BRITISH STANDARD

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15698-1:2009

District heating pipes — Preinsulated bonded twin pipe systems for directly buried hot water networks

Part 1: Twin pipe assembly of steel service pipe, polyurethane thermal insulation and outer casing of polyethylene

ICS 23.040.10

BSI
British Standards

National foreword

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The UK participation in its preparation was entrusted to Technical Committee RHE/9, Insulated underground pipelines.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Tuyaux de chauffage urbain - Systèmes bloqués de bitubes préisolés pour les réseaux d'eau chaude enterrés directement - Partie 1: Assemblage de bitubes pour tube de service en acier, isolation thermique en polyuréthane et tube de protection en polyéthylène

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Contents

Foreword

This document (EN 15698-1:2009) has been prepared by Technical Committee CEN/TC 107 “Prefabricated district heating pipe systems”, the secretariat of which is held by DS.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2009, and conflicting national standards shall be withdrawn at the latest by July 2009.

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Introduction

This specification is part of the standards for bonded systems using polyurethane foam thermal insulation applied to bond to two steel service pipes and a polyethylene casing.

This standard has been elaborated as a complement to the standards for bonded systems using polyurethane foam thermal insulation applied to bond to one steel service pipe and a polyethylene casing.

These standards are:

EN 253, *District heating pipes – Preinsulated bonded pipe systems for directly buried hot water networks – Pipe assembly of steel service pipe, polyurethane thermal insulation and outer casing of polyethylene;*

EN 448, *District heating pipes – Preinsulated bonded pipe systems for directly buried hot water networks – Fitting assemblies of steel service pipes, polyurethane thermal insulation and outer casing of polyethylene;*

EN 488, *District heating pipes – Preinsulated bonded pipe systems for directly buried hot water networks – Steel valve assembly for steel service pipes, polyurethane thermal insulation and outer casing of polyethylene;*

EN 489, *District heating pipes – Preinsulated bonded pipe systems for directly buried hot water networks – Joint assembly for steel service pipes, polyurethane thermal insulation and outer casing of polyethylene;*

EN 13941, *Design and installation of preinsulated bonded pipe systems for district heating;*

EN 14419, *District heating pipes – Preinsulated bonded pipe systems for directly buried hot water networks – Surveillance systems.*

Waste management and recycling of materials is dealt with in Annex C.

1 Scope

This European Standard for District Heating Twin Pipes, specifies requirements and test methods for straight lengths of prefabricated thermally insulated pipe-in-pipe assemblies for directly buried hot water networks, comprising two steel service pipes from DN 15 to DN 250, rigid polyurethane foam insulation and one cylindrical outer casing of polyethylene. The pipe assembly may also include the following additional elements: Measuring wires, spacers and diffusion barriers.

This standard applies only to insulated twin pipe assemblies, for continuous operation with hot water at various temperatures up to 120 °C and occasionally with a peak temperature up to 140 °C.

The estimation of expected thermal life with continuous operation at various temperatures is outlined in Annex B of EN 253.

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.

EN 253:2009, *District heating pipes – Preinsulated bonded pipe systems for directly buried hot water networks – Pipe assembly of steel service pipe, polyurethane thermal insulation and outer casing of polyethylene*

EN ISO 3126, *Plastics piping systems - Plastics components - Determination of dimensions (ISO 3126:2005)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 253:2009 and the following apply.

3.1
single pipe assembly
technical solution of district heating pipes with one steel service pipe in one casing

3.2
twin pipe assembly
technical solution of district heating pipes with two steel service pipes in one casing

3.3
twisting of service pipes
tendency of the service pipes of a twin pipe assembly to twist around each other

4 Requirements

4.1 General

Unless otherwise specified, the requirements shall be valid for each single measurement.

For information on suitable guidelines for inspection of manufactured preinsulated twin pipes see Annex A.

4.2 Steel service pipe

Material, dimensions, tolerances and surface condition of the steel service pipes shall be as specified in EN 253.

4.3 Material, casing properties and dimensions

Material and casing properties shall be as specified in EN 253.

For the casing diameters specified in Table 1 the dimensions of the casing shall be as specified in EN 253.

The maximum out-of-roundness shall conform to Table 1 and be measured in accordance with EN ISO 3126.

Table 1 — Casing diameters

Nominal diameter of service pipes DN	Casing diameter, insulation series1 $D_{c\,min}$ mm	Casing diameter, insulation series 2 $D_{c\,min}$ mm	Casing diameter, insulation series 3 $D_{c\,min}$ mm	Maximum out-of-roundness mm
15	125	140	160	1,2
20	125	140	160	1,2
25	140	160	180	1,2
32	160	180	200	1,3
40	160	180	200	1,4
50	200	225	250	1,4
65	225	250	280	1,5
80	250	280	315	1,6
100	315	355	400	2,0
125	400	450	500	2,5
150	450	500	560	3,0
200	560	630	710	4,0
250	710	800	900	5,0

4.4 Polyurethane rigid foam insulation (PUR)

Material and insulation properties shall be as specified in EN 253.

4.5 Pipe assembly

4.5.1 End alignment of forward and return service pipes

The alignment of the ends of the forward and return service pipes shall not differ more than 1 mm when measured in the longitudinal direction.

4.5.2 Distance between forward and return service pipes

The distance between forward and return service pipes shall be in accordance with Table 2.

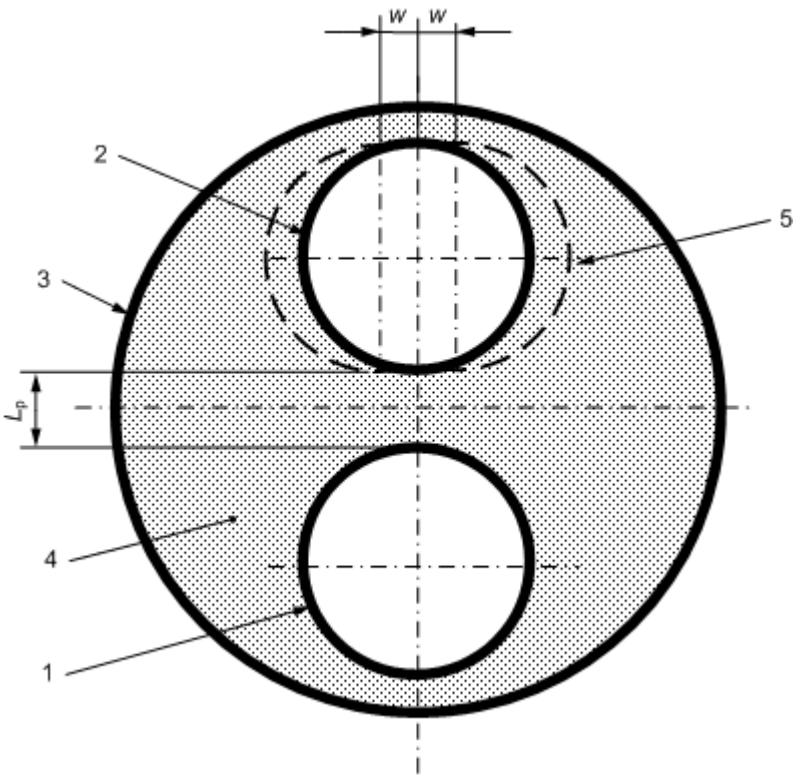
The tolerance of the distance between the forward and return service pipes, Lp, is ± 1 mm when measured in the pipe ends and ± 2 mm when measured at any point inside the twin pipe assembly, see Figure 1.

Table 2 — Distance between service pipes

Nominal diameter of service pipes DN	**Distance between service pipes** L_p mm
15	19
20	19
25	19
32	19
40	19
50	20
65	20
80	25
100	25
125	30
150	40
200	45
250	45

4.5.3 Twisting of service pipes

The twisting, w, of the service pipes in one end of the twin pipe assembly in relation to the other end shall be maximum 3 mm. The twisting, w, of the service pipes in any end of the pipe assembly in relation to any point inside the pipe assembly shall be maximum 6 mm. For cut pipes the twisting, w, shall be maximum $\pm$ 3 mm, see Figure 1.



Key

1 forward service pipe
2 return service pipe
3 casing
4 insulation
5 service pipe at maximum twisting, w_{max}
L_p distance between service pipes
w twisting

Figure 1 — Twisting, *w*, and distance between service pipes, L_p

4.5.4 Centre line deviation

The distance between the common centre line of the service pipes and the centre line of the casing at any point shall not exceed the limits given in Table 3.

Table 3 — Centre line deviation related to nominal diameters

Nominal outside diameter of casing mm	Maximum centre line deviation mm
75 to 160	3,0
180 to 400	5,0
450 to 630	8,0
710 to 800	10,0

4.5.5 Pipe ends

The pipe ends shall be in accordance with EN 253.

4.5.6 Axial shear strength

When measured in accordance with 5.5.1.4 and 5.5.1.5 the axial shear strength on each service pipe shall fulfil the requirement in EN 253.

4.5.7 Expected thermal life and long term temperature resistance

When tested in accordance with 5.5.2 the expected thermal life and long term temperature resistance shall be in accordance with EN 253.

4.5.8 Thermal conductivity in unaged condition

When tested in accordance with 5.5.3 the thermal conductivity in unaged condition shall be in accordance with EN 253. The thermal conductivity in unaged condition shall be used to calculate the thermal transmittance as described in 5.5.4.

4.5.9 Impact resistance

When determined in accordance with 5.5.5 the impact resistance shall be in accordance with EN 253.

4.5.10 Long term creep resistance and modulus

When tested in accordance with 5.5.6 the creep behaviour shall be in accordance with EN 253.

4.5.11 Surface conditions at delivery

The surface conditions at delivery shall be in accordance with EN 253.

4.5.12 Measuring wires for surveillance systems

Measuring wires, if any, shall comply with the requirements of EN 14419.

5 Test methods

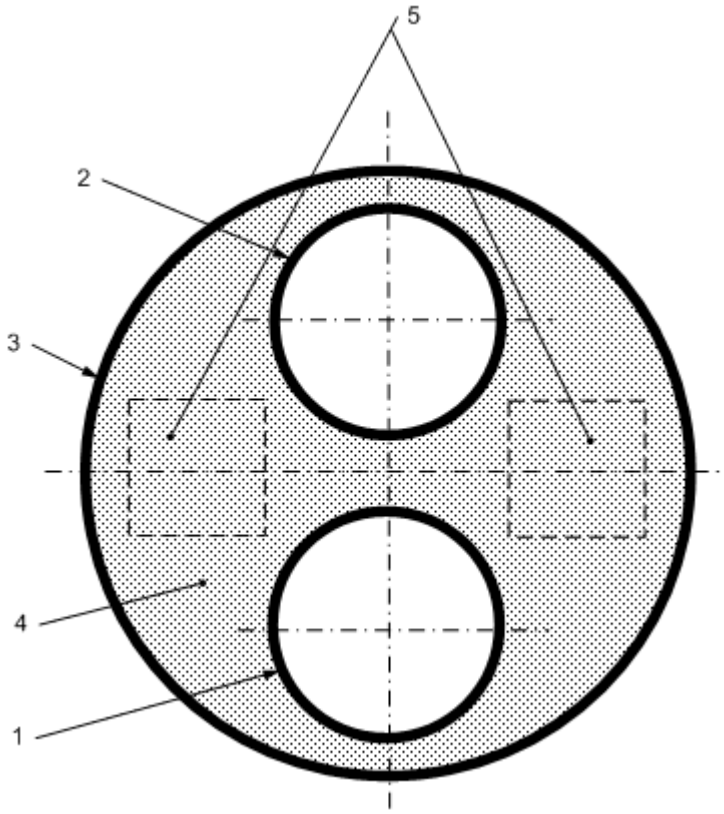
5.1 General

Where test requirements specified in this standard differ from those in other standards referred to, the requirements laid down in this European Standard shall apply.

All test specimens shall be representative for the production.

5.2 Test specimens

Test specimens shall be taken in accordance with EN 253 except for the position of test specimens for compressive strength that shall be as shown in Figure 2.



Key

1 forward service pipe

2 return service pipe

3 casing

4 insulation

5 areas where the test specimens shall be taken

Figure 2 — Areas for test specimens

5.3 Casing

The casing shall be tested in accordance with EN 253.

5.4 Polyurethane rigid foam insulation (PUR)

The polyurethane rigid foam insulation shall be tested in accordance with EN 253.

5.5 Pipe assembly

5.5.1 Axial shear strength

5.5.1.1 Test specimen

The test specimen shall be a length of pipe assembly of 200 mm. The test specimen shall be cut perpendicular to the axis of the pipes and be taken in accordance with EN 253:2009, 5.1.2.2 and in the middle of the pipe.

5.5.1.2 Test procedure

An axial force shall be applied to one service pipe at a time. The speed of the testing machine shall be 5 mm/min. The axial force shall be recorded and the shear strength calculated in accordance with 5.5.1.3. This test may be performed with the axis of the pipe assembly in vertical or horizontal position (see Figure 3). The dead weight of the service pipes shall be taken into consideration when the axis is vertical.

The test result shall be determined as an average value of 3 measurements on each service pipe.

NOTE The axial shear test arrangement shown in Figure 3 may give different results than performing the same test applying the axial force to both service pipes at the same time.

5.5.1.3 Calculation of shear strength

The shear strength is calculated from the following formula:

$$\tau_{ax} = \frac{F_{ax}}{L \times D_s \times \pi}$$

where

τ_{ax} = axial shear strength, MPa;

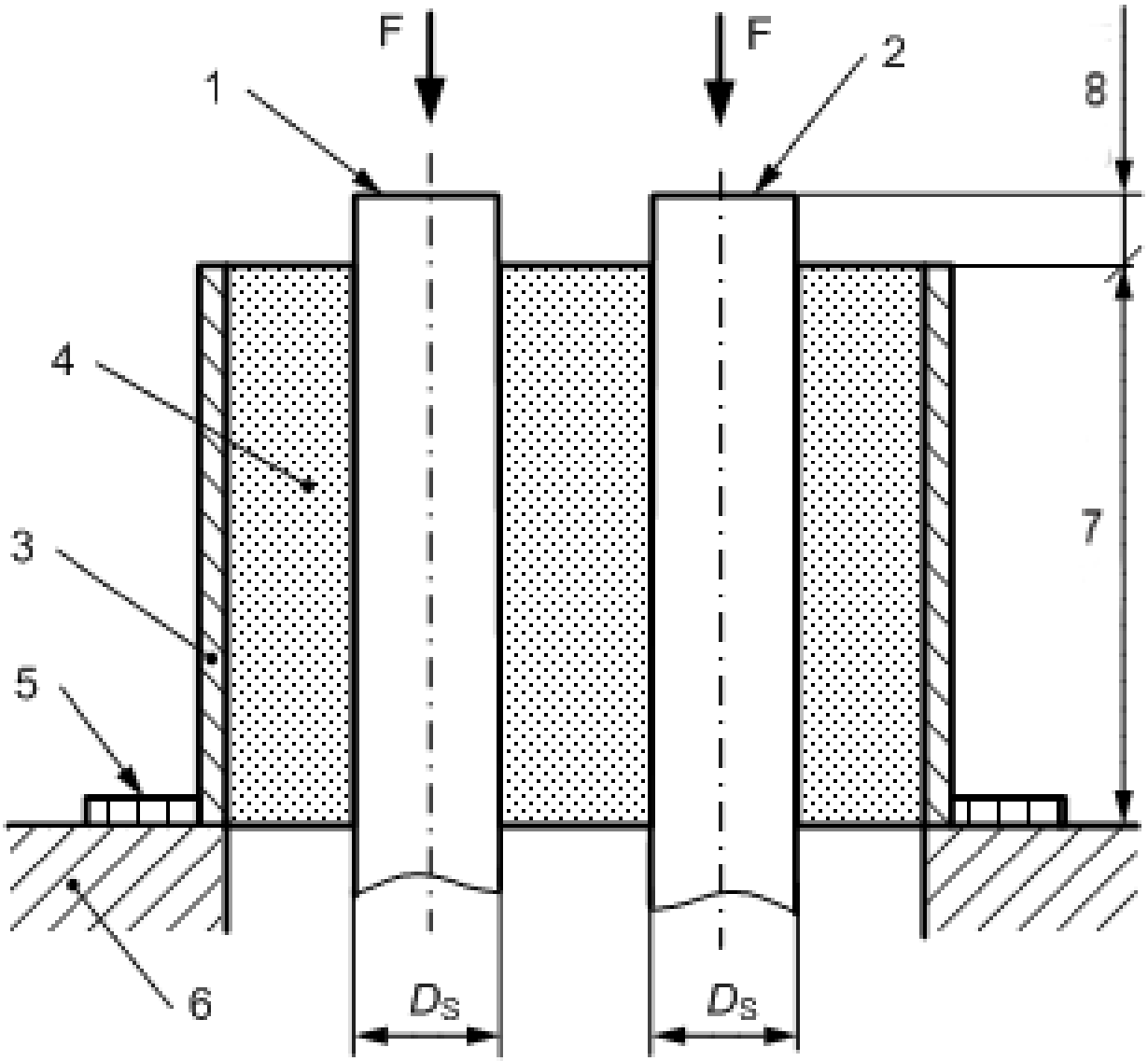
F_{ax} = axial force, N;

L = length of specimen, mm;

D_s = outside diameter of the service pipe, mm.

5.5.1.4 Axial shear strength before ageing

The test shall be carried out in accordance 5.5.1.1 to 5.5.1.3 with the entire test specimen kept at a temperature of (23 ± 2) °C and at a temperature of (140 ± 2) °C.



Key

1 service pipe
2 service pipe
3 casing
4 insulation
5 guide ring
6 base plate of the test machine
7 L = 200 mm
8 ≥ 0 mm
D_s outside diameter of service pipe
F_{ax} applied axial force

Figure 3 — Axial shear test arrangement

5.5.1.5 Axial shear strength after ageing

The test shall be carried out on a single pipe assembly in accordance with EN 253 with the entire test specimen kept at a temperature of (23 ± 2) °C and at a temperature of (140 ± 2) °C using the same foam recipe and production method as used for the production of twin pipes.

5.5.2 Expected thermal life and long term temperature resistance

The test shall be carried out on a single pipe assembly in accordance with EN 253 using the same foam recipe and production method as used for the production of twin pipes.

5.5.3 Thermal conductivity in unaged condition

The test shall be carried out on a single pipe assembly in accordance with EN 253 using the same foam recipe and production method as used for the production of twin pipes.

5.5.4 Thermal transmittance

The thermal transmittance shall be calculated as a U-value per meter [W/m × K] but measured on a single pipe assembly using the same foam recipe and production method as used for the production of twin pipes. Formula for the calculation is given in Annex B.

5.5.5 Impact resistance

The impact resistance shall be determined in accordance with EN 253. This test shall be carried out on a twin pipe assembly.

5.5.6 Creep behaviour at 140 °C

The creep behaviour shall be measured in accordance with EN 253. This test shall be carried out on a single pipe assembly using the same foam recipe and production method as used for the production of twin pipes.

6 Marking

Marking shall be in accordance with EN 253 with the exception that the number of this European Standard (15698-1) shall be used.

Annex A
(informative)

Guidelines for inspection and testing

The inspection items and frequences according to EN 253 together with the items given in Table A.1 are recommended to asssure that manufactured preinsulated pipes comply with the requirements specified in this European Standard.

A quality system certified to be in accordance with EN ISO 9001 with reference to EN 15698-1 and the obtained statistics of consistency of test results can be used to adjust inspection frequencies to the actual needs.

Table A.1 — Twin pipe assembly inspection

Clause	Item	Test frequency		
		Manufacturer's type test	**Manufacturer's quality control**	**External inspection**
4.5.1	End alignment of forward and return service pipes	Measured once in each end on min. two dimensions	Measured min. once per shift per machine	Once per inspection visit Inspection of internal records
4.5.2	Distance between forward and return service pipe	Measured once in each end and in the middle on min. two dimensions	Measured min. once per shift per machine (only on pipe ends)	Once per inspection visit Inspection of internal records (only on pipe ends)
4.5.3	Twisting of service pipes	Measured once in the ends and in the middle on min. two dimensions	Measured min. once per shift per machine (only on pipe ends)	Once per inspection visit Inspection of internal records (only on pipe ends)

Annex B
(informative)

Calculation of thermal transmittance

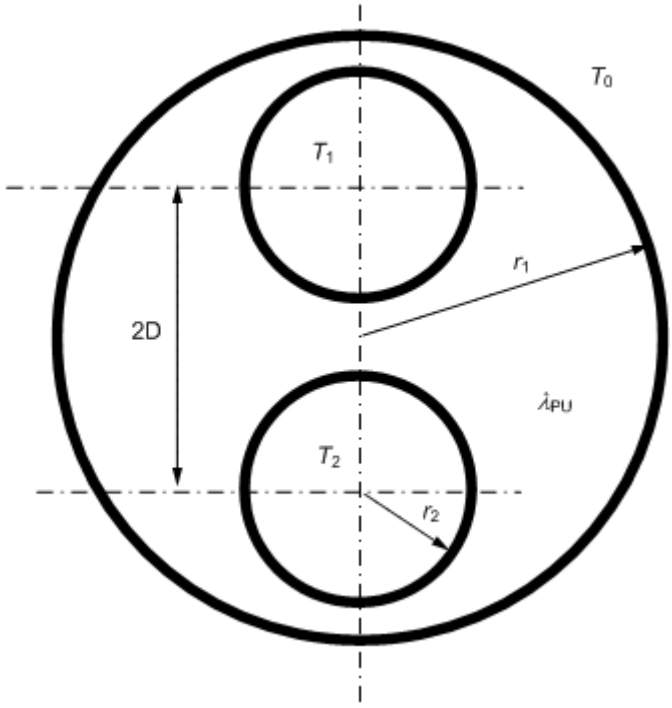


Figure B.1 - Calculation of thermal transmittance

The linear thermal transmittance (U) can be written

$$U = \frac{q_{total}}{\left(\frac{T_1 + T_2}{2} - T_0\right)} \quad \text{(W m}^{-1}\text{ K}^{-1}\text{)}$$

The thermal conductivity λ_{PU} can be expressed

$$q_{total} = 4 \times \pi \times \lambda_{PU} \times h_s \times \left(\frac{T_1 + T_2}{2} - T_0\right) \quad \text{(W m}^{-1}\text{ K}^{-1}\text{)}$$

where

$$h_s^{-1} = \ln\left(\frac{r_1^2}{2 \times D \times r_2}\right) - \ln\left(\frac{r_1^4}{r_1^4 - D^4}\right) - \frac{\left(\frac{r_2}{2 \times D} + \frac{2 \times r_2 \times D^3}{r_1^4 - D^4}\right)^2}{1 + \left(\frac{r_2}{2 \times D}\right)^2 - \left(\frac{2 \times r_2 \times r_1^2 \times D}{r_1^4 - D^4}\right)^2}$$

where

D = Half the distance between the centre of pipes, in m;
T_0 = Average temperature at outer casing, in ˚C;
T_1 = Temperature at pipe 1, in ˚C;
T_2 = Temperature at pipe 2, in ˚C;
U = Linear thermal transmission, in (W m^{-1} K^{-1});
h_s = Heat loss factor;
q = Heat loss, in (W m^{-1});
r_1 = Radius of casing pipe, in m;
r_2 = Radius of inner pipe, in m;
λ_{PU} = Thermal conductivity of polyurethane foam, in (W m^{-1} K^{-1}).

Annex C
(informative)

Waste treatment and recycling

Necessary requirements for waste management and recycling of materials used for district heating pipes shall be stated in the manufacturer's documentation and be submitted to the purchaser.

Bibliography

[1] Wallentén, P., Steady-State heat loss from insulated pipes, Report TVBH-3017, Lund Institute of Technology, Sweden, 1991.

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