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**Plastics pipes and fittings —  
Equipment for fusion jointing  
polyethylene systems —**

**Part 1:  
Butt fusion**

*Tubes et raccords en matières plastiques — Appareillage pour  
l'assemblage par soudage des systèmes en polyéthylène —*

*Partie 1: Soudage bout à bout*

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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 the 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)

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 fourth edition cancels and replaces the third edition (ISO 12176-1:2012), which has been technically revised so that it applies to larger pipe diameters.

The modifications are the following:

- increase of the wall thickness and diameter;
- various clarifications such as the guide elements and work-holding fixtures;
- editorial changes have been introduced.

A list of all parts in the ISO 12176- series can be found on the ISO website.

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# Plastics pipes and fittings — Equipment for fusion jointing polyethylene systems —

## Part 1: Butt fusion

### 1 Scope

This document specifies the general characteristics of, and performance requirements for, equipment for butt fusion jointing of polyethylene (PE) piping systems using electrically powered heater plates.

It is applicable to mechanical and pressure-activated equipment for butt fusion jointing of PE pipes and fittings either intended to be used for the supply of gaseous fuels, conforming to ISO 4437-2[1] and ISO 4437-3[2], or intended for the conveyance of water for human consumption (including raw water prior to treatment) and for the conveyance of water for general purposes, conforming to ISO 4427-2[3] and ISO 4427-3[4].

Butt fusion machines with an automatic controller are subject to additional requirements as given in [Annex A](#).

NOTE This document is also applicable to butt fusion machines for larger nominal pipe diameters and nominal wall thicknesses than given in this document.

### 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 4287, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters*

ISO 11414, *Plastics pipes and fittings — Preparation of polyethylene (PE) pipe/pipe or pipe/fitting test piece assemblies by 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

##### base framework

self-supporting entity composed of two or more guides and pipe clamps

Note 1 to entry: It provides the mechanism for heating and fusing the pipes and/or fittings.

### 3.2

#### **frictional resistance of the butt fusion machine**

force necessary to overcome friction in the whole mechanism without pipe

Note 1 to entry: See [6.1](#).

### 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

Note 1 to entry: It is a convenient round number for reference purposes.

### 3.4

#### **nominal wall thickness**

$e_n$   
numerical designation of the wall thickness of a component

Note 1 to entry: It is a convenient round number approximately equal to the manufacturing dimension in millimetres.

### 3.5

#### **drag compensation**

ability of the butt fusion machine to overcome mechanical and frictional forces, as well as forces caused by operating on site, in order to achieve and maintain the fusion parameters specified for the pipe

### 3.6

#### **standard dimension ratio**

##### **SDR**

ratio of the nominal outside diameter,  $d_n$ , of a pipe to its nominal wall thickness,  $e_n$

[SOURCE: ISO 4427-1:2007, 3.1.1.15]

## 4 Design configurations

### 4.1 General

The normal ambient temperature range in which the butt fusion machine is intended to operate is  $-10\text{ }^{\circ}\text{C}$  to  $+40\text{ }^{\circ}\text{C}$ . Use outside this temperature range shall be agreed upon between the user and the supplier of the machine.

### 4.2 Configurations

To conform to the requirements of this document, butt fusion machines may have different design configurations, as follows:

- a mechanical linkage system for force generation;
- a hydraulic hand-pump system for force generation;
- a semi-automatic externally powered system for force generation (manual pre-set of pressure);
- a semi-automatic system incorporating a device for monitoring and recording the fusion parameters;
- an automatic system that controls and records the fusion parameters.

Machines are generally designed for well-defined ranges of diameters, SDR ratios and fusion cycles.

Each component of the machine shall conform to relevant national safety regulations.

NOTE For example, the safety aspects for Europe are regulated in Reference [5].

Machines which record fusion data shall be capable of transferring the data for further use.

## 5 Chassis and clamps

### 5.1 General

The butt fusion machine shall be as maintenance-free as possible.

The base framework of the butt fusion machine shall provide rigidity and stability without unnecessary weight.

The butt fusion machine shall be sufficiently robust to withstand normal field use.

The chassis shall provide facilities for the alignment of and relative movement between pipes and/or fittings.

The butt fusion machine shall incorporate a facility for supporting the heating plate and planing tool when in use. This support shall not affect transmission of interface forces across the heating plate and shall not prevent proper alignment of the heating plate during the heating operation.

The butt fusion machine shall be capable of making satisfactory joints at ambient temperature and under normal worksite conditions with pipes and fittings at extremes of dimensional tolerances.

With butt fusion machines designed for use in narrow trenches, the design and construction of the clamps shall enable the butt fusion machine to be removed from the trench after fusion without damaging the PE pipe.

The base framework shall be fitted with a minimum of two clamps, one fixed and one moveable, to position the PE pipes during the fusion cycle. These clamps shall be designed to enable the pipes to be positioned or removed quickly.

The clamps shall grip the circumference of the pipes and fittings and shall be designed and dimensioned to avoid damage to the pipe or fitting surfaces.

To avoid human damage, the clamp jaws should preferably be designed so that they cannot close to less than a certain minimum distance apart.

No adjustment of the centreline of either pipe shall be required after changing the relevant parts to accommodate different pipe sizes. The clamps, inserts and liners shall not damage the pipe or fitting.

Clamps and/or liners for each pipe size should preferably be interchangeable between similar machines made by the same manufacturer.

The maximum number of removable clamping liners shall be three for machines for pipe diameters up to and including  $d_n = 400$  mm, and four for machines for pipe diameters above  $d_n = 400$  mm.

Operating instructions shall be available.

### 5.2 Guide elements

#### 5.2.1 General

The sliding surfaces of the guide elements shall be protected from corrosion, e.g. by hard chromium plate.

The design of the butt fusion machine shall allow the heating plate to be removed and the pipe ends to be closed after heating, without damaging the heated surfaces, within a maximum time as given in [Table 1](#).

**Table 1 — Maximum time for removing the heating plate**

Nominal wall thickness $e_n$ mm	Maximum time $t_{max}$ s
$e_n \leq 4,5$	$\leq 5$
$4,5 < e_n \leq 7$	$\leq 6$
$7 < e_n \leq 12$	$\leq 8$
$12 < e_n \leq 19$	$\leq 10$
$19 < e_n \leq 26$	$\leq 12$
$26 < e_n \leq 37$	$\leq 16$
$37 < e_n \leq 50$	$\leq 20$
$50 < e_n \leq 70$	$\leq 25$
$70 < e_n \leq 90$	$\leq 30$
$90 < e_n \leq 130$	$\leq 35$

The clamp alignment system shall provide the frictional resistance necessary to resist the jointing forces at extreme temperatures.

### 5.2.2 Rigidity under pressure

The butt fusion machine shall provide rigidity and stability, which shall be evaluated after trimming the gap between the pipe ends, when they are in contact. When measured in accordance with [10.3.4](#), the gap between Sp1 and Sp2 (see [Figure 5](#)) shall conform to [Table 2](#).

**Table 2 — Maximum gap**

Nominal outside diameter $d_n$ mm	Maximum gap between pipe ends mm
$d_n \leq 315$	0,25
$315 < d_n \leq 630$	0,50
$630 < d_n \leq 800$	0,65
$800 < d_n \leq 1\ 000$	0,80
$1\ 000 < d_n \leq 1\ 200$	0,95
$1\ 200 < d_n \leq 1\ 600$	1,30
$1\ 600 < d_n$	0,2 % of $d_n$

### 5.2.3 Rigidity under bending

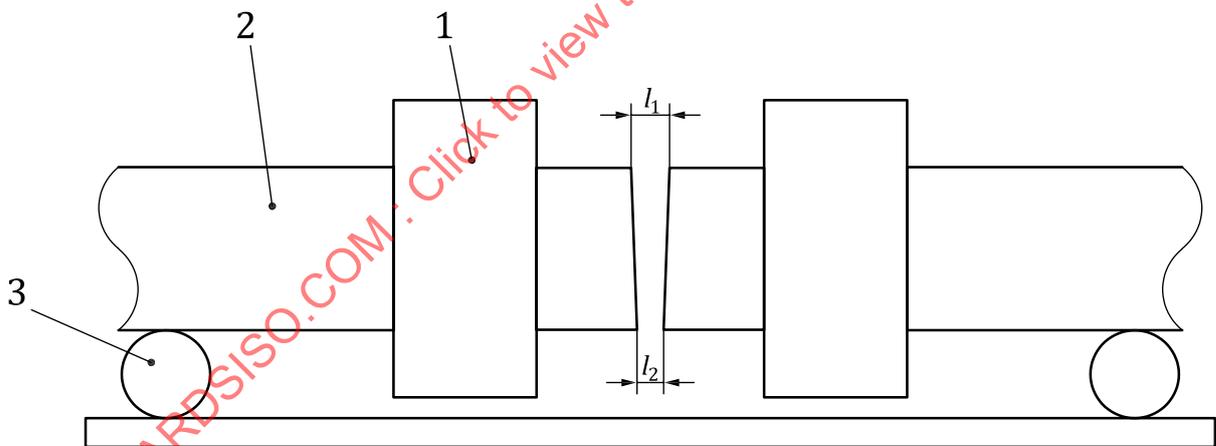
The clamp support and bearing system shall be sufficiently rigid to maintain axial alignment to within 0,2 mm over its entire length of travel when tested in accordance with [10.1.2.1](#).

Angular misalignment of supported pipes shall not exceed 0,5 mm when determined in accordance with [10.1.2.2](#).

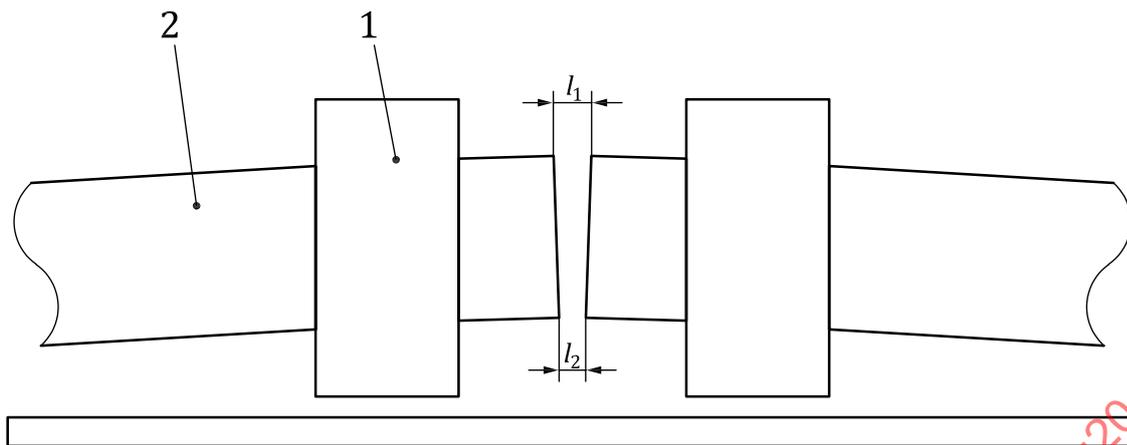
For equipment suitable for PE pipes  $\leq 315$  mm, when the pipe supports are removed (see [Figure 1](#)), the additional misalignment by bending of the butt fusion machine chassis and clamps shall not result in a deflection greater than the values given in [Table 3](#).

**Table 3 — Maximum additional angular misalignment (to be tested with SDR 17,6 or SDR 17 pipes)**

Nominal outside diameter $d_n$ mm	Maximum additional angular misalignment $f_{\max}$ mm
$\leq 225$	0,5
250	1
315	2



a) Support rollers present,  $|l_1 - l_2| \leq 0,5$  mm



b) Support rollers removed,  $|l_1 - l_2| \leq f_{\max} + 0,5 \text{ mm}$

**Key**

- 1 clamp
- 2 pipe
- 3 support roller
- $l_1$  gap at upper measurement position
- $l_2$  gap at lower measurement position
- $f_{\max}$  maximum additional angular misalignment given in [Table 3](#)

**Figure 1 — Gap (angular misalignment) between pipes**

**5.2.4 Re-rounding action**

The clamp alignment system shall have a re-rounding action on the pipe such that any out-of-roundness at the pipe end does not exceed 5 % of the pipe wall thickness and any mismatch of the pipe ends does not exceed 10 % of the wall thickness, when the test for out-of-roundness is carried out in accordance with [10.1.1](#).

**6 Interface force transmission**

**6.1 General**

All types of operating system are acceptable (e.g. manual, hydraulic, pneumatic, electric), provided they meet the requirements of this document.

Pipe-to-pipe interface forces generated during the jointing cycle shall either be measured directly or, alternatively, means shall be provided to determine the interface force indirectly from the measurement of appropriate machine-operating parameters which take into account the force transfer efficiency and frictional resistance of the machine.

In the case of machines with fluid power rams, the force may be indicated in terms of the applied cylinder pressure.

For such machines, a specific calibration table shall be provided that gives the relationship between the real interface force and the pressure indicated by the pressure gauge. The pressure gauge shall be calibrated. The accuracy of the pressure gauge shall be 1 % of full scale.

## 6.2 Manual systems

Mechanically operated equipment shall have the following features:

- the moving clamp shall be capable of continuous and steady displacement;
- a system for verifying the forces applied during the fusion cycle;
- a locking system to maintain the fusion force (fusion machines for pipes of  $d_n < 63$  mm are not required to have such a locking system).

## 6.3 Hydraulic and pneumatic systems

The butt fusion machine shall be capable of maintaining the required interface pressure throughout each stage of the jointing cycle. Where the fluid pressure is generated by a manually operated pump, the pump shall be capable of single-person operation to meet all force and time requirements of the jointing cycle for the range of pipe sizes for which the butt fusion machine is designed.

The pressure indication display shall be clear and easily readable from a normal working distance.

The hydraulic system shall be protected against overpressure.

National standards shall apply for the construction of pressure vessels.

## 6.4 Electric systems

The butt fusion machine shall be capable of maintaining the required interface force throughout each stage of the jointing cycle.

The force indication display shall be clear and easily readable from a normal working distance.

National standards shall apply for the construction and safety of electric systems.

## 6.5 Performance

For drag compensation, the butt fusion machine shall have at least 30 % additional fusion force specified for the maximum pipe diameter and wall thickness and the fusion cycle process for which the machine has been designed.

The maximum permitted variation in the frictional resistance of the butt fusion machine, with the moving clamp in any position, shall be less than 10 %.

## 7 Planing tool

### 7.1 General

The planing tool shall be a double-sided surface planer, powered by hand or by electrical, hydraulic or pneumatic power, and shall establish clean, flat, parallel mating surfaces of the pipe and fitting ends, perpendicular to the centreline of the pipe, in preparation for heating.

The design of the planing tool shall ensure that cut material is deflected away from the cut face, the planing tool and the bore of the pipe or fitting. The swarf produced shall be visible to the operator, so that completion of planing can be recognized.

Planing tools shall be interchangeable between any butt fusion machines of the size and type for which they were designed. They shall be suitable for planing the complete range of pipe sizes and materials for which the butt fusion machine is designed.

The cutting blades shall be removable.

Provision shall be made to prevent the planing of the pipe/fitting end beyond the limit needed for a good fusion joint.

## 7.2 Performance

The planing tool shall operate on both sides and produce a smooth cut on each fusion face so that the maximum gap between fusion faces, when measured in accordance with 10.2, shall not exceed that permitted in Table 2.

## 8 Heating plate

### 8.1 General

The heating plate shall establish a satisfactory melt or molten condition of the pipe and/or fitting ends in preparation for fusion. The heating plate shall be equipped with a temperature control system.

Heating plates shall be interchangeable between any butt fusion machines of the size and type for which they were designed.

If the heating plate cannot be easily removed during operation by one person for reasons of its weight or other factors, then hydraulic, pneumatic or other mechanical assistance shall be provided as part of the butt fusion machine.

For manual butt fusion machines, the total heat capacity of the tool shall be such that, if the electrical power supply is accidentally disconnected from the heating plate at the operating temperature, it can still complete a satisfactory joint. If the heating plate is not capable of meeting this requirement, then a fool-proof alarm indicating accidental disconnection shall be provided on the butt fusion machine.

The heating system shall be designed to ensure that, under normal ambient conditions, the pipe and/or fitting ends are heated up correctly to the operating temperature and stable fusion conditions are maintained.

### 8.2 Dimensions

The heating plate shall be of adequate size to ensure good heat transfer to the two fusion ends.

The width  $x$  of the inside and outside parts of the heating plate (see Figure 2) shall fulfil the requirements in Table 4.

**Table 4 — Width of heater plate**

Nominal outside diameter $d_n$ mm	Width of heater plate $x$ (see Figure 2) mm
$d_n \leq 250$	$\geq 10$
$250 < d_n \leq 630$	$\geq 15$
$630 < d_n \leq 1600$	$\geq 20$

The heating plate shall be flat on both sides to  $\pm 0,1$  mm/100 mm.

The thickness shall not vary by more than 0,2 mm up to  $d_n = 250$  mm or by more than 0,5 mm above this size, and the plate shall have no holes or screws within the area of pipe contact.

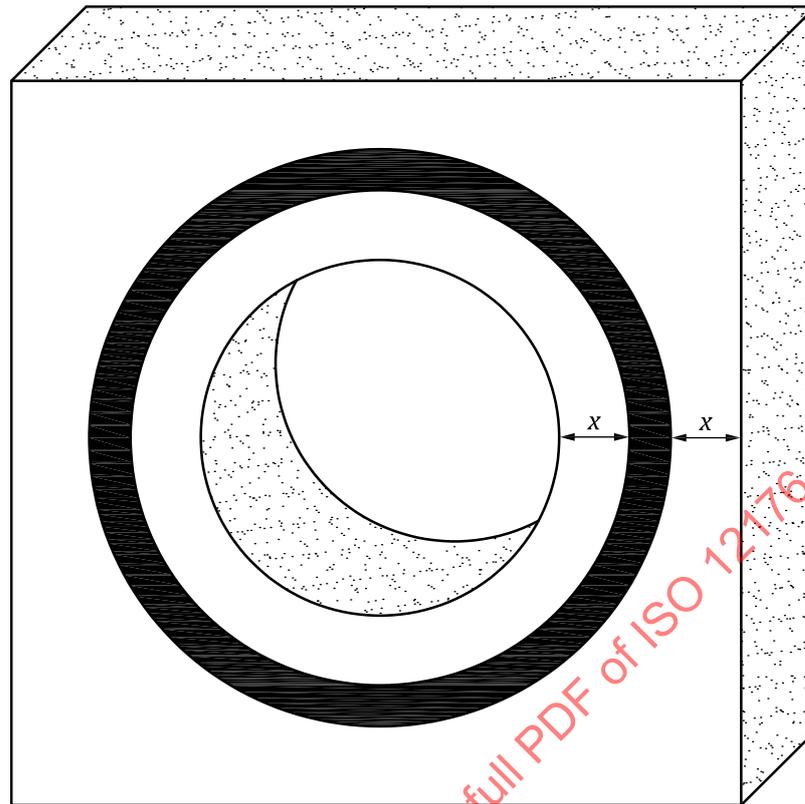


Figure 2 — Heating plate dimensions

### 8.3 Materials and surface finish

Heating plates shall be made of materials having good thermal conductivity and capable of resisting normal site handling.

The surfaces in contact with the pipe or fittings shall be such that molten material does not stick to them, and they will allow damage-free cleaning and resist normal site handling. This can be attained, for example, by coating the surface with coloured polytetrafluoroethylene (PTFE) or by other surface treatments. The colour of the PTFE coating shall be such that, after the tool has been used for jointing operations, the presence of any surplus PE on the plate will be readily visible, regardless of any degradation of the PE or of the PTFE coating. No release spray of any type, such as PTFE, shall be used at any time during the jointing cycle. Such a spray coating can be transferred to the fusion interface during the jointing procedure.

Alternatively, the heating plate may be made of hard-chromed or stainless steel.

### 8.4 Heating system

The heating plate shall be electrically heated.

For heating systems with electrical-resistance heater elements, the heating plate shall be fitted with a temperature-indicating device which clearly and visibly indicates when the operating temperature has been reached. This temperature indicator shall be independent of any other temperature control or monitoring system. It shall be protected from mechanical, electrical or thermal damage and shall be replaceable.

Heating plates shall be capable of continuous operation in the vertical position at their operating temperature for a minimum period of 4 h. After this period, the temperature of the grip shall not exceed 50 °C, measured at ambient temperature and no sun exposure.

An indicator shall be fitted to show clearly that the plate is under electric power and that it is heating up. This device shall indicate an operating temperature within  $\pm 5$  °C of the plate temperature, measured at a predefined reference point.

Provision shall be made to avoid accidental changing of the pre-set temperature.

## 8.5 Performance

**8.5.1** The surface roughness  $R_a$ , as defined in ISO 4287, of a hard-chromed or stainless-steel heating plate shall be less than  $0,63 \mu\text{m}$  when measured in accordance with [10.3.1](#), and this type of plate shall be free of all non-stick surface coatings.

If the heating-plate surfaces have a coating made of PTFE or some other non-stick material, then the contact faces shall have a maximum roughness  $R_a$  of  $2,5 \mu\text{m}$  when measured in accordance with [10.3.1](#).

**8.5.2** The coating shall be capable of withstanding for at least 1 h a temperature of 270 °C. After cooling to ambient temperature and reheating to the fusion temperature, the coating material shall meet all requirements on it.

The temperature control system shall be such that the contact surface temperature is controlled to within  $\pm 7$  °C of the required temperature over the range 170 °C to 260 °C under ambient operating conditions in the temperature range  $-10$  °C to  $+40$  °C.

The temperature control system shall also conform to these criteria before and after 50 test cycles of heating and cooling between ambient temperature and the operating temperature in accordance with [10.3.2](#).

**8.5.3** The thermal capacity and heat transfer efficiency shall be such that the interface temperature of a pipe of the maximum diameter and thickness can be raised from  $-5$  °C to  $+180$  °C in less than 20 s when the heating plate is at working temperature and the specified bead formation pressure is applied. This pipe interface temperature shall be measured at a temperature of  $-5$  °C  $\pm 2$  °C. Testing shall be carried out in accordance with [10.3.3](#).

In case the interface temperature cannot be measured at  $-5$  °C  $\pm 2$  °C the interface temperature should be chosen between  $-5$  °C  $\pm 2$  °C and  $23$  °C  $\pm 2$  °C and should be specified by the producer.

## 9 Power supply

The butt fusion machine shall be capable of operating satisfactorily from a domestic mains supply or from a generator.

Machines designed for use with portable generators shall make allowance for the harmonic distortion, inductance and reactance levels of the generator, which might affect its maximum available power output.

The input-voltage range shall be at least  $\pm 15$  % of the nominal value.

The butt fusion machine manufacturer shall be consulted for generator frequency limits during operation.

## 10 Test methods

### 10.1 Chassis and clamps

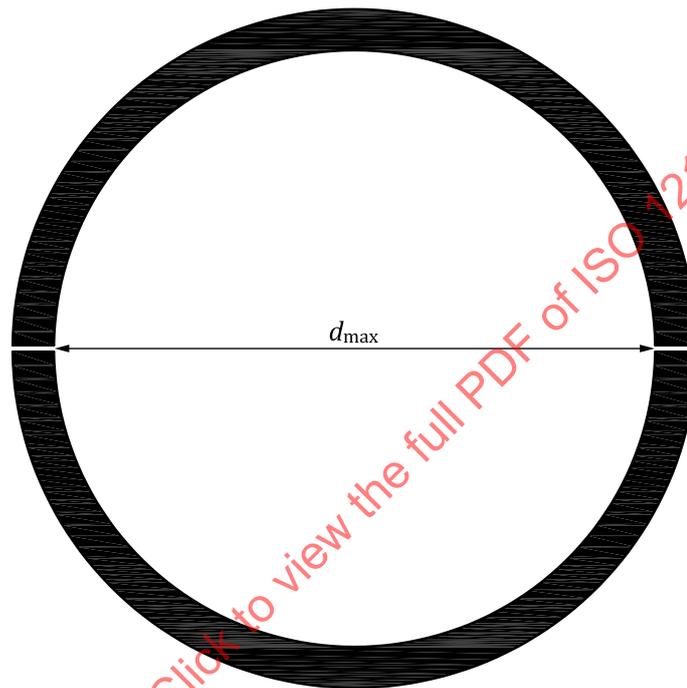
#### 10.1.1 Effectiveness of re-rounding (see [Figure 3](#))

Cut two pieces of SDR 11 pipe of the maximum diameter for the machine being tested and of a length that is at least twice the diameter. Compress each piece in a vice or press to a diameter of 80 % of

its nominal outside diameter. If the piece is too long to compress the entire length, position the pipe such that there is no more than 25 mm of pipe extending out of the vice jaw or platen at the end to be checked. Hold for 15 min and insert the pipe into the butt fusion machine at the jointing position so that the larger dimension is perpendicular to the jaw pivot and/or clamping position. Install and tighten the clamps with the pipe ends held in the pipe clamps at typical pipe jointing positions, in accordance with the manufacturer's instructions.

Using vernier callipers or another suitable instrument, measure the maximum and minimum diameters half way between the end of the pipe and the face of the clamp.

Calculate the out-of-roundness as the difference between the maximum and minimum diameters.



#### Key

$d_{\max}$  maximum pipe diameter

**Figure 3 — Positioning of clamps**

### 10.1.2 Clamp alignment

**10.1.2.1** Confirm the axial alignment of the pipe clamps by the use of two rigid metal cylinders. These shall be machined to the same external diameter as the nominal diameter of the pipe for which the butt fusion machine has been designed and shall have an ovality of less than 0,1 % of  $d_n$ . The end faces of each cylinder shall be flat and perpendicular to its axis. With the cylinders held in the clamps at typical pipe-jointing positions, any resultant step at the cylinder interface, due to misalignment, shall not exceed that specified in [5.2.3](#).

**10.1.2.2** Determine the stability and alignment of the pipe-clamping arrangement with the butt fusion machine supported such that the lowest point of a maximum-diameter pipe, measured at the clamp, is at least 200 mm above ground level (see [Figure 4](#)). With no pipe fitted, close up the clamps, face to face, and adjust to a close fit. Then clamp two maximum-diameter pipes of length 6 m into the butt fusion machine. Measure the distance between the clamp leading faces at the top and bottom and on both sides of the pipe, with the pipe faces closed together and then with the clamps fully retracted. At each clamp position, misalignment or bending of the framework will be evident as differences between each of the distances measured from one clamp face to the other. Conduct the test with both the pipes supported horizontally

by support rollers at 1 m and 4 m from the butt fusion machine, and repeat it with the supports removed if applicable. In both cases, the criterion for acceptability shall be as specified in 5.2.3.

NOTE In case it is not possible, for any reason, to fix pipes up to 200 mm above ground, another distance can be chosen and specified by the manufacturer in the technical file.

### 10.2 Planing tool and check of gap after planing

Plane two maximum-diameter pipes for each range of the butt fusion machine. The applied force on the pipe ends shall be zero at the end of the planing operation.

After removing the planing tool, close the two pipe faces together with a force sufficient to overcome the frictional resistance. With the two pipe faces in contact, the maximum gap between the pipe ends shall not exceed the applicable value specified in Table 2.

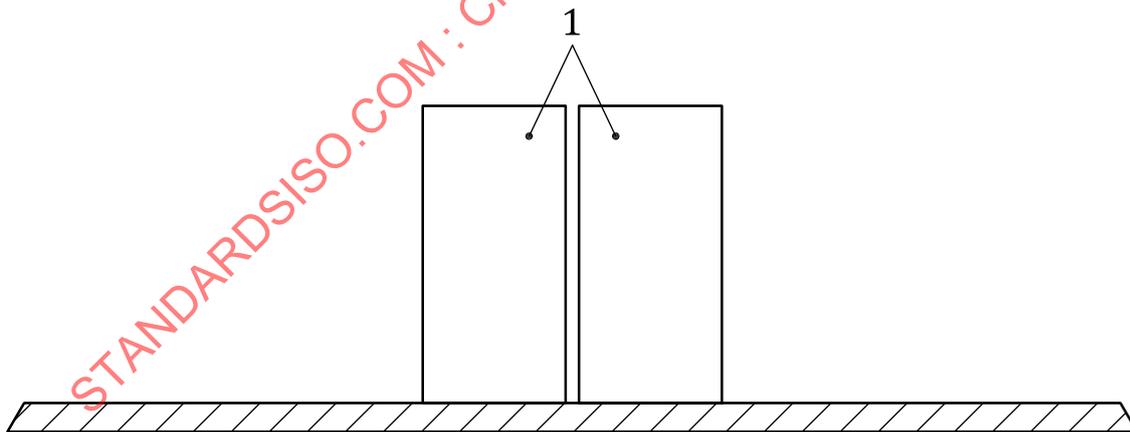
### 10.3 Heating plate

#### 10.3.1 Roughness check

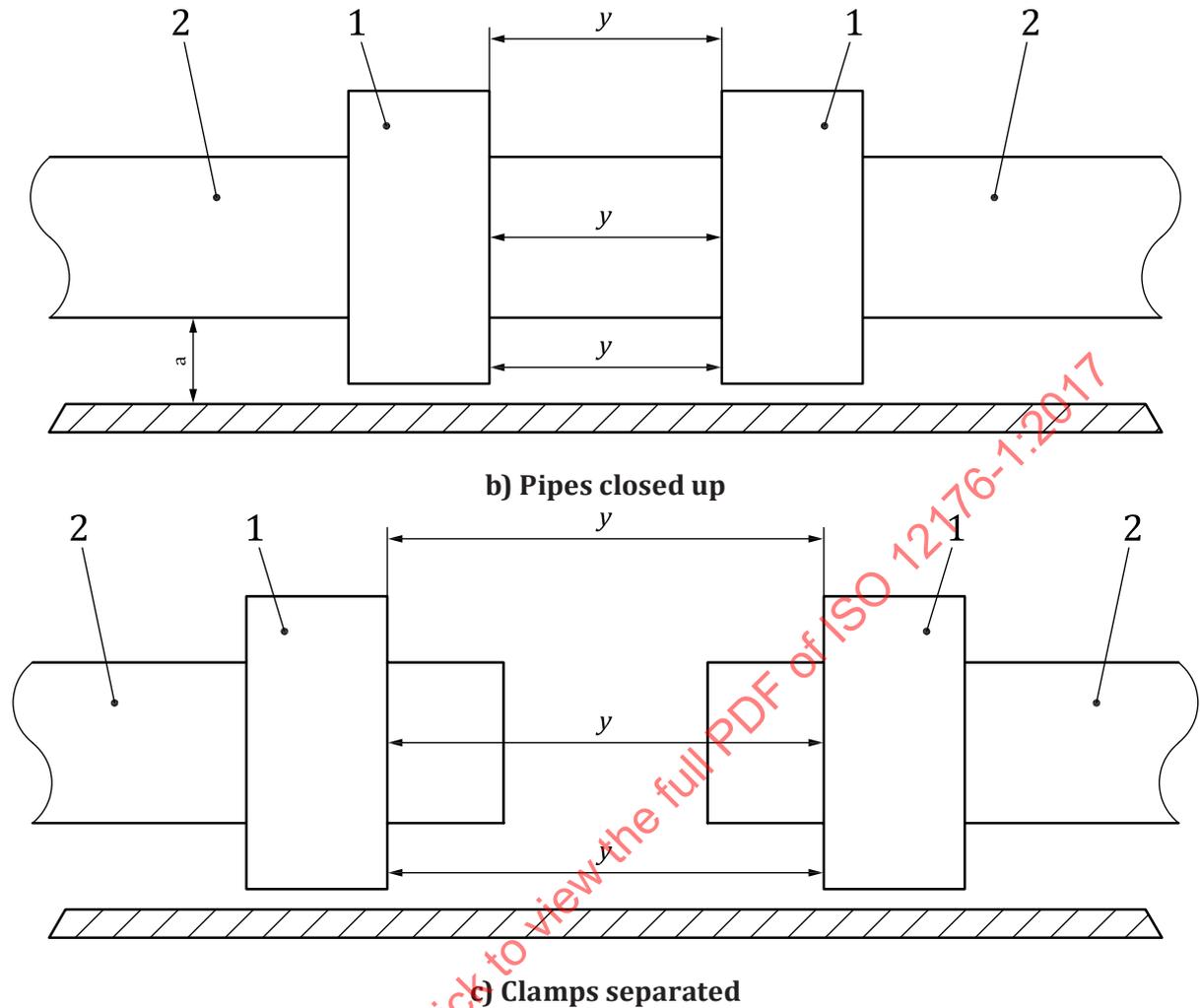
Measure the roughness on each side of the heating plate as follows:

- Clamp a pipe of the maximum diameter for which the butt fusion machine has been designed into the butt fusion machine and place the heating plate in position between the pipe ends. Draw the outside circumference of the pipe on the heating plate.
- Repeat with all the other pipe diameters for which the butt fusion machine has been designed.
- Draw two diagonal lines at 45° to the horizontal axis.
- Measure the surface roughness at the points of intersection of each of the pipe circumferences with the diagonals.

The surface roughness  $R_a$  shall be within the limit given in 8.5.1.



a) Initial adjustment

**Key**

- 1 clamp
- 2 pipe
- y measurement
- a At least 200 mm at lowest point.

**Figure 4 — Clamp alignment check****10.3.2 Temperature control system check**

The temperature control system check shall be conducted with the heating plate in the vertical position in still air at  $23\text{ °C} \pm 2\text{ °C}$ .

The temperature measurements shall be made with an accurate, calibrated thermocouple suitable for the measurement of surface temperatures, or any other appropriate device.

First check that the heating plate conforms to the requirements given in [8.5.2](#).

Then heat and cool the heating plate from ambient to operating temperature for 50 complete cycles.

Subsequently check the temperature on each side of the heating plate at the same points as for the surface roughness check.

The temperatures shall be within the limits given in [8.5.2](#).

### 10.3.3 Heat transfer efficiency

Carry out the test for heat transfer to the pipe surface during normal fusion jointing operations. Condition the pipe and the machine at  $-5\text{ °C} \pm 2\text{ °C}$  for at least 4 h. A thermocouple will need to be mounted in the end surface of the pipe. This shall be done after the pipe end has been trimmed. Small self-adhesive-patch thermocouples are satisfactory for this purpose.

Alternatively, a small bead thermocouple or equivalent may be fixed in the surface using a soldering iron to melt a region of the pipe surface. Thicker wire thermocouples or soldered assemblies are not satisfactory since heat conduction along wires should be minimized.

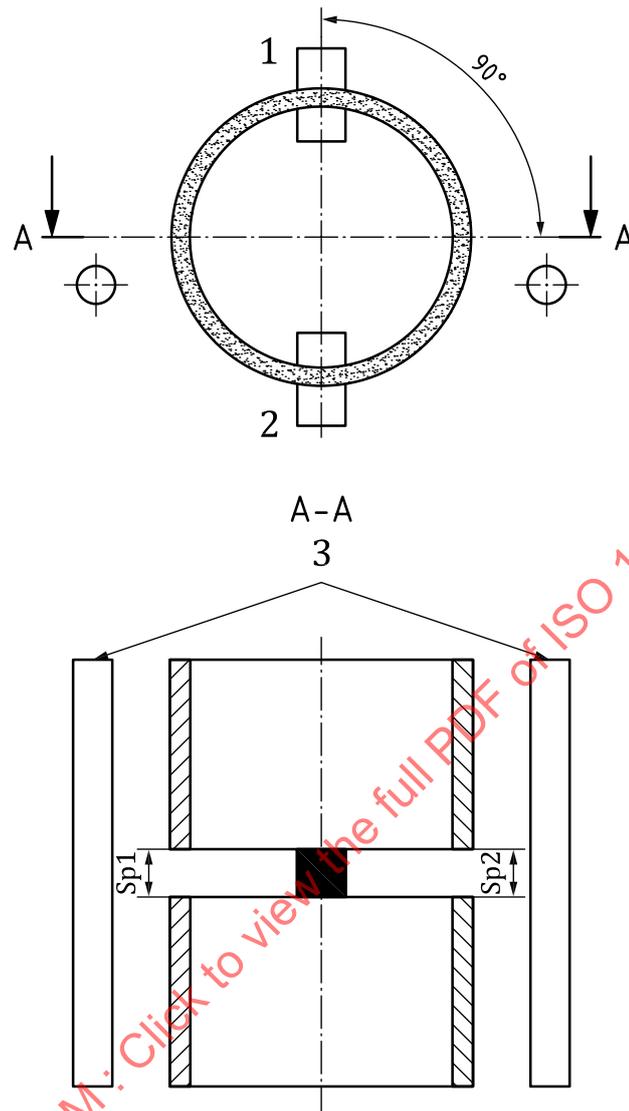
The use of a recording instrument facilitates measurement of the temperature rise time. The acceptance limit is specified in [8.5.3](#).

### 10.3.4 Guide elements and work-holding fixtures

Carry out the test with the largest available pipe to fit in the machine clamped and fixed on pipe support stands then plane the pipe ends. Align and plane the pipes carefully so that no gap remains between the pipe ends. Then open the machine and place two gauge blocks on the pipe ends at  $90^\circ$  off-centre relative to the guide elements. Bring the pipe ends together again under a jointing pressure of  $0,15\text{ N/mm}^2$  until the pipe ends contact the gauge blocks. The difference between the largest gap measurement at points Sp1 and Sp2 (see [Figures 5](#) and [6](#)) and the thickness of the gauge blocks shall not exceed the value given in [Table 2](#).

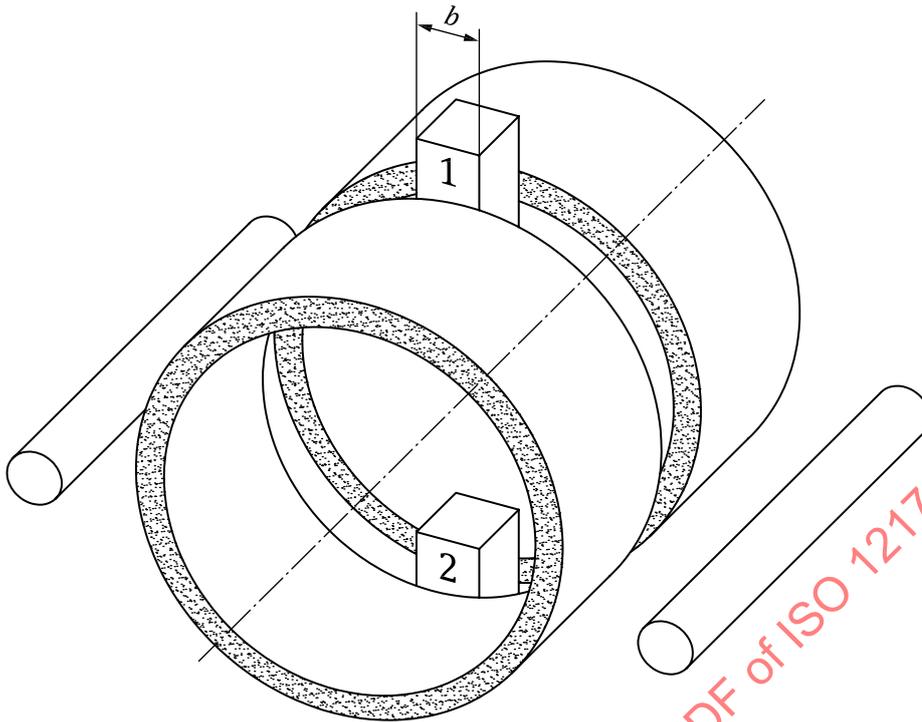
For checking the gap as shown in [Figure 5](#), a wedge gauge should preferably be used. An overview is given in [Figure 6](#).

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**Key**

- 1, 2 gauge blocks on centreline of pipes (off-centred 90 ° relative to the guide elements, e.g. pipe disposed horizontally with guide elements arranged below)
- 3 guide elements
- Sp1 upper measurement point
- Sp2 lower measurement point

**Figure 5 — Check of guide elements and work-holding fixtures — Measurement of gap size**



**Key**

- 1, 2 gauge blocks on centreline of pipes (off-centred 90 ° relative to the guide elements, e.g. pipe disposed horizontally with guide elements arranged below)
- b* width of gauge blocks  
 $b = (d_n - e) \pi / 100$  (minimum 10 mm)  
 where  
 $d_n$  is the nominal outside diameter of the pipe;  
 $e$  is the wall thickness of the pipe.

**Figure 6 — Check of guide elements and work-holding fixtures — Overview**

**11 Auxiliary equipment**

For each size of butt fusion machine, the manufacturer shall make available the following items:

- Heating-plate guard and support. This shall provide thermal insulation and protection, keep the surface clean and avoid the risk of burns to people or equipment. The guard shall ensure secure retention of the insulating material and stable stowage, and carry a clearly visible “HOT” warning.
- Planing-tool stands or other suitable devices, used to support the trimmers when they are out of the butt fusion machine.

Operating instructions, and relevant legal safety requirements and maintenance schedules, shall be supplied for each butt fusion machine.

**12 Maintenance**

In order to maintain the performance of the machine in accordance with this document, it is recommended that the complete machine be inspected, serviced and adjusted at least once per year. This should be carried out by the machine manufacturer or the manufacturer’s authorized representative. After maintenance, all components of the machine (chassis, heating plate, planing tool, etc.) should be marked with a service badge.

National regulations, manufacturer's instructions and/or customer requirements shall be taken into account.

### 13 Marking on the butt fusion machine

The butt fusion machine and accompanying components shall be indelibly marked on all appropriate parts with the following information:

- a) the manufacturer's identification mark;
- b) the model of machine as defined by the manufacturer;
- c) the power supply used (input voltage and power consumption);
- d) the serial number;
- e) the maximum diameter for which the machine is designed.

### 14 Other information to be provided by the manufacturer

The following data shall be provided with the machine, e.g. on a technical data sheet or in the operating instructions:

- a) the effective ram area of the machine (if applicable);
- b) the pipe diameter range for which the machine is designed;
- c) the SDRs for each pipe diameter;
- d) the fusion-jointing procedure(s) for which the equipment has been designed;
- e) the type of machine.

The type classification scheme for butt fusion machines given in [Annex B](#) may be used.

## Annex A (normative)

### Additional performance requirements for butt fusion machines with automatic controllers

**A.1** Automated butt fusion machine systems shall have consistent, reliable and repeatable performance in accordance with ISO 11414.

**A.2** The system shall control, monitor and record the critical parameters/sequence of events followed in the construction of each joint.

The range of parameters covered should preferably include fusion cycle times and pressures, drag pressure, heating-plate temperature, dwell time between heating plate removal and bringing the pipe ends together and pipe slippage.

The system should preferably abort the process when an event is outside predefined limits and indicate the cause.

**A.3** The system shall provide for entry and retrieval of identification data such as date, time, job, employee, pipe diameter and wall thickness or SDR and joint sequence numbers.

**A.4** Provision shall be made for independent monitoring of the temperature control system and the automatic cut-off of power to the heating elements in the event of imbalance between the control and monitoring circuits. Power cut-off facilities shall also be provided in the case of the failure of a single element in a multi-element system.