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**Plastics pipes and fittings — Butt  
fusion jointing procedures for  
polyethylene (PE) piping systems**

*Tubes et raccords en matières plastiques — Modes opératoires  
d'assemblage par soudage bout à bout de tubes et raccords en  
polyéthylène (PE)*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html). (standards.iteh.ai)

This document was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 4, *Plastics pipes and fittings for the supply of gaseous fuels*.

This third edition cancels and replaces the second edition (ISO 21307:2011), which has been technically revised.

The main changes compared to the previous edition are as follows:

- Added calculation of gauge pressure in 4.7;
- Included normative non-destructive joint integrity testing (visual examination with requirements) in 6.3;
- Updated process parameters in Tables 1, 2, A.1, B.1 and C.1.

## Introduction

With the increasing use of polyethylene (PE) pipes of larger diameters and wall thicknesses there is a need for this document which provides details on three butt fusion procedures. This document is developed for the benefit of countries without a national standard or technical specification for butt fusion procedures of PE pipes. High quality butt fusion welds can be obtained with all three butt fusion procedures mentioned in this document. The choice for one of these three procedures can depend on experience, on the practical trials of the three butt fusion procedures and on availability of equipment.

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# Plastics pipes and fittings — Butt fusion jointing procedures for polyethylene (PE) piping systems

## 1 Scope

This document establishes general principles regarding the procedure used in the construction and quality assessment of butt fusion jointing of polyethylene (PE) piping system components specified in accordance with relevant ISO standards. These components are installed in accordance with the relevant codes of practice, national regulations or industry guidance. Specifically, this document specifies three butt fusion jointing procedures for PE pipes and fittings. These are:

- single low-pressure fusion jointing procedure;
- dual low-pressure fusion jointing procedure;
- single high-pressure fusion jointing procedure.

This document takes into consideration the materials and components used, the fusion jointing procedure and equipment and the quality assessment of the completed joint. It can be applied in conjunction with appropriate national regulations and standards.

NOTE 1 The references for these procedures are given in the Bibliography. [1][2][3][4][5][6] Single low-pressure fusion jointing procedure is derived from multiple procedures and agreed by experts, given in the Bibliography [1][2].

NOTE 2 The three procedures detailed in this document are based on those most commonly used. It is not the intention that one or more of these procedures be used to replace well established and verified industry based procedures.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 12176-1, *Plastics pipes and fittings — Equipment for fusion jointing polyethylene systems — Part 1: Butt fusion*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

### 3.1

#### heater plate temperature

measured temperature on the surface of the heater plate where the pipe or fitting wall cross-section makes contact

**3.2  
nominal wall thickness**

$e_n$   
wall thickness tabulated in ISO 4065<sup>1)</sup>, corresponding to the minimum wall thickness  $e_{y,min}$  at any point  $e_y$

**3.3  
nominal outside diameter**

$d_n$   
numerical designation of size which is common to all components in a thermoplastics piping system other than flanges and components designated by thread size

**3.4  
standard dimension ratio  
SDR**

numerical designation of a pipe series, which is a convenient round number, approximately equal to the dimension ratio of the nominal outside diameter,  $d_n$ , and the nominal wall thickness,  $e_n$

**3.5  
drag pressure**

gauge pressure required to overcome, on a given machine, the sliding frictional drag force of the machine and pipe

Note 1 to entry: Drag pressure, if present, can be a positive or negative value.

**3.6  
bead-up**

initial melt under pressure around the circumference of the ends of the pipes or fittings which ensures that complete pipe or fitting to heater plate contact is achieved

**3.7  
bead-up pressure**

pressure exerted on the heater plate by the pipe or fitting ends during the bead-up phase of the jointing cycle

Note 1 to entry: The value of the corresponding gauge pressure is calculated with [Formulae \(1\)](#) and [\(2\)](#).

**3.8  
bead-up size**

bead size formed on the pipe or fitting ends during the bead-up phase

**3.9  
heat soak**

portion of the heating cycle done at 0 to drag pressure so that the heat can melt the pipe or fitting to a depth sufficient for proper mixing and fusion

**3.10  
heat soak pressure**

pressure required to maintain the pipe or fitting in contact with the heater plate taking into account the drag pressure

**3.11  
0 to drag pressure**

lowest possible pressure during the heat soak that will allow the pipe or fitting to remain in contact with the heater plate, up to a maximum of the current drag pressure

Note 1 to entry: The drag pressure required to move the pipe or fitting may be much higher than the pressure required to maintain pipe or fitting/heater contact during heat soak.

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1) To be published.



**3.12****heating cycle**

part of the welding process in which pipe or fitting ends are in contact with the heater plate composed by bead up pressure and followed by heat soak pressure

**3.13****heat soak time**

time during which the heater plate is in contact with the pipe or fitting ends at the heat soak pressure

**3.14****minimum bead size after heating**

minimum value of bead size to be attained after completing the heat soak time

Note 1 to entry: Single high-pressure butt fusion procedure only.

**3.15****heater plate removal time**

time taken to separate the pipe or fitting ends from the heater plate, remove the heater plate and close the carriage in order to bring the molten pipe or fitting ends together

**3.16****fusion jointing pressure****interfacial pressure**

actual pressure exerted on the pipe or fitting ends during jointing

Note 1 to entry: The value of the corresponding gauge pressure is calculated with [Formulae \(1\)](#) and [\(2\)](#).

**3.17****gauge pressure**

actual pressure (bead-up pressure or fusion jointing pressure with drag pressure) in the cylinders of the butt fusion jointing machine read by the gauge

**3.18****fusion jointing time**

time period allotted for bead roll-over before cooling-cycle reduced pressure

Note 1 to entry: Dual low-pressure butt fusion procedure only.

**3.19****cooling-cycle reduced pressure**

pressure, exerted on the pipe or fitting ends during the cooling cycle of the dual low-pressure procedure after fusion jointing time

Note 1 to entry: The value of the corresponding gauge pressure is calculated with [Formulae \(1\)](#) and [\(2\)](#).

**3.20****cooling time in machine under pressure**

time period during which the butt fusion joint remains under pressure when still clamped in the machine

**3.21****cooling time in machine without pressure or out of machine**

additional cooling period that may be required after the cooling time under pressure to ensure optimum joint strength, particularly when working at high ambient temperatures and prior to rough handling or pipe installation

**3.22****operator**

qualified person authorized to construct polyethylene (PE) systems from pipes and/or fittings, based on a written procedure agreed by the pipeline operator according to ISO/TR 19480

**3.23**

**pipeline operator**

private or public organization authorized to design, construct and/or operate and maintain a pipeline supply system

**3.24**

**dummy joint**

unfinished joint made prior to production welding to ensure cleanliness of the heater plate in which the welding procedure is stopped after the heat soak time

**3.25**

**jointing session**

uninterrupted series of welds made with the same parameters and same equipment

**3.26**

**rough handling**

any action whereby stresses are applied to the fused joint, such as tensile and bending forces

Note 1 to entry: Some examples of rough handling are immediately after the cooling time in the machine under pressure:

- the joint is removed from the machine by single point lifting at the joint;
- several lengths of joined pipe are pulled with the freshly made fusion joint;
- the joint is immediately subjected to a severe bending stress.

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**4 Butt fusion jointing process (standards.iteh.ai)**

**4.1 General**

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Polyethylene (PE) pipes and fittings for the production of butt fusion joints in accordance with this document should conform with the relevant ISO, local or national piping system standards.

PE components with fusion ends of different SDR/DR values shall not be jointed by butt fusion.

Ambient temperatures mentioned in this document shall be measured with a thermometer with an accuracy of  $\pm 1,0$  °C.

To prevent potential contamination of welds it is recommended that welding is carried out in a shelter, and the welding equipment is sited on a baseboard or ground sheet.

It is recommended to block off the PE pipe ends to prevent contamination and reduction of the temperature of the heater plate.

It is recommended, before starting the welding procedure, to check the functioning of the fusion equipment, particularly the temperature of the heating plate on both sides.

It is recommended to record the welding data in welding protocols or on data carriers.

**4.2 Principle**

The principle of butt fusion jointing is to heat two pipe or fitting ends for a specified time by means of a heater plate maintained at a specified temperature. Following heater plate removal the pipe ends are brought together by applying a specified pressure, and then cooled for a specified time. Butt fusion joints shall be made by qualified operators using butt fusion jointing machines that conform to ISO 12176-1. The training and level of skill of the operator shall be in accordance with the requirements of the jointing procedure. A written jointing procedure, authorized by the pipeline operator, shall be available prior to the construction of a pipeline. Any one of the three jointing procedures mentioned in this document can be used as the basis. The jointing procedure shall include specification of the

jointing method, the fusion parameters, the fusion equipment, the jointing conditions, the level of skill of the operator, and the quality control methods to be used. Guidelines for quality control are given in [Clause 6](#).

Key elements of the jointing process shall include:

- a) cleaning the pipe or fitting ends, planing unit and heater surfaces;
- b) clamping the components to be joined (pipe support with drag reducing rollers may be required to ensure proper alignment);
- c) planing the pipe or fitting ends;
- d) aligning the pipes or fittings;
- e) measuring the drag and compensating pressure accordingly;
- f) melting the pipe or fitting ends;
- g) jointing the pipe or fitting ends;
- h) holding the pipe or fitting ends under pressure for the duration of the cooling time in the machine;
- i) completing the cooling time in machine without pressure or out of machine if required.

These key elements are explained in more detail in [4.3](#) to [4.11](#).

#### 4.3 Cleaning the pipe or fitting ends, planing unit and heater surfaces

Before placing them in the machine, clean the inside and outside of the pipe or fittings to be joined by wiping the joint area with a clean lint-free cloth, using a suitable solvent (e.g. ethanol, isopropanol) only if necessary or if specified in codes of practice or national regulations. All foreign matter shall be removed from the jointing area.

If the pipe has a protective outer layer, it shall be peeled back far enough so that the pipe can be properly clamped in the fusion machine, unless otherwise specified by the pipe manufacturer.

Cleaning the planing unit and the heater plate surfaces shall be done using a clean lint-free cloth, a clean lint-free cloth with a suitable solvent or by making dummy joints at the start of each jointing session whenever the heater plate has been allowed to cool below 180 °C and for a change of pipe size or SDR/DR prior to commencement of production welding. The number of dummy joints to be made shall be included in the written jointing procedure and/or as specified in codes of practice or national regulations.

#### 4.4 Clamping the components

Clamp the components in the butt fusion jointing machine and adjust as necessary to achieve proper alignment. Pipe support may be needed to achieve proper alignment and reduce drag. It is recommended to support the pipe(s) to ensure the uniformity of the drag pressure.

NOTE Pipe support can be achieved by using rollers or appropriate low friction alignment blocks, etc.

It is good practice to ensure that the pipe details printed along the two pipes are aligned and placed at the top of the machine when possible.

#### 4.5 Planing the pipe or fitting ends

Plane the pipe or fitting ends to establish clean, parallel mating surfaces that are perpendicular to the centreline of the machine guide rods.