

ROADS AND MARITIME SERVICES (RMS)

QA SPECIFICATION R141

PAVEMENT MARKING

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REVISION REGISTER

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 1/Rev 1		New specification	GM, CMS	Jan 91
Ed 2/Rev 1		Extensive changes. Thermoplastic material added.	GM, CMS (Neal/Pike)	09.12.91
Ed 2/Rev 2	R60.5.3	Cold film thickness of sprayed thermoplastic changed from 1.0 mm to 1.5 mm.	GM, CEC (R Pike)	15.12.92
Ed 3/Rev 0	Revision Register	Clause numbers and lists have been restructured to suit the new format.	GM, CEC	24.07.95
	1.2	References have been added.		
	1.4	New clause added.		
	2.1.2	First paragraph deleted, AS 4049.2 added.		
	2.1.3	New clause has been included.		
	2.1.4	Supplier's name deleted.		
	2.1.5	First paragraph reworded.		
	2.2	Clause has been reworded.		
	3.1	Hold point has been reworded.		
	3.2	Heading changed. Three tolerances changed.		
		New sentence has been added to the end of the clause.		
	3.3, 5.2,	Consolidation and extension of Surface preparation requirements into Clause 3.3 from other clauses.		
	4.1	Waterborne paints added.		
	4.3	Paragraphs 1 and 2 reworded.		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 3/Rev 0 (cont'd)	4.3	Thickness specification applies to unbeaded line.		
	4.3, 5.2	Specified glass bead application rate is a minimum.		
	4.4, 5.3	Clauses deleted and consolidated into Clause 9.		
	5	Heading changed. References to materials transferred to Clause 2, clauses renumbered.		
	5.1	Oil bath kettle reference deleted. Last sentence reworded.		
	5.2	Parts of clause reworded. Details for QUALITY PLAN.		
	5.2	Thicknesses and tolerances changed.		
	6	New clauses for Profile Thermoplastic Road Marking Material.		
	8	Mechanical abrasion required for removal of markings.		
	9	New clause for field testing.		
	10	Payment for temporary lines clarified.		
	Annexure R60/2	Each item changed, two new items added.		
	Figure 11, Figure 12	Chevrons and painted median markings are reflectorised.		
Ed 4/Rev 0		Specification Number changed from R60 to R141. Change to Word 6.0c format. General Revision of Specification.	GM, TM	02.08.96
Ed 4/Rev 1	Table R141.6	Content reformatted with tables, editorial changes. Table of areas added.	GM, TM	03.10.96
Ed 4/Rev 2	Revisions to Edition 2 1.2, 4 Figure 1 Figure 3 Figure 6	New clause. Reference to RTA R142 added. Line S3 added. Line E6 width changed from 0.15 m to 0.20 m. Change to UA4(L) shape.	GM, TM (R Walsh)	05.03.97

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 4/Rev 3	2.1.5.1 2.1.5.2 11 Pay Item R141 P1	Clauses rewritten, brands deleted. Measurement redefined.	GM, TM (R Walsh)	21.04. 97
Ed 4/Rev 4	4 6 11.4 Annex R141/2	Minimum waterborne paint and bead application rates specified. Application rates amended. Lesser longitudinal application removed. Table R141.6 - some areas added, some amended. Minor editorial changes. Schedule of Identified Records added.	GM, TM (R Walsh)	11.04.00
Ed 4/Rev 5	1.2, Annex. R141/4	Minor changes.	GM, TM (R Walsh)	22.08.00
Ed 4/Rev 6		Type B beads replaced by Type A.	GM, TM (R Walsh)	29.11.00
Ed 4/Rev 7	4, 5, 6 4	Crushed quartz requirement standardised. Crushed quartz not excluded from longitudinal lines.	GM, TM	21.08.01
Ed 5/Rev 0	Various Foreword 1.2 1.3 1.5 2.1.1, Annex R141/M 2.1.6, Tables R141.2, .3, .4, Annex M 2.2 3.1 3.1.1 3.7	Specification reformatted Text revised to direct imperative style "Superintendent" changed to "Principal", "Contractor" to "you" Minor editorial changes. New clause after the Table of Contents Expanded to describe structure. "you" and "your" defined. Replaced by Clause 1.2.4. Solvent based paint clause deleted AS 4049.1 deleted AS 4049.3 replaces RTA 3356. AS 2009 replaces RTA 3353. Approved state road authority added. Last paragraph revised EPA reference changed to DEC. Added	GM, TM (Paul Yu)	19.05.05

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 5/Rev 0 (cont'd)	Table R141.3, .4, .5 9 11 Annexures Drawings	Major changes and footnote added. Procedure revised Transferred to Annexure R141/B. All Payment Items deleted. Rearranged and renumbered. Figure 2 added Figure 4A added Figure 19 added Figure 20 added Figures renumbered and revised		
Ed 5/Rev 1	3.1.1, 3.3, 4, 5, 6, 10.6, 10.7 2.1.6 4 5 5, 6, 7 5, 6, 7 5, 6 7 Table R 141.3, .4, .5 Drawings	Minor editorial changes Test beads in the uncoated state Use Type D standard glass beads Sprayed thermoplastic deleted for transverse lines Application rates changed Bead types changed Crushed quartz sizes changed Crushed quartz deleted Application rates, types of materials and footnote revised Figure 3, revised (L2 Lane line not recommended)	GM, TM (Paul Yu)	15.07.05
Ed 5/Rev 2	Annexure R141/B 1.2 Various	First paragraph revised Pay Items reinstated The words “and an Attachment” added Minor corrections	GM, RNIC	22.02.06
Ed 5/Rev 3	Pay Items P6 and P7	Pay Items corrected.	GM, IC	03.11.07
Ed 6/Rev 0	All sections Guide Notes 1.1, 1.4 2.1.2 2.1.4	Clauses rearranged, retitled and edited. Removed, text moved to other sections. Reworded. Reference to sprayed or extruded thermoplastic added. Reference to sprayed, trowelled, rolled-on and screeded two part cold applied material added.	GM, IC	24.07.09

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 6/Rev 0 (cont'd)	2.1.7	New clause on anti-skid material added.		
	2.2	New clause “Materials Colours” inserted.		
	3.1	New clause titled “General” added. Former clause 3.1.1 “Department Of Environment and Climate Change Requirements” deleted.		
	3.1.2	New sub-clauses on “Reinstatement After Road Works” and “New Installation” added.		
	3.1.7	New clause “Reinstatement of Pavement Markings after Road Works” added.		
	3.1.8	Requirement for sacrificial coat of pavement marking added.		
	3.1.9	New clause “Redundant Pavement Markings” added.		
	3.2, 3.3, 3.4	Reworded.		
	Tables 3 & 4	Typed D glass bead changed to Type D-HR.		
	3.5	Specific reference to thermoplastic material removed. Reference to “continuous” and “discontinuous” profile line types included.		
	Table 5	Type B glass bead changed to Type D-HR. Rate retained changed from $\geq 300\text{g/m}^2$ to $\geq 500\text{g/m}^2$. Requirement for intermix glass beads and anti-skid material included.		
	4.7	Reference to anti-skid material added.		
	Annexure E	New annexure on Guidelines for applying waterborne paint.		
	Annexure F	New annexure on “Linemarking Application Guide” (previously located in Guide Notes).		
	Annexure O	New annexure on Glass Bead Calibration Guide (previously located in Guide Notes).		
	Annexure M	References updated to include: AS/NZS 1580.601.1, AS 4049.4, RTA Delineation Manual, APAS 0042.		
	Appendices	Figures 1 to 8 replaced by Appendices 1 to 4 to accord with RTA Delineation Manual.		
Ed 6/Rev 1	Global	Clauses rearranged and reworded. New subclause headings added.	GM, IC	19.04.11
	1.1	Exclusions to scope of spec added.		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 6/Rev 1 (cont'd)	1.4	New clause added on "Painting Contractors Certification Program" (PCCP) accreditation requirement. Subsequent clause renumbered.		
	2.1	New clause incorporating 1st para of clause 3.1. Subsequent clauses renumbered.		
	2.1.1	Solvent-borne paint may be used only with written approval from Principal. Requirements for solvent-borne paint changed from Aust Std to RTA Material spec 3359.		
	2.1.2	Requirements for thermoplastic pavement marking material changed from Aust Std to RTA Material spec 3360.		
	2.5	Clause heading title changed to "Handling, Storage and Mixing".		
	3.1	New headings for subclauses 3.1.1 and 3.1.2 added.		
	3.2	New clause with heading "Position and Tolerances", incorporating previous subclauses 3.1.2 and 3.1.3, added.		
	3.4	Previously subclause 3.1.7.		
	3.5	Previously subclause 3.1.9. Individual subclauses rearranged and reworded. New headings for subclauses 3.5.1 to 3.5.6 added.		
	3.6	New headings for subclauses 3.6.1 to 3.6.3 added.		
	3.6.4	New subclause moved here from previous clause 3.1.8. Heading title changed from "Waterborne Paint" to "Two Stage Application for New Chip Seal Surfaces".		
	3.9	New Figure 3.5 showing profile longitudinal linemarking dimensions.		
	5	New clause "Conformity" incorporating previous subclause 3.1.5.		
	Annex F	Form for determining waterborne linemarking application rates deleted.		
	Annex G	Details corresponding to 80mm and 120mm widths removed (widths no longer used).		
	Annex M	Referenced documents updated.		
	Appendices 1, 2 and 3	Linemarking lengths, widths and spacings amended.		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 6/Rev 1 (cont'd)	Appendix 4 Appendix 5 Figures 14, 15 and 16	Deleted, as line types C2 and C3 shown in Appendix 1. New appendix providing details of pavement markings at roundabouts. Dimensions of markings for chevrons, medians and left turn island amended.		
Ed 6/Rev 2	1.2.4 2.1 3.3.1 Annex B	Minor revisions to improve clarity or to make clause consistent with corresponding clause in R145.	GM, IC (M Andrew)	27.10.11
Ed 6/Rev 3	Appendix 2 Figure 10 Figure 16	Additional dimensions added to transverse pavement marking drawings to improve clarity. Arrow label, shown as RA3, corrected to RA2. Dimension added to infill length in chevron.	GM, IC (M Andrew)	09.11.11
Ed 6/Rev 4	Appendix 2	Figure for Transverse lines at traffic signals updated (Page 35).	GM, IC	21.05.12
Ed 6/Rev 5	Annex C, L Annex L	Clause references corrected. Characteristic analysed using T841 to include Dry Film thickness.	GM, IC	25.01.13
Ed 6/Rev 6	1.4	Relevant pavement marking classes under PCCP accreditation added.	GM, IC	26.06.13
Ed 7/Rev 0	Global 1.1 1.5, Annex B Table B.1, Figures 9, 10 and 11 2.1 2.2	Clauses rearranged and reworded to improve clarity. Type B-HR and Type D-HR specified for all small and large glass beads respectively. Scope elaborated. Reference to Annex A deleted. Superfluous clarification of types of roads for use of this spec removed. Pavement arrow labelling nomenclature introduced. Previous clauses on default material for longitudinal lines and use of long life materials changed to “comments”. Heading title changed.	GM, CB	11.02.16

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 7/Rev 0 (cont'd)	2.2.1	New sub-clause titled “General” added. Subsequent sub-clauses renumbered.		
		Requirement for pavement marking materials to be compatible with other materials used relocated here from Clause 2.5.		
	2.2.7	Previously clause 2.2.6.		
		Requirement for reflective glass beads to comply with AP-S0042 for heavy metal content restriction emphasised.		
		Requirement for glass beads to be precoated with compatible coupling agent where required moved here from Tables R141.3 and R141.4 note.		
	2.3	Heading title changed. Headings added to form new sub-clauses 2.3.1 to 2.3.4.		
	2.3.2	Reference colour “Green G16” deleted.		
	2.4	Heading title changed.		
	3.1	Previously clause 3.2. Headings added to form new sub-clauses 3.1.1 to 3.1.5.		
	3.2	Previously clause 3.1. Heading title changed. Headings added to form new sub-clauses 3.2.1 to 3.2.5.		
	3.2.4	Clauses relating to glass beads and anti-skid materials application consolidated under this clause and reworded.		
	3.3	Previously clause 3.6. Individual sub-clauses renumbered.		
	3.3.2	Heading title changed.		
	3.3.3	Table 1 (previously Table 2) amended.		
	3.4	Previously clause 3.7. Headings added to form new sub-clauses 3.4.1 to 3.4.4.		
		Requirement for reflective glass beads to comply with RMS 3353, etc deleted (duplicated in clause 2.2.7).		
	3.4.4	Table 2 (previously Table 3) amended.		
	3.5	Previously clause 3.8. Headings added to form new sub-clauses 3.5.1 to 3.5.3.		
	3.5.3	Table 3 (previously Table 4) amended.		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 7/Rev 0 (cont'd)	3.6	Previously clause 3.9. Headings added to form new sub-clauses 3.6.1 to 3.6.4. Previous Figure 3.5 for profile linemarking deleted.		
	3.6.4	Table 4 (previously Table 5) amended.		
	3.7	Previously clause 3.10.		
	3.8	Previously clause 3.3. Heading title changed. Individual sub-clauses rearranged and renumbered.		
	3.9	Previously clause 3.4. Headings added to form new sub-clauses 3.9.1 and 3.9.2.		
	3.10	Previously clause 3.5. Individual sub-clauses rearranged and renumbered. Headings added to form new sub-clauses 3.10.2 to 3.10.5, 3.10.7 and 3.10.8. Previous clause on cause of redundant markings changed to “comment”.		
	3.10.2	New sub-clause on use of black non-reflective masking tapes as temporary masking materials added.		
	3.10.8	Requirement for disposal of removed marking material to comply with EPA guidelines added.		
	4	Heading title changed.		
	4.2	New clause titled “Verification of Thickness” added. Previous clauses 4.2 to 4.6 changed to sub-clauses 4.2.1 to 4.2.5. Subsequent clauses renumbered.		
	5	Heading title changed.		
	5.1	New clause, moved here from previous sub-clause 3.1.2. Heading title changed from “Uniformity” to “Shape and Appearance”.		
	5.2	New clause on inspection of pavement markings removal added.		
	5.3	Heading added to form new clause 5.3.		
	Annex A	Table amended.		
	Annex D	Planning documents amended.		
	Annex G	Notes to table reorganised and reworded.		
	Figs 9 & 10	Titles and details of figures amended.		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 7/Rev 0 (cont'd)	Fig 11 Fig 12	Combining previous Figures 11 and 12. Deleted. Incorporated into Figure 11.		



PAVEMENT MARKING

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VERSION FOR: DATE:

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FOREWORD

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REVISIONS TO PREVIOUS VERSION

This document has been revised from Specification RMS R141 Edition 6 Revision 6.

All revisions to the previous version (other than minor editorial and project specific changes) are indicated by a vertical line in the margin as shown here, except when it is a new edition and the text has been extensively rewritten.

PROJECT SPECIFIC CHANGES

Any project specific changes are indicated in the following manner:

- (a) Text which is additional to the base document and which is included in the Specification is shown in bold italics e.g. ***Additional Text***.
- (b) Text which has been deleted from the base document and which is not included in the Specification is shown struck out e.g. ~~Deleted Text~~.

RMS QA SPECIFICATION R141

PAVEMENT MARKING

1 GENERAL

1.1 SCOPE

This Specification sets out the requirements for the supply and application of pavement markings for works such as:

- (i) installation of markings on new roads and for revised traffic schemes;
- (ii) reinstatement of markings after road works;
- (iii) maintenance of markings (e.g. marking over existing markings),

using materials such as waterborne paint, thermoplastic, two part cold applied material, glass beads, and preformed pavement marking tape.

This Specification does not cover all the requirements for markings for School Zones. For School Zones markings not covered by this Specification, contact the RMS Centre for Road Safety. For details of “Dragon’s Teeth” pavement markings at School Zones, refer to the RMS Centre for Road Safety Technical Direction TD 2009/SR02.

This Specification includes the requirements for Bus Lane and Bicycle Lane markings. For requirements for Bus Lane and Bicycle Lane surface coatings, refer to Specification RMS R110 “Coloured Surface Coatings for Bus Lanes and Cycleways”.

1.2 STRUCTURE OF SPECIFICATION

This Specification includes a series of annexures and appendices that detail additional requirements.

1.2.1 Project Specific Information

Project specific details of work are shown in Annexure R141/A.

1.2.2 Measurement and Payment

The method of measurement and payment is detailed in Annexure R141/B.

1.2.3 Schedules of HOLD POINTS and Identified Records

The schedules in Annexure R141/C list the **HOLD POINTS** that must be observed. Refer to Specification RMS Q for the definition of **HOLD POINTS**.

The records listed in Annexure R141/C are **Identified Records** for the purposes of RMS Q Annexure Q/E.

1.2.4 Planning Documents

The PROJECT QUALITY PLAN must include each of the documents and requirements listed in Annexure R141/D and must be implemented.

In all cases where this Specification refers to the manufacturer's recommendations, these must be included in the PROJECT QUALITY PLAN.

1.2.5 Minimum Frequency of Testing

The Inspection and Test Plan must nominate the proposed testing frequency to verify conformity of the item, which must not be less than the frequency specified in Annexure R141/L. Where a minimum frequency is not specified, nominate an appropriate frequency. Frequency of testing must conform to the requirements of RMS Q.

1.2.6 Referenced Documents

Unless specified otherwise or is specifically supplied by the Principal, the applicable issue of a referenced document, is the issue current at the date one week before the closing date for tenders, or where no issue is current at that date, the most recent issue.

Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 1234). For convenience, the full titles are given in Annexure R141/M.

1.3 DEFINITIONS

The terms “you” and “your” mean “the Contractor” and “the Contractor’s” respectively.

The following definitions apply to this Specification:

Stripe	That part of longitudinal linemarking comprising pavement marking material.
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.
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.
Other markings	All diagonal and chevron markings, messages on the pavement including symbols, words, numerals and arrows, kerb markings and markings for parking.
Pavement marking	All longitudinal linemarking, transverse lines and other markings used on the road pavement and kerbs for the purpose of guiding traffic, but excluding raised pavement markers, which are covered in Specification RMS R142.

1.4 ACCREDITATION TO PAINTING CONTRACTORS CERTIFICATION PROGRAM

All works carried out using this Specification must be by pavement marking organisations accredited to the “Painting Contractors Certification Program” (PCCP), administered by CSIRO, under the appropriate classes from Category B “Pavement markings”, as follows:

Class	Description
20	Long-run longitudinal pavement marking on major roads
21	Short to medium-run longitudinal pavement marking on minor roads
22	Audio tactile markings
24	Transverse pavement marking including intersection markings and messages
26	High friction surfacings
27	Pavement marking: removal

Provide evidence to the Principal that the work is carried out by a pavement marking organisation holding the appropriate PCCP accreditation.

1.5 TYPES OF MARKINGS

Details of the various types of pavement markings are shown on the following Appendices and Figures which are included at the back of this Specification:

Appendix 1	Longitudinal Pavement Markings
Appendix 2	Transverse Pavement Markings
Appendix 3	Pavement Markings and Symbols for Bicycle Facilities
Appendix 4	(Not Used)
Appendix 5	Pavement Markings at Roundabouts
(Figures 1 to 8 are not used)	
Figure 9	Pavement Arrows at Intersections – Common Types (AR1, AR3(R), AR4(R))
Figure 10	Pavement Arrows at Intersections – Special Types (AR2, AR7, AR8, AR9)
Figure 11	Lane Change Arrows – Urban and Rural (ARU5, ARR5)
Figure 12	(Not Used)
Figure 13	Pavement Arrow for Use in One Way Roads
Figure 14	Chevron Layout
Figure 15	Pavement Marking – Median
Figure 16	Pavement Marking – Left Turn Island
Figure 17	Pavement Marking in Advance of Open Level Crossings
Figure 18	Pavement Alphabet and Numerals
Figure 19	Speed Numeral Pavement Patch
Figure 20	E-TAG Pavement Marking

2 MATERIALS

2.1 GENERAL

Apply the markings using the materials specified in the Drawings or directed by the Principal.

The default material for marking longitudinal lines on State Roads and National Highways is waterborne paint, with large glass beads.

For new work in high traffic volume areas, commonly in urban locations, long life materials, such as thermoplastic or two part cold applied material, may be specified.

2.2 MATERIAL TYPES

2.2.1 General

Materials for pavement markings must comply with the requirements stated in Clauses 2.2.2 to 2.2.8.

The materials must be compatible with other materials which they are in contact with.

2.2.2 Pavement Marking Paint

Waterborne paint must conform to the requirements of Specification RMS 3356.

You may use solvent-borne paint, conforming to the requirements of Specification RMS 3351, only with the written approval of the Principal.

2.2.3 Non-profile Thermoplastic Pavement Marking Material

Non-profile thermoplastic pavement marking material must conform to the requirements of Specification RMS 3357.

Sprayed or extruded thermoplastic may be used for longitudinal lines. Screeded or preformed thermoplastic may be used for transverse lines and other markings.

2.2.4 Profile Thermoplastic Material

Profile thermoplastic road marking material for audible/tactile treatment must comply with the requirements of Specification RMS 3359.

2.2.5 Two Part Cold Applied Pavement Marking Material

Two part cold applied material must comply with the requirements of Specification RMS 3360.

Sprayed and extruded two part cold applied materials may be used for longitudinal linemarkings. Trowelled, screeded, sprayed, or extruded two part cold applied materials may be used for transverse lines and other pavement markings where glass beads are required. Roll-on two part cold applied materials may be used for pavement markings where glass beads are not required.

2.2.6 Pavement Marking Tape

2.2.6.1 Temporary

Temporary pavement marking tape must be a strippable type approved by the Principal.

2.2.6.2 Permanent

Permanent pavement marking tape must be approved by the Principal.

2.2.7 Reflective Glass Beads

Reflective glass beads must comply with the requirements of Specification RMS 3353, AS/NZS 2009 (when tested in the uncoated state) and Australian Paint Approval Scheme (APAS) Specification AP-S0042, including the heavy metal content restriction in Clause 6.2 of AP-S0042. The Principal may request evidence of compliance of this at any time.

Where required in Tables R141.2 to R141.4, precoat the glass beads with a compatible coupling agent to improve the adhesion and bonding with the marking material.

2.2.8 Anti-skid Material

Anti-skid material must be angular, polishing resistant particles added to provide characteristics of skid resistance. The particles must be of a colour consistent with the marking colour.

2.3 COLOUR

2.3.1 General

All pavement markings must be in white colour, unless otherwise detailed in the Drawings or relevant RMS specifications or directed by the Principal.

2.3.2 Colour Match

When requested by the Principal, prepare a sample pavement marking material panel in accordance with AS 4049.4 Appendix F.

The colour of the sample must be at least an “approximate match”, as determined by unaided visual inspection in accordance with AS/NZS 1580.601.1, against the reference colours in AS 2700S, as follows:

White: Y35

Yellow: Y14

Red: R62

2.3.3 Mixed Colour Markings

Where mixed colour markings are used, with different colours providing different daytime colour contrasts to deliver a message, assess each individual colour for compliance with the colour specified, and clarity of definition of the markings, both between the different colours, and between the coloured marking and the pavement, as well as the retention of the message.

2.3.4 Colour Change

When non-white colour pavement markings in the wheel-path are assessed for colour change against a reference sample in accordance with AS 4049.4 Appendix G, the grey scale rating must be 3 or greater.

2.4 CERTIFICATION

At least 7 days prior to their proposed use, submit a signed statement to the Principal certifying that the materials meet the respective requirements of Clause 2. The statement must include test results from a NATA accredited facility or laboratory approved by the Principal. The test results submitted must not be older than 36 months at the time of submission.

2.5 HANDLING, STORAGE AND MIXING

The pavement marking materials must be handled, stored, combined with other products and used in accordance with each individual manufacturer's recommendations, such as the recommended application temperatures.

3 APPLICATION OF PAVEMENT MARKINGS

3.1 SURFACE PREPARATION

3.1.1 Responsibility for Surface Preparation

Surface preparation is, at all times, your responsibility.

3.1.2 Surface Condition

The surface area to be marked must be dry and free of dirt, gravel and other loose or foreign material.

The area around the marking must also be free of dirt, gravel and other loose or foreign material to avoid tracking of such material on to newly applied markings.

Do not carry out the pavement marking work until the above conditions have been met.

3.1.3 Condition of Existing Marking

When marking over existing markings, and the existing marking material is flaking or chipping, is of a type or is in such a condition that adhesion of the new marking to the road surface cannot be guaranteed for its required life, obtain the agreement of the Principal to the proposed method of surface preparation and its extent.

3.1.4 Compatibility with Existing Surface

Where a pavement marking material to be applied may be incompatible with the existing marking or surface, prepare the marking or surface suitably before applying the pavement marking material.

3.1.5 Existing Curing Compound Film

Where a curing compound has been applied to a new rigid concrete pavement surface, remove the curing compound by physical abrasive means such as grinding or blasting, from the areas where the pavement marking material is to be applied.

3.2 APPLICATION OF PAVEMENT MARKING – GENERAL

3.2.1 General

Apply all pavement marking materials strictly in accordance with the manufacturers' instructions and guidelines.

3.2.2 Longitudinal Lines

Apply all longitudinal lines using a self propelled machine, unless otherwise approved by the Principal.

Apply each of the pair of longitudinal lines forming a one-way or two-way dividing (barrier) line concurrently, except for enhanced barrier lines.

3.2.3 Transverse Lines and Other Markings

You may apply transverse lines, symbols, legends, arrows and chevrons manually using templates to provide the shape and pattern, or alternatively using preformed markings.

3.2.4 Glass Beads and Anti-skid Materials

All pavement markings covered by this specification, with the exception of marking tapes used for masking (refer Clause 3.10.2) or school zone markings, must have reflective glass beads incorporated.

For longitudinal markings with both glass beads and anti-skid materials that are surface applied, apply uniformly the glass beads first followed by the anti-skid material. The method of application must ensure retention of the glass beads in the material.

3.2.5 Dispensing Rates for Glass Beads

For each line width applied and each vehicle speed, determine the required dispensing rate of glass bead and anti-skid material, taking into account any loss of material during application, to achieve conformity to the application rates specified in Tables R141.1, R141.2, R141.3 and R141.4 for the respective pavement marking material types.

A calibration guide is provided in Annexure R141/G showing the required dispensing rates of glass beads to achieve a specified application rate of 400 g/m² (mass of glass beads per unit area of marking).

3.3 APPLICATION OF WATERBORNE PAINT

3.3.1 General

Apply waterborne paint uniformly.

Apply the glass beads uniformly to the wet paint, prior to its surface skin forming, to produce a uniform, properly bonded coverage over the whole marking.

Apply anti-skid material uniformly to all transverse lines and other markings where specified.

3.3.2 Recommended Conditions for Application of Waterborne Paint

Recommended conditions for application of waterborne paints with large glass beads (Type D-HR) to produce markings with optimum long term performance are given in Annexure R141/E1 as a guide.

3.3.3 Application Rates

The application rates must be as specified in Table R141.1.

Table R141.1 – Application Rates - Waterborne Paint Markings

Material	Longitudinal Lines	Transverse Lines and Other Markings
Dry paint thickness (excluding surface applied beads)	≥ 0.300 mm	≥ 0.200 mm
Glass beads, surface applied:		
Type	D-HR ⁽¹⁾	B-HR ⁽²⁾
Rate retained in surface	≥ 400 g/m ²	≥ 300 g/m ²
Anti-skid material, 0.4 – 0.7 mm size:		
Stirred into paint prior to application	–	≥ 500 g/L
Surface applied	–	≥ 200 g/m ²

Notes:

⁽¹⁾ In accordance with AS/NZS 2009.

⁽²⁾ In accordance with APAS AP-S0042.

⁽³⁾ “g/L” is the mass of anti-skid material per volume of paint prior to mixing.

“g/m²” is the mass of either glass beads or anti-skid material per unit area of marking.

3.3.4 Two Stage Application for New Sprayed Bituminous Surfacing

For waterborne paint applied over new sprayed bituminous surfacings, a two stage application process must be carried out.

A first coat of paint using Type B-HR glass beads, which is a sacrificial coat, is applied soon after the sprayed bituminous surfacing has been placed. After 2 months has elapsed but before 3 months, a second coat of paint is applied using Type D-HR glass beads.

3.4 APPLICATION OF NON-PROFILE THERMOPLASTIC PAVEMENT MARKING MATERIAL

3.4.1 Tack/Primer Coat

Where the surface of the pavement is concrete or is smooth or polished or where recommended by a manufacturer, apply a tack/primer coat in accordance with the manufacturer's recommendations.

3.4.2 Recommended Conditions for Application

Recommended conditions for application of sprayed or extruded thermoplastic with large glass beads to produce markings with optimum long term performance are given in Annexure R141/E2.

3.4.3 Application of Glass Beads and Anti-skid Materials

For longitudinal markings using thermoplastic material with surface applied glass beads and anti-skid materials, apply the glass beads and anti-skid material separately in accordance with Clause 3.2.4, immediately after the thermoplastic material has been applied to the pavement and while it is still molten.

3.4.4 Application Rates

The application rates must be as specified in Table R141.2.

Table R141.2 – Application Rates - Non-profile Thermoplastic Markings

Material	Longitudinal Lines	Transverse Lines and Other Markings	
	Sprayed or Extruded	Screeded	Preformed
Thermoplastic, applied thickness:			
Cold film	$\geq 1.8 \text{ mm}$	$3.0 \text{ mm} \pm 1.0 \text{ mm}$	–
Preformed	–	–	$2.5 \text{ mm} \pm 0.5 \text{ mm}$
Glass beads, surface applied ⁽¹⁾ :			
Type	D-HR ^(2, 3)	B-HR ⁽⁴⁾	B-HR ⁽⁴⁾
Rate retained in surface	$\geq 400 \text{ g/m}^2$	$\geq 300 \text{ g/m}^2$	$\geq 300 \text{ g/m}^2$
Anti-skid material, surface applied ⁽¹⁾ :			
0.4 – 0.7 mm size	–	$\geq 200 \text{ g/m}^2$	$\geq 200 \text{ g/m}^2$
1.0 – 2.0 mm size	$\geq 200 \text{ g/m}^2$	–	–

Notes:

- (1) For longitudinal markings with surface applied glass beads and anti-skid materials, apply the glass beads first followed by the anti-skid material.
- (2) Precoated with a compatible coupling agent to improve adhesion and bonding.
- (3) In accordance with AS/NZS 2009.
- (4) In accordance with APAS AP-S0042.
- (5) “g/m²” is the mass of either glass beads or anti-skid material per unit area of marking.

3.5 APPLICATION OF TWO PART COLD APPLIED PAVEMENT MARKING MATERIAL**3.5.1 Tack/Primer Coat**

Where the surface of the pavement is concrete or is smooth or polished or where recommended by a manufacturer, apply a tack/primer coat in accordance with the manufacturer's recommendations.

R141**Pavement Marking****3.5.2 Application of Glass Beads and Anti-skid Material**

For longitudinal markings using two part cold applied marking material with surface applied glass beads and anti-skid material, apply the glass beads and anti-skid material separately in accordance with Clause 3.2.4, immediately after the two part cold applied marking material has been applied to the pavement and while it is still fluid.

3.5.3 Application Rates

The application rates must be as specified in Table R141.3.

Table R141.3 – Application Rates - Two Part Cold Applied Markings

Material	Longitudinal Lines	Transverse Lines and Other Markings	
	Sprayed	Sprayed	Trowelled, Screeded or Extruded
Applied thickness:			
Excluding surface applied beads	0.50 ± 0.05 mm (wet)	1.00 ± 0.1 mm (wet)	2.0 ± 0.2 mm (dry)
Including surface applied beads	–	2.00 ± 0.2 mm	–
Glass beads, surface applied ⁽¹⁾ :			
Type	D-HR ^(2, 3)	B-HR ^(2, 4)	B-HR ^(2, 4)
Rate retained in painted surface	≥ 400 g/m ²	≥ 300 g/m ²	≥ 300 g/m ²
Anti-skid material, surface applied ⁽¹⁾ :			
0.4 – 0.7 mm size	–	≥ 200 g/m ²	≥ 200 g/m ²
1.0 – 2.0 mm size	≥ 200 g/m ²	–	–

Notes:

- ⁽¹⁾ For longitudinal markings with surface applied glass beads and anti-skid materials, apply the glass beads first followed by the anti-skid material.
- ⁽²⁾ Precoated with a compatible coupling agent to improve adhesion and bonding.
- ⁽³⁾ In accordance with AS/NZS 2009.
- ⁽⁴⁾ In accordance with APAS AP-S0042.
- ⁽⁵⁾ “g/m²” is the mass of either glass beads or anti-skid material per unit area of marking.

3.6 APPLICATION OF PROFILE (OR AUDIO TACTILE) LONGITUDINAL PAVEMENT MARKING**3.6.1 Types**

Profile (or audio tactile) longitudinal pavement marking may be either:

- (i) raised ribs applied at a regular interval over a base strip layer of the same material (**continuous type**), or
- (ii) raised ribs only, placed directly on the road surface (**discontinuous type**).

3.6.2 Tack/Primer Coat

Where the surface of the pavement is concrete or is smooth or polished, apply a tack/primer coat in accordance with the manufacturer's recommendations prior to the application of the profile marking material.

3.6.3 Application of Glass Beads and Anti-skid Material

The glass beads must be precoated with a compatible coupling agent (refer Clause 2.2.7). Where directed by the Principal, preheat the glass beads to 185°C just prior to application.

Apply glass beads uniformly to the completed profile pavement marking immediately after application of the profile marking material. Set the actual application rate to compensate for any loss of beads between the bead dispenser and the applied line.

Where the profile marking is of the continuous type with anti-skid material in addition to the glass beads, apply the glass beads and anti-skid material separately in accordance with Clause 3.2.4.

3.6.4 Application Rates

The application rates and dimensions must be as specified in Table R141.4.

Table R141.4 – Application Rates - Profile Longitudinal Markings

Description	Requirement
Height of raised ribs, proud of pavement surface (excluding surface applied beads)	10 ± 2 mm
Thickness of strip in between raised rib sections (if applied)	≤ 2 mm
Clear spacing of raised ribs (in longitudinal direction)	250 ± 50 mm
Length of raised ribs (in longitudinal direction)	60 ± 10 mm
Slope angle of raised rib lead and trail faces	45° (approximately)
Glass beads, surface applied ⁽¹⁾ :	
Type	D-HR ^(2, 3)
Rate retained in marked surface	≥ 500 g/m ²
Glass beads, intermix:	
Type	D-HR ⁽³⁾
% of glass beads in intermix	20%
Anti-skid material, surface applied ^(1, 4) :	
1.0 – 2.0 mm size	≥ 200 g/m ²

Notes:

- ⁽¹⁾ For longitudinal markings with surface applied glass beads and anti-skid materials, apply the glass beads first followed by the anti-skid material.
- ⁽²⁾ Precoated with a compatible coupling agent to improve adhesion and bonding.
- ⁽³⁾ In accordance with AS/NZS 2009.
- ⁽⁴⁾ Only for continuous type of profile longitudinal pavement marking (refer Clause 3.6.1).

(5) “g/m²” is the mass of either glass beads or anti-skid material per unit area of marking.

3.7 APPLICATION OF PAVEMENT MARKING TAPE

Apply pavement marking tape in accordance with the manufacturer's recommendations, including surface preparation.

Remove pavement marking tape, where required, in accordance with the manufacturer's recommendations.

3.8 POSITION, DIMENSIONS AND TOLERANCES

HOLD POINT

Process Held: Application of pavement markings.

Submission Details: Notification that set out is complete.

Release of Hold Point: The Principal may inspect the set out prior to authorising the release of the Hold Point.

3.8.1 Position of Markings

3.8.1.1 New Installation

New installation refers to the installation of markings on new roads and for revised traffic schemes.

Set out the work such that the markings are placed in accordance with the Drawings and/or the Figures at the back of this Specification and within the tolerances listed in Table R141.5.

3.8.1.2 Reinstatement After Road Works

Where the markings require reinstatement following pavement works carried out by others, such as reseals, apply the reinstated markings to the set out placed by others and within the tolerances listed in Table R141.5.

3.8.1.3 Maintenance

Apply markings directly over the existing markings within the tolerances listed in Table R141.5.

At locations where the existing markings are so badly worn that installation of new markings is required, set these out to achieve the correct shape and position of the markings within the tolerances listed in Table R141.5.

3.8.2 Tolerances

Comply with the tolerances shown in Table R141.5 when installing the pavement markings.

Table R141.5 – Pavement Marking Positions, Dimensions and Tolerances

Position or Dimension	New Installation or Reinstatement^(3, 4)	Maintenance⁽⁵⁾
1. Longitudinal linemarking		
(a) Distance between centreline of new and old linemarking	N.A.	< 15 mm
(b) Start of new stripe relative to start of old stripe	N.A.	Lesser of: ± 5% of stripe length or ± 100 mm
(c) Position of centreline of new linemarking	< 50 mm from positions shown on Drawings	N.A.
(d) Length of new stripe (and for maintenance: total length of new and old stripe, unless otherwise directed)	Lengths shown in Appendix 1 ± 50 mm	Old stripe length ± lesser of: 5% of old stripe length or 100 mm
(e) Width of new linemarking (and for maintenance: total width of new and old linemarking, unless otherwise directed)	Widths shown in Appendix 1 ± 5 mm	Width of old linemarking ± 10 mm
(f) Gap between double lines	Gap shown in Appendix 1 ± 10 mm	Gap shown in Appendix 1 ± 10 mm
2. Transverse and other markings		
(a) Position of centreline of transverse marking	< 50 mm from positions shown on Drawings	N.A.
(b) Length of new marking	Lengths shown in Appendices 2, 3 and 5, ± 10 mm	Length of old marking ± 10 mm ⁽¹⁾
(c) Width of new marking	Widths shown in Appendices 2, 3 and 5, ± 10 mm	Width of old marking ± 10 mm ⁽¹⁾
3. Markings in advance of open level crossings		
(a) Length of new marking	Length shown in Figure 17 ± 50 mm	Length of old marking ± 10 mm ⁽¹⁾
(b) Width of new marking	Width shown in Figure 17 ± 10 mm	Width of old marking ± 10 mm ⁽¹⁾
4. Arrows, chevrons, marked medians, marked left turn islands, speed markings⁽²⁾		

Position or Dimension	New Installation or Reinstatement ^(3, 4)	Maintenance ⁽⁵⁾
(a) Each dimension	Dimensions shown in Figures 9 to 11, 13 to 16, and 18 to 20, ± 50 mm	Dimensions of old marking ± 50 mm ⁽¹⁾
5. Thickness of all pavement markings, other than profile pavement marking	≤ 6 mm (unless otherwise directed by the Principal)	≤ 6 mm (unless otherwise directed by the Principal)

Notes:

- (1) Where the dimensions of existing markings exceed the dimensions permitted for Reinstatement, the dimensions and tolerances applicable to Reinstatement also apply to the new Maintenance markings, unless otherwise directed by the Principal.
- (2) Place arrows and speed markings square to the direction of travel.
- (3) For Reinstatement markings done to set out placed by others, follow the set out as much as practicable but minimising any disruption to the marking pattern to which it links.
- (4) For New Installation markings, set out the markings such that, at the ends, any disruption to the marking pattern to which it links is minimised.
- (5) The alignment of longitudinal linemarking must be a smooth and continuous apparent line when viewed in the direction of the line.

3.9 REINSTATEMENT OF PAVEMENT MARKINGS AFTER ROAD WORKS

3.9.1 Time Limits for Reinstatement

Reinstate the pavement markings as soon as possible after road works where the pavement markings have been removed or damaged, to maintain the delineation for road safety purposes.

3.9.2 Use of Temporary Raised Pavement Markers

You may use temporary raised pavement markers for delineation for up to 10 days after opening to traffic, after which the pavement markings must be reinstated.

3.10 REDUNDANT PAVEMENT MARKINGS

Redundant pavement markings usually arise:

- as part of traffic switches during road construction or reconstruction (involving temporary removal or masking of the markings). In most cases, a final pavement surface will be re-laid, over which permanent markings are installed.*
- as a result of a pavement marking/delineation scheme being changed due to traffic and road safety considerations (involving permanent removal of the markings).*

3.10.1 General

Remove or mask pavement markings which are no longer required, and leave behind a clean and undamaged pavement with surface texture, reflectivity characteristics and colour comparable to the adjacent pavement surface.

3.10.2 Use of Temporary Masking Materials

You may use black non-reflective pavement marking tapes, specially designed for the purpose, as temporary masking materials. Remove the tapes to expose the masked marking when the marking is once again required.

3.10.3 Methods of Pavement Marking Removal

Remove pavement markings in a manner that will not damage the pavement structure, surface or texture. After removal of the markings, the condition of the resulting pavement surface must be suitable for bonding of new markings.

Remove pavement markings over expansion joints on concrete pavements by methods acceptable to the Principal.

3.10.4 Extent of Removal or Masking

When removing or masking longitudinal and transverse lines such as edge lines, centre lines, lane lines, holding lines, or other lines, the removal or masking must cover a minimum of 200% of the total area of existing lines; i.e. minimum 50% extra coverage on both sides of the existing lines.

When removing or masking pavement markings such as arrows, numerals, letters, or other pavement markings, the removal or masking must take the form of a rectangular area or block around such markings.

3.10.5 Repair of Damage Caused by Markings Removal

Repair, by methods acceptable to the Principal and at your own cost, any damage to the pavement structure, pavement surface or pavement joint caused by the markings removal.

3.10.6 Time Limits for Removal of Redundant Pavement Markings

Remove, within 48 hours of application, any painted “blackout” or overlay that is applied as a temporary measure.

Remove, within 6 months of application, any pavement marking tape that is applied over existing markings as a temporary masking measure, unless directed otherwise by the Principal. Renew the marking tapes where they are to remain longer than 6 months after application.

3.10.7 Sequence of Removal

Where existing pavement markings are to be removed and replaced by other pavement markings, do not remove the pavement markings until adequate provision has been made to complete the installation of the replacement markings.

Remove pavement markings in such order that the markings remaining in place at any time will not be in a pattern that will mislead or misdirect road users.

3.10.8 Disposal of Removed Marking Material

Promptly remove any material deposited on the pavement resulting from the markings removal by the methods stated in the PROJECT QUALITY PLAN. On completion of the markings removal, clear the pavement surface of any residue or debris.

Do not leave any marking material that has been removed from the pavement on the Site. Dispose of marking material removed in accordance with current EPA guidelines.

3.10.9 Measurement of Quantity

Before removal of pavement markings, determine the face area of the pavement markings to be removed. Obtain the Principal's agreement to the face area of the pavement markings to be removed, prior to their removal.

4 SAMPLING AND TESTING

4.1 FREQUENCY OF TESTING

The minimum frequency of field testing is specified in Annexure R141/L. Unless otherwise specified in the Contract, keep records of all testing carried out for a minimum of twelve calendar months.

4.2 VERIFICATION OF THICKNESS

4.2.1 Paint

Calculate the thickness of the unbeaded dry film applied to the wearing surface using Test Method RMS T841 and the percent volume solids of the paint used. Confirm this by measuring with a suitable dry film thickness gauge the thickness of the cured unbeaded material on a suitable metal test plate, and take the mean of at least six readings distributed over the test area.

4.2.2 Non-profile Thermoplastic

Verify the thickness of the cold film of unbeaded non-profile thermoplastic material applied to the road pavement using a vernier or suitable dry film thickness gauge. Measure the thickness of the thermoplastic material applied to a metal test plate and take the mean of at least six readings distributed over the test area.

4.2.3 Two Part Cold Applied Pavement Marking Material

Verify the thickness of the unbeaded material applied to the road pavement using Test Method RMS T841.

4.2.4 Profile Thermoplastic

Verify the thickness of the cold film of unbeaded profile thermoplastic material applied to the road pavement with a vernier or a suitable dry film thickness gauge. Measure the thickness of both the peak of the profile section and the line joining the profile sections applied to a suitable metal test plate.

4.2.5 Glass Beads

Verify for each line width applied and each vehicle speed, the application rate of glass beads applied to the surface of the markings and the loss of beads during application.

4.3 VERIFICATION OF QUANTITIES

Record the quantities of materials used for longitudinal linemarking, as a minimum, for each Lot, and as follows:

- | | |
|-------------------------------------|-----------|
| (a) Paints | litres |
| (b) Thermoplastic materials | kilograms |
| (c) Two part cold applied materials | litres |
| (d) Glass beads | kilograms |
| (e) Anti-skid material | kilograms |

The quantity for each Lot must not be less than the area of marking applied multiplied by the specified minimum application rate.

5 CONFORMITY**5.1 SHAPE AND APPEARANCE**

Completed markings must be uniform in appearance, texture, width and thickness and the surface must be free from unbeaded areas, traffic damage or other defects.

Markings must be straight or with smooth even curves where intended. All edges must have a clean sharp cut off.

Remove at your cost any marking material beyond the defined marking, leaving a neat marking on the wearing surface of the pavement.

5.2 PAVEMENT MARKINGS REMOVAL

Inspect areas where removal of redundant markings has been carried out, to verify that:

- (i) redundant markings have been completely removed;
- (ii) pavement area has been cleaned up and waste material removed from the Site;
- (iii) any damage to the pavement caused by the marking removal has been repaired;
- (iv) guidance provided by the delineation to road users is clear and not misleading.

5.3 NONCONFORMITY

Pavement markings which are not in accordance with the Specification and Drawings are nonconforming and must be dealt with in accordance with the quality management system requirements and/or your PROJECT QUALITY PLAN.

ANNEXURE R141/A – PROJECT SPECIFIC REQUIREMENTS

Refer to Clause 1.2.1.

NOTES TO TENDER DOCUMENTER: (Delete this boxed text after customising Annexure R141/A)

Nominate below the type of pavement marking work required (whether New Installation/Reinstatement or Maintenance) by deleting whichever is not applicable.

Clause	Description	Requirement
3.8.1	The pavement marking work is:	New Installation or Reinstatement/ Maintenance

ANNEXURE R141/B – MEASUREMENT AND PAYMENT

Pavement markings provided as a temporary measure in accordance with Specification RMS G10 will be made under the appropriate pay items in RMS G10.

Payment will be made for all costs associated with completing the work detailed in this Specification in accordance with the following Pay Items.

Where no specific pay items are provided for a particular item of work, the costs associated with that item of work are deemed to be included in the rates and prices generally for the Work Under the Contract.

Unless specified otherwise, a lump sum price for any of these items will not be accepted.

The cost of provision for traffic and protection of work are included in the pay items for pavement markings.

Calculate the areas of markings applied in accordance with Figures 9, 10, 11 and 13 from the areas shown in Table R141/B.1.

Table R141/B.1 – Areas of Other Markings - Figures 9, 10, 11 and 13

Figure No	Figure Type	Area (m²)
9	Straight ahead arrow (AR1)	1.4
9	Combination – straight ahead and turn arrow (AR4)	2.5
9	Exclusive turn arrow (AR3)	1.8
10	Double turn arrow (AR2)	2.8
10	U–turn arrow (AR7)	3.0
10	45° turn arrow (AR9)	1.5
10	Sequential turns arrow (AR8)	3.0
11	Lane change arrows	
	Urban (ARU5)	1.72
	Rural (ARR5)	3.42
13	SA1 (painted area only)	3.11

Calculate the areas of markings applied in accordance with Figure 18 from the areas shown in Table R141/B.2.

The areas are based on letter and numeral characters 4000 mm high, that is $X = 100$ mm. For characters other than 4000 mm high, adjust the areas shown in Table R141/B.2 by the factor: (Actual height of character in mm) / 4000. Round off the area of each character to the nearest 0.01 m².

Table R141/B.2 – Areas of Other Markings - Figure 18

Character	A	B	C	D	E	F	G	H	I	J
Area (m ²)	0.91	1.29	0.80	1.06	1.02	0.78	0.89	1.01	0.40	0.64
Character	K	L	M	N	O	P	Q	R	S	T
Area (m ²)	0.90	0.61	1.34	1.07	1.08	0.96	1.23	1.13	1.00	0.64
Character	U	V	W	X	Y	Z				
Area (m ²)	0.94	0.84	1.52	0.76	0.64	1.08				
Character	1	2	3	4	5	6	7	8	9	0
Area (m ²)	0.71	1.71	1.54	1.78	1.73	1.61	1.08	2.20	1.61	1.46

Pay Item R141P1 - Waterborne Paint - Longitudinal Lines

The unit of measurement is the linear metre for each line type as shown on the relevant Figures.

The length must be measured along the centreline of the longitudinal line(s) that constitute a line type. Where the line type is comprised of multiple lines, only one line must be measured. The length includes any longitudinal spaces between the lines, as required by the line type.

Pay Item R141P2 - Waterborne Paint - Transverse Lines and Other Markings

The unit of measurement is the square metre.

The face area of the line or marking applied is determined from the dimensions shown on relevant figures and Drawings unless otherwise directed by the Principal.

Pay Item R141P3 - Non-profile Thermoplastic Pavement Marking Material - Longitudinal Lines

The unit of measurement is the linear metre for each line pattern calculated from the actual length including spaces between lines measured along the centre line of the longitudinal line.

Pay Item R141P4 - Screeded or Sprayed Non-profile Thermoplastic Pavement Marking Material - Transverse Lines and Other Markings

The unit of measurement is the square metre.

The face area of the thermoplastic material applied is determined from the dimensions shown on relevant figures and Drawings unless otherwise directed by the Principal.

Pay Item R141P5 - Preformed Non-profile Thermoplastic Pavement Marking Material - Transverse Lines and Other Markings

The unit of measurement is the square metre.

The face area of the thermoplastic material applied is determined from the dimensions shown on relevant figures and Drawings unless otherwise directed by the Principal.

Pay Item R141P6 - Two Part Cold Applied Pavement Marking Material - Longitudinal Lines

The unit of measurement is the linear metre for each line pattern calculated from the actual length including spaces between lines measured along the centre line of the longitudinal line.

Pay Item R141P7 - Not Used

Pay Item R141P8 - Trowelled, Screeded or Extruded Two Part Cold Applied Pavement Marking Material - Transverse Lines and Other Markings

The unit of measurement is the square metre.

The face area of the line or marking applied is determined from the dimensions shown on relevant figures and Drawings unless otherwise directed by the Principal.

Pay Item R141P9 - Sprayed Two Part Cold Applied Pavement Marking Material - Transverse Lines and Other Markings

The unit of measurement is the square metre.

The face area of the line or marking applied is determined from the dimensions shown on relevant figures and Drawings unless otherwise directed by the Principal.

Pay Item R141P10 - Profile Thermoplastic Pavement Marking Material - Longitudinal Lines

The unit of measurement is the linear metre for each line pattern calculated from the actual length including spaces between lines measured along the centre line of the longitudinal line.

Pay Item R141P11 - Pavement Marking Tape - Longitudinal Lines

The unit of measurement is the linear metre for each line pattern calculated from the actual length including spaces between lines measured along the centre line of the longitudinal line.

Pay Item R141P12 - Pavement Marking Tape - Transverse Lines and Other Markings

The unit of measurement is the square metre.

The face area of the line or marking applied is determined from the dimensions shown on relevant figures and Drawings unless otherwise directed by the Principal.

Pay Item R141P13 - Removal of Longitudinal Linemarkings, Transverse Lines and Other Symbols

The unit of measurement is the square metre.

The face area of the pavement markings removed must be determined prior to the work being carried out.

ANNEXURE R141/C – SCHEDULES OF HOLD POINTS AND IDENTIFIED RECORDS

C1 SCHEDULE OF HOLD POINTS

Clause	Description
3.8	Set out of pavement markings.

C2 SCHEDULE OF IDENTIFIED RECORDS

The records listed below are Identified Records for the purposes of RMS Q Annexure Q/E.

Clause	Description of Identified Record
2.4	Statement verifying that materials meet the respective requirements of Clause 2 including NATA endorsed test results.

ANNEXURE R141/D – PLANNING DOCUMENTS

Refer to Clause 1.2.4.

The following documents are a summary of documents that must be included in the PROJECT QUALITY PLAN. The requirements of this Specification and others included in the Contract must be reviewed to determine additional documentation requirements.

Clause	Description
1.4	Evidence of accreditation to the “Painting Contractors Certification Program”.
3.2 to 3.7	Details of materials and methods for application of various types of markings including application of glass beads and anti-skid materials.
3.10	Details of materials and methods for masking or removal of redundant pavement markings.

ANNEXURE R141/E – RECOMMENDED CONDITIONS FOR APPLICATION OF WATERBORNE PAINT AND THERMOPLASTIC MATERIALS WITH LARGE GLASS BEADS

E1 Waterborne Paint with Large Glass Beads (Type D-HR)

To achieve optimum long term performance, apply waterborne paint incorporating Type D-HR glass beads under the following conditions:

- (a) air temperature and pavement temperature > 15°C;
- (b) relative humidity < 70%;
- (c) air movement > 10 km/hr (reasonable air movement);
- (d) adequate protection of lines from traffic during the drying process.

Do not apply waterborne paint when relative humidity is above 85% or when air or road temperatures are below 10°C.

E2 Thermoplastic Materials

For application of thermoplastic materials, follow the manufacturer's recommended application temperature. Application at the manufacturer's recommended temperature will assist in achieving the correct glass bead embedment depth, aid bead retention and marking retro-reflectivity or night time visibility. This is an important consideration especially when using the large diameter type D-HR glass beads.

Application of profile pavement markings at a temperature below the recommended temperature, to achieve a stiffer mix and to assist rib rigidity, will result in premature delamination of the marking material from the pavement.

ANNEXURE R141/F – (NOT USED)

ANNEXURE R141/G –CALIBRATION CHART FOR DISPENSING TYPE D-HR GLASS BEADS

Table R141/G.1 – Calibration Chart for Dispensing Type D-HR Glass Beads at 400 g/m²

Speed (km/hr)	Dispensing Rate (millilitres per 10 seconds)		
	Line Width (mm)		
	100	150	200
3	220	340	450
4	300	450	600
5	370	550	740
6	450	660	890
7	520	780	1040
8	590	890	1180
9	660	1000	1340
10	740	1110	1480
11	820	1220	1630
12	890	1340	1780
13	960	1440	1930
14	1040	1550	2070
15	1110	1660	2220
16	1180	1780	2370

Notes:

- (1) The figures in the table above are for a dispensed bead rate of 400 g/m². Make additional allowance for any bead loss during application, to achieve a retained bead rate of 400 g/m² for Type D-HR glass beads, as specified in Tables R141.1 to R141.3 (but not Table R141.4 which specifies a rate of 500 g/m²).
- (2) The maximum speed in the table above is 16 km/hr, which is the recommended maximum speed for application of Type D-HR glass beads, to limit the amount of bounce and roll.
- (3) Low pressure (50 psi) or gravity delivery to a gravity dispenser will produce the best application results.
- (4) Line widths 80 mm and 120 mm are not shown in the table above as they are no longer used.

ANNEXURES R141/H TO R141/K – (NOT USED)

ANNEXURE R141/L – MINIMUM FREQUENCY OF TESTING

Clause	Characteristic Analysed	Test Method	Minimum Frequency of Testing
Pavement Marking Paint			
4.2.1	Wet film thickness/Dry film thickness	RMS T841 See Clause 4.2.1	Two per day or one per site visit of line marker whichever is the greater AND after pressure or speed settings are changed
4.2.5	Application rate of glass beads	RMS T1208	Two per day or one per site visit whichever is the greater AND after pressure or speed settings are changed
4.3	Verification of Lot quantities	See Clause 4.7	Per tank fill or one per day, whichever is the greater
Non-profile Thermoplastic Pavement Marking Material			
4.2.2	Thickness of cold film	See Clause 4.3	Two per day or one per site visit of line marker whichever is the greater AND after pressure or speed settings are changed
4.2.5	Application rate of glass beads	RMS T1208	Two per day or one per site visit whichever is the greater AND after pressure or speed settings are changed
4.3	Verification of Lot quantities	See Clause 4.7	Per tank fill or one per day, whichever is the greater
Two Part Cold Applied Pavement Marking Material			
4.2.3	Thickness of film	See Clause 4.4	Two per day or one per site visit of line marker whichever is the greater AND after pressure or speed settings are changed
4.2.5	Application rate of glass beads	RMS T1208	Two per day or one per site visit whichever is the greater AND after pressure or speed settings are changed
4.3	Verification of Lot quantities	See Clause 4.7	Per tank fill or one per day, whichever is the greater
Profile Pavement Marking Material			
4.2.4	Thickness of cold film	See Clause 4.5	Two per day or one per site visit of line marker whichever is the greater AND after pressure or speed settings are changed
4.2.5	Application rate of glass beads	RMS T1208	Two per day or one per site visit whichever is the greater AND after pressure or speed settings are changed
4.3	Verification of Lot quantities	See Clause 4.7	Per tank fill or one per day, whichever is the greater

ANNEXURE R141/M – REFERENCED DOCUMENTS

RMS Specifications

RMS Q	Quality Management System
RMS G10	Traffic Management
RMS R110	Coloured Surface Coatings for Bus Lanes and Cycleways
RMS R142	Raised Pavement Markers
RMS 3351	Road Marking Paint
RMS 3353	Glass Beads (for Application to Road Marking Materials)
RMS 3356	Waterborne Road Marking Paint
RMS 3357	Thermoplastic Road Marking Material
RMS 3359	Profile Thermoplastic Road Marking Material
RMS 3360	Two Part Cold Applied Road Marking Material

RMS Test Methods

RMS T841	Field Measurement of Wet Film Thickness of Road Marking Paint
RMS T1208	Measurement of Rate of Application of Spherical Glass Beads

Australian Standards

AS/NZS 1580.601.1	Paints and related materials - Methods of test - Colour - Visual comparison
AS/NZS 2009	Glass beads
AS 4049.4	High performance pavement marking systems

RMS Technical Documents

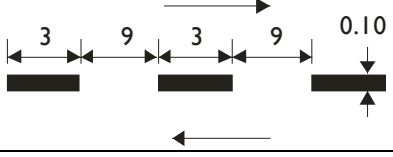
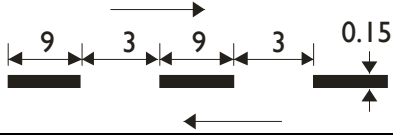
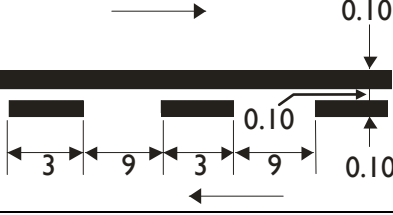
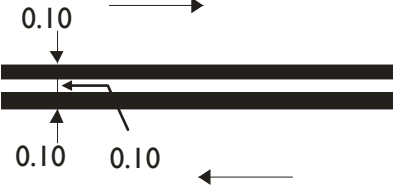
	RMS Delineation Manual
TD 2009/SR02	Dragon's Teeth at School Zones (RMS Centre for Road Safety)

Australian Paint Approval Scheme (APAS) Specifications

AP-S0042	Glass Beads for Pavement Marking Paint
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APPENDICES 1 TO 5

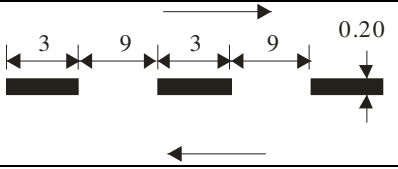
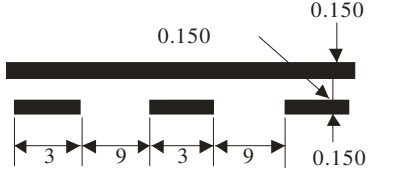
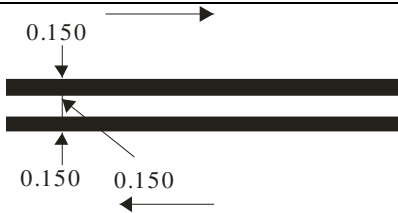
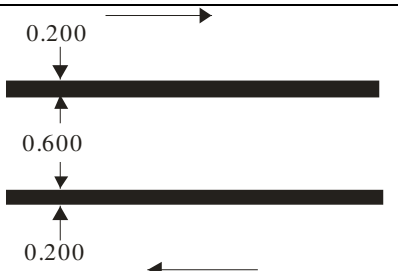
APPENDIX 1 – LONGITUDINAL PAVEMENT MARKINGS

Line	Type	Pattern and Dimensions	Reference Section*
DIVIDING LINES			
Dividing (Separation) line on 2 lane road	S1		4.2
	S2	NO LONGER USED	
Dividing (Separation) line on multi lane road	S6		4.2
Dividing (Barrier) lines (Restricted overtaking in one direction)	BS		4.4
Dividing (Barrier) lines	BB		4.4

Notes:

(all dimensions in m unless stated otherwise)

* Section in RMS Delineation Manual

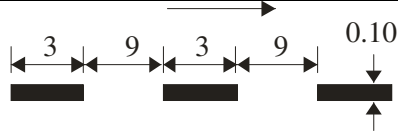
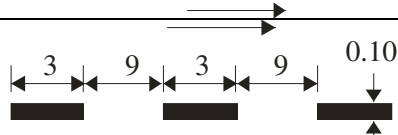

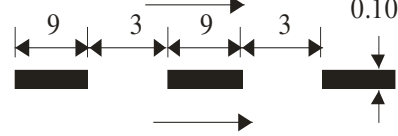
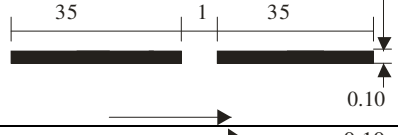
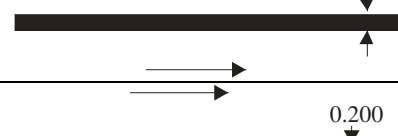

Line	Type	Pattern and Dimensions	Reference Section*
ENHANCED DIVIDING LINES #			
Dividing (Separation) line on 2 lane road	S3		5.2.2
Dividing (Barrier) lines (Restricted overtaking in one direction)	BS1		5.2.3
Dividing (Barrier) lines	BB1		5.2.3
Dividing (Barrier) lines	BB2		5.2.3

Notes:

(all dimensions in m unless stated otherwise)

* Section in RMS Delineation Manual

Use of enhanced dividing lines requires approval of GM, Traffic Management




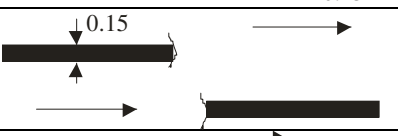


Line	Type	Pattern and Dimensions	Reference Section*
LANE LINES			
Lane line on multi lane roads including motorways and dual-carriageways	L1		4.6
Enhanced lane line (profile) on motorways, dual carriageways or on special locations such as bridges [#]	L2		4.6, 5.2.5
Lane line on multi lane road	L3		4.6
Exit lane line on multilane roundabouts	L4		4.6
Defines the edge of a Bus Lane and Bus Only lane adjacent to general traffic lane	L6		4.6
Defines the edge of a Bicycle Lane adjacent to general traffic lane	L7		4.6
Enhanced lane line	L5		4.6, 5.2.4

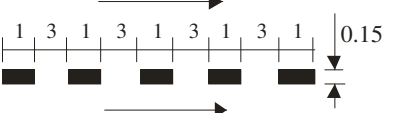
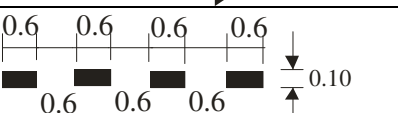
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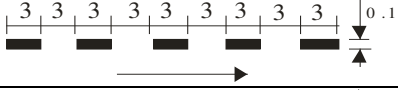

(all dimensions in m unless stated otherwise)

* Section in RMS Delineation Manual

[#] Use of enhanced dividing lines requires approval of GM, Traffic Management

Line	Type	Pattern and Dimensions	Reference Section*
EDGE LINES			
Left hand edge line on general purpose road	E1		4.7
Left hand edge line on Motorway	E2		4.7
Right hand edge on divided carriageway	E3		4.7
Outline of traffic island or freeway ramp gore	E4		4.7
Outline of painted median	E5		4.7
Line applied to incline face of median kerb	E6		4.7


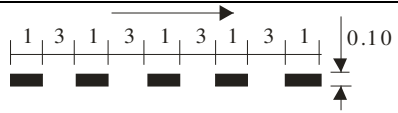

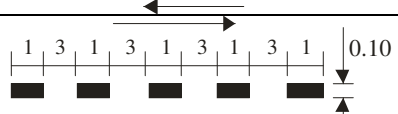

Line	Type	Pattern and Dimensions	Reference Section*
PROFILE LINES (Edge line, lane line and dividing lines)			5.2.6
Continuity line	C1		4.8
Turning line	T1		4.9

Line	Type	Pattern and Dimensions	Reference Section*
KERBSIDE PARKING RESTRICTION LINES			
Clearway line	C2		13.2
No Stopping line	C3		13.3

Notes:

(all dimensions in m unless stated otherwise)

* Section in RMS Delineation Manual

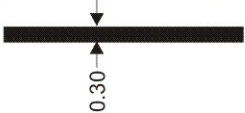
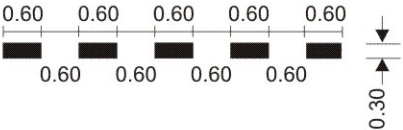
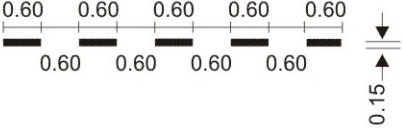
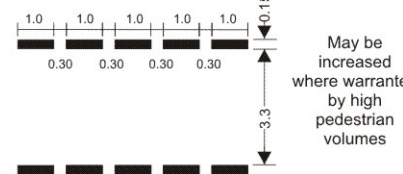
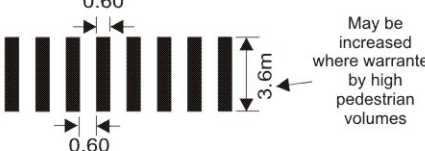
Line	Type	Pattern and Dimensions	Reference Section*
BICYCLE LINES			
Bicycle lane line	L7		4.10
Bicycle lane continuity line	C4		4.10
Bicycle separation line for off-road bike path (with restricted visibility)	S4		4.10
Bicycle lane separation line for off-road bike path (Straight sections)	S5		4.10
Bicycle edge line for off-road bike paths & shared paths	E7		4.10

Notes:

(all dimensions in m unless stated otherwise)

* Section in RMS Delineation Manual

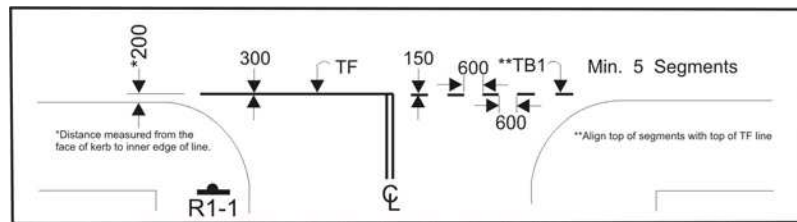
APPENDIX 2 – TRANSVERSE PAVEMENT MARKINGS

Line Type	Use	Dimensions (m)	Colour
TF	Stop line		White
TF1		NO LONGER USED	
TF2		NO LONGER USED	
TB	Give Way Line (Used with signs)		White
TB1	Give Way Line (Used on right side of road)		White
PCW	Pedestrian Cross Walk Lines		White
PX	Pedestrian Crossing		White

Dimensions in mm unless stated otherwise

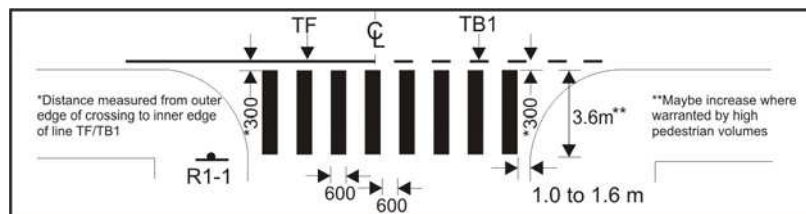
Transverse line at a stop sign

(all dimensions in mm unless stated otherwise)



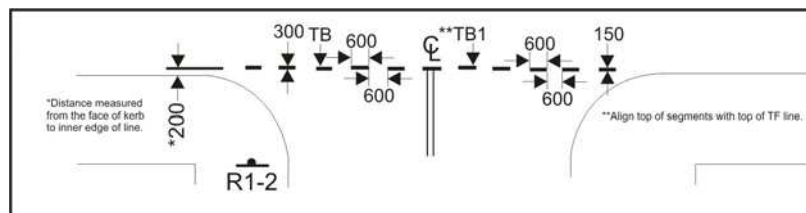
Transverse line at a stop sign with pedestrian crossing

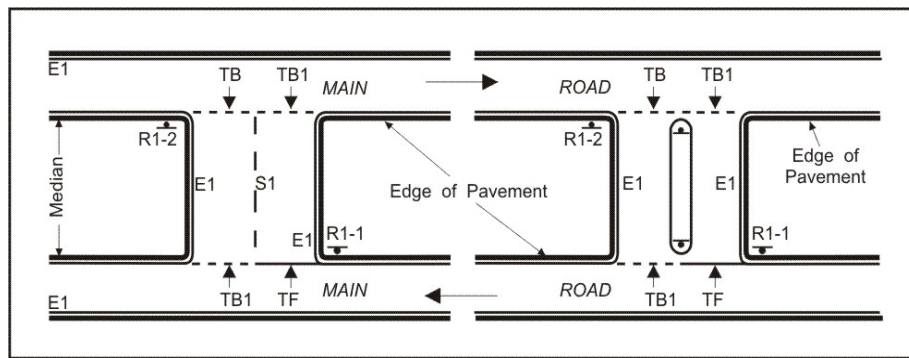
(all dimensions in mm unless stated otherwise)



Transverse line at a give way sign

(all dimensions in mm unless stated otherwise)



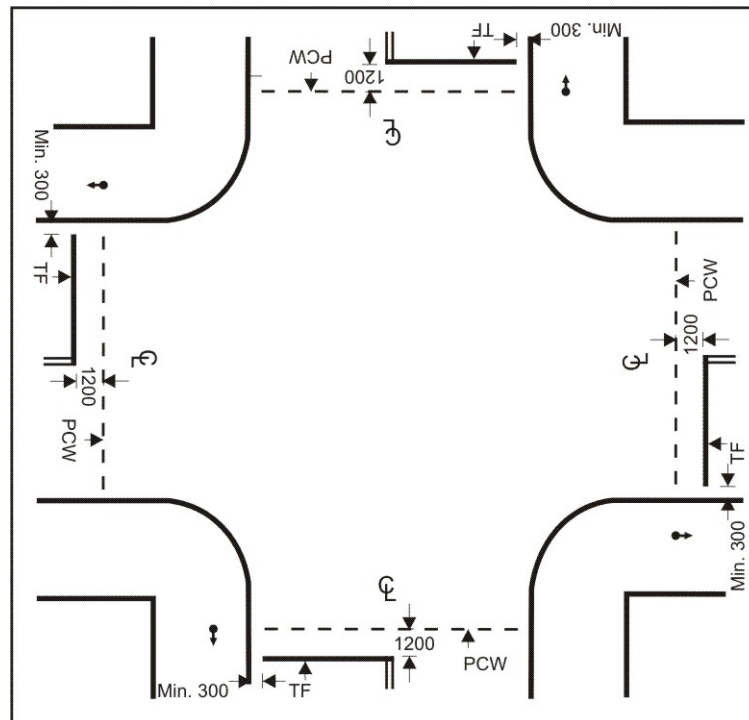
Transverse line at a stop & give way sign connecting road on a dual carriageways.**Transverse lines for other applications**

(all dimensions in mm unless stated otherwise)

<ul style="list-style-type: none"> ● Ferry Approach ● Opening Bridge ● One Lane Bridge ● Level Crossing with Signals and/or Gate 	<p>* 5 - 10m Ferry Gate or Signals 3m Gate other than Ferry</p>
<ul style="list-style-type: none"> ● Level Crossing With Stop Sign 	
<ul style="list-style-type: none"> ● Open Level Crossing ● One Lane Bridge without Stop Signs or Signals 	<p>Give Way Sign or RLC - B Assembly</p>

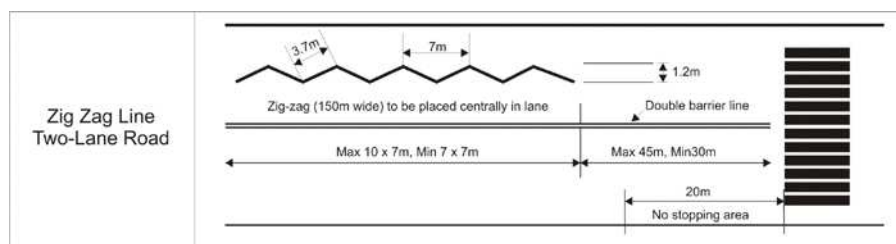
Transverse lines for scramble crossing

(all dimensions in mm unless stated otherwise)



Zig Zag Markings

(all dimensions in mm unless stated otherwise)



Arrows – types, uses and shapes

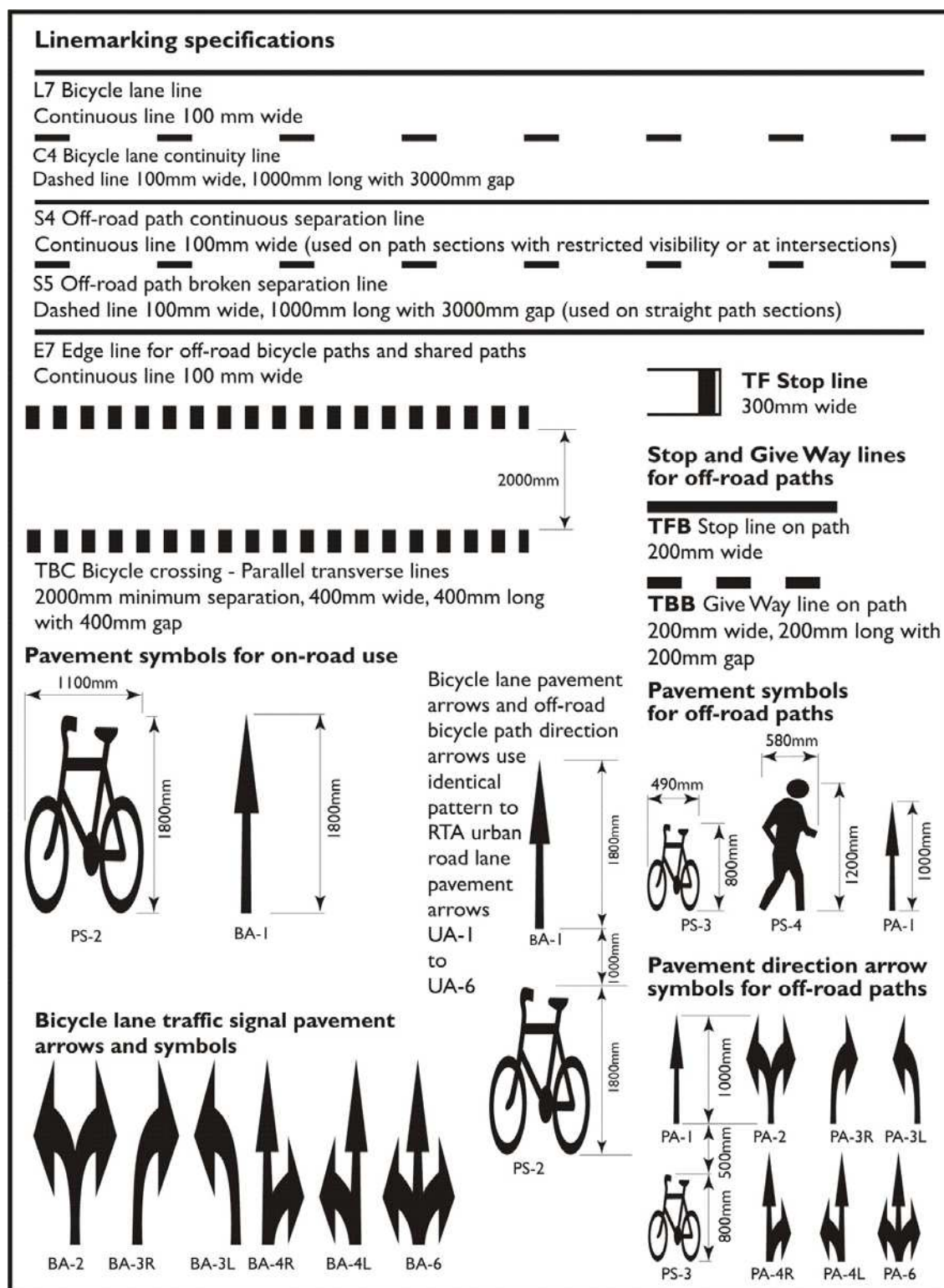
No	Description of requirements	Two lane	Three lane	Four lane
1	Legal manoeuvres if lane unmarked			
2	Legal manoeuvres if left lane only marked			
3	Legal manoeuvres if right lane only marked			
4	Markings for two exclusive left turn lanes			
5	Markings for two exclusive right turn lanes			
6	Markings for shared left turn and through from lane adjacent to left turn lane			
7	Markings for shared right turn and through from lane adjacent to right turn lane			
8	Markings for shared left turn and through from lane adjacent to two exclusive left turn lanes	NOT APPLICABLE		
9	Markings for shared right turn and through from lane adjacent to two exclusive right turn lanes	NOT APPLICABLE		
10	Markings to indicate left turn prohibition (signing also required, see Clause 2.8.2)			
11	Markings to indicate right turn prohibition (signing also required, see Clause 2.8.2)			

NOTES:

- 1 Full lines indicate arrows to be marked.
- 2 Dotted lines indicate manoeuvres which are permitted by regulations but which need not be marked.
- 3 On some intersection approaches, it may be necessary to combine two or more of the marking methods shown.

(Ref. AS 1742.2 Fig. 5.8)

APPENDIX 3 – PAVEMENT MARKINGS AND SYMBOLS FOR BICYCLE FACILITIES

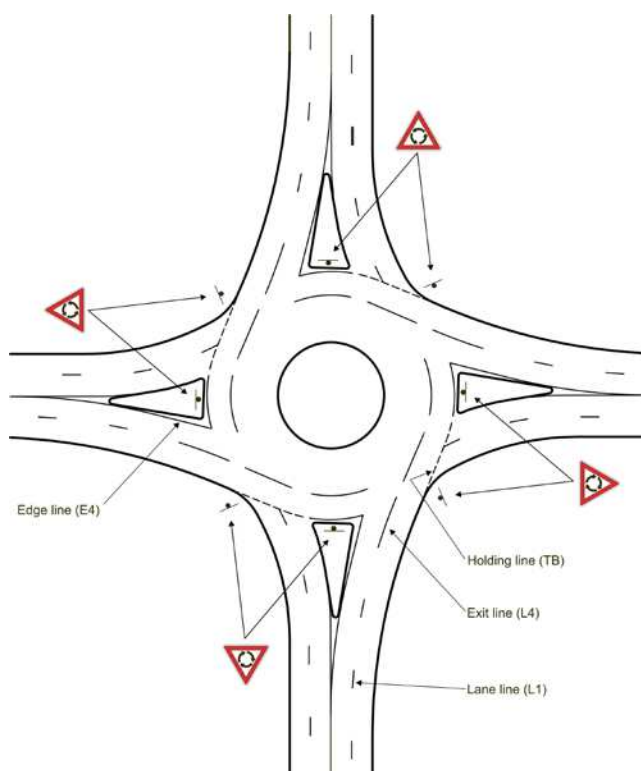


APPENDIX 4 - (NOT USED)

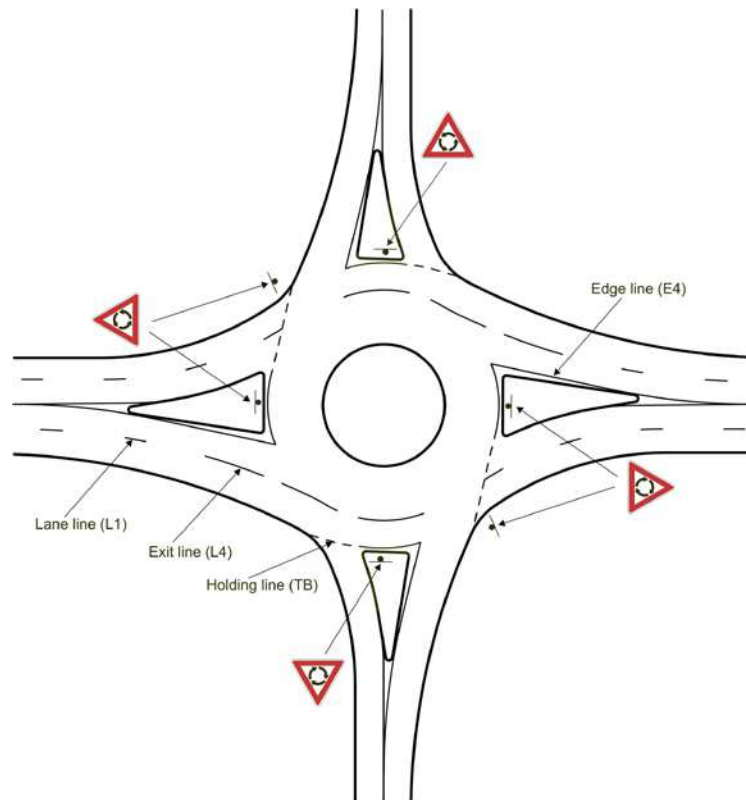
APPENDIX 5 – PAVEMENT MARKINGS AT ROUNDABOUTS

Line Type	Use	Dimensions (m) (for dimensions shown * see marker spacing column)	Colour
L4	Exit lane line on multilane roundabouts		White
TB	Holding Line		White

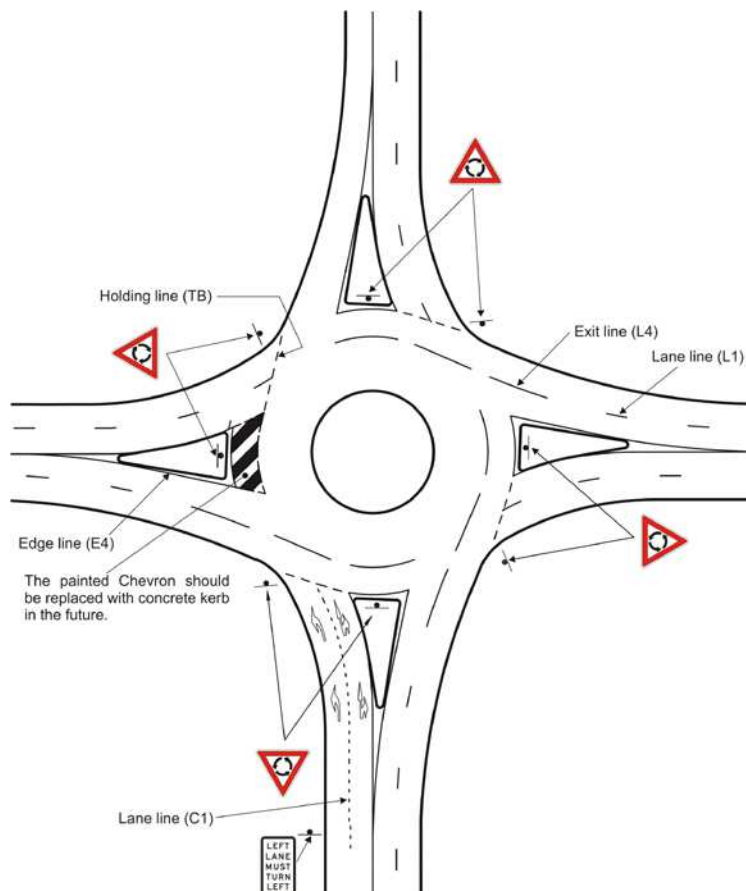
Roundabout Pavement Markings, four 2 lane entry/exits



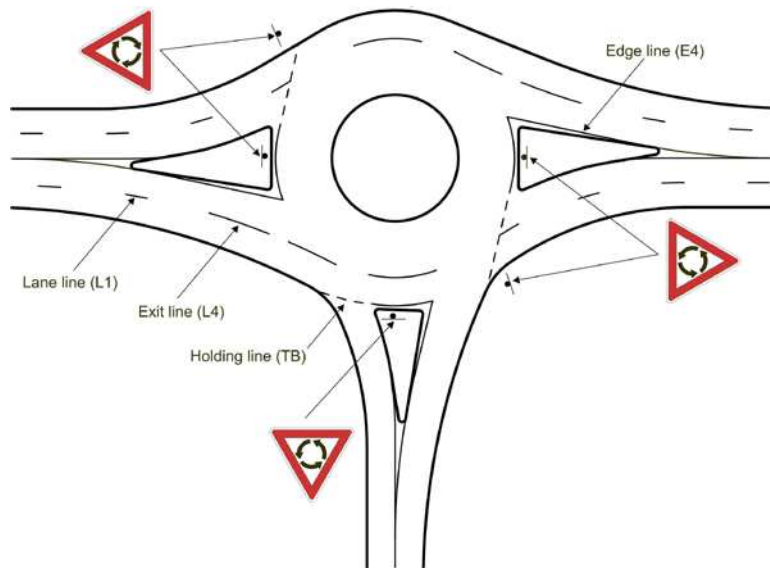
Roundabout pavement markings, two 2 lane entry/exits with two 1 lane entry/exits



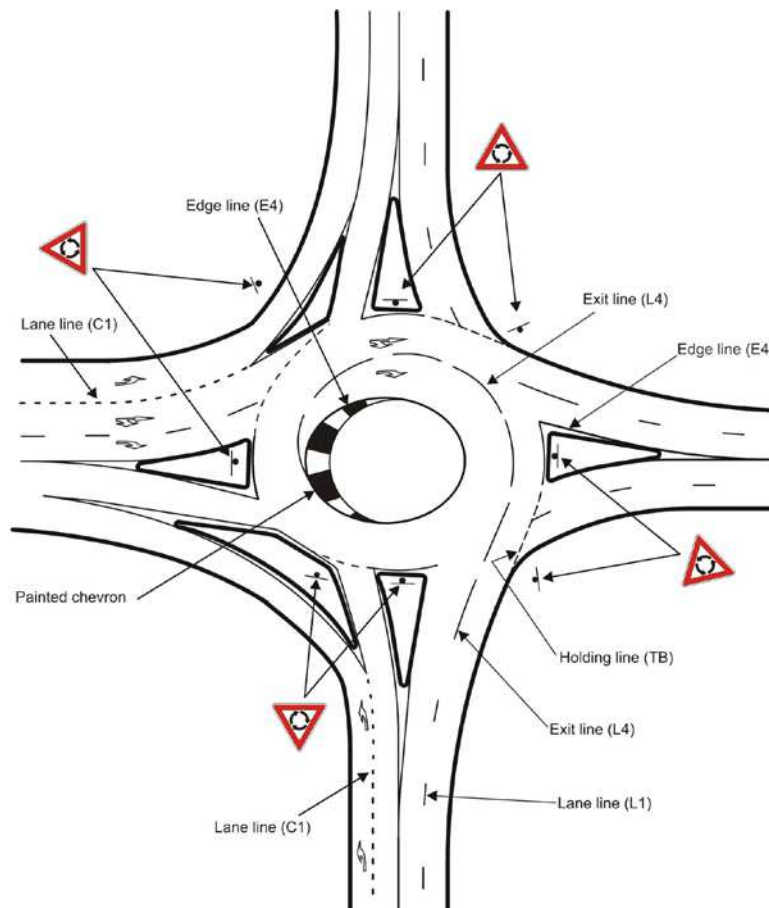
Roundabout pavement markings, four 2 lane entry/exit with one exclusive left turn lane



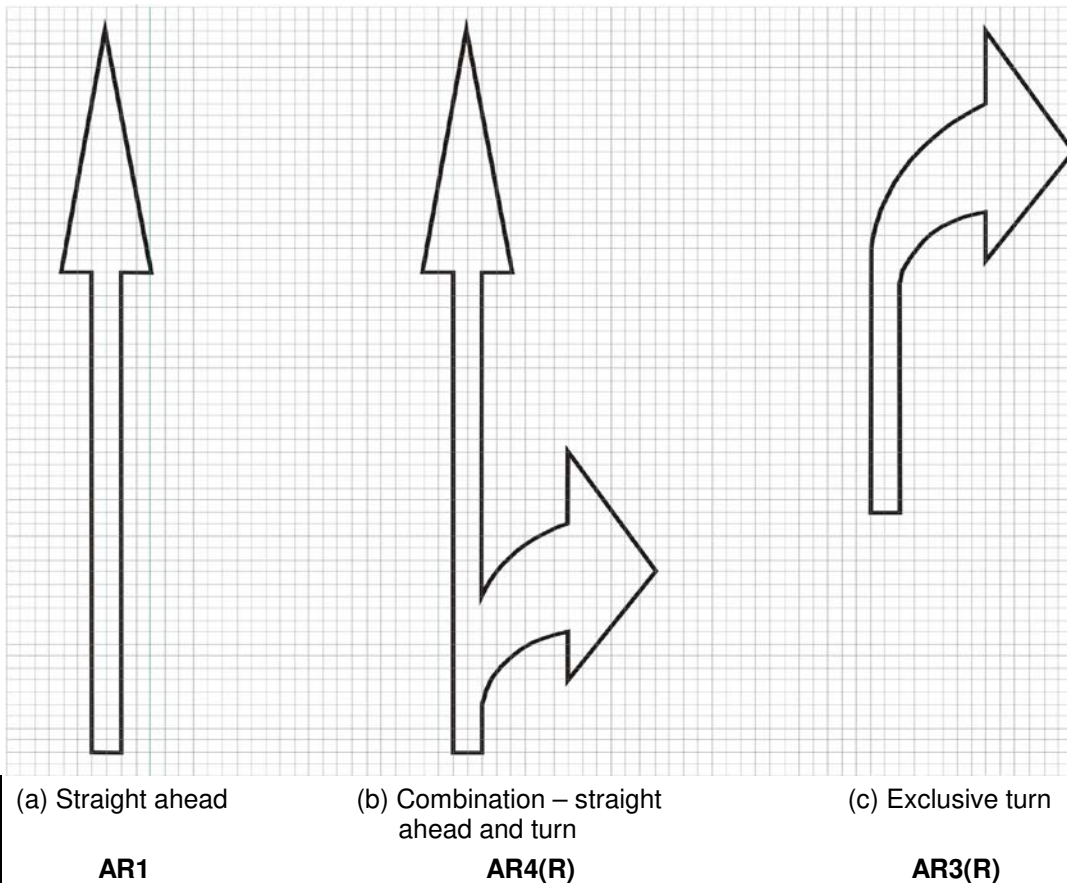
Roundabout pavement markings, T junction with two 2 lane and one 1 lane entry/exit



Roundabout pavement markings, dual right turn on one approach



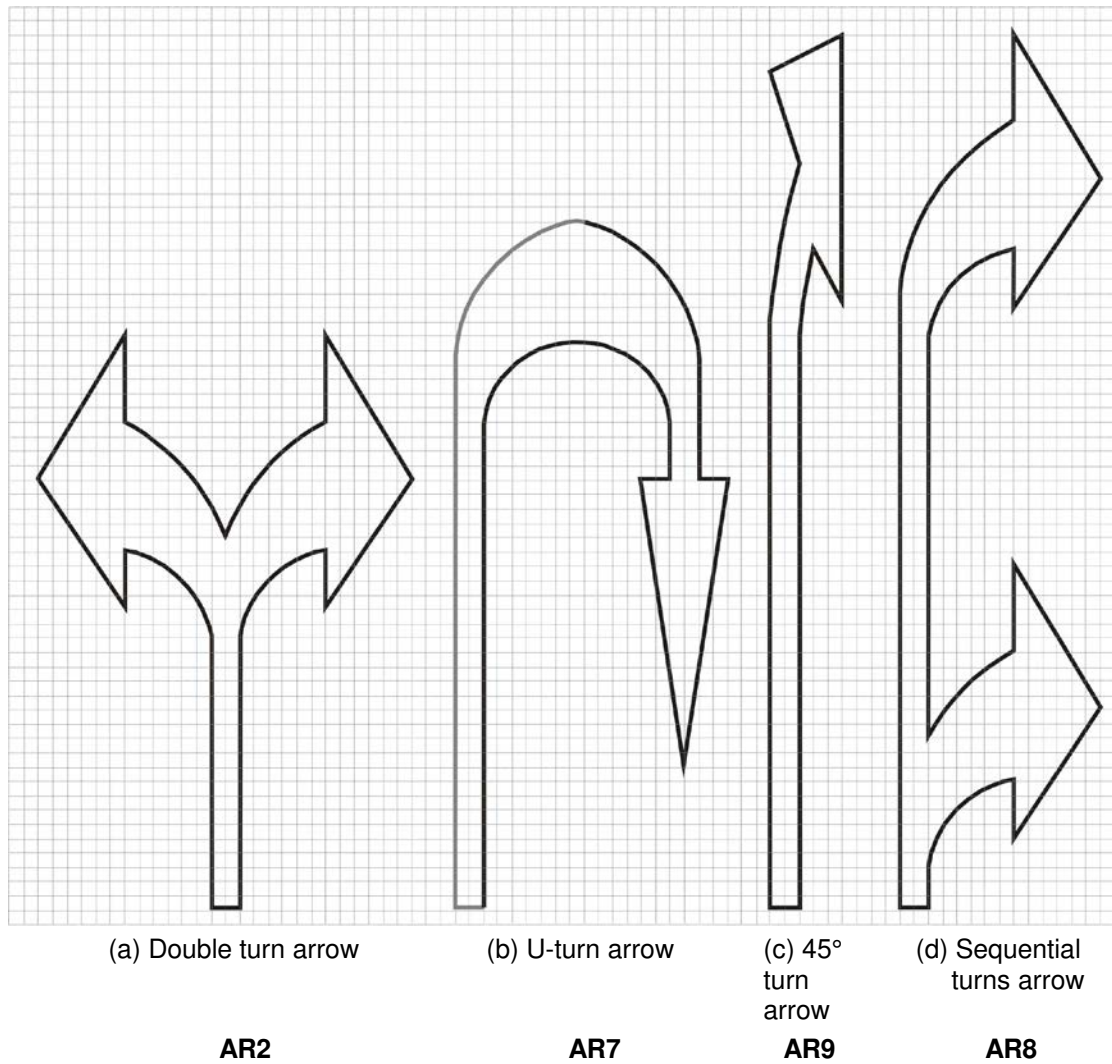
FIGURES 9 TO 20



Notes:

1. Minimum length of arrow:
 - (a) Straight ahead arrow and combined arrow = 6 m.
 - (b) Turn arrow = 4 m.
2. The width of grid squares is constant at 100 mm. The height of the grid is 100 mm minimum.

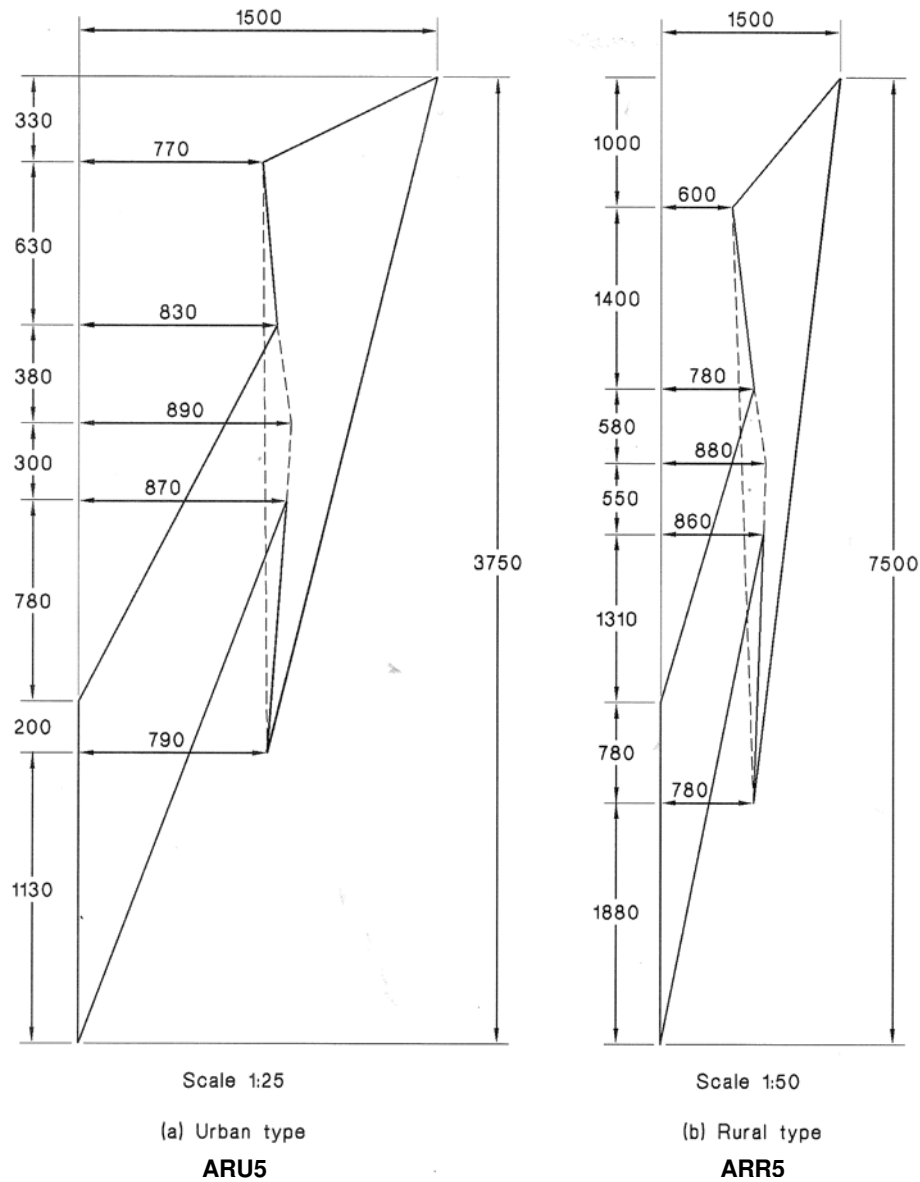
Figure 9 - Intersection Arrows (Ref. AS 1742.2 Fig. 5.9)



Notes:

1. Minimum length of arrow:
 - (a) Double turn arrow = 4 m.
 - (b) U-turn arrow = 5 m.
 - (c) Sequential turns and 45° turn arrows = 6 m.
2. The width of grid squares is constant at 100 mm. The height of the grid is 100 mm minimum.

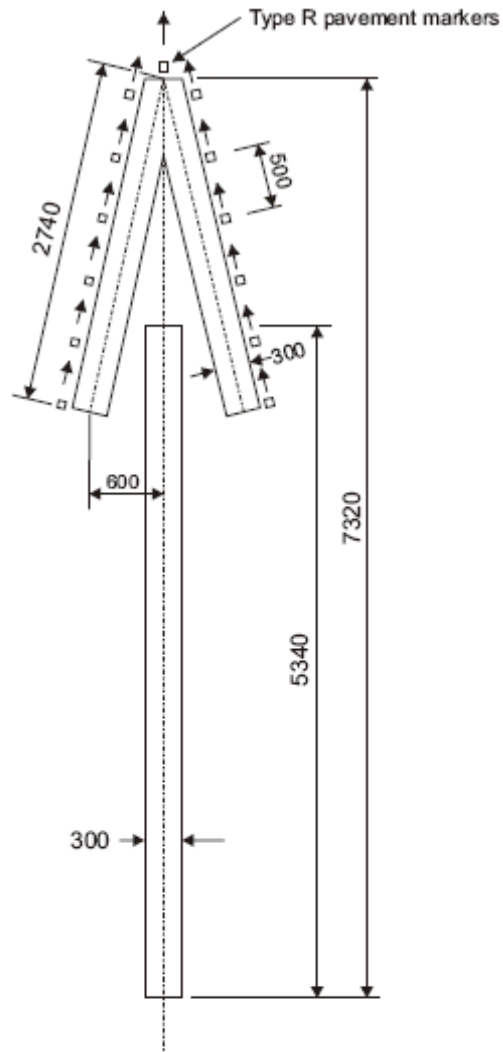
Figure 10 - Intersection Arrows (Ref. AS 1742.2 Fig. 5.10)



NOTE: When installing arrows it is recommended that the head be laid first.

Figure 11 - Lane Change Arrows (Ref. AS 1742.2 Fig. 5.11)

Figure 12 - (Not Used)



Measurements are in mm, unless otherwise stated

PAVEMENT ARROW FOR USE ON ONE WAY ROADS

(For Restraint of Wrong Way Movements)

SA1

Figure 13

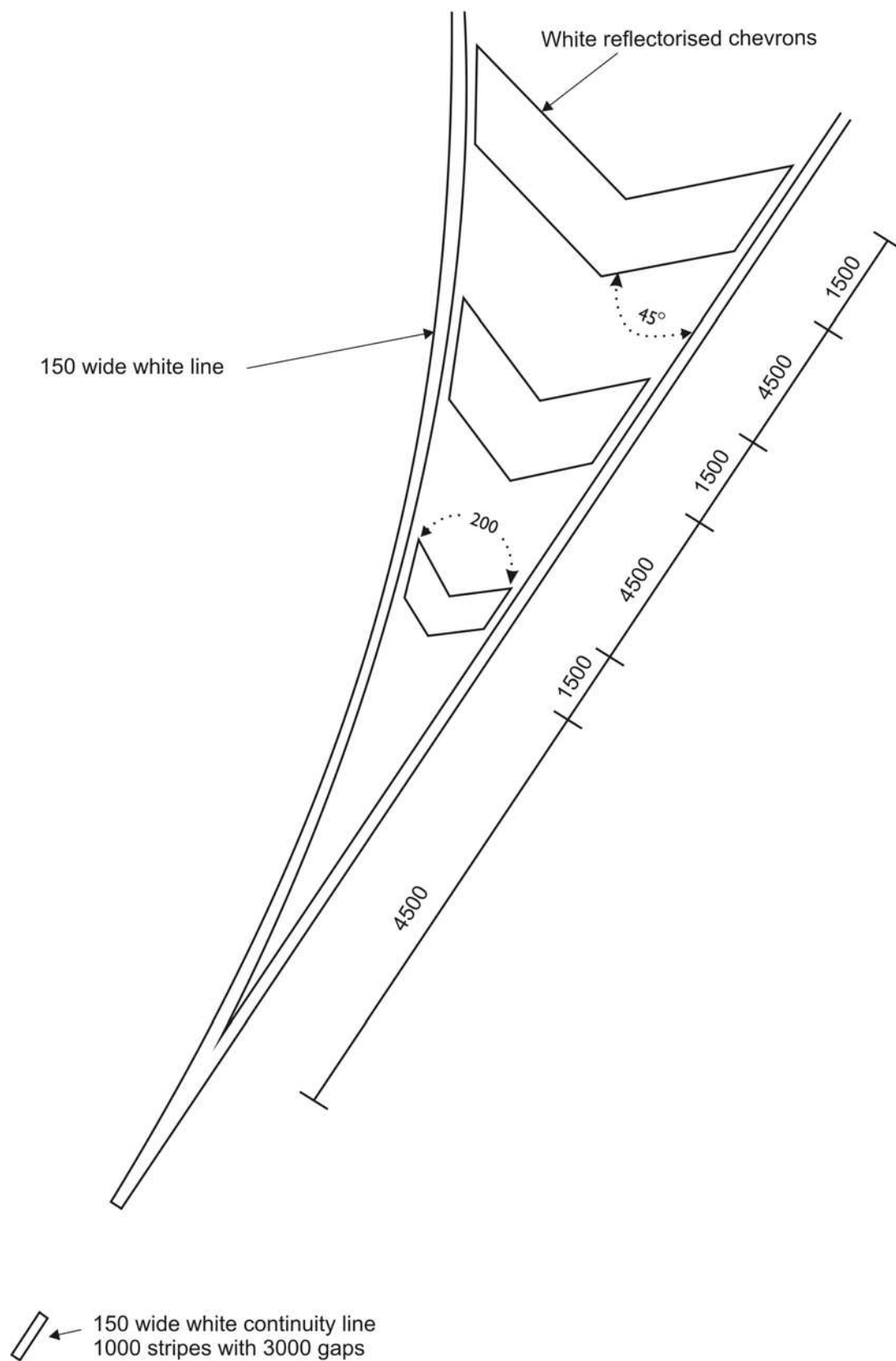


Figure 14



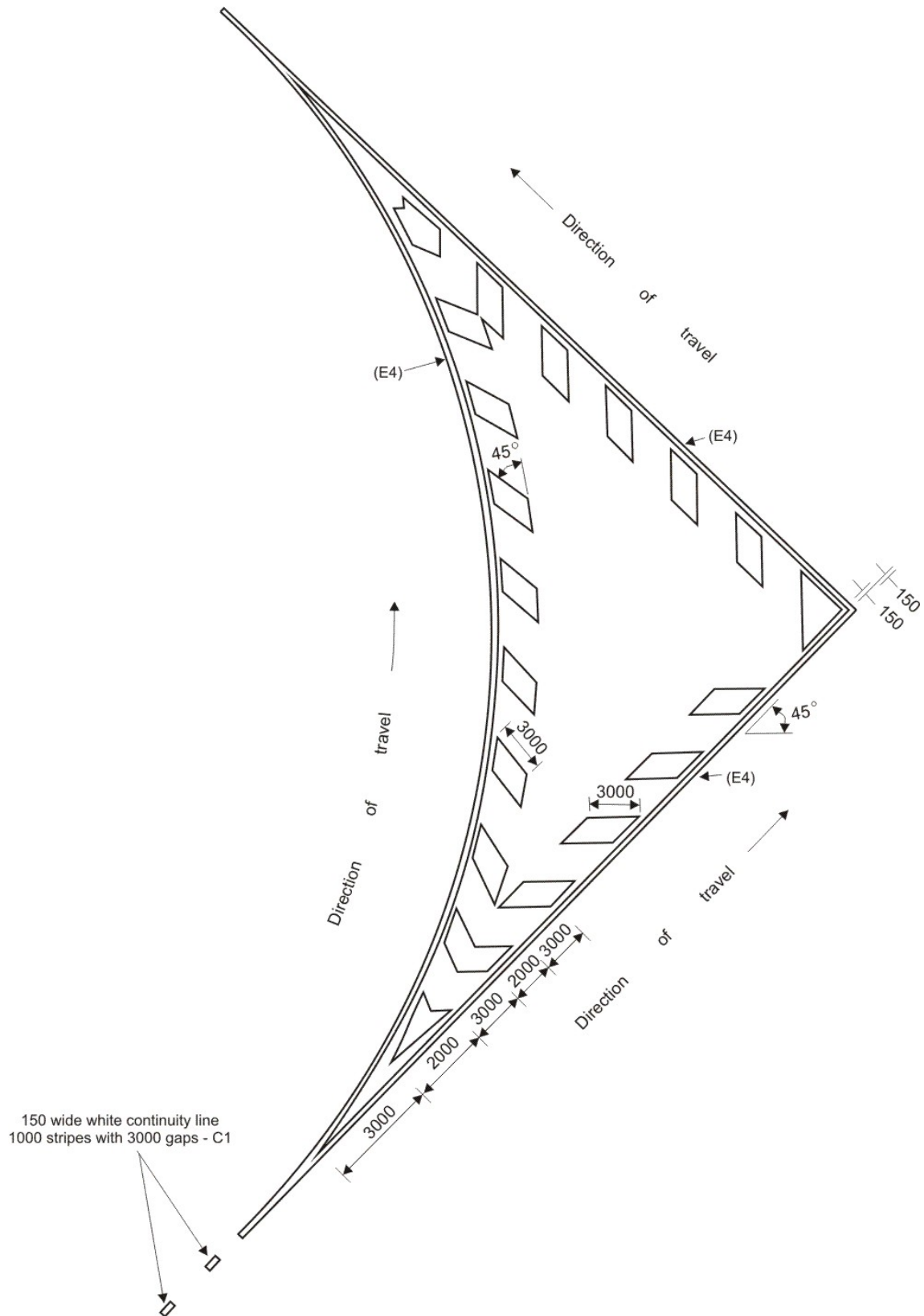
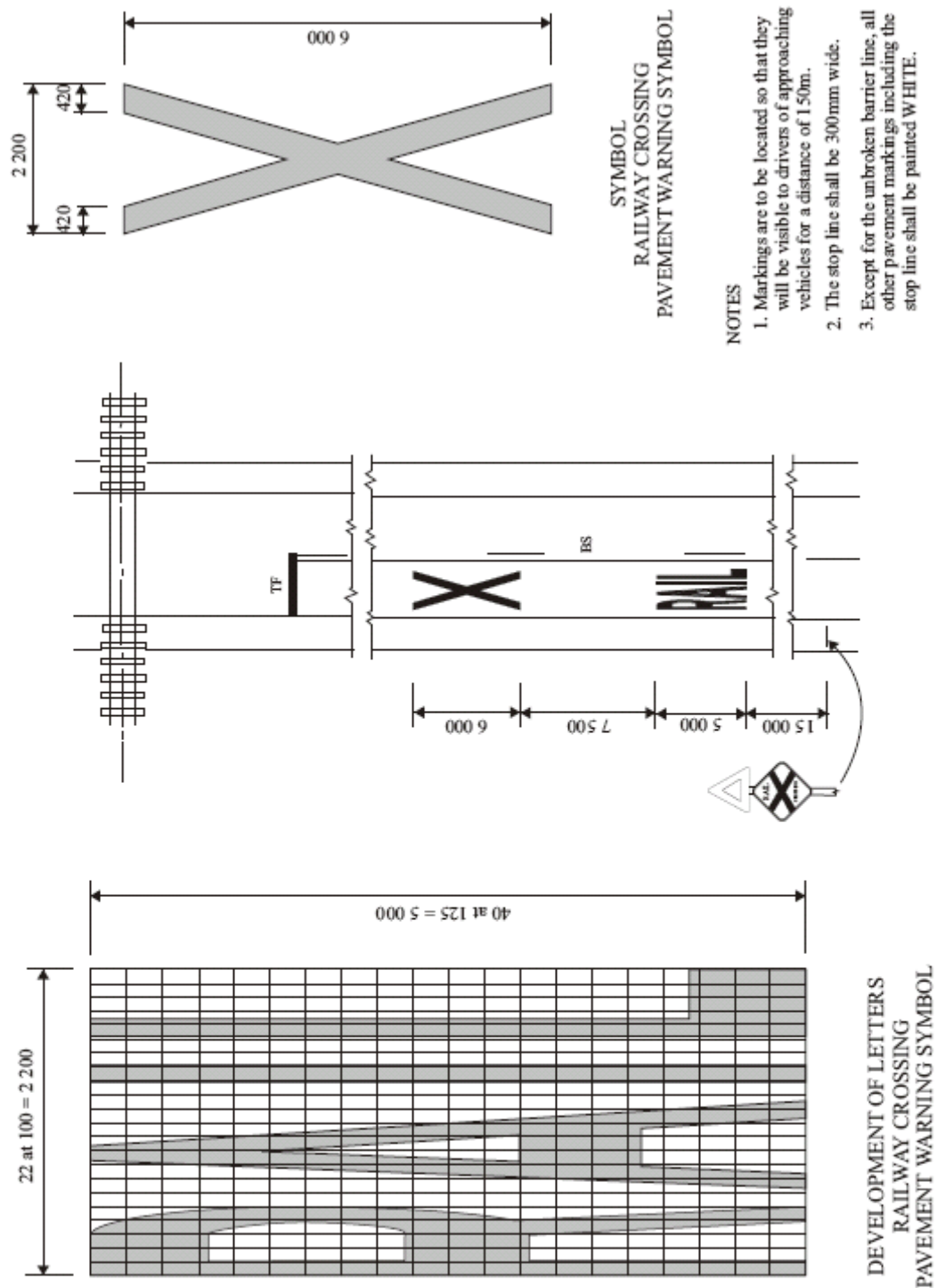
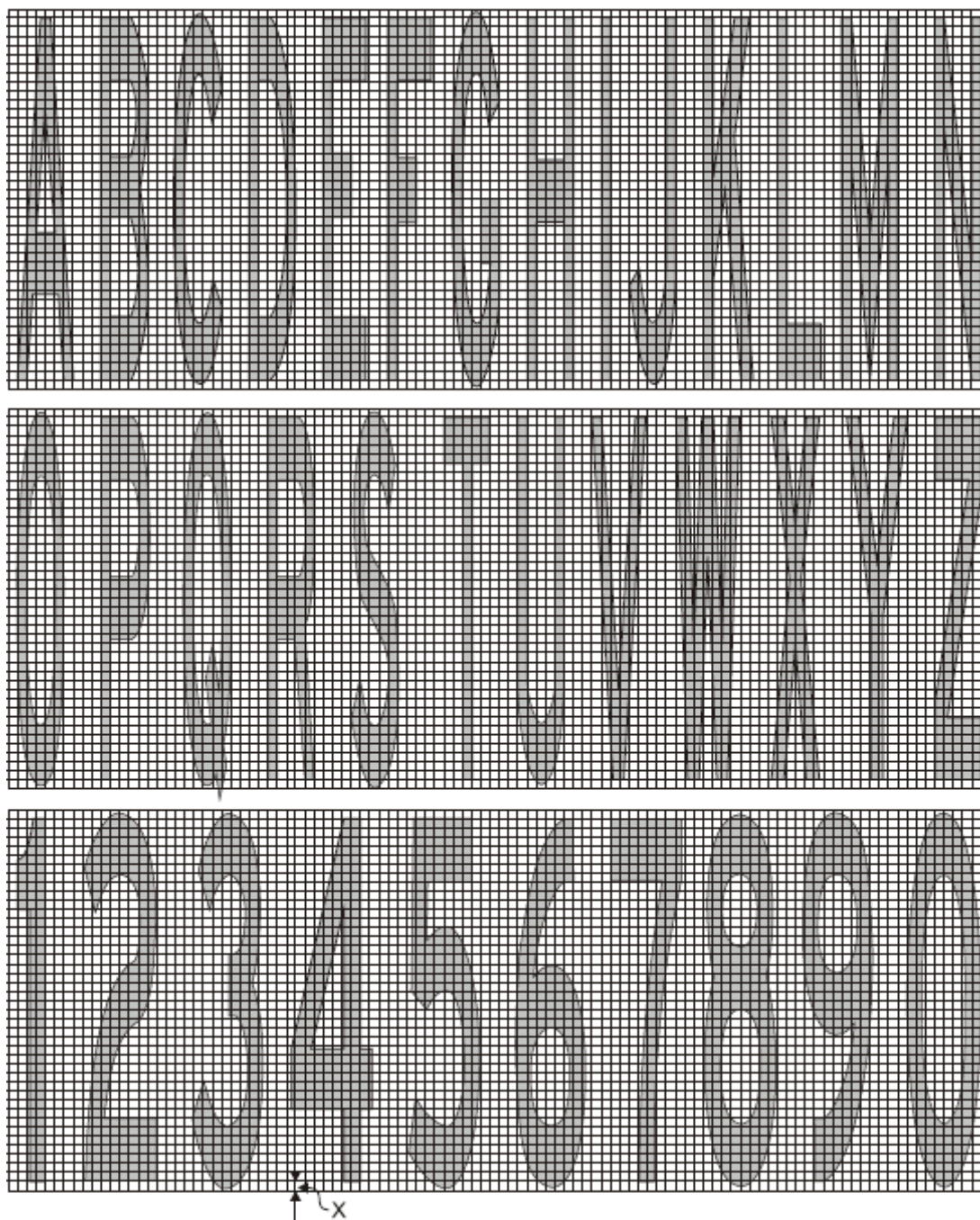


Figure 16



**PAVEMENT MARKING IN ADVANCE OF
OPEN LEVEL CROSSINGS**

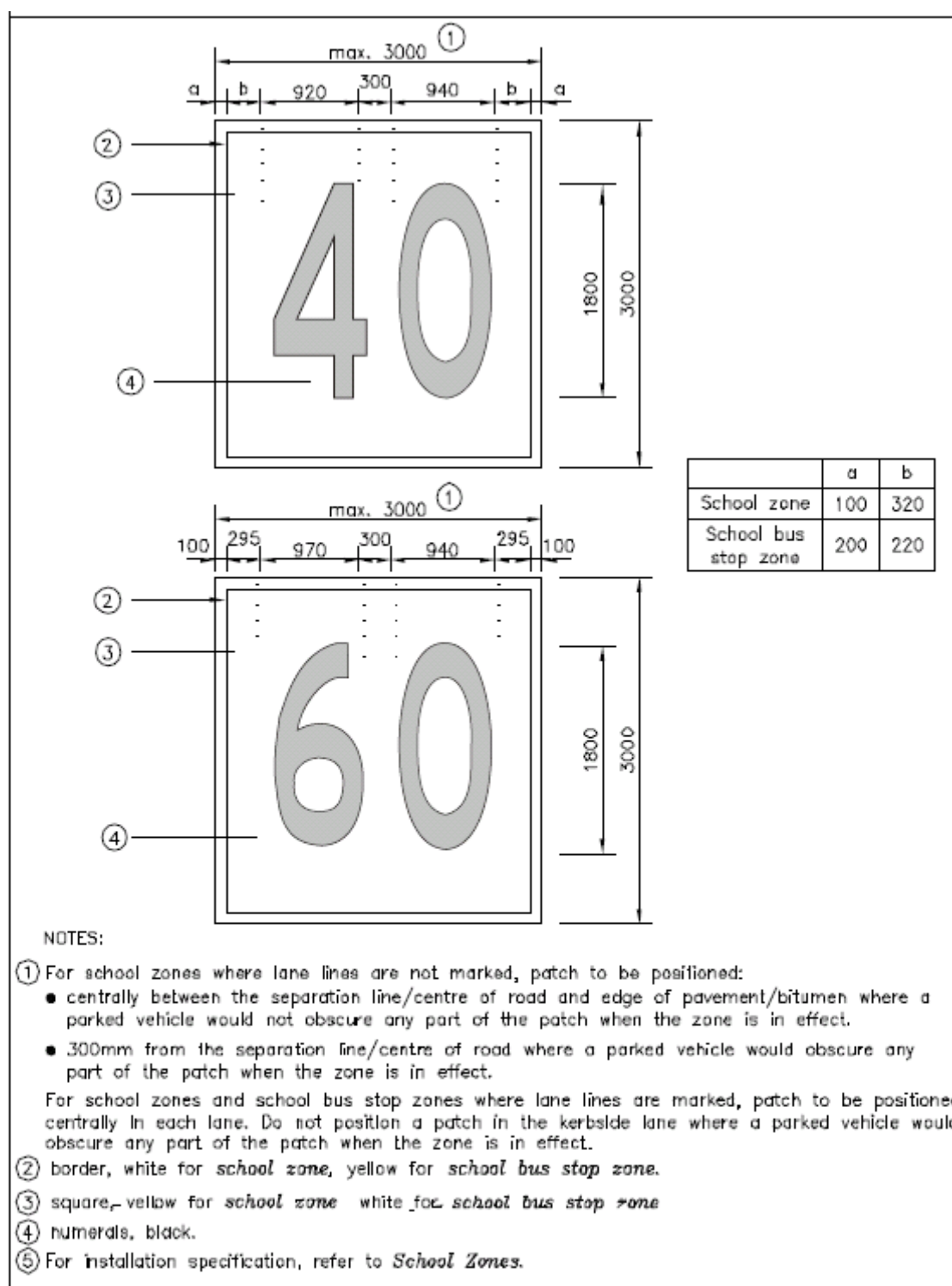
Figure 17



- Note: 1. The grid width is constant at 100mm but the grid height "X" may vary.
2. The grid height X = $\frac{\text{height of letter or numeral required in mm}}{40}$

PAVEMENT ALPHABET AND NUMERALS

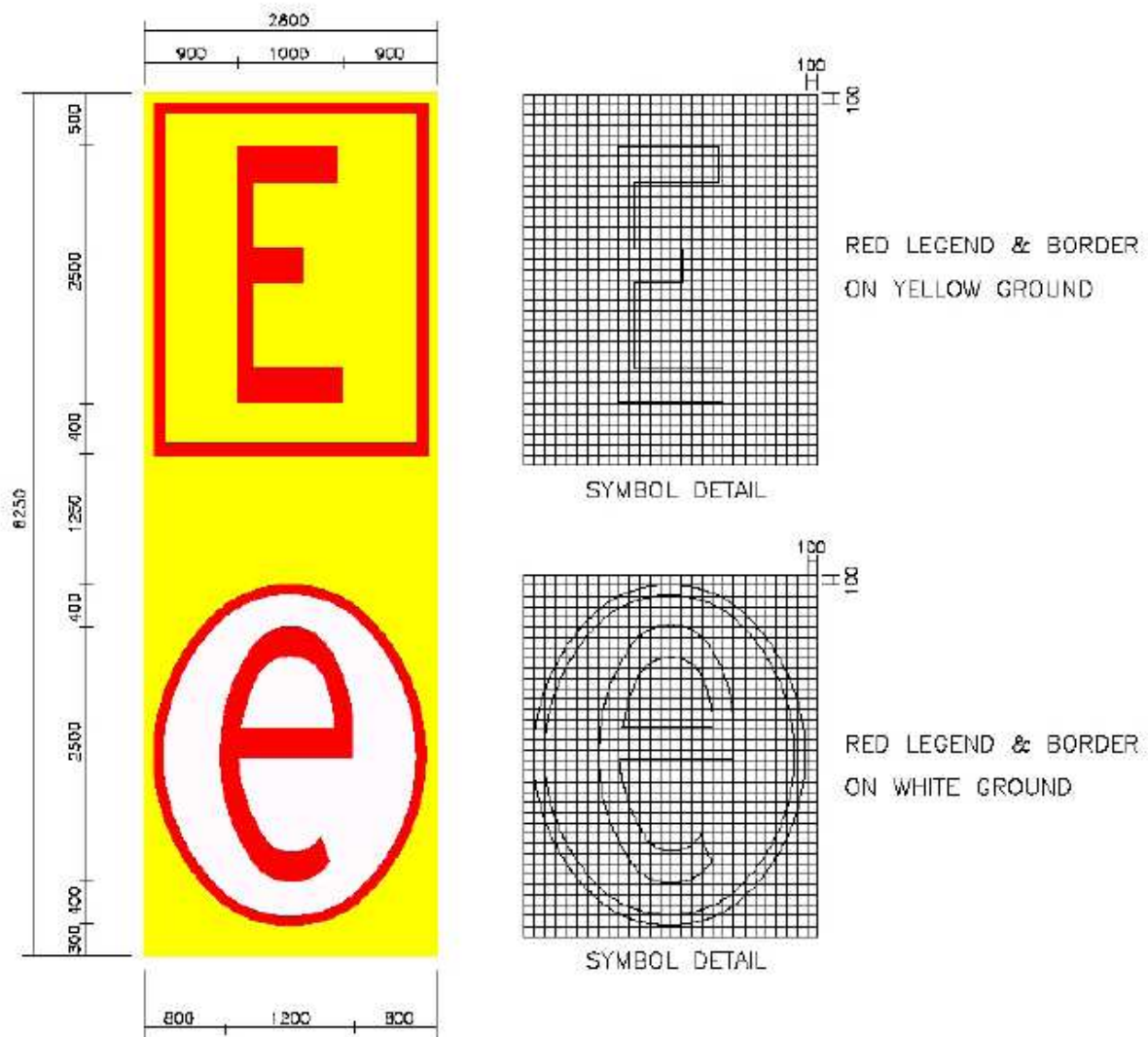
Figure 18



Measurements are in mm, unless otherwise stated

SCHOOL ZONE AND SCHOOL BUS STOP ZONE SPEED NUMERAL PAVEMENT PATCH

Figure 19



RED LEGEND & BORDER ON YELLOW GROUND

The pavement marking shall be two (2) part cold applied plastic or thermoplastic material, conforming to RTA specifications 3360 or 3357 respectively. The pavement marking shall have retro-reflective and skid resistance properties as per Australian Standard AS4049.2

Measurements are in mm, unless otherwise stated

E-TAG PAVEMENT MARKING

Figure 20