TECHNICAL SPECIFICATION

ISO/TS 16486-7

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Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing —

Part 7: Assessment of conformity

Systèmes de canalisations en matières plastiques pour la distribution de combustibles gazeux — Systèmes de canalisations en polyamide non plastifié (PA-U) avec assemblages par soudage et assemblages mécaniques —

Partie 7: Evaluation de la conformité

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 4, *Plastics pipes and fittings for the supply of gaseous fuels,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 155, *Plastics piping systems and ducting systems,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 16486 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document specifies requirements and guidance for the assessment of conformity (AoC) for a piping system and its components made from unplasticized polyamide (PA-U), and which is intended to be used for the supply of gaseous fuels.

Requirements and test methods for material and components of the piping system are specified in ISO 16486-1, ISO 16486-2, ISO 16486-3 and ISO 16486-4.

Characteristics for fitness for purpose of the system and generic fusion parameters are covered in ISO 16486-5.

Recommended practice for installation is provided in ISO 16486-6, which will not be implemented as European Standard under the Vienna Agreement.

Recommended practice for installation is also provided in CEN/TS 12007-6,[1] prepared by Technical Committee CEN/TC 234, *Gas infrastructure*.

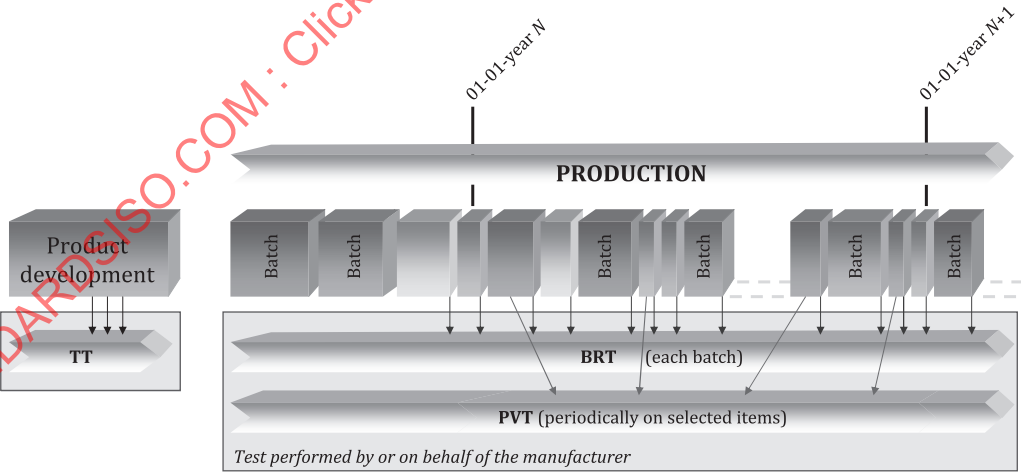
Training and assessment of fusion operators is given in ISO/TS 16486-8.

NOTE While ISO 16486-1, ISO 16486-2, ISO 16486-3, ISO 16486-5, ISO 16486-6 and ISO/TS 16486-7 (this document) and ISO/TS 16486-8 have been prepared by ISO/TC 138, SC 4, ISO 16486-4 has been prepared by ISO/TC 138, SC 7.

This document details the applicable characteristics to be assessed for type testing (TT), batch release testing (BRT), process verification testing (PVT) and audit testing (AT), as well as the frequency and sampling for testing.

The concept of testing and organization of those tests used for the AoC is shown, without or with certification, in Figures 1 and 2.

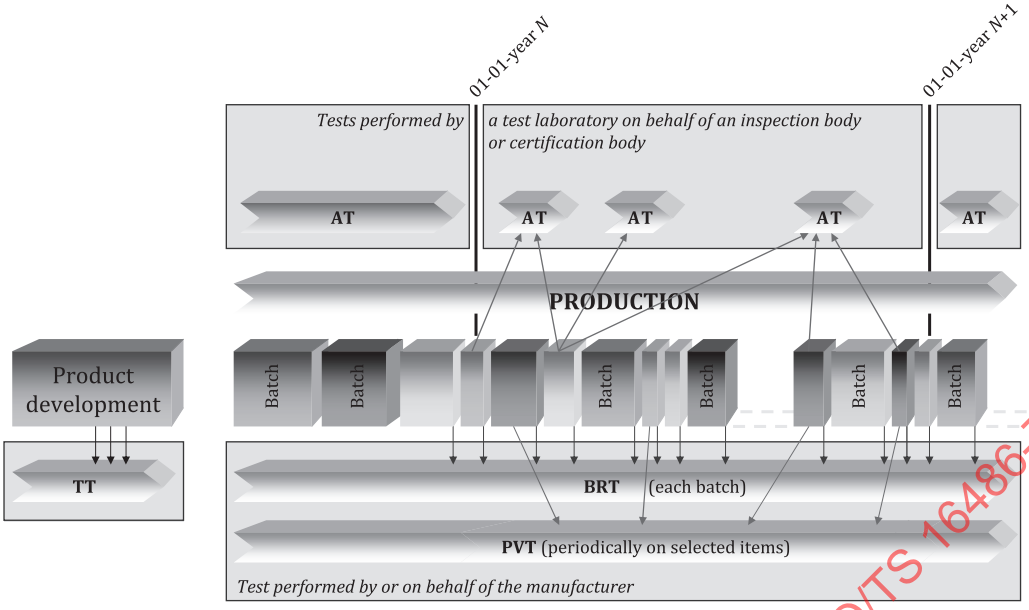
A typical scheme for the assessment of conformity of materials, compounds, pipes, fittings, valves, joints or assemblies by product manufacturers is given in Figure 1.



SOURCE ISO/TS 15874-7:2018.

Figure 1 — Typical scheme for the AoC by a manufacturer, without certification

A typical scheme for the assessment of conformity of compounds, pipes, fittings, valves, joints or assemblies by manufacturers, including certification, is given in Figure 2.



SOURCE ISO/TS 15874-7:2018.

Figure 2 — Typical scheme for the AoC by a manufacturer, including certification

Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing —

Part 7: Assessment of conformity

1 Scope

This document gives guidance and requirements for the assessment of conformity of compounds, products, joints and assemblies in accordance with the applicable part(s) of the ISO 16486 series which are intended to be included in the manufacturer's quality plan as part of the quality management system and for the establishment of certification procedures.

NOTE 1 A basic test matrix in Annex B provides an overview of the testing scheme.

It is recommended for the manufacturer to have a management system such as ISO 9001[4] or equivalent.

NOTE 2 If certification is involved, certification bodies and inspection bodies operating according to ISO/IEC 17065 and ISO/IEC 17020 are considered to be competent.

In conjunction with the other parts of the ISO 16486 series (see Clause 2), this document is applicable to unplasticized polyamide (PA-U) piping systems intended to be buried and used for the supply of gaseous fuels. It is applicable to PA-U pipes, fittings and valves, as well as to their joints and to joints with components of other materials intended to be used under the following conditions:

a) a maximum operating pressure (MOP) up to and including 18 bar[1)] (the MOP is limited to 16 bar for CEN member countries, where ISO 16486-6 is replaced by CEN/TS 12007-6[1]);

b) an operating temperature of 20 °C as the reference temperature.

NOTE 3 For operating temperatures different to 20 °C, derating coefficients can be used (see ISO 16486-6). CEN member countries use CEN/TS 12007-6[1] and ISO/TS 16486-7 (this document) as a basis, but they can also request additional requirements. For non-CEN member countries, information for dealing with special cases for PA-U can be found in ISO/TS 16486-7 (this document) and PPI TR-3.[7]

For mechanical fittings conforming to ISO 17885, guidance for assessment of conformity is not given in this document. When requested, a quality plan based on the tests mentioned can be set up in agreement between user and manufacturer.

The ISO 16486 series covers a range of maximum operating pressures and gives requirements concerning colours.

NOTE 4 It is the responsibility of the purchaser or specifier to make the appropriate selections from these aspects, taking into account their particular requirements and any relevant national regulations and installation practices or codes.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

1) 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.

ISO 12162, *Thermoplastics materials for pipes and fittings for pressure applications — Classification, designation and design coefficient*

ISO 13477, *Thermoplastics pipes for the conveyance of fluids — Determination of resistance to rapid crack propagation (RCP) — Small-scale steady-state test (S4 test)*

ISO 16486-1:2020, *Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing — Part 1: General*

ISO 16486-2:2020, *Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing — Part 2: Pipes*

ISO 16486-3:2020, *Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing — Part 3: Fittings*

ISO 16486-4:2022, *Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing — Part 4: Valves*

ISO 16486-5:2021, *Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing — Part 5: Fitness for purpose of the system*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16486-1, ISO 16486-2, ISO 16486-3, ISO 16486-4 and ISO 16486-5 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
certification body
third-party conformity assessment body operating certification schemes

Note 1 to entry: A certification body can be non-governmental or governmental (with or without regulatory authority).

3.2
laboratory
body that performs one or more of the following activities:

— testing;

— calibration;

— sampling, associated with subsequent testing or calibration

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

3.3
quality management system
part of a management system with regard to quality

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

[SOURCE: ISO 9000:2015, 3.5.4, modified — Note 1 to entry added.]

3.4
quality plan
document setting out the specific quality practices, responsibilities, resources and sequence of activities relevant to a particular product or range of products

3.5
type testing
TT
test performed to prove that the material, component, product, joint or assembly is capable of conforming to the requirement(s) given in the relevant standard

3.6
batch release test
BRT
test performed on a batch of material, components, products, joints or assemblies which has to be satisfactorily completed before the batch can be released

Note 1 to entry: A batch release test can be performed by the manufacturer or outsourced on behalf of the manufacturer.

3.7
process verification test
PVT
test performed on material, component, product, joint or assembly at specific intervals to confirm that the process continues to be capable of producing components, products which conform to the requirements given in the relevant standard

Note 1 to entry: Process verification tests can be performed by the manufacturer or outsourced on behalf of the manufacturer.

Note 2 to entry: Process verification tests are regularly performed to demonstrate that the product remains compliant with the type test results.

Note 3 to entry: ISO/AWI 8149:—[2)] presents the stress rupture curves for PA-U and PPI TR-4[9] lists the long-term hydrostatic strength at different temperatures for a number of different PA-U piping materials.

3.8
audit test
AT
test performed on behalf of a certification body

Note 1 to entry: Audit tests are generally required to confirm that the compound, components, product, joint or assembly continues to conform to the requirements given in the relevant standard and to provide information to assess the effectiveness of the quality management system.

3.9
indirect test
IT
batch release test performed which differs from that specified test for that particular characteristic, having previously verified its correlation with the specified test

Note 1 to entry: Indirect tests can be performed by the manufacturer or outsourced on behalf of the manufacturer.

3.10
witness test
WT
type test or audit test which is performed in the presence of a representative of the certification body

2) Under preparation. Stage and the time of publication: ISO/AWI 8149:2023.

3.11
material
generic term for compounds grouped by families, expressed by generic names

Note 1 to entry: Examples of generic names are PA-U 11, PA-U 12.

3.12
compound
homogenous mixture of substances used for the manufacture of the product as defined in the referring product standard

Note 1 to entry: Annex A gives testing requirements for changes made to the compound.

3.13
material batch
batch of material
quantity of a given homogeneous compound manufactured under uniform conditions defined and identified by the compound manufacturer

3.14
product
item as defined in the scope of this document, e.g. pipe, fitting, valve

3.15
product batch
batch of products
clearly identified collection of products, manufactured consecutively or continuously under the same conditions, using the same compound conforming to the same specification

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

3.16
lot
clearly identifiable sub-division of a batch for inspection purposes

3.17
sample
one or more units or products drawn from the same production batch or a lot, selected at random without regard to their quality

3.18
group
collection of similar components or products from which samples are selected for testing purposes

3.19
component
item manufactured out of a specific compound, supplied as part of a product or as a spare part for that product

Note 1 to entry: Depending on the context, components can potentially be considered as products and be individually approved (e.g. o-ring, gasket) or they are tested as an integral part of a finished product (e.g. in a valve).

3.20
joint
connection between two or more products

3.21
assembly
set of components that forms a product or a test piece

3.22
product type
generic description of a product

EXAMPLE A pipe or fitting or valve or their main parts, of the same design, from a particular compound.

3.23
body type
<valve> generic description of a valve body

Note 1 to entry: A valve body is of a particular design which can have different end connections.

3.24
cavity
space within a mould to be filled to form the moulded product

EXAMPLE That part of an injection mould which gives the form to the injection-moulded product.

4 Abbreviated terms

To avoid misunderstanding, the abbreviated terms listed in this Clause are defined as being equivalent in each language. For the same reason, the terms are given in the languages, English, French, Russian and German; see Table 1.

Table 1 — Abbreviated terms in English, French, Russian and German

Term	EN	FR	RU	DE
AT	audit test	essai d'audit	Инспекционные испытания	Überwachungsprüfung
BRT	batch release test	essai de libération de campagne de fabrication	Приемо-сдаточные испытания	Freigabeprüfung einer Charge
PVT	process verification test	essai de vérification du procédé de fabrication	Периодические испытания	Prozessüberprüfung
TT	type test	essai de type	Типовые испытания	Typprüfung

5 General

Materials, products and fitness for purpose shall conform to the requirements given in ISO 16486-1, ISO 16486-2, ISO 16486-3, ISO 16486-4 and ISO 16486-5.

Materials and products shall be produced by the manufacturer under a quality management system which includes a quality plan.

6 Testing and inspection

6.1 Grouping

6.1.1 General

For the purpose of this document, the groups specified in 6.1.2 to 6.1.4 apply.

6.1.2 Size groups

Three size groups are defined for pipes and fittings, as given in Table 2.

For testing purposes, one individual nominal diameter, d_n, shall be selected from each group.

Table 2 — Size groups

Size group	Nominal diameter d_n mm
1	$16 \leq d_n \leq 63$
2	$63 < d_n \leq 225$
3	$225 < d_n \leq 630$

6.1.3 Fitting groups

Three groups of fittings each having a similar design are defined, as given in Table 3.

For testing purposes, one individual fitting shall be selected from each group.

Table 3 — Fitting groups

Fitting groups	
(A)	Electrofusion socket fitting
(B)	Electrofusion saddle fitting
(C)	Spigot end fitting

6.1.4 Fitting types

Fitting groups are divided into fitting types.

Fitting group (A) includes the following fitting types: electrofusion couplers, electrofusion 45° elbows, electrofusion 90° elbows, electrofusion tees, electrofusion reducers, electrofusion end caps, etc.

Fitting group (B) includes the following fitting types: electrofusion tapping saddles, electrofusion branch saddles, etc.

Fitting group (C) includes the following fitting types: 45° elbows, 90° elbows, tees, reducers, end caps, etc.

6.2 Type testing

Type testing is intended to demonstrate the ability of the product to fulfil the intended use and characteristics detailed in the referring product standard.

Type testing shall be performed as described in Tables 4, 5, 6 and 7 whenever there is:

a) a new system (N);

b) a change in design (D);

c) a change in material (M);

d) an extension of the product range (E).

It can be necessary to revalidate type testing in the case of process verification test deviation (see 6.4).

When a change of production site occurs, the manufacturer shall determine which type tests need to be revalidated.

Unless any of the conditions described in points a) to d) occurs, the type test results remain valid.

A type test may be performed by the manufacturer or outsourced on behalf of the manufacturer.

NOTE It is recommended that the location of the test be made available if certification is involved.

Type tests shall demonstrate that the products conform to all requirements for the characteristics given in Tables 4 to 7, as applicable.

In case of a change in compound as defined in Clause A.2, relevant type testing requirements as defined in Clause A.3, and in Tables 4 to 7 as applicable, shall apply.

For the purposes of a change:

a) dimensions and geometry (see column D1 of Tables 6 and 7), are defined as: change of visual and functional optimizations, change of overall dimensions, change of a non-PA part;

b) jointing system joint affected part (see column D2 of Tables 6 and 7), is defined as: change of the dimensions of the fusion zone (e.g. wire pitch, wire depth), the electrical characteristics (e.g. wire, resistance), the fusion parameters (e.g. time, voltage).

For the extension of the production range, the relevant characteristics given in Table 6 and Table 7, column E, as applicable, shall be retested. If certification is involved, retesting shall be agreed between the certification body and the manufacturer.

Table 4 — Characteristics of compounds that require type testing (TT) by the compound manufacturer

Characteristic	Reference	Sampling procedure
Compound density	ISO 16486-1:2020, 5.2.5	Once/compound
Viscosity number	ISO 16486-1:2020, 5.2.5	Once/compound
Water content	ISO 16486-1:2020, 5.2.5	Once/compound
Carbon black content [a]	ISO 16486-1:2020, 5.2.5	Once/compound
Carbon black dispersion [a]	ISO 16486-1:2020, 5.2.5	Once/compound
Pigment dispersion [b]	ISO 16486-1:2020, 5.2.5	Once/compound
Chemical resistance (or resistance to gas condensate)	ISO 16486-1:2020, 5.2.5	Once/compound
Resistance to weathering	ISO 16486-1:2020, 5.2.5	Once/compound [c]
Resistance to rapid crack propagation (Critical pressure, p_c) ($e \geq 5$ mm) (Full-scale test)	ISO 16486-1:2020, 5.2.5	Once/compound [d] according to ISO 13478 (withdrawn) [e]
Resistance to rapid crack propagation (critical pressure, $p_{c,S4}$) (S4 test)	ISO 16486-1:2020, 5.2.5	Once/compound [f,g] according to ISO 13477
Resistance to slow crack growth (d_n: 110 mm SDR 11)	ISO 16486-1:2020, 5.2.5	Once/compound

Table 4 *(continued)*

Characteristic	Reference	Sampling procedure
Determination of the failure mode in a tensile test on a butt fusion weld (d_n: 110 mm SDR 11)	ISO 16486-1:2020, 5.3, ISO 16486-5:2021, 5.2.1.1 and Table 5	Once/compound
	ISO 16486-1:2020, 5.3, ISO 16486-5:2020, 5.2.1.2 and Table 5	Once/compound
Classification	ISO 16486-1:2020, 5.4	Shall conform to ISO 12162, Once/compound

[a] Only applicable for black compound.

[b] Only applicable for non-black compound.

[c] Three pieces for elongation at break/Three pieces for hydrostatic strength/One sample for decohesion of an electrofusion joint.

[d] And for every pipe dimension with d_n > 90 mm.

[e] Cooling for crack initiation according to ISO 16486-1:2020, 5.2.5.

[f] Relation between pipe sample for FS- and S4-test according to ISO 16486-1:2020, 5.2.5

[g] Reference value definition according to ISO 16486-1:2020, 5.2.5 with link for use as defined in ISO 16486-2.

Table 5 — Characteristics of pipes that require type testing (TT)

Characteristic	Reference	Conditions requiring test [a]			Sampling procedure	
		N	M[b]	E	Manufacturer [c]	Certification body [c,d]
Appearance	ISO 16486-2:2020, 5.1	+	+	+	Each diameter	One diameter/size group
Colour	ISO 16486-2:2020, 5.2	+	+	+	Each diameter	One diameter/size group
Geometrical characteristics	ISO 16486-2:2020, Clause 6	+	+	+	Each diameter	One diameter/size group
Hydrostatic strength (20 °C, 1 000 h)	ISO 16486-2:2020, 7.2	+	+[e]	+	One diameter/size group	One diameter/size group
Hydrostatic strength (80 °C, 165 h)	ISO 16486-2:2020, 7.2	+	+[e]	+	One diameter/size group	One diameter/size group
Elongation at break	ISO 16486-2:2020, 7.2	+	+ [e]	+	One diameter/size group	One diameter/size group
Resistance to slow crack growth e > 5 mm (notch test)	ISO 16486-2:2020, 7.2	+	+ [e]	+	One diameter/size group	One diameter/size group
Resistance to rapid crack propagation (critical pressure, p_c)	ISO 16486-2:2020, 7.2	+	+	+	Number of samples shall conform to ISO 13477 of one diameter	Number of samples shall conform to ISO 13477 of one diameter
Melt volume flow rate (MVR)	ISO 16486-2:2020, 8.2	+[f]	-	-	One diameter/size group	Not applicable
Viscosity number	ISO 16486-2:2020, 8.2	+	+	-	One diameter/size group	One diameter/size group
Longitudinal reversion [g]	ISO 16486-2:2020, 8.2	+	+	+	One diameter/size group	One diameter/size group

Table 5 *(continued)*

Characteristic	Reference	Conditions requiring test [a]			Sampling procedure	
		N	M[b]	E	Manufacturer [c]	Certification body [c,d]
Marking	ISO 16486-2:2020, Clause 9	+	+	-	Each diameter	By checking the test result of the manufacturer
Resistance to weathering	ISO 16486-1:2020, 5.2.5	Tested on the compound in the form of pipe by the compound supplier				
Tensile strength for butt fusion	ISO 16486-5:2020, 5.2.1.1	+	+	-	One diameter/size group 2	By checking the test results of the manufacturer
Tensile strength for butt fusion	ISO 16486-5:2020, 5.2.1.1	+	+	-	One diameter/size group 2	By checking the test results of the manufacturer
Squeeze off	ISO 16486-2:2020, Annex A	+	+	-	One diameter [e,h]	By checking the test results of the manufacturer

[a] N : new system;
M : change of compound;
E : extension of the product range (except the products already covered by the scheme of sampling procedure);
\+ : test to be carried out;
\- : test not to be carried out.

[b] Annex A gives testing requirements for changes made to the compound.

[c] Successful testing will validate pipe with the same d_n and a higher SDR, i.e. thinner wall thickness. Where a manufacturer extends their production beyond their approval, additional relevant type testing shall be carried out.

[d] Recommended sampling procedure for a testing laboratory working on behalf of a certification body. Testing undertaken in manufacturer's laboratory can be taken into account, by prior agreement with the certification body.

[e] Sampling procedure of only one diameter per size group.

[f] Reference for BRT and PVT at the manufacturer.

[g] Longitudinal reversion is applicable to wall thickness ≤ 16 mm.

[h] To be performed preferably on d_n 63 SDR 11.

Table 6 — Characteristics of fittings that require type testing (TT)

Characteristic [c]	Reference	Conditions requiring test [a]					Sampling procedure	
		N	D1	D2	M	E	Manufacturer	Certification body [b]
Appearance	ISO 16486-3:2020, 5.1	+	–	–	+	+	5 fittings/size/ fitting type [f]	5 fitting of one diameter/size group/fitting type
Colour	ISO 16486-3:2020, 5.3	+	–	–	+	+	5 fittings/size/ fitting type [f]	5 fitting of one diameter/size group/fitting type
Electrical characteristics (A) (B)	ISO 16486-3:2020, 5.4	+	–	+	-	+	5 fittings/size/ fitting type [f]	5 fitting of one diameter/size group/fitting type
Geometrical characteristics	ISO 16486-3:2020, Clause 6	+	+	+	+	+	5 fittings/size/ fitting type [f]	5 fitting of one diameter/size group/fitting type
Hydrostatic strength (20 °C, 1 000 h)	ISO 16486-3:2020, 7.3	+	–	–	+ [e]	+	3 fittings/size/ fitting type [f,h,i,j]	3 fitting of one diameter/size group/fitting type [i,j,k]
Hydrostatic strength (80 °C, 165 h) (A,B,C[g])	ISO 16486-3:2020, 7.3	+	–	+	+	–	3 fittings/size/ fitting type [f,h,i,j]	3 fittings of one diameter/size group/fitting type [i,j,k]
	ISO 16486-5:2021, 5.2	+	–	+	+	+	1 fitting/size group/ fitting type[i,j]	By checking the test results of the manufacturer
Cohesive resistance for electrofusion socket fittings (A)	ISO 16486-3:2020, 7.3 ISO 16486-5:2021, 5.2.2.1	+	–	+	+ [e]	+	1 fitting/size/fitting type/condition [f]	1 fitting of one diameter/size group/fitting type/condition
	ISO 16486-5:2021,5.2.2.2	+	–	+	+ [e]	+	1 fitting/size/fitting type/condition [f]	1 fitting of one diameter/size group/fitting type/condition
Evaluation of ductility of fusion joint interface for electrofusion saddle fittings (B)	ISO 16486-3:2020, 7.3 ISO 16486-5:2021, 5.2.2.1	+	–	+	+ [e]	+	1 fitting/size/fitting type/condition [f,k]	1 fitting of one diameter/size group/fitting type/condition [k]
	ISO 16486-5:2021, 5.2.2.2	+	–	+	+ [e]	+	1 fitting/size/fitting type/condition [f,k]	1 fitting of one diameter/size group/fitting type/condition [k]
Tensile strength for butt fusion joints [g] (C)	ISO 16486-3:2020, 7.3 ISO 16486-5:2021, 4.2.1.1	+	–	–	+	+	1 fitting/size group/ fitting group/condition	By checking the test results of the manufacturer
	ISO 16486-5:2021, 5.2.1.2	+	–	–	–	–	1 fitting/size group/ fitting group/condition	By checking the test results of the manufacturer
Impact resistance (B)	ISO 16486-3:2020, 7.3	+	–	+	+ [e]	+	1 fitting/size/fitting type	1 fitting/size group/fitting type
Pressure drop (B)	ISO 16486-3:2020, 7.3	+	+	–	–	+	1 fitting/size/fitting type	By checking the test results of the manufacturer
Short-term internal pressure resistance (A) [d]	ISO 16486-3:2020, 7.3	+	–	+	+ [e]	+	3 fittings/size/ fitting type [f,k]	3 fittings of one diameter/size group/fitting type [k]
Resistance to tensile load (A) [d]	ISO 16486-3:2020, 7.3	+	–	+	+ [e]	+	3 fittings/size/ fitting type [f,k]	3 fittings of one diameter/size group/fitting type [k]
Melt volume flow rate (MVR)	ISO 16486-3:2020, 8.2	+[l]	-	-	+	-	1 fitting of one diameter/size group	Not applicable
Viscosity number	ISO 16486-3:2020, 8.2	+	-	-	+	-	1 fitting of one diameter/size group	1 fitting of one diameter/size group

Table 6 *(continued)*

Characteristic [c]	Reference	Conditions requiring test [a]					Sampling procedure	
		N	D1	D2	M	E	Manufacturer	Certification body [b]
Marking	ISO 16486-3:2020, 11.1 to 11.3	+	–	–	+	+	5 fittings/size/ fitting type [f]	5 fittings of one diameter/size group/fitting type
Fusion system recognition (A) (B)	ISO 16486-3:2020, 11.4	+	–	+	-	+	5 fittings/size/ fitting type	–

[a] N : new system;

D1 : change of dimensions and geometry as: change of visual and functional optimisation, change of overall dimensions, change of a non-PA-U part;

D2 : change of joint affected part as: change of the dimension of the fusion zone (e.g. wire pitch, wire depth), the electrical characteristics (e.g. wire, resistance), the fusion parameters (e.g. time, voltage);

M : change of compound of the same MRS. In case of change of the MRS, type tests according column (N) shall apply;

E : extension of the fitting range;

+ : test to be carried out;

- : test not to be carried out.

[b] Recommended sampling procedure for a testing laboratory working on behalf of a certification body. Testing undertaken in manufacturer's laboratory can be taken into account, by prior agreement with the certification body.

[c] The characteristic is relevant for (A), (B) and (C), if (A), (B) and/or (C) are not mentioned:

(A): Electrofusion socket fitting;

(B): Electrofusion saddle fitting;

(C): Spigot end fitting.

[d] Only applicable if ISO 16486-3:2020, 6.2.2 c) applies.

[e] Manufacturer sampling procedure changed from "size/fitting type" to "2 dimensions/size group/fitting type".

[f] Shall contain fittings from each cavity. The minimum number of samples shall be at least one from each cavity.

[g] Only applicable to size group 2 and 3.

[h] One test piece for size group 3.

[i] Alternatively for d_n > 450 mm, the test can be performed water-in-air. In case of dispute, water-in-water shall be used.

[j] For fitting type (B), d_n > 450 mm alternative testing (e.g. pressurization through saddle outlet) allowed.

[k] Alternatively for fitting type (B) d_n > 450 mm may be checked by the strip bend test according to ISO 21751.

[l] Reference for BRT and PVT at the manufacturer.

Table 7 — Characteristics of valves that require type testing (TT)

Characteristic	Reference	Conditions requiring test [a]					Sampling procedure	
		N	D1	D2	M	E	Manufacturer	Certification body [b]
Appearance	ISO 16486-4:2022, 6.1	+	+ ½/6	–	+ ½/6	+	5 valves/size/product type [c]	5 valves of one diameter/size group/product type
Colour	ISO 16486-4:2022, 6.2	+	+ ½	–	+ ½	+	5 valves/size/product type [c]	5 valves of one diameter/size group/product type
Geometrical characteristics	ISO 16486-4:2022, Clause 7	+	+ 2/6	+ 2/6	+ 2/6	+	5 valves/size/product type [c]	5 valves of one diameter/size group/product type
Hydrostatic strength (20 °C, 1 000 h)	ISO 16486-4:2022, 8.3	+	–	+ ½	+ ½	+	3 valves/size/pro duct type [c]	3 valves of one diameter/size group/product type
Hydrostatic strength (80 °C, 165 h)	ISO 16486-4:2022, 8.3	+	–	+ ½/4	+ ½/4	+	3 valves/size/product type [c]	3 valves of one diameter/size group/product type
Leaktightness of seat and packing (25 mbar, 1 h)	ISO 16486-4:2022, 8.3	+	–	+	+	+	1 valve/body type	1 valve/body type
Leaktightness of seat and packing (1,5 MOP, 30 s)	ISO 16486-4:2022, 8.3	+	-	+	+	+	1 valve/body type	1 valve/body type
Pressure drop	ISO 16486-4:2022, 8.3	+	–	+ ½/3/4	–	+	1 valve/size/product type	1 valve/size/product type
Operating torque	ISO 16486-4:2022, 8.3	+	–	+	+	+	1 valve/body type	1 valve/ body type
Stop resistance	ISO 16486-4:2022, 8.3	+	–	+ 1/3/5/6	+ 1/3/5/6	+	1 valve/body type	1 valve/body type
Actuation mechanism resistance	ISO 16486-4:2022, 8.3	+	–	+ 3/5/6	+ 3/5/6	–	1 valve/body type	1 valve/body type
Resistance to bending between supports	ISO 16486-4:2022, 8.3	+	–	+ ½/3/4	+ ½/3/4	+	1 valve/size/product type [c]	1 valve/size/product type
Thermal cycling resistance d_n > 63 mm	ISO 16486-4:2022, 8.3	+	–	+	+	+	1 valve/body type	1 valve/body type
Leaktightness under bending with thermal cycling, $d_n \leq 63$ mm	ISO 16486-4:2022, 8.3	+	–	+	+	+	1 valve/body type	1 valve/body type
Leaktightness after tensile loading [h]	ISO 16486-4:2022, 8.3	+	–	+ ½/3/4	+ ½/3/4	+	1 valve/body type	1 valve/body type
Leaktightness under and after bending applied to the operating mechanism	ISO 16486-4:2022, 8.3	+	–	+	+	+	1 valve/body type	1 valve/body type
Impact loading resistance	ISO 16486-4:2022, 8.3	+	–	+ 1/3/5/6	+ 1/3/5/6	–	1 valve/body type	1 valve/body type
Multiple test after the internal pressure test [e,f] 1) Long term resistance 2) Leaktightness of seat and packing 25 mbar 3) Leaktightness of seat and packing 1,5 MOP 4) Operating torque 5) Impact loading resistance	ISO 16486-4:2022, 8.3	+	–	+	+	+	1 valve/body type/size group	1 valve/body type/size group
Melt volume flow rate (MVR)	ISO 16486-4:2022, 9.2	+ [g]	-	-	+	+	1 valve of one diameter/size group	Not applicable

Table 7 *(continued)*

Characteristic	Reference	Conditions requiring test [a]					Sampling procedure	
		N	D1	D2	M	E	Manufacturer	Certification body [b]
Viscosity number	ISO 16486-4:2022, 9.2	+	-	-	+	+	1 valve of one diameter/size group	1 valve of one diameter/size group
Marking	ISO 16486-4:2022,12	+	+ ½	+ ½	–	+	1 valve/size/product type	1 valve/size/product type
Tensile strength for butt fusion [d]	ISO 16486-5:2021, 5.2.1.1	+	–	+ 2	+ 2	+	1 valve/size group/ product type	By checking the test results of the manufacturer
Tensile strength for butt fusion [d]	ISO 16486-5:2021-5.2.1.2	+	–	+ 2	+ 2	+	1 valve/size group/ product type	By checking the test results of the manufacturer
Hydrostatic strength (80 °C, 165 h) [d]	ISO 16486-5:2021-5.2.1.2	+	–	+ 2	+ 2	–	1 valve/size group/ product type [c]	By checking the test results of the manufacturer

[a] N : new system;
D1 : change in design with no effect on valve performance;
D2 : change in design with effect on valve performance;
M : change of compound of the same MRS. In case of change of the MRS, type tests according column (N) shall apply;
E : extension of the valve range;
+ : test to be carried out;
- : test not to be carried out.
The code numbers following the + indicate which modified component of the valve initiates testing:
Code 1 : body
Code 2 : outlets
Code 3 : obturator
Code 4 : sealing element
Code 5 : spindle/drive
Code 6 : actuator

[b] Recommended sampling procedure for a testing laboratory working on behalf of a certification body. Testing undertaken in a manufacturer laboratory can be taken into account, by prior acceptance by the certification body.

[c] Valves shall contain components from each PA-U cavity. The minimum number of samples shall be at least one from each cavity.

[d] Only applicable for valves with a spigot end of size groups 2 and 3.

[e] If agreed between the manufacturer and the end-user an additional test can be carried out to check the initiating torque after a specified time in a closed position under pressure.

[f] The multiple tests shall be carried out at least 24 h after completion of the pressure test, if not otherwise specified by the manufacturer.

[g] Reference for BRT and PVT at the manufacturer.

[h] For CEN, the additional regional requirement according to ISO 16486-4:2022, Table 1, footnote j, with link to its subclause 8.4 is required.

6.3 Batch release testing

Batch release testing is intended to demonstrate via short-term testing the ability of the products to be placed on the market, assuming that the PVT has proven the stability of the process.

Those characteristics specified in ISO 16486-1 to ISO 16486-5 and listed in Tables 8 to 11 shall be subject to BRTs with the minimum sampling frequency as given in Tables 8 to 11, as applicable.

A batch release test may be performed by the manufacturer or outsourced on behalf of the manufacturer.

NOTE If certification is involved, the certification body can request the location of the test.

The manufacturer shall specify a batch in a quality plan.

A batch shall only be released for supply when all the relevant tests and inspections have been carried out at the specified frequencies and the requirements have been met.

If a product fails in respect of any characteristic given in Tables 8 to 11, as applicable, the batch shall be rejected or the retest procedures shall be performed for the characteristic on which the product failed.

The retest procedure shall be as follows:

— Find the last and the first product which conforms to the requirements as specified in Tables 8 to 11.

— Release all products produced before and after these points and reject the products produced between these points.

Procedures for dealing with rejected products shall be detailed in the manufacturer's quality plan.

Table 8 — Characteristics of compounds and minimum sampling frequencies for BRTs by the compound manufacturer

Characteristic	Reference	Minimum sampling frequency [a]
Compound density	ISO 16486-1:2020, 5.2.5	1 test piece/batch/but at least every 7 days
Viscosity number [b]	ISO 16486-1:2020, 5.2.5	1 test piece/batch/but at least every 7 days
Water content [c]	ISO 16486-1:2020, 5.2.5	1 test piece/batch/but at least every 7 days
Carbon black content [d]	ISO 16486-1:2020, 5.2.5	1 test piece/batch/but at least every 7 days
Carbon black dispersion [d]	ISO 16486-1:2020, 5.2.5	1 test piece/batch/but at least every 7 days
Pigment dispersion [e]	ISO 16486-1:2020, 5.2.5	1 test piece/ batch/but at least every 7 days

[a] The number of samples given in the table is the minimum. All samples shall pass the relevant test(s).

[b] Reference for BRT and PVT at the manufacturer.

[c] Only applicable if the requirement for volatile content is not conformed to. In case of dispute the requirement for water content shall apply.

[d] Only applicable for black compound.

[e] Only applicable for non-black compound.

Table 9 — Characteristics of pipes, and minimum sampling frequencies for BRTs by the pipe manufacturer

Characteristic	Reference	Minimum sampling frequency [a]
Appearance	ISO 16486-2:2020, 5.1	At start up and at least every 8 h
Colour	ISO 16486-2:2020, 5.2	At start up and at least every 8 h
Geometrical characteristics	ISO 16486-2:2020, Clause 6	At start up and continuously [b] or at least every 8 h
Hydrostatic strength (80 °C, 165 h)	ISO 16486-2:2020, 7.2	1 test piece/batch/7 days (size groups 1 and 2), 1 test piece/batch (size group 3)
Melt volume flow rate (MVR) [c,d,e]	ISO 16486-2:2020, 8.2	Once/batch, but at least every 10 days
Marking	ISO 16486-2:2020, Clause 9	At start up and every 8 h

[a] Batch refers to pipe batch but an alternative approach could be considered based on compound batch if agreed by the certification body.

[b] By indirect testing.

[c] Reference from TT for BRT and PVT at the manufacturer.

[d] It is essential that the water content of the sample be < 0,1 %. This is essential because PA-U resin is sensitive to hydrolysis. Therefore, the test sample shall be dried prior to testing at 80 ˚C in a dry air or vacuum dryer for 3 h, or as recommended by the PA-U resin producer. The MVR report shall include the water content of the sample prior to testing, along with the methodology used for its determination.

[e] The MVR can be measured by the pipe manufacturer for internal quality control (QC), as an alternative for the viscosity number, e.g. to test deviations prior to and after working with the material. In practice, the MVR is extremely sensitive to any influence of water content, even if the water content is extremely low (see ISO 1133-2:2012, Table B.1, example for PA 6). For PA-U, it is recommended to compare only MVR results from one test device.

Table 10 — Characteristics of fittings and minimum sampling frequencies for BRTs by the fitting manufacturer

Characteristic [a]	Reference	Minimum sampling frequency
Appearance	ISO 16486-3:2020, 5.1	Once/cavity at start-up, then once per shift, but at least every 8 h [c]
Colour	ISO 16486-3:2020, 5.3	Once/cavity at start-up, then once per shift, but at least every 8 h [c]
Electrical characteristics (A) (B)	ISO 16486-3:2020, 5.4	Once/cavity at start-up, then: a) once per shift (quantitative), but at least every 8 h [c] b) each fitting during production [d]
Geometrical characteristics	ISO 16486-3:2020, Clause 6	Once/cavity at start-up, then once per shift, but at least every 8 h [c]
Hydrostatic strength (80 °C, 165 h) [g,h]	ISO 16486-3:2020, 7.3	1 test piece/batch/cavity, but at least every 10 days [f]
Evaluation of ductility of fusion joint interface (B) [b,i]	ISO 16486-3:2020, 7.3	1 test piece/batch/cavity, but at least every 10 days [f]

Table 10 *(continued)*

Characteristic [a]	Reference	Minimum sampling frequency
Melt volume flow rate (MVR) [j,k,l]	ISO 16486-3:2020, 8.2	Once/batch, but at least every 10 days
Marking	ISO 16486-3:2020, 11.1 – 11.3	Once/cavity at start-up, then once per shift, but at least every 8 h [c]
Fusion system recognition (A) (B)	ISO 16486-3:2020, 11.4	Once/batch, but at least every 10 days [c,e,f]

[a] (A): Electrofusion socket fitting;
(B): Electrofusion saddle fitting.

[b] Only to be performed if requested by the end-user.

[c] For multiple cavity moulds, a rotating sampling procedure between the cavities for testing during the shifts shall be considered. The manufacturer shall give details in their quality plan accordingly.

[d] May be checked on a qualitative basis (pass – do not pass).

[e] To be checked when welding the hydrostatic strength test sample.

[f] For fittings in size group 3, test to be performed either every 10 days or alternatively every 1 000 fittings.

[g] Alternatively, for d_n > 450 mm, the test can also be performed in water-in-air. In case of dispute, water-in-water shall be used.

[h] For fitting type (B), d_n > 450 mm alternative testing (e.g. pressurization through saddle outlet) allowed.

[i] Alternatively for fitting type (B) d_n > 450 mm may be checked by the strip-bend test according to ISO 21751.

[j] Reference from TT for BRT and PVT at the manufacturer.

[k] It is essential that the water content of the sample be < 0,1 %. This is essential because PA-U resin is sensitive to hydrolysis. Therefore, the test sample shall be dried prior to testing at 80 °C in a dry air or vacuum dryer for 3 h, or as recommended by the PA-U resin producer. The MVR report shall include the water content of the sample prior testing, along with the methodology used for its determination.

[l] The MVR can be measured by the fitting manufacturer for internal QC, as an alternative for the viscosity number, e.g. to test deviations prior to and after working with the material. In practice, the MVR is extremely sensitive to any influence of water content, even if the water content is extremely low (see ISO 1133-2:2012, Table B.1, example for PA 6). For PA-U, it is recommended to compare only MVR results from one test device.

Table 11 — Characteristics of valves and minimum sampling frequencies for BRTs by the valve manufacturer

Characteristic	Reference	Minimum sampling frequency
Appearance	ISO 16486-4:2022, 6.1	Once at start-up, then 1 test piece per shift, but at least every 8 h
Colour	ISO 16486-4:2022, 6.2	Once at start-up, then 1 test piece per shift, but at least every 8 h
Geometrical Characteristics	ISO 16486-4:2022, Clause 7	Once at start-up, then 1 test piece per shift, but at least every 8 h
Hydrostatic Strength (80 ºC-165 h)	ISO 16486-4:2022, 8.3	1 test piece/batch, but at least every 10 days
Operating Torque	ISO 16486-4:2022, 8.3	Every valve
Leaktightness of seat packing at 1,5 MOP (see safety precautions) [a]	ISO 16486-4:2022, 8.3	Every valve

Table 11 *(continued)*

Characteristic	Reference	Minimum sampling frequency
Melt volume flow rate (MVR) [b,c,d]	ISO 16486-3:2020, 8.2	Once/batch, but at least every 10 days
Leaktightness of seat packing at 25 mbar	ISO 16486-4:2022, 8.3	Once/batch, but at least every 10 days
Marking	ISO 16486-4:2022, Clause 12	Once at start-up, then once per shift, but at least every 8 h

[a] SAFETY PRECAUTIONS — Safety precautions need to be taken when testing with air or nitrogen up to 1,5 MOP.

For testing with air or nitrogen a pressure of a maximum of 6 bar should be used. For MOP > 4 bar, testing with water should be considered, and the test conditions shall be agreed between the manufacturer and end user.

[b] Reference from TT for BRT and PVT at the manufacturer.

[c] It is essential that the water content of the sample be < 0,1 %. This is essential because PA-U resin is sensitive to hydrolysis. Therefore, the test sample shall be dried prior to testing at 80 °C in a dry air or vacuum dryer for 3 h, or as recommended by the PA-U resin producer. The MVR report shall include the water content of the sample prior testing, along with the methodology used for its determination.

[d] The MVR can be measured by the pipe manufacturer for internal QC, as an alternative for the viscosity number, e.g. to test deviations prior to and after working with the material. In practice, the MVR is extremely sensitive to any influence of water content, even if the water content is extremely low (see ISO 1133-2:2012, Table B.1, example for PA 6). For PA-U, it is recommended to compare only MVR results from one test device.

Preferably, testing shall be performed using the test methods referred to in ISO 16486-1 to ISO 16486-5.

Indirect testing may only be used for assessing batch release test characteristics under the following conditions.

— The indirect test method used and the correlation of the indirect testing with the specified testing shall be documented in the manufacturer's quality plan.

— The continuing validity of the indirect testing shall be checked at regular intervals.

In cases of dispute, the batch release tests as specified in the product standard, ISO 16486-1 to ISO 16486-5, as applicable, shall be used.

If certification is involved, the use of indirect testing shall be agreed between manufacturer and certification body.

6.4 Process verification tests

Process verification testing is intended to demonstrate the ability of the process to deliver products complying with type test requirements.

Those characteristics specified in ISO 16486-1 to ISO 16486-4 and listed in Tables 12 to 15 shall be subject to process verification tests with the minimum sampling frequency given in Tables 12 to 15, as applicable, if not type tested or audit tested in the same period.

A process verification test may be performed by the manufacturer or outsourced on behalf of the manufacturer.

NOTE If certification is involved, the certification body can request the location of the test.

If the product does not conform to the requirements in respect of any characteristic given in Tables 12 to 15, as applicable, the retest procedure detailed in the manufacturer's quality plan shall be performed.

If the retest procedure does not confirm conformity of the product to the requirements, then the process shall be investigated and corrected in accordance with the procedures given in the manufacturer's

quality plan. In addition, the manufacturer should check that the product complies with all relevant type test characteristics.

NOTE When third-party certification is involved, it is recommended that the certification body be informed when the result of the retest procedure does not conform to the requirements.

A test that has been performed as an audit test does not need to be repeated as a process verification test.

Table 12 — Characteristics and minimum sampling frequencies for PVTs by the compound manufacturer

Characteristic [a]	Reference	Minimum sampling frequency
Classification [b]	ISO 16486-1:2020, 5.4	Once/two years/compound/production site
Resistance to rapid crack propagation (critical pressure, $p_{c,S4}$, $e \geq 5$ mm)	ISO 16486-1:2020, 5.2.5	Once/two years/compound/production site
Resistance to slow crack growth (d_n: 110 mm SDR 11)	ISO 16486-1:2020, 5.2.5	Once/year/compound/production site

[a] Only to be performed if no AT is performed during the same period.

[b] Check according to ISO 8149 two stress levels at 20 °C as follows:

PA-U160 at 20,5 MPa / 100 h, 18,7 MPa / 2 500 h

PA-U 180 at 23,1 MPa / 100 h, 21,0 MPa / 2 500 h

In addition, every 8 years a test at 80 °C for PA-U 160 at 9,3 MPa/ 5 000 h and for PA U 180 at 10,5 MPa/ 5 000 h shall be carried out. Test three test pieces on 1 diameter of size group 1 pipe. The corresponding time shall be exceeded without failure.

Table 13 — Characteristics of pipes and minimum sampling frequencies for PVTs by the pipe manufacturer

Characteristic	Reference	Minimum sampling frequency [a,b]
Hydrostatic strength (20 °C, 1 000 h)	ISO 16486-2:2020, 7.2	One diameter/year/compound designation/size group/production site 3 test pieces of size group 1 or 2, 1 test piece size group 3
Elongation at break	ISO 16486-2:2020, 7.2	One diameter/size group/year/compound designation/production site
Longitudinal reversion [c]	ISO 16486-2:2020, 8.2	One diameter/size group/year/compound designation/production site

[a] Only to be performed if no AT is performed during the same period.

[b] Rotate sizes, SDR and compound, as applicable.

[c] Longitudinal reversion applicable to wall thickness ≤ 16 mm.

Table 14 — Characteristics of fittings and minimum sampling frequencies for PVTs by the fitting manufacturer

Characteristic [a]	Reference	Minimum sampling frequency [b,c]
Hydrostatic strength (20 ºC, 1 000 h) [f,g]	ISO 16486-3:2020, 7.3	1 fitting per cavity of one diameter from one fitting type/fitting group/size group/year/compound/production site
Cohesive resistance for electrofusion socket fittings (A)	ISO 16486-3:2020, 7.3	1 fitting per cavity of one diameter from one fitting type/size group/year/compound/production site
Evaluation of ductility of fusion joint interface for electrofusion saddle fittings (B) [d,h]	ISO 16486-3:2020, 7.3	1 fitting per cavity of one diameter from one fitting type/size group/year/compound/production site
Tensile strength for — butt fusion fittings — spigot end fittings (C)	ISO 16486-3:2020, 7.3	1 fitting per cavity of one diameter from one fitting type/size group 2/year/compound/production site
Impact resistance (B)	ISO 16486-3:2020, 7.3	1 fitting per cavity of one diameter from one fitting type/size group/year/compound/production site
Short-term internal pressure resistance (A) [e]	ISO 16486-3:2020, 6.2.2	1 fitting per cavity of one diameter from one fitting type/size group/year/compound/production site
Resistance to tensile load (A) [e]	ISO 16486-3:2020, 6.2.2	1 fitting per cavity of one diameter from one fitting type/size group/year/compound/production site

[a] (A): Electrofusion socket fitting;
(B): Electrofusion saddle fitting;
(C): Spigot end fitting.

[b] Change of product type, diameter and SDR every year to grant that all fittings are tested over a certain time period. Details shall be given in the manufacturer's quality plan.

[c] Results from audit tests should be regarded as PVTs.

[d] Only to be performed if not tested in the BRT.

[e] Only applicable if ISO 16486-3:2020, 6.2.2 c) applies.

[f] Alternatively, for d_n > 450 mm, the test can also be performed in water-in-air. In case of dispute, water-in-water shall be used.

[g] For fitting type (B), d_n > 450 mm alternative testing (e.g. pressurization through saddle outlet) allowed.

[h] Alternatively for fitting type (B) d_n > 450 mm may be checked by the strip-bend test according to ISO 21751.

Table 15 — Characteristics and minimum sampling frequencies for PVTs by the valve manufacturer

Characteristic	Reference	Minimum sampling frequency [a,b]
Hydrostatic strength (80 ºC, 165 h)	ISO 16486-4:2022, 8.3	1 valve/body type/year/compound/production site
Stop resistance	ISO 16486-4:2022, 8.3	1 valve/body type/year/compound/production site
Actuation mechanism resistance	ISO 16486-4:2022, 8.3	1 valve test piece/body type/year/compound/production site
Resistance to bending between supports	ISO 16486-4:2022, 8.3	1 valve test piece/body type/year/compound/production site

Table 15 *(continued)*

Characteristic	Reference	Minimum sampling frequency [a,b]
Leaktightness under tensile loading	ISO 16486-4:2022, 8.3	1 valve test piece/body type/year/compound/production site
Impact loading resistance	ISO 16486-4:2022, 8.3	1 valve test piece/body type/year/compound/production site
[a] Change of product type, diameter and SDR every year to grant that all valves are tested over a certain time period. Details shall be given in the manufacturer's quality plan.		
[b] Results from audit tests should be regarded as PVTs.		

6.5 Audit tests

Audit tests are only performed if certification is involved.

Those characteristics specified in ISO 16486-1 to ISO 16486-5 and listed in Tables 16 to 19 are intended to be audit tested with the minimum sampling frequency as given in Tables 16 to 19, as applicable.

The sizes, types and classes selected for tests should preferably be primarily those which have not previously been selected for audit testing. Samples should be preferably taken from the largest volume of production per group.

Table 16 — Characteristics and minimum sampling frequencies for ATs for the compound

Characteristic	Reference	Minimum sampling frequency
Classification	ISO 16486-1:2020, 5.4	Once/two years/compound/production site [a]
Resistance to rapid crack propagation (critical pressure, $p_{c,S4}$) ($e \geq 5$ mm)	ISO 16486-1:2020, 5.2.5	Once/year/compound/production site
Resistance to slow crack growth (d_n: 110 mm - SDR 11)	ISO 16486-1:2020, 5.2.5	Once/year/compound/production site
[a] Check according to ISO 8149 two stress levels at 20 °C as follows: PA-U160 at 20,5 MPa / 100 h, 18,7 MPa / 2 500 h PA-U 180 at 23,1 MPa / 100 h, 21,0 MPa / 2 500 h In addition, every 8 years a test at 80 °C for PA-U 160 at 9,3 MPa/ 5 000 h and for PA U 180 at 10,5 MPa/ 5 000 h shall be carried out. Test three test pieces on 1 diameter of size group 1 pipe. The corresponding time shall be exceeded without failure.		

Table 17 — Characteristics and minimum sampling frequencies for ATs for pipes

Characteristic	Reference	Minimum sampling frequency [a]
Appearance	ISO 16486-2:2020, 5.1	One diameter/year/size group/production site
Colour	ISO 16486-2:2020, 5.2	One diameter/year/size group/production site
Geometrical characteristics	ISO 16486-2:2020, Clause 6	One diameter/year/size group/production site
Hydrostatic strength (20 °C, 1 000 h)	ISO 16486-2:2020, 7.2	One diameter/year/one size group/production site 3 test pieces of size group 1 or 2, 1 test piece size group 3

Table 17 *(continued)*

Characteristic	Reference	Minimum sampling frequency [a]
Resistance to slow crack growth e > 5 mm (Notch test)	ISO 16486-2:2020, 7.2	One diameter/year/one size group/production site 3 test pieces of size group 1 or 2, 1 test piece size group 3
Resistance to rapid crack propagation (critical pressure, $p_{c,S4}$)	ISO 16486-2:2020, 7.2	Once/year/production site
Elongation at break	ISO 16486-2:2020, 7.2	One diameter/year/size group/production site
Viscosity number	ISO 16486-2:2020, 8.2	One diameter/year/size group/production site
Longitudinal reversion [b]	ISO 16486-2:2020, 8.2	One diameter/year/size group/production site
Marking	ISO 16486-2:2020, Clause 9	One diameter/year/size group/production site
[a] Rotate sizes and SDR every year. [b] Longitudinal reversion is applicable to wall thickness ≤ 16 mm.		

Table 18 — Characteristics and minimum sampling frequencies for ATs for fittings

Characteristic [a]	Reference	Minimum sampling frequency [b]
Appearance	ISO 16486-3:2020, 5.1	One diameter from one fitting type/fitting group/size group/2 years/compound/production site
Colour	ISO 16486-3:2020, 5.3	One diameter from one fitting type/fitting group/size group/2 years/compound/production site
Electrical characteristics (A) (B)	ISO 16486-3:2020, 5.4	One diameter from one fitting type/fitting group/size group/2 years/compound/production site
Geometrical characteristics	ISO 16486-3:2020, Clause 6	One diameter from one fitting type/fitting group/size group/2 years/compound/production site
Hydrostatic strength (20 ºC, 1 000 h) [d,e]	ISO 16486-3:2020, 7.3	One diameter from one fitting type/fitting group/2 years/compound/production site
Cohesive resistance for electrofusion socket fittings (A)	ISO 16486-3:2020, 7.3	One diameter from one fitting type/2 years/compound/production site
Evaluation of ductility of fusion joint interface for electrofusion saddle fittings (B) [c,f]	ISO 16486-3:2020, 7.3	One diameter from one fitting type/2 years/compound/production site
Tensile strength for — butt fusion fittings — spigot end fittings (C)	ISO 16486-3:2020, 7.3	One diameter from one fitting type of size group 3/2 years/compound/production site
Impact resistance (B)	ISO 16486-3:2020, 7.3	One diameter from one fitting type/2 years/compound/production site
[a] (A): Electrofusion socket fitting;		

Table 18 *(continued)*

Characteristic [a]	Reference	Minimum sampling frequency [b]
(B): Electrofusion saddle fitting; (C): Alternatively Spigot end fitting.		
[b] Change of fitting type, diameter and SDR every visit to grant that all fittings are tested over a certain time period.		
[c] If tested in BRT this may be carried out by checking the test results of the manufacturer.		
[d] Alternatively, for d_n > 450 mm, the test can also be performed in water-in-air. In case of dispute, water-in-water shall be used.		
[e] For fitting type (B), d_n > 450 mm alternative testing (e.g. pressurization through saddle outlet) allowed.		
[f] for fitting type (B) d_n > 450 mm may be checked by the strip-bend test according to ISO 21751.		

Table 19 — Characteristics and minimum sampling frequencies for ATs for valves

Characteristic	Reference	Minimum sampling frequency [a]
Appearance	ISO 16486-4:2022, 6.1	1 valve/2 years/compound/production site
Colour	ISO 16486-4:2022, 6.2	1 valve/2 years/compound/production site
Geometrical characteristics	ISO 16486-4:2022, Clause 7	1 valve/2 years/compound/production site
Hydrostatic strength (80 ºC, 1 000 h)	ISO 16486-4:2022, 8.3	1 valve/2 years/compound/production site
Stop resistance	ISO 16486-4:2022, 8.3	1 valve/2 years/compound/production site
Actuation mechanism resistance	ISO 16486-4:2022, 8.3	1 valve/2 years/compound/production site
Resistance to bending between supports	ISO 16486-4:2022, 8.3	1 valve/2 years/compound/production site
Thermal cycling resistance d_n > 63 mm	ISO 16486-4:2022, 8.3	1 valve/2 years/compound/production site
Leaktightness under bending with thermal cycling , $d_n \leq 63$ mm	ISO 16486-4:2022, 8.3	1 valve/2 years/compound/production site
Leaktightness under tensile loading	ISO 16486-4:2022, 8.3	1 valve/2 years/compound/production site
Impact loading resistance	ISO 16486-4:2022, 8.3	1 valve/2 years/compound/production site
[a] Change of product type, diameter and SDR every visit to grant that all valves are tested over a certain time period.		

An audit test can be performed as a witness test if accepted by the certification body.

NOTE 1 Provided it is accepted by the certification body, a witness test can be performed at a manufacturer site or outsourced on behalf of the manufacturer.

NOTE 2 If an audit test has been performed as a witness test, it does not need to be repeated.

6.6 One-off products and products produced in very low quantity

For fittings and valves produced one-off or in a very low quantity, testing shall be agreed between the manufacturer and end user.

6.6.1 Type test results

All type tests and their results shall be documented in test reports.

All test reports shall be retained by the manufacturer at least until the last date of production of the pipes, fittings or valves to which they relate.

6.6.2 Test records

Unless otherwise specified, all records shall be maintained for a minimum of 10 years in accordance with the information given in the quality management system.

6.6.3 Technical file for certification purposes

A technical file shall be made available to the certification body by the pipe, fitting and/or valve manufacturer for product certification purposes, containing:

a) a description of product range concerned;

b) a technical product specification.

NOTE 1 This specification needs to contain (depending on the product) for example:

— dimensions and tolerances for each geometrical characteristic in accordance with ISO 16486-1 to ISO 16486-5;

— components and materials list with characteristics;

— for electrofusion fittings: electrical characteristics (wire material, diameter and length of the resistive wire, nominal value of the electrical resistance, material and dimensions of terminal connection);

— welding parameters and/or cooling time

— type test results of the products concerned

— quality plan of the products concerned

NOTE 2 ISO/TS 19911 can be used as a reference for a technical file for PA-U spigot ended fittings.

Annex A
(normative)

Change of compound

A.1 General

For the purposes of this document, the following definitions of the change of compound shall apply in the determination of type test re-evaluation requirements for compound.

NOTE For non-CEN member countries, information for dealing with special cases for PA-U can also be found in PPI TR-3.[7]

A.2 Change

A.2.1 Change of base polymer

Change of polymer manufacture, polymerization process or chemical nature of the comonomer.

A.2.2 Change of grade

A.2.2.1 Any change of viscosity number of granules outside of the following limit:

— decrease below the minimum viscosity number or increase of > 20 %. If the viscosity number is increased more than 20 % on top of the minimum value, the processing conditions (e.g. injection-moulding) of the compound could be influenced and this should be verified with the product manufacturer.

If the changes are within the above-mentioned limits, only PVT testing as described in Table 12 is required.

A.2.2.2 Production of the same base polymer at a different site.

A.2.2.3 Production of the same base polymer with a new production line at the same site.

A.2.3 Change of pigment

A.2.3.1 Change of chemical nature or colour of pigment.

A.2.3.2 Increase of pigment level by > 30 %.

A.2.4 Change of additives other than pigments

A.2.4.1 Change of chemical nature or addition or deletion of any additive.

A.2.4.2 Change of any additive (other than UV-stabilisers) level by > 30 %.

A.2.4.3 Decrease of UV-stabilisers by > 30 % or increase by > 50 %.

A.3 Type testing required for re-evaluation

A.3.1 Changes A.2.1 and A.2.3.1

Changes conforming to A.2.1 and/or A.2.3.1 shall require the compound to be regarded as a new compound, for which all type tests shall be required and carried out according to Table 4.

A.3.2 Changes A.2.2.1, A.2.2.2, A.2.2.3, A.2.3.2, A.2.4.1, A.2.4.2 and A.2.4.3

These changes are considered as "minor changes".

Type tests shall be carried out as shown in Table A.1, adapted from Table 4 of this document.

Failure of the specified requirements is not acceptable.

Table A.1 — Type testing required for re-evaluation

Characteristic	Change [a]						
	A.2.2.1	A.2.2.2	A.2.2.3	A.2.3.2	A.2.4.1	A.2.4.2	A.2.4.3
Physical [a,b]	+	+	+	+	+	+	+
Resistance to slow crack growth	+	+	+	+	+	+	+
Resistance to rapid crack propagation	+	+	+	+	+	–	–
Tensile strength for butt fusion	+	–	–	+	+	+	+
Resistance to weathering	–	–	–	–	+	–	+
Hydrostatic strength [c] (20 °C)	+	+	+	–	+	–	–
Hydrostatic strength [d] (80 °C)	+	+	+	+	+	+	+

[a] Change of product type, diameter and SDR every visit to grant that all valves are tested over a certain time period.

" + " denotes test to be carried out.

" – " denotes test not to be carried out.

[b] As defined in Table 3 of this document (conventional density, oxidation induction time, water content, carbon black content and dispersion, pigment dispersion, MFR).

[c] Check according to ISO 8149 two stress levels at 20 °C as follows:

PA-U160 at 20,5 MPa / 100 h, 18,7 MPa / 2 500 h

PA-U 180 at 23,1 MPa / 100 h, 21,0 MPa / 2 500 h

Test three test pieces at each stress level on size group 1 pipe.

The corresponding times shall be exceeded without failure.

[d] Check two stress levels at 80 °C as follows: PA-U 160 at 9,3 MPa/ 5 000 h and PA U 180 at 10,5 MPa/ 5 000 h. Test three test pieces on 1 diameter of size group 1 pipe. The corresponding time shall be exceeded without failure.