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Technical Specification

Transport and Main Roads Specification
MRTS219 Internally Illuminated Pavement Markers

July 2023

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1 Introduction

This Technical Specification defines the supply, installation, testing, commissioning, performance, documentation, training and maintenance requirements for Internally Illuminated Pavement Markers (IIPM).

The IIPM is a stand-alone self-contained device which consists of a Retro Reflective Pavement Marker (RRPM) fitted with Light Emitting Diodes (LEDs) incorporated into the reflector surface. The IIPM can either be Photovoltaic solar cell with battery, inductively powered or hardwired.

These devices shall either be unidirectional or bi-directional with the colours listed below.

Red, Yellow, White and Green IIPM are to be installed in compliance with Queensland *Manual of Uniform Traffic Control Devices* (Queensland MUTCD) Part 2.

This Technical Specification shall be read in conjunction with MRTS01 *Introduction to Technical Specification*, MRTS201 *General Equipment Requirements* and other Technical Specification as appropriate. This Technical Specification forms part of the Transport and Main Roads Specifications Manual.

1.1 Excluded from scope

There is no need for blue IIPM, as blue RRPM are only installed in the centre line of a road to mark an adjacent footpath fire hydrant point.

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2 Definition of terms

The definitions and terminology defined in MRTS201 *General Equipment Requirements* apply to this Specification. Additional terminology relevant under this Specification is defined in Table 2.

Table 2 – Definitions

Term	Definition
ACMA	Australian Communications and Media Authority
cd	Candela, SI basic unit for Luminous intensity with dimensions lumens per Steradian. One candela is the luminous intensity, in a given direction, of a source emitting monochromatic radiation of frequency 540 x 1012 hertz (yellow) and whose radiant intensity is 1/683 watts per Steradian.
CE	The CE mark is a mandatory conformity marking for certain products sold within the European Economic Area (EEA). It is also found on products sold outside the EEA that are manufactured in, or designed to be sold in, the EEA. CE marking is a self-certification scheme. Australia has an agreement on mutual recognition of conformity assessment with the European Union (EU).
Class A	Classification of photometric performance, defined in AS/NZ 1906.3
Colour temperature	The colour temperature of a light source is the temperature of an ideal black body radiator that radiates light of comparable hue to that of the light source. Colour temperature is conventionally stated in the unit of absolute temperature, the kelvin, having the unit symbol K.
IIPM	Internally Illuminated Pavement Marker

Term	Definition
Intensity half angle	The angle where half of the maximum Luminous Intensity is measured compared to the peak measurement when measured at square on (Normal) to the LED face
IPxx	Ingress Protection rating to degree "xx" as defined in AS 60529
LED	Light Emitting Diode
Luminance (L)	Physical quantity of light falling upon a surface corresponding to the brightness of a surface in a specific direction. The unit is Candelas per square meter (cd / m²)
Luminous Intensity	The perceived power per unit solid angle. The SI unit of luminous intensity is the candela (cd) for yellow, or the brightness of the LED in Lumens per Steradian for the emission colour of that LED.
MRTS	Transport and Main Roads Technical Specification
MUTCD	Queensland *Manual of Uniform Traffic Control Devices*
NATA	National Association of Testing Authorities
PV	Photo Voltaic (Solar cell)
RCM	Regulatory Compliance Mark (RCM) The compliance mark suitable for use to indicate compliance to any ACMA regulatory arrangement for suppliers registered on the national database.
RRPM	Retro-Reflective Pavement Marker

3 Reference documents

The requirements of the referenced documents listed in Table 3 of MRTS201 *General Equipment Requirements* and Table 3 below apply to this Technical Specification. Where there are inconsistencies between this Technical Specification and the referenced documents (including those referenced in MRTS201), the requirements specified in this Technical Specification shall take precedence.

Where a Technical Specification is quoted or implied, the latest version shall be applicable, including its amendments to date.

Table 3 – Referenced documents

Reference	Title
AS/NZS 1906.3	*Retroreflective Materials and Devices for Road Traffic Control Purposes* Part 3: *Raised Pavement Markers (Retroreflective and Non-retroreflective)*
AS/NZS 2633	*Guide to the Specification of Colours*
AS 4852.1	*Variable message signs* – Part 1: *Fixed Signs*
AS 60068.2.6	*Environmental testing* – Part 2.6 *Tests – Test Fc: Vibration (Sinusoidal)*
AS 60068.2.29	*Environmental testing* – Part 2.29 *Tests – Test Eb and guidance – Bump tests*
AS/NZS 60529	*Degrees of protection provided by enclosures (IP Code)*
MRTS01	*Introduction to Technical Specifications*
MRTS45	*Road Surface Delineation*
MRTS50	*Specific Quality System Requirements*

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Reference	Title
MRTS201	*General Equipment Requirements*
Queensland MUTCD	*Queensland Manual of Uniform Traffic Control Devices*
RPDM 2nd edition, Volume 3 Part 3	*Road Planning and Design Manual – Supplement to Austroads Guide to Road Design – Geometric Design*

4 Quality system requirements

4.1 Hold Points, Witness Points and Milestones

General requirements for Hold Points, Witness Points and Milestones are specified in Clause 5.2 of MRTS01 *Introduction to Technical Specifications*.

The Hold Points, Witness Points and Milestones applicable to this Technical Specification are summarised in Table 4.1.

There are no Witness Points or Milestones defined.

Table 4.1 – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point	Milestones
4.3	1. Samples for approval		
6.2	2. Physical testing for Type approval		
7	3. Flush mounted IIPM for bike ways		
7.1	4. Testing of RRPM performance		
9.1.1	5. Power supply – autonomy 36 hours		
9.1.2.1	6. Battery saving light output test		
11	7. Installation practices 8. Pavement intrusion		

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4.2 Guarantee and Warranty

The IIPM shall have a minimum guarantee period of three years from the date of installation.

This warranty shall cover all aspects of the manufacture and performance of the markers including electronic components. Upon proof of failure, replacement markers shall be supplied free of charge to the relevant contractor's designated premises.

IIPM shall have a design lifespan of at least five years.

4.3 Samples for Approval

Samples, including all associated installation items, shall be provided for approval by the Department of Transport and Main Roads. **Hold Point 1**

5 Functional requirements

The functional requirement is to provide retro-reflective and active marker functions installed in accordance with the Queensland MUTCD Part 2.

5.1 Function

The IIPM shall function continuously in normal operation in the conditions described below:

a) installed directly in sunlight

b) ambient external air temperature range between -10°C and 70°C, and

c) protected against extended periods of immersion under pressure, ingress protection of IP68.

The IIPM operation shall cause no adverse effect on the surrounding environment in which it is installed.

5.2 Failure Mode

The IIPM and/or associated system(s) shall automatically shut down in a safe manner upon power failure. Any failure of an IIPM shall not adversely affect the passive reflective properties of the unit (if applicable) which shall continue to comply with the requirements of AS/NZ 1906.3 as a Class A reflector. Any failed or damaged IIPM shall cause no adverse effect on the surrounding environment or pavement in which it is installed.

If the Installed IIPM is inductive or cable powered, then the failure of individual markers shall not have an adverse effect on the surrounding markers operation.

6 Physical requirements

The IIPM shall comply with all the physical requirements of AS/NZ 1906.3 *Retroreflective Materials and Devices for Road Traffic Control Purposes* Part 3: *Raised Pavement Markers (Retroreflective and Non-retroreflective)*. The markers must be constructed from durable materials to enable the installation and reliable operation when installed.

The IIPM shall have a rating of IP68.

6.1 Structural Requirements

The IIPM shall have a design, construction and method of installation that resists rotation of the facing away from its installed alignment.

Anti-theft features should be present on the design of the IIPM to avoid unauthorised removal. A minimum of two features shall be installed with a minimum of one being mechanical.

The structural requirements of IIPM used in bicycle pathways in any configuration shall be the same as the other IIPM for roadways with the exception of being flush mounted and shall comply with the requirements of Queensland MUTCD Part 9 *Bicycle Facilities* and be approved by the Department of Transport and Main Roads.

6.2 Physical testing for acceptance and type product approval

The approval of all IIPM makes and models is subject to passing the following tests in an approved NATA certified laboratory. **Hold Point 2**

6.2.1 Impact resistance and compression testing

The IIPM shall pass the Impact Resistance Test and Compressive strength Test as defined in AS/NZ 1906.3.

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6.2.1.1 Vibration testing

A test sample of 10 (IIPM) shall be subjected to vibration tests in accordance with AS 60068.2.6, for sinusoidal vibration.

For all tests specified in this clause, the displacement amplitude shall not exceed 0.75 mm up to the cross-over frequency (approximately 8.2 Hz). For higher frequencies, the acceleration shall be maintained constant at 0.2 g.

In vibration testing, *displacement amplitude* refers to the maximum displacement or distance travelled by a vibrating object from its equilibrium or rest position during a single vibration cycle. It is usually measured in units of millimetres or inches. *Acceleration amplitude* is a measure of the maximum acceleration experienced by a vibrating object during a single vibration cycle and is directly related to the forces that a vibrating object experiences. It is typically expressed in units of meters per second squared (m/s²) or gravitational units (g).

The tests shall be performed for three mutually perpendicular axes with the equipment in the normal (upright) orientation.

For each axis of the tests, an investigative sweep cycle shall be performed on the test specimen over the frequency range 5-55 Hz with an amplitude of up to 0.75 mm to identify critical frequencies at which:

a) equipment malfunction, deterioration of performance or both due to vibration are exhibited; and/or

b) mechanical resonances and other response effects, such as chatter, occur.

The frequencies and the applied amplitudes at which these effects occur shall be noted, together with the behaviour of the test specimen at each critical frequency.

The equipment shall be tested for 10 minutes at each of the critical frequencies identified, with vibration amplitude of 0.75 mm below the cross-over frequency, and 0.2 g acceleration above the cross-over frequency.

For each axis of the tests, the entire equipment shall be tested with an endurance of 20 sweep cycles over the frequency range 5-55 Hz with initial amplitude of 0.75 mm. The sweep rate shall be 1 octave per minute as defined in AS 60068.2.6.

The equipment shall be fully operational with all display elements energized and operate without malfunction during the tests.

6.2.1.2 Bump testing

The same 10 (IIPM) samples tested for vibration, shall be subjected to a bump test in accordance with (Test Eb) to AS 60068.2.29. The severity shall be 1000 ± 10 bumps at an acceleration of 98 m/s² (10 g) with a pulse duration of 16 ms.

The samples must all be fully operational at the conclusion of the bump test.

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6.3 Marking and packaging

Marking and packaging shall be in accordance with AS/NZ 1906.3.

All IIPM shall be clearly identified with the manufacturer's brand and type or model number of marker permanently labelled on the top of each marker.

Each maker shall also be marked with a production batch number which includes the year and month of manufacture. The batch number may be alpha numeric.

6.4 Colour

The markers body shall be a natural metallic or grey colour finish.

7 Optical requirements

The optical performance of flush mounted IIPM for bicycle pathways shall be approved by the Department of Transport and Main Roads. **Hold Point 3**

For all other IIPM the optical performance shall be as follows.

7.1 Testing of RRPM functionality

In addition to the physical tests outlined in Clause 6 above, all of the other tests required of AS/NZ 1906.3 shall be completed by a NATA certified laboratory. **Hold Point 4**

7.2 Reflector compliance to AS/NZ 1906.3

a) IIPM shall meet the requirements of AS/NZ 1906.3 and shall be Class A (as per AS/NZ 1906.3 definition) for both one-way retroreflective markers and two-way retroreflective; and the requirements of MRTS45 *Road Surface Delineation* Clause 6.2 on "Raised Retro-reflective Pavement Markers".

b) The retro-reflector colour shall conform to the requirements of AS/NZ 1906.3, and the embedded LEDs shall be of the same colour.

c) The surface area of retro-reflectivity for any IIPM shall not be less than that specified in AS/NZ 1906.3 for Red, White, Yellow and Green RRPM. If IIPM are designed for specialised switching applications, reflectors shall not be retroreflective.

7.3 Reflector Colours

Single sided (unidirectional) IIPM shall be available in Red, Yellow, White and Green colours, as per AS/NZ 1906.3.

Double sided (bi-directional) IIPM shall be available in the following reflector colour options with matching LED colours:

a) Both panels to be Yellow.

b) Both panels to be White.

c) Both panels to be Green.

The performance value shall be equivalent to Class A from AS/NZ 1906.3.

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7.4 LED Requirements

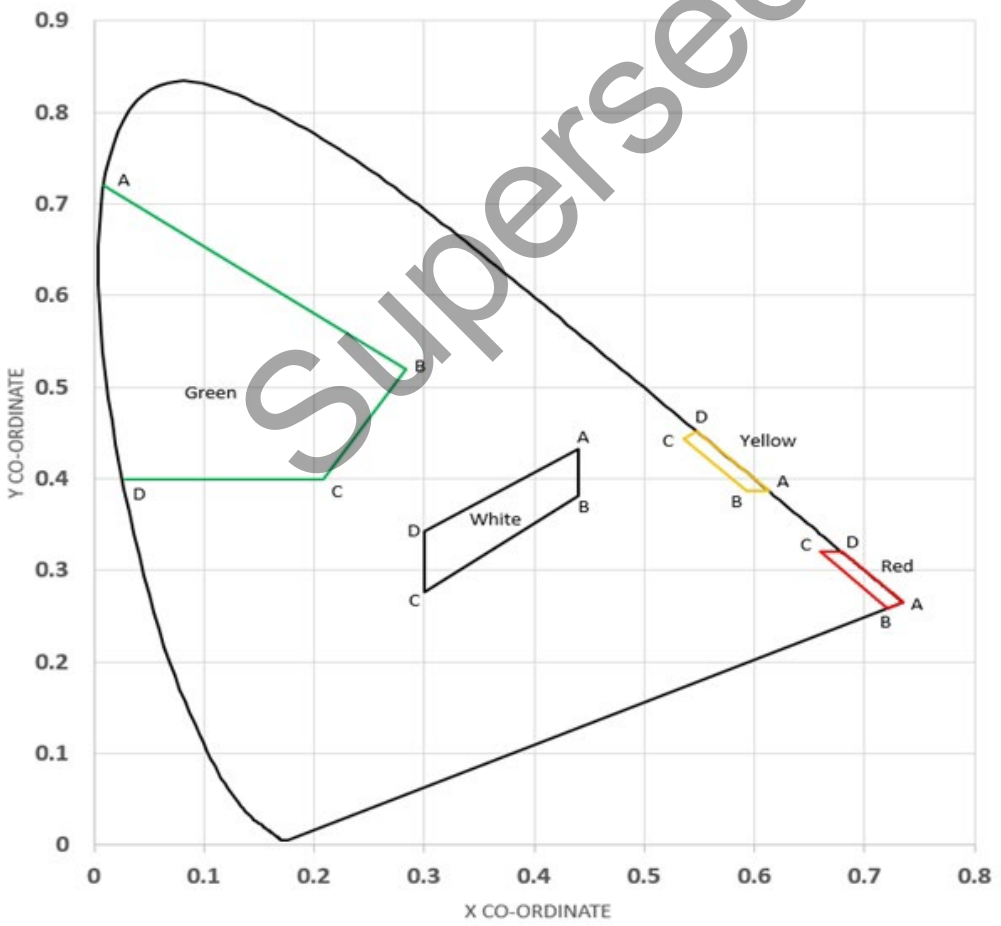
7.4.1 LED Colours

The LED's located within the IIPM shall be tested and comply to one of the colours listed in Table 7.4.1 (and illustrated in Figure 7.4.1) below and shall lie within the associated regions specified by the chromaticity coordinates.

Table 7.4.1 – LED colour designation and CIE chromaticity coordinates (x, y)

Colour		A	B	C	D
Red	x y	0.735 0.265	0.721 0.259	0.660 0.320	0.680 0.320
Yellow	x y	0.613 0.387	0.597 0.387	0.536 0.424	0.547 0.439
Green	x y	0.009 0.720	0.284 0.520	0.209 0.400	0.028 0.400
White	x y	0.440 0.432	0.440 0.382	0.300 0.276	0.300 0.342

Figure 7.4.1 – Chromaticity limits for IIPM LED's



Note that the above co-ordinates have been derived from AS/NZS 1906.3 *Retroreflective Materials and Devices for Road Traffic Control Purposes* Part 3: *Raised Pavement Markers (Retroreflective and Non-retroreflective)* and AS 4852.1 *Variable message signs* – Part 1: *Fixed Signs*.

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The White retroreflectors which will comply with AS/NZ 1906.3 shall be fitted with white LEDs which will preferably have a white colour spectral output in the range of 4000° to 8000° Kelvin, consistent with White as defined by the above Table 7.4.1 and Figure 7.4.1. The White LED shall not appear to be Yellow or Red but may have a hue towards the blue spectrum. For further information refer to AS/NZS 2633 *Guide to the Specification of Colours*.

7.4.2 Luminous Intensity minimum sight distance

a) The LEDs shall neither flash nor flicker to the human eye, producing a constant luminous intensity output at a frequency of 100 Hz or higher.

b) The elevation angle of the LEDs must be such that the luminous intensity of the LEDs as seen by the driver should be more than the reflectors luminous intensity when they come into the car's headlights. This will be checked as a part of the field acceptance assessment with manual illumination.

c) To ensure the driver awareness of bends in the road, where line-of-sight permits the IIPM shall be visible to the driver's eye at a minimum stopping sight distance (for trucks, on level grade) in accordance with the *Road Planning and Design Manual* 2nd edition, Volume 3 – *Supplement to Austroads Guide to Road Design* Part 3 – *Geometric Design*.

d) The minimum intensity shall be 2.5 cd per LED with a minimum of 2 LEDs per reflector face. The number of LEDs must not reduce the area of retro reflectivity.

7.4.3 LED luminous intensity half angle specification

The LEDs installed shall be manufactured with the luminance intensity half angle (°) for each LED in the range of 15° to 25°.

8 Operational requirements

The marker shall not be used in a flashing mode.

8.1 Trigger ON and switch OFF points

a) The marker LEDs shall switch ON when the ambient light illumination drops below 300 lux ± 25% for at least 30 seconds. This delay is to prevent nuisance activation by vehicles shadows.

b) The marker LEDs shall switch OFF when the ambient light illumination exceeds 200 lux ± 25% for at least 30 seconds. This delay is to prevent nuisance deactivation by oncoming headlights.

c) Deactivated LEDs shall have no voltage applied to their terminals.

d) If IIPM are not equipped with ON / OFF delays, the proposed installation needs to be investigated for suitability. Consideration needs to be made for approaching vehicles to ensure illumination is maintained.

9 Solar type IIPM

9.1 Power Supply – Solar type IIPM

The IIPM battery or capacitor shall be charged by an integral solar photovoltaic power system.

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9.1.1 Battery operation and autonomy

a) IIPM shall be powered by a battery or capacitor with a built-in PV solar panel to charge the battery or capacitor.

b) The IIPM shall be able to run continuously for a minimum of 36 hours without being recharged. That test period is equal to three consecutive nights of operation without a recharge.
The LED intensity shall not drop below 70% of 2.5cd after the 36 hours test period.

c) During battery operation the depth of discharge cannot be exceeded as to cause permanent damage.

Hold Point 5

9.1.2 Power Consumption

a) For each individual LED, no peak magnitude can exceed 70% of the LED manufacturer's maximum continuous rating.

b) All electrical and electro-optical components shall be appropriately de-rated and have a minimum lifespan of five years when operating within the operational requirements specified in this Technical Specification.

9.1.2.1 Battery saving function (Option)

The manufacturer may supply an IIPM which features a battery saving function. Any battery saving function shall not degrade the above optical performance without the written approval of the Department of Transport and Main Roads Principal. **Hold Point 6** When activated by the ambient light the LEDs may be switched at 100 Hz or faster.

During the no light or space period the LEDs shall still have a lower forward bias voltage applied, across its junction.

The LEDs shall neither flash nor flicker to the human eye, producing a constant luminous intensity output at a frequency of 100 Hz or higher.

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10 Externally powered type IIPM

10.1 Operational requirements

System activation shall either be by manual i.e., pushbutton, or automatic i.e. sensor input, activation.

Passive system shall be used where no individual IIPM control is required.

Intelligent systems shall be used where individual or group of IIPMs are to be controlled. The intelligent IIPM shall communicate with the power supply using protocol multiplexed over the inductive cable loop or hardwired cable. The IIPM shall be set to a timer allowing on / off operation of dusk and dawn for each day, over-rides should be considered for abnormal light days including fog, overcast days and eclipses etc. Intelligent IIPM's shall be able to provide dimming functionality of the LEDs.

At the request of the Principal some externally powered IIPM's may be required to be permanently illuminated if specified.

10.2 Power Supply – Externally powered type IIPM

10.2.1 Power Transfer

a) Power to the IIPM may be through induction, requiring no direct electrical connection between the main supply cable and the IIPM.

b) A high frequency generator (12V – 48V) which is RCM certified (complying with susceptibility and immunity parameters for electromagnetic compatibility) shall provide the inductive power supply to the IIPM. The generator shall be located in the control cabinet.

c) A node shall be installed into the pavement beneath each installed IIPM. This node shall inductively couple power to the installed marker.

d) Two core power cable (halogen free and non-flammable) shall be installed in the pavement (cut in) running between the control cabinet (inductive power supply) and the last IIPM (end of run).

e) Power to the IIPM may be directly hardwired, requiring a power supply cable connected to each marker and the main power supply, power losses from the length of cable must be taken into account.

f) Power supplied in this fashion must be 12V with suitable protective devices installed.

10.2.2 Power Consumption

a) Each individual LED must be driven with no peak magnitudes exceeding 70% of the LED manufacturer's maximum continuous rating.

b) All electrical and electro-optical components shall be appropriately de-rated and have a minimum lifespan of five years when operating within the operational requirements specified in this Specification.

11 Installation requirements

The placement for these units shall be consistent with practices for placement of Retro-Reflector Pavement Markers as per Queensland MUTCD Part 2.

With the principal's agreement, these IIPM may be used in place of RRPM in the application listed in Clause 4.6.7 of Queensland MUTCD Part 13.

The IIPM may be installed on roads subject to fog as a substitute for normal RRPMs, in the same location as normal RRPMs would be used.

Installation method shall be as per the manufacturer's instructions which shall have approval of the Department of Transport and Main Roads. **Hold Point 7**

The IIPM shall not be recessed into the pavement by more than 60 mm. **Hold Point 8**

Where multiple markers of the same colour are to be installed at a given location, all units shall be of the same make and model number.

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11.1 Recommended installed visible sight distance

To establish driver awareness of the approaching traffic hazard: Where line-of-sight permits and when measured on a clear night at mid-night, with no moon and no man-made light, and with the viewer square on (normal) to the IIPM unit, the first IIPM should be visible at a distance of at least 250 m with an eye height 1.10 m.

12 Testing and commissioning

The testing and commissioning requirements defined in MRTS201 *General Equipment Requirements* apply to this Technical Specification.

13 Documentation

The documentation requirements defined in MRTS201 *General Equipment Requirements* apply to this Technical Specification.

14 Training

The training requirements defined in MRTS201 *General Equipment Requirements* apply to this Technical Specification.

15 Maintenance

The maintenance requirements defined in MRTS201 *General Equipment Requirements* apply to this Technical Specification.

16 Handover

The handover requirements defined in MRTS201 *General Equipment Requirements* apply to this Technical Specification.

17 Product approval checklist

The checklist for the product approval evaluation is published as Appendix A to this Technical Specification.

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Appendix A – Product Approval Compliance Checklist

Type Approval Compliance Checklist Row	MRTS219 Internally Illuminated Pavement Markers	Reference Clause	VERIFICATION METHOD					
			Visual Inspection	NATA Certification	Field OR Bench Test	Detailed Drawings	Other records (Datasheets, internal testing, RPEQ)	Compliance (Y, TBC, N, N/A)
4 Quality system requirements								
1	The IIPM shall have a minimum guarantee period of three years from the date of installation.	4					**X**	
2	This warranty shall cover all aspects of the manufacture and performance of the markers including electronic components.	4					**X**	
3	Upon proof of failure, replacement markers shall be supplied free of charge to the relevant contractor's designated premises.	4					**X**	
4	IIPM shall have a design lifespan of at least five years.	4					**X**	
5	Samples, including all associated installation items, shall be provided for approval by the Department of Transport and Main Roads.	4.3	**X**					
5 Functional requirements								
6	The functional requirement is to provide retro-reflective and active marker functions installed in accordance with the Queensland MUTCD Part 2.	5					**X**	
7	The IIPM shall function continuously in normal operation in the conditions described below: a) installed directly in sunlight b) ambient external air temperature range between -10°C and 70°C, and c) c) protected against long periods of immersion under pressure, ingress protection of IP68.	5.1			**X**	**X**		
8	The IIPM operation shall cause no adverse effect on the surrounding environment in which it is installed.	5.1			**X**		**X**	
9	The IIPM and/or associated system(s) shall automatically shut down in a safe manner upon power failure.	5.2			**X**		**X**	
10	Any failure of an IIPM shall not adversely affect the passive reflective properties of the unit (if applicable) which shall continue to comply with the requirements of AS/NZ 1906.3 as a Class A reflector.	5.2					**X**	
11	Any failed or damaged IIPM shall cause no adverse effect on the surrounding environment or pavement in which it is installed.	5.2			**X**		**X**	

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Type Approval Compliance Checklist Row	MRTS219 Internally Illuminated Pavement Markers	Reference Clause	VERIFICATION METHOD					
			Visual Inspection	NATA Certification	Field OR Bench Test	Detailed Drawings	Other records (Datasheets, internal testing, RPEQ)	Compliance (Y, TBC, N, N/A)
12	If the Installed IIPM is inductive or cable powered, then the failure of individual markers shall not have an adverse effect on the surrounding markers operation.	5.2			**X**		**X**	
6 Physical requirements								
13	The IIPM shall comply with all the physical requirements of AS/NZ 1906.3 *Retro-Reflective Materials* and *Devices for Road Traffic Control Purposes* – Part 3: *Raised Pavement Markers*.	6					**X**	
14	The markers must be constructed from durable materials to enable the installation and reliable operation when installed.	6					**X**	
15	The IIPM shall have a rating of IP68.	6		**X**				
16	The IIPM shall have a design, construction and method of installation that resists rotation of the facing away from its installed alignment.	6.1			**X**		**X**	
17	Anti-theft features should be present on the design of the IIPM to avoid unauthorised removal.	6.1					**X**	
18	A minimum of two features shall be installed with a minimum of one being mechanical.	6.1					**X**	
19	The structural requirements of IIPM used in bicycle pathways in any configuration shall be the same as the other IIPM for roadways with the exception of being flush mounted and shall comply with the requirements of Queensland MUTCD Part 9 *Bicycle Facilities* and be approved by the Department of Transport and Main Roads.	6.1				**X**	**X**	
20	The approval of all IIPM makes and models is subject to passing the following tests in an approved NATA certified laboratory.	6.2						
21	The IIPM shall pass the Impact Resistance Test and compressive strength test as defined in AS/NZ 1906.3.	6.2.1		**X**				
22	A test sample of 10 (IIPM) shall be subjected to vibration tests in accordance with AS 60068.2.6, for sinusoidal vibration.	6.2.1.1		**X**				
23	For all tests specified in this clause, the displacement amplitude shall not exceed 0.75 mm up to the cross-over frequency (approximately 8.2 Hz).	6.2.1.1		**X**				
24	For higher frequencies, the acceleration shall be maintained constant at 0.2 g.	6.2.1.1		**X**				

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Type Approval Compliance Checklist Row	MRTS219 Internally Illuminated Pavement Markers	Reference Clause	VERIFICATION METHOD					
			Visual Inspection	NATA Certification	Field OR Bench Test	Detailed Drawings	Other records (Datasheets, internal testing, RPEQ)	Compliance (Y, TBC, N, N/A)
25	The tests shall be performed for three mutually perpendicular axes with the equipment in the normal (upright) orientation.	6.2.1.1		X				
26	For each axis of the tests, an investigative sweep cycle shall be performed on the test specimen over the frequency range 5-55 Hz with an amplitude of up to 0.75 mm to identify critical frequencies at which: a) equipment malfunction, deterioration of performance or both due to vibration are exhibited; and/or b) mechanical resonances and other response effects, such as chatter, occur.	6.2.1.1		X				
27	The frequencies and the applied amplitudes at which these effects occur shall be noted, together with the behaviour of the test specimen at each critical frequency.	6.2.1.1		X				
28	The equipment shall be tested for 10 minutes at each of the critical frequencies identified, with vibration amplitude of 0.75 mm below the cross-over frequency, and 0.2 g acceleration above the cross-over frequency.	6.2.1.1		X				
29	For each axis of the tests, the entire equipment shall be tested with an endurance of 20 sweep cycles over the frequency range 5-55 Hz with initial amplitude of 0.75 mm.	6.2.1.1		X				
30	The sweep rate shall be 1 octave per minute as defined in AS 60068.2.6.	6.2.1.1		X				
31	The equipment shall be fully operational with all display elements energized and operate without malfunction during the tests.	6.2.1.1		X				
32	The same 10 (IIPM) samples tested for vibration, shall be subjected to a bump test in accordance with (Test Eb) to AS 60068.2.29.	6.2.1.2		X				
33	The severity shall be 1000 ± 10 bumps at an acceleration of 98m/s² (10 g) with a pulse duration of 16 ms.	6.2.1.2		X				
34	The samples must all be fully operational at the conclusion of the bump test.	6.2.1.2		X				
35	Marking and packaging shall be in accordance with AS/NZ 1906.3.	6.3				X	X	

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			Visual Inspection	NATA Certification	Field OR Bench Test	Detailed Drawings	Other records (Datasheets, internal testing, RPEQ)	Compliance (Y, TBC, N, N/A)
36	All IIPM shall be clearly identified with the manufacturer's brand and type, or model number of marker permanently labelled on the top of each marker.	6.3					X	
37	Each maker shall also be marked with a production batch number which includes the year and month of manufacture.	6.3					X	
38	The batch number may be alpha numeric.	6.3				X	X	
39	The markers body shall be a natural metallic or grey colour finish.	6.4				X	X	
7 Optical requirements								
40	The optical performance of flush mounted IIPM for bicycle pathways shall be approved by the Department of Transport and Main Roads.	7						
41	For all other IIPM the optical performance shall be as follows.	7						
42	In addition to the physical tests outlined in Clause 6 above, all of the other tests required of AS/NZ 1906.3 shall be completed by a NATA certified laboratory.	7.1		X				
43	a) IIPM shall meet the requirements of AS/NZ 1906.3 and shall be Class A (as per AS/NZ 1906.3 definition) for both one-way retroreflective markers and two-way retroreflective, and the requirements of MRTS45 *Road Surface Delineation* Clause 6.2 on "Raised Retro-reflective Pavement Markers".	7.2					X	
44	b) The retro-reflector colour shall conform to the requirements of AS/NZ 1906.3, and the embedded LEDs shall be of the same colour.	7.2		X				
45	c) The surface area of retro-reflectivity for any IIPM shall not be less than that specified in AS/NZ 1906.3 for Red, White, Yellow and Green RRPM.	7.2		X				
46	If IIPM are designed for specialised switching applications, reflectors shall not be retroreflective.	7.2					X	
47	Single sided (unidirectional) IIPM shall be available in these colours Red, Yellow, White and Green as per AS/NZ 1906.3.	7.3		X				

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48	Double sided (bi-directional) IIPM shall be available in the following reflector colour options with matching LED colours: a) Both panels to be Yellow. b) Both panels to be White. c) Both panels to be Green.	7.3		**X**			**X**	
49	The performance value shall be equivalent to Class A from AS/NZ 1906.3.	7.3		**X**				
50	The LEDs located within the IIPM shall be tested and comply to one of the colours listed in Table 7.4.1 (and illustrated in Figure 7.4.1) and shall lie within the associated regions specified by the chromaticity coordinates which have been derived from AS/NZS 1906.3 *Retroreflective Materials and Devices for Road Traffic Control Purposes* Part 3: *Raised Pavement Markers (Retroreflective and Non-retroreflective)* AS 4852.1 *Variable message signs* – Part 1: *Fixed Signs*.	7.4.1		**X**				
51	The White retroreflectors which will comply with AS/NZ 1906.3 shall be fitted with white LEDs which will preferably have a white colour spectral output in the range of 4000° to 8000° Kelvin, consistent with White as defined by the above Table 7.4.1 and Figure 7.4.1.	7.4.1		**X**				
52	The White LED shall not appear to be Yellow or Red but may have a hue towards the blue spectrum.	7.4.1		**X**				
53	For further information refer to AS/NZS 2633 *Guide to the Specification of Colours*.	7.4.1					**X**	
54	a) The LEDs shall neither flash nor flicker to the human eye, producing a constant luminous intensity output at a frequency of 100 Hz or higher.	7.4.2		**X**			**X**	
55	b) The elevation angle of the LEDs must be such that the luminous intensity of the LEDs as seen by the driver should be more than the reflectors luminous intensity when they come into the car's headlights. This will be checked as a part of the field acceptance assessment with manual illumination.	7.4.2		**X**			**X**	

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56	c) To ensure the driver awareness of bends in the road, where line-of-sight permits, the IIPM shall be visible to the driver's eye at a minimum stopping sight distance (for trucks, on level grade) in accordance with the *Road Planning and Design Manual 2nd edition,* Volume 3 – *Supplement to Austroads Guide to Road Design* Part 3 *Geometric Design*.	7.4.2		**X**				
57	d) The minimum intensity shall be 2.5 cd per LED with a minimum of 2 LEDs per reflector face.	7.4.2		**X**				
58	The number of LEDs must not reduce the area of retro reflectivity.	7.4.2		**X**				
59	The LEDs installed shall be manufactured with the luminance intensity half angle (°) for each LED in the range of 15° to 25°.	7.4.3		**X**				
8 Operational requirements								
60	The marker shall not be used in a flashing mode.	8					**X**	
61	a) The marker LEDs shall switch ON when the ambient light illumination drops below 300 lux ± 25% for at least 30 seconds. This delay is to prevent nuisance activation by vehicles shadows.	8.1					**X**	
62	b) The marker LEDs shall switch OFF when the ambient light illumination exceeds 200 lux ± 25% for at least 30 seconds. This delay is to prevent nuisance deactivation by oncoming headlights.	8.1					**X**	
63	c) Deactivated LEDs shall have no voltage applied to their terminals.	8.1					**X**	
64	d) If IIPM are not equipped with ON / OFF delays, the proposed installation needs to be investigated for suitability.	8.1					**X**	
65	Consideration needs to be made for approaching vehicles to ensure illumination is maintained.	8.1					**X**	
9 Solar Type IIPM								
66	The IIPM battery or capacitor shall be charged by an integral solar photovoltaic power system.	9.1					**X**	
67	a) IIPM shall be powered by a battery or capacitor with a built-in PV solar panel to charge the battery or capacitor.	9.1.1					**X**	

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68	b) The IIPM shall be able to run continuously for a minimum of 36 hours without being recharged. That test period is equal to three consecutive nights of operation without a recharge. The LED intensity shall not drop below 70% of 2.5 cd after the 36 hours test period.	9.1.1			X		X	
69	c) During battery operation the depth of discharge cannot be exceeded as to cause permanent damage.	9.1.1			X		X	
70	a) For each individual LED, no peak magnitude can exceed 70% of the LED manufacturer's maximum continuous rating.	9.1.2			X		X	
71	b) All electrical and electro-optical components shall be appropriately de-rated and have a minimum lifespan of five years when operating within the operational requirements specified in this Technical Specification.	9.1.2					X	
72	The manufacturer may supply an IIPM which features a battery saving function.	9.1.2.1			X		X	
73	Any battery saving function shall not degrade the above optical performance without the written approval of the Department of Transport and Main Roads Principal.	9.1.2.1					X	
74	When activated by the ambient light the LEDs may be switched at 100 Hz or faster.	9.1.2.1					X	
75	During the no light or space period the LEDs shall still have a lower forward bias voltage applied, across its junction.	9.1.2.1					X	
76	The LEDs shall neither flash nor flicker to the human eye, producing a constant luminous intensity output at a frequency of 100 Hz or higher.	9.1.2.1					X	
10 Externally powered type IIPM								
77	System activation shall either be by manual i.e., pushbutton, or automatic i.e., sensor input, activation.	10.1			X		X	
78	Passive system shall be used where no individual IIPM control is required.	10.1					X	
79	Intelligent systems shall be used where individual or group of IIPMs are to be controlled.	10.1					X	
80	The intelligent IIPM shall communicate with the power supply using protocol multiplexed over the inductive cable loop or hardwired cable.	10.1					X	

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81	The IIPM shall be set to a timer allowing on / off operation of dusk and dawn for each day, over-rides should be considered for abnormal light days including fog, overcast days and eclipses etc.	10.1					X	
82	Intelligent IIPM's shall be able to provide dimming functionality of the LEDs.	10.1					X	
83	At the request of the Principal some externally powered IIPM's may be required to be permanently illuminated if specified.	10.1					X	
84	a) Power to the IIPM may be through induction, requiring no direct electrical connection between the main supply cable and the IIPM.	10.2.1					X	
85	b) A high frequency generator (12V – 48V) which is RCM certified (complying with susceptibility and immunity parameters for electromagnetic compatibility) shall provide the inductive power supply to the IIPM.	10.2.1					X	
86	The generator shall be located in the control cabinet.	10.2.1					X	
87	c) A node shall be installed into the pavement beneath each installed IIPM.	10.2.1					X	
88	This node shall inductively couple power to the installed marker.	10.2.1					X	
89	d) Two core power cable (halogen free and non-flammable) shall be installed in the pavement (cut in) running between the control cabinet (inductive power supply) and the last IIPM (end of run).	10.2.1					X	
90	e) Power to the IIPM may be directly hardwired, requiring a power supply cable connected to each marker and the main power supply, power losses from the length of cable must be taken into account.	10.2.1					X	
91	f) Power supplied in this fashion must be 12V with suitable protective devices installed.	10.2.1					X	
92	a) Each individual LED must be driven with no peak magnitudes exceeding 70% of the LED manufacturer's maximum continuous rating.	10.2.2					X	
93	b) All electrical and electro-optical components shall be appropriately de-rated and have a minimum lifespan of five years when operating within the operational requirements specified in this Specification.	10.2.2					X	

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11 Installation requirements								
94	The placement for these units shall be consistent with practices for placement of Retro-Reflector Pavement Markers as per Queensland MUTCD Part 2.	11						
95	With the principal's agreement, these IIPM may be used in place of RRPM in the application listed in Clause 4.6.7 of Queensland MUTCD Part 13.	11						
96	The IIPM may be installed on roads subject to fog as a substitute for normal RRPMs, in the same location as normal RRPMs would be used.	11						
97	Installation method shall be as per the manufacturer's instructions which shall have approval of the Department of Transport and Main Roads.	11						
98	The IIPM shall not be recessed into the pavement by more than 60 mm.	11						
99	Where multiple markers of the same colour are to be installed at a given location, all units shall be of the same make and model number.	11						
100	To establish driver awareness of the approaching traffic hazard: Where line-of-sight permits and when measured on a clear night at mid-night, with no moon and no man-made light, and with the viewer square on (normal) to the IIPM unit, the first IIPM should be visible at a distance of at least 250 m with an eye height 1.10 m.	11.1						

Superseded

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