BRITISH STANDARD

BS EN 489:2009

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

ICS 23.040.01; 91.140.60

BSI British Standards

National foreword

This British Standard is the UK implementation of EN 489:2009. It supersedes BS EN 489:2003 which is withdrawn.

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.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 May 2009

ISBN 978 0 580 57358 3

Amendments/corrigenda issued since publication

Date	Comments

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 489

March 2009

ICS 23.040.01

Supersedes EN 489:2003

English Version

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

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

Fernwärmerohre - Werkmäßig gedämmte Verbundmantelrohrsysteme für direkt erdverlegte Fernwärmenetze - Rohrverbindungen für Stahlmediumrohre mit Polyurethan-Wärmedämmung und Außenmantel aus Polyethylen

This European Standard was approved by CEN on 31 January 2009.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This document (EN 489:2009) 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of an identical text or by endorsement, at the latest by September 2009, and conflicting national standards shall be withdrawn at the latest by September 2009.

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

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Introduction

The first edition of EN 489 was approved in 1994 and updated in 2003. The main areas of this revision are the following:

— Requirements for welded joints have been added;

— Requirements for joints insulated with prefabricated joint insulation have been added;

— Requirements and test methods for PUR foam properties have been lifted from EN 253 into this standard;

— Requirements for marking of joints have been added.

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

For information on the minimum expected thermal life with operation at various temperatures with respect to PUR foam performance see EN 253:2009, Annex B.

The other standards from TC 107 are:

— 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 448:2009, *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 488:2003, *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 13941:2003, *Design and installation of preinsulated bonded pipe systems for district heating*;

— EN 14419:2009, *District heating pipes – Preinsulated bonded pipe systems for directly buried hot water networks – Surveillance systems*.

As information to the users of this standard CEN/TC 107 has decided to mention that at the time of publication of this European Standard CEN/TC 107 had already concluded on the investigation and further preparation of the following topics:

— appropriate short- and long-term type tests for all jointing systems;

— incorporation of the findings of running research activities to introduce new test procedures and requirements;

— further preparation of Annex C aiming at making this annex normative;

— further preparations of Annex B concerning on site joint inspection and establish suitable methods for field tests;

— requirements and test methods regarding the closure of foaming hole plugs.

The abovementioned items should be dealt with and the intention is to include the results in the next revision of this European Standard.

1 Scope

This European Standard specifies requirements for joints made under field conditions between adjacent preinsulated pipes and/or fittings in district heating networks. The specified general requirements are also valid for field-made T-branches, bends, reducers, caps, etc.

This European Standard covers jointing of steel service pipes by means of fusion welding, the connecting of casing ends with joint casings and the thermal insulation with poured rigid PUR foam or prefabricated PUR-foam insulation.

This European Standard specifies methods for type tests of complete joints and PUR-foam for joints under laboratory conditions.

The requirements of this European Standard can also be applied to casing pipe weldings/connections of on site made fittings.

The requirements of this European Standard aim to obtain a technical life of the joints of at least 30 years.

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 287-1, *Qualification test of welders – Fusion welding – Part 1: Steels*

EN 444, *Non-destructive testing – General principles for radiographic examination of metallic materials by X- and gamma-rays*

EN 1435, *Non-destructive examination of welds – Radiographic examination of welded joints*

EN 12517-1:2006*, Non-destructive testing of welds – Part 1: Evaluation of welded joints in steel, nickel, titanium and their alloys by radiography – Acceptance levels*

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*

EN ISO 845, *Cellular plastics and rubbers – Determination of apparent (bulk) density (ISO 845:1988)*

EN ISO 4590:2003, *Rigid cellular plastics – Determination of the volume percentage of open cells and of closed cells (ISO 4590:2002)*

EN ISO 5817:2007, *Welding – Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) – Quality levels for imperfections (ISO 5817:2003, corrected version:2005, including Technical Corrigendum 1:2006)*

EN ISO 6520-1, *Welding and allied processes – Classification of geometric imperfections in metallic materials – Part 1: Fusion welding (ISO 6520-1:2007)*

EN ISO 9692 (all parts), *Welding and allied processes – Recommendations for joint preparation (ISO 9692)*

EN ISO 15607:2003, *Specification and qualification of welding procedures for metallic materials – General rules (ISO 15607:2003)*

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
joint
complete construction of the connection between adjacent pipes and/or fittings

3.2
joint casing
part that connects the two pipe casing ends in a joint

3.3
joint insulation
thermal insulation that fills the volume confined by the steel service pipe, the joint casing and the ends of the two connecting pipes

3.4
on site poured joint insulation
joint insulation manufactured by pouring the liquid polyurethane foam components[1)] into the joint volume at the work site

3.5
prefabricated joint insulation
joint insulation manufactured by installing prefabricated elements of polyurethane foam in the joint volume prior to installation of the joint casing[2)]

3.6
steel weld
connection between the steel service pipes by welding

3.7
polyethylene weld
fusion jointing of polyethylene to polyethylene under influence of heat, pressure and time

3.8
double sealing
two-sealing systems independently installed on the same joint, not influencing each other negatively and thus independently functioning during the service life of the joint

3.9
surveillance system
system that consists of measuring sections and measuring instruments for surveillance of pipe systems

4 Requirements

4.1 General requirements

NOTE The assumptions of EN 13941 have been taken as the base for these requirements.

4.1.1 General requirements for the joint

The joint shall be:

1) Ernst Kaufmann, 050715.

2) Ernst Kaufmann, 050715.

— watertight;

— able to withstand axial forces initiated by axial movements of the pipe in the ground;

— able to withstand radial forces and bending moments;

— able to withstand effects of temperature and temperature variations.

In case of double sealing each one of the sealing systems and the combination of both systems shall fulfil the requirements of the type test as described in Clause 5.

4.1.2 Installation of the joint

Each individual step in the installation of a joint shall follow the system supplier's installation instructions in order to ensure that the joint obtained is equivalent to the joint as previously type-tested.

4.1.3 Competence of the welder and fitter

Persons installing joints on preinsulated pipe networks shall possess a valid evidence of qualification stating that they have received training relevant to the system and the type of joint.

Steel service pipe welders shall possess a valid certificate in accordance with EN 287-1.

Polyethylene welders shall possess a valid evidence of qualification which documents their ability to reproduce welding of the quality specified.

Recommended subjects for training are given in Annex C.

4.1.4 Expected thermal life and long term temperature resistance

The requirements for expected life and long term temperature resistance shall be in accordance with 5.4.4 of EN 253:2009.

4.1.5 Steel service pipe weld

The steel service pipe weld shall:

— be tight when tested in accordance with A.6;

— have mechanical properties equivalent to those of the service pipe.

4.1.6 Polyurethane rigid foam insulation (PUR)

The foaming of a joint on site shall be carried out in a confined space.

The insulation shall completely fill the joint.

The requirements for the rigid PUR foam insulation shall be in accordance with 4.2.3.2, 4.2.3.3, 4.2.3.4 and with EN 253:2009, 4.4.3 for the compressive strength.

4.1.7 Joint casing

The joint casing shall be tight against external water pressure.

Casings for welded joints shall fulfil Clause 4.3.1 of EN 253:2009.

All joints shall be subject to a leak-test. If this is not possible, a type specific procedure of 100 % visual test in combination with a destructive spot test scheme shall be described in the manufacturer's documentation.

NOTE Leakage testing of joints should be carried out with air or another suitable gas. The test pressure of 20 kPa should be applied at a temperature of ≤ 40 °C for a minimum of 2 min. The leak-tightness should be checked by means of a suitable indicator liquid or a leakage detector. The indicator liquid should be detrimental neither to the casing and joint material, nor to the environment.

Proper handling and installation procedures and type specific test procedures for the verification of leak-tightness of installed joint casings shall be described in the manufacturer's documentation.

4.2 Type test requirements

4.2.1 Water tightness

No water ingress shall be detected after the water impermeability test in accordance with 5.2.

Both welded and non-welded joints shall be tested.

4.2.2 Soil stress test

Non-welded joints shall pass the soil stress test in accordance with 5.1 before the water impermeability test in accordance with 5.2 is carried out.

4.2.3 Polyurethane rigid foam insulation (PUR) properties

4.2.3.1 General

The polyurethane rigid foam insulation (PUR) material for joint assemblies shall, when tested as a pipe assembly[3)], meet the requirements of EN 253 regarding voids and bubbles, compressive strength, long term temperature resistance and thermal conductivity in addition to 4.2.3.2, 4.2.3.3 and 4.2.3.4.

When tested according to 5.4.4 the joint insulation shall not shrink more than 2 mm in the axial or the radial direction.

4.2.3.2 Cell structure

The average size of the cells in a radial direction shall be less than 0,5 mm, determined in accordance with 5.4.5.1.

The closed cell content determined in accordance with 5.4.5.2 shall be not less than 88 %.

4.2.3.3 Foam density

The density of the foam at any position shall be not less than 60 kg/m^3 when measured in accordance with 5.4.6.

No specimen may have a density below 60 kg/m^3.

4.2.3.4 Water absorption at elevated temperature

When tested in accordance with 5.4.7, the water absorption after 90 min of immersion in boiling water shall not exceed 10 % of the original volume.

4.2.4 Weld joint stress crack resistance

When tested in accordance with 5.3 the time until failure shall be at least 300 hours.

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3) Ernst Kaufmann, 050715.

4.3 Installation instructions

4.3.1 General

Installation instructions, crucial for the quality of the installed joint and for achieving the expected life, shall be a part of the manufacturer's documentation and shall be supplied together with the component parts.

The installation instructions shall, as a minimum, deal with the topics mentioned in 4.3.2 to 4.3.7.

4.3.2 Work environment

Proper procedures to obtain optimum work conditions on site shall be specified.

4.3.3 Cleaning

Proper procedures for the cleaning and drying shall be specified for:

— steel pipe surfaces;

— insulation surfaces;

— joint casing surfaces;

— casing surfaces.

The sentence ”Any wet foam shall be removed from the pipe ends" shall be included in the instructions.

4.3.4 Surveillance system

When measuring elements for a surveillance system is installed in the joint, proper procedures for connecting the surveillance system shall be specified before the assembly takes place. This specification shall comply with EN 14419 and include procedures for:

— check of measuring elements upon receipt of pipe elements;

— assembly work in joints to ensure the function of the system;

— assembly check of the surveillance system during construction;

— test after finishing a measuring section.

4.3.5 Steel site weld

Proper procedures for the steel weld shall be described. This description shall, as a minimum, include the parts "Welding process" and "Preparation for welding and lining up" in accordance with Annex A.

4.3.6 Joint casing

Proper handling and installation procedures for the joint casing shall be specified.

Type specific test procedures for leak-tightness of installed joints shall be described.

4.3.7 Joint insulation

Proper procedures for on site foaming of joints or installation of prefabricated joint insulation shall be described.

The following procedures for on site foaming of joints shall, as a minimum, be described:

— the precautions to be taken if surface temperatures are outside the range of 15 °C to 45 °C;

— the temperature at which PUR components may be stored if outside the range of 15 °C to 25 °C;

— the precautions to be taken to optimize venting of the joint and to prevent excessive foam losses.

The following procedures for the installation of prefabricated joint insulation shall, as a minimum, be described:

— storage procedures to prevent damage of the insulation material and to keep it dry;

— installation procedures to prevent air gaps between joint insulation and pipe ends.

5 Methods for type tests

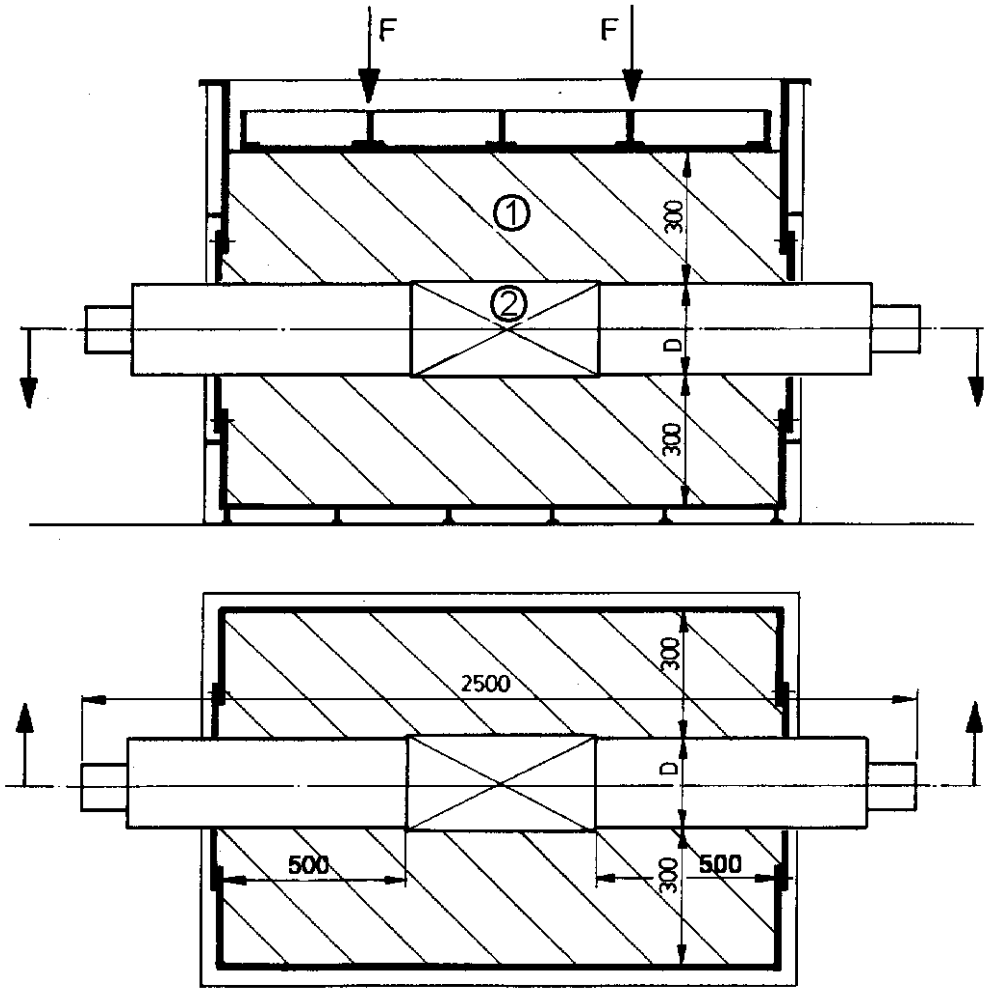
5.1 Soil stress test

The soil stress test shall be carried out as follows.

5.1.1 Sand box.

A box with minimum dimensions as shown in Figure 1 shall be used. The box shall be provided with a rigid compression plate that covers the entire box.

Dimensions in millimetres



Key

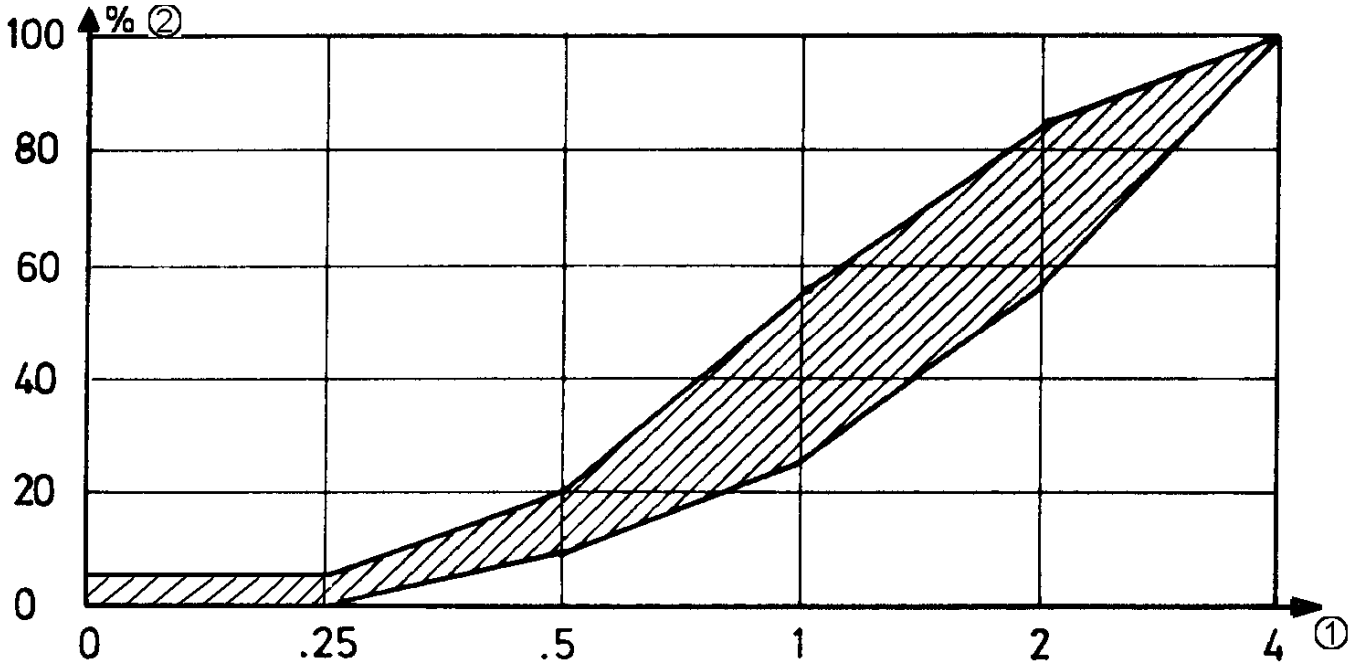
1 Sand

2 Joint

Figure 1 — Minimum dimensions of sand box

5.1.2 Sand.

Natural sand in air-dried condition with a moisture content of maximum 0,5 % (mass fraction), at room temperature with a grain distribution as shown in Figure 2 shall be used.



Key

1 Grain size, mm

2 Accumulated weight, %

Figure 2 — Standard sand quality

5.1.3 Test specimens.

Three test specimens of minimum length 2,5 m with a joint casing in the middle shall be used.

Two test specimens shall be made of pipes with casing diameter 160 mm and one specimen shall be made of pipe with casing diameter 250 mm. The test can also be applied on other casing diameters.

5.1.4 Sand box test.

The following test parameters shall be used:

— service pipe temperature of (120 ± 2) °C maintained for 24 h before the testing;

— simulated sand overfill of 1 m (18 kN/m^2 effective vertical soils stress);

— displacement of 75 mm;

— forward speed of 10 mm/min;

— backward speed of 50 mm/min;

— 100 cycles, where a cycle is defined as one forward and one backward movement without pause.

5.2 Water impermeability test

Test joints[4)] shall be immersed in a water tank at room temperature (23+/-2°C) and pressurized externally with a constant pressure of 30 kPa for a period of 24 h.

To facilitate assessment of water ingress, the liquid can be coloured.

5.3 Weld joint stress crack resistance test

Samples shall be tested according to Clause 5.2.4 in EN 253:2009.

The test samples shall be cut perpendicular to the weld seam.

The sample shall cover the whole length of weld seam plus at least 20 mm parallel length between the dumbbell shoulders and the outside of the welded area in both ends.

As a deviation to the test method in 5.2.4 of EN 253:2009, no notch shall be cut in the sample.

NOTE The weld seam is considered to be the notch

Samples of overlap welds shall be protected from excessive bending forces. Measures shall be taken in the design of the clamping device to prevent this.

In case the material thickness of casing and joint casing differ, the tensile stress shall be calculated based upon the smaller thickness.

5.4 Polyurethane rigid foam insulation (PUR)

5.4.1 General

The type tests for polyurethane rigid foam insulation (PUR) for joints shall be carried out in accordance with 5.3 of EN 253:2009, with the additions given in 5.4.2 to 5.4.7.

5.4.2 Test specimens

The test specimens shall comprise two joints for a casing diameter of at least 160 mm. The length of the joint insulation shall be at least two times the minimum free pipe end according to EN 253:2009, Clause 4.5.1.

If the joints are made on one pipe, the minimum space between the joint casings shall be 400 mm (see Figure 3).

4) Ernst Kaufmann, 050715.

Dimensions in millimetres

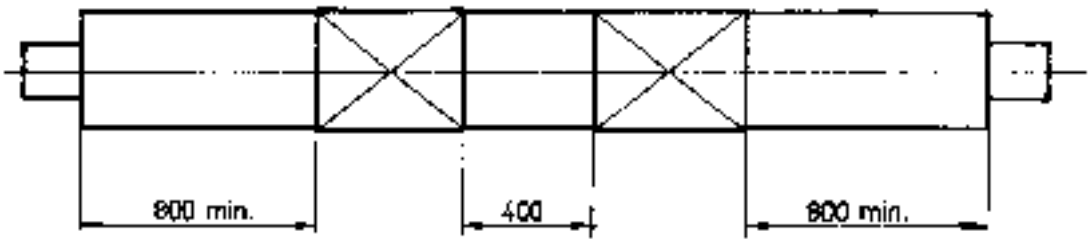


Figure 3 — Specimens for testing ageing resistance of joint foam

5.4.3 Sampling

PUR test specimens shall only be taken from the foam after the sample has been stored at room temperature for at least 72 h.

Cutting of test specimens from the foam to determine foam density, cell structure, compressive strength and water absorption shall be done in accordance with 5.1.1.4 and 5.1.1.5 of EN 253:2009.

5.4.4 Ageing resistance

Two joints shall be positioned in accordance with Figure 3.

The pipe and joint specimen shall be aged by maintaining the service pipe at a temperature of 160 °C for 3600 hours, or alternatively at a temperature of 170 °C for 1450 hours, while the casing pipe is exposed to room temperature.

Before the test, the ends of the foam shall be adequately sealed to prevent air penetration. The service pipe temperature shall be recorded continuously during the aging period and shall not deviate more than 0,5 °C from the required temperature.

After cooling to room temperature, the joints shall be opened for inspection.

5.4.5 Cell structure

5.4.5.1 Cell size

The size of the cells shall be determined over a length of 10 mm measured in a radial direction with the centre of the 10 mm measurement coinciding with the centre point of the applied insulation.

The size of the cells shall be the quotient of the test length and the number of cells counted along the radial line of test length selected and shall be determined as an average value of measurements on 3 specimens.

5.4.5.2 Closed cell content

The ratio of open to closed cells shall be determined in accordance with EN ISO 4590:2003 (method 1).

Deviating from the procedure described in EN ISO 4590 the test specimen shall be a cube with an edge of 25 mm. If this size of cube cannot be cut from the insulation in accordance with 5.4.5.1, the dimensions shall be 25 mm x 25 mm x t, where t is the maximum radial thickness.

5.4.6 Foam density

The density shall be measured in accordance with EN ISO 845.

Test specimens shall be taken from the centre of the foam in sets of three in accordance with Clause 5.1.2.5. of EN 253:2009. Each test specimen shall be 30 mm $\times$ 30 mm $\times$ t where t is the maximum obtainable thickness but not exceeding 30 mm. Alternatively, test specimens shall be cylindrical, 30 mm long in the axial direction of the pipe and of diameter d where d is the maximum obtainable diameter but not exceeding 30 mm.

5.4.7 Water absorption at elevated temperature

The test shall be performed on a cube with an edge of 25 mm, or a cylinder of length 25 mm in the axial direction of the pipe and a diameter of 25 mm. The mass (m_0) of the test specimen shall be determined to an accuracy of 0,01 g and the volume (V_0) shall be determined to an accuracy of 0,1 ml. The specimen shall be immersed in boiling water for 90 min. After this it shall be immersed immediately in water at (23 $\pm$ 2) °C for 1 h. Surface water shall be removed from the specimen by successively placing each side of the specimen for 3 s to 5 s on a cleaning tissue. The mass (m_1) shall then be determined to an accuracy of 0,01 g.

The water absorption percentage shall be calculated from:

$$\frac{m_1 - m_0}{V_0 \times \rho} \times 100\%$$

where

m_0 is the mass of the test specimen before testing, in g;

m_1 is the mass of the test specimen after the test period, in g;

ρ is the density of the water, in g/ml;

V_0 is the original volume of the test specimen, in ml.

The test result shall be determined as an average value of measurements come out on 3 specimens.

6 Marking

6.1 General

The joint casing shall be marked by any suitable method which does not affect the functional properties of the pipe casing and which is able to withstand conditions of handling, storage and use.

6.2 Joint casing

On the joint casing, the following shall be marked:

— Name of producer;

— Name of product – if any;

— Year and week of manufacture; if this is written in code, the key for the code shall be accessible e.g. in the installation guide;

— Name, identification or type of sealing material.

6.3 Plugs

The marking of the foaming hole plug shall be made in such a way that it is readable after the plug is installed. The plugs shall be marked with name of the producer.

6.4 Joint insulation system

After installation, the installer shall mark the casing with the name and/or type identification of the joint insulation system.

Annex A
(normative)

Fusion welding of steel service pipes on site

A.1 General

This Annex specifies requirements and test methods for the joint between two adjacent steel service pipes by means of fusion welding.

A.2 Material

The mechanical properties of the weld shall correspond to those of the pipe material.

A.3 Welding process

Welding processes shall be suitable for welding during pipeline construction (site welding). The various components of the pipeline (straight pipes and fittings) shall be butt-welded.

Precautions shall be taken to avoid damage to the PUR foam insulation and, where present, the surveillance system components.

The welding process shall be specified according to Clause 5 of EN ISO 15607:2003 and approved according to 6.1 of EN ISO 15607:2003.

The method of approval shall be agreed between the contracting parties at the enquiry or at the ordering stage.

A.4 Preparation for welding and lining up

All necessary precautions shall be taken to prevent environmental conditions from lowering the quality of the weld (insufficient space, wind, humidity, rain, temperature, etc).

Longitudinally or spirally welded pipes shall be rotated before welding in such a way that the distance between the two successive longitudinal or spiral welds is at least 10 times the wall thickness of the service pipe. The minimum distance shall be 50 mm (care shall be taken to position components of surveillance systems in accordance with the installation instructions).

The ends of the pipes to be welded shall be prepared in accordance with EN ISO 9692 (all parts).

The pipe ends to be welded shall be aligned and kept in a fixed position during welding, using suitable means.

A.5 Qualification of welders

Welders shall be qualified in accordance with EN 287-1.

A.6 Steel weld inspection

A.6.1 General

Only qualified personnel shall inspect the welds.

The welding area shall be clean and free from paint, coating and insulation material. Externally recognisable imperfections are classified in EN ISO 6520-1.

For the acceptance of visual imperfections the weld shall fulfil "Quality level B" of EN ISO 5817:2007.

The welds shall be inspected over the entire circumferential length by one or more of the following non-destructive test methods.

A.6.2 Leak-tightness test with air/gas

The leak-tightness test with air/gas shall be performed in accordance with EN 13941.

A.6.3 Leak-tightness test with water

The leak-tightness test with water shall be performed in accordance with EN 13941.

A.6.4 Radiographic examination

Radiographic examination with X- or γ-rays (γ-rays only to be used in exceptional cases) shall be carried out in accordance with EN 444 and EN 1435.

The welding shall comply with "Quality level 1" of EN 12517-1:2006.

A.6.5 Ultrasonic examination

For wall thickness exceeding 6 mm ultrasonic examination in accordance with EN 1714 and EN 583-1 is permitted instead of radiographic examination. The acceptance criteria shall then be according to EN 1712.

Annex B
(informative)

General guidelines for inspection of the joint on site

Table B.1 — Inspection programme for the steel welds

No.	Operation	Inspection activity	Reference
1	Evaluation of welder's qualifications	Inspection of welder's certificate	A.3
2	Inspection of steel quality, diameter, wall thickness, marking, etc.	Visual Measurements	Steel pipe manufacturer's manual Standards Project specification
3	Verification of electrode/wire type	Check for correct electrode/wire type.	Project specification
4	Storage of electrodes/wires on sites	Check for storage conditions.	Electrode/wire manufacturer's information
5	Removal of burrs, scales, paint, rust, dirt, etc. from the welding zone	Visual	Project specification A.3
6	Removal of dirt, sand, stones, etc. from the internal steel pipe surface		
7	Cutting and bevelling of pipe ends	Visual Measurement of cutting angle/joint profile	A.4
8	Positioning of the tubular joint components and attachment to pipe	Check for presence of tubular joint components.	Components manufacturer's manual
9	Lining up Positioning of surveillance system components	Visual Measurement of misalignment	A.4
10	Creation of optimum work environment	Visual	A.4
11	Removal of moisture and frost by preheating steel pipe ends	Check for absence of moisture and frost.	Project specification
12	Welding Heat treatment if necessary	Measurements of temperatures	A.3
13	Surface examination after welding	Visual check of cleanliness and imperfections	Annex A, A.6
14	Testing of welds	Leak-tightness test with air/gas	A.6.2
15		Leak-tightness test with water	A.6.3
16		Radiographic examination	A.6.4
17		Ultrasonic examination	A.6.5
18	Identification and marking of welds	Visual Check of records	Project specification

Table B.2 — Inspection programme for insulating and sealing

No.	Operation	Inspection activity	Requirement
1	Preparation	Check of organization, materials, disposition and storage Check of fitters qualification and equipment	Project specification
2	Creation of optimum work environment	Visual	4.3.2 Installation instruction
3	Cleaning of joint area Removal of wet foam	Visual	4.3.3
4	Assembly of surveillance system	Visual Check of continuity of measuring elements	4.3.4
5	Preparation of insulating and sealing materials	Check for condition	Installation instruction
6	Insulating and sealing	Check for correct methods	4.3.6 and 4.3.7
7	Preparation of records by installation company	Inspection of records	Presence of data for on site foamed joints on raw materials, mixing ratio, mixing method, and temperatures
8	Testing of PUR-foam	Sampling of test specimens	Project specification

Annex C
(informative)

Qualification of fitters installing joints in preinsulated bonded pipe networks

C.1 Knowledge and skills

The fitters installing joints in preinsulated pipe networks and persons supervising such work shall be able to demonstrate theoretic knowledge and practical skills with respect to:

— the material to be used;

— the relevant jointing system;

— the insulation procedure;

— the installation of surveillance system;

— quality and fault characteristics;

— preparation for installation and handling of materials;

— quality inspection and documentation;

— rules for accident prevention, valid measures of protection.

This Annex describes the recommended minimum for basic training including adequate testing, as well for upgrading of the specialists' skills.

The necessary training programs can be set up by manufacturers, suppliers or other competent organizations, e.g. technical schools. An evidence of qualification should be issued specifying training undergone and skills acquired.

C.2 Background for training and testing

Practical experience with installation of preinsulated pipe networks is recommended for those who are intended to receive further education, relevant to the installing of joints.

The training programs should include the following fields and listed subjects and give reasonable time for practical exercises in jointing techniques, insulation procedures and [5)] assembly of surveillance systems. Installation of joints under site conditions should be part of the training.

C.3 Subjects for training and testing

C.3.1 General

Specialists who carry out installation work on preinsulated pipe systems and on joint systems should prove a basic knowledge of the behaviour of the casing material as well as the appropriate handling of the preinsulated pipes in order to avoid general damage of the preinsulated pipe system.

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5) Jan Elleriis, 050713.

The details of consequences of incorrect handling on the service life of the preinsulated pipes should be included in the training and the proof of this knowledge should be stated in the evidence of qualification.

More comprehensive and deeper material knowledge should be given to specialists working with hot air draw- and extrusion welding.

C.3.2 Casing of polyethylene (PE)

C.3.2.1 Important construction characteristics and properties

— The material group plastics

— Thermo-plastics

— Polyethylene (PE)

C.3.2.2 Technological behaviour of PE

a) States

   1) Fusion of materials

   2) Degradation of materials

b) Properties/type characteristics

   1) Density/Density groups

   2) Melt flow Rate (MFR)

   3) Stabilizing systems

c) Cross linked PE-types

   1) Change of material behaviour

   2) Main points of application

C.3.2.3 Mechanical properties of PE

a) Resistance behaviour under load

   1) Pull, bend, impact

   2) Short-term and long-term strength

   3) Behaviour under creep

b) Heat influence on the mechanical properties. Short- and long-term properties

c) Internal stresses in the casing (from manufacturing process)

   1) In the weld joint (cooling shrink stresses)

   2) Shrink relaxation by time and temperature

C.3.2.4 Conditions for casing elements under load

— Local stress increases caused by geometric shaping or by change of cross section

— Notches caused by inexpert handling and treatment of defective weld seams

C.3.3 Surveillance

a) Function mode of surveillance

   1) Resistance-comparison principle

   2) Impulse reflection principle

b) Design of the applied surveillance system

c) General requirements to proper installation

C.3.4 PUR-foam system

C.3.4.1 PUR-foam as a two component material

— Components and additives, foaming procedure

— Foaming temperature limits

— Physical and chemical blowing agents

— Mixture, start and reaction time, curing time

— Requirements for joint foams

— Safety regulations

C.3.4.2 Insulation procedures on job site

a) Manual foaming

   1) Open can method

      i) Disposable mixing jug

      ii) Exact quantity/mixing ratio

      iii) Special personal safety precautions

   2) Foam packs particular adapted to joint size

      i) Correct package size

      ii) Intensive mixing

   3) Job site foaming machines

      i) Equipment maintenance

      ii) Fixed volumetric ratio of mixture

iii) Observance of temperature/viscosity

iv) Starting up checks

b) Installation of prefabricated joint insulation

1) Tight application without air gaps

2) Check dryness of prefabricated insulation

C.3.5 Joint types/jointing systems

C.3.5.1 General

— System characteristics

— Requirements for installation and use

C.3.5.2 Shrink sleeve joint with mastic/adhesive sealing

— Joint face form

— Sealing system

— Joint elements

— Installation process, shrinking process/heat treatment

— Testing characteristics and quality control

— Protective precautions

C.3.5.3 Welded joints/systems

a) Characteristic feature is the insoluble jointing

1) Joint face form/preparation

2) Joint elements

3) Installation procedure

4) Welding equipment/proceedings

5) Job site condition-matters of influence/counteractions

6) Testing characteristics

7) Protective precautions

b) Joint systems and weld methods

1) Constructional permanent material bond

i) Joint casing with overlap and surface welds, with and without longitudinal weld seam

ii) Weld method with heating wires/grid

iii) Joint casing with fillet welds and overlap, with and without longitudinal weld seam

iv) Extrusion weld method

v) Joint casing with butt welds and flush without overlap, with longitudinal weld seam

vi) Extrusion weld method

c) Conditional permanent material bond

1) Joint casing with and without longitudinal weld seam with multi-layer, combined shrink/weld sleeves

C.3.5.4 Mechanically clamped joints as coated shell muffs made from metal with tapered/bolted seal

— Joint face form

— Sealing system

— Joint elements

— Installation procedure

— Cathodic protection

— Test characteristics

C.3.6 Installation of joints

C.3.6.1 General

a) Check of job site conditions

1) Conditions of pipes (dimensions, surface condition, joint faces)

2) Conditions for installation (accessibility of trench, pipe position)

3) Position of measuring wires for surveillance system

4) Conditions of surroundings

5) Protective precautions

C.3.6.2 Installation of surveillance system

C.3.6.2.1 General

— General requirements for correct installation

C.3.6.2.2 Preparation of installation

— Circuit diagram, location of components

— System suppliers installation instructions

— Function check of wires and components prior to installation

— Cutting out foam at the ends of pipes and fittings

— Cleaning of joint casing and joint area

— Measurement of moisture level

C.3.6.2.3 Installation of surveillance systems and their components

— System suppliers installation instructions

— Final measurements before insulation

— Record/documentation

C.3.6.2.4 Measurements after insulation

— Real resistance value

— Functional test

— Fault simulation

— Record/documentation

C.3.6.3 Sealed joints

a) General conditions for sealing/adhesion

   1) Adhesive behaviour

   2) Measures for preparatory surface treatment

   3) Ambient conditions, requirements and protective measures

   4) System suppliers instructions to be observed

b) Making of joints

   1) Waiting time to be kept after foaming

   2) Requirements to sealing systems to be observed

   3) Preparation of joint faces

   4) Ambient conditions, protective measures

   5) Applying of sealing material

   6) Processing steps

   7) Heating/shrinking procedure

   8) Waiting time, cooling stage

   9) Test and assessment, quality check

C.3.6.4 Welded joints

C.3.6.4.1 Joint face forms and welding procedures in accordance with joint types described in C.3.4.2

— Basis, welding parameters, particularities by execution

— Joint welding systems with specific welding apparatus and equipment

— Durable sealing of foaming and venting openings

C.3.6.4.2 Training and testing

a) Special knowledge of:

1) Material basis of plastic welding

2) Specialities of the applied welding process

3) Measures for preparation and requirements for implementation

4) Consequences in case of failure by installation

5) Choice of parameters

6) Test characteristics and basis for assessment

7) Quality check

NOTE As a basic information about the different welding techniques the German DVS guidelines 2207, part 1, 3, 4 and 5, as well as DVS 2202, part 1 (assessments of defects in plastic welding) can be used.

C.3.6.5 Insulation of joints

C.3.6.5.1 Special factors of influence to job site conditions

— Measures to be taken when working with PUR-foam

— Storage conditions

— Indications of durability

— Safety precautions

C.3.6.5.2 On site foaming work

— Marking, checking of joint type and size, ambient conditions

— Removal of possible wet foam and foam film in joint area

— Clean and dry service pipe and casing

— Check of foam quality adapted to joint volume and proper mixing of foam components

— Working temperatures in accordance with system suppliers instructions

— Filling-in of the mixed foam liquids, sealing of venting holes

— Consequences of faults in above listed points

— Final quality check

C.3.6.5.3 Prefabricated joint insulation installation work

— Marking, checking of joint type and size, ambient conditions

— Removal of possible wet foam and foam film in joint area

— Clean and dry service pipe and casing

— Dimension and quality check of prefabricated insulation shells

— Cutting and installation of insulation shells with tight fit and no air gaps

— Consequences of faults in above listed points

— Final quality check

C.3.6.6 Documentation

— Pipe isometric drawings with indication of all components to be built in and their position

— All tests and measurements to be laid down in an acceptance report

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