No. 4-32-08
August 1988: Issue 1
(Sheet 1 of 29)
ISSN 0267-0305

WAA Sewers and Water Mains Committee: Materials and Standards

Information and Guidance Note

Information and Guidance Notes are also issued by: United Kingdom Water Fittings Byelaws Scheme ISSN 0267-0313

SPECIFICATION FOR SITE FUSION JOINTING OF MDPE PIPE AND FITTINGS

FOREWORD

This specification has been prepared by a Liaison Group under the direction of the Water Authorities Association, Sewers and Water Mains Committee with membership drawn from the Water Industry, Water Training 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 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.

The requirements of this document relate to the jointing conditions for materials designated PE-X since current products in use by the Water Industry are manufactured from this material.

A list of quality assured MDPE pipe and fittings manufacturers can be supplied by WRc Swindon upon request.

This specification does not cover hot gun fusion techniques which have not been validated for PE pressure pipe applications.

Attention is drawn to the following British Standards (BS) and Information and Guidance Notes (IGN) to which this specification relates.

BS 6572*
BS 6730
IGN No. 4-32-02*
IGN No. 4-32-03
IGN No. 4-32-04
IGN No. 4-32-05
IGN No. 4-32-06¶
IGN No. 4-32-07¶
IGN No. 4-32-09¶

* BS 6572 is equivalent to IGN No. 4-32-02 and is now regarded as the lead specification for MDPE pipe systems up to 63mm.
¶ In course of preparation.

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

This specification covers socket fusion, butt fusion, saddle fusion, electrofusion socket and electrofusion saddle jointing, together with requirements for training, maintenance, servicing and calibration. It does not necessarily cover the full fusion jointing procedures for pipes used for sewer lining and swage down or roll down techniques.

Socket fusion fittings are available in the size range 20 to 125 and are fused to the pipe using electrically heated tools. Fittings are rated at 12 bar for sizes up to and including 63 and 10 bar for sizes greater than 63. These fittings can be jointed to both 6 bar (SDR 17.6) and 10 or 12 bar pipes (SDR 11).

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 pressure rating may be jointed together i.e. a 250 SDR 11 pipe should not be jointed to a 250 SDR 17.6 fitting.

Saddle fusion fittings are available for most mains sizes and are also fused onto the pipe using electrically heated tools. Such fittings are rated at 10 bar but are suitable for jointing to both 6 bar (SDR 17.6) for pipes of nominal size 125 and above and 10 bar (SDR 11) pipes.

Electrofusion fittings have recently been introduced on to the market in which the sockets contain electrical wires which when connected to the appropriate power source fuses the socket onto the pipe without the need for additional heating equipment. These are currently available for a pressure rating of 12 bar for sizes up to and including 63 and 10 bar for sizes greater than 63. These can be welded to both 6 bar (SDR 17.6) and 10 bar (SDR 11) pipe. Electrofusion saddles are also available.

It has been assumed in the drafting of this specification that the execution of its provision is entrusted to appropriately qualified and experienced people.

To claim compliance with this specification, the installer shall operate an audited quality assurance

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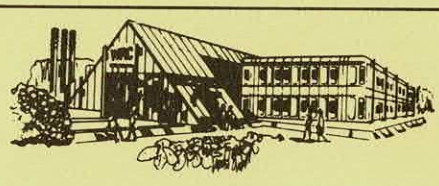


system relating to the installation of the pipe, acceptable to WRc Swindon, who can provide advice upon request. Enquiries relating to the recognition of training organisations should also be addressed to WRc.

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 but neither the Water Authorities Association nor the Water Research Centre can accept any responsibility for actions taken as a result.

CONTENTS

1. SCOPE

This document specifies the equipment to be used, the jointing procedure to follow, 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 socket fusion, butt fusion, saddle fusion, socket electrofusion and saddle electrofusion. Outline procedures for these jointing methods for use by the trained jointers are given in the Appendices.

This specification requires that the installer shall operate a quality assurance system relating to the fusion jointing of MDPE pipe acceptable to WRc.

NOTE The titles of the publications referred to in this document are listed under clause 8 – REFERENCES.

2. SOCKET FUSION

This method of jointing uses electrically heated tools to heat both pipe ends and socket to the fusion temperature and are available for sizes 20 – 125. Sizes 63 and below are assembled manually. For sizes greater than 63, joints are assembled mechanically.

2.1 Manual socket fusion jointing

2.1.1 Equipment

2.1.1.1 Heating Tool

i) The tool shall be electrically heated using a 110v supply and be provided with a suitable temperature controller to give a uniform surface temperature of 275 ± 15°C. **GAS HEATED TOOLS SHALL NOT BE USED.**

ii) The heads of the tool shall provide a means of heating the outside surface of the pipe end and internal surface of the socket of the fitting.

iii) The heating heads shall be uniformly coated with a PTFE based coating having adequate release properties. The coating should be light coloured to show the presence of any contaminant. **ADDITIONAL SPRAY-ON RELEASE AGENTS SHALL NOT BE USED.**

iv) The heating tool shall be fitted with a temperature indicator and a facility to measure the temperature of the heating heads using a digital thermometer with a probe.

v) A clean protective holder which shields the heating tool against dust and draughts shall be provided for the tool when not in use. The heating tool should not be stored in any box/bag from which dust and other contaminants can be attracted to the plate.

vi) Adequate heating tool extension handles shall be available to allow safe control of the heating tool during use.

2.1.1.2 Depth gauge

A clean depth gauge shall be provided to determine the insertion depth required for the pipe end into the fitting.

2.1.1.3 Re-rounding clamp

A re-rounding clamp shall be provided to re-round the pipe and provide the insertion depth stop.

2.1.1.4 Fittings holder

A means shall be provided for externally holding each type of fitting to be jointed.

2.1.1.5 Generator

For pipe sizes up to 63 the alternating current generator rating shall be at least 1.5kVA. The nominal output voltage should be 110V but the output voltage should not exceed 120V and should be not less than 103V at any kVA loading between no load and full load.

2.1.1.6 Ancillary equipment

i) Pipe cutters
ii) Digital thermometer with appropriate surface probe
iii) Timer
iv) Scraper
v) Saw and saw guide.

2.1.2 Manual socket fusion jointing method

2.1.2.1 Preparation

i) Check that pipes and fitting to be jointed are of the same size and material. Only compatible materials should be joined together. If in doubt, the advice of the pipe or fitting manufacturer should be sought.

ii) Check that the heating tool is in working order using a suitable digital thermometer with probe at the correct temperature (275 ± 15°C) and that the heating heads are the size required, undamaged and clean.

iii) If the pipe is to be site cut, ensure that the pipe end is cut square and if cut with a saw, the pipe end deburred.

iv) Clean both the outside surface of the pipe end and inside of the socket of the fitting using disposable, clean, lint-free material. Any remaining deposits shall be removed using a knife or suitable scraping tool.

v) Position the depth gauge over the cleaned pipe end to its full depth.

vi) Position the rerounding clamp against the depth gauge, taking care not to move it. Tighten up the clamps and remove the depth gauge.

vii) A fitting holder may be required for such components as:
straight couplers
reducers
caps
or any other fitting which may be difficult to grip. Install such fittings in the holder taking care not to overtighten.

viii) Check that there is sufficient fuel for the generator to complete the joint. Start the generator and check that it is functioning correctly.

2.1.2.2 Manual socket fusion jointing procedure

i) Check the heating time required for the size of pipe and fitting being jointed. This information will be found on a label attached to the fitting (see also Table 1).

ii) If required, fix the extension handle to the heating tool.

iii) Place the socket of the fitting onto the spigot head followed by the pipe spigot into the socket head of the heating tool. Apply firm pressure until both pipe and fitting are at the full insertion depth of the heater heads. **THE HEATING TIME STARTS NOW.** Maintain good alignment of both components. Ideally, pipes should be jointed so that pipe markings are uppermost when the pipe is in the trench.

iv) When the heating time has elapsed separate pipe and fitting from heating tool by a "positive" snap action to prevent the adhesion of melt on the tool.

NOTE TO (iv): "Sheeting" or "curtaining" may occur if this procedure is not fully respected.

v) Push pipe and fitting together until the face of the socket is against the rerounding clamp. Maintain the joint under a firm constant pressure for at least 2 minutes cooling time.

vi) Remove fitting holder, if used, and rerounding clamp.

vii) Inspect the joint for uniformity of melt distribution on the face of the socket.

viii) Inspect the heating faces for the presence of any melt. If present, this should be removed using a wooden spatula.

Table 1 – Socket fusion heating times – for PE-X sizes 20 to 63

Nominal size	Heating time (sec)
20	5 – 7
25	7 – 10
32	10 – 15
50	15 – 20
63	20 – 30

2.1.3 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 heating tool and generator.

2.2 Socket fusion jointing by machine

2.2.1 Equipment

2.2.1.1 Frame

i) The frame shall be suitably designed to hold both pipe and fittings with clamps which are sufficiently robust to reround the pipe and accurately align both pipe and fitting to be jointed. The fitting clamp shall be so designed as to grip the fitting without distortion.

ii) The machine should preferably have a minimum of two smooth sliding runners, manually operated, enabling both clamps to move freely. There should be provision between the clamps to locate a heating tool.

iii) All slides shall be kept free from rust and kept lubricated at all times.

2.2.1.2 Heating tool

i) The heating tool shall be electrically heated using a 110V supply and be provided with a suitable temperature controller to give a uniform surface temperature of 275 ± 15°C. **GAS HEATED TOOLS SHALL NOT BE USED.**

ii) The heads of the tool shall provide a means of heating the outside surface of the pipe end and the internal surface of the socket of the fitting.

iii) The heating heads shall be uniformly coated with a PTFE based coating having adequate release properties. The coating should be light coloured to show the presence of any contaminants. **ADDITIONAL SPRAY-ON RELEASE AGENTS SHALL NOT BE USED.**

iv) The heating tool shall be fitted with a temperature indicator and a facility to measure the temperature of the heating heads using a digital thermometer with an appropriate surface probe.

v) A clean protective holder which shields the heating tool against dust and draughts shall be provided for the tool when not in use. The heating tool should not be stored in any box/bag from which dust and other contaminants can be attracted to the heating heads.

2.2.1.3 Depth gauge and alignment mandrel

A depth gauge shall be provided to determine the insertion depth required for the pipe end into the fitting together with the alignment mandrel.

2.2.1.4 Generator

The alternating current generator shall have a rating of at least 3kVA. The nominal output voltage should be 110V but the output voltage should not exceed 120V and should be not less than 103V at any kVA loading between no load and full load.

2.2.1.5 Ancillary equipment

i) Pipe cutters
ii) Digital thermometer with probe
iii) Timer
iv) Scraper
v) Saw and saw guide.

2.2.2 Socket fusion jointing machine method

2.2.2.1 Preparation

i) Check that the clamps move smoothly within the frame and separate the clamps completely;

ii) Check that the heating tool is in working order using a digital thermometer with probe, at the correct temperature (275 ± 15°C) and that the heating heads are the size required, undamaged and clean;

iii) Check that pipes and fitting to be jointed are of the same size and material. Only compatible materials should be jointed together. If in doubt, the advice of the pipe or fittings manufacturer should be sought.

iv) If the pipe has been site cut, ensure that the pipe end has been cut square and, if cut with a saw, the pipe end deburred;

v) Clean both pipe end and the inside of the socket of the fitting using disposable, clean, lint-free material. Any remaining deposits shall be removed using a knife or suitable scraping tool;

vi) Position fitting into fitting holder and align using a mandrel positioned in the pipe clamp. When aligned, tighten fitting clamp so that the fitting is gripped but not distorted. Remove mandrel from pipe clamp.

vii) Position pipe in its clamp. Pipes should be jointed so that the pipe markings are uppermost when the pipe is in the trench;

NOTE: An SDR 11 fitting may be jointed to an SDR 17.6 pipe.

viii) Position the depth gauge over the cleaned pipe end to its full depth;

ix) Position the pipe with its depth gauge against the rerounding clamps taking care not to move the depth gauge. Tighten up the clamps and remove the depth gauge.

x) Place heating tool in the machine.

xi) Check that there is sufficient fuel for the generator to complete the joint. Start the generator and check that it is functioning correctly.

2.2.2.2 Procedure

i) Check the heating time required for the size of the pipe and fitting to be jointed. This information will be found on the fitting (see also Table 2).

ii) Bring the clamps together so that the socket of the fitting locates on to the spigot head and the pipe spigot into the socket head of the heating tool. Apply firm pressure until both pipe and fitting are at the full insertion depth of the heater heads. **THE HEATING TIME STARTS NOW.**

iii) When the heating time has elapsed, separate pipe and fittings from the heating tool by a "positive" snap action to prevent the adhesion of melt on the tool. Remove heating tool.

Table 2 – Typical socket fusion heating times – For PE-X sizes 63 to 125

Nominal size	Heating time (sec)
63	20 – 30
90	30 – 40
125	35 – 45

iv) Push pipe and fitting together until the face of the socket is hard against the rerounding clamp. Maintain the joint under a firm constant pressure for at least 2 minutes (cooling time).

v) Remove joint from rerounding clamp and fitting holder.

vi) Inspect the joint for evenness of melt distribution on the face of the socket.

vii) Inspect the heating faces for the presence of any melt. If present, this should be removed using a wooden spatula.

2.2.3 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 heating tool and generator.

2.3 Records

2.3.1 Job supervision

Written records of appropriate weld procedure details shall be kept as required using the format illustrated in Figure 1(a).

2.3.2 Equipment servicing and calibration

Written records of appropriate servicing and calibration details carried out at a frequency agreed with the equipment manufacturers shall be kept using the format illustrated in Figure 1(b), Figure 1(c) and Figure 1(d).

Calibration shall be carried out in accordance with BS 5781.

2.4 Training requirements for socket fusion jointing of MDPE

2.4.1 Scope

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

2.4.2 Objectives

The course should enable the participant to:

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

2.4.3 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 MDPE pipe and fittings of nominal size 20 to 125;
* suitably maintained and calibrated socket fusion equipment and accessories for the nominal size range 20 to 125.

2.4.4 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 2.4.2.

The certificate shall identify the pipe and fittings size range used.

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

SOCKET FUSION JOINT RECORD SHEET

CONTRACT:
CONTRACTOR:
PIPE SIZE/RATING:
JOINTING EQUIPMENT:

OFFICE:
SITE ENGINEER:
PIPE/FITTING MANUFACTURER:
SUPERVISOR:

Date	Joint number or location	Jointer	Weather conditions	Ambient temperature (°C)	Heating tool temperature (°C)	Heating time (seconds)	Cooling time (minutes)	Melt/joint appearance

Figure 1(a) Socket fusion joint record sheet

SERVICING AND CALIBRATION RECORD SHEET
SOCKET FUSION EQUIPMENT
GENERATORS

AUTHORITY/CONTRACTOR: ..... DATE: .....

ADDRESS: ..... SERVICE CONTRACT NO.: .....

..... EQUIPMENT MANUFACTURER: .....

CONTACT: ..... TYPE: ..... SERIAL NO.: .....

AMBIENT TEMP. °C: ..... VOLTAGE: ..... POWER RATING: .....

VISUAL INSPECTION	SATISFACTORY YES	NO
Is unit complete?		
Is any damage evident?		
Check oil and fuel levels		
Check starting mechanism		

WARM UP AT FULL LOAD FOR 15 MINUTES
LOAD TEST AS FOLLOWS:

POWER %	kVA	VOLTS	Hz	AMPS		
0						
60						
100						
110						

kVA Manufacturer's Rating

kVA Maximum Tested Rating

ELECTRICAL TEST	VALUE LIMIT	ACTUAL		
Check R.C.C.B. operation				
Check internal wiring for security				
Check voltmeter display				
Check changeover switch				
Check oil alert device (During oil change)				
Check earth bond				
Check insulation				

RECOMMENDED ACTION: _____

_____

_____

_____

The above work has been carried out: Test equipment used/calibration traceability:

Checked by: ..... Calibration date: .....

Supervisor's signature: ..... Next service/calibration due: .....

Figure 1(b) Typical servicing and calibration record sheet

SERVICING AND CALIBRATION RECORD SHEET
SOCKET FUSION EQUIPMENT
HEATING TOOL

AUTHORITY/CONTRACTOR: .....
ADDRESS: .....
.....
CONTACT: .....
AMBIENT TEMP. °C: .....

DATE: .....
SERVICE CONTRACT NO.: .....
EQUIPMENT MANUFACTURER: .....
TYPE: ..... SERIAL NO.: .....
VOLTAGE: .....

	VALUE		SATISFACTORY	
VISUAL INSPECTION	**LIMIT**	**ACTUAL**	**YES**	**NO**
Is tool complete?				
Is handle damaged?				
Check for water ingress				
Check for electrical security				
Check cable condition				
Check hose condition				
Check thermometer for damage				
Check for signs of over temperature				
ELECTRICAL INSPECTION				
Check for earth continuity				
Check insulation resistance				
Check element resistance				
Check temperature setting				
Check thermometer accuracy				
OPERATIONAL TEST				
TEMPERATURE READINGS MONITORED				
MECHANICAL INSPECTION				
Check head for wear and damage				
Check face for distortion				

RECOMMENDED ACTION: _____

The above work has been carried out:

Checked by: .....
Supervisor's signature: .....

Test equipment used/calibration traceability:

Calibration date: .....
Next service/calibration due: .....

Figure 1(c) Typical servicing and calibration record sheet

SERVICING AND CALIBRATION RECORD SHEET
SOCKET FUSION EQUIPMENT
ELECTRICAL SAFETY TEST

AUTHORITY/CONTRACTOR: ..... DATE: .....

ADDRESS: ..... SERVICE CONTRACT NO.: .....

..... EQUIPMENT MANUFACTURER: .....

CONTACT: ..... TYPE: ..... SERIAL NO.: .....

AMBIENT TEMP. °C: ..... VOLTAGE: .....

	VALUE		SATISFACTORY	
VISUAL INSPECTION	**LIMIT**	**ACTUAL**	**YES**	**NO**
Is unit complete?				
Is unit damaged?				
Check plug for electrical security				
Check socket for electrical security				
ELECTRICAL INSPECTION				
Check earth bond				
Check insulation				
Flash test (where permissible)				
Operational test				
Load test				
		Pass or Fail		

RECOMMENDED ACTION: _____

_____

_____

_____

_____

The above work has been carried out:

Checked by: .....

Supervisor's signature: .....

Test equipment used/calibration traceability:

Calibration date: .....

Next service/calibration due: .....

Figure 1(d) Typical servicing and calibration record sheet

3. JOINTING BY BUTT FUSION

This method of jointing requires an electrically heated plate to raise the temperature of the pipe ends to the fusion temperature and is used for (MDPE) pipe of size 90 and above of the same pressure class (SDR). This part of the specification relates to butt fusion jointing for the size range 90 to 250. For sizes greater than 250, additional training is required – see 3.5.1.

3.1 Equipment

3.1.1 Frame

i) A frame containing clamps which are sufficiently robust to reround and accurately align the pipes to be jointed.

ii) The machine should 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 kept lubricated at all times.

3.1.2 Hydraulic/pneumatic unit

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

ii) A data plate permanently attached to the unit setting out weld pressures and times for specified sizes of pipe. The ram pressure shall be calculated from an interface fusion pressure of 0.15MPa.

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

3.1.3 Planing tool

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

ii) Trimming blades of the planer shall be sharp and have defect free cutting edges to provide continuous swarf of uniform thickness.

3.1.4 Heater plate

i) The plate shall be electrically heated using a 110V supply and be provided with a suitable temperature controller to give a uniform surface temperature of 205 ± 10°C.

ii) The plate shall be uniformly coated with a PTFE based coating having adequate release properties. The coating should be light coloured to show the presence of any contaminants. **ADDITIONAL SPRAY ON RELEASE AGENTS SHALL NOT BE USED.**

iii) The heater plate shall be fitted with an accurate temperature probe or indicator and a facility to measure the temperature of the plate using a digital thermometer with an appropriate surface probe.

iv) A clean dry protective holder which shields the plate from contact with the ground and against dust and draughts shall be provided for the plate when not in use. The heater plate should not be stored in any box/bag from which dust and other contaminants can be attracted to the plate.

The protective holder shall be cleaned at regular intervals.

3.1.5 Shelter

A shelter shall be used to provide adequate protection for pipe, fittings and equipment against airborne dust, rain, snow and draughts.

3.1.6 External bead remover

An external debeader shall be provided, capable of removing the cold bead cleanly, in a continuous strip, without damage to either joint or bead.

3.1.7 Generator

For pipe up to nominal size 250 the alternating current generator rating shall be at least 3kVA. The nominal output voltage should be 110V but the output voltage should not exceed 120V and should be not less than 103V at any kVA loading between no load and full load.

NOTE: The generator should be selected to suit the butt fusion machine capacity and heater plate rating.

3.1.8 Ancillary equipment

i) Pipe suppport rollers
ii) Pipe cutters
iii) Digital thermometer with probe
iv) Timer
v) Marker pen for marking beads
vi) Pipe end plugs
vii) Bead gauge
viii) Saw and saw guide.

3.2 Butt fusion jointing method

3.2.1 Preparation

(a) Cleaning the planing tool

The planing tool surfaces shall be visually inspected for grease and dirt and cleaned where necessary. 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 with copious quantities of clean water prior to any welding.

ii) Only clean, disposable, lint-free materials shall be used to clean the plate.

iii) The heater plate shall be cold when washed. A hot plate will evaporate the water from its face, cause smearing and leave hardness salts behind.

iv) 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 will 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.

(c) Siting the equipment

i) The butt jointing machine shall be on a clean, hard surface. If necessary the jointing machine should be placed on a suitable baseboard.

ii) To aid alignment of pipes into the machine and for ease of movement, pipes to be jointed shall always be supported on rollers.

3.2.2 Preliminary procedure

i) Check that there is sufficient fuel for the generator to complete the joint. Start the generator and check that it is functioning correctly.

ii) Check planing tool, hydraulic pump and heater plate are in workings order.

iii) Check both pipes to be jointed are of the same size, pressure rating and material. Only compatible materials should be jointed together. If in doubt the advice of the pipe or fitting manufacturer should be sought.

iv) The ends of the pipes to be planed shall be wiped with a clean, damp cloth on both inner and outer surfaces to remove mud or dust. The pipe shall be wiped dry prior to proceeding.

v) Fully open the machine clamps and position the planer in its location.

vi) Position pipes in the clamps with ends adjacent to planing 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 reround the pipes.

viii) Determine the drag pressure. This is effected for each set of pipes to be jointed by closing the carriage of the machine using a steady action. The pressure on the gauge to close the carriage shall be recorded. This pressure shall be added to the fusion pressure, for the appropriate size and pressure rating of pipe (to be found on the blue data plate on the machine), to obtain the bead-up pressure, the jointing pressure and the cooling pressure.

ix) Switch on the planing tool and move the pipe ends against the planing tool until continuous shavings are produced from each pipe end.

x) Keep the planing tool turning whilst separating the pipe ends to avoid steps on the trimmed surfaces. Switch off the planing tool and remove after the blades have come to rest.

xi) Remove loose shavings from the machine and inside the pipes. To prevent contamination of the clean surfaces, **DO NOT TOUCH PIPE ENDS.**

xii) Visually check that pipe ends are completely planed and repeat planing if necessary. Replace blades if a smooth surface on the planed ends is not obtained.

xiii) Bring pipe ends together and check there is no visible gap between planed faces. The maximum outside diameter mismatch is given in Table 3. If the mismatch is greater than that given in the table then the pipe shall be realigned and replaned.

xiv) Cover the free pipe ends to prevent cooling of the plate by internal draughts.

3.2.3 Making the joint

3.2.3.1 Definitions

The following terms are used with the text:

Interface fusion pressure: the actual pressure exerted on the heater plate by the pipe during bead-up or the actual pressure exerted on the pipe ends during jointing or cooling. For PE-X grade of material, the actual pressure is 0.15MPa.

Fusion pressure: the gauge pressure required to provide on a given machine and for a given size and pressure rating of pipe an interface fusion pressure of 0.15MPa. 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.

Drag pressure: the gauge pressure required to overcome the frictional drag of the pipe on machine closure. The drag pressure shall be measured for each set of pipes to be jointed.

Initial bead-up pressure: the gauge pressure required to form the initial bead on the end of the pipe against the heater plate.

Soak pressure: the pressure required to maintain the pipe in contact with the heater plate. At this pressure, the pressure gauge will normally register zero.

Jointing pressure: the sum of the fusion pressure and the drag pressure.

Cooling pressure: the gauge pressure to be maintained during the cooling time (see Table 3).

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: The drag pressure should normally be less than the fusion pressure.

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

Fusion pressure + drag pressure
= initial bead-up pressure
= jointing pressure
= cooling pressure.

3.2.3.2 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. A second dummy joint shall also be made for sizes greater than nominal size 180.

This procedure, which is the same as that for making a butt joint (see 3.2.3.2 to 3.2.3.4), will ensure that the portion of the plate to be used for production jointing is free from dust.

Using two spare pieces of pipe:

i) Trim the pipe ends;

ii) Follow the normal bead-up and soak time routine for jointing;

iii) Remove ends from heater plate (there is no need to butt them together).

Lengths of pipe which are to be installed may be used for this procedure, providing the ends are allowed to cool for at least 10 minutes before re-planing to make the production joint.

3.2.3.3 Bead-up

i) The pipe shall be pressed against the heater plate using the "initial" bead-up pressure.

ii) The "initial bead" size shall be as given in Table 3.

3.2.3.4 Heat soak

After the initial bead-up, release the pressure in the system so that the pressure gauge registers zero. This is achieved by switching the valve to the neutral position. Do not switch the valve to the open position. Check that the clamps do not move. Maintain the pipe ends in contact with the heater plate at the soak pressure.

3.2.3.5 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 plates examined.

ii) The maximum plate removal time including the time to bring the hot ends of the pipe together shall be as given in Table 3. These plate removal times are maxima and it is always desirable to keep the heater plate removal time to a minimum. A shelter shall be used under conditions of low ambient temperature (below 0°C) and/or wind chill.

NOTE: For sizes greater than nominal size 250, additional guidance should be obtained from the equipment manufacturer with regard to the use of heated shelters.

3.2.3.6 Fusion jointing

i) Immediately after plate removal the hot pipe ends shall be brought together in a smooth controlled manner and the pressure raised to the jointing pressure.

ii) The fused material should "roll" back in a uniform manner and there should be no sign of bubbles or contamination present.

3.2.3.7 Cooling

i) The joint shall be allowed to cool whilst maintaining the joint at the joint pressure for at least the time given in Table 3 for the appropriate thickness.

NOTE: Ensure that the pressure is maintained during the cooling time.

ii) Any cover used may be removed from the pipe end to promote a draught through the pipe to assist cooling.

iii) At the end of the cooling time the clamps may be released and the jointed pipes removed. No handling of the pipe shall take place until the surface temperature of the bead is below 40°C as measured by a digital thermometer.

3.2.4 Debeading

i) The external and internal beads shall be removed if required after the cooling time (see Table 3) using a suitable debeading tool. The bead removal tool shall not induce any slits, gouges or defects in the pipe wall.

ii) Pipe to pipe beads shall be uniform on both sides of the joint and equal in size to within 1mm. They shall have no wrinkles or discontinuities and the external beads shall have overall dimensions as given in Table 3.

iii) The beads and joint shall be numbered/coded using an indelible marker pen.

iv) On examination of the underside of the bead surfaces and the external pipe joint surface after debeading, there shall be no sign of any circumferential slits, gouges or similar defects between the fused beads. It should not be possible to separate the beads by flexing them parallel to the line of the weld.

If such a defect is seen then the joint shall be cut from the pipeline and the joint remade. If a similar defect recurs, all further production jointing shall cease until the equipment has been thoroughly cleaned and examined and new trial joints made and tested.

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 heater plate, the hydraulic or pneumatic unit, the frame/clamp unit, planing tool and the generator.

3.4 Records

3.4.1 Job supervision

Written records of appropriate weld procedure details shall be kept as required using the format illustrated in Figure 2(a).

3.4.2 Equipment servicing and calibration

Written records of appropriate servicing and calibration details carried out at a frequency agreed with the equipment manufacturer shalll be kept using the format illustrated in Figures 2(b), 2(c), 2(d), 2(e), 2(f), 2(g) and 2(h) (if required).

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

3.5 Training requirements for butt fusion jointing of MDPE

3.5.1 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 250.

Separate training for nominal sizes in excess of 250 will be required which are not covered by this specification.

Table 3 – Typical butt fusion conditions for PE-X Heater plate surface temperature 195°C – 215°C

Nominal pipe size (mm)	Allowable mismatch on O.D. (mm)	Initial bead size (mm)	Heat soak time (seconds)	Maximum plate removal time (seconds)	Typical final bead size (mm)	Cooling time (mins)	
						In m/c under fusion press	Out of m/c
90	1.0	2	90	8	6–11	10	10
125	1.0	2	120	8	6–11	10	10
180	1.0	2	140	8	6–11	10	10
250	1.0	2	180	8	13–18	10	10
315	2.0	3	180	10	13–18	15	15
355	2.0	3	180	10	13–18	15	15
400	2.0	3	180	10	18–23	15	15
450	2.0	3	180	12	18–23	15	15
500	2.0	3	180	12	18–23	20	20
560	2.0	4	240	12	20–25	20	20
630	2.0	4	240	12	20–25	20	20
710	3.0	4	240	15	20–25	25	25
800	3.0	4	300	15	25–30	25	25
900	3.0	4	300	15	25–30	30	30
1000	3.0	4	300	15	25–30	30	30

Butt fusion machine data plates shall contain relevant information as above, plus gauge pressures calculated from an interface fusion pressure of 0.15MPa.

NOTE: This specification applies to the procedures to be followed for butt fusion jointing for pipe sizes 90 to 250. The butt fusion jointing conditions given in Table 3 for sizes greater than 250 are provided for guidance only.

BUTT FUSION JOINT RECORD SHEET

CONTRACT:
CONTRACTOR:
PIPE SIZE/RATING:
JOINTING MACHINE:

OFFICE:
SITE ENGINEER:
PIPE/FITTING MANUFACTURER:
SUPERVISOR:

Date	Joint number or location	Jointer	Weather condi-tions	Ambient tempera-ture (°C)	Drag pressure (bar)*	Bead-up pressure (bar)*	Joint pressure (bar)*	Cooling pressure (bar)*	Bead time (sec)	Soak time (sec)	Plate release time (sec)	Cooling time (min)	Bead size (mm)	Bead examina-tion

* IMPa = 10 bar

Figure 2(a) Butt fusion joint record sheet

SERVICING AND CALIBRATION RECORD SHEET
BUTT FUSION EQUIPMENT
GENERATORS

AUTHORITY/CONTRACTOR: ..... DATE: .....

ADDRESS: ..... SERVICE CONTRACT NO.: .....

..... EQUIPMENT MANUFACTURER: .....

CONTACT: ..... TYPE: ..... SERIAL NO.: .....

AMBIENT TEMP. °C: ..... VOLTAGE: ..... POWER RATING: .....

VISUAL INSPECTION	SATISFACTORY YES	NO
Is unit complete?		
Is any damage evident?		
Check oil and fuel levels		
Check starting mechanism		

WARM UP AT FULL LOAD FOR 15 MINUTES
LOAD TEST AS FOLLOWS:

POWER %	kVA	VOLTS	Hz	AMPS		
0						
60						
100						
110						

kVA	Manufacturer's Rating
kVA	Maximum Tested Rating

ELECTRICAL TEST	VALUE LIMIT	ACTUAL		
Check R.C.C.B. operation				
Check internal wiring for security				
Check voltmeter display				
Check changeover switch				
Check oil alert device (During oil change)				
Check earth bond				
Check insulation				

RECOMMENDED ACTION: _____

_____

_____

_____

The above work has been carried out: Test equipment used/calibration traceability:

Checked by: ..... Calibration date: .....

Supervisor's signature: ..... Next service/calibration due: .....

Figure 2(b) Typical servicing and calibration record sheet

SERVICING AND CALIBRATION RECORD SHEET
BUTT FUSION EQUIPMENT
HEATER PLATE

AUTHORITY/CONTRACTOR: ..... DATE: .....

ADDRESS: ..... SERVICE CONTRACT NO.: .....

..... EQUIPMENT MANUFACTURER: .....

CONTACT: ..... TYPE: ..... SERIAL NO.: .....

AMBIENT TEMP. °C: ..... VOLTAGE: .....

	VALUE		SATISFACTORY	
VISUAL INSPECTION	**LIMIT**	**ACTUAL**	**YES**	**NO**
Is tool complete?				
Is handle damaged?				
Check for water ingress				
Check for electrical security				
Check cable condition				
Check hose condition				
Check thermometer for damage				
Check for signs of over temperature				
ELECTRICAL INSPECTION				
Check for earth continuity				
Check insulation resistance				
Check element resistance				
Check temperature setting				
Check thermometer accuracy				
OPERATIONAL TEST				
TEMPERATURE READINGS MONITORED				
MECHANICAL INSPECTION				
Check head for wear and damage				
Check face for distortion				

RECOMMENDED ACTION: _____

The above work has been carried out: Test equipment used/calibration traceability:

Checked by: ..... Calibration date: .....

Supervisor's signature: ..... Next service/calibration due: .....

Figure 2(c) Typical servicing and calibration record sheet

SERVICING AND CALIBRATION RECORD SHEET
BUTT FUSION EQUIPMENT
HYDRAULIC POWER PACK

AUTHORITY/CONTRACTOR: ..... DATE: .....

ADDRESS: ..... SERVICE CONTRACT NO.: .....

..... EQUIPMENT MANUFACTURER: .....

CONTACT: ..... TYPE: ..... SERIAL NO.: .....

AMBIENT TEMP. °C: ..... VOLTAGE: .....

	VALUE		SATISFACTORY	
VISUAL INSPECTION	**LIMIT**	**ACTUAL**	**YES**	**NO**
Is unit complete?				
Is any damage evident?				
ELECTRICAL INSPECTION AND TEST				
Check for earth continuity				
Check insulation resistance				
Check MCB value is correct				
Check operation of controls				
Check output socket for operation				
Check lead and plug for electrical security				
MECHANICAL AND HYDRAULIC TEST				
Check directional control valve operation				
Check oil for air				
Check oil level and condition				
Check gauge for operation and accuracy				
Check pressure can be maintained				
Check timer operates correctly				
Check for external oil leaks				
Check hose connectors				
Check motor selection is correct				
Check pressure control valve operation				

RECOMMENDED ACTION: _____

_____

_____

_____

The above work has been carried out.
Checked by: .....

Test equipment used/calibration traceability:

Supervisor's signature: .....

Calibration date: .....

Next service/calibration due: .....

Figure 2(d) Typical servicing and calibration record sheet

SERVICING AND CALIBRATION RECORD SHEET
BUTT FUSION EQUIPMENT
MACHINES AND TRIMMERS

AUTHORITY/CONTRACTOR: .....

ADDRESS: .....

.....

CONTACT: .....

AMBIENT TEMP. °C: .....

DATE: .....

SERVICE CONTRACT NO.: .....

EQUIPMENT MANUFACTURER: .....

TYPE: ..... SERIAL NO.: .....

VOLTAGE: .....

VISUAL INSPECTION	SATISFACTORY YES	NO
Is machine complete?		
Is trimmer complete?		
Is any damage evident?		

ELECTRICAL INSPECTION AND TEST	VALUE LIMIT	ACTUAL		
Check for earth continuity				
Check insulation resistance				
Check fuse/MCB value is correct				
Check operation of safety cut out device				
Check limit switch operation				
Check junction box for water ingress				
Check terminations for security				
Check emergency stop				
Check alarm operation				

MECHANICAL INSPECTION AND TESTS				
Check machine rigidity				
Check clamp action				
Check pinch gap				
Check trimmer action				
Check shell alignment				

MECHANICAL INSPECTION AND TESTS (continued)	SATISFACTORY YES	NO
Check trimmer stop gap		
Check for excessive friction		
Check bearing alignment for wear		
Check for pressure retention		
Check for excessive chain wear		
Check trimmer blades		
Check trimmer locking mechanism		
Check for oil leaks		
Check hydraulic system for ingress of air		
Check hydraulic connections condition		
Check hydraulic cylinder alignments		
Check heater plate release mechanism . . . bar		
Check security of linear transducer		
Check hydraulic hose condition		

TEST JOINT

RECOMMENDED ACTION: _____

The above work has been carried out.

Test equipment used/calibration traceability:

Checked by: .....

Supervisor's signature: .....

Calibration date: .....

Next service/calibration due: .....

Figure 2(e) Typical servicing and calibration record sheet

SERVICING AND CALIBRATION RECORD SHEET
BUTT FUSION EQUIPMENT
TOOLING ANCILLARIES

AUTHORITY/CONTRACTOR: ..... DATE: .....

ADDRESS: ..... SERVICE CONTRACT NO.: .....

..... EQUIPMENT MANUFACTURER: .....

CONTACT: ..... TYPE: ..... SERIAL NO.: .....

AMBIENT TEMP. °C: ..... VOLTAGE: .....

		SATISFACTORY	
VISUAL INSPECTION		**YES**	**NO**
Is unit complete?			
Is any damage evident?			
Is any oil leakage evident?			
Oil level and condition			
MECHANICAL INSPECTION			
RRT-WC	Check clamp action and locking mechanism		
SST	Check for excessive wear on screw		
SST/MST	Check limit plate operation		
MST	Check top bar movement		
MST	Hydraulic relief valve operation		
MST	Check effectiveness of safety stops		
TTD	Check boring bar operation		
TTD	Check feed nut operation		
TTD	Check packing gland		
SJM	Check freedom of operation		
SJM	Check locking mechanism		
SKT,JM	Check for excessive friction		
SKT,JM	Check shell alignment		

RECOMMENDED ACTION: _____

The above work has been carried out.

Test equipment used/calibration traceability:

Checked by: ..... Calibration date: .....

Supervisor's signature: ..... Next service/calibration due: .....

Figure 2(f) Typical servicing and calibration record sheet

SERVICING AND CALIBRATION RECORD SHEET
BUTT FUSION EQUIPMENT
ELECTRICAL SAFETY TEST

AUTHORITY/CONTRACTOR: .....
ADDRESS: .....
.....
CONTACT: .....
AMBIENT TEMP. °C: .....

DATE: .....
SERVICE CONTRACT NO.: .....
EQUIPMENT MANUFACTURER: .....
TYPE: ..... SERIAL NO.: .....
VOLTAGE: .....

	VALUE		SATISFACTORY	
VISUAL INSPECTION	**LIMIT**	**ACTUAL**	**YES**	**NO**
Is unit complete?				
Is unit damaged?				
Check plug for electrical security				
Check socket for electrical security				
ELECTRICAL INSPECTION				
Check earth bond				
Check insulation				
Flash test (where permissible)				
Operational test				
Load test				
		Pass or Fail		

RECOMMENDED ACTION: _____

The above work has been carried out:

Checked by: .....
Supervisor's signature: .....

Test equipment used/calibration traceability:

Calibration date: .....
Next service/calibration due: .....

Figure 2(g) Typical servicing and calibration record sheet

SERVICING AND CALIBRATION RECORD SHEET
BUTT FUSION EQUIPMENT
MICROPROCESSOR CONTROLLER

AUTHORITY/CONTRACTOR: ..... DATE: .....

ADDRESS: ..... SERVICE CONTRACT NO.: .....

..... EQUIPMENT MANUFACTURER: .....

CONTACT: ..... TYPE: ..... SERIAL NO.: .....

AMBIENT TEMP. °C: ..... VOLTAGE: .....

	SATISFACTORY	
VISUAL INSPECTION	**YES**	**NO**
Is unit complete?		
Is any damage evident?		
Is any oil leakage evident?		
Oil level and condition		
ELECTRICAL INSPECTION & TEST		
Check for earth continuity		
Check insulation resistance		
Check internal integrity and security		
Check for water ingress		
CHECK & RECORD EXISTING DATA		
Polymer SDR Pipe size		
CHECK ALL CONTROLLER FUNCTIONS & ALPHANUMERICAL DISPLAY		
Check power up		
Check load		
CHECK DATA SELECTION		
Check polymer 'X'		
Check SDR 11		
Check SDR 17.6		
Check 90mm		
Check 125mm		
Check 180mm		
Check 250mm		
Check confirm selection		
CHECK OUT-OF-SEQUENCE COMMANDS		
Join: Fault check not done (audible alarm)		
Check: Fault trim not done (audible alarm)		
Trim: Fault trimmer not in (audible alarm)		
Check: Heater plate present		
Join: Heater not in (audible alarm)		
Join: Insert heater		

	SATISFACTORY	
CHECK AUTO ALARMS	**YES**	**NO**
High drag 4 sec delay time (audible alarm)		
Fault: Trimmer blades blunt (audible alarm)		
Fault: Clamps loose (audible alarm)		
Heater temperature wrong (audible alarm)		
Poor bead (audible alarm)		
Fault: Can't lift heater (audible alarm)		
Fault: Long dwell time (audible alarm)		
Fault: Cooling time short		
CHECK NORMAL OPERATION MODE & TEST JOINT **Action Display Message**		
Reset: All stopped. ⟨Load trimmer and pipes. Trim when ready.⟩		
Trim: ⟨Automatic trimming cycle.⟩ Press **trim** when OK (audible alarm)		
Trim: Automatic trimming cycle. Press **trim** when OK. ⟨Remove trimmer to check.⟩		
Check: ⟨Pipe alignment OK. Press **check** when done.⟩		
Check: ⟨Load heater.⟩		
Join: ⟨Insert heater plate. Press **join** when done.⟩		
Join: ⟨Join cycle. Soaking. Time left... Fusing. Cooling. Joint complete⟩ (audible alarm)		
Reset: ⟨Load trimmer and pipes. Press **trim** when ready.⟩		
RESET ORIGINAL DATA IF ERASED		
Polymer SDR Pipe size		

RECOMMENDED ACTION:

The above work has been carried out to approved standards:

Test equipment used:

Checked by: ..... Calibration date: .....

Supervisor's signature: ..... Next service/calibration due: .....

Figure 2(h) Typical servicing and calibration record sheet

3.5.2 Objectives

The course should enable the participant to:

* understand the principles of MDPE 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 pipes of different sizes;
* inspect for and identify acceptable quality joints, including debeading.

3.5.3 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 MDPE pipe of nominal size 90 – 250;
* suitably maintained and calibrated butt fusion equipment and accessories for the nominal size range 90 – 250.

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 fittings size range used.

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

4. SADDLE FUSION JOINTING

This section covers saddle fusion jointing using electrically heated tools for raising the temperature of pipe and fitting to the fusion temperature. It is used for making service connections of nominal size 20 to 63 off mains of nominal size 90 to 315. Equipment is available to provide a mechanical means of assembly and jointing details should be obtained from the equipment manufacturer. Detail of the procedures for manual saddle fusion jointing is described below.

4.1 Equipment

4.1.1 Heating tool

i) The tool shall be electrically heated using a 110V supply and be provided with a suitable temperature controller to give a uniform surface temperature of 275 ± 15°C. **GAS HEATED TOOLS SHALL NOT BE USED.**

ii) The heating faces of the tool shall consist of concave and convex surfaces to provide a means of contact heating the pipe and fitting fusion areas.

iii) The heating heads shall be uniformly coated with a PTFE based coating having adequate release properties. The coating should be light coloured to show the presence of any contaminants. **ADDITIONAL SPRAY-ON RELEASE AGENTS SHALL NOT BE USED.**

iv) The heating tool shall be fitted with a temperature indicator and a facility to measure the temperature of the heating heads using a digital thermometer.

v) A clean protective holder which shields the heating tool against dust and draughts shall be provided for the tool when not in use. The heating tool should not be stored in any box/bag from which dust and other contaminants can be attracted to the heating faces.

4.1.2 Window clamp

A clamping device to reround and straighten the pipe over the fusion area.

4.1.3 Generator

For pipes up to nominal size 250, the alternating current generator rating shall be at least 1.5kVA. The nominal output voltage should be 110V but the output voltage should not exceed 120V and should be not less than 103V at any kVA loading between no load and full load.

4.1.4 Ancillary equipment

i) Digital thermometer
ii) Timer
iii) Scraper.

4.2 Saddle fusion jointing method

4.2.1 Preparation

i) Check that the heating tool is in working order using a digital thermometer with probe, at the correct temperature (275 ± 15°C) and that the heating heads are of the size required, undamaged and clean.

ii) Check that pipe and fitting base to be jointed are of the same size and material. Only compatible materials shall be jointed together. If in doubt, the advice of the pipe or fitting manufacturer should be sought.

iii) Clean the surface of the pipe in the fusion area using clean, disposable, lint-free material. Retain the saddle fitting in its packaging until required, to minimise contamination.

iv) Scrape an area of the pipe in excess of the proposed fusion area and lightly scrape the saddle base. The saddle shall then be placed in a clean dry place until required.

v) Where necessary, fit and tighten the correct sized window clamp round the pipe in the cleaned area.

vi) Check that there is sufficient fuel for the generator to complete the joint. Start the generator and check that it is functioning correctly.

4.2.2 Saddle fusion jointing procedure

i) Check the heating time required for the size of saddle being jointed. This information will be found on the fitting (see also Table 4).

ii) If required, fix the extension handle to the heating tool.

iii) To preheat the pipe, place the heating tool onto the prepared pipe. surface and press firmly for 10 seconds. Remove the tool and check for alignment and formation of the melt pattern. Replace the tool and correct for alignment if required. Press firmly for up to a further 30 seconds checking that the formation of the melt pattern is substantially complete at 10 second intervals. If a satisfactory melt pattern is not obtained after a maximum of 40 seconds total heating time do not proceed. Recommence the jointing procedure at a minimum distance of 200mm from the abandoned position, typically 250mm.

iv) If the melt pattern is substantially complete, carefully replace the fusion tool on the melt pattern. Position the saddle on the fusion tool and apply firm pressure to the fitting. **THE HEATING TIME STARTS NOW.**

v) For service connections size 25 – 32, when a small complete bead forms around the saddle of the fitting, relax the pressure.

vi) For service connections size 63, press down firmly onto the saddle, localising the pressure as required to achieve a complete internal and external bead formation.

vii) At the end of the heating time, first snap fitting off the fusion tool then the fusion tool off the pipe.

viii) Check (quickly) that the melt patterns are complete, even and clean. Position the saddle within the pipe melt pattern. Press firmly to form a continuous double weld bead. Maintain the pressure for at least 60 seconds.

ix) Allow the joint to cool for 15 minutes before making the service connection. Do not re-use the fitting or re-heat the same area on the pipe after it has been through the heating cycle.

Table 4 – Typical heating time for PE-X

Service size	Pipe pre-heat time* (sec)	Heating time (sec)
20 – 32	10 – 40	25
63	10 – 40	60
*As indicated on the fitting		

NOTE: The heating times in Table 4 apply both to the pipe when empty and when under pressure.

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 heating tool and generator.

4.4 Records

4.4.1 Job supervision

Written records of appropriate weld procedure details shall be kept as required using the format illustrated in Figure 3(a).

4.4.2 Equipment servicing and calibration

Written records of appropriate servicing and calibration details carried out at a frequency agreed with the equipment manufacturer shall be kept using the format illustrated in Figures 3(b), 3(c) and 3(d).

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

4.5 Training requirements for saddle fusion jointing of MDPE

4.5.1 Scope

Instruction shall be provided for operatives, supervisory and technical staff who need to acquire the skills of saddle fusion jointing for making service outlet connections in the size range 20 to 63 and who already have a background knowledge of MDPE pipe systems.

4.5.2 Objectives

The course should enable the participant to:

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

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 MDPE pipe and fittings of nominal size 20 – 250;
* suitable maintained and calibrated saddle fusion equipment and accessories for the nominal size range 63 – 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 outlined in 4.5.2.

The certificate shall identify the pipe and fittings size range used.

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

SADDLE FUSION JOINT RECORD SHEET

CONTRACT:
CONTRACTOR:
PIPE SIZE/RATING:
JOINTING EQUIPMENT:

OFFICE:
SITE ENGINEER:
PIPE/FITTING MANUFACTURER:
SUPERVISOR:

Date	Joint No. or location	Jointer	Weather conditions	Ambient temperature (°C)	Heating temperature (°C)	Pre-heating time (sec)	Fusion heating time (sec)	Melt pattern appearance	Assembly pressure time (sec)	Cooling time (min)	Bead appearance

Figure 3(a) Saddle fusion joint record sheet

SERVICING AND CALIBRATION RECORD SHEET
SADDLE FUSION EQUIPMENT
GENERATORS

AUTHORITY/CONTRACTOR: ..... DATE: .....

ADDRESS: ..... SERVICE CONTRACT NO.: .....

..... EQUIPMENT MANUFACTURER: .....

CONTACT: ..... TYPE: ..... SERIAL NO.: .....

AMBIENT TEMP. °C: ..... VOLTAGE: ..... POWER RATING: .....

VISUAL INSPECTION	SATISFACTORY YES	SATISFACTORY NO
Is unit complete?		
Is any damage evident?		
Check oil and fuel levels		
Check starting mechanism		

WARM UP AT FULL LOAD FOR 15 MINUTES
LOAD TEST AS FOLLOWS:

POWER %	kVA	VOLTS	Hz	AMPS		
0						
60						
100						
110						

kVA	Manufacturer's Rating
kVA	Maximum Tested Rating

ELECTRICAL TEST	VALUE LIMIT	VALUE ACTUAL		
Check R.C.C.B. operation				
Check internal wiring for security				
Check voltmeter display				
Check changeover switch				
Check oil alert device (During oil change)				
Check earth bond				
Check insulation				

RECOMMENDED ACTION: _____

The above work has been carried out:

Test equipment used/calibration traceability:

Checked by: .....

Calibration date: .....

Supervisor's signature: .....

Next service/calibration due: .....

Figure 3(b) Typical servicing and calibration record sheet

SERVICING AND CALIBRATION RECORD SHEET
SADDLE FUSION EQUIPMENT
HEATING TOOL

AUTHORITY/CONTRACTOR: ..... DATE: .....

ADDRESS: ..... SERVICE CONTRACT NO.: .....

..... EQUIPMENT MANUFACTURER: .....

CONTACT: ..... TYPE: ..... SERIAL NO.: .....

AMBIENT TEMP. °C: ..... VOLTAGE: .....

	VALUE		SATISFACTORY	
VISUAL INSPECTION	**LIMIT**	**ACTUAL**	**YES**	**NO**
Is tool complete?				
Is handle damaged?				
Check for water ingress				
Check for electrical security				
Check cable condition				
Check hose condition				
Check thermometer for damage				
Check for signs of over temperature				
ELECTRICAL INSPECTION				
Check for earth continuity				
Check insulation resistance				
Check element resistance				
Check temperature setting				
Check thermometer accuracy				
OPERATIONAL TEST				
TEMPERATURE READINGS MONITORED				
MECHANICAL INSPECTION				
Check head for wear and damage				
Check face for distortion				

RECOMMENDED ACTION: _____

The above work has been carried out:

Checked by: .....

Supervisor's signature: .....

Test equipment used/calibration traceability:

Calibration date: .....

Next service/calibration due: .....

Figure 3(c) Typical servicing and calibration record sheet

SERVICING AND CALIBRATION RECORD SHEET
SADDLE FUSION EQUIPMENT
ELECTRICAL SAFETY TEST

AUTHORITY/CONTRACTOR: .....
ADDRESS: .....
.....
CONTACT: .....
AMBIENT TEMP. °C: .....

DATE: .....
SERVICE CONTRACT NO.: .....
EQUIPMENT MANUFACTURER: .....
TYPE: ..... SERIAL NO.: .....
VOLTAGE: .....

	VALUE		SATISFACTORY	
VISUAL INSPECTION	**LIMIT**	**ACTUAL**	**YES**	**NO**
Is unit complete?				
Is unit damaged?				
Check plug for electrical security				
Check socket for electrical security				
ELECTRICAL INSPECTION				
Check earth bond				
Check insulation				
Flash test (where permissible)				
Operational test				
Load test				
		Pass or Fail		

RECOMMENDED ACTION: _____

The above work has been carried out:

Checked by: .....
Supervisor's signature: .....

Test equipment used/calibration traceability:

Calibration date: .....
Next service/calibration due: .....

Figure 3(d) Typical servicing and calibration record sheet

5. ELECTROFUSION SOCKET JOINTING OF MDPE

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 cleanliness, in particular the removal of the oxidised surface of the pipe over the socket depth.

Electrofusion fittings are available in the size range 20 to 250 although additional sizes of fittings are under development.

The equipment and procedures described below relate to fittings with centre stops. If fittings without centre stops are used, advice should be sought from the supplier for guidance on equipment and jointing procedures. There are two control systems specified – manual time selection and automatic time selection. Both are described in this section.

5.1 Equipment

i) Control box capable of providing up to 2kVA at 39/40 volts RMS. The control box input supply shall be from a nominal 110 volt (55V–0–55V) generator of 2.5/3kVA capacity. The nominal output of the generator should be 110V but the output voltage should not exceed 120V and should be not less than 103V at any kVA loading between no load and full load. Control boxes shall conform to WAA Information and Guidance Note (IGN) No. 4-32-07 (in course of preparation) and shall include safety devices to prevent voltages greater than 42Vac 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 and shall not therefore be taken into the trench.

ii) Pipe surface preparation tool capable of removing the oxidised surface of the pipe in excess of the insertion depth before welding is attempted. The tool shall remove a layer 0.2 – 0.4mm 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.

iii) Pipe clamps or other approved method for restraining and aligning the pipes during the weld cycle shall be used.

iv) Pipe cutters including saw and saw guide.

5.2 Electrofusion jointing method

5.2.1 Preparation.

i) Check that the pipe ends to be jointed are cut square to the axis and any burrs removed.

ii) Wipe pipe end using clean, disposable, lint-free material to remove traces of dirt or mud, etc.

iii) Mark the area over which the oxidised surface is to be removed, i.e. in excess of the penetration 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.

iv) Connect the electrofusion control box input leads to the generator.

v) Check that there is sufficient fuel for the generator to complete the joint.

vi) Check that reset stop button, if fitted on the control box, is in the correct mode.

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 penetration depth.

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.

5.2.2 Electrofusion jointing procedure

i) Remove the fitting from its packaging and check that the bore of the fitting is clean and dry. If necessary, dry it with clean, disposable, lint-free material and degreased with a clean cloth dampened by a suitable solvent.

NOTE: Isopropanol is a suitable cleaner for the material if permitted by the site health and safety regulations.

ii) Insert the pipe ends into the fitting so that they are in contact with the centre stop.

iii) 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.

iv) If applicable, remove the terminal caps from the fitting.

v) Start the generator and check that it is functioning correctly.

vi) Connect the control box output leads to the fitting terminals and check that they have been fully inserted.

vii) Switch on the control box where applicable.

viii) 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: It is recommended that gloves and goggles be worn during the jointing process.

ix) Press the start button on the control box and check that the heating cycle is proceeding as indicated by the display countdown.

x) 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 after 5.2.2(x)).

xi) If a satisfactory joint has been made, the joint shall be left in the clamps for the cooling time specified on the fitting.

NOTE TO (xi): If the fusion cycle terminates before completion of the count down, check for faults as indicated by the control box warning lights. Do not attempt a second fusion cycle for at least one hour after the first attempt.

5.3 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.

5.4 Records

5.4.1 Job supervision

Written records of appropriate fusion procedure details shall be kept as required using the format illustrated in Figure 4(a).

5.4.2 Equipment servicing and calibration

Written records of appropriate servicing and calibration details, carried out at a frequency agreed with the equipment manufacturer shall be kept using the format illustrated in Figure 4(b), 4(c) and 4(d).

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

NOTES relating to Figure 4(a) – Electrofusion socket joint fault recognition

A well made electrofusion joint should have the following features:

* the melt indicators should have operated;
* there should be no melt flowing from the ends of the fitting;
* removal of surface at pipe end should be evident all round the pipe in the vicinity of the completed joint;
* couplers should be centralised between the depth of insertion marks on the adjoining pipes.

The following features indicate faults during the jointing procedure:

(1) **Fusion indicators fail to operate**

Causes:
(a) pipe ends not cut square;
(b) incorrect fusion time selected – too short;
(c) control box out of specification – under voltage;
(d) fitting heating coil failure;
(e) insertion depth of pipe into fitting not achieved.

(2) **Excess melt from melt indicators or from socket mouth**

Causes:
(a) pipe ends not cut square;
(b) incorrect fusion time selected – too long;
(c) control box out of specification – over voltage;
(d) pipe – fitting misalignment;
(e) pipe and/or fitting out of specification – oversized gap;
(f) inaccurate timer – too long.

(3) **Insufficient fusion of pipe in socket**

Causes:
(a) lack of pipe preparation;
(b) fitting heating coil failure.

ELECTROFUSION SOCKET JOINT RECORD SHEET

CONTRACT:
CONTRACTOR:
PIPE SIZE/RATING:
JOINTING EQUIPMENT:

OFFICE:
SITE ENGINEER:
PIPE/FITTING MANUFACTURER:
SUPERVISOR:

Date	Joint No./ location	Jointer	Weather conditions	Ambient temperature (°C)	Heat cycle (sec)	Cooling cycle (min)	Melt indicators risen	Melt at socket mouth	Evidence of pipe end preparation	Coupler centralised

Figure 4(a) Electrofusion socket joint record sheet

SERVICING AND CALIBRATION RECORD SHEET
ELECTROFUSION SOCKET JOINTING
GENERATORS

AUTHORITY/CONTRACTOR: ..... DATE: .....

ADDRESS: ..... SERVICE CONTRACT NO.: .....

..... EQUIPMENT MANUFACTURER: .....

CONTACT: ..... TYPE: ..... SERIAL NO.: .....

AMBIENT TEMP. °C: ..... VOLTAGE: ..... POWER RATING: .....

VISUAL INSPECTION	SATISFACTORY YES	NO
Is unit complete?		
Is any damage evident?		
Check oil and fuel levels		
Check starting mechanism		

WARM UP AT FULL LOAD FOR 15 MINUTES
LOAD TEST AS FOLLOWS:

POWER %	kVA	VOLTS	Hz	AMPS		
0						
60						
100						
110						

kVA	Manufacturer's Rating
kVA	Maximum Tested Rating

ELECTRICAL TEST	VALUE LIMIT	ACTUAL		
Check R.C.C.B. operation				
Check internal wiring for security				
Check voltmeter display				
Check changeover switch				
Check oil alert device (During oil change)				
Check earth bond				
Check insulation				

RECOMMENDED ACTION: _____

The above work has been carried out: Test equipment used/calibration traceability:

Checked by: ..... Calibration date: .....

Supervisor's signature: ..... Next service/calibration due: .....

Figure 4(b) Typical servicing and calibration record sheet

SERVICING AND CALIBRATION RECORD SHEET
ELECTROFUSION SOCKET JOINTING
ELECTROFUSION CONTROL BOX

AUTHORITY/CONTRACTOR: ..... DATE: .....

ADDRESS: ..... SERVICE CONTRACT NO.: .....

..... EQUIPMENT MANUFACTURER: .....

CONTACT: ..... TYPE: ..... SERIAL NO.: .....

AMBIENT TEMP. °C: ..... VOLTAGE: .....

VISUAL INSPECTION EXTERNAL	SATISFACTORY YES	NO
Check input cables for security & damage		
Check output cables for security & damage		
Check fitting lead		
Check frame & box for security & damage		

VISUAL INSPECTION INTERNAL		
Check for water ingress		
Check condition of 'O' ring		
Check for electrical security		
Check for correct fuses		
Check all securing screws for security		

ELECTRICAL INSPECTION AND TESTS	VALUE LIMIT	ACTUAL		
Check for earth continuity				
Check insulation resistance				
Check output voltage (@ 1A 97- 150V)				
Check output voltage (@ 50A 97-150V)				
Check low output voltage trip				
Check cal'n of 42 Volts safety trip				
Check high output voltage trip				
Check high input voltage trip				
Check low input voltage trip				

ELECTRICAL INSPECTION AND TESTS (continued)	VALUE LIMIT	ACTUAL	SATISFACTORY YES	NO
Check timer operation				
Check timer accuracy				
Check all display segments				
Check voltage display accuracy				
Check for fitting fault				
Check full & correct response to push buttons				

CHECK LCD & LED DISPLAYS FOR CORRECT OPERATION			
Operational functions	1 READY		
	2 HEAT		
	3 FINISH		
	4 STOP		
Diagnostics	1 INPUT		
	2 OUTPUT		
	3 FITTING		

Counter Reading

RECOMMENDED ACTION: _____

The above work has been carried out.

Checked by: .....

Supervisor's signature: .....

Test equipment used/calibration traceability:

Calibration date: .....

Next service/calibration due: .....

Figure 4(c) Typical servicing and calibration record sheet

SERVICING AND CALIBRATION RECORD SHEET
ELECTROFUSION SOCKET JOINTING
ELECTRICAL SAFETY TEST

AUTHORITY/CONTRACTOR: .....
ADDRESS: .....
.....
CONTACT: .....
AMBIENT TEMP. °C: .....

DATE: .....
SERVICE CONTRACT NO.: .....
EQUIPMENT MANUFACTURER: .....
TYPE: ..... SERIAL NO.: .....
VOLTAGE: .....

	VALUE		SATISFACTORY	
VISUAL INSPECTION	**LIMIT**	**ACTUAL**	**YES**	**NO**
Is unit complete?				
Is unit damaged?				
Check plug for electrical security				
Check socket for electrical security				
ELECTRICAL INSPECTION				
Check earth bond				
Check insulation				
Flash test (where permissible)				
Operational test				
Load test				
		Pass or Fail		

RECOMMENDED ACTION: _____

The above work has been carried out:

Checked by: .....
Supervisor's signature: .....

Test equipment used/calibration traceability:

Calibration date: .....
Next service/calibration due: .....

Figure 4(d) Typical servicing and calibration record sheet

5.5 Training

5.5.1 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 250.

5.5.2 Objectives

The course should enable the participant to:

* understand the principles of MDPE 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;
* inspect for and identify acceptable quality joints.

5.5.3 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 MDPE pipe and fittings of nominal size 20 to 250;
* suitably maintained and calibrated electrofusion socket jointing equipment and accessories for the nominal size range 20 to 250.

5.5.4 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 5.5.2.

The certificate shall identify the pipe and fitting size range used.

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

6. ELECTROFUSION SADDLE JOINTING OF MDPE

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 effectiveness of this technique depends on attention to cleanliness, in particular the removal of the oxidised surface of the pipe over an area equivalent to the saddle base.

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 180.

Three methods of holding the tapping tee saddle during the fusion cycle are used, top loading, under clamping and wrap-around systems. However, because of the variations of equipment used for under clamping and wrap-around systems, common procedures for holding the saddle during the fusion cycle
cannot be specified, although 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.

6.1 Equipment – procedure

i) Control box capable of providing up to 2kVA at 39/40 volts RMS. The control box input supply shall be from a nominal 110 volts (55V–0–55V) generator of 2.5/3kVA capacity. Control boxes shall conform to WAA Information and Guidance Note (IGN) No. 4-32-07 (in course of preparation).

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

WARNING: Control boxes are not intrinsically safe 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 – 0.4mm thick.

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.

6.2 Electrofusion saddle jointing method

6.2.1 Preparation

i) Expose the pipe onto which the tapping tee saddle is to be assembled.

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.

iv) Remove the surface of the pipe over the full marked area using a suitable tool to a depth of 0.2 to 0.4mm. Remove the swarf.

v) Check that reset stop button on the control box, if fitted, is in the correct mode.

6.2.2 Electrofusion saddle jointing procedure

i) Remove the fitting from its packaging, take off the threaded cap and attach the fitting to the adaptor of the top loading assembly tool by means of the socket in the fitting's integral cutter.

ii) Position the fitting base onto the prepared pipe surface and apply the pre-set load.

iii) Remove the terminal caps from the fitting.

iv) Check that there is sufficient fuel for the generator to complete the joint. Start the generator and check that it is functioning correctly.

v) Connect the electrofusion control box input leads to the generator.

vi) Connect the control box output leads to the fitting terminals and check that they have been fully inserted.

vii) Switch on the control box if applicable.

viii) 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.

ix) Press the start button on the control box and check that the heating cycle is proceeding as indicated by the display count down.

x) On completion of the heating cycle, the melt indicators should have risen. If there is no apparent movement of the melt indicators, where incorporated, a new saddle joint should be made. Cut the tee of the faulty joint from its base.

xi) If a satisfactory joint has been made, the joint shall be left in the clamps for the cooling time specified on the fitting label.

NOTE 1: If the fusion cycle terminates before completion of the count down, check for faults as indicated by the control box warning lights. 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 fusion cycle.

6.3 Maintenance, calibration and servicing

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.

6.4 Records

6.4.1 Job supervision

Written records of appropriate fusion procedure details shall be kept as required using the format illustrated in Figure 5(a).

6.4.2 Equipment servicing and calibration

Written records of appropriate servicing and calibration details, carried out at a frequency agreed with the manufacturer shall be kept using the format illustrated in Figures 5(b), 5(c) and 5(d).

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

6.5 Training

6.5.1 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.

6.5.2 Objectives

The course should enable the participant to:

* understand the principles of MDPE 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 acceptable quality joints.

6.5.3 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 MDPE pipe and fittings of nominal pipe size 20 to 250;
* suitably maintained and calibrated electrofusion saddle jointing equipment and accessories for nominal pipe size range 20 to 250.

6.5.4 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 6.5.2.

The certificate shall identify the pipe and fitting size range used.

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

ELECTROFUSION SADDLE JOINT RECORD SHEET

CONTRACT:
CONTRACTOR:
PIPE SIZE/RATING:
JOINTING EQUIPMENT:

OFFICE:
SITE ENGINEER:
PIPE/FITTING MANUFACTURER:
SUPERVISOR:

Date	Joint No./ location	Jointer	Weather conditions	Ambient temperature (°C)	Heat cycle (sec)	Cooling cycle (min)	Melt indicator risen	Melt at saddle base	Surface pipe preparation

Figure 5(a) Electrofusion saddle joint record sheet

NOTES relating to Figure 5(a) – Electrofusion saddle joint fault recognition

A well made electrofusion saddle joint should have the following features:

* The melt indicator should have operated;
* There should be no melt flowing from round the saddle base;
* There should be evidence of pipe surface preparation round the saddle base.

The following features indicate faults during the assembly/fusion operation:

(1) **Fusion indicator fails to operate**

Causes: (a) incorrect fusion time selected – too short;
(b) control box out of specification – under voltage;
(c) fitting heating coil failure;
(d) incorrect fitting for size of main;
(e) top load too low on loading tool.

(2) **Excess melt from melt indicator or from saddle base**

Causes: (a) incorrect fusion time selected – too long;
(b) control box out of specification – over voltage;
(c) insufficient pressure from top loading assembly tool;
(d) timer failure – too long;
(e) incorrect fitting for size of main;
(f) top load too high on loading tool.

(3) **Inadequate fusion of saddle base on main**

Causes: (a) lack of pipe preparation;
(b) fitting heating coil failure.

SERVICING AND CALIBRATION RECORD SHEET
ELECTROFUSION SADDLE JOINTING
GENERATORS

AUTHORITY/CONTRACTOR: ..... DATE: .....

ADDRESS: ..... SERVICE CONTRACT NO.: .....

..... EQUIPMENT MANUFACTURER: .....

CONTACT: ..... TYPE: ..... SERIAL NO.: .....

AMBIENT TEMP. °C: ..... VOLTAGE: ..... POWER RATING: .....

	SATISFACTORY	
VISUAL INSPECTION	**YES**	**NO**
Is unit complete?		
Is any damage evident?		
Check oil and fuel levels		
Check starting mechanism		

WARM UP AT FULL LOAD FOR 15 MINUTES
LOAD TEST AS FOLLOWS:

POWER %	kVA	VOLTS	Hz	AMPS		
0						
60						
100						
110						

kVA	Manufacturer's Rating
kVA	Maximum Tested Rating

	VALUE			
ELECTRICAL TEST	**LIMIT**	**ACTUAL**		
Check R.C.C.B. operation				
Check internal wiring for security				
Check voltmeter display				
Check changeover switch				
Check oil alert device (During oil change)				
Check earth bond				
Check insulation				

RECOMMENDED ACTION: _____

_____

_____

_____

The above work has been carried out: Test equipment used/calibration traceability:

Checked by: ..... Calibration date: .....

Supervisor's signature: ..... Next service/calibration due: .....

Figure 5(b) Typical servicing and calibration record sheet

SERVICING AND CALIBRATION RECORD SHEET
ELECTROFUSION SADDLE JOINTING
ELECTROFUSION CONTROL BOX

AUTHORITY/CONTRACTOR: ..... DATE: .....

ADDRESS: ..... SERVICE CONTRACT NO.: .....

..... EQUIPMENT MANUFACTURER: .....

CONTACT: ..... TYPE: ..... SERIAL NO.: .....

AMBIENT TEMP. °C: ..... VOLTAGE: .....

VISUAL INSPECTION EXTERNAL	SATISFACTORY YES	NO
Check input cables for security & damage		
Check output cables for security & damage		
Check fitting lead		
Check frame & box for security & damage		

VISUAL INSPECTION INTERNAL		
Check for water ingress		
Check condition of 'O' ring		
Check for electrical security		
Check for correct fuses		
Check all securing screws for security		

ELECTRICAL INSPECTION AND TESTS	VALUE LIMIT	ACTUAL		
Check for earth continuity				
Check insulation resistance				
Check output voltage (@ 1A 97- 150V)				
Check output voltage (@ 50A 97-150V)				
Check low output voltage trip				
Check cal'n of 42 Volts safety trip				
Check high output voltage trip				
Check high input voltage trip				
Check low input voltage trip				

ELECTRICAL INSPECTION AND TESTS (continued)	VALUE LIMIT	ACTUAL	SATISFACTORY YES	NO
Check timer operation				
Check timer accuracy				
Check all display segments				
Check voltage display accuracy				
Check for fitting fault				
Check full & correct response to push buttons				

CHECK LCD & LED DISPLAYS FOR CORRECT OPERATION			
Operational functions	1 READY		
	2 HEAT		
	3 FINISH		
	4 STOP		
Diagnostics	1 INPUT		
	2 OUTPUT		
	3 FITTING		

Counter Reading

RECOMMENDED ACTION: _____

_____

_____

_____

_____

The above work has been carried out.

Test equipment used/calibration traceability:

Checked by: .....

Calibration date: .....

Supervisor's signature: .....

Next service/calibration due: .....

Figure 5(c) Typical servicing and calibration record sheet

SERVICING AND CALIBRATION RECORD SHEET
ELECTROFUSION SADDLE JOINTING
ELECTRICAL SAFETY TEST

AUTHORITY/CONTRACTOR: .....
ADDRESS: .....
.....
CONTACT: .....
AMBIENT TEMP. °C: .....

DATE: .....
SERVICE CONTRACT NO.: .....
EQUIPMENT MANUFACTURER: .....
TYPE: ..... SERIAL NO.: .....
VOLTAGE: .....

	VALUE		SATISFACTORY	
VISUAL INSPECTION	**LIMIT**	**ACTUAL**	**YES**	**NO**
Is unit complete?				
Is unit damaged?				
Check plug for electrical security				
Check socket for electrical security				
ELECTRICAL INSPECTION				
Check earth bond				
Check insulation				
Flash test (where permissible)				
Operational test				
Load test				
		Pass or Fail		

RECOMMENDED ACTION: _____

The above work has been carried out:

Checked by: .....
Supervisor's signature: .....

Test equipment used/calibration traceability:

Calibration date: .....
Next service/calibration due: .....

Figure 5(d) Typical servicing and calibration record sheet

7. QUALITY ASSURANCE

To claim compliance with this specification, and in order to achieve consistently good quality fusion joints, installers shall operate a management control system for site fusion jointing practice acceptable to WRc.

Assessment by WRc of the achievement of these requirements will take the form of an audit against 7.1 to 7.10 below. Independent testing of fusion joints may also be required.

7.1 Organisation

On each site where pipes and fittings are to be jointed in accordance with the requirements of IGN No. 4-32-08, 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.

7.2 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.

7.3 Document control

This shall ensure that:
(a) 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.

7.4 Purchasing

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

7.5 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 IGN No. 4-32-08 (Sections 2. to 6.)

7.6 Inspection and testing

7.6.1 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.

7.6.2 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.

7.6.3 Inspection and test records

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

7.7 Corrective action

The installer shall establish, and maintain procedures to show evidence of:
(a) 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 correcrive action.

7.8 Handling and storage

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

7.9 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.

7.10 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. Appropriate records of training shall be maintained.

8. REFERENCES

This specification makes reference to the latest edition (except where otherwise stated) of the following publications, including all addenda and revisions which should also be consulted.

BS 5750	Quality systems Part 2 Specification for production and installation
BS 5781	Measurement and calibration systems Part 1 Specification for system requirements
BS 6572	Specification for blue polyethylene pipes up to nominal size 63 for below ground use for potable water
BS 6730	Specification for black polyethylene pipes up to nominal size 63 for above ground use for cold potable water

WAA Sewers and Water Mains Committee Information and Guidance Notes:

No. 4-32-02	Specification for polyethylene press ure pipe for cold potable water (underground use)
No. 4-32-03	Specification for blue polyethylene (PE) pressure pipes for cold potable water (nominal sizes 90 to 1000 for underground or protected use)
No. 4-32-04	Specification for polyethylene socket and spigot fittings, saddles and drawn bends for fusion jointing for use with cold potable water PE pressure pipes
No. 4-32-05	Specification for polyethylene (PE) pipes for sewer linings (non pressure applications)
No. 4-32-06*	Specification for polyethylene electrofusion couplers and fittings for cold potable water supply for nominal sizes up to and including 180
No. 4-32-07*	Specification for electrofusion control boxes for use with fittings complying with IGN No. 4-32-06.
No. 4-32-09*	Specification for black polyethylene (PE) pressure pipes for sewage and above ground potable water (nominal sizes 90 to 1000)
WRc/WAA	Manual for MDPE pipe systems for water supply

* in course of preparation.

APPENDICES

The outline procedures given in Appendices A to F are written to assist trained operatives in the making of good fusion joints.

For full details of the procedures to follow, reference should be made to Section 2. to 6. of this specification.

1. Check equipment is complete, clean, undamaged and in working order.

2. Check pipe and fittings are of the same nominal size and material.

3. Check pipe end has been cut square and deburred.

4. Clean pipe and fitting.

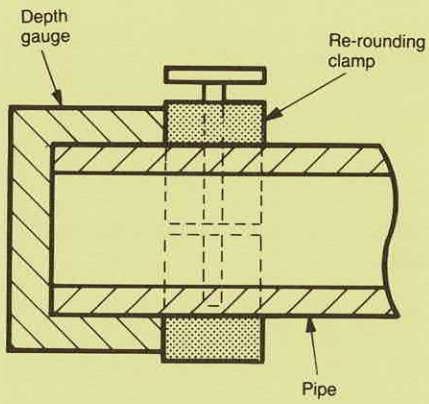
5. Position depth gauge and fix re-rounding clamp. Remove depth gauge.

6. Where required use fitting holder.

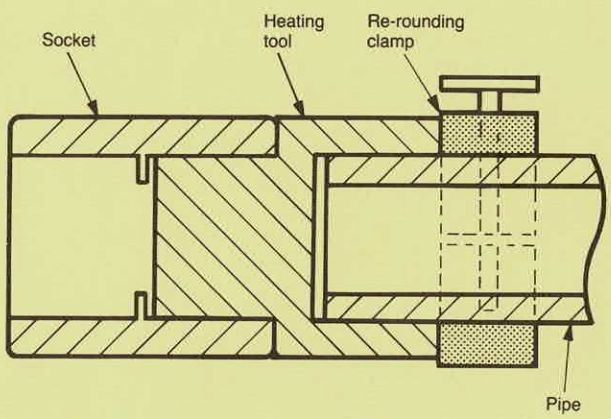
7. Check fuel in generator.

8. Determine heating time required.

9. Place heating tool onto pipe end and into fitting to full insertion depth.



Stage 5 Position of depth gauge and re-rounding clamp.



Stage 9 Heating pipe end and fitting socket.

10. Start heating time.

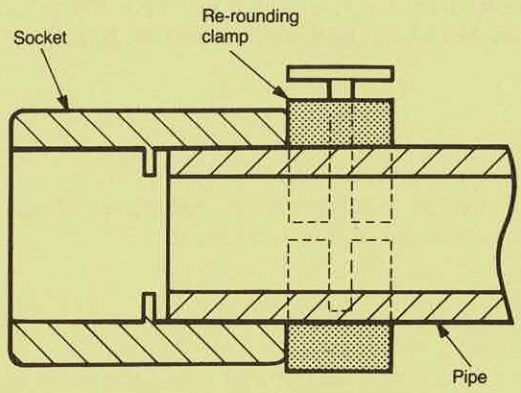
11. At end of heating time remove pipe and fitting from tool by snap action.

12. Immediately push pipe and fitting fully together and hold for at least 2 minutes.

13. Remove fitting holder and re-rounding clamp.

14. Inspect joint.

15. Remove any melt contamination from heating faces.



Stage 11 Assembly of fittings socket onto pipe.

1. Check equipment is complete, clean, undamaged and in working order.

2. Separate the clamps completely.

3. Check pipe and fitting are of the same nominal size and material.

4. Check pipe end has been cut square and deburred.

5 Clean pipe and fitting.

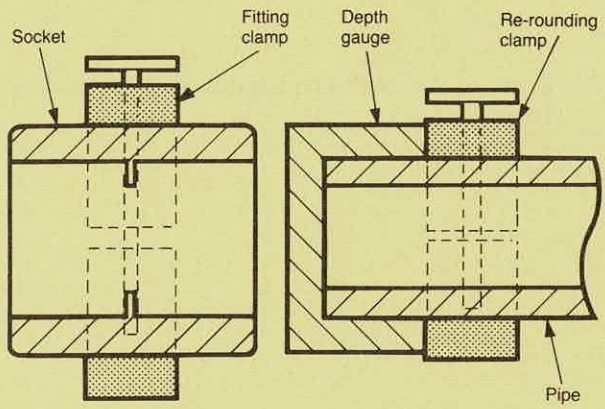
6. Position pipe and fitting in their respective clamps.

7. Position depth gauge and fix re-rounding clamp. Remove depth gauge.

8. Place heating tool in the machine.

9. Check fuel in generator.

10. Determine heating time required.



Stage 7 Position depth gauge and re-rounding clamp.

11. Bring clamps together so that both pipe and fitting are at the full insertion depth on the heating heads.

12. Start heating time.

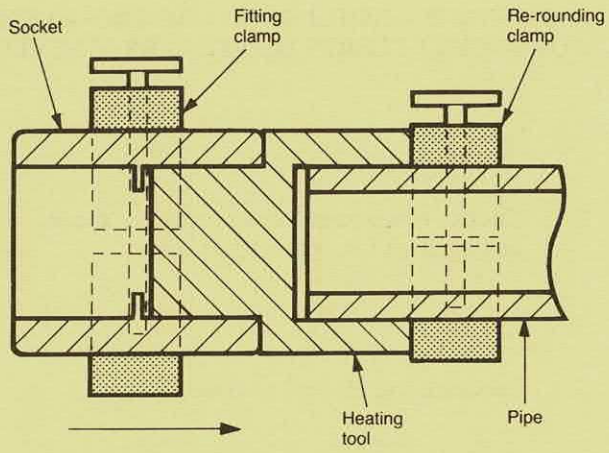
13. At the end of heating time, separate pipe and fitting from tool by snap action.

14. Immediately bring pipe and fitting fully together and hold for at least 2 minutes.

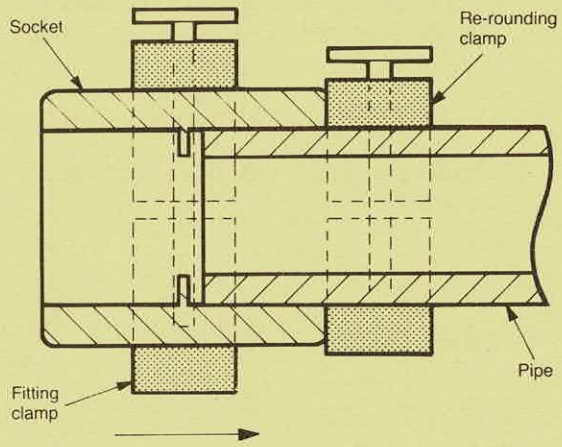
15. Remove jointed pipe from re-rounding clamp and fitting holder.

16. Inspect joint.

17. Remove any melt contamination from heating faces.



Stage 12 Heating pipe end and fitting socket.



Stage 14 Assembly of fitting socket onto pipe.

1. Check equipment is complete, clean, undamaged and in working order.

2. The first weld of the day shall be a dummy joint. For sizes greater than 180, two dummy joints shall be made.

3. Check pipes (or pipe and fitting) are of the same nominal size, pressure rating and material.

4. Clean pipe and, where applicable, fitting.

5. Separate clamps completely and position planer.

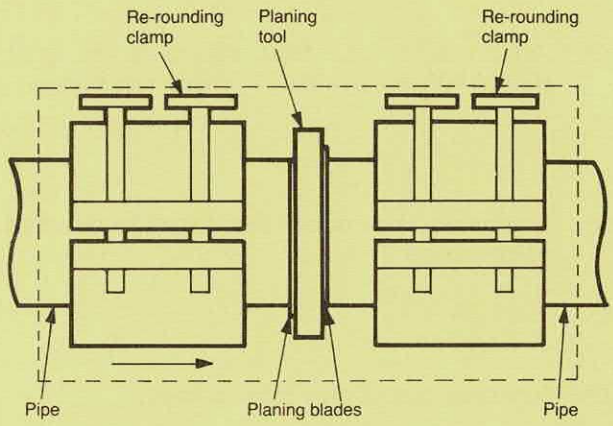
6. Position pipe (or pipe and fitting) with ends touching and planing tool end tighten clamps.

7. Switch planing tool on and press pipe ends (or pipe and fitting) against tool until continuous shavings are produced from both components.

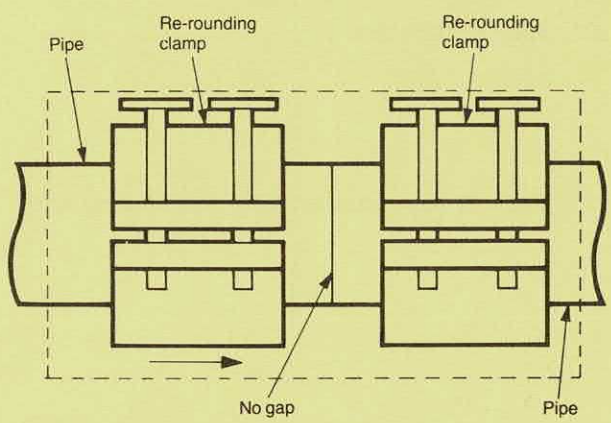
8. Continue planing whilst separating pipes (or pipe and fitting). Switch off planing tool and remove after blades are at rest.

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. Replane if necessary. Check that mismatch is within acceptable limits.



Stage 7 Planing pipe ends.



Stage 10 Check no gap between pipe ends.

11. Check fuel in generator.

12. Check required bead-up pressure and initial bead size. Press pipes or pipe and fitting against the heater plate using this pressure.

13. After the initial bead-up release the pressure in the system. Check that clamps do not move and maintain ends in contact with the heater plate for the soak time – see machine data plate.

14. Open clamps, remove heater plate and examine it for molten material. If present, do not make the joint.

15. If heater plate is clean, immediately bring the two ends together over an 8 second period (including plate release time) using a smooth action. The fused material should roll back in a uniform manner.

16. Allow the joint to cool whilst maintaining it at the joint pressure.

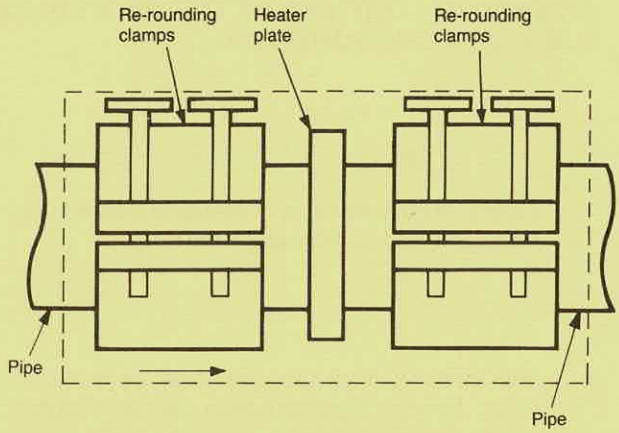
17. After cooling (the temperature of the bead should be less than 40°C) release the clamps.

18. If required, the external beads shall be removed after cooling.

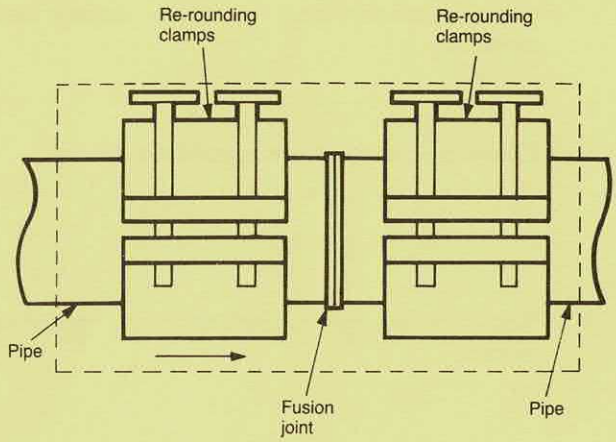
19. Remove jointed pipe from clamps.

20. Inspect the joint.

21. Remove any contamination from heating faces.



Stage 13 Heater plate installed.



Stage 15 Formation of fusion joint.

1. Check equipment is complete, clean, undamaged and in working order.

2. Check pipe and fitting are of the same nominal size and material.

3. Clean pipe surface in the fusion area. Retain saddle in its packaging.

4. Scrape pipe surface over fusion area. Lightly scrape base of saddle.

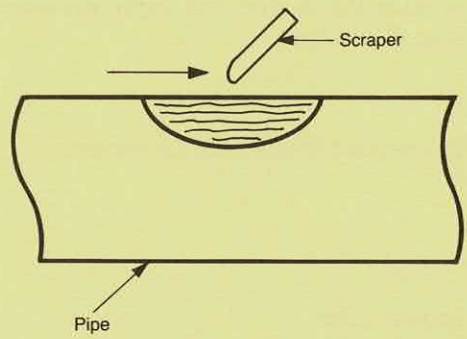
5. Where required fit correct size of window clamp.

6. Check fuel in generator.

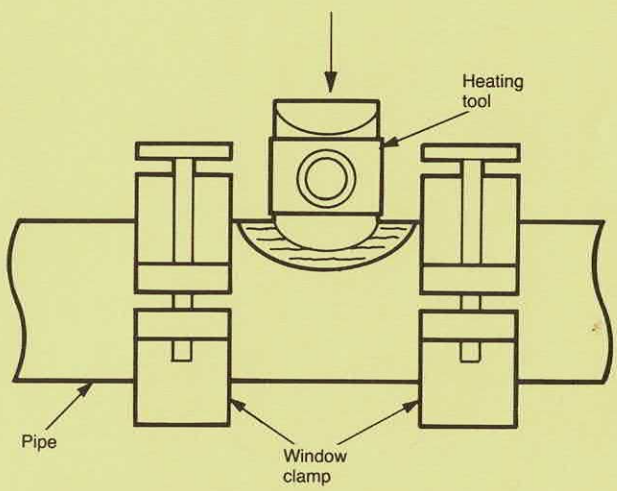
7. Determine heating time required.

8. Place heating tool onto prepared pipe surface and press firmly for 10 seconds. Remove the tool and check for alignment.

9. Replace tool and correct for alignment if required. Press firmly for further 15 – 20 seconds. Snap off heating tool and check for melt pattern. If this is not complete, do not proceed and restart ther jointing procedure 250mm away.



Stage 4 Preparation of pipe surface.



Stage 8 Alignment check.

10. If the melt pattern is satisfactory replace heating tool and position saddle on the outer surface of the tool. Apply pressure.

11. Heating time starts now.

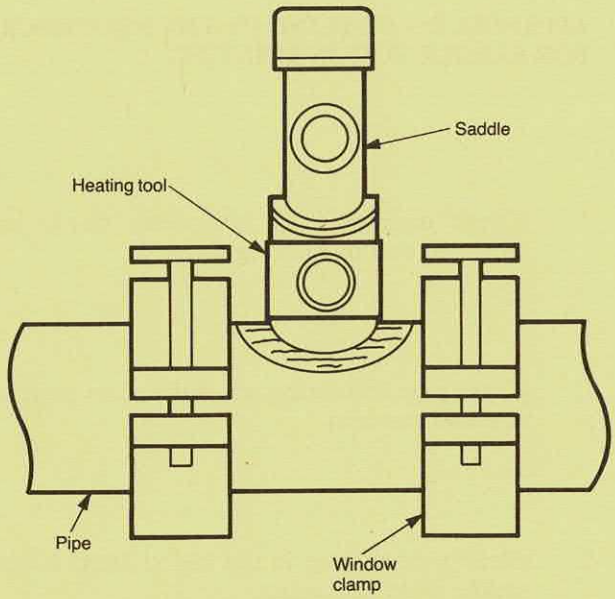
12. At the end of the heating time snap fitting off heating tool and heating tool off pipe.

13. Check melt pattern and if satisfactory quickly position the saddle and apply pressure for at least 60 seconds.

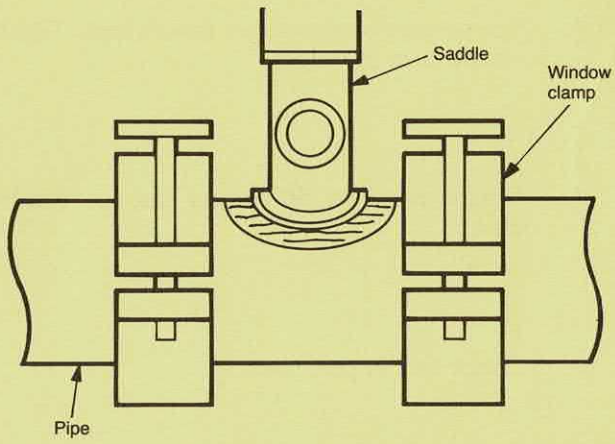
14. Allow joint to cool for 15 minutes.

15. Inspect joint.

16. Remove any melt contamination from heating faces.



Stage 10 Heating saddle and pipe surfaces.



Stage 13 Forming joint between saddle and pipe.

1. Check equipment is complete, clean, undamaged and in working order.

2. Clean pipe ends.

   DO NOT REMOVE FITTING FROM ITS PACKAGING.

3. Connect the electrofusion control box input leads to generator.

4. Check fuel in generator.

5. Check reset stop button on the control box, if fitted, is in the correct mode.

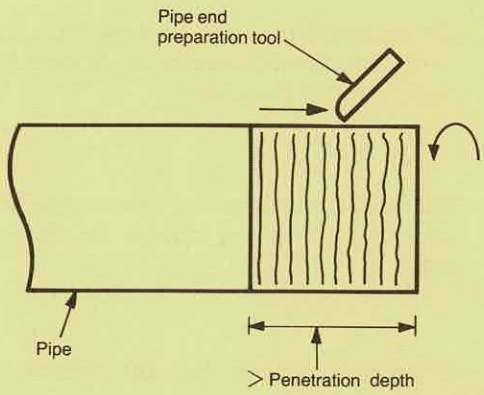
6. Using the pipe end preparation tool remove the pipe surface over a length in excess of the penetration depth.

DO NOT TOUCH THE PREPARED PIPE SURFACE.

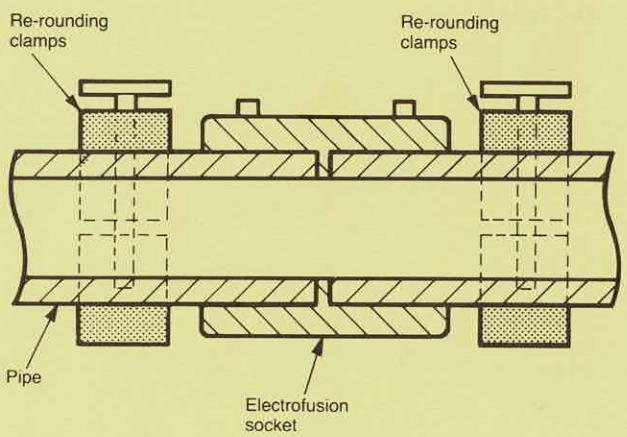
7. Remove fitting from its packaging and check that it is clean. If necessary, dry it with clean lint-free material.

8. Insert pipe ends up to the centre stop of the fitting.

9. Secure the pipes with the pipe clamps and check for alignment of pipes and fittings.



Stage 6 Pipe end preparation (repeat both ends).



Stage 9 Alignment check.

10. If applicable, remove terminal caps.

11. Connect control box output leads to the fitting terminals. Check that they are fully inserted.

12. Switch on the control box.

13. Enter the fusion time into the control box timer. Check that the time shown on the control box display is the same as that indicated on the fitting.

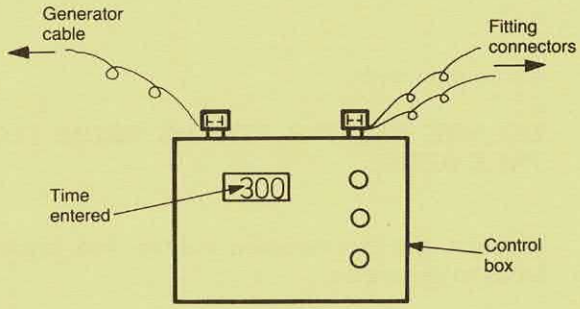
14. Press the start button and check that the count-down is proceeding.

15. On completion of the heating cycle, the melt indicators should have risen. If they have not risen, cut out the joint.

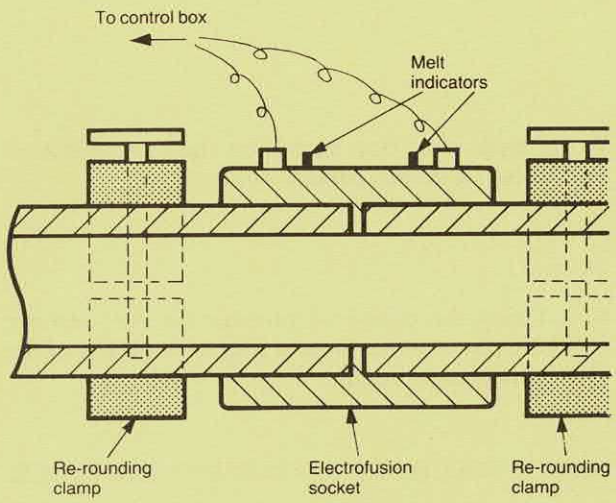
16. If a satisfactory joint has been made, allow the joint to cool in the clamps for the specified time.

17. When cool, remove the joint from the clamps.

18. Inspect joint.



Stage 13 Enter fusion time into control box.



Stage 15 Completion of heating cycle.

1. Check equipment is complete, clean, undamaged and in working order.

2. Check pipe and fitting are of the same nominal size and material.

   RETAIN SADDLE IN ITS PACKAGING.

3. Clean pipe surface in the fusion area.

4. Scrape pipe surface over fusion area.

   DO NOT TOUCH THE PREPARED PIPE SURFACE

5. Remove fitting from its packaging and attach fitting to the adaptor of the top loading assembly tool. Remove protective saddle pad.

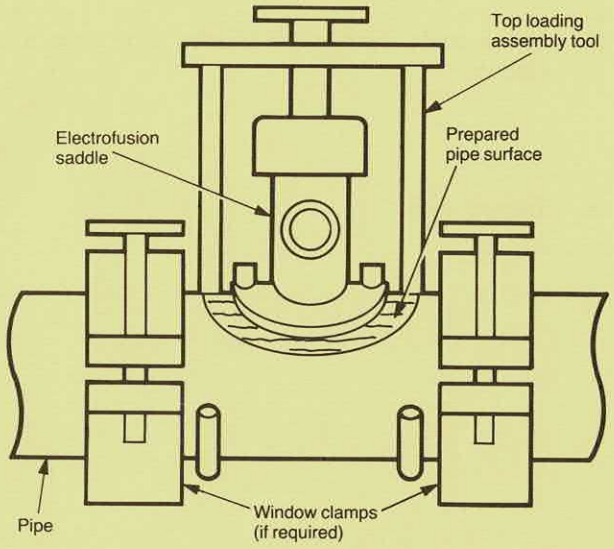
6. Position fitting base onto the prepared area and apply the pre-set load.

7. Remove terminal caps from fitting.

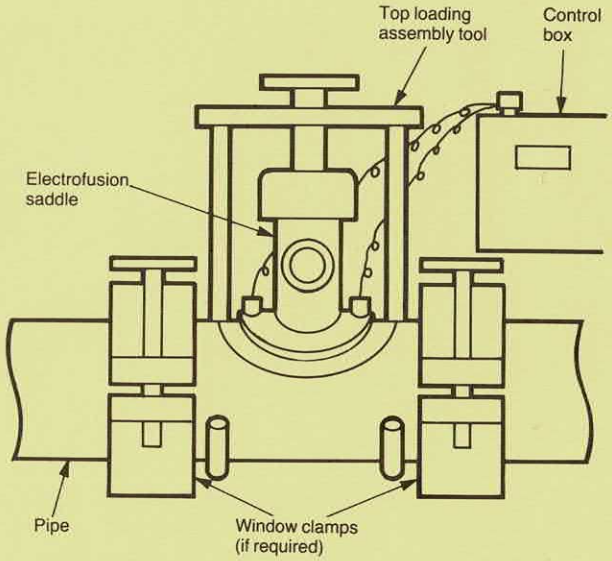
8. Connect control box output leads to fitting and check that they have been fully inserted.

9. Switch on the control box.

10. 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 6 Assembly of fitting onto prepared pipe and application of pre-set load.



Stages 8/9/10 Connections to control box and setting fusion time.

11. Press the start button and check that the count-down is proceeding.

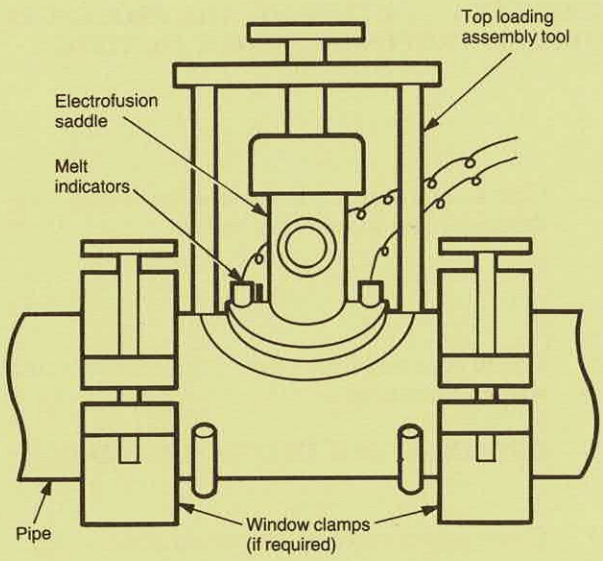
12. On completion of the heating cycle, the melt indicators should have risen. If they have not risen, a new saddle joint should be made at a distance 250mm from the abandoned position.

13. Cut off the faulty saddle at the base.

14. If a satisfactory joint has been made, allow the joint to cool in the clamps for the specified time.

15. When cool, remove the jointed pipe from the clamps.

16. Inspect joint.



Stage 12 Check fusion indicators have risen.