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DIN 8061:1994-08

Unplasticized polyvinyl chloride (PVC-U) pipes – General quality requirements and testing English version of DIN 8061:2009-10

Rohre aus weichmacherfreiem Polyvinylchlorid (PVC-U) – Allgemeine Güteanforderungen, Prüfung
Englische Übersetzung von DIN 8061:2009-10

Tuyaux en polychlorure de vinyle non plastifié (PVC-U) – Exigences générales en matière de qualité, essais
Traduction anglaise de DIN 8061:2009-10

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In case of doubt, the German-language original shall be considered authoritative.

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A comma is used as the decimal marker.

Contents

Foreword

This document has been prepared by Working Committee NA 054-05-02 AA *Prüfverfahren für Rohre* of the *Normenausschuss Kunststoffe* (FNK) (Plastics Standards Committee).

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

Amendments

This standard differs from DIN 8061:1994-08 as follows:

a) The title has been changed.

b) The content has been editorially revised.

c) The material designation requirements have been expanded.

d) Materials PVC-U-K and PVC-HI have been deleted.

e) An equation for calculating long-term hydrostatic strength reference lines has been added.

f) Testing of water absorption is no longer specified.

g) Testing of resistance to external blows is now specified.

h) Testing of resistance to dichloromethane is now specified.

Previous editions

DIN 8061-1: 1974-11
DIN 8061-2: 1971-10
DIN 8061: 1941xx-07, 1960-07, 1962-09, 1965-01, 1968-12, 1984-04, 1994-08

1 Scope

This standard applies to straight, circular, seamless pipes of unplasticized polyvinyl chloride (PVC-U) having dimensions as in DIN 8062.

Attention is brought to the fact that there are European product standards which apply to specific applications; these are to be complied with where relevant. Some of these product standards are listed in the bibliography for the information of users of this standard. Please note that because European Standards are continually being developed, this list is not exhaustive.

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.

DIN 323-1, *Preferred numbers and series of preferred numbers — Part 1: Basic values, calculated values, rounded values*

DIN 8062, *Unplasticized polyvinyl chloride (PVC-U) pipes — Dimensions*

DIN EN 580, *Plastics piping systems — Unplasticized poly(vinyl chloride) (PVC-U) pipes — Test method for the resistance to dichloromethane at a specified temperature (DCMT)*

DIN EN 744, *Plastics piping and ducting systems — Thermoplastics pipes — Test method for resistance to external blows by the round-the-clock-method*

DIN EN 10204, *Metallic products — Types of inspection document*

DIN EN ISO 179 series, *Plastics — Determination of Charpy impact strength*

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

DIN EN ISO 2505, *Thermoplastics pipes — Longitudinal reversion — Test methods and parameters*

DIN EN ISO 9080:2003-10, *Plastics piping and ducting systems — Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation*

3 Terms and definitions

For the purposes of this document, the following applies.

3.1
long-term hydrostatic strength
σ
strength of a pipe subjected to internal pressure p

NOTE Calculated as in equation (1).

$$\sigma = p\frac{d-e}{2e} \quad \text{[MPa]} \tag{1}$$

where

p is the internal pressure, in MPa[1)];

d is the outside diameter of the pipe, in mm;

e is the wall thickness of the pipe, in mm.

4 Material (moulding material)

4.1 General

Pipes shall be made of unplasticized polyvinyl chloride (PVC-U). The choice of stabilizers and other additives (e.g. pigments, lubricants) shall be left to the pipe manufacturer. The standard does not apply to the use of recycled materials or reinforced moulding materials (e.g. with chalk or glass fibres). The use of own reprocessable material is permitted. Moulding materials and additives of unknown identity and composition shall not be used.

4.2 Demonstrating long-term hydrostatic strength

It shall be demonstrated that values for the long-term hydrostatic strength of the material used lie on or above the reference lines (time-to failure curves) shown in Figure 1.

Long-term hydrostatic strength shall be determined as in DIN EN ISO 9080. Extrapolation values and limits are based on the extrapolation factors given in Table 2 of DIN EN ISO 9080:2003-10.

The reference lines are based on equation (2).

$$\lg t = -164{,}461 - \frac{29\,349{,}493\ (\lg\sigma)}{T} + \frac{60\,126{,}534}{T} + 75{,}079\ \lg\sigma \qquad (2)$$

In the above:

t is the time, in h;

T is the temperature, in K;

σ is the long-term hydrostatic strength, in MPa.

1) 1 MPa = 10 bar

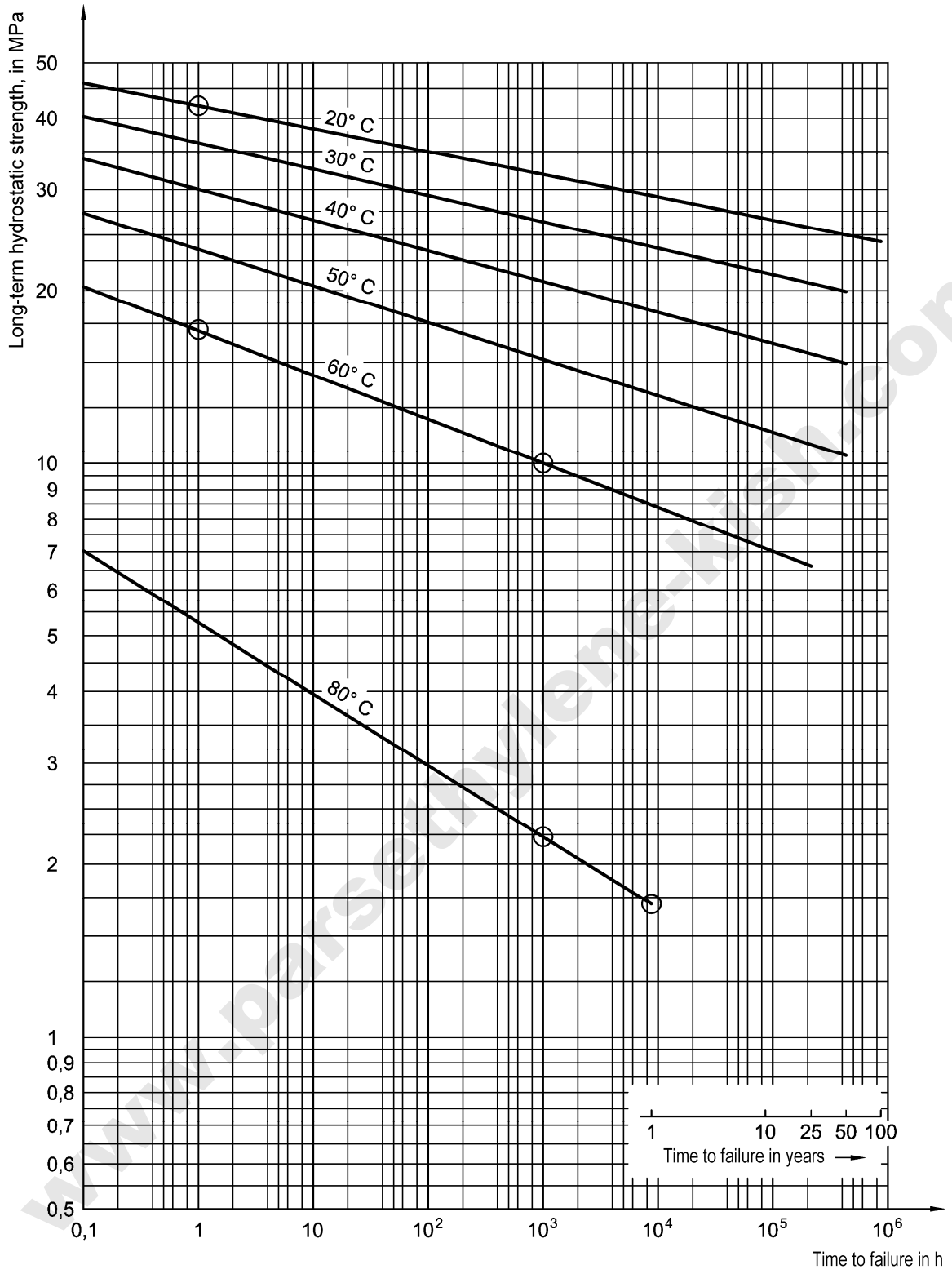

Figure 3 — Reference lines for long-term hydrostatic strength (time-to-failure curves) for PVC-U pipes

5 Requirements

5.1 Form supplied and surface quality

Pipe ends should be cut as square as possible to the pipe axis. Pipes shall be free from any blisters, blowholes and any other inhomogeneities which could impair their performance. Pigmentation shall be uniform throughout. Pipe surfaces shall be smooth both inside and out. Shallow grooves and the resulting minor irregularities in wall thickness are permitted, as long as the actual wall thickness does not go below the nominal value. Sharp edged grooves and cavities are not permitted in any case. Testing shall be as in 6.1.

5.2 Dimensions, tolerances and out-of-roundness

The pipe outside diameter, wall thickness and out-of-roundness, and the relevant tolerances shall be as in DIN 8062. Testing shall be as in 6.2.

For pipes with special dimensions which are not covered by DIN Standards because they deviate from preferred number series (as in DIN 323-1) and international specifications, calculations shall be made on the basis of DIN 8062.

5.3 Strength characteristics determined by long-term hydrostatic strength testing

When tested in accordance with 6.3 pipes shall meet the strength requirements of Table 1. During the prescribed period of stressing they shall not show signs of leakage or fail. The long-term hydrostatic behaviour of pipes shall be as in the minimum time-to-failure curves shown in Figure 1. The long-term hydrostatic strength (minimum time-to-failure) values given in the following diagrams are based on currently available results of long-term hydrostatic strength tests and the temperature-dependent ageing behaviour of the pipe material.

Table 1 — Test conditions for long-term hydrostatic strength testing

Test temperature ϑ °C	Proof stress σ_0 MPa	Test time (min. failure time) t h
20	42	1
60	17	1
	10	1 000
80	2,2	1 000
	1,7	8 760[a, b]

a This test shall only be carried out if the operating temperature lies within the range 40 °C $< T \leq$ 60 °C.

b Quality control shall be carried out at the start of production or when any modifications are made to the materials or manufacturing process.

The proof stress values σ_0 specified in Table 1 correspond to the stresses marked O in Figure 1.

5.4 Impact strength

5.4.1 General

Impact strength may be determined either as in 6.4.1 or by testing resistance to external blows as in 6.4.2.

5.4.2 Impact strength when testing as in 6.4.1

When testing as in 6.4.1 the failure rate shall not exceed 10 % of the number of specimens tested.

5.4.3 Resistance to external blows

When testing as in 6.4.2 the True Impact Rate (TIR) shall not be greater than 10 %.

5.5 Heat reversion

When testing in accordance with 6.5 the mean relative change in pipe length shall not be greater than 5 %. There shall be no blisters, cracks or flaking.

5.6 Resistance to dichloromethane

Specimens shall not exhibit any signs of attack at a specified temperature of 15 °C when immersed for 30 min. Individual spots which are smaller than 2 mm may not be seen as a sign of attack.

As an alternative, the test can also be carried out at +23 °C to check for the partial attack that is necessary for proper bonding. Here a slight swelling or dissolving is permitted.

6 Testing

6.1 Surface quality

The inside and outside surfaces of the pipe shall be inspected with backlight, without using optical aids.

6.2 Dimensions and out-of-roundness

The mean pipe outside diameter shall be determined to an accuracy of 0,1 mm. The wall thickness shall be determined to an accuracy of 0,1 mm by measuring its circumference at at least four points spaced as evenly as possible. Measurements shall be taken at ambient temperature or, in cases of dispute, at (23 ± 2) °C.

Out-of-roundness shall be determined to an accuracy of 0,1 mm immediately after production.

6.3 Strength characteristics determined by long-term hydrostatic strength testing

General information on testing is given in DIN EN ISO 1167-1. For each proof stress value as in Table 1 take three sections of pipe (referred to below as “pipes”) as test pieces having a length l_1 (see Figure 2):

for $d \leq 250$ mm: $l_1 \approx 3\,d + 2\,l_5 + 250$ mm

for $d > 250$ mm: $l_1 \approx 1\,000$ mm $+ 2\,l_5$

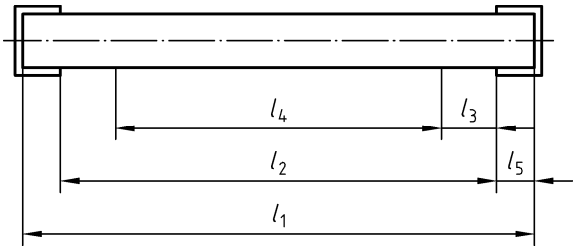

Figure 4 — Test piece for long-term hydrostatic strength test

where

d is the pipe outside diameter, in mm;

l_1 is the test piece length, in mm;

l_2 is the test length, in mm;

l_3 is the length of pipe affected by clamping of end caps, in mm;

for $d \leq 250$ mm: $l_3 = d$;

for $d > 250$ mm: $l_3 = 250$ mm;

l_4 is the assessment length, in mm; $l_4 = l_2 - 2\,l_3$;

l_5 is the free length, in mm (for end caps).

Along the assessment length l_4 of the pipe, determine the wall thickness e at eight points and the outside diameter d at three points, in both cases by circumferential measurement and to an accuracy of 0,1 mm; also determine the minimum wall thickness e_{min} and the mean outside diameter $\overline{d}$.

Fit end caps to both ends of the pipe, ensuring free axial movement during testing. Through an opening in one of the end caps, fill the pipe with water at the test temperature specified in Table 1 (to within ± 5 K), then place the pipe in a bath which has been heated to the test temperature (maintained to within ± 1 K) and leave it there for at least 1 h. If the pipe is filled with cooler water, leave it in the bath for 12 h until temperature equilization is achieved.

With the pipe still in the bath, steadily increase the pressure for 1 min until the specified test pressure is reached. Maintain the test pressure to within (+2/–1) % throughout the test time (minimum time-to-failure) specified in Table 1.

Calculate the test pressure p using equation (3):

$$p = \frac{2 \cdot e_{min} \cdot \sigma_0}{\overline{d} - e_{min}} \qquad (3)$$

where

$\overline{d}$ is the mean outside diameter over l_4, in mm;

e_{min} is the minimum wall thickness over l_4, in mm;

σ_0 is the proof stress as in Table 1, in MPa.

Determine whether the pipe has failed or developed signs of leakage during the specified test time.

If the pipe has failed within length l_3 (clamping zone) during this period, disregard the test results and repeat the test.

6.4 Impact strength

Testing can be carried out as in either 6.4.1 or 6.4.2 of this standard.

6.4.1 Impact strength testing

Specimens shall be taken from pipes and be either in the form of pipe sections or of bars taken along the pipe axis, with the dimensions shown in Table 2. Bar specimens shall be cut from the same pipe section at points spaced as evenly as possible around the pipe circumference. The pipe surfaces shall not be machined.

Testing shall be carried out on 10 specimens using a pendulum testing machine as in DIN EN ISO 179, but taking the test parameters from Table 2 of the present standard, applying the impact to the specimen's outer surface. Testing shall be carried out at (23 ± 2) °C.

Table 2 — Test conditions for impact test

Pipe		Specimen			Impact energy	Distance between supports
Outside diameter d mm	Wall thickness e mm	Length mm	Width mm	Height mm	J	mm
< 25	$= e$	(100 ± 2) mm long pipe section			15	$70\ ^{+0,5}_{0}$
≥ 25	≤ 9,5	50 ± 1	6 ± 0,2	in accordance with unmachined wall thickness $= e$	15	$40\ ^{+0,5}_{0}$
> 25	> 9,5	120 ± 2	15 ± 0,5		50	$70\ ^{+0,5}_{0}$

Determine whether the specimens fail. If more than 10 % of the specimens fail, repeat the test on 20 new specimens from the same batch. In this case, the failure rates in the first and second tests shall be added together for evaluation.

6.4.2 Resistance to external blows

See DIN EN 744 for general information on testing.

Table 3 — Striker

Striker type	Types d25 and d90
Striker mass	As in Table 4 or 5
Fall height	As in Table 4 or 5
Test temperature	(0 ± 1) °C

Table 4 — Masses and fall heights for pipe series SDR 9 to SDR 21 at level M*)

Outside diameter *d* mm	Mass *m* kg	Fall height *h* mm
20	0,5	400
25		500
32		600
40		800
50		1 000
63	0,8	1 000
75		1 000
90		1 200
110	1,0	1 600
125	1,25	2 000
140	1,6	1 800
160		2 000
180	2,0	1 800
200		2 000
225	2,5	1 800
250		2 000
280	3,2	1 800
≥ 315		2 000

Table 5 — Masses and fall heights for pipe series SDR 26 to SDR 34,4 at level H*)

Outside diameter *d* mm	Mass *m* kg	Fall height *h* mm
20	0,5	400
25		500
32		600
40		800
50		1 000
63	0,8	1 000
75		1 200
90	1,0	2 000
110	1,6	2 000
125	2,5	2 000
140	3,2	1 800
160		2 000
180	4,0	1 800
200		2 000
225	5,0	1 800
250		2 000
280	6,3	1 800
≥ 315		2 000

For other SDR series as in DIN 8062 impact testing shall be as in 6.4.1 of the present standard.

*) Translator's note: As in ISO 3127, Annex B.

6.5 Heat reversion

Specimens shall be either three complete 200 mm-long pipe sections or, where the pipe outside diameter is $d \geq 200$ mm, 200 mm-long sections having an approximate arc length of 200 mm cut along the pipe axis. In the latter case the 200 mm-long pipe section shall be divided, along the entire circumference, into pieces measuring approximately 200 mm × 200 mm (e.g. a 200 × 9,6 pipe shall be cut into three pieces and a 1 000 × 8 pipe into 15 pieces). The direction of the pipe axis shall be marked on the pieces, all of which are to be tested. A mark shall be made on the outside surface of each specimen about 50 mm from each end, in the axial pipe direction (for complete pipe sections the mark shall be applied around the entire circumference). The distance between the two marks l_0 (initial length) shall be about 100 mm and is to be measured at (23 ± 2) °C to an accuracy of 0,25 mm.

To ensure that changes in length are not obstructed, place the specimens convex side down on a glass plate dusted with talcum. Then, in accordance with DIN EN ISO 2505 place the glass plate with the specimens in a forced air oven that has been brought to the test temperature and leave it there according to the conditions specified in Table 6.

Table 6 — Test conditions for heat reversion test

Wall thickness e mm	Test temperature ϑ °C	Test period t min
≤ 8	150 ± 2	60 ± 2
8 < e ≤ 16		120 ± 2
> 16		240 ± 2

After removing the specimens from the oven and – leaving them in the same position on the plate – cooling them in air to ambient temperature, measure the minimum distance l_{min} between the two marks.

Calculate the relative change in length ε, in %, using equation (4):

$$\varepsilon = \frac{l_0 - l_{min}}{l_0} \cdot 100 = \frac{\Delta l}{l_0} \cdot 100 \qquad (4)$$

where

l_0 is the distance between marks before heat treatment, in mm;

l_{min} is the distance between marks after heat treatment and after cooling, in mm;

Δl $l_0 - l_{min}$

The mean relative change in length ε for the pipe under test is given by the arithmetic mean of the relative changes in length ε determined as shown above.

Specimen surfaces shall also be examined to establish whether blisters or cracks have occurred as a result of heat treatment.

6.6 Resistance to dichloromethane

Testing shall be as in DIN EN 580.

As an alternative, testing may be carried out according to a comparable company specification.

6.7 Inspection documents

If so agreed, the pipe manufacturer shall issue an inspection document as in DIN EN 10204 regarding routine testing during production.

Annex A
(informative)

Explanatory notes

This standard is a basic standard which specifies general quality requirements and test methods for pipes of PVC-U. Specifications regarding the scope of testing, inspection and requirements for special applications are given in the relevant product standards.

The requirements and test methods specified in this standard are based on long-term investigations carried out by FNK-KOA 504 *Koordinierung der Kunststoff-Rohr-Normung*, particularly by its Working Committee 504.2 *Prüfverfahren für Rohre* (renamed as NA 054-05-02 AA *Prüfverfahren für Rohre*) and on investigations of the long-term behaviour of PVC-U pipes carried out by the *Kunststoffrohrverband e. V.* (KRV) (German Plastics Association).

The focus of the German Plastics Association's investigations was the long-term behaviour of these pipes to demonstrate their serviceability over more than 100 years. To this end more than 1 250 pipe specimens were subjected to various stresses in long-term hydrostatic strength tests within a temperature range of +20 °C to +80 °C and under alternating dynamic pressures (cyclic testing). At the same time physical characteristic values beyond those covered by the relevant standards and guidelines for PVC-U pipes were also determined wherever thermal ageing in air at +60 °C to +120 °C was investigated.

The long-term hydrostatic strength results for failure times over 72 000 h show that PVC-U pipes are capable of meeting the requirements not only for pressure pipes but also for waste water (sewage) pipes over more than 100 years at 40 °C.

Moulding materials for manufacturing PVC-U pipes are classified as in DIN EN ISO 1163-1.

Table A.1 — PVC-U properties (guideline values)

Properties	Guideline values for PVC-U
Density (tested as in DIN ISO 1183)	$\approx 1{,}42\ g/cm^3$
Mean coefficient of linear thermal expansion at temperatures between 0 °C and 80 °C (when tested as in DIN 53752)	$\approx 0{,}8 \times 10^{-4}\ K^{-1}$
Thermal conductivity (when tested as in DIN 52612-1)	$\approx 0{,}15\ W \times K^{-1} \times m^{-1}$
Surface resistivity (when tested as in DIN IEC 60093 (VDE 0303-30))	$> 10^{12}\ \Omega$
When tested as in DIN 4102-1 using 1 mm to 4 mm-thick sheets, PVC-U is classified as "not easily flammable" (building material class B1).	

Bibliography

DIN 4102-1, *Fire behaviour of building materials and building components — Part 1: Building materials; concepts, requirements and tests*

DIN 53752, *Testing of plastics — Determination of the coefficient of linear thermal expansion*

DIN EN 1401-1, *Plastics piping systems for non-pressure underground drainage and sewerage — Unplasticized poly(vinyl chloride) (PVC-U) — Part 1: Specifications for pipes, fittings and the system*

DIN EN 1452-1, *Plastics piping systems for water supply — Unplasticized poly(vinyl chloride) (PVC-U) — Part 1: General*

DIN EN 1452-2, *Plastics piping systems for water supply — Unplasticized poly(vinyl chloride) (PVC-U) — Part 2: Pipes*

DIN EN 1456-1, *Plastics piping systems for buried and above ground drainage and sewerage under pressure — Unplasticized poly(vinyl chloride) (PVC-U) — Part 1: Specifications for piping components and the system*

DIN EN ISO 1163-1, *Plastics — Unplasticized poly(vinyl chloride) (PVC-U) moulding and extrusion materials — Part 1: Designation system and basis for specifications*

DIN EN ISO 1183 series, *Plastics — Methods for determining the density of non-cellular plastics*

DIN EN ISO 15493, *Plastics piping systems for industrial applications — Acrylonitrile-butadiene-styrene (ABS), unplasticized poly(vinyl chloride) (PVC-U) and chlorinated poly(vinyl chloride) (PVC-C) — Specifications for components and the system — Metric series*

DIN IEC 60093 (VDE 0303 Part 30), *Methods of test for insulating materials for electrical purposes — Volume resistivity and surface resistivity of solid electrical insulating materials*

[1] Egon Barth: *Das Langzeitverhalten von PVC-U-Rohren mit unterschiedlicher Stabilisierung* (The long-term behaviour of PVC-U pipes with different types of stabilization), *Kunststoffrohrverband e.V.*, Bonn (December 2005)