

## ISO 21809-3 Petroleum and Natural Gas Industries – External Coatings for Buried or Submerged Pipelines Used in Pipeline Transportation Systems – Field Joint Coatings – Testing Equipment

### Description

**Table 3 – Requirements for Type 1A – Hot-applied bituminous tape**

Property	Test temperature °C	Unit	Requirements	Test method
Thickness	—	mm	$\geq 0,9 \times$ nominal value	Annex A
Holiday detection at 5 kV/mm + 5 kV	—	—	no holiday	Annex B
Impact resistance	20	J/mm	$\geq 2$	Annex G
Indentation resistance, pressure – Holiday detection at 5 kV/mm + 5 kV – Residual thickness	23	N/mm <sup>2</sup> — mm	1,0 no holiday $\geq 0,6$	Annex H
Specific electrical insulation resistance – $R_{S100}$ – $R_{S100}/R_{S70}$ <sup>a</sup>	23	$\Omega \cdot m^2$ —	$\geq 10^6$ $\geq 0,8$	Annex K
Cathodic disbondment resistance, 28 days	23	mm	$\leq 20$	Annex F
Peel strength – to steel surface <sup>b</sup> – to plant coating – plant coating after 28-day hot-water immersion test at 30 °C – steel surface after 28-day hot-water immersion test at 30 °C	23 23 23 23	N/mm N/mm N/mm N/mm	$\geq 0,4$ $\geq 0,2$ $\geq 0,1$ $\geq 0,2$	Annex D  Annex I
Lap shear strength	23	N/mm <sup>2</sup>	$\geq 0,05$	Annex L
<p><sup>a</sup> It is necessary that this requirement (<math>R_{S100}/R_{S70} \geq 0,8</math>) be fulfilled only if the specific electrical insulation resistance after 70 days is less than 10 times the requirement of the specific electrical insulation resistance after 100 days.</p> <p><sup>b</sup> If the result is less than 0,4 N/mm, residual thickness of bituminous compound on the pipe surface or plant coating shall be <math>\geq 0,25</math> mm.</p>				

**Table 4 — Requirements for Type 1B — Petrolatum tape**

Property	Test temperature °C	Unit	Requirements	Test method
Thickness	—	mm	$\geq 0,9 \times$ nominal value	Annex A
Holiday detection at 5 kV/mm + 5 kV	—	—	no holiday	Annex B
Impact resistance	20	J/mm	$\geq 0,8$	Annex G
Indentation resistance, pressure - Holiday detection at 5 kV/mm + 5 kV - Residual thickness	23	N/mm <sup>2</sup> — mm	0,1 no holiday $\geq 0,6$	Annex H
Specific electrical insulation resistance - $R_{S100}$ - $R_{S100}/R_{S70}$ <sup>a</sup>	23	$\Omega \cdot m^2$ —	$\geq 10^6$ $\geq 0,8$	Annex K
Cathodic disbondment resistance at 28 days	23	mm	$\leq 20$	Annex F
Peel strength to pipe surface and plant coating	23	—	leave a film of compound on the substrate	—
Peel strength to steel and plant coating before and after 28-day hot-water immersion test at 30 °C	23	—	leave a film of compound on the substrate	Annex I
Drip resistance	45	—	no dripping of compound	Annex J
<sup>a</sup> It is necessary that this requirement ( $R_{S100}/R_{S70} \geq 0,8$ ) be fulfilled only if the specific electrical insulation resistance after 70 days is less than 10 times the requirement of the specific electrical insulation resistance after 100 days.				

**Table 5 — Requirements for Type 1C — Wax tape and primer**

Property	Test temperature °C	Unit	Requirements	Test method
<b>Primer</b>				
Congeval point	—	°C	55 to 70	ASTM D 938
Flash point	—	°C	≥ 65	ASTM D 92
Specific gravity	25	g/cm <sup>3</sup>	0,9 to 1,25	ASTM D 70
Cone penetration	25	0,1 mm	75 to 225	ASTM D 937
Dielectric strength	—	V/μm	≥ 4	ASTM D 149
<b>Tape</b>				
Congeval point of saturant	—	°C	65 to 70	ASTM D 938
Flash point of saturant	—	°C	≥ 60	ASTM D 92
Thickness	—	mm	> 1,75	ASTM D 1000
Dielectric strength	—	V/μm	> 6,7	ASTM D 149
Impact resistance	20	J/mm	≥ 0,8	Annex G
Indentation resistance, pressure		N/mm <sup>2</sup>	0,1	
– Holiday detection	23	—	no holiday	Annex H
– Residual thickness		mm	≥ 0,6	
Specific electrical insulation resistance				
– $R_{S100}$	—	Ω·m <sup>2</sup>	≥ 10 <sup>6</sup>	Annex K
– $R_{S100}/R_{S70}$ <sup>a</sup>		—	≥ 0,8	
Cathodic disbondment resistance at 28 days	23	mm	< 12	Annex F
Peel strength to pipe surface and plant coating	23	—	leave a film of compound on the substrate	—
Peel strength to steel and plant coating before and after 28-day hot-water immersion test at 30 °C	23	—	leave a film of compound on the substrate	Annex I
Drip resistance	45	—	no dripping of compound	Annex J
Holiday detection at 5 kV/mm + 5 kV	—	—	no holiday	Annex B

**Table 6 — Requirements for Type 1D — Polymeric tapes**

Property	Test temp.	Unit	Requirements (up to 50 °C)	Requirements (up to 80 °C)	Test method
Thickness	—	mm	$\geq 0,9 \times$ nominal value		Annex A
Holiday detection at 5 kV/mm + 5 kV	—	—	no holiday		Annex B
Impact resistance	20 °C	J/mm	$\geq 4$		Annex G
Indentation resistance, pressure – Holiday detection at 5 kV/mm + 5 kV – Residual thickness	23 °C and $T_{max}$	N/mm <sup>2</sup>	10,0 no holiday	1,0 no holiday	Annex H
		mm	$\geq 0,6$	$\geq 0,6$	
Specific electrical insulation resistance – $R_{S100}$ – $R_{S100}/R_{S70}$ <sup>a</sup>	23 °C	$\Omega \cdot m^2$	$\geq 10^8$	$\geq 10^8$	Annex K
		—	$\geq 0,8$	$\geq 0,8$	
Cathodic disbondment resistance at 28 days	23 °C $T_{max}$	mm mm	$\leq 15$ <sub>b</sub>	$\leq 15$ <sub>b</sub>	Annex F
Peel strength between tape layers – inner/inner, inner/outer – inner/inner, inner/outer – outer/outer – outer/outer	23 °C	N/mm	$\geq 1,50$	$\geq 1,50$	Annex M
	$T_{max}$	N/mm	$\geq 0,30$	$\geq 0,30$ <sub>c</sub>	
	23 °C	N/mm	$\geq 0,20$	$\geq 0,20$	
	$T_{max}$	N/mm	$\geq 0,20$	$\geq 0,20$ <sub>c</sub>	
Peel strength – to steel surface – to steel surface – to plant coating – to plant coating – to plant coating after 28-day hot-water immersion test at 50 °C – to steel surface after 28-day hot-water immersion test at 50 °C or 80 °C	23 °C	N/mm	$\geq 1,00$	$\geq 1,00$	Annex D
	$T_{max}$	N/mm	$\geq 0,10$	$\geq 0,10$ <sub>c</sub>	
	23 °C	N/mm	$\geq 0,40$	$\geq 0,40$	Annex I
	$T_{max}$	N/mm	$\geq 0,04$	$\geq 0,04$ <sub>c</sub>	
	23 °C	N/mm	$\geq 0,40$	$\geq 0,40$	Annex I
	23 °C	N/mm	$\geq 0,40$	$\geq 0,40$	
Lap shear strength	23 °C	N/mm <sup>2</sup>	$\geq 0,050$	$\geq 0,050$	Annex L
	$T_{max}$	N/mm <sup>2</sup>	$\geq 0,050$	$\geq 0,020$	
Thermal ageing resistance	—	—			Annex N
Ratio of	—	—	$1,25 \geq E_{70}/E_{70} \geq 0,75$		
– elongation at break	—	—	$E_{100}/E_{70} \geq 0,8$		
– peel strength between tape layers	—	—	$P'_{100}/P'_0 \geq 0,75$		
– peel strength to pipe surface	—	—	$P'_{100}/P'_{70} \geq 0,8$		
	—	—	$P_{100}/P_0 \geq 0,75$		
	—	—	$P_{100}/P_{70} \geq 0,8$		

<sup>a</sup> It is necessary that this requirement ( $R_{S100}/R_{S70} \geq 0,8$ ) be fulfilled only if the specific electrical insulation resistance after 70 days is less than 10 times the requirement of the specific electrical insulation resistance after 100 days.

<sup>b</sup> By agreement after qualification.

<sup>c</sup> The test is considered passed when the tape leaves a film of adhesive on the substrate.

**Table 13 — Requirements for type 2A joint coatings — PE backed, without primer**

Property	Test temp.	Unit	Type 2A-1 up to 50°C	Type 2A-2 up to 80°C	Type 2A-3 up to 120°C	Test method
Thickness	—	mm	$\geq 0,85 \times$ nominal value			Annex A
Holiday detection at 5 kV/mm + 5 kV	—	—	no holiday			Annex B
Impact resistance (holiday detection at 5 kV/mm + 5 kV after recovery)	20 °C	J/mm	$\geq 5$	$\geq 5$	$\geq 5$	Annex G
Indentation resistance (holiday detection at 5 kV/mm + 5 kV after recovery)	23 °C	N/mm <sup>2</sup>	1,0	10,0	10,0	Annex H
	$T_{max}$	N/mm <sup>2</sup>	1,0	5,0	1,0	—
	residual thickness	mm	$\geq 0,60$	$\geq 0,60$	$\geq 0,60$	—
Cathodic disbondment at 28 days	23 °C	mm	$\leq 10$	$\leq 10$	$\leq 15$	Annex F
	$T_{max}$ limited to 95 °C	mm	a	a	a	—
Peel strength at 10 mm/min:	—	N/mm	—	—	—	Annex D
	— to pipe surface and to plant coating	23 °C	$\geq 0,40$	$\geq 1,0$	$\geq 2,50$	—
		$T_{max}$	b	b	$\geq 0,20$	—
	— to pipe surface after 28-day hot-water immersion test at $T_{max}$ limited as per Annex I	23 °C	$\geq 0,20$	$\geq 0,50$	$\geq 1,50$	Annex I
	— to plant coating after 28-day hot-water immersion test at $T_{max}$ limited as per Annex I	23 °C	$\geq 0,40$	$\geq 1,0$	$\geq 1,50$	Annex I
Lap shear strength at 10 mm/min	23 °C	N/mm <sup>2</sup>	$\geq 0,05$	$\geq 0,10$	$\geq 1,0$	Annex L
	$T_{max}$	N/mm <sup>2</sup>	a	a	a	
Thermal ageing resistance (aged at $T_{max} + 20$ °C)	—	—	—	—	—	Annex N
Elongation at break	23 °C	$E_{100}/E_0$	$\geq 0,75$	$\geq 0,75$	$\geq 0,75$	—
		$E_{100}/E_{70}$	$\geq 0,80$	$\geq 0,80$	$\geq 0,80$	
Peel strength to pipe surface	23 °C	$P_{100}/P_0$	$\geq 0,75$	$\geq 0,75$	$\geq 0,75$	—
		$P_{100}/P_{70}$	$\geq 0,80$	$\geq 0,80$	$\geq 0,80$	

<sup>a</sup> By agreement after qualification.

<sup>b</sup> The test is considered passed when the tape leaves a film or residue on the substrate.

**Table 14 — Requirements for type 2B and 2C joint coatings — PE- or PP-backed, with primer**

Property	Test temp.	Unit	Type 2B polyethylene	Type 2C polypropylene	Test method
Thickness	—	mm	≥ 0,85 × nominal value		Annex A
Holiday detection at 5 kV/mm + 5 kV	—	—	no holiday		Annex B
Impact resistance (holiday detection at 5 kV/mm + 5 kV after recovery)	20 °C	J/mm	≥ 5	≥ 8	Annex G
Indentation resistance (holiday detection at 5 kV/mm + 5 kV after recovery)	$T_{max}$	N/mm <sup>2</sup>	10,0	10,0	Annex H
	—	mm	≥ 0,6	≥ 0,6	
Cathodic disbondment at 28 days	23 °C	mm	≤ 8,0	≤ 8,0	Annex F
	$T_{max}$ limited to 95 °C	mm	≤ 15	≤ 15	
Peel strength at 10 mm/min to pipe surface primed with epoxy and to plant coating	23 °C	N/mm	≥ 2,50	≥ 4,0	Annex D
	$T_{max}$	N/mm	≥ 0,20	≥ 2,0	
Peel strength at 10 mm/min to pipe surface and to plant coating after 28-day hot-water immersion test at $T_{max}$ limited as per Annex I	23 °C	N/mm	≥ 1,50	≥ 2,0	Annex I
Lap shear strength at 10 mm/min	23 °C	N/mm <sup>2</sup>	≥ 1,0	≥ 2,0	Annex L
	$T_{max}$	N/mm <sup>2</sup>	≥ 0,07	≥ 0,50	
Thermal ageing resistance (aged at $T_{max} + 20$ °C)					Annex N
– Elongation at break ( $E_{100}/E_0$ )	23 °C	$E_{100}/E_{70}$	≥ 0,75	≥ 0,75	
– Peel strength to pipe surface ( $P_{100}/P_{70}$ )	23 °C	$P_{100}/P_{70}$	≥ 0,75	≥ 0,75	

**Table 19 — Requirements for types 4A, 4B, 4C and 4D liquid coatings**

Property	Test temp.	Unit	Type 4A	Type 4B	Type 4C	Type 4D	Test method
			Liquid epoxy	Liquid PU	Reinforced epoxy	Reinforced vinyl ester	
Minimum thickness	—	µm	By agreement				Annex A
Visual inspection	—	—	Continuous and uniform film free of sags runs and colour striations (when applicable)		—	—	—
Holiday detection	—	kV/mm	5				Annex B
Impact resistance (holiday detection at 5 kV/mm)	20 °C	J/mm	≥ 3	≥ 5	≥ 5	≥ 5	Annex G
	-5 °C		≥ 1,5	≥ 2,0	≥ 1,5	≥ 1,5	
Indentation resistance at 10 N/mm <sup>2</sup> (holiday detection at 5 kV/mm)	T <sub>max</sub>	% DFT	≤ 30	≤ 30	≤ 10	≤ 10	Annex H
Cathodic disbondment at 28 days	23 °C	mm	≤ 8	≤ 10	≤ 8	≤ 8	Annex F
	T <sub>max</sub> limited to 95 °C		≤ 15	≤ 20	≤ 15	≤ 15	
Hardness (Shore A or D)	23 °C	—	As per manufacturer specification				ISO 868
Adhesion to pipe surface	20 °C	MPa	≥ 10,0	≥ 10,0	≥ 10,0	≥ 10,0	ISO 4624
Adhesion to pipe surface	2 °C	—	Rating 1	Rating 1	Not applicable	Not applicable	Annex C
Adhesion to plant coating	20 °C	—	Rating 1	Rating 1	Not applicable	Not applicable	Annex C
Adhesion to plant coating	20 °C	MPa	≥ 3,5	≥ 3,5	≥ 3,5	≥ 3,5	ISO 4624
Adhesion to pipe surface after 28-day hot-water immersion test at T <sub>max</sub> limited as per Annex I	20 °C	MPa	≥ 7,0	≥ 7,0	≥ 7,0	≥ 7,0	Annex I plus ISO 4624
Adhesion to plant coating after 28-day hot-water immersion test at T <sub>max</sub> limited as per Annex I	20 °C	—	Rating 2	Rating 2	Not applicable	Not applicable	Annex I plus Annex C
Adhesion to plant coating after 28-day hot-water immersion test at T <sub>max</sub> limited as per Annex I	20 °C	MPa	≥ 2,0	≥ 2,0	≥ 2,0	≥ 2,0	ISO 4624
Specific electrical insulation resistance (R <sub>S100</sub> )	23 °C	Ω·m <sup>2</sup>	10 <sup>6</sup>	10 <sup>6</sup>	10 <sup>6</sup>	10 <sup>6</sup>	Annex K
R <sub>S100</sub> /R <sub>S70</sub>	—	—	Direct Sales by Manufacturer 0,30		0,80	0,80	—

**Table 20 — Requirements for cast polyurethane — 4E**

Property	Test temp.	Unit	Type 4E Cast polyurethane	Test method
Minimum thickness	—	—	20 mm	Annex A
Holiday detection	—	kV/mm	> 5	Annex B
Compressive strength	23 °C	MPa	≥ 30	ASTM D 695
Cathodic disbondment at 28 days	23 °C	mm	≤ 10	Annex F
	$T_{max}$ limited to 95 °C	—	≤ 20	—
Cathodic disbondment at 48 h	60 °C	mm	≤ 10	Annex F
Hardness (Shore A or D)	23 °C	—	As per manufacturer specification	ISO 868
Adhesion to pipe surface	20 °C	MPa	≥ 10	ISO 4624
Adhesion to plant coating	20 °C	MPa	≥ 3,5	ISO 4624
Adhesion to plant coating after 28-day hot-water immersion test at $T_{max}$ limited as per Annex I	20 °C	MPa	≥ 2,0	Annex I plus ISO 4624
Adhesion to pipe surface after 28-day hot-water immersion test at $T_{max}$ limited as per Annex I	23 °C	MPa	≥ 7	Annex I plus ISO 4624
Electrical volume resistivity	23 °C	Ω·cm	≥ 10 <sup>12</sup>	ASTM D 257
Water absorption at 7 days	23 °C	mass %	≤ 0,1	ISO 62

**Table 24 — Requirements for types 5A, 5B and 5C — PP**

Property	Test temperature	Unit	Requirements	Test method
Total coating thickness	—	mm	By agreement	Annex A
Epoxy layer thickness	—	mm	By agreement	Annex A
Holiday detection at 10 kV/mm	—	—	No holiday	Annex B
Peel strength	90 °C	N/mm	≥ 4	Annex D
	$T_{max}$	N/mm	≥ 1,5	Annex D
Adhesion to pipe surface and plant coating after 28-day hot-water immersion test at $T_{max}$ limited as per Annex I	20 °C	—	Rating 3	Annex I plus Annex C
Degree of cure	—	°C	$\Delta T_g$ given by the manufacturer	Annex E
Cathodic disbondment at 28 days	23 °C	mm	≤ 7	Annex F
	$T_{max}$ limited to 95°C	mm	≤ 10	Annex F
Impact resistance <sup>a</sup>	20 °C	J/mm	$7 \times \alpha \times \beta^a$	Annex G
Indentation resistance at a pressure of 10 N/mm <sup>2</sup>	$T_{max}$	mm	≤ 0,9	Annex H
Flexibility	b	—	b	b
Oxidation induction time at 220 °C (intercept in the tangent method) <sup>c</sup>	—	min	≥ 15	ISO 11357-6

<sup>a</sup>  $\alpha = 0,7$  for coating thickness less than or equal to 2 mm;  
 $\alpha = 1$  for coating thickness greater than 2 mm;  
 $\beta = 0,7$  for pipe with nominal diameter less than 65 mm;  
 $\beta = 0,85$  for pipe with nominal diameter from 65 mm to less than 200 mm;  
 $\beta = 1,0$  for pipe with nominal diameter from 200 mm.

<sup>b</sup> By agreement, if applicable.

<sup>c</sup> May be omitted for types 5B and 5C if agreed between end user or purchaser and applicator.

**Table 25 — Requirements for types 5D (flame-sprayed PE) and 5E (PE tapes)**

Property	Test temperature	Unit	Value	Test method
Total coating thickness	—	mm	By agreement	Annex A
Epoxy layer thickness	—	mm	By agreement	Annex A
Holiday detection	—	kV/mm	> 10	Annex B
Peel strength	$T_{max}$	N/mm	> 1,5	Annex D
Adhesion to pipe surface and plant coating after 28-day hot-water immersion test at $T_{max}$ limited as per Annex I	20 °C	—	Rating 3	Annex I plus Annex C
Degree of cure	—	°C	$\Delta T_g$ given by the manufacturer	Annex E
Cathodic disbondment at 28 days	23 °C	mm	$\leq 7$	Annex F
	$T_{max}$	mm	$\leq 10$	Annex F
Impact resistance <sup>a</sup>	20 °C	J/mm	$5 \times \alpha \times \beta$	Annex G
Indentation resistance at a pressure of 10 N/mm <sup>2</sup>	$T_{max}$	mm	$\leq 1,0$	Annex H
Flexibility	b	—	b	b
Oxidation induction time at 200 °C (intercept in the tangent method) <sup>c</sup>	—	min	$\geq 15$	ISO 11357-6

<sup>a</sup>  $\alpha = 0,7$  for coating thickness less than or equal to 2 mm;  
 $\alpha = 1$  for coating thickness greater than 2 mm;  
 $\beta = 0,7$  for pipe with nominal diameter less than 65 mm;  
 $\beta = 0,85$  for pipe with nominal diameter from 65 mm to less than 200 mm;  
 $\beta = 1,0$  for pipe with nominal diameter from 200 mm.

<sup>b</sup> By agreement, if applicable.

<sup>c</sup> May be omitted for types 5B and 5C if agreed between end user or purchaser and applicator.

Annex A  
Inspection of thickness

## A.2 Equipment

A.2.1 Magnetic, electromagnetic or ultrasonic measuring instrument, with  $\hat{\Delta}\pm 10\%$  reading accuracy, calibrated for the range of coating thickness being measured.

## Annex B

### Holiday detection test

## B.2 Equipment

B.2.1 Holiday detector, adjustable, high-voltage, with  $\hat{\Delta}\pm 10\%$  reading accuracy, equipped with a sound and/or light signal.

B.2.2 Scanning electrode, in the form of a metal brush, coiled spring with continuous spirals or conductive rubber conforming to the shape of the joints.

B.2.3 Conductors, connecting the joint to an earth electrode.

## Annex C

### Adhesion test "Resistance to removal"

## C.2 Equipment

C.2.1 Utility knife, e.g. with a stiff, straight blade.

C.2.2 Steel rule, if required.

C.2.3 Steel rod, if required.

## Annex D

### Peel-strength test

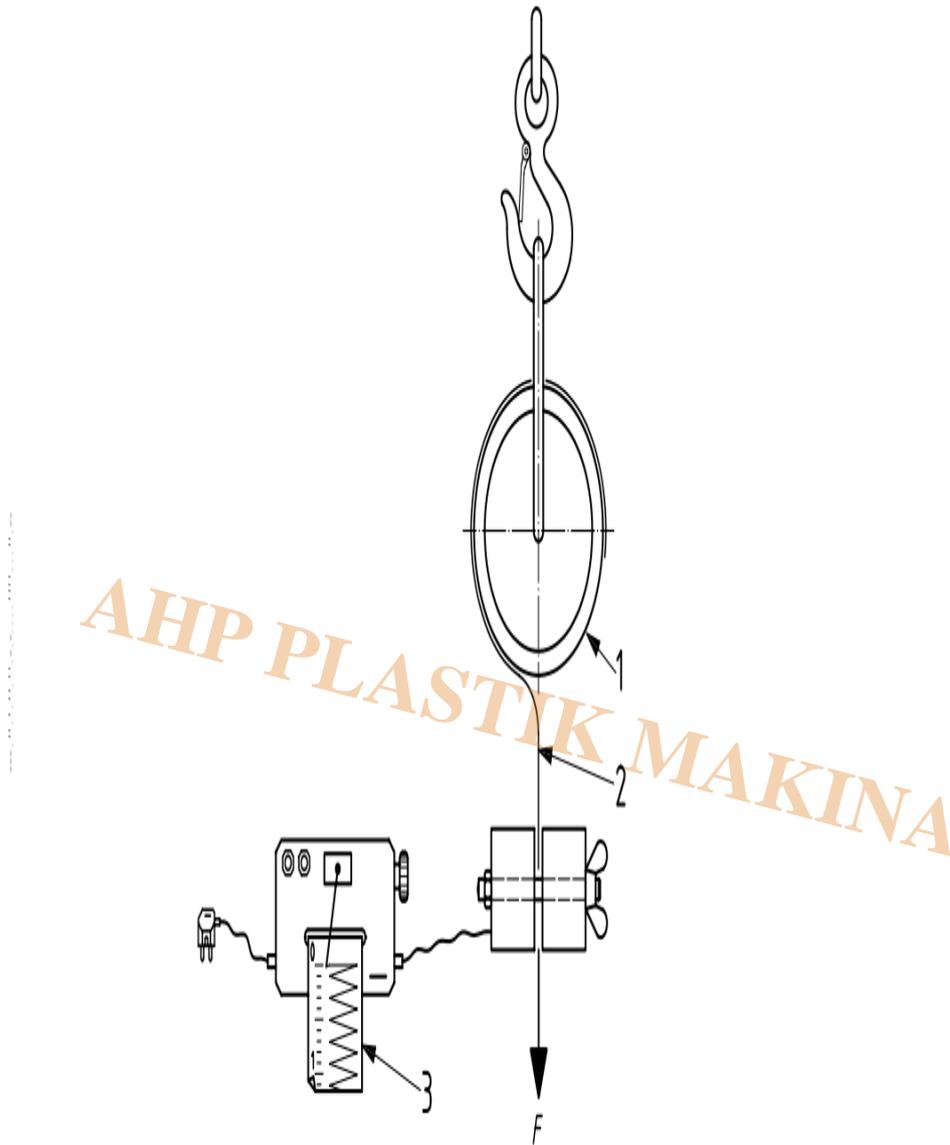
## D.1.2 Equipment

D.1.2.1 Tensile testing machine, capable of recording the peel force with  $\hat{\Delta}\pm 5\%$  reading accuracy, that operates at a rate of pull of 10 mm/min  $\hat{\Delta}\pm 1$  mm/min, as shown in Figure D.1 for small diameters or as in

Figure D.2 for large diameters.

D.1.2.2 Cutting tool, e.g. knife.

D.1.2.3 Equipment, as suggested in Figures D.1 or D.2.

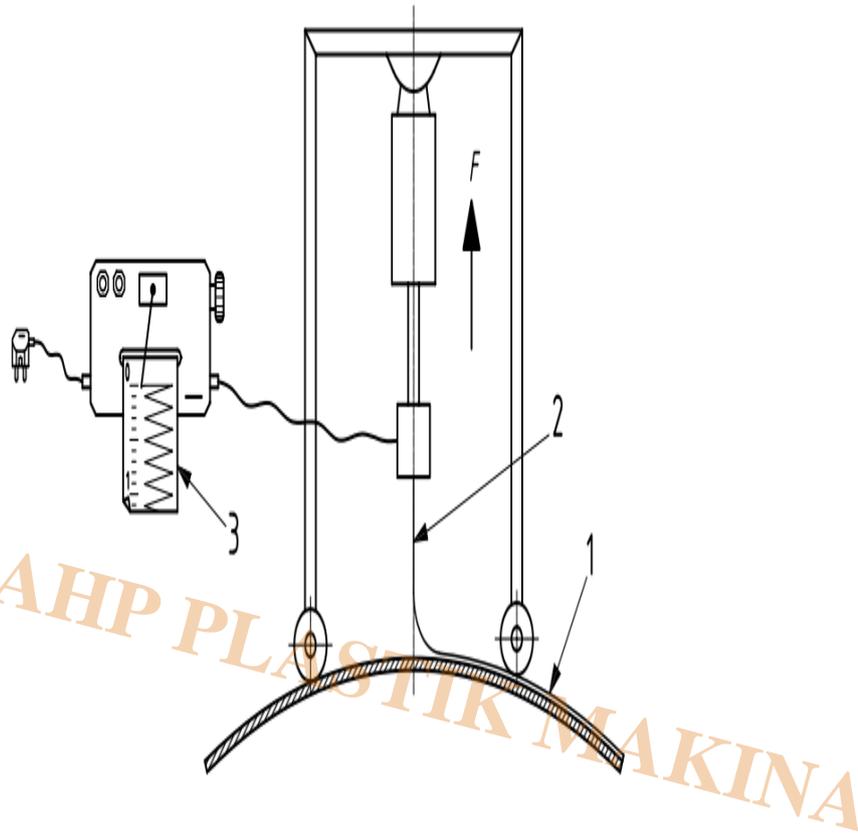


**Key**

- 1 pipe ring
- 2 coating strip
- 3 registration unit

*F* peel force

**Figure D.1 — Peel-strength test equipment for a small-diameter joint**

**Key**

- 1 coated pipe surface
- 2 coating strip
- 3 registration unit

$F$  peel force

Figure D.2 — Peel-strength test equipment for a large-diameter joint

**Annex E**

Thermal analysis of epoxy powder and cured coating film (FBE)

**E.2 Equipment**

- E.2.1 Differential scanning calorimeter (DSC), with cooling accessory.
- E.2.2 Balance, accurate to 0,1 mg.
- E.2.3 Sample-encapsulating press.
- E.2.4 Aluminium pans, with covers.
- E.2.5 N<sub>2</sub> gas supply, dry, analytical grade.

**Annex F**

Cathodic disbondment test

## F.2 Equipment

F.2.1 Electrical source, consisting of a controlled voltage d.c. power unit capable of supplying 20 mA to each test area simultaneously.

Except when otherwise specified, a cathodic polarization potential of  $\approx 1500$  mV to a saturated calomel reference electrode (equivalent to UH equal to  $\approx 1260$  mV where UH is the potential of the standard hydrogen

electrode) shall be maintained. The potentials are defined as follows:

$E$  is the potential of the working electrode with regard to the reference electrode.

$V$  is the difference of potential between the working electrode and the auxiliary electrode.

F.2.2 Electrolytic cell, having a typical test-cell configuration as shown in Figure F.1 for large-diameter components and as in Figures F.2 and F.3 for small-diameter components.

The electrolytic cell shall comprise of

• a rigid plastic pipe with an internal diameter of minimum 50 mm. The height shall be such that the total volume of the electrolyte is equal to or greater than 150 cm<sup>3</sup> with a minimum height of the electrolyte of 70 mm;

• a rigid plastic cover in which holes shall be drilled to allow the passage of the electrodes and any other measuring instruments deemed necessary, and to allow the escape of hydrogen.

### F.2.3 Electrodes

F.2.3.1 Reference electrode, capable of giving a suitable potential (see F.2.1) and suitable for the test temperature required, placed in an electrode holder situated in a glass pipe with a porous end diaphragm.

The end of this assembly shall be placed approximately 10 mm from the surface of the coating and approximately 20 mm from the coating defect.

F.2.3.2 Auxiliary electrode (anode), consisting of an inert material, e.g. platinum wire, 0,8 mm to 1,0 mm in diameter.

It shall be immersed in the electrolyte to within approximately 10 mm over the coating defect.

The ratio of the surface area of the anode to that of the cathode shall be greater than 1.

F.2.3.3 Working electrode (cathode), represented by the artificial defect, 6 mm in diameter, with a maximum depth of 0,5 mm in the steel substrate (see Figure F.4).

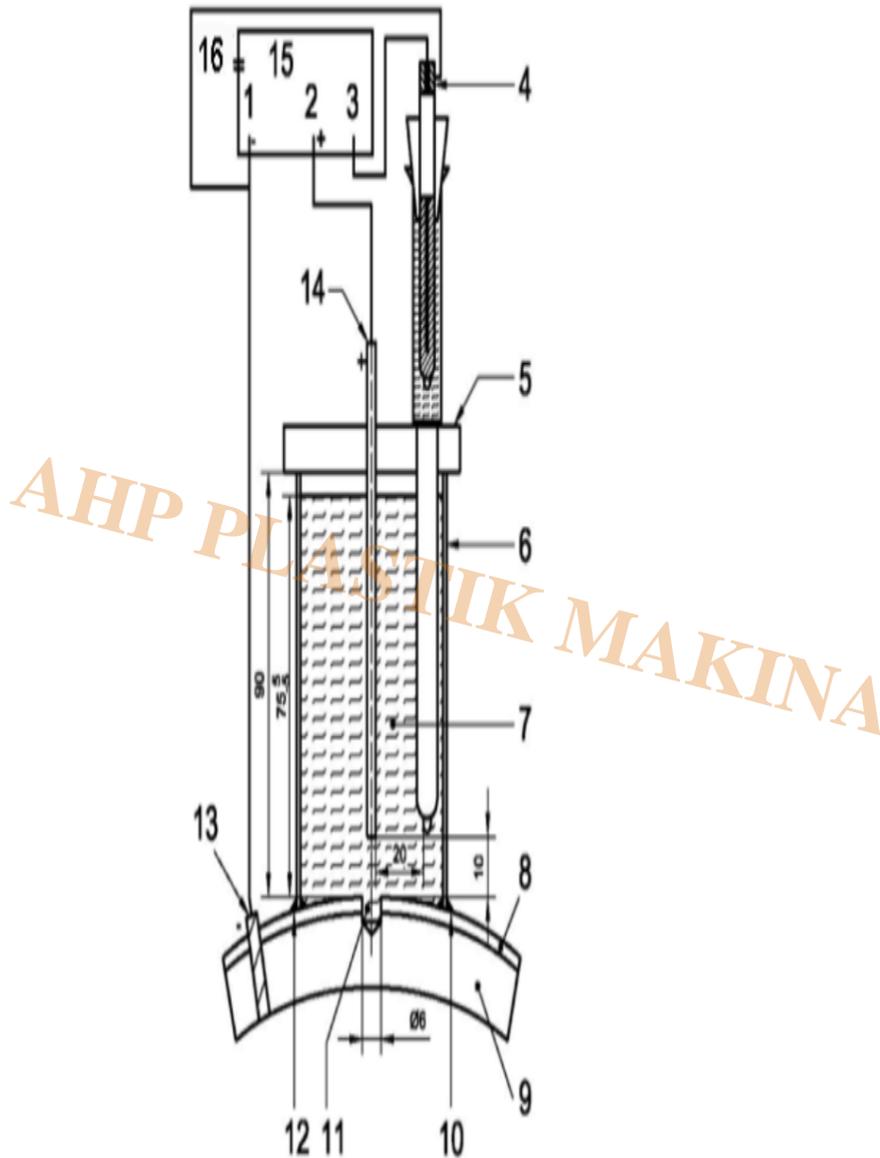
F.2.4 Electrolyte, consisting of a 3 % solution of NaCl in distilled or deionized water.

The solution shall be made from analar grade sodium chloride. The pH at 23  $\pm$  2  $^{\circ}$ C during the test shall be in the range of 6 to 9.

The height of the electrolyte in the cell shall be 75 mm  $\pm$  5 mm.

F.2.5 Heating equipment, suitable to establish and to maintain the test temperature of the sample. If not heated in an oven, the temperature shall be checked on the artificial defect by an appropriate means, e.g. a temperature sensor.

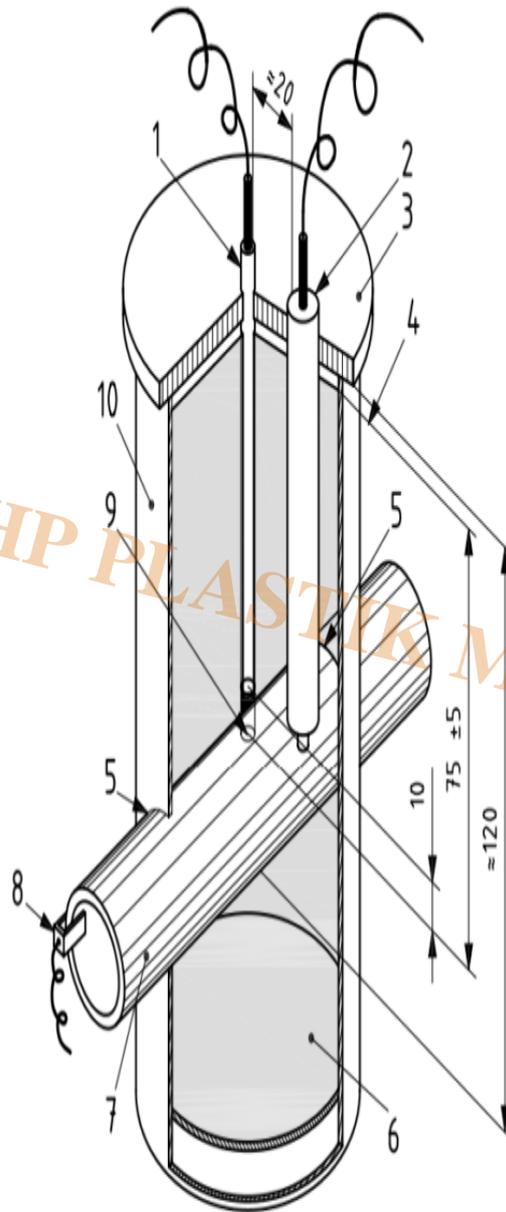
Dimensions in millimetres



**Key**

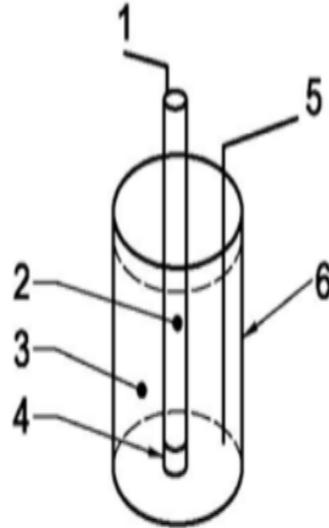
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|--|--|
| 1 working electrode                                  | 10 sealing material  |
| 2 electrode (anode)                                  | 11 artificial defect, $\varnothing$ 3 mm to 6 mm if coating thickness is less than 1 mm; $\varnothing$ 6 mm in other cases |
| 3 electrode (reference)                              | 12 sealing material  |
| 4 reference electrode                                | 13 electrode (cathode)   |
| 5 plastic cover                                      | 14 platinum electrode, $\varnothing$ 0,8 mm to 1,0 mm (anode)  |
| 6 plastic pipe, minimum internal $\varnothing$ 50 mm | 15 potentiostat  |
| 7 electrolyte $\geq$ 150 ml                          | 16 220 V power supply  |
| 8 coating  |  |
| 9 steel test piece                                   |  |

Dimensions in millimetres



**Key**

- 1 platinum electrode,  $\varnothing$  0,8 mm to 1,0 mm (anode)
- 2 reference electrode
- 3 plastic cover
- 4 electrolyte level
- 5 sealing material
- 6 electrolyte
- 7 coated pipe
- 8 working electrode (cathode)
- 9 artificial defect,  $\varnothing$  3 mm to 6 mm if coating thickness is less than 1 mm;  $\varnothing$  6 mm in other cases
- 10 plastic pipe, minimum internal  $\varnothing$  50 mm

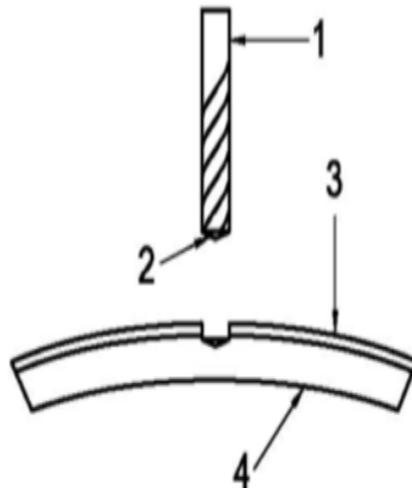


**Key**

- 1 to negative lead (-)
- 2 holiday
- 3 electrolyte
- 4 end cap
- 5 to positive lead (+)
- 6 beaker

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Figure F.3 — Electrolytic cell for small-diameter pipe — Example 2



**Key**

- 1 fluted and mill face mill  $\varnothing$  3 mm to 6 mm if coating thickness is less than 1 mm;  $\varnothing$  6 mm in other cases
- 2 conic end
- 3 coating
- 4 steel

## Annex G Impact test

### G.2 Equipment

Drop weight testing machine, consisting of the following:

– straight guide made of steel, aluminium or plastic, rigid and non-deformable, with an inside diameter

between 40 mm and 60 mm, length at least 1,30 m and incorporating a smooth and even inside surface;

– support and levelling device (for example, two spirit levels for the horizontal plane and a plumb-line for the vertical plane);

– graduated rod, to determine the drop height to an accuracy of 5 mm;

– hard steel punch, with a hemispherical head, free from notches, porosity or other surface irregularities

and with a diameter of 25 mm (A small metal rod with a diameter of 6 mm shall be fixed perpendicular to

the flat face of the head and in its centre; this rod shall be long enough to hold the additional weights required for the tests. The punch shall be equipped with a system for raising it to the required height; the

mass of this assembly shall be  $1 \pm 0,005$  kg.);

– number of weights, formed of metal discs (preferably made of stainless steel) with an outside diameter of approximately 24 mm and incorporating a central hole of diameter 6,5 mm. The mass of each disc shall

have an accuracy of  $\pm 5$  g.

Other guides may be used by agreement.™

## Annex H Indentation test

### H.2 Equipment

H.2.1 Chamber or bath, thermostatically controlled to  $\pm 2^\circ\text{C}$ ;

H.2.2 Penetrometer, comprised of

– a cylindrical indenter on the top of which is mounted a weight; the assembly, indenter plus weight, shall

produce a pressure in accordance with Table H.1;

– dial gauge or any other measurement system, accurate to  $\pm 0,01$  mm.

Table H.1 — Pressure, indenter diameter and mass of assembly

Pressure N/mm <sup>2</sup>	Indenter diameter mm	Mass of the assembly kg
0,10	11,2 ± 0,05	1,0
1,00	5,65 ± 0,05	2,5
5,00	1,80 ± 0,05	1,25
10,0	1,80 ± 0,05	2,5

## Annex I

## Hot-water immersion test

## I.2 Equipment

I.2.1 Oven, controllable to within 3 Â°C.

I.2.2 Holiday detector.

I.2.3 Cylinder, plastic, 150 mm long, with an interior diameter of 75 mm Â± 3 mm.

I.2.4 Knife, pointed, sharp.

I.2.5 Adhesive, elastomeric, e.g. silicone sealant.

I.2.6 Hacksaw blade, small, â€œJuniorâ€ type or similar.

[DIN EN ISO 21809-2 Epoxy Coatings for Buried or Submerged Pipelines / Flexibility of the Coating / Testing Equipment](#)

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[DIN EN ISO 21809-2 Epoxy Coatings for Buried or Submerged Pipelines / Particle Size of Epoxy Powder / Testing Equipment](#)

▪

[DIN EN ISO 21809-1 External Coatings for Buried or Submerged Pipelines/ Polyolefin coatings \(3-layer PE and 3-layer PP\) / UV Ageing Test and Thermal Ageing Test / Testing Equipment](#)

▪

[DIN EN ISO 21809-1 External Coatings for Buried or Submerged Pipelines/ Polyolefin coatings \(3-layer PE and 3-layer PP\) / Annex C Peel Strength Test / Testing Equipment](#)

▪

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▪

**Category**

1. Equipment for Standards
2. Standards

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