Plastics Industry Pipe Association of Australia Limited ACN 086 511 686

Industry Guidelines

BUTT FUSION JOINTING OF PE PIPES AND FITTINGS - RECOMMENDED PARAMETERS

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BUTT FUSION JOINTING OF PE PIPES AND FITTINGS - RECOMMENDED PARAMETERS

The PIPA Technical Committee has prepared this publication as a guide to the butt fusion of polyethylene pipe using AS/NZS 4130 material as a basis.

INTERNATIONAL STANDARDS

PIPA recommends the butt fusion procedures and parameters as specified in ISO 21307, *Plastics pipes and Fittings – Butt Fusion Jointing Procedures for Polyethylene (PE) Pipes and Fittings Used in Construction of Gas and Water Distributions Systems*. Copies of ISO 21307 may be purchased from SAI Global www.saiglobal.com or other Standards suppliers.

ISO 21307 specifies three proven butt fusion jointing procedures for pipes and fittings with a wall thickness up to and including 70 mm, taking into consideration the materials and components used, the fusion jointing procedure and equipment and the quality assessment of the completed joint. It also covers the weld procedure for activities such as surface preparation, clamping, alignment and cooling procedures.

Where ISO 21307 references other International Standards, the equivalent Australian Standard is deemed to apply. Where there is no equivalent Australian Standard then the International Standard applies.

International Standard	**Subject Matter**	**Australian Standard**
ISO 8085-2	Fittings	AS/NZS4129 Section 6
ISO 4437	Gas Pipe	AS/NZS4130
ISO 4427	Water Pipe	AS/NZS4130
ISO 12176-1	Equipment	**Not applicable *****
ISO/TS 10839	Installation	AS/NZS2033, AS/NZS 4645
ISO 13593	Tensile Test	N/A
ISO 1167-1	Hydrostatic Pressure Test	AS/NZS 4130 Clause 10.1
ISO 1167-3	Hydrostatic Pressure Test	AS/NZS 4130 Clause 10.1
ISO 1167-4	Hydrostatic Pressure Test	AS/NZS 4130 Clause 10.1
ASTM F2634	High speed tensile test	N/A

******* PIPA does not require the use of the International Standard ISO 12176-1 *Plastics pipes and fittings — Equipment for fusion-jointing polyethylene systems*. Some technicalities in the design requirements of the ISO standard have the potential to unjustly exclude welding machines that have clearly demonstrated consistent, successful performance in Australia for many years.

Background Information

Butt welding involves the heating of two pipe ends to fusion temperature and then subsequently joining the two ends by the application of force. However, a successful butt weld requires the correct combination and sequence of the welding parameters time, temperature and pressure.

Various proven butt fusion methods with minor differences have been in use in different countries for many years. ISO 21307 contains three distinct fusion methods described below for pipe and fittings with a wall thickness up to and including 70 mm.

It is essential that the parameters specified for a given method are followed. Do not mix and match parameters from each method.

- **Single pressure – low fusion jointing pressure**
  This method has been used by most European countries and in Australia. The single pressure parameters specified are very similar to those previously specified by PIPA. Welders familiar with those parameters will adapt easily to the ISO Single pressure – low fusion jointing method.
- **Dual pressure – low fusion jointing pressure**

  This method is used by the water industry in the UK, and in Europe for pipe with a wall thickness greater than 20mm. These parameters are not commonly used in Australia.
- **Single pressure – high fusion jointing pressure**

  This method has been used extensively in Northern America. The weld interface pressure is approximately three times the low pressure method and, as a consequence, more of the molten material is extruded from the weld zone, thereby enabling a reduced cooling time. The method is relatively new in Australia and therefore extra attention is required to ensure that:

  1. welding machines have sufficient structural strength and hydraulic capacity to achieve the high pressure parameters in a safe manner. Confirmation should be sought from the machinery manufacturer.
  2. The welding operator is sufficiently experienced and proficient with the parameters.

Where the pipe or fitting wall thickness exceeds 70mm - welding parameters should be agreed between the asset owner and the installer. Under these circumstances the pipe and fitting supplier and the equipment supplier should also be consulted.

APPENDIX: Comparison of ISO 21307 Welding Parameters and values previously published by PIPA

		ISO 21307:2011(E)						Old PIPA Guidelines	
		single pressure and low fusion jointing pressure procedure		dual pressure and low fusion jointing pressure procedure		single pressure and high fusion jointing pressure procedure		as previously published for reference only	
Butt Fusion Parameter	**Units**		Value		Value		Value		Value
Heater plate temperature	°C		200 to 245		230 (+10,-5)		200 to 230		220 ± 15
Initial bead up pressure	MPa	P1	0.17 ± 0.02	P1	0.15 ± 0.02	P1	0.52 ± 0.1	P1	0.175 ± 0.025
Bead up time	second	T1	variable	T1	variable	T1	variable	T1	Approx. $6e_n$
Min. Bead size after T1	mm		first indication of melt everywhere around pipe, up to 1mm						
Bead size after T2 (d)	mm		0.5 + 0.1 e_n (Max 6mm)		0.5 + 0.1 e_n (Max 6mm)		0.15 e_n + 1		0.5 + 0.1 e_n
Heat soak pressure	MPa	P2	0 to drag pressure	P2	0 to drag pressure	P2	0 to drag pressure	P2	Drag only
Minimum heat soak time	second	T2	(11 ± 1) e_n	T2	10 e_n + 60	T2	(11 ± 1) e_n	T2	15 e_n
Maximum heater plate removal time	second	T3	0.1 e_n + 4	T3	≤10	T3	0.1 e_n + 8	T3	3 + 0.01 D_n
Fusion jointing pressure	MPa	P3	0.17 ± 0.020	P3	0.15 ± 0.02	P3	0.52 ± 0.1	P3	0.175 ± 0.025
Max. time to achieve welding pressure	second	T4	0.4 e_n + 2	T4		T4		T4	3 + 0.03 D_n
Fusion jointing time	second				10 ± 1				
Cooling cycle reduced pressure	MPa				0.025 ±0.002 (b)				
Minimum cooling time in machine under pressure	minute	T5	e_n + 3	T5	See ISO 21307 Table A2	T5	0.43 e_n		
Minimum cooling time out of the machine	minute	T6	e_n + 3 (c)	T6	See ISO 21307 Table A2	T6	(a)		
Welding & cooling time: t<15mm	minute							T5	10 + 0.5 e_n
Welding & cooling time: t>15mm	minute							T5	1.5 e_n

(a) A cooling time out of the machine and before rough handling or installation may be recommended, but in most cases is not necessary with these cooling times (see ISO 21307 4.11 for details)
(b) If the wall thickness is above 20mm
(c) additional cooling period that may be required after the cooling time under pressure to ensure optimum joint strength, particularly when working at high ambient temperatures and prior to rough handling or pipe installation
(d) ISO 21307 refers to this value as either "Minimum initial bead-up size" or "Minimum bead size after heating"

Rough Handling means any action other than careful removal of the joint from the machine. Rough handling would include the application of bending or tensile load on the joint and T6 must be completed before the pipe is installed or placed in service.

Notes:

1. e_n = mean pipe wall thickness calculated from AS4130 min/max values, rounded to the nearest mm.
2. D_n = mean pipe outside diameter calculated from AS4130 min/max values, rounded to the nearest mm.
3. Pressure calculation formula:

$$\text{Pressure gauge reading} = \frac{\text{area of pipe annulus x weld interface pressure}}{\text{Cross - sectional area of pressure cylinder}}$$

Where:

Pipe annulus area = π (D - t)t

Pressure MPa

Area mm^2