

Australian Standard™

**Fusion-bonded medium-density
polyethylene coating and lining for
pipes and fittings**

This Australian Standard was prepared by Committee WS-009, Rolled and Welded Steel Pipes. It was approved on behalf of the Council of Standards Australia on 20 April 2001 and published on 5 May 2001.

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Australian Chamber of Commerce and Industry
Australian Industry Group
New Zealand Manufacturers Association
Water Services Association of Australia
Department of Land and Water Conservation

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Australian Standard™

**Fusion-bonded medium-density
polyethylene coating and lining for
pipes and fittings**

Originated as AS 4321—1995.
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PREFACE

This Standard was prepared by the Standards Australia Committee WS-009, Rolled and Welded Steel Pipe, to supersede AS 4321—1995.

This edition differs from the 1995 edition as follows:

- (a) A new sampling and testing frequency plan has been included.
- (b) Allowable variations, which can be tolerated prior to retesting, have been specified.
- (c) The allowable number of pipes with six coating repairs has been reduced.
- (d) Changes have been made to the marking requirements.
- (e) References to nominal size have been deleted.
- (f) Minor changes have been made to improve the test methods.

The objective of this Standard is to provide a standard specification for fusion-bonded medium-density polyethylene coating and lining for pipes and fittings, for use by the manufacturers and purchasers of these products.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

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STANDARDS AUSTRALIA

Australian Standard

Fusion-bonded medium-density polyethylene coating and lining for pipes and fittings**1 SCOPE**

This Standard specifies requirements for factory-applied fusion-bonded medium-density polyethylene coating and lining of pipes and fittings, for protection against corrosion.

Polyethylene materials complying with this Standard are intended for application to pipes and fittings where the pipeline operating temperatures are not less than -40°C nor more than 70°C for the coating and 50°C for the lining.

The coating is intended for use on pipes and fittings for underground and underwater service, including steel piling. The lining is intended for use on pipes and fittings for pipelines conveying wastewater and water intended for human consumption.

Methods for determining compliance with this Standard are given in Appendix A.

NOTE: Guidelines on requirements that are to be specified by the purchaser at the time of enquiry or order are given in Appendix B.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

- | | |
|--------|--|
| 1145 | Determination of tensile properties of plastics materials |
| 1145.1 | Part 1: General principles |
| 1145.3 | Part 3: Test conditions for films and sheets |
| 1193 | Plastics—Methods for determining the density and relative density of non-cellular plastics |
| 1199 | Sampling procedures and tables for inspection by attributes |
| 1281 | Cement mortar lining of steel pipes and fittings |
| 1627 | Metal finishing—Preparation and pretreatment of surfaces |
| 1627.2 | Part 2: Power tool cleaning |
| 1627.4 | Part 4: Abrasive blast cleaning |
| 3855 | Suitability of plumbing and water distribution systems products for contact with potable water |
| 3894 | Site testing of protective coatings |
| 3894.3 | Method 3: Determination of dry film thickness |

AS/NZS

- | | |
|--------|---|
| 3500 | National Plumbing and Drainage Code |
| 3500.0 | Part 0: Glossary of terms |
| 4020 | Products for use in contact with drinking water |
| 4131 | Polyethylene (PE) compounds for pressure pipes and fittings |

ISO	
2859	Sampling procedures for inspection by attributes
2859-1	Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection
3951	Sampling procedures and charts for inspection by variables for percent non-conforming
SAI/SANZ	
HB18	Guidelines for third-party certification and accreditation
HB18.28	Guide 28 General rules for a model third-party certification scheme for products
(ISO/IEC Guide 28)	
ASTM	
D1238	Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
D1693	Test Method for Environmental Stress-cracking of Ethylene Plastics
G14	Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test)
G62	Test Methods for Holiday Detection in Pipeline Coatings

3 DEFINITIONS

For the purpose of this Standard, the definitions given in AS 3500.0 and those below apply.

3.1 Coating

Fusion-bonded medium-density polyethylene (FBPE) compound applied to the external surface of pipes and fittings.

3.2 Fusion bond

The bond produced between the polyethylene and the surface of the pipe or fittings when the polyethylene is applied to the heated pipe or fitting.

3.3 Holiday

A discontinuity of the coating/lining, which exposes the steel to the outside environment.

3.4 Joint region

Spigot and socket connecting elastomeric ring joint pipe ends (see Figure 1 for details).

3.5 Lining

Fusion-bonded medium-density polyethylene (FBPE) compound applied to the internal surface of pipes and fittings.

3.6 Outside diameter

The specified outside diameter of the uncoated pipe or fitting, expressed in millimetres.

3.7 Reinstatement

Restoration of the coating or lining after the primary coating process.

NOTE: This applies only for pipes that are both coated and lined, for pipes with a coating that extends around the ends (e.g. elastomeric ring joints) and for fittings.

3.8 Repair

Restoration of the coating where it has been damaged, or where it fails the continuity test.

3.9 Surface preparation

Treatment of the pipe or fitting surface to receive polyethylene coating or lining.

4 MATERIALS

4.1 General

Material used for the coating and lining shall comply with the requirements of Clauses 4.2 and 4.3, and shall not contain solvents or other additives known to adversely affect the applied polyethylene coating and lining.

4.2 Polyethylene coating (and lining) compound

4.2.1 Composition

The polyethylene compound shall consist of the following components:

- (a) Polyolefin polymer such that the density of the base polymer (without additives) shall be in the range 930 to 945 kg/m³ when tested in accordance with AS 1193 at 23°C.
- (b) Antioxidants of a non-migratory type.
- (c) Carbon black of 2.5 ±0.5% concentration and type complying with AS/NZS 4131.

The combination of the above components shall be such as to ensure a coating and lining complying with Clause 6.1.2.

4.2.2 Dispersion of additives

The components listed in Clauses 4.2.1(b) and 4.2.1(c) shall be evenly dispersed in the polymer. The resultant polyethylene compound shall be tested for, and shall meet the dispersion of, additives requirement specified in AS/NZS 4131.

4.3 Polyethylene reinstatement compound

4.3.1 Composition

The reinstatement compound shall adhere to steel and shall fuse with the polyethylene coating compound specified in Clause 4.2. It shall consist of the following components:

- (a) Polyolefin polymers (which may be chemically modified).
- (b) Antioxidants of a non-migratory type.
- (c) Carbon black of 2.5 ±0.5% concentration and type complying with AS/NZS 4131.

The addition of antioxidant and carbon black is only required when the reinstatement compound is used as a single stage coating as specified in Clause 7.2.

The combination of the above components shall ensure a coating and lining complying with Clause 6.1.3.

4.3.2 Dispersion of additives

The components listed in Clauses 4.3.1(b) and 4.3.1(c) shall be evenly dispersed in the polymer. The resultant polyethylene compound shall be tested for and shall meet the dispersion of additives requirement specified in AS/NZS 4131.

5 COATING AND LINING APPLICATION

5.1 Preparation of surface

All surfaces to be coated shall be abrasive blast-cleaned in accordance with AS 1627.4, minimum Class 2^{1/2}.

5.2 Application

The pipe shall be heated so as not to produce any deleterious contaminants on the surface to be coated. The polyethylene compound shall be applied to obtain a smooth finished surface. The coating should not be post-heated by use of a torch or other flame treatment being applied directly to the coating.

5.3 Cleaning of pipe and fitting ends

The length of end that is to be left free of coating shall be cleaned by mechanical means.

5.4 End treatment

Unless otherwise specified, end treatment shall be as follows:

- (a) Where the coating is terminated externally, it shall be set back a nominal distance of 100 mm from the closest assembly weld point. It should be sealed with an overlapping corrosion-preventing paint.
- (b) Where the coating in the joint region terminates internally and the pipe is cement mortar lined in accordance with AS 1281, the mortar shall overlap by a minimum of 25 mm.
- (c) The end coating shall be tapered over a distance not less than three times the coating thickness.

NOTE: The purchaser may specify a particular end coating (for corrosion protection) and end set back (see Appendix B).

6 TEST REQUIREMENTS

6.1 Type test

6.1.1 General

Type tests shall be carried out at intervals of no greater than five years and at any change in formulation or source of polyethylene compounds and at any change in application process.

6.1.2 Polyethylene coating (and lining) compound

6.1.2.1 General

The polyethylene compound to be used for coating, lining and reinstatement/repair shall be type tested for thermal stability, water absorption, penetration resistance, tensile stress at yield, environmental stress-cracking resistance, density and impact resistance as specified in Clauses 6.1.2.2 to 6.1.2.8. Test samples may be prepared in the laboratory or in the coating plant. If the same formulation and source of polyethylene is used for both the coating and lining, then tests on the coating shall also qualify the lining. The impact resistance test is not required for the lining.

6.1.2.2 Thermal stability

When exposed to air at 100°C for 100 days in accordance with Appendix C, the melt flow index shall not change by more than 35%.

6.1.2.3 Water absorption

When immersed in water at 23°C for 100 days in accordance with Appendix D, the water absorption shall be $\leq 0.1\%$.

6.1.2.4 Penetration resistance

When subjected to a compressive stress of 10 MPa applied in accordance with Appendix E, the penetration at 23°C shall be ≤ 0.15 mm and at 70°C shall be ≤ 0.25 mm.

6.1.2.5 Tensile stress at yield

When tested in accordance with Appendix F, the tensile stress at yield shall be ≥ 15.0 MPa.

6.1.2.6 Environmental stress-cracking resistance

When tested in accordance with Appendix G, the F_{50} value shall be not less than 100 h.

6.1.2.7 *Density*

When determined in accordance with AS 1193, Method A, at 23°C on a test piece obtained and prepared in accordance with Appendix H, the density shall be $\geq 920 \text{ kg/m}^3$.

6.1.2.8 *Impact resistance*

When tested in accordance with Appendix I, the impact resistance shall be $\geq 18.0 \text{ J}$.

6.1.3 *Polyethylene reinstatement compound*

6.1.3.1 *General*

The polyethylene reinstatement compound shall be type tested for water absorption, adhesion to steel and adhesion to polyethylene coating compound, as specified in Clauses 6.1.3.2 to 6.1.3.4.

6.1.3.2 *Water absorption*

When immersed in water at 23°C for 100 d in accordance with Appendix D, the water absorption shall be $\leq 0.2\%$.

6.1.3.3 *Adhesion to steel*

When tested in accordance with Appendix J, the bond strength to steel shall be $\geq 3.0 \text{ N/mm}$ width of strip.

6.1.3.4 *Adhesion to polyethylene coating compound*

When tested in accordance with Appendix K, the bond strength to polyethylene shall be $\geq 3.0 \text{ N/mm}$ width of strip.

6.2 *Application process qualification*

The application process shall be qualified by a cathodic disbondment test from each coating plant. The test shall be undertaken at an interval of no greater than one year or at a change in polymer formulation, source or application process. The test shall be carried out on a production coated pipe.

When tested in accordance with Appendix L, the radial disbonded length shall be $\leq 15 \text{ mm}$.

6.3 *Production tests*

6.3.1 *General*

The coating and lining shall comply with the production test requirements specified in Clauses 6.3.2 to 6.3.4.

6.3.2 *Thickness*

When tested using a thickness gauge complying with AS 3894.3, the minimum coating thickness of the FBPE shall be as specified in Table 1. On any pipe the minimum thickness may be up to 0.2 mm less than that specified in Table 1, provided that the area of coating (or lining) with reduced thickness does not cover more than 5% of the total pipe coating (or lining) area. Pipes with reduced thickness shall comprise not more than 5% of a pipe coating order.

6.3.3 *Continuity test*

The total coated and lined surfaces of every pipe and fitting shall be tested in accordance with Appendix M. All holidays detected shall be repaired in accordance with Clause 8.

6.3.4 Bond strength

When tested in accordance with Appendix N, the coating and lining shall exhibit a minimum bond strength of 3.0 N/mm width of strip. Where the bond test fails, that pipe or fitting shall be rejected and the test shall be repeated on two further pipes (or fittings) taken from the same batch. If either of the retests fail to pass the test the batch shall be rejected. The coating applicator shall have the option of testing each individual pipe (or fitting) for compliance with this Standard and those that comply shall be accepted.

TABLE 1
COATING AND LINING THICKNESS

Pipe outside diameter	Minimum thickness			millimetres
	Coating	Lining	Elastomeric ring joint region (Note 1)	
≤273	1.6	1.0	(Note 2)	
>273 ≤508	1.8	1.0	0.8	
>508 ≤762	2.0	1.0	1.0	
>762	2.3	1.0	1.0	

NOTES:

- 1 See Figure 1 for joint region.
- 2 Not generally available.

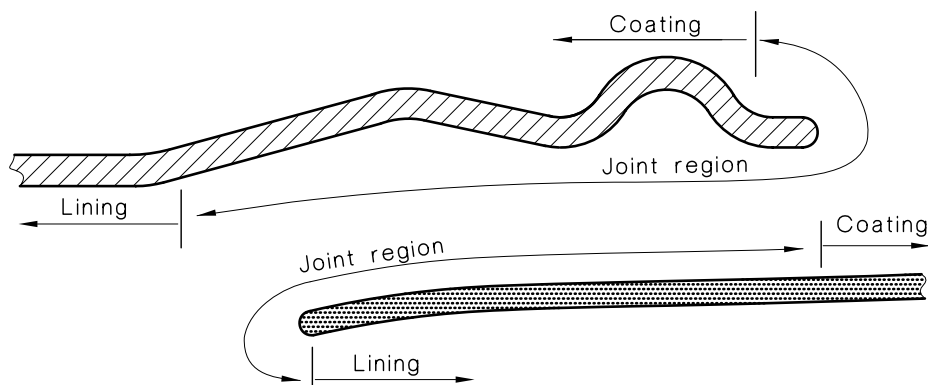


FIGURE 1 DESIGNATION OF ELASOMERIC RING JOINT REGION

7 REINSTATEMENT

7.1 General

Reinstatement shall only be allowed for the following coatings, linings and application techniques:

- (a) An FBPE coating applied to cover the entire external surface of the pipe and extending around the ends for a short distance, e.g. elastomeric ring-jointed pipes (see Figure 1).

- (b) An FBPE coating and lining applied to cover the entire external and internal pipe surfaces.
- (c) An FBPE coating or lining applied on a fitting.

Where pipes are supported by pins (after coating), the maximum area of each pin support reinstatement shall not exceed 5000 mm². Where a region of uncoated pipe results in a full circumference discontinuity, the maximum longitudinal length of each discontinuity shall not exceed 500 mm. The total longitudinal length of all full circumferential discontinuities in a pipe or fitting shall not exceed 1 m. Reinstatement of the coating or lining shall be by a fusion-bonded process, as specified in Clause 7.2. The coating or lining shall not be preheated by use of a torch or any other flame treatment being applied directly to the coating.

7.2 Application of reinstatement

The coating or lining adjacent to the region to be reinstated shall be tapered, as specified in Clause 5.4(b). The steel surface shall not require additional treatment unless surface rusting is evident. If surface rusting is evident the steel surface shall be prepared in accordance with AS 1627.2, Class 2.

The region to be reinstated shall be heated to a temperature such that all the adjacent coating or lining melts. The temperature of the steel and adjacent coating or lining shall not exceed 200°C.

Reinstatement compound, as specified in Clause 4.3, shall be applied when the steel is in the temperature range used to type test the reinstatement compound (see Appendix J). The reinstatement compound shall cover the entire steel surface and shall overlap the full thickness of the adjacent coating or lining. The average thickness of the reinstatement compound should not exceed 0.5 mm.

Immediately after application of the reinstatement compound, the polyethylene coating compound, as specified in Clause 4.2, shall be applied to achieve the required coating thickness.

Reinstatements of size up to 5000 mm² may be made by using either polyethylene coating compound, as specified in Clause 4.2, or polyethylene reinstatement compound, as specified in Clause 4.3, in a single-stage coating operation. Reinstatement compounds that meet all the requirements of Clause 6.1.2 may be used as a single-stage coating for all reinstatements. The other requirements specified above (Clause 7.2) for a two-stage coating operation shall apply.

7.3 Reinstatement test requirements

All reinstatements shall comply with the continuity test requirement specified in Clause 6.3.3. Reinstatement areas greater than 5000 mm² shall comply with the thickness and bond strength requirements specified in Clauses 6.3.2 and 6.3.4.

8 REPAIRS

8.1 General

Where a holiday is located, it shall be repaired to produce a continuous coating and lining. Damaged areas that pass the continuity test need not be repaired, provided the coating or lining thickness remains greater than or equal to 1.0 mm.

The bare steel surface shall be prepared in such a way to produce a rust-free, clean, abraded surface. The adjacent FBPE coating or lining shall be tapered, as specified in Clause 5.4.

All lining repairs shall be in accordance with Clause 7.2.

Where practicable, the following coating repair methods should be used:

- (a) Fusion-bonded repairs, as specified in Clause 7.2.
- (b) Heat shrink sleeve repair.
- (c) Polyethylene welding repair.

NOTES:

- 1 The repair methods outlined apply to repairs at the application plant only. For repairs in the field other methods are applicable.
- 2 The purchaser may specify a particular repair method (see Appendix B).

8.2 Repair limits

8.2.1 Coating repairs

The number of coating repairs (this includes repairs to the joint region, see Figure 1) shall not exceed three per pipe or fitting. An allowance is made for up to six repairs per pipe or fitting provided that the number of pipes or fittings with this larger number of repairs shall not exceed the following limits:

- (a) 5% of pipes for orders up to 400 pipes.
- (b) 20 pipes plus 1% of the remainder of pipes for orders above 400 pipes.

The area of any single coating repair shall not exceed 100 000 mm², and the length of such repair shall not exceed 2 m in the longitudinal direction.

8.2.2 Lining repairs

The number of lining repairs shall not exceed three per pipe or fitting. The area of any single lining repair shall not exceed 5000 mm².

8.3 Repair test methods

All repairs shall comply with the continuity test requirements of Clause 6.3.3.

9 TEST FREQUENCY

Tests shall be carried out at a frequency not less than that specified in Table 2.

TABLE 2
FREQUENCY OF TESTING

Test	Reference Clause	Test frequency					Repair
		Coating	Lining	Joint region	Reinstatement		
					≤5000 mm ² area	>5000 mm ² area	
Thickness	6.3.2	Every pipe and fitting	Every pipe and fitting	Once per shift	Not required	Every reinstatement	Not required
Continuity	6.3.3	Every pipe and fitting	Every pipe and fitting	Every pipe and fitting	Every reinstatement	Every reinstatement	Every repair
Bond strength	6.3.4	Twice per shift or every 10 pipes (or fittings), whichever is the less frequent	Once per shift or every 10 pipes (or fittings), whichever is the less frequent	Not required	Not required	Once per shift or every 10 reinstatements, whichever is the less frequent	Not required