INTERNATIONAL STANDARD

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Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure — Unplasticized poly(vinyl chloride) (PVC-U) —

Part 1: General

Systèmes de canalisations en plastique pour l'alimentation en eau, pour branchements et collecteurs d'assainissement enterrés et aériens avec pression — Poly(chlorure de vinyle) non plastifié (PVC-U) —

Partie 1: Généralités

Reference number
ISO 1452-1:2009(E)

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 1452-1 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 155, *Plastics piping systems and ducting systems*, in collaboration with ISO Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 2, *Plastics pipes and fittings for water supplies*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition cancels and replaces ISO 4422-1:1996, which has been technically revised.

ISO 1452 consists of the following parts, under the general title *Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure — Unplasticized poly(vinyl chloride) (PVC-U)*:

— *Part 1: General*

— *Part 2: Pipes*

— *Part 3: Fittings*

— *Part 4: Valves*

— *Part 5: Fitness for purpose of the system*

Guidance for the assessment of conformity is to form the subject of a part 7.

Introduction

The System Standard, of which this is Part 1, specifies the requirements for a piping system and its components made from unplasticized poly(vinyl chloride) (PVC-U). The piping system is intended to be used for water supply and for buried and above-ground drainage and sewerage under pressure.

In respect of potential adverse effects on the quality of water intended for human consumption, caused by the products covered by this part of ISO 1452, the following are relevant.

a) This part of ISO 1452 provides no information as to whether or not the products can be used without restriction.

b) Existing national regulations concerning the use and/or the characteristics of these products remain in force.

Requirements and test methods for components are specified in ISO 1452-2, ISO 1452-3 and ISO 1452-4. Characteristics for fitness for purpose (mainly for joints) are established in ISO 1452-5.

This part of ISO 1452 specifies the general aspects of PVC-U.

Guidance for installation is given in ISO/TR 4191[1].

Guidance for assessment of conformity is provided in ENV 1452-7[2].

Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure — Unplasticized poly(vinyl chloride) (PVC-U) —

Part 1: General

1 Scope

This part of ISO 1452 specifies the general aspects of unplasticized poly(vinyl chloride) (PVC-U) solid-wall piping systems intended for water supply and for buried and above-ground drainage and sewerage under pressure.

In conjunction with ISO 1452-2, ISO 1452-3, ISO 1452-4 and ISO 1452-5, it is applicable to PVC-U pipes, fittings, valves and ancillary equipment, their joints and to joints with components of other plastics and non-plastics materials intended to be used for the following:

a) water mains and services buried in the ground;

b) conveyance of water above ground for both outside and inside buildings;

c) buried and above-ground drainage and sewerage under pressure.

It is applicable to piping systems intended for the supply of water under pressure up to and including 25 °C (cold water), intended for human consumption and for general purposes as well as for waste water under pressure.

This part of ISO 1452 is also applicable to components for the conveyance of water and waste water up to and including 45 °C. For temperatures between 25 °C and 45 °C, Figure A.1 of ISO 1452-2:2009 applies.

NOTE The producer and the end-user can come to agreement on the possibilities of use for temperatures above 45 °C on a case-by-case basis.

2 Normative references

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

ISO 472:1999, *Plastics — Vocabulary*

ISO 1043-1:2005, *Plastics — Symbols and abbreviated terms — Part 1: Basic polymers and their special characteristics*

ISO 1167-1, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 1: General method*

ISO 1167-2, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 2: Preparation of pipe test pieces*

ISO 6401:2008, *Plastics — Poly(vinyl chloride) — Determination of residual vinyl chloride monomer — Gas-chromatographic method*

ISO 9080, *Plastics piping and ducting systems — Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation*

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

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472 and ISO 1043-1 and the following apply.

NOTE If not included in this part of ISO 1452, see the designations given in EN 805[3] and EN 806-1[4].

3.1.1 Wall construction definition

3.1.1.1
solid-wall
having smooth internal and external surface and the same homogeneous compound/formulation throughout the wall

NOTE This term can be applied to pipes, fittings and valves.

3.1.2 Geometrical definitions

3.1.2.1
nominal size
DN
numerical designation of the size of a component, other than a component designated by thread size, which is a convenient round number approximately equal to the manufacturing dimension in millimetres (mm)

3.1.2.2
nominal size
DN/OD
nominal size, related to the outside diameter

3.1.2.3
nominal size
DN/ID
nominal size, related to the inside diameter

3.1.2.4
nominal diameter
d_n
specified diameter assigned to a nominal size

NOTE 1 According to ISO 1452, the nominal (outside) diameter of a thermoplastics pipe or a spigot, is equal to its minimum mean outside diameter, $d_{em,min}$.

NOTE 2 The nominal (inside) diameter of the socket of a fitting, pipe, valve or of ancillary equipment is equal to the nominal (outside) diameter of the connecting pipe for which they are designed.

NOTE 3 The nominal diameter is expressed in millimetres.

3.1.2.5
outside diameter at any point
d_e
value of the measurement of the outside diameter through its cross-section at any point of a pipe or spigot, rounded up to the nearest 0,1 mm

3.1.2.6
mean outside diameter
d_{em}
value of the measurement of the outer circumference of a pipe or spigot end of a fitting in any cross-section, divided by π ($\approx$ 3,142), rounded up to the nearest 0,1 mm

3.1.2.7
mean inside diameter of socket
d_{im}
arithmetical mean of two measured inside diameters perpendicular to each other at the midpoint of the socket length

3.1.2.8
out-of-roundness
ovality
difference between the measured maximum and the measured minimum outside diameter in the same cross-section of a pipe or spigot, or the difference between the measured maximum and the measured minimum inside diameter in the same cross-section of a socket

3.1.2.9
nominal wall thickness
e_n
numerical designation of the wall thickness of a component which is identical to the minimum permissible wall thickness at any point

NOTE The wall thickness is expressed in millimetres.

3.1.2.10
wall thickness at any point
e
value of the measurement of the wall thickness at any point around the circumference of a component

3.1.2.11
mean wall thickness
e_m
arithmetical mean of a number of measurements of the wall thickness, regularly spaced around the circumference and in the same cross-section of a component, including the measured minimum and the measured maximum values of the wall thickness in that cross-section

3.1.2.12
tolerance
permitted variation of the specified value of a quantity, expressed as the difference between the permitted maximum and the permitted minimum value

3.1.2.13
pipe series
S
dimensionless number for pipe designation

NOTE 1 The pipe series S is related to a given pipe geometry as given in Equation (1):

$$S = \frac{d_n - e_n}{2e_n} \quad (1)$$

NOTE 2 Adapted from ISO 4065:1996[5], definition 3.6.

3.1.2.14
standard dimension ratio
SDR
numerical designation of a pipe series which is a convenient round number approximately equal to the dimension ratio of the nominal outside diameter, d_n, and the nominal wall thickness, e_n

NOTE According to ISO 4065[5], the standard dimension ratio, SDR, and the pipe series S are related as given in Equation (2):

$$SDR = 2S + 1 \quad (2)$$

3.1.3 Material definitions

3.1.3.1
virgin material
material in the form of granules or powder that has not been subjected to use or processing other than that required for its manufacture and to which no reprocessable or recyclable material(s) has been added

3.1.3.2
own reprocessable material
material prepared from rejected unused pipes, fittings and valves, including trimmings from the production of pipes, fittings and valves, which will be reprocessed in a manufacturer's plant after having been previously processed by the same manufacturer by a process such as moulding or extrusion and for which the complete formulation or compound is known

3.1.3.3
external reprocessable material
material comprising either one of the following forms:

a) material from rejected unused pipes, fittings or valves or trimmings therefrom, which will be reprocessed and which were originally processed by another manufacturer;

b) material from the production of unused PVC-U products other than pipes, fittings and valves, regardless of where they are manufactured

3.1.3.4
recyclable material
material comprising either one of the following forms:

a) material from used pipes, fittings or valves which have been cleaned and crushed or ground;

b) material from used PVC-U products other than pipes, fittings or valves which have been cleaned and crushed or ground

3.1.4 Definitions related to material characteristics

3.1.4.1
lower prediction limit
σ_{LPL}
quantity which can be considered as a material property, representing the 97,5 % lower confidence limit of the predicted long-term hydrostatic strength at 20 °C for 50 years with internal water pressure

NOTE Lower prediction limit is expressed in megapascals (MPa).

3.1.4.2
minimum required strength
MRS
value of σ_{LPL}, rounded to the next lower value of the R10 series when σ_{LPL} is below 10 MPa, or to the next lower value of the R20 series when σ_{LPL} is 10 MPa or greater

NOTE The R10 and R20 series are the basic series of preferred numbers conforming to ISO 3[6] and ISO 497[7].

3.1.4.3
design coefficient
C
overall coefficient with a value greater than 1, which takes into consideration service conditions as well as properties of the components of a piping system other than those represented in the lower predictive limit

3.1.4.4
design stress
σ_s
allowable stress for a given application at 20 °C

NOTE 1 It is derived from the MRS by dividing it by the coefficient, C, using Equation (3):

$$\sigma_s = \frac{MRS}{C} \tag{3}$$

NOTE 2 Design stress is expressed in megapascals (MPa).

3.1.5 Definitions related to service conditions

3.1.5.1
nominal pressure
PN
numerical designation used for reference purposes related to the mechanical characteristics of a component of a piping system

NOTE 1 For plastics piping systems, it corresponds to the allowable operating pressure, in bar [1)], conveying water at 20 °C during 50 years, as given in Equation (4):

$$PN = \frac{20\,MRS}{C \times (SDR - 1)} \tag{4}$$

NOTE 2 Research on long-term performance prediction of existing PVC water distribution systems shows possible service life of at least 100 years (see Figure 1 and KRV Nachrichten 1/95[8] and TNO Science and Industry[9]).

3.1.5.2
allowable operating pressure
PFA
maximum hydrostatic pressure which a component is capable of withstanding continuously in service (excluding surge)

NOTE For water temperatures up to and including 25 °C: PFA = PN

For water temperatures above 25 °C: PFA = $f_T \times$ PN

1) 1 bar = 10^5 N/m^2 = 0,1 MPa.

where

f_T is the derating factor depending on water temperature;

PN is the nominal pressure.

In cases where a further derating factor for application is required: PFA $= f_A \times f_T \times$ PN, where f_A is the factor depending on the application.

3.1.5.3
allowable site test pressure
PEA
maximum hydrostatic pressure which a newly installed component is capable of withstanding for a relatively short duration, in order to ensure the integrity and leaktightness of the pipeline

NOTE For this part of ISO 1452, PEA equals 1,5 $\times$ PFA, with a maximum of PFA + 5 bar.

3.1.5.4
hydrostatic stress
σ
stress induced in the wall of a pipe when a pressure is applied using water as a medium

NOTE 1 The hydrostatic stress is related to the applied pressure, p, in bar, the wall thickness at any point, e, and the mean outside diameter, d_{em}, of a pipe and is calculated using approximation Equation (5):

$$\sigma = \frac{p(d_{em} - e)}{20e} \tag{5}$$

NOTE 2 Hydrostatic stress is expressed in megapascals.

3.1.6 Definitions for pipe joints

3.1.6.1
end-load-bearing joint
joint that can resist axial loads without additional external mechanical support

3.1.6.2
non-end-load-bearing joint
joint that cannot resist axial loads without additional external mechanical axial support

3.2 Symbols

C design coefficient

d_e outside diameter at any point

d_{em} mean outside diameter

d_i inside diameter at any point

d_{im} mean inside diameter of socket

d_n nominal outside or inside diameter

e wall thickness at any point

e_m mean wall thickness

e_n nominal wall thickness

f_A derating factor for application

f_T derating factor for water temperatures

δ material density

σ hydrostatic stress

σ_s design stress

σ_{LPL} lower predicted limit

3.3 Abbreviated terms

DN nominal size

DN/ID nominal size, inside diameter related

DN/OD nominal size, outside diameter related

MRS minimum required strength

PFA allowable operating pressure

PEA allowable site test pressure

PN nominal pressure

PVC-U unplasticized poly(vinyl chloride)

S pipe series

SDR standard dimension ratio

TIR true impact rate

VCM vinyl chloride monomer

4 Material

4.1 General requirements for compounds or formulations

The material from which the pipes, fittings and valves are made shall be an unplasticized poly(vinyl chloride) compound or formulation. This compound or formulation shall consist of PVC-U resin/powder, to which shall be added those additives which are needed to facilitate the manufacture of pipes, fittings and valves conforming to ISO 1452-2, ISO 1452-3, ISO 1452-4 and ISO 1452-5, as applicable.

None of these additives shall be used separately or together in quantities sufficient to constitute a toxic, organoleptic or microbiological hazard or to impair the fabrication or solvent cementing properties of the product or to impair the chemical and physical or mechanical properties (in particular long-term mechanical strength and impact strength) as specified in the applicable part(s) of ISO 1452.

The vinyl chloride monomer (VCM) in the resin used in PVC-U compound/formulation shall be less than ± 0,000 1 % volume fraction [2)] if determined by means of gas-phase chromatography using the "headspace" method in accordance with ISO 6401.

4.2 Special requirement for compounds or formulations for components in contact with drinking water

All plastics and non-plastics materials for components of the PVC-U piping system, e.g. pipes, fittings, valves, elastomeric sealing rings, solvent cement, lubricants, when in permanent or in temporary contact with water, which is intended for human consumption, shall not adversely affect the quality of the drinking water.

4.3 Use of reprocessable and recyclable material

The use of the manufacturer's own reprocessable material obtained during the production and production testing of products conforming to ISO 1452 (all parts) is permitted in addition to the use of virgin material. Reprocessable material obtained from external sources and recyclable material shall not be used.

4.4 Classification and verification of materials

4.4.1 Classification of compounds or formulations in pipe form

Compounds or formulations shall be designated by the material type (PVC-U) and the level of minimum required strength (MRS), in accordance with Table 1.

The compound or formulation shall have an MRS equal to the values specified in Table 1. The MRS value for compound or formulation classification shall be derived from σ_{LPL} in accordance with ISO 12162. The σ_{LPL} is determined by analysis in accordance with ISO 9080, of hydrostatic pressure tests carried out in accordance with ISO 1167-1 and ISO 1167-2 and using pipe series $6{,}3 \leqslant S \leqslant 12{,}5$ and end caps type A, tested with water in water. The test temperatures shall be 20 °C and 60 °C.

NOTE 1 If fittings or valves are manufactured from the same compound or formulation as the pipe, the material classification is the same as for the pipe.

NOTE 2 Analyses established according to previous editions of ISO 9080 are deemed to satisfy this clause.

Table 1 — Material designation and corresponding maximum design stress values

Designation [a]	Minimum required strength MRS	Pipes		Fittings			
				Injection moulded		Fabricated	
		$d_n \leqslant 90$ ($C = 2{,}5$)	$d_n > 90$ ($C = 2{,}0$)	$d_n < 160$ ($C = 2{,}5$)	$d_n \geqslant 160$ ($C = 2{,}0$)	$d_n \leqslant 90$ ($C = 2{,}5$)	$d_n > 90$ ($C = 2{,}0$)
		σ_s	σ_s	σ_s	σ_s	σ_s	σ_s
	MPa	MPa	MPa	MPa	MPa	MPa	MPa
PVC-U 250	25,0	10,0	12,5	10,0	12,5	10,0	12,5
PVC-U 200	20,0	[b]	[b]	8,0	10,0	[b]	[b]

[a] This is only used for compound classification declared by the compound manufacturer.

[b] Not applicable.

2) This is the equivalent of 1 ppm; ppm is a deprecated unit.

4.4.2 Verification of compounds or formulations in pipe form of PVC-U 250

If long-term experience with a defined compound or formulation is available, the MRS shall not be re-evaluated. In that case, testing on five samples in parallel for each chosen condition shall be performed. All values found shall be located on or above the σ_{LPL} minimum reference curve [3)] given in Figure 1.

Alternatively, the testing time of 10 samples per temperature may be dispersed along the minimum reference curve. In that case, the time frame shall be:

— for 20 °C: Time from 100 h up to and including 5 000 h; the times of which 3 samples shall be between 3 000 h and 5 000 h,

— for 60 °C: Time from 100 h up to and including 5 000 h; the times of which 3 samples shall be between 3 000 h and 5 000 h,

where the check points given in Table 2 shall be integral part of the testing scheme. For the pipe series and end caps to be used, see 4.4.1.

The values of the minimum required hydrostatic strength shall be calculated using Equation (6):

$$\lg t = -164{,}461 - 29\,349{,}493 \times \frac{\lg\sigma}{T} + 60\,126{,}534 \times \frac{1}{T} + 75{,}079 \times \lg\sigma \qquad (6)$$

Table 2 — Example of verification test requirements

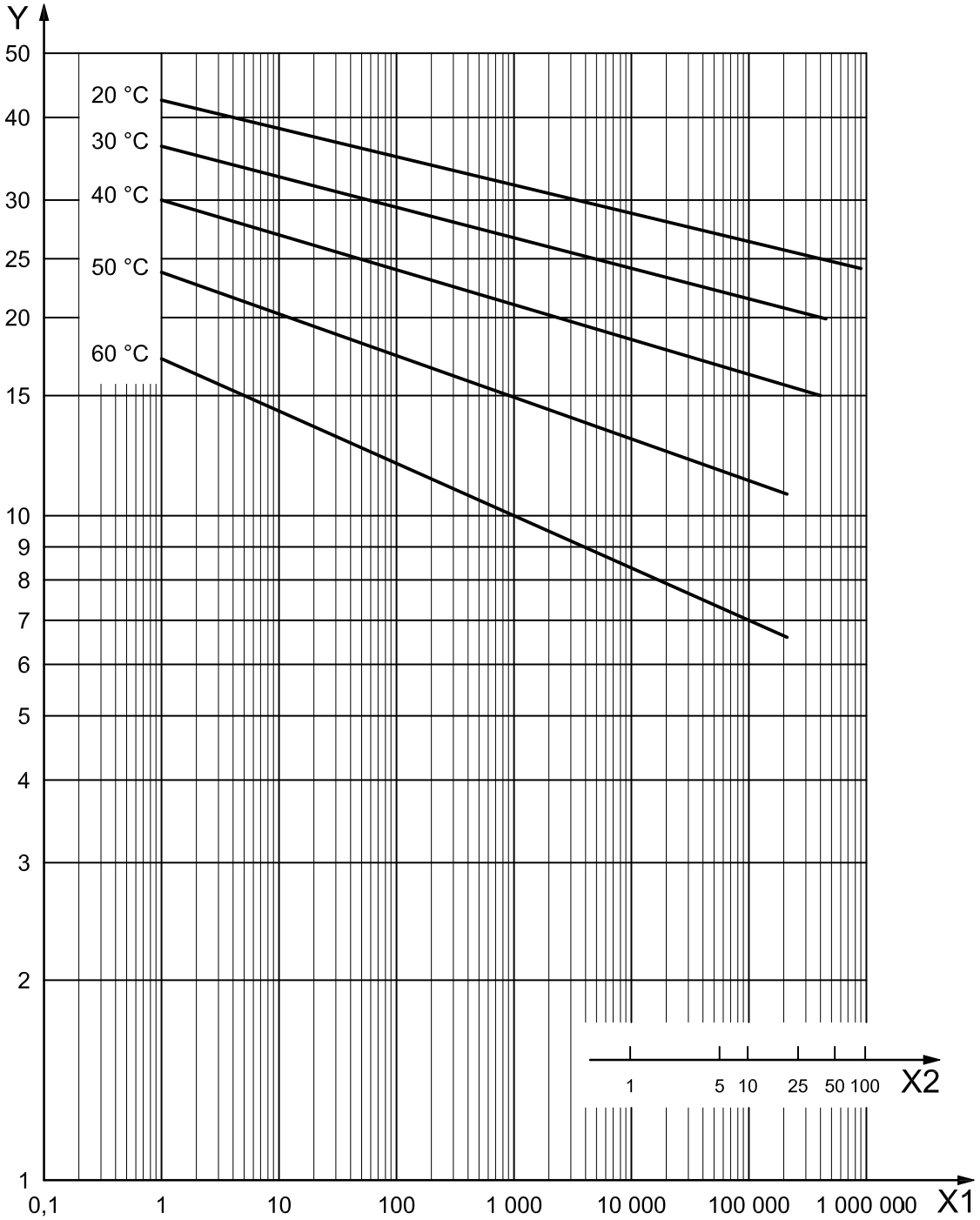
Time h	Temperature °C	Stress MPa
100	20	35,00
100	60	11,95
1 000	20	31,87
1 000	60	10,00
5 000	20	29,90
5 000	60	8,85

NOTE Verification testing is used to confirm the material properties after a change of formulation on a long-term experienced material. Verification testing does not give precise information about the slope of the regression curve and therefore is not representative of the MRS value determination.

4.4.3 Verification of compounds or formulations in pipe form of PVC-U with an MRS less than 25 MPa

For the verification of materials with an MRS < 25 MPa, the originally established curve in accordance with ISO 9080 shall be used accordingly.

3) This minimum reference curve was established for TEPPFA (The European Plastic Pipes and Fittings Association, Brussels). The extrapolation data-sets are documented in the reports from OFI (Österreichisches Forschungsinstitut für Chemie und Technik, Wien), expert opinion 47.201 and TGM (Staatliche Versuchsanstalt – TGM, Fachbereich Kunststoff & Umwelttechnik, Wien), expert opinion VA-KU 19607.



Key

X1 time, t, to fracture, in hours

X2 time, in years

Y hoop stress, σ, in megapascals

Figure 1 — Minimum reference curve for PVC-U 250

Bibliography

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[3] EN 805, *Water supply — Requirements for systems and components outside buildings*

[4] EN 806-1, *Specifications for installations inside buildings conveying water for human consumption — Part 1: General*

[5] ISO 4065:1996, *Thermoplastics pipes — Universal wall thickness table*

[6] ISO 3, *Preferred numbers — Series of preferred numbers*

[7] ISO 497, *Guide to the choice of series of preferred numbers and of series containing more rounded values of preferred numbers*

[8] KRV Nachrichten 1/95, Dipl.Ing. Reinhard E. Nowack, Dipl. Phys. Egon Barth, Ing.-Oec. Ilse Otto, Dr. Erich W. Braun: *60 Jahre Erfahrung mit Rohrleitungen aus weichmacherfreiem Polyvinylchlorid (PVC-U)*

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