TECHNICAL SPECIFICATION

ISO/TS 10839

First edition
2000-03-15

Polyethylene pipes and fittings for the supply of gaseous fuels — Code of practice for design, handling and installation

Tubes et raccords en polyéthylène pour le transport de combustibles gazeux — Code de pratique pour la conception, la manutention et l'installation

Reference number
ISO/TS 10839:2000(E)

Contents

Page

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 3.

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.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

— an ISO Publically Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by more than 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed every three years with a view to deciding whether it can be transformed into an International Standard.

Attention is drawn to the possibility that some of the elements of this Technical Report may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TS 10839 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*.

Annexes A and B are for information only.

Polyethylene pipes and fittings for the supply of gaseous fuels — Code of practice for design, handling and installation

1 Scope

This Technical Specification presents a code of practice dealing with polyethylene (PE) pipes and fittings for buried pipeline systems outside buildings and designed to distribute gaseous fuels within the temperature range – 20 °C to + 40 °C and gives appropriate temperature-related requirements.

The code of practice covers mains and service lines whose components are prepared for jointing by scraping and/or machining, and gives instructions for the design, storage, handling, transportation, laying conditions and fusion quality control of PE pipes and fittings up to and including 630 mm outside diameter, as well as subsequent joint testing, backfilling, pipe system testing, commissioning and decommissioning.

The jointing methods covered by this Technical Specification are heated-tool fusion jointing (butt, socket and saddle fusion), electrofusion jointing and mechanical jointing.

No special precautions are necessary for areas exposed to the influence of mining and earthquakes other than those precautions mentioned in this code of practice.

Existing and new national regulations take precedence over this Technical Specification.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this Technical Specification. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this Technical Specification are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 4437:1997, *Buried polyethylene (PE) pipes for the supply of gaseous fuels — Metric series — Specifications*.

ISO 8085-1:—[1)], *Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels — Metric series — Specifications — Part 1: Fittings for socket fusion heated tools.*

ISO 8085-2:—[1)], *Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels — Metric series — Specifications — Part 2: Spigot fittings for butt or socket fusion using heated tools and spigot fittings for use with electrofusion fittings.*

ISO 8085-3:—[1)], *Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels — Metric series — Specifications — Part 3: Electrofusion fittings.*

ISO 10838-1:2000, *Mechanical fittings for polyethylene piping systems for the supply of gaseous fuels — Part 1: Metal fittings for pipes of nominal outside diameter less than or equal to 63 mm.*

1) To be published.

ISO 10838-2:2000, *Mechanical fittings for polyethylene piping systems for the supply of gaseous fuels — Part 2: Metal fittings for pipes of nominal outside diameter greater than 63 mm.*

ISO 10838-3:—[2)], *Mechanical fittings for polyethylene piping systems for the supply of gaseous fuels — Part 3: Thermoplastics fittings for pipes of nominal outside diameter less than or equal to 63 mm.*

ISO 10933:1997, *Polyethylene (PE) valves for gas distribution systems.*

ISO 11413:1996, *Plastics pipes and fittings — Preparation of test piece assemblies between a polyethylene (PE) pipe and an electrofusion fitting.*

ISO/TR 11647:1996, *Fusion compatibility of polyethylene (PE) pipes and fittings*.

ISO 12162:1995, *Thermoplastics materials for pipes and fittings for pressure applications — Classification and designation — Overall service (design) coefficient.*

ISO 12176-1:1998, *Plastics pipes and fittings — Equipment for fusion jointing polyethylene systems — Part 1: Butt fusion.*

ISO 12176-2:—[2)], *Plastics pipes and fittings — Equipment for fusion jointing polyethylene systems — Part 2: Electrofusion.*

ISO 12176-3:—[2)], *Plastics pipes and fittings — Equipment for fusion jointing polyethylene systems — Part 3: Operator's badge*.

EN 12327:—[2)], *Gas supply systems — Pressure testing, commissioning and decommissioning procedures — Functional requirements*.

3 Terms and definitions

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

3.1
butt fusion machine pressure
pressure indicated on the manometer or on a pressure display on a butt fusion machine, giving an indication of the interface force applied to the pipe and/or fitting ends

3.2
clearance
shortest distance between the outer limits of two objects

3.3
drag resistance
frictional resistance due to the weight of the length of pipe fixed in the moveable clamp at the point at which movement of the moveable clamp is initiated (peak drag), or the friction occurring during movement (dynamic drag)

3.4
electrofusion control box
unit implementing the output fusion parameters of voltage or current and time or energy to execute the fusion cycle as specified by the electrofusion fitting manufacturer

3.5
frictional losses in the butt fusion machine
force necessary to overcome friction in the whole mechanism of a butt fusion machine

2) To be published.

3.6
interface force
force between the fusion surfaces of the pipe(s) and/or fitting(s) during the fusion cycle, as specified in the fusion diagram

3.7
operator
person authorized to build PE systems from pipes and/or fittings, based on a written procedure agreed by the pipeline operator

3.8
overall service (design) coefficient
C
overall coefficient, with a value greater than 1, which takes into consideration service conditions as well as properties of the components of a piping system

3.9
pipeline operator
private or public organization authorized to design, construct and/or operate and maintain a gas supply system

3.10
soil cover
vertical distance between the top of a buried pipe and the normal surface after finishing work

4 Symbols and abbreviated terms

d_e external diameter of pipe

MOP maximum operating pressure

MRS minimum required strength

RCP rapid crack propagation

SDR standard dimension ratio

5 Design

5.1 General

A written laying procedure, authorized by the pipeline operator, shall be made available prior to the construction of a pipeline. The laying procedure shall include specification of the jointing procedure, the pipe and fitting materials to be used, the trenching and backfilling requirements, the pressure testing and commissioning requirements, and the data to be collected for the traceability system.

The selection of materials, SDR series, dimensions and assembling techniques shall be the responsibility of the pipeline operator.

There are two SDR series in common use for gas supply systems: SDR 17,6 and SDR 11. Other SDR series can also be used, such as SDR 26 for renovation.

The training and the level of skill of the operator shall be in accordance with the requirements of the jointing procedures.

General guidelines for supervision and quality control are given in clause 8.

5.2 Materials, components and jointing equipment

The PE materials and components used shall conform to the relevant ISO standards: ISO 4437, ISO 8085-1, ISO 8085-2, ISO 8085-3, ISO 10838-1, ISO 10838-2, ISO 10838-3 and ISO 10933.

Other components not covered by the above-mentioned standards shall conform to the relevant national standards.

If pipes and fittings are to be stored outside, requirements on maximum storage time shall be given in the laying procedure. PE materials shall be stabilized to give protection against a UV radiation level of 3,5 GJ/m^2. It is desirable that national bodies give recommendations for allowed storage times in their countries. Annex B gives, as an example, the average radiation levels in Europe.

The fusion equipment used for the construction of the pipeline shall comply with the requirements of ISO 12176-1 or ISO 12176-2. If the operation of the fusion equipment requires an operator's badge, the badge shall conform to ISO 12176-3.

5.3 Maximum operating pressure

The maximum operating pressure (MOP) of the system shall be selected by the pipeline operator on the basis of the gas supply system operating requirements and the materials used. The MOP of a PE system depends upon the type of resin used (the MRS), the pipe SDR series and the service conditions, and is limited by the overall service (design) coefficient C and the RCP criteria.

The overall service (design) coefficient C for thermoplastics materials is specified in ISO 12162. This coefficient is used to calculate the MOP of the pipeline. C shall be greater than or equal to 2 for PE pipeline systems for natural gas.

The MOP shall be calculated using the following equation:

$$\mathrm{MOP} = \frac{20 \times \mathrm{MRS}}{C \times (\mathrm{SDR} - 1) \times D_\mathrm{F}}$$

NOTE The derating factor D_F is a coefficient used in the calculation of the MOP which takes into account the influence of the operating temperature. Derating factors for various operating temperatures are given in annex A.

The ratio of the critical RCP pressure to the MOP shall be $\geqslant 1,5$ at the minimum operating temperature. The critical RCP pressure is dependent upon temperature, pipe size and type of PE material used. It is defined here in accordance with ISO 4437:1997, which specifies a test temperature of 0 °C.

Where the pipe temperature decreases below 0 °C, the p_RCP/MOP ratio shall be recalculated using a p_RCP value determined from the minimum expected operating temperature of the pipe. If necessary, the value of the MOP shall be reduced so as to maintain the p_RCP/MOP ratio at a value $\geqslant 1,5$.

5.4 Assembly techniques

Jointing procedures may vary depending upon the type of PE material and the pipe size used.

Fusion is the preferred jointing method. Preference shall be given to butt fusion and electrofusion.

Care shall be taken when making fusion joints with PE materials which are not compatible (see ISO 4437).

A written jointing procedure, authorized by the pipeline operator, shall be available prior to the construction of a pipeline. 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.

5.5 Squeeze-off properties

When squeeze-off techniques are considered, the suitability of the pipe for squeeze-off shall be established in accordance with ISO 4437.

6 Installation

6.1 Jointing procedure

The jointing operation shall be performed in accordance with the pipeline operator's written procedure and shall take into account any advice from the pipe, fitting and accessory manufacturers.

Polyethylene pipes, fittings and accessories may be jointed by heated-tool fusion jointing, electrofusion jointing or mechanical jointing. The jointing and quality control methods used for the construction of the gas supply system shall be appropriate to the design of the network.

6.2 Training

The operator shall be competent in the appropriate laying and jointing methods. He shall possess the necessary skill and knowledge to produce joints of consistently high quality.

Operators shall receive formal training under the supervision of a qualified instructor. The gas company may require a certificate indicating that he has reached an adequate standard in accordance with national or local regulations.

6.3 Heated-tool fusion jointing (butt, socket and saddle fusion)

6.3.1 General

Heated-tool fusion joints shall be made under defined conditions of pressure, time and temperature, using a written procedure (see 6.1). Mating surfaces are heated to their fusion temperature and then brought into contact with one another.

6.3.2 Fusion temperature

The production of a strong fusion bond depends, among other things, upon the fusion temperature of the polyethylene material: overheating may degrade the material, and insufficient heating will not soften it adequately.

The temperature range over which any particular polyethylene material may be satisfactorily jointed shall be considered. The jointing procedure shall specify the heating cycle and the temperature levels for the polyethylene material chosen.

Cold weather and wind can adversely affect the fusion temperature. Under these circumstances, special precautions such as shielding, end caps and longer heating times shall be considered.

6.3.3 Fusion equipment

The butt fusion equipment used shall conform to ISO 12176-1. Socket and saddle fusion equipment shall comply with a relevant ISO standard or a national or company standard which guarantees a high-quality product fit for the purpose intended.

As high-quality fusion joints cannot be made with fusion equipment in poor condition, maintenance of the fusion equipment is very important and shall be carried out on a regular basis. The cleanliness and integrity of the heating surfaces, the ability of the heating tools to produce the correct temperature and the correct alignment and operation of the equipment when used are of paramount importance.

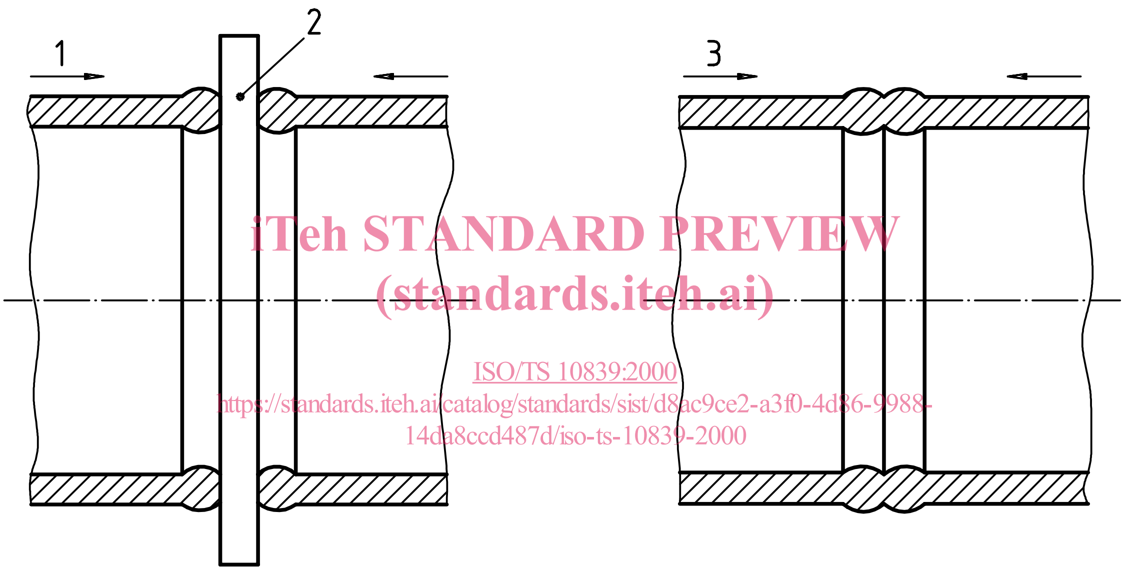
The heating tools are designed to maintain uniform temperatures within the fusion temperature range of the particular polyethylene material and shall have calibrated means of measuring and indicating the temperature. A precise temperature measurement device such as a pyrometer or a digital thermometer with a surface temperature sensor may be used to check the surface temperature of the heating tools, although additional care is necessary to avoid inconsistency of readings when such a device is used.

All heating tools used shall be electrically heated.

6.3.4 Butt fusion

6.3.4.1 Principle

The butt fusion technique consists of heating the planed ends of the mating surfaces by holding them against a flat heating plate until molten, removing the heating plate, pushing the two softened ends against one another, holding under pressure for a prescribed time and allowing the joint to cool (see Figure 1).



a) Heating **b) Fusion**

Key

1 Pressure during heating

2 Heating plate

3 Pressure during fusion

Figure 1 — Butt fusion

Butt fusion is not recommended for pipes < 63 mm in diameter. Pipes and/or fittings with fusion ends of different SDR values shall not be jointed by butt fusion.

6.3.4.2 Butt fusion cycle

The butt fusion cycle can be represented by a pressure/time diagram for a defined fusion temperature. Different butt fusion cycles are available, depending on the PE material used, the pipe diameter and the working conditions. The butt fusion cycle to be used shall be specified in the written procedure.

An example of a butt fusion diagram is given in Figure 2.

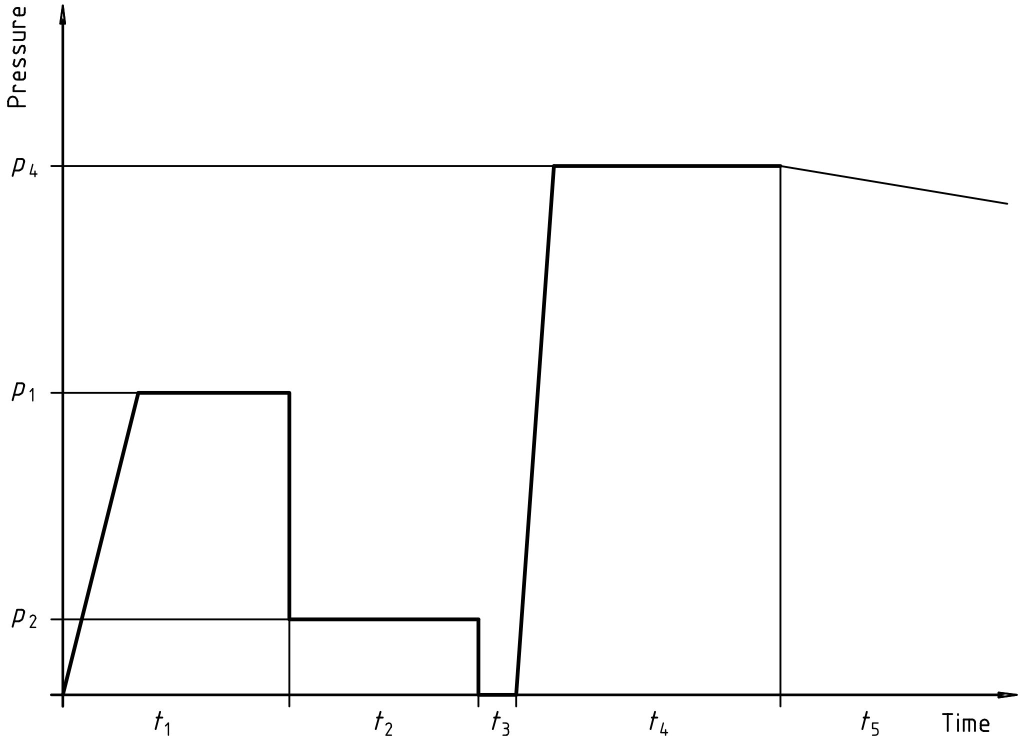


Figure 2 — Example of a butt fusion diagram

Table 1 — Parameters of butt fusion diagram shown in Figure 2

Period of time	Description	Pressure at interface
t_1	Formation of a bead measuring 1 mm to 4 mm, depending on the pipe diameter	p_1
t_2	Heating of the material (heat soak)	p_2
t_3	Removal of the heating plate	—
t_4	Building up the fusion pressure and the fusion-jointing operation	p_4
t_5	Cooling of the fusion joint	—

The pressures shall be chosen so that the required force is produced at the interface, irrespective of frictional and pressure losses in the butt fusion machine and drag resistance from the pipe system.

In the case of machines with hydraulic power rams, the force is normally indicated in terms of the applied cylinder pressure. For such machines, a specific calibration table is provided that gives the relationship between the real interface pressure and the pressure indicated by the manometer (pressure gauge).

6.3.4.3 Butt fusion temperature

The butt fusion temperature is normally situated between 200 °C and 235 °C and is given in the jointing procedure.

6.3.4.4 Butt fusion jointing

The following gives an overview of the minimum operations necessary to produce a but fusion joint with a specified butt fusion cycle and temperature:

— Reduce the drag resistance as much as possible, for example by using pipe rollers.

— Clamp the spigot ends of the pipe(s) and/or fitting(s) in the butt fusion machine.

— Clean the spigot ends.

— Check that the butt fusion machine is compatible with the pipe diameter and the prescribed butt fusion cycle.

— Plane the pipes parallel by moving the movable clamp against the planing tool (see Figure 3). The closing pressure shall be sufficient to produce a steady flow of PE slivers on both sides of the planing tool. Planing is complete when the pipe face(s) and/or fitting face(s) are plane and parallel to each other.

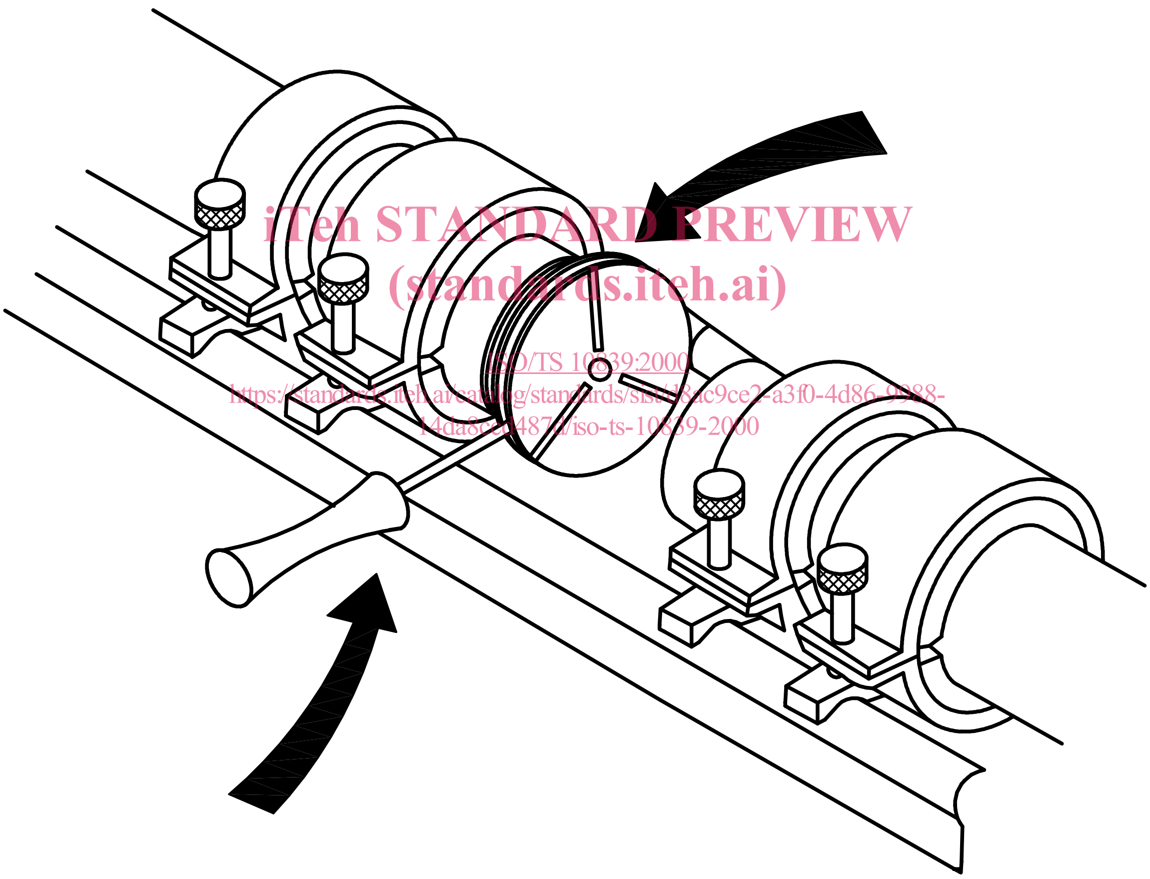


Figure 3 — Planing the spigot ends

— Lower the pressure, keeping the planing tool rotating in order to avoid a burr on the pipe and/or fitting faces. Move the movable clamp backwards and remove the planing tool.

— Close the butt fusion machine and check that the pipes are aligned. The spigot ends of pipe(s) and/or fitting(s) shall be aligned as much as possible and not exceed the maximum misalignment given in the jointing procedure.

— The gap between the pipe and/or fitting faces after planing shall be as small as possible and shall not exceed the maximum gap given in the jointing procedure.

— Measure the additional pressure caused by the frictional losses in the butt fusion machine and the drag resistance by moving the movable clamp forwards, and add this pressure to the required butt fusion pressure.

— If necessary, clean the fusion surfaces and the heating plate. Polyethylene residues shall only be removed from the heating plate with a wooden spatula.

— Check that the surface coating of the heating plate is intact and without scratches.

— Check that the heating plate is at the correct fusion temperature.

— Place the heating plate between the pipe faces. Close the butt fusion machine against the heating plate to apply the fusion pressure, including the measured additional pressure, until the specified bead width has been reached (see Figure 4).

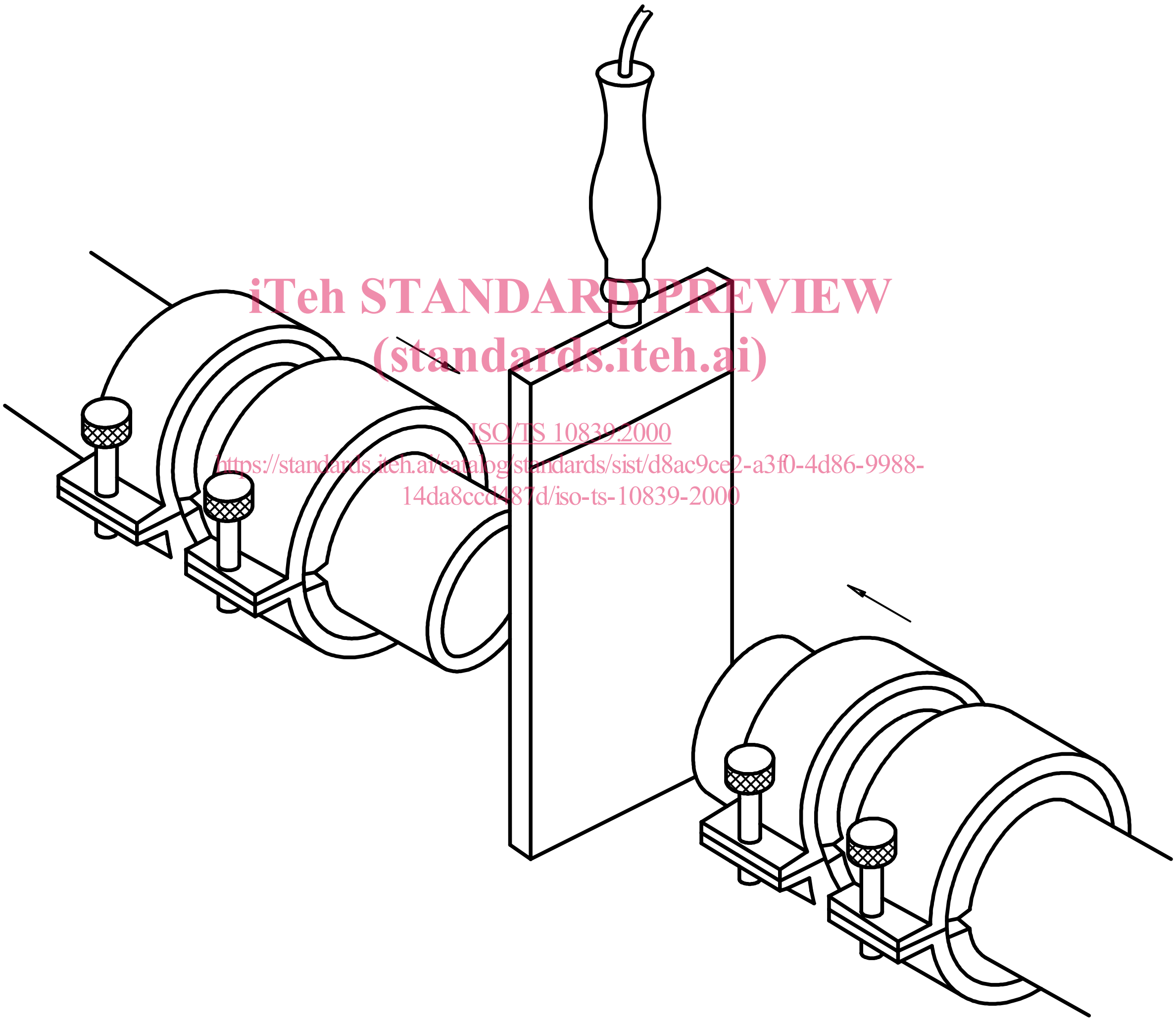


Figure 4 — Heating the spigot ends

— Reduce the pressure to a level at which contact is just maintained between the pipe ends and the heating plate.

— When the heat soak time has elapsed, open the butt fusion machine and remove the heating plate. Check the heated pipe ends quickly for possible damage to the melted ends caused by the removal of the heating plate, and close the butt fusion machine again. The period between opening and closing shall be within the maximum time given in the jointing procedure.