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BSI Standards Publication

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

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National foreword

This Published Document is the UK implementation of CEN/TS 14632:2012. It supersedes DD CEN/TS 14632:2006 which is withdrawn.

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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

Systèmes de canalisations en plastique pour les branchements, les collecteurs d'assainissement et l'alimentation en eau, avec ou sans pression - Plastiques thermodurcissables renforcés de verre (PRV) à base de résine polyester (UP) - Guide pour l'évaluation de conformité

Kunststoff-Rohrleitungssysteme für die Entwässerung und Wasserversorgung mit und ohne Druck - Glasfaserverstärkte duroplastische Kunststoffe (GFK) auf der Basis von ungesättigtem Polyesterharz (UP) - Empfehlungen für die Beurteilung der Konformität

This Technical Specification (CEN/TS) was approved by CEN on 20 September 2011 for provisional application.

The period of validity of this CEN/TS is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the CEN/TS can be converted into a European Standard.

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Foreword

This document (CEN/TS 14632:2012) has been prepared by Technical Committee CEN/TC 155 “Plastics piping systems and ducting systems”, the secretariat of which is held by NEN.

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

This document supersedes CEN/TS 14632:2006.

This Technical Specification can be used to support elaboration of national third party certification procedures for GRP products (glass-reinforced thermosetting plastics based on unsaturated polyester resin) to be used in piping systems for the transport of water, drainage and sewage.

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

Introduction

Figures 1 and 2 are intended to provide general information on the concept of testing and organisation of those tests used for the purpose of the assessment of conformity. For each type of test (i.e. type testing (TT), batch release test (BRT), process verification test (PVT) and audit test (AT), this document details the applicable characteristics to be assessed and the frequency and sampling of testing.

A typical scheme for the assessment of conformity of pipes, fittings and assemblies by manufacturers is given in Figure 1.

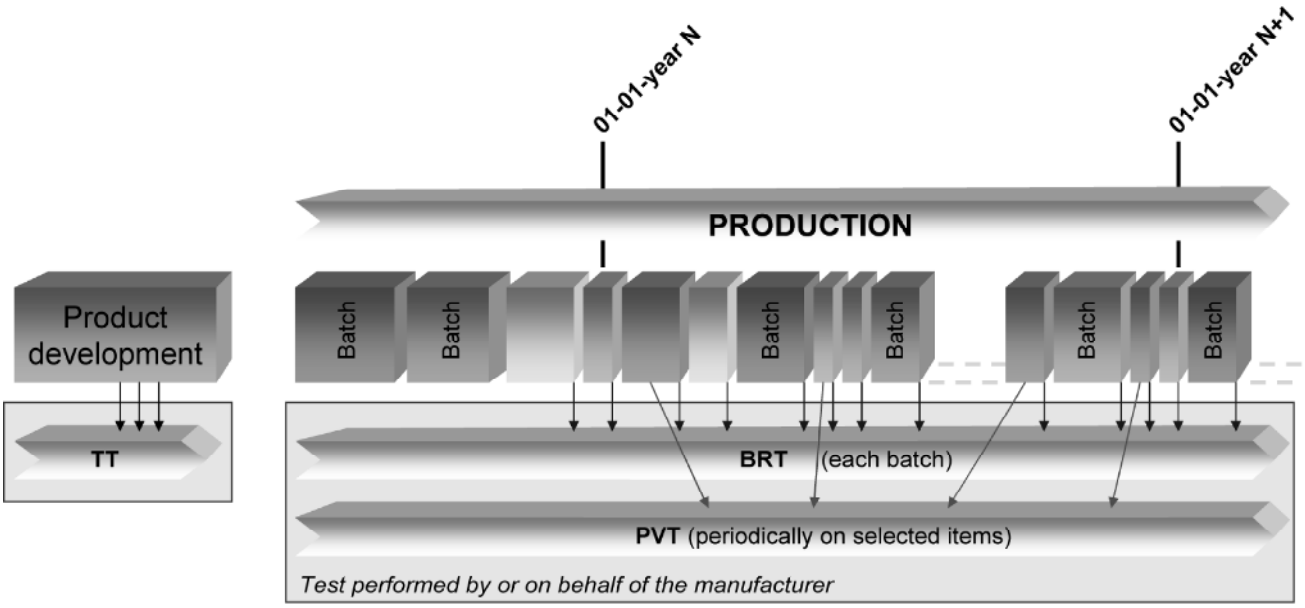


Figure 1 —Typical scheme for the assessment of conformity by a manufacturer

A typical scheme for the assessment of conformity of pipes, fittings and assemblies by manufacturers, including a third-party certification, is given in Figure 2.

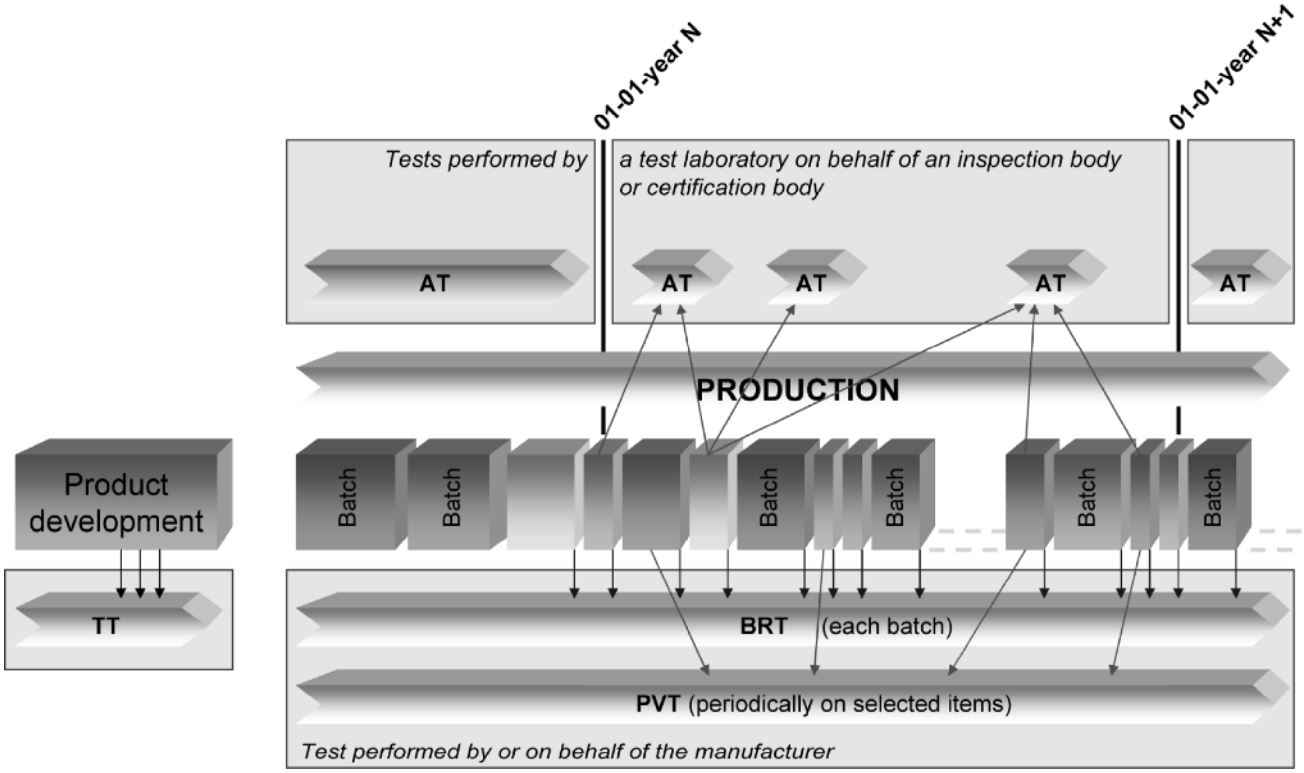


Figure 2 — Typical scheme for the assessment of conformity by a manufacturer, including a third-party certification

1 Scope

This Technical Specification gives guidance on the assessment of conformity of GRP-UP (glass-reinforced thermosetting resins based on unsaturated polyesters) piping products and assemblies in accordance with EN 1796 and EN 14364 intended to be included in the manufacturer's quality plan as part of the quality management system and for the establishment of third-party certification procedures.

This Technical Specification also gives guidance on the assessment of conformity of GRP-UP manholes and inspection chambers in accordance with prEN 15383. Pipes according to EN 14364 are used for manufacturing the shafts and chamber units. Additional statements as needed to assess the conformity of manholes and inspection chambers are given in Annex F.

NOTE 1 It is recommended that the quality management system conforms to or is no less stringent than the relevant requirements to EN ISO 9001 [3].

NOTE 2 If third-party certification is involved, it is recommended that the certification body is accredited to EN 45011 [1], EN 45012 [2] or EN ISO/IEC 17021 [5], as applicable.

2 Normative references

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

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

EN 978:1997, *Underground tanks of glass-reinforced plastics (GRP) — Determination of factor alpha and factor beta*

EN 1119, *Plastics piping systems — Joints for glass-reinforced thermosetting plastics (GRP) pipes and fittings — Test methods for leaktightness and resistance to damage of non-thrust resistant flexible joints with elastomeric sealing elements*

EN 1447, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Determination of long-term resistance to internal pressure*

EN 1796:2006+A1:2008, *Plastics piping systems for water supply with or without pressure — Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP)*

EN 14364:2006+A1:2008, *Plastics piping systems for drainage and sewerage with or without pressure — Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP) — Specifications for pipes, fittings and joints*

prEN 15383:2010, *Plastics piping systems for drainage and sewerage — Glass-reinforced thermosetting plastics (GRP) based on polyester resin (UP) — Manholes and inspection chambers*

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

ISO 7432, *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 7510, *Plastics piping systems — Glass-reinforced plastics (GRP) components — Determination of the amounts of constituents using the gravimetric method*

ISO 7684, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Determination of the creep factor under dry conditions*

ISO 7685:1998, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Determination of initial specific ring stiffness*

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

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

ISO 8521, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Test methods for the determination of the apparent initial circumferential tensile strength*

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

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, *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 for the inside of a section in a deflected condition*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1796:2006+A1:2008, EN 14364:2006+A1:2008 and prEN 15383:2010 and the following apply.

3.1
certification body
impartial body, governmental or non-governmental, possessing the necessary competence and responsibility to carry out certification of conformity according to given rules of procedure and management

Note 1 to entry: A certification body is preferably accredited to EN 45011 [1].

3.2
inspection body
impartial organisation or company, approved by the certification body as possessing the necessary competence to verify and/or to carry out initial type testing, audit testing and inspection of the manufacturer's factory production control in accordance with the relevant standard

Note 1 to entry: An inspection body is preferably accredited to EN ISO/IEC 17020 [4].

3.3
testing laboratory
laboratory which measures, tests, calibrates or otherwise determines the characteristics of the performance of materials and products

Note 1 to entry: In the context of this document, the materials and products can be subjected to type testing, batch release testing, process verification testing, audit testing, and witness testing, as applicable.

Note 2 to entry: A testing laboratory is preferably accredited to EN ISO/IEC 17025 [6].

3.4
quality management system
management system to direct and control an organization with regard to quality

Note 1 to entry: Requirements for quality management systems are given in EN ISO 9001 [3].

3.5
quality plan
document setting out the specific quality practices, resources and sequence of activities relevant to a particular product or range of products

3.6
type testing
TT
testing performed to prove that the material, product, joint or assembly is capable of conforming to the requirements given in the relevant standard

Note 1 to entry: The type test results remain valid until there is a change in the material or product or assembly provided that the process verification tests are done regularly.

3.7
batch release test
BRT
test performed by or on behalf of the manufacturer on a batch of products, which has to be satisfactorily completed before the batch can be released

3.8
process verification test
PVT
test performed by or on behalf of the manufacturer on products at specific intervals to confirm that the process continues to be capable of producing products which conform to the requirements given in the relevant standard

Note 1 to entry: Such tests are not required to release batches of products and are carried out as a measure of process control.

3.9
audit test
AT
test performed by a test laboratory on behalf of an inspection body or certification body to confirm that the product continues to conform to the requirements given in the relevant standard and to provide information to assess the effectiveness of the quality management system

3.10
indirect test
IT
test performed by or on behalf of the manufacturer, different from that specified test for that particular characteristic, having previously verified its correlation with the specified test

3.11
witness test
WT
test accepted by an inspection or a certification body for type testing and/or audit testing, which is carried out by or on behalf of the manufacturer and supervised by a representative of the inspection or certification body, qualified in testing

3.12
product
pipe, fitting, manhole or inspection chamber of a clearly identified type intended to be a part of a piping system which the manufacturer puts on the market

3.13
product batch
clearly identified collection of products, manufactured consecutively or continuously under the same conditions, conforming to the same specification

Note 1 to entry: The production batch is defined and identified by the product manufacturer.

3.14
lot
clearly identifiable sub-division of a batch for inspection purposes

3.15
sample
one or more products drawn from the same production batch or lot, selected at random without regard to their quality

Note 1 to entry: The number of products in the sample is the sample size.

3.16
group
collection of similar products from which samples are selected for testing purposes

3.17
reduced long-term test
RLTT
test using shorter time periods than those specified for the long-term test

Note 1 to entry: The RLTT results are to be compared to the results from the long-term test to verify that the current performance of a product conforms to the initially established long-term performance.

4 Abbreviated terms

To avoid misunderstanding, the abbreviations in this Clause are defined as being the same in each language. For the same reason, the terms are given in the three languages, English, French and German.

	EN	FR	DE
AT	audit test	essai d'audit	Überwachungsprüfung
BRT	batch release test	essai de libération de campagne de fabrication	Freigabeprüfung einer Charge
IT	indirect test	essai indirect	indirekte Prüfung
PVT	process verification test	essai de vérification du procédé de fabrication	Prozessüberprüfung
RLTT	reduced long-term test	essai à long-terme écourté	verkürzte Langzeitprüfung
TT	type test	essai de type	Typprüfung
WT	witness testing	essai témoin	Prüfung unter Aufsicht

5 General

5.1 The materials, pipes, fittings, joints, manholes and inspection chambers shall conform to the requirements in EN 1796, EN 14364 and prEN 15383, as applicable.

5.2 Pipes, fittings, joints, manholes and inspection chambers shall be produced by the manufacturer under a quality management system which includes a quality plan.

It is recommended that the quality management system conforms to or is no less stringent than the relevant requirements of EN ISO 9001 [3].

5.3 For the effect on water quality, attention is drawn to the requirements of National regulations.

6 Testing and inspection

6.1 General

6.1.1 Records of inspection and test

Unless otherwise specified all records shall be maintained for a minimum of ten years.

6.1.2 Indirect tests

Generally, testing shall be performed according to the test method referred to EN 1796, EN 14364 and prEN 15383, as applicable.

Indirect testing may be used for BRT and PVT characteristics as given in 6.4.1 and 6.4.2, respectively. Indirect testing shall not be applied to type testing.

The correlation or safe relationship of the indirect testing to the specified testing shall be documented in the manufacturer's quality plan. If a third party certification is involved, the IT shall be accepted by the certification body. The continuing validity of the indirect testing shall be checked at regular intervals. In cases of dispute, the test methods referred to in EN 1796, EN 14364 and prEN 15383, as applicable, shall be used for BRT or PVT, using RLTT, where applicable.

6.2 Type testing

6.2.1 General

Type tests shall be conducted in accordance with the requirements and rules given in Annex A and, the requirements given in 6.2.2 to 6.2.4, as applicable.

6.2.2 Pipe type test group

A pipe type test group consists of a range or family of products made such that the results of the long-term type tests are applicable to all products in the group. A pipe type test group shall be made of products:

a) manufactured by the same process;

b) with the same material specifications;

c) with the same pipe wall construction (i.e. the sequence of layers, layer compositions, material properties and design method for using the results of the long-term type tests in determining the pipe wall for all combinations of DN, PN and SN);

d) tested with the same loading condition (i.e. uniaxial or biaxial load).

The quality management system shall document all process details that could influence type test performance. The quality management system shall document the complete product design method and demonstrate how the results of the type tests are used to establish product designs.

Table 1 lists the constituents which are addressed by a certificate of conformity to the pipe-manufacturer's specification from the material producer. Table 2 lists the characteristics declared by the manufacturer. Table 3 lists the long-term type tests to be conducted. In addition, all short-term properties listed in Table 6 for BRT shall be tested and documented for the pipes used for the long-term type tests.

Table 1 — Characteristics for pipe type test (TT) — Constituents covered by a certificate of conformity

Constituents
Glass fibre reinforcements
Thermosetting polyester resins
Fillers
Aggregates
Thermoplastic liners
Elastomers
Metals

Table 2 — Characteristics for pipe type test (TT) — Characteristics declared by the manufacturers

Characteristic[a]
Wall construction
Wall thickness
[a] The wall construction (the sequence and composition of the individual layers comprising the pipe wall) shall be documented by the manufacturer. The manufacturer shall translate the product design into detailed process specifications to control the amount and placement of material components.

Table 3 — Characteristics for pipe long-term type test (TT) - Characteristics verified by testing

Characteristic	Test method	Minimum sampling frequency
Pipes		
Creep factor under wet conditions	ISO 10468	one DN per pipe type test group
Resistance to long-term ultimate ring deflection	ISO 10471	one DN per pipe type test group
Long-term failure pressure	EN 1447	one DN per pipe type test group
Resistance to strain corrosion for sewer pipe only	ISO 10952	one DN per pipe type test group

6.2.3 Joint type test group

6.2.3.1 General

A joint type test group is determined by the configuration of the joint and the loading condition. Joint type test groups are the following:

a) flanged uniaxial loading;

b) flanged biaxial loading;

c) butt/wrap uniaxial loading;

d) butt/wrap biaxial loading;

e) cemented uniaxial loading;

f) cemented biaxial loading;

g) gasket sealed uniaxial loading;

h) gasket sealed biaxial loading.

NOTE The term “uniaxial loading” refers to pressurization where there is no pressure end thrust component (the pressure end thrust is taken by the test fixture and not the pipe) and thus the pipe is loaded only in the circumferential direction while “biaxial loading” refers to pressurization where the pressure end thrust component is carried by the pipe and thus the pipe is loaded in both circumferential and longitudinal directions.

The joint testing methods give the performance requirements for the various configurations of joints, but recognizing the very wide range of diameters and pressures it is clearly impractical to test all combinations of DN/PN. The quality management system shall document the procedures for designing and manufacturing the joints and include the results of testing programs to verify performance and establish over what range the test results are applicable and how the design procedures are established and how they apply across the product range. It is likely that multiple tests will be required to qualify the full range of PN and DN for any given combination of joint configuration and loading condition and these results shall be documented as part of the quality management system.

6.2.3.2 Butt/wrap and cemented joints

For butt/wrap and cemented joints, the methodology for designing joints shall be established by conducting type tests that can be used to establish the procedures for design of the complete range of joints. Butt/wrap and cemented joints are evaluated according to ISO 8533. When applicable, the bending resistance of end thrust loaded joints is evaluated according to ISO 8533 or the procedure given in of EN 1796:2006+A1:2008, Annex A, or EN 14364:2006+A1:2008, Annex A, as applicable, as agreed by manufacturer and purchaser.

6.2.3.3 Bolted flanged joints

For bolted flanged joints, the methodology for design shall be established by conducting type tests that can be used to establish the procedures for the design of the complete range of joints. Testing of flanged joints shall also consider the type of gasket (flat face or O-ring) sealing systems. Flanged joints are evaluated according to ISO 8483. When applicable, the bending resistance of end thrust loaded joints is evaluated according to ISO 8483 or the procedure given in EN 1796:2006+A1:2008, Annex A, or EN 14364:2006+A1:2008, Annex A, as applicable, as agreed by manufacturer and purchaser.

6.2.3.4 Elastomeric sealed joints

Elastomeric sealed joints have a laminate design consideration (for example how to determine the thickness of the bell or coupling and how to contain the gasket seal) as well as many dimensional aspects e.g. the gasket configuration, gasket size, gasket hardness and spigot to socket gap. Elastomeric sealed joints are evaluated according to EN 1119 for uniaxial and ISO 7432 for biaxial joints. When applicable, the bending resistance of end thrust loaded joints are evaluated according to ISO 7432 or the procedure given in EN 1796:2006+A1:2008, Annex A, or EN 14364:2006+A1:2008, Annex A, as applicable, of as agreed by manufacturer and purchaser.

6.2.4 Fitting Type Test Groups

A fitting type test group is determined by production method (fabricated or moulded) and loading condition (uniaxial or biaxial). Fitting groups are the following:

a) fabricated uniaxial loaded;

b) fabricated biaxial loaded;

c) moulded uniaxial loaded;

d) moulded biaxial loaded.

Because of the large range of fittings (bends, tees, reducers, etc) possible and the very wide diameter and pressure range of GRP fittings, type testing of fabricated fittings shall be directed at evaluation of the validity of the fitting design and construction procedures. The quality management system shall document the fabricated fitting design procedures including materials, material properties, sequence of attaching and reinforcing layups, the process for applying layups and quality control procedures during and after fabrication for the entire range of fittings produced.

While typically moulded fittings are made over a smaller diameter range than fabricated fittings, the materials and all process and design details shall be fully documented in the quality management system.

For either fitting production method, the quality management system shall also include the results of a prototype testing and qualification program that demonstrates fitting performance over the range of available fittings. The joint test methods may provide a framework for developing the fitting testing procedures. The prototype test fittings and fitting test program should be selected considering:

e) the range of DN and PN to which the design procedures apply;

f) fitting geometry – e.g. a tee is a far more complex design that say a reducer;

g) how the results of the testing are applied to the full fitting range;

h) influence of layup thickness and thickness/diameter ratio;

i) use of strain gauges and FEM/FEA to correlate the test results and provide data for designing the full product range.

6.2.5 Permitted special procedure

Where a factory, factory A, uses the same manufacturing procedures, raw materials and design (see Annex B) as another factory, factory B, then data from factory B may be used by factory A to demonstrate conformity to the long-term properties subject to all the following conditions:

a) the data provided by factory B fulfil the conditions in Annex A and factory A performs RLTT (see 6.3.2) to confirm that both factories products have the same long-term properties;

b) if a third party certifying body is involved it shall be informed prior to conducting the RLTT that these procedures are being used to satisfy the TT requirements.

The procedures detailed in this clause may be applied to TT (see 6.2) and AT (see 6.3), but not to quality control tests (see 6.4).

6.3 Audit tests (AT)

6.3.1 General

Those characteristics specified in the relevant standard, and listed in Table 4 are intended to be audit tested at the minimum sampling frequency as given in Table 4.

Where possible the classes selected for tests should be primarily those which have not previously been subject to audit testing.

When a manufacturer fabricates fittings using pipes of the same classification from which the fittings are to be used, the audit test for the pipes covering mechanical and chemical characteristics cover these fittings. Where tests have been witnessed during routine inspections additional tests for audit purposes will not be required.

Reduced long-term type tests (RLTT) as detailed in 6.3.2 may be used for satisfying the relevant audit test requirements, as well as proving that products still conform to the original specifications. Reduced long-term tests can thus be used as a comparison with existing long-term data, but not as a basis for a new design.

Table 4 — Characteristics and minimum sampling frequencies for AT

Characteristic	Minimum sampling frequency
General	
Wall construction (content of glass plus resin)	Once/year per pipe type test group
Pipes	
Creep under wet conditions	Once/ 5 years per pipe type test group
Resistance to long-term ultimate ring deflection	Once/5 years per pipe type test group
Long-term failure pressure	Once/5 years per pipe type test group
Resistance to strain corrosion for sewer pipe	Once/5 years per pipe type test group
Joint performance [a]	
Flexible joints with elastomeric sealing components Locked socket and spigot joints with elastomeric sealing components Wrapped and cemented joints Bolted flange joints	Joint test according to the appropriate test method every 5 years. See also NOTE 2.
NOTE 1 When a manufacturer makes fittings using pipes of the same classification with which the fittings are to be used, the tests for the pipes covering mechanical and chemical characteristics also cover fittings. NOTE 2 Joint types manufactured infrequently need only be audit tested once every five years or when manufactured whichever is the longer period. NOTE 3 For manufacturers with limited production and infrequent changes the frequency can be reconsidered.	
[a] Only the joint types most commonly used by a manufacturer may be subject to audit testing. Audit tests covering the joint profiles most commonly used shall be witnessed over a period of five years.	

6.3.2 Reduced long-term tests (RLTT)

Those characteristics that may be subjected to reduced long-term tests to show conformance to the long-term test requirements are detailed in Table 5.

The reduced long-term test procedures and parameters together with the applicable consequences are given in Annex E.

Table 5 — Characteristics that may be subjected to RLTT

Characteristic
Pipes
Resistance to long-term ultimate ring deflection
Long-term failure pressure
Resistance to strain corrosion

6.4 Quality control tests

6.4.1 Batch release tests (BRT)

6.4.1.1 Procedure

The manufacturer shall describe in his quality plan the limits used to define a batch for testing purposes. Typically, a quality control batch consists of products of a particular diameter, stiffness class and pressure class.

Samples for BRT can be obtained from a pre-manufactured batch, periodically from a continuous production or other appropriate method, depending on the manufacturing process. At least 1 % of the production shall be sampled for testing the characteristics detailed in Table 6.

Table 6 — Characteristics for BRT

Characteristic
Pipes
Specified diameters (EN ISO 3126)
Wall thickness (EN ISO 3126)
Length (EN ISO 3126)
Initial specific ring stiffness (ISO 7685)
Resistance to initial ring deflection (ISO 10466)
Initial failure pressure (for pressure pipe only) (ISO 8521)
Initial longitudinal tensile properties (ISO 8513)
Fittings
Bends
Fitting angle and angular tolerances (EN ISO 3126)
Length (EN ISO 3126)
Branches
Length (EN ISO 3126)
Reducers
Wall thickness (EN ISO 3126)
Length (EN ISO 3126)
Flanged adaptors
Wall thickness (EN ISO 3126)
Length (EN ISO 3126)
Joint performance
All joint types
Dimensions (EN ISO 3126)

A batch may be released for supply when all the relevant tests and inspections have been carried out and the requirements have been met. If one or more items fail one or more tests or inspections, then the retest procedures detailed in 6.4.1.2 shall be performed.

6.4.1.2 Retesting procedures

6.4.1.2.1 General

The manufacturer's quality plan shall include a rejecting/retesting procedure to deal with non-conformities.

In the event of non-conformity with one or more characteristic(s) the following procedures apply:

Find the last product, which conforms to the requirements. Release all products produced before that point and reject all produced after that point. Alternatively, the procedures detailed in 6.4.1.2.2 shall be followed.

6.4.1.2.2 Procedure to be followed when a batch or lot is rejected

When a batch or lot is rejected, one of the following actions shall be taken:

a) the batch or lot shall be scrapped;

or

b) all items in the batch or lot shall be subjected to the test or tests that were failed and only those that pass shall be released;

or

c) the batch or lot shall be reclassified into a class where the results of the tests meet the requirements of that class.

6.4.2 Process verification tests (PVT)

The manufacturer shall detail in his quality plan a verification procedure of such a nature and of such a frequency as to ensure, with reasonable probability, that the long-term properties are maintained. The frequency of these tests shall complement the frequency of audit tests, if applicable.

The purpose of PVT tests is to assess the conformity of the long-term properties of the product. The characteristics listed in Table 3 shall be addressed. Test methods referred to in the relevant standard or indirect tests and observations shall be used (see 6.1.2). Indirect tests and observations may include alternate accelerated tests or continuous verification of the detailed process specifications. A combination of tests that are indicative of the same property can be considered.

Where the long-term properties are verified according to the test methods referred to in the relevant standard, RLTT is recommended when establishing the PVT procedures for use in the manufacturer's quality plan.

When the results from PVT tests show non-compliance then the process shall be investigated and corrected and the retest procedures detailed in the manufacturer's quality plan shall be performed. If third party certification is involved then the certification body shall be informed.

Annex A
(normative)

Procedures for dealing with test data provided by the manufacturer and for witnessed tests in a manufacturer's laboratory

A.1 General

Test data provided by the manufacturer may only be accepted when it has been produced under a recognized quality management system.

NOTE Quality management systems conforming to EN ISO 9001:2000 [3] are recognised. Other equivalent quality management systems may be used.

A.2 Test data provided by the manufacturer

Manufacturer's documentation can include results of tests carried out in approved testing laboratories (those testing laboratories meeting the requirements of EN ISO/IEC 17025 [6] or EN 45011 [1].

The manufacturer's data shall be traceable to the materials, product design and relevant production practices.

The certification body shall consider data obtained from tests performed in the manufacturer’s laboratory.

A.3 Witnessed tests in a manufacturer's laboratory

A.3.1 General

The certification body shall make an agreement with the manufacturer for type testing (TT) and/or audit testing (AT) to be done as witnessed testing.

NOTE Examples of reasons for witnessed testing are:

a) the availability of staff qualified in testing, and with experience of the material and product, and the necessary equipment and facilities provides the most cost effective means of testing the products;

b) the approved testing laboratories, which the certification body might normally use, do not have the necessary test equipment, e.g. for testing of large diameter pipes;

c) the approved testing laboratories, which the certification body/inspection body might normally use, do not have the capacity for testing available within a reasonable time scale.

A.3.2 Control of witnessed tests

A representative of the certification body, qualified in testing the material and product in question, shall witness the tests and check the state of calibration of the test equipment.

For long-term testing the certification body or its representative shall confirm the validity of recorded data. Results of testing shall be traceable to the raw material, design and current production practices.

Annex B
(normative)

Definitions of changes in material, design and process

B.1 General

The objective of this annex is to define what constitutes a change in a pipeline component's material, design or process and consequently requiring a certain degree of reassessment of conformity.

NOTE Recommendations about the component characteristics to be counterchecked are given in Annex C.

The manufacturer shall define in his quality plan the following parameters, which have been assessed and accepted by type testing for use in production:

— processes used to manufacture the products;

— methods used to design the products;

— materials used in the manufacturing process.

When more than one material, design method or process has been assessed and accepted then changing from one assessed and accepted parameter to another does not constitute a change.

However, what constitutes a change shall be discussed and agreed upon between the involved parties (certification body and component manufacturer assisted if necessary by material suppliers).

For products supplied for use in systems supplying water intended for human consumption irrespective of this assessment of conformity, materials or process changes, as defined in this annex, may require notification to the relevant national health and/or water authorities.

B.2 Change in materials — Reinforcements

When any of the following are altered then a change has occurred:

a) reinforcement manufacturer;

b) sizing (indicated by code number);

c) glass type (e.g. Type E or C or R etc.);

d) roving type (direct pull or assembled) (depending on process).

When any of the following are altered then a minor change has occurred:

e) roving type (direct pull or assembled) (depending on process);

f) linear density (tex);

g) mass per unit area (mat and fabrics).

B.3 Resins

B.3.1 General

When any of the following are altered then a change has occurred:

a) resin manufacturer;

b) resin type, e.g. orthophthalic, isophthalic;

c) primary code as defined by the resin manufacturer.

NOTE The pipe manufacturer should be satisfied that significant changes in resin characteristics are reflected in primary code changes.

A variation indicated by a secondary code, such as inclusion of accelerators, inhibitors, paraffin, thixotropic agents and viscosity modifiers shall not be considered as a resin change but treated as a change of curing system.

B.3.2 Curing agents or systems

When any of the following are altered then a change has occurred:

a) type of curing agents and additives (e.g. catalyst, accelerator, inhibitors);

b) curing and/or post-curing conditions (other than routine in-process adjustments).

B.3.3 Fillers and/or aggregates

When any of the following are altered then a change has occurred:

a) material type, e.g. sand, calcium carbonate, grit;

b) particle size distribution detailed in the quality plan.

B.3.4 Joint materials

B.3.4.1 Gasket sealed joints

When the following is altered then a change has occurred:

— hardness class according to EN 681-1.

B.3.4.2 Bonded joints

When any of the following are altered then a change has occurred:

a) adhesive manufacturer;

b) resin type (see B.3);

c) code (see B.3);

d) curing agents and systems.

NOTE If the joint system described in the manufacturer's quality plan includes other parts, not covered by a) or b) above, or components delivered by a different manufacturer, a change of the material type and/or manufacturer could be considered as a change.

B.4 Change in design

When any of the following are altered then a change has occurred:

a) for joints, an altered component shape (e.g. gasket cross section) and dimensions (e.g. clearance between socket and spigot);

b) for pipes and fittings, the laminate design and construction methodology.

Slight thickness and/or composition modifications of individual layers, to compensate for normal process and/or material property variations, as defined in the quality management system, do not constitute a change in design.

B.5 Change in process

When any of the following are altered then a change has occurred:

a) the type of manufacturing process is altered, then a major change has occurred;

b) modifications of process conditions other than routine adjustments and maintenance occur, then a minor change has occurred.

For a specific process where minor modifications are known to have no influence on the product properties, they should be declared by the manufacturer in his quality plan.

Annex C
(normative)

Tests to assess the effects of changes

C.1 Tests

Tests and conditions given are given which in Table C.1 and Table C.2 should be used to assess the effect of a proposed change in material, design or process, as indicated in Annex B.

The proposed change should be implemented only when the evaluation requirements detailed in C.2 are satisfied.

C.2 Evaluation of test results

C.2.1 Initial properties

The results of the initial tests given in Table C.1 and Table C.2 should fulfil the applicable requirements detailed in the relevant standard.

C.2.2 Reduced long-term tests

The results of the RLTTs detailed in Table C.1 and Table C.2 should be evaluated according to Annex D.

Table C.1 — Test to be performed to material changes

Property to be tested	Reinforcements [reference to item(s) of B.2]	Resins [reference to item(s) of B.3]	Curing agents or systems [reference to item(s) of B.3.2]	Aggregates or fillers [reference to item(s) of B.3.3]
Glass-/aggregates-/ resin content [a]	a), b), c), d), e), f)	[a), b), c)] [b]	—	a), b)
Initial specific ring stiffness	a), b), d), e), f)	[a), b), c)][b]	—	a), b)
Initial resistance to ring deflection	a), b), d), e), f)	[a), b), c)] [b, c]	—	a), b)
Initial failure pressure	a), b), d), e), f)	—	—	a), b)
RLTT failure pressure	a), b)	—	—	a), b)
RLTT resistance to strain corrosion for sewer pipes	c)	[a), b), c)] [c]	—	[a), b)] [d]
Creep factor (24 h) (see Annex E)	—	—	a), b)	—
α and β factors (see Annex E)	—	[a), b), c)] [b]	—	—

[a] Conduct a test in accordance with ISO 7510. A difference of less than 10 % of the declared value for the DN, SN and PN in question between the results before and after the proposed change, do not require a full ITT.

[b] If structural layer resin has changed.

[c] If liner resin has changed.

[d] If the filler in the liner resin has changed.

Test methods to prove the properties of the new raw materials, other than those listed in Table C.1 can be considered.

Table C.2 — Tests to be performed for changes design, process or joint materials

Component characteristic	Joint materials [reference to item(s) of B.3.4]	Design [reference to item(s) of B.3]	Process [a] [reference to item(s) of B.4]
Glass-/Aggregates-/ Resin content [b]	—	a), b)	b)
Initial specific ring stiffness	—	a), b)	b)
$\underline{\alpha}$ and $\underline{\beta}$ factors	—	a), b)	b)
Initial resistance to ring deflection	—	a), b)	b)
Initial failure pressure	—	a), b)	b)
RLTT failure pressure	—	a), b)	b)
Joint performance tests	a), b)	a), b)	b)

[a] If it is a major change [see B.4.a)] then a full ITT/PTT is required.

[b] Conduct a test in accordance with ISO 7510. A difference of less than 10 % of the declared value between the results before and after the proposed change, do not require a full ITT.

Annex D
(normative)

Parameters and criteria for reduced long-term tests (RLTT)

D.1 General

Where RLTT are being used to assess conformity to the requirements or to evaluate and, if applicable, accept a proposed change in material, design or process according to Annexes B and C the following test parameters and criteria shall be used.

The number of test pieces cited in this annex is a minimum to execute an RLTT test. However, a greater number can be used.

D.2 Reduced long-term test parameters

D.2.1 Reduced parameters for long-term failure pressure

To perform an RLTT for the resistance to long-term internal pressure the test procedures described in EN 1447 shall be used.

Six test pieces should be cut from pipes of the same size and classification and the length of the test pieces shall conform to the relevant standard.

The internal pressure levels shall be selected from the current pressure design curve derived in accordance with the relevant procedures described in ISO 10928 for the following expected times to failure: 100 h, 600 h and 2 000 h.

Two test pieces should be tested at each of the three determined pressures.

The results shall be evaluated in accordance with D.3.

D.2.2 Reduced parameters for the resistance to strain corrosion

D.2.2.1 General

To perform an RLTT for the resistance to strain corrosion (see D.2.2.2 or D.2.2.3) the test procedures described in ISO 10952 shall be used except that six test pieces shall be cut from pipes of the same size and classification. The length of the test pieces shall conform to the relevant standard.

The RLTT shall use the same basis as that used for TT i.e. failure points or specified levels.

The test solution shall comprise sulphuric acid solution at a concentration of 0,5 mol/l. This shall be introduced into the test pieces within 2 h of deflecting in accordance with ISO 10952. This is the zero time from which the long-term properties are determined.

D.2.2.2 Procedure using failure points

The deflection levels at the beginning of the tests shall be selected from the measured strain corrosion regression line, derived in accordance with the relevant procedures described in ISO 10928, for the following expected times to failure: 100 h, 600 h and 2 000 h.

Two test pieces shall be tested at each of the three determined deflection levels.

The results shall be evaluated in accordance with D.3.

D.2.2.3 Procedure using specified levels

D.2.2.3.1 General

Two test pieces shall be tested at each of the three deflections or strain levels corresponding to expected failure periods of 100 h, 600 h and 2 000 h. All test pieces shall exceed the corresponding time period without failure.

D.2.2.3.2 Using deflection

Using the measured deflection of the test piece, S_0, and the duration of the test required, the percentage deflection for the individual test piece shall be calculated using Equation (D.1):

$$\left(y_{\text{test},t} / d_{\text{m}}\right) = \frac{K_t}{\sqrt[3]{S_0}} \tag{D.1}$$

where

$y_{\text{test},t}/d_{\text{m}}$ is the required percentage relative ring deflection for test period t in hours calculated for the test pieces initial specific ring stiffness;

K_t is a constant and is equal to: 260,7 for a test period t of 100 h, 245,6 for a test period t of 600 h, 237,0 for a test period t of 2 000 h;

S_0 is the initial specific ring stiffness of the test piece.

D.2.2.3.3 Using strain

Using the measured initial ring stiffness, S_0, of the individual test piece, and the percentage deflection calculated from Equation (D.1) determine the required relative strain, $\varepsilon_{t,\text{test}}$, for the individual test piece using Equation (D.2):

$$\varepsilon_{t,\text{test}} = \frac{4{,}28 \times V_{15}}{\left[1 + \left(V_{\text{D1}} / 200\right)\right]^2} \times \frac{e}{d_{\text{m}}} \tag{D.2}$$

where

$\varepsilon_{t,\text{test}}$ is the strain for the test time t calculated for the actual initial ring stiffness, S_0, of the individual test piece;

V_{DI} is the value calculated for the test piece using Equation (D.1);

e is the wall thickness of the test piece in millimetres (mm);

d_m is the mean diameter of the test piece in millimetres (mm).

D.2.3 Reduced parameters for ultimate long-term resistance to failure in a deflected condition

To perform an RLTT for the resistance to long-term ultimate ring deflection the test procedures described in ISO 10471 shall be used.

Six test pieces should be cut from pipes of the same size and classification and the length of the test pieces shall conform to the relevant standard.

The strain levels shall be selected from the measured regression line derived in accordance with the relevant procedures described in ISO 10928 for the following expected times to failure: 100 h, 600 h and 2 000 h.

Two test pieces should be tested at each of the three determined strains.

The results shall be evaluated in accordance with D.3.

D.3 Evaluation of results of destructive RLTTs (see D.2.1, D.2.2 and D.2.3)

D.3.1 General

The following procedures shall be used to evaluate results of RLTT tests. The method is based on the principles outlined in ISO 10928 and can be applied to either verification of a measured regression line or a design line.

The property value can be expressed in terms of strain, stress, deflection or pressure. If the RLTT data has been obtained from products identical to the original data, deflection or pressures can be used directly. If not, stress or strain values should be used for the comparison.

Using the current regression line of the relevant property, determine the property value level, vp, for each of the three expected failure times, T_e, *i.e.*100 h, 600 h and 2 000 h.

The following modifications apply:

a) if the manufacturer's allowable long-term deflection is different from the one assumed in the referring standard, the RLTT deflection values shall be adjusted accordingly;

b) if the stiffness of the RLTT samples is different from the one used in the original regression line, deflection values shall be adjusted accordingly;

c) if the pressure class of the RLTT samples is different from the one used in the original regression line, pressure values shall be adjusted accordingly.

Using the modified property values, determine the time to failure, TRLTT, for each of the test pieces as described in, D.2.1, D.2.2, and D.2.3. These measured times, TRLTT, shall be compared to the expected times to failure using the following procedures:

d) establish the constants a and b in the original regression line as described in ISO 10928:

$$\log(v) = a + b\log(t) \tag{D.3}$$

e) determine the intercept for the lower bound average line using Equation (D.4):

$$a' = \log(0{,}91 \times 10^{a}) \tag{D.4}$$

f) for each of the property value levels, vp, determine the lower bound average time using Equation (D.5):

$$t' = 10^{(\log(vp) - a')lb} \quad \text{(D.5)}$$

g) determine the intercept for the lower bound individual line using Equation (D.6):

$$a'' = \log(0{,}81 \times 10^{a}) \quad \text{(D.6)}$$

A student's t of 2,11 has been assumed to determine the multiplier 0,81. If the number of samples for the line is different from the minimum requirement of 18 then a corresponding Student's *t* value shall be used;

h) for each of the property value levels, vp, determine the lower bound individual time using Equation (D.7):

$$t'' = 10^{(\log(vp) - a'')lb} \quad \text{(D.7)}$$

The procedure described herein is based on a coefficient of variation of 0,09. If the original initial values have greater variance, that variance should be used instead of 0,09. The intercepts will then be a' = log $((1 - c_{var}) \times 10^{a})$ and a'' = log $((1\text{-}t_v \times c_{var}) \times 10^{a})$, where c_{var} is the coefficient of variation and t_v is student's t for the data.

i) for each property value level, compute the average of the measured times to failure $T_{ave,RLTT}$.

The results shall meet the following criteria:

— the average of each of the measured times, $T_{a,RLTT,}$ shall not be less than the corresponding lower bound average time, t';

— no individual measured time, T_{RLTT}, shall be less than the corresponding lower bound individual time, t''.

If the results of the RLTT tests do not meet these requirements then the manufacturer shall do one of the following:

— conduct three additional tests at the same level. If one or more of the three test pieces fails to fulfil the above requirement then a full TT shall be conducted;

— a full TT may be conducted.

D.3.2 Example

The following example explains the procedure. The data used is fictitious and the property values could represent deflections, pressures, stresses or strains.

The data used is given in Table D.1.

Table D.1 — Data used for example

Time	Value	Time	Value	Time	Value
1,5	42	1,5	32	2 300	27,8
1	41	15	32	7 000	27,5
8	38,5	700	32	11 000	27
50	36,5	300	31	600	27
10	34,5	50	30,5	400	26
100	34	1 300	30,4	7 500	26
250	34	3 800	30,2		
25	34	1 000	27,8		

Original line: $\log(v) = a + b \log(t) = 1{,}606\ 15 - 0{,}048\ 71 \log(t)$

From this line, the following values are computed for the three expected times to failure:

Time	Value level (vp)
100 h	32,26
600 h	29,57
2 000 h	27,88

Two samples are tested to failure at each of these value levels and the results are summarised in Table D.2.

Table D.2 — Times to failure

Set value, *vp*	Measured failure times, h	
	Sample 1	Sample 2
32,26	1	50
29,57	50	300
27,88	1 000	3 000

Do the samples pass the evaluation criteria?

— Lower average line:

The intercept is determined using Equation (D.4), i.e.

$$a' = \log(0{,}91 \times 10^{a}) = \log(0{,}91 \times 10^{1{,}60615}) = 1{,}56519$$

The lower bound line for the average value is therefore defined by the following equation by assuming the slope to be equal to that of the original line:

$$\log(vp) = 1{,}56519 - 0{,}04871 \log(t') \qquad \text{(D.8)}$$

Consequently from Equation (D.5) when vp is 32,26 the calculated failure time from the lower average line is t' = 14,5 h

— Lower individual line:

The intercept is determined using Equation (D.6), i.e,

$$a'' = \log(0{,}81 \times 10^{a}) = \log(0{,}81 \times 10^{1{,}60615}) = 1{,}51464$$

The lower bound line for individual values is therefore defined by the following equation by again assuming the slope to be equal to the original line:

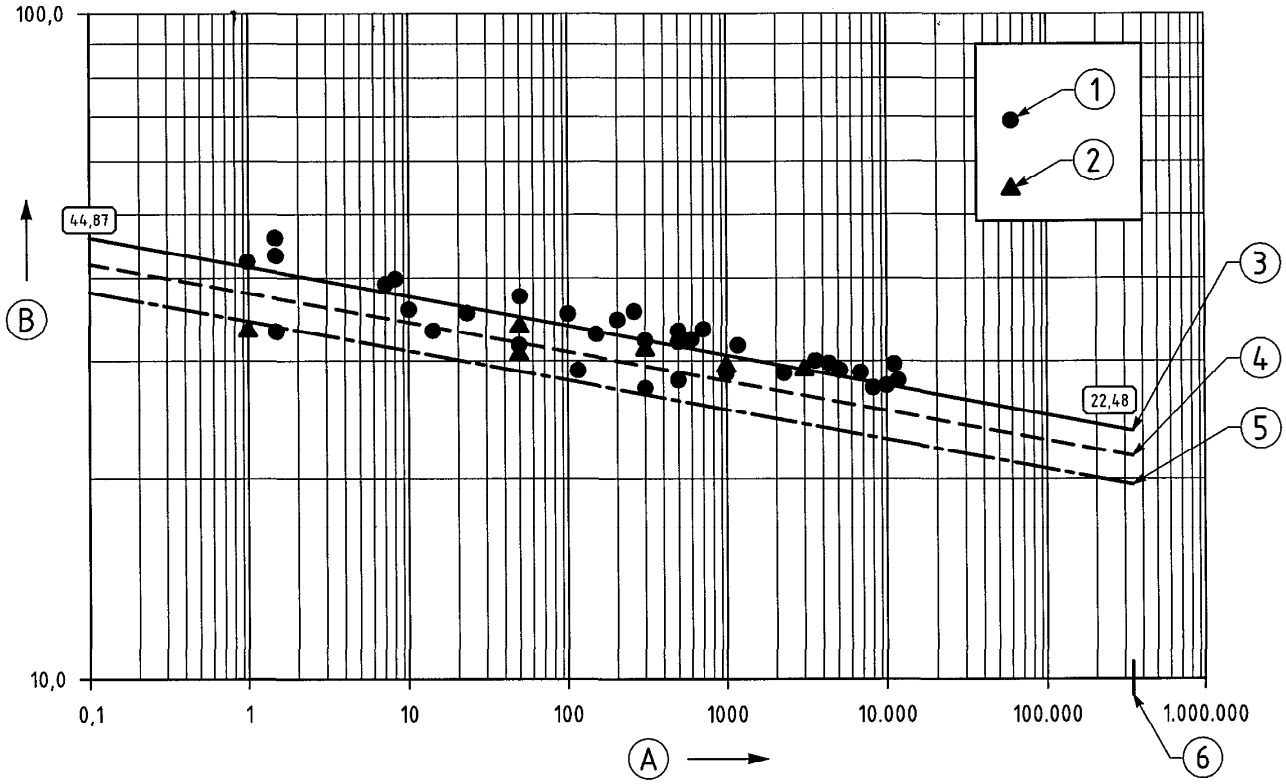
$$\log(vp) = 1{,}51464 - 0{,}04871 \log(t'') \quad \text{(D.9)}$$

Consequently from Equation (D.7) when vp is 32,26 the calculated failure time from the lower individual line is t'' = 1,3 h

Using the same procedure for the other vp values the minimum values for the average and the individual result are obtained and summarised in Table D.3. These values are compared to the actual values and the results are given in Table D.1. A graphical representation of the data and results of the calculations is given in Figure D.1.

Table D.3 — Summary of calculated rated values and comparisons

Set value, vp	Measured failure times, h		Average failure time, h	Minimum average from lower average line, h	Minimum individual from lower individual line, h	Is actual average > the minimum average?	Is lowest measured > minimum individual?
32,26	1	50	25,5	14,5	1,3	Yes	No
29,57	50	300	175	86,4	7,9	Yes	Yes
27,88	1 000	3 000	2 000	289,4	26,5	Yes	Yes



Key
A Time (hours)
B Value
1 Property values
2 RLTT data
3 Regression line
4 Lower bound average
5 Lower bound individual
6 50 years

Figure D.1 — Plots of the lines and data

From the comparisons shown in Table D.3 it can be seen that the data does not fulfil the requirements, since one of the values falls below the lower individual line. Therefore, either a further three additional samples have to be set up at a value of 32,26, or a full TT conducted. If any of the three test pieces fails to fulfil the above requirement then a full TT shall be conducted.

Annex E
(normative)

Parameters and criteria for dry creep and α and β testing

E.1 General

The dry creep factor and α and β factors are determined to assist in the evaluation of changes of resins and/or curing agents.

E.2 Test parameters for the creep factor under dry conditions

The procedures described in ISO 7684 shall be used.

Three test pieces shall be cut from three different pipes of the same size and classification. The length of the test pieces shall conform to ISO 7684 subject to permissible deviations of $\pm$ 5 % of the specified length.

The creep factor under dry conditions, $\theta_{24,dry}$, shall be determined for the time t = 24 h.

The results obtained from these tests shall be compared with the results obtained using the current product by the following procedure:

a) from the current TT data compute the average specific ring stiffness $\theta_{24,dry.TT}$;

b) from the three test samples compute the average specific ring stiffness $\theta_{24,dry,test}$

The results shall meet the following criteria:

— $\theta_{24,dry,test} \geq 0{,}91 \times \theta_{24,dry.TT}$;

— no individual test sample shall have $\theta_{24,dry,test} < 0{,}81\ \theta_{24,dry.TT}$.

If the results of the tests do not meet these requirements then three additional tests shall be conducted. If the results do not fulfil the above requirements then the manufacturer shall either:

— conclude the change is significant and not accept the change or

— if the change is to be accepted, a full TT series will need to be conducted.

E.3 Test parameters for the determination of α and β factors

E.3.1 General

The general procedures described in EN 978:1997 for determination of α and β factors shall be used.

E.3.2 α factor

Three test pieces shall be cut from pipes of the same size and classification. The length of the test pieces shall conform to the relevant standard subject to permitted deviations of ± 5 % of the specified length. Care shall be taken to ensure that the distance between sampling points shall be at least 2 m.

The α factor shall be determined as the ratio of the dry creep stiffness at 1 000 h and the initial specific ring stiffness determined using ISO 7685:1998, Method A.

The results obtained from these tests shall be compared with the results obtained using the current product by the following procedure:

a) from the current TT data compute the average $\alpha_{dry,i,1000,TT}$;

b) from the three test samples compute the average $\alpha_{dry,1000,CH}$.

The results shall meet the following criteria:

— $\alpha_{dry,1000,CH} \geq 0{,}91\alpha_{dry,i,1000,TT}$;

— no individual test sample shall have $\alpha_{dry,1000,CH} < 0{,}81\alpha_{dry,i1000,TT}$.

If the results of the tests do not meet these requirements then three additional tests shall be conducted. If the results do not fulfil the above requirements then the manufacturer shall either:

— conclude the change is significant and not accept the change or

— if the change is to be accepted, a full TT series will need to be conducted.

E.3.3 β factor

The β factor shall be determined as the ratio between the initial specific ring stiffness determined using Method A of ISO 7685:1998 following post-curing and exposure to water of 50 °C and the initial specific ring stiffness before exposure to water using the same test method.

The results obtained from these tests shall be compared with the three results obtained using the current product by the following procedure:

a) from the current TT data compute the average $\beta_{wet,i1000,TT}$;

b) from the three test samples compute the average $\beta_{wet,1000,CH}$.

The results shall meet the following criteria:

— $\beta_{wet,1000,CH} \geq 0{,}91\beta_{wet,I,1000,TT}$;

— no individual test sample shall have $\beta_{wet,1000,CH} < 0{,}81\beta_{wet,I,1000,TT}$.

If the results of the tests do not meet these requirements then three additional tests shall be conducted. If the results do not fulfil the above requirements then the manufacturer shall either:

— conclude the change is significant and not accept the change or

— if the change is to be accepted, a full TT series will need to be conducted.

Annex F
(normative)

Additional statements for manholes and inspection chambers

F.1 General

Manholes and inspection chambers are produced using pipes made in accordance to EN 14364 for the shaft and chamber units. The assessment of conformity of the pipes covers those portions of the manholes or inspection chambers. This annex gives additional considerations as necessary for the assessment of conformity of manholes and inspection chambers.

F.2 Tests specific to manholes and chambers

F.2.1 Longitudinal compressive strength

Longitudinal compressive properties of the pipes used for the shafts and chamber units shall be evaluated according to prEN 15383:2010, Annexes A and/or B, as appropriate.

F.2.2 Determination of the resistance of installed steps to vertical and horizontal loading

The resistance of installed steps to vertical and horizontal loading shall be evaluated according to prEN 15383:2010, Annex C.

F.3 Type tests

For TT, in addition to the characteristics given in Table 3 the longitudinal compressive strength of a spool piece and the resistance of installed steps shall be evaluated in accordance with prEN 15383:2010, Annex B and Annex C, respectively.

F.4 Audit tests

For AT, in addition to the characteristics given in Table 4 the longitudinal compressive strength of a spool piece and the resistance of installed steps shall be evaluated in accordance with prEN 15383:2010, Annex B and Annex D, respectively.

F.5 Batch release tests

For BRT, in addition to the characteristics given in Table 6 the longitudinal compressive strength shall be evaluated according to prEN 15383:2010, Annex A.

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