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Assessment of Polyethylene Welds

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ASSESSMENT OF POLYETHYLENE WELDS

This guideline discusses the assessment of butt fusion (BF) and electrofusion (EF) welds in polyethylene pipeline systems. The guideline is separated into 3 sections:

- Section 1: General – Information applicable to both BF and EF welds.
- Section 2: Testing of butt fusion welds
- Section 3: Testing of electrofusion welds

Note: Butt welding and Butt fusion are equivalent terms referring to the same process.

SECTION 1 GENERAL

1.0 INTRODUCTION

The two principal methods for welding polyethylene (PE) pipe are butt fusion (also referred to as butt welding (BW)) and electrofusion (EF). Butt fusion has been used successfully in Australia since the 1960s, with electrofusion introduced in the early 1980s.

Both methods are widely used internationally, with in excess of 100 million butt fusion welds and approximately 20 million electrofusion joints completed annually.

PE is the material of choice for gas distribution pipeline systems worldwide and is also extensively used in the water industry, irrigation, mining, and industrial applications. Building on this long record of successful performance, PE is now increasingly specified for highly critical pipeline networks, including applications such as nuclear power generation.

The weld procedures and practices used for jointing polyethylene (PE) pipe systems are well established and comprehensively documented. In Australia, the primary reference documents include:

- **POP001** – *Electrofusion Jointing of PE Pipe and Fittings for Pressure Applications*
- **POP001A** – *Guide to Electrofusion Assembly and Welding (supporting the POP001 guideline)*
- **POP003** – *Butt Fusion Jointing of PE Pipes and Fittings – Recommended Parameters and Practices*

POP003 references the international standard ISO 21307 — *Plastics pipes and fittings – Butt fusion jointing procedures for polyethylene (PE) pipe systems* — which specifies butt fusion welding parameters.

In addition to the above, the acceptance criteria adopted in this guideline are based on established industry standards and supporting technical documentation, including:

- The German DVS Technical Codes on Plastics Joining Technologies
- AS/NZS 2033 – *Design and installation of polyolefin pipe systems*
- AS/NZS 4129 – *Fittings for Polyethylene (PE) Pipes for Pressure Applications*
- UK Water Industry Standards
- ASTM F1055 – *Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing*
- ASTM F2620 – *Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings*

Collectively, these documents form the technical basis for the welding procedures and acceptance criteria referenced in this guideline.

2.0 BACKGROUND TO WELD ASSESSMENT

The examination and testing of PE pipe welds have traditionally been based on visual and destructive testing methods. These approaches have proven highly effective when combined with strict adherence to correct surface preparation and welding procedures.

Visual examination is a valuable non-destructive testing (NDT) technique for PE welds as it provides significant information regarding the joint preparation, potential contamination, pipe alignment, and applied weld pressures. The importance of visual examination is often underestimated, largely because many practitioners are accustomed to relying on radiography or ultrasonics testing in traditional metal welding applications.

However, butt fusion of PE pipe differs significantly from metal welding and these differences make visual examination considerably more effective for PE joints.

During metal welding, a consumable filler material, often different in composition from the parent pipe is commonly introduced in a small, localised molten pool. This pool is typically at a much higher temperature than the surrounding material and progresses incrementally around the circumference during welding.

Butt fusion of PE pipes requires a machine that clamps and aligns the pipe ends, planes the surfaces to ensure they are clean and square, applies heat using a calibrated plate followed by controlled pressure to complete the weld. Each stage of this process is timed and recorded. In this process, no external welding consumables are introduced, the parent pipe material itself forms the weld. The entire joint interface is heated uniformly and after heating, the pipe ends are brought together under pressure. Some of the material from the original face of the pipe end is rolled out to form the bead.

As a result, the appearance, size, and shape of the PE weld bead provide valuable information about the integrity of the entire welding process. Visual examination of metal pipe welds cannot provide equivalent process-wide information, as there is no direct counterpart to the fully formed and displaced bead characteristic of PE butt fusion welding.

3.0 EMERGING NON-DESTRUCTIVE TESTING (NDT) METHODS FOR PE

NDT Techniques other than visual assessment (for example, ultrasonics and radiography) commonly used in the metals industry have limited application to PE weld examination. Methods developed for steel do not reliably detect PE-specific joint issues, such as incomplete fusion or "cold welds," due to differences in material properties and signal response. Mechanisms used in metal inspection, including magnetic or conductivity-based techniques are not suitable for PE, which is neither magnetic nor conductive. Simple pulse-echo ultrasonics and conventional radiography are further limited by high signal attenuation and low density.

Emerging technologies, including phased array time-of-flight diffraction (PAUT) ultrasonics and microwave methods, show potential for future NDT of PE welds. At the time of preparing this guideline, these methods had not matured sufficiently for standardised acceptance criteria. ISO Technical Specifications provide updated guidance for these techniques:

- → ISO/TS 16943 – PAUT for electrofusion socket joints (2023)
- → ISO/TS 22499 – PAUT for butt fusion joints (2024)
- → ISO/TS 24399 – ToFD for butt fusion joints (2025)

These specifications currently apply only to pipes and fittings without barriers to ultrasonic waves.

Table 3 provides guidance on potential butt fusion defects that may be detected by emerging NDT technologies and suggested acceptance criteria should these methods become suitable. No equivalent guidance is provided for electrofusion joints due to current uncertainties regarding technology capabilities.

Further information on emerging NDT techniques can be found in PIPA Technical Note **TN016 – Non-Destructive Examination of PE Welds: Emerging Techniques.**

4.0 OPERATOR COMPETENCE

The success of PE pipe welding depends heavily on the competency of the welder. The single most important factor in achieving a sound butt fusion or electrofusion weld is a welder's skill, adherence to correct surface preparation, and strict compliance with welding procedures.

Welder competency should be considered relative to the criticality of the pipeline. Specifying minimum competency levels ensures consistent performance and allows tenders or quotes to be fairly assessed. Welding crews typically include a mix of skills and experience, ranging from unskilled workers to highly trained welders.

For major projects, the on-site welding supervisor should be a trained and experienced welder, certified by a Registered Training Organisation (RTO) with at least three years of relevant experience, including welding pipe of similar or larger diameters than those used in the project. The remainder of the crew should consist of trained welders (with RTO training within the last three years) supported by unskilled workers.

Welding operators should hold current qualifications and be regularly recertified in the following units:

- **PMBWELD301E** – Join polyethylene plastic pipelines using butt welding
- **PMBWELD302E** – Join polyethylene plastic pipelines using electrofusion welding

5.0 LONG TERM AND SHORT-TERM TESTING

This guideline focuses on short term testing of PE welds primarily intended for field based or rapid turnaround test options typically used as QA/QC measures.

The distinction between long term and short-term testing is often misunderstood. The following provides an overview of the long-term type testing undertaken to demonstrate the long-term performance of welded PE pipe joints.

Plastics pipe systems are subjected to a range of laboratory based long-term type tests to verify performance over their intended service life. These tests commonly involve the pipe being exposed to elevated temperatures for extended periods, often exceeding one year. They are not production tests but rather type tests used to validate materials, product design and jointing techniques to ensure service lives of 100 years or more.

PE welds are similarly assessed using long-term performance tests. For butt fusion joints, these include:

- EN 12814-3 *Testing of welded joints in thermoplastics semi-finished products – Part 3*: *Tensile creep test*
- ISO 1167 *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids - Determination of the resistance of internal pressure*

Long-term creep rupture testing involves either preparing a tensile test specimen from the weld or testing with a full pipe section. In both cases an initial axial stress of 5.4-5.5MPa is generated in the pipe wall or at the weld interface. Testing is conducted in a hot water bath at 80°C until failure – which typically occurs after several thousand hours.

Hydrostatic pressure testing is also conducted in a hot water bath at 80°C and continued until failure, again generally after several thousand hours of testing.

SECTION 2: TESTING OF BUTT FUSION WELDS

1.0 VISUAL EXAMINATION OF BUTT FUSION WELDS

Weld assessment should begin with a detailed visual inspection of the weld and weld bead. Due to the nature of PE butt fusion, the bead itself provides valuable information about the quality of the weld.

The weld bead should be uniform and symmetrical around the full circumference as illustrated in Figure 1 and should not contain any sharp notches. It should also be free from contamination, blistering or voids.

Table 1 defines those features which can be quantitatively assessed, while Table 2 provides bead shapes considered undesirable. Measurement and comparison of bead size are deliberately not specified, as bead dimensions can vary with differing weld parameters, the type of PE materials and even gravitational effects from the top to the bottom of the pipe.

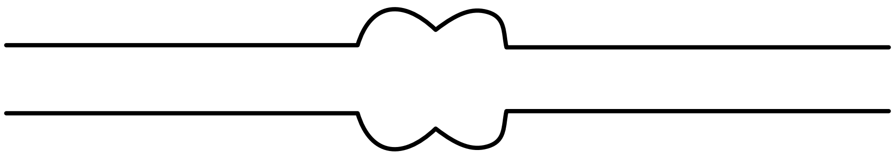


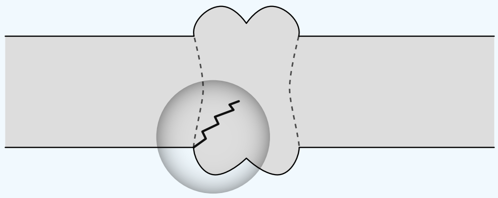
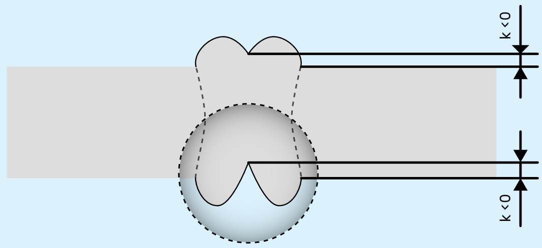
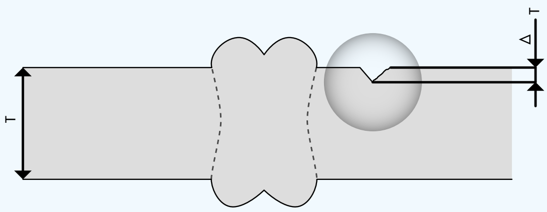
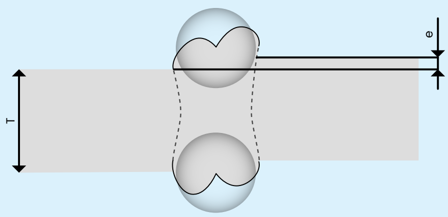
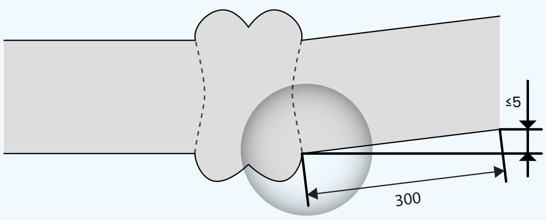
Figure 1

BEAD TESTING

Field testing of the weld bead after removal from the pipe surface can provide a simple indication of weld quality. This test is performed once the weld has fully cooled to ambient temperature. Using a suitable bead removal tool, the bead is carefully removed, ensuring it includes both sides, either side of the centre line of the weld.

The removed bead is then twisted or bent in the reverse curvature to the pipe surface. A sound weld will remain intact. If the bead separates, this indicates a potential issue and the welding parameters and process should be investigated.

Table 1
Quantifiable Criteria for Butt Weld Visual Examination

WELD FEATURE	COMMENTS	ACCEPTANCE CRITERA
1. CRACKING 	Cracking of any kind anywhere in any direction or orientation In the weld bead or parent pipe.	Not acceptable *Based on the German DVS Code and also accepted industry practice internationally*
2. NOTCHES AT INTERFACE 	Sharp notch between weld beads that extends below the original pipe surface with k <0.	Not acceptable *Based on the German DVS Code and also accepted industry practice internationally*
3. SCORING OR NOTCHING OTHER THAN AT THE INTERFACE 	Notches or scoring in any direction. T=wall thickness	Acceptable Where the depth of the notch or score does not exceed 10% of pipe wall thickness. *Based on the German DVS Code, AS/NZS 2033 and also accepted industry practice internationally*
4. MISMATCH OF JOINT FACES 	The joint faces are not aligned or the thickensses have not been matched correctly.	Acceptable When the extent of the displacement does not exceed 10% of the wall thickness. *Based on the German DVS Code and also accepted industry practice internationally*
5. ANGULAR MISALIGNMENT 	Where pipe ends are not aligned squarely.	Acceptable Where the extent of misalignment measured at a point 300mm from the weld bead does not exceed 5mm. *Based on the German DVS Code and also accepted industry practice internationally*

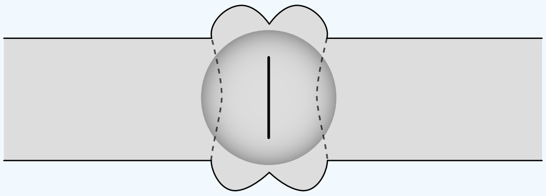
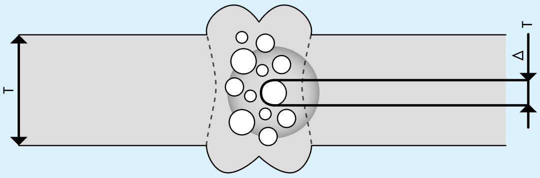
WELD FEATURE	COMMENTS	ACCEPTANCE CRITERA
6. BLISTERING, BUBBLES OR LUMPS ON THE WELD BEAD	Where the surface of the weld bead contain blisters, bubbles or lumps indicating the weld surface may have been wet, too hot or possibly contaminated.	Typically the weld is not acceptable where there is foreign matter visible on the surface or large inclusions or lumps Conditions exist where the weld may be acceptable and these would typically occur where the surface imperfections were small and isolated. Under these circumstances further weld testing is recommended to confirm acceptance. Expert Investigation required. *Based on accepted industry practice internationally*

Table 2
Undesirable Bead Profiles and Associated Investigative Actions

Weld shape – Due to the wide variety of materials and material types, different flash formations may occur during welding. As a result it is not possible to define a standardised evaluation scheme based on flash appearance. The long-term performance and integrity of the welded joint cannot be determined solely by visual inspection of the flash shape.

WELD FEATURE	COMMENTS	ACCEPTANCE CRITERA
1. WELD BEAD VARIATION	The size and shape of weld beads vary due to the weld procedure. Any comparison must be done in relation to a known good weld using the nominated weld procedure and parameters. Possible causes for variations with known good welds could include incorrect pressures and/or temperatures.	Comparisons need to be made to known acceptable welds. Investigate temperature and pressure aspects of welding machine and process.

Table 3
Internal Weld Defects and Acceptance Criteria

WELD FEATURE	COMMENTS	ACCEPTANCE CRITERIA
1. LACK OF FUSION 	Incomplete or no fusion of the pipe faces. Typically caused by contamination of the joint surfaces or incorrect weld parameters.	Not acceptable. *Based on the German DVS Code and also accepted industry practice internationally*
2. VOIDS AND FOREIGN MATTER 	Isolated pores, shrinkage cavities or inclusions within the weld zone.	Permitted where the voids or inclusions are isolated (i.e. not in rows or grouped together) and where the size of individual pores or inclusions do not exceed 5% of the wall thickness. *Based on the German DVS Code*

2.0 DESTRUCTIVE TESTING OF BUTT FUSION WELDS

TENSILE TESTING OF BUTT FUSION WELDS

There are a variety of standard test methods used for tensile testing PE butt fusion welds for example those nominated in:

- POP003 - *Butt Fusion Jointing of PE Pipes and Fittings – Recommended parameters and practices*
- ISO 21307 - *Plastic Pipes and Fittings – Butt Fusion Jointing Procedures for Polyethylene (PE) Pipes and Fittings Used in The Construction of Gas and Water Distribution Systems*
- ISO 13953 - *Polyethylene (PE) pipes and fittings – Determination of the tensile strength and failure mode of test pieces from a butt-fused joint*
- ASTM D638 - *Standard Test Method for Tensile Properties of Plastics*
- ASTM F2634 - *Polyethylene Butt Fusion Joint Test Testing Equipment*
- WIS 4-32-08 - *Specification for the fusion jointing of polyethylene pressure pipeline systems using PE80 and PE100 materials*

These tests are carried out on weld specimens cut from the joint and tested in a laboratory or in the field. Generally, the specimen is expected to fail in a ductile manner, and the failure mode must be interpreted from visual examination of fracture surface. All testing should be conducted in a suitably qualified laboratory by competent personnel to ensure reliable and accurate results. The figures below show ductile and mixed mode photos with their corresponding stress vs extension graphs.

Figure 2: DN800 SDR11 Ductile failure mode photo with corresponding stress vs extension graph.

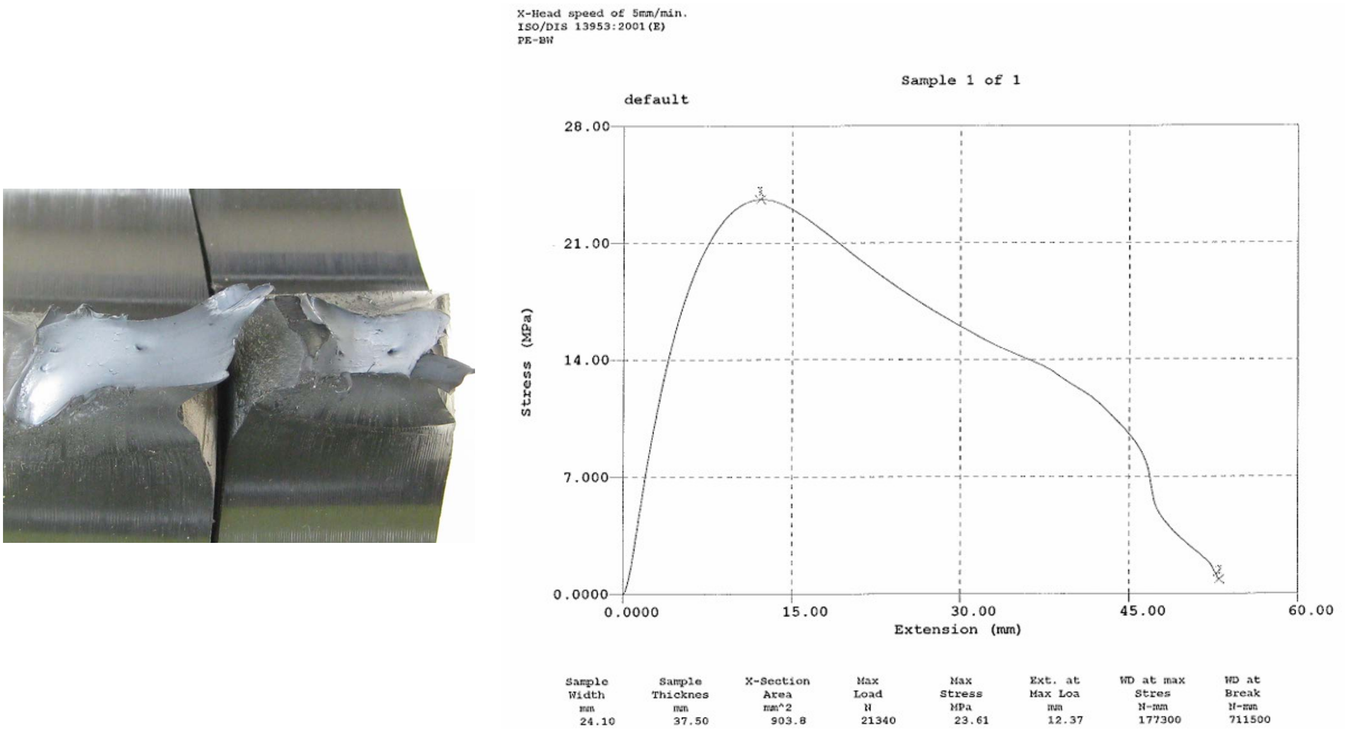


Figure 3: DN400 SDR11 Ductile failure mode photo with corresponding stress vs extension graph.

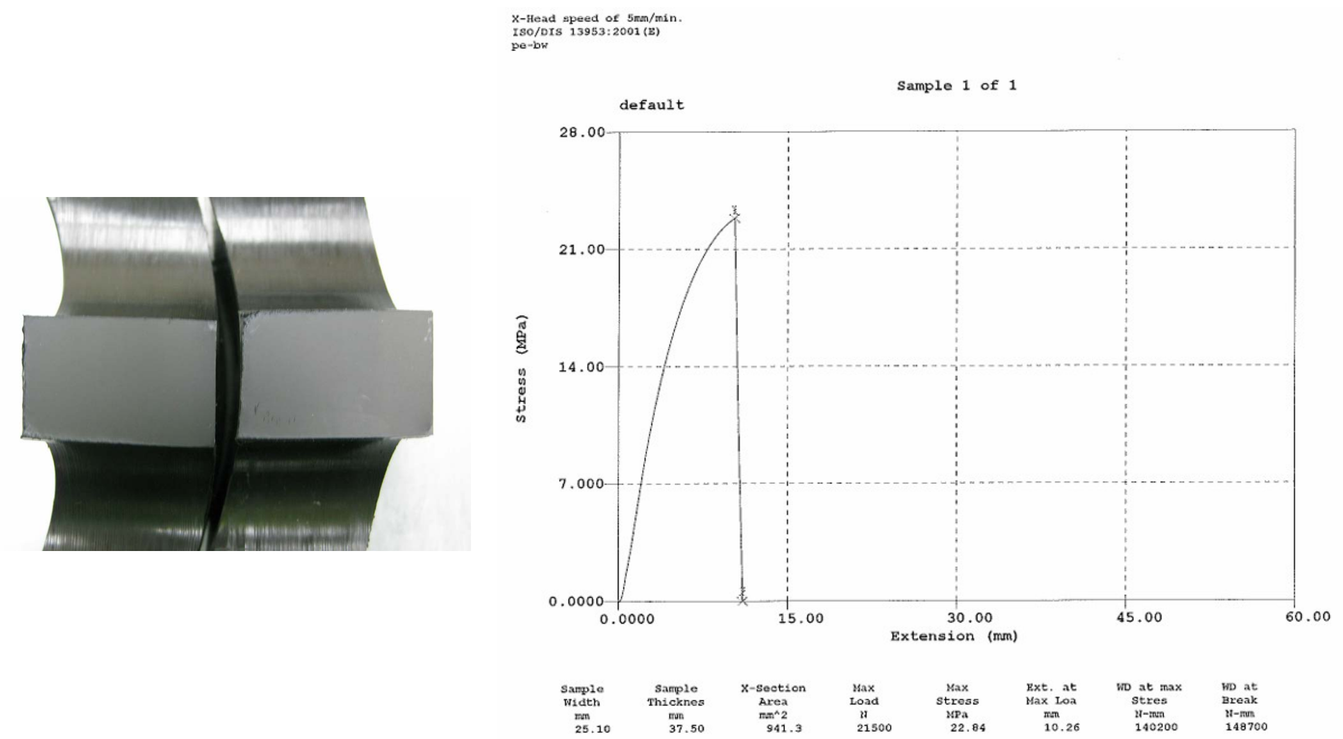


Figure 4: DN400 SDR11 Brittle mode photo with corresponding stress vs extension graph.

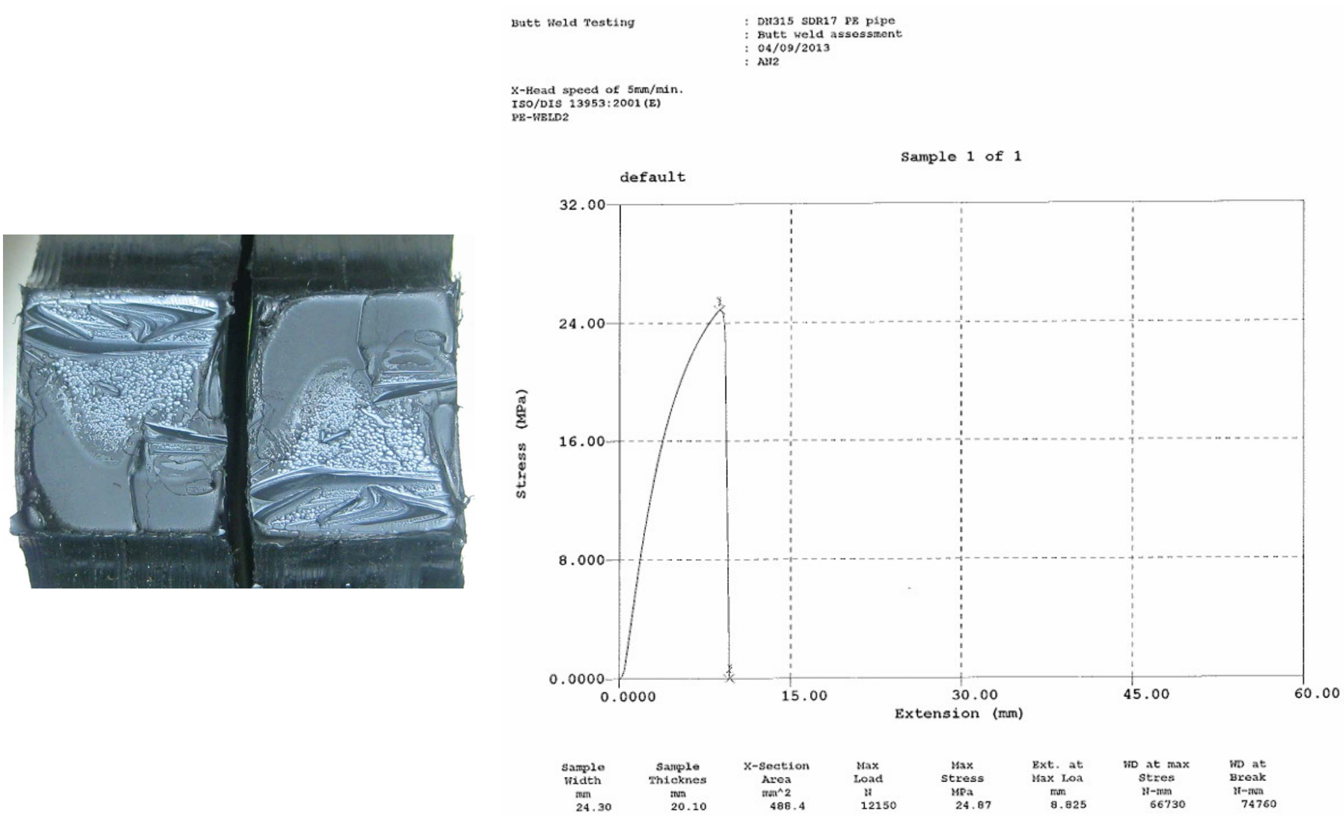


Figure 5: DN315 SDR17 Mixed mode photo with corresponding stress vs extension graph.

In addition to laboratory testing, several field-based tensile testing procedures have been adopted internationally. These methods are destructive and require test coupons to be cut from the weld under examination.

Interpretation of the fracture surface

Following tensile testing, examination of the fracture surface and the recorded load or stress vs. extension graph is required to correctly interpret the overall mode of failure of the test sample i.e., ductile, brittle, or mixed mode. The key fractographic features observed for each of these failure modes and their corresponding load vs. extension graphs plus other pertinent features are described in the table below.

MODE OF FAILURE	FRACTOGRAPHIC FEATURES	LOAD VS. EXTENSION GRAPH FEATURES	OTHER FEATURES	WELD QUALITY
Ductile only	Evidence of necking and plastic deformation. Fracture surface is rough and often highly stretched. Refer to figure 2 & 3	Significant extension is shown after the yield point is achieved with gradual load drop. Load does not drop to zero instantaneously post yield. Refer to figure 6	Weld strength tautology 90% or greater than parent pipe. Failure may occur outside the weld fusion zone i.e., in the parent material.	Acceptable
Brittle only	Fracture surface is flat, smooth, and featureless. No evidence of necking or plastic deformation. Refer to figure 4	Yield point is not achieved and load drops to zero instantaneously. Yield point may be achieved but load drops to zero instantaneously very soon after yield i.e., low extension to break. Refer to figure 7	Failure localised at the weld fusion interface. Loud “bang” typically associated with brittle failure due to the rapid release of energy.	Poor – reject
Mixed mode	Fracture surface exhibits both ductile and brittle features as described above at varying ratios. Ductile regions may show micro-ductility. Refer to figure 5	Yield point may or may not be achieved but load drops to zero instantaneously. i.e., low extension to break. Refer to figure 8	Failure localised at the weld fusion interface. Audible ‘crack’ maybe associated with mixed mode failures.	Marginal to poor - reject

Typical load/stress versus extension graphs by failure mode

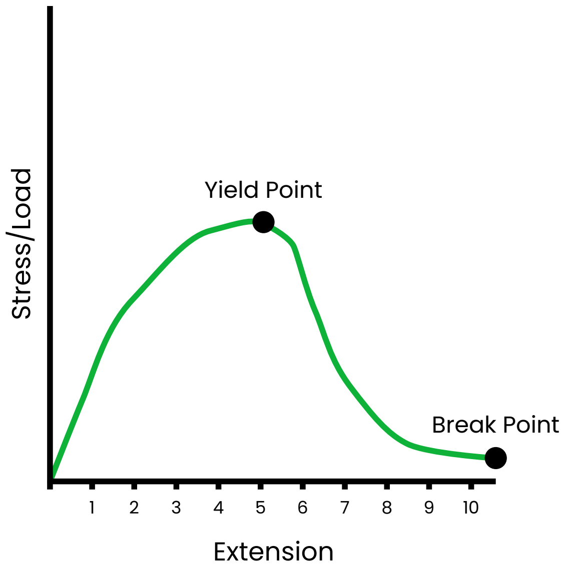


Figure 6 – Ductile mode failure

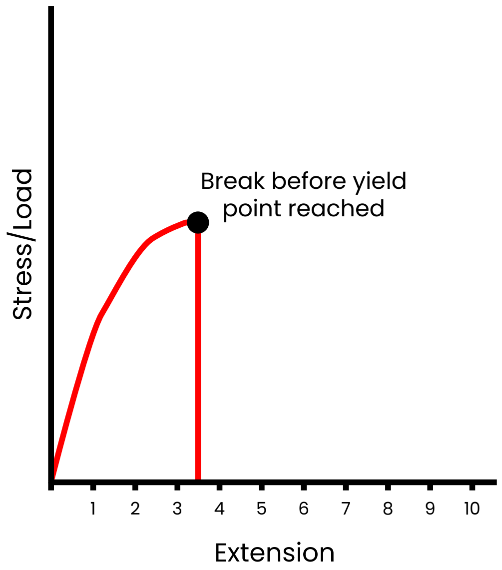


Figure 7 - Brittle mode failure

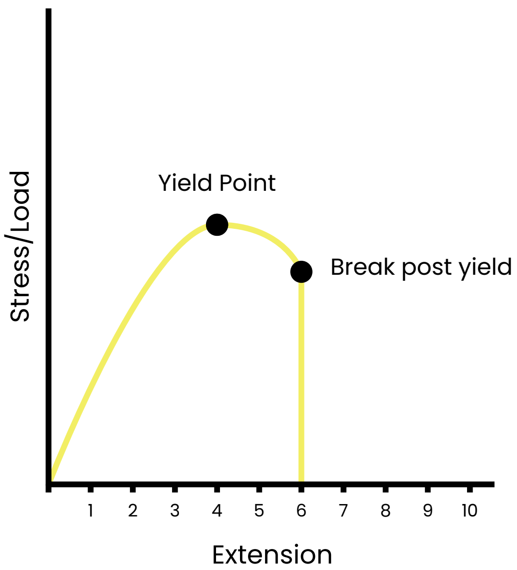


Figure 8 – Mixed mode failure

BEND TESTING OF BUTT FUSION WELDS

As for tensile testing, several standard bend tests are used in Europe, Australia and the United States. Some have well-defined acceptance criteria, while others rely on more qualitative assessment. Testing should always be conducted in a suitably qualified laboratory by competent personnel.

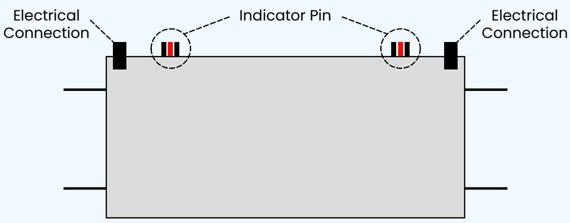
One such test is described in ASTM F2620 *Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings*. In this method a longitudinal strip of pipe including the weld is cut, secured in clamping device and bent back on itself. This is a relatively simple test that can be used in the field. The acceptance criterion is that the specimen does not crack or fracture at the weld.

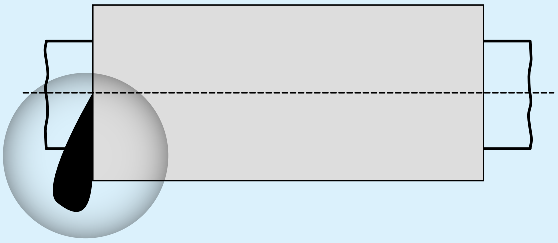
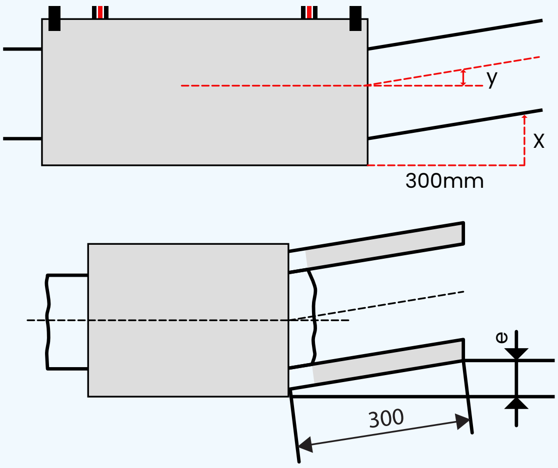
However, this test has practical limitations. For wall thickness exceeding 20-25mm, the stored energy in the bent specimen presents potential operational health and safety risks for those performing the test.

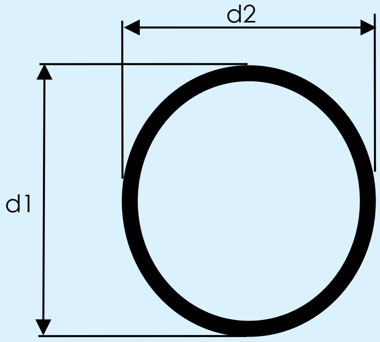
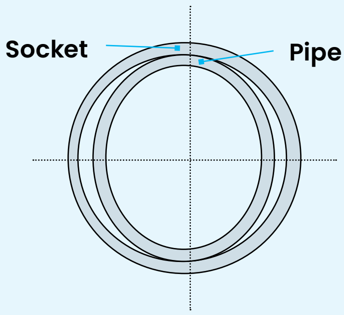
SECTION 3: TESTING OF ELECTROFUSION WELDS

1.0 VISUAL EXAMINATION OF ELECTROFUSION JOINTS

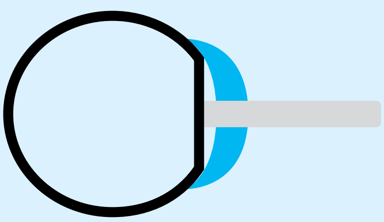
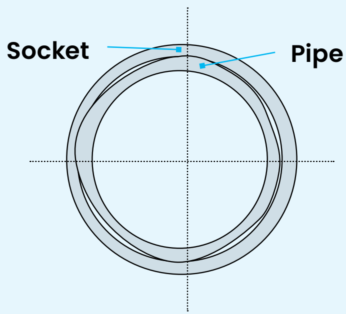
Table 4
Weld Features and Acceptance Criteria for EF Joints

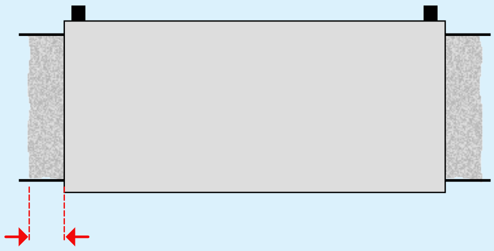
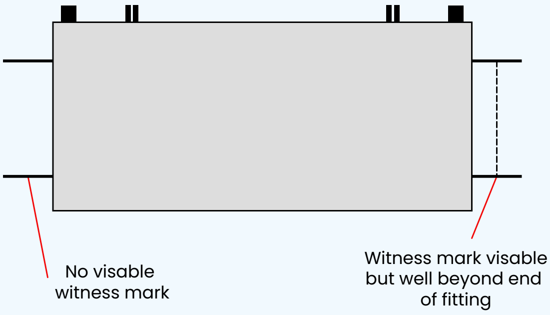
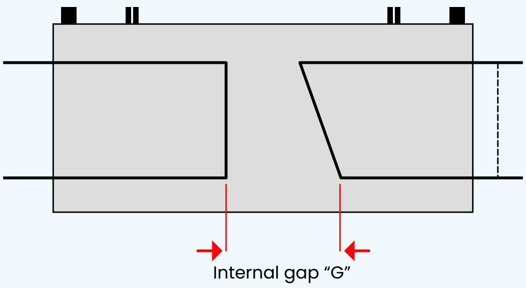
WELD FEATURE	COMMENTS	ACCEPTANCE CRITERIA
1. MELT INDICATOR PINS 	Different EF fittings may use different indicator designs and configurations. Colour indicators or fusion indicator pins on the fittings become visible once the required temperature or melt pressure has been achieved. Many electrofusion (EF) fittings are fitted with melt indicator pins that rise during the welding process. The movement of these pins indicates that sufficient internal melt pressure has developed during fusion. However, failure of the indicator pins to rise does not necessarily mean that the weld has failed. Similarly, the final height of the pins may vary depending on the clearance between the pipe and fitting surfaces. Variations in pin height alone should not be interpreted as evidence of an unacceptable weld.	Pins failing to rise should be a trigger to investigate the joint further. Acceptance criteria and suggested actions are provided in POP001.

WELD FEATURE	COMMENTS	ACCEPTANCE CRITERIA
2. MELT OUT 	Molten PE extrudes from the fitting socket. There are multiple reasons why this could occur including: → excessive welding time; → uneven gap between pipe and fitting; → incorrect welding process; and / or → Misalignment → Pipe ovality	Not acceptable. *Based on the German DVS Code and also accepted industry practice internationally.*
3. MISALIGNMENT 	Pipe welded at an angle on one or both sides of a fitting may result in joint misalignment. Misalignment can create excessive gaps between the pipe and fitting surfaces and may damage the heating wire filament, potentially leading to internal defects. Such misalignment may arise from poor joint assembly, incorrect or inadequate use of alignment clamps, or movement and external stresses applied to the joint during the welding process. Misalignment can also be created by incorrectly assembled alignment clamps. Refer to coiled pipe section.	Acceptable if the angle 'y' does not exceed 1.2 degrees or alternatively measure displacement at a point 300mm from the end of the coupler - the displacement 'x' does not exceed 6mm. *Based on the German DVS Code and also accepted industry practice internationally.*

WELD FEATURE	COMMENTS	ACCEPTANCE CRITERIA
4. PIPE OVALITY  d1 = maximum OD of pipe d2 = minimum OD of pipe	Ovality can create an uneven annular gap between the pipe and the EF fittings. This gap can be tolerated up to a certain limit. **EXAMPLES** 	Pipe ovality at the fusion zone should not exceed the limits below: **Pipe DN <315** d1-d2 < 1.5% DN or 3mm (whichever is the smallest value) **Pipe DN ≥315** Pipe DN ≤ 1% DN or 5mm (whichever is the smallest value)

EXAMPLE CALCULATION		
Pipe nominal diameter (DN) = 110 Measured maximum outside diameter (d1) = 111.0mm Measure minimum outside diameter (d2) = 109.5mm	Calculate the pipes ovality where Ovality = d1 – d2 = (111.0 – 109.5) = 1.5mm	Maximum allowable ovality for DN110 pipe is the smallest of 1.5%xDN or 3mm. 1.5%DN = (1.5/100)x110 = 1.65mm Pipe ovality of 1.5mm is less than maximum allowable of 1.65mm

WELD FEATURE	COMMENTS	ACCEPTANCE CRITERIA
5. PIPE FLAT SPOTS  **Measuring pipe flat spots** Following pipe re-rounding, accurately measure the flat post depth using a pipe ovality gauge, intersected with a steel ruler.	Flat spots can create excessive localised annular gaps between the pipe and EF fitting. This gap can be tolerated up to a certain limit. **EXAMPLES** 	Maximum flat spot depth is 3mm.

WELD FEATURE	COMMENTS	ACCEPTANCE CRITERIA
6. EXTENT OF SURFACE PEELING 	Surface peeling of the pipe should extend 20mm beyond the end of the fitting to provide a visual indication that the surface has been peeled with a rotational peeler and to enable a Pi tape to be used - the difference between the peeled and unpeeled pipe diameter indicates the peel depth. Hand scraping is unacceptable.	This feature alone should not be a justification for rejection but should trigger an investigation of the weld under consideration. Acceptance would rely on all other aspects of the weld being acceptable.
7. INCORRECT INSERTION  	Pipe ends not inserted correctly into fitting socket exposing the fusion zone inside the fitting. Typically caused by incorrect insertion of one or both pipe ends, failure to cut the pipe end square, or as a result of pull-out during welding in an incorrectly restrained joint.	Ensure the witness mark is just visible and aligns with the end of the fitting socket. The weld is unacceptable if the witness mark is well outside the end of the fitting socket. Where no witness mark is visible the joint requires further investigation as it is not possible to determine if the correct insertion has been achieved, without use of an endoscope pipe insertion camera. Unless otherwise specified by the fitting manufacturer, for pipe sizes <400mm diameter the internal gap “G” between any point on the pipe ends shall be ≤5% of the pipe diameter. For sizes ≥ 400mm diameter the gap shall not exceed 20mm. Based on the German DVS Code and also accepted industry practice internationally

Coiled pipe

Misalignment can occur with coiled pipe where alignment clamps alone are unable to address the problem. There are several other measures that can be employed to correct misalignment with coiled pipe including:

- Butt Welding short lengths of straight pipe to the end of the coiled pipe
- On warmer days lay out the coil and restrain at several points along the pipe to aid in controlling pipe curvature.
- Use coil straightening equipment as the coil is unrolled.
- Use two alignment clamps, both mounted eccentrically to the joint. Both clamps reinforce each other acting as quadruple clamp, forming a stress-free joint.

2.0 DESTRUCTIVE TESTING ELECTROFUSION WELDS

PEEL DECOHESION TESTING

This test involves cutting a longitudinal specimen form a welded fitting and pipe and mechanically peeling them apart to assess joint integrity.

Acceptance criteria are defined in AS/NZS 4129 with reference to:

- ISO 13954 Plastic pipes and fittings – Peel decohesion test for polyethylene (PE) electrofusion assemblies of nominal outside diameter greater than or equal to 90mm
- ISO 13955 Plastic pipes and fittings – Crushing decohesion test for polyethylene (PE) electrofusion assemblies.

According to AS/NZS 4129, the peel decohesion requirement specifies that brittle failure must account for less than 33.3% of the joint fusion length; in other words, at least 66.7% of the fusion zone must exhibit ductile separation.

Figure 9: Ductile fracture (tearing) of the PE between the windings

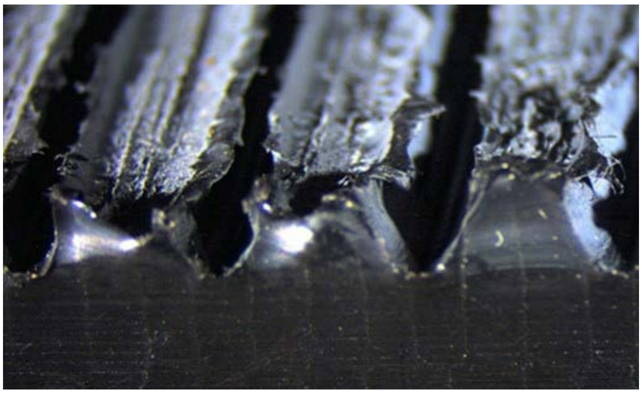


Figure 10: shows the side view

Figure 11: shows a large brittle area of brittle separation at the interface of the pipe and fittings surface

Interpretation of peel decohesion results requires the assessment of ductile and brittle fracture surfaces based on appearance. This process is inherently subjective and depends on visual evaluation.

In some EF weld tests weld quality is assessed relative to the proportion of the fusion zone length. The length of the fusion zone varies between fittings from different manufacturers and is a design specific feature. The design fusion length should be provided by the fitting manufacturer. Measuring the length covered by the heating wires is not a suitable method of determining the design fusion length. Determining the correct fusion zone is critical to accurate test interpretation, and the manufacturer's guidance should always be sought.

For additional guidance on interpreting destructive testing of electrofusion welds, refer to POP020 – Principles of Polyethylene (PE) Electrofusion Welding and Assessment.

STRIP BEND TESTING

ISO 21751 describes a simple decohesion test for assessing the integrity of EF joints, referred to as the *Strip Bend Test*.

In this method, a longitudinal specimen is cut axially through the joint and subjected to a side bend test, as illustrated in Figures 12, 13 and 14. The test is intended to evaluate joint cohesion and identify potential lack of fusion or interfacial separation.

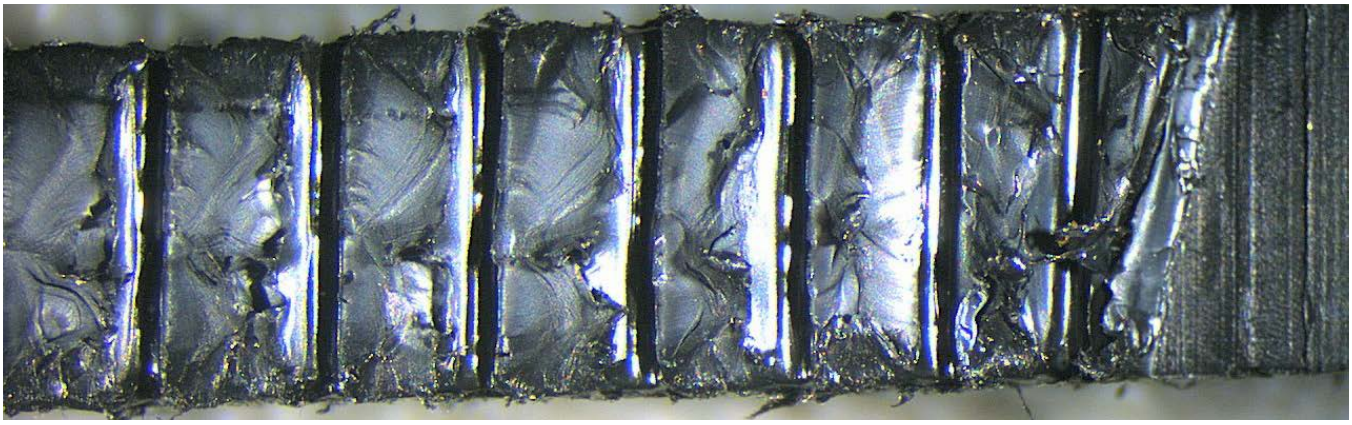


Figure 12: ISO 21751 Strip bend test - ductile plan view

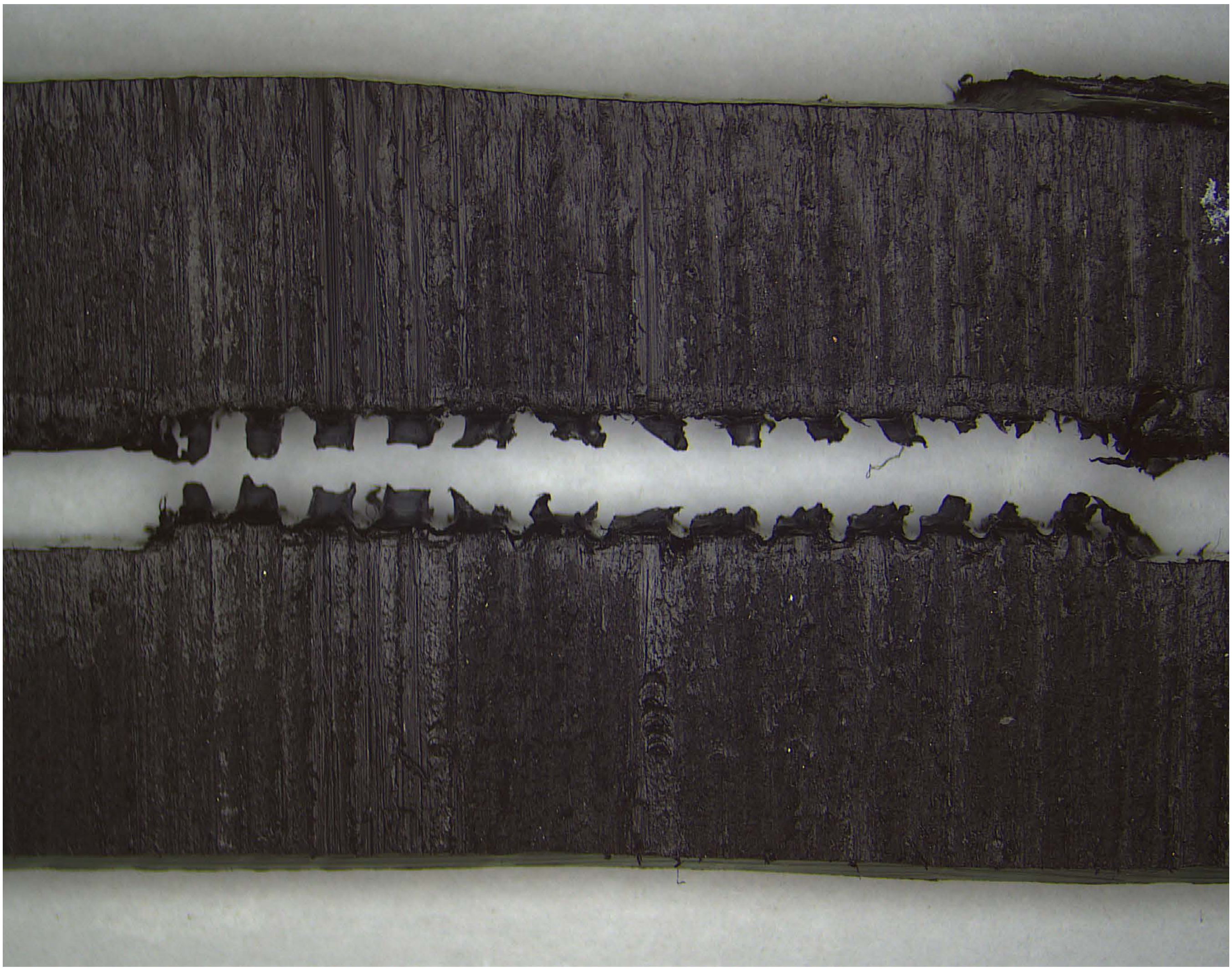


Figure 13: ISO 21751 Strip bend test – ductile side view

Figure 14: ISO 21751 Strip bend test - brittle

TECHNICAL REFERENCES

POP001	Electrofusion Jointing of PE Pipe and Fittings for Pressure Applications
POP001A	Guide to electrofusion Assembly and Welding
POP003	Butt Fusion Jointing of PE Pipes and Fittings - Recommended Parameters and Practices
TN016	Non-Destructive Examination of PE Welded Joints
DVS	Technical Codes on Plastics Joining Technologies (German Welding Association)

STANDARD REFERENCES

AS/NZS 2033	Installation of Polyethylene Pipe Systems
AS/NZS 4129	Fittings for polyethylene (PE) pipes for pressure applications
WIS 4-32-08	Specification for the Fusion Jointing of Polyethylene Pressure Pipeline Systems Using PE 80 and PE 100 Materials
ASTM F1055	Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing
ASTM F2620	Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
ASTM D638	*Standard Test Method for Tensile Properties of Plastics*
ASTM F2634	*Polyethylene Butt Fusion Joint Test Testing Equipment*
ISO 13954	Plastics pipes and fittings - Peel decohesion test for polyethylene (PE) electrofusion assemblies of nominal outside diameter greater than or equal to 90 mm (note the size restriction)
ISO 11413	Plastics pipes and fittings - Preparation of test piece assemblies between a polyethylene (PE) pipe and an electrofusion fitting
ISO 11414	Plastics pipes and fittings - Preparation of polyethylene (PE) pipe/pipe or pipe/fitting test piece assemblies by butt fusion
ISO 13953	Polyethylene (PE) pipes and fittings - Determination of the tensile strength and failure mode of test pieces from a butt-fused joint
ISO 13957	Plastics pipes and fittings - Polyethylene (PE) tapping tees - Test method for impact resistance
ISo 13955	Plastics pipes and fittings - Crushing decohesion test for polyethylene (PE) electrofusion assemblies
ISO 13956	Plastics pipes and fittings - Decohesion test of polyethylene (PE) saddle fusion joints - Evaluation of ductility of fusion joint interface by tear test
ISO 21307	Plastics pipes and fittings - Butt fusion jointing procedures for polyethylene (PE) pipes and fittings used in the construction of gas and water distribution systems
ISO 21751	Plastics pipes and fittings - Decohesion test of electrofusion assemblies - Strip-bend test
ISO 1167	Thermoplastics pipes, fittings and assemblies for the conveyance of fluids - Determination of the resistance of internal pressure
EN 12814-3	Testing of welded joints in thermoplastics semi-finished products – Part 3: Tensile creep test

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