

Suggested minimum content for training of fusion welders

Background

The Plastic Pipes Liaison Group's paper "Practical Steps to Achieving Zero Interruptions, Zero Leaks" <https://bit.ly/2CFmuDA> challenges the industry to build on the current best practice set out in WIS 4-32-08: Issue 4 using properly designed and delivered training which promotes knowledge of the entire fusion jointing process, explains the fundamental principles of good jointing and measures the competency of attendees.

The objectives and means of assessment are set out in the PPLG paper. The detailed content, which has been prepared by water companies, manufacturers, equipment suppliers and training providers, is included in this companion document.

Structure of document

The document sets out the theory and practical course content for each jointing type and pipe size range in turn. The list below contains links to the relevant content.

Electrofusion - Theory

- [Objectives](#)
- [EF1 Electrofusion 1 \(20mm-180mm\)](#)
- [EF2 Electrofusion 2 \(200mm-315mm\)](#)
- [EF3 Electrofusion 3 \(≥355mm to 630mm\)](#)

Electrofusion - Practical

- [Objectives](#)
- [EF1 Electrofusion 1 \(20mm-180mm\)](#)
- [EF2 Electrofusion 2 \(200mm-315mm\)](#)
- [EF3 Electrofusion 3 \(≥355mm to 630mm\)](#)

Butt fusion – Theory

- [Objectives](#)
- [BF1 Butt Fusion 1 \(63mm-315mm\)](#)
- [BF2 Butt Fusion 2 \(>355mm to 900mm\)](#)
- [Pipes > 900mm](#)

Butt fusion – Practical

- [Objectives](#)
- [BF1 Butt Fusion 1 \(63mm-315mm\)](#)
- [BF2 Butt Fusion 2 \(>355mm to 900mm\)](#)

- [Pipes > 900mm](#)

A. ELECTROFUSION TRAINING – THEORY

Training objectives – all modules

By completing the theoretical training module, candidates will:

- be able to describe the equipment and procedures used for jointing PE pipes by electrofusion;
- be able to recognise the adaptations in equipment and procedures needed for different pipe types (e.g. coiled, peelable);
- be able to explain using examples how the incorrect use of equipment and procedures can contribute to poor quality joints;
- be ready to apply the theoretical learning to practical situations.

Training content – EF1 (20mm – 180mm)

Topic	Detail
Introduction	Health and safety relevant to the welding process and working in the field
	Relevant standard (WIS 4-32-08)
	Pressure rating and SDR rating for pipes and fittings
	Correct storage for pipes and fittings
	The consequences of producing a poor quality weld
	The different types of PE (PE 80 and PE 100) and how these materials differ from Polypropylene and Polyvinylchloride (PVC)
	The effect of ovality, pipe end alignment and pipe end reversion
	Pupped bends and fittings (potential issues regarding clamping and scraping)
Welding equipment	Generator and use of power ratings relevant to the procedure being undertaken
	Control box and bespoke equipment to ensure correct welding set up
	Pipe surface preparation tools for conventional pipes, pipes with a peelable skin, barrier pipes and coextruded pipes.
	Pipe clamps for re-rounding and restraining pipes and positioning electrofusion tapping tees and saddles
Ancillary equipment	Welding shelter
	Pipe support Rollers
	Coil straightening equipment
	Techniques for lifting of pipes
	Pipe Cutters
	Pi tape
	Marker pen (for marking insertion depths)
	Isopropanol cleaning wipes
	Pipe end plugs
Feeler gauge	
Site preparation, equipment and hygiene	Preparation of welding area (planning)
	Siting of equipment
	Importance of site hygiene
	Erecting the shelter

	Appropriate ambient temperature for welding and control of ambient temperature
	Checks for generator, control box and tooling
Production of welds (straight lengths)	Checking of pipe/ fittings (markings, damage or ovality)
	Cleaning/preparation of pipe surface (conventional pipes)
	Cleaning/preparation of pipe surface (pipes with protective skin)
	Clamping, re-rounding of pipe and dealing with end reversion
	Checking alignment of pipe relative to fitting and for evidence of gaps
	Operation of the control box
	Making the weld
	Consequences of missing a step in the welding process
Production of welds (coiled pipes)	All elements for straight lengths plus the following:
	Understanding of difficulty and safety issues with coiled pipes
	Specialist equipment (coil straighteners) for welding of coiled pipes
	Techniques for welding of coiled pipes
	Making the weld
	Consequences of missing a step in the welding process
Production of branch saddle welds	Outlet sizes appropriate for service to be supplied (e.g. 25mm, 32mm or 63mm)
	Cleaning/preparation of pipe surface (conventional pipe, co-extruded pipe & pipe with protective skins)
	Types of clamping (underclamp, top loading and strap clamps)
	Re-rounding of pipe
	Making the weld
	Consequences of missing a step in the welding process
	Pipe cutting
Assessment of weld quality	Alignment of weld and evidence of gaps
	Check for axial movement of pipe relative to fittings
	Observation of melt indicators
	Techniques for destructive and non-destructive testing (NDT) of welds
	Commissioning pressure tests. Pressure tests for electrofusion top tees and saddles
Maintenance	Importance of machine calibration and periodic checks on pipe surface preparation tools. Welder's responsibility for checking
	Maintenance of equipment and the responsibility of the welder for maintenance
	Servicing and calibration of equipment
Records	Welding records
	Job supervision records
	Certification information for welding personnel
	Calibration records
	Welder's personal log book of welds produced

Training content – EF2 (200mm - 315mm)

Topic	Detail
Introduction	As EF1
Welding equipment	As EF1 amended as:
	Add: Appreciation of working with smartphone-based weld monitoring systems
	Delete: Pipe surface preparation tools for pipes with peelable skin, barrier pipes and coextruded pipes
Ancillary equipment	As EF1
Site preparation	As EF1
Production of welds (straight lengths)	As EF1 amended as:
	Delete: Cleaning / preparation of pipe surface (pipes with protective skin)
Production of welds (coiled pipes)	Not included in EF2
Production of branch saddle welds	As EF1
Assessment of weld quality	As EF1
Maintenance	As EF1
Records	As EF1

Training content – EF3 (≥355mm - 630mm)

The training for EF3 is the same as EF2 with the addition of specific instruction on:

- Mechanical handling and safe working with heavy items
- Manufacturer specific equipment (for pipe preparation, alignment and clamping e.g. Pi-tape, mechanical scraper, specific type of fusion control box, de-burring tool, saddle clamps and straps, tooling for cutting and tapping into pipes)
- Manufacturer specific methodology (e.g. use of impact force to drive fittings onto pipes, pre-heat cycles, data logging)
- Importance of attention to dimensional tolerances, their measurement and recording

B. ELECTROFUSION TRAINING – PRACTICAL

Training objectives – all modules

By completing the practical training module, candidates will be able to:

- demonstrate the correct preparation and procedures for jointing PE pipes by electrofusion in realistic site conditions chosen to show the different conditions encountered due to seasonal or environmental factors;
- complete the satisfactory jointing of PE pipes by electrofusion in the range of pipe sizes and pipe types (e.g. coiled, peelable) covered by the training;
- adapt to changes in equipment and procedures needed for different coupler / fitting types;
- apply the practical learning to the working environment.

Training content – EF1 (20mm – 180mm) and EF2 (200mm – 315mm)

Topic	Detail
Health and safety	Potential dangers with use of electrofusion equipment and tooling
	Setting up a safe area for electrofusion welding and safety procedures that should be followed
Site and equipment pre-welding checks	Site suitability
	Calibration dates
	Welding shelter
	Visual checks for equipment damage
	Checks on suitability of ancillary equipment
Pipe and fitting pre-welding checks	Pipe size
	Pipe surface damage
	Identify pipe type (Material type and whether solid wall, coextruded or skinned pipe)
	Ovality
	Pipe end reversion
	Pipe end alignment
	Fitting packaging damage
Fitting damage	
Pipe preparation	Hygiene
	Marking pipe
	Scraping pipe surface
	Use of isopropanol welding wipes and consequences of improper use
	Skinned and peelable pipe
	Clamping arrangement
Coupler joint assembly	Restraint and alignment
	Rerounding and ovality
	Voltages
	Fusion and cooling times
Saddle joint assembly	Restraint and clamping
	Rerounding and ovality
	Voltages
	Fusion & Cooling times
Making the joint	Operation of fusion equipment

	Procedure if the fusion cycle is not completed
Post welding checks	Visual checks for successful completion of fusion
	Checks for misalignment, excessive pipe and melt movement
	Procedure to follow if the weld is observed to be defective

Training content - EF3 (≥355mm - 630mm)

The training for EF3 is the same as EF2 with the addition of specific instruction on:

- Mechanical handling and safe working with heavy items
- Manufacturer specific equipment (for pipe preparation, alignment and clamping e.g. Pi-tape, mechanical scraper, specific type of fusion control box, de-burring tool, saddle clamps and straps, tooling for cutting and tapping into pipes)
- Manufacturer specific methodology (e.g. use of impact force to drive fittings onto pipes, pre-heat cycles, data logging)
- Importance of attention to dimensional tolerances, their measurement and recording

C. BUTT FUSION TRAINING – THEORY

Training objectives – All modules

By completing the theoretical training module, candidates will:

- be able to describe the equipment and procedures used for jointing PE pipes by butt fusion;
- be able to recognise the adaptations in equipment and procedures needed for different pipe types (e.g. coiled, straight length) and sizes;
- be able to explain using examples how the incorrect use of equipment and procedures can contribute to poor quality joints;
- be ready to apply the theoretical learning to practical situations.

Training content – BF1 (63mm - 315mm) and BF2 (>355mm - 900mm)

Topic	Detail
Introduction	Health and safety relevant to the welding process and working in the field
	Relevant standard (WIS 4-32-08)
	Differences between manual, semi-automatic and automatic machines
	Pressure rating and SDR rating for pipes and fittings
	Correct storage for pipes and fittings
	The consequences of producing a poor quality weld
	The different types of PE (PE 80 and PE 100) and how these materials differ from Polypropylene and Polyvinylchloride (PVC)
	The effect of ovality, pipe end alignment and pipe end reversion
	Pupped bends and fittings (potential issues regarding clamping)
Welding equipment	Generator and use of power ratings relevant to the procedure being undertaken
	Control box
	Chassis and clamps
	Hydraulic unit/control box
	Trimming tool
	Heater plate
Ancillary equipment	Welding shelter
	Pipe support Rollers
	Coil straightening equipment (coiled pipe only)
	Techniques for lifting of pipes
	Pipe Cutters
	Pi tape
	Marker pen
	Lint free cloths and water
	Digital thermometer and probe
	Timer
	Bead gauge
	Pipe end plugs
De-beading tools (External & Internal beads)	
Site preparation	Preparation of welding area (planning)

	Siting of equipment
	Checking the equipment
	Importance of site hygiene
	Use of ground sheets or baseboards
	Erecting the shelter
	Appropriate ambient temperature for welding and control of ambient temperature
Preparation for welding	Cleaning the trimming tool
	Cleaning/washing the heater plate
	Checking the pipe (for damage and excessive ovality)
	Positioning of the pipe
	Clamping of the pipes
	Using the trimming tool
	Removing the pipe shavings from the machine
Checking the pipe ends (misalignment and mismatch)	
Production of welds	Applying the heater plate
	Initial bead-up pressure and heat soak
	Heater plate removal and weld cooling
	Dummy welds
	Single pressure welding
	Dual pressure welding
	Understanding Drag pressure and gauge pressure calculation
Rejection of unsuitable welds	
Assessment of weld quality	Removal of internal and external weld beads and need for inspection by the twist test
	Applying the twist test to weld beads
	Techniques for destructive and non-destructive testing (NDT) of welds
	Commissioning pressure test
Maintenance	Importance of machine calibration and periodic checks of trimming tool and heater plate
	Maintenance of equipment
	Servicing and calibration of equipment
Records	Welding records
	Job supervision records
	Certification information for welding personnel
	Calibration records
	Databases for recording welding production and location of welds
Welder's personal log book of welds produced	

Additional training content – Pipes > 900mm

Training content for butt fusion welding of pipes greater than 900mm diameter is the same as BF1 and BF2 with the addition of specific instruction on:

- Mechanical handling and safe working with heavy items
- Manufacturer specific equipment

D. BUTT FUSION TRAINING – PRACTICAL

Training objectives – All modules

By completing the practical training module, candidates will:

- demonstrate the correct preparation and procedures for jointing PE pipes by butt fusion in realistic site conditions chosen to show the different conditions encountered due to seasonal or environmental factors;
- complete the satisfactory jointing of PE pipes by butt fusion in the range of pipe sizes and pipe types (e.g. coiled, straight length) covered by the training (see Figure 2);
- apply the practical learning to the working environment.

Training content – BF1 (63mm - 315mm) and BF2 (>355mm - 900mm)

Topic	Detail
Health and safety	Potential dangers of use of butt fusion equipment and tooling
	Setting up a safe area for butt fusion welding and the safety procedures that should be followed
Welding equipment	Manual, semi-automatic and automatic machines
Site and equipment preparation	Site suitability (Planning)
	Calibration dates
	Welding shelter
	Visual checks for equipment damage
	Checks on suitability of ancillary equipment
Pipe pre-welding checks	Pipe size and SDR
	Pipe surface damage
	Identify pipe type (Material type and whether Solid wall, coextruded or skinned pipe)
	Ovality
	Pipe end reversion
Preparation for welding	Pipe handling – use of supports
	Pipe preparation – skinned pipe requirements
	Alignment of pipe ends
	Dummy weld(s)
Production of welds	Welding parameters (single and dual pressure) and stages of welding cycle
	Monitoring of gauge pressure
	Drag pressure
Post welding checks	Review of welding record produced
	Examination of bead and assessment of pipe alignment
	Removal and testing of the weld bead
	Action to be taken in the case of a defective weld bead

Additional training content – Pipes > 900mm

The training for butt fusion welding of pipes greater than 900mm diameter is the same as BF1 and BF2 with the addition of specific instruction on:

- Mechanical handling and safe working with heavy items
- Manufacturer specific equipment
- Manufacturer specific methodology
- Importance of attention to dimensional tolerances, their measurement and recording