

NZRF RPM REMOVAL GUIDE

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1 Introduction and Need for the Guide

Raised pavement markers (RPM's) are routinely removed from the pavement because of their relatively short life, the necessity of removing them prior to resealing of pavements and the revision of pavement marking layouts.

The replacement of damaged or non performing RPM's will commonly require the removal of the existing one to ensure that the performance of new one is not compromised. The specific requirements are specified in Clause 11 of NZTA P 14:1995.

The existence of RPM's may have an adverse affect on subsequent resealing operations, and they need to be removed to enable effective seal application.

Although there are a number of methods that may be used to remove RPM's, the cost-effectiveness of particular treatments is dependent on the quantity of markers to be removed.

Mechanical destruction is the most common means of breaking the bond between RPM's and the pavement.

Some damage is likely to occur where the adhesive is torn from the pavement. The removal of stud mounted RPM's is likely to leave a hole in the pavement surface. This damage needs to be repaired to ensure that the pavement strength and integrity is not compromised. The material used needs to match the pavement for strength, moisture barrier and appearance.

This guide is aimed at providing a general description of the more common RPM removal methods, with a simplified method for the selection of an appropriate removal system and a description of appropriate pavement repair methods. References to appropriate legislation are also provided.

Although the removal methods described in this guide are legitimate and practical, it is recognised that not all methods may be available in all locations.

2 Scope

This document provides guidance to principals, contract specifiers, contractors and subcontractors on the methods used to remove RPM's from paved surfaces.

The document is aimed at providing a useful minimum standard interpretation of current Road Controlling Authority requirements for RPM removal.

The document also provides detailed descriptions of RPM removal methods and the associated personal protective equipment required for such activities.

3 Application of the Guide

This document is limited to the removal of RPM's and the subsequent repair of the pavement surface. Methods used to modify or alter pavement surfaces themselves are not covered.

This document does not specify the requirements for associated processes such as temporary traffic management.

It is intended that this document be used in conjunction with NZRF Safety, Health and Environment Guide.

4 Definitions and References

4.1 References

NZRF Safety, Health and Environment Guide
 NZRF Roadmarking Materials Guide
 NZTA P 14 Specification for Installation of Raised Pavement Markers
 NZTA M 12 Specification for Raised Pavement Markers
 NZTA M 29 Specification for Internally Illuminated Pavement Markers

4.2 Definitions

“Internally Illuminated Raised Pavement Marker”	Raised Pavement Marker fitted with light emitting diodes. They may be continuously lit or linked to sensors monitoring ambient conditions
“Raised Pavement Marker”	Raised Pavement Markers (RPM's) are small objects applied to the pavement surface aimed at providing visible / audible / tactile feedback to motorists. They are commonly ceramic, metallic or high impact plastic. They may contain a retro-reflective element aimed at providing night-time visibility or be internally illuminated. They may have a flat base, be mounted onto a plate or have a short stud
“Reseal”	The activity of applying a coat of chipseal or slurry over an existing pavement surface. This activity requires the removal of existing RPM's which may adversely affect paving activities, compromise seal integrity and / or subsequently appear through the completed seal
“Type A RPM”	Retroreflective raised pavement marker
“Type B RPM”	Non retroreflective raised pavement marker

5 RPM Removal and Pavement Repair Standards

Clause 11 of NZTA P 14:1995 prescribes the number of defective RPM's which may remain at any one location.

Clause 9 of NZTA P 14:1995 specifies the requirements for the pavement repair following removal of an RPM.

While particular methods may limit the degree of damage to the pavement surface, the cost-effectiveness of particular treatments is highly dependent on the quantity of RPM's to be removed.

Effective RPM removal is managing the balance between limiting cost and creating an increased risk of subsequent pavement failure.

Removal and pavement repair methods should be prescribed in contract quality plans / methodology statements.

6 RPM Removal Principles

1. Defective RPM's which may reduce the effectiveness of their replacements must be removed
2. RPM's which may adversely affect paving activities, compromise seal integrity and / or subsequently appear through the completed seal are to be removed
3. The removal method used is to minimise the damage to the surrounding pavement and to the RPM being removed
4. Any damage to the pavement caused by removal is repaired immediately. The repair is aimed at ensuring pavement is waterproof and void filling matches seals as closely as practical.

6.1 Supporting Principles

1. Prior to the commencement of work, the client's representative must approve the proposed method and determine acceptability standards
2. All RPM removal works must be carried out in accordance with the ordinances, statutes and laws relevant to the various jurisdictions
3. All RPM removal works must be carried out in such a manner as to not endanger the health, safety or amenity of employees or the public in general
4. All defective / damaged RPM's and detritus related to their removal are removed from the site and disposed of in an approved disposal site.

7 Selection of Removal Method

There is no one single method of RPM removal that will work well / be cost effective in all of the scenarios commonly encountered in the roadmarking environment.

However, given an understanding of the rpm fixing system used and the characteristics of the particular pavement types, it is possible to determine the method most likely to achieve a satisfactory end result.

The lower technology / more labour intensive methods are more cost effective for the removal of small numbers of RPM's.

A method selection matrix is provided below. The information supporting the decision rationale is provided in following sections.

It is strongly recommended that the supporting information is read and understood before selections using the matrix are made.

7.1 Selection Matrix

The following matrix is aimed at describing methods that may be appropriate for a range of marking types on a range of pavement surfaces. The key for the methods is as follows:

1. Shearing of bond using bolster, pick or air chisel
2. Shearing of bond using blade on mobile plant such as a bobcat
3. Mechanical destruction by Grinding or Scabbling
4. Destruction / softening of glue bond combined with levers

Type of RPM System to be Removed	Type of Pavement Surface				
	Chipseal	Open Graded Asphaltic Concrete	Dense Graded Asphaltic Concrete	Concrete	Pavers
Surface mounted using hot-melt	1, 2, 3	1, 2	1, 2, 3	1, 2, 3	1
Surface mounted using epoxy or construction adhesive	3, 4	3, 4	3, 4	3, 4	4
Plate or stud mounted using hot-melt or epoxy	4	4	4	4	4*

* Care is required to ensure surface of paver is not damaged or paver is not dislodged or loosened.

8 Raised Pavement Marker Fastening Methods

The system for fastening / gluing the RPM to the road surface has a major impact on the removal and repair method selection.

Raised pavement markers are typically either:

1. Surface mounted, or
2. Stud or plate mounted.

Surface mounted RPMs in themselves do not penetrate the pavement and repair methods are related to making good any damage caused by breaking the bond between the RPM and pavement.

Stud or plate mounted RPM's are inherently more difficult to remove. Obviously a depression / hole in the pavement results from the removal of these RPM's.

Adhesives used to bond the RPM to the pavement are typically:

1. Hot-melt bitumen, or
2. Epoxy (sometimes used to fasten stud or plate mounted RPM's to pavement or to fasten RPM to concrete).

The bitumen bond with a surface mounted RPM is more easily broken when cold / chilled.

The epoxy or bitumen bond with a stud or plate mounted RPM is weakened / destroyed by heat.

Note: Although self-adhesive RPM's and those glued using single-pack construction adhesive are sometimes encountered, their removal methods are similar to hot-melt glued surface mounted RPM's.

9 Raised Pavement Marker and Glue Types

A wide range of RPM's and glues is used by the roadmarking industry. Information on the use and characteristics of each of these RPM's is provided in the NZRF Roadmarking Materials Guide, available in electronic format on the NZRF Website - www.nzrf.co.nz

10 Reasons for RPM Removal

There are three primary reasons to remove RPM's from the pavement:

1. Marking is obsolete / layout is being changed
2. RPM is defective and is likely to compromise its replacement
3. RPM's are likely to compromise resealing operations.

10.1 Marking is Obsolete / Layout is being Changed

When removing pavement markings which incorporate RPM's, all of these must be removed to ensure that road-users are not confused by any stray RPM's that were used in conjunction with the old markings.

Similarly, where there is a change in approach angle to a set of markings, the RPM's need to be removed and realigned to optimise their performance.

10.2 Marker is Defective and may Compromise Performance of Replacement RPM

Care needs to be taken to ensure that RPM's used to replace defective ones are not shadowed by the existing defective one. NZTA P 14 sets out the requirements for placement of the new RPM and the requirement to remove the failed RPM.

10.3 RPM is Likely to Compromise Resealing Operation

Removal of RPM's should be considered prior to resealing of the road surface for a variety of reasons.

Resealing over the top of existing RPM's may:

1. Have an adverse impact on sealing process/ equipment. The size and shape of RPM's (approx 100mm square by 20mm high) presents a shape that may impact on paving / sealing machinery
2. Result in a breakdown of some seal types (debonding) due to the extra stresses imposed on them by the nature of the RPM
3. Result in the reappearance of the RPM either immediately or sometime after reseal
4. Impact on the reinstatement of markings following the reseal.

Complete removal may not be required but must be sufficient to mitigate the potential problems mentioned above.

11 Pavement Characteristics

Pavement surfaces on roads are designed to provide a dust free, waterproof, skid resistant surface on which the motorist may travel safely. The characteristics that may be compromised by RPM removal are related to change in surface texture, ponding and membrane integrity.

11.1 Membrane Integrity

A key component in a chipseal pavement is the integrity of the waterproof membrane that is formed between the wearing course and the underlying basecourses. This membrane is particularly sensitive to damage from removal processes and / or "over-enthusiastic" removal. The most common problem caused by a failure of membrane is the development of potholes either immediately, or over time as water gets into the pavement.

12 Pavement Issues

A wide range of materials and structures are used on pavements in New Zealand. A critical component in the selection of the appropriate line removal method is an understanding of the pavement surface, its performance characteristics and how these characteristics may be adversely affected by the line removal operation.

For further information on pavement types reference should be made to the NZRF Line Removal Guide.

The issues related to removal of RPM's from the various pavement types are as follows:

12.1 Chipseal

The issues relating to RPM removal on chipseals are destruction of membrane integrity and / or ponding or water.

12.2 Open Graded Porous Asphalt

The issue of RPM removal on open graded asphalt is primarily one of the clogging of the drainage courses.

12.3 Slurry Seals

The issue of RPM removal on slurry seals is the destruction of the bond between the slurry and the substrate and / or within the slurry itself.

12.4 Concrete

The issue of RPM removal on concrete is the loss of its finished surface. Localised spalling of surface may occur with extreme heat.

Removal of RPM's on patterned concrete with coloured pigments and sealing compounds may result in the exposure of aggregate and a contrasting background colour, possibly requiring rectification.

12.5 Block Paving

The issue of RPM removal on pavers is the maintenance of surface texture / appearance of the surface. RPM removal on these pavements can cause:

- Destruction of pavers
- Abrasion and pitting of surface
- Spalling of edges and cracking
- Loss of sand between segments allowing excessive movement
- Change of appearance of surface
- Change of colour of paver.

12.6 Specialist Coatings (Coloured & Antiskid)

It is unlikely that any RPM removal process would be successful on such surfaces without seriously compromising the surface characteristics.

13 Removal Methods

There are three principal methods related to RPM removal:

1. Shearing of glue bond (methods 1 & 2 in selection matrix)
2. Partial or full mechanical destruction / grinding or scabbling (method 3 in selection matrix)
3. Destruction / softening of glue bond combined with levers used to detach RPM from pavement surface (method 4 in selection matrix).

14 Partial or Full Mechanical Destruction of RPM Body

Partial or total destruction of the RPM body is appropriate where the pavement is to be resealed.

A sufficient degree of reduction in height / profile is carried out to minimise the impact of the remaining RPM on resealing operation / subsequent seal quality.

For large number of RPM's, this height reduction is conducted by traversing over the RPM with a grinder or blade.

For smaller numbers handheld masonry breaker, grinders, air chisel, brick bolster, pick or axe may be used to remove all or part of the RPM from the pavement.

14.1 Advantages of Full or Partial Destruction of RPM

Grinding off or blading off RPM's is one of the most cost-effective methods of removing large numbers of RPM's off pavements.

14.2 Disadvantages of Full or Partial Destruction of RPM

Parts of, or entire RPM's, may be projected from the blade / grinder / pick etc with considerable force. The direction of travel is somewhat random.

This method of RPM removal results in detritus which must be cleared from the site.

The results are highly dependent on the pavement surface conditions, the controllability of the machine, the skill of the operator and the cleanup methods used.

14.3 Full or Partial Destruction of RPM Equipment

Grinding is achieved by the use of motorised, high-speed rotation of hardened steel or tungsten carbide cutters. The orientation and pressure on the cutter head and the depth of grinding is continuously adjusted during operation to achieve optimum results. The device is commonly mounted on a specialist multi-purpose rubber tyred machine e.g. a Bobcat.

A push-along grinder is a comparatively inexpensive item of equipment that can effectively be operated by a single operator.

Handheld masonry breakers, air chisels, brick bolsters or axes are more cost effective for low numbers of RPM's or when removal is sporadic.

15 Shearing of Glue Bond

Shearing of the glue bond is appropriate where the RPM is of a surface mounted type and the adhesive is bituminous.

To shear the bond a wide flat blade is driven across the joint parallel to the pavement surface. Where RPM's are to be re-used, the blade should be driven from the side to minimise damage as typically RPM's are stronger at the sides.

This method works best when the ambient temperature is low. Where RPM removal is required at elevated road / ambient temperatures, the RPM should be cooled / chilled immediately before shearing glue bond.

15.1 Advantages of Shearing of Glue Bond

This method minimises damage to both the RPM and the pavement substrate. With care and skill RPM's may be reused.

High efficiency rates can be achieved.

15.2 Disadvantages of Shearing of Glue Bond

This method is not suitable for stud mounted RPM's or those mounted using two-pot glues.

Parts of, or entire RPM's, may be projected from the blade / grinder / pick etc with considerable force. The direction of travel is somewhat random.

15.3 Shearing of Glue Bond Equipment

Specialist blades are available for skid steer equipment which are claimed to remove RPM's with minimal damage at high removal rates.

Pneumatic spud bars, air or electric powered floor tile removers, or air chisels are cost effective for smaller quantities.

Picks, handheld air chisels, brick bolsters or axes are more cost effective for low numbers of RPM's or when removal is sporadic.

16 Destruction / Softening of Glue Bond

Destruction of the glue bond is appropriate where the RPM is of a stud mounted type and / or the adhesive is two-pot.

The RPM is heated to a temperature at which the bond is destroyed or significantly weakened and a lever(s) is used to prise the RPM from the surface. For stud mounted RPM's two levers are used, one on each side, to lift the RPM straight out of the mounting hole.

16.1 Advantages of Destruction / Softening of Glue Bond

With care metal stud mounted RPM's can be removed with minimal / repairable damage.

16.1 Disadvantages of Destruction / Softening of Glue Bond

Non-metallic RPM's are damaged / destroyed.

Noxious fumes may be given off.

Process is relatively slow and results are dependent on skill of the operator.

16.1 Destruction / Softening of Glue Bond Equipment

Gas wands used for RPM application can be used.

Specialist lever systems are available for the removal of stud mounted RPM's.

17 Pavement Repairs

Clause 9 of NZTA P 14:1995 specifies the requirements for the pavement repair following removal of an RPM.

Removal and pavement repair methods should be prescribed in contract quality plans / methodology statements.

While particular methods may limit the degree of damage to the pavement surface, there will always be some degree of damage. For pavement types other than bituminous ones, the damage may be irreparable or require replacement of individual paver(s).

The common types of surface conditions following RPM removal from bituminous pavements are:

1. RPM/glue bond has sheared leaving RPM adhesive intact on surface
2. RPM removal has created a shallow depression slightly larger than RPM
3. RPM removal has created a deep depression in pavement
4. Stud mounted RPM removal has resulted in hole in pavement.

17.1 Approved Methods of Seal Repair

There are a number of options related to the repair of the pavement, with a range needing to be in place to reflect the varying degrees of damage which may occur on site.

The methods used need to be agreed with the road-owner and described in the contract quality plan.

17.2 RPM/glue bond has sheared leaving RPM adhesive intact on surface

Little or no repair should be required when the glue bond shears cleanly leaving the majority of the bituminous adhesive in place. If the adhesive is proud of the surface it could be lowered by the application of heat.

17.3 RPM removal has created a shallow depression slightly larger than RPM

When a shallow depression is created, this needs to be filled with an appropriate quantity of fine chip held in place with bituminous RPM adhesive. The chip should be lightly tamped to smooth it out. The principal aim is to ensure that water does not pond in the depression.

17.4 RPM removal has created a deep depression in pavement

Where a deep depression has been formed, an assessment is required to determine if the membrane has been destroyed or significantly compromised.

If the membrane strength is in question, repairs need to be carried out in strict accordance with client's representative's instructions.

Where the membrane is not significantly impacted, the depression can be filled with an appropriate quantity of fine chip held in place with bituminous RPM adhesive. The chip should be lightly tamped to smooth it out. The principal aim is to ensure that water does not pond in the depression.

17.5 Stud mounted RPM removal has resulted in hole in pavement

Repairs need to be carried out in strict accordance with client's representative's instructions.

18 Legislation & Guidelines

The following legislation and guidelines have application to the practices described by this document:

The Health and Safety in Employment Act 1992, and its subsequent amendments

The Health and Safety in Employment Regulations 1995

The HSE Pressure Equipment, Cranes and Passenger Ropeways Regulations 1999

The Resource Management Act 1991

NZRF Safety, Health and Environment Guide

19 Obligations & Responsibilities

The legislation details specific requirements for particular operations and both Principals and Contractors are advised to familiarise themselves with those requirements.

19.1 In general

All RPM removal works must be carried out in such a manner as to not endanger the health, safety or amenity of employees or the public in general. All RPM removal operations are potentially hazardous and as such require hazard analysis prior to the commencement of work.

Particular care needs to be applied for powered raised pavement markers to eliminate any risk of electrocution during removal.

Appropriate personal protective equipment must be supplied and regular checks made to ensure that these items are correctly fitted and worn.

As with all operations carried out on roads, the safety of the worker and the public is of paramount importance.

When removing RPM's in or near built up areas, the possible adverse effects of noise pollution and dust must be considered when selecting a removal method. Consents may be required, either for each exercise or as required by the Regional Council.

The removed RPM's and detritus must be contained, collected and disposed of in accordance with legislated environmental guidelines. It is recommended that traps be utilised to prevent dislodged materials from entering the storm water drainage system. RPM's and detritus removed by this process are either swept or vacuumed up at the end of the operation and disposed of in accordance with environmental guidelines.

19.2 Specific Requirements

Where a "noise nuisance" is likely, Consent is required from the appropriate Regional / Local Council.

RPM removal activities on roads and public thoroughfares are required to be carried out within closures established in accordance with the RCA requirements for temporary traffic management.

Information on the operational requirements of the related legislation may be found in the NZRF Safety, Health and Environment Guide.

20 Training & Competency Assessment

Principals and Employers are obliged under the respective legislation to ensure that all operatives have been appropriately trained and / or supervised for the task that they are assigned to.

There are a number of Unit Standards registered on the NZQA Framework which relate to the practices as described by this document, i.e.

15936	Remove raised pavement markers from roadway
20455	Demonstrate basic knowledge of safety relating to bituminous materials

Assessors registered by the relevant Industry Training Organisation may assess competency against the appropriate unit standard.

21 Industry Review and Improvement

21.1 Document Development

The content of this document has been developed on the basis of industry participation and consultation. The development group has endeavoured to provide clear interpretation of the information gained during consultation and an understanding of industry collected knowledge.

21.2 Submissions for Change

Submissions for change can be separated into three categories in relation to their importance and complexity; i.e.

1. Critical and Urgent – Make submission directly to the writer
2. Formal Submission – Make submission to the NZRF Executive Director

21.3 Notice of Amendments

A control copy of this document and the attachments is available on the NZRF website www.nzrf.co.nz. This copy is to be the formal notice of change.

22 Appendices

Shearing Glue Bond Method Statement / Process Description

22.1 Shearing Glue Bond Method Statement / Process Description

HOW ARE RAISED PAVEMENT MARKERS REMOVED FROM PAVEMENTS?

Raised Pavement Markers are normally removed from pavements by breaking the bond between the RPM and the pavement by driving a sharp object between them.

For small quantities a bolster or a pick may be used, for larger quantities an air chisel or even a leveling device on a bobcat or similar may be used.

The removal process should be carried out at when the pavement is as cold as possible to limit damage to the surface.

HOW IS ANY DAMAGE TO PAVEMENT REPAIRED

Some damage is likely to occur where the adhesive is torn from the pavement. This damage needs to be repaired to ensure that the pavement strength and integrity is not compromised.

The material used needs to match the pavement for strength, moisture barrier and appearance.

The material and method needs to match that described in the contract methodology statement.

EQUIPMENT AND TOOLS

- Bolster / Cold Chisel
- Small Sledge Hammer
- Pick
- Air chisel /compressor
- Leather gauntlet gloves
- Protective glasses / face shield.

SITE SAFETY

Choose and implement the appropriate approved traffic management plan (consider the location of the RPM's, volume of traffic and site visibility).

Brief the work crew as to hazards associated with RPM removal using the method selected. Consider public safety.

Fill in Site Hazard Identification forms

FIND IT

Confirm the task numbers and location from physical works sheets.

Locate work-site(s).

Identify RPM's that are damaged and / or require removal before installation of new ones.

PUT ON SAFETY EQUIPMENT

You should already have your high-visibility vest on.

- Skin Protection: Wear full length overalls and safety boots or shoes at all times
- Hand Protection: Wear gloves when handling bolter / air chisel
- Eye Protection: Use full face-shield / glasses while chipping RPM off surface.
- Hearing Protection: Use ear protectors when using air chisels or noisy equipment
- Shin / groin protection: Wear shin pads / box when using pick.

REMOVE THE RAISED PAVEMENT MARKER

Remove the RPM by striking the bond between the RPM and the pavement. The RPM needs to be restrained such that it is not projected towards a workmate, bystander or out of the worksite.

REPAIR THE PAVEMENT SURFACE

Apply the selected pavement repair material as appropriate and smooth off such that surface is flush with or slightly proud of the surface after compaction.

CLEAN UP THE AREA

Sweep up and remove excess pavement repair material and all removed RPM's, including fragments.

RECORD AND MEASURE

Determine the number of RPM's removed and the quantities of repair material used.

Record the details required by the contract specification and the Daily Job Records

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