INTERNATIONAL STANDARD

ISO 6993

Second edition
2001-12-01

Buried, high-impact poly(vinyl chloride) (PVC-HI) pipes for the supply of gaseous fuels — Specifications

Tubes enterrés en poly(chlorure de vinyle) à résistance au choc améliorée (PVC-HI) pour réseaux de combustibles gazeux — Spécifications

Reference number
ISO 6993:2001(E)

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

Contents

Page

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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 6993 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*.

This second edition cancels and replaces the first edition (ISO 6993:1990), which has been technically revised. Substantial changes have been made to the specifications for the PVC-HI material and to those for the mechanical properties of the PVC-HI pipe. In addition, references have been added to ISO test methods which were not published at the time the first edition was issued.

Annexes A to F form a normative part of this International Standard.

Buried, high-impact poly(vinyl chloride) (PVC-HI) pipes for the supply of gaseous fuels — Specifications

1 Scope

This International Standard specifies the requirements for pipes made of high-impact poly(vinyl chloride) (PVC-HI) intended to be used for the supply of gaseous fuels through buried pipelines with an operating temperature range of 0 °C to 30 °C and a maximum operating pressure of 1 bar.

Such pipes are only suitable for those gases which do not contain potentially damaging components in such concentrations as to impair the properties of the pipe material.

NOTE 1 bar = 10^5 N/m^2 = 100 kPa

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 3, *Preferred numbers — Series of preferred numbers*

ISO 161-1, *Thermoplastics pipes for the conveyance of fluids — Nominal outside diameters and nominal pressures — Part 1: Metric series*

ISO 877:1994, *Plastics — Methods of exposure to direct weathering, to weathering using glass-filtered daylight, and to intensified weathering by daylight using Fresnel mirrors*

EN 922, *Plastics piping and ducting systems — Pipes and fittings of unplasticized poly(vinyl chloride) (PVC-U) — Specimen preparation for determination of the viscosity number and calculation of the K-value*

ISO 1167, *Thermoplastics pipes for the conveyance of fluids — Resistance to internal pressure — Test method*

ISO 2505-1:1994, *Thermoplastics pipes — Longitudinal reversion — Part 1: Determination methods*

ISO 2505-2:1994, *Thermoplastics pipes — Longitudinal reversion — Part 2: Determination parameters*

ISO 2507-1, *Thermoplastics pipes and fittings — Vicat softening temperature — Part 1: General test method*

ISO 2507-2, *Thermoplastics pipes and fittings — Vicat softening temperature — Part 2: Test conditions for unplasticized poly(vinyl chloride) (PVC-U) or chlorinated poly(vinyl chloride) (PVC-C) pipes and fittings and for high impact resistance poly(vinyl chloride) (PVC-HI) pipes*

ISO 3127, *Thermoplastics pipes — Determination of resistance to external blows — Round-the-clock method*

ISO 4065, *Thermoplastics pipes — Universal wall thickness table*

ISO/TR 9080:1992, *Thermoplastics pipes for the transport of fluids — Methods of extrapolation of hydrostatic stress rupture data to determine the long-term hydrostatic strength of thermoplastics pipe materials*

ISO 9852, *Unplasticized poly(vinyl chloride) (PVC-U) pipes — Dichloromethane resistance at specified temperature (DCMT) — Test method*

ISO 9969, *Thermoplastics pipes — Determination of ring stiffness*

ISO 11922-1, *Thermoplastics pipes for the conveyance of fluids — Dimensions and tolerances — Part 1: Metric series*

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1 Geometrical definitions

3.1.1
nominal outside diameter
d_n
numerical designation of size which is common to all components in a thermoplastics piping system, other than flanges and components designated by thread size, and is a convenient round number for reference purposes

NOTE For metric pipes conforming to ISO 161-1, the nominal outside diameter, expressed in millimetres, is the minimum mean outside diameter $d_{em,min}$.

3.1.2
mean outside diameter
d_{em}
measured length of the outer circumference of the pipe divided by π and rounded up to the nearest 0,1 mm

NOTE The value of π is taken to be 3,142.

3.1.3
minimum mean outside diameter
$d_{em,min}$
minimum value of the mean outside diameter specified in this International Standard

NOTE It is equal to the nominal outside diameter d_n, expressed in millimetres.

3.1.4
maximum mean outside diameter
$d_{em,max}$
maximum value of the mean outside diameter specified in this International Standard

3.1.5
outside diameter at any point
d_{ey}
outside diameter measured through the cross-section at any point along the pipe, rounded up to the nearest 0,1 mm

3.1.6
out-of-roundness
difference between the measured maximum outside diameter and the measured minimum outside diameter in the same cross-sectional plane of the pipe

3.1.7
nominal wall thickness
e_n
wall thickness, in millimetres, tabulated in ISO 4065, corresponding to the minimum wall thickness at any point $e_{y,min}$

3.1.8
mean wall thickness
e_m
arithmetic mean of at least four measurements regularly spaced around the same cross-sectional plane of the pipe, including the measured minimum and maximum values obtained, rounded up to the nearest 0,1 mm

3.1.9
wall thickness at any point
e_y
wall thickness measured at any point around the circumference of the pipe, rounded up to the nearest 0,1 mm

3.1.10
minimum wall thickness
$e_{y,min}$
minimum wall thickness specified for the pipe in this International Standard

3.1.11
maximum wall thickness
$e_{y,max}$
maximum wall thickness of the pipe, not specified in this International Standard but which can be determined from the tolerance on $e_{y,min}$ given in ISO 11922-1

3.1.12
standard dimension ratio
SDR
numerical designation of a pipe series, which is equal to the ratio of the nominal outside diameter d_n to the nominal wall thickness e_n

$$\text{SDR} = \frac{d_n}{e_n}$$

3.2 Material definitions

3.2.1
high-impact PVC
mixture of unplasticized PVC and an impact-resistance modifier

3.2.2
lower confidence limit
σ_{lcl}
quantity with the dimensions of stress, in megapascals, which can be considered as a property of the material and represents the 97,5 % lower confidence limit of the mean long-term hydrostatic strength at 20 °C for 50 years determined by pressurizing internally with water

[ISO 8085-1]

3.2.3
minimum required strength
MRS
value of σ_{lcl} rounded down to the next value in the R 10 series when σ_{lcl} is less than 10 MPa, or to the next lower value in the R 20 series when σ_{lcl} is greater than or equal to 10 MPa

NOTE The R 10 and R 20 series are the Renard number series as defined in ISO 3 and ISO 497.

[ISO 8085-1]

3.2.4
overall service (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 confidence limit

NOTE For gas applications, C can have any value $\geqslant$ 2,0.

3.3 Definitions related to service conditions

3.3.1
natural gas
gaseous fuel containing a mixture of hydrocarbons, primarily methane, but generally also including ethane, propane and higher hydrocarbons in much smaller amounts

NOTE 1 Natural gas generally also includes some inert gases, such as nitrogen and carbon dioxide, plus minor amounts of trace constituents.

NOTE 2 Natural gas remains in the gaseous state under the temperature and pressure conditions normally found in service.

3.3.2
pressure
overpressure relative to atmospheric pressure

3.3.3
maximum operating pressure
MOP
maximum effective pressure of the gas in a piping system, expressed in bars, which is allowed in continuous use

NOTE It takes into account the physical and the mechanical characteristics of the components of the piping system and is given by the equation:

$$\text{MOP} = \frac{20 \times \text{MRS}}{C \times (\text{SDR} - 1)}$$

[ISO 8085-1]

4 Symbols and abbreviated terms

4.1 Symbols

C overall service (design) coefficient

ΔD indentation, in millimetres

d_{ey} outside diameter at any point

d_{em} mean outside diameter

$d_{em,max}$ maximum mean outside diameter

$d_{em,min}$ minimum mean outside diameter

d_m mean diameter (= $d_{em} - e_m$)

d_n nominal outside diameter

E_{mod} initial modulus of elasticity

e_m mean wall thickness

e_n nominal wall thickness

e_y wall thickness at any point

$e_{y,max}$ maximum wall thickness

$e_{y,min}$ minimum wall thickness

I moment of inertia

p_b internal hydraulic pressure

ε strain, in percent

σ hoop stress

σ_{lcl} lower confidence limit

4.2 Abbreviated terms

PVC-AK acrylate-modified PVC

PVC-CPE chlorinated polyethylene modified PVC

PVC-EPR ethylene propylene rubber modified PVC

MOP maximum operating pressure

MRS minimum required strength

PVC-HI high-impact PVC

PVC-U unplasticized PVC

SDR standard dimension ratio

STIS specific tangential initial stiffness

THT tetrahydrothiophene

5 Operating conditions

When considering the use of PVC-HI pipes, the impact strength and the environmental conditions may have more influence on performance than the internal pressure.

The most commonly used SDR values are 41 and 33. For specific applications, other SDR values can be taken from all series given in ISO 4065 and ISO 161-1. SDR 41 series pipes are suitable for use under a maximum service pressure of 0,2 bar. SDR 33 series pipes are suitable for use under a maximum service pressure of 1,0 bar.

Transport, handling and storage, climatic conditions and the buried environment (notably soil loading) will vary in different countries. It will therefore be necessary to refer to the codes of practice and the local regulations within each country.

6 Product requirements

6.1 Pipe appearance and finish

Pipes shall be conditioned for at least 4 h and then examined visually without magnification.

The internal and external pipe surfaces shall be free from grooves, pits, blisters, indications of burning and other defects. The pipe ends shall be cut cleanly and square to the axis of the pipe. The cut end shall not show any voids.

6.2 Pipe material

6.2.1 Composition

The pipes shall be made of high-impact PVC, to which shall be added only those additives that are necessary to facilitate conformity of the pipes to this International Standard.

The impact-resistance modifier shall be one of the following:

a) a mixture based on PVC;

b) a blend based on PVC;

c) a copolymer based on PVC;

d) a combination of these types.

The proportion of PVC in the material shall be at least 80 % by mass.

NOTE Only materials such as PVC-CPE, PVC-EPR and PVC-AK, for which studies have been completed by ISO/TC 138, are included in this International Standard.

6.2.2 Long-term strength

The MRS value of the material shall be at least 18 MPa. Conformity to this requirement shall be demonstrated using a long-term evaluation in accordance with ISO/TR 9080:1992, method I. Testing shall be carried out at 20 °C, 40 °C and 60 °C, for periods up to 10 000 h. The knee at 60 °C shall occur beyond 5 000 h.

6.2.3 Vicat softening temperature

The Vicat softening temperature of the high-impact PVC shall be not less than 76 °C, when measured in accordance with ISO 2507-1 and ISO 2507-2.

6.2.4 Degree of gelation

When tested in accordance with ISO 9852, the material shall not show any visual deterioration at 15 °C.

6.2.5 *K*-value

The *K*-value of the unplasticized poly(vinyl chloride) (PVC-U) shall exceed 65, when measured in accordance with EN 922.

6.2.6 Initial modulus of elasticity

The initial modulus of elasticity E_{mod} calculated from the specific tangential initial stiffness (STIS) measured in accordance with ISO 9969 shall be at least 2 150 MPa.

$$\text{STIS} = \frac{E_{mod} \times I}{(d_m)^3}$$

$$E_{mod} = \text{STIS} \times \left(\frac{(d_m)^3}{I} \right)$$

$$E_{mod} = \text{STIS} \times \left(\frac{(d_{em} - e_m)^3}{I} \right)$$

where

$$I = \frac{(e_m)^3}{12}$$

6.2.7 Contaminants

When tested in accordance with clause 8 and annex A, the pipe material shall not show any contaminant particles, such as inorganic particles or agglomerations thereof, exceeding 50 µm in size.

6.2.8 UV stability

Test specimens with a d_n of 63 mm shall be exposed for weathering in accordance with clause 8 and annex B. After exposure, the impact resistance of the weathered side shall be determined in accordance with 7.3, using a falling weight of $(750\,^{+5}_{0})$ g and a drop height of $(2\,000\,^{+10}_{0})$ mm.

6.2.9 Resistance to gas constituents

The resistance to gas constituents shall be determined in accordance with clause 8 and annex D.

6.3 Pipe dimensions and tolerances

6.3.1 Nominal outside diameter d_n

The nominal outside diameter d_n shall be selected from those given in Table 1.

6.3.2 Mean outside diameter d_{em}

The mean outside diameter at any point shall conform to Table 1.

6.3.3 Out-of-roundness $(d_{em,max} - d_{em,min})$

The out-of-roundness at any cross-section shall conform to Table 1.

6.3.4 Wall thickness e_y

The wall thickness at any point shall conform to Table 1. The measured value of e_m shall not be less than e_n.

NOTE In order to meet the requirements for handling and resistance to soil loads, a minimum wall thickness of 2,0 mm is specified for all series.

Table 1 — Pipe dimensions and tolerances

Dimensions in millimetres

d_n	Mean outside diameter d_{em}		Out-of-roundness $d_{em,max} - d_{em,min}$	Wall thickness e_y			
				SDR 41[c]		SDR 33[c]	
	min.	max.[a]	max.[b]	min.[d]	max.[e]	min.[d]	max.[e]
25	25	25,2	0,6			2,0	2,4
32	32	32,2	0,8			2,0	2,4
40	40	40,2	1,0			2,0	2,4
50	50	50,2	1,2			2,0	2,4
63	63	63,2	1,6			2,0	2,4
75	75	75,3	1,8	2,0	2,4	2,3	2,8
90	90	90,3	2,2	2,2	2,7	2,8	3,3
110	110	110,4	2,7	2,7	3,2	3,4	3,9
125	125	125,4	3,0	3,1	3,6	3,8	4,4
140	140	140,5	3,4	3,5	4,0	4,3	4,9
160	160	160,5	3,9	3,9	4,6	4,9	5,6
180	180	180,6	4,4	4,4	5,1	5,5	6,3
200	200	200,6	4,8	4,9	5,6	6,1	6,9
225	225	225,7	5,4	5,5	6,3	6,9	7,8
250	250	250,8	6,0	6,1	7,0	7,6	8,6
280	280	280,9	6,8	6,9	7,6	8,6	9,6
315	315	316,0	7,6	7,7	8,7	9,6	10,8
355	355	356,0	8,6	8,7	9,6	10,8	12,1
400	400	401,0	9,6	9,8	11,0	12,2	13,6
450	450	451,0	10,8	11,0	12,3	13,7	15,3
500	500	501,0	12,0	12,2	13,7	15,2	16,9
560	560	561,0	13,5	13,7	15,2	17,0	18.9
630	630	631,0	15,2	15,4	17,2	19,1	21,3

a $0{,}003d_{em}$ rounded up to the nearest 0,1 mm, with a minimum of 0,2 mm and a maximum of 1 mm.

b $0{,}024d_{em}$ rounded up to the next 0,1 mm.

c The designation SDR applies starting from a nominal diameter of 63 mm.

d $e_{y,min} = e_n$

e $1{,}1e_n$ + 0,2 mm, rounded up to the nearest 0,1 mm.

7 Functional requirements

7.1 Longitudinal reversion

Longitudinal reversion shall be determined in accordance with clause 8 of this International Standard, ISO 2505-1:1994 and ISO 2505-2:1994.

Using the test parameters given in ISO 2505-2:1994, Table 2, for PVC-U, the calculated longitudinal reversion shall be $\leqslant 5$ %.

In addition, there shall be no visible cracks, voids or blisters.

7.2 Resistance to internal hydrostatic pressure

When tested in accordance with clause 8 and annex E, using the pressures and temperatures given in Table 2, the failure time shall be in accordance with Table 2.

Table 2 — Minimum failure times at a given temperature and hoop stress

Temperature °C	Hoop stress MPa	Minimum failure time h
20	30	1
	25	100
60	9	1 000

The internal hydrostatic pressure p_b, expressed in MPa, shall be calculated using the following equation:

$$p_b = \frac{2\sigma \times e_{y,min}}{d_{em} - e_{y,min}}$$

where σ is the specified hoop stress, expressed in MPa.

7.3 Resistance to impact

When tested in accordance with clause 8 and annex C, under the conditions given in Table 3, the pipes shall either exhibit no failure in 60 tests or shall fail not more than two out of 100 tests.

NOTE These requirements are based on a true impact rate (TIR) of not more than 5 % with a reliability interval of 90 %. This is illustrated graphically in Figure C.1 of annex C.

7.4 Ring stiffness of pipes with $d_n \geqslant 63$ mm

When determined in accordance with clause 8 and annex F, the initial value for the ring stiffness shall not be less than 2,75 kN/m^2 for SDR 41 pipes and 5,50 kN/m^2 for SDR 33 pipes.

Table 3 — Conditions for impact resistance testing

d_n mm	Falling weight g	Drop height mm
25	500^{+5}_{0}	$2\,000^{+10}_{0}$
32	750^{+5}_{0}	
40	$1\,000^{+10}_{0}$	
50	$1\,250^{+10}_{0}$	
63	$1\,750^{+15}_{0}$	
75	$2\,250^{+15}_{0}$	
90	$3\,000^{+15}_{0}$	
110	$4\,000^{+15}_{0}$	
$\geqslant 125$	$4\,000^{+15}_{0}$	

8 Test specimens

All test specimens used shall be at least 15 h old.

The tests shall be carried out in triplicate, unless otherwise specified. In addition, a representative selection of the different dimensions from the entire range of dimensions shall be made.

The pipe dimensions shall be checked using a measuring instrument capable of reading to $\pm 0{,}05$ mm. The values shall conform to those given in clause 6 in addition to any values specified by the manufacturer.

9 Marking

The pipes shall be clearly and durably marked in accordance with the relevant national standard with the word "Gas" and the following information:

— the manufacturer's mark;

— the material designation;

— the nominal outside diameter;

— for $d_n \leqslant 63$ mm: the mean wall thickness e_m, and for $d_n > 63$ mm: the SDR designation;

— the production period (year and week, if desired coded);

— the extruder number.

The marks shall be made in such a way that the properties of the pipe are not adversely affected.

Annex A
(normative)

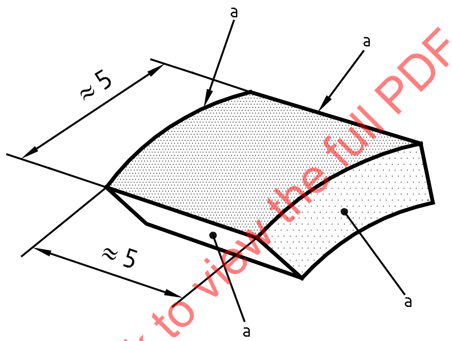
Examination for contaminant particles

Cut out at random from a pipe five test specimens, each measuring approximately 5 mm × 5 mm and of the thickness of the pipe wall (see Figure A.1). Cool the specimens for 20 min in liquid nitrogen in order to prevent any deformation during the subsequent microtoming.

Smooth the radial surfaces of the test specimens using a microtome with a diamond-tipped blade.

Examine the smoothed surfaces, using transmitted light, under a microscope with a graduated ocular (having 0,01 mm divisions) for contaminant particles exceeding 50 µm in size.

Dimensions in millimetres



[a] All four radial surfaces to be smoothed and examined.

Figure A.1 — Test specimen for contaminant-particle examination

Annex B
(normative)

Weathering procedure

Carry out the weathering procedure on pipes with a d_n of 63 mm in accordance with ISO 877:1994, method A.

Expose a total of 24 test specimens with a length of 1 m to sunlight at the selected site, at 45° facing south for countries in the northern hemisphere and at 45° facing north for countries in the southern hemisphere. Set up the test specimens next to each other in such a way that they are in the same plane. Record the incident radiation energy *in situ*.

After exposure to a total incident radiation energy of 3,5 GJ/m^2, cut each test specimen into five pieces of about 200 mm in length for impact resistance testing.

Annex C
(normative)

Determination of resistance to impact at 0 °C

C.1 Apparatus

Carry out the impact resistance test using the apparatus described in ISO 3127, except for the shape of the bottom face of the falling weight and observing the conditions given in Table 3. The bottom face of the falling weight shall be in the form of a hemisphere of diameter (25 ± 0,5) mm.

C.2 Procedure

Carry out the test as described in ISO 3127, using a temperature of (0 ± 1) °C for conditioning and testing. The minimum number of blows shall be 60.

C.3 Interpretation of results

Figure C.1 shows the different areas for the number of fractured specimens in relation to the number of blows for which the lot has a TIR smaller than 5 % or a TIR greater than 5 %, and the area where no decision can be taken.

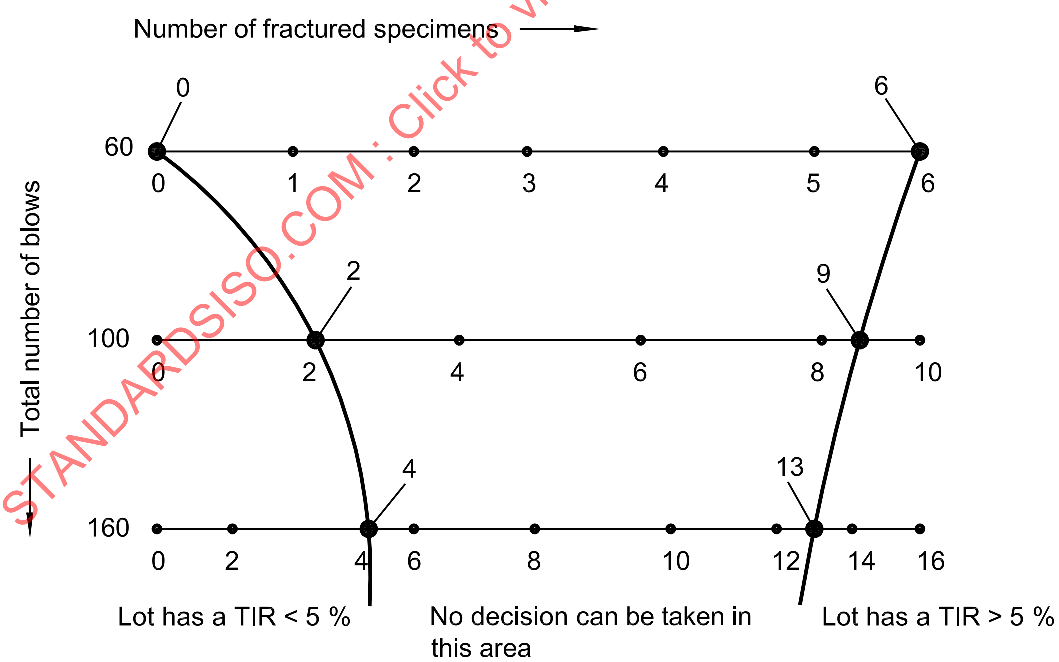


Figure C.1 — Number of specimens for the determination of a true impact rate (TIR) of less than 5 % with a reliability interval of 90 %

Annex D
(normative)

Determination of resistance to gas constituents

Use pipes with a d_n of 63 mm for testing. Cut five rings having a width of (10 ± 1) mm from such pipes. Age the rings for (24 ± 1) h at (60 ± 4) °C and, after allowing to cool to (23 ± 2) °C, measure the maximum wall thickness and the mean outside diameter of each ring.

Place the rings in a U-shaped holder, ensuring that the position of maximum wall thickness coincides with one of the points which will be subsequently compressed. Compress the rings in the holder to an extent ΔD, in mm, calculated from the following equation:

$$\Delta D = \varepsilon \times \frac{(d_{em} - e_{max})^2}{4{,}27 \times e_{max} \times 100}$$

where

ε is the strain, in % (= 1,0 %);

e_{max} is the measured maximum wall thickness, in mm;

d_{em} is the measured mean outside diameter, in mm.

The actual extent of the compression shall correspond to the calculated value to within ± 0,1 mm.

After 5 h, place the holder and rings in a sealed glass vessel connected to a reservoir filled with nitrogen containing (75 ± 5) mg of tetrahydrothiophene (THT) per m^3 of N_2. No part of the apparatus coming into contact with the gas mixture shall absorb any THT. The exact concentration of the THT shall be determined by gas chromatography.

Pass a gentle flow of this gas mixture through the glass vessel and back into the reservoir for a minimum of 1 300 h at a temperature of (23 ± 2) °C.

After the required exposure time, take the rings from the holder and expose them for at least 1 h to ambient air.

Determine the THT concentration in the gas mixture again by gas chromatography. The concentration shall have remained within the limits given above.

Cut two segments about 20 mm long from each ring at the position of maximum inside tensile stress (i.e. the position of maximum thickness).

Place each segment in a microtome apparatus, orienting the segment so that slices will be cut from one of the long sides. Clamp the segment in place between two jaws, one of radius equal to the radius of the pipe inside surface and the other of radius equal to the radius of the pipe outside surface. The microtome blade shall have the shape shown in Figure D.1 and shall be adequately supported to prevent it bending.

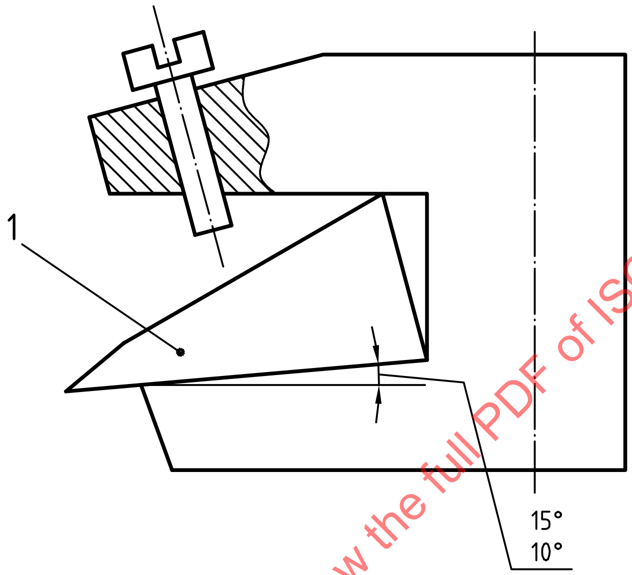
After several slices have been cut to make the surface smooth, cut slices of (7^{+3}_{-1}) µm thickness. From each segment, cut at least 10 suitable slices, evenly spaced across the entire width of the segment. Leather the microtome blade after every 20 cuts.

Prepare microscope viewing specimens from the slices by placing each slice between two slides, using *n*-hexadecane (analytical grade) as the contact liquid. Examine the slices using transmitted light at a magnification of ×100. Cracks or crazing having a depth of over 30 µm are unacceptable.

NOTE 1 It is recommended that the correct use of this method be checked using a segment from an unexposed pipe in order to ensure that the apparatus being used is as specified and that the technique has been sufficiently mastered. The slides from the unexposed pipe shall show no cracks, crazing or damage of any other nature.

NOTE 2 The conditions of this test are geared to those encountered in practice.

NOTE 3 Cracks or crazing less than 30 µm deep are not regarded as initiating stress corrosion. In addition, they have been found to have no effect on the impact resistance of the material.



Key

1 Blade

Figure D.1 — Mounting of blade in microtome