1. **SCOPE**

This specification covers performance requirements of retroreflective and non-retroreflective raised pavement markers which are bonded directly to the road surface.

Australian Standard AS 1906.3 : 1992 is the major support document for this specification. The scope, description, definitions and also the classification of marker type used in this specification are in accordance with AS 1906.3 : 1992 Sections 1 and 2.1.

This specification does not cover requirements for markers subsequent to their installation as part of a contract. These issues are covered in Transit New Zealand (Transit) P/14 Specification for the Installation of Raised Pavement Markers.

2. **GENERAL**

2.1 **Classification**

Markers are classified according to whether they are retroreflective or non-retroreflective as follows:

(a) **Retroreflective Markers (AS 1906.3 Type A markers)**

Retroreflective markers are designed primarily for nighttime use. The colours specified herein are white, red and yellow.

(b) **Non-Retroreflective Markers (AS 1906.3 Type B markers)**

Non-retroreflective markers are designed primarily for daytime use. These markers shall be coloured white.

2.2 **Acceptance**

This specification sets out minimum requirements which apply to markers both as new and after field trialing. These requirements are detailed in Section 3 (non-retroreflective markers) and Section 4 (retroreflective markers). Ceramic non-retroreflective pavement markers are not required to be field tested.

Markers must satisfy the requirements of this specification to be accepted by Transit.
2.3 Sampling and Testing Sequence

Sampling shall be random in accordance with AS 1906.3 : 1992, Clause 3.1.2. The sequence of testing and the sample sizes used for the tests shall be in accordance with Figure 1.

![Testing Sequence and Sampling Size](image)

* reflective properties: Type A - retroreflectivity, Type B - reflectance

**Figure 1: Testing Sequence and Sampling Size**

3. REQUIREMENTS OF NON-RETROREFLECTIVE MARKERS

3.1 Field Trial (Non-Ceramic Markers)

A sample of 50 markers shall be trafficked for a period of 12 months. The test sampling and procedure shall be in accordance with AS 1906.3 : 1992 Appendix B, Clauses B3 and B4. The markers shall be installed on the lane line between the two lane line markings.

After 12 months the reflectivity of a randomly selected sample of 30 markers shall be measured in accordance with Clause 3.2.3 of this specification (daylight directional reflectance).

The upper surface of each of the top performing 80% of the markers shall have a daylight directional reflectance change of not more than 15% of the value specified in Clause 3.2.3 and shall lie within the colour coordinates specified in Clause 3.2.2 of this specification.
3.2 Laboratory Tests

3.2.1 Appearance

The appearance of the markers shall comply with AS 1906.3: 1992, Clause 3.5.8. In addition, markers shall meet the following requirements;

- markers shall be domed with a circular base of 100 mm nominal diameter;
- the top surface of the marker shall be convex with a radius of curvature between 90 mm and 150 mm - the desirable radius being 100 mm to 105 mm. The radius within 13 mm of the edge may be less, but any change in curvature shall be gradual;
- the base of the markers shall be free from gloss, glaze or substances that may reduce its bond to the adhesive. Where the base has a pattern of protrusions, these must not deviate more than 2mm from a flat surface;
- the diameter of the base shall be 100 ±10 mm and the thickness at the centre shall be between 13 mm and 20 mm. The thickness at the edge shall be between 3 mm and 6 mm; and
- the top and sides shall be smooth and free of mould marks, pits, indentations, air bubbles or other blemishes or discolouration.

3.2.2 Colour

When viewed under natural daylight conditions, the perceived colour of the non-reflective markers shall be white.

Test viewing shall be carried out using a comparison sample of acceptable colour in accordance with AS 1906.3 : 1992, Clause 3.4.2. The acceptable colour of the comparison sample shall comply with either;

(a) AS/NZS 1906.1:1993 Clause 2.2 (a), or

(b) the trichromatic coordinates of the glazed surface under standard illuminant C (daylight) as defined by the International Commission on Illumination (CIE) shall lie within the area defined by the four points:

\[
\begin{align*}
 & x = 0.304 & y = 0.306 \\
 & x = 0.297 & y = 0.313 \\
 & x = 0.326 & y = 0.327 \\
 & x = 0.320 & y = 0.333
\end{align*}
\]
3.2.3 Reflective properties (retroreflectivity)

A sample of five markers shall be tested in accordance with ASTM E1347-90 (formerly ASTM E97), except that the test area shall be 50 mm in diameter and no more than 3 mm of the curved surface shall protrude into the measuring apparatus.

For any one marker, the glazed surface shall have a daylight directional reflectance of not less than 75%.

3.2.4 Water absorption

When a sample of five markers is tested in accordance with AS 1906.3:1992, Clause 3.5.1, the markers shall show no visible signs of water ingress.

The change in reflectivity of the tested markers, must not be more than 15% of the value specified in Clause 3.2.3 of this specification.

3.2.5 Heat test (non-ceramic markers only)

A sample of five markers shall be tested in accordance with AS 1906.3:1992, Clause 3.5.2.

The tested markers shall show no colour change greater than 4 on the ISO 105-A02 grey scale, loss of gloss or any distortion, softening or other physical deterioration. In addition, the change in reflectivity must not be more than 15% of the value specified in Clause 3.2.3 of this specification.

3.2.6 UV (non-ceramic markers only)

A sample of five markers shall be tested in accordance with AS 1906.3:1992, Clause 3.5.3.

The tested markers shall show no greater deterioration in physical condition, colour change or fade compared to that of an acceptable control marker that has also been subjected to the same test conditions. In addition, the change in reflectivity must not be more than 15% of the value specified in Clause 3.2.3 of this specification.

3.2.7 Compressive strength

Five samples are to be tested in accordance with AS1906.3:1992, Clause 3.5.5; the samples shall comply with the compressive strength and deformation values of this Clause. The compressive strength shall be not less than the value given in Table 1 for the corresponding deformation at failure.
Table 1: Variation of Allowable Minimum Compressive Strength with Deformation at Failure (source AS 1906.3 : 1992, Table 3.5)

<table>
<thead>
<tr>
<th>Deformation at Failure (mm)</th>
<th>Allowable Minimum Compressive Strength (kN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>7</td>
</tr>
<tr>
<td>&lt;3 ≥1</td>
<td>6</td>
</tr>
<tr>
<td>≥3*</td>
<td>5</td>
</tr>
</tbody>
</table>

* If failure has not occurred at 5 mm deformation, the load at 5 mm deformation shall be taken as the compressive strength

3.2.8 Glaze thickness (ceramic markers only)

The glaze thickness of a sample of five ceramic markers shall be measured in accordance with AS 1906.3 : 1992, Clause 3.5.6 and Appendix I. For any one marker, the glaze on the top surface of the ceramic markers shall have a thickness of not less than 0.075 mm.

3.2.9 Hardness (ceramic markers only)

A sample of five ceramic markers shall be tested for hardness in accordance with Mohs’ Scale of Hardness. The top surface of any one marker shall have a scratch hardness of not less than 6 on this scale.

4. REQUIREMENTS OF RETROREFLECTIVE MARKERS

4.1 Field Trial

A sample of 50 markers shall be field conditioned in accordance with AS 1906.3 : 1992 Appendix B.

After 12 months the retroreflectivity, as measured by the Coefficient of Luminous Intensity (CIL) values, of a randomly selected sample of 30 markers shall be determined in accordance with AS 1906.3 : 1992, Appendix A. The terminal CIL values shall be not less than those specified in Table 2. The terminal CIL value is defined in AS 1906.3 : 1992, Clause 1.4.10, as the average CIL value obtained from the best performing 80% of the 30 randomly selected field-trialed markers.
Table 2: Minimum Retroreflectivity (CIL) Values for Retroreflective Markers After Field Conditioning
(source AS 1906.3 : 1992, Table 2.1)

<table>
<thead>
<tr>
<th>Entrance Angle $\beta$ (deg)</th>
<th>Observation Angle $\alpha$ (deg)</th>
<th>Minimum CIL Values (mcd/lux)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.2</td>
<td>5.0  3.0  1.5</td>
</tr>
<tr>
<td>20</td>
<td>0.2</td>
<td>2.2  1.3  0.7</td>
</tr>
<tr>
<td>0</td>
<td>1.0</td>
<td>2.0  1.2  0.6</td>
</tr>
</tbody>
</table>

4.1.1 Appearance

The exterior casing of the markers shall be smooth. The retroreflective element(s) of the markers shall be either on one side (mono-directional), or, on opposing sides (bi-directional) of the marker, as specified. The base of the marker which is not inset shall be generally flat, though this shall not preclude markers which have embossed bases or ribbed structures, or a single prong for insertion into a predrilled hole in the pavement.

The retroreflective component of the markers shall be white, red or yellow as specified. The colour of the marker casing shall comply with the P/14 specification.

The dimensions and shape shall be in accordance with AS 1906.3 : 1992, Clause 3.2

4.1.2 Colour

Colour compliance is by comparison with that of a control marker regarded as having an acceptable colour when viewed in simulated nighttime conditions.

The colour and viewing conditions shall comply with AS 1906.3 : 1992, Clause 3.4.1.

4.1.3 Reflective properties (retroreflectivity)

The primary retroreflectivity (CIL) requirement is compliance with Clause 4.1 (field trial) of this specification. However, a minimum “as-new” CIL value for a given brand and generic type of marker may be specified with evidence required that this value will ensure compliance with Clause 4.1, i.e. service equivalent to the 12 months field trial. This minimum value shall be as agreed by Transit and the supplier. AS 1906.3, Clause 3.3.1.3 is an example of the process required.

The requirements for the “as-new” CIL value of markers shall be as follows:
the CIL value of a sample of 30 new markers shall be determined in accordance with Appendix A of AS 1906.3 : 1992; and

• the CIL values of the tested markers shall exceed the minimum agreed value.

4.1.4 Water absorption

When a sample of five markers are tested in accordance with AS 1906.3 : 1992, Clause 3.5.1, the markers shall show no visible signs of water ingress. The change in reflective properties of any one marker shall not be more than 15% of the “as-new” CIL value for that marker type.

4.1.5 Heat test

A sample of five markers shall be tested in accordance with AS 1906.3 : 1992, Clause 3.5.2.

Each of the tested markers shall show no colour change greater than 4 on the ISO 105-A02 grey scale, loss of gloss or any distortion, softening or other physical deterioration.

The change in reflective properties of the tested markers shall not be more than 15% of the “as-new” CIL value for that marker type.

4.1.6 UV exposure test

A sample of five markers shall be tested in accordance with AS 1906.3 : 1992, Clause 3.5.3. The tested markers shall show no greater deterioration in physical condition, colour change or fade compared to that of an acceptable control marker that has also been subjected to the same test conditions.

5. MARKING AND PACKAGING

Marking and packaging shall be in accordance with AS 1906.3 : 1992, Section 4.0.

All markers (both Type A and B) shall be clearly identified with the brand and type of marker permanently identified on each marker.

6. APPROVAL

Results from the field and laboratory testing (as appropriate) together with a formal recommendation from an accredited testing agency (a recognised agency accepted by Transit) shall be forwarded to Transit, with a request for approval.

On acceptance of the results the generic type of marker will be included on the Transit Raised Pavement Markers Type Approval List, (Transit M/12 Notes).

The type approval may be withdrawn if there is any evidence of less than complete satisfactory in-service performance.