts precisely on the cutting element.*

The resin to be used must be of polyester with the following technical characteristics:

- *Thermal distortion temperature > 70 °C*
- *Minimum Elongation at Break: 3%*
- *The resin must be pre-accelerated and thixotropic by the supplier.*
- *A natural colour resin will be used to laminate the fittings. It is not allowed to use colouring and/or dyes that can hide defects in the laminate, such as bubbles, delaminations, dry areas, etc.*

## **9.7 Mechanical characteristics of the fittings**

The fittings must be designed and manufactured in accordance with the appropriate design rules, in order to obtain a mechanical operation equal to or higher than that of the GRP pipe of the same pressure and stiffness class as established in this specification, once installed in a pipeline system, and, if applicable, supported by anchor blocks or embedded.

The GRP laminates, which are used to produce the fittings, will be designed in compliance with the requirements of the EN 1796, ISO10639 and AWWA C950 standards.

### **9.7.1 Post-cured system**

A **post-cured treatment at high temperature** must be carried out on **all the fittings and laminates** supplied.

This treatment provides the laminate with its maximum structural and chemical resistance, which can be estimated between 25% and 30% increase compared to a lamination without treatment.

This treatment will be carried out at 80°C for at least three hours.

## **9.8 Dimensions**

By declaration and agreement between the purchaser and the manufacturer, the dimensions of the fittings to be used will be established.

## **9.9 Marking**

The details of the marking must be printed or made directly on the fitting in such a way that the marking does not initiate cracks or other breaks. If the marking is printed with ink, the colour of the printed information should differ from the basic colour of the product in such a way that the marking should be readable to the naked eye.

On the outer face of each fitting must be the following marking:

- *Reference Number of the Standard.*

- *Nominal size DN and diameter series.*
- *For bends, branches and the angle of elbows.*
- *For reducers, nominal sizes DN1 and DN2.*
- *Stiffness class.*
- *Pressure value.*
- *Name or brand of the manufacturer.*
- *Date and manufacturing code.*
- *If applicable, standard quality mark.*

## 10 MANUFACTURER REQUIREMENTS

The manufacturer must be in possession of the following certificates:

- *ISO 9001 quality management system certificate.*
- *ISO 14001 environmental management system certificate.*
- *ISO 45001 Occupational Health and Safety Assessment Series*
- *Potable water certificate NSF or similar.*
- *Recognized international trademark certificate (e.g. TÜV, CSTB)*

## 11 INSTALLATION AND SUPERVISION ASSISTANCE

The representative of the Technical Assistance Department must make a first visit to the installation site at the beginning of the works.

The total period of assistance must be agreed and specified in the supply contract between the Manufacturer and the Customer.

