# WATER INDUSTRY SPECIFICATION

WIS 4-32-08

August 1994: Issue 2 (Page 1 of 28) ISSN 1353-2510

UK Water Industry
Engineering and Operations Committee

# SPECIFICATION FOR SITE FUSION JOINTING OF PE80 AND PE100 PIPE AND FITTINGS

#### **FOREWORD**

This Specification has been prepared by WRc plc under the direction of the UK Water Industry Engineering and Operations Committee in consultation with the Water Industry, Water Training International and relevant UK manufacturers and contractors.

This specification defines the equipment required, the jointing procedure to be carried out, the maintenance, servicing and calibration procedures to follow, the records to be kept and the training programme to be respected in order to produce good fusion joints in polyethylene pipes. In order to make good joints it is necessary to respect the requirements of the jointing procedure with particular reference to pipe end preparation as well as temperature and pressure control.

This revision has been issued to extend this Water Industry Specification to cover the fusion jointing of both PE 80 (MDPE) and PE 100 (HPPE) pipes.

Pipes and fittings can be jointed by butt fusion using an electrically heated plate. Butt fusion is suitable for jointing pipes and fittings in the size range greater than 63. However, only pipes and fittings of the same standard dimension ratio may be jointed together i.e. a 250 SDR 11 pipe should not be jointed to a 250 SDR 17.6 fitting.

Electrofusion fittings and electrofusion saddle fittings are available in both PE80 and PE100 grades of material and are suitable for jointing to pipes of SDR 11, SDR 17.6 and SDR 26.

Pipes of different materials and/or SDR can be jointed successfully using electrofusion sockets, provided that all components have adequate nominal pressure rating for the operating conditions.

With the introduction of electrofusion jointing, the use of hot tool socket and saddle fusion jointing has decreased markedly and the relevant jointing procedures have, therefore, been deleted from this specification. This specification does not necessarily cover the full fusion jointing procedures used for pipeline renovation techniques.

The FWR/WRc research programme on butt fusion jointing of PE100 pipe has identified a need to revise existing fusion jointing conditions for thicker walled pipes in order to optimise jointing performance.

This amendment contains the dual pressure butt fusion jointing procedures for thicker walled pipes, and single pressure jointing procedures for thinner walled pipes, as well as the procedures for electrofusion socket and saddle jointing and the requirements for site Quality Assurance.

Good control of jointing conditions and accurate record keeping are important in all fusion jointing operations. Manual or automatic equipment which accommodates these functions is therefore preferred.

The opportunity has also been taken of updating the text in line with the evolution of the Industry as well as aligning, where possible, with the draft CEN Standard for Polyethylene (PE) piping

This document has been prepared by the UK Water Industry Engineering and Operations Committee and published by WRc plc.

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systems for water supply (CEN/TC 155/WG12 N43).

Attention is drawn to the following British Standards (BS) and Water Industry Specifications (WIS) to which this specification relates:

BS 6572*	WIS 4-32-06
BS 6730	WIS 4-32-09
WIS 4-32-02*	WIS 4-32-11
WIS 4-32-03	WIS 4-32-13
WIS 4-32-04	WIS 4-32-14
WIS 4-32-05	WIS 4-32-15

\* BS 6572 is equivalent to WIS 4-32-02 and is now regarded as the lead specification for MDPE pipe systems up to 63 mm.

Attention is also drawn to the WSA/WRc PE Manual which gives recommendations on the installation of PE pipelines for water supply.

Users are reminded that fusion jointing is a skilled operation, and operators should be trained to an appropriate standard, e.g. under an appropriate National Vocational Qualification (NVQ) scheme.

Where required by the purchaser, third party certification may be applied to the service described in the specification. Enquiries regarding the availability of third party certification should be addressed to an appropriate NACCB or equivalent accredited third party certification body. Attention is drawn to the Civil Engineering Specification for the Water Industry, CESWI, which states that the Water Industry prefers kitemarked products where these are available.

This specification calls for the use of procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Compliance with this specification does not of itself confer immunity from legal obligations nor does the specification purport to include all the necessary provisions of a contract. Users of this specification are responsible for its correct application.

Information contained in this specification is given in good faith. Neither the U.K. Water Industry Research Ltd., the Water Services Association nor WRc plc can accept any responsibility for actions taken by others as a result.

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#### 1. SCOPE

This document specifies the principal requirements of the equipment to be used, the jointing procedure to be followed, the maintenance, servicing and calibration of the equipment to be carried out, the records to be maintained and the training required for fusion jointing by butt fusion, socket electrofusion and saddle electrofusion. Outline procedures for these jointing methods for use by trained jointers are given in the Appendices.

This specification requires that the installer shall operate a quality assurance system relating to this specification in accordance with the principles of BS EN ISO 9002 (BS 5750: Part 2). See also Clause 5 of this document.

NOTE: The titles of the publications referred to in this document are listed under 6 - REFERENCES.

#### 2. JOINTING BY BUTT FUSION

This method of jointing requires an electrically heated plate<sup>1</sup> to raise the temperature of the pipe ends to the fusion temperature and is used both for PE80 (MPDE) and PE100 (HPPE) grade of material for pipe of size 90 and above of the same Standard Dimension Ratio (SDR).

Tables 1 and 2 of this specification present the amended fusion conditions which shall be used for jointing pipe series SDR11, SDR17.6 and SDR26. For pipes with SDR other than 11, 17.6 or 26, or of non-standard sizes, guidance should be sought from the pipe manufacturer.

For SDR 11 pipes of size 250 mm, 280 mm, and 315 mm, and for all pipes (SDRs 11, 17.6, 26) of size 355 and above, butt fusion jointing machine ram pressures should be reduced after 10 seconds as summarised in Table 2 and the associated footnotes. This technique is referred to as dual pressure jointing.

It is very important that the butt fusion jointing machine employed can control the secondary (reduced) ram pressures accurately, as these pressures will sometimes be only slightly greater than the drag pressure alone.

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For dual pressure butt fusion jointing, the principle is that, once the initial bead has been formed in the bead-up phase, the interface stress (based on the nominal pipe wall cross-sectional area) should be reduced to just above zero, so that the pipe ends remain fully in contact with the heater plate surface but without excessive stress being applied. The butt fusion jointing machine ram pressure (in bar) necessary to achieve the specified minimum interface stress of 0 MPa during the soak period will be found in practice to lie between 0 bar and "drag".

NB. Too high a pressure during the heat soak will squeeze out the melt excessively, and detract from final joint quality. Conversely, too low a pressure may result in loss of full contact between the pipe or fitting ends and the heater plate.

Pipes with a non-circular section (e.g. egg-shaped sewer linings) can also be joined by butt fusion. Specialised equipment may be needed, and guidance should be sought from the pipe manufacturer.

#### 2.1 Equipment

#### 2.1.1 Chassis and Clamps

- (i) The machine shall have a frame containing clamps which are sufficiently robust to re-round and accurately align the pipes to be jointed.
- (ii) The machine shall have a minimum of two rams mounted on the pipe centre-line axis. The rams shall move freely and control the movement of any sliding clamps. All slides shall be kept free from rust and lubricated at all times.

#### 2.1.2 Hydraulic/pneumatic unit

(i) The unit shall be capable of actuating the clamp unit to provide adequate force and speed of operation. A pressure monitoring device shall be provided to monitor ram pressure.

In principle, plates can also be heated by electromagnetic induction. This technique is not covered by this document, but the key stages of the jointing operation would remain the same.

(ii) For manual machines a data plate shall be permanently attached to the unit setting out jointing and cooling pressures and times for relevant sizes of pipe. For dual pressure jointing, the jointing pressure shall be calculated based on a weld interface stress of 0.15MPa and the cooling pressure based on a weld interface stress of 0.025MPa.

The data plate shall be blue and printed in a contrasting colour.

For automatic machines, jointing data can be provided by means other than a data plate.

#### 2.1.3 Trimming tool

(i) The trimming tool shall be capable of being mounted securely within the frame of the jointing machine, to prevent twist during machining, so that this equipment can produce accurately matched planed faces.

NOTE: All trimming tools shall be fitted with suitable safety devices to prevent their operation outside the fusion machine.(ii) Trimming blades shall be sharp and have defect free cutting edges to provide continuous swarf of uniform thickness.

#### 2.1.4 Heater plate

(i) The plate shall be electrically heated and be provided with a suitable temperature controller to give a uniform operating surface temperature of 230 +10, -5°C (225°C to 240°C).

(ii) The plate surface shall have adequate release properties. The surface shall clearly show the presence of any contaminants.

# ADDITIONAL SPRAY-ON RELEASE AGENTS SHALL NOT BE USED.

(iii) The heater plate shall be fitted with a temperature probe or indicator accurate to within  $\pm 1^{\circ}$ C in the range 225 to 240°C.

(iv) Surface temperature shall be measured during routine calibrations and in cases of dispute. To ensure that the temperature of the heater plate has stabilised, the machine shall be in operation with the plate in its guard or

muff for at least twenty minutes prior to measurement. The temperature of each side of the plate should be measured, in still air, at a minimum of four equally spaced points denoted North, South, East, West (with North at the top of the plate) for plates used for pipes up to 250 mm diameter, and eight equally spaced points for all larger systems. The probe shall be held in position for at least 60 seconds before the reading is taken.

Site readings shall be taken inside a jointing shelter.

NOTE: The probe could scratch or otherwise mark the surface of the heater plate if used carelessly. Readings may therefore be taken just outside the position where the pipe contacts the heater plate.

#### 2.1.5 Control system

(i) The control system shall be designed to carry out the operations detailed below automatically at the temperatures, times and pressures indicated in the notes to Figure 1a and 1b as appropriate.

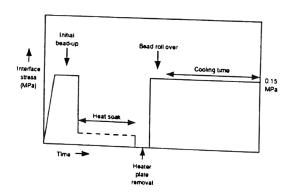


Figure 1a - Single pressure butt fusion jointing cycle (not to scale)

Heater plate temperature Initial bead-up stress Heat soak time Indicated gauge pressure during heat soak time Heater plate removal time Bead roll-over stress

230°C (+10°C, -5°C) 0.15MPa ±0.02MPa See Table 1

0 to drag 10 s maximum 0.15MPa ± 0.02MPa Bead roll-over time Interface fusion stress

Cooling time (in clamps)

10 s ± 1 s 0.15MPa ± 0.02MPa See Table 1 and 2.2.5.6

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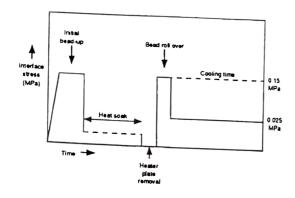


Figure 1b - Dual pressure butt fusion jointing cycle (not to scale)

Heater plate temperature
Initial bead-up stress
Heat soak time
Indicated gauge pressure
during heat soak time
Heater plate removal time
Bead roll-over stress
Bead roll-over time
Interface fusion stress

Cooling time (in clamps)

230°C (+10°C, -5°C) 0.15MPa ±0.02MPa See Table 2

0 to drag 10 s maximum 0.15MPa ± 0.02MPa 10 s ± 1 s 0.025MPa ± 0.02MPa See Table 2 and 2.2.5.6

NOTE: Care should be taken in monitoring effective or indicated pressure as this can be a significant proportion of the above stress values.

(ii) Where automatic machines are used, the control system shall be capable of being programmed according to the SDR of the pipe and/or fitting.

NOTE: To establish the heat soak and cooling times of pipes or fittings, with SDR other than 11, 17.6 or 26, or of non-standard sizes the guidance of the pipe and/or fitting manufacturer should be sought.

(iii) Where automatic machines are used, the control system shall incorporate

temperature sensors which adjust the heating and/or cooling time in accordance with the ambient temperature, (see 2.2.5.6).

#### 2.1.6 Shelter

A shelter shall be used to provide adequate protection for pipe, fittings and equipment against adverse weather conditions and contamination.

Appropriate auxiliary space heating must be provided if the air temperature in the fusion jointing shelter during jointing operations falls below 0°C in the case of "single pressure" sizes (see Table 1), or below 5°C in the case of "dual pressure" sizes (see Table 2), in order to maintain the air temperature at or above these minimum values.

#### 2.1.7 External and internal bead remover

External and internal debeaders shall be capable of removing the cold bead cleanly in a continuous strip without damage to either joint or bead. The bead removal tool shall not introduce any slits, gouges or other defects into the pipe wall.

#### 2.1.8 Generator

The generator shall be selected to suit the butt fusion machine electrical rating with output voltage tolerance of +25%, -10%.

- 2.1.9 Ancillary equipment
- (i) Pipe support rollers
- (ii) Pipe cutters
- (iii) Calibrated digital thermometer with surface probe
- (iv) Timer
- (v) Indelible marker pen for marking beads and joint numbers
- (vi) Pipe end plugs

- (vii) Bead gauge
- (viii) Saw and saw guide
- (ix) Baseboard.
- 2.2 Butt fusion jointing method
- 2.2.1 Definitions

The following terms are used with the text:

Fusion pressure and cooling pressure: the gauge pressure required to provide, on a given machine and for a given size and SDR of pipe, an interface stress of 0.025MPa or 0.15MPa as appropriate. This pressure is a function of the ram dimensions and the efficiency of the machine and shall be given on the blue data plate of the machine.

For a given pipe size, the butt fusion jointing machine basic ram pressures (in bar) that equate to the specified joint interface stresses of 0.15 MPa and 0.025 MPa should be obtained from the machine supplier or pipe manufacturer.

Drag pressure: the minimum gauge pressure required to overcome the sliding frictional drag of the machine including that of the pipe.

NB. "Drag" pressure (in bar) must be assessed accurately prior to making each fusion joint and added to the obtained basic ram pressure values (in bar). This operation will normally be carried out automatically when fully automatic fusion jointing machines are used.

Bead-up pressure: the gauge pressure required to provide, on a given machine and for a given size and SDR of pipe, an interface stress of 0.15MPa.

Indicated gauge pressure during heat soak time: the pressure required to maintain the pipe in contact with the heater plate.

Bead roll over pressure: the gauge pressure required to provide, on a given machine and for a given size and SDR of pipe an interface stress of 0.15MPa.

Plate removal time: the maximum time permitted for the opening of the carriage, removal of the heating plate and closure of the carriage to bring the two hot pipe ends together.

NOTE 1: For manual butt fusion equipment, the drag pressure should normally be less than the fusion pressure.

NOTE 2: The gauge pressures required for initial bead-up and bead roll over during jointing have the same value and are calculated from:

Interface pressure + drag pressure

- = initial bead-up pressure
- = bead roll over pressure.

NOTE 3: The gauge pressure required for the cooling stage during dual pressure jointing is calculated from:

1/6 (interface pressure) + drag pressure = cooling pressure

NOTE 4: For maximum accuracy, the indicated pressure should lie within the middle half of the gauge's display range.

#### 2.2.2 Preparation

(a) Cleaning the trimming tool

The trimming tool surfaces shall be inspected for grease and dirt and cleaned where necessary using clean water and lint free materials. Particular attention shall be paid to the blades. Blunt or damaged blades shall be replaced.

- (b) Cleaning/washing the heater plate
  - (i) The heater plate shall be thoroughly washed, when cold with copious quantities of clean water at the start of a jointing session.

NOTE: smearing can occur on a hot plate.

- (ii) Only clean, disposable, lint-free materials shall be used to clean or dry the plate.
- (iii) Grease and oily films will not be fully removed by using water, therefore wiping with a clean, disposable, lint-free cloth or cleaning material dampened by a suitable solvent may be necessary. When using solvents, the plate should be cold to prevent rapid evaporation and avoid unnecessary fumes.

NOTE: Isopropanol is a suitable cleaner for the material if permitted by the site health and safety regulations. Disposable wipes impregnated with Isopropanol are available, and appropriately formulated wipes may be used where agreed with the pipe and fittings manufacturers.

#### (c) Siting the equipment

- The butt jointing machine shall be placed on a suitable level baseboard inside a shelter.
- (ii) To aid alignment of pipes into the machine and for ease of movement, pipes to be jointed shall always be supported on rollers.
- (iii) Pipe strings should be laid out on a level surface where possible. If the pipe string is on a steep slope, particular care must be taken when measuring and controlling machine ram pressures to ensure that consistent results are obtained.

#### 2.2.3 Dummy Joints

Although washing will remove large patches of dirt, very fine particles of dust may still accumulate within the hollows of the textured surface of a heater plate. To remove such dust it is necessary to make a dummy joint at the start of each jointing session, whenever the plate has been allowed to cool below 180°C, or at a change of size. A second dummy joint shall also be made for sizes greater than nominal size 180.

A dummy joint can be made using pipe off-cuts of the same size, SDR and material as the pipe being installed. Alternatively, lengths of pipe which are to be installed may be used for this procedure, providing the pipe ends are allowed to cool for at least 10 minutes before replaning to make the production joint.

It is not necessary to actually make a joint. The procedure can be discontinued after the full heat soak cycle (see 2.2.5.3).

#### 2.2.4 Preliminary procedure

- (i) Check that there is sufficient fuel for the generator to complete the joint. Start the generator before connection to the machine and check that it is functioning correctly.
- (ii) Check trimming tool, hydraulic pump and heater plate are in working order.
- (iii) Check both pipes or pipe and fitting to be jointed are of the same size, SDR and

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material. Only compatible materials shall be joined together. If in doubt the advice of the pipe or fitting manufacturer should be sought.

- (iv) The ends of the pipes, or pipe and fitting, to be trimmed shall be wiped with a clean, damp cloth on both inner and outer surfaces to remove mud or dust. The cleaned ends shall be wiped dry prior to proceeding.
- (v) Operate the machine to open clamps and position the trimming tool in its location.
- (vi) Position pipes in the clamps with ends adjacent to the trimming tool and with the pipe markings aligned. This will assist in obtaining the best match in diameter. Pipes should be jointed so that the pipe markings are uppermost when the pipe is in the trench.
- (vii) Tighten pipe clamps to grip and re-round the pipes.
- (viii) Cover the free pipe ends to prevent cooling of the plate by internal draughts.
- (ix) Switch on the trimming tool. The pipe ends shall be moved against the trimming tool until continuous shavings are produced from each pipe end.
- (x) Keep the trimming tool turning, whilst separating the pipe ends to avoid steps on the trimmed surfaces. Switch off the trimming tool and remove after the blades have come to rest.
- (xi) Remove loose shavings from the machine and inside the pipes and/or fittings. DO NOT TOUCH PIPE OR FITTING ENDS, to prevent contamination of the prepared surfaces.
- (xii) Check that pipe or pipe and fitting ends are completely planed and repeat

trimming if necessary. Replace the trimming tool blades if a smooth surface on the planed ends is not obtained.

(xiii) Bring pipe or pipe and fitting ends together and check there is no visible gap between trimmed faces. The maximum permitted outside diameter mismatch is:

1.0 mm for pipes with nominal OD 90 to 315.

2.0 mm for pipes with nominal OD 316 to 800.

3.0 mm for pipes with nominal OD 801 to 1000.

If the mismatch is greater than that given above then the pipe shall be realigned and replaned.

2.2.5 Making the joint

#### 2.2.5.1 Trimming

Using two pieces of pipe, trim the pipe ends (see 2.2.4 (ix) to 2.2.4 (xiii).

#### 2.2.5.2 Bead-up

- (i) The pipe shall be pressed against the heater plate using the initial bead-up pressure.
- (ii) The typical initial bead size is given in Tables 1 and 2.

#### 2.2.5.3 Heat soak

After the initial bead-up, the pressure in the system shall be released so that the pressure gauge registers between zero and the drag pressure to control bead growth during heat soak time. Check that the clamps do not move. The pipe ends shall be maintained in contact with the heater plate.

#### 2.2.5.4 Plate removal

- (i) During removal of the heater plate, no molten polymer should stick to the heater plate. If it does, then the joint shall be aborted, the plate cleaned and the surface quality of the plate examined. If the surface of the plate is damaged, the manufacturer's advice should be sought on cleaning and/or replacement.
- (ii) The maximum plate removal time, including the time to bring the hot ends of the pipe together, shall not exceed 10 seconds.

#### 2.2.5.5 Fusion jointing

- (i) Immediately after plate removal the hot pipe ends shall be brought together in a smooth manner and the pressure raised to the bead roll over pressure for a period of 10 seconds.
- (ii) The fused material should roll back in a uniform manner and there should be no sign of bubbles or contamination present.

Provided that each half of the final bead is of a similar shape and size, it has been agreed that the overall width should not be a critical factor for the assessment of a butt fusion joint - hence the values quoted in the tables are typical only.

The principle is that sufficient bead should be formed during the fusion part of the cycle to demonstrate that bonding has been effected, but that this should not be excessive (especially for "dual pressure" fusion joints) to avoid squeezing out the melt which can impair joint quality.

The uniformity of the fusion joint bead around the full circumference of the pipe, and between the two halves of the bead at any single point around the circumferences, is however important, as this indicates whether the butt fusion equipment is set up and operating correctly.

Significant deviations beyond the limits detailed in 2.2.6 indicate the need for investigation of both machine operation and pipe material dimensions in order to identify the cause and reduce this variation to within the recommended values.

#### 2.2.5.6 Cooling

- (i) The joint should be allowed to cool in the clamps, whilst maintaining the joint at the cooling pressure for at least the time given in Tables 1 and 2 for the appropriate thickness pipe.
- (ii) Pipes which have not been supplied coiled may be released from the clamps for the final stage of cooling. During the 'cooling time, out of clamps' the pipe joint should be lifted no more than absolutely necessary to progress to the next joint. Pipe strings shall not be pulled via a newly made joint until the full cooling time has elapsed.

- (iii) Any cover used may be removed from the pipe end to promote a draught through the pipe to assist cooling.
- (iv) At the end of the cooling time, the clamps may be released and the jointed pipes removed. Installation of the pipe shall not take place until the surface temperature of the bead is below 40°C as measured by a digital surface probe thermometer.

If the ambient temperature is greater than 22°C, additional cooling time of 60 sec/°C of excess temperature is required. If the ambient temperature is less than 5°C, a similar reduction in cooling time of 60 sec/°C is permitted.

#### 2.2.6 Debeading

- (i) All external beads, and internal beads if required, shall be removed after the cooling time (see Table 1 and 2) using a suitable debeading tool complying with 2.1.7.
- (ii) At any single point around the pipe joint circumference, the width of each half of the joint bead shall not differ by more than 2 mm for "single pressure" butt fusion joints (Table 1), and by not more than 3 mm for "dual pressure" joints (Table 2).

Similarly, the width of each half bead shall not itself vary around the full pipe circumference by more than 2 mm for "single pressure" butt fusion joints (Table 1), or more than 3 mm for "dual pressure" joints (Table 2).

- (iii) The beads and joint shall be numbered/coded using an indelible marker pen.
- (iv) The beads shall be twisted at several positions.

If the bead is seen to split at any point then the joint shall be cut from the pipeline and remade. If a similar defect recurs, all further production jointing shall cease until the equipment has been thoroughly cleaned and examined. New trial joints shall be made and shown to be satisfactory.

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## 2.3 Maintenance, servicing and calibration

All equipment shall be well maintained and kept in a clean condition both in stores and at all times on site.

The equipment shall be serviced and calibrated regularly. The frequency at which this is carried out will be different for individual items of equipment and will also depend on usage but should be at least once every 6 months. Guidance shall be sought from the equipment manufacturer and a scheme of calibration and servicing implemented. Particular attention shall be given to the heater plate, the hydraulic or pneumatic unit, the frame/clamp unit, trimming tool and the generator.

#### 2.4 Records

#### 2.4.1 Job supervision

Electronic or written records of appropriate joint procedure details identified in Figure 1 shall be kept as required. Additional information may be recorded and can prove useful for quality control purposes.

#### 2.4.2 Equipment servicing and calibration

Electronic or written records of appropriate servicing and calibration shall be kept. The minimum information to be recorded is given in Appendix A.

Calibration shall be carried out in accordance with BS 5781: Part 1.

#### 2.5 Training

#### 2.5.1 Scope

Instruction shall be provided for operatives, supervisory and technical staff who need to acquire the skills of butt fusion jointing of pipes up to and including nominal size 1000.

Pipes and fittings whose nominal size exceeds 315 mm and SDR11 pipes of size 225 and above must be jointed using the dual pressure cycle. Additional training may be required to ensure that operatives, supervisory and technical staff appreciate its application and use.

Separate training for jointing pipes and fittings of nominal sizes in excess of 1000 will be required. Jointing of these sizes is not covered by this specification.

#### 2.5.2 Objectives

The course should enable the participant to:

- Understand the principles of PE butt fusion jointing and alternative types of equipment available;
- Identify pipe and appropriate fitting markings;
- Carry out pre-jointing machine and equipment checks;
- Make satisfactory butt fusion joints from a range of pipe sizes and materials, including at least one with a nominal pipe wall thickness in excess of 25 mm;
- Inspect for and identify acceptable quality joints, including inspection of beads.

#### 2.5.3 Training facilities

Instruction shall be provided by a recognised training organisation. Acceptable training facilities shall include:

- a suitably qualified instructor;
- a practical working area including adequate power supply;
- a supply of PE pipe of nominal size 90 1000 including at least one sample with a nominal wall thickness in excess of 25 mm;
- suitably maintained and calibrated butt fusion equipment and accessories for the nominal size range 90 - 1000, including at least one set of equipment capable of dual pressure jointing.

#### 2.5.4 Assessment and certification

On completion of the course, a certificate shall be provided by the recognised training organisation to the participant who has satisfactorily achieved the objectives outlined in 2.5.2.

The certificate shall identify the pipe and fittings size range used, and shall comply with NVQ certification requirements.

It is essential that all equipment and facilities shall meet the above requirements. This should be checked prior to course commencement.

# 3. ELECTROFUSION SOCKET JOINTING

With electrofusion socket jointing, an electrical resistance element is incorporated in the socket of the fitting which, when connected to an appropriate power supply, melts and fuses the material of the pipe and fitting together.

The effectiveness of this technique depends on attention to effective preparation of the jointing surfaces, in particular the removal of the oxidised surface of the pipe over the socket depth and ensuring the jointing surfaces are clean.

Electrofusion fittings are available in the size range 20 to 400 although larger sizes are under development.

The equipment and procedures described below relate to fittings with centre stops. If fittings without centre stops are used, the maximum insertion depth shall be clearly and indelibly marked on the pipe ends prior to jointing.

There are 2 control systems specified - manual time selection and automatic time selection. Both are described in this section.

NOTE: Some coiled pipes (notably 160 and 180 mm SDR 11 and SDR 17.6) may be too oval to fit into couplers, or the bend of the pipe may make alignment of the ends impossible. A number of approaches have been proposed, including:

- use a mechanical pipe straightener or rerounding tool;
- (ii) butt fuse a straight length of pipe onto the end of the coil before jointing.

Note that similar fittings exist in which the heat input is provided by electromagnetic induction. This technique is not presently specified here, but the key stages would remain the same.

#### 3.1 Equipment

(i) The control system shall be capable of providing up to 2kVA at 39/40 volts RMS (40V system) or up to 4.8kVA at 79/80 volts RMS (80V system). The control box input supply shall be from a nominal 110 volt (55V - 0 - 55V) generator of up to 4.8kVA capacity. The nominal output of the generator shall be 110V +25%, -10% between no load and full load. Control boxes shall include safety devices to prevent voltages greater than 42V a.c. for a 40V system, or 84V a.c. for an 80V system being present at the control box output. The safety device shall operate in less than 0.5s.

# NO EXTENSION LEADS SHALL BE USED ON THE CONTROL BOX OUTLET CONNECTORS.

WARNING: Control boxes are not intrinsically safe electrically and shall not therefore be taken into the trench.

(ii) A mechanical pipe surface preparation tool capable of removing the oxidised surface of the pipe in excess of the insertion depth shall be used before fusion is attempted. The tool shall remove a layer 0.2 - 0.4 mm thick from the outer surface of the pipe preferably as a continuous strip of swarf over that length and round the pipe.

NOTE: Hand scrapers can be difficult to use effectively in trench conditions, and effective preparation by hand is time consuming and physically demanding.

- (iii) Pipe clamps or other approved methods for restraining, aligning and rerounding the pipes during the fusion cycle shall be used.
- (iv) Pipe cutters shall include saw and saw guide.
- (v) A shelter shall be used to provide adequate protection for pipe, fittings and equipment against adverse weather conditions and contamination.
- (vi) An adequate supply of disposable wipes and other cleaning materials is required.

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#### 3.2 Electrofusion jointing method

#### 3.2.1 Preparation

(iv)

- (i) Ensure there is sufficient space to permit access to the jointing area. In a trench, a minimum clearance of 150 mm is required all round. Larger clearances may be needed at larger nominal sizes.
- (ii) Check that the pipe ends to be jointed are cut square to the axis and any burrs removed.
- (iii) Wipe pipe ends using clean, disposable, lint-free material to remove traces of dirt or mud, etc.
  - Mark the area over which the oxidised pipe surface is to be removed, i.e. in excess of the insertion depth, on each pipe to be jointed by placing the socket of the bagged fitting alongside the pipe end. Trace a line round the circumference at the appropriate distance from the pipe end using a suitable marker.

# DO NOT REMOVE THE FITTING FROM ITS PACKAGING AT THIS STAGE

- (v) Connect the electrofusion control box input leads to the generator.
- (vi) Check that the reset stop button, if fitted on the control box, is in the correct mode.

Table 1 - Single pressure butt fusion jointing conditions for PE80 and PE100

Heater Plate Surface Temperature: 226°C to 240°C

Typical Final Overall Bead Width	Max	(mm)	15 16 16	15 16 17	15 16 17	16 16 18	16 17 18	16 17 19	16	22	23	
Typical Final Overall Bead Width	Min	(mm)	ထာထာတ	8 6 0	8 6 01	9 6 11	9 10 11	9 10 12	9	13	13	
Cooling Time for Coiled Pipes In	Clamps	(minutes)	15 15 15	15 15 15	15 15 15	15 15 15	15 15 15					
Cooling Time Out of Clamps		(minutes)	5.0 5.0 5.0	55.0 0.0 0.0	5.0 5.0 5.0	5.0 0.0 0.0	5.0 5.0 5.0	5.0 5.0 5.0	5.0	5.0	5.0	
Cooling Time In Clamps		(minutes)	10.0 10.0 10.0	10.0 10.0 10.0	10.0 10.0 10.0	10.0 10.0 10.0	10.0 10.0 10.0	10.0 10.0 10.0	10.0	10.0	10.0	
Fusion and Cooling Interface Stress		(MPa)	0.150 0.160 0.150	0.150 0.150 0.150	0.150 0.160 0.150	0.150 0.150 0.150	0.150 0.150 0.150	0.150 0.150 0.150	0.150	0.150	0.150	±0.02
Maximum Plate Removal Time		(seconds)	10 10 10	10	1000	10 01	100	100	10	10	10	
Minimum Soak Interface Stress		(MPa)	000	000	000	000	000	000	00	00	00	
Sonk Time		(seconds)	95 110 140	100 125 160	110 130 175	120 150 205	130 160 225	145 190 265	165 200	170 220	180	#3
Initial Bead Size (approximate)		(mm)	8 8 8	0 0 0	000	000	01 01 01	000	01 01	က က	m m	
Bead-Up Interface Stress		(MPa)	0.150 0.150 0.150	0.150 0.150 0.150	0.150 0.150 0.150	0.150 0.150 0.150	0.150 0.150 0.150	0.150 0.150 0.150	0.150	0.150	0.150	±0.02
Wall Thickness (minimum)		(mm)	3.5 5.1 8.2	4.2 6.3 10.0	4.8 7.1 11.4	6.2 9.1 14.6	6.9 10.2 16.4	8.6 12.8 20.5	9.6 14.2	10.7	17.9	
SDR			26 17.6 11	26 17.6 11	26 17.6 11	26 17.6 11	26 17.6 11	26 17.6 11	26 17.6	26 17.6	17.6	
Outside Diameter		(mm)	06	110 110 011	125 125 125	160 160 160	180 180 180	225 225 225	250 250	280	315	Iolerance

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Table 2 - Dual pressure butt fusion jointing conditions for PE80 and PE100

# Heater Plate Surface Temperature: 225°C to 240°C

		$\overline{}$	_					_			_			_														
Typical Pinal Overall Bead Width	Max	(mm)	25 25	26	នន	32	23	7	z	23	ង	87	76	2,0	ន	34	36	31	z	2 2	25	8	56	59	22	5	3 2	
Typica Overal Wi	Min	(mm)	15	11	8 1	81	<u>.</u>	12	18	=	16	19	5	12	50	15	1.	21	16	18	16	6	11	70	<b>2</b> 8		2 2	
Cooling Time Out of Clamps		(minutes)	7.5	7.5	5.0	2.5	6.0	7.5	10.0	5.0	7.6	10.0	0.9	7.5	0.01	7.5	7.5	0.01	7.5	12.6	7.6	0.01	7.5	0.01	10.0		10.0	
Cooling Time In Clampa		(minutes)	15.0	15.0	10.0	16.0	10.0	15.0	20.0	10.0	16.0	20.0	10.0	15.0	20.0	15.0	16.0	70.0	15.0	16.0 25.0	16.0	0.02	15.0	202	20.0	-	25.0	
Cooling Interface Stress (after 10 seconds)		(MPA)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.026	0.025	0.026	0.025	0.026	0.025		0.025	0.025	0.026		0.025		0.025 0.025	3000	0.025	₹0.01
Fusion interface Stross (first 10 seconds)		(MPa)	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150		0.150	0.150	0.150		0.150		0.150	3,5	0.150	±0.02
Maximum Plate Removal Timo		(seconds)	0 0	10	01	2.0	10	0 :	10	10	2	01	10	0	0	0	2 0		0.5	0	2 2	:	2 2		2 2	01	10	
Minimum Soak Interfaco Stross		(MPa)	00	0	00	. 0	0	0 (	0	0	0	0	0	0	0	0 (			0 0	0	00	,	• •			•	0	
Soak Timo		(seconds)	285	345	195	385	215	285	425	235	315	470	250	345	615	275	670		300	635	335	-	515	-	\$70 \$70	445	630	±3
Initial Boad Sizo (approximate)		(mm)	3.5	6	e1 e2	. 69	e	en e	m	6	9	n	8	-	n	er e	, 4		9 11	s	5 5 5		. 6	e	26	c	3	
Bead-Up Interface Stress		(MPa)	0.150	0.150	0.150	0.150	0.150	051.0	0.150	0.150	0.150	0.150	0.150	0.150	081.0	0.150	81.0		0.150	0.150	0.150		0.150	-	0.150	0.150	0.150	*0.02
Wal) Thickness (misimum)		(m.m)	22.7	28.6	13.6	32.3	15.3	22.7	36.4	17.2	25.6	41.0	1.61	28.3	45.5	21.4	50.8		24.1	57.2	40.2		45.3		34.6 50.9	38.4	9.99	
SOR			==	=	26	=	36	17.6	=	56	17.6	=	26	17.6	=	26	2 2		26	=	26 17.6	;	17.6	-	26 17.6	26	17.6	
Outside		(mm)	250	315	355	355	00	8 8	8	\$	95 1	8	009	200	200	260	999		00 00	069	710		909	-	88	0001	1000	Tolerance

(vii) Using the pipe end preparation tool, remove the entire surface of the pipe uniformly, preferably as a continuous swarf over the area identified, i.e. in excess of the insertion depth.

The use of mechanical scrapers is preferred, as it is time consuming and onerous to adequately prepare a complete pipe end by hand scraping.

## DO NOT TOUCH THE PREPARED PIPE SURFACE BY HAND.

- (viii) Check that the pipe clamps are of the correct size for the pipes to be jointed.
- 3.2.2 Electrofusion jointing procedure
- (i) Remove the fitting from its packaging and check that the bore of the fitting is clean and dry. If necessary, the bore of the fitting may be washed with copious quantities of clean water and dried with a disposable lint-free material.
- (ii) Clean the scraped area of the pipe surface and the bore of the coupler with a disposable wipe impregnated with a suitable solvent.
- (iii) Insert the pipe ends into the fitting so that they are in contact with the centre stop.
- (iv) Using the pipe clamps, secure the pipes so that they cannot move during the fusion cycle. Check that the pipe ends and the fitting are correctly aligned.
- (v) Remove the terminal protection caps from the fitting.
- (vi) Check that there is sufficient fuel for the generator to complete the joint. Start the generator and check that it is functioning correctly.
- (vii) Connect the control box output leads to the fitting terminals and check that they have been fully inserted.
- (viii) Switch on the control box.

- (ix) Enter the fusion jointing time into the control box timer. The jointing time is indicated on the fitting. Check that the correct time is shown on the control box display.
- NOTE 1: Automatic control boxes are available which obviate the need to enter the fusion time.

NOTE 2: It is strongly recommended that gloves and goggles be worn during the jointing process.

- (x) Press the start button on the control box and check that the heating cycle is proceeding as indicated by the display countdown.
- (xi) On completion of the heating cycle, the melt indicators should have risen. If there is no apparent movement of the melt indicators, the joint should be cut out and a new joint made (see note 3).
- (xii) If a satisfactory joint has been made, the joint shall be left in the clamps for the cooling time specified on the fitting or by the automatic control system.

NOTE 3: If the fusion cycle terminates before completion of the count-down, check for faults as indicated by the control box warning lights and check there is adequate fuel in the generator. DO NOT attempt a second fusion cycle.

### 3.3 Maintenance, servicing and calibration

All equipment shall be well maintained and kept in a clean condition both in stores and at all times on site.

The equipment shall be serviced and calibrated regularly. The frequency at which this is carried out will be different for individual items of equipment and will also depend on usage, but should be at least once every 6 months. Guidance shall be sought from the equipment manufacturer and a scheme of calibration and servicing implemented. Particular attention shall be given to the control box and generator.

Isopropanol is a suitable cleaner for PE pipes and fittings if permitted by the site health and safety regulations.

Disposable wipes impregnated with Isopropanol are available, and appropriately formulated wipes may be used where agreed with the fittings manufacturers.

#### 3.4 Records

#### 3.4.1 Job supervision

Electronic or written records of appropriate fusion procedure details shall be kept as required. 1

#### 3.4.2 Equipment servicing and calibration

Electronic or written records of appropriate servicing and calibration shall be kept. The minimum information to be recorded is given in Appendix A.

Calibration shall be carried out in accordance with BS 5781: Part 1.

#### 3.5 Training

#### 3.5.1 Scope

Instruction shall be provided for operatives, supervisory and technical staff who need to acquire the skills of electrofusion socket jointing of pipes up to and including nominal size 125, and for larger sizes.

#### 3.5.2 Objectives

The course should enable the participant to:

- Understand the principles of PE electrofusion socket jointing and alternative types of equipment available;
- Identify pipe and appropriate fitting markings;
- Carry out pre-jointing machine and equipment checks;
- Make satisfactory electrofusion socket joints from pipes and fittings of different sizes (i.e. up to and including 125 mm and larger sizes);
- Inspect for and identify joints of acceptable quality.

#### 3.5.3 Training facilities

Instruction shall be provided by a recognised training organisation. Acceptable training facilities shall include:

A suitably qualified instructor;

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- A practical working area including adequate power supply;
- A supply of PE pipe and fittings of nominal size 20 to 125; and larger than 125;
- Suitably maintained and calibrated electrofusion socket jointing equipment and accessories for the nominal size ranges 20 to 125, and larger than 125.

NOTE: Increased care is required for preparation of joints in pipes larger than size 125.

#### 3.5.4 Assessment and certification

On completion of the course, a certificate shall be provided by the recognised training organisation to the participant who has satisfactorily achieved the objectives outlined in 3.5.2.

The certificate shall identify the pipe and fitting size range used, and shall comply with NVQ certification requirements.

It is essential that all equipment and facilities shall meet the above requirements. This should be checked prior to course commencement.

# 4. ELECTROFUSION SADDLE JOINTING

With electrofusion saddle jointing, an electrical resistance element is incorporated in the base of the saddle which, when connected to an appropriate power supply, melts and fuses the material of the pipe and fitting together.

The success of this technique depends on effective preparation of the jointing surfaces, in particular the removal of the oxidised surface of the pipe over

A number of systems have been proposed in which operatives place a distinctive individual mark on a joint after completion. Where this is proposed, users should satisfy themselves that the prospective identification system will not adversely affect the system performance.

an area equivalent to the saddle base, and of cleaning of the jointing surfaces.

Electrofusion saddles are available to fit all commonly used main sizes with sizes 20, 25 or 32 service connections. Outlet connections are also available up to nominal size 280. Larger fittings are not presently specified, but the key stages will remain constant, although in general, additional care may be needed.

Three methods of holding the tapping tee saddle during the fusion cycle are used, top loading, under clamping and wrap-around systems. However, the general parameters are similar to those for top loading. Where such fittings are used, the manufacturer's procedure for holding the fitting during the fusion cycle should be followed.

The procedure for top loading is described in the following text.

#### 4.1 Equipment

(i) The control system shall be capable of providing up to 2kVA at 39/40 volts RMS (40V system) or up to 4.8kVA at 79/80 volts RMS (80V system). The control box input supply shall be from a nominal 110 volt (55V - 0 - 55V) generator of up to 4.8kVA capacity. The nominal output of the generator shall be 110V +25%, -10% between no load and full load. Control boxes shall include safety devices to prevent voltages greater than 42V a.c. for a 40V system, or 84V a.c. for an 80V system being present at the control box output. The safety device shall operate in less than 0.5s.

# NO EXTENSION LEADS SHALL BE USED ON THE CONTROL BOX OUTLET CONNECTORS.

**WARNING:** Control boxes are not intrinsically safe electrically and shall not be taken into the trench.

(ii) Pipe surface preparation tool capable of removing the oxidised surface of the pipe over the full area of the saddle base. The tool shall remove a surface layer 0.2 - 0.4 mm thick. Care must be taken to avoid over-scraping the pipe.

- (iii) Top loading assembly tool capable of applying a vertical load applicable to the size of the fitting.
- (iv) A pipe clamp of suitable dimensions for making the service or branch connection.
- (v) A shelter shall be used to provide adequate protection for pipe, fittings and equipment against adverse weather conditions and contamination.

#### 4.2 Electrofusion saddle jointing method

#### 4.2.1 Preparation

- (i) Expose the pipe onto which the tapping tee saddle is to be assembled, ensuring there is clear space around the pipe. In a trench a minimum clearance of 150 mm is required all round. Larger clearances may be needed at larger nominal sizes.
- (ii) Clean the pipe over the general area on which the saddle is to be assembled using clean, disposable, lint-free material.
- (iii) Without removing the fitting from its packaging, place it over the required position on the main. Mark the pipe surface all round and clear of the saddle base area with an indelible marker pen.
- (iv) Remove the surface of the pipe to a depth of 0.2 to 0.4 mm over the full area marked using a suitable tool. Remove the swarf.
- (v) Connect the electrofusion control box input leads to the generator.
- (vi) Check that the reset stop button on the control box, if fitted, is in the correct mode.
- 4.2.2 Electrofusion saddle jointing procedure
- (i) Remove the fitting from its packaging, take off the threaded cap and attach the fitting to the adapter of the top loading assembly tool by means of the socket in the fitting's integral cutter.
- (ii) If necessary, clean the pipe and fitting over the contact area of the saddle using

It is possible to attach saddle fittings to pipes which have been installed as liners in existing pipes. Although the means of access may be different, the key points remain unchanged.

copious quantities of clean water and dry with a disposable, lint-free material.

- (iii) Clean the scraped area of the pipe surface and the contact area of the saddle with a disposable wipe impregnated with a suitable solvent¹.
- (iv) Position the fitting base onto the prepared pipe surface, clamp and apply the pre-set load.
- (v) Remove the terminal protection caps from the fitting.
- (vi) Check that there is sufficient fuel for the generator to complete the joint. Start the generator and check that it is functioning correctly.
- (vii) Connect the control box output leads to the fitting terminals and check that they have been fully inserted.
- (viii) Switch on the control box if applicable.
- (ix) Enter into the control box the fusion jointing time as indicated on the fitting's label. Check that the correct time is shown on the control box display.

NOTE: Automatic control boxes are available which obviate the need to enter fusion time.

- (x) Press the start button on the control box and check that the heating cycle is proceeding as indicated by the display count-down.
- (xi) On completion of the heating cycle, the melt indicator, where incorporated, should have risen. If there is no apparent movement of the melt indicator, a new saddle joint should be made. Cut the tee of the faulty joint from its base.
- (xii) If a satisfactory joint has been made, the joint shall be left in the clamps for the cooling time specified on the fitting label or by the automatic control system.

NOTE 1: If the fusion cycle terminates before completion of the count-down, check for faults as

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indicated by the control box warning lights and check there is adequate fuel in the generator. DO NOT attempt a second fusion cycle.

NOTE 2: The connection of the service pipe to the fitting outlet shall be carried out in accordance with the procedure of the appropriate section of this specification.

NOTE 3: DO NOT attempt to tap the main with the integral cutter for at least 10 minutes after completion of the cooling cycle.

## 4.3 Maintenance, servicing and calibration

All equipment shall be well maintained and kept in a clean condition both in stores and at all times on site.

The equipment shall be serviced and calibrated regularly. The frequency at which this is carried out will be different for individual items of equipment and will also depend on usage but should be at least once every 6 months. Guidance shall be sought from the equipment manufacturer and a scheme of calibration and servicing implemented. Particular attention shall be given to the control box and generator.

Isopropanol is a suitable cleaner for PE pipes and fittings if permitted by the site health and safety regulations.

Disposable wipes impregnated with Isopropanol are available, and appropriately formulated wipes may be used where agreed with the fittings manufacturers.

#### 4.4 Records

#### 4.4.1 Job supervision

Electronic or written records of appropriate fusion procedure details shall be kept as required. <sup>1</sup>

#### 4.4.2 Equipment servicing and calibration

Electronic or written records of appropriate servicing and calibration shall be kept. The minimum information to be recorded is given in Appendix A.

Calibration shall be carried out in accordance with BS 5781: Part 1.

#### 4.5 Training

#### 4.5.1 Scope

Instruction shall be provided for operatives, supervisory and technical staff who need to acquire the skills of electrofusion saddle jointing of fittings onto mains up to and including nominal size 250.

#### 4.5.2 Objectives

The course should enable the participant to:

- understand the principles of PE electrofusion saddle jointing and alternative types of equipment available;
- identify pipe and appropriate fitting markings;
- carry out pre-jointing machine and equipment checks;
- make satisfactory electrofusion saddle joints from pipes and fittings of different sizes;
- inspect for and identify joints of acceptable quality.

#### 4.5.3 Training facilities

Instruction shall be provided by a recognised training organisation. Acceptable training facilities shall include:

- a suitably qualified instructor;
- a practical working area including adequate power supply;

- a supply of PE pipe and fittings for nominal pipe size 20 to 250;
- suitably maintained and calibrated electrofusion saddle jointing equipment and accessories for nominal pipe size range 20 to 250.

#### 4.5.4 Assessment and certification

On completion of the course, a certificate shall be provided by the recognised training organisation to the participant who has satisfactorily achieved the objectives in 4.5.2.

The certificate shall identify the pipe and fitting size range used, and shall comply with NVQ certification requirements.

It is essential that all equipment and facilities shall meet the above requirements. This should be checked prior to course commencement.

#### 5. QUALITY ASSURANCE

To claim compliance with this specification, and in order to achieve consistently good quality fusion joints, installers shall operate a quality system relating to this specification in accordance with the principles of BS EN ISO 9002 (BS 5750: Part 2).

Assessment of the achievement of these requirements will take the form of an audit against 5.1 to 5.10 below. Independent testing of fusion joints may also be required.

#### 5.1 Organisation

On each site where pipes and fittings are to be jointed in accordance with the requirements of this specification, a person (or persons) shall be nominated to supervise work affecting quality. In particular, they shall have the organisational freedom and authority to:

- (a) initiate action to prevent the occurrence of poor quality joints;
- (b) identify and record any joint quality problems;
- (c) verify the implementation of solutions.

A number of systems have been proposed in which operatives place a distinctive individual mark on a joint after completion. Where this is proposed, users should satisfy themselves that the prospective identification system will not adversely affect the system performance.

#### 5.2 Management review

The control system adopted to satisfy the requirements of this document shall be reviewed at appropriate intervals by management to ensure its continuing suitability and effectiveness. Records of such reviews shall be maintained.

5.3 Document control

This shall ensure that:

- the pertinent issues of appropriate documents are available at all necessary points of use;
- (b) obsolete documents are promptly removed from all points of use.

#### 5.4 Purchasing

The installer shall ensure that purchased items including pipe, fittings and fusion jointing equipment conform to specified requirements.

#### 5.5 Fusion jointing control

The installer shall ensure that fusion jointing procedures as well as servicing and maintenance of fusion jointing equipment are carried out in accordance with the requirements of this specification (Sections 2 to 4).

#### 5.6 Inspection and testing

5.6.1 Inspection of goods received and used on site

The installer shall ensure that incoming pipe, fittings and fusion jointing equipment are not used until they have been inspected and confirmed as conforming to specified requirements including appearance and marking. Any non-conforming items shall be identified, recorded and segregated.

#### 5.6.2 Final inspection and testing

At the commencement of each contract, the frequency and type of inspection by the installer shall be agreed with the client and documented.

#### 5.6.3 Inspection and test records

The installer shall establish and maintain electronic and/or written records of appropriate fusion jointing procedures, servicing and calibration details in accordance with this specification.

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#### 5.7 Corrective action

The installer shall establish and maintain procedures to show evidence of:

- investigating the cause of poor quality joints and the corrective action needed to prevent recurrence;
- (b) analysing work practices, quality records, service reports and customer complaints to detect and eliminate causes of poor quality joints;
- (c) applying controls to ensure that corrective actions are taken and that they are effective;
- (d) implementing and recording changes to procedures resulting from corrective action.

#### 5.8 Handling and storage

The installer shall establish and maintain appropriate procedures for handling and storage of pipe, fittings and fusion jointing equipment on site.

NOTE: Damaged packaging can permit ingress of dirt and moisture which can adversely affect joint integrity.

#### 5.9 Quality records

The installer shall establish and maintain procedures for collection, indexing, filing and storage of quality records for a minimum period of 6 years from the date of installation.

#### 5.10 Training

The installer shall establish and maintain procedures for identifying the training needs and provide for the training of all personnel performing fusion jointing. The training programme shall meet the requirements of this specification and shall comply with relevant NVQ requirements. Appropriate records of training shall be maintained.

edition (except wh following publication	ENCES  makes reference to the latest here otherwise stated) of the ons, including all addenda and uld also be consulted.	WIS 4-32-09	Specification for black polyethylene pressure pipes for sewage and above ground potable water (nominal sizes 90 to 1000)							
British Standards		WIS 4-32-11	Specification for end load resistant mechanical joints and							
i: P	Specification for production, installation and servicing (to be bublished to replace BS 5750: Part 2).		compression fittings made principally of thermoplastics for use with polyethylene pipes of nominal size <63 with outside diameters to BS 5556 (metric).							
S	Measurement and calibration systems Part 1 Specification for system requirements	Specification for higher performance blue polyethylene (PE100) pressure pipes,								
F r £	Specification for blue polyethylene pipes up to nominal size 63 for below ground use for cold potable water		nominal sizes 90 - 1000 for underground or protected use for the conveyance of water intended for human consumption.							
] 1 8	Specification for black polyethylene pipes up to nominal size 63 for above ground use for cold potable water	WIS 4-32-14	Specification for polyethylene PE100 electrofusion couplers and fittings, including tapping tees, for cold potable water supply for use with PE100 pipe and fittings for nominal sizes up to and including 500. (Draft).							
Water Industry S	pecifications	WIS 4-32-15	Specification for polyethylen							
	Specification for polyethylene pressure pipe for cold potable water (underground use)		PE100 socket and spigot fittings, saddles and drawn bends for fusion jointing for use with PE100 cold potable water							
	Specification for blue polyethylene (PE) pressure pipes for cold potable water (nominal sizes 90 to 1000 for	Other documen	pressure pipes, nominal sizes 90 to 1000. (Draft).							
WIS 4-32-04	underground or protected use)  Specification for polyethylene socket and spigot fittings,	WSA/WRc	Manual for PE pipe systems for water supply.							
	saddles and drawn bends for fusion jointing for use with cold potable water PE pressure pipes	FR 0351	Report on materials characterisation and performance evaluation of							
	Specification for polyethylene (PE) pipes for sewer linings (non-pressure applications)		higher performance polyethylene (HPPE) pipe systems.							

WIS 4-32-06

WSA/WRc

Civil Engineering Specification

for the Water Industry.

Specification for polyethylene

fittings for cold potable water supply for nominal sizes up to

electrofusion couplers

and including 180

#### APPENDIX A - RECORD SHEETS

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Record sheets shall be maintained for all equipment required for all fusion jointing operations. The sheet shall be headed:

"SERVICING AND CALIBRATION RECORD SHEET"

Followed by:

"BUTT FUSION EQUIPMENT/
ELECTROFUSION SOCKET EQUIPMENT/
ELECTROFUSION SADDLE EQUIPMENT"
(delete as appropriate)

and then the appropriate sub-title from the following list (additional record sheets may be kept if required):

Butt Fusion equipment:

Generators
Heater plate
Hydraulic power pack
Machines and trimmers
Tooling ancillaries
Electrical safety test
Microprocessor controller

Electrofusion socket jointing:

Generators
Electrofusion control box
Electrical safety test

Electrofusion saddle jointing:

Generators Electrofusion control box Electrical safety test

The information recorded on the record sheet shall include but not be restricted to:

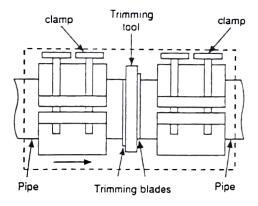
- The date of servicing or maintenance
- The name, address and telephone number of the undertaking or contractor operating the equipment
- The name, address and telephone number of the company conducting the service or maintenance
- The member (or members) of staff responsible for servicing or maintenance
- The serial number of the equipment
- The details of service and/or maintenance carried out. This shall include relevant details

of test equipment, procedures and/or manuals used, and relevant ambient conditions

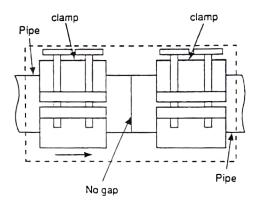
 The signature(s) of the member (or members) of staff responsible for the servicing or maintenance operations conducted

# APPENDIX B - OUTLINE OF THE PROCEDURE FOR BUTT FUSION JOINTING

- Check equipment is complete, clean, undamaged, in working order and protected by a shelter.
- At the start of each jointing session a dummy joint shall be made. Make two dummy joints for pipes and fittings larger than 180 mm nominal size.
- Check pipes (or pipe and fitting) are of the same nominal size, pressure rating and material.
- Clean pipe ends and, where applicable, fitting.
- Separate clamps completely and position trimming tool.
- Position pipe (or pipe and fitting) with ends just clear of trimming tool. Tighten clamps.
- Switch trimming tool on and press pipe (or pipe and fitting) ends against tool until continuous shavings are produced from both components.
- 8. Continue trimming whilst separating pipes (or pipe and fitting). Switch off trimming tool and remove after blades are at rest.
- 9. Remove shavings. Do not touch pipe (or pipe and fitting) ends. Check that mismatch is within acceptable limits.
- 10. Bring pipe ends (or pipe and fitting ends) together and check there is no visible gap. Retrim if necessary. Check that mismatch is within acceptable limits.
- 11. Check fuel in generator.
- 12. Switch on generator and allow heater plate to reach operating temperature (20 minutes).



Stage 7 - Trimming pipe ends



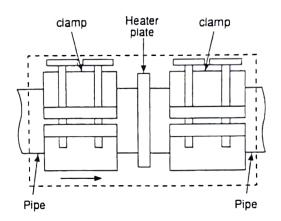
Stage 10 - Check no gap between pipe ends

- 13. Select the appropriate pressure from Tables 1 or 2 for the given pipe size and drag pressure. The pipe, or pipe and fitting ends shall be pressed against the heater plate using the bead-up pressure.
- 14. Check the initial bead size.
- 15. After the initial bead-up, the pressure in the system should be set to the appropriate heat soak pressure. The pipe, or pipe and fitting ends should remain in contact with the heater plate for the appropriate heat soak time.

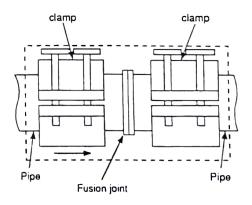
- 16. The clamps should then be opened, the heater plate removed and the two ends brought together within the specified time with a smooth action. The fused material should roll back in a uniform manner.
- 17. The joint should cool for the specified period whilst being maintained at the cooling pressure.
- 18. After cooling release the clamps (the temperature of the bead should be less than 40°C).
- 19. Remove jointed pipe from clamps.
- 20. Inspect the joint and bead.
- The external beads shall be removed after cooling and examined.
- 22. Examine heater plate surfaces and, if required remove any contamination.

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Stage 14 - Heater plate installed



Stage 16 - Formation of fusion joint

# APPENDIX C - OUTLINE OF THE PROCEDURE FOR ELECTROFUSION SOCKET JOINTING

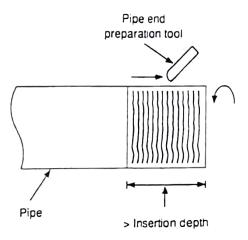
- Check equipment is complete, clean, undamaged, in working order and protected by a shelter.
- Clean pipe ends and check there is sufficient clearance all round (minimum 150 mm).

## DO NOT REMOVE FITTING FROM ITS PACKAGING AT THIS STAGE.

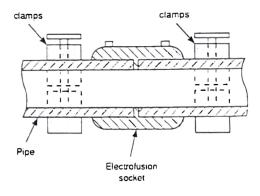
- Connect the electrofusion control box input leads to generator.
- 4. Check fuel in generator.
- Check reset stop button on the control box, if fitted, is in the correct mode.
- If necessary, clean the jointing surfaces.
   Using the pipe end preparation tool remove the pipe surface over a length in excess of the insertion depth.

## DO NOT TOUCH THE PREPARED PIPE SURFACE.

- 7. Remove fitting from its packaging and check that it is clean. If necessary, wash it with water and dry it.
- Clean the scraped area of the pipe and the bore of the coupler with a disposable wipe.
- Insert pipe ends up to the centre stop of the fitting, and mark the insertion depth.
- Secure the pipes with the pipe clamps and check for alignment.



Stage 6 - Pipe end preparation (repeat both ends)



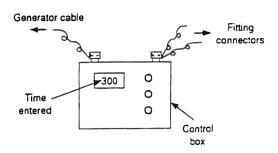
Stage 10 - Alignment check

- 11. Remove terminal caps from fitting.
- Connect control box output leads to the fitting terminals. Check that they are fully inserted.
- Switch on the control box if necessary.

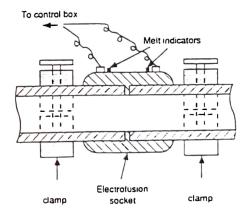
- 14. Enter the fusion time into the control and box timer. Check that the time shown on the control box display is the same as that indicated on the fitting.
- Press the start button and check that the count-down is proceeding.
- 16. On completion of the heating cycle, the melt indicator should have risen. If they have not risen, cut out the joint.
- 17. If a satisfactory joint has been made, allow the joint to cool in the clamps for the specified time.
- When cool, remove the joint from the clamps.
- 19. Inspect joint.

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Stage 14 - Enter fusion time into control box



Stage 16 - Completion of heating cycle

#### APPENDIX D - OUTLINE OF THE PROCEDURE FOR ELECTROFUSION SADDLE JOINTING

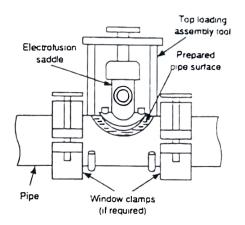
- Check equipment is complete, clean, undamaged, in working order and protected by a shelter.
- Check pipe and fitting are of the same nominal size and material and that there is sufficient clearance all round.

# DO NOT REMOVE SADDLE FROM ITS PACKAGING AT THIS STAGE.

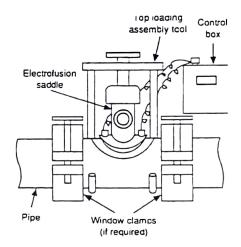
- 3. Connect the electrofusion control box input leads to generator.
- Check fuel in generator.
- Check reset stop button on the control box, if fitted, is in the correct mode.
- If necessary, clean pipe surface in the fusion area. Scrape pipe surface over fusion area.

## DO NOT TOUCH THE PREPARED PIPE SURFACE.

- 7. Remove fitting from its packaging and attach fitting to the adapter of the top loading assembly tool. Remove protective saddle pad.
- Check that the base of the saddle is clean.
   If necessary, wash it with water and dry it.
- Clean the scraped area of the pipe and the base of the saddle with a disposable wipe.
- Position fitting base onto the prepared area and apply the pre- set load.
- 11. Remove terminal caps from fitting.
- 12. Connect control box output leads to fitting and check that they have been fully inserted.
- 13. Switch on the control box if necessary.
- 14. Enter the fusion jointing time into the control box. Check that the time shown on the control box display is the same as that indicated on the fitting.



Stage 10 - Assembly of fitting onto prepared pipe and application of pre-set load

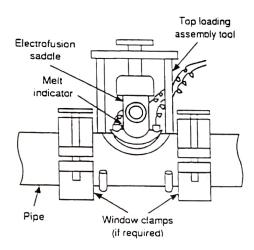


# Stages 12/13/14 - connections to control box and setting fusion time

- 15. Press the start button and check that the count-down is proceeding.
- 16. On completion of the heating cycle, the melt indicator(s) should have risen. If it has not risen, a new saddle joint should be made at a minimum distance 250 mm

from the abandoned position and the faulty saddle should be cut off at the base.

- 17. If a satisfactory joint has been made, allow the joint to cool in the clamps for the specified time.
- 18. When cool, remove the jointed pipe from the clamps.
- 19. Inspect joint.
- Do not tap through into main until at least 10 minutes after end of cooling period.



Stage 16 - Check fusion indicator has risen

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