Manual

Traffic and Road Use Management
Volume 3 – Signing and Pavement Marking

Part 3: Application of Markings

March 2018
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1 Installation of pavement markings

1.1 The Transport and Main Roads Technical Specification

Refer to MRTS45 Road Surface Delineation (August 2012) Clauses 1, 2 and 3.

1 Introduction

This Technical Specification applies to the supply and installation of pavement markings, raised pavement markers and audio tactile line marking (ATLM).

This Specification shall be read in conjunction with MRTS01 Introduction to Technical Specifications, MRTS50 Specific Quality System Requirements and other Technical Specifications as appropriate.

This Specification forms part of the Transport and Main Roads Specifications Manual.

2 Definition of terms

The terms used in this Specification shall be as defined in Clause 2 of MRTS01 Introduction to Technical Specifications. Additional terms used in this Specification shall be as defined in Table 2.

Table 2 – Definition of terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATLM</td>
<td>Audio Tactile Line Marking</td>
</tr>
<tr>
<td>Longitudinal lines</td>
<td>Dividing, barrier, lane, edge and continuity lines and outline markings</td>
</tr>
<tr>
<td>Pavement markings</td>
<td>Longitudinal lines and transverse lines</td>
</tr>
<tr>
<td>MUTCD</td>
<td>Manual of Uniform Traffic Control Devices</td>
</tr>
<tr>
<td>Retroreflectivity</td>
<td>The value of reflected light measured in millicandellas per lux per m², using a retroreflectometer calibrated to a nationally recognised standard, using a 30 m geometry instrument.</td>
</tr>
<tr>
<td>Transverse lines</td>
<td>Stop and give way lines, turn lines, markings at stop and give way signs, pedestrian crosswalk lines, diagonal and chevron markings, arrows, shapes, symbols, numerals, parking areas and kerb markings.</td>
</tr>
</tbody>
</table>

3 Referenced documents

Table 3 lists documents referenced in this Technical Specification.

Table 3 – Referenced documents

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Paint Approval Scheme – Specification 0041/4</td>
<td>Roadmarking paint, thermoplastic</td>
</tr>
<tr>
<td>Australian Paint Approval Scheme – Specification 0041/5</td>
<td>Roadmarking paint, water borne</td>
</tr>
<tr>
<td>AS 1580.205.4</td>
<td>Paints and related materials – Methods of test – Application properties – Airless spraying</td>
</tr>
<tr>
<td>AS 1906.1</td>
<td>Retroreflective materials and devices for road traffic control purposes – Retroreflective sheeting</td>
</tr>
</tbody>
</table>
1.2 New work

Markings on new or maintained roads are specified on engineering layout drawings. All work necessary must be carried out to establish satisfactory alignment of pavement markings, within the specified tolerances, using any device or method which will not damage the pavement nor conflict with other traffic control devices. A control line shall be installed at 20 metre intervals in accordance with the drawing requirements prior to spotting.

There are occasions where the drawing should allow the marking gang supervisor some leeway in determining the precise layout of markings, especially longitudinal lines, based on site conditions. In any case, markings should always be checked, on the drawing and after installation, for appropriateness to site conditions and safety objectives.

1.3 Reinstatement and maintenance

Existing markings should be critically examined prior to reseals and maintenance. Prior to resealing or placement of an asphalt overlay, such measurements shall be taken, such drawings prepared and such offset marks established that will allow the existing pavement markings to be reinstalled following completion of the surface re-treatment.

Prior to spotting on reseals and asphalt overlay, a control line shall be installed at 20 metre intervals.

In particular, see Part 2 Section 3.3 of this guide for details of setting out and checking No-Overtaking Zones. Also, new property developments may necessitate alterations to line markings across accesses, particularly barrier lines. If an inventory of pavement markings exists, it should be used as a reference, ensuring at the same time that it is an accurate record of the existing markings. The inventory should be updated at completion of the work.

1.4 Setting out

Refer to MRTS45 Clause 7.1.

7.1 Setting out

The Contractor shall carry out all work necessary to establish satisfactory alignment of pavement markings, within the specified tolerances, using any device or method which will not damage the pavement nor conflict with other traffic control devices.

Prior to resealing or placement of an asphalt overlay, the Contractor shall take such measurements, prepare such drawings and establish such offset marks that will allow the existing pavement markings to be reinstalled following completion of the surface re-treatment.
Prior to spotting on reseals and asphalt overlay, the Contractor shall install a control line at 20 metre intervals.

For new construction, the Contractor shall install a control line at 20 metre intervals in accordance with the Drawing requirements prior to spotting.

1.5  Spotting

Refer to MRTS45 Clause 7.4.

7.4 Spotting

7.4.1 General

Spotting shall consist of spots approximately 30 mm wide and 150 mm long painted on the pavement surface.

The Contractor shall obtain approval from the Administrator of the spotting prior to any application of pavement markings. [Hold Point 1]

7.4.2 Longitudinal lines

Spotting for longitudinal lines shall be carried out generally at 5 metre intervals with 3 metre intervals on curves of less than 50 m radius.

7.4.3 Transverse markings

Spotting for transverse markings shall be carried out as shown on the design documents.

1.6  Preparation

Refer to MRTS45 Clauses 7.2 and 7.3.

7.2 Weather conditions

Pavement markings shall not be applied when freshly applied pavement markings may become damaged by rain, fog or condensation before they have dried or set. Pavement surfaces shall be thoroughly dry immediately prior to the application of pavement markings.

Pavement markings shall not be applied when the temperature is below, or likely to drop below, the temperature specified in Table 7.2.

<table>
<thead>
<tr>
<th>Material</th>
<th>Minimum temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paint, water-borne – Type 3</td>
<td>Not applicable †</td>
</tr>
<tr>
<td>Thermoplastic material</td>
<td>7 (surface)</td>
</tr>
</tbody>
</table>

† Drying time may be affected at low temperatures
7.3 Surface preparation

Surfaces which are to receive pavement markings shall be cleaned of all dirt, loose material and other contaminants. Pavement surfaces shall be thoroughly dry immediately prior to the application of pavement markings.

1.7 Protection of the work

Refer to MRTS45 Clause 7.8.

7.8 Protection of the work

Newly placed pavement markings shall be protected from damage by traffic or other causes, using acceptable traffic management procedures; until paint is dry (no pick up condition) or thermoplastic material has hardened sufficiently to prevent such damage.

1.8 Maintaining a record of pavement markings in rural townships and other areas

Once a pavement marking job is finalised, original plans should be amended to reflect the finished work where necessary, and filed as a record of typical pavement marking practice. An up-to-date register of pavement markings will:

- provide a legal record of existing pavement markings in the event of litigation
- serve as a reference for preparation of new work in order to maintain consistency in treatments
- help to identify problem areas, and
- document and assist in the planning of maintenance works.

Similar pavement marking plans of major rural roads or urban arterials should be maintained for the same purposes.

1.9 Removal of markings

1.9.1 General

Refer to MRTS45 Clause 7.10.

7.10 Removal of existing pavement markings

Where required under the Contract, existing pavement markings shall be removed by the appropriate method stated in Table 7.10. Where a method is stated in Clause 1 of Annexure MRTS45.1, that method shall be used.

**MRTS45 Table 7.10 – Method of removal of existing pavement markings**

<table>
<thead>
<tr>
<th>Method of removal</th>
<th>Duration of result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emulsion and sand</td>
<td>&lt; 2 weeks</td>
</tr>
<tr>
<td>Skid resistant enhanced black cold applied resin or plastic</td>
<td>&lt; 6 months</td>
</tr>
<tr>
<td>Chip seal</td>
<td>Permanent</td>
</tr>
</tbody>
</table>
### Method of removal | Duration of result
--- | ---
Line grinder (asphalt only) | Permanent
Profiler (asphalt only) | Permanent
Abrasive blasting | Permanent

Note: Refer to this Part 4 Section 3 of this guide for details of line marking tape as an option to cover lines.

#### 1.9.2 Deviations

The junctions of new deviations and existing roadways can present problems in relation to previous centre and edge lining. Figure 1.9.2 outlines a typical example. The residual centre line, if overpainted in black, may be more easily discerned than the newly painted line under certain lighting conditions. Edge lines, or construction joints that follow original edge lines, can remain visible for the same reasons, or for reasons of physical discontinuity, even after a reseal. In such cases construction joints should be square to the new centre line as shown in Figure 1.9.2.

**Figure 1.9.2 – Pavement construction joint**

(a) Not Preferred  
(b) Preferred
This may involve scarifying the pavement, re-compacting and sealing it along with the new work. In the case of asphaltic concrete, the new asphalt surfacing may be extended so that there is no detectable oblique joint. Designs may require special provisions to cover this procedure. If necessary, until new pavement marking can be carried out, additional delineation (such as delineation posts or line marking tape) should be used to lead traffic onto new work. Where confusion may result under adverse conditions, consideration should be given to the incorporation of retroreflective raised pavement markers (RRPMs) in conjunction with the new lining.

Problems similar to those with deviations may arise in redirecting traffic to a side track around new construction.

When the side track is no longer required, care should be taken to ensure that any delineation and markings that are no longer required are removed and the side track is effectively blocked off by barriers or other appropriate means. Line marking tape provides a satisfactory means of temporary pavement marking at side tracks. Complete resealing of the affected area is also a positive way of removing previous markings. Any pavement joints should be constructed as described.

1.9.3 Responsibility

Pavement markings and delineation devices are provided for the guidance of motorists, particularly when visibility and recognition conditions are reduced. Practices that result in potential confusion under these difficult conditions should be avoided.

Before opening sections of road where markings have been altered or are new, the site should be inspected by the supervising engineer to ensure that no unsafe or confusing conditions exist.

1.10 Application of pavement markings

1.10.1 General

Refer to MRTS45 Clause 6.1.1.

<table>
<thead>
<tr>
<th>6.1.1 Performance criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal line marking, excluding ATLM, when applied, shall have a minimum retroreflectivity of 350 mcd/lux/m² measured between 10 and 20 days of wear.</td>
</tr>
</tbody>
</table>

All painted markings, whether installed by machine or hand, are retroreflectorised by the application of drop-on glass beads (ballotini). Materials used instead of paints, such as raised pavement markers, must also have retroreflective properties.

Longitudinal line marking, excluding ATLM, when applied, shall have a minimum retroreflectivity of 350 mcd/ lux/m² measured between 10 and 20 days of wear.

1.10.2 Principles of retroreflection

Reflection is a passive process in which light rays strike a material and bounce from it without causing a chemical or physical change in the reflecting material.

There are three basic types of reflection:

a) Diffuse reflection results when light strikes a microscopically rough surface. Most objects viewed under normal lighting conditions are visible because of light being scattered from surfaces such as wood, cloth, flat paint and skin. Because only a very small amount of light is
returned along the path of the incident (incoming) light beam, diffuse reflecting materials have low night time visibility.

b) Mirror (or specular) reflection results when light strikes a surface which is microscopically smooth and is reflected from the surface at an equal but opposite angle to that of the incident light beam. Light is returned directly to the source only when the light beam is exactly perpendicular to the surface.

c) Retroreflection (or reflex reflection) describes the case when incoming light is returned directly to the source, irrespective of the angle of incidence. Since a relatively large amount of light is returned, retroreflective materials appear brightest to an observer located near the light source.

Retroreflective materials are used extensively for traffic signing and pavement markings because of their ability to return a large portion of light directly to the source. When illuminated by vehicle headlights at night, these materials are typically several hundred times brighter than a white-painted surface.

1.10.3 Retroreflection with glass beads

The use of glass beads in road marking paint to improve reflectivity is accepted worldwide and has been in operation for more than 40 years.

The refractive index (usually 1.5 or higher) and grading of the glass spheres are variables that have a definite influence on initial and long-term reflectivity and durability.

Reflective glass beads shall comply with the requirements for Type B, C or D glass beads as described in AS 2009. The type to be used shall be as stated in Annexure MRTS45.1 Clause 2.

1.10.4 Application

Refer to MRTS45 Clause 7.5.

<table>
<thead>
<tr>
<th>7.5 Application of pavement markings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>7.5.1 Procedure</strong></td>
</tr>
<tr>
<td>The Contractor shall submit its procedure for application of pavement markings. The procedure shall include details of the materials, application rates, equipment and method, including manufacturer’s recommendations, to be used when applying pavement markings.</td>
</tr>
<tr>
<td><strong>7.5.2 Paint</strong></td>
</tr>
<tr>
<td><strong>7.5.2.1 Mixing</strong></td>
</tr>
<tr>
<td>Mixing of paint shall be carried out strictly in accordance with the manufacturer’s recommendations.</td>
</tr>
<tr>
<td><strong>7.5.2.2 Application equipment</strong></td>
</tr>
<tr>
<td>Mechanical means shall be used to apply painted pavement markings.</td>
</tr>
<tr>
<td>All equipment used in the application of pavement markings shall produce pavement markings of uniform quality which conform to the requirements of this specification.</td>
</tr>
<tr>
<td>The longitudinal line application machine shall be capable of accurately superimposing succeeding coats of paint upon the first coat and upon existing lines.</td>
</tr>
</tbody>
</table>
The longitudinal line application machine shall consist of a rubber-tyred vehicle which is manoeuvrable to the extent that straight lines can be followed and normal curves can be painted in true arcs. The machine shall be capable of applying road marking paints and glass beads at the rates specified.

The longitudinal line application machine shall be equipped with the following:

a) a positive acting cut-off device to prevent depositing paint in gaps of broken lines, and

b) a glass bead dispenser located behind the paint applicator nozzle and which is controlled simultaneously with the paint applicator nozzle.

Where the configuration or location of a longitudinal line is such that the use of a longitudinal line application machine is unsuitable, road marking paint and glass beads may be applied by hand-sprayed means.

Stencils, boards and hand spray equipment shall be used to paint transverse markings. Stencils shall conform to the dimensions shown on the design documents or in the Manual of Uniform Traffic Control Devices.

7.5.2.3 Application of paint and glass beads

All markings shall be of uniform thickness and intensity. Care shall be taken to avoid overspray on to the surrounding area.

Water-borne paint shall not be heated to a temperature greater than 65 degrees Celsius.

Two coats of paint and glass beads shall be applied on longitudinal lines to new surfaces. The first coat shall be cured to ‘no pick up time’ prior to the application of the second coat.

Each coat of paint for any longitudinal line group, including glass beads, shall be applied in one pass of the longitudinal line application machine, regardless of the number, width, and pattern of the individual lines involved.

Table 7.5.2.3 – Maximum temperature of paint

<table>
<thead>
<tr>
<th>Material</th>
<th>Maximum Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paint, water-borne</td>
<td>65</td>
</tr>
</tbody>
</table>

Glass beads shall be uniformly incorporated in all coats of paint concurrently with the application of the paint.

7.5.2.4 Application rates

The minimum application rates for the paint and glass beads shall be as specified in Table 7.5.2.4.

Table 7.5.2.4 – Application rates for paint and glass beads

<table>
<thead>
<tr>
<th>Work type</th>
<th>Coverage (minimum per coat)</th>
<th>Wet application rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal lines – first coat Type B (drop-on beads)</td>
<td>&gt; 300 g/m²</td>
<td>0.375 lit/m² ± 0.025</td>
</tr>
<tr>
<td>Longitudinal lines – second coat Type B (drop-on beads)</td>
<td>&gt; 300 g/m²</td>
<td>0.375 lit/m² ± 0.025</td>
</tr>
<tr>
<td>Longitudinal lines – repaint Type B (drop-on beads)</td>
<td>&gt; 200 g/m²</td>
<td>0.300 lit/m² ± 0.025</td>
</tr>
</tbody>
</table>
Longitudinal lines – second coat or repaint applying Type D beads | > 400 g/m² | 0.500 lit/m² ± 0.025
---|---|---
Transverse lines – Type B (drop-on beads) | > 300 g/m² | 0.375 lit/m² ± 0.025
Transverse lines – Type D beads | > 400 g/m² | 0.500 lit/m² ± 0.025

The combination application rates for anti-skid and glass beads shall not exceed the values specified above and in Clause 6.1.4 unless specified by the manufacturer.

### 7.5.3 Thermoplastic material

#### 7.5.3.1 Primer

A primer, of the type recommended by the manufacturer of the thermoplastic material, shall be applied to the surface immediately in advance of, but concurrent with, the application of thermoplastic material. The primer shall be applied at the application rate recommended by the manufacturer and shall not be thinned.

#### 7.5.3.2 Application of thermoplastic material

Thermoplastic material may be applied by screeding, spraying, extrusion or profiling or as preformed material.

Thermoplastic material shall be applied to the pavement at a temperature between 180°C and 200°C unless a different temperature is recommended by the manufacturer.

The pavement surface to which thermoplastic material is applied shall be completely coated by the material and any voids in the pavement surface shall be filled.

#### 7.5.3.3 Application rate

Thermoplastic material shall be applied at the minimum thickness specified in Table 7.5.3.3.

### Table 7.5.3.3 – Thermoplastic application thickness

<table>
<thead>
<tr>
<th>Location</th>
<th>Minimum application thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal lines</td>
<td>2</td>
</tr>
<tr>
<td>Transverse markings</td>
<td>2</td>
</tr>
</tbody>
</table>

Where specified, glass beads shall be applied immediately to the surface of the molten thermoplastic material at a rate of not less than 0.12 kg per m².

### 1.10.5 Skid resistance

For specification of anti-skid treatments, see MRTS45 Clause 6.1.4.

Glass beads reduce skid resistance and for this reason may not be suitable, or may be applied at a lower rate in pedestrian crossings and other wide transverse markings and symbols. The reduced skid resistance is more apparent to pedestrians and cyclists than to motorists.
1.11 Traffic control during marking

1.11.1 General guidance

Part 3 (Works on Roads) of the MUTCD describes in detail the traffic control devices and procedures to be adopted to warn, instruct and guide road users safely past general works on roads. Reference should be made to Part 3 of the MUTCD for general safety and traffic control requirements for pavement marking activities.

2 Longitudinal lines

2.1 Spotting (setting out)

On new permanent works and reseals where longitudinal markings are required, the constructing agency is usually responsible for setting out the location of the markings. Setting out involves laying a length of rope accurately along the proposed marking alignment and painting dots (spotting) along the rope.

Centre lines (dividing and barrier lines), whether on straight or curved sections of road with the same number of lanes in each direction, should be located along the geometric centre of the sealed width. Where curve widening of the pavement has been applied to one side only, the spotted centre line should be offset from the curve ‘centre’ line so that the dividing line or barrier line will be located along the geometric centre line.

The centre line is marked initially, using TRPMs or paint. Lane widths should be checked and lane lines offset. The starting points of tapers should also be offset.

Edge line locations can be measured from the centre line where there is a consistent lane width and spotted at the same interval as for the centre line. Where lane width varies or at turnout tapers, a rope should be used to fix the edge alignment.

For installation of spotting, see MUTCD Part 3 Work on Roads Section 1.5.

Because reseals are done under traffic, it is important that spotting for these is done within one week. When planning reseal operations, it is desirable to allow for spotting to be done while traffic control is still in place.

2.2 Use of temporary raised pavement markers (TRPMs)

Proposed reseals and newly primed permanent works jobs may be marked with TRPMs before the next layer of bitumen is applied. Gluing of TRPMs is not reliable for long periods or in moist conditions. They are held in place by the bitumen seal. They should not be placed more than 24 hours before the seal is applied and application should be delayed when moisture is present or expected.

The use of TRPMs may preclude the need for spotting where existing markings are to be reinstated after a reseal and for re-spotting if proposed line markings were set out before the final seal on new works is applied. In these cases, the distance between TRPMs should be the same as would apply for spotting.

Alternatively, the centre line may be marked by TRPMs at longer intervals (say 25 metres on curves and 50 metres on straights) before the seal is applied and spotting is carried out, using the TRPMs as a guide, on the final seal. In this instance, TRPMs should not take the place of spotting as TRPMs may be broken off by traffic before final marking can be carried out.
Once the longitudinal lines have been marked, the TRPM flaps can be removed by cutting them off flush with the pavement surface.

### 2.3 Coding

The points where different line types start and finish are usually coded on the road for new work or marked on stakes beside the road for reseals. For new work, the line type is usually shown on the job drawings – otherwise, the guidelines in this guide or the MUTCD may be used.

For reseals, the coding on the stake must be done before resealing. Stakes should be located well clear of the road shoulder and table drain to avoid dislodgment. After resealing, the coding should be painted on the pavement adjacent to the dotted line.

Coding marks on the pavement should be visible and legible at a far enough distance for the line marking machine operator to be prepared to take action. Modern line marking machines travel at about 18 km/h, and a reasonable distance is about 50 metres. The code mark needs to be about one metre long.

Generally, coding marks are used only for designating the ends of:

- dividing lines
- barrier lines
- lane lines
- edge lines
- continuity lines.

The widths and stripe:gap ratios of these lines are, for the most part, standard within a region or city and it is unnecessary to specify these parameters on the code marks. Three line codes will cover the possible line types:

```
continuous barrier line
continuous dividing line
continuous lane line
edge line

diving line (3:9 ratio)
broken barrier line
broken lane line

continuity line
```

Any variation in width (such as between lane lines and edge lines) can be inferred from the context. In cases where confusion could occur, the width or stripe:gap ratio might be specified alongside the code mark.

The end of the line type is identified by a stroke perpendicular to the direction of the line. Some examples of code marks are shown in Figure 2.3.
**Figure 2.3 – Examples of code marks**

<table>
<thead>
<tr>
<th>Code</th>
<th>Line type</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Code 1]</td>
<td>double barrier/single barrier</td>
</tr>
<tr>
<td>![Code 2]</td>
<td>single barrier/separation</td>
</tr>
<tr>
<td>![Code 3]</td>
<td>double barrier/double barrier with diverging continuity</td>
</tr>
<tr>
<td>![Code 4]</td>
<td>edge/continuity with edge line transition</td>
</tr>
<tr>
<td>![Code 5]</td>
<td>continuity/broken lane</td>
</tr>
</tbody>
</table>

### 2.4 Reinstatement period

In all cases, the reinstatement of longitudinal markings, particularly barrier lines and dividing lines, should occur as soon as possible after the new seal has been laid. As a general guide, however, the maximum period before reinstatement of centre lines can be obtained by reference to Table 2.4.

**Table 2.4 – Maximum periods to reinstatement of centre line markings**

<table>
<thead>
<tr>
<th>AADT</th>
<th>Maximum period (weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TRPMs Not used TRPMs Used</td>
</tr>
<tr>
<td>&lt; 400</td>
<td>12 12</td>
</tr>
<tr>
<td>400-1000</td>
<td>4  8</td>
</tr>
<tr>
<td>1000-5000</td>
<td>2  4</td>
</tr>
<tr>
<td>&gt; 5000</td>
<td>2  2</td>
</tr>
</tbody>
</table>
Where traffic volume is not the major consideration (such as on range sections with poor horizontal and vertical alignment), or traffic volumes are very high (such as on freeways), markings must be reinstated in an appropriately short time. Therefore, small line marking equipment, probably not available in the region, may be necessary, resulting in some advantages, such as:

a) The time between surfacing and reinstatement is minimised, reducing potential hazards to traffic.

b) The Regional Director will be more capable of ensuring the line markings for which they are responsible are correct before the general line marking with larger machines. This will result in the larger machines being more productive.

During all periods before line marking is in place, the sign T3-12 should be displayed in any situation on two-way roadways where there will be overtaking in an oncoming traffic lane. The T3-11 sign should be used in locations such as multilane or one-way roadways where there is no overtaking risk.

2.5 Maintenance

The life of pavement markings depends on a number of factors, including:

- type of material
- line type
- traffic volume
- pavement type
- surface roughness
- ambient temperatures
- precipitation.

As a consequence, only general guidelines on maintenance can be given and these must be amended in accordance with local conditions and materials. The cost effectiveness of various marking materials is covered in more detail in Part 4 of this guide.

Generally, maintenance on an annual basis should be the target, subject to the following qualifications:

a) On roads carrying small volumes of traffic (less than 500 vpd) where the grading and alignment is of a high standard, consideration should be given to remarking lines at less frequent intervals than once a year.
b) Where the lines are subjected to abnormal wear, for example due to high traffic volumes, or where reseals or new construction have recently been done, more than one marking a year may need to be arranged; pavement markings on important roads should be maintained at a high standard.

c) Where lines are augmented with raised pavement markers, a systematic programme of replacing missing markers should be undertaken.

d) Where plastic markings are used, less frequent remarking is usually necessary.

At locations where lines are subject to greater volumes of traffic encroachment, such as on straight sections between winding sections or on substandard curves, additional maintenance may be needed. Alternatively, two coats of paint may be applied on each occasion to maintain similar reflectivity to that on adjacent sections.

When assessing the need for pavement marking repainting, day and night site inspections are necessary. Pavement marking requires maintenance when it has poor visibility by day or poor reflectorisation at night.

Reflectorisation loss (absence of glass beads) severely reduces night-time visibility. One method of simulating night-time reflectorisation performance of a pavement marking involves the viewer positioning himself with the sun behind his or her shoulder so that the marking is viewed adjacent to the shadow of the viewer’s head. The extent of loss of glass beads can be judged from the brightness of reflected sunlight.

2.6 Choice of materials

Water-borne road marking paint is used for line repairs, remarking and new line marking. Some regions use thermoplastics when small quantities are required.

Thermoplastics may be applied to the surface by spraying or extrusion. The most common application is usually (but not always) for longitudinal lines with the advantage that the pattern being applied can be quickly changed although specialised equipment is needed and the work usually needs to be carried out by specialist contractors. This is particularly the case for profiled or audio-tactile linemarkings.

Marking material used for longitudinal lines should be of a similar skid resistance to the road surface as a different skid resistance can cause a breaking vehicle to change direction.

3 Transverse lines and other markings

3.1 Setting out

3.1.1 Transverse lines

Examples of the location of transverse lines are given in Part 2 Section 4.2 of this guide.
A set of templates, as shown in Figure 3.1.1, may be used to mark out broken transverse lines, where:

- \( L_1 \) is the stripe length
- \( L_2 \) is the gap length
- \( W \) is the stripe width

as given in MUTCD Part 2 Figure 5.1 for each broken line type.

Spotting for transverse markings shall be carried out as shown on the design documents.

### 3.1.2 Diagonals and chevrons

The geometric parameters applicable to diagonals and chevrons are described in Part 2 Section 2.4.1 of this guide.

Notwithstanding the range of marking widths, spacings and angles recommended for different situations, pragmatism suggests the use of one or two standard templates for setting out diagonals and chevrons, perhaps one each for rural and urban conditions.

Figure 3.1.2 shows a method of setting out diagonals or chevrons within outlines (edge lines). The template is in the shape of an isosceles triangle, with equal angles of either 45°, 30° or 22.5°. The length of each short side, \( L \), is 1.0 or 1.2 metres.
A hole is cut in the template, such that there is a strip along the base equal in width, ‘W’, to the required distance between the end of the chevron (or diagonal) and the edge line (see also MUTCD Part 2 Figures 5.4, 5.5 and 5.6).

The template is first placed with its base, or long side, on an edge line and its apex touching the opposite edge lines at ‘A’ in Figure 3.1.2. The line ‘AB’ then forms the edge of the first chevron or diagonal. The template is then turned point-over-point a number of times to achieve the required spacing. The edges ‘CD’ and ‘EF’, when projected, form the edges of the second chevron or diagonal. The process is repeated along the opposite edge line to complete the chevron perimeters.

Strictly, the template should be moved along a central control line and this should be done if the control line is easily beatable.

Each time the template is placed at a chevron location, the end of the chevron is also marked using the inside edge of the base strip.
If one edge of the island is too curved or divergent to serve as a control line for the template, only the other edge need be used and the opposite edge ‘CF’ of the template can be used to project the other half of the chevron.

### 3.1.3 Arrows

Arrows are described in Part 2 Section 2.4.2 of this guide and MUTCD Part 2 Figures 5.10, 5.11 and 5.12.

Generally, more than one arrow is required in a lane. Each arrow should be set out an equal distance from the lane line nearer to the centre of the road to ensure that all the arrows align with one another.

### 3.1.4 Letters, numerals and other symbols

Other pavement markings are described in Part 2 Sections 2.4.2 to 2.4.3 of this guide and depicted in the associated figures.

As generic templates for letters and numerals (see MUTCD Part 2 Figure 5.7) can be devised, it is not necessary to make templates for individual characters.

### 3.2 Inauguration period

Installation of markings should occur as soon as possible after a new seal has been laid. In general, transverse lines and other markings should be installed at the same time as longitudinal lines. Marking operations must also be co-ordinated with the erection of associated road signs.

### 3.3 Maintenance

Transverse lines are generally subject to greater wear than longitudinal lines and as a consequence have shorter lives. Other markings, particularly chevrons and diagonals, not often encroached upon by traffic have longer lives.

Dirt and rubber residue also reduce the reflectivity and brightness of transverse and other markings, either because of heavy traffic encroachment or, conversely, because traffic wheels rarely clean the markings by running over them. A coat of road marking paint is sometimes used on thermoplastic markings to brighten them up.

### 3.4 Choice of materials

#### 3.4.1 General

Because of the high cost of labour involved in applying transverse lines, high quality materials are desirable in order to minimise their maintenance. As transverse markings are commonly used in hazardous locations, in particular for pedestrian (zebra) crossings and stop bars, it is important that the material selected presents a higher skid resistance than the surrounding surface.

The addition of quartz to the material or to the surface can improve skid resistance properties of transverse markings, but caution is needed so as not to compromise other important qualities such as reflectivity. Plastic materials usually provide better performance than paint.

#### 3.4.2 Transverse lines

Plastic material is an economical way to mark transverse lines. Permanent marking tapes and preformed thermoplastic markings are cost effective on smooth textured surfaces.

Water-borne road marking paint is usually used by most Regions for transverse line marking and maintenance.
Cold screeded plastic materials or preformed thermoplastic markings are recommended for stop bars, crosswalks and pedestrian (zebra) crossings as they are more cost effective when small quantities are involved.

3.4.3 Pavement messages and symbols

Thermoplastic is the material usually preferred for marking messages and symbols on the pavement, either as a preformed material applied manually or by screeding (manual or self-propelled application). However, most Regions exclusively use water-borne road marking paint to perform such work.

4 Raised pavement markers and pavement bars

4.1 Location of raised retro-reflective pavement markers

Raised retro-reflective pavement markers (RRPMs) used to augment painted lines should be located either to one side of the line or, if it is a broken line, in the gaps between painted stripes, to avoid contamination during line marking operations.

In general, RRPMs should be located on the outside (non-traffic side) of edge lines and painted medians and islands for protection of the RRPMs in high traffic situations.

On sharp curves, RRPMs augmenting painted edge lines, continuity lines and painted median and island approaches should be oriented so that the full reflective effect is realised on approach. This is achieved by aiming the reflective face in the direction of approaching traffic rather than tangential to the curve.

4.2 Installation and maintenance

Requirements for pavement markers are set out in Australian Standard AS 1906 Part 3 and methods of sampling and testing the devices are described in Australian Standards AS 2445.3.1 to AS 2445.3.10.

Markers should be chosen for their operational effectiveness, ease of installation, ability to self-clean under traffic, and noise in operation.

Raised pavement markers require a systematic programme to replace missing markers to prevent loss of effectiveness. Their life depends upon many variables, particularly traffic wear. Replacement rates are normally about 5 to 10% per annum, but in areas of heavy wear this can rise to more than 25%. Expensive, longer life markers are available for use in such locations. Generally, the life of raised pavement markers ends when the pavement is resurfaced.

The adhesive used to install raised pavement markers shall be soft adhesives (such as ‘hot-melt’) specified as single part, bituminous based materials, which are applied by heating to high temperature. Care shall be taken when heating soft adhesives. A proprietary built, gas-heated kettle shall be employed for this purpose. To ensure satisfactory bonding of the marker to the pavement, the following conditions must be observed:

a) The pavement must be sound and not prone to excessive deformation.

b) The pavement surface must be clean, moderately rough, dry and free of loose material and any other material detrimental to the adhesion between the item and the pavement.

c) The base of the marker must be clean.

d) The base of each marker is to be completely covered with adhesive.
The marker must not be disturbed until the adhesive has set.

The procedure to be followed in placing pavement markers is as follows:

a) Assemble the necessary markers. Care should be taken to ensure that the correct markers are used (white, red, green or yellow; bidirectional, unidirectional or non-retroreflective as specified).

b) Select the grade of adhesive to suit the road temperature and the length of time for which the traffic lane can be closed.

c) Close the working area to traffic, ensuring adequate signing is provided.

d) Mark the location of each marker (for example, with chalk or crayon).

e) Sand blast or burn the area of pavement clean if it is noticeably fouled with oil droppings, rubber detritus and so on.

f) Sweep the pavement.

g) Mix enough adhesive. The amount will depend on the type of adhesive used, the experience of the gang, marker spacing and traffic conditions under which the markers are being laid.

Where hot melt adhesives are used, the adhesive is dispensed to the road surface at 180 to 200°C, using a special machine. Setting time of the adhesive is approximately 1 to 2 minutes. Ambient temperature should be above 20°C.

h) Spread the adhesive over the underside of the marker to a depth of approximately 5 to 10 mm so that the base of the marker is completely covered. The amount needed will vary with the roughness of the pavement surface.

i) Place the marker right way up on the pavement in its correct position and press down, rotating back and forth slightly until the adhesive is squeezed out around all edges of the marker.

j) Do not permit traffic to run on the markers until the setting time of the adhesive has elapsed.

4.3 Audio-Tactile Line Marking (ATLM)

The commercial methods of forming ATLM available in Queensland are:

- A special grade of thermoplastic material is formed by mechanically screeding a conventional thermoplastic, simultaneously applying transverse ribs of the same material at regular intervals. The screed line is approximately 2 mm thick, with the ribs 8 mm high and 50 mm long. The height of the thermoplastic raised ribs is measured from the plane surface formed by the tops of the aggregate.

The slope angle of the raised rib should be approximately 45 degrees once installed. Glass beads are mixed into the material and pressured applied to the surface to provide immediate retro reflectivity.

- A thermoplastic line is extruded and applied as an intermittent bar or checkerplate pattern. A continuous line can also be applied, involving a two-stage process with the base line applied initially and the ribs posteriorly placed.

Rib centre spacing is 250 mm on 150 mm wide edge lines, with a 1.5 metre gap every 20 metres for cyclists. The rib centre spacing is 250 mm on double-barrier lines, each 80 mm wide.
The distance between the centreline of the completed marking and the centreline of the existing painted line marking is to be less than 10 mm. The apparent line of the markings is to be a smooth, continuous alignment when viewed in the direction of the line.

Glass beads in accordance with AS 2009 Type C shall be mixed into the thermoplastic material at a rate of not less than 30% by mass prior to application.

Glass beads in accordance with AS 2009 Type B shall be applied immediately to the surface of the molten thermoplastic material. The minimum rate to be retained on the thermoplastic surface is 200/m². In order to enhance retention, the beads shall have a proprietary adhesive coating.

The thermoplastic material shall have a minimum titanium dioxide content of 10% by mass.

Acceptance of the retro reflectivity of the road marking shall be based on the marking, achieving a minimum level of reflectivity of 350 mcd/lux/m² measured at the time of application.

*MRTS45 Figure 7.7.3A – ATLM edge line*

![ATLM edge line diagram](image)

*MRTS45 Figure 7.7.3B – ATLM double-barrier line*

![ATLM double-barrier line diagram](image)
Figure 4.3 – Gaps in ATLM edge lines for cyclists

5 Tolerances and compliance testing

5.1 Tolerances

Refer to MRTS45 Clause 7.9.

<table>
<thead>
<tr>
<th>7.9 Tolerances</th>
</tr>
</thead>
</table>

7.9.1 Pavement markings

Completed pavement markings shall:

a) be uniform

b) have clean and well-defined edges without running or deformation, and

c) conform to the dimensions shown on the design documents or in the *Manual of Uniform Traffic Control Devices* (Qld).

Longitudinal lines shall be straight on straight alignment and shall be on a true arc on curved alignment.

When completed, pavement markings shall conform to the tolerances specified in Table 7.9.1. Additionally, arrows and letters shall be placed square to the centreline of the traffic lane.

Drips, overspray, improper markings, and paint and thermoplastic material tracked by traffic shall be immediately removed from the pavement surface by methods which do not damage the pavement surface.

7.9.2 Audio tactile line marking

The distance between the centreline of the completed marking and the centreline of the existing painted line marking is to be less than 10 mm. The apparent line of the markings is to be smooth, continuous alignment when viewed in the direction of the line.

Audio tactile material shall comply with the requirements of Clause 6.1.5. The contractor shall install thermoplastic ATLM within the limits outlined in Table 7.9.2.

7.9.3 Raised pavement markers

When installed, raised pavement markers shall conform to the tolerances specified in Table 7.9.3.
### MRTS45 Table 7.9.1 – Tolerances – pavement marking

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Tolerance (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Longitudinal lines</strong></td>
<td></td>
</tr>
<tr>
<td>Width of line</td>
<td>± 5</td>
</tr>
<tr>
<td>Width of gap between adjacent lines</td>
<td>± 5</td>
</tr>
<tr>
<td>Length of line and/or gap</td>
<td>± 100</td>
</tr>
<tr>
<td>• new construction, reseals and asphalt, and</td>
<td></td>
</tr>
<tr>
<td>• repaints</td>
<td>± 300</td>
</tr>
<tr>
<td>Placement from spotting for new construction,</td>
<td></td>
</tr>
<tr>
<td>reseals and asphalt overlays</td>
<td>± 20</td>
</tr>
<tr>
<td>Placement from existing line (repaints)</td>
<td>± 15</td>
</tr>
<tr>
<td>Trueness of line</td>
<td>&lt; 15 in 10 metres</td>
</tr>
<tr>
<td><strong>Transvers markings</strong></td>
<td></td>
</tr>
<tr>
<td>Dimension of transverse markings and shapes</td>
<td>± 20</td>
</tr>
<tr>
<td>Placement from spotting</td>
<td>± 10</td>
</tr>
<tr>
<td>Placement from existing markings</td>
<td>± 10</td>
</tr>
</tbody>
</table>

### MRTS45 Table 7.9.2 – ATLM tolerances

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Dimension</th>
<th>Tolerance (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height of raised nib</td>
<td>8 mm</td>
<td>plus 2 mm or minus 1 mm</td>
</tr>
<tr>
<td>Spacing of raised rib</td>
<td>250 mm</td>
<td>plus or minus 10 mm</td>
</tr>
<tr>
<td>Length of raised rib</td>
<td>50 mm</td>
<td>plus or minus 2 mm</td>
</tr>
<tr>
<td>Slope angle of raised rib</td>
<td>45 degrees</td>
<td>approximately</td>
</tr>
<tr>
<td>Width of raised rib (edge line)</td>
<td>150 mm</td>
<td>plus or minus 2 mm</td>
</tr>
<tr>
<td>Width of raised rib (centre barrier line)</td>
<td>80 mm</td>
<td>plus or minus 2 mm</td>
</tr>
</tbody>
</table>

### MRTS45 Table 7.9.3 – Tolerances – raised pavement markers

<table>
<thead>
<tr>
<th>Tolerance (mm)</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral position:</td>
<td></td>
</tr>
<tr>
<td>• barrier/edge line</td>
<td>+25, -50</td>
</tr>
<tr>
<td>• broken line</td>
<td>± 10</td>
</tr>
<tr>
<td>• flush medians</td>
<td>± 10</td>
</tr>
<tr>
<td>Longitudinal position:</td>
<td></td>
</tr>
<tr>
<td>• broken line</td>
<td>± 10</td>
</tr>
<tr>
<td>• new construction</td>
<td>± 100</td>
</tr>
<tr>
<td>• replacement</td>
<td>± 300</td>
</tr>
<tr>
<td>• 1 m from start of line</td>
<td></td>
</tr>
</tbody>
</table>
5.2 Compliance testing

Refer to MRTS45 Clause 9.

9 Compliance testing

9.1 General

Compliance testing shall be carried out for each lot during installation and maintenance.

9.2 Testing frequencies and number of tests

The Contractor is responsible for performing sufficient tests to ensure that the Works comply with the Contract, including the requirements of this specification.

However, the Contractor’s testing program shall be such that the testing frequencies and number of tests are not less than those stated in Clause 5.3.

9.3 Geometrics

The geometric tolerances shall be checked at regular intervals not greater than those specified in the Annexure.