Project PRIME
Installation Toolkit

November 2024

Prince Michael
INTERNATIONAL
ROAD SAFETY AWARDS

TRANSPORT SCOTLAND
CÒMHDHAIL ALBA

THE ROAD SAFETY TRUST
Making Roads Safer

BEAR SCOTLAND

open road

Contents **Page**

List of contributors

Prof Alex Stedmon[1], David McKenzie[2], Richard Perry[2], Kevin McKechnie[3], Stuart Geddes[3], Martin Langham[1], Stuart Wlison[2], Morag Mackay[2]

[1]Open Road Simulation Ltd, UK [2]Transport Scotland, UK [3]BEAR Scotland, UK

Version control

Date	Version	Document	Notes
07/11/24	V1.0	Published	Approved for distribution
28/01/25	V1.1	Published	Amendment to design drawings

This document is provided as a pdf. Please refer to the document control record for the most up to date version.

1 Introduction

1.1 Purpose

This document:

- Provides details of the process adopted and experience gleaned during Phase 1 of PRIME traffic signs and markings road trials on the Scottish trunk road network
- may be of interest to road safety professionals responsible for instigating schemes improving the road environment for motorcyclists (i.e. vulnerable road users) to support safe journeys, in line with the 'Safe System' approach set out in Scotland's Road Safety Framework to 2030

This document is primarily aimed at those working in various areas of road safety such as road authorities, their supply chain, and road safety partnerships who may be interested in the use of PRIMEs on their road networks. It presents the practical outputs of Project PRIME Phase 1 to assist in considering replicating the design and implementation of the Scottish trials.

1.2 Background

Project PRIME (Perceptual Rider Information for Maximisation of Enjoyment and Expertise) has undertaken pioneering, world-leading and award-winning research into new traffic signs and road markings for motorcyclists approaching bends.

During Phase 1 (2020 to 2022) PRIME road markings were installed as a series of 'gateways' on approach to a bend to encourage safer riding. They were installed on trunk roads in Scotland with either 50 mph or 60 mph speed limits. The results have demonstrated improvements in rider behaviour in relation to speed, position and braking which are all key factors for safer riding. The findings also support the 'Safe System' approach to preventing and reducing motorcycle casualties.

Project PRIME, funded by Transport Scotland and the Road Safety Trust has helped to deliver the research and provide the scientific evidence base for installing PRIMEs. Project PRIME is currently progressing with Phase 2 (2023 to 2025) and this document will be updated based on feedback and further research findings.

1.3 Costs and benefits

PRIMEs offer a low-cost and low-maintenance road engineering intervention to improve rider behaviour. Although there is no legal requirement for motorcyclists to use the PRIME road markings, the research evidence demonstrates that PRIMEs are readily adopted by riders and could potentially to be incorporated into education initiatives for road safety and casualty reduction.

Once sites have been identified and designs have been completed, the PRIME traffic sign and road markings can be installed in a relatively short time (typically 1 to 2 hours) with minimal disruption to the road network and without the need for other road engineering or improvement works, although this might be considered as part of a wider scheme to implement PRIMEs.

1.4 Impact

Project PRIME has received worldwide interest for motorcycle casualty reduction and underpins Transport Scotland's current 'Road Safety Framework to 2030' with a desired 30% reduction in motorcycle KSIs within that timeframe.

From the success of Phase 1, Project PRIME has been recognised in the following awards:

- 'Prince Michael International Road Safety Award' 2023
- Institute of Highways Engineers Highways Awards 2023 – 'Road Safety Scheme of the Year' and 'Judges Special Merit Award'
- Chartered Institution of Highways and Transportation Awards 2023 – 'Road Safety Award' (highly commended) and 'Research Initiative of the Year' (commended)

Detailed and rigorous scientific research underpins Project PRIME. This research has been peer-reviewed to the highest standards and published in leading international journals and at international conferences (see: Appendix A).

1.5 Using this document

This document draws together the processes followed in the research from Project PRIME Phase 1 (2020 to 2022) for installing PRIMEs at specific sites for traffic driving on the left-hand side of the road and reflects legislation and practice in Scotland at that time.

This document presents key information in an accessible format that you may wish to use in order to replicate installations but it does not constitute specific instructions to follow.

The document should not be considered as an approved standard or best practice. It is also not an exhaustive description of every potential installation as it is likely PRIMEs will be installed in many different areas.

Special note: PRIMES traffic signs and road markings are not currently prescribed in the Traffic Signs Regulations and General Directions 2016 ("TSRGD"). It is important that any organisation using PRIMEs traffic signs and road markings gains the appropriate authorisation before installing PRIMEs on their road network. Consideration may be needed of relevant legislation and procedures pertaining to intended installations.

The information in this document is provided in good faith and is intended to provide information on the PRIMEs trial on Scottish Trunk Roads to practitioners in other organisations. Nevertheless, whoever uses the information contained herein does so at their own risk and needs to satisfy themselves that they are competent to do so and have met the requirements of their Overseeing Organisation and other relevant regulations. Neither Transport Scotland, The Road Safety Trust or any partners on Project PRIME will be liable for any loss or damage sustained by any person relying on this document, whatever the cause of such loss or damage.

In the following sections, this document provides details on:

- PRIME site characteristics and behaviour change
- PRIME site selection
- PRIME design and installation
- PRIME site monitoring and evaluation

Taken together, these points could help inform where and how PRIMEs might be installed for specific behavioural change, road safety and casualty reduction outcomes.

1.6 Feedback

We welcome any feedback on your experiences of using the information provided and installing PRIMEs in your area so that we can continue to make improvements to the presentation of the document in the future. Please contact: strategic_road_safety@gov.scot

2 PRIME site characteristics and behaviour change

2.1 Where have PRIMEs been trialled?

In Phase 1 (2020 to 2022) PRIMEs were installed at 22 trunk road sites in the West Highlands of Scotland.

Full details for each trial site are provided including information about the locations, bend directions, what3words, and Google Streetview links (see: Appendix B).

Sites were defined using the following characteristics:

- **speed** – taking the 85th% speed for a site, where this was below 50mph it was classed as a 'slower' approach and if it was above 50mph it was class as a 'faster' approach
- **gradient** – this was classed as either 'downhill', 'flat', or 'uphill' towards the bend
- **approach** – this was based on whether the bend for the PRIME installation was preceded by another bend or a straight section of road

These characteristics provide the basis for defining 12 bend types (i.e. speed = 'slower' or 'faster' x gradient = 'downhill', 'flat' or 'uphill' x approach = 'from a bend' or 'from a straight'). The site characteristics help refine the trial sites into overall categories that help with identifying suitable locations for installing PRIMEs. The knowledge gained from the research provides insights that could assist with choosing sites based on potential behaviour change results.

While a range of research questions have been addressed in Phase 1 of Project PRIME there are specific issues that need to be considered:

- due to a specific focus in the research within Phase 1, the trial sites consisted of 18 left-hand bends and 4 right-hand bends. While there is less data for the performance of PRIMEs on right-hand bends, some evidence exists that they produce positive behaviour change. The evidence base for right-handed bends will be increased during Phase 2 of Project PRIME
- to date the PRIME road markings have been trialled on two-lane trunk roads (divided by a centreline). Within the United Kingdom, 5.5m is the minimum overall road width for roads with centrelines. This document provides two designs for PRIME road markings based on different lane widths up to 3.5m and over 3.5m
- the focus of Project PRIME has been in supporting motorcyclists before they navigate round a bend. As such, PRIME road markings are not envisaged to be installed on bends
- Project PRIME has not installed PRIMEs on single-track or one-way roads and given the focus of casualty reduction specifically on rural roads which tend to be two-lane roads for traffic in both directions, more research would be required before any guidance can be issued
- Project PRIME has not installed PRIMEs on motorways or dual-carriageways and it is not envisaged they would be suitable for these situations. It is possible that the PRIME road markings could conflict with traffic spacing chevrons and with bend radii being much greater the likelihood of motorcyclists losing control on bends is reduced

Details for the characteristics of each trial site is provided including information about the speed limits and 85th%tile speed surveys (see: Appendix C).

2.2 Where did PRIMEs work best?

With 32,213 motorcyclists observed, the following statistically significant results were observed for rider behaviour:

- speed reductions at 10 trial sites
- positive changes in lateral position at the final PRIME gateway marking (closest to the bend) at 15 trial sites
- positive changes in lateral position at the apex of the bend at 13 trial sites
- reductions in braking at 9 trial sites
- increased use of PRIME road markings by motorcyclists across 18 of the 22 trial sites

The findings from Project PRIME Phase 1 provide an indication of potential behaviour change effects that might be observed on bends with similar characteristics (Table 1).

Site characteristics Speed – Gradient - Approach (number of sites in Phase 1)	**Speed**	**Position**		**Braking**	**Gateway**
		PRIME	**Apex**		
Slow – downhill - from a bend (1)		✓✓			✓
Slow – downhill - from a straight (1)	✓✓	✓			✓✓
Slow - flat - from a bend (2)	✓✓	✓✓	✓✓	✓✓	✓✓
Slow - flat - from a straight (2)	✓✓	✓✓	✓✓	✓✓	✓✓
Slow - uphill - from a bend (1)	✓✓		✓	✓	✓
Slow - uphill - from a straight (2)	✓✓	✓	✓✓	✓✓	✓✓
Fast – downhill - from a bend (2)	✓✓	✓✓	✓✓	✓	✓✓
Fast – downhill - from a straight (2)		✓✓	✓✓	✓✓	✓✓
Fast - flat - from a bend (1)		✓✓	✓✓	✓✓	✓✓
Fast - flat - from a straight (4)	✓✓	✓✓	✓✓	✓✓	✓✓
Fast - uphill - from a bend (2)	✓✓	✓✓	✓✓	✓✓	✓✓
Fast – uphill - from a straight (2)	✓✓	✓✓	✓✓	✓	✓✓

Table 1: Behaviour change results across the trial sites

Table 1 provides an overview of the results for each of the twelve site categories. The following legend is used:

- **bold text** – indicates the sites where most behaviour change was observed
- ✓✓ – statistically significant results for behaviour change observed
- ✓ – trends in the data observed (i.e. not statistically significant but almost)
- no tick – no behaviour change was observed

These results represent the combined results across all the sites in each category. It is possible that where significant results are shown for measures these were not found across all sites in that category. For individual site results please refer to the research reports (see: Appendix D).

The information above may assist anyone looking to install the PRIME traffic sign and road markings to consider where they might be most beneficial.

From Phase 1, the results indicate that PRIMEs delivered the greatest behaviour change at the following sites with statistically significant results across all the measures:

- slow – flat – from a bend
- slow – flat – from a straight
- fast – flat – from a straight
- fast – uphill – from a bend

At these sites a range of encouraging results were observed:

- slow – uphill – from a straight
- fast – downhill – from a bend
- fast – downhill – from a straight
- fast – flat – from a bend
- fast – uphill – from a straight

The fewest results for behaviour change were observed at the following sites:

- slow – downhill – from a bend
- slow – downhill - from a straight
- slow – uphill – from a bend

It is important to emphasise that even at sites where less evidence of behaviour change was observed, there were no instances recorded of negative behaviours arising from the installation of PRIMEs. This provides evidence that PRIMEs did not have a detrimental effect on rider behaviour at the pilot locations.

3 PRIME site selection

3.1 Collision data analyses

As PRIMEs are an intervention intended to positively influence rider behaviour, historical data regarding locations where injury motorcycle collisions have occurred may assist in selecting sites for their use. Routine road safety reviews may lead to the identification of cluster sites involving motorcycle collisions at specific bends. It may be the case that due to the spread-out nature of such incidents and the fact that motorcycles make up a small percentage of vehicles an extended reference period may have to be used. This was the approach adopted by Project PRIME where collisions were reviewed over a 10-year period. The initial review of collision data to identify potential sites can be conducted as a desktop activity and regarded as a strategic overview.

Collisions where other contributory factors were recorded (e.g. overtaking or junction conflicts) are beyond the scope of the research conducted so far in Project PRIME. Where other contributory factors are apparent this may mean that PRIMEs are not best suited as a casualty reduction initiative.

Collision data analyses can help to identify sites where PRIMEs may be beneficial to reduce accident risk. However, accident history does not need to be the only factor to determine suitability of a bend for PRIME application. Other considerations are useful to keep in mind.

3.2 Site selection considerations

PRIMEs may be considered as a pro-active measure for bends that motorcyclists may find challenging. In such situations the positive behaviour change may serve to reduce the risk of harm to riders. Identifying such bends could involve input from riders themselves. Another approach could be to use near miss data which is an acceptable method to identify potentially problematic sites. If riders with local knowledge report problems, even if these are not generating accident data, other riders (i.e. less experienced or not familiar using a particular road) may become involved in accidents.

Throughout Project PRIME the trial sites were identified from collision data and reviews of technically demanding bends for motorcyclists. In addition to the desktop reviews, this involved experienced motorcyclists reviewing specific locations for their suitability for the research programme. Motorcyclist involvement could be more significantly increased in bend selection by approaching local motorcycle groups or police motorcycling teams as a way of finding out local bends or routes that are known to riders and may in turn benefit from the application of PRIMEs.

PRIME trial sites had a mixture of bend radii, but actual bend radii was not a determining factor in selecting them.

During Phase 1 of the project there was no active publicity for PRIMEs. This was important in order to measure normal riding behaviour without 'priming' any riders as to how their behaviour might be changed by the PRIME road markings. Also, PRIMEs are meant to be intuitive so they should not need much publicity to educate riders about the desired behaviour change. Where there have been opportunities to engage with riders (i.e. the research interviews) a key message was that they appreciated PRIMEs are not installed using white paint on the roads which motorcyclists avoid due to expected increased loss of traction.

3.3 Site appraisal and preparation

Once the site selection process has been undertaken there are likely to be a number of candidate bends that may be suitable for PRIME application. It is then important to assess the sites based on their readiness for installing PRIMEs either as standalone activities or as part of a road upgrade or engineering programme. It is envisaged that PRIMEs can be installed without the need for expensive road works where the road condition and environment is already suitable for their installation.

However, with sites identified, it was considered beneficial to conduct a site visit to check the location and its suitability for PRIMEs. Particular considerations at potential bend sites may include:

- condition of carriageway surface (both in terms of defects and its ability for road markings to successfully adhere to it)
- locations of any ironwork
- locations of existing road markings, particularly "SLOW" and other markings in traffic lanes that may affect rider behaviour
- locations of existing signs on approach that may distract riders from the PRIMEs or prevent installation of the PRIMEs sign at a suitable location
- vegetation that may affect visibility

Depending upon the issue identified then some action may need to be taken by the road authority prior to installation of PRIME markings and traffic signs.

The Institute of Highways Engineers (IHE) have produced an engineering guidance document to assist with reducing motorcycling collisions named "Guidelines for Motorcycling" (https://motorcycleguidelines.org.uk/the-guidelines/introduction/). This guidance document provides information on key motorcycling challenges such as pot holes, road surface cracks, access chamber covers etc. which may also be relevant to the installation of PRIMEs. Where there are such features in the line of travel for motorcyclists using the PRIME road markings, these ideally need to be addressed before PRIMEs are installed.

Section 4 details the process for the installation of the road markings and sign.

4 PRIMEs design and installation

4.1 Design overview

Installing PRIMEs in a consistent manner using the same designs and approach for traffic signs and road markings as that trialled in the Project PRIME research should yield similar positive results to those seen in the PRIME Phase 1 trials. This document has been prepared to assist others to replicate the approach adopted so as to ensure consistent application.

This will hopefully replicate the benefits of PRIMEs based on the research findings and also support motorcyclists from across the United Kingdom with a consistent understanding of PRIMEs in order to recognise their installation on approach to demanding bends.

The PRIMEs consist of two engineering features: the traffic sign and road marking.

The PRIME traffic sign whilst non-prescribed was designed to be consistent with features of the TSRGD. The shape and colour scheme is consistent with other signs providing information to road users and the motorcycle legend used in other sign details was adopted. The traffic sign design and dimensions are included in Appendix E.

The PRIME road marking is a series of three truncated chevrons positioned on the approach to a bend. The intention is that the markings encourage motorcyclists to ride 'through the gap' and act as a cue for riders to adjust their speed, position and braking behaviour.

Two versions of the PRIME road marking were used depending on the lane width. The PRIME road marking design and dimensions used are included in Appendix F.

The distance between each of the three PRIME road markings was always set out equally. However, at some sites the overall distance for all three PRIME markings was decreased or increased based on motorcycle approach speed and any prior bends.

Before any road trials were conducted, rider and driver interviews were undertaken to assess levels of acceptance of the PRIMEs concept and understanding of the traffic sign and road markings. The results indicated that when the traffic sign was presented before the road marking (as would be experienced on the road) the understanding of the road marking increased from 28% to 79% which was taken as good evidence for using the traffic sign with the road marking. It may be that later research will identify that the sign or road marking could be used individually. Until that research is undertaken it is recommended that bends treated with PRIMEs utilise both road markings and sign.

4.2 Design process

The PRIME design process is set out in five stages covering speed surveys, establishing the PRIME traffic sign and road marking positions, site visit and installation. These are described in more detail below to assist roads authorities who wish to install PRIMEs.

Step 1 – Motorcycle Speed Surveys

Whilst not essential, it is suggested that motorcycle speed measurements are undertaken at potential PRIME sites as this has a direct bearing on the layout of the PRIME markings and signs. Ideally the speed measurement should be undertaken on the direct approach to the bend and within approximately 90m of the commencement of the bend (see: Figure 1). The point 90m in advance of the bend is where the PRIME markings will be sited is therefore the ideal location where a speed survey can be undertaken if feasible.

Various survey methods are available but the more inconspicuous the less they are likely to influence existing rider behaviour. Where possible, a true unimpeded representation of motorcyclist approach speed is best.

Step 2 – Establishing the PRIME traffic sign position

Two factors determine the position of the PRIME traffic sign:

- the position of the first PRIME road marking that a motorcyclist will encounter on approach to the bend. This is the datum point for setting out the PRIME traffic sign
- the sign should be located in advance of the first PRIME road marking in accordance with Traffic Signs Manual Chapter 4 Appendix A 'Sizes of Warning Signs and Siting Details' (TSM). This ensures that the sign is visible to approaching motorcyclists and they have sufficient time available to anticipate the PRIME road markings ahead

As shown in the TSM, the distance the PRIME traffic sign is measured from is the first PRIME road marking encountered by motorcyclists. The distance required is determined by the approach speed of motorcyclists. This information will have been determined from the previously detailed speed measurements.

Local site constraints and topography may have an impact on the final location of the PRIME traffic sign. It is not critical that the PRIME traffic sign is situated within view of the PRIME road markings. It may be positioned in advance of a bend prior to the road markings. The most important factor is that the PRIME traffic sign has clear forward visibility to it.

The PRIME traffic sign itself is a standard size, which does not vary depending upon the approach speed of motorcyclists or other traffic. The signposts used in the PRIME trials are passively safe and have been selected for conditions experienced in Scotland. It is recommended that the roads authority select a suitable signpost based on their own experience and procedures.

Step 3 – Establishing the PRIME road marking position

Identifying the position of the PRIME road marking at the bend is critical to the success of the PRIMEs. The initial dimension required for setting out PRIME road markings and the sign is the distance of the PRIME road marking from the tangent point of the bend (shown as 'B' in Figure 1). The PRIME research has identified that this distance varies depending upon the recorded approach speed of motorcyclists before the use of PRIMEs.

Generally, where motorcyclists approach a bend at speeds less than 50mph 'PRIME Marking 3' is required to be closer to the start of the bend. Conversely where approach speeds generally exceed 50mph, 'PRIME Marking 3' should be sited further back from the bend. The approach speed of motorcyclists also determines the spacing between 'PRIME Marking 1, 2 and 3' (see: Table 2).

For a lower approach speed of 50mph and less, it is recommended 'PRIME Marking 3' is sited in the range of 15m to 25m from the commencement of the bend and the spacing between 'PRIME Marking 1, 2 and 3' is between 20m to 25m. The spacing between the 'PRIME Marking 1, 2 and 3' should always be equal.

For a higher approach speed greater than 50mph it is recommended that 'PRIME Marking 3' is sited in the range of 25m to 35m from the commencement of the bend and the spacing between 'PRIME Marking 1, 2 and 3' is 30m. The spacing between the 'PRIME Marking 1, 2 and 3' should always be equal.

It is possible there will be other road markings on the road on approach to the chosen PRIME bend (such as 'SLOW'). In this case the placement of the PRIME road markings can be adjusted as part of the design to make sure there is no overlap or conflict. Similarly the presence of previous bends or nearby access/junctions may require an adjustment in the PRIME design and/or spacing to achieve the optimal locations. In the research trials, the spacing was not adjusted below 20m spacings and for consistency this is considered the minimum.

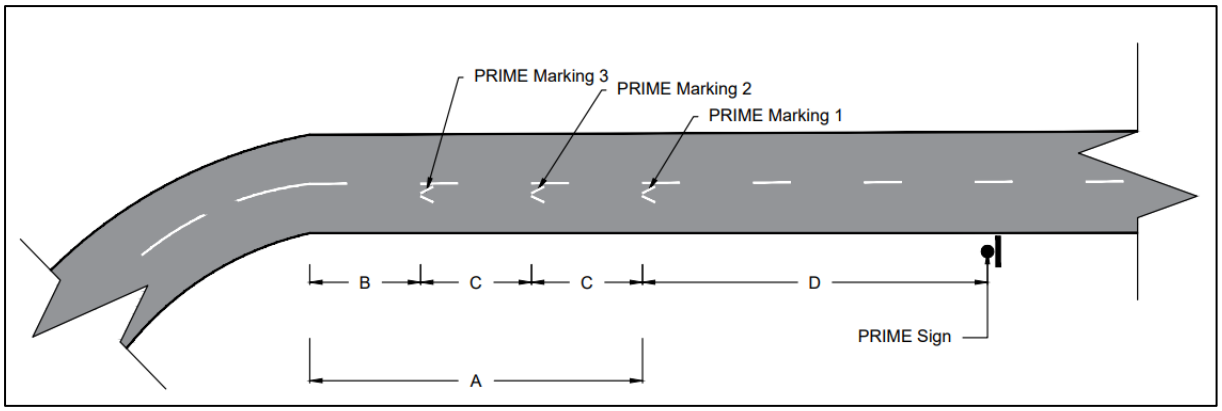


Figure 1: Setting out PRIME Road Markings and Signs

A	B	C	D
85th percentile speed of motorcycles (mph) on approach to bend[1]	Distance from start of bend to closest PRIME marking. (PRIME Marking No. 3)	Spacing of PRIME markings	Distance of PRIME Marking No.1 to PRIME traffic sign
Up to 50mph	15m -25m	20m – 25m	To be sited in accordance with Traffic Signs Manual Chapter 4 Appendix A 'Sizes of Warning Signs and Siting Details'.
Over 50mph	25m – 35m	30m	

Table 2: Setting out PRIME Road Markings and Signs

Notes

If speed surveys are conducted, it is suggested that the 85th percentile speed be measured on the approach to the bend where the PRIME markings are to be installed. This would typically be up to 90m from the commencement of the bend (See Figure 1, distance A

The PRIME road markings are a series of three pairs of truncated chevrons and are positioned towards the centreline of the approach lane to the bend for a left-hand bend. On the approach to a right-hand bend the PRIME markings are positioned towards the edge line.

It is important to retain a gap between the PRIME road marking and the carriageway centre or edge line so it is clear to motorcyclists that they are approaching a PRIME marking and there is an area on the lane free of road marking material.

To allow PRIMEs to be installed on narrower roads an alternative marking is available which conveys the same message but is a shorter length than the standard marking. This shorter marking is used when the lane width is 3.5m or less.

The PRIME road marking material selected for use by Transport Scotland in Project PRIME was a permanent tape marking (3M Stamark A380 ESD). This material is a factory product which meets specifications set out in BS EN 1436. It offers a high value of skid resistance, has a high level of retro-reflectivity and luminance which is important for conspicuity in all conditions. As the product is a structured material it also allows surface water to pass over its profile whilst not allowing water to sit on the material where motorcyclists would be riding over it. Other high performance road markings may be available with similar characteristics and may therefore be suitable for PRIMEs application.

Motorcyclists are often concerned about the grip of traditional road markings (i.e. white paint). By using a permanent tape marking with a high grip this should reduce concerns from motorcyclists about riding over the tape marking.

If a tape marking is proposed, particular care should be given to follow the manufacturer and supplier installation guidance to ensure the tape is secured to the road surface. This will reduce the possibility of premature failure of the product from taking place.

As with all road markings, preparation of the road surface is important and a clean and dry surface is considered essential for installation of the tape marking. Designers and Clients should ensure the contractor selected for installation is competent and experienced in installing their chosen product.

Step 4 – Chosen PRIME Bend Site Visit and Concluding the Design Process

Prior to installation of the PRIME road markings and signs a site visit will allow the opportunity to review the chosen locations to ensure appropriateness.

For the Transport Scotland PRIME Trials, the Design Team installed roadside wooden posts on the verge to mark out where the PRIME traffic sign and three PRIME road markings would be installed. These were easily adjusted and enabled the Design Team to review the traffic sign and road marking positions for suitability and to ensure that no conflicts were present, such as road surface defects, visibility, etc.

If possible, having expert/staff motorcyclists available to ride through the bends is a benefit as they can provide valuable feedback on the approach characteristics of the bend where PRIMEs are to be installed. However, if roads authorities are unable to arrange site rides by motorcyclists this should not preclude the use of PRIMEs.

Once the marking up of the traffic sign and road markings is agreed, temporary spray markings can be applied on the verge next to the posts allowing the posts to be removed from the site. Measurements can then be taken of the exact layout for non-prescribed signs applications.

In order to adhere to best practice the guidance contained in the General Principles and Scheme Governance General Information (GG119) of the Design Manual for Roads and Bridges (DMRB) was followed. Stage 1/2 and Stage 3 Road Safety Audits were undertaken for each installation on the Scottish Trunk Road Network. If required, designers should follow the relevant Road Safety Audit procedure used by the Overseeing Organisation for their own PRIMEs installations. It may be beneficial if at least one member of the Road Safety Audit team has experience of motorcycling.

As the PRIME road marking and traffic sign are not approved signs within the TSRGD, they required Non-Prescribed Signs (NPS) approval from the respective Overseeing Organisation.

Approval for their use on the Scottish Trunk Road Network had to be sought from Scottish Ministers on a site-by-site basis with Non-Prescribed Signs approval gained for every individual PRIME site. The form is available here. Other road authorities in Scotland follow the same process and procedure, and submissions should be sent to: non-prescribedsigns@transport.gov.scot for consideration. Any deviation from the layout shown in a non-prescribed signs authorisation may mean the PRIME marking is not authorised.

Outwith Scotland, designers should follow the relevant procedure for having non-prescribed signs and road markings approved through their respective Overseeing Organisation.

Once the design process is concluded, including any Road Safety Audits, Non-Prescribed Signs approval or any other road authorities specific requirements, the chosen PRIME bend sites can progress to the installation phase.

Step 5 – Installation

Installation of the PRIME traffic sign and road markings is a simple engineering measure which should be routine for roads authorities and their contractors.

Experience has shown that the road markings for three or four PRIME sites can be achieved in a single day, but this will be determined by the geographic location of the sites. The installation of the PRIME traffic sign should also be achievable in a short period of time, typically a foundation and post installation could be completed in a single day with the sign erected on the post on a subsequent day.

To aid setting out of the road markings, it may be possible to make a simple template for the PRIME road markings off-site, which can then be used on site to speed up the installation process and reduce the time required on site. This reduces road worker exposure to potential harm on the road and disruption to the travelling public caused by traffic management operation.

5 PRIME site monitoring and evaluation

5.1 PRIME site monitoring

Extensive scientific trials have been conducted during the research phases of Project PRIME in order to develop the knowledge and understanding upon which this document is based. It is not envisaged that those installing PRIMEs will be required to conduct their own research, although feedback on their performance is very welcome. However, it may be necessary to monitor sites where PRIMEs are installed in order to measure behaviour change. There are a range of options detailed in the scientific papers that have been published (see: Appendix A).

5.2 Safety performance monitoring

In order to monitor the effectiveness of PRIMEs authorities may wish to continue to monitor safety performance. Each authority will have their established processes and best practise for monitoring collisions which can be used to inform the success of PRIMEs.

5.3 PRIME site maintenance

PRIMEs signs and road markings should be subject to regular inspection, particularly before and during the motorcycling season in order to maximise their effectiveness. It is suggested that they are entered onto a formal asset register and included in routine maintenance surveys. Particular attention is needed for the road markings to ensure they remain bonded to the carriageway surface, with remedial measures carried out as soon as possible to repair any missing or deteriorated markings. As with all road markings, areas subject to higher traffic levels, or which are often subject to wet/damp conditions appear more likely to deteriorate quickly.

It is important to liaise with Police to allow any issues with PRIMEs to be reported, particularly if collisions, near-misses or other unintended outcomes occur.

Appendices

Appendix A – scientific papers reporting Project PRIME results

Stedmon, A.W., McKenzie, D., Langham, M., McKechnie, K., Perry, R., and Wilson, S. (2021). Safeguarding motorcyclists: Trialing new PRIME road markings for casualty reduction. *Transportation Research Part F: Psychology and Behaviour* 83(2021), 333-350
https://www.sciencedirect.com/science/article/abs/pii/S1369847821002515

Stedmon, A., McKenzie, D., Langham, M., McKechnie, K., Perry, R., and Wilson, S. (2022). Safer road users: Investigating the influence of PRIME road markings on motorcycle rider behaviour. *Transportation Research Part F: Psychology and Behaviour* 83(2021), 368-385

https://www.sciencedirect.com/science/article/abs/pii/S136984782200256X

Stedmon, A., McKenzie, D., Langham, M., McKechnie, K., Perry, R., Wilson, S., Mackay, M. and Geddes, S. (2023). PRIME road markings for motorcycle casualty reduction. In, D. Golightly, N. Balfe, and R. Charles (eds) *Contemporary Ergonomics and Human Factors 2023, Chartered Institute of Ergonomics and Human Factors*, 64-72

https://publications.ergonomics.org.uk/uploads/PRIME-Road-Markings-for-Motorcycle-Casualty-Reduction-in-Scotland.pdf

Stedmon, A., McKenzie, D., Langham, M., McKechnie, K., Perry, R., Wilson, S., Mackay, M. and Geddes, S. (2024). Participatory ergonomics: The design of PRIME road markings for motorcycle casualty reduction. In, D. Golightly, N. Balfe, and R. Charles (eds) *Contemporary Ergonomics and Human Factors 2023, Chartered Institute of Ergonomics and Human Factors*.

Stedmon, A., McKenzie, D., Langham, M., McKechnie, K., Perry, R., Wilson, S., Mackay, M. and Geddes, S. (2024). Project PRIME: Road markings for motorcycle casualty reduction (an overview of findings from 2020 to 2022). *Ergonomics, 1-16*.
https://doi.org/10.1080/00140139.2024.2361304

https://www.tandfonline.com/doi/full/10.1080/00140139.2024.2361304

Appendix B – Project PRIME trial site details

Site & Road	Bend direction	Location (What3words)	Google Streetview
2020			
Appin House (A828)	Left	tasks.crunching.race	https://maps.app.goo.gl/ZSLsKMh5MJbkEApv6
Appin House (A828)	Left	clots.fallback.warned	https://maps.app.goo.gl/5NUxMLHwd6PpLvbK9
Kingshouse (A82)	Right	kipper.smirking.expose	https://maps.app.goo.gl/qL7yVEnmNc7atcMz7
Kingshouse (A82)	Left	bound.fond.grandest	https://maps.app.goo.gl/Zt5ckDpFnBrRwxT56
Loch Lubhair (A85)	Left	funnels.vanish.snowstorm	https://maps.app.goo.gl/cwzq73xzdfBn8VGH7
Loch Lubhair (A85)	Right	stand.magic.pollution	https://maps.app.goo.gl/HqMqMuKXEetc9wuj6
Rob Roy's Dip (A85)	Right	reserve.importing.liberty	https://maps.app.goo.gl/DyDR8yYsE55hkNRK7
Rob Roy's Dip (A85)	Left	gates.equipment.rocks	https://maps.app.goo.gl/3Th6tDsAR7w69r5g6
Rob Roy's Dip (A85)	Right	shuttle.conquests.takers	https://maps.app.goo.gl/NH2pqJdNEUA71SJb8
Rob Roy's Dip (A85)	Left	lawfully.buckling.heap	https://maps.app.goo.gl/NH2pqJdNEUA71SJb8
2021			
Taynuilt (A85)	Left	goodbye.cherry.seeing	https://maps.app.goo.gl/xNtG9vaajvEVrn9AA
Inveruglas (A82)	Left	arch.admires.flashback	https://maps.app.goo.gl/4dXD8tPoCMKg1RUS7
Runacraig (A84)	Left	dearest.reclusive.manual	https://maps.app.goo.gl/TigharPPsYTsxDUz9
Runacraig (A84)	Left	brimmed.moral.dives	https://maps.app.goo.gl/xAzwcYp38nMXUWaSA
Dunira (A85)	Left	finally.universes.choice	https://maps.app.goo.gl/Hma2cd4CFHQZfSok6
Bonawe (A85)	Left	ballots.narrowest.conveys	https://maps.app.goo.gl/DoAu4mU4jNuQhpDK6

2022			
Dailnamac (A85)	Left	loaf.deed.alpha	https://maps.app.goo.gl/7YLif6FAV6jRGwLq9
Pulpit Rock (A82)	Left	tango.regularly.robe	https://maps.app.goo.gl/K769eFJ3NwmUEmp76
Butterbridge (A83)	Left	puzzled.applied.novelists	https://maps.app.goo.gl/6p8XhjvxppZhxKJs7
Middle Kames (A83)	Left	friday.targeted.height	https://maps.app.goo.gl/ZMqmd3YCXM3wA3Tf9
Salmon Draught (A83)	Left	draw.snapping.decimals	https://maps.app.goo.gl/3hFweDemX92shHdf7
Salmon Draught (A83)	Left	fearfully.hike.magnets	https://maps.app.goo.gl/GcfYQKC4rhSoCPfy7

Appendix C – Project PRIME trial site characteristics

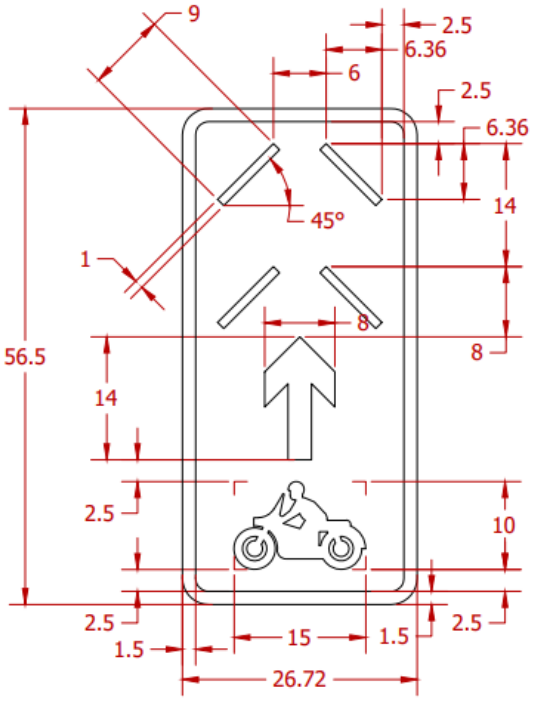
Site characteristics Speed – Gradient - Approach	**Location**	**Speed limit**	**85th% percentile speed range (mph)**
Slow downhill from a bend	Appin House North	60	40.5
Slow downhill from a straight	Runacraig North	60	41.3
Slow flat from a bend	Pulpit Rock	50	40.7
	Loch Lubhair West (RH)	60	42.7 (RH)
Slow flat from a straight	Rob Roys Dip East (RH)	60	47.1 (RH)
	Dunira	60	47.9
Slow uphill from a bend	Bonawe	60	42.9
Slow uphill from a straight	Runacraig South	60	40.7
	Inveruglas	50	40.8
Fast downhill from a bend	Rob Roys Dip East	60	51.6
	Rob Roys Dip West (RH)	60	53.2 (RH)
Fast downhill from a straight	Dailnamac	60	49.7
	Butterbridge	60	55.9
Fast flat from a bend	Loch Lubhair East	60	53.7
Fast flat from a straight	Salmon Draft North	60	52.6
	Appin House South	60	52.8
	Salmon Draft South	60	53.7
	Kingshouse South	60	63.9
Fast uphill from a bend	Middle Kames	60	50.7
	Rob Roys Dip west	60	51.6
Fast uphill from a straight	Taynuilt	60	53.1
	Kingshouse North (RH)	60	59.7 (RH)

Appendix D – Project PRIME trial site results

Site	Rider Behaviour				
	Speed	**Position at PRIME**	**Position at Apex**	**Braking**	**Use of Gateway**
2020					
Appin House *north*		Sig			Trend
Appin House *south*	Sig	Sig	Sig	Trend	Sig
Kingshouse *north*	Trend	Sig			Sig
Kingshouse *south*		Sig	Sig	Trend	
Loch Lubhair *east*		Sig	Sig	Sig/Trend	Sig
Loch Lubhair *west*	Sig	Sig	Sig	Sig	Sig
Rob Roy's Dip *east 1*		Sig		Trend	Sig
Rob Roy's Dip *east 2*		Sig	Sig	Trend	Sig
Rob Roy's Dip *west 1*	Sig	Sig	Sig	Trend	Sig
Rob Roy's Dip *west 2*	Sig	Sig	Sig	Trend	Sig
2021					
Taynuilt	Sig		Sig	Trend	Sig
Inveruglas	Trend	Trend	Sig	Sig	Trend
Runacraig – *north*	Sig	Trend			Sig
Runacraig – *south*	Sig	Trend		Sig	Sig
Dunira	Sig	Sig	Sig	Sig/Trend	Sig
Bonawe	Sig		Trend	Trend	Trend
Landrick Bends	*no effect*	*no effect*	*no effect*	*Trend*	*no effect*
2022					
Dailnamac		Sig	Sig	Sig/Trend	Sig
Pulpit Rock			Sig	Sig/Trend	Sig
Butterbridge		Sig		Trend	Sig
Middle Kames	Trend	Sig		Sig	Sig
Salmon Draft – *north*	Sig			Sig/Trend	Sig
Salmon Draft – *south*	Trend	Sig	Sig		Sig
Carrick	*no effect*	*no effect*	*no effect*	*no effect*	*no effect*

Appendix E – PRIME traffic sign design and dimensions

SIGN APPEARANCE



SIGN DIMENSIONS IN STROKE WIDTHS

SIGN COLOURS
Border = White
Lane symbols = White
Arrow = White
Motorcycle = White
Background = Blue.
No. 109
(Middle blue)
to BS 381C
Material = Reflective Class R2

Sign designed to the requirements contained in the TSRGD 2016, Schedule 11, Part 2.

Arrow symbol to;
TSRGD 2016, Schedule 12, Part 5, Item 1B

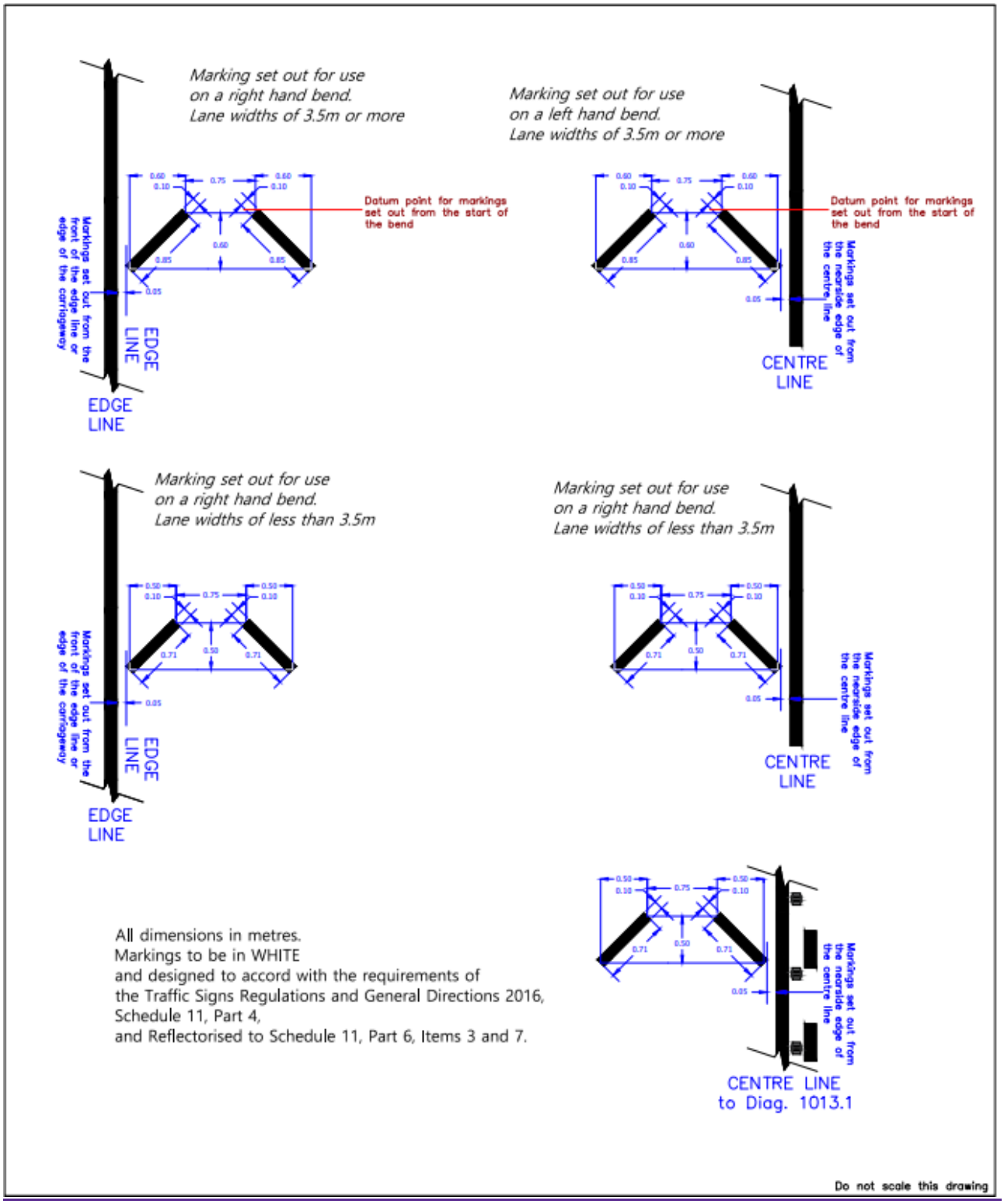
Motorcycle symbol to;
TSRGD 2016, Schedule 12, Part 11, Item 27

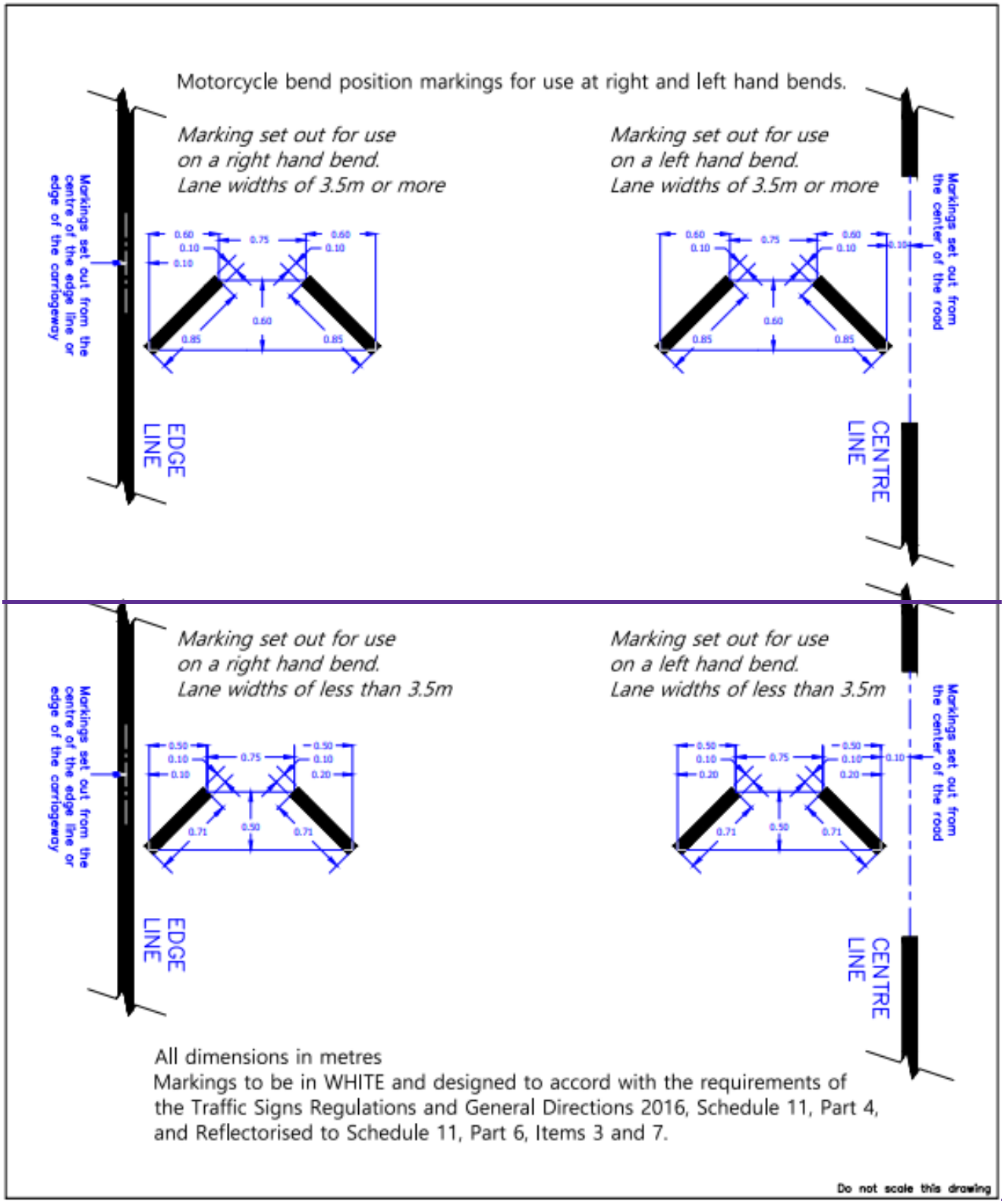
Overall sign size based on 100mm 'x' height were 1sw = 25mm
1415mm height
670mm wide.

Motorcycle Project PRIME

Motorcycle bend position sign

Appendix F – PRIME road marking design and dimensions


Marking set out for use
on a right hand bend.
Lane widths of 3.5m or more
Datum point for markings set out from the start of the bend
Markings set out from the front of the edge line or edge of the carriageway
EDGE LINE
EDGE LINE
Marking set out for use
on a left hand bend.
Lane widths of 3.5m or more
Datum point for markings set out from the start of the bend
Markings set out from the nearside edge of the centre line
CENTRE LINE
Marking set out for use
on a right hand bend.
Lane widths of less than 3.5m
Markings set out from the front of the edge line or edge of the carriageway
EDGE LINE
EDGE LINE
Marking set out for use
on a right hand bend.
Lane widths of less than 3.5m
Markings set out from the nearside edge of the centre line
CENTRE LINE
All dimensions in metres.
Markings to be in WHITE
and designed to accord with the requirements of
the Traffic Signs Regulations and General Directions 2016,
Schedule 11, Part 4,
and Reflectorised to Schedule 11, Part 6, Items 3 and 7.
Markings set out from the nearside edge of the centre line
CENTRE LINE
to Diag. 1013.1
Do not scale this drawing



Motorcycle Project PRIME

Road Markings - Left & right bends