INTERNATIONAL STANDARD

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Third edition
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 12176-1 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 12176-1:2006), which has been technically revised.

ISO 12176 consists of the following parts, under the general title *Plastics pipes and fittings — Equipment for fusion jointing polyethylene systems*:

— *Part 1: Butt fusion*

— *Part 2: Electrofusion*

— *Part 3: Operator's badge*

— *Part 4: Traceability coding*

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

Part 1:
Butt fusion

1 Scope

This part of ISO 12176 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 PE pipes and fittings either intended to be used for the supply of gaseous fuels, conforming to ISO 4437 and ISO 8085-2, 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 and ISO 4427-3.

The normal ambient temperature range in which the butt fusion machine is intended to operate is −10 °C to +40 °C. Use outside this temperature range will need to be agreed between the user and the supplier of the machine.

Butt fusion machines with an automatic controller are subject to additional requirements as given in Annex A.

NOTE The requirements for machines may be different for larger diameters pipes than given in this part of ISO 12176.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 4427-2, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 2: Pipes*

ISO 4427-3, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 3: Fittings*

ISO 4437, *Buried polyethylene (PE) pipes for the supply of gaseous fuels — Metric series — Specifications*

ISO 8085-2, *Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels — Metric series — Specifications — Part 2: Spigot fittings for butt fusion, for socket fusion using heated tools and for use with electrofusion fittings*

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.

3.1
base framework
self-supporting entity composed of two or more guides and pipe clamps

NOTE This 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

NOTE See 6.1.

3.3
peak drag
friction at the point at which movement is initiated

3.4
dynamic drag
friction occurring during movement

3.5
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 It is a convenient round number for reference purposes.

NOTE 2 Adapted from ISO 161-1.

3.6
nominal wall thickness
e_n
numerical designation of the wall thickness of a component, which is a convenient round number approximately equal to the manufacturing dimension in millimetres

3.7
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

4 Design configurations

To conform to the requirements of this part of ISO 12176, 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 preset 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.

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 layers 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
$e_n \leq 4,5$	5
$4,5 < e_n \leq 7$	$5 \leq t_{max} \leq 6$
$7 < e_n \leq 12$	$6 \leq t_{max} \leq 8$
$12 < e_n \leq 19$	$8 \leq t_{max} \leq 10$
$19 < e_n \leq 26$	$10 \leq t_{max} \leq 12$
$26 < e_n \leq 37$	$12 \leq t_{max} \leq 16$
$37 < e_n \leq 50$	$16 \leq t_{max} \leq 20$
$50 < e_n \leq 70$	$20 \leq t_{max} \leq 25$

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. This shall be evaluated by determining it 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
$d_n \leq 250$	0,3
$250 < d_n \leq 400$	0,5
$400 < d_n \leq 630$	1
$630 < d_n$	0,2 % of d_n

5.2.3 Rigidity under bending

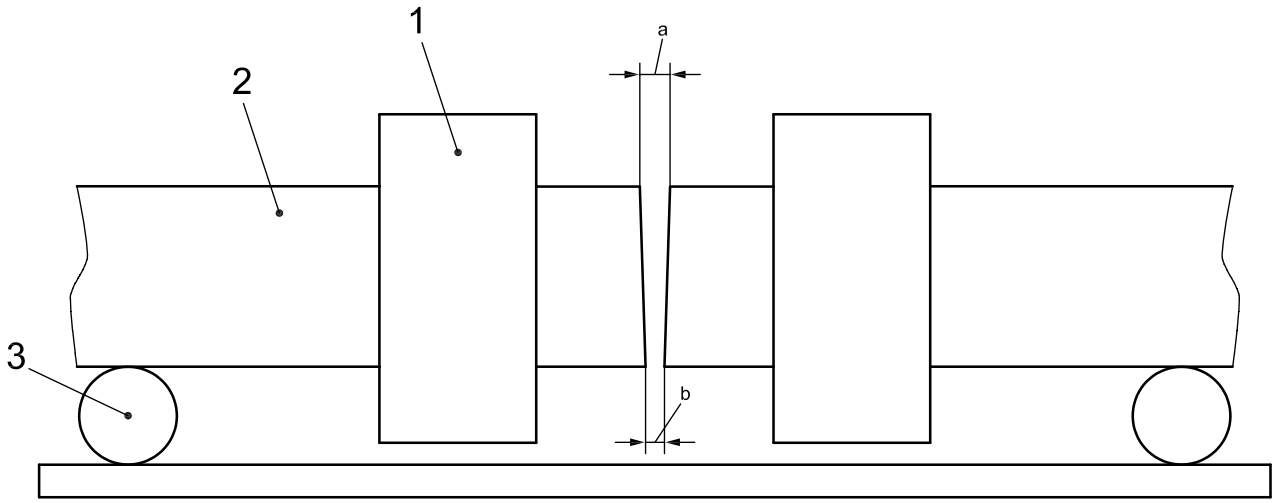
The clamp support and bearing system shall be sufficiently rigid to maintain axial alignment to within 0,2 mm over its entire length of travel when tested in accordance with 10.1.2.1.

Angular misalignment of supported pipes shall not exceed 0,5 mm when determined in accordance with 10.1.2.2.

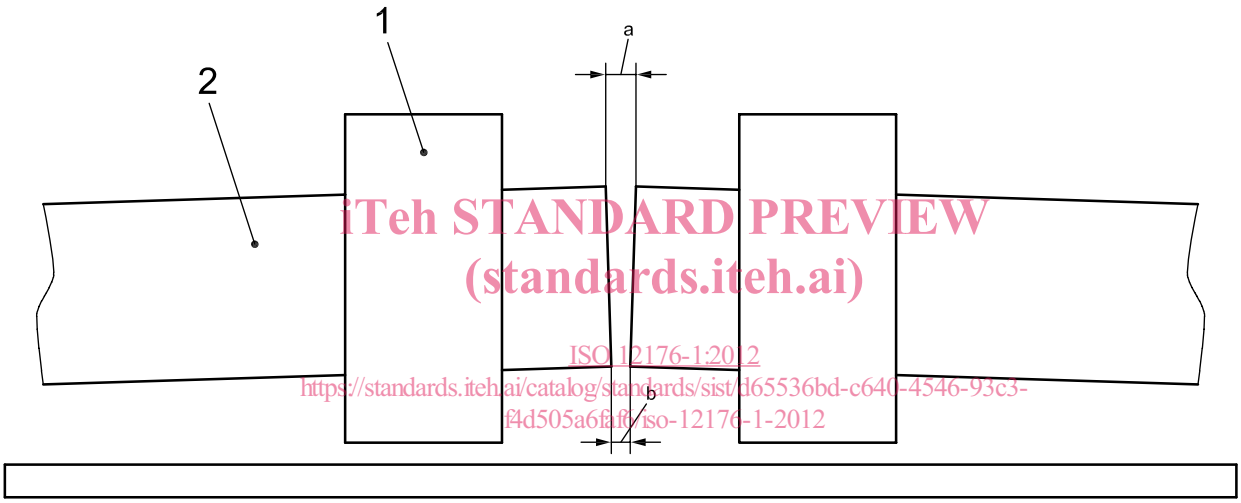
When the pipe supports are removed (see Figure 1), the additional bending of the butt fusion machine chassis and clamps shall not result in a deflection greater than the values given in Table 3.

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

Nominal outside diameter d_n mm	Maximum deflection f_{max} mm
< 225	0,5
250	1
315	2
400	3
500	4
630	5
800	7
1 000	9
1 200	11
1 600	15



a) **Support rollers present,** $|a-b| \leq 0{,}5\text{mm}$



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

Key

1 clamp
2 pipe
3 support roller

NOTE f_{max} is the maximum deflection given in Table 3.

a Gap at upper measurement position.
b Gap at lower measurement position.

Figure 1 — Gap between pipes when bent

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 part of ISO 12176.

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 peak drag compensation, the butt fusion machine shall have a minimum reserve of 30 % of the fusion force specified for the maximum pipe diameter and wall thickness and the fusion cycle 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 %.