Engineering Construction Specification

C18 Pavement Markings

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This document is a modified version of AUS-SPEC 1191 Pavement Markings October 2018 version

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Table of Contents

1 General

1.1 Responsibilities

1.1.1 General

Requirement: Provide pavement markings, as documented.
Authority requirements: This worksection does not override any applicable State or Local Government legislation and is to be read in conjunction with AS 1742.3 and the applicable State Road Authority pavement marking specification: RMS QA Specification DCM R141 Pavement Marking.

1.2 Cross references

1.2.1 General

Requirement: This worksection is not a self-contained specification. In addition to the requirements of this worksection, conform to the following:

- *C01 General requirements (Construction)*
- *C02 Quality management (Construction)*
- *C03 Control of traffic*

1.3 Standards

1.3.1 General

Pavement markings: To AS 1742.2.

1.4 Interpretation

1.4.1 Definitions

General: For the purposes of this worksection the following definitions apply:

- Longitudinal linemarking: All lines that are generally parallel to the traffic flow, such as centre, lane, edge, turn, continuity and transition lines and outline markings.
- Other markings: All diagonal and chevron markings on the pavement including symbols, words, numerals and arrows, kerb markings and markings for parking.
- Paint (AUS-SPEC): In this worksection implies pavement marking paint.
- Pavement marking: All longitudinal linemarking, transverse lines, raised pavement markers and other markings placed on the road to control traffic movement or parking.
- Thermoplastic material: In this worksection implies thermoplastic pavement marking material.
- Transverse lines: All lines that are marked at right angles to the general traffic flow, such as Stop/Give way lines and pedestrian crosswalk lines.

1.5 Tolerances

1.5.1 Marking tolerances table

Marking type and dimension	New installation	Maintenance
Spotting		
All markings: Documented location	± 50 mm	-
Arrows, chevrons, painted	± 50 mm	± 50 mm of existing marking

Marking type and dimension	New installation	Maintenance
medians, painted left turn islands and speed markings: Each dimension		
Longitudinal linemarkings		
Width	± 5 mm	Width of existing marking ± 10 mm
Width of gap between adjacent lines	± 10 mm	± 10 mm
Length	± 50 mm	Length of existing marking ± 100 mm
Distance between centreline of new and existing	-	< 15 mm
Transverse lines and other markings		
Width	± 10 mm	Width of existing marking ± 10 mm
Length	± 10 mm	Width of existing marking ± 10 mm
Raised pavement markers		
Documented location: Transverse	± 25 mm	-
Documented location: Longitudinal	± 100 mm	
From other markers in the same line for a distance of 1.5 m	± 25 mm	-
Documented direction	± 4°	-

1.6 Submissions

1.6.1 Execution details

Removal of redundant markings: Submit details of method for removing redundant pavement markings.

1.6.2 Products and materials

Material properties: Submit test reports from a registered laboratory verifying material property conformance, including for paint, glass beads, raised pavement markers and thermoplastic material.

- Test currency: Not older than 3 years.

1.6.3 Samples

Permanent pavement marking tape: If marking tape is required, submit samples and product details for approval.

1.6.4 Tests

Results: Submit results of testing to **ANNEXURE – MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES**.

1.6.5 Warranties

Manufacturer's warranty: Submit the manufacturer's published product warranties for all materials and components.

1.7 Inspections

1.7.1 Notice

General: Give notice so that inspection may be made of the following:

- Setting out: Completion of pavement marking set-out.
- Surface preparation: Completes surface preparation, before applying pavement markings.
- Completion: Completed pavement marking.

2 Materials

2.1 Pavement marking paint

2.1.1 Type

Waterborne paint: To AS 4049.3.
Solvent-borne paint: Do not use.

2.2 Anti-skid pavement markings

2.2.1 Properties

Anti-skid materials: Angular, polishing resistant particles which provide skid resistance.

- Colour: Compatible with marking colour.

Particle size:

- For transverse lines and other markings: 0.4 to 0.7 mm.
- For longitudinal linemarking: 0 to 2.0 mm.

2.3 Thermoplastic material

2.3.1 Standard

Thermoplastic marking: To AS 4049.2.

2.3.2 Non-profile thermoplastic pavement marking material

Longitudinal linemarkings: Sprayed or extruded thermoplastics applied uniformly.
Transverse lines and other markings: Screeded or preformed thermoplastic.

2.4 Two-part cold applied pavement marking material

2.4.1 Properties

Lead content: Not greater than 0.25% to ASTM D3335.
No-pick-up time: Measured at 23°C and to AS 1580.401.8, as follows:

- For trowel or screed applied material (containing intermix glass beads): Maximum 20 minutes for 2.0 ± 0.25 mm applied film thickness.
- For spray material (not containing glass beads): Maximum 5 minutes for 0.200 ± 0.025 mm applied film thickness.

White road marking material luminance factor: Not less than 80% as delivered.
Abrasion resistance: Loss in mass not exceeding 0.3 g for 500 cycles to AS 4049.2 Appendix G.

Longitudinal linemarking: Sprayed material.
Transverse lines and other markings: Trowelled, screeded, sprayed or extruded material.

2.5 Reflective glass beads

2.5.1 Properties

Glass beads for pavement marking: To AS/NZS 2009.
Glass bead proportion: Incorporate glass beads in thermoplastic material as follows:

- In the proportion of a minimum 20% of the total mass.
- As part of the aggregate constituent and conforming to AS/NZS 2009.

Glass beads: Conform to the following:

- Bead type: B or D-HR.
- Type D-HR for use with thermoplastic applications: Provide with a proprietary adhesive coating and in clearly labelled packaging.

2.6 Pavement marking tape

2.6.1 Type

Temporary markings: Strippable tape.

2.7 Raised pavement markers

2.7.1 Classification type

Markers: Reflective and non-reflective markers to AS/NZS 1906.3, to the documented dimensions.
Adhesive to wearing surface: Hot melt bitumen adhesive.

2.7.2 Tests

Sampling: To AS/NZS 1906.3.

2.8 Testing

2.8.1 Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.
Quality verification: If material/product quality verification can be obtained from the supplier, documented tests need not be repeated.

3 Execution

3.1 General

3.1.1 Protection of work

Protection of markings: Protect markings until the material has hardened sufficiently so that traffic will not cause damage.

3.1.2 Material application

Pavement marking paint: Provide in conformance with the following:

- Permanent markings: To all wearing surfaces.
- Temporary markings: To surfaces other than final wearing surfaces.

Thermoplastic pavement marking material: Install where permanent markings are required.

Pavement marking tape: Use where temporary markings on final wearing surfaces are required.
Reflective glass beads: Apply to all painted and thermoplastic markings.
Raised pavement markers: Install as permanent and temporary markings, as documented.
Cold applied plastics: Install to the manufacturer's recommendations.

3.1.3 Pavement marking finish

Pavement marking appearance: Straight or with smooth, even curves, where applicable.
Edges: Clean, sharp cut off.
Faulty application beyond defined edge: Remove and leave a neat and smooth marking on the wearing surface of the pavement.

3.2 Establishment

3.2.1 Colour

All pavement marking materials: White Y35 to AS 2700 with a luminance factor not less than 80% to AS 4049.3.
Anti-skid materials: White, equivalent to or whiter than Y35, Off White to AS 2700.

3.2.2 Setting out

Locations: Place all markings as documented. The work shall be set out with materials which will be easily removable upon placement of permanent markings and survey if required.
Surface preparation
Application surface: Apply to clean dry surfaces only. Clean the surface, make sure there is a satisfactory bond between the markings and wearing surface of the pavement.
Existing material: If the existing surface is flaking, chipping or in a condition where adhesion of new material to the road surface cannot be guaranteed for the required life of the marking, obtain approval for the proposed extent and method of surface preparation.
Curing compound applied to new rigid concrete pavement surface: Remove by physical abrasion such as grinding or blasting.
Wet weather: Do not carry out pavement marking during wet weather or if rain is likely to fall during the process.
Raised markers on concrete wearing surface: Lightly scabble the full area under each marker to remove fine mortar material (laitance).

3.2.3 Maintenance of pavement markings

Requirement: Maintain and replace, if necessary, all raised pavement markers and pavement marking during the contract period and the contract defects liability period.

3.3 Paint marking

3.3.1 General

Glass bead application: Apply to a smooth surface.

3.3.2 Mixing of paint

Requirement: Thoroughly mix all paint in its original container before use to produce a smooth uniform product, consistent with the freshly manufactured product.

3.3.3 Application of paint and beads

Paint thickness excluding surface applied beads: Apply uniformly and at the following minimum dry film thickness:

- Type B beads for transverse lines and other markings: 0.20 mm.
- Type D-HR beads for longitudinal linemarkings: 0.30 mm.

Ambient conditions for applying paint with glass beads: For optimum performance and durability, incorporate glass beads under the following conditions:

- Air and pavement temperature: > 15°C.
- Relative humidity: > 70%.
- Air movement: 10 km/hr (reasonable air movement).
- Protection of markings from traffic during the drying process.

Hand spraying: Hand spraying with the use of templates to control the pattern and shape is permitted for transverse lines, symbols, legends, arrows and chevrons.

3.3.4 Longitudinal lines

Paint application: Spray lines in conformance with the following:

- With a self-propelling machine.
- Two sets of lines forming a one-way or two-way barrier line pattern: Spray concurrently.

Glass bead application rate: Conform to the following:

- Type D-HR beads: Apply to the surface of all longitudinal lines at a minimum application rate of 0.50 kg/m2 immediately after applying the paint.
- Actual application rate: Set to overcome any loss of beads between the bead dispenser and the sprayed line.

3.3.5 Other markings

Dimensions: Conform to local or state requirements for the following:

- Arrows.
- Chevrons.
- Painted medians.
- Painted left turn islands.
- Speed markings.

Thickness of non-profile markings: Maximum 6 mm.
Arrows and speed markings: Place square with the centreline of the traffic lane.
Glass bead application: Apply as for other paint markings at the following rate:

- Type B glass beads: Minimum 0.30 kg/m2, immediately after applying paint.
- Type D-HR glass beads: Minimum 0.5 kg/m2.

3.3.6 Field measurement of spherical glass bead application rate

Requirement: Measure spherical glass bead application rate onto wet paint or thermoplastic surfaces as follows:

- Turn off the paint or thermoplastic supply valves and operate the glass bead dispenser for 10 seconds, allowing glass beads to run into a plastic bag or tray.
- Pour the glass beads from the bag or tray into a suitable measuring cylinder calibrated in mL to measure the volume of glass beads collected. Level, but do not compact, the glass beads in the cylinder.
- Compare the volume of glass beads collected with that in Volume of glass beads (mL) required in 10 seconds of operation table.

Volume required for 0.50 kg/m^2: For the calibration of application rates to suit type D-HR beads, alter the **Volume of glass beads (mL) required in 10 seconds of operation table** to 0.50 kg/m^2.

3.3.7 Volume of glass beads (mL) required in 10 seconds of operation table

Road speed (km/h)	Line widths				
	80 mm	**100 mm**	**120 mm**	**150 mm**	**200 mm**
8	396	495	594	742	990
13	643	804	965	1207	1698
16	791	990	1188	1484	1484

Notes:

- These figures are calculated for an actual application rate of 0.34 kg/m^2 and are used for calibrating the machine because there is a loss of beads between the bead dispenser and the marked line and the volume is measured with beads not compacted.
- Tolerance of + 10% is permissible when measuring these volumes.
- If using two or more glass bead dispensers, check each dispenser separately to make up the required totals.
- Glass beads weigh approximately 1.53 g/mL.

3.3.8 Anti-skid material

Surface application: Apply anti-skid material before applying glass beads.

3.3.9 Anti-skid material application rates for transverse lines and other markings

Material stirred into paint before application: Minimum 500 g/L.
Material surface applied: Minimum 200 g/m².

3.4 Thermoplastic (non-profile) marking

3.4.1 General

Arrows and speed markings: Place square with the centreline of the traffic lane.
Application of thermoplastic materials and beads: Uniformly apply the thermoplastic material.

3.4.2 Preparation of thermoplastic material on site

Heating: Immediately before application, uniformly heat the thermoplastic material in a suitable kettle to the temperature recommended by the manufacturer without overheating.
Molten pot life: Maximum 6 hours for hydrocarbon resins and 4 hours for wood and gum resins.
Discard: Over-heated resin and/or expired molten materials.

3.4.3 Tack coat

Requirement: Apply where wearing surface of the pavement is smooth or polished.
Application: To the thermoplastic and tack coat manufacturer's recommendations.
Timing: Immediately before applying the thermoplastic material in accordance with the directions of the manufacturer of the thermoplastic and the manufacturer of the tack coat material.

3.4.4 Anti-skid materials and glass beads

Bead application: Apply materials conforming to the following:

- Generally: Uniformly apply after application of thermoplastic material to pavement, whilst material is molten.

- Longitudinal lines: Separate bead applications, use application methods which retains bead in the materials.
- Type B glass beads: For lines other than longitudinal lines, apply to screeded markings using an approved method.

Bead application rate: Conform to the following:

- Type B glass beads: Minimum 0.30 kg/m2.

Rate retained in the surface for transverse lines and other markings: Minimum 0.30 kg/m^2.

- Type D-HR glass beads: Minimum 0.50 kg/m2.

Rate retained in the surface for longitudinal lines: Minimum 0.40 kg/m2.

Anti-skid material application rate: Minimum 0.20 k/m^2.

3.4.5 Longitudinal lines

Applying thermoplastic material: Spray lines in conformance with the following:

- With a self-propelling machine.
- Two sets of lines forming a one-way or two-way barrier line: Spray concurrently.
- Application: Apply uniformly with minimum cold film thickness of 1.8 mm.

Bead application: Conform to the following:

- Type B glass beads: Apply by air propulsion or gravity feed to the surface of all lines immediately after application of thermoplastic material.

Actual application rate: Set to overcome any loss of beads between the bead dispenser and the sprayed line.

- Application rate: Conform to Anti-skid materials and glass beads.

3.4.6 Transverse lines and other markings

Other marking dimensions: Conform to local or state requirements for the following:

- Arrows.
- Chevrons.
- Painted medians.
- Painted left turn islands.
- Speed markings.

Thickness: 3 mm ± 1 mm.
Screeded markings: If required, screed thermoplastic material using a mobile applicator and templates to control the pattern.

3.4.7 Field testing

Thermoplastic material: Verify the cold film thickness applied to the road pavement.
Test method: Use a vernier or suitable dry film thickness gauge to measure the thickness of thermoplastic material applied to a metal test plate. Take the mean of at least 6 readings distributed over the test area.

3.4.8 Field measurement of spherical glass bead application rate

Requirement: Measure to **PAINT MARKING**, **Field measurement of spherical glass bead application rate**.

3.5 Two-part cold applied pavement marking

3.5.1 General

Primer: Apply if the surface is concrete, smooth or polished, or where recommended by the manufacturer. Apply to the manufacturer's recommendations.
Anti-skid material and glass beads: Uniformly apply onto the two-part cold applied material while fluid and immediately after it has been applied to the pavement.

3.5.2 Longitudinal lines

Bead applications: Separate bead application. Use methods which retain beads in the material.

3.5.3 Application rates for two-part cold applied pavement materials and glass beads table

Material	**Longitudinal linemarking**	**Transverse lines and other markings**	
	Sprayed application	**Trowelled, screeded or extruded**	**Sprayed**
Cold applied material thickness (excluding surface applied beads)	0.5 ± 0.05 mm (wet)	2.0 ± 0.2 mm (dry)	1.00 ± 0.1 mm (wet)
Completed marking thickness	-	-	2.0 ± 0.2 mm
Surface applied glass beads*:			
• Type (AS/NZS 2009)	Type D-HR (adhesive coated)	Type B	Type B
• Rate retained in the painted surface	≥ 400 g/m^2	≥ 300 g/m^2	≥ 300 g/m^2
Anti-skid material	≥ 200 g/m^2	≥ 200 g/m^2	≥ 200 g/m^2
* Glass beads coated with a compatible coupling agent for an improved adhesive bond with thermoplastic or two-part cold applied road marking material.			

3.6 Pavement marking tape

3.6.1 General

Application: To the manufacturer's recommendations.
Removal: If required, remove to the manufacturer's recommendations.

3.7 Raised pavement markers

3.7.1 Installation

Adhesive preparation: Freshly heat and mix the adhesive to the manufacturer's recommendations. Do not allow the adhesive to cool and do not reheat before use.
Application of adhesive: Spread the adhesive uniformly over the underside of the marker to a depth of approximately 10 mm.
Fixing marker to pavement: Conform to the following:

- Press marker onto the pavement surface in its correct position and rotate slightly until the adhesive is squeezed out around all edges of the marker.
- Do not disturb the marker until the adhesive has set.

3.7.2 Rough surfaces

Locations: Newly laid coarse sprayed bituminous seals.
Fixing marker to pavement: Conform to the following:

- Apply an initial pad of adhesive 20 mm larger than the diameter of the base of marker.
- Apply adhesive to fill irregularities in the pavement surface to produce a flat, smooth surface, flush with the upper stone level.
- Allow the adhesive pad to set.
- Apply additional adhesive to the pavement in conformance with Installation and press down marker onto the adhesive pad on the pavement surface. Make sure there is good adhesion.

3.8 Removal of redundant markings

3.8.1 Removal method

Redundant markings: Remove immediately before or after placement of new markings. Removal techniques include grinding (preferred) or painting.

Requirement: Remove marking from wearing surface of pavement as follows:

- Without significant damage to the surface.
- Remove markings in blocks to avoid ghosted images.
- Black out markings only as a temporary measure.
- Complete removal within 48 hours.

3.9 Testing

3.9.1 Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

4 Annexures

4.1 Annexure – Summary of hold and witness points

Reference No:	Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
C18-HP01	SUBMISSIONS, Execution details Removal of redundant markings	H	Removal method of redundant markings.	3 days before commencement	Removal of markings
C18-HP02	SUBMISSIONS, Samples Permanent pavement marking tape	H	Samples and product details.	5 days before commencement	Material ordering and delivery
C18-WP03	SUBMISSIONS, Products and materials Type tests, material properties	W	Tests reports verifying material properties.	5 days before commencement	Material ordering and delivery
C18-HP04	INSPECTION, Notice Setting out	H	Pavement marking set-out.	5 days before marking application	Marking application, For development inspections book through "MyInspect"
C18-HP05	INSPECTION, Notice Surface preparation	H	Completed surface preparation.	1 day before marking application	Marking application, For development inspections book through "MyInspect"
C18-WP06	INSPECTION, Notice Completion	W	Completed marking.	1 day before inspection	
	*H = Hold Point, W = Witness Point				

4.2 Annexure – Maximum lot sizes and minimum test frequencies

Activity	Key quality verification requirements	Test method
Materials supply	Material quality – supplier's documentary evidence of:	
	Paint	AS 4049.3
	Glass beads	AS/NZS 2009
	-Thermoplastic material	AS 4049.2
	-Raised pavement markers	AS/NZS 1906.3
Paint application	Paint marking wet film thickness	AS/NZS 1580.107.3 Method B, comb gauge
	Application rate of glass beads	To **PAINT MARKING**, **Field measurement of spherical glass bead application rate**
Thermoplastic application	Cold film thickness	Measure by micrometer
	Unbeaded material thickness applied to road pavement	RMS T841
	Application rate of glass beads	To **THERMOPLASTIC (NON-PROFILE) MARKING**, **Field testing**
Two-part cold applied material application	Lead content	ASTM D3335
	No-pick-up time	AS 1580.401.8
	Abrasion resistance	AS 4049.2 Appendix G

4.3 Annexure - Referenced documents

The following documents are incorporated into this worksection by reference:

AS 1580		Paints and related materials - Methods of test
AS/NZS 1580.107.3	1997	Determination of wet film thickness by gauge
AS 1580.401.8	1997	No-pick-up time of road marking paints
AS 1742		Manual of uniform traffic control devices
AS 1742.2	2009	Traffic control devices for general use
AS 1742.3	2009	Traffic control for works on roads
AS 1906		Retroreflective materials and devices for road traffic control purposes
AS/NZS 1906.3	2017	Raised pavement markers (retroreflective and non-reflective)
AS/NZS 2009	2006	Glass beads for pavement-marking materials
AS 2700	2011	Colour standards for general purposes
AS 4049		Paints and related materials - Pavement marking materials
AS 4049.2	2005	Thermoplastic pavement marking materials - For use with surface applied glass beads
AS 4049.3	2005	Waterborne paint - For use with surface applied glass beads
RMS T841	2001	Field measurement of wet film thickness of road marking paint
ASTM D3335	2014	Standard Test Method for Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy

RMS Standards