
POLYETHYLENE PIPE WELDING

General

The Engineer must approve the test weld results before commencement of further welding or any pipe installation can occur. Acceptance or rejection of the weld test results will be available within 3 working days of the results being given to the Engineer.

Polyethylene pipes must be jointed to the manufacturer's recommendations, in compliance with NZSA/AS 4131 and as specified below.

Butt-fusion welding is the primary methodology and must be used to join polyethylene pipes. In some situations the Engineer will approve the Contractor to use Electrofusion welding to join polyethylene pipes. The Contractor must have the Engineer's approval before using Electrofusion welding.

Only automatic or semi-automatic butt-welding machines will be acceptable for this work. Manually operated welding machines are not permitted. All butt welds must be performed by equipment that is specifically designed for welding a range of pipe sizes.

Experienced and suitably qualified personnel must undertake the welding procedure. It is required that the pipe welder will have a recognised PE welding certificate from Unitec or an equivalent. A copy of the certificate is to be provided to the Engineer before any welds are made.

A methodology stating the times, pressures and temperatures that are to be used for each diameter of pipe welded must be submitted to the Engineer prior to welding commencing on site. These will generally be consistent with the manufacturer's recommendations but may be modified to achieve consistently good welds.

Weld Testing Requirements

General

There are two separate phases relating to the testing of Polyethylene welds. The first phase must occur prior to construction of the pipeline and is used to define the welding parameters that will be used for the duration of the works. The second phase is quality assurance testing during construction of the pipeline.

The Contractor is to make sure that during the Bead Pressure time the pipe ends are not quickly pulled together causing the heated material to disperse away from the pipe ends. The pipes ends must be slowly brought together until they touch and then brought up to full pressure.

Weld beads are not required to be removed for water supply applications or storm water. In case of wastewater, beads will be removed from all fusion butt welded joints. Every butt weld is each to be stamped with a weld number and the welder's certification number before the weld cools. The stamp depth must not exceed 5mm. a welding log stating the weld pressures, temperatures and times corresponding to each weld number and certification number must be submitted to the Engineer before the pipe is installed.

Weld Testing to Define Construction Parameters

Prior to construction the Contractor must undertake a series of test welds to demonstrate that the welding parameters being used will produce acceptable weld results. The welds must be undertaken on the specific machine and by the specific operator as will undertake the construction welding.

Where the pipe wall thickness is less than 20mm, two (2) pre-construction welds must be carried out at the same weld parameters. Where the pipe wall thickness is equal to or greater than 20mm, five (5) pre-construction welds must be carried out at varied weld parameters.

Where the pipe wall thickness is equal or greater than 20mm, it is the Contractors responsibility to vary the weld parameters in order to obtain a weld that meets the acceptance requirements in Section E 4.2.

Quality Assurance Testing

During construction the Engineer will randomly select welds from the pipeline. The Contractor must remove the welds and arrange to have them tested.

The Engineer may take quality assurance test welds, in addition to those scheduled, if:

- The Contractor changes the machine, operator, pipe source or resin source during construction.
- Previous weld test results have not met the acceptance criteria.
- In the opinion of the Engineer, a weld is not of an acceptable quality standard.

Weld Test Method

The Contractor must cut out sample welds and arrange for the welds to be tested by an IANZ Registered Laboratory or one approved by the Engineer. These welds are to be a minimum length of 300mm either side of the weld.

The following test must be undertaken on the samples:

Tensile test of a longitudinal strip of pipe including the weld will be taken from equidistant sites in the weld. Refer to table 2 of ISO standard 13953 for the correct number of test pieces per weld for each pipe diameter.

Tensile testing of a longitudinal strip will generally be carried out in accordance with IRS/FDIS 13953 but must be modified as follows:

- a) The type A test specimen must only be used for all samples exceeding 20mm in thickness.
- b) All test strips for Type A tests must be machined down to 20mm thickness by removing material evenly from each side of the pipe and then tested in the Type A test apparatus.

Samples tested in the above manner are referred to as Modified Type A testing to avoid confusion with ISO/FDIS 13953.

- c) For polyethylene pipes with a wall thickness less than 20mm a Type B test must be carried out.

A graph of load versus tensile extension must be supplied with each test specimen to assist in interpretation of ductile and brittle failures. It is acceptable for the tensile extension to be measured on the machine clamps and not on the pipe itself if desired.

Acceptance of Butt Welds

It is recognised that it is difficult to achieve consistent ductile ruptures of PE welds, from the Type A Tensile Test, when the wall thickness is greater than about 20mm. Random brittle results do occur in the thicker walled Type A test specimens, irrespective of the weld parameters used.

The acceptance of tensile results will be based on the following:

- The weld record sheet must show that the weld has been carried out within the tolerances of the weld procedure.
- The visual inspection of the weld must confirm that the weld is consistent with Section 4.3.2.
- Ultimate tensile strength of the weld must be no less than 90% of the pipe strength.
- Modified Type A test specimens must rupture in a generally ductile manner. Some degree of brittleness will be accepted provided that:
 - It occurs in no more than half of the test coupons for any given weld.
 - The nature of the brittleness does not extend over more than 25% of the surface of the weld area tested.
- The Type B test specimens must rupture in a generally ductile manner.

Evaluation of Butt Joint Quality

Welds will be evaluated on the following criteria:

- Visual inspection of welds.
- Welding within agreed welding procedures.
- Weld records to be maintained so that checking of actual weld parameters used can be made against target weld parameters.
- Any welds that are made without the required records being made and supplied to the Engineer will be rejected.
- Until the results of the weld testing to define construction parameters have been approved by the Engineer the Contractor may, entirely at their own risk, weld pipes but may not install any pipe.

Visual Inspection

Each joint will be visually inspected to check that:

- Both fusion beads are of the same size and shape and project evenly above the outside diameter of the pipe.
- The bead width is within the parameters shown in Table 5.
- There are no cracks in the beads.

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- There are no obvious inclusions or other faults present.

A check sheet must be kept by the welder for each weld to show that the above items have been checked.

- Visual inspection of welds.
- Welding within agreed welding procedures.

Wall Thickness (mm)	Overall Bead Width (mm)
11 or less	9-12
13	10-14
16	11-15
18	12-16
19	12-18
22	13-18
24	14-19
28	15-20

Table 5: Bead Width

Note: The width of bead is the total width of the bead measured across both pipe ends.

Supply of Records to the Engineer

Any welds that are made without the required documentation being supplied to the Engineer will not be accepted and will have to be redone.

All welding machines used must have automatic logging facilities incorporated in them. The Contractor must submit the welding log to the Engineer before the pipe is installed. As a minimum these will record the following:

1. Pipeline and location (accurate enough so that the weld location can be determined to 61m).
2. Weld number
3. Weld date
4. Welder ID number
5. Pipe Size
6. Pipe SDR
7. Wall Thickness (e)
8. Annular Area (A)
9. Cylinder Area (a)
10. Fusion Pressure (Po)
11. Plate (T1)
12. Drag Pressure (Dp)
13. Bead Pressure (P1)
14. Soak Pressure (P2)
15. Soak Time (T2)
16. Changeover Time – T3 – ref Auspoly POP 003 Recommended Parameters
17. Time to Achieve Welding Pressure (Ramping Pressure Time) – T4 – ref Auspoly POP 003 Recommended Parameters
18. Weld Pressure 1 (P3 1)
19. Cooling time 1 (t31)
20. Weld Pressure 2 (P32) if applicable
21. Cooling time 1 (t32) if applicable

The results must be given in tabular form. Graphical results are not acceptable.

Welds THAT DO NOT MEET THE ACCEPTANCE CRITERIA

General

If a tensile tested weld fails in a brittle mode before the pipe wall yields then, the test will be classified as a failure.

Failure of a Weld during the Definition of Construction Parameters Stage of Proving of the Strength of the Welds

The Contractor may not carry out any further welding or pipe installation until the Contractor has provided the Engineer with acceptable test results.

If a tensile weld is found to fail at this construction parameters testing stage, the Engineer will instruct the Contractor to supply another two welds for testing.

If these additional two welds fail then the Contractor must submit a report to the Engineer indicating the reasons why welds are failing.

Failure of a Weld during Construction

During Construction the Engineer may select two random welds for testing. The Contractor must test these welds.

If one or both tensile welds fail during construction, the Engineer will instruct the Contractor to supply another two welds for testing. The Engineer will select these next two welds.

If either of the additional two welds fail then the Contractor will be instructed to expose and re-weld every weld constructed up to this point in the Contract to the satisfaction of the Engineer.

The Contractor must also submit a report to the Engineer indicating the reasons why the welds failed.