

High density polyethylene (PE-HD) pipes and fittings for cable ducting

Dimensions and technical delivery conditions

DIN
16874

ICS 29.120.10; 83.140.30

Rohre und Formstücke aus Polyethylen hoher Dichte (PE-HD) für den Kabelschutz – Maße und technische Lieferbedingungen

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

Contents

	Page		Page
Foreword	2	6.7 Heat reversion	8
1 Scope	2	6.7.1 Pipes	8
2 Normative references	2	6.7.2 Fittings	8
3 Concepts, quantities, symbols and abbreviations	3	6.8 Leaktightness of pipes, fittings and pipe assemblies	9
3.1 Concepts	3	6.8.1 Resistance to hydrostatic pressure	9
3.1.1 Virgin material	3	6.8.2 Airtightness	9
3.1.2 Reworked material	3	6.9 Ring seal performance	9
3.1.3 Reprocessed material	3	6.10 Weldability	9
3.1.4 Recycled material	3	6.11 Interchangeability	9
3.2 Quantities and symbols	3	7 Testing	9
3.3 Abbreviations	3	7.1 Surface	9
4 Dimensions and designation	3	7.2 Colour	9
4.1 General	3	7.3 Dimensions	9
4.2 Pipes	3	7.4 Ovality	9
4.2.1 General	3	7.5 Resistance to internal pressure	9
4.2.2 Tolerances on outside diameter (ovality)	4	7.6 Melt mass-flow rate	10
4.3 Sockets	4	7.7 Heat reversion	10
4.4 Fittings	6	7.7.1 Pipes	10
4.4.1 General	6	7.7.2 Fittings	10
4.4.2 Bends	6	7.8 Leaktightness of pipes, fittings and pipe assemblies	10
4.4.3 Double sockets and pipe sleeves	6	7.8.1 Resistance to hydrostatic pressure	10
5 Material	6	7.8.2 Airtightness	10
5.1 Pipes and fittings	6	7.9 Ring seal performance	10
5.2 Seals	7	7.10 Weldability	10
6 Requirements	8	7.11 Marking	10
6.1 General	8	7.12 Additional tests	10
6.2 Surface	8	8 Marking	11
6.3 Colour	8	9 Installation instructions	11
6.4 Dimensions and tolerances	8	9.1 Structural strength	11
6.5 Resistance to internal pressure	8	9.2 Installation of pipes and fittings	11
6.6 Melt mass-flow rate	8	Other relevant standards	11

Continued on pages 2 to 11.

Translation by DIN-Sprachendienst.

In case of doubt, the German-language original should be consulted as the authoritative text.

Foreword

This standard has been prepared by Technical Committee *Schutzrohrsysteme* of the *Normenausschuss Kunststoffe* (Plastics Standards Committee).

All dimensions are in millimetres.

1 Scope

This standard specifies the dimensions and technical delivery conditions for high-density polyethylene (PE-HD) pipes and fittings used for cable ducting in telecommunications and high and low voltage electrical power systems for buried conduit systems. (see DIN EN 50086-2-4)

2 Normative references

This standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the titles of the publications are listed below. For dated references, subsequent amendments to or revisions of any of these publications apply to this standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

DIN 4060	Pipe joint assemblies with elastomeric seals for use in drains and sewers – Requirements and testing
DIN 8074	Polyethylene pipes – Dimensions
DIN 8075	Polyethylene pipes – General quality requirements and testing
DIN EN 681-1	Elastomeric seals – Material requirements for pipe joint seals used in water and drainage applications – Part 1: Vulcanized rubber
DIN EN 681-2	Elastomeric seals – Material requirements for pipe joints seals used in water and drainage applications – Part 2: Thermoplastic elastomers
DIN EN 743	Plastics piping and ducting systems – Thermoplastics pipes – Determination of longitudinal reversion
DIN EN 763	Injection-moulded thermoplastics pipe fittings – Test method for visually assessing the effects of heating
DIN EN 921	Thermoplastics pipes – Determination of resistance to internal pressure at constant temperature
DIN EN 1053	Thermoplastics piping systems for non-pressure applications – Test method for watertightness
DIN EN 1054	Thermoplastics piping systems for soil and waste discharge – Test method for airtightness of joints
DIN EN 1277	Thermoplastics piping systems for buried non-pressure applications – Test methods for leaktightness of elastomeric sealing ring type joints
DIN EN 50086-2-4	Conduit systems for cable management – Part 2-4: Particular requirements for buried conduit systems
DIN EN ISO 1133	Plastics – Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics (ISO 1133 : 1997)
DIN EN ISO 3126	Plastics piping systems – Plastics piping components – Measurement and determination of dimensions (ISO/DIS 3126 : 1999)*)
ISO 161-1 : 1996	Thermoplastics pipes for the conveyance of fluids – Nominal outside diameters and nominal pressures – Part 1: Metric series

ATV-Arbeitsblatt (ATV Code of practice) A 127 *Richtlinie für die statische Berechnung von Entwässerungskanälen und -leitungen* (Code of practice for the structural analysis of drains and sewers)³⁾

DVS-Richtlinie (DVS Code of practice) 2203-2 *Prüfen von Schweißverbindungen aus thermoplastischen Kunststoffen – Zugversuch* (Tensile testing of welded joints in thermoplastic materials)¹⁾

*) Currently at stage of draft.

¹⁾ Obtainable from *Verlag für Schweißen und verwandte Verfahren DVS Verlag GmbH*, Postfach 10 19 65, 40010 Düsseldorf, Germany.

³⁾ Obtainable from *Gesellschaft zur Förderung der Abwassertechnik e.V.*, Theodor-Heuss-Allee 17, 53758 Hennef, Germany.

DVS-Richtlinie 2207-1 Schweißen von thermoplastischen Kunststoffen – Heizelementschweißen von Rohren, Rohrleitungsteilen und Tafeln aus PE-HD (Welding of high-density polyethylene pipes and pipe fittings for gas and water pipework)¹⁾

KRV-Arbeitsblatt (KRV Code of practice) 5.3.5 *Kabelschutzrohre aus PE-HD für erdverlegte Rohrsysteme für den Kabelschutz* (Buried high-density polyethylene pipes for cable ducting)²⁾

RAL 840 HR Colour index⁴⁾

3 Concepts, quantities, symbols and abbreviations

3.1 Concepts

3.1.1 Virgin material

Unused material in the form of pellets, granules, powder or the like that has not been processed other than necessary for its manufacture, and to which no reprocessed or recycled material has been added.

3.1.2 Reworked material

Material prepared by the original manufacturer from trimmings or rejected pipes and fittings processed by moulding or extrusion, and for which the complete formulation is known.

3.1.3 Reprocessed material

Material prepared from unused plastic pipes, fittings or trimmings originating from a different manufacturer.

3.1.4 Recycled material

Material recovered from used pipes and fittings which have been cleaned and crushed or ground.

3.2 Quantities and symbols

<i>A</i>	Socket length to groove
<i>B</i>	Length of 'lead in'
<i>b</i>	Length of chamfer
<i>d_e</i>	Pipe outside diameter
<i>d_{em}</i>	Mean pipe outside diameter
<i>d_n</i>	Nominal pipe outside diameter
<i>d_s</i>	Socket inside diameter
<i>d_{sm}</i>	Socket mean inside diameter
<i>e</i>	Wall thickness
<i>e₂</i>	Wall thickness of socket
<i>e₃</i>	Wall thickness at groove
<i>l</i>	Pipe length
<i>l₁</i>	Spigot length
<i>r</i>	Bending radius
<i>α</i>	Swept angle (nominal angle)

3.3 Abbreviations

MFR	melt mass-flow rate
PE-HD	high-density polyethylene

4 Dimensions and designation

4.1 General

Designs shown are for illustrative purposes, but the dimensions of pipes and fittings shall be as specified. Pipe dimensions which do not comply with the specifications of ISO 161-1 shall comply with DIN 8074.

4.2 Pipes

4.2.1 General

For the purposes of this standard, pipes are extruded pipes coiled, wound on drums or supplied as straight lengths with plain ends (G), or spigot (S). The effective length is the total pipe length less the length of the socket.

¹⁾ Obtainable from *Verlag für Schweißen und verwandte Verfahren DVS Verlag GmbH*, Postfach 10 19 65, 40010 Düsseldorf, Germany.

²⁾ Obtainable from *Kunststoffrohrverband e.V.*, Dyroffstr. 2, 53113 Bonn, Germany.

⁴⁾ Obtainable from *Beuth Verlag*, 10772 Berlin, Germany.

Lengths up to 12 m are subject to limit deviations of ± 10 mm. The tolerances on length for coil or drum-wound pipes is $\pm 1\%$ of the total length.

The pipe outside diameters, wall thicknesses and the chamfer of spigots shall comply with the specifications given in table 1 (cf. figure 1).

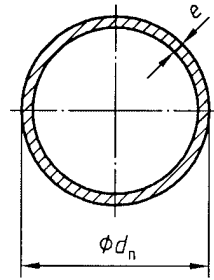


Figure 1: Pipe cross section (notation)

4.2.2 Tolerances on outside diameter (ovality)

The outside diameter of pipes shall be subject to the following limit deviations:

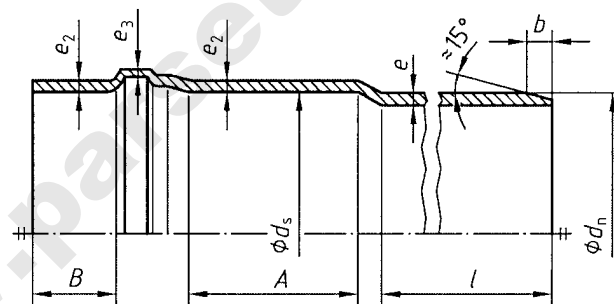
- a) for straight lengths:
 - where d_n is 75 mm or less: $0,008 d_{em} + 1$ mm, rounded to the nearest 0,1 mm;
 - where d_n is 90 mm or more: $0,02 d_{em}$, rounded to the nearest 0,1 mm;
- b) for coils:
 - where d_n is 63 mm or less: $0,06 d_{em}$, rounded to the nearest 0,1 mm, at least 1 mm;
 - where d_n is 75 mm or more: by agreement between manufacturer and customer.
- c) drum wound pipes:
 - where d_n is 32 or more: by agreement between manufacturer and customer.

4.3 Sockets

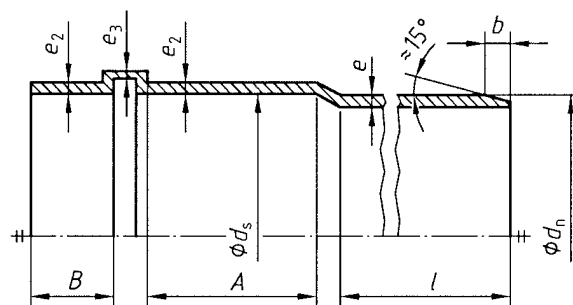
The dimensions of sockets shall comply with those given in table 2.

The wall thickness of sockets, e_2 , shall be equal to at least $0,9 e$, given to the nearest 0,1 mm, and the wall thickness in the groove area, e_3 , shall be equal to at least $0,55 e$, expressed to the nearest 0,1 mm.

Figure 2 shows typical examples of sockets.



a) Design 1



b) Design 2

Figure 2: Examples of sockets

Table 1: Pipe outside diameters, wall thicknesses and chamfer of spigots

Nominal pipe outside diam- eter, d_n	Mean pipe outside diameter, d_{em}		Wall thickness, $e^2)$		Approx. length of cham- fer, $b^3)$
	Min.	Max.	Min.	Max.	
32	2,0	32,3	1,8	2,2	3,5
			2,9	3,4	5,5
40	40,0	40,4	1,8	2,2	3,5
			2,3	2,8	4,5
			3,7	4,3	7,0
50	50,0	50,5	2,0	2,4	4,0
			2,9	3,4	5,5
			4,6	5,3	9,0
63	63,0	63,6	2,5	3,0	5,0
			3,6	4,2	7,0
			5,8	6,6	11,0
75	75,0	75,7	2,9	3,4	5,5
			4,3	5,0	8,5
			6,8	7,7	12,0
90	90,0	90,9	3,5	4,1	7,0
			5,1	5,9	10,0
			8,2	9,3	15,5
106 ¹⁾	106,0	107,0	4,1	4,8	8,0
			6,1	7,0	11,5
110	110,0	111,0	3,4	4,0	5,5
			4,2	4,9	8,5
			6,3	7,2	12,0
			10,0	11,2	19,0
125	125,0	126,2	4,8	5,5	9,5
			7,1	8,1	13,5
			11,4	12,8	21,5
126 ¹⁾	126,0	127,2	4,9	5,6	9,5
			7,2	8,2	13,5
140	140,0	141,3	5,4	6,2	10,5
			8,0	9,0	15,0
			12,7	14,2	24,0
158 ¹⁾	158,0	159,5	6,1	7,0	11,5
			9,1	10,3	17,0
160	160,0	161,5	6,2	7,1	12,0
			9,1	10,3	17,0
			14,6	16,3	27,5
200	200,0	201,8	7,7	8,7	14,5
			11,4	12,8	21,5
			18,2	20,3	34,0
225	225,0	227,1	12,8	14,3	24,0
			20,5	22,8	38,5

1) Dimensions do not comply with ISO 161-1.

2) Wall thicknesses shall be selected to suit the intended use of pipes and the load to which they are to be subjected.

3) $b = 0,5 e \cdot \cot 15^\circ$; given to the nearest 0,5 mm.

Table 2: Dimensions of pipes and sockets

Pipe barrel	Socket		
Nominal pipe outside diameter, d_n	Minimum mean inside diameter of socket, d_{sm}	Minimum socket length to groove, A ²⁾	Minimum length of 'lead-in', B
32	32,4	75	20
40	40,5	76	
50	50,6	77	
63	63,7	79	
75	75,8	80	
90	91,0	71	
106 ¹⁾	107,1	83	
110	111,1	83	
125	126,3	85	
126 ¹⁾	127,3	85	
140	141,4	86	
158 ¹⁾	159,6	88	
160	161,6	88	
200	201,9	92	
225	227,2	95	

1) Dimensions do not comply with ISO 161-1.

2) The minimum socket length to the groove shall be calculated using the following equation:
 $A = 0,012 l + 0,1 d_n$.

The pipe length, l , is taken to be 6 m, given to the nearest 1 mm.

4.4 Fittings

4.4.1 General

Fittings shall be manufactured by injection moulding or made from pipe material as moulded parts. The dimensions of spigots and sockets shall be as specified in subclauses 4.2 and 4.3.

The minimum wall thickness of injection-moulded fittings shall be equal to e as specified in table 1. The wall thickness of moulded parts may be less, except in the case of spigots and sockets, provided the minimum requirements for e_3 are satisfied.

4.4.2 Bends

Bends shall usually have a swept angle, α , of 45° or 90°, and their bending radius, r , shall be equal to at least eight times the nominal pipe outside diameter, d_n (see figure 3).

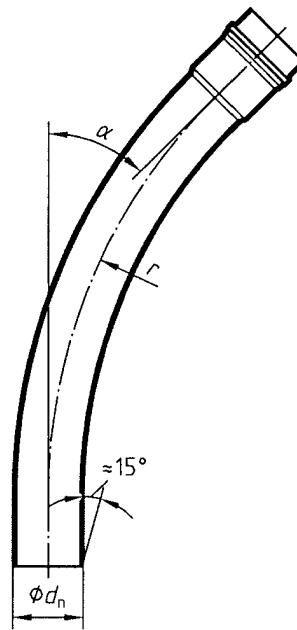
4.4.3 Double sockets and pipe sleeves

The dimensions of double sockets and pipe sleeves shall comply with those given in table 2 (see figure 4).

5 Material

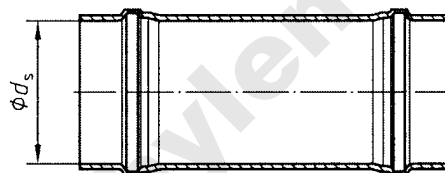
5.1 Pipes and fittings

Pipes and fittings shall be made from high density polyethylene (PE-HD), as specified in DIN 8075. Material of unknown composition shall not be used. Pipes and fittings may be made from reworked material, and reprocessed and recycled material may be used provided the requirements of this standard are met. The properties of the material shall be as in table 3 and in DIN 8075.

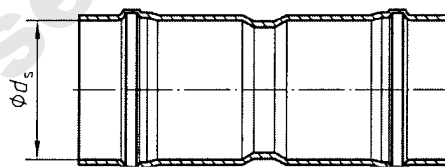


Pipe with integral socket

Figure 3: Bend



a) Pipe sleeve



b) Double socket

Figure 4: Pipe sleeve and double socket

Table 3: Properties of high density polyethylene

Property	Requirement
Mean density	$\approx 945 \text{ kg/m}^3$
Mean coefficient of linear thermal expansion	$\approx 2,0 \cdot 10^{-4} \text{ K}^{-1}$
Thermal conductivity	$\approx 0,41 \text{ WK}^{-1}\text{m}^{-1}$
Surface resistivity	$> 10^{12} \Omega$

5.2 Seals

Seals shall comply with the specifications of DIN 4060, DIN EN 681-1 and DIN EN 681-2.

6 Requirements

6.1 General

Pipes shall be subject to quality control. Those bearing a quality mark such as that awarded by the *Gütegemeinschaft Kunststoffrohre e.V.* shall be considered to have met quality control requirements. Fittings shall meet the same quality control requirements as pipes, unless otherwise specified.

6.2 Surface

Pipes and fittings shall have a smooth or profiled (depending on manufacturing method) inner surface and a smooth outer surface, when inspected as in subclause 7.1. The material shall be free from voids and blisters. However, minor irregularities and shallow grooves are permissible, provided the minimum wall thickness as specified in clause 4 is maintained throughout. Sharp-edged grooves and any other defects on sockets likely to impair pipe performance or tightness are not permissible.

Pipe ends shall be cut square to the pipe axis and be burr-free.

6.3 Colour

When checked as in subclause 7.2, pipes and fittings shall be of a uniform colour throughout. For multi-layer pipes used for casing, it shall suffice for the outer layers to be uniformly coloured. Colours shall be selected from the RAL 840-HR index, with a slight deviation in shade being permissible. Colours which are generally used in other applications shall be not be selected.

6.4 Dimensions and tolerances

When measured as in subclauses 7.3 and 7.4, the dimensions of pipes and fittings shall comply with the specifications of clause 4. Greater wall thicknesses are permissible for injection-moulded fittings.

In the case of pipes with profiled inner surfaces, the manufacturer's specifications shall be made available to the inspection body (e.g. *Gütegemeinschaft Kunststoffrohre e.V.*).

6.5 Resistance to internal pressure

Pipes shall not fail when tested as specified in subclause 7.5 and table 4.

Table 4: Test conditions for hydrostatic pressure test

Test temperature, in °C	Test period, in h (minimum time to failure)	Proof stress, in N/mm ²
80 ± 1	170	4,0

6.6 Melt mass-flow rate

When tested as in subclause 7.5 (with the material categorized in a melt mass-flow rate group as in table 5), the melt mass-flow rate of the pipe and fitting material may deviate from that of the original material by no more than 0,2 g/10 min.

Table 5: Melt flow-mass rate

Melt mass-flow rate group	Melt mass-flow rate, in g/10 min
003	Over 0,2 up to 0,4
005	Over 0,4 up to 0,7
010	Over 0,7 up to 1,3

Pipes shall be marked with their MFI group.

6.7 Heat reversion

6.7.1 Pipes

When tested as in subclause 7.7.1, the pipe length shall not change by more than 3 %, and the surface shall neither blister, crack nor become delaminated.

6.7.2 Fittings

When tested as in subclause 7.7.2, injection-moulded fittings shall neither blister nor crack. Slight delamination in the vicinity of the inlet shall not account for more than 20 % of the wall thickness at that point, when measured to an accuracy of 0,1 mm.

6.8 Leaktightness of pipes, fittings and pipe assemblies

6.8.1 Resistance to hydrostatic pressure

6.8.1.1 Pipes and fittings

Pipes and fittings shall be leaktight. When tested as in subclause 7.8.1.2, joints shall be deemed leaktight if no water escapes from them.

6.8.1.2 Push-in joints

6.8.1.2.1 Pipes subjected to angular deflection

When subjected to angular deflection as in subclause 7.8.1.3.1, push-in joints shall show no signs of leakage.

6.8.1.2.2 Pipes subjected to distortion

When subjected to distortion as in subclause 7.8.1.3.2 pipes shall show no signs of leakage.

6.8.1.3 Fabricated fittings

When tested as in subclause 7.8.1.4, fittings manufactured from segments shall show no signs of leakage.

6.8.2 Airtightness

When tested as in subclause 7.8.2, no air bubbles shall escape from the pipes, fittings or pipe joints.

6.9 Ring seal performance

When tested as in subclause 7.9, the seal ring placed in the groove shall not fall out nor be able to be displaced.

6.10 Weldability

Pipes and fittings shall be weldable when tested as in subclause 7.10.

6.11 Interchangeability

Pipes and fittings which conform to this standard are interchangeable.

7 Testing

7.1 Surface

The inner and outer surfaces of pipes and fittings shall be visually checked using backlighting.

7.2 Colour

The colour of pipes and fittings shall be compared with the corresponding RAL 840-HR colour card.

7.3 Dimensions

Dimensions shall be checked in accordance with DIN EN ISO 3126. Measurements shall be taken at ambient temperature, or at $(23 \pm 2) ^\circ\text{C}$ in arbitration cases.

The following dimensions shall be checked:

- a) mean pipe outside diameter, d_{em} (in the case of fittings, measure near the spigot);
- b) wall thickness, e (at any point);
- c) mean socket inside diameter, d_{sm} (measure at the middle of the socket length, A);
- d) socket wall thickness, e_2 (measure away from any marking);
- e) groove wall thickness, e_3 (measure away from any marking);
- f) sockets: length of socket beyond the groove, A , and length of spigot, L_1 ;
- g) effective length, L , or total pipe length;
- h) swept angle of bend, α .

7.4 Ovality

The difference between the minimum and maximum pipe outside diameters at the same cross section shall be established to an accuracy of 0,1 mm immediately after production.

7.5 Resistance to internal pressure

Testing shall be carried out as specified in DIN EN 921, using three samples for each test.

Samples fitted with type a) or type b) end caps shall be filled with water and placed vertically in a water bath brought to test temperature. The proof stress shall be applied when the samples have reached thermal equilibrium after one hour in the water bath.

7.6 Melt mass-flow rate

The melt mass-flow rate shall be determined to an accuracy of 0,1 g/10 min at a test temperature of 190 °C using a nominal load of 5 kg, as specified for test condition T in DIN EN ISO 1133.

7.7 Heat reversion

7.7.1 Pipes

Testing shall be carried out in accordance with DIN EN 743, using method A (liquid bath) or method B (air), at a temperature of (110 ± 2) °C. If method A is used, testing shall be carried out for 30 minutes; if method B is used the test duration shall be selected as follows:

- a) 60 minutes for wall thicknesses of 8 mm or less;
- b) 120 minutes for wall thicknesses over 8 mm up to 16 mm;
- c) 240 minutes for wall thicknesses greater than 16 mm.

In cases of arbitration, method B as in DIN EN 743 shall be used.

7.7.2 Fittings

Fittings shall be tested as specified in DIN EN 763, using method A (oven), at a temperature of (110 ± 2) °C, for 30 minutes.

7.8 Leaktightness of pipes, fittings and pipe assemblies

7.8.1 Resistance to hydrostatic pressure

7.8.1.1 General

The leaktightness of pipes and fittings shall be tested at a temperature of (23 ± 5) °C.

7.8.1.2 Pipes and fittings

Testing shall be carried out using assemblies comprising three components, and applying a hydrostatic pressure of 0,5 bar at a temperature of (23 ± 5) °C for at least 15 minutes.

7.8.1.3 Push-in joints

7.8.1.3.1 Angular deflection

Testing shall be carried out in accordance with DIN EN 1277, test condition C, method 4.

7.8.1.3.2 Distortion

Testing shall be carried out in accordance with DIN EN 1277, test condition B, method 4.

7.8.1.4 Fabricated fittings

Testing shall be carried out in accordance with DIN EN 1053.

7.8.2 Airtightness

Testing shall be carried out in accordance with DIN EN 1054.

7.9 Ring seal performance

The ring seal shall be placed in the clean groove of a socket, the spigot shall be lubricated and inserted as far as possible into the socket slightly out of line.

7.10 Weldability

A butt-welded test weld shall be made in accordance with DVS 2207-1, and then subjected to tensile testing as in DVS 2203-2.

7.11 Marking

Marking on pipes and fittings shall be examined visually to ensure that it is legible, complete and correct.

7.12 Additional tests

Any tests which go beyond the scope of this standard shall be agreed in writing between the manufacturer and customer.

8 Marking

Pipes and fittings shall be legibly and durably marked with the following details:

	Example
a) manufacturer's mark	xyz
b) quality or inspection mark	☐
c) application	CABLE DUCTING
d) DIN number	DIN 16874
e) material	PE-HD
f) melt mass-flow rate group	010
g) outside diameter	63
h) wall thickness	3,6
i) date of manufacture	
for pipes (day, month, year)	20 April 2000
for fittings (month, year)	December 2000
j) machine number	17

Marking shall be repeated at intervals not greater than 1 m, and applied at least once if pipes are shorter than 1 m. Pipes should not be imprinted deeper than 0,2 mm. Bends shall additionally be marked with their nominal angle. By applying this marking, the manufacturer assures that the product complies with this standard.

9 Installation instructions

9.1 Structural strength

Proof of the structural strength of pipes shall be provided, based on *ATV-Arbeitsblatt A 127* and taking account of local installation conditions. If the installation conditions comply with the structural specifications of *ATV-Arbeitsblatt A 127*, separate analysis need not be undertaken.

9.2 Installation of pipes and fittings

The specifications of *KRV-Verlegeanleitung A 535* and the manufacturer's instructions shall be observed when installing pipes and fittings.

Other relevant standards

DIN 16928	Installation of thermoplastic pipes and fittings – General
DIN 18200	Conformity assessment of construction products – Factory production control, third-party inspection, and certification
DIN EN 728	Plastics piping and ducting systems – Polyolefin pipes and fittings – Determination of oxidation induction time
DIN EN 12107	Injection-moulded thermoplastics fittings, valves and ancillary equipment – Determination of the long-term hydrostatic strength of thermoplastics materials for injection moulding of piping components
DIN EN ISO 9001	Quality systems – Model for quality assurance in design/development, production, installation and servicing (ISO 9001 : 1994)
DIN EN ISO 9002	Quality systems – Model for quality assurance in production and installation (ISO 9002 : 1994)
ISO 4065 : 1996	Thermoplastics pipes – Universal wall thickness table