

NZTA M29:2023 SPECIFICATION FOR THE DESIGN, MANUFACTURE, INSTALLATION AND MAINTENANCE OF INTERNALLY ILLUMINATED PAVEMENT MARKERS

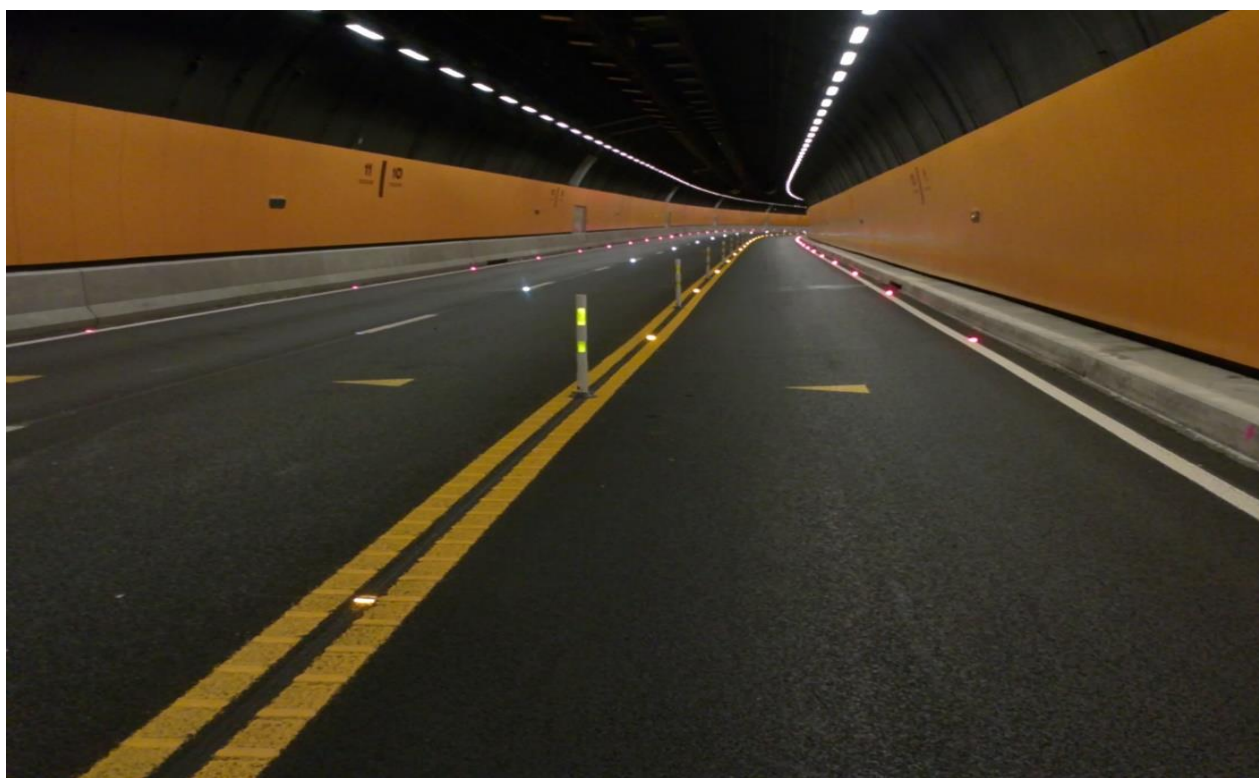
Incorporating

NZTA M29 Notes to the specification and

Introducing Section 14 *Specification for the Installation of IIPMs*

March 2023

VERSION 2.0



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Waka Kotahi

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If you have further queries, call our contact centre on 0800 699 000 or write to us:

Waka Kotahi
Private Bag 6995
Wellington 6141

This document is available on the Waka Kotahi website at www.nzta.govt.nz

This Specification will be updated periodically to incorporate advances in technology and changes within the industry. The Waka Kotahi website should be checked to confirm the most recent edition of the specification.

DOCUMENT INFORMATION	
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Document Author(s)	Julian Chisnall (Waka Kotahi)
	Grant Bosma (Waka Kotahi)
	Alan Parker ALANRO Consultants
Document Owner	Julian Chisnall

RECORD OF AMENDMENTS			
Edition Number	Subject	Effective Date	Updated by
1	NZTA M29:2013 <i>Specification for Internally Illuminated Pavement Markers</i> -and- NZTA M29:2018 <i>Notes for internally illuminated pavement markers</i>	May 2013 July 2018	
2	Introduction of NZTA M29:2023 <i>Specification for the design, manufacture, installation and maintenance of Internally Illuminated Pavement Markers</i> - NZTA M29:2023 <i>Test templates for IIPMs</i> NZTA M29:2023 <i>Listing of accepted IIPMs</i> Withdrawal: M29:2018 <i>Notes for internally illuminated pavement markers</i>	March 2023	Julian Chisnall

1 FOREWORD

The Specification is prepared by Waka Kotahi NZ Transport Agency¹ in order to introduce new technologies, terminologies and test methodologies relevant to a fast progressing technology.

It is based on advice from internally illuminated pavement marker (IIPM) manufacturers, overseas practice, and consultation with interested parties in New Zealand. Because internally illuminated pavement markers are a developing science the requirements listed will periodically be updated as technology improves and experience grows.

The objective for this revised M29 *Specification for internally illuminated pavement markers* is to provide more up to date guidance for manufacturers or suppliers wishing to supply IIPMs in New Zealand.

The description, definitions and classification of all marker types used in this specification standardise on terms that better differentiate between products and technologies that are common when specifying active or passive markers and to introduce terminologies that exist internationally.

The main changes to the Standard that are being incorporated into this Specification include:

- New reference code system
- Inclusion of Chromaticity corners of the colour regions for LEDs
- Improved detail of testing to be undertaken

1.1.1 Land Transport Rule Approval

Manufacturers or suppliers must be aware of the need to seek approval from Waka Kotahi for any new system concept that is to be promoted for installation prior to any installation being undertaken. For example IIPMs have been approved for use at pedestrian crossing points only after this use has been approved and included in the Land Transport Rule, Traffic Control Devices 2004.

IIPMs must be both tested to confirm compliance at a Waka Kotahi approved testing laboratory and the objective for the installation must also be confirmed by the Land Transport Rule.

2 SCOPE

This document confirms the specifications for Internally Illuminated Pavement Markers (IIPMs) that a Manufacturer and/or Supplier must comply with before being awarded *Provisional Acceptance* and *Type Acceptance* by Waka Kotahi, to authorise their use on the New Zealand roading network.

Internally Illuminated Pavement Markers are sometimes referred to as 'active' markers to differentiate them from retroreflective raised pavement markers (RRPMs) or 'passive' markers. IIPMs bonded directly to, or set into the road surface, are designed to emit light towards an approaching motor vehicle in order to warn, guide or inform road users of specific circumstances or situations ahead.

This revision of M29 differentiates between IIPMs designed to be installed into or onto the trafficked road versus IIPMs that will be referred to as being non-trafficked. The non-trafficked IIPMs will include those solely for use on raised kerbing and markers that may, as has been used internationally, be installed on tunnel walls to indicate emergency exits or safety zones.

Also not specifically covered in this specification is the controller and system design details required to drive an IIPM installation. The specifier is advised to ensure that individual contract documents cover this operational requirement and that the IIPMs being selected will communicate as expected.

¹ Hereafter referred to as Waka Kotahi

3 RELATED DOCUMENTS

Land Transport Rule	Traffic Control Devices 2004, Rule 54002 https://www.nzta.govt.nz/resources/rules/traffic-control-devices-2004/
AS/NZS 1906.3	Part 3: <i>Raised pavement markers (retroreflective and non-retroreflective)</i>
AS 1906.1	Part 1: <i>Retroreflective sheeting</i>
AS 2144	Traffic signal lanterns
NZTA M12:	<i>Specification for raised pavement markers</i> (includes Installation) https://www.nzta.govt.nz/resources/raised-pvmt-markers/
AS 60529:	<i>Degree of protection provided by enclosures</i> (IP Code)
TCD Manual:	Traffic Control Devices Manual – <i>Traffic control devices for general use – Part 4 at intersections</i> and – <i>Part 5 between intersections</i> https://www.nzta.govt.nz/resources/traffic-control-devices-manual/
NZTA M29	Listing of accepted IIPMs and approved layouts
NZTA M29	Certificate and worksheet templates for IIPMs
NZTA SM032	Network Outcomes Contract Volume 4: Maintenance Specifications, System Management V3.1. SM032 Network outcomes contract 2019, Volume 4: Maintenance specification, v3.1 - 3 March 2020 (nzta.govt.nz)
Traffic Note 10	Trials of traffic control devices https://www.nzta.govt.nz/assets/resources/traffic-notes/docs/traffic-note-10-rev3.pdf

4 DEFINITIONS

(a) Chromaticity:

A term referring to colour quality expressed numerically. Chromaticity co-ordinates; two numbers that set a point onto a graph, for such points create the area that a specified colour must fall within.

(b) Goniometer:

Used in a testing laboratory it is the instrument that an active or passive pavement marker is mounted on that will provide rotation about two axes, vertical and horizontal. This sets the marker on the required angles shown in Table 4

(c) LEDs:

Light emitting diodes – a semiconductor light source that emits light when current flows through it.

(d) LED Face:

A term used to describe the performance of the IIPM when positioned for testing indicating that the test is for the performance output of the active element of the IIPM.

(e) Luminance (L)

Luminance is a photometric measure of the luminous intensity per unit area of light travelling in a given direction. The SI (System International) for luminance is candela per square meter (cd/m²). The measurement of luminance is taken from a specific distance that captures the net effect of the combined performance of all LEDs within an APM

(f) Luminous intensity

This is the quantity of visible light that is emitted in unit time per unit solid angle. It is typically thought of as brightness. The SI (System International) unit for luminous intensity is candela (cd)

(g) Manufacturer: (refer also to Supplier)

The organisation or company who manufactures the IIPM. In some instances this may be a supplier marketing the IIPMs for a manufacturer or a responsible agent that handles the IIPM on behalf of the manufacturer or supplier.

(h) May:

Term used to indicate something that is optional and may be considered for use

(i) Must:

Term used to indicate something that is mandatory or required by law

(j) Peak Intensity:

Measurement of LED intensity at vertical plain $\beta_1 = 0^\circ$ horizontal plain $\beta_2 = 0^\circ$

(k) Personal transportation device:

This includes all devices used by a pedestrian as a form of transport including but not limited to bicycles, motorised and manual scooters, motorised and manual skateboards, roller blades and roller skates.

(l) Retroreflective:

Describes a material or device that reflects light back to the light source being distinct from simple mirror reflection that beams light away from a light source in an equal but opposite direction to its direction of input

(m) RCA:

Road controlling authority. (This could include an engineer working on behalf of an RCA)

(n) Shall:

Term used to indicate something that is mandatory or required by law

(o) Should:

Term used to indicate a recommendation based on industry best practice

(p) Specification:

In this set of documents the word "Specification" shall be interpreted as referring to the NZTA M Series *Specification*

(q) Standard:

In this specification the word "Standard" shall be interpreted as a Transport Agency approved national or international document that has been published by a recognised Standards organisation being used to provide a means of compliance with this specification. Standards must be identified by their Standards organisation and number; e.g. AS 1906.1.

(r) Suitable for purpose (Suitability):

A statement of overall daytime appearance and night-time retroreflective performance referred to as being *Suitable for Purpose* is not a finite measurement but recognises that the degree of day and night visibility is deemed to be sufficient for a driver to view an active or passive marker and act in a safe manner, relative to the markers purpose.

(s) Supplier: (refer also to Manufacturer)

A person, company or organisation, typically in New Zealand, that represents a manufacturer of IIPMs or is the source for a brand of IIPMs in place of the original manufacturer. For the purposes of this specification a supplier must accept the responsibilities of a manufacturer when they accept product and system responsibility for the markers in New Zealand.

(t) Trafficked:

In this document the term trafficked indicates that vehicles of all sizes and weights can be expected to run over the markers in any installation. This is versus non-trafficked where markers are set off the travelled pavement being set on a raised kerb or pavement limited to pedestrians and related personal transport devices.

5 GENERAL

The Internally Illuminated Pavement Marker (IIPM) or 'active' markers provides a light output, typically using LEDs, differentiating them from 'passive' retroreflective raised pavement markers (RRPMs) that provide light by retroreflection when illuminated by the headlamps of an approaching vehicle. Retroreflective raised pavement markers are covered in the NZTA M12 Specification.

IIPMs are typically fitted with light emitting diodes (LEDs), aimed towards oncoming vehicles, to either replace or supplement other road markings. This specification is based on the use of LEDs. Any other form of light emission must first be approved by Waka Kotahi.

In establishing this 2023 revised specification, a degree of harmonisation has been included where appropriate with the recently published AS/NZS 1906.3:2017 Standard *Raised pavement markers (retroreflective and non-retroreflective)*.

Equally, although not necessarily installed using the same methodology as retroreflective raised pavement markers, the similarity is such that this specification should be read in conjunction with NZTA M12 *Specification for Raised Pavement Markers Clause 10 Marker installation*.

IIPM technology, performance and construction, continues to change and improve; this specification takes note of such developments and of other international standards for active pavement markers.

Waka Kotahi welcomes the introduction of new technologies, IIPM types and systems, however any new IIPMs or new installation set-out configurations, placements or new system design objectives that include IIPMs must be either compliant with this specification or be presented to Waka Kotahi prior to being introduced to the New Zealand market.

Active markers can be:

- (a) Illuminated continuously
- (b) Linked to sensors that monitor ambient light levels or detect weather conditions activating the marker only when a pre-set condition occurs or ceases, or
- (c) Activated by sensors that are linked to a controller or computer system, or
- (d) Programmed to synchronise with a primary system such as intersection traffic signals which may also activate markers.
- (e) Linked to a wider traffic management system to guide motorists through a specific area

5.1 Preplanning considerations

Specifiers should seek the approval of the engineer responsible for managing the pavement at the proposed site of any planned installation to confirm that the pavement structure is suitable for the installation of any recessed IIPM system and that any pavement cuts will not compromise the waterproofness or integrity of the surface.

Specifiers should also consider any future pavement maintenance plans before committing to the installation of IIPMs. Any resealing programs will typically require any IIPMs to be removed hence planned installations should be completed relative to such forward maintenance plans by consulting with the appropriate road authority's maintenance contract.

6 GENERAL CATEGORIES

Internally Illuminated Pavement Markers must satisfy the requirements of this specification to be acceptable by Waka Kotahi for installation on the New Zealand roading network.

These IIPMs will typically be fitted with light emitting diodes (LEDs) aimed at oncoming vehicles to, typically, supplement other road markings. Depending upon the requirement, they may either; be lit continuously, be linked to a systems controller or be activated by sensors that monitor either ambient light levels or temperature that will activate only when the light or temperature drops below pre-set levels.

Some IIPMs are developed to be used within the general roading environment to provide an element of guidance for road users but are not designed to be installed in an actual trafficked pavement. These IIPMs could, upon specific approval from Waka Kotahi, be installed off the trafficked surface on raised kerbing or even on tunnel walls to indicate emergency exit doors or escape routes.

IIPMs not intended to be placed on the trafficked road surface must be laboratory tested to gain *Provisional Acceptance* but will not be required to be formally field tested on a trafficked surface. They will be required to be installed in the non-trafficked test location for six (6) months. After this Waka Kotahi test installation has been operating successfully for six (6) months these markers may be awarded *Type Acceptance* but will be listed as being for “non-trafficked pavements” only.

6.1 Marker Identification

Internally Illuminated Pavement Marker identification is divided into three primary sub-categories.

- (a) Marker Type – Indicating the power source
- (b) Illumination capabilities – active sides and LED illumination setting
- (c) LED Colour

6.1.1 Marker Type

IIPMs are first classified referencing the method by which the LED's are powered.

- (a) **Type C** – Identifying IIPMs that are actually connected to the power source, sometimes referred to as hard wired, typically to a 12 V power source with recognised protective devices installed:

LED's are powered via a low voltage wire installed beneath the pavement surface set along the line of the IIPMs to which the IIPMs themselves are connected. This may include markers that are powered by a remote solar powered system.

- (b) **Type I** – Identifying Inductive powered IIPMs

LED's are powered via an inductive cable, installed beneath the pavement surface, set along the line of IIPMs, powering the IIPMs without the need to actually be physically connected. This may include IIPMs that are powered by a remote solar powered system.

- (c) **Type S** – Identifying Solar powered IIPMs

IIPMs where the LED's are activated via a solar panel incorporated in the upper surface of each individual IIPM that is designed to charge electric cells within the IIPM.

Solar charged IIPMs installed onto the pavement surface shall, unless otherwise specified, also be fitted with reflective elements to reflect the light from vehicle headlights back to the driver. The colour of reflective elements and the colour of light emitted by the LEDs shall be the same per side unless specified otherwise.

NOTE: Owing to the attractiveness of solar powered (Type S) markers to thieves, special care should be exercised to ensure that they are resistant to unauthorised removal.

6.1.2 Marker Illumination

This category identifies an IIPMs primary directional capability and setting that typically recognises direction toward an oncoming motorist.

(a) Directional capability

Identifying IIPMs that emit light in a single direction (1 - one way), in two directions (2 - two way)

In some instances LEDs may be placed equally around an entire circular unit. Considered to be an omnidirectional IIPM it will typically be used in conjunction with circular traffic islands, in place of a one way marker. This enables easier or more efficient marker alignment. In such instances the LEDs must be tested as for a one way or two way marker.

If the LEDs are confirmed to be the same as LEDs in a one-way or two-way marker that has been tested compliant this test can be cross applied. (Refer clause 8.1 and 8.2)

- (i) One way – 1
- (ii) Two way – 2

NOTE: In order to separate the *Directional* symbol from the *Type* symbol a dash (-) precedes the Marker Direction symbol. Example: A *Connected* Type C IIPM with two-way illumination will become an IIPM Type C-2

(b) Illumination setting

Identifying an IIPM incorporating an LED that can be used either as constant illumination or low frequency flashing illumination:

- (i) Constant: **C**
- (ii) Low frequency flash: **F**

NOTE: The Illumination setting symbol immediately follows the *Directional Capability* symbol without a space. Example: A Type C IIPM with *two way* illumination and *constant lit* LEDs will become an IIPM Type C-2C

IIPMs that include LEDs declared to be suitable for use with a controller that is programmed to maximise output performance (brightness) when daytime light levels so require and reduce this output to dim the LED performance at night must have this feature tested through a minimum of 1000 cycles.

(c) Marker activation

An IIPM may be activated (on/off) by a standard switching method that is operated manually or by a timing system such as but not limited to phasing with traffic signals. Alternatively the unit can be linked to a sensor that activates the IIPMs when a specific ambient light level is reached or climatic condition (temperature and humidity) is attained or when any of these conditions cease to exist.

(d) LED colour

LED Colour	Code Letter
White	W
Yellow/Amber	Y
Red	R
Green	G
<u>Dark Green</u>	D
Blue	B
NOTE: Unit body colour, if specified, is noted separately.	

Table 1: LED colours and symbols²

LED colours for IIPMs are limited to the colours specified in the TCD Manual *Traffic control devices for general use – Part 4 at intersections* and – Part 5 *between intersections*. Led colour is separated from the illumination direction setting by a dash (–) as shown in Table 1.

An internally illuminated pavement marker may emit light in a number of directions. Colour(s) emitted are noted by active side.

- (i) A one way marker emitting one colour (eg white): **–W**
- (ii) A two way marker emitting one colour (eg white) on each active side: **–W**
- (iii) A one way marker capable of emitting two colours (eg white & yellow): **–WY**
- (iv) A two way marker capable of emitting two colours on each active side (eg white & yellow): **–WY**
- (v) A two way marker capable of emitting two different colours per side (eg white yellow & white red): **–WY.WR**

NOTE: Example: A Type C marker with two-way constant illumination white LEDs will become an IIPM Type C-2C-W. If the marker has two LED colours eg white and yellow it will become an IIPM Type C-2C-WY

(e) Marker body colour

For a surface mounted marker the marker body includes all the plastic or metal other than the LEDs. For a marker that is recessed into the pavement the marker body colour typically refers to the upper surface components other than the LEDs.

- (i) For a surface mounted trafficked internally illuminated pavement marker positioned within or representing a road marking line the marker body should harmonise with the road marking line colour and typically the lens colour. If the marker is not representing a specific recognised colour the body should be black, grey, clear or neutral
- (ii) For a marker that is to be recessed into the pavement (trafficked or non-trafficked) the marker body colour is less important hence it will typically be black, grey or a neutral colour. When the recessed marker is located within a road marking line the visible topmost surface may be required to match the line colour.
- (iii) Where a surface mounted or recessed marker is not to be recognised until activated, such as in changeable lane marking installations, the marker body and top surface colouring must harmonise with the pavement surface e.g. black, grey, clear or neutral.
- (iv) Marker body colour shall be a neutral colour (black, grey, neutral or clear) if the marker is capable of emitting more than one LED colour.

7 CONSTRUCTION

The marker must be constructed of robust materials typically comparable to Retroreflective Raised Pavement Markers specified in AS 1906.3 without any sharp edges that can be snagged by passing traffic. Markers, or components of markers, should only be removable from an installation using, at the least, reasonably specialised tools or manufacturer available tools.

Marker dimensions

- (a) For IIPMs (trafficked or non-trafficked) installed onto the pavement surface using a manufacturer or supplier recommended adhesive system:
 - Height of the standard surface installed marker body above a trafficked pavement shall be no greater than 25mm (Figure 2).

² Use of the orange coloured LEDs has been discussed, but usage had not been permitted at time of publication. If orange is being considered this must be discussed with Waka Kotahi before progressing with any introduction.

Height for a non-trafficked IIPM may, with Waka Kotahi approval, be to a maximum of 30mm providing this will not create a potential hazard on pedestrian walkways, cycle ways or areas shared jointly by motorists, pedestrians and personal transportation devices (Clause 4(k)).

- Width of marker shall be no less than 80mm or greater than 130mm
- Length of marker shall not be less than 80mm or greater than 130mm

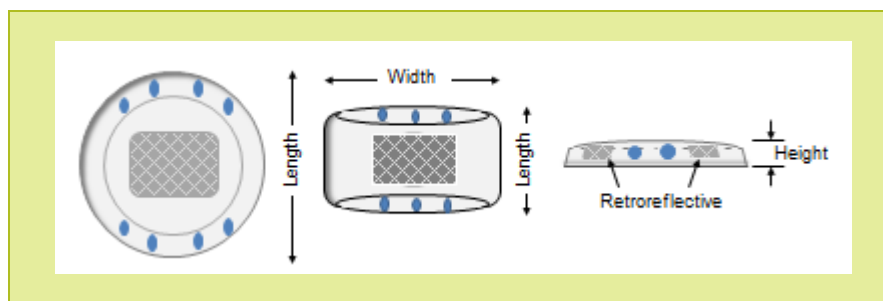


Figure 2: Dimensions for markers installed onto the pavement

- Where a non-trafficked marker format is to be installed partially recessed into the pavement, to ensure it will not extend above the pavement surface by greater than 5mm, the dimensions may, with Waka Kotahi approval, exceed 130mm width and 130mm length provided the upper surface exhibits a non-slip surface.
- (b) Trafficked IIPMs recessed into the pavement where the main body of the marker is installed to be nominally level with the pavement surface; the actual LED housing may extend above the pavement by up to a maximum of **10mm**:
- The maximum width at the surface shall be no greater than 170mm unless Waka Kotahi provides special exemption
 - The maximum length at the surface shall be no greater than 170mm unless Waka Kotahi provides special exemption
 - Any such marker exceeding 130mm in either dimension must have an upper surface that exhibits some form of anti-skid resistance for cyclists and motorcycles.

IIPMs should not be recessed into any pavement surface that lacks the strength or integrity to hold the maker securely without damaging the pavement or risking potential release from the pavement. If the depth of the seal risks requiring either Type C or Type I wiring to be laid within a compacted base course it may be necessary to protect such wiring in a special conduit.

IIPMs should not be installed onto or recessed into chip seal surfaces without the explicit authority of the relevant RCA. A chip seal foundation will typically not be suitable and the loose chip is likely to damage the LED housing.

8 PERFORMANCE SPECIFICATIONS

8.1 LED Colour

Maintenance of IIPMs will typically require a more precise survey program. While robust, these markers are subject to more features that can be affected by constant traffic especially if exposed to routes with a high percentage of heavy vehicles.

Testing need not be completed in New Zealand or Australia but must be completed by a testing laboratory that promotes this testing capability and is accepted by Waka Kotahi.

To harmonise with international specifications, M29 requires that the LED colour emitted by each IIPM, when tested in accordance with Appendix D, AS 2144 shall fall within the chromaticity co-ordinates shown in

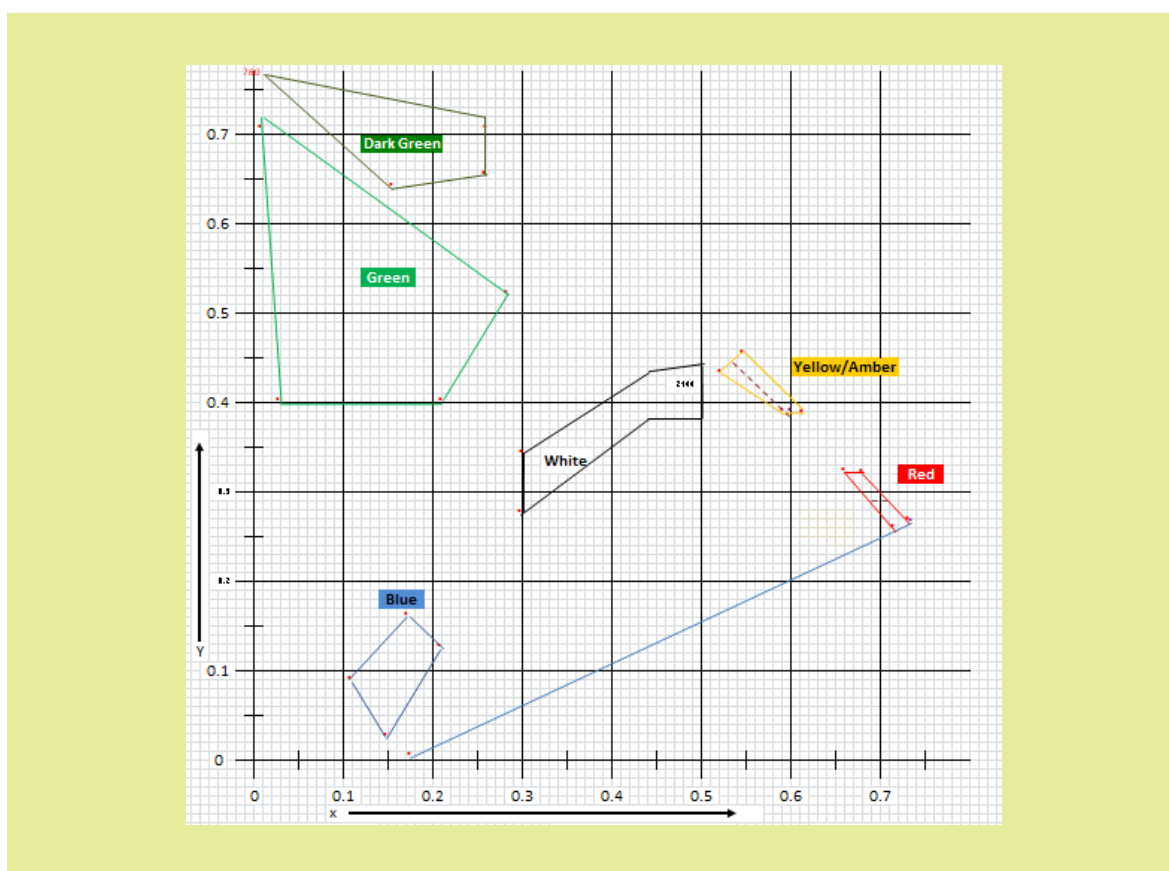
Table 3. These colours shall comply with the colorimetric requirements and be measured after a 20 minute warm-up period. Test laboratories not located in New Zealand or Australia must be accepted by Waka Kotahi. The full identifiable name of such laboratories must be provided.

COLOUR		Corner points of Chromaticity regions					
		1	2	3	4	5	6
White	x	0.300	0.440	0.500	0.500	0.440	0.300
	y	0.342	0.432	0.440	0.382	0.382	0.276
Yellow / Amber	x	0.522	0.547	0.613	0.573		
	y	0.430	0.452	0.387	0.387		
Red	x	0.660	0.680	0.715	0.735		
	y	0.320	0.320	0.258	0.265		
Green	x	0.009	0.284	0.209	0.028		
	y	0.720	0.520	0.400	0.400		
Dark Green	x	0.015	0.155	0.260	0.260		
	y	0.780	0.640	0.665	0.720		
Blue	x	0.109	0.173	0.208	0.149		
	y	0.087	0.160	0.125	0.025		

Table 3: Corner points of the chromaticity regions for emitted radiation of permanent and temporary internally illuminated pavement markers³.

NOTE: Chromaticity of emitted light is measured in the same way as luminous intensity. This is completed in the reference direction by using a colorimeter instead of a photometer.

If a Manufacturer or Supplier declares in writing that the LED setting in an IIPM to be tested uses the exact same LEDs, including LED setting and placement density as an IIPM that has previously proven compliant with this specification then cross compliance of LED chromaticity may be awarded without further testing. The *Test Summary Certificate* number of the original test must be quoted.



Graph 1: Chromaticity co-ordinate limits for colour designations expressed graphically

³ These co-ordinates have been developed to harmonise with AS 2144, Queensland MRTS219, NZ VMS and International Standards

8.2 Photometric requirements

The testing of photometric requirements will be completed using a system very similar to that used when testing a retroreflective raised pavement marker (RRPM) in that it will be mounted on a goniometer that is aligned with the reference centre of the luminous face of the marker.

As is the system when measuring retroreflective performance of RRPMs, the test result should not include any stray light that may interfere with the primary measurement from the LED face of the IIPM.

If a Manufacturer or Supplier declares in writing that the LED setting in an IIPM to be tested uses the exact same LEDs, including LED setting and placement density, as an IIPM that has previously proven compliant with this specification then cross compliance of LED photometric performance may be awarded without further testing. The *Test Summary Certificate* number of the original test must be quoted.

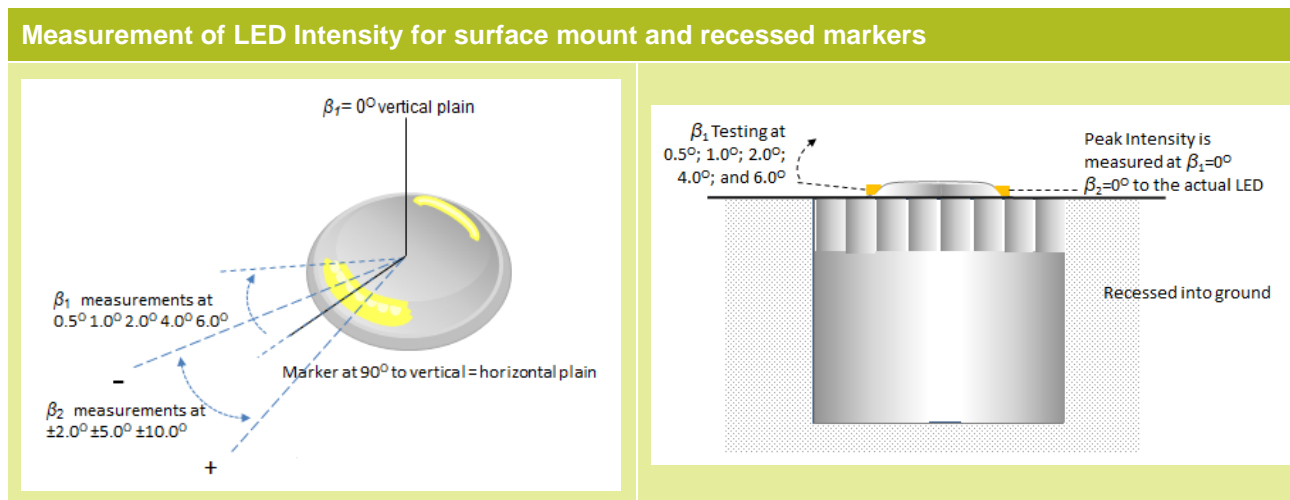


Figure 2: Vertical and horizontal test measurement geometry for LED performance in cd. Peak luminous intensity is taken at $\beta_1=0^\circ$ vertical and $\beta_2=0^\circ$ horizontal relative to the actual LED.

Test results shall be provided from an accredited testing agency⁴ accepted by Waka Kotahi showing that the following requirements can be met.

- (a) After a 20 minute warm-up period, markers for daytime use and for typical night-time and in-tunnel uses, (usually wired markers or inductively powered markers), shall have a minimum luminous intensity (in cd) as shown in Table 4. Colours other than white shall meet the values in Table 4 multiplied by the relevant value from Table 5.

β_1 Vertical Angle degrees	β_2 Horizontal Angle degrees			
	0	± 2.0	± 5.0	± 10.0
6.0				5.0
4.0			25	
2.0		40		10
1.0			25	
0.5		40		

Table 4: Minimum Luminous Intensity levels (cd) for 1 way and 2 way IIPMs for daytime use, and for specific night-time uses

⁴ Accreditation must be provided by IANZ in New Zealand or NATA in Australia. Overseas testing agencies would be accredited by a body which is signatory to the ILAC MRA.

- (b) After a 20 minute warm-up period, markers for specific night-time use (which may be solar charged markers or inductively powered markers from a solar source), shall have a minimum luminous intensity (in cd) as shown in Table 6. Colours other than white shall meet the values in Table 6 multiplied by the relevant value from Table 5.
- (c) When solar charged markers are specified, the energy collection and storage arrangements shall be such that the LEDs will meet the requirements of Table 6 measured at a vertical angle of +1.5° and a horizontal angle of 0° for 40 hours with no solar input
- (d) When a Type C or Type I IIPM is capable of being dimmed or independently controlled this capability shall be stated by the manufacturer including the degrees of dimming that can be achieved and this performance must be achieved. Dimming to 25% is a common requirement.

Colour	Colour Factor
White	1.0
Yellow / Amber	0.4
Red	0.4
TL and NZ Green	0.5
Blue	0.1

Table 5: Colour factors

β_1 Vertical Angle degrees	β_2 Horizontal Angle degrees		
	±2.0	±5.0	±10.0
6.0			0.3
4.0		1.0	
2.0	2.0		0.3
1.0		1.0	
0.5	2.0		

Table 6: Minimum Luminous Intensity Levels (cd) for 1 way and 2 way IIPMs for in-tunnel use and for specific night-time uses

- (e) When an IIPM is confirmed capable of being activated by ambient light level the manufacturer must confirm the markers capability:
 - Declare that whenever the light level drops below a predetermined ambient light level or exceeds a predetermined light level measured in lux (eg 50±5 lux and 200±5 lux) this must be substantiated using a source closely approximating CIE Illuminant D65
 - The threshold lag time for switching on or off shall be damped such that the LEDs only react if the setting is crossed either up or down, for at least five minutes, when tested using a light source set at a vertical angle of +1.5° and a horizontal of 0°. Type C and Type I markers shall shine at all times if so specified.
- (f) When a marker is confirmed capable of being activated by temperature and humidity the manufacturer must confirm the precise capability:
 - By creating a test laboratory setting that confirms the required switching temperatures.

- A threshold lag time shall be damped such that the LEDs only react when the predetermined conditions are met for at least five minutes when tested.
- (g) Markers shall meet the requirements of Table 4 or 6 when measured at a vertical angle of 0.5° and a horizontal angle of 2.0° after a minimum of 1000 on/off cycles.
- (h) In order to ensure that there is no apparent flicker emitted from the LED the lowest frequency of the light shall be measured. This frequency shall not be less than 100 Hz.
- (i) When an active pavement marker is designed to provide a visible flash this shall not exceed 3 Hz

8.3 Power supply

Although explicit within this specification a road controlling authority or a system specifier should ensure that connected (Type C) extra low voltage and induction powered (Type I) IIPM power supply arrangements can be demonstrated to be suitable for purpose using the markers specified in a contract. These systems typically utilise a transformer and an installation plan that allows for power loss along the wires.

A ring supply arrangement is desirable. Failure of any IIPM in an installation shall not adversely affect the operation of other markers within the direct installation.

8.4 Solar powered IIPMs

Solar powered (Type S) markers installed onto the road pavement surface – surface mounted – must have a minimum of two LED's per active side as shown in Figure 1 and two retroreflective elements of minimum Class 400 AS 1906.1. In circumstances where a requirement to house solar batteries will increase the marker height above the maximum 25 mm the marker must be partially recessed into the pavement. In such instances, if the section above the pavement is in excess of 15 mm, the retroreflective elements must be maintained.

If mounted within a pedestrian walkway where foot placement is likely the marker must not become a hazard for pedestrians or personal transportation devices. Reference to Waka Kotahi NZ Transport Agency publication *Pedestrian Planning Design Guide*, (Clause 3.11) suggests that a rise above the pavement of just 6 mm risks becoming a trip hazard for ten percent (10%) of pedestrian's, particularly older pedestrians. For this reason markers to be placed in a pedestrian walkway within the footfall of pedestrians should not rise (nominally) above the pavement. If positioned within the common footfall area the marker rise from the pavement, with the approval of the client RCA, may be a maximum of 5 mm (equal to tactile paving). Any height above this must be approved by the RCA prior to installation which may require the marker to be sited in such a manner that footfall is unlikely or some alteration to the pavement lessens footfall possibility.

The manufacturer must confirm the typical hours the marker will operate from fully charged without additional charging and confirm the hours required to fully charge the internal storage from "empty internal storage in the off state".

When a solar powered marker's integral storage is fully charged it must be able to operate in a mode declared by the manufacturer without any additional charging. The number of operational hours the marker operates to an acceptable standard from fully charged will be recorded.

As a minimum the energy collection and storage arrangements shall be such that the LEDs will meet the requirements of Table 6 (and Table 5) for 40 hours with no solar input.

Marker operation shall be deemed not to be acceptable when:

- (a) The luminous intensity in the reference direction falls below 80 % of the minimum requirement, or
- (b) The chromaticity leaves the relevant box or
- (c) A visible flicker develops.

If surface mounted, a solar powered marker must have a minimum of 300mm² (eg 15mm x 20mm) of retroreflective per active side positioned to retroreflect vehicle head lights back to a vehicle driver. (Refer Figure 1)

Such retroreflective material shall exhibit a performance no less than Class 400 Table 3.3 AS 1906.1 for *Retroreflective sheeting*. The colour of the retroreflective may be either white or yellow as appropriate relative to line marking or match the colour of the LEDs dependent upon the requirements of the installation.

8.5 Ingress Protection

The internally illuminated pavement marker must be capable of excluding dust (foreign solids) or moisture (liquid) penetration to an Ingress Protection (*IP*) rating of *IP* 68 as defined AS 60529 *Degree of protection provided by enclosures (IP code)*. Typically, this will mean that the equipment is hermetically sealed.

The manufacturer must provide a certificate of compliance issued by an accredited recognised testing laboratory capable of performing such testing and accepted by Waka Kotahi.

8.5.1 Dust test to Ingress Protection numeral six (6)

The first *IP* character numeral 6 specifies there is to be no evidence of dust ingress when tested in a dust chamber according to IEC 60529 or Clause 13.4 AS 60529

The level of protection is satisfactory if there is no evidence of dust deposit inside the test marker.

8.5.2 Moisture test to Ingress Protection numeral eight (8)

The second *IP* character numeral 8 rating specifies there to be no evidence of water or moisture ingress after being submerged totally in a minimum of 1.0 metre of clean fresh water at $15 \pm 3^\circ\text{C}$ for a period of no less than four (4) hours.

The level of protection is satisfactory if there is no evidence of water or moisture ingress after continuous immersion in water. Testing for water jet is not required.

8.6 Tolerance to temperature

The marker must be able to withstand anticipated daytime temperatures without physical body damage or performance deterioration outside specification.

Sample markers are to be exposed in a chamber capable of maintaining ambient temperatures of -15°C and $+65^\circ\text{C}$, for a period of no less than 5 hrs.

The testing procedure harmonises with AS/NZS 1906.3, Appendix F, recognising the different requirements for active markers. IIPMs will be measured at $\beta_1=0.5^\circ$, $\beta_2=2.0^\circ$ results will be compared with Clause 8.2.

Three markers must be held at $-15 \pm 3^\circ\text{C}$ and a second three markers held at $+65 \pm 3^\circ\text{C}$ for a minimum of five hours.

The procedure shall be:

- (i) Select three markers for each temperature, each compliant with the photometric measurement specified in Tables 4 and 5 or Tables 6 and 5 and the chromaticity shown in Table 3.
- (ii) Adjust one chamber to the specified temperature of $-15 \pm 3^\circ\text{C}$ and the other to $+65 \pm 3^\circ\text{C}$.
- (iii) Place the markers centrally in the chamber and leave for a period of no less than 5 hours.
- (iv) Remove from the chamber.
- (v) For each marker immediately examine the body for distortion softening or any other physical deterioration.
- (vi) Permit the markers to return to an approximate ambient room temperature of $25 \pm 3^\circ\text{C}$
- (vii) Measure the photometric performance and chromaticity both of which must remain within specifications herein.
- (viii) There must be no evidence of visible flicker

Markers shall meet the Luminous intensity requirements of Table 4 and 5 (or Tables 6 and 5) when measured at a vertical angle $\beta_1 = +0.5^\circ$ and a horizontal angle $\beta_2 = 2.0^\circ$ after being exposed to the tested temperature.

Marker chromaticity shall return to be within the specifications of Table 3.

8.7 Impact resistance and resistance to LED damage

This test shall be required for APMs intended to be installed in trafficked locations.

The internally illuminated pavement marker must confirm that the marker body shell and “LED” system is able to withstand constant impact from traffic including heavy vehicles.

When a sample of five markers, are tested in accordance with Appendix H AS/NZS 1906.3, Clause H3 Apparatus⁵ and H5 Procedure⁶ the markers shall exhibit no permanent damage detrimental to their designed use.

In particular, a marker body incorporating integrally mounted electronic elements and LEDs, shall not exhibit:

- (i) Fracturing of the shell extending more than 10 mm from the centre of the point of impact of the hammer, in any direction;
- (ii) Delamination of the LED housing from the body of the marker such that the IP rating is jeopardised.
- (iii) No permanent damage considered to be detrimental to the designed use of the marker such as damage to the shell or upper lens and LED system.

8.8 Compressive strength and resistance to LED damage

This test shall be required for IIPMs intended to be installed in trafficked locations.

The marker body must confirm that the casing itself is capable of resisting the compression experienced from overpassing traffic especially heavy transport such that the casing will not expose the internal electronics to damage or jeopardise the performance of the LEDs.

When a sample of five (5) markers are tested in accordance with Appendix I AS/NZS 1906.3, Clause I2 Apparatus and I4 Procedure the marker body shall not be less than the value given in Table 3.7 Clause 3.4.6.

The outcome of any such deformation shall not affect any damage that will result in the active pavement marker failing to operate or the LEDs fail to perform.

8.9 Ultra violet exposure test

All IIPMs to be installed in trafficked locations manufactured using plastic or polycarbonate for the body, or casing, surface mounted onto the pavement or recessed into the surface, must ensure that this is sufficiently robust after exposure to UV radiation to withstand the expected traffic volumes and vehicle types.

The surface installed marker body and the top exposed section of a recessed marker or transparent polycarbonate solar panel cover atop a Type S marker and any plastic immediately below this cover exposed to direct sunlight must be subjected to the ultra violet test as specified in AS/NZS 1906.3 Appendix G⁷.

Markers are exposed to UV radiation and visible light and compared with a control sample which has also been exposed and found acceptable. Markers will then be examined for signs of physical degradation.

Five (5) markers will be tested and subjected to 500 ± 1 hour exposure to the test lamp. Surface temperature shall not exceed 65°C before being compared with an agreed control sample that will be included in the test program.

⁵ Clause H3 (a) Substitute *adjacent to the retroreflective face* with *adjacent to the LED housing*

⁶ Clause H5 (b) Substitute *centre of the retroreflective shoulder* with *proximity to the LED housing*

⁷ The Procedure will disregard sub clauses (a) and (e) referencing retroreflectivity and the Report will disregard sub clause (b) relating to retroreflectivity.

For each of the five (5) markers the report shall note if there has been any physical deterioration or colour change greater than that shown by the exposed control sample.

9 MANUFACTURER SUPPLIER'S WARRANTY

All markers shall carry a Manufacturer's or Supplier's warranty of two years from the date of dispatch from the Manufacturers or Suppliers premises. This warranty shall cover all aspects of the manufacture and performance of the markers including electronic components.

The IIPM Manufacturer or Supplier should be able to demonstrate that they have technical support in New Zealand or that it is readily accessible should any technical situation so require. This availability should also include the ability to successfully train a contractor in the installation of the system or have a Technical Bulletin or some such document that details the installation specifications especially any wire connection made to the marker.

Upon proof of failure of a marker, the cost of the replacement marker(s) shall be accepted by the manufacturer. Failure of a marker caused by faulty installation or due to failure of the pavement will not be included in this warranty.

10 MARKING AND PACKAGING

Individual markers shall be clearly and durably labelled in a visible position such that the marker can be positively identified or the marker detail must be clearly noted in the roadside systems operational cabinet to determine:

- (a) Manufacturers or Suppliers name or trademark
- (b) Marker series ID.
- (c) Marker Type

Markers shall be packaged in such a manner that they will not be subject to scratching or damage in transit. Packages shall be clearly marked with the following information:

- (i) The Manufacturers or Suppliers name or trademark
- (ii) Marker series identification
- (iii) Marker Type including colour, illumination and colour.
- (iv) Date of manufacture and batch number.

11 IIPM ACCEPTANCE

The cost of all testing of internally illuminated pavement markers must be met by the IIPM Manufacturer or Supplier.

Marker body colours white and yellow may be confirmed compliant based on being within the chromaticity co-ordinates in Table 3.1 AS/NZS 1906.3 or:

- (a) For white; closely approximating white in a popular paint colour chart
- (b) For yellow; closely approximating Pantone® 7549 in a popular paint colour chart such as Resene™ Y74-173-075 *Buttercup*™ on colour card R18.

11.1 Provisional Acceptance

To gain *Provisional Acceptance* IIPMs, trafficked and non-trafficked, must comply with the specifications herein. Tests must be completed at a Waka Kotahi accepted testing laboratory that has expertise in testing the various technologies that IIPMs feature.

Test results must be submitted using the *Test Summary Certificate* template available in NZTA M29 *Test templates for IIPMs* (Clause 11.1.1 herein). Waka Kotahi does not require the marker Manufacturers or Suppliers confidential test report unless it is specifically requested.

Provisional Acceptance is awarded for twelve months and is confirmed after being listed in Table A1, NZTA M29 *Listing of accepted IIPMs*. Within this twelve month period it is expected that up to three Performance Field Tests may be completed. (Clause 12.2)

After the IIPM has been awarded *Provisional Acceptance* the IIPMs may be promoted for installation in up to three *Performance Field Test* sites (Clause 13 herein) approved by Waka Kotahi and chosen in conjunction with a Road Controlling Authority.

11.1.1 Test Summary Certificate Template

The template for this certificate can be found in NZTA M29 *Test templates for IIPMs*.

The Waka Kotahi approved testing laboratory will complete an official client report of testing completed. It is advisable that the marker Manufacturer or Supplier completes the first section of the *Test Summary Certificate* before handing it to the test laboratory to ensure that company name and product information detail is correct. The testing laboratory or organisation must also complete the compliance confirmation

section such that every line is noted as a Pass/Fail/Not tested /Not applicable. The test laboratory must sign this form and issue it without changes as a PDF to the client manufacturer.

The marker Manufacturer or Supplier must hold a copy of the *Test Summary Certificate(s)* and submit one to Waka Kotahi as confirmation of compliance.

This completed certificate(s) will form the basis of *Provisional Acceptance* and must be provided as confirmation of compliance before commencing the Field Test.

11.2 Type Acceptance

In order to be awarded final *Type Acceptance* an IIPM must have confirmed *Provisional Acceptance* which then permits up to three field tests to be installed. Enabling three gives the Manufacturer or Supplier an opportunity to install a backup test just in case an uncontrollable event renders a site unusable.

The *Field Test and Report* must outline the reason that the trial is being conducted and what the main objectives are using the appropriate template found in M29 *Test templates for IIPMs*.

The *Field Test* must approximate the Manufacturer's or Supplier's promoted use for the IIPM such as testing at a pedestrian crossing installation versus testing an IIPM that is to be installed in a larger lane marking installation or for an installation using non-trafficked IIPMs. IIPMs installed for testing purposes must be in a location representative of the long term in-service application for the IIPM in question.

11.2.1 Approved use of IIPMs

It is important that the IIPM manufacturer/supplier, possibly in conjunction with an RCA agreeing to facilitate such *Field Test*, must ensure that the actual use of the IIPM for the proposed *Field Test* is an approved use according to the Land Transport Rule: Traffic Control Devices 2004 (the TCD Rule). The TCD Rule sets out rules for the introduction or installation of traffic control devices by RCAs.

<https://www.nzta.govt.nz/assets/resources/traffic-notes/docs/traffic-note-10-rev3.pdf>

If confirmed as an approved use the *Field Test* required by this specification (noted above) is to be followed. If not an application under the Land Transport Rule: Traffic Control Devices (TCD Rule) must be made to the Road Safety Technical Support Officer Waka Kotahi for the trial of a new traffic control device.

11.2.2 IIPM testing in a trafficked location

Testing for trafficked IIPMs will be divided into installation categories based on the number of IIPMs that will potentially be used in an eventual completed installation.

- (a) Testing IIPMs intended for use at a pedestrian crossing⁸ or similar installations requiring less than thirty (≤ 30) markers (two tests sites of minimum twelve (12) IIPMs are required – minimum twenty four (24) test markers)
- (b) When markers are activated by climatic conditions, such as ice warning markers, testing may be completed if necessary in sets of no less than ten (10) IIPMs each. In these instances it may be necessary to ensure that the testing period runs through an appropriate time or season to ensure that marker activation is suitably confirmed. Three test locations will be permitted.
- (c) Testing an IIPM that is to be used in a larger thirty plus (>30) marker installation, such as a tidal flow installation or for tunnel lane line marking that will involve more complex installations and potentially higher traffic counts must be tested in sets of minimum thirty (>30) IIPMs.

The trafficked *Type Acceptance* field testing must confirm the specific installation i.e. ≤ 30 or >30 markers. If *Type Acceptance* is awarded for an >30 marker lane line installation it will be reasonable to expect that this will also approve *Type Acceptance* for ≤ 30 markers but the opposite will not be so.

⁸ As at 1 May 2021 placement of IIPMs at pedestrian crossings (Zebras) must conform with Traffic Control Devices Rule 2004 Clause M1-4 Placement of warning lights

11.2.3 IIPM testing in a non-trafficked location

Final *Type Acceptance* for non-trafficked IIPMs is not based on marker numbers (11.2.1 above) hence IIPM numbers in the test will be based on the number of IIPMs required for the specific test set out however the test should include no less than 20 IIPMs.

In situations where an IIPM Manufacturer/Supplier seeks both trafficked and non-trafficked *Type Acceptance*, non-trafficked *Type Acceptance* will be awarded after confirmation of compliance in a *Trafficked* location.⁹

Markers not intended for use on trafficked pavements will be awarded *Type Acceptance* after being trialled in a non-trafficked location for a minimum of six (6) months as recommended by the RCA Engineer responsible for the trial. Refer to Section 14 for further details.

11.2.4 Marker *Field Test* installation

The decision as to what testing is appropriate; M29 *Field Test* or a Traffic Control Devices Rule trial; must be confirmed by the Manufacturer/Supplier and the requesting RCA and confirmed by the Lead Safety Advisor in consultation with the Senior Engineer (TCD) Regulatory Services Waka Kotahi.

The *Field Test Record and Report* for an IIPM (M29 *Certificate and Worksheet templates for IIPMs*) must not be instigated in place of an official Waka Kotahi **Traffic Control Devices Rule (TCD Rule) trial**. The *Field Test* is only to be used when testing markers that are similar to those already approved eg; a different marker construction, brand or manufacturer, that are intended to be used in a placement that has already been approved by Waka Kotahi.

An official Waka Kotahi sanctioned Traffic Control Devices Rule trial is required for, but not limited to;

- (a) all new concepts for Traffic Control Devices or
- (b) differing colours of IIPMs not specified in the Rule
- (c) differing configurations or set-outs of the IIPM on the roadway that fall outside of previous approved uses or objectives

Subsequent to confirmation that a Field Test is the correct option the marker Manufacturer/Supplier and the RCA must draft and submit a Field Test brief using the Field Test Record and Report template. This must ensure that the selected installer is qualified for such installations. Where the installer will not have detailed supervision by the Manufacturer/Supplier documentation must be available to ensure that the installation will be completed in such a manner that marker warranties will be maintained.

The Field Test Record and Report must highlight critical installation requirements including recommendation as to related componentry and be set out with support figures to ensure installation contractor understanding. Availability of this brief will not preclude the Manufacturer or Supplier from attending the test installation or any future installation.

After a successful *Field Test* installation the markers may be granted *Type Acceptance* and are therefore deemed to be accepted for general use on the New Zealand roading network for a period of up to seven (7) years. If, through circumstances, a test, commenced before the twelve (12) month period, must remain in progress beyond the twelve month *Provisional* expiry date the marker Manufacturer/Supplier should contact Waka Kotahi and seek an extension of time to enable the test(s) to be completed.

Upon written confirmation by the marker Manufacturer/Supplier that a marker body structure, colour and LED colour are the only variants between markers in an identified range with confirmation of *Provisional Acceptance*, the marker used in a Field Test will equally qualify all marker body colours and LED colours named in the range that also have confirmed *Provisional Acceptance*¹⁰.

⁹ Situations may occur when testing an ice warning IIPM that is activated by temperature i.e. where it may prove difficult to confirm a trafficked test site away from frequent or potential snow plough activity. Where this situation arises it may become necessary to traffic test the IIPM at a separate location.

¹⁰ If a minor structural change has been made to an IIPM marker body e.g. to house one added LED, the Manufacturer or Supplier must highlight this point to Waka Kotahi who may then consider the marker body to be a match for testing purposes.

Type Acceptance for the IIPMs is issued by Waka Kotahi but is confirmed only after being listed in Table B2 M29 *Listing of accepted IIPMs* upon the successful completion of two trial installations.

Type Acceptance is at the discretion of the Waka Kotahi and may be withdrawn at any time if there is evidence of less than satisfactory in-service performance.

12 PERFORMANCE FIELD TEST

The objective of the *Field Test* is to test the IIPM itself. However the components, system controller, operating systems and connections recommended by the marker Manufacturer/Supplier and installed in accordance with the marker Manufacturer/Supplier's instructions, will obviously be duly noted to ensure that the IIPMs themselves function as specified.

Using the *Field Test Record and Report* template available in M29 *Test templates for IIPMs* the markers will be monitored to confirm performance over a six (6) month period, monitored at two (2) monthly periods in conjunction with Waka Kotahi and or the relevant RCA. Any expense completing this *Field Test and Report* must be accepted by the marker Manufacturer/Supplier.

Location of the RCA or Waka Kotahi *Performance Test* sites must be approved by the Waka Kotahi Lead Safety Advisor and relevant Network Manager or RCA Traffic and Roading Manager. No additional installations may be commenced until *Type Acceptance* has been confirmed.

Because a trafficked, temperature and or humidity activated blue ice warning IIPM must be Field Tested in an approved centreline position, care must be taken to select a Field Test location where snow plough use is unlikely if the marker is to be surface installed.

Type Acceptance permits the markers to be actively promoted for installation on the New Zealand roading network relative to the field test undertaken:

- (a) Smaller trafficked installations for use at pedestrian crossings or similar installations using up to a maximum of 30 IIPMs or
- (b) A trafficked installation involving lane lines or traffic flow delineation using in excess of 30 IIPMs
- (c) A non-trafficked installation where the Field Test has required a minimum of 20 IIPMs

Upon a successful outcome the IIPMs must be listed in M29 *Listing of Accepted IIPMs*, Table B1 before *Type Acceptance* is confirmed. *Type Acceptance* is confirmed for a period of seven (7) years. After this period the marker manufacturer or supplier must initiate a meeting with Waka Kotahi in order to seek an extension for a renewed period of up to seven (7) years.

12.1 Performance Field Test Documentation

Details for the Field Test must be entered and recorded on the *Field Test Record and Report* (Template 2, M29 *Test templates for IIPMs*) and a signed *Test Summary Certificate* must be provided to confirm the markers *Provisional Acceptance* is valid.

The Road Controlling Authority that has responsibility for the area where the Field Test is being completed may recognise the need for a Traffic Note to be submitted in addition to a Test Record. The Test Record however must be completed because it forms the basis of the judgement that the IIPM being tested has successfully passed the field test (or otherwise).

A decision as to who should draft and present the document must be agreed. The first section should be completed by the IIPM Manufacturer or Supplier to ensure that this detail is correct. Both templates have guideline copy added in light blue. This light blue copy must be overwritten as appropriate.

13 MARKER RE-COMPLIANCE

At an appropriate time, before an Internally Illuminated Pavement Markers *Type Acceptance* is due to expire, the Manufacturer/Supplier must contact the Road Safety Technical Support Officer Waka Kotahi in order to initiate a meeting with the Principal Surfacing Engineer, System Design and Delivery to extend the *Type Acceptance* accreditation.

At this meeting the Manufacturer or Supplier will be required to confirm in writing to Waka Kotahi that the specific marker remains exactly as previously tested with no modifications or changes to the manufacturing process, materials used, marker body design¹¹, LED supplier or the country of manufacture have been introduced.

The IIPM Manufacturer or Supplier must be prepared to outline current installations for review at this meeting in order to present a successful in-service history.

Upon gaining this assurance Waka Kotahi reserves the right to:

- (a) Require some specific retesting to be commissioned in order to reconfirm a markers physical specifications and or performance in field subsequent to possible negative reports prior to extending *Type Acceptance*.
- (b) If the working history has proved successful and no negative reports exist extend *Type Acceptance* for another period of up to seven years.

13.1 Marker re-compliance with M29:2023:

Marker Manufacturers or Suppliers of IIPM markers that are **in current use on the publication of the NZTA M29:2023 Specification** will be permitted to cross comply some previous M29 testing for compliance with M29 2002 with the approval of Waka Kotahi. All current compliance will remain valid for 12 months in which time the following laboratory re-testing must be completed.

IIPM marker manufacturers with IIPMs **in current use** at the publication of the revised M29:2023 are required to submit laboratory test confirmation of compliance for the following:

- Clause 8.1 LED Chromaticity,
- Clause 8.2 Photometric performance,
- Clause 8.4 Ingress Protection to IP68 and
- Clause 8.8 UV exposure test for markers manufactured using polycarbonate construction

This is to ensure that all IIPMs comply with these very important requirements where the testing for some has varied from the previous edition of M29. After test results have been confirmed Waka Kotahi will award either renewed *Provisional Acceptance* or *Type Acceptance*. Waka Kotahi judgement will recognise some current installation performance in conjunction with the new test results.

¹¹ Minor IIPM body modification may be acceptable where such minor design change may be to add strength, add an additional LED or minor design enhancement provided the Manufacturer or Supplier has sought and gained acceptance from Waka Kotahi prior to the modification being introduced.

14 IIPM INSTALLATION SPECIFICATION

The contractor and marker Manufacturer/Supplier should appreciate the similarity between this section and the installation section in NZTA M12 *Specification for the design, manufacture, installation and maintenance of raised pavement markers* potentially amending some detail to harmonise with the installation of IIPMs.

The RCA Engineer responsible for managing the pavement surface at the installation site must confirm that the pavement structure is suitable for this installation as outlined in Clause 5.1 *Installation considerations*.

14.1 Scope

This section specifies the requirements that IIPM¹² Manufacturers/Suppliers and installation contractors must comply with when installing IIPMs that are to be bonded directly to the road surface or recessed into the road surface.

Waka Kotahi requires the Installation Contractor to ensure that IIPMs have been confirmed compliant with this *Specification* and are appropriate for the installation before they can be applied within the New Zealand roading network. The internally illuminated pavement markers being installed must have either *Provisional Acceptance* or *Type Acceptance* as required for the contract being completed.

Additional information relative to the use of IIPMs is also available in the Traffic Control Devices Manual (TCD Manual) Part 4 and TCD Manual Part 5. <https://www.nzta.govt.nz/roads-and-rail/traffic-control-devices-manual/part-5-traffic-control-devices-for-general-use-between-intersections/treatment-of-straight-general-delineation/raised-pavement-markers/special-purpose-raised-pavement-markers/> TCD Manual Pt 5 IIPMs

14.2 General

Because installation is critical to the performance of an IIPM and the objective for the installation, marker installation must be completed according to the IIPM Manufacturer's/Supplier's instructions. Installation should be limited to a contractor that has been trained by the IIPM manufacturer in order to protect the marker warranty.

In all instances the manufacturer/supplier must have written installation instructions available to the installation contractor and these instructions must detail all electrical connections and wire jointing for Type C and Type I markers including the separation of wire cabling for Type I markers.

Typically this contractor will have prior experience cutting and sealing cables into trafficked road surfaces such as for installing detector loops at traffic signal installations, but the contractor must:

- Have experience in the installation or cutting of wiring into a pavement surface and
- Understand the connection requirements for Type C markers and cable placement for Type I markers.

If the contractor has not received manufacturer/supplier training the contractor is responsible for ensuring that they can show and demonstrate that they have worked, and are working in compliance with, the manufacturer's installation instructions.

14.3 Installation

The IIPM manufacturer/supplier may attend any installation. IIPMs may be:

- (i) Surface mounted onto the trafficked pavement (as is typical when installing retroreflective raised pavement markers) using an appropriate manufacturer recommended adhesive.
- (ii) Surface mounted for use on non-trafficked pavements such as on kerbing, footpaths (roading corridor or other commercial sites) or on tunnel walls or similar in order to provide direction towards emergency exit ways from tunnels
- (iii) Partially recessed where a part of the marker is inset into the pavement but also held in place by an appropriate manufacturer recommended adhesive.
- (iv) Recessed into a trafficked pavement surface where the LED elements and the top of the marker are either flush with or fractionally above the pavement surface.
- (v) Recessed into the pavement for non-trafficked installations

¹² Hereafter Internally Illuminated pavement markers may be referred to as IIPMs or markers

Most IIPM installations are very specific in terms of the set out and detailing of marker placement hence details of set out are not specified in this document.

Where new markers are installed onto or recessed into the pavement for the first time, with or without supportive paint line markings, the Contractor shall set out all markers from pilot marks provided by the Engineer, or, the Contractor shall set out all marker positions with paint spots or other appropriate methods to ensure start, finish, spacing and orientation is defined using a detailed set out plan that includes spacing detail supplied by the RCA or the Engineer.

It is important that larger IIPM system set out designs recognise the need for ongoing maintenance and fault identification, potentially by avoiding large sections in favour of smaller subsections that harmonise but enable maintenance without requiring a complete system shutdown.

Before commencing any installation the road surface shall be prepared according to the requirements of the marker Manufacturer or Supplier.

Any markers placed outside the permitted tolerances shall be removed, the pavement repaired to the satisfaction of the Engineer, and a new marker installed in the correct location.

If the marker is to be surface installed it is necessary for the Contractor to ensure that the adhesive to be used in any tender meets the approval of the marker Manufacturer/Supplier especially if this is limited to the use of an epoxy system.

If the marker is to be recessed into the pavement the contractor is to ensure that they have equipment appropriate to the formation of the recess holes and that any supportive adhesive or base filling meets the marker Manufacturer's specifications. Inlaying any wiring for Type C or Type I markers must be completed and over filled to the marker Manufacturers specifications as detailed in Clause A4.

The adhesive and method of use shall not be changed without the written approval of the Engineer.

14.4 Power cable installation

Installation of the cable supplying power to either Type C (Connected) or Type I (Inductive) IIPMs should be completed in harmony with the installation method outlined in ITS-03-01 *Specification Inductive loops and feeder cables*. Part of this specification is included herein.

ITS-03-01 states the power cable shall be installed in a saw-cut slot where the width and depth meets the specification detailed by the IIPM Manufacturer or Supplier. The depth of the saw cut slot shall provide a minimum cover to the wire of 25 mm or such depth as may otherwise be specified.

Where corners are required the saw cuts shall extend past the corners to ensure the specified depth of cut remains constant throughout. All straight saw cuts shall be straight to a tolerance of +/- 5 mm of the standard cable requirements.

It is recommended that a pressure washer is used after cutting the slot to ensure that it is free of dirt and debris. Then in order for the sealant to adhere, prior to placing the cable, the slot shall be checked and fully dried, free of debris, in order to provide a smooth bed for the cable. The recommended method of doing this is with the use of compressed air.

The cable shall be placed carefully into the slot without damaging any insulation. A methodology must be adopted that can achieve this critical requirement but it shall not be completed with the use of a screwdriver as a prodding or placement device.

Special care shall be taken at any corners to ensure the cable is curved rather than bent. Prior to sealing the slot, the cable must be tested to ensure the insulation or wire is not damaged.

The cable shall be sealed with Trixophlate or the IIPM manufacturer/supplier approved equivalent flexible epoxy sealant, ensuring a continuous seal over the complete length of the cable. The sealant shall be finished flush to the road surface; sealing shall be done within 2 hours of saw cutting the slot.

Where appropriate the installer should consider the need to add some form of added protection or a protective conduit if the substrate suggests the potential for movement that could damage the cabling.

14.5 System components and installation plan

The installer must be able to confirm that all components for the installation, particularly the system controller, are appropriate for the installation and that the wiring and connection plan is approved by the IIPM manufacturer or supplier.

If not being installed by the IIPM manufacturer or supplier the installer may input to the installation plan but any such decisions must be agreed to by the IIPM manufacturer/supplier. This installation plan should have a maintenance plan and an ability to identify, with a reasonable level of accuracy, where an issue may have occurred in order to ensure efficient remedial action can be actioned with a minimum of traffic disruption.

The installation must enable an appropriate communication system that is able to identify marker or system points of failure and alert controlling personnel to ensure that any fail situation does not misdirect or confuse motorists. Consideration should be given to the installation of a CCTV surveillance system to ensure that the overall system is operating within requirements

If the installation includes IIPM dimming such as for day and night brightness levels, the pulse width modulation (PWM) controller frequency must remain such that it does not cause any unwanted affects to drivers or CCTV cameras. Additionally any LED brightness variance between individual IIPMs or sections of IIPMs must not reach a level that could create driver confusion or be interpreted as a cause of an incorrect manoeuvre.

Where an individual IIPM or series of IIPMs are to be activated by either a photo, humidity or temperature sensor the installation must ensure that the sensor is positioned such that debris, dust and soil does not risk failing to activate the IIPM(s) when required. Some level of consideration must be given to incorporating an ability to confirm that an individual or a system is functioning whether this be via a CCTV system or system trigger to alert if a malfunction occurs.

Where IIPMs are designed to activate upon the presence of a pedestrian at a pedestrian crossing, some consideration should be given to enabling the activation to be cancelled if the pedestrian leaves the crossing entry before the IIPMs are activated.

14.6 Materials

14.6.1 IIPMs

All IIPMs shall have current *Provisional* or *Type Acceptance* accreditation as specified herein and be listed in M29 *Listing of Accepted IIPMs*. This list of *Accepted* markers is updated regularly as testing of new markers is completed.

Before commencing installation the Contractor shall advise the Engineer in writing of the brand and classification of the marker to be installed. The brand and classification shall not be changed without written approval.

14.6.2 IIPM body colour

IIPM body colours must be limited to the colours approved in the TCD Manual Part 4 or Part 5 and this specification.

Typically an IIPM installed within a paint marked setting will have a body colour appropriate to the line colour unless the marker is only intended to be effective when activated in which case the marker body will be black, grey or neutral.

Two way IIPMs with a different LED colour on each side should have a neutral body colour unless the contract specification requires otherwise.

In special circumstances where a marker body is made of aluminium the colour will be recognised as neutral or no colour will be specified

14.6.3 LED performance

At the time of tender the contractor shall confirm the LED performance of the marker. If a solar marker the contractor shall confirm the details regarding the recharging and battery capacity of the marker.

15 IIPM INSPECTION AND MAINTENANCE

Any RCA that has an IIPM based installation, or is planning such an installation, must, in conjunction with their engineer responsible for pavement management, alert their maintenance Contractor to the presence or addition of an IIPM installation into the network and introduce the Contractor to the IIPM Manufacturer. This is to ensure that the maintenance Contractor team becomes aware of any installation and the unique and technical requirements that will surround the maintenance or repair activity within the bounds of the IIPM system, either to the pavement or berm areas. Importantly the maintenance contractor must be instructed not to carry out any maintenance within the IIPM installation in order to avoid severance of underground wiring or electronic systems.

Although the individual RCA is primarily responsible for specifying the requirements for their maintenance Contractor when carrying out routine maintenance of road safety systems, the unique specialisation of the IIPM markers and related systems will require the installation Contractor and the IIPM Manufacturer to maintain a close working relationship with the maintenance of IIPMs.

The RCA should confirm with the maintenance contractor and IIPM Manufacturer of any need to reference other maintenance specifications such as SM032 Network Outcomes Contract Volume 4 Maintenance Specification, Systems Management or any Maintenance Alliance that may be active.

Where the maintenance Contractor may become aware of the need for maintenance to be necessary it is recommended that the maintenance Contractor seeks advice from the IIPM Manufacturer before undertaking any repair work connected to or surrounding an IIPM installation.

Monitoring the performance of IIPM installations should be part of the inspection surveys that are scheduled by RCAs for road safety systems. The maintenance Contractor should be aware of the operating system that controls any IIPM installation. This is in order to establish the operating program and accordingly should note daytime and or night-time definition of the IIPM relative to visual presentation, colour and overall performance to ensure the IIPMs remain suitable for purpose.

Prior to the instigation of any remedial work with IIPMs or any other maintenance in an area where IIPMs are installed the maintenance Contractor must seek specific approval from the RCA and the IIPM Manufacturer to ensure the integrity of the IIPM system, the setting of individual markers and any underground wiring critical to the operation of the system.

APPENDIX A

Introduction to M29 Listing of Accepted IIPMs

The official List of *Provisional Accepted* and *Type Accepted* IIPMs is available as NZTA M29 Listing of *Accepted IIPMs*. Any IIPMs being installed on the New Zealand roading network must have a minimum of *Provisional Acceptance* as detailed in this specification.


Table A1		Internally Illuminated Pavement Markers. PROVISIONAL ACCEPTANCE								
		Provisional Acceptance is for 12 months. * LED Colour: W=White; Y=Yellow; R=Red; D=dark green; G=green; B=blue; O=orange ** Less than / greater than 30 markers								
Manufacturer	Brand & ID	Type C-I-S	Illumination 1 or 2	Setting C-Constant or F-Flashing	LED Colour(s)* Accepted	Body Colour(s) Accepted	Surface Mount or Recessed	Trafficked, ≤30 or >30** or Non-Trafficked	Provisional Acceptance Expiry month/yyyy	

Table A1 lists those Internally Illuminated Pavement Markers with *Provisional Acceptance* under the headings shown.

Table B1		Internally illuminated Pavement Markers. TYPE ACCEPTANCE								
		* LED Colour: W=White; Y=Yellow; R=Red; D=Dark green; G=Green; B=Blue; O=Orange ** Equal to or less than / greater than 30 markers *** Type Acceptance is for seven (7) years after which the manufacturer or supplier must meet with Waka Kotahi for an extension								
Manufacturer	Brand & ID	Marker Type C-I-S	Illumination 1 or 2	Setting C=Constant or F=Flashing	LED Colour(s)* Accepted	Body Colour(s) Accepted	Surface Mount or Recessed	Trafficked, ≤30 or >30** or Non-Trafficked	Type Acceptance Expires*** month/year	

Table B1 lists those Internally Illuminated Pavement Markers with *Type Acceptance* under the headings shown.

Table C1		Internally illuminated Pavement Markers.							
		Traffic Control Devices Rule (2004) Approved IIPM Installations							
Design Code	Description and specification				Design plans and layouts				Date Approved

Table C1 lists the approved IIPM uses, systems and installation lay outs that have been approved.

APPENDIX B

Introduction to M29 Test templates for IIPMs

B1 Test Summary Certificate

In order to ensure that Manufacturers or Suppliers complete active pavement marker testing to confirm that IIPMs comply with this specification the Manufacturer/Supplier must require any Waka Kotahi *Accepted* testing agency or laboratory to complete the *Test Summary Certificate* coversheet that is available in an electronically editable format in NZTA M29 *Certificates and Worksheets for IIPMs*. It is recommended that the Manufacturer/Supplier completes the first section of the *Test Summary Certificate* (as noted in Figure C1) to ensure that markers are correctly identified and described and hand this to the testing laboratory when confirming the testing to be completed.

A completed *Test Summary Certificate* must be signed and issued to the marker Manufacturer or Supplier in PDF format in addition to the marker Manufacturer/Supplier receiving their full and detailed report. All lines of the *Test Summary Certificate* must be completed. Where a test laboratory is completing less than the total testing required any test not completed must state "Not Tested".

The *Test Summary Certificate* merely confirms the results of each test completed without the addition of any performance details thereby negating any responsibility for Waka Kotahi to adjudge the detailed results for compliance. The marker Manufacturer/Supplier must forward or introduce the *Test Summary Certificate* to Waka Kotahi who will then record the details and update M29 *Listing of Accepted IIPMs* Table A1 *Provisional Acceptance*.

If the *Test Summary Certificate* includes more than one LED colour or marker base colour all variations must be equally compliant. If one colour, marker body or feature does not meet compliance equal to the others it must be left for inclusion in its own *Test Summary Certificate*.

1 Internally Illuminated Pavement Markers		No.:	
Test Summary Certificate		Date:	
Testing Laboratory: XYZ Product Testing Pty Ltd		Supporting Lab Report Number(s):	
Address: 123 Anytown Street, Anytown.		XYZ-21-187; XYZ-21-188	
Phone: +64 4 555 5555			
Marker Manufacturer/Supplier:		Brightlite Markers PTY Ltd	
Including Street Address and City		42 Another Road, Anytown	
Marker Description		Brite Brand 98 LED Marker	
Brand; Type; Body Colour		Type C (Connected) Neutral body colour	
Surface Mounted or Recessed		Recessed	Trafficked / Non-Trafficked
			Trafficked
LED Detail		White; Yellow; Blue; Red Constant & Flashing Table 4 and 6	
Colour; Active slides ;Setting;		One way and Two way	
Photometric performance Table 4 or 6			
Line	Clause	Description	Pass / Uncertain / Fail / Not Tested / N/A
1	8.1.2	Marker body colour (white, yellow, black, grey or neutral or matched to LED)	N/A
2	7	Construction: height, width, length (Surface mounted Trafficked markers only)	Pass
3	8.1	LED Chromaticity - Colour	Pass
4	8.2	LED Photometric performance (table 4 or 6)	Pass
5	8.2(d)	Dimming conformance to declaration- 1000 cycles	Pass
6	8.2(e)	LED Activation to ambient light; C to D*	Pass

Figure C1: Partial Test Summary certificate example showing detail to be entered

B2 Field Test Record and Report

After having gained *Provisional Acceptance* the marker Manufacturer is then permitted to actively seek and install up to three (3) Field Test Sites.

The management of these test sites will follow the *Field Test Record and Report* template in NZTA M29 *Test templates for IIPMs*. (Figure C2) Using this template ensures that each manufacturer must follow the same consistent field test before being awarded *Type Acceptance*.

2 Internally Illuminated Pavement Marker		Number			
Field Test Record and Report		Date			
This template should be used when testing a "new to the marker" Brand of IIPM where the basic design of the IIPM has already been approved for use as a Traffic Control Device on the New Zealand roading network by Waka Kotahi for installations already approved by Waka Kotahi.*					
* This Field Test and Report must not be used if the actual marker design or technology has not previously been approved by Waka Kotahi for use as a Traffic Control Device and/or the actual purpose of the installation has not previously been approved by Waka Kotahi. In such instances an RCA must apply to the Senior Engineer Regulatory Services Waka Kotahi and establish the field trial according to NZTA Traffic Note 10 <i>Trials of traffic control devices</i> .					
Instigator of Field Trial HCA, Manufacturer or Supplier		Downtown City Council			
Address	123 Questionable Street, Anyplace, Downton				
Contact	Mrs Smith	Phone	04 123 4567	Email	
RCA Field Test Supervisor	Mr Jones			Phone	
Waka Kotahi Approval by	Mr Contact			Phone	
IIPM Marker Manufacturer		Brightlite Markers PTY Ltd			
Marker Brand	Brite Brand 98	LED Colour	White	Specific IIPM ID	98-01
Contact	Mr Dull			Phone	
Marker Use:	<i>Trafficked / Non-trafficked pavements</i>	Trafficked	<i>Installation onto or recessed into pavement</i>		Recessed
Test Summary Certificate Number	XYZ-21-456		Dated	June 2021	
Confirmation Provisional Acceptance No.					
If advanced warning/confirmation of trial is required (name publications)					
Publication	N/A			Publication Date	
Publication				Publication Date	
Publication				Publication Date	
Field Trial IIPM installer		Trafficway Marker Installations Co			
Address	321 Different Street, Southton				
Contact	Danny Goodman	Phone		Email	
Installation review provided by	John Smith	Phone		Email	
Installation plan or sketch of wiring plan, markers and connections power source					

Figure C2: Field test Record and report example

3	M29: Internally Illuminated Pavement Markers							
	Certificate of Type Acceptance							
Field Test Number	3231-21 OS			Date	August 2021			
Having met the performance requirements of the Field Test, the Trial Manager is satisfied that the results of the trial justify a recommendation to the Director that the TCD Rule be amended to allow all road controlling authorities to use the below listed Internally Illuminated Pavement Marker(s).								
The below listed IIPMs now qualify as "Type Accepted" markers for use on New Zealand roads per the classification(s) noted, immediately after being officially confirmed by listing on the Waka Kotahi web site M29 Listing of accepted IIPMs.								
Marker Manufacturer/Supplier:								
Company	Brightlite Markers PTY Ltd							
Address:	42 Another Road, Anytown							
Brand	Model & Series ID No.	Surface or Recessed	Marker Type C, I or S	Setting C or F	Directional Capability 1, 2	LED Colour(s) (W, Y, R, G, D, B, O)	Trafficked Non-Trafficked, ≤30 or >30	Marker Body Colour(s) w, y, neutral
Brite Brand	98-01	Recessed	C	C & F	1 & 2	W, Y, R, B	Trafficked	Neutral

Figure C3: Certificate of Type Acceptance example