BS EN 448:2015

BSI Standards Publication

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

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National foreword

This British Standard is the UK implementation of EN 448:2015. It supersedes BS EN 448:2009 which is withdrawn.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.

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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

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

Fernwärmerohre - Werkmäßig gedämmte Verbundmantelrohrsysteme für direkt erdverlegte Fernwärmenetze - Verbundformstücke, bestehend aus Stahl-Mediumrohr, Polyurethan-Wärmedämmung und Außenmantel aus Polyethylen

This European Standard was approved by CEN on 5 September 2015.

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CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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Contents

Page

European foreword

This document (EN 448:2015) has been prepared by Technical Committee CEN/TC 107 “Prefabricated district heating and district cooling pipe system”, 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of an identical text or by endorsement, at the latest by May 2016, and conflicting national standards shall be withdrawn at the latest by May 2016.

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This document supersedes EN 448:2009.

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Introduction

EN 448 has been aligned with EN 488 and other relevant European Standards.

Other standards from CEN/TC 107 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 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;*

— EN 15632 (all parts), *District heating pipes — Pre-insulated flexible pipe systems;*

— EN 15698-1, *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;*

— EN 15698-2, *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.*

1 Scope

This European Standard specifies requirements and test methods for fittings of prefabricated thermally insulated pipe-in-pipe assemblies comprising a steel service fitting from DN 20 to DN 1200, rigid polyurethane foam insulation and an outer casing of polyethylene for use in directly buried hot water networks with preinsulated pipe assemblies in accordance with EN 253.

This European Standard covers the following fittings: bend, tee, reducer, single use compensator and anchor.

This European Standard applies only to factory made prefabricated fitting assemblies and single use compensators for continuous operation with hot water at various temperatures in accordance with EN 253.

This European Standard applies to fitting assemblies with a minimum design pressure of 16 bar (overpressure) complying with EN 13941.

This European Standard does not include calculation rules for loads and stresses. The design and installation rules, for the system, are given in EN 13941.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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+A2:2015, *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 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*

EN 10216-2, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 2: Non-alloy and alloy steel tubes with specified elevated temperature properties*

EN 10217-1, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 1: Non-alloy steel tubes with specified room temperature properties*

EN 10217-2, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 2: Electric welded non-alloy and alloy steel tubes with specified elevated temperature properties*

EN 10217-5, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 5: Submerged arc welded non-alloy and alloy steel tubes with specified elevated temperature properties*

EN 10253-2, *Butt-welding pipe fittings — Part 2: Non alloy and ferritic alloy steels with specific inspection requirements*

EN 12814-1, *Testing of welded joints of thermoplastics semi-finished products — Part 1: Bend test*

EN 13018, *Non-destructive testing — Visual testing — General principles*

EN 13941, *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*

EN 14870-1, *Petroleum and natural gas industries — Induction bends, fittings and flanges for pipeline transportation systems — Part 1: Induction bends (ISO 15590-1:2009 modified)*

EN ISO 3452-1, *Non-destructive testing — Penetrant testing — Part 1: General principles (ISO 3452-1)*

EN ISO 5579, *Non-destructive testing — Radiographic testing of metallic materials using film and X- or gamma rays — Basic rules (ISO 5579)*

EN ISO 5817, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections (ISO 5817)*

EN ISO 8501-1, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings (ISO 8501-1)*

EN ISO 9606-1, *Qualification testing of welders — Fusion welding — Part 1: Steels (ISO 9606-1)*

EN ISO 9692-1:2013, *Welding and allied processes — Types of joint preparation — Part 1: Manual metal arc welding, gas-shielded metal arc welding, gas welding, TIG welding and beam welding of steels (ISO 9692-1:2013)*

EN ISO 9934-1, *Non-destructive testing — Magnetic particle testing — Part 1: General principles (ISO 9934-1)*

EN ISO 10675-1, *Non-destructive testing of welds — Acceptance levels for radiographic testing — Part 1: Steel, nickel, titanium and their alloys (ISO 10675-1)*

EN ISO 11666, *Non-destructive testing of welds — Ultrasonic testing — Acceptance levels (ISO 11666)*

EN ISO 14732, *Welding personnel — Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials (ISO 14732)*

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

EN ISO 16810, *Non-destructive testing — Ultrasonic testing — General principles (ISO 16810)*

EN ISO 17636-1, *Non-destructive testing of welds — Radiographic testing — Part 1: X- and gamma-ray techniques with film (ISO 17636-1)*

EN ISO 17636-2, *Non-destructive testing of welds — Radiographic testing — Part 2: X- and gamma-ray techniques with digital detectors (ISO 17636-2)*

EN ISO 17637, *Non-destructive testing of welds — Visual testing of fusion-welded joints (ISO 17637)*

EN ISO 17638, *Non-destructive testing of welds — Magnetic particle testing (ISO 17638)*

EN ISO 17640, *Non-destructive testing of welds — Ultrasonic testing — Techniques, testing levels, and assessment (ISO 17640)*

EN ISO 23277, *Non-destructive testing of welds — Penetrant testing — Acceptance levels (ISO 23277)*

EN ISO 23278, *Non-destructive testing of welds — Magnetic particle testing — Acceptance levels (ISO 23278)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 253:2009+A2:2015 and the following apply.

3.1
anchor
construction used to transfer the loads from the steel service pipe through the insulation and the casing to a fixed point

3.2
bending angle
α
deviation in direction of the steel pipe centre lines

3.3
butt welded bend
bend manufactured either by hot bending of steel pipe or by hot forming of steel plates which are subsequently welded together

3.4
cold formed bend
bend manufactured by cold bending of steel pipe

3.5
cap
not pre-insulated butt welded fitting to be welded on the end of a pipe or fitting

3.6
fitting
reducer, tee, factory-made elbow and bend, cap, welding stub, mechanical joint

3.7
forged T-piece
T-piece manufactured by hot forming of either steel pipes or steel plates which are subsequently welded together

3.8
hot formed bend
bend manufactured by heating pipe during bending

3.9
induction bend
bend manufactured by induction bending

3.10
induction bending
continuous bending process which utilizes induction heating to create a narrow, circumferential, heated band around the material being bent

3.11
nominal size, DN
alphanumeric designation of size, common to components in piping systems which are used for reference purposes

[SOURCE: EN ISO 6708:1995, 2.1, modified]

3.12
pipe element
reducer, tee, factory-made elbow and bend, flange, cap, welding stub, mechanical joint

3.13
reducer
butt welding fitting to be welded between two steel pipes of different diameters

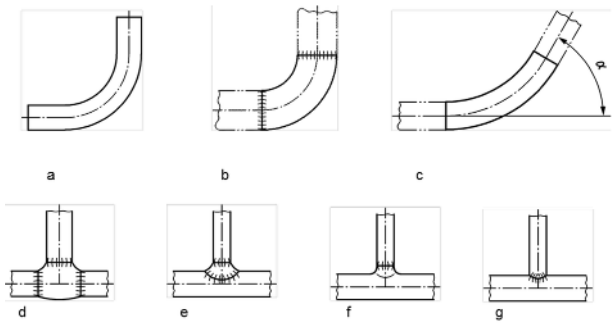
3.14
single use compensator
SUC
compensator functioning during pre-heating, but being locked after pre-heating

NOTE Single use compensators are not preinsulated units.

3.15
surveillance system
system that consists of measuring sections and measuring instruments for surveillance of pipe systems according to EN 14419:2009

3.16
welded tee
butt welding fitting manufactured by welding together pieces of steel pipes with or without the use of a welding saddle or a drawn collar on the main pipe

3.17
welding saddle
butt welding fitting to be welded into the main pipe for the welded connection between the main pipe and the branch pipe in a T-piece



Key

a	cold or hot formed bends	e	tee with welding saddle
b	butt welding bend or elbows	f	tee with drawn collar
c	bending angle, α	g	directly welded tee
d	forged tee		

Figure 1 — Examples

4 Requirements

4.1 Steel parts

4.1.1 General

The material of the fitting steel parts shall be certified in accordance with EN 10204. If traceability on material is required by the end user it shall be specified at the time of ordering. Corresponding material certificates shall be delivered to the end user if specified at the time of ordering.

4.1.2 Quality

The quality of pipe material used for the assembly of fittings shall be in accordance with EN 253:2009+A2:2015, Table 1. The quality of butt welding pipe fittings shall be in accordance with EN 10253-2.

NOTE For Sweden, a deviating situation is applicable for EN 253:2009+A2:2015, Table 1 (see the A-deviation in EN 253:2009+A2:2015, Annex G).

4.1.3 Wall thickness and diameter

According to the scope of this European Standard, all components shall be designed for a minimum of 16 bar.

NOTE If the fitting assemblies have to be used in situations with pressures higher than 16 bar, extra calculations will be necessary.

The minimum nominal wall thickness of all components shall prior to processing be at least the same as for the straight pipes.

The nominal diameter, the outside diameter and the minimum nominal wall thickness shall be the same as for the straight pipes in accordance with EN 253:2009+A2:2015, Table 2. The tolerances on the outside diameter of the pipe ends shall be in accordance with EN 253:2009+A2:2015, Table 3.

Subject to design considerations other wall thicknesses than those given in EN 253:2009+A2:2015, Table 2 may be used, but in no case shall these be less than the minima indicated in EN 253:2009+A2:2015, Table 2.

All components shall be designed in accordance with EN 13941, for the actions and stresses that normally occur during a system's entire service life.

4.1.4 Bends

4.1.4.1 Butt welding bends

The dimensions shall be in accordance with EN 10253-2 with the exception that the bend radius shall be ≥ 1,5 times the outer diameter.

4.1.4.2 Cold formed bends

Cold formed bends shall be produced from seamless pipe or longitudinal welded pipes. At cold formed bends made of longitudinal welded pipes the weld bead shall be welded to factor V = 1 (calculation stress = 100 %).

After bending, the minimum wall thickness of the bent pipe shall be not less than 85 % of the nominal wall thickness of the straight pipe (see EN 253:2009+A2:2015, Table 2).

The maximum ovality in the bent area shall not exceed 6 %.

The formula for the calculation of the ovality is:

$$o = \frac{\left(D_{s\,max} - D_{s\,min}\right)}{D_s} \times 100 \qquad (1)$$

where

o is the ovality, in %;

$D_{s\,max}$ is the maximum outside diameter;

$D_{s\,min}$ is the minimum outside diameter in the same cross section in the bended area;

D_s is the specified outside diameter.

There shall be no folding in the bent area. Waves can be accepted, when the maximum height between trough and crest of the wave does not exceed 25 % of the nominal wall thickness of the bent pipe.

4.1.4.3 Hot-formed bends

For hot-formed bends manufactured from straight pipes by means of inductive heating (induction bends), no heat treatment is necessary as far as this method is applied with unalloyed or low-alloyed steel with [Mo] < 0,65 %. Hot-formed bends shall be supplied in conformity with EN 14870-1.

If for the bending other heating methods are applied, heat treatment following the bending of the pipes is required.

If a hot-formed bend has to be made from line pipe, this should be specified to the pipe manufacturer at the time of ordering so that they can take this into account when selecting the (chemical) composition of the pipe material and the welding filler material.

It is recommended to determine per batch, diameter, wall thickness and bend radius, through mechanical testing, that the bends comply with the applicable material specifications. It is customary that a representative bend or an (additional) section of a bend of adequate length be manufactured during the production process and that 10 % of the bends be tested.

4.1.4.4 Tolerances of bending angles

The deviation from the nominal bending angle shall not exceed the tolerances given in Table 1.

Table 1 — Deviations from nominal bending angle

Nominal diameter of service pipe	Deviation
≤ DN 200	±2,0°
> DN 200	±1,0°

4.1.5 T-pieces

4.1.5.1 Forged T-pieces

The wall thickness T and T_1, see EN 10253-2, shall be at least the same as those for the straight pipes, see EN 253:2009+A2:2015, Table 2. All other dimensions shall be in accordance with EN 10253-2.

4.1.5.2 Welding saddles

Welding saddles shall be of the type which shall be welded into the wall of the main pipe.

The wall thickness of the welding saddles shall be at least the same as the wall thicknesses of the main pipes and the branch pipes which shall be welded to the saddles.

4.1.5.3 Welded T-pieces

Welded T-pieces shall be manufactured either by using welding saddles or by drawing a collar on which the branch pipe is welded or by welding the branch pipe directly to the main pipe. The wall thickness of the collar shall be at least the same as that for the branch pipe, see EN 253:2009+A2:2015, Table 2. The collar shall be drawn opposite the welding seam in the main pipe. When using branch pipe directly welded to the main pipe, compensating (reinforcement) plates can be used according to EN 13941 requirements.

4.1.5.4 Tolerances of angles between branch pipes and main pipes

The branch pipes shall be perpendicular to the main pipes within a tolerance of ± 2,0°.

4.1.6 Reducers

Reducers shall be in accordance with EN 10253-2, except for the wall thicknesses T and T_1, see EN 10253-2 which shall be at least the same as for the straight pipes (see EN 253:2009+A2:2015, Table 2) to be welded to the fittings.

4.1.7 Anchors

The anchors shall be marked with the information concerning maximum loads for which the construction was designed and calculated. The lifetime of the system shall not be influenced by the anchors construction.

4.1.8 Single use compensators

A single use compensator shall comply with the requirements of EN 13941.

4.1.9 Caps

Caps (dished ends) shall be in accordance with EN 10253-2 and comply with the requirements of EN 13941.

4.1.10 Fusion welding of steel fittings

4.1.10.1 Filler material

Filler material shall after welding have mechanical characteristics comparable with the parent metal.

4.1.10.2 Welding process

All types of fusion welding are acceptable but arc welding with covered electrodes and gas-shielded metal-arc welding are preferred. The welding process shall be specified and approved in accordance with EN ISO 15607.

The method of approval may be chosen by the manufacturer.

Fittings of wall thickness ≥ 5,6 mm shall be welded in more than one pass.

4.1.10.3 Preparation for welding

Pipe ends shall be prepared in accordance with the welding procedure used. When using covered electrodes or gas-shielded metal-arc welding, pipe ends and fittings with equal wall thickness shall be prepared in accordance with EN ISO 9692-1.

Table 2 of this standard is derived from EN ISO 9692-1:2013, Table 1 and gives the relation between wall thickness and reference number.

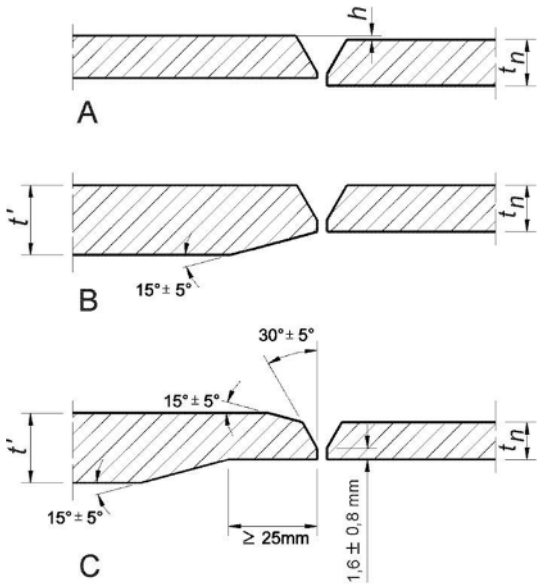
Table 2 — Preparation of ends of pipes and fittings for weldings according to EN ISO 9692-1:2013

Symbol	**Type of preparation**	**Wall thickness T of service pipe fittings or fitting end**	**Reference to** EN ISO 9692-1:2013, Table 1
II	Square preparation	T < 3 mm	1.2.1
V	Single V preparation	3 mm ≤ T ≤ 10 mm	1.3
Y	Single Y preparation with broad root face	T > 10 mm	1.5
NOTE Symbols are in accordance with ISO 2553.			

Pipe ends and fittings with different wall thicknesses shall be prepared and adapted for misalignment in accordance with Table 3 and Figure 2 of this standard.

Table 3 — Adaptation of misalignment and difference in wall thickness

	Adaptation	**Required action**
Misalignment		
Misalignment $h \leq 0{,}3\ t$, max. 1 mm	Figure 2 detail A	
Misalignment 1 mm < $h \leq$ 10 mm		Adaptation of pipe ends
Misalignment $h >$ 10 mm	Extra fitting	Extra prepared steel fitting minimum length, see note
Difference in wall thickness		
Differences in wall thickness: $t' \leq 1{,}5\ t_n$	Figure 2 detail B	Adaptation of thicker wall t'
Differences in wall thickness: $t' > 1{,}5\ t_n$	Figure 2 detail C	Adaptation of both sides
The seam spacing shall be such that the heat-affected zones do not overlap or interact. A spacing of 100 mm or more is recommended. The minimum spacing is 50 mm.		



Key

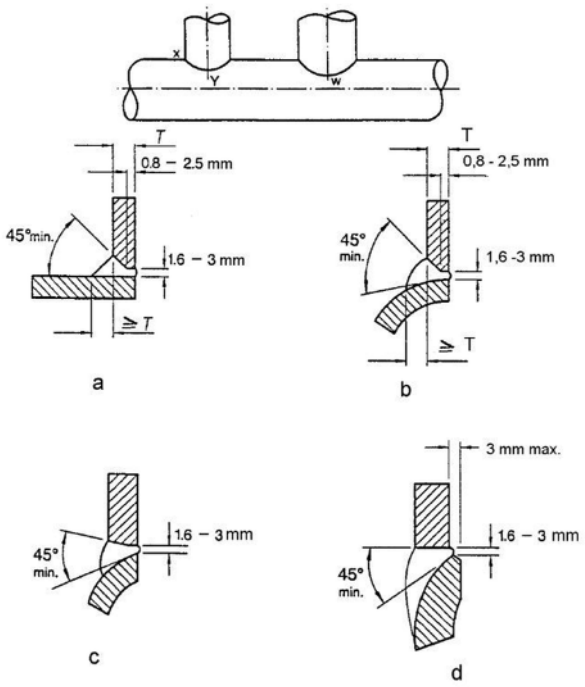
h misalignment

t_n smallest wall thickness

t' largest wall thickness

Figure 2 — Misalignment, difference in wall thickness and joint end preparation, in accordance with EN 13941

When manufacturing T-pieces with the branch pipe welded directly to the main pipe, preparations shall comply with Figure 3.



Key

a	section X at crotch of right angle branch	c	section Y at flank of unequal branch. Ratios of diameters > 2/3.
b	section Y at flank of unequal branch. Ratios of diameters ≤ 2/3.	d	section W at flank of equal branch.

Figure 3 — Preparation of set-on branches

4.1.10.4 Inspection of welds

4.1.10.4.1 Detail a – Visual surface examination

When visual surface examination is carried out, it shall be in accordance with 5.3.1. The examinations include a check of surface, internal, joint geometry and multiple imperfections. The welding shall comply with "quality level B" of EN ISO 5817.

4.1.10.4.2 Detail b – Leak tightness test

When a leak-tightness test is carried out in accordance with 5.3.2 or 5.3.3, the welds shall fulfil the conditions stated there.

4.1.10.4.3 Detail c – Non-destructive examination of welds

When non-destructive is carried out, it shall be in accordance with 5.3.4. The weld shall comply with "quality level B" of EN ISO 5817.

4.1.10.5 Competence of the welder

The welder shall have a valid certificate according to EN ISO 9606-1 for the techniques, material groups, dimension ranges and welding position concerned. Welding personnel operating mechanized welding equipment shall be qualified in accordance with EN ISO 14732.

4.1.11 Surface condition

In order to ensure proper bonding between the steel service pipe and the PUR-foam insulation, the following procedure shall be followed:

a) prior to insulation, the outer surface of the pipe shall be cleaned so that it is free from rust, mill scale, oil, grease, dust, paint, moisture and other contaminants;

b) before cleaning the pipe, the outer surface of the pipe shall comply with rust grade A, B or C according to EN ISO 8501-1, without pitting.

4.2 Casing

The casings shall meet the requirements of EN 253:2009+A2:2015, 4.3.

The casing shall be tested in accordance with 5.4 of this standard.

4.3 Polyurethane rigid foam insulation (PUR)

The polyurethane rigid foam insulation for fitting assemblies shall meet the requirements of EN 253:2009+A2:2015, 4.4, 4.5.5 and 4.5.6 and shall be tested in accordance with 5.5 of this standard. Test specimens from fitting assemblies to establish foam properties shall be taken in accordance with 5.2 of this standard.

4.4 Fitting assemblies

4.4.1 Fitting ends

4.4.1.1 Service pipe

The ends of the service pipe shall be prepared for welding in accordance with EN ISO 9692-1and shall be free from insulation for a minimum length of 150 mm. The tolerance on the declared value shall be ± 10 mm.

4.4.1.2 Centre line deviation

When tested in accordance with 5.6.1 the distance between centre lines of the service pipe and the casing at fitting ends shall not exceed the limits given in EN 253:2009+A2:2015, Table 7.

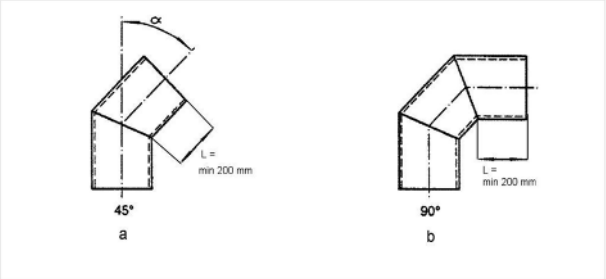
4.4.1.3 Angular deviation between service pipe and casing

When tested in accordance with 5.6.1, the angular deviation between centre lines of the not insulated end of the service pipe, and the casing at a length of 100 mm from the end, shall not exceed 2°.

4.4.2 Angle between casing segments of bend and minimum length

The maximum angle, α, between two adjacent segments of the casing of a bend shall not exceed 45°, see Figure 4.

The length, L, see Figure 4, of the casing at the ends of the fittings shall not be less than 200 mm.



Key

a α ≤ 45° with minimum 2 segments

b α > 45° with minimum 3 segments

Figure 4 — Segmental casing pipe bends

4.4.3 Requirements of polyethylene welding

4.4.3.1 General

The quality of a PE weld cannot easily be tested with non-destructive methods.

The observation of proper working procedures shall ensure that the welds are leak-tight.

The welding process should, therefore, be performed according to a documented procedure in accordance with Annex B or its equivalent.

For PE welding the following precautions shall be taken and documented:

a) only pipes fulfilling the requirements of EN 253:2009+A2:2015, 4.3 shall be used;

b) weld fillers of PE shall fulfil the requirements of EN 253:2009+A2:2015, 4.3.1;

c) proven welding processes using suited and maintained tools shall be used;

d) the personnel shall be trained and possess a valid evidence of their qualifications;

e) a 100 % visual examination according to 4.4.3.3 shall be carried out.

4.4.3.2 Melt flow rate

The melt flow rate of the pipes to be welded shall not differ more than 0,5 g/10 min when determined in accordance with EN 253:2009+A2:2015, 4.3.1.2.

4.4.3.3 Visual appearance

All welds shall be examined in accordance with 5.6.2. The following requirements shall be fulfilled:

a) Butt fusion welding:

   1) the valley between the weld beads shall not go beneath the pipe surface;

   2) the permitted butt misalignment shall not exceed 20 % of the wall thickness on the entire seam length. On particular fittings, such as extruded tees, a butt misalignment of up to 30 % and the resulting imperfection can be tolerated. The permitted butt misalignment applies internally as well as externally. At two different wall thicknesses the permitted butt misalignment shall be related to the smaller wall thickness;

   3) the two weld beads shall be approximately alike and symmetrical at the same wall thickness;

   4) the weld beads shall have approximately the same shape and size on the entire length. A double bead width of approximately (0,6 – 1,2) mm × e shall be obtained. For e < 6 mm, however, a width of 2 mm × e shall be obtained;

   5) inspect the wall thickness of the casing pipe;

   6) the weld beads shall be smooth, round, without burrs, notches or important imprints from the tool division line.

b) Extrusion weld seams:

   1) the filler material shall fill out the weld joint entirely;

   2) during any destructive tests the seam in the cross and the longitudinal section shall not have any visual dividing or binding failure zones between filler and casing material;

3) the seam surface shall be convex and 10 % to 40 % of the wall thickness higher than the casing surface;

4) the edges of the V-seam of the casing material shall be covered by the weld seam overlapping by ≥ 2 mm;

5) next to the weld seam a melt print of the welding shoe shall be visible;

6) melt overflow may occur and is eventually to be removed notchless;

7) the seam root shall be welded through. Root notches are not permitted. Root sinks are permitted locally up to a length of approximately 20 mm and a depth of ≤ 0,1 × *e* and maximum 1 mm;

8) inspect the wall thickness of the casing pipe;

9) edge notches (from the welding shoe marks or the machining) are generally permitted if these end up flat and do not exceed 10 % of the wall thickness;

10) a root overflow of 20 % of the wall thickness is permitted;

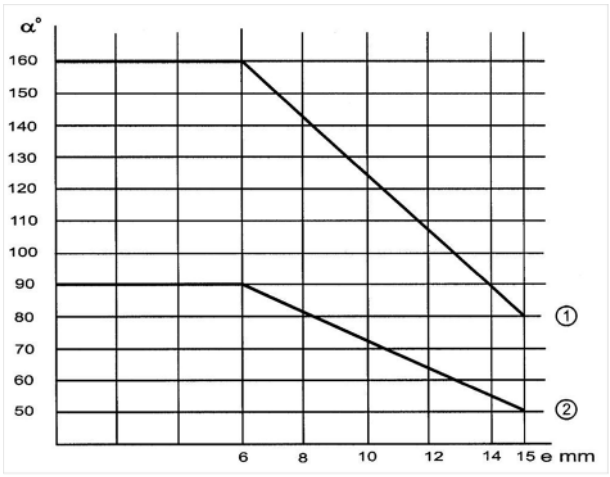
11) bonding failures are not permitted;

12) pits and cavities shall not exceed 15 % of the basic pipe wall thickness;

13) with regard to the root maximum of 2 mm, however, an edge misalignment of a maximum of 20 % of the wall thickness is permitted.

4.4.3.4 Bending test

When tested in accordance with EN 12814-1 cracks shall not occur in the weld seam until the testing angle is reached. The minimum bending angle, α, shall be in accordance with the diagram shown in Figure 5.



Key

1 butt weld

2 extrusion weld

Figure 5 — Minimum bending angle

4.4.4 Leak-tightness of the welded casing pipe

The fittings shall be leak-tight.

If the PUR-foam is visible on the outside of the weld after the foaming the complete casing shall be removed and the whole production series inspected.

The welding process shall be correct and the product examined according to 4.4.3.3 and 4.4.3.4.

NOTE A guideline for training, process parameters, maintenance and proper workmanship can be found in Annex B.

4.4.5 Diameter and wall thickness of the casing

The outside diameter and the minimum wall thickness of the PE casing shall be in accordance with EN 253:2009+A2:2015, 4.3.2.2.

4.4.6 Minimum insulation thickness in bends

The insulation thickness of the bends, measured in accordance with 5.6.4, shall not at any point be less than 50 % of the nominal insulation thickness and nowhere less than 15 mm.

4.4.7 Tolerances of the main fitting dimensions

The tolerances of the main fitting dimensions shown in Figure 6 shall be in accordance with Table 4.

Table 4 — Tolerances on the main fitting dimensions

DN	H mm	L mm
≤ 300	±10	±20
> 300	±25	±50

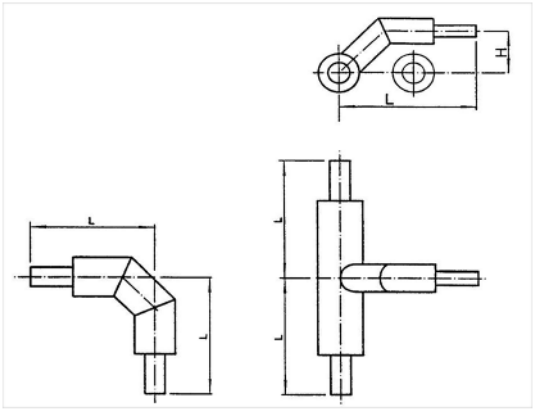


Figure 6 — Main fitting dimensions

4.5 Surveillance system

When measuring elements for a surveillance system are installed in the fitting all specifications shall comply with EN 14419:2009.

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 standard shall apply.

5.2 Test specimens

Test specimens shall only be taken from the casing after it has been stored at room temperature for not less than 16 h, or from the PUR foam and fitting assemblies after they have been stored at room temperature for not less than 72 h.

Deviations from these periods are allowed, e.g. for quality control purposes; however, in event of a dispute the required periods shall be observed.

To establish foam properties, test specimens shall be taken from all ends of the fitting assemblies, but in such a way as to exclude at least 100 mm from the end of the foam, and 50 mm from welded areas of the polyethylene casing.

Provided that there is no dispute, test specimens may be taken closer to the fitting ends and welded areas of the polyethylene casing, for example for quality control purposes.

When taking out test specimens from the foam to determine the compressive strength, the foam adjacent to the service pipe surface and casing surface shall be excluded. A clearance of at least 5 mm and 3 mm respectively shall be allowed.

At the locations where test specimens are taken to determine compressive strength, at least three test specimens shall be taken, equally distributed around the circumference.

The outside dimensions of the test specimens shall be measured by means of a gauge having a square or circular face area of 100 mm^2 and an applied force of 0,75 N to 1,0 N.

5.3 Steel parts

5.3.1 Visual surface examination of welds

The examination of imperfections of the weld shall be carried out in accordance with EN ISO 5817. The entire length of the weld shall be visually examined for defects.

5.3.2 Leak-tightness test with water

Clean water shall be used.

The test pressure shall be at least 1,3 times the design pressure.

Water shall not be visible at the surface of the weld after a test period of 10 min.

5.3.3 Leak-tightness test with air

The test pressure inside the pipe shall be at least 0,02 MPa over the external pressure or 0,02 MPa under the external pressure. No air bubbles shall be visible at the surface of the weld when immersed in water or when wetted with soap water or any other test liquid after a test period of 30 s.

Other test methods using, e.g. nitrogen and helium are acceptable.

5.3.4 Non-destructive examination of welds

The examination shall be carried out on the entire length of the weld according to Table 5.

Radiographic examination with X-rays or γ-rays shall be carried out in accordance with standards given in EN ISO 17636-1 and EN ISO 17636-2.

Table 5 — Non-destructive (NDT) weld seam examination

NDT Method	General principle	Weld seam examination	Acceptance criteria
Visual inspection	EN 13018	EN ISO 17637	EN ISO 5817
Radiographic examination	EN ISO 5579	EN ISO 17636-1 EN ISO 17636-2	EN ISO 10675-1
Ultrasonic examination	EN ISO 16810	EN ISO 17640	EN ISO 11666
Dye penetrant examination	EN ISO 3452-1	EN ISO 3452-1	EN ISO 23277
Magnetic particle examination	EN ISO 9934-1	EN ISO 17638	EN ISO 23278

5.3.5 NDT of welds

NDT of welds in pipelines is generally done by radiography or ultrasonic. Alternatively, in particular cases where this method is unable to give adequate information on the quality of the weld, it should be replaced by dye penetrant or magnetic particle examination. Magnetic particle examination of welds shall be carried out in accordance with EN ISO 17638, dye penetrant examination of welds shall be carried out in accordance with EN ISO 3452-1.

5.4 Casing

Casings shall be tested in accordance with EN 253:2009+A2:2015, 5.2.

5.5 Polyurethane rigid foam insulation (PUR)

Polyurethane rigid foam insulation shall be tested in accordance with EN 253:2009+A2:2015, 5.3 and 5.4.1 to 5.4.4.

5.6 Fitting assemblies

5.6.1 Centre line deviation and angular deviation

The centre line deviation and the angular deviation shall be measured between the centre lines with the largest deviation.

5.6.2 Visual examination of welds on casing pipes

Visual examination shall be carried out on the entire length of the weld.

5.6.3 Bending test

Test pieces with dimensions according to Table 6 shall be cut in the pipe length direction across the weld seam.

The weld beads shall be removed on the compression side of the sample. The sample edges shall be broken.

The test pieces shall be placed in a test apparatus in accordance with Figure 7 with the internal pipe wall in the tensile position.

For butt weld seams five samples from the same weld seam shall be tested with the inner pipe wall in the tensile position.

For extrusion weld seams six samples from the same weld seam shall be tested with three samples having the pipe inner wall in the tensile position and three samples having the pipe outer wall in the tensile position.

Table 6 — Dimensions for test pieces

e	b	l_t (mm)	l_s (mm)	d (mm)
$3 < e \leq 5$	15	150	80	8
$5 < e \leq 10$	20	200	90	8
$10 < e \leq 15$	30	200	100	12

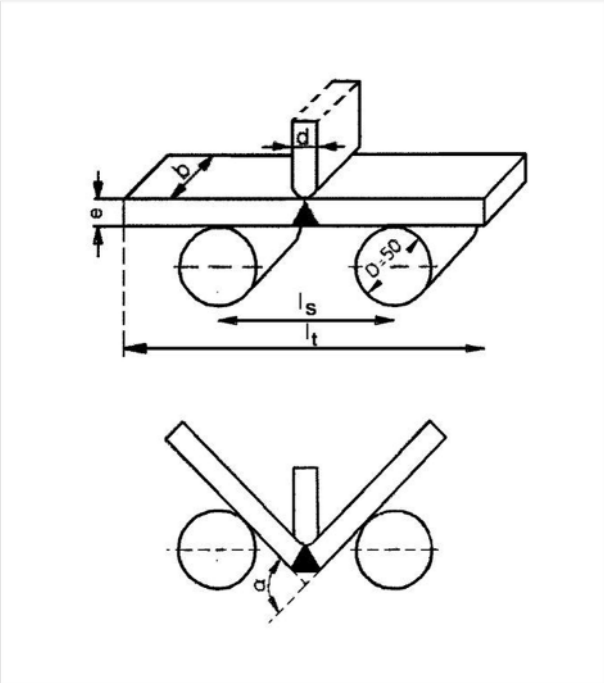


Figure 7 — Test apparatus for bending test

5.6.4 Minimum insulation thickness

Bends shall be cut longitudinally in the tube axis and the minimum insulation thickness measured at the cutting surface.

5.7 Surveillance system

When measuring elements for a surveillance system is installed in the fitting test for controlling the function of the installed measuring elements shall be performed. The test shall be performed according to EN 14419:2009, Clause 6.

6 Marking

6.1 General

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

6.2 Steel service pipe

The steel service pipe shall be marked according to the requirements on marking given in the relevant standards, EN 10216-2, EN 10217-1, EN 10217-2, or EN 10217-5.

6.3 Casing

The manufacturer of the casing shall mark thereon. If the casing of the fitting is too small the manufacturer is allowed to put information about the casing pipe parts as a label on the outside of the fitting assembly:

a) raw material of the PE, by trade name or code;

b) MFR – table value as declared by the raw material supplier;

c) nominal diameter and nominal wall thickness of the casing pipe;

d) year and week of manufacture;

e) manufacturer's identification.

6.4 Fitting assembly

The manufacturer of the fitting assembly shall mark on the casing:

a) nominal diameter and nominal wall thickness of the service pipe(s);

b) bend angle (where applicable);

c) steel specification and grade of the service pipe(s);

d) manufacturer's identification;

e) number of this European Standard;

f) year and week of foaming;

g) type of physical blowing agent, if any;

h) information about the diffusion barrier, if any;

i) maximum axial load or axial stress permissible by fitting manufacturer (not for bends).

6.5 Single use compensators

The manufacturer of the single use compensator shall mark on the casing:

a) nominal diameter and nominal wall thickness of the service pipe(s);

b) steel specification and grade of the service pipe(s);

c) manufacturer's identification;

d) number of this European Standard;

e) minimum and maximum axial force;

f) design temperature difference for the full load cycle;

g) maximum operating pressure.

Annex A
(informative)

Guidelines for inspection and testing

A.1 General

The following inspection frequencies are recommended to ensure that manufactured pre-insulated fittings comply with the requirements specified in this standard.

A quality system certified to be in accordance with EN ISO 9001, with reference to EN 448 and the obtained statistics of consistency of test results can be used to adjust inspection frequencies to the actual needs.

The recommended inspection includes the following:

A.2 Manufacturer's type test

A type test is used to obtain an initial validation of materials and production methods. A new test should be performed where these materials or methods are essentially changed.

A.3 Manufacturer's quality control

This control is applied to ensure that the intended quality level of the products is maintained. The manufacturer is responsible for ensuring that the tests specified in this standard are carried out and the results recorded.

A.4 External inspection

This inspection is primarily intended as an evaluation of the extent and the proper functioning of the manufacturer's quality assurance. This inspection also includes sampling of products to ensure that the requirements specified in this standard are fulfilled.

A.5 Extent of inspection

The suggested extent of the inspection is given in the Tables A.1 and A.2.

External inspection should normally be made at least once a year.

A.6 Manufacturer's responsibility

Where a manufacturer of pre-insulated fittings makes their own raw material or produces parts for which there is a requirement for "manufacturer's certificates", the manufacturer of the pre-insulated fittings takes over the responsibilities of the supplier.

Table A.1 — Steel parts inspection

Clause	Item	Test frequency		
		Manufacturers type test	**Manufacturers quality control**	**External inspection**
4.1.1 to 4.1.9	Dimensions of steel parts — outside diameter — wall thickness — angle in bends and branches — wall thickness, folding and ovality of cold formed bends	None	Receiving or production inspection procedure 2 %, equally distributed over the yearly production (or receiving inspection) In case of defect: Next: — 4 similar parts; — 8 similar parts; — 16 similar parts, etc.	Inspection of records and certificates
4.1.10.1	Material, make, delivery, specification on of steel welding	None	Receiving inspection procedure	Inspection of records and certificates
4.1.10.4 A, B and C	Inspection of steel welds	A. Check of procedure B. Check of procedure C. Check of procedure	A. Visual surface examination 100 % of welds B. Leak tightness test Butt welds DN ≤ 300: 20 % pressure test with water or air DN > 300: 20 % pressure test with water or air (DN > 300: 20 % radiographic, magnetic particle or dye penetrant examination can replace tightness tests) Other welds: DN ≤ 300: 100 % pressure test with water or air DN > 300: 100 % pressure test with water or air (DN > 300: 100 % radiographic, magnetic particle or dye penetrant examination can replace tightness tests) For butt welds, in case of defect: — 100 % 2 weeks; — 100 % 4 weeks; — 100 % 8 weeks, etc. C. Radiographic examination of welds DN ≤ 300: 2 %, for each welder, equally distributed over the yearly production DN > 300: 10 %, for each welder, equally distributed over the yearly production For those fittings for which radiographic examination is unable to give adequate information on the quality of the weld, magnetic particle or dye penetrant examination can replace the radiographic examination. In case of defect: for the same welder. Next: — 2 parts; — 3 parts; — 4 parts, etc. See NOTE	Inspection of internal records
4.1.11	Surface condition	None	Receiving inspection procedure	Inspection of internal records
NOTE	The test can also be performed in accordance with ISO 2859-2.			

Table A.2 — Polyethylene casing, polyurethane and fitting assembly inspection

Clause	Item	Test frequency		
		Manufacturer's type test	**Manufacturer's quality control**	**External inspection**
4.2	Polyethylene casing	See EN 253:2009+A2:2015, Table D.2	See EN 253:2009+A2:2015, Table D.2	See EN 253:2009+A2:2015, Table D.2
4.3	Polyurethane	See EN 253:2009+A2:2015, Table D.3	See EN 253:2009+A2:2015, Table D.3	See EN 253:2009+A2:2015, Table D.3
4.4	Fitting assemblies			
4.4.1 and 4.4.5	Dimensions of fitting ends and outside diameter	Measured on one fitting per dimension	Once a shift for each foaming machine	5 different fittings per inspection visit
4.4.3	General requirements on PE welding	Check of procedure	Receiving and production inspection procedure	5 different fittings per inspection visit
4.4.3.3	Visual appearance	Once per welding process	100 % visual inspection	5 different fittings per inspection visit
4.4.3.4	Bending test	Once per welding process	Min. one per year per machine and operator	Once per machine
4.4.4	Leak-tightness of welded PE-casing	Check of procedure	100 % visual inspection after foaming	5 different fittings per inspection visit
4.4.6	Minimum insulating thickness	Once by taking out of fitting for other test	Min. twice a year	Inspection of internal records
4.4.7	Tolerances on main fitting dimension	Check of procedure	Once a shift for each foaming machine	Once per inspection visit per type of fittings
4.5	Surveillance system	See EN 14419:2009, 6.2 and 6.6	See EN 14419:2009, Annex F	All fittings upon receipt cf. EN 14419:2009, 7.1

Annex B
(informative)

Procedures for polyethylene welding

B.1 General

For the production of fittings butt welding fusion of segments from pipes should be preferred.

The extrusion weld procedure can be applied to longitudinal and circumferential seams only.

The hot air welding procedure should only be applied in exceptional cases where butt welding or extrusion weld procedures cannot be applied.

For the welding only suitable and calibrated equipment and machines should be applied.

Written working instructions should be applied to and used for all machines and procedures.

For the completion of the weldings only qualified welders should be appointed. For education and test of the work force see EN 489:2009, Annex C.

B.2 Recommendations for site, machine and equipment

The site should be clean, free from dust, dirt, moisture and oil. Draught should not occur and the working temperature should be approximately constant. The light conditions should be satisfactory to allow the welder to observe the welding and perform the visual examination.

The machines and equipment should be maintained regularly to ensure repetition of the processes.

Prior to the welding the machine and equipment should be tested as to their function – preferably by test weldings.

The welding temperature, pressures and times should be checked and possibly recorded.

Prior to the operation the heating element and the welding tools should be cleaned and the surface should be inspected for damage.

The heating elements should be coated with PTFE or a similar product. The welding shoes should be produced from PTFE or a similar product.

B.3 Items

Prior to the welding all the items should be machined to clean surfaces.

The items should be conditioned so that approximately the same temperature of the equipment, the working place and the machine is achieved. A maximum variation of 5 °C is allowed.

B.4 Butt fusion welding

B.4.1 Equipment

The applied heating element should be plane parallel within its working surface. Permitted variations of the plane parallelism are given in Table B.1.

Table B.1 — Permitted variations of the plane parallelism

Casing pipe diameter D_c mm	Permitted variation of the plane parallelism mm
< 250	≤ 0,2
250 - 500	≤ 0,4
> 500	≤ 0,8

The heating element temperature should be controlled electronically, so that the temperature accuracy of the entire working surface and the entire welding time as given in Table B.2 is reached.

Table B.2 — Temperature accuracy

Casing pipe diameter D_c mm	Temperature accuracy K
< 380	±5
380 - 650	±8
> 650	±10

The temperature difference between the two sides of the heating element should not exceed 5 °C. Temperatures should be checked at working temperature in vertical position.

The heating element should have an adequate heating capacity to achieve an approximate constant temperature during the time of the welding.

Clamps and guides should be sufficiently stiff and parallel to ensure that non-parallelism of the welding surfaces occurring through bending of the welding machine under maximum forces cannot exceed the values given in Table B.3.

Table B.3 — Maximum non-parallelism of welding surfaces

Casing pipe diameter D_c mm	Maximum non-parallelism of welding surfaces mm
≤ 355	0,5
> 355 < 630	1,0
630 - 800	1,3
900 - 1400	1,5

B.4.2 Welding procedure

The surfaces to be welded should when held in a fixed position under the melting pressure 0,01 N/mm² be parallel to a maximum variation of 1,0 mm. For dimensions ≥ 630 mm a maximum variation of 1,3 mm is allowed.

The welding procedure should consist of the following steps:

a) heating with a pressure of approximately 0,15 N/mm² until the welding surfaces are in complete contact with the heating element;

b) heating with a pressure of approximately 0,01 N/mm² in a prescribed time (working instructions).

The transition time in which the machine is opened, the heating element removed and the welding surfaces pressed together again should be kept as short as possible (working instructions).

Welding with increasing pressure over 1 s to 15 s (according to wall thickness) to approximately 0,15 N/mm^2 (working instructions).

The cooling time with pressure without forced cooling until < 70 °C. The weld seam should be completely cooled off before it can be stressed.

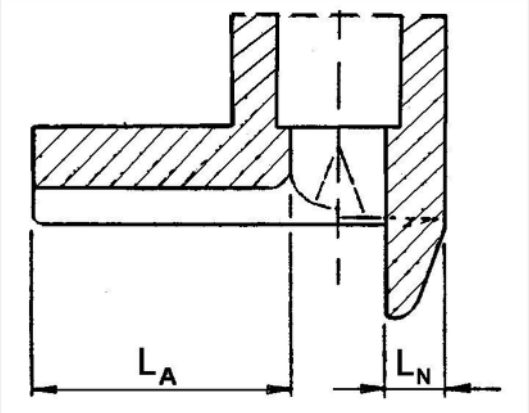
B.5 Extrusion welding

B.5.1 Equipment

The applied equipment should provide an even preheating with the melting of the joint surfaces in their total depths including the edges.

The homogeneously plasticized weld filler material should be pressed into the V-notch by the weld shoe with sufficient welding pressure.

The welding shoe should be adapted to the seam form, see Figure B.1 and Table B.4.



Key

L_A Length of the pressure sole

L_N Length of the nose

Figure B.1 — Minimum dimensions on weld shoes

Table B.4 — Minimum dimension on weld shoes

Wall thickness mm	**Length** mm	
	L_A	L_N
≤ 15	≥ 35	10
> 15 ≤ 20	≥ 45	15
> 20 < 30	≥ 55	20
L_A Length of the pressure sole. L_N Length of the nose.		

The dimensions are valid for welding speeds up to 200 mm per minute. Higher welding speeds require longer pressure soles.

The seam end should be pressed and smoothed with a suitable hand tool made of PTFE or a similar material.

B.5.2 Welding procedure

The filler material should comply with the requirements of EN 253:2009+A2:2015, 4.3.1.

The manual for the applied equipment should be used.

When welding a melting depth of ≥ 0,5 mm on the entire surface should be provided and controlled.

Bibliography

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[3] EN ISO 2553, *Welding and allied processes — Symbolic representation on drawings — Welded joints (ISO 2553)*

[4] ISO 2859-2, *Sampling procedures for inspection by attributes — Part 2: Sampling plans indexed by limiting quality (LQ) for isolated lot inspection*

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