TNZ P/20:2006 Draft

PERFORMANCE-BASED SPECIFICATION FOR ROADMARKINGS

1. INTRODUCTION

1.1 Scope of the Specification

The Specification provides for a system of maintenance of the performance of roadmarkings installed on the road surface using materials such as paint, thermoplastic, and long-life materials. It can be applied to the performance of profiled roadmarkings where the primary purpose of the profile is to improve the visual performance of the roadmarking. The Specification does not apply to the application of other delineation devices such as audio tactile profiled roadmarkings, edge marker posts, or raised pavement markers.

1.2 Outcome to be achieved

This Specification will ensure roadmarkings installed on New Zealand roads provide users with consistent and effective visual information and also ensure that when the roadmarkings are travelled upon by road users adverse effects are avoided. It is expected that this outcome will be best achieved when the Contractor and the Engineer maintain a collaborative relationship, particularly when finding solutions to problems that may arise in achieving the performance standards throughout the Contract Area.

1.3 Key aspects of this Specification's approach to maintenance

This Specification provides for a predictive approach to consistently achieving the performance required of roadmarkings by the Contractor applying their knowledge of the expected performance of roadmarkings to the specific circumstances of the Contract Area so that the re-marking of the roadmarkings is scheduled and completed prior to the roadmarkings deteriorating below the minimum level of performance required.

This process is informed by specific monitoring of the performance of the roadmarkings within the Contract Area. This monitoring of the performance of the roadmarkings is to be conducted at "Monitoring Sites" within the Contract Area. The Monitoring Sites are selected to be representative of the normal areas of the Contract Area network.

This Specification provides for recognition that the demands on roadmarkings may vary over a Contract Area network and therefore a single roadmarking system (of material, application rate, and application scheduling) may not be effective over the full Contract Area network. This Specification provides for different roadmarking systems to be used over the normal areas of the Contract Area network and provides for identification of "abnormal areas" of the Contract Area network. A separate specific delineation strategy will be developed for those "abnormal areas".

This Specification requires the Contractor to prepare a "Schedule of Key Tasks". The activities and timetabling detailed in the Schedule of Key Tasks are such that providing that those activities are performed in accordance with the scheduled timetabling then complying roadmarkings are expected. Therefore, compliance can be assessed by comparing the actual activities performed with the Schedule of Key Tasks, and monthly Contractual payments are also similarly be linked to the Schedule of Key Tasks.

2. PERFORMANCE CRITERIA

The performance criteria for the roadmarkings are specified in 2.1 to 2.5 of this Specification.

2.1 Colour

2.1.1 Daytime colour

a) White roadmarkings: The colour of white roadmarkings must fall within the colour boundary described by discolouration of not more than 4/5 (using *ISO 105-A03*) from colour Y35 of *AS 2700S*.

b) Yellow roadmarkings: The colour of yellow roadmarkings must fall within the colour boundary described by a discolouration of not more than 4/5 (using *ISO 105-A03*) from colour Y13 - Y14 of *AS 2700S*.

The method of assessment for white and yellow roadmarkings is set out in Section 6A of Appendix 2 to this Specification.

2.1.2 Night-time colour

When viewed under normal headlights at night-time, roadmarkings shall substantially retain their daytime colour.

2.2 Daytime visibility (Interim)

When viewed dry or wet in daytime, the roadmarking shall be readily visible for a forward distance of 150 m, or as far forward as possible until obstructed by the road geometry if less than 150 m.

The method of measurement is set out in Section 7A.1 of Appendix 2 to this Specification.

2.3 Night-time visibility

Night-time visibility shall be assessed by retroreflective properties.

2.3.1 Night-time visibility in the dry condition

The retroreflectivity of the roadmarking (white or yellow) shall exceed the greater of:

a) the value (in mcd/m^2/lux) specified within the Contract; or

b) 100 mcd/m^2/lux when referenced to a common base as described in Appendix 3 of this Specification. (This is equivalent to about 100 mcd/m^2/lux measured with a Mirolux-12 retroreflectometer.)

Retroreflectivity shall be measured according to Section 7A.2 of Appendix 2 to this Specification.

2.3.2 Night-time visibility in the wet condition

Transit New Zealand recognises the significance of the night-time visibility of roadmarkings in the wet condition and is developing a performance requirement. Pending this development, in this Specification, no formal requirement for night-time visibility of roadmarkings in the wet condition is set.

2.4 Skid-resistance

The skid-resistance shall be either:

a) 45 BPN or greater for roadmarkings with a dry film thickness of less than 0.9 mm; or

b) 50 BPN or greater for roadmarkings with a dry film thickness of 0.9 mm or greater; or

c) the value (in BPN) specified within the Contract.

The skid-resistance shall be measured according to Section 8A of Appendix 2 to this Specification.

2.5 Minimum durability

All roadmarkings, including longitudinal and transverse roadmarkings and symbols, words, and trafficked intersection roadmarkings, are required to exceed the minimum criteria shown in Clauses 2.1 to 2.4 above, without maintenance from time of application, for a period the greater of:

a) the time period stated in the Contract; or

b) three months.

3. CONTRACT AREA

The roadmarkings to be maintained in accordance with this Specification will be detailed in the Contract documents. The form of any roadmarkings is to be in accordance with the *Manual of Traffic Signs and Markings (MOTSAM).*

3.1 Reseals and road reconstructions

Reinstating roadmarkings after resurfacing and reconstructions are not part of this Specification. Where reseals occur within the Contract Area the Contractor will be paid at the tendered rate to bring the roadmarkings up to standard, thereafter those roadmarkings will be again part of the Contract Area. Reseals include maintenance works undertaken under *TNZ P/17* where those maintenance activities remove or significantly degrade the existing roadmarkings.

The Engineer will liaise with the roadmarking Contractor and the reseal Contractor to ensure that the initial roadmarking will be compatible with the subsequent roadmarkings intended by the roadmarking Contractor.

3.2 Abnormal areas

"Abnormal areas" are any areas of the Contract Area network that are identified as "abnormal areas" within a Schedule to the Contract documents. These areas are those that are expected to be problematic if treated with a roadmarking system (of material, application rate, and application scheduling) that would be satisfactory for "normal areas" of the Contract Area. Each "abnormal area" will be managed by a specific strategy that will be co-operatively developed by the Contractor and the Engineer and approved by the Engineer. This specific strategy will deliver for road users, as far as is practical, an equivalent delineation experience at the "abnormal areas" as at the "normal areas". The specific strategy may involve the application of wider roadmarking lines to give equivalent brightness or delineation devices other than roadmarkings.

The specific strategy for each "abnormal area" will include specification of the monitoring regime and Residual Life requirement for that "abnormal area".

NZS 3910: Conditions of contract for building and civil engineering construction will be used throughout the duration of the Contract to address any variations to the "abnormal areas" identified in the Schedule to the Contract documents.

4. INFORMATION AVAILABLE TO TENDERERS

The Engineer will advise interested Tenderers of the following:

a) The locations, extents, and timings of any reseals within the Contract Area during the Contract period, as anticipated at the time of Contract;

b) Traffic volumes expected on the roads over the Contract period, expressed as AADT and with the percentage of heavy vehicles. This information is to

include whether counts are estimates or actual counts and where an actual count, the date and time of that count.

c) Any areas within the Contract area which are to be treated as "abnormal areas" due to unpredictable events, (e.g. the depositing of debris from cut faces or flooding, gritting, unless the likely extent of gritting is advised,) and other circumstances causing excessive wear which are to be excluded from the normal Contract.

d) The Engineer's best available information of the roadmarkings in place including generic type and location; the age of roadmarking (in years), the most recent test values for the Contract Area provided these were taken within the last four months prior to issuing the Request for Tender. (This may include a summary of non-commercially-sensitive information from the database described in Section 8.)

e) The duration of the "Residual Life" of the roadmarkings required at the end of the Contract Period, as detailed in Section 12.

5. PRICING

It will be expected that Contractors have assessed those factors which will be significant in the performance of the Contract should they be the successful Tenderer. For example, they should note the road surface types in the Contract Area, and also the likely rate of wear of materials they may select. The onus is on the Contractor to seek further information from the Engineer if required.

The Contractor will be required to provide a lump sum price to monitor and maintain the roadmarkings (including re-marking) for the duration of the Contract for the areas identified in the Contract documents.

The Tender documents may identify a requirement for a further price and its form, e.g. lump sum, or unit rate, and establishment, for roadmarkings required that are additional to those covered by the normal performance-based Contract such as roadmarkings after reseals, or to bring an area “up to standard”, or to provide delineation in those areas regarded as "abnormal areas".

6. QUALITY SYSTEMS

6.1 Quality Assurance System

The roadmarking work shall be carried out by a Contractor who has in place, an approved Quality Assurance System that has been certified by an Approved Agency and is available for inspection and review by the Engineer. Quality Assurance System means *AS/NZS ISO 9001: Quality management systems* incorporating the technical requirements of the *New Zealand Roadmarkers Federation's Quality Assurance Programme*. Approved Agency, for certification of the Quality Assurance System, means either a *Joint Accreditation System of Australia and New*

Zealand (JAS-ANZ) accredited agency or an agency approved by Transit New Zealand.

6.2 Quality Plan

The Quality Plan, which the Contractor prepares as part of the Contract, shall include:

a) A step-wise process for selecting a roadmarking system which comprises classification of areas within the Contract Area according to whether roadmarkings there are expected, depending on trafficking and other circumstances, to be subject to high-wear, medium- (normal-) wear, or low-wear conditions. High-wear, medium- (normal-) wear, and low-wear are relative terms within the Contract Area.

   The roadmarking system (of material, application rate, and application scheduling) which shall be used for re-marking these areas of different conditions of wear will be identified.

   The "Expected Life" of these roadmarkings in conditions of high-wear, medium- (normal-) wear, and low-wear shall be stated, with the evidence on which this Expected Life is based. Section 6.4 identifies how Expected Life may be determined.

   If symbols, words, and other trafficked intersection roadmarkings do not readily fit the high-wear, medium- (normal-) wear, or low-wear classification, or a specific roadmarking system is being used to re-mark them, then they may be treated as a fourth category for which a separate Expected Life, separate Monitoring Sites, and separate Key Tasks for re-marking are required.

   Note: As a result of this three-step process the high-wear areas may be marked with more durable materials and have a longer re-mark cycle than the re-mark cycle of the medium-wear and low-wear areas marked with a less durable material.

b) The expected "start-of-life" performance levels of the roadmarkings.

c) Information on any likely incompatibility and cohesion with materials likely to be used in succeeding Contracts.

d) Identification of the personnel who will undertake the monitoring of performance, and evidence of their competence for this work.

e) Identification of equipment available for monitoring performance, and evidence that a system is in place to ensure that the equipment is in current calibration when used.

f) A Schedule of Key Tasks as set out in Section 6.3.

6.3 Schedule of Key Tasks

The Quality Plan shall contain a "Schedule of Key Tasks". Maintenance of a database, as set out in Section 8, is an ongoing Key Task. Other Key Tasks shall be

outlined in the "Schedule of Key Tasks" with the dates by which these shall be completed, including:

a) The date by which initial testing of roadmarkings shall be completed.

b) The date by which any initial re-mark to bring the Contract Area up to standard shall be completed.

c) The dates by which the "start-of-life" testing at monitoring sites, mid-life testing at monitoring sites, and, if intended, near-end-of-life testing at monitoring sites (as outlined in Section 7 and Appendix 1) shall be completed.

d) The dates by which re-marking of high-wear areas will be completed.

e) The dates by which re-marking of medium- (normal-) wear areas will be completed.

f) The dates by which re-marking of low-wear areas will be completed.

g) (If separate, the dates by which re-marking of symbols, words, and other trafficked intersection roadmarkings will be completed.)

The setting of these Scheduled dates shall be established with regard to the identification of the wear areas as in Section 6.2, the Expected Life as identified in 6.4, and the required testing as identified in Section 7.

This Schedule shall be modified in response to information on performance provided by the testing in Section 7 and as agreed with the Engineer so as to ensure that the Contract Area remains above the required performance levels.

6.4 Expected Life

The "Expected Life" of the roadmarkings identified above is the time period between time of application and earliest time to fall below the performance criterion for the wear areas where the material is used. It is expected that a separate Expected Life shall be provided for each of high-wear areas, medium- (normal-) wear areas, and low-wear areas. (As outlined in Section 6.2 a separate Expected Life shall be provided for symbols, words, and trafficked intersection roadmarkings if these are being treated separately.) The assessment of Expected Life must be soundly based. It shall be based on:

a) Known in situ performance of the same material in an equivalent situation to the Contract Area with regard to, for example, traffic volumes, speed and type, surface type, climatic condition, etc; or

b) Known in situ performance of alternative materials known to be similar to the one being considered in the same or equivalent situation to the Contract Area; or

c) Laboratory tests to provide accelerated conditioning of the material, and extrapolation of these tests to in situ performance by comparison with other materials.

6.5 Roadmarking system used

a) Where more than one roadmarking system (of material, application rate, and application scheduling) is used in a Contract, the roadmarking systems need to be used in a clearly established and manageable pattern which enables monitoring of the performance condition of each system.

b) For longitudinal lines the minimum continuous length where any one roadmarking system is to be used is 2 km unless the Engineer gives approval for shorter lengths.

c) Each intersection must be marked using only a single roadmarking system (except symbols, words, and trafficked intersection roadmarkings may be marked using a second roadmarking system of longer life compared to the first roadmarking system, if appropriate).

6.5.1 Trial roadmarking systems

The Engineer may allow the Contractor to trial new roadmarkings systems as part of the process of gaining test data provided that:

a) Trial areas in total are only a small proportion of the Contract Area;

b) The Contractor has in place an appropriate regime to monitor these trials and replace the roadmarkings should any fall below the performance criteria; and

c) The trial roadmarking systems always meet the performance criteria as set out in Section 2.

6.6 Verification of Achievement of Quality

6.6.1 Visual inspection

The Contractor shall inspect all new roadmarkings and re-marking visually prior to the removal of temporary traffic control to ensure that the intended quality has been achieved. This inspection shall verify that the roadmarkings are correctly placed, are of the correct dimensions including thickness, and contain on the surface those necessary ingredients properly distributed to input properties such as skid-resistance and retroreflectivity.

6.6.2 Testing

When first re-marking a new Contract Area or when using a new roadmarking system (of material, application rate, and application scheduling), the Contractor shall undertake testing in the period between one day and three days after applying the first 5 km of roadmarkings to substantiate that they are achieving the expected level of performance. Testing shall take place at five locations within the first 5 km of roadmarkings laid using a roadmarking system (of material, application rate, and application scheduling). Testing shall follow the methods outlined in Appendix 2 of this Specification.

6.6.3 Reporting compliance of roadmarkings

6.6.3.1 Complying roadmarkings

The Contractor shall advise the Engineer within seven days of application of areas at which complying new roadmarkings or re-markings have been laid (using extracts from the database described in Section 8). This advice shall include a statement that roadmarkings comply, together with relevant test information that supports this statement.

6.6.3.2 Non complying roadmarkings

The Contractor shall advise the Engineer of any roadmarkings laid which may not conform within 12 hours of:

a) Any visual inspection which indicates defective roadmarkings may have been laid; or

b) Receiving test reports showing non compliance.

Or,

c) If the Contractor believes the deficiency is such that a significant major traffic hazard exists then the Engineer shall be advised immediately.

The Contractor will also advise the Engineer at that time of advising of the non-conforming roadmarking of the steps that will be taken to rectify any deficiencies and the timing of these steps.

7. MONITORING

The Contractor shall monitor the performance of the roadmarkings. For this Specification monitoring is the process by which the delivery of roadmarkings with the required properties is substantiated. Monitoring is the systematic assessment of performance of the roadmarkings, by examination of the roadmarkings, the taking of measurements, and recording and charting measurement results and comparing the performance being achieved with that expected as outlined in Section 6.4.

The Contractor shall establish Monitoring Site locations as described in Appendix 1 and shall undertake the specific testing as set out in that Appendix.

In addition to this testing the Contractor shall visually inspect the Contract Area roadmarkings at appropriate intervals to identify that the deterioration occurring at the Monitoring Sites is typical of the Contract Area and if not then schedule appropriate remedial action.

7.1 Reporting of Results

The results of all Monitoring assessments and measurements shall be reported to the Engineer in a timely manner. The Engineer may agree, or request, for these measurements to be appropriately summarised.

8. DATABASE

The Contractor shall be required to maintain a database of roadmarkings for the Contract Area in a format approved by the Engineer. This shall include details of the roadmarkings, comprising:

Application of roadmarkings:

a) location of any application in terms of Route Position;

b) date of application;

c) material and application rate used and its expected life in that location.

Monitoring:

d) location of Monitoring Site;

e) date of monitoring activities;

f) values measured and observations during monitoring activities.

Other:

g) maintenance and re-markings;

h) other treatments;

i) traffic volumes supplied by the Engineer;

j) abnormal sites (where known).

Extracts from this database can be used in reporting conformance of roadmarkings.

The database is to be made available to the Engineer on request and is to be returned to the Engineer on completion of the Contract.

Summary information from the database, excluding any commercially-sensitive information, will be made available to Tenderers of subsequent Contracts.

9. CRITERIA FOR ACCEPTANCE AND ACTION

The Contract Area is acceptable if the re-marking is completed before the end-of-life of the roadmarkings, as identified by the performance testing at the monitoring sites, as set out in Section 7 and as identified in the Schedule of Key Tasks set out in Section 6.3, provided that:

a) inspection shows that performance at the monitoring sites is typical for the Contract Area; and

b) the initial test values following re-marking are at their expected levels.

10. REMEDIAL ACTIONS

The normal remedial action to restore roadmarkings is re-marking, but other actions (such as cleaning or light surface grinding) which ensure roadmarkings remain

above the required performance criteria are acceptable. The remedial action taken is at the Contractor's initiative provided that the durability requirement is met without any further maintenance and the Engineer's approval is granted.

10.1 Tolerances for re-marking and layout of roadmarkings

When re-marking of existing roadmarkings or layout of new roadmarkings is undertaken, the tolerances of placement will be as follows.

The maximum permitted dimensional tolerances shall be:

a) Gap length between segments, where:

gap is 3.0 m or longer	± 300 mm
gap is shorter than 3.0 m but longer than 1.0 m	± 150 mm
gap is 1.0 m or shorter	± 50 mm

b) Length of segments, where:

segment is longer than 5.0 m	± 150 mm
segment is shorter than 5.0 m but longer than 1.0 m	± 75 mm
segment is 1.0 m or shorter	± 50 mm

c) Line width:

All line widths	+ 10 %, - 5 %

d) When roadmarkings already exist, the centreline of the new roadmarking shall be within 15 mm of the centreline of the existing roadmarking;

e) For new roadmarkings when spotting out is provided by the Engineer, the centreline of the new roadmarking shall be within 15 mm of the centreline of the pilot line;

f) Separation of the centreline and no overtaking lines is to be between 100 mm and 130 mm;

g) Where raised pavement markers are placed between double yellow lines, the separation of the lines may be increased to a maximum of 130 mm;

h) Where raised pavement markers are placed on roadmarkings, the roadmarking may be omitted for a length of up to 300 mm before and after the marker;

i) Roadmarkings of high-build materials, excepting structured or profiled roadmarkings, shall not exceed the following thicknesses:

new roadmarkings on asphalt	2.5 mm
new roadmarkings on chip seal	3.0 mm
re-marking over existing high-build roadmarkings	4.0 mm
joins and overlaps	4.0 mm

j) Any deviation beyond these permitted tolerances shall be corrected at the Contractor's expense.

10.2 Removal of roadmarkings

Removal of any roadmarkings shall be in accordance with the *New Zealand Roadmarkers Federation Line Removal Guide*, as issued as an Appendix to Section 12 of the *New Zealand Roadmarkers Federation Safety, Health, and Environment Guide*.

11. SURVEILLANCE BY THE ENGINEER

At any time within the Contract Period and during the period of required Residual Life, the Engineer may visit any normal areas within the Contract Area and take measurements and/or take representative samples from roadmarkings installed under the Contract or from the Contractor's supplies of materials intended for installation under the Contract, for the purpose of assessing roadmarking performance and checking compliance with that identified in the Contractor's Quality Plan (detailed in Section 6.2) and the Database (detailed in Section 8).

This surveillance may be undertaken at Monitoring Sites or at other locations previously measured by the Contractor or elsewhere at the Engineer's discretion. The results of the Engineer's surveillance may be grouped with those made by the Contractor for the purposes of establishing the extent of compliance.

11.1 Surveillance of roadmarkings

The Engineer may substantiate the Contractor's achievement of complying roadmarkings by a process which comprises all or some of the following steps:

a) Review of reports of complying roadmarkings;

b) Review of test information;

c) Enforcement so that reports are delivered on time;

d) Inspection of a sample of the roadmarkings;

e) Review of any deficient roadmarkings now rectified;

f) Sufficient verification testing to confirm the Contractor's results.

12. RESIDUAL LIFE

The Contractor shall so manage the Contract that on completion of the Contract Period the average remaining "Residual Life" of *all* roadmarkings, in normal areas of the Contract Area, is at least the duration for the Residual Life set in the Contract.

At the time of Tendering the Engineer shall set the duration for the Residual Life requirement as a period of no less than three months and being up to six months.

The Residual Life of the roadmarkings shall be established using the Database (detailed in Section 8) and performance deterioration information collected from Monitoring Sites throughout the duration of the Contract.

13. PAYMENT

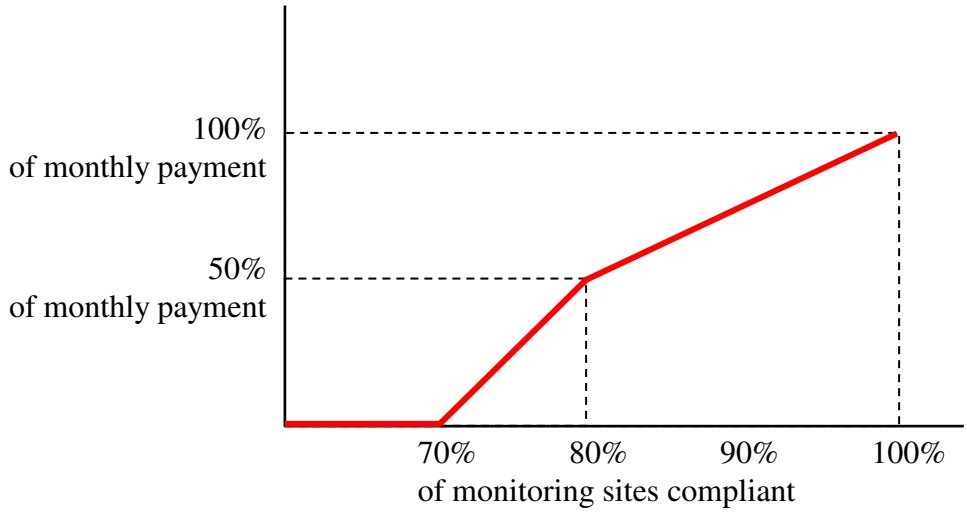
Payment is made in equal monthly instalments, but there are circumstances where monthly payments may be withheld or reduced.

The monthly payment may be withheld, and any subsequent monthly payments may also be withheld, while any Key Task scheduled for completion within that month has not been completed.

Payment of the withheld amounts may be reduced to zero where the Key Tasks are still not completed within the month succeeding the month in which the payment was withheld.

If Monitoring at Monitoring Sites as required under Section 7 is not completed by the scheduled date then any monthly payments and subsequent monthly payments are reduced to zero until the Monitoring is satisfactorily completed and confidence in a level of performance above performance requirements established.

If the incompletion of Key Tasks scheduled would mean that the projected performance at any Monitoring Site would be expected to be below performance requirements, then the amount of the withheld payment to be paid may be reduced according to the number of Monitoring Sites that are projected to have fallen to non-compliance, as shown in the figure below.



APPENDIX 1

TESTING OF ROADMARKINGS

1A. SCOPE

This Appendix outlines the role of testing within TNZ P/20, describes circumstances where different levels of testing are appropriate, and outlines the testing programme.

2A. INTRODUCTION

TNZ P/20 is a performance-based Specification for roadmarkings that entrusts the Contractor with managing the roadmarking asset above the required criteria for the duration of the Contract. The Engineer has primarily an audit role. Monthly payment is made on the basis that the asset meets or exceeds the minimum required criteria each month. Testing and payment are inextricably linked. Testing defines the level of performance being achieved and payment then follows. The intent of TNZ P/20 is that testing is used to *predict* ongoing performance, rather than testing being reactive and being used to establish the performance at that time.

There are two key elements of this *predictive* system:

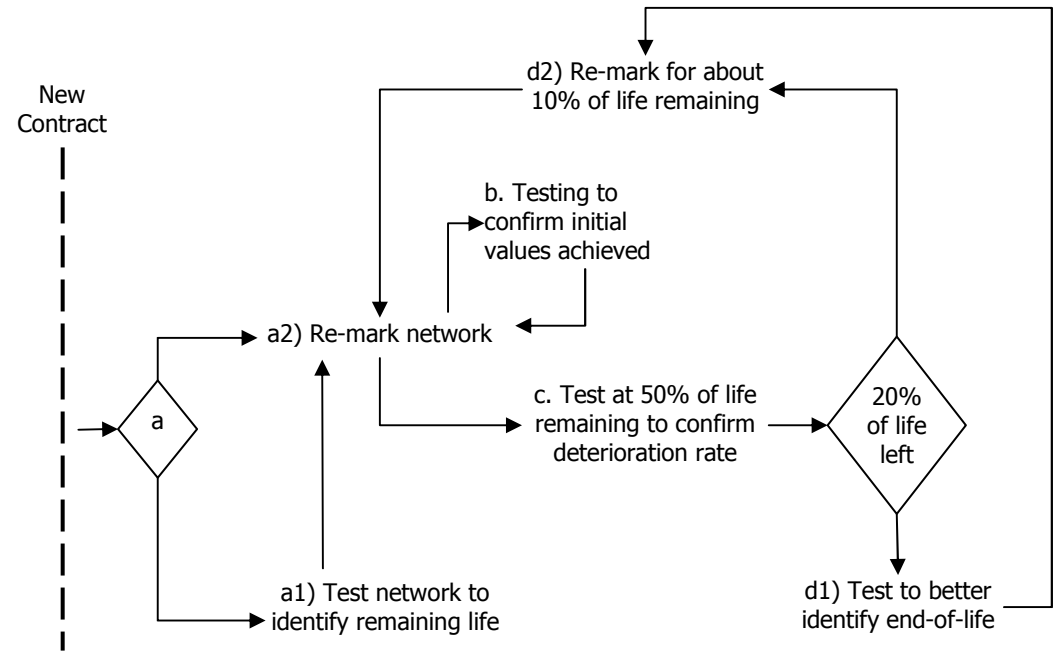
a) The Contractor must use a material for which the likely performance-deterioration curve is well known. This requirement is described in Section 6.

b) Testing is undertaken at a few points along the performance-deterioration curve to confirm that the performance-deterioration profile is as expected and therefore the required performance will be delivered.

This predictive approach greatly reduces the amount of testing required, as testing is only needed to confirm two or at most three points along the known performance-deterioration curve. The confirmed performance-deterioration curve is therefore the basis for payment of monthly instalments being made.

3A. TESTING REQUIRED

The figure below shows when testing is to be carried out in TNZ P/20.



a) When a new Contract is awarded the Contractor can either:

a1) measure the condition of existing roadmarkings with the intent of extracting the remaining life; or

a2) not measure the condition of existing roadmarkings and proceed immediately to re-marking.

b) At the time of re-marking testing is done to ensure that the initial performance levels expected for the material are being achieved. The performance levels expected at this point are the initial values for the material, not the minimum values for the Contract.

c) Measurement of the condition at about 50% of the expected life of the roadmarking confirms that the rate of deterioration of the material is as expected. If it differs, a re-forecast of the end-of-life should be made. Before the bulk of the roadmarking needs replacement, roadmarkings in high-wear areas may need replacement.

d) When the roadmarkings are have been in place for about 80% of the expected life the Contractor can either:

d1) measure the condition of roadmarkings to better identify the actual end-of-life, so as to both extract this remaining life and to properly schedule re-marking so that it occurs comfortably before any roadmarking falls below the required performance criteria; or

d2) not measure the condition of roadmarkings but re-mark the Contract area when the material deterioration curve and testing indicates there is about 10% of the life remaining (and the cycle is then re-entered at Step b).

4A. NORMAL P/20 TESTING

4A.1 Locations of Monitoring Sites

Testing for monitoring performance of the roadmarkings is undertaken at Monitoring Sites. The Monitoring Sites selected are to be representative of the high-wear areas of the Contract Area and of the medium- (normal-) and low-wear areas of the Contract Area, and of the roadmarking systems used throughout the Contract Area. Monitoring Sites are to be selected as follows:

a) (As required within Section 6.2 of this Specification) the network is classified into high-, medium- (normal-), and low-wear areas, where high, medium (normal), and low are relative conditions within the network.

Generally, high-wear areas are the edgelines on the internal radius of a curve and low-wear areas on the outer. Edgelines on straight sections are medium-(normal-) wear areas unless a very narrow shoulder or roadside hazard means that the edgeline is seldom crossed, in such situations the edgelines are low-wear areas. Sections, such as leading to an access point or rest area, where the edgeline is frequently crossed are usually too short to be included as a test site.

The wearing rates of transverse roadmarkings across the direction of trafficking, (such as limit lines,) and roadmarkings within the traffic lane, (such as pedestrian crossings, words, and symbols,) should be included when assessing the range of wear conditions present within the network.

b) For on a Contract Area network length of 300 km or greater, six Monitoring Sites will be selected from high-wear areas and nine Monitoring Sites will be selected from medium- (normal-) or low-wear areas. The number of Monitoring Sites for Contract Areas with network lengths of less than 300 km will be calculated pro rata to that given for networks of 300 km or greater.

c) The high-wear Monitoring Sites will be selected to be representative of the roadmarking systems used for the high-wear areas. That is, where only one roadmarking system is used for all roadmarkings in high-wear areas over the Contract Area, all the Monitoring Sites will be monitoring that one roadmarking system. Where more than one roadmarking system is used for the roadmarkings in high-wear areas, then the total number of high-wear Monitoring Sites will be divided between those different roadmarking systems pro rata to the lengths of high-wear roadmarkings using each of those roadmarking systems.

d) Similarly, the medium- (normal-) and low-wear Monitoring Sites will be selected to be representative of the lengths of roadmarkings systems used within those areas.

Precedent to the conditions of c) and d), if the Contract Area network contains yellow "no overtaking" roadmarkings then at least one Monitoring Site shall be located on such roadmarkings. Where a Contract Area network is surfaced with a range of surface types, the Monitoring Sites should be distributed among the different surface types in roughly the same proportions as the length of network is proportionally surfaced with the different surface types, as far as is practicable given the prior restraints on the selection of monitoring sites with respect to materials and wear areas.

4A.2 Lengths of Monitoring Sites and testing within the Monitoring Site

a) Each Monitoring Site comprises approximately 100 to 200 m of roadmarking.

The length of each site shall be selected and adjusted to ensure that the state of wear over the site appears homogenous. Only one edgeline needs to be measured at each site. (Where it is the yellow "no overtaking" roadmarking being assessed then the Monitoring Site is only the yellow centreline and the edgeline need not be measured.)

b) Within each Monitoring Site, five testing sections are to be identified. Each of these testing sections is approximately 5 m long. Testing is to be conducted within these testing section lengths.

c) Where multiple readings are required for a test, the locations of the readings should be distributed throughout the length of the testing section.

4A.3 Properties to be tested

There are four main properties for assessment: retroreflectivity, skid resistance, colour, and daytime visibility. However, these need not *all* be measured at every Monitoring Site.

a) Retroreflectivity should be measured at every Monitoring Site.

A reading should be taken at each of five locations within each of the five testing sections within the Monitoring Site. Thus, 25 readings of retroreflectivity will be made. All 25 readings are averaged to obtain a value for the Monitoring Site.

b) Colour and daytime visibility:

An initial appraisal of colour and of daytime visibility should be done at each Monitoring Site.

A full assessment and recording of colour should be carried out on only one of the testing sections within each of the high-wear Monitoring Sites, and at any of the other Monitoring Sites where the initial appraisal gives doubt as to whether it conforms.

Daytime visibility is assessed as length of forward view. This should be done while standing at one end of the Monitoring Site viewing forward over the Monitoring Site.

c) Skid-resistance.

Skid-resistance is generally an inherent property of the material. Skid-resistance measurements need only be made at one location within only two testing sections. Thus two measurements are taken per Monitoring Site measured but skid-resistance is not required to be measured at all Monitoring Sites. The number of Monitoring Sites where skid-resistance measurements are to be made at shall be determined as follows:

c1) Standard paint-type roadmarkings over chipseal need to be measured at only one high-wear Monitoring Site. If it does not comply then the skid-resistance of all high-wear Monitoring Sites should be measured within that re-mark cycle.

c2) Where standard paint-type roadmarkings are applied over asphaltic concrete or friction-course, skid-resistance should be measured on all high-wear Monitoring Sites for the first re-mark cycle. If compliance is shown then only one of these high-wear Monitoring Sites needs to be measured for the remainder of the re-mark cycles over the Contract Period.

c3) For high-build and long-life roadmarkings (such as thermoplastic, two-part systems, and the like,) all Monitoring Sites shall be initially appraised to confirm that the elements intended to impart skid-resistance are present (such as grit etc on the surface of the material). This is solely a visual inspection, and if the required elements are present, then skid-resistance need only be measured at two high-wear Monitoring Sites and two Monitoring Sites from medium- (normal-) or low-wear areas.

5A. MEASUREMENT EQUIPMENT

The measurement equipment shall be as set out in the methods of this Specification. All equipment shall be in current calibration when used to make performance assessment measurements.

APPENDIX 2

6A. MEASUREMENT OF COLOUR

Colour shall be measured by comparison against colour standards and discolouration scales. The comparison is made in daylight or in the shade, but not full sun. The discolouration scale is A03 of *ISO 105*.

The white colour is Y35 of *AS 2700*, the yellow is Y13-Y14 of *AS 2700*.

The assessor is to have full colour vision.

The colour and discolouration scales are used to form a judgement whether the colour change shown by the roadmarking is less than the extent of the discolouration scale.

7A. MEASUREMENT OF VISIBILITY

7A.1 Assessment of visibility in daylight conditions

This technique consists of a subjective assessment as to whether the roadmarkings on the road ahead are clearly visible, in terms of the minimum performance criteria described below. The assessment is made by an observer in clear dry or wet daylight conditions but not in falling rain, snow or fog conditions, and excluding conditions where the sun is forward in the view at a low angle to the horizontal. By clearly visible, the roadmarkings are easily seen and can be instantly recognised as such.

At the time of assessment the observer must:

a) have eye sight (corrected with lenses if necessary) currently passing driver licensing vision tests, and

b) have full colour vision.

7A.2 Assessment of visibility of roadmarkings in night lighting conditions: Retroreflectivity

Retroreflectivity shall be measured with a hand held retroreflectometer operated to the manufacturer's instructions and adjusted to the common base as described in Appendix 3.

8A. MEASUREMENT OF SKID RESISTANCE

This will require a portable skid-resistance tester, known as the British Pendulum Tester and as described in *Instructions for using the portable skid-resistance tester,* Road Note 27, Second Edition, Road Research Laboratory, Ministry of Transport

(United Kingdom) 1969. The portable skid-resistance tester should be fitted with a TRRL rubber slider. The test instrument is to be in current calibration and is to be operated by personnel who are competent in its use.

Mobile Instruments such as the GripTester may be used so long as it can be demonstrated that the measurements can be made on the roadmarking only and the results can be reliably converted to BPN units

APPENDIX 3

MEASUREMENT OF THE RETROREFLECTIVITY (VISIBILITY) OF ROADMARKINGS

This Appendix will be superseded when the specification on measuring retroreflectivity is published.

9A. INTRODUCTION

Retroreflectometers are used for the measurement of the retroreflectivity (visibility) of roadmarkings. These retroreflectometers have been found to be quite variable.

Although the results are variable, they are also systematic. Mirolux 7 readings tend to be 30-60% higher than Mirolux 12 readings. MX-30 or Zhetner instruments read lower. Readings from each instrument on each of the surfaces tend to maintain the same rankings.

Calibration of the instruments against recognised national standards would be the normal manner in which this variability could be resolved. However at present there may be none suited. Work is being undertaken in Australia to establish a calibration system. Systems are also being developed in Europe. In the interim the following procedure for converting readings to a common base shall be followed.

9A.1 The Common Base

In 1993, a working party, which was part of a Transit New Zealand research project, examined a range of roadmarkings and identified a roadmarking of an acceptable level of brightness. When measured with a Mirolux 7 the retroreflectivity of that roadmarking was approximately 100 mcd/m^2/lux. At the same time readings were taken on four plates supplied by a firm, Advanced Retro Technology. The base proposed is the numbers obtained when the ART plates 108A, B, C and D were measured at that time with the Transit New Zealand retroreflectometer.

By measuring on these same plates with other instruments, conversions to the common base can be developed. This same process could also be applied to the Transit New Zealand retroreflectometer so its readings now could be adjusted to the readings *made earlier.*

This common base is valid even if the calibration process as envisaged by Transport SA is completed. While this may change the values that we assign to the ART plates, what does not change is the level of reflectivity to which we assigned a value of 100 mcd.m^{-2} lux^{-1} as measured by a Mirolux 12 in 1993.

If the calibration process showed that this number should be 130 for example, then the requirement would be adjusted to this level. The common base is also enhanced if a record of checks made over time is kept so that consistency can be checked.

Care is needed however if either a retroreflectometer with another geometry, or an alternate set of check plates without a cross reference to the Opus, Central Laboratories set, is used.

Reflectometers with different geometrics would give a consistent relationship on smooth surfaces. However, on chipseals the higher angled instrument will see into the voids more than the lower geometry, giving an inconsistent relationship.

If another set of reference plates was used, measured either to another standard, or not traceable to the same standard, then the apparent relationship between retroreflectometers may be inconsistent. However all reference plates could be put into a common pool for comparison purposes.

9A.2 An Example:

The figure below shows an example of using a common base. The base line is linear over the main range but tends to become non-linear at high values. For most values the equation of the line is Y=MX+C. It is zero on the black plate.

The reading on the plates with retroreflectometer 1 is:

Reading(1) = (Slope of Line (1)) x nominal reading on plate

The reading with retroreflectometer 2, where black reading does not equal zero is:

Reading(2) = (Slope of Line (2)) x nominal - reading on plate plus reading on black

These can be rearranged so that the nominal reading on the plate drops out.

$$\text{Reading(1)} = \frac{\text{Reading(2)} - \text{Reading (Black Plate)}}{\text{Slope of Line(2)}} \times \text{Slope of Line(1)}$$

$$\text{Reading(1)} = \frac{\text{Reading(2)} - 4}{1.7} \times 2.4$$

Using this formula any reading made by retroreflectometer 2 can be converted as if it was read by retroreflectometer 1.

Figure 1 Converting retroreflectometer readings to a common base