PIPA PLASTICS INDUSTRY PIPE ASSOCIATION OF AUSTRALIA LIMITED

TECHNICAL PAPER

TP003 SPECIFYING BUTT WELDING OF POLYETHYLENE PIPE SYSTEMS

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This document provides assistance to those involved in preparing specifications for the butt welding of PE pressure pipe systems. The purpose is to make suggestions which can help in the creation of specifications but is **not intended to provide a template for specifications**. This list does not necessarily cover all aspects of a welding specification and, in some cases, it might be required to specify additional elements.

Areas that are covered in specifications include:

PROJECT BACKGROUND

Background information helps the welding contractors understand the conditions that may to be encountered.

Typical aspects that could be covered are:

- location,
- purpose of the project,
- fluid being conveyed,
- pipe procurement and installation if part of the project,
- typical weather conditions,
- any significant site issues,
- accommodation options for remote sites,
- any significant cultural or heritage conditions,
- weld debe
- supplies cranes,
- who supplies Traffic Control,
- Site work hours.

Pipe Specification

If the pipe is clearly specified, then a thorough assessment of butt-welding parameters can be made. The specification should include:

- pipe standard,
- diameter,
- PN and/or SDR,
- standard pipe lengths,
- Series Number (if not specified, series 1 is assumed),
- stripe or jacketing requirements.

The applicable Australian Standards for polyethylene pipe in Australia are:

> AS/NZS 4130:2003, *Polyethylene (PE) pipes for pressure applications*
> AS/NZS 4401:2006, *PE pipe for soil and waste discharge* AS/NZS 5065:2005, *PE and PP pipes for drainage and sewerage*.

It is not necessary to specify that all pipes are to be made from the same compound, or that the pipes are manufactured by the same company, as PE80 and PE100 pipes made to the Australian Standard can be welded to each other.

Only pipes of the same diameter and wall thickness should be butt welded together.

Note: PE80 pipe of the same pressure class and diameter will have a thicker wall than an equivalent PE100 pipe. Where wall thickness variation is a concern consideration should be given to using either Electrofusion fittings, mechanical fittings or consult the pipe manufacturer regarding chamfering options for the thicker pipe.

Fittings Specification

When butt welded fittings are clearly specified there is no confusion with the configuration, for example, moulded elbow versus a sweep bend.

In general, butt welded fittings are supplied in a limited range of SDR's. If the same SDR as the pipe is not available, then a smaller SDR (i.e. thicker wall) may be used providing it is approved within the hydraulic design. If fittings with a smaller SDR are used, then the inside needs to be chamfered to match the inside diameter of the pipe.

Butt Welding Parameters

The butt welding method to be used on the pipeline is specified so that the contractor can consider the equipment required and the competency of the operators with that method. **POP003 contains information regarding welding parameters.** This is available from the Technical Guidelines page in pdf format. POP003 references the ISO 21307 standard *Plastics pipes and Fittings – Butt Fusion Jointing Procedures for Polyethylene (PE) Pipes and Fittings Used in Construction of Gas and Water Distributions Systems*.

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

The "single pressure - high fusion" method is relatively new in Australia so care should be taken to review the equipment and the level of experience of the operators. Although the number of operators experienced with this method may initially be low, this should not preclude them from performing this method. Consideration could be given to testing pre-qualification butt welds or conducting more frequent field tests until all parties are comfortable with this method.

Butt Fusion Equipment

The operator should confirm that the butt fusion equipment has sufficient structural strength and hydraulic capacity to achieve the specified parameters in a safe manner and is in good working order. It is good practice to check heater plate surface temperature and hydraulic pressure gauges with an external device that is regularly calibrated.

Transport, Handling and Storage

The responsibility for handling pipe on site should be clearly defined, considering:

- responsibility for stringing the pipeline,
- drop off points defined,
- storage and security,
- site accessibility,
- unloading responsibility.

Regardless of the level of involvement by the welding contractor, note that transporting, handling and storage of polyethylene pipes should be undertaken in accordance with Section 3.2 of AS/NZS 2033:2008, *Installation of Polyethylene Pipe Systems*.

Pre-Welding Inspection

Time and money can be wasted if the incorrect pipe or damaged pipe is welded. Therefore the welding contractor should always inspect the pipe, using the same criteria as the pre-installation inspection specified in Section 3.3 of AS/NZS 2033:2008, *Installation of Polyethylene Pipe Systems*.

Operator Competence

The value of having competent welders cannot be overstated. The biggest single contribution to a successful butt weld is the competency of the welder. Therefore, it is important that the competency level of the welder be considered in relation to the risks associated over the life of the pipeline. Specifying the level required helps ensure that quotes or tenders can be assessed on an equal basis.

A welding crew will normally contain people with a range of skills and experience from unskilled workers through to trained welders with extensive experience. The specification can define the composition of the crew in terms of expected skills and experience. Typically for a major project the welding supervisor on site would be a trained and experienced welder – i.e. a person trained by a Registered Training Organisation (RTO) and be in a position to provide objective evidence of at least

3 years relevant experience. The remainder of the crew would typically be trained welders (where training was provided by an RTO within the last 3 years) assisted by unskilled workers.

In the case of less critical installations, the level of expertise and experience of the crew can be reduced. In these circumstances consideration may also be given to welders who have been trained by groups other than RTO's.

Butt Welding Site Records

Maintaining records of the welding parameters allows traceability for trouble shooting should a fault be found during weld testing, pipe line commissioning or operation. If traceability is required, the specification should make it clear that records are to be maintained with copies available at any time during construction and a compiled dossier upon completion of the project.

Each weld should be numbered and records for each weld number kept in a log book or computer file, showing:

- weld number
- operator identification
- date and time,
- welding equipment type and model,
- pipe DN and SDR,
- hot plate condition in terms of roughness and cleanliness,
- essential parameters as outlined for the method in ISO 21307 (i.e. hot plate temperatures, heat soak and cooling times, drag, calculated and total pressures),
- confirmation that the weld appears good (no signs of misalignment, porosity, or contamination; beads even and well formed).

Butt Welding Assessment

Visual examination of the weld bead is one of the most effective Non Destructive Test (NDT) techniques.

Bead shape: A visual assessment of the bead is the first indicator of a good or bad weld. Beads should be well rounded on either side of the joint, of uniform size and symmetrical. Observations of bead dimensions, shape and uniformity should be recorded.

Debeading: Beading is the overflow of polyethylene that is extruded on the inside and outside of the pipe. Debeading is the removal of the bead. A section of the external bead is sometimes removed and subjected to a simple bend test to provide a non destructive assessment of weld integrity. This has some potential to highlight problems in a weld such as contamination, inclusions, brittle areas, poor fusion etc. The debeading technique used should not gouge or otherwise damage the pipe.

Butt Welding Testing

Weld testing techniques can be divided into 2 categories – long term tests that are used to evaluate weld parameters and materials and short term tests that are used to assess production welds.

The type and frequency of any tests required should be specified to ensure that quotes or tenders can be assessed on an equal basis. The level of testing needs to be considered in conjunction with the skill and experience of the crew.

In general, traditional NDT options like x-ray or ultrasonics used for steel welding are not suitable for use with PE. There are no definitive references that address all PE weld testing options.

A commonly used destructive method for testing a butt welded joint is a tensile test undertaken in accordance with ISO 13953:2001, *Polyethylene (PE) pipes and fittings - Determination of the tensile strength and failure mode of test pieces from a butt-fused joint*.

Two less common tests are referenced in ISO 21307.

- hydrostatic pressure testing at 80 °C for 1 000 h in accordance with ISO 1167-1, ISO 1167-3 and ISO 1167-4 (this is an example of a long term test),
- high-speed tensile testing in accordance with ASTM F2634 (a short term test).

Destructive tests are undertaken in a laboratory and therefore cannot be used to "prove" the welds in the finished pipe line. Such tests can only be used to provide confidence that the correct parameters and controls are followed by the operator. Tests should be considered for substantial projects but the best controls are provided by adopting appropriate Quality Assurance practices.

If tests are specified, the following points need to be clearly communicated:

- the test method;
- who is responsible for paying for the test;
- at which laboratory the tests are to be performed;
- frequency of testing (e.g. prequalification, random, at defined frequencies such as once per day per welder or once every 50 welds);
- who selects the weld for testing;
- procedures if a test fails.

Quality Assurance Plan

Added assurance can be gained by specifying that the contractor provides a Quality Assurance Plan which demonstrates that the contractor has the resources, capacity and sufficient controls to satisfy the requirements of the project.

A typical Quality Assurance Plan would contain the following:

- document control and distribution;
- list Quality Management Systems (i.e. ISO9001 etc);
- list of personnel showing responsibilities, training, experience;
- welding procedures;
- sample weld records (i.e. blank proforma sheet);
- inspection and Test Plan (tailored to suit the specification);
- any other items required by the specification.

Pipe Commissioning

Refer to AS/NZS 2033 sections 7 and 8 as required.

Other Considerations

The following aspects are not critical for the performance of a successful butt weld but they can be considered and included if necessary.

Installation rates

The contractor can be asked to provide estimated installation rates. This provides useful timing for project management but it can also be used to judge the contractors understanding of the butt welding parameters and the time involved.

Debeading

Debeading is expensive, generally provides no benefit, and should only be considered if really necessary. External debeading may be specified for aesthetic reasons (e.g. steel cable covers on a bridge). Internal bead removal may be specified in situations where low flow fluids carry contaminants that may hang up on the bead.

GPS Records

Recording the GPS coordinates of each weld.

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