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Technical Note - TN 069: 2016

Issued date: 29 September 2016

Effective date: 29 September 2016

Subject: Replacement of AK track recording units

This technical note is issued by the Asset Standards Authority to address an issue arising from the replacement of the AK track recording units by the Mechanised Track Patrol (MTP) vehicles. Tables 16 and 17 in ESC 210 *Track Geometry and Stability*, Version 4.8 list track geometry measurement limits for manual methods and measurements derived by the AK Car.

1. ESC 210 - Section 12.1.1

This section specifically deals with mainline track geometry limits. Table 16 - *Normal Limits for Track Geometry* and Table 17 – *Damage Limits for Track Geometry* both provide limits for measurements derived by the AK Car. Due to the planned replacement of the AK Car by MTP vehicles in December 2016, any references to “AK Car” should be replaced with the term “Track Recording Car”.

Authorisation:

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Technical Note – TN 028: 2015

Issued date 14 May 2015

Effective date 14 May 2015

Subject: Configuration control of speed boards

This technical note is issued by the Asset Standards Authority to expand on the requirements of ESC 210 *Track Geometry and Stability,* Version 4.8. This technical note relates to configuration control of speed boards, specifically applicable to the process for amending and advertising the authorised speed boards published in the train operating conditions (TOC) manual.

All parties involved in undertaking a review or modification to track speed and the associated speed boards across the Sydney metropolitan rail area shall consult and seek approval from the AEO responsible for operations and maintenance, Sydney Trains.

All queries shall be directed to the Track unit of the Engineering and Systems Integrity division of Sydney Trains via sydneytrainsstandards@transport.nsw.gov.au.

Authorisation:

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Engineering Standard
Track

ESC 210

TRACK GEOMETRY AND STABILITY

Version 4.8

Issued April 2013

Engineering Standard

Owner:	Chief Engineer, Track		
Approved by:	Andrew Wilson Technical Specialist Wheel/Rail	Authorised by:	Malcolm Kerr Chief Engineer Track

Document control

Version	Date	Summary of change
1	October 2006	First issue as a RailCorp document. Includes content from C 2009, C 2010, C 2108, C 2200, C 2501, C 4601, C 4610, C 4641, TS 2621, TS 3103, TS 3104, TS 3105, TS 3106, TS 3107, TS 3108, TS 3109, TS 3202, TS 3208, RC 4800, RTS 3640, CTN 05/07, CTN 05/27.
2	April 2007	Minor corrections; inclusion of minimum cant deficiency; clarification on turnouts in vertical curves; clarification of permanent speed design; inclusion of City Underground X Speed sign; addition of kilometre and ½ km posts; inclusion of measurement of kilometrage.
3	October 2007	Correction of errors in formulae in Figure 4 and Figure 5; Clarification of acceptance limits at platforms and clarification of measuring conventions.
4	May 2008	Sections 6.1.3 and 6.1.4 – Correction of symbol errors in figures; Section 7.3.6 – Correction of titles; Section 7.3.6 – Inclusion of limits on grade of track through station platforms; Section 7.5.2.4 – Additional requirements for alignment design at platforms; Section 8.2.1.1 – Correction of error in vertical placement of permanent speed signs to match Figure 11.
4.1	December 2008	Section 3.2 – inclusion of reference to SPC 203; Section 6 – Inclusion of requirement to meet SPC 203; Section 7.3.6 Changes to limits on Grades; Section 7.3.6, 7.5.2 and 7.7 changes to position titles; New Section 10 – Trackside signage; Section 12.2.2 – Inclusion of Foot gauge for zero cant.
4.2	May 2009	Format change; Section 5.3.2 – Vertical curves – Correction of formula for "y"; New Section 6.5 – Inclusion of requirement to determine Clearance Point; Section 7.5.2.4 – Realignment of an Existing Platform - Inclusion of requirement for design that includes a platform cut-back to be approved by the Chief Engineer Track; Section 8.2.1.2 – Sighting time for speedboards - Minimum 6 second sighting time changed to guideline rather than mandatory.
4.3	December 2009	5.1.3 - Correction made to formula for Φ in Figure 4; 6.3 - Table 1 Maximum or minimum limits for Max D for XPT on light passenger lines – added -50; 6.7.1 Change position title from Chief Engineer Bridges & Structures to Chief Engineer Civil; 7 - Added description of new speed sign regime; 9 - Add requirement for signage to be visible to drivers for 6 seconds; 10 - Correction of error 350 C becomes 35°C; 11.1 - Added "ballasted to title and body of section to differentiate from fixed track; 11.3 - New section 11.3 Construction and upgrading limits for fixed track; 11.4 - Section 11.3 Track Condition Indices renumbered to 11.4; 12.1 - Damage Limits – Track Stability – deleted – covered in Section 10; 12.1 - Section 12.2 Track Geometry limits renumbered to 12.1
4.4	July 2010	Section 6.8 - Addition of requirements for Level Access platform design and consultation with defined stakeholders. Addition of reference to Station Design guidelines Section 7 - Addition of requirement for repeater boards where main line tracks converge.
4.5	February 2011	Section 6.3.3.1 – Addition of limits to horizontal curvature of track approaching conventional turnouts (includes content from CTN 10/16); New Section 6.3.4.3 – Limits on super

		ramps in special trackwork; Section 6.3.5 - Additional detail relating to limits on vertical curves in turnouts; Section 6.4 – Addition of reference to Siding Design Guidelines; Section 6.4.4 - Additional requirements for maximum grades in Train Examination areas; Section 7.2.1.1 Addition of rules for orientation of Permanent Speed Signs previously contained in Network Rule NSG 604, now deleted.
4.6	August 2011	6 - Table 1 – Change max E_a T/out (Thru road) Sim to 50mm; Change max E_a T/out (Thru road) Contra to 50mm (from 55mm) to match requirement in ESC 250; 7.1.1 - Addition of requirement for all speed signs to be erected at 3 speed sign locations. Deletion of description applicable when only 2 or one of the 3 signs are installed; 11.2.3 - Correction of error in acceptance limits for general height for mechanised resurfacing (+ and _ need to be reversed; reduction in allowable lift from 150mm to 100mm; addition of requirements to consider impact of track lifts on ballast top bridges; 11.3.2 - Changed and additional acceptance limits for track geometry on fixed track
4.7	April 2012	Reformatted to new template; 5.1.4 - Figure 6 - Corrections of errors in compound transition diagram and flow chart ; 6.3.6 - Table 1 - Added limits on cant deficiency in diamond crossings; Added guidance on transition ramp limits; 11.1.1 - Addition of requirement to do visual check on “as constructed” geometry; 11.2.3 - Varied maintenance acceptance limits on height at restricted clearance locations; 12.1.3 - Table 18 – Correction of error in Rail level limits associated with OHW
4.8	April 2013	Changes detailed in Summary table below.

Summary of changes from previous version

Summary of change	**Section**
Control changes	Control Pages
Changed percentage increment of grade design from MR to NL	5.3.1
Included statement regarding use of straights between curves	6.3.3.4
Clarification of requirements for curvature in platforms	6.6.2.2
Clarification of requirements for curvature in platforms	6.6.2.3

Contents

1 Purpose, Scope and Application

This Standard establishes design requirements, acceptance standards and damage limits for track geometry, track stability and maximum speed of trains.

It is applicable to all RailCorp mainline and siding tracks.

2 References

2.1 Australian and International Standards

Nil

2.2 RailCorp Documents

ESC 200 Track System

ESC 215 Transit Space

ESC 250 – Turnouts & Special Trackwork

ESC 410 – Formation & Earthworks

SPC 203 – Track Design Specification

SPC 211 – Survey Specification

SPC 213 – Track Side Signs

NSG 604 – RailCorp Network Rule – "Track speed signs"

OS 001 IM – Train Operating Conditions Manual (TOC Manual)

RailCorp Drawing CV0218653 – Standard Speed Sign Fixings

Station Design Guidelines

RailCorp Design Guidelines for the Upgrade & Construction of New & Existing Train Stabling Yards and Turnback Sidings

2.3 Other References

Nil

3 Conventions

This document contains mandatory requirements and guidelines. To aid understanding and compliance, all instances have been marked as follows:

Mandatory Requirement – SHALL be met	**……MR**
Guideline – preferred where practical	**………G**
Normal design limit. Where maintenance issues arise, maintainer acceptance is required	**……NL**
Maximum (or minimum) design limit. SHALL NOT be exceeded unless EXCEPTIONAL limits apply	**……ML**

4 Design and Performance Criteria

This standard has been developed in consideration of the following criteria:

- Horizontal alignment of the rails including gauge, curves and transitions,
- Vertical alignment including vertical curves and grades,
- Minimising grades and curvature,
- Rollingstock speed, response and wheelset geometry,
- Superelevation and cant deficiency requirements for both track and rollingstock,
- Terrain,
- Sighting distance requirements.

5 Horizontal and Vertical Alignment

Horizontal and vertical alignment shall be designed to meet the requirements specified in Section 6 using a combination of the following components. **……MR**

The design output (framepoint co-ordinates) for horizontal alignment shall be stated (calculated) to a minimum of 6 decimal places of a metre (0.000001). **……MR**

Preparation, content and presentation of track design documentation and drawings shall be undertaken in accordance with the requirements of RailCorp Engineering Specification SPC 203 - Track Design. **……MR**

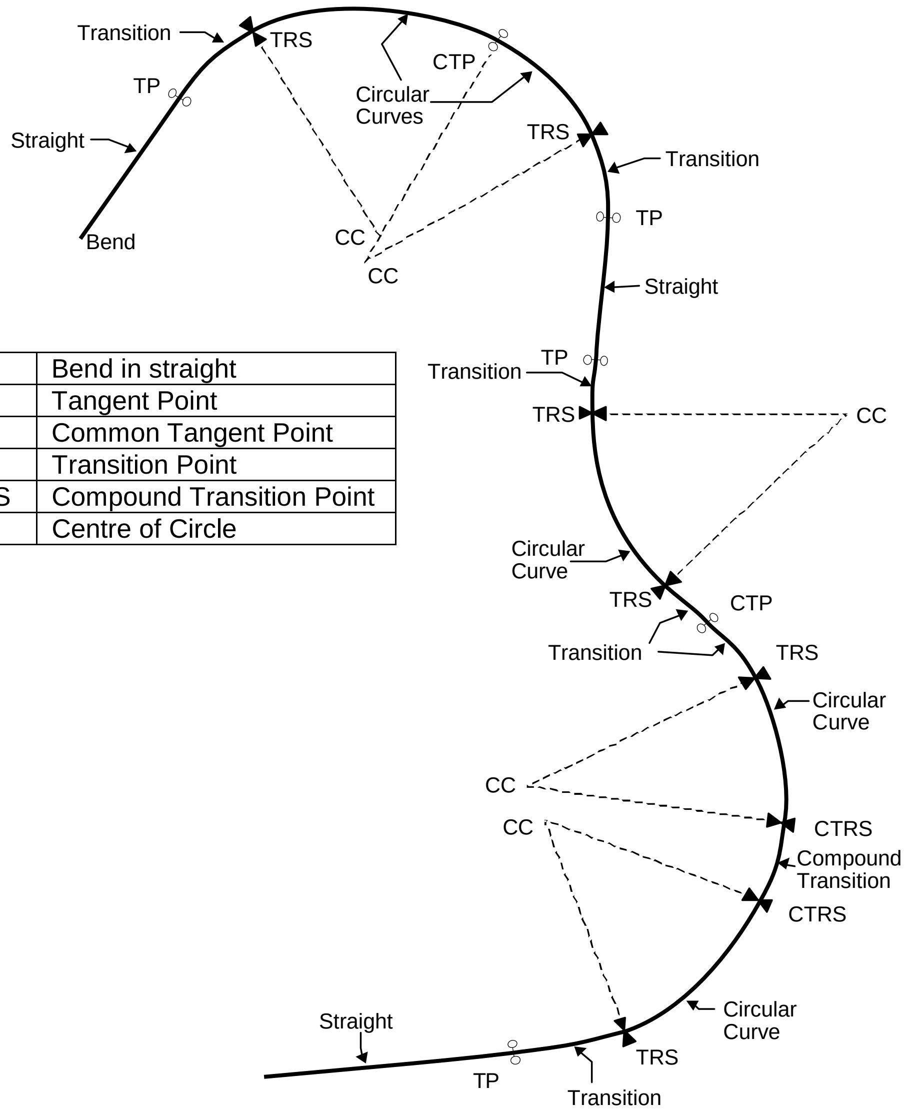
5.1 Horizontal Alignment Components

Horizontal alignment defines the centreline of the '4 foot' of each track.

Horizontal alignment shall be defined by combination of any of the following individual components: **……MR**

- Straights
- Circular curves
- Transitions
- Compound transitions

See Figure 1 for component names, point names and various combinations of components.



Bend	Bend in straight
TP	Tangent Point
CTP	Common Tangent Point
TRS	Transition Point
CTRS	Compound Transition Point
CC	Centre of Circle

Figure 1 - Horizontal Alignment Component Combinations

5.1.1 Straights

A straight shall be defined by a pair of tangent points (TP), a pair of bends, or a combination of both. **……MR**

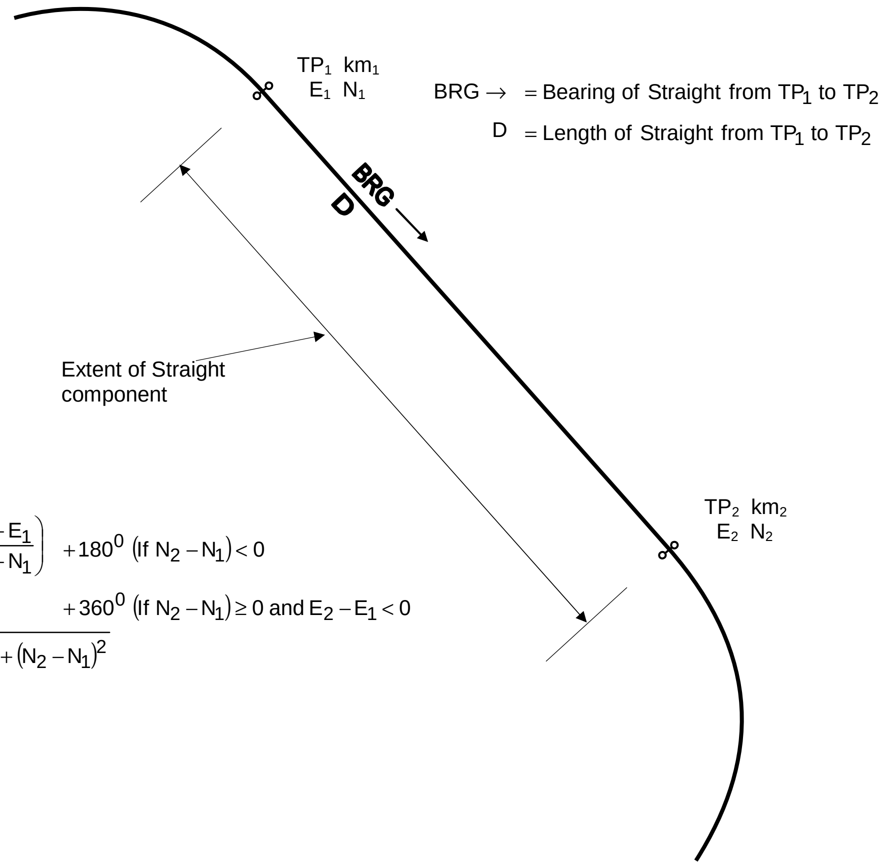
A bend is the point of intersection of two separate straights.

A bend shall be created when a change of angle occurs or where it is necessary to define the alignment of a point on the straight. **……MR**

Each TP or bend shall have a unique coordinate set (Easting-E, Northing-N). **……MR**

The bearing and distance of each straight are derived numbers.

See Figure 2 for the mathematical relationship for straights.



$$BRG \rightarrow = \tan^{-1}\left(\frac{E_2 - E_1}{N_2 - N_1}\right) + 180^0 \ (\text{If } N_2 - N_1) < 0$$

$$+360^0 \ (\text{If } N_2 - N_1) \geq 0 \text{ and } E_2 - E_1 < 0$$

$$D = \sqrt{(E_2 - E_1)^2 + (N_2 - N_1)^2}$$

$$km_2 = km_1 + D$$

Figure 2 – Straight Component

5.1.2 Circular Curves

A circular curve shall be defined by three coordinated points, two being the end points of the circular curve on the centreline and the third being the centre of circle (CC). **……MR**

Each of the three points shall have a unique coordinate set (E, N). **……MR**

The radius of the circular curve is a derived number and shall be the arithmetic mean of the distances calculated from each end point coordinate set to the CC coordinate set. **……MR**

The length of the circular curve is nominated by the arc distance, shown in metres.

See Figure 3 for the mathematical relationships for circular curves.

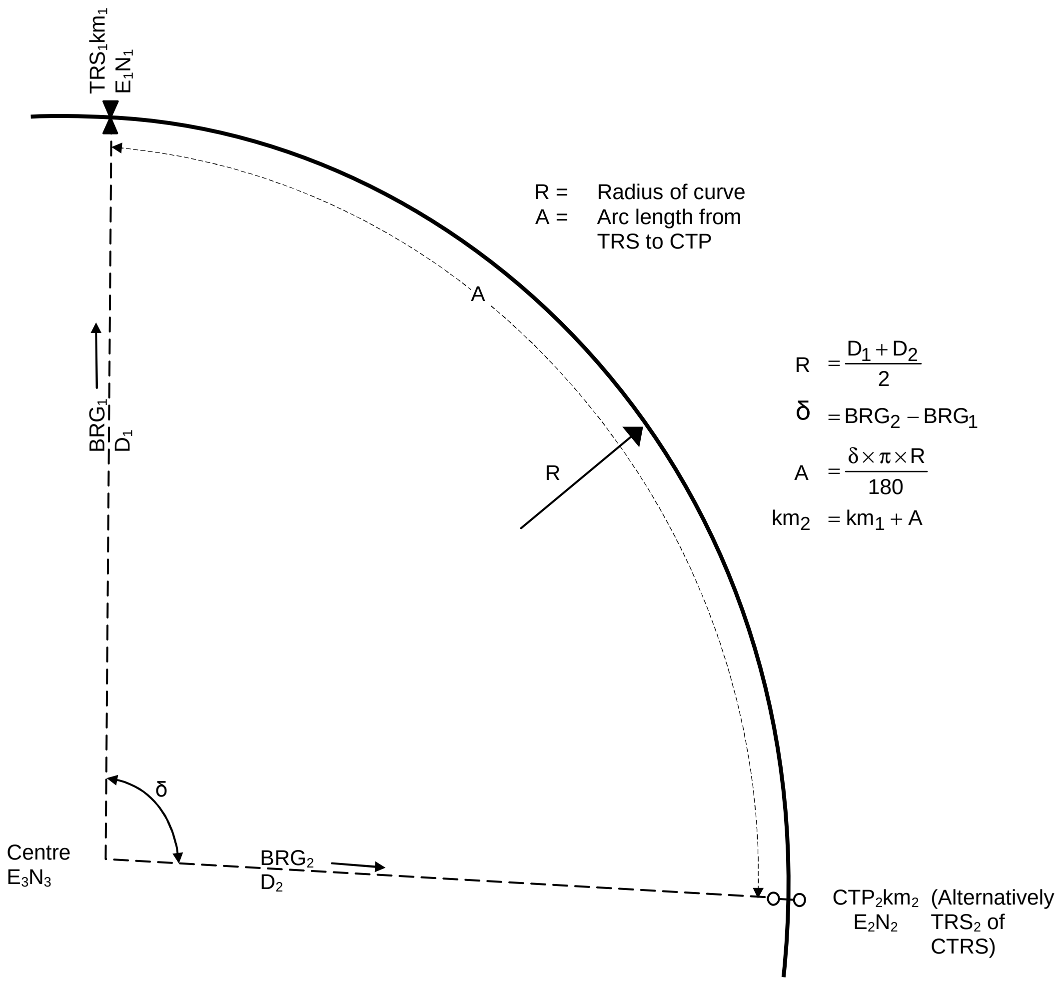


Figure 3 – Circular Curve Component

5.1.3 Transitions

A transition is the component that joins the straight to the circular curve and is based on a cubic parabola.

The transition shall be defined by three co-ordinate points, being the tangent point (TP), transition point (TRS) and the centre of circle (CC). **……MR**

Each of the three points shall have a unique coordinate set (E,N). **……MR**

The associated radius and transition data (Xc, X', h, θ, Ø, m, L) are derived values using the three coordinate sets.

The length of the transition (L) is a derived distance. **……MR**

See Figure 4 and Figure 5 for the mathematical relationships for transition curves.

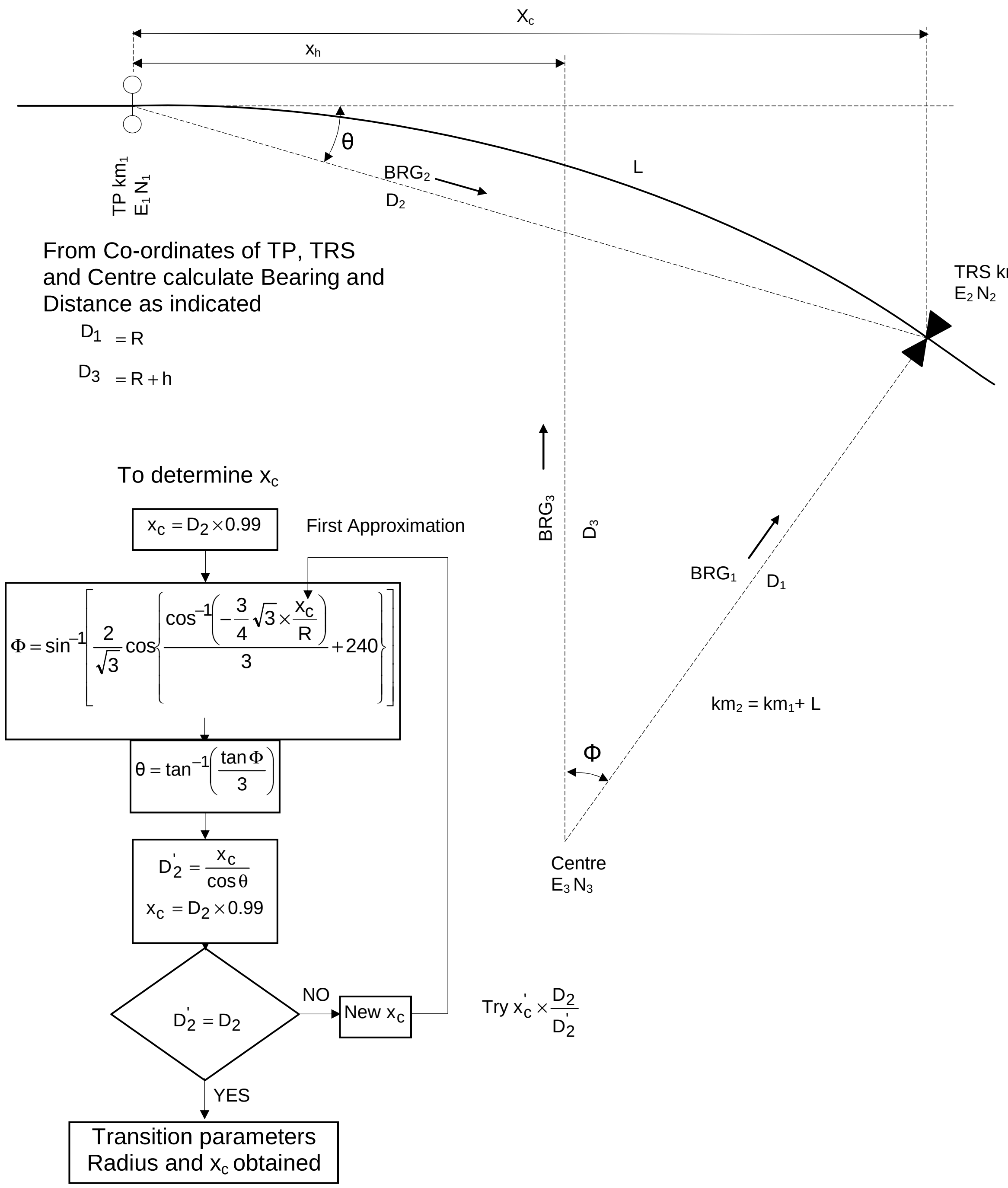


Figure 4 – Transition Component

Parameters: Radius (R); Transition Identifier (x_c)

$$\Phi = \sin^{-1}\left[\frac{2}{\sqrt{3}}\cos\left\{\frac{\cos^{-1}\left(-\frac{3}{4}\sqrt{3}\times\frac{x_c}{R}\right)}{3}+240\right\}\right]$$

$$m = \left(\frac{\tan\Phi}{3x_c^{2}}\right)$$

$$y_c = mx_c^{3}$$

$$x^{1} = R.\sin\Phi$$

$$h = y_c + R(\cos\Phi - 1)$$

$$\theta = \tan^{-1}\left(\frac{\tan\Phi}{3}\right)$$

$$L = x_c + \frac{9}{10}m^2x_c^{5} - \frac{9}{8}m^4x_c^{9} + \frac{729}{208}m^6x_c^{13} - \frac{32805}{2176}m^8x_c^{17} + \ldots\ldots\ldots$$

$$R = \frac{\left(1+9m^2x_c^{4}\right)^{3/2}}{6mx_c}$$

$$R_1 = \frac{\left(1+9m^2x_1^{4}\right)^{3/2}}{6mx_1}$$

$$x_1 = L_1 - 0.9m^2L_1^{5} + 5.175m^4L_1^{9} - 43.1948m^6L_1^{13} + 426.0564m^8L_1^{17}$$

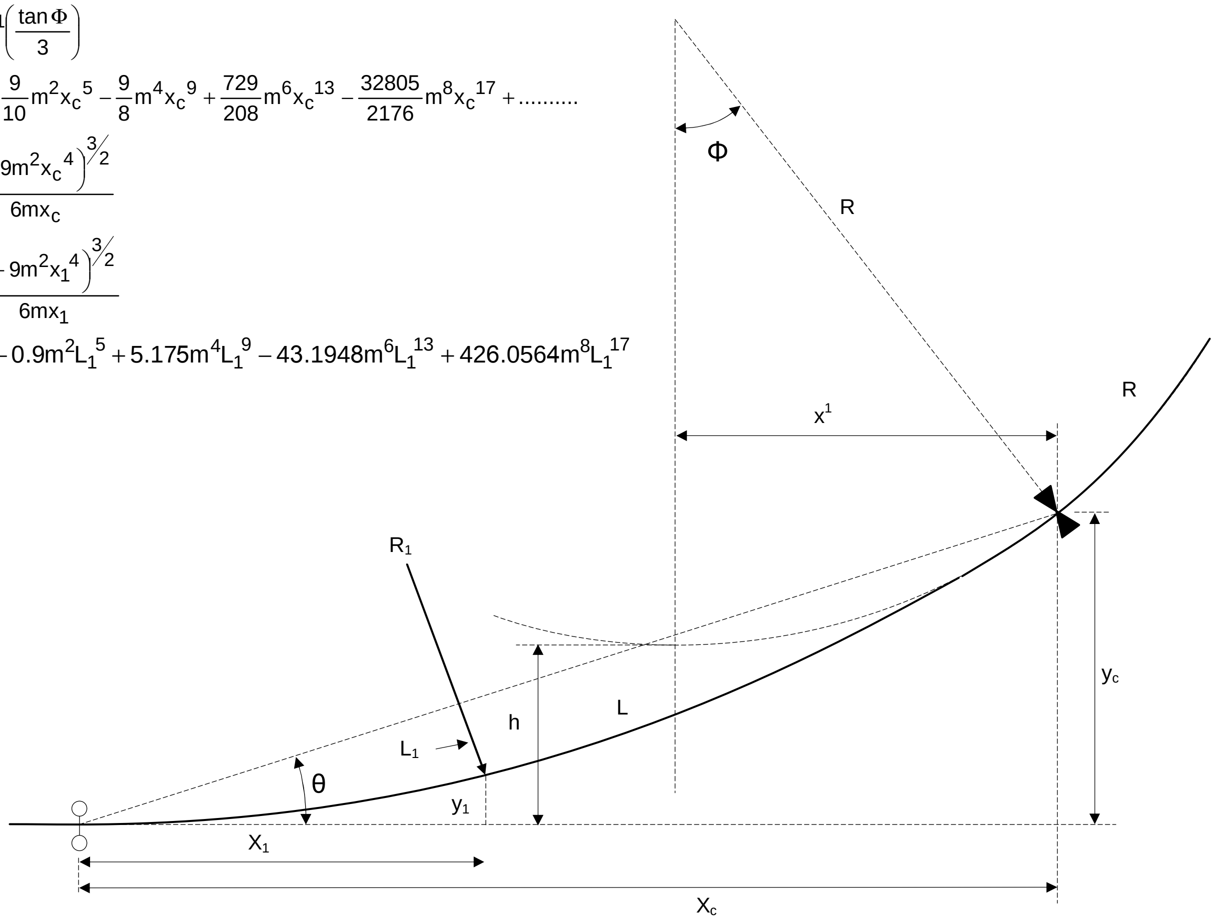


Figure 5 – Transition Formulae

5.1.4 Compound Transition

A compound transition is the component that joins two circular curves of different radii.

The compound transition shall be defined by four coordinated points, two being the common points joining the compound transition to the two radii (CTRS) and the other two being the respective centre of circles of each circular curve. **……MR**

Each of the four points shall have a unique coordinate set (E,N). **……MR**

A compound transition is a specific segment of a transition.

See Figure 6 for the mathematical relationships for compound transitions.

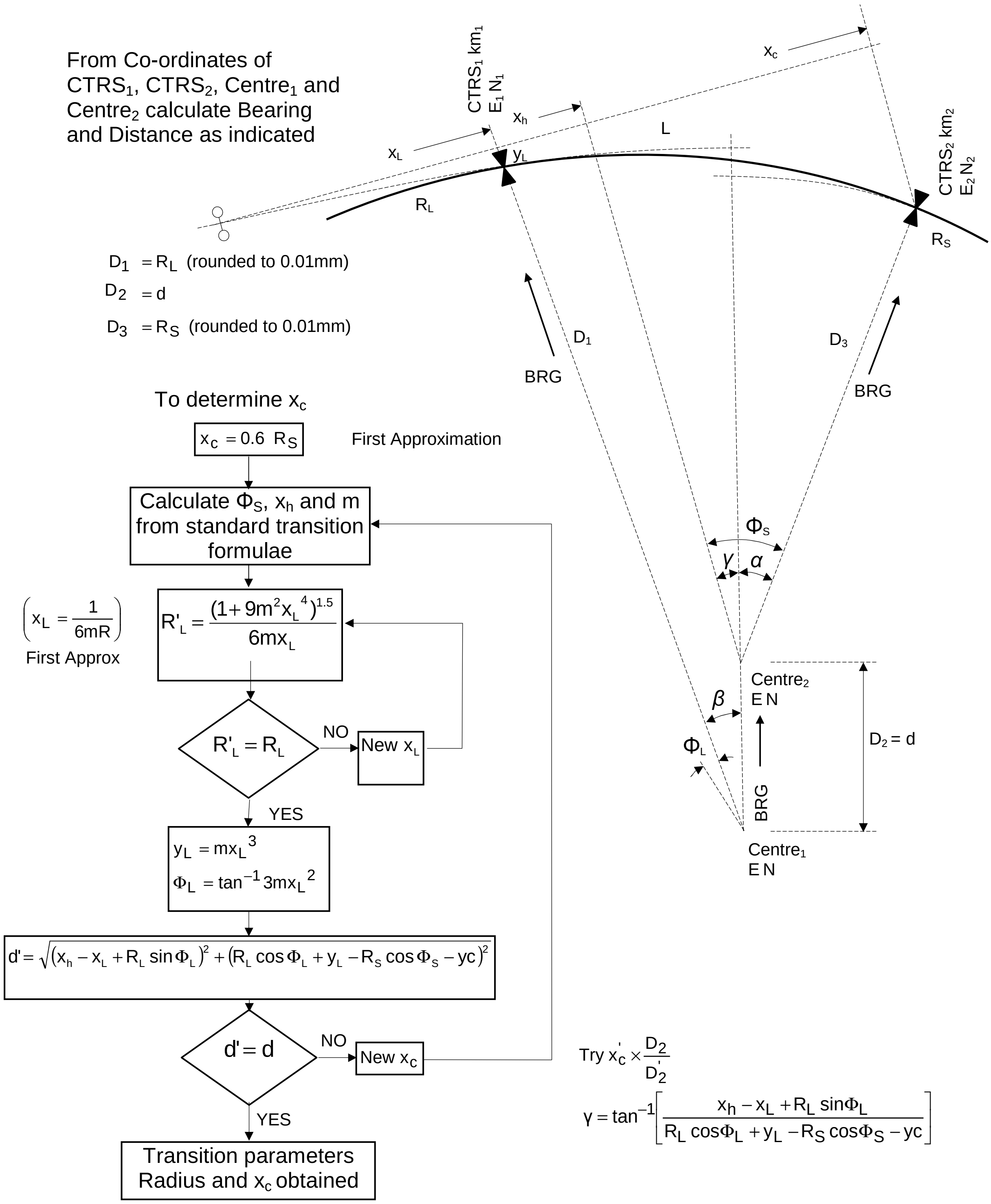


Figure 6 – Compound Transition Component

5.2 Location of Kilometrage

5.2.1 Frame Points

Each frame point (i.e., TP, TRS, CTP, CTRS, Ea point or BEND) shall be given a label called a "Survey kilometrage". **……MR**

The "Survey kilometrage" is a distance measured from Sydney along the centreline '4 foot' of each track. "Survey kilometrage" 0.000km is located at the Buffer Stop at Central No.1 Platform.

The "Survey kilometrage" of any frame point shall be the cumulative total from Sydney of the individual "adjusted" component lengths, each component length being derived. **……MR**

5.2.2 Kilometrage Adjustments

Kilometrage adjustments shall be incorporated to align the survey kilometrage of one track section to another. This requirement recognises the practical difficulties involved in repositioning all location markers and survey details where alignment changes result in changes to length of sections of track.

In multiple track locations, where practical, kilometrage adjustments shall be placed at the beginning of parallel straights greater than 100 metres in length to align the kilometrage of each centreline. **……..G**

The Down track should be adopted as the through survey kilometrage. **……..G**

The nominated survey kilometrage at this point shall be the adjusted kilometrage, ie, the kilometrage to be carried forward. **……MR**

5.2.3 Long and Short Intervals

A long or short interval shall be nominated as well as the actual length. This interval shall be located on a straight immediately before the point adjustment. **……MR**

The length of the interval shall be limited to the distance between the last increment point and the point adjustment. **……MR**

The length of the interval shall be such that there is only one location for any nominated kilometrage. **……MR**

A long interval is a negative adjustment.

A short interval is a positive adjustment.

The interval shall be contained within the track to which it relates. **……MR**

The interval should be contained wholly within a straight. **……G**

The straight should be >100m in length. **……G**

The kilometrage of a point within a long interval shall be nominated as 'the start of interval kilometrage' plus a distance e.g., in Figure 7, the end of platform kilometrage would be 43km200+24.308. **……MR**

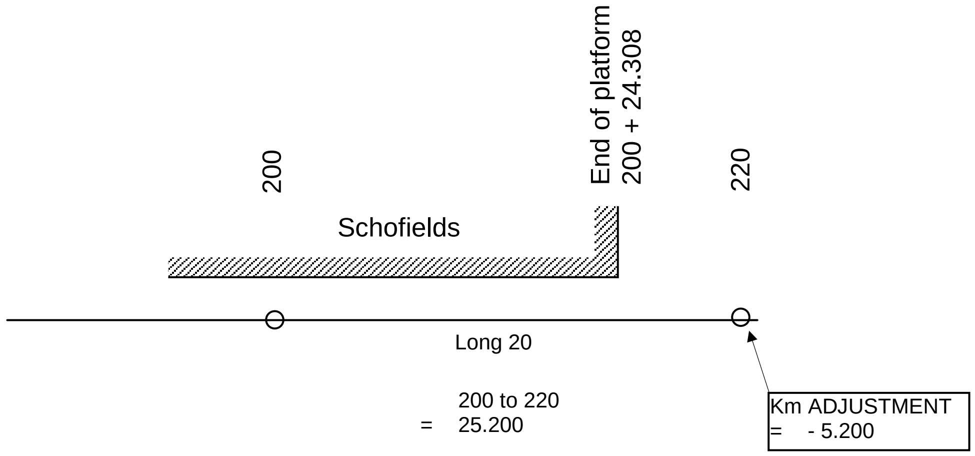


Figure 7 – Long Kilometrage Adjustment

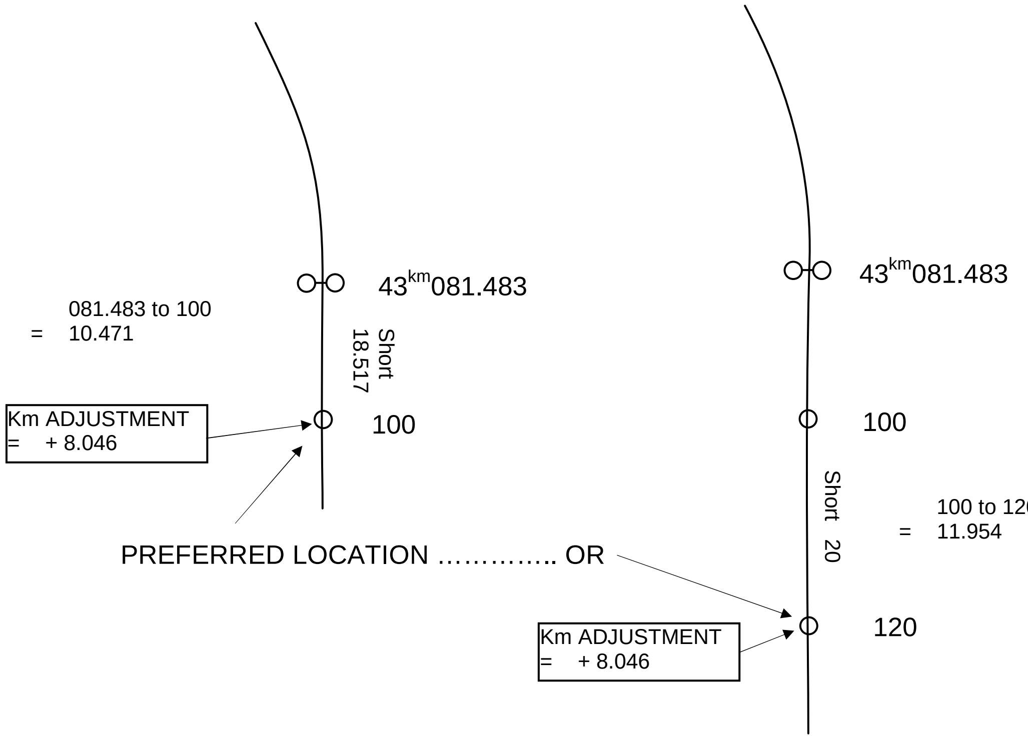


Figure 8 – Short Kilometrage Adjustment

5.3 Vertical Alignment Components

Vertical alignment defines the position of the low rail of each track.

Vertical alignment shall be defined as a series of straight grades connected by vertical curves (VC). **……MR**

The parameters which define the components shall be: **……MR**

- Intersection Point, reduced level (IPRL)
- Vertical curve, length (L_v)

5.3.1 Straight Grade

Each straight grade shall be defined by a pair of terminal points called intersection points (IP), which shall be located at whole 20m kilometrage points. **……MR**

Each IP shall have a defined reduced level (RL). **……MR**

The 'grade' of each straight grade shall be expressed as a percentage. **……MR**

The percentage grade shall be an exact increment of 0.005% to give an exact number of millimetre changes per 20 metres, except where kilometrage adjustment or other similar constraints occur. A grade projected from one IP shall allow the RL of the other IP to be derived to an accuracy of 0.001 of a metre. **……NL**

5.3.2 Vertical Curves

The vertical curve shall defined by the length (Lv) and shall to be a multiple of 40m i.e., 40m, 80m, 120m. **……..G**

The vertical curve shall be based on the quadratic parabola. However in the determination of its length it shall be equated to a circular curve for convenience and practical purposes. **……MR**

The parameters of the vertical curve are defined in Figure 9 and by the following formulae.

X = Steeper grade (%) (Note: +ve Grade = UP (Rising)

x = Flatter grade (%) -ve Grade = DOWN (Falling)

$$R_V = \frac{1}{2}V_m^2$$

$\Delta G = X + x$ OR $X - x$ if grades are in same direction

$$L_V = \frac{R_V G}{100}$$ round L_V up to an even number of 20m intervals (eg. 40, 80,….).

$$R_V = \frac{100 L_V}{G}$$

$$Y = \frac{L_V G}{200}$$

$Y = \frac{L_V}{2}(X + x)$ OR $Y = \frac{L_V}{2}(X - x)$ if grades are in same direction

$$y = Y\left|\frac{L}{L_V}\right|^2$$

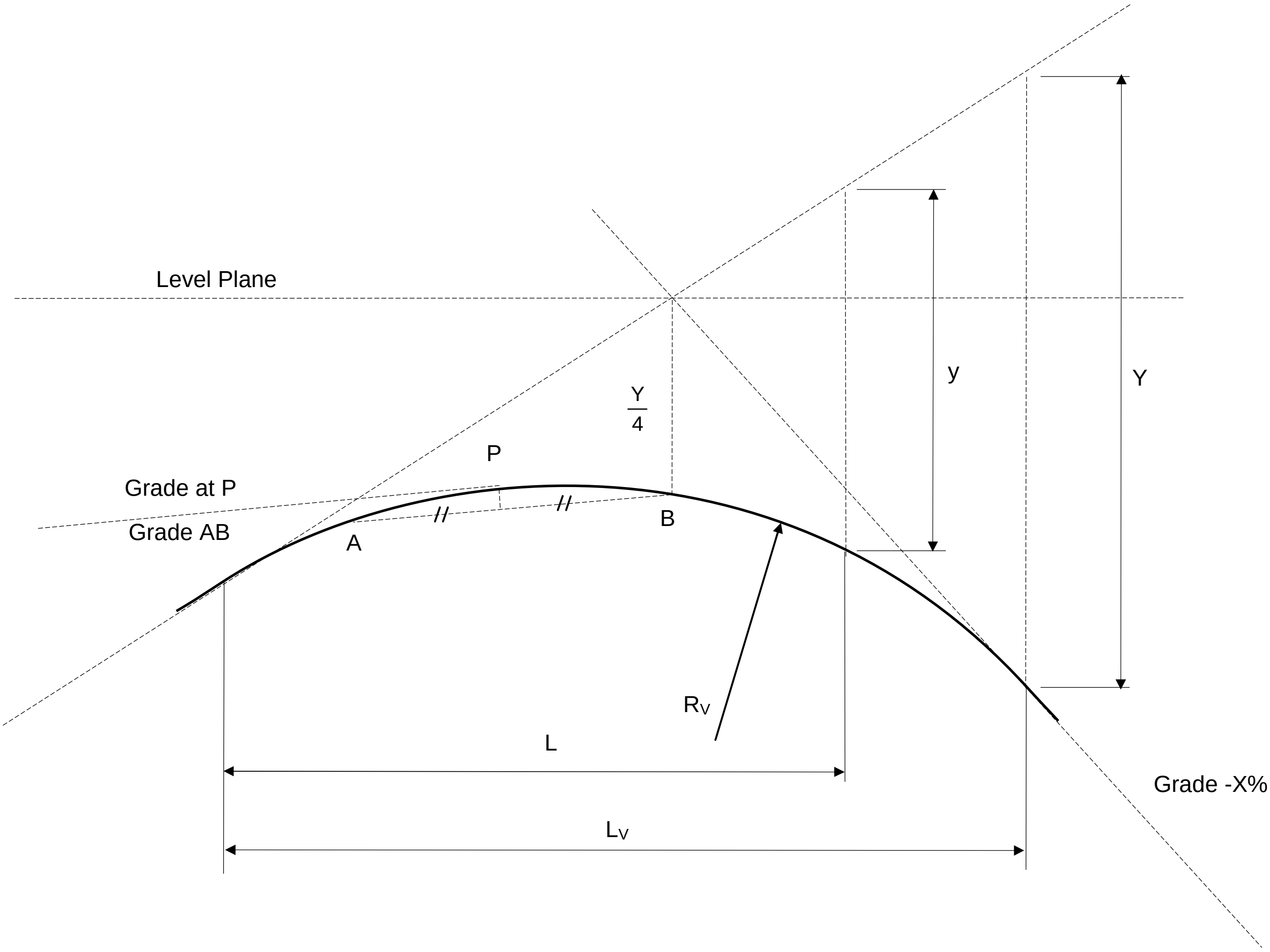


Figure 9 – Vertical Curve Component

6 Geometry Design Requirements

6.1 General

Track geometry for track in all classes of mainline and siding shall be designed to meet the limits for the track class detailed in Table 1 or Table 2 using the formulae detailed in the following sections. **……MR**

The definition of the structure of different track classifications used in this standard is detailed in RailCorp standard ESC 200.

HST refers to all currently approved High Speed Trains as detailed in OS 001 IM - TOC Manual.

Design of multiple track shall include allowances for multiple track centres as detailed in ESC 215. **……MR**

For single lines the alignment of the centre line of the track (4 foot) shall be used for geometry design calculations. **……MR**

When redesign of multiple tracks defined by one centre line alignment is undertaken, the geometry shall be converted to a centre line for each track. **……MR**

6.1.1 Definition of Design Limits

6.1.1.1 Normal Design Limits

The Normal Design Limits represent preferred engineering practice. They allow for low maintenance track. The Normal Design Limits are detailed in Section 6.3 for mainline track and Section 6.4 for sidings.

Track geometry design shall conform to the Normal Design Limits unless otherwise approved by a person with Engineering Authority for track geometry design, following review and sign-off of maintenance impact (eg resourcing, additional costs, environmental effects etc.) by a person with Engineering Authority for track maintenance for the location in question. **……MR**

6.1.1.2 Maximum (or Minimum) Design Limits

The Maximum (or Minimum) Design Limits allow for the track to be maintained within the safety limits but may result in higher maintenance requirements and costs. The Maximum (or Minimum) Design Limits are found in Section 6.3 for mainline track and Section 6.4 for sidings.

Track geometry design shall conform to these the Maximum (or Minimum) Design Limits unless otherwise allowed by the application of Exceptional Design Limits in Section 6.1.1.3 below. **……MR**

6.1.1.3 Exceptional Design Limits

Some existing infrastructure has been designed with short transitions and higher rates of change of deficiency that exceed the Maximum (or Minimum) Design Limits. Under controlled circumstances these Exceptional Limits shall be authorised by the Chief Engineer Track. The limits are described in Table 2.

These limits shall only be applied in the following circumstances: **……MR**

- it applies to existing plain track infrastructure and for new or existing tangential turnout designs
- it applies to individual locations, each justified on a case by case basis
- maintenance personnel shall review the ride on any sections of plain track for which exceptional limits have been applied during routine front of engine inspections (as part of Track Examination) and verify that the ride remains satisfactory at the track speed

6.2 Design Formulae

6.2.1 Abbreviations

Term	Symbol	Unit
Speed	V	km/h
Equilibrium speed	V_e	km/h
Maximum allowable speed	V_m	km/h
Radius	R	metre
Radius of turnout	R_t	metre
Bend angle	β	degrees
Applied Superelevation (or Cant)	E_a	millimetre
Difference in Applied Superelevation	ΔE_a	millimetre
Maximum Design Superelevation	E_m	millimetre
Equilibrium Superelevation	E_e	millimetre
Superelevation Ramp Rate	E_r	1 in _
Superelevation Deficiency	D	millimetre
Maximum Superelevation Deficiency	D_m	millimetre
Superelevation Deficiency in Bend	D_β	millimetre
Rate of Change of Deficiency	D_{roc}	mm/s
Difference in Deficiency	ΔD	millimetre
Length of Transition	L	metre
Length of Superelevation Ramp	L_r	metre
Grade	G	%
Difference between two adjacent grades	ΔG	%
Vertical Curve, Equivalent Radius	R_v	metre
Length of vertical Curve	L_v	metre
Vertical Acceleration	a_v	m/s^2
Nominal Spacing of Vehicle Bogies	B_c	m

6.2.2 Bends

The relationship between the bend angle in degrees between straights (β), and speed (V) is given by: $4.85 = \frac{\beta \cdot V^2}{D_\beta \cdot B_c}$

6.2.3 Circular Curves

6.2.3.1 Radius

The relationship between (R) and the parameters E_a, V & D is given by: $11.82 = \frac{R \cdot E_e}{V^2}$

where $E_e = E_a + D$

6.2.3.2 Superelevation (or Cant)

The relationship between applied superelevation (E_a) and the parameters R, V & D (see Radius above).

6.2.3.3 Deficiency

The relationship between deficiency (D) and the parameters R, E_a & V (see Radius above).

6.2.4 Transition Curves

6.2.4.1 General

The following provisions apply to transitions from straight to curve and between similar flexure curves.

Transitions shall be as defined in Section 5.1.3.

The relationship between transition length (L) and speed (V) is given by: $3.6 = \frac{\Delta D \cdot V}{L \cdot D_{roc}}$

Except where the adopted L is less than B_c, in which case: $3.6 = \frac{\Delta D \cdot V}{B_c \cdot D_{roc}}$

This equates to a virtual transition due to the spacing of the vehicle bogies.

6.2.4.2 Superelevation

The relationship between superelevation ramp length (L_r) and superelevation parameters is given by: $1000 = \frac{E_r \cdot \Delta E_a}{L_r}$

6.2.5 Vertical Curves

Vertical curves shall be as defined in Section 5.3.2.

The relationship between speed (V), vertical curve radius (R_v), and vertical acceleration (a_v) is given by: $12.96 = \frac{V^2}{a_v \cdot R_v}$

6.2.6 Calculation of Speed

Determination of the design speed of trains requires the application of the following rules: ......MR

- Calculate the maximum speed by applying the above formulae to the section of track being reviewed
- Round the speed to the nearest 1 km (e.g. 75.4 becomes 75, 75.5 becomes 76)
- Since Permanent speeds are advertised in multiples of 5km/hr only, adjust the speed to the next LOWEST 5km/hr speed band. (e.g. 76 becomes 75, 79 becomes 75.)

6.3 Mainline Geometry Design Limits

6.3.1 Gauge

Nominal track gauge is 1 435mm for all classes of track. ......MR

6.3.2 Bends

Bends in alignment are generally not desirable. ....G

The normal limit on bends between straights (β) is given in Table 1. ......NL

The normal limit on allowable deficiency on a bend (D_β) is the same as the maximum allowable limit in Table 1. ......NL

The maximum allowable bend between straights (β) is given in Table 1. ......ML

The maximum allowable deficiency on a bend (D_β) is given in Table 1. ......ML

6.3.3 Circular Curves

6.3.3.1 Radius

The selection of curve radii should account for train operating speeds. Generally flat curves are more desirable than sharp curves but the requirements of platform gaps, environmental impact and maintainability also need to be considered. ....G

The normal limiting radius (R) is given in Table 1. ......NL

The minimum allowable radius (R) is given in Table 1. ......ML

Where radii sharper than Normal Design Limits is proposed detailed consideration shall be given to the effect of: wear on wheels and rails; flanging ......MR and squeal noise; and to the requirements for lubrication and friction modification. Separate requirements shall be imposed at platforms to control the platform gap. (See Section 6.6).

Special requirements apply to horizontal alignment approaching turnouts with conventional switches. The conventional heeled switch forms a blunt angle to the stockrail. The wheels on the bogie of a vehicle form an angle of attack to the switch. With a sharp radius immediately approaching the switch (and with similar hand to the turnout road) the angle of attack to the turnout switch is increased. This increases the opportunity for derailment also depending on the wheel condition and bogie tracking. **……..G**

Design of any track approaching turnouts with conventional switches shall not significantly increase the angle of attack at the switches. **…...MR**

For a minimum of 4 m in advance of the points the track shall be straight. **……NL**

Where the normal limit cannot be achieved, the curve shall be no sharper than 1000m radius. **…...ML**

The requirement does not apply if the hand of the curve is opposite to the hand of the turnout
i.e. where the curve does not increase the angle of attack at the switch.

6.3.3.2 Superelevation (or Cant)

The normal limit on superelevation (E_a) is the same as the maximum allowable superelevation in Table 1. **…...NL**

The maximum allowable superelevation (E_a) is given in Table 1 **...…ML**

Superelevation shall be rounded to the nearest 5mm. **…...MR**

Superelevation should be constant throughout the circular curve and zero on straights unless design constraints require variation in superelevation. **……..G**

6.3.3.3 Deficiency

The normal limit on deficiency (D) is given in Table 1. **…...NL**

The maximum allowable deficiency (D) is given in Table 1 **...…ML**

Where track is being designed for a controlled system with basically one operation and hence a choice of superelevation and cant deficiency, the minimum cant deficiency to be applied is 25mm. This requirement is in line with the principle that a level of positive deficiency is desirable to promote consistent vehicle tracking. **……..G**

6.3.3.4 Length of Horizontal Alignment Components

Straights are not required between adjacent curves ……NL

If a straight is designed between adjacent curves, the following requirements apply:

The most desirable minimum straight length (in metres) between adjacent curves is given by: $\frac{V}{2}$ *subject to:* ……..G

- The minimum length of straight between adjacent curves of similar flexure is equal to B_c ……ML
- The minimum length of straight between reversing curves is equal to B_c ……ML

The normal minimum length of a circular or transition curve is equal to B_c. ……NL

The maximum allowable transition curve length is: $L = 0.68R$ ……ML

The normal minimum length of superelevation ramp is equal to B_c. ……NL

If L is calculated to be less than B_c, then a transition curve is not essential. ……G

The normal minimum length of superelevation ramp in a non-transitioned compound curve is equal to B_c (see Figure 10, d). No limits apply to maximum length. ……NL

6.3.4 Transition Curves

6.3.4.1 General

The normal limit on Rate of Change of Deficiency (D_{roc}) is given in Table 1. ……NL

The maximum allowable rate of change of deficiency (D_{roc}) is given in Table 1. ……ML

6.3.4.2 Superelevation

Superelevation shall be applied linearly throughout L_r. ……MR

The normal design methods of applying superelevation for various situations are shown in Figure 10. ……MR

The maximum allowable superelevation ramp is related to speed through the transition but shall also consider the need for the track to be maintainable to meet the Base Operating Condition limits for Track Geometry, where superelevation ramp is considered a twist. Maintenance requirements shall be considered for designs that exceed Normal Limits. ……MR

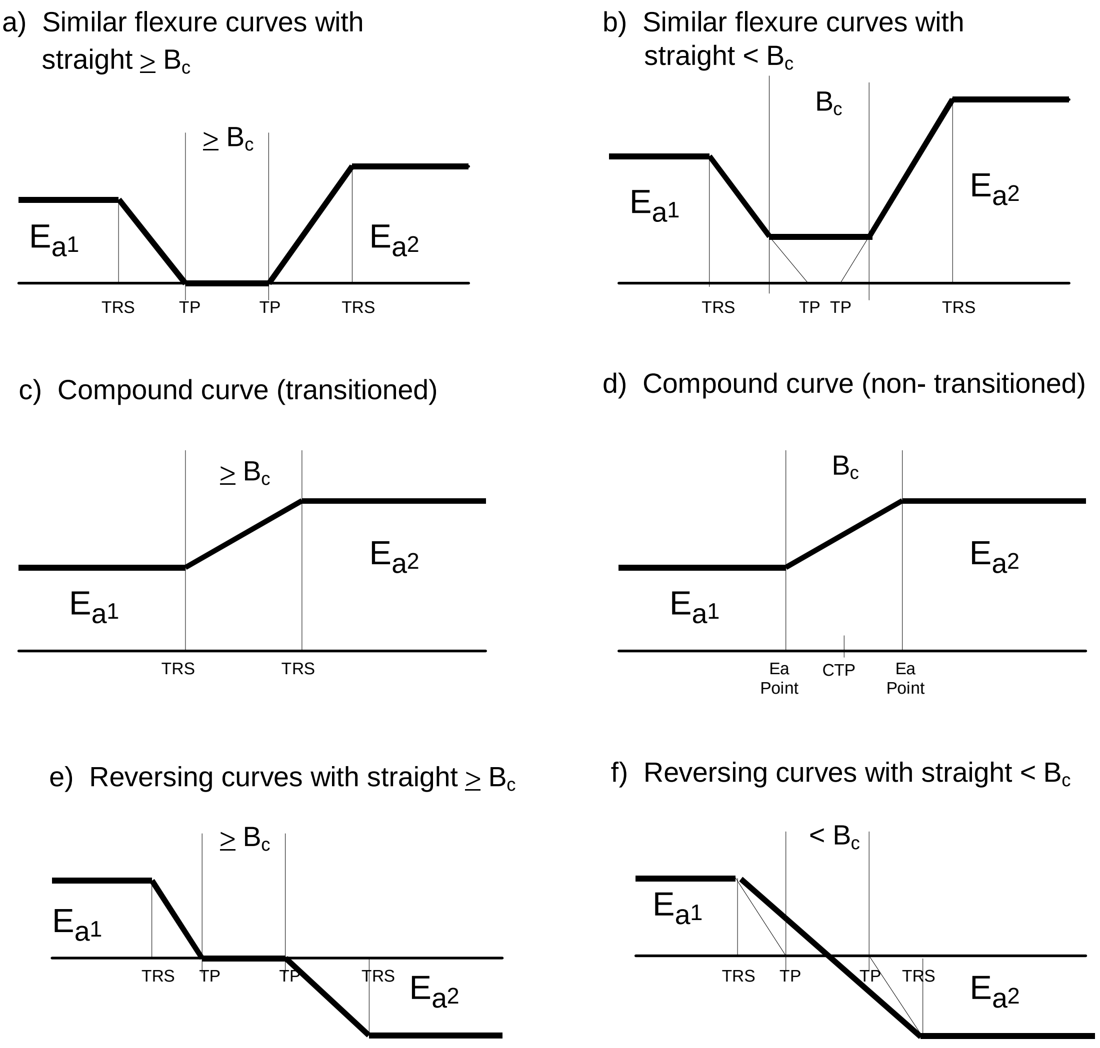


Figure 10 – Methods of Applying Superelevation

Note: The heavy line represents the applies superelevation through the area of the transitions.

When a curve has no transition then the superelevation shall be applied symmetrically about the geometric framepoint (i.e. TP or CTP) as in case (d), above. **......MR**

6.3.4.3 Transitions in Special Trackwork

There should be no superelevation transitions through or within 5m of a turnout or other special trackwork (diamonds, slips etc.). **......NL**

The maximum allowable superelevation ramp rate (E_r) through or within 5m of a turnout except at diamond crossings or swingnose crossings shall be 1 in 1000. **......ML**

The maximum allowable superelevation ramp rate (E_r) through or within 5m of a diamond crossing or swing nose crossing shall be 1 in 2000. **......ML**

6.3.5 Vertical Curves

The normal limiting vertical radius (R_v) is given in Table 1. ……NL

The minimum allowable vertical radius (R_v) is given in Table 1. …..ML

The maximum allowable vertical acceleration (a_v) in a vertical curve is given in Table 1. …..ML

A vertical curve is required when the grade difference is: $\Delta G \geq \frac{2600}{V^2}$ or when $\Delta G \geq 1\%$ ……MR

Track through turnouts and for 5m in front of switch tip shall be of constant gradient (no vertical curvature). ……NL

Configuration approval is required if the turnout (new or replacement) is not located on a constantly graded section of track. …..MR

If vertical curves cannot be avoided, special consideration shall be given to:

- vertical displacement of the switch to determine that it falls within tolerances for installation and maintenance,
- changes in superelevation in switches. Super ramp in switches needs to be avoided or at least limited in any case,
- absolute vertical curve limit,
- the effect of negative superelevation on the turnout road.

The minimum allowable vertical radius (R_v) through turnouts and for 5m in front of switch tip is given in Table 1. ……ML

6.3.6 Grades

Track gradient should be as flat as possible excepting that design of grade shall consider requirements for drainage, particularly through cuttings and platforms, as detailed below. ……..G

The normal limit on grades is given in Table 1 ……NL

The maximum limit on grades is given in Table 1. ……ML

The maximum significant grade allowable in a section of track is the ruling grade for that section. Grades over short distances may be steeper than the ruling grade if it can be shown that there will be no effect on train operations (including the effects of curvature). ……MR

The ruling grade for a section of track is documented in OS 001 IM - Train Operating Conditions (TOC) Manual.

When designing grades within 1 in 5 of the ruling grade advice shall be sought from the Manager Rolling Stock Access Integrity.

The design grade shall not exceed the ruling grade without the approval of the Manager Rolling Stock Access Integrity.

When designing grades within 1 in 5 of the ruling grade the grade shall be compensated for curvature by an amount: $\frac{60}{R}\%$ ……MR

The minimum grade in cuttings shall not be flatter than 0.5% (1 in 200) without provision for special drainage. **……MR**

Grades at platforms

For the design of new platforms facing new track work:

- Track grade shall be constant through the platform and for 40m beyond each end of the platform **……NL**
- The Normal Limit on grade shall be no steeper than 1:150 **……NL**
- The Maximum Limit on grade shall be no steeper than 1:100 **……ML**

Where a combination of existing and new infrastructure is being designed, use "best endeavours" to approach the standards for new infrastructure.

Care needs to be taken with drainage design to ensure effective drainage flow.

Parameter			Normal Limits		Maximum (or Minimum) Limits	
			Passenger Main Line and Mixed Passenger Freight Main Line	**Light Passenger**	**Passenger Main Line and Mixed Passenger Freight Main Line**	**Light Passenger**
Max V (km/h)		Normal	115	100	115	100
		XPT	160	140	160	140
Adopted B_c (m)			13	13	13	13
Max β (degrees)			1°	1°	1°50'	1°50'
Max D_β (mm)			25	25	40	40
Min R (m)			400	400	160	160
Max E_a (mm)	Mainline		125	100	140	100
	Platforms		See Section 6.6.2		See Section 6.6.2	
	T/out (Thru road) Sim		50	50	50	50
	T/out (Thru road) Contra		20	20	50 (Note 3)	40 (Note 3)
Max D (mm) (Note 1)	Plain Track	Normal	±75	±50	+80/-75	±75
		XPT (T1)	+110/-75	+75/-50	+110/-75	+75/-50
	Turnout track Conventional turnouts	Normal	75	50	75	75
		XPT (T1)	100	75	110	100
	Turnout track Tangential turnouts	Normal	75	75	85	85
		XPT (T1)	100	100	110	110
	Diamond Crossings	Normal	0	0	25	25
		XPT (T1)	0	0	25	25
Max D_{roc} (mm/s)	Plain Track	Normal	37	37	55	55
		XPT (T1)	55	55	65	65
	Turnout track Conventional turnouts	Normal	85	75	110	85
		XPT (T1)	85	75	110	85
	Turnout track Tangential turnouts	Normal	110	110	135	135
		XPT (T1)	110	110	135	135
Rate of change of superelevation E_{aroc} (mm/s)		Normal	37	37	55	55
		XPT (T1)	55	55	65	65
Min E_r (1 in)			1000	900	500 (Note 4)	400 (Note 4)
Min R_v (m)	Plain Track		1300	1300	1300	1300
	Turnouts		Constant Grade		3000	3000
Max a_v (m/s^2)			0.2	0.2	0.4	0.4
Grade G (compensated) (Note 2)			1 in 100	1 in 100	Ruling Grade	Ruling Grade

Table 1 – Normal and maximum (or minimum) design limits of basic parameters

Note: 1 The design limit for negative D applies to the normal operation of the most significant trains over the track being designed.

2. Ruling grade shall not be compromised

3. Only allowable when maximum deficiency does not exceed 75mm on Turnout Road

4. Consideration needs to be given to the implications for Base Operating Conditions for track geometry. Rates less than 1 in 650 will impact on track maintenance for speeds more than 60kph

Parameter		Passenger Main Line and Mixed Passenger Freight Main Line	Light Passenger
Max D (mm)	Passenger only	100	[redacted]
Max D_{roc} (mm/s)	Normal	135	[redacted]
Min E_r (1 in)		300	300
Grade G (compensated)		1 in 30	1 in 30

Table 2 - Exceptional design limits of basic parameters

6.4 Siding Geometry Design Limits

All classes of sidings shall be designed to the following geometric standards. **…..MR**

The maximum design train speed on a siding is 25km/h. If proposed speeds in a siding are >25km/h main line geometry design standards shall apply. **…..MR**

The “RailCorp Design Guidelines for the Upgrade & Construction of New & Existing Train Stabling Yards and Turnback Sidings” contain design requirements for stabling yards and turnback sidings that include the requirements for train presentation, train examination, staff access etc. These must be considered as part of the geometry design in any applicable sidings.

6.4.1 Circular Curves

6.4.1.1 Radius

The Normal minimum radius (R) for sidings is given in Table 3 and the minimum allowable radius (R) is given in Table 4 **……MR**

Transitions are not required on curves in sidings. **……..G**

The gauge shall be widened on sharp curves as detailed Table 5 **……MR**

6.4.1.2 Superelevation

Superelevation is not required on sidings except as required to connect to a mainline turnout. **……..G**

The maximum rate of removing mainline superelevation shall be 1 in 500. The superelevation ramp shall commence clear of turnout bearers. **……MR**

6.4.2 Reverse Curves

A desirable straight of 20m shall be provided between reverse curves of 200m radius and less. ……NL

For reverse curves of greater than 200m radius the length of straight may be reduced to 13m. ……..G

If, because of existing restraints, this straight cannot be economically obtained, the straight may be reduced to 10m provided it is understood long vehicles may require shunting separately to avoid buffer locking. ……ML

6.4.3 Vertical Curves

Vertical curves shall be provided when the grade difference is: $\Delta G \geq \frac{2600}{V^2}$ or when $\Delta G \geq 1\%$ ……MR

Vertical curves should be similar to adjacent mainlines. ……..G

The limits for curve radius shall be as detailed in Table 3 for normal design and Table 4 for minimum design. ……MR

6.4.4 Gradients

The normal limiting Gradients (G) is given in Table 3. ……NL

The maximum limiting Gradients (G) is given in Table 4. …..ML

When designing grades within 1 in 5 of the ruling grade the grade shall be compensated for curvature by an amount: $\frac{60}{R}\%$ …..MR

Mainline gradients shall extend into a siding for a minimum of 15m before commencement of any vertical curve. …..MR

For new yards and for substantial alterations requiring redesign of existing yards, where passenger trains will be examined the following additional limits on grading apply.

The normal limiting gradient shall be 0.5% ……NL

The maximum limiting gradient shall be 0.67% …..ML

The limits apply only to those roads to be used for examination. On these roads a section of track for examination must be provided with limited grade over 200m minimum length. This can be reduced to 163m if only suburban sets are to be examined.

Where the maximum limit cannot be achieved approval must be obtained from the Chief Rollingstock Engineer for any reduction in the requirements and included in the design record/ design report.

Track centres shall be widened where tracks are at different levels and grades to ensure that the designed batter slopes and formation widths are obtained for each track. If this is not possible, retaining walls and standard cess drainage shall be provided. …..MR

Parameter	Siding Class	
	General Yard / Passenger operations/ or maintenance	Passenger Siding / Engineering Maintenance Siding
Min Radius (R) m	200	180
Min Radius (R_v) m	2000	1200
Max Gradient (G) Examination %	0.66	0.66
Max Gradient (G) %	1	1

Table 3 – Normal design limits for sidings

Parameter	Siding Class	
	General Yard / Passenger operations/ or maintenance	Passenger Siding / Engineering Maintenance Siding
Radius (R) m	160	160
Min Radius (R_v) m	800	800
Max Gradient (G) %	1.25	1.25

Table 4 – Maximum (or minimum) design limits for sidings

Radius (m)	Gauge (mm)	
200 - 160	1440[(1)]	
159 - 140	1445	Existing designs only
139 - 120	1450	Existing designs only

Table 5 – Gauge widening in sidings

Note: 1 Gauge widening is not required on curves ≥160m radius if concrete or pre-bored timber sleepers are used.

6.5 Clearance Points at Converging Tracks

6.5.1 General

The safety clearance point between two (2) adjacent converging tracks is the point v/here a moving vehicle passes a stationary vehicle, on the adjacent track, with a minimum distance between vehicles of 450mm.

Clearance points are used to establish the location of catchpoints and associated insulated joints together with details with which the related signals can be located.

6.5.2 Design Requirements

Use the design method detailed in Engineering Standard ESC 250 Section 4.4.7 to calculate the required track centres at the Clearance Point.

6.5.3 Protection

Clearance Points are protected by:

- Catchpoints or derail devices

  The need for catchpoints shall be determined by the Chief Engineer Signals

  The location of catchpoints and derail devices shall be established in accordance with the requirements of Engineering standard ESC 250

- Clearance Board

  A clearance board is a board provided at the safety clearance point of all turnouts not protected by signals or catchpoints to indicate the point beyond which vehicles must not be permitted to pass without proper authority. When required the clearance board may be located at the Operations Clearance Point which is located at wider track centres to provide specific working conditions for Operating Staff.

- Insulated Joints and/or Signals

  The need for and location of insulated joints and signals shall be determined by the Chief Engineer Signals

6.6 Geometry Design Requirements for Alignment at Platforms

When track alignment is being reviewed or new trackwork is being constructed, consideration shall be given to the effects on the platform gap. Whilst the following requirements address alignment, changes in track alignment and superelevation design may also necessitate small changes in track grading.

The requirements address different situations where different levels of flexibility are available to the designers.

Where a completely new corridor is being designed maximum flexibility is available allowing the location of a station and the geometry at the station to be determined to minimise the platform gap. Where a new track and platform are to be designed within an existing corridor there is much less capacity to minimise gap and where the platform and track are already fixed there is no flexibility at all.

6.6.1 Platform Gap

The size of the platform gap is influenced by the following issues:

- Track structure - Concrete track requires less gap than timber sleepered track.
- Track alignment – track on curves, especially sharp curves, will require a greater gap than tangent track.
- Changes in track alignment – changes in curvature within or near to the platform area will cause an increase in the clearance required.
- Turnouts – the presence of any turnouts within the platform area will require an additional clearance or scallop that also gives rise to an inconsistency in the platform gap.
- Superelevation – higher superelevation shall require a greater gap.

6.6.2 Platform Gap Design Requirements

6.6.2.1 New Corridor Design

The following design requirements for new corridor design shall apply unless approved otherwise by the Chief Engineer Track and the Customer Service General Manager for the platform location: **……MR**

- Turnouts prohibited in or within 20m of the platform. **……NL**
- Track curvature - minimum radius 1000m. **……NL**
- Sharpening of curvature within 20m of a platform prohibited. **……NL**
- Superelevation - maximum of 50mm or up to 75mm where clearance affects are negated by coping design (overhang). **……NL**
- Track structure - Concrete sleepers. **……NL**

6.6.2.2 New Platform or Track Design Within an Existing Corridor – Normal Limits

The following requirements shall apply for the design of new platforms and/or new trackwork at platforms that are in an existing corridor unless approved otherwise by the Customer Service General Manager for the platform location: **……MR**

- Turnouts prohibited in or within 20m of the platform. **……NL**
- Track curvature - minimum radius 600m though the platform and for 20m either side of the platform. **……NL**
- Superelevation - maximum of 60mm or up to 100mm where clearance affects are negated by coping design (overhang). **……NL**
- Track structure - Concrete sleepers. **……NL**

6.6.2.3 New Platform or Track Design Within an Existing Corridor – Maximum or Minimum Limits

The following requirements shall apply for the design of new platforms and/or new trackwork at platforms that are in an existing corridor unless approved otherwise by the Chief Engineer Track and Customer Service General Manager for the platform location: **……MR**

- Turnouts prohibited excepting those which affect only the end of the platform (last 15m) by no more than 10mm and for which the gap shall be consistently applied for the remainder of the platform after a 1 in 20 ramp to the basic clearance. **……ML**
- Track curvature - minimum radius 400m. **…..ML**
- No sharpening of curvature from the end of a platform for 20m beyond the platform that would increase clearance requirement below the 400m minimum radius requirement by more than 10mm. **…..ML**

- Superelevation - maximum of 75mm or up to 100mm where clearance affects are negated by coping design (overhang). **…..ML**
- Track structure - Concrete sleepers. **…..ML**

6.6.2.4 Realignment of an Existing Platform

Realignment designs for existing platforms should endeavour to reduce the platform gap by considering the following effects and selecting the most effective combination that is practical to implement. Both the track alignment and the platform coping design should be considered: **……..G**

- *Removing or minimising the effect of turnouts*
- *Removing or minimising the effect of changes in curvature within 20m of a platform*
- *Reducing the superelevation*
- *Installing concrete sleepers*
- *Sharpening of curvature within 20m of a platform should be avoided*

If there are variations in the alignment of the platform coping, designing a track alignment based on an average coping alignment may result in numerous significant infringements of the clearance envelope.

The design shall consider the actual platform position in setting the clearance for the new alignment. Occasional instances of protrusion or wide gap should be identified for correction. **……MR**

Any design that includes a platform cut-back shall be approved by the Chief Engineer Track. **…..MR**

6.6.2.5 Temporary Platforms

Where staging of new work requires the construction of a temporary platform the requirements of Section 6.6.2.3 - “New Platform or Track Design within an Existing Corridor – Maximum or Minimum Limits” shall be met unless otherwise approved by the by Chief Engineer Track and Customer Service General Manager for the platform location. **…..MR**

6.7 Geometry Design Requirements for Regrading and Realignment

This section sets out the geometry requirements for re-grading (adjustment of the vertical level) and re-alignment (adjustment of the horizontal position) of existing tracks including works in conjunction with electrification.

When upgrading or reconditioning track, the approved grading shall be appropriate to the Operating Classification. **…..MR**

Where a track is completely reconstructed from (and including) the formation, it shall be treated as a new construction for survey and application of standards. **…..MR**

6.7.1 Regrading

Where design is being undertaken for re-grading the following requirements shall be considered: **……..G**

- *The condition of formation and variation of existing formation level necessary to meet standards.*
- *The condition and depth of existing ballast and the Operating Classification to which the work is to be carried out.*
- *In electrified areas, the existing overhead wiring height, the limits of increase in height possible without altering the main catenary and the increase in height possible by altering the main catenary without raising the overhead wiring structures.* **……..G**

The special requirements of finished level for bridges, platforms and other fixed structures shall be considered as outlined below.

- The effect of excavation or fill on the stability of adjacent structures shall **…..MR** be reviewed by the Chief Engineer Civil. This applies to the footings of all structures, such as bridge abutments, piers, wingwalls, tunnels, retaining walls, platform walls, overhead wiring structures, signal gantries and towers.

- When regrading past platforms, platform heights shall comply with RailCorp Engineering Standard ESC 215 and the operational specification for the platform (eg Level Access, Extended Medium etc). Design approval is required for lowering of the formation level to achieve the required coping height at platforms. Provision shall be made for drainage of the depressed formation area and the new track surface shall conform to relevant standards. **…..MR**
- If minimum clearances cannot be obtained at overbridges and raising the overbridge is not possible, lowering the existing formation is only acceptable if provision is made for drainage of the lowered area. **…..MR**
- Where regrading is proposed in tunnels and reconstruction of the track bed is required, the finished reconstruction is to provide for a tunnel complying with the clearances specified in with ESC 215. **…..MR**

6.7.2 Re-alignment

Where track alignments are required to be modified to accommodate electrification or other changed operating environments, the requirements of other standards shall be taken into consideration. Some of the issues that need to be considered include: **……..G**

- *Formation shall be widened to meet the requirements of RailCorp Engineering Standard ESC 410.* **……..G**
- *The provision of road access needs to be considered to permit reasonable access to all overhead wiring masts and signals as well as for track maintenance purposes. In multiple track areas, one side shall be the prime access with special access where specifically required on the other.* **……..G**
- *The basic centreline for the section shall be re-established and all track centres checked.* **……..G**
- *In multiple track areas, the ultimate mainline track centres shall be as set out in ESC 215.* **……..G**
- *Where structures require reconstruction or modification, provision shall be made for the ultimate track centres with the minimum of future alteration.*
  This shall include placement of trackside structures (except platforms). The requirements of ESC 215 – Transit Space, shall be met in existing and future designs. **……..G**
- *Track centres across existing underbridges shall comply with ESC 215.* **……..G**
- *ESC 215 details the requirements for upgrading existing platforms. Where the existing platform face cannot be modified to comply, it may need to be rebuilt.* **……..G**
- *Where fixtures to carry overhead wiring are required to be fitted to overbridges and the location of such fixtures would not comply with ESC 215, the bridge and/or overhead wiring fittings shall be modified.* **……..G**
- *Bridges that cannot be modified to comply with ESC 215 may need to be reconstructed or rebuilt.* **……..G**
- *Where a tunnel does not allow widening of track centres and the provision of overhead wiring to comply with ESC 215, it shall be modified to allow the passage of any vehicle conforming to the appropriate Rolling Stock Structure Gauge.* **……..G**

6.8 Changes to Track Geometry Affecting Station Platforms

Where track reconstruction is proposed through existing platforms the following matters shall be resolved as part of the design:- **……MR**

- Review track alignment design to consider the platform Gap design requirements. (See Section 6.6.2).
- Review the design platform height. It may be appropriate to upgrade to Level Access.
- Review what, if any, works are proposed for the platform.

When track design work is being considered at platforms it must consider the requirements of other stakeholders e.g. track geometry, clearances, platform height, platform crossfall, building levels etc. For example the requirements of the slope of the platform when related to platform height, may impact on the disability access requirements with access ramps. A detailed Platform Reconstruction Scope Checklist is contained in RailCorp's Station Design Guidelines **……MR**

Level Access is the preferred platform height. **…..MR**

Where level access is proposed for a platform it shall be reviewed for Out-of-Gauge load access.

DO NOT plan or undertake design, maintenance or upgrading activities that would cause the track to be non-compliant to platform height tolerances unless a Standards Waiver is obtained from the Chief Engineer Track. The Chief Engineer Track shall consult with the Customer Service General Manager for the platform location as part of the Waiver approval process. **…..MR**

6.9 Geometry Design Requirements for Temporary Trackwork

Geometry design of temporary trackwork that is required for no longer than six months during staged construction of permanent works shall meet the following requirements:

Track geometry shall be designed to the maximum (or minimum) limits detailed in Sections 6.3 and 6.4 except for track at platforms, which shall meet normal limits, also detailed in Sections 6.3 and 6.4.

Track shall be constructed to meet the maintenance limits detailed in Section 11.2.

6.10 Geometry Design Requirements for Train Monitoring Equipment

6.10.1 Electronic Weighbridges and Wheel Impact Load Detector (WILD) Sites

For accurate and repeatable reading of trains passing in-motion weighbridges WILD sites, track geometry should be consistent over the site and for a distance of 100m or more on each side of the site.

6.10.2 Other Train Monitoring Equipment Sites

No specific track geometry requirements apply for Automatic Equipment Identifier reader sites, Hot box detectors or Dragging Equipment Detectors.

6.11 Changes to Design Geometry Affecting Overhead Wiring

In electrified areas, alteration of design superelevation by >10mm, OR horizontal track alignment by >100mm constitutes a design change requiring consideration of the position of the overhead wiring and shall be approved by the Chief Engineer Electrical. **.....MR**

Alteration of vertical alignment in electrified areas shall be approved by the Chief Engineer Electrical in the following circumstances: **.....MR**

- Any design change in height restricted areas
- Any design change in track or road surface at Level Crossings
- Any design change >100mm in other areas

7 Permanent Speed of Trains

The allowable speed of trains around curves to meet track geometry requirements shall be determined by the application of the design criteria detailed in Section 6.

The permanent speed of particular sections of track may be restricted because of other influences (e.g. approach speed to turnback roads with buffer stops that are designed to operate at a certain maximum speed).

Speed signs indicate the maximum allowable speed on Main Line track and shall be erected adjacent to the track at points of increasing or decreasing speed. **.....MR**

The locations of Permanent Speed signs shall be documented in RailCorp's Train Operating Conditions (TOC) Manual OS 001 IM. **.....MR**

Speed signs shall be manufactured in accordance with the requirements of RailCorp Engineering Specification SPC 213 - Track Side Signs. **.....MR**

Where main line tracks converge (or diverge) one road shall be nominated as the "Through" road. This shall be determined in conjunction with Signal Engineering. **.....MR**

Plain track speed signs shall be applied to the Through road. Turnout speed signs shall be applied to the diverging movement to the "Other main line".

For new work involving converging tracks, a repeater speed sign shall be placed on the joined track as close to the junction as possible to remind drivers of the speed. This requirement applies to main lines and secondary tracks (e.g. refuges) joining a main line. It does not apply to sidings. **.....MR**

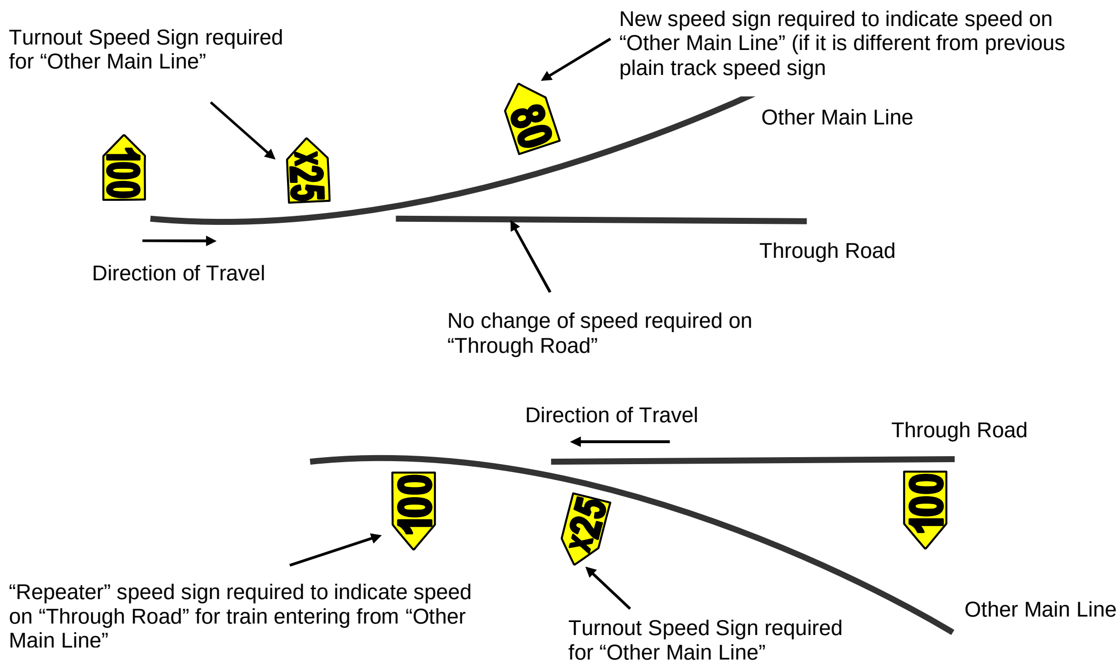


Figure 11 – Example of speed sign layout for converging/diverging roads

7.1 Speed Sign Description

7.1.1 Plain Track Speed Signs

Plain track Speed Signs are described in RailCorp's Network Rule NSG 604: "Track speed signs".

Note: RailCorp is transitioning from a two speed sign regime to a three speed sign regime. Designers shall establish the regime that is applicable to the design they are undertaking.

Where a review of speeds has been carried out using the new speed signs, then 3 speed signs shall be installed at each plain track speed sign location unless specific authorisation has been given by the Chief Engineer Track.

7.1.1.1 Three Speed Regime

These signs are rectangular (see Figure 12). They:

- have black text on a white background for XPT, Xplorer, Hunter and Endeavour trains, or
- have white text on a blue background for all Electric multiple unit trains, or
- have black text on a yellow background for Locomotive hauled freight and passenger trains, track vehicles, rail motors and 620 class diesel trains.

Figure 12 – Examples of rectangular type permanent track speed signs

7.1.1.2 Two Speed Regime

These signs have a pointed left side: They:

- have black text on a white background for XPT, Xplorer and Endeavour trains, or
- have black text, including the letters "MU", on a white background for XPT and all multiple unit trains, or
- have black text on a yellow background for other rail traffic.

A single yellow background speed sign applies to all rail traffic.

A white background speed sign, by itself or under a yellow background speed sign, applies only to XPT, Xplorer, Hunter and Endeavour trains.

Figure 13 – Examples of pointed permanent track speed signs

7.1.2 Turnout Speed Signs (Normal, XPT and MU)

Turnout Speed Signs, placed for trains traversing the diverging route of the turnout, are described in RailCorp's Network Rules. They are placed at some turnouts on main lines to show the maximum speed for a train travelling on the turnout track.

Turnout Speed Signs shall include the prefix "X". **.....MR**

They are required where the default turnout speed of 25km/h is not suitable, including when the turnout is traversed in the trailing direction. **.....MR**

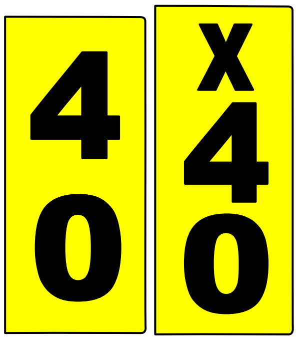
7.1.3 Restricted Location Speed Signs

Restricted Location speed signs are permanent plain track or turnout speed signs that may be placed at locations where clearances are too small to fit standard plain track or turnout speed signs. **.....ML**

7.1.3.1 Description

Restricted Location speed signs:

- have BLACK text on a YELLOW background for all rail traffic
- No provision is made for higher speeds for XPT, Xplorer, Endeavour, Millenium trains or Multiple Unit trains



City Underground type

Sydney Yard type

7.1.3.2 Application

City Underground type signs are approved for use in the tunnels of the City Underground ONLY. **…..MR**

Sydney Yard type signs are currently approved for use in Sydney Yard ONLY. **…..MR**

7.2 Placement Rules

The following rules describe the location of speed signs relative to the track.

7.2.1 Placement of Plain Track, Repeater and Turnout Speed Signs

7.2.1.1 Orientation

Speed signs are placed on the left-hand side of the line in the direction of travel. **…..MR**

In Bi-directional signalling areas, speed signs are placed on the left-hand side of the line in the right running direction and on the right-hand side of the line for trains travelling in the wrong running direction. **…..MR**

In single line areas, Speed signs are placed on the left-hand side of the line in each direction of travel. **…..MR**

7.2.1.2 Lateral and Vertical

NOTE: Lateral and Vertical Placement Rules apply to NEW work or when signs are being repositioned. **…..MR**

Where practical, signs are to be placed in the following "Standard" position." **……..G**

- *The sign shall be placed within the following envelope.*
- *The closest part of sign shall be no closer to the gauge face of nearest running rail than 1800mm. This means that the centre of the support post, where used, shall be at least 2030mm from the gauge face of nearest running rail.*
- *The closest part of sign is to be no further than 3000mm from the gauge face of nearest running rail.*

- *The bottom of lowest sign is to at least 1000 mm above Rail Level.*
- *The top of highest sign to be no more than 3200mm above Rail Level.*
- At locations where lateral clearances are restricted, the lateral and vertical tolerances may be reduced provided minimum transit space requirements are met. **…..MR**
- *Consistent positioning is preferred. For example, in an area where speed signs are generally placed on OHW masts, placement of a speed sign on a stand-alone post should be at a height and lateral placement consistent with the location of the signs on the masts.* **……..G**

7.2.1.3 Sighting

Speed signs should be clearly visible to a driver for a minimum of 6 seconds. **……..G**

7.2.1.4 Mounting

A Speed sign may be mounted on its own post (old rail, 50mm galvanised pipe or equivalent), or on overhead wiring structures if they are within the lateral placement envelope. Details of preferred methods of attachment are provided in RailCorp Drawing CV0218653 - Standard Speed Sign Fixings. **……..G**

Signs shall NOT be mounted on signal posts or signal structures **…..MR**

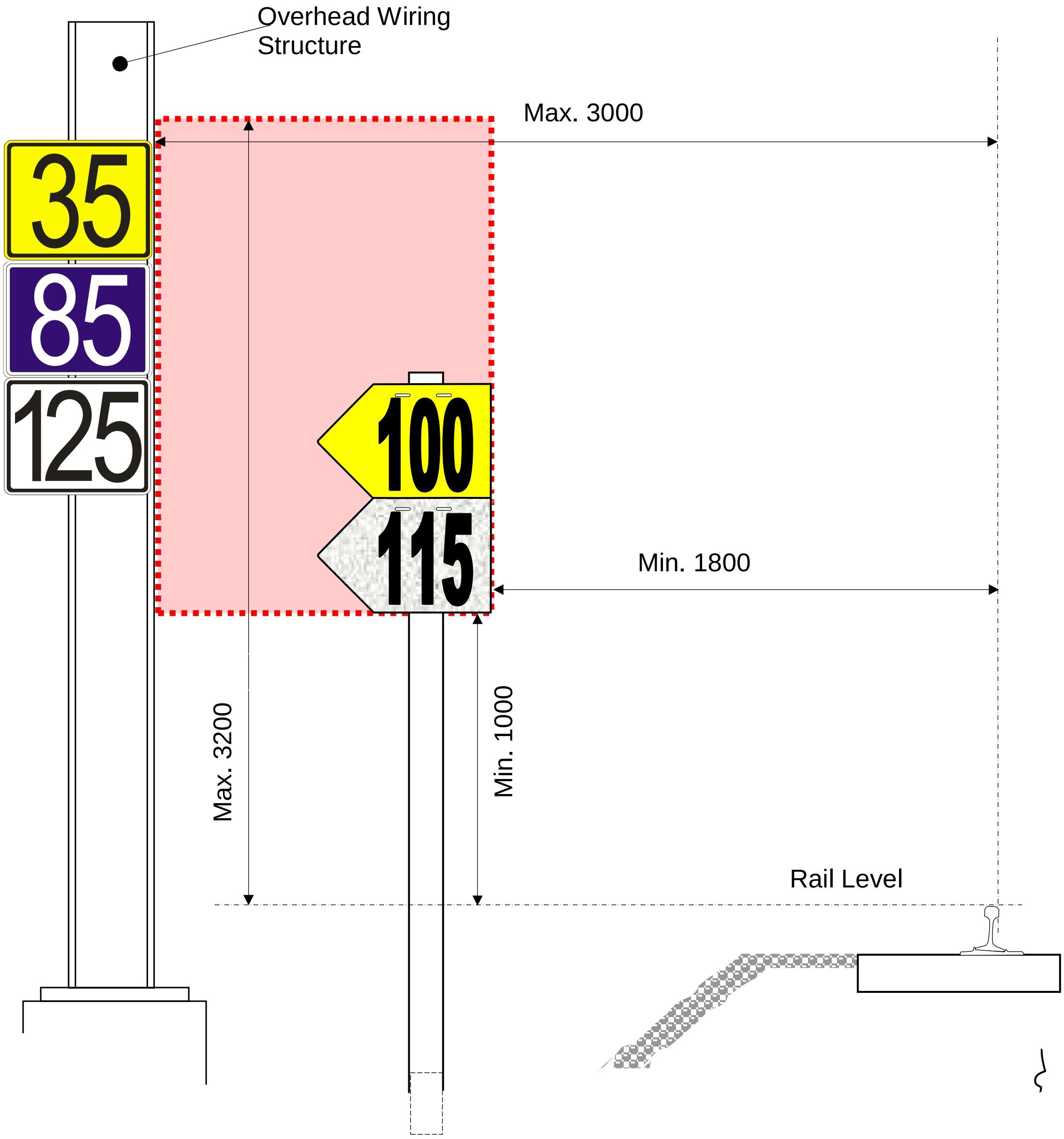


Figure 14 – Placement envelope for permanent speed signs

7.2.2 Placement of Restricted Location Speed Signs

7.2.2.1 Orientation

City Underground type signs are placed on the left-hand side of the line in the direction of travel. **.....MR**

Sydney Yard type signs are placed in the CENTRE of the Four foot of the track to which it applies. **.....MR**

7.2.2.2 Lateral and Vertical

City Underground type signs shall be attached to the tunnel wall. **.....MR**

For City Underground type signs the bottom of the sign shall be between 1000 mm and 1500mm above rail level. **.....MR**

Sydney Yard type signs shall be placed on a sleeper. The top of the sign shall be no higher than rail level. ……MR

7.2.2.3 Sighting

City Underground type signs shall be clearly visible to a driver for a minimum of 100m. …..MR

Sydney Yard type signs shall be clearly visible to a driver for a minimum of 50m. …..MR

8 Survey Control Requirements

8.1 General

The location of track infrastructure shall be established by Track Control. …..MR

Track Control shall be established from RailCorp Survey Control. …..MR

All surveys for RailCorp purposes shall be established using Map Grid of Australia (MGA) and Australian Height Datum (AHD). Alternative systems shall only be used with the approval of RailCorp's Principal Surveyor. …..MR

All surveys shall be conducted in accordance with RailCorp Engineering Specification SPC 211 – Survey Specification …..MR

Surveys for railway purposes have exacting accuracy requirements and, therefore have enhanced checking requirements.

8.2 Track Control Standard Marking

Track Control Marks to define alignment and grade shall be placed as detailed in Table 6. …..MR

Location	Spacing
Straights	Every 20m
Circular curves and transition curves	Every 10m
Platforms	Either end (100mm in) and every 10m
Overbridge Abutments and tunnels	Either end (100mm in) and every 10m

Table 6 – Placement of Survey Control Marks

Track control marks shall be placed, as far as is practical, on stable permanent structures adjacent to the tracks. (Overhead Wiring structures and other similar structures). ……..G

Where standards of accuracy are not nominated in the design, all marks shall be placed to an accuracy, relative to adjacent marks, of at least twice the accuracy standards defined in Section 11.1.2 for track construction standards. …..MR

Each Track Control Mark shall be referenced by a Survey Plaque containing, at least, the following information: **.....MR**

- Track referenced
- OHWS Identification (if applicable)
- Kilometrage of TCM to 1mm (eg 49km 357.345m)
- Design Track Centres from referenced track to adjacent track (if applicable)
- Design superelevation of referenced track (mm)
- Horizontal offset from TCM to Design running face of nearest rail of referenced track (mm)
- Vertical offset from TCM to Design Low (datum) Rail of referenced track (mm)

8.3 Kilometre Posts

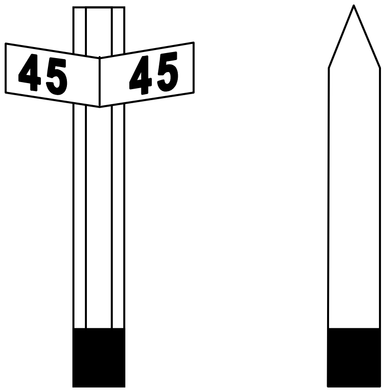


Figure 15 – Kilometre and half kilometre posts

The location of kilometre and half kilometre posts, manufactured in accordance with SPC 213, shall be established and documented in track designs. The location should be as close as is reasonably practicable to the design location of the km and ½ km points. Where alignment designs relate to existing track on which kilometre and half kilometre posts have been previously installed, no alterations in longitudinal location are required. They shall, however, be reviewed to determine if alteration of lateral placement is required to meet the requirements of Figure 16.

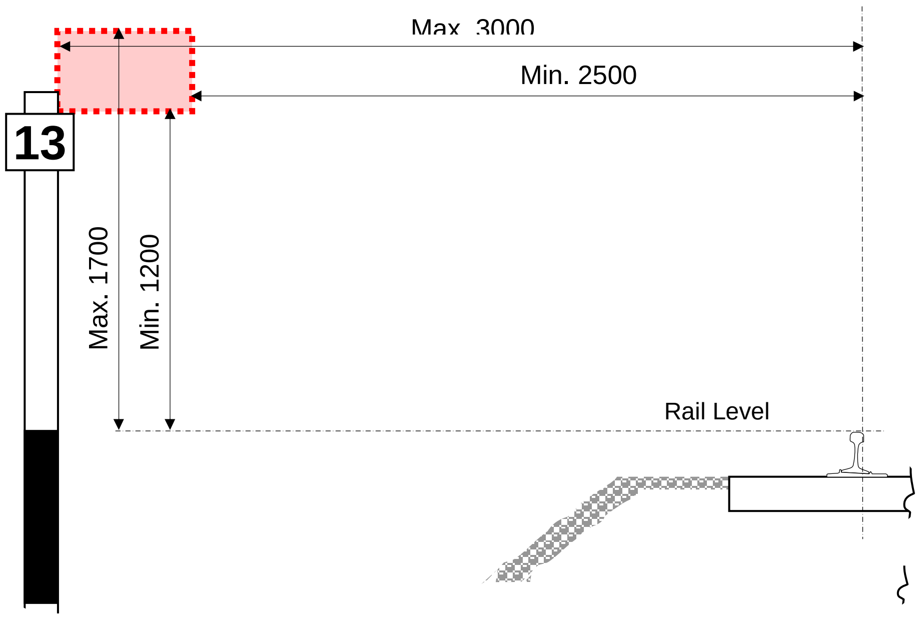


Figure 16 – Lateral placement of kilometre posts

8.4 Measurement of Kilometrage

8.4.1 Authorised Surveyors

Surveyors with appropriate engineering authority are responsible for the precise location of Track Control Marks and other features. They have authority to locate infrastructure using means other than the nearest Track Control Mark and they are the only people who can place, amend or relocate Track Control Marks.

8.4.2 For Non- Surveyors

When precisely locating the kilometrage of an item of infrastructure measurements shall be taken from the kilometrage displayed on the nearest Track Control Mark.

Where Track Control Marks are not available approximate locations can be determined from:

- Kilometre and half-kilometre pegs - use for approximate location of track features or when no other reference is available as these locations are not precisely located. then the Km posts may be used.
- OHW mast numbers can also be used but by convention these shall be referenced with the "+" symbol

Where an OHW mast number is used, the location should be described as a distance and direction from OHWS XX+YYY (e.g. 25 m away from Sydney from structure no. 35+324).

Where a survey plaque or kilometre post is used the location should be described by kilometrage (i.e. by using the decimal point e.g. 35.316Km).

9 Trackside Signage

The Civil Maintenance Engineer shall authorise the placement of all types of freestanding signage within 4 metres of any track centre to ensure that signs do not interfere with track maintenance.

Signs shall be mounted on old rail posts, 50mm galvanised pipe or equivalent, and shall be founded in concrete at least 750mm below ground level in accordance with RailCorp Drawing CV0218653.

Placement of signs on signalling structures is approved by the Chief Engineer Signals and is not included in this requirement.

Placement of signs on electrical structures (except permanent speed signs detailed in Section 7.2.1) is approved by the Chief Engineer Electrical Systems and is not included in this requirement.

Any sign that needs to be read by drivers should be placed so that the instruction on the sign is visible for at least 6 seconds prior to the point of intended action.

10 Track Stability

The track structure capacity to resist the effects of neutral temperature error depends on, sleeper type, curve radius, fastening torsional restraint, ballast quality (angularity and compaction) and quantity in the cribs and shoulders.

The design of new track geometry and track structure, and the reconstruction and maintenance of existing track shall meet the following track stability requirements:

- Rail shall be laid and adjusted to maintain a rail neutral temperature of 35℃ in an open air environment.
- Rail shall be laid and adjusted at ambient temperature in tunnel environments (that is, more than 50m in from portals).
- Track structure design shall be capable of providing resistance to lateral movement for the rail temperature range established in RailCorp Engineering Standard ESC 200 - Track System, in circumstances where rail adjustment varies from neutral temperature by ± 20℃.
- Track structure design shall be capable of providing resistance to longitudinal movement of rail and rail/sleeper system due to traction and gradient effects.

11 Acceptance Standards

11.1 Construction and Upgrading of Plain Ballasted Track

11.1.1 General

This section specifies the track geometry requirements for the construction and upgrading of ballasted trackwork. Gauge requirements are based on new rails. Where other rails are used then an appropriate allowance shall be made for rail wear. **……..G**

The track material shall be to the standards detailed in ESC 200. **…...MR**

The limits provided in this section assume that the track has been aligned using maintenance surfacing machinery including laser technology and sophisticated smoothing algorithms. On this basis individual locations between specified survey points will be automatically aligned to an acceptable intermediate tolerance. **……..G**

A visual examination is required of alignment and surface geometry between survey points. Any deviations from smooth alignment or surface shall be measured in accordance with, and meet the requirements of, the unevenness **…..MR** criteria in Table 11

Where track has been placed by other methods then more detailed survey may be required to ensure smooth alignment to the geometry required. These shall be specified as part of the design.

Where interfaces exist between new construction and existing track appropriate variations in tolerances are acceptable. These will depend on the time the interface will exist between stages of upgrading activity, the track speed, traffic etc. They shall not exceed the maintenance acceptance levels for unevenness specified in Table 11 or the Base Operating limits for track geometry for the relevant track speed specified in Table 16. **…..MR**

11.1.2 Accuracy to Survey

Track Control Marks shall be provided as specified in Section 8.2. The survey marks and the information provided shall form the primary source of information for assessing compliance. **…..MR**

Installed track shall conform to the basic surveyed design within the tolerances for alignment and level detailed in Table 7. **…..MR**

		Variation from design	
		Main line (mm)	Sidings (mm)
Alignment			
Alignment at platforms		± 6	NA
Alignment at restricted clearance locations (Note 1)		± 10	± 10
Alignment general		± 15	± 25
Variation in alignment between stations up to 20m apart		± 15	± 20
Superelevation			
Superelevation variation from design		± 5	± 8
Track Surface			
Height at platform relative to design rail level	Level access	± 15	NA
	Standard access	− 0 to + 50	NA
Height at other restricted height clearance locations relative to design rail level		− 0 to + 50	− 0 to + 50
General height relative to design rail level (Note 2)		− 30 to + 50	− 30 to + 50
Variation in level between stations up to 20m apart		± 20	± 30
Gauge			
Gauge		± 4	± 6

Table 7 – Construction Survey Acceptance Limits

Note
1. Where separate construction tolerances have been supplied as part of a Transit Space Infringement Approval these shall take precedence.
2. Additional restrictions on height tolerance may be required to suit overhead wiring. For example in areas of fixed tension the allowable tolerance would be normally restricted to − 10 to + 50.
3. Measurement convention (+ means track is lower than design rail level) – see Figure 17 below.

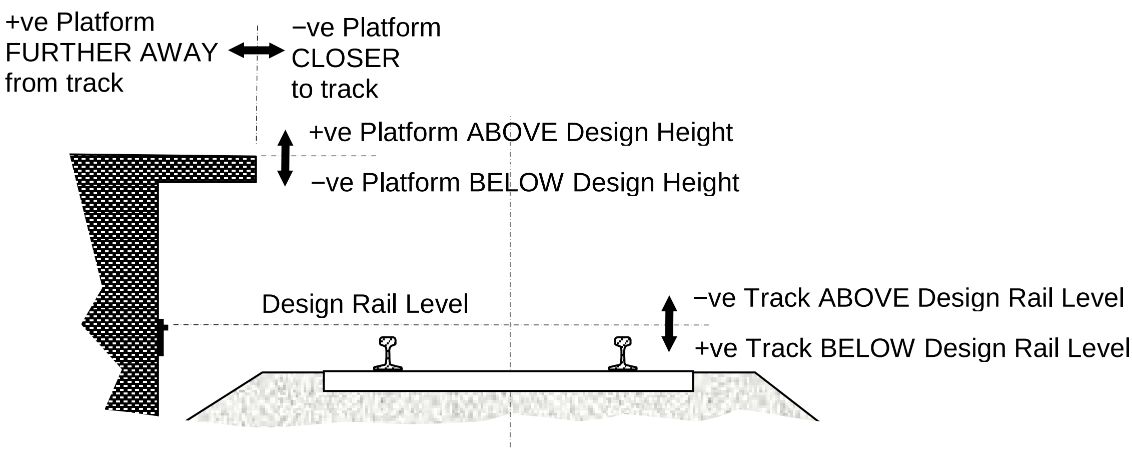


Figure 17 – Measurement Conventions

11.2 Maintenance of Plain Ballasted Track

11.2.1 General

This section details the minimum standard of track geometry that is to be achieved at the completion of the different types of maintenance activities. …..MR

Maintenance of geometric alignment on ballasted track may be carried out by mechanised surfacing or by manual maintenance (fettling). ……..G

Criteria have been specified for compliance to survey and for track unevenness depending on the nature of the work (manual or mechanised) and the specific site conditions. Separate requirements have been specified for maintenance activities affecting track gauge. ……..G

11.2.2 Gauge of Track

The limits in Table 8 shall be applied (at each sleeper) when new sleepers are installed or track is cross bored or regauged. …..MR

		Main line (mm)	Sidings (mm)
Gauge			
Variation to design gauge	Wide	5	5
	Tight (including head flow)	5	5
		Limiting tight gauge 1430mm	
Variation in 1m (due to rail wear)		2	2
maximum deviation at a discontinuity (e.g. a joint)		1	1

Table 8 – Maintenance Acceptance Limits for Gauge

Where gauge widening has been applied on curves by design, the limit applies to the widened design gauge. …..MR

Rail play is not permitted except small amounts arising from construction tolerances (eg 1mm between insulator and foot of rail). .....MR

Work shall be carried out to correct "foot gauge" ± 5mm (See Table 9. .....MR

Rail Cant		Rail Size (kg/m			
		47	50	53	60
1 in 20	Plain Track	1390	1391	1373	1374
Zero	In Turnouts	1379	1379	1360	1360

Table 9 – Foot Gauge

11.2.3 Accuracy to Survey

Track on which maintenance work has been undertaken shall conform to the basic surveyed design within the tolerances for alignment and level detailed in Table 10. .....MR

		Variation from design	
		Main line (mm)	Sidings (mm)
Alignment			
Alignment at platforms		±15	NA
Alignment at restricted clearance locations (Note 1)		±15	±15
Alignment general		±15	±25
Superelevation			
Superelevation		±6	±8
Track Surface			
Height at platform	Level access	− 25 (Note 5) to + 15	NA
	Standard access	− 0 (Note 5) to + 50	NA
Height at other restricted height clearance locations		- 25 to + 50	- 25 to + 50
General height, only applicable to mechanised resurfacing		− 100 (Note 2) to + 50	− 100 (Note 2) to + 50

Table 10 – Maintenance Survey Acceptance Limits

Note
1. Where separate construction tolerances have been supplied as part of a Transit Space Infringement Approval these shall take precedence.
2. Will depend on the overhead wiring configuration in the area. Allowances above 50mm can only be utilised after confirmation with the Electrical Maintenance Authority.
3. Before any significant track lifting is carried out including any mechanised resurfacing the track maintainer shall check with the Electrical Maintenance Authority to ensure that the proposed lift will meet electrical clearance requirements. Any proposed lifts shall also consider the loading on ballast top

bridge structures and the impact on any ballast retaining structures such as wingwalls. The requirements do not apply to manual fettling of short term settlement locations.

4. Note: Measurement convention (+ means track is lower than design rail level) – see Figure 17.
5. Over time the track level will rise as a result of maintenance resurfacing. When track maintenance is carried out any lifts that will take the rail level above the tolerances should be minimised.

11.2.4 Unevenness

Track on which maintenance work has been undertaken shall conform to the limits track unevenness detailed in Table 11. **…..MR**

	Main line (mm)	Sidings (mm)
Line		
Tangent Mid-ordinate (mm) from overlapping chords and maximum versine (mm) for 8m chord with 2m overlap	1	4
Curve Mid-ordinate variation (mm) in successive overlapping chords for 8m chord with 2m overlap	2	7
Twist		
Track twist over 2m(1)	6	10
Track twist over 14m(1)	12	20
Track Surface		
Mid-ordinate of 6m chord	6	10

Table 11 – Maintenance Acceptance Limits

Note 1. Where the track being assessed is within a transition the designed variation in superelevation (ie a designed twist) shall be considered when determining compliance.

2. Irrespective of any allowances in the table above the Base Operating limits for track geometry for the relevant track speed specified in Table 16 shall not be exceeded.

11.2.5 Mechanised Surfacing

Where mechanised surfacing is undertaken track geometry shall conform to the basic surveyed design within the tolerances for alignment and level detailed in Table 10. **…..MR**

In addition a visual examination shall be undertaken to confirm geometry is visually smooth. If visible deviations are evident then the anomaly shall be checked as follows: …..MR

Alignment use overlapping chords as per Table 11.

Surface use overlapping chords or a "Level" to determine compliance to Table 11.

Superelevation shall be checked against the tolerances in Table 10 at the following locations:

- At all geometry change points including TP, TRS, CTP, CTRS, Ea points.
- At all surveyed locations
- At no more than 20m intervals on track of consistent curvature
- At no more than 5m intervals on track with changing curvature (eg transitions)
- At any location where any visible deviation in rail surface is evident

On multiple tracks with centres less than 4 000mm, where variations in the superelevation roll the vehicles towards each other, the sum of the variations in superelevation shall not exceed 12mm. …..MR

11.2.6 Manual Maintenance

Where Manual maintenance activities are undertaken track geometry shall conform to the Unevenness Criteria in Table 11 and with the following survey acceptance criteria from Table 10. …..MR

- track height at platforms and restricted height locations
- track height to design for longer sections of track (more than 30m) at the nearest survey reference points
- Superelevation at 2m intervals through the worksite and for 14m either side

Track twist shall be checked for 2m and 14m chord lengths against Twist criteria in Table 11. …..MR

On multiple tracks with centres less than 4 000mm, where variations in the superelevation roll the vehicles towards each other, the sum of the variations in superelevation shall not exceed 12mm. …..MR

11.3 Construction and Upgrading Limits for Fixed Track

11.3.1 General

This section specifies the track geometry requirements for the construction and upgrading of trackwork that has been fixed directly to the track support structure (e.g. track slabs and other non-ballasted track forms). More detailed survey is required to ensure smooth alignment to the tolerances specified. ……..G

Other aspects of the acceptance standards remain the same as for construction of ballasted track.

Gauge requirements are based on new rails. Where other rails are used then *an appropriate allowance shall be made for rail wear.*

11.3.2 Accuracy to Survey

Track Control Marks shall be provided as specified in Section 8.2. The survey marks and the information provided shall form the primary source of information for assessing compliance. **…..MR**

Installed track shall conform to the basic surveyed design within the tolerances for alignment and level detailed in Table 12. **…..MR**

		Variation from design	
		Main line (mm)	**Sidings (mm)**
Alignment			
Alignment at platforms		± 4	NA
Alignment at restricted clearance locations (Note 1)		± 5	± 10
Alignment general		± 8	± 15
Variation in alignment between stations up to 20m apart		± 8	± 15
Superelevation			
Superelevation variation from design		± 5	± 8
Track Surface			
Height at platform relative to design rail level	Level access	± 10	NA
Height at other restricted height clearance locations relative to design rail level		− 0 to + 20	− 0 to + 35
General height relative to design rail level (Note 2)		± 20	± 30
Variation in level between stations up to 20m apart		± 15	± 20
Gauge			
Gauge		± 3	± 5

Table 12 – Construction survey acceptance for fixed track

Note 1 Where separate construction tolerances have been supplied as part of a Transit Space Infringement Approval these shall take precedence.

2. Additional restrictions on height tolerance may be required to suit overhead wiring.

Note: Measurement convention (+ means track is lower than design rail level) – see Figure 17.

With slab track it is important that a construction method be adopted that will enable the track be placed to provide a smooth alignment vertically and horizontally. Normally vibration isolation fastenings are used. Such systems should not be forced to distort to accommodate horizontal and vertical variations in position.

Where possible fastenings should be provided with lateral adjustment with no more than 1mm steps so gauge and alignment can be placed precisely.

With the rail in place and with clips removed there should be a vertical gap no greater than 2mm between the rail and the supporting insulator and fastening at any fastening location and a variation between consecutive supports of not more than 1mm.

Where possible the clear vertical gap from the underside of the rail and the top of the slab should not be less than 60mm to enable rail clamping and welding to be carried out.

11.4 Track Condition Indices

This section details limiting Track Condition Indices (TCI) to be met at the completion of construction, renewal and maintenance work. . The limits apply where new rails and sleepers have been installed. **…..MR**

Track is to be evaluated over half kilometre lengths excluding turnouts. **…..MR**

The individual parameter TCI shall not be greater than that shown in Table 13. **…..MR**

Indices – Construction and Renewal				
	Top + Twist	**Gauge**	**Line**	**Total**
Plain Track	17	6	8	31
Turnouts	Not applicable			
Indices - Maintenance (following resurfacing)				
	Top + Twist	**Gauge**	**Line**	**Total**
Mainline				
Tangent Track and curves ≥ 800 radius	TBA	NA	8	NA
Curved Track >240m but < 800m radius	TBA	NA	10	NA
Turnouts	Not applicable			

Table 13 – Track Condition Index limits

11.4.1 Track Code Maintenance Targets

The primary measure for the assessment of the maintenance status of each main line track code shall be the Track Surface measure, which is the sum of the top and twist PCIs. Targets for line codes are based on the track speed for the section (nominally the 80% percentile highest speed). Because this is a statistical measure sections less than about 3km may be higher and hence an additional adjustment in target is to be made of between 0 to 3 points for track lengths 0 to 3km on a pro rata basis. The targets are detailed in Table 14. **…..MR**

For assessing local maintenance targets the limits shown in Table 14 for track lengths < 0.5km may be applied.

Track Speed	Track Surface (top + twist)						
	Length of track section (km)						
	≥ 3	**2.5 - <3**	**2 - <2.5**	**1.5 - <2**	**1 - <1.5**	**0.5 - <1**	**0 - <0.5**
Main line							
≤ 60	25	25.5	26	26.5	27	27.5	28
61 - 70	24	24.5	25	25.5	26	26.5	27
71 - 80	23	23.5	24	24.5	25	25.5	26
81 - 89	22	22.5	23	23.5	24	24.5	25
≥ 90	21	21.5	22	22.5	23	23.5	24
Slow speed loops							
≤ 60	26	26.5	27	27.5	28	28.5	29

Table 14 – Track Code Maintenance Targets

The overall target upper limits for all RailCorp main lines are detailed in Table 15.

	Top
Track Surface	23
Track Condition Index TCI	45

Table 15 – RailCorp Track Condition Targets

12 Damage Limits

12.1 Track Geometry Limits

12.1.1 Mainline

Normal (Note 1)	Track Speed (Normal / Passenger) km/hr					
	20/20	40/40	60/60	80/90	100/115	115/160
Gauge						
Wide	30	28	26	22	20	20
Tight	16	14	12	10	9	9
Short Twist						
AK Car (2.7m)	25	23	21	18	15	15
Manual (2m)	18	16	15	13	11	11
Long Twist						
Not in a Transition						
AK Car (13.2m)	49	43	38	33	28	28
Manual (14m)	52	46	40	35	29	29
In a Transition						
AK Car (13.2m)	52	46	41	36	31	31
Manual (14m)	55	48	43	38	32	32
Line						
Line (10m)	45	34	24	18	14	14
Cross Level						
Cross Level Variation from Design	60	55	50	40	35	35
Top						
Manual (6m)	30	27	24	20	16	16
AK Car (1.8m/ 10m)	27	24	21	18	14	14

Note 1. The limit at or below which no response is required.

Table 16 – Normal Limits for Track Geometry

Maximum Limits (Note 2)	Track Speed (Normal / Passenger) km/hr					
	20/20	40/40	60/60	80/90	100/115	115/160
Gauge						
Wide	34	34	32	30	28	26
Tight	18	18	17	16	14	12
Short Twist						
AK Car (2.7m)	29	29	27	25	23	21
Manual (2m)	22	22	20	18	16	15
Long Twist						
Not in a Transition						
AK Car (13.2m)	60	60	56	49	43	38
Manual (14m)	64	64	59	52	46	40
In a Transition						
AK Car (13.2m)	63	63	59	52	46	41
Manual (14m)	67	67	63	55	48	43
Line						
Line (10m)	60	60	55	45	34	24
Cross Level						
Cross Level Variation from Design	71	71	66	60	55	50
Top						
Manual (6m)	34	34	32	30	27	24
AK Car (1.8m/ 10m)	31	31	29	27	24	21

Note 2. The limit beyond which an emergency level response is required.

Table 17 – Damage Limits for Track Geometry

12.1.2 Sidings

To be determined

12.1.3 Additional Base Operating Limits for Track Geometry Under Overhead Wiring

Track with electrical overhead contact wiring shall be maintained to the tolerances in Table 18, as measured at each survey mark (unless approval of the relevant Electrical Maintenance Authority is obtained).

Between monuments, the alignment, superelevation or rail level shall not change in such a way as to increase the deviations from the design standards to beyond the above limits.

	Limit (mm)
Alignment	
Alignment to survey	± 50
Superelevation variation from design	± 25
Rail Level relative to design	-50 / +100 (Note 1)
Rail Level relative to design in Restricted Height Areas	−25 + 50 or as specified in the design

Table 18 – Track Geometry Limits associated with OHW

Note
1. Will depend on the overhead wiring configuration in the area. Allowances above 50mm can only be utilised after confirmation with the Electrical Maintenance Authority.
2. There are separate restrictions on significantly changing alignment or superelevation as overhead wiring may have previously been adjusted to the old alignment.
3. Note: Measurement convention (+ means track is lower than design rail level) – see Figure 17.