

INTERNATIONAL STANDARD

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High-density polyethylene (PE-HD) pipes and fittings for soil and waste discharge (low and high temperature) systems inside buildings — Specifications

Tubes et raccords en polyéthylène haute densité (PE-HD) pour les systèmes d'évacuation d'eaux usées et d'eaux-vannes (à basse et à haute température) à l'intérieur des bâtiments — Spécifications



Reference number
ISO 8770:1991(E)

Foreword

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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.

International Standard ISO 8770 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*.

Annexes A, B, C, D, E, F and G form an integral part of this International Standard. Annex H is for information only.

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High-density polyethylene (PE-HD) pipes and fittings for soil and waste discharge (low and high temperature) systems inside buildings — Specifications

1 Scope

This International Standard lays down the specifications for high-density polyethylene (PE-HD) pipes and fittings, with nominal outside diameters of 32 mm to 315 mm, intended for domestic installation inside buildings for

- a) soil and waste discharge pipelines (including the ventilation of these pipes), and
- b) internal rainwater pipes

for the transportation of domestic waste waters¹⁾ (low and high temperature).

The pipes and fittings are for jointing mainly by butt-welding, by electro-welded sockets and by sockets with elastomeric sealing rings.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 265-1:1988, *Pipes and fittings of plastics materials — Fittings for domestic and industrial waste pipes — Basic dimensions: Metric series — Part 1: Unplasticized poly(vinyl chloride) (PVC-U)*.

ISO 1043-1:1987, *Plastics — Symbols — Part 1: Basic polymers and their special characteristics*.

ISO 1133:1991, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics*.

ISO 1167:—²⁾, *Thermoplastics pipes for the transport of fluids — Resistance to internal pressure — Test method and basic specification*.

ISO 2506:1981, *Polyethylene pipes (PE) — Longitudinal reversion — Test methods and specification*.

ISO 3126:1974, *Plastics pipes — Measurement of dimensions*.

ISO 3607:1977, *Polyethylene (PE) pipes — Tolerances on outside diameters and wall thicknesses*.

ISO 3663:1976, *Polyethylene (PE) pressure pipes and fittings, metric series — Dimensions of flanges*.

ISO/TR 7024:1985, *Above-ground drainage — Recommended practice and techniques for the installation of unplasticized polyvinyl chloride (PVC-U) sanitary pipework for above-ground systems inside buildings*.

1) For the definition of the term "domestic waste waters" refer to annex A or, alternatively, to national regulations.
2) To be published. (Revision of ISO 1167:1973)

3 Symbols

The symbols used in this International Standard are given in table 1.

Table 1 — Symbols

Symbol	Meaning
D	Nominal outside diameter of pipe
$D_{e,m}$	Mean outside diameter
$d_{s,m}$	Socket mean inside diameter
e	Nominal wall thickness
e_2	Wall thickness at socket cylindrical part
e_3	Wall thickness at socket groove
l_1	Spigot length
l	Nominal length of pipe
A	Length of engagement
C	Length of socket mouth

4 Material

4.1 The material shall consist of polyethylene (PE) to which may be added only those additives needed to facilitate the manufacture of sound, durable pipes and fittings of good surface finish.

When required by national regulations, further appropriate additives may be used to retard the flammable properties of the material.

When sealing rings are retained by means of retaining caps or rings, the retaining caps or rings may be made from polymers other than PE provided that they conform to the same functional dimensions and test requirements as applied to sockets with either loose or fixed seal rings.

4.2 The use of the manufacturer's own clean rework material is permissible provided that it conforms to the requirements of this International Standard. No other rework material shall be used.

4.3 Carbon black added to ensure resistance to ultraviolet light shall comply with the following requirements:

- mass content: 2,4 % \pm 0,6 %

- density: 1 500 kg/m³ to 2 000 kg/m³
- average particle size: 0,01 μ m to 0,025 μ m

5 Geometrical characteristics

NOTE 1 The figures are schematic sketches only, to help demonstrate relevant dimensions. They do not necessarily represent manufactured components.

All measurements of dimensions shall be carried out in accordance with ISO 3126.

5.1 Pipe dimensions

The pipe dimensions are illustrated in figure 1.

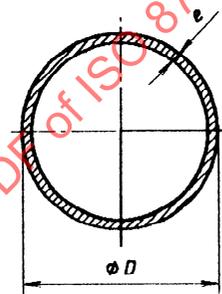


Figure 1 — Dimensions

5.1.1 Outside diameter

The nominal outside diameter D shall be in accordance with table 2.

Tolerances on mean outside diameters $D_{e,m}$ shall be in accordance with ISO 3607.

Table 2 — Nominal outside diameter

Dimensions in millimetres

32	40	50	63	75	90	110	125	160	200	250	315
<p>NOTE — These values have been taken from ISO 161-1:1978, <i>Thermoplastics pipes for the transport of fluids — Nominal outside diameters and nominal pressures — Part 1: Metric series.</i></p>											

5.1.2 Wall thickness

The nominal wall thickness e shall be in accordance with table 3. Tolerances on wall thickness shall be in accordance with ISO 3607.

5.1.3 Length

The nominal length l of a pipe shall be measured as shown in figure 2.

The nominal pipe length shall be agreed between the interested parties.

The tolerance on the agreed pipe length shall be $\pm [(0,1 \% \text{ of } l) + 10 \text{ mm}]$, measured at a temperature of $23 \text{ }^\circ\text{C} \pm 2 \text{ }^\circ\text{C}$.

5.2 Fitting dimensions

5.2.1 Basic dimensions

Basic dimensions of fittings shall be in accordance with ISO 265-1.

The angles of branches shall be 45° , 60° , $(67,5^\circ)$, $(87,5^\circ)$ or $88,5^\circ$, where the values given in parentheses are non-preferred.

5.2.2 Wall thickness

The nominal wall thickness of the body of a fitting shall be at least equal to the values given in table 3.

Table 3 — Nominal wall thickness

Dimensions in millimetres

Nominal outside diameter D	Nominal wall thickness e			
	Pipe series S16		Pipe series S12.5	
32	3			
40	3			
50	3			
63	3			
75	3			
90	3			
110	3,4		4,2	
125	3,9		4,8	
160	4,9		6,2	
200	6,2		7,7	
250	7,7		9,6	
315	9,7		12,1	

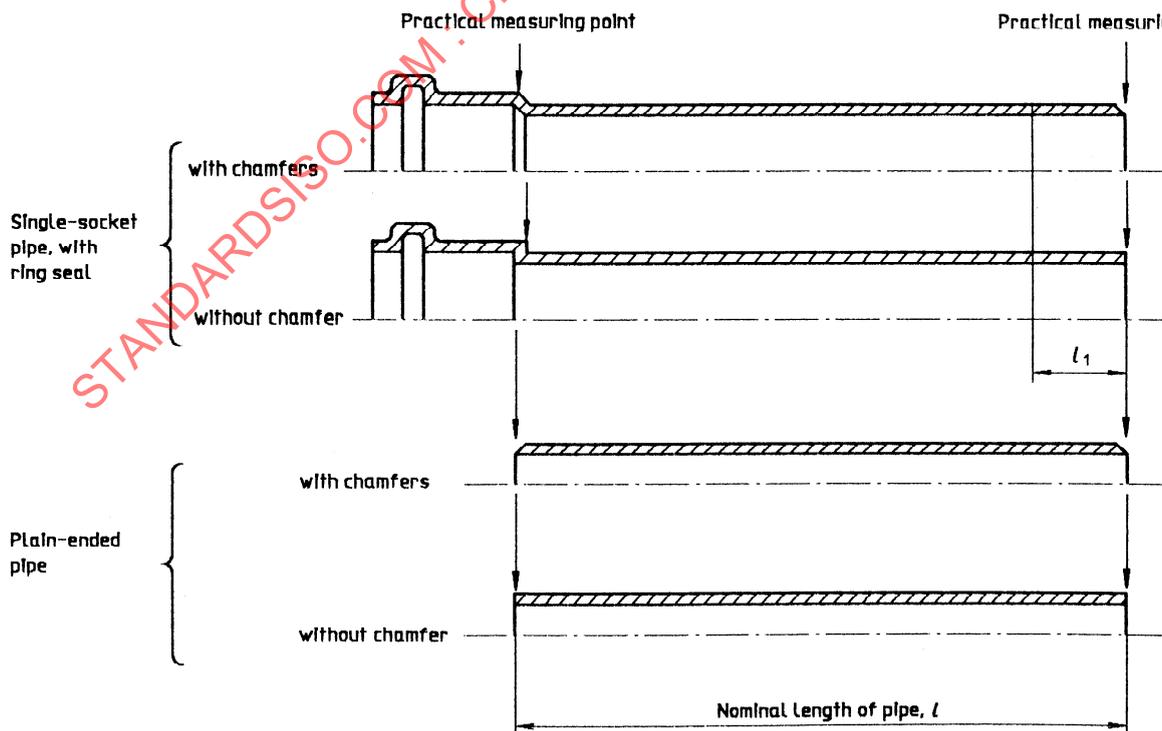


Figure 2 — Nominal pipe length and definitions

5.3 Socket and spigot dimensions of pipes and fittings

The basic dimensions of sockets and spigots of pipes and fittings shall be calculated as follows:

$$A_{\min} = 0,2D + 18 \text{ mm, at least 28 mm}$$

$$C_{\max} = 0,2D + 18 \text{ mm}$$

$$l_{1, \min} = 0,4D + 18 \text{ mm, at least 46 mm}$$

5.3.1 Basic dimensions

A socket and spigot joint fitted with a sealing component complying with this International Standard shall accommodate the thermal movement due to temperature variations in waste water of a pipe of nominal length l without losing its tightness. The basic dimensions shall be in accordance with table 4 (see also figure 3).

Where sealing rings are firmly fixed and have multiple sealing zones, the dimensions A_{\min} and C_{\max} (see figure 4) shall be measured to the effective sealing point as specified by the manufacturer. C_{\max} shall be checked with a gauge, as this dimension determines the tightness of the joint.

Table 4 — Basic dimensions of sockets and spigots

Dimensions in millimetres

Nominal outside diameter D	Minimum mean inside diameter of the socket $d_{s, m, \min}$	Maximum length of the socket mouth C_{\max}	Minimum length of engagement A_{\min}	Minimum length of the spigot end $l_{1, \min}$
32	32,4	25	28	46
40	40,5	26	28	46
50	50,6	28	28	46
63	63,7	31	31	49
75	75,8	33	33	51
90	91	36	36	54
110	111,1	40	40	62
125	126,3	43	43	68
160	161,6	50	50	82
200	201,9	58	58	98
250	252,4	68	68	118
315	318	81	81	144

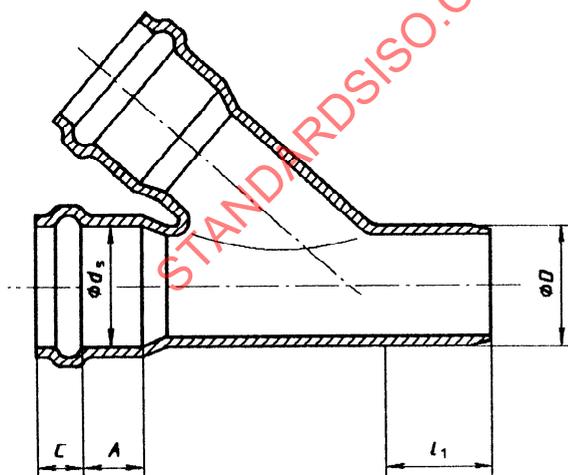


Figure 3 — Basic dimensions

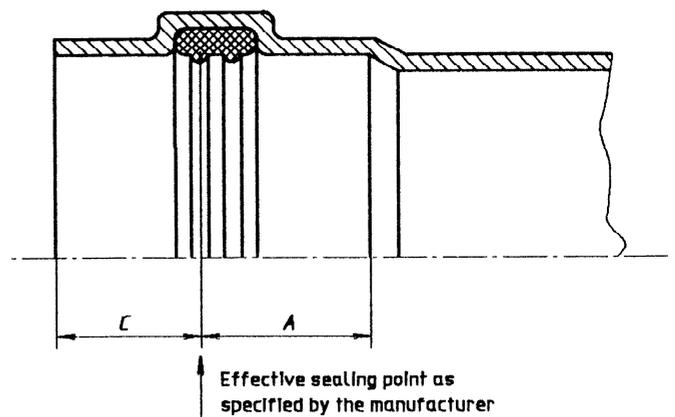


Figure 4 — Effective sealing point

5.3.2 Wall thickness

The minimum wall thickness of sockets for sealing joints shall meet the requirements of table 5 (see figure 5 for an example).

When a sealing ring is firmly retained by means of a retaining component (see figure 6 for an example), the wall thickness of the socket in this area and that of the retaining component may be added together to achieve the required e_3 dimension provided that they are not separated by the sealing ring.

In all cases, the components shall meet the functional test requirements specified in clause 8.

5.3.3 Inside diameter

The minimum mean inside diameter $d_{s, m, min}$ of the cylindrical part of the socket is calculated as follows:

$$d_{s, m, min} = 1,009D + 0,1 \text{ mm}$$

The values shall be in accordance with table 4.

NOTE 2 The maximum mean inside diameter $d_{s, m, max}$ depends on the sealing ring shape, dimensions and hardness specified by the manufacturer.

Table 5 — Minimum wall thickness of sockets on pipe ends and fittings

Dimensions in millimetres

Nominal outside diameter D	Pipe series			
	S16		S12,5	
	Minimum wall thickness			
	$e_{2, min}$	$e_{3, min}$	$e_{2, min}$	$e_{3, min}$
32	2,7	2,3	2,7	2,3
40	2,7	2,3	2,7	2,3
50	2,7	2,3	2,7	2,3
63	2,7	2,3	2,7	2,3
75	2,7	2,3	2,7	2,3
90	2,7	2,3	3,2	2,7
110	3,1	2,6	3,8	3,2
125	3,6	3	4,4	3,6
160	4,5	3,7	5,6	4,7
200	5,6	4,7	7	5,8
250	7	5,8	8,7	7,2
315	8,8	7,3	10,9	9,1

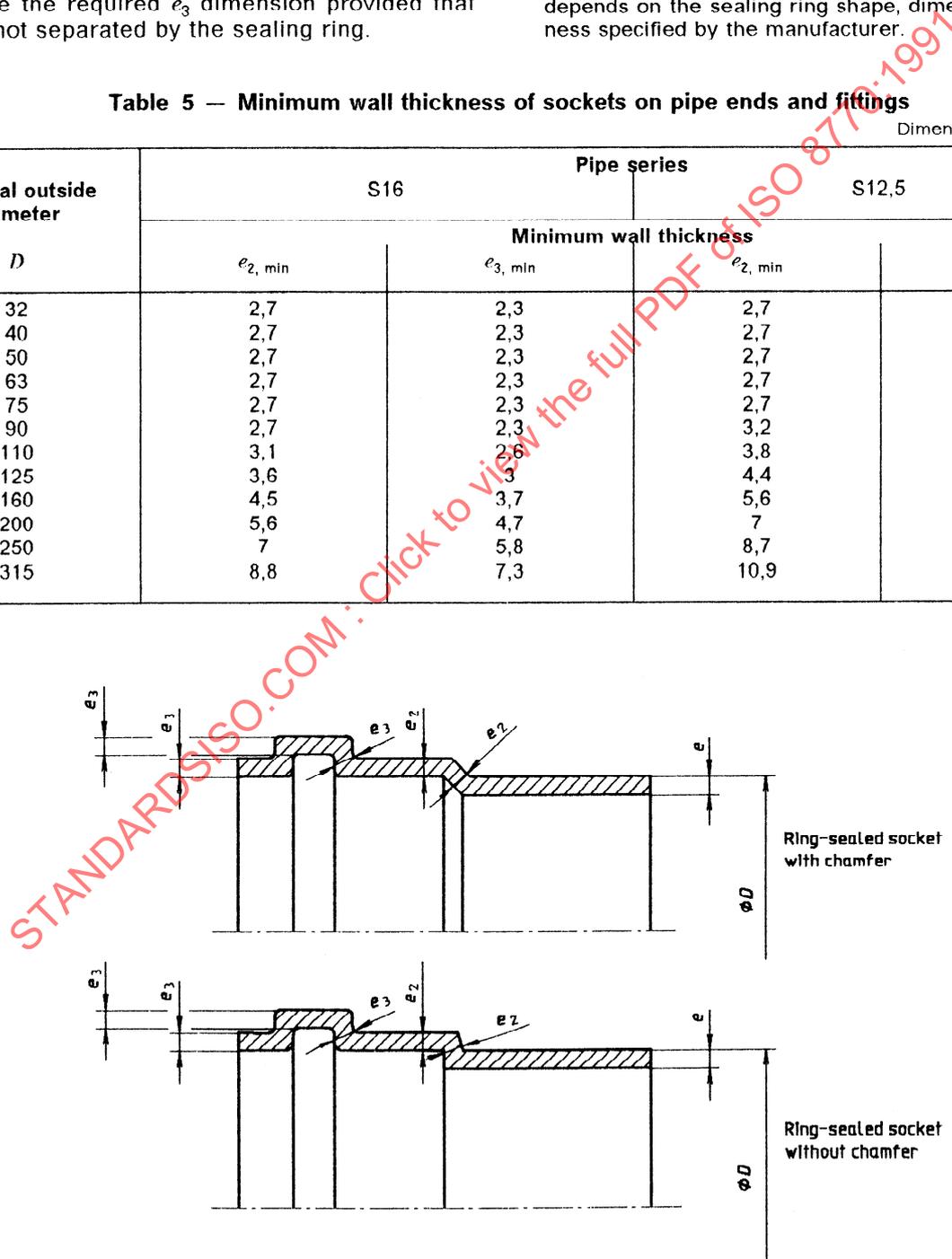


Figure 5 — Socket details

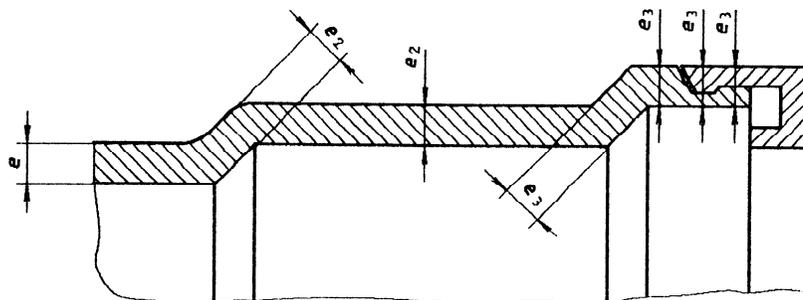


Figure 6 — Example of a seal retaining cap

6 Mechanical test requirements

The resistance to internal pressure of the pipe and fitting material shall be confirmed by a hydrostatic internal pressure test in accordance with ISO 1167. The test parameters are given in table 6.

Five test pieces (selected at random) of the same nominal outside diameter shall be tested.

The test pieces shall be in pipe form. They are either extruded from the pipe material or, in the case of fittings made of a material different from that of the pipes, injection-moulded to pipe form from the fitting material.

If any of the five test pieces bursts before the specified period of test has elapsed, the test shall be stopped and repeated with a second set of five test pieces taken at random from the batch. In the retest all test pieces shall meet the requirement or the material shall be considered to have failed the test.

Table 6 — Internal pressure test data

Water temperature °C	Test time h	Induced stress MPa 1)
80 ± 1	170	3,9
1) 1 MPa = 1 N/mm ²		

7 Physical test requirements

7.1 Longitudinal reversion of pipes

The longitudinal reversion of pipes, as determined in accordance with ISO 2506 at a temperature of 110 °C, shall not exceed 3 %.

7.2 Oven test for fittings

After testing in accordance with annex B, fittings shall not exhibit excessive blistering, delamination, cracking or signs of weld-line splitting. Weld lines may become pronounced during the test, but this shall not be considered as a failure. Deviations from the original geometric shape shall not be deemed a failure either. In the vicinity of injection points, the depth of penetration of cracks, etc., shall be less than 50 % of the local wall thickness.

7.3 Melt flow rate

The melt flow rate of pipes and fittings shall be tested in accordance with ISO 1133. The melt flow rate (MFR) shall be in the range $0,3 \text{ g}/10 \text{ min} \leq \text{MFR} (190, 5) \leq 1 \text{ g}/10 \text{ min}$.

8 Functional test requirements

The functional testing shall be repeated wherever there is any change in the material, design or dimensions of the fittings.

8.1 Watertightness

Joints between pipes and fittings, pipes and pipes, and fittings and fittings shall not leak when tested in accordance with annex C at an ambient temperature of $23 \text{ °C} \pm 5 \text{ °C}$.

8.2 Airtightness

Joints between pipes and fittings, pipes and pipes, and fittings and fittings shall remain airtight when tested in accordance with annex D at an ambient temperature of $23 \text{ °C} \pm 5 \text{ °C}$.

8.3 Elevated-temperature cycling

The test assembly used shall meet the requirements given in either annex E or annex F. Where national standards specify which of these two tests is to be used, they shall be complied with.

Annex G specifies the information to be provided and the symbols to be used in the test report.

9 Jointing

Pipes and fittings which comply with the specifications of this International Standard may be connected to each other in the following various ways.

9.1 Butt-welded joint

The joint shall be made in accordance with the instructions given by the pipe manufacturer.

9.2 Elastomeric sealing ring socket joint

The socket joint shall comply with the specifications of this International Standard. The dimensions of the sealing elements are dependent on the specific system and shall meet the manufacturer's specification. These elements shall not have a detrimental effect on the pipe or fittings, as demonstrated by the functional requirements.

Further requirements will be stated in future specifications (for rubber sealing rings for drainage purposes, see ISO 4633:1983, *Rubber seals — Joint rings for water supply, drainage and sewerage pipelines — Specification for materials*).

9.3 Flanged joint

The flanges shall comply with ISO 3663 or be the subject of a technical agreement between the interested parties.

9.4 Other joints

When using other jointing methods, such as mechanical, socket fusion, ring seal compression fittings or electro-welded sockets, the recommendations given by the manufacturer shall be followed.

10 Delivery conditions

10.1 Appearance

The internal and external surfaces of pipes and fittings shall be smooth and free from grooving, blistering and any other surface discontinuities. The materials shall not contain visible impurities or pores. Pipe ends shall be cleanly cut, and the ends

of pipes and fittings shall be square with the axis of the pipe.

10.2 Colour

The colour of pipes and fittings shall normally be black. However, other colours may be supplied as agreed between the interested parties.

11 Marking

Pipes, fittings and sealing rings shall be marked clearly and indelibly so that legibility is maintained for the life of the products under normal conditions of storage, weather and use.

The markings may be integral with the product or on a label. The markings shall not damage the product.

11.1 Pipes

Pipes shall be marked with at least the following information:

- manufacturer's name or trade mark;
- pipe material;
- nominal diameter of pipe;
- nominal wall thickness of pipe;
- manufacturing information, in plain text or in code, providing traceability of the production period to within the year and month and the production site if the manufacturer is producing at several national or international sites;
- the number of this International Standard.

Pipes with a nominal laying length up to and including z_2 metres shall be marked at least once. Pipes with a nominal laying length greater than z_2 shall be marked at intervals of z_3 metres at the most. The value of z_2 and z_3 shall be as specified by the authorities in each country.

11.2 Fittings

Fittings shall be marked with at least the following information:

- manufacturer's name or trade mark;
- fitting material (may be given on packing only in the case of PVC, provided this information is not required on each article by national authorities);
- nominal diameter of fitting;

- classification (where applicable);
- values of angles, if any;
- manufacturing information, in plain text or in code, providing traceability of the production period to within the year and month and the production site if the manufacturer is producing at several national or international sites (may be given on packing only, provided this information is not required on each article by national authorities);
- the number of this International Standard (may be given on packing only, provided this information is not required on each article by national authorities).

11.3 Sealing rings

Sealing rings shall be marked with at least the following information:

- manufacturer's name or trade mark;
- nominal dimension of ring;
- manufacturing information, in plain text or in code, providing traceability of the production period to within the year and the production site if the manufacturer is producing at several national or international sites.

No markings are required on sealing rings which are moulded to pipes or fittings or any other marked component.

11.4 Designation of the material (in accordance with ISO 1043-1)

PE-HD

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Annex A (normative)

Definition of domestic waste waters

domestic waste waters: Waters discharged and diverted into the sewage system, in particular

- a) waters that have become altered in composition and have become fouled (or impure) by being used domestically (including waters from flushing systems containing human excrement and, if necessary or authorized, animal excrement, and

waters from normal households, offices, old people's homes, hotels, schools, etc.), and

- b) rainwater, if a separate discharge channel is not available.

Such waters never have a temperature exceeding 100 °C continuously for more than 2 min and have a pH value normally in the range pH 2 to pH 12.

Annex B (normative)

Oven test for fittings

B.1 Apparatus

B.1.1 Oven, in which the fittings can be exposed to a temperature of $110\text{ °C} \pm 2\text{ °C}$.

B.2 Test pieces

Select three test pieces, which shall be complete fittings, from each type of fitting.

If the fitting incorporates an elastomeric sealing ring, this shall be removed before testing.

B.3 Procedure

Heat the oven to $110\text{ °C} \pm 2\text{ °C}$. Put the test pieces in the oven and arrange them so that they are standing on one of their sockets, avoiding all contact with other test pieces or the sides of the oven.

Allow the oven to return to a temperature of $110\text{ °C} \pm 2\text{ °C}$ and then leave the test pieces in the oven for 60 min if the wall thickness $e \leq 8\text{ mm}$ or 120 min if $e > 8\text{ mm}$.

Remove the test pieces from the oven taking care not to deform or damage them.

Allow the test pieces to cool in air until they can be handled and examined.

Annex C
(normative)

Watertightness test

C.1 Apparatus

C.1.1 Apparatus, to which the test assembly can be connected, allowing a controlled water pressure to be applied.

C.1.2 Precision pressure gauge.

C.2 Test assembly

Pipes, fittings and joints in accordance with this International Standard in all other respects shall be used.

The connection (joint) shall be made in accordance with the manufacturer's instructions.

C.3 Procedure

If the joint to be tested permits deflection, perform the test with the test assembly under the maximum possible deflection of the axis without forcing.

Connect the test assembly (see clause C.2) to the precision pressure gauge (C.1.2). By allowing water to enter the test assembly, gradually increase the internal pressure from 0 MPa to 0,05 MPa (0 bar to 0,5 bar) over a period of not less than 15 min and maintain the pressure of 0,05 MPa (0,5 bar) for at least 15 min.

C.4 Test requirement

The test requirement (see 8.1) shall be fulfilled for all types of test assembly, including those combining minimum spigot ends and maximum sockets.

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Annex D (normative)

Airtightness test

D.1 Apparatus

D.1.1 Apparatus, to which the test assembly can be connected, allowing a controlled air pressure to be applied.

A suitable apparatus is shown in figure D.1.

D.1.2 Precision pressure gauge or manometer.

D.2 Test assembly

Pipes, fittings and joints in accordance with this International Standard in all other respects shall be used.

The connection (joint) shall be made in accordance with the manufacturer's instructions.

The test assembly shall consist of a specimen of pipe mounted in two clamped blocks. Seal one end of the pipe with a plug that has a combined water and air inlet. Insert any fitting or joint into the open end of the pipe. The joint or fitting shall then be sealed at all open ends with plugs, one of which has a water outlet and shut-off valve mounted centrally in the sealing plug.

D.3 Procedure

D.3.1 Apply a strong solution of soapy water or detergent around the annular space between the mouth of the fitting and the pipe.

D.3.2 Open the water outlet valve and close the air inlet valve on the pipe shut-off.

D.3.3 Open the water inlet valve. When the assembly is half full, that is to say when water flows from the outlet, close the water inlet and outlet valves.

D.3.4 Open the air inlet valve and increase the internal air pressure to $0,01 \text{ MPa} \pm 0,001 \text{ MPa}$ ($0,1 \text{ bar} \pm 0,01 \text{ bar}$) at ambient temperature. Maintain this pressure for 5 min.

D.3.5 Note, during this 5 min period, any leaks which occur between the mouth of the fitting and the pipe, and which are evident by the formation of bubbles.

D.3.6 Deflect the pipe manually in the socket of the fitting until it reaches the maximum permissible deflection for the particular joint under test. Carry out this deflection at 0° , 90° , 180° and 270° (see figure D.1), maintaining it for 1 min in each of these directions.

D.4 Test requirements

No water leaks shall occur, but if bubbles appear at any time during the test, a new application of soapy water or detergent shall be made. If there is still a continuous emission of bubbles during the test, the joint shall be deemed not to meet the requirements of the test.

The test requirements (see 8.2) shall be fulfilled for all types of test assembly, including those combining minimum spigot ends and maximum sockets.

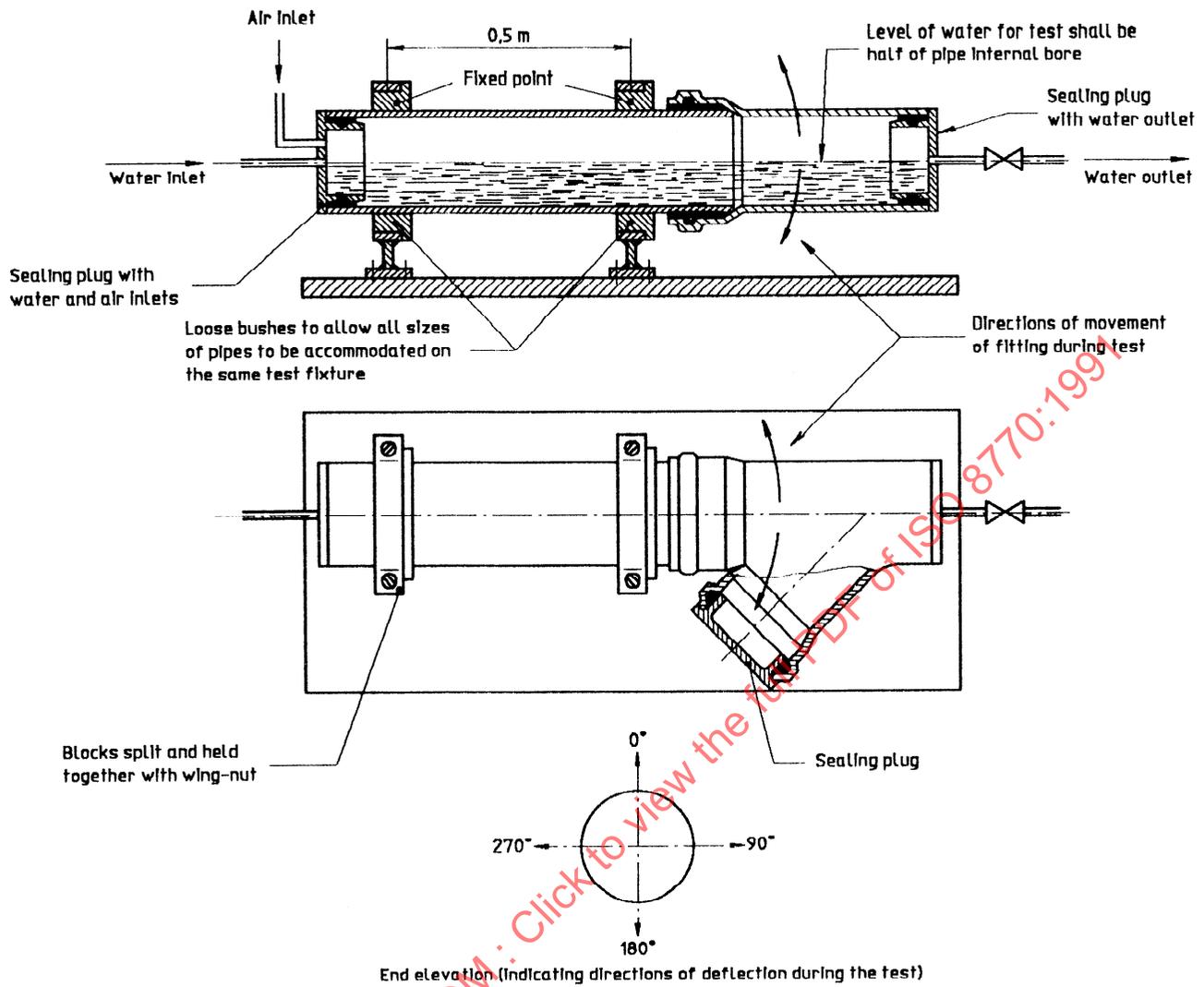


Figure D.1 — Test assembly for airtightness test

Annex E (normative)

Elevated-temperature cycling test — 1 500-cycle test

E.1 Test assembly

The test assembly shall consist of a vertical stack of pipes with fittings and two near-horizontal pipe assemblies with fittings in accordance with figure E.1. Installation shall be carried out on a firm wall or frame with guide and anchor brackets, with no other support of the test assembly.

Anchor brackets shall be located directly below or behind the sockets of each pipe length. Guide brackets shall be placed not less than $10D$ apart for near-horizontal assemblies. (An exception to this is the first pipe in the near-horizontal line from the inlet, where possible sagging is to be measured.)

Room for expansion of pipes shall be provided for all spigot ends of pipes, but not for the spigot ends of fittings. The entry of hot water into the test assembly shall be direct; there shall be no heat-absorbing intermediate pieces.

E.2 Procedure

E.2.1 Carry out a watertightness test on the test assembly under the conditions described in F.3.1.

E.2.2 Subject the test assembly to the passage of hot and cold water according to the following schedule for 1 500 cycles:

a) 30 l of water at a temperature of $93\text{ °C} \pm 2\text{ °C}$

(measured at the point of entry) over a period of 1 min (30 l/min);

b) rest and drain period of 1 min;

c) 30 l of water at a temperature of $15\text{ °C} \pm 5\text{ °C}$ (measured at the point of entry) over a period of 1 min (30 l/min);

d) rest and drain period of 1 min.

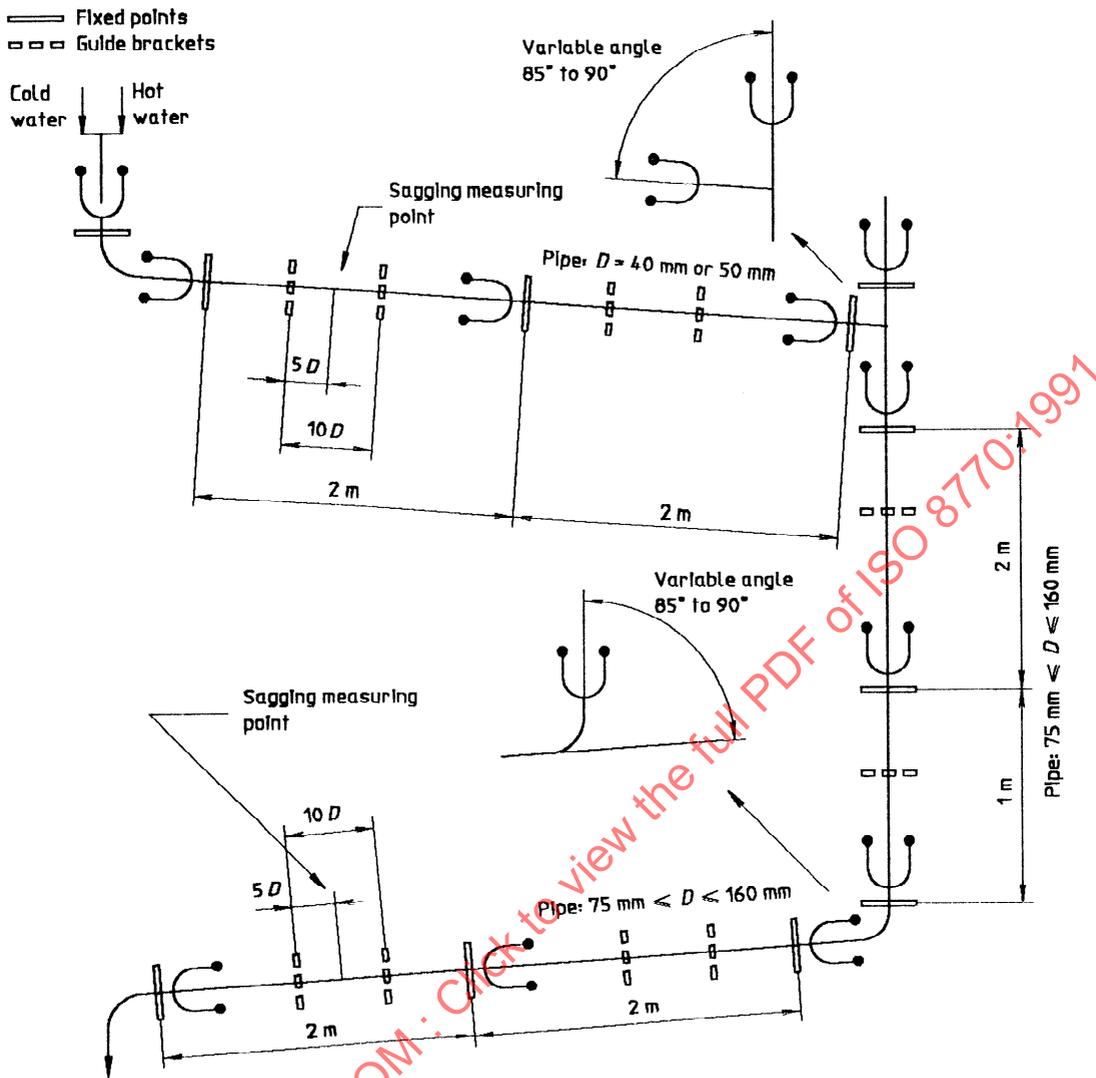
E.3 Test requirements

E.3.1 On completion of the test, fill the test assembly with water, at a temperature not exceeding 20 °C , to a head of 0,5 m. Leave for a minimum period of 15 min and then visually check for leaks. Any leakage shall be deemed a failure of the test assembly.

E.3.2 Check for sagging between guide brackets at a distance of $5D$ from any individual bracket. Any sagging greater than $0,1D$ shall be deemed a failure.

E.4 General information

See annex G.



NOTE - The fittings shall be assembled without undue stresses. The test assembly illustrated is only representative and the positions of the joints are not mandatory but should follow appropriate installation techniques (see ISO/TR 7024) and the manufacturer's instructions.

Figure E.1 Test assembly for elevated-temperature cycling test (1 500 cycles)

Annex F (normative)

Elevated-temperature cycling test — 5-cycle test

F.1 Test assembly

The test assembly shall consist of a vertical stack of pipes with fittings and two near-horizontal pipe assemblies with fittings in accordance with figure F.1. Installation shall be carried out on a firm wall or frame with guide and anchor brackets, with no other support of the test assembly.

Anchor brackets shall be located directly below or behind the sockets of each pipe length. Guide brackets for near-horizontal assemblies shall be positioned as shown in figure F.1.

It shall be checked that the test assembly exhibits no sagging greater than $0,1D$ at the mid-point between two guide brackets (see figure F.1).

Devices shall be provided, and positioned as indicated in figure F.1, to measure any sagging f_1 and f_2 of the test assembly.

Room for expansion of pipes shall be provided for all spigot ends of pipes, but not for the spigot ends of fittings. The entry of hot water into the test assembly shall be direct; there shall be no heat-absorbing intermediate pieces.

F.2 Procedure

F.2.1 Test the assembly for watertightness and airtightness in accordance with F.3.1 and F.3.2.

F.2.2 Subject the test assembly to the passage of hot and cold water according to the following schedule for 5 cycles:

- a) circulation of water at $93\text{ °C} \pm 2\text{ °C}$ for 15 min, at a flow-rate of 0,3 l/s (18 l/min);
- b) circulation of water at $15\text{ °C} \pm 5\text{ °C}$ for 10 min, at a flow-rate of 0,3 l/s (18 l/min).

During the cycling test

- a) check that the temperature of the water remains constant within the specified limits,
- b) note any leaks from the test assembly and any "incidents" which may have an influence on the results,

- c) record the sagging f_1 and f_2 between guide brackets.

F.2.3 After completion of the cycling test, carry out the watertightness test again, as described in F.3.1.

F.3 Tightness test procedures

F.3.1 Watertightness

Carry out the following procedure:

- a) Seal off the lower end of the test assembly.
- b) Apply a pressure of at least 0,01 MPa (0,1 bar) to each joint by filling the installation with water.
- c) Maintain the pressure for a period of 1 min.
- d) Take note of any leaks at each joint.

F.3.2 Airtightness

Carry out the following procedure:

- a) Seal off the ends of the test assembly.
- b) Coat the annular space between spigot and socket ends of joints with soapy water.
- c) Apply an air pressure of 0,01 MPa (0,1 bar) at ambient temperature.
- d) Maintain the pressure for a period of 1 min.
- e) Take note of any leaks, evident through the formation of bubbles.

F.4 Test requirements

F.4.1 The joints shall remain watertight and airtight before and after the 5-cycle test.

F.4.2 The sagging at the mid-point between two guide brackets shall not exceed $0,1D$.

F.5 General information

See annex G.

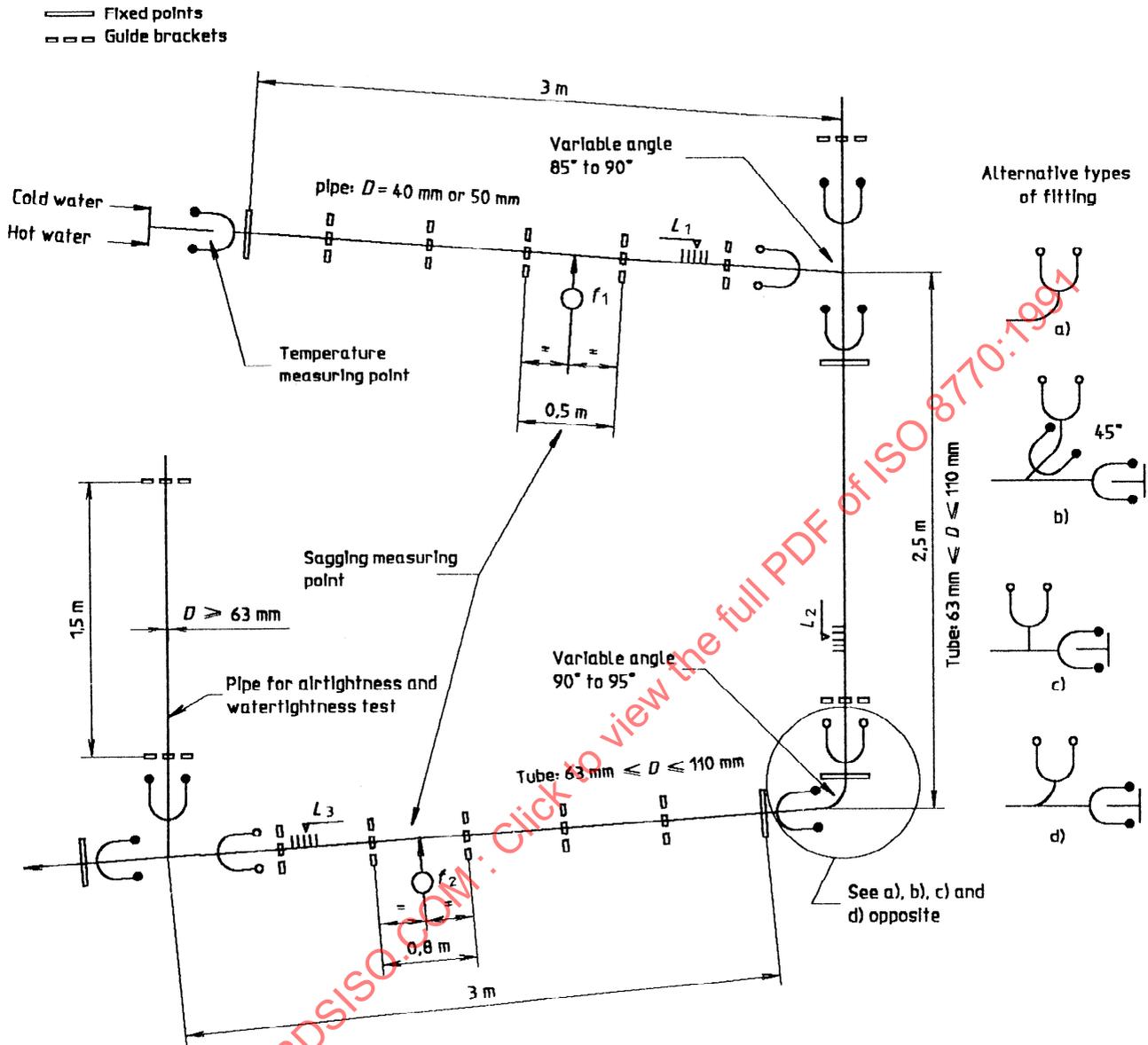


Figure F.1 — Test assembly for elevated-temperature cycling test (5 cycles)

Annex G (normative)

Cycling tests — General information for both 1 500-cycle and 5-cycle tests

G.1 Test report

The test report shall include the following information:

- a) a statement indicating the cycling test carried out (i.e. 1 500-cycle or 5-cycle test);
- b) the types and dimensions of the components used in the test assembly;
- c) all test parameters;
- d) results of leakproofness tests before the cycling test;
- e) observations during the cycling test;
- f) results of leakproofness tests after the cycling test;
- g) any sagging noted;
- h) results of final inspection of the test assembly;
- i) all details not provided for in this International Standard, as well as any incidents which might have had an influence on the results.

G.2 Key to symbols

The symbols used to specify or report on a test assembly shall comply with ISO/TR 7024.

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