

Category 1 Standard

S1159 Track – Dimensions and Tolerances

The compliance date for
this revision is Sunday 16
August 2015



Please read the Written Notices
attached to this standard

Issue: A4

Issue date: July 2015

MAYOR OF LONDON



Contents

1	Purpose	3
2	Scope	3
3	Requirements	3
3.1	General	3
3.2	Evidence of compliance	3
3.3	Completed works: requirements and tolerances	3
3.4	Maintenance: requirements and tolerances	55
4	Responsibilities	126
5	Supporting information	126
5.1	Safety considerations	126
6	References	127
6.1	References	127
6.2	Abbreviations	127
6.3	Definitions	128
6.4	Person accountable for the document	129
6.5	Document history	129
7	Current Written Notices attached to this standard	130

1 Purpose

1.1 The purpose of this standard is to define the dimensions and tolerances for track, and the actions to be taken if these are not achieved, in respect of:

- a) completed works;
- b) maintenance intervention.

2 Scope

2.1 This standard applies to all track, including plain line and junctionwork in open, sub-surface and tube sections and in depots.

2.2 This standard does not apply to the conductor rail system, the dimensions and tolerances and actions for which are covered in S1164.

2.3 Where it is mandatory that any of the supporting information in Section 5 of this standard is to be applied, the appropriate requirement is set in Section 3.

3 Requirements

3.1 General

3.1.1 Where information from this standard is to be used as part of a tender or contract documentation for vehicle design it shall be made clear that:

- a) Section 3.3 describes requirements and quality values for completed work only; in practice the actual quality of the track system will deteriorate over time with the passage of traffic;
- b) Section 3.4 describes requirements and quality values which in practice may be exceeded.

3.2 Evidence of compliance

3.2.1 Compliance with the requirements of this standard shall be demonstrated by the organisation responsible for the work. Additionally, compliance may be audited as part of the track surveillance regime.

3.3 Completed works: requirements and tolerances

3.3.1 Work shall be completed to the tolerances defined in this section 3.3 for the highest class (as defined in section 6) appropriate to the nature and scope of the work.

3.3.2 In the event that the work does not comply with the completed works tolerances, the work shall be compared to the maintenance values indicated in 3.4 to establish whether any intervention is required before start of traffic.

3.3.3 Particular attention shall be given to the interface between new (or newly maintained) track and existing track. Any sudden change in the gauge, alignment or level of the track shall be avoided.

Index for Completed work tolerances

1	Geometric standards – track recording vehicle	7
1.1	Vertical profile – TRV/AIT/ATMS (discrete exceedences)	7
1.2	Lateral alignment – TRV/AIT/ATMS (discrete exceedences)	7
1.3	Dynamic crosslevel – TRV/AIT/ATMS (discrete exceedences)	8
1.4	2-metre twist – TRV/AIT/ATMS (discrete exceedences)	8
1.5	10 metre twist – TRV/AIT/ATMS (discrete exceedences)	9
1.6	Wheel unloading factor – TRV/AIT/ATMS (discrete exceedences)	9
1.7	Gauge TRV/AIT/ATMS (discrete exceedences)	10
1.8	Delivered Track Quality as measured by Standard Deviation (SD): all parameters, all lines – TRV/AIT/ATMS.	10
1.9	Corrugations (short wavelengths - 20 to 100mm) – TRV/AIT/ATMS	10
2	Geometric standards – manual measurements	11
2.1	Vertical	11
2.1.1	Vertical profile (long undulations - 5 metre intervals)	11
2.1.2	Vertical profile (short undulations - 1 metre straightedge)	11
2.1.3	Vertical profile – site welded joints	12
2.1.4	Vertical profile – plated joints (dipped joint)	13
2.1.5	Rail end batter – plated joints	14
2.1.6	Vertical position of rail relative to design position	15
2.1.7	Maximum rail level plates	16
2.2	Lateral	16
2.2.1	Lateral alignment (long base 10 metre chord versine)	16
2.2.2	Lateral alignment (short base versine - 1 metre straightedge) - not joints	16
2.2.3	Straightness lateral alignment (1 metre straightedge) - all joints	17
2.2.4	Lateral position of running edge	17
2.3	Cross level (cant)	18
2.4	Twist 2 metre base (cross level variation)	19
2.5	Twist 10 metre base (cross level variation)	20
2.5.1	10 metre twist, ballasted track	20
2.5.2	10 metre twist, concrete track	20
3	Gauge	21
3.1	Running rail – gauge (dynamic), plain line (see Table 13.1 for junctionwork)	21
3.2	Running rail – variation in gauge	21
4	Rail condition	22
4.1	Running rail - side wear as measured with the head wear and side wear gauge	22
4.1.1	Running rail - side wear on track used by LU stock only <u>and</u> which is outside fishplate limits	22
4.1.2	Running rail - side wear at fishplates or on track used by TOC stock	23
4.2	Running rail –Side wear	23
4.3	Running rail – chair gall	24
4.4	Running rail - headwear as measured with the headwear and sidewear gauge	24
4.4.1	Running rail - headwear on track used by LU stock only <u>and</u> which is outside fishplate limits	24
4.4.2	Running rail - headwear at fishplates or on track used by TOC stock	24
4.5	Corrugations (long wavelength > 100 mm pitch)	24
4.6	Corrugations (short wavelengths – 20mm to 100 mm)	25
5	Rail Joints	25
5.1	Assembly – all plated joints	25
5.2	Bolt assembly - all plated joints	25
5.3	Bolt security- all plated joints	25
5.4	Bolt tightness	26
5.4.1	Bolt tightness- fishplated joints (non-insulated)	26
5.4.2	Bolt tightness - tight joints	26
5.4.3	Bolt tightness - insulated joints (all types)	26
5.4.4	Bolt tightness - elsewhere	26
5.5	Fishplates - all plated joints	26
5.6	Rail expansion gaps	27
5.6.1	Short rail gap - all plated joints	27



5.6.2 Long rail gap - plated joints	27
5.7 Rail joint position	28
5.7.1 Plated joints - sleeper distance	28
5.7.2 Plated joints - stagger	28
5.7.3 Welded joints - longitudinal positioning	28
5.8 Rail foot wear at fishing surface (fishplate fretting): Rail Condition / Notch Depth	28
6 Track fastenings	29
6.1 Running rail support - baseplates and chairs	29
6.1.1 Baseplates and chairs – defective	29
6.1.2 Baseplates and chairs - voiding	29
6.1.3 Baseplates and chairs - longitudinal	29
6.2 Pandrol housings (concrete sleepers)	29
6.3 Screwspikes, bushes, rail pads	30
6.4 Keys, clips	30
6.4.1a Keys (wood, steel or Panlock) - applies also to check rails	30
6.4.1b Keys - steel	30
6.4.2 Mixed keys	31
7 Check rail	32
7.1 Check rail flangeway, plain line (see Table 13.6.2 for junctionwork)	32
7.2 Check rail height, plain line (see Table 13.6.1 for junctionwork)	32
7.3 Check rail - joint assembly	33
7.4 Check rail - bolt security - plated joints	33
7.5 Check rail - Check block assembly - bullhead rail	33
7.6 Check rails– bolt or clamp security – flat bottom running rail	33
8 Adjustment/expansion switches	34
8.1 Adjustment/expansion switches - assembly	34
8.2 Adjustment/expansion switches - bolt security	34
8.3 Adjustment switch to stock rail fit	34
8.4 Adjustment switch tip	35
8.4.1 Longitudinal position	35
8.4.2 Longitudinal position - switch tip overhang	35
8.4.3 Switch tip overlap	36
8.5 Expansion switch gaps and overlaps (Network Rail scarf type)	37
9 Sleepers (to be read as including pitblocks where appropriate)	38
9.1 Sleeper spacing, plain line (see Table 13.7.1 for junctionwork)	38
9.2 Sleeper squareness	39
9.3 Sleepers – condition, plain line (see Table 13.7 for bearers in junctionwork)	39
9.3.1 Chair or baseplate indentation	39
9.3.2 Redundant screwspike holes	39
10 Ballast	41
10.1 Ballast level	41
10.2 Ballast shoulder profile	41
10.3 Ballast depth	42
10.4 Blanketing sand level	42
10.5 Blanketing sand depth	42
11 Concreted track	44
11.1 Concrete level	44
11.2 Shingle level	44
11.3 Screeding level	44
11.4 Rendering	44
12 Lubrication	45
12.1 Rail lubricators – fixing	45
12.2 Rail lubricators – effectiveness	45
13 Junctionwork	46
13.1 Junctionwork - rails/rail geometry	46
13.1.1 Running rails - track gauge	46
13.1.2 Junctionwork - running rails/lead rails - relative rail heights	46
13.2 Switches or points	46
13.2.1 Switch assembly	46



13.2.2 Rail fit	47
13.2.3 Switch opening	48
13.2.4 Switch flangeway gap	48
13.2.5 Switch tip - longitudinal position	48
13.2.6 Switch tip - squareness	48
13.2.7 Switch and stock rail wear	49
13.3 Switch diamonds	49
13.3.1 Switch rail position - original design	49
13.3.2 Switch rail position - current design	49
13.3.3 Switch rail position - vertical FB design	49
13.4 Switch fittings/assemblies	50
13.4.1 Soleplate assembly	50
13.4.2 Protective cover over signal equipment	50
13.4.3 Locked wheel ramp assembly (where installed)	50
13.4.4 Stretcher bar assembly	50
13.4.5 Switch anchors, stress transfer blocks, ball & claw configurations	50
13.4.8 Slide baseplate/chair lubrication	51
13.5 Crossings	51
13.5.1 Crossing assembly (common and obtuse crossings).	51
13.5.2 Crossing wear (nose and wing rail)	51
13.5.3 Crossing - multi groove locking pins (Huck bolts)	51
13.5.4 Voids between crossing and bearer	51
13.6 Check rails	52
13.6.1 Check rails - relative heights	52
13.6.2 Flangeway gaps (common and obtuse crossings)	52
13.7 Junctionwork - bearers	53
13.7.1 Bearer spacing	53
13.7.2 Bearer - condition	53
13.7.3 Timber bearer - chair or baseplate indentation	53
13.7.4 Timber bearer - redundant chair screw holes	53
14 General	54
14.1 Ditches and drains - freedom of flow	54
14.1 Catchpit covers	54

Note: Dimensions are in millimetres unless otherwise stated.

1 Geometric standards – track recording vehicle

1.1 Vertical profile – TRV/AIT/ATMS (discrete exceedences)

	Tolerance		
	Work class	Running lines	Depots & sidings
The maximum allowable values of the vertical profile of the running rails as measured by the TRV/AIT/ATMS. Discrete exceedences can be located manually for rectification by sighting, use of string line or optical instrument. Allowance for dynamic movements will require to be made. At platforms and other locations where track position is limited by clearance requirements or where a standard concession has been granted, the effects of the clearance standard S1156 must be considered when determining the actual track geometry which can be applied.	Class I (Open & Sub-surface)	± 3.5	± 3.5
	Class I (Tube)	± 5.5	± 5.5
	Class II ♣	± 12	± 17
	Class III	± 15	± 18
	Class IV	± 15	± 20
	♣ Class I tolerances shall apply where track ballast below bottom of sleeper has been replaced or where reconditioning has been carried out. See Table 1.9 for standard deviation of 100m section of track		

1.2 Lateral alignment – TRV/AIT/ATMS (discrete exceedences)

	Tolerance		
	Work class	Running lines	Depots & sidings
The maximum values of the lateral alignment of the centreline of the two running rails as measured by the TRV/AIT/ATMS. Discrete exceedences can be located manually for rectification by sighting, use of string line or optical instrument. Allowance for dynamic movements as well as designed track curvature will require to be made. At platforms and other locations where track position is limited by clearance requirements or where a standard concession has been granted, the effects of the clearance standard S1156 must be considered when determining the actual track geometry which can be applied.	Open and sub-surface sections		
	Class I	± 3	± 3
	Class II ♣	± 10	± 17
	Class III	± 19	± 21
	Class IV	± 19	± 21
	Tube sections only		
	Class I	± 3.5	± 3.5
	Class II ♣	± 10	± 15
	Class III	± 15	± 18
	Class IV	± 15	± 18
	♣ Class I tolerances shall apply where track ballast below bottom of sleeper has been replaced or where reconditioning has been carried out. See Table 1.9 for standard deviation of 100m section of track		

1.3 Dynamic crosslevel – TRV/AIT/ATMS (discrete exceedences)

	Tolerance		
	Work class	Running lines	Depots & sidings
The maximum values of the dynamic crosslevel as measured by the TRV/AIT/ATMS. No exceedence of the Class 1 work values shall be allowed. Discrete exceedences can be located manually for rectification by sighting, use of cross level gauge or optical instrument. Allowance for dynamic movements will require to be made. At platforms and other locations where track position is limited by clearance requirements or where a standard concession has been granted, the effects of the clearance standard S1156 must be considered when determining the actual track geometry which can be applied.	All lines except tube sections		
	Class I	+ 4.5	+ 4.5
	Class II ♣	+ 12	+ 18
	Class III	+ 15	+ 24
	Class IV	+ 15	+ 24
	All tube sections		
	Class I	+ 5	+ 5
	Class II ♣	+ 8	+ 8
	Class III	+ 12	+ 12
	Class IV	+ 12	+ 12
	♣ Class I tolerances shall apply where track ballast below bottom of sleeper has been replaced or where reconditioning has been carried out.		
	See Table 1.9 for standard deviation of 100m section of track		

1.4 2-metre twist – TRV/AIT/ATMS (discrete exceedences)

	Tolerance		
	Work class	Running lines	Depots & sidings
The maximum values of the twist on a 2-metre base as measured by the TRVAIT/ATMS. Class I values are deviations from the twist in a designed cant gradient. Class II, III and IV values include any twist in the designed cant gradient. Discrete exceedences can best be located manually for rectification by the use of a cross level gauge to measure cant at 1 metre intervals or at each sleeper and comparing these values across a base of 2 metres. Allowance for dynamic movement will require to be made. At platforms and other locations where track position is limited by clearance requirements or where a standard concession has been granted, the effects of the clearance standard S1156 must be considered when determining the actual track geometry which can be applied.	All lines except defined lines		
	Class I Where cant gradients are 1 in 500 or less	4	4
	Class I Where cant gradients are steeper than 1 in 500	2	2
	Class II ♣	12	18
	Class III	20	20
	Class IV	20	20
	The defined lines: District Line – East Putney to Wimbledon		
	Class I Where cant gradients are 1 in 500 or less	4	4
	Class I Where cant gradients are steeper than 1 in 500	2	2
	Class II ♣	12	18
	Class III	18	19
	Class IV	18	19
	♣ Class I tolerances shall apply when the track has been replaced or where reconditioning has been carried out.		
	See Table 1.9 for standard deviation of 100m section of track		

**1.5 10 metre twist – TRV/AIT/ATMS (discrete exceedences)**

	Tolerance		
	Work class	Running lines	Depots & sidings
The maximum values of the twist on a 10 metre base as measured by the TRV/AIT/ATMS.	Ballasted track		
	Class I ♣	25 (1 in 400)	25 (1 in 400)
	Class II ♣	25 (1 in 400)	25 (1 in 400)
	Class III	33 (1 in 300)	33 (1 in 300)
	Class IV	33(1 in 300)	33 (1 in 300)
	Concreted track		
Discrete exceedences can best be located manually for rectification by the use of a cross level gauge to measure cant at 1 metre intervals or at each sleeper and comparing these values across a base of 10 metres. Allowance for dynamic movement will require to be made. At platforms and other locations where track position is limited by clearance requirements or where a standard concession has been granted, the effects of the clearance standard S1156 must be considered when determining the actual track geometry which can be applied.	Class I ♣	33 (1 in 300)	33 (1 in 300)
	Class II ♣	33 (1 in 300)	33 (1 in 300)
	Class III	37 (1 in 270)	37 (1 in 270)
	Class IV	37 (1 in 270)	37 (1 in 270)
	♣ Also dictated by geometry design.		

1.6 Wheel unloading factor – TRV/AIT/ATMS (discrete exceedences)

	Tolerance		
	Work class	Running lines	Depots & sidings
Wheel unload (WU) is a combination of 2 metre twist and 10 metre twist. The acceptance value of 40%, as measured by the TRV/AIT/ATMS, limits the combination of both to be within their individual acceptance values on design transitions up to 1 in 300.	(1) District Line – East Putney to Wimbledon.		
	Class I	40	40
	Class II	40	40
	Class III	43	43
	Class IV	43	43
	(2) Central line - All of line		
	Class I	40	40
	Class II	40	40
	Class III	55	55
	Class IV	55	55
	(3) All other lines		
	Class I	40	40
	Class II	40	40
	Class III	85	85
	Class IV	85	85

1.7 Gauge TRV/AIT/ATMS (discrete exceedences)

	Tolerance		
	Work class	Running lines	Depots & sidings
Maximum deviation from nominal track gauge as measured by the TRV/AIT/ATMS outside junctionwork.	Class I	- 3 + 3	- 3 + 3
	Class II ♣	- 5 + 14	- 5 + 14
	Class III ♣	- 7 + 28	- 7 + 28
	Class IV ♣	- 7 + 28	- 7 + 28
The deviation from gauge is based on 1432mm which is the nominal gauge of the TRV/AIT/ATMS systems. See also 3.3 Tables 3.1 and 3.2 for different gauges and manual measurements. This parameter is to be used as a guide only. Any exceedences shall be checked manually; see 3.3 Tables 3.1 and 3.2. ♣ Class I tolerances shall apply when the nature of the work can accommodate re-gauging e.g. renewal of rail and rail support or renewal of sleepers.			

1.8 Delivered Track Quality as measured by Standard Deviation (SD): all parameters, all lines – TRV/AIT/ATMS.

The geometric quality of the vertical profile of the running rails, the lateral alignment of the centre-line of the two running rails, the cross level variations in the track and the twist on a 2m base as measured by TRV/AIT/ATMS for a 100m track section. The TRV/AIT/ATMS uses a 25m base and the quality is expressed as a standard deviation in mm. The values cannot be checked manually.

Parameter		Work class, running lines			Work class, depots and sidings		
		I	II ♣	III/IV	I	II ♣	III/IV
Vertical SD	Open/sub-surface	1.5	3.9	5.0	1.5	5.0	6.0
	Tube	1.9	3.9	5.0	1.9	5.0	6.0
Lateral SD	all	1.2	3.6	4.6	1.2	4.8	6.4
Dynamic cross-level SD	Open/sub-surface	1.0	2.8	4.5	1.0	4.6	5.5
	Tube	1.6	2.8	4.5	1.6	4.6	5.5
2-metre twist SD over 100m	all	1.6	4.2	5.0	1.6	5.0	5.5
♣ Class I tolerances shall apply where track ballast below bottom of sleeper has been replaced or where reconditioning has been carried out.							

1.9 Corrugations (short wavelengths - 20 to 100mm) – TRV/AIT/ATMS

	Tolerance		
	Work class	Running lines	Depots & sidings
The short wave corrugations are presented as chart output on the TRV/AIT/ATMS. The values are the magnitude of the largest peak to peak corrugation in microns (1/1000mm). The limiting values are taken manually from the chart estimating an average over a typical grinding length.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	80	150
	Class IV	80	150
Note that the TRV/AIT/ATMS should be at speeds over 35kph for the records to be valid. See 3.3 Table 4.6 for manual measurements.			

2 Geometric standards – manual measurements

2.1 Vertical

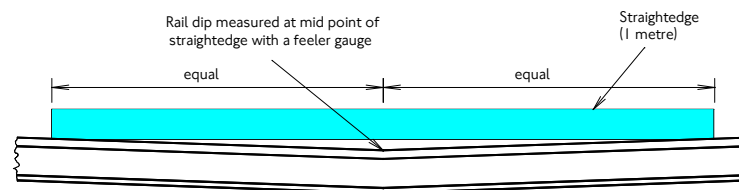
	Tolerance		
	Work class	Running lines	Depots & sidings
2.1.1 Vertical profile (long undulations - 5 metre intervals) Maximum deviation between consecutive levels on any rail, measured at 5 metre intervals. These values are for level track and allowance shall be made for variations in design level for transitions vertical curves and gradients.	Class I	2	2
	Class II ♣	5	8
	Class III	7	10
	Class IV	7	10
	♣ Class I tolerances shall apply when the track has been relaid.		

2.1.2 Vertical profile (short undulations - 1 metre straightedge) Maximum permitted vertical error in the rail, using a 1 metre long straightedge.	Class I	0.5	0.5
	Class II ♣	2	3
	Class III	3	5
	Class IV	3	5
	♣ Class I tolerances shall apply when new rail has been installed or when the track has been relaid.		

The gap is measured between the rail head and the straightedge using a feeler or other suitable gauge. For a dipped joint, see 3.3 Table 2.1.4.

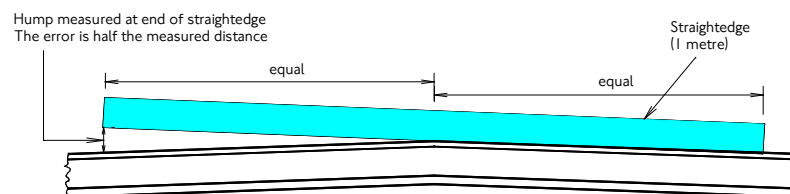
Measurement of rail profile

Rail dip



Side view

Hump

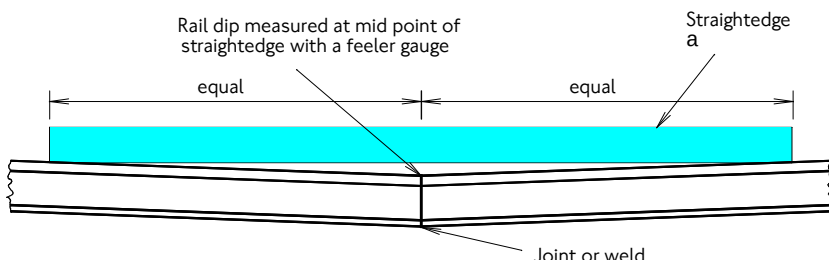


Side view

	Tolerance		
	Work class	Running lines	Depots & sidings
2.1.3 Vertical profile – site welded joints Maximum permitted error in straightness of vertical profile of the joint using a 1 metre straightedge as shown in the drawing and measuring the gap between the rail head and the straightedge. No upward step allowed in either direction. Note: positive value denotes hump at joint and negative denotes dip at joint.	Class I	0 to + 0.5	0 to+ 0.5
	Class II ♣	± 1	± 1
	Class III	± 2	± 4
	Class IV	± 2	± 4
	♣ Class I tolerances shall apply when new rail is welded to new rail		

Measurement of joint geometry

Rail dip



Rail dip measured at mid point of straightedge with a feeler gauge

equal

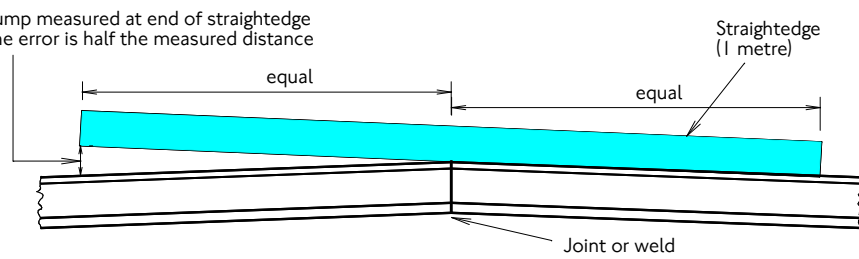
equal

Straightedge a

Joint or weld

Side view

Hump



Hump measured at end of straightedge
The error is half the measured distance

equal

equal

Straightedge (1 metre)

Joint or weld

Side view



	Tolerance		
	Work class	Running lines	Depots & sidings
2.1.4 Vertical profile – plated joints (dipped joint) Maximum permitted error in straightness of vertical profile of the joint using a 1 metre straightedge and measuring the gap between the rail head and the straightedge. See 3.3 Table 2.1.3 for drawing illustrating method of measurement.	Insulated joints		
	Class I	0 + 2	0 + 2
	Class II ♣	- 3 + 2	- 3 + 2
	Class III	- 5 + 3	- 7 + 3
	Class IV	- 5 + 3	- 7 + 3
	This limit includes dip and rail end batter. If batter present refer to 2.1.5 ♣ Class I tolerances shall apply when new rails are installed.		
	Non-insulated joints		
	Class I	0 + 2	0 + 2
	Class II ♣	- 4 + 3	- 4 + 3
	Class III	- 8 + 6	- 8 + 6
	Class IV	- 8 + 6	- 8 + 6
	This limit includes dip and rail end batter. If batter present refer to 2.1.5		
Maximum allowable upward or downward vertical step between running rail ends	Class I	None allowed	None allowed
	Class II ♣	1	2
	Class III	1	2
	Class IV	1	2
	♣ Class I tolerances shall apply when new rails are installed.		

	Tolerance		
	Work class	Running lines	Depots & sidings
2.1.15 Rail end batter – plated joints Maximum permitted rail end batter measuring the gap between the rail head and a 1m straightedge with a feeler gauge.	Open		
	Class I	None allowed	None allowed
	Class II ♣	3	3
	Class III	4	4
	Class IV	4	4
	♣ Class I tolerances shall apply when new rails are installed		
	Sub-surface		
	Class I	None allowed	None allowed
	Class II ♣	2	2
	Class III	3	3
	Class IV	3	3
	Tube sections only		
	Class I	None allowed	None allowed
	Class II ♣	1	1
	Class III	2	2
	Class IV	2	2
	♣ Class I tolerances shall apply when new rails are installed.		

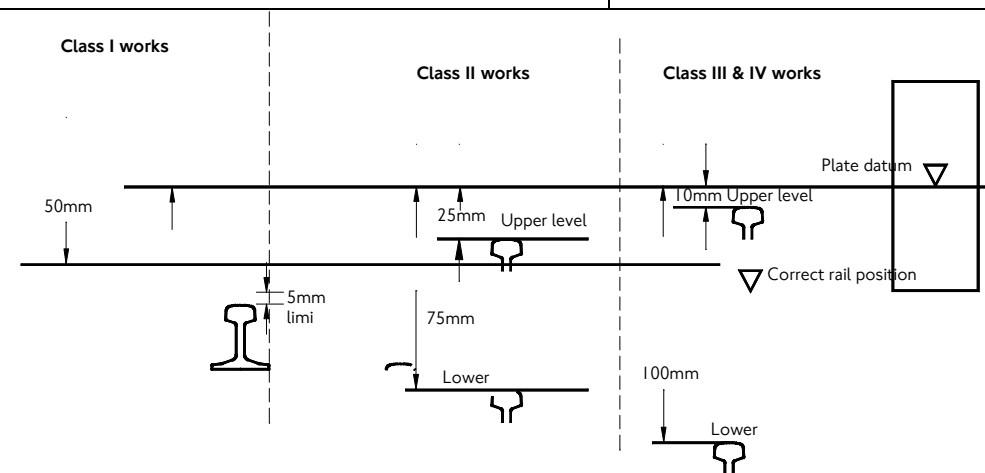
Rail batter

<



	Tolerance		
	Work class	Running lines	Depots & sidings
2.1.6 Vertical position of rail relative to design position Maximum permitted deviation from the engineer's marked vertical position (excluding sites where the rules for 'rail level' plates apply, 3.3 Table 2.1.7). The geometric tolerances given in the previous sections also must not be exceeded. At platforms and other locations where track position is limited by clearance requirements or where a standard concession has been granted, the effects of S1156 must be clarified wherever possible in advance of any work.	Open sections		
	Class I	- 15 + 8	- 15 + 8
	Class II ♣	- 20 + 15	- 20 + 15
	Class III	- 23 + 18	- 25 + 18
	Class IV	- 23 + 18	- 25 + 18
	Subsurface sections		
	Class I	<u>±</u> 5	<u>±</u> 5
	Class II ♣	- 16 + 6	- 20 + 15
	Class III	- 18 + 8	- 23 + 18
	Class IV	- 18 + 8	- 23 + 18
	Tube sections		
	Class I	<u>±</u> 3	<u>±</u> 3
	Class II ♣	- 14 + 5	- 14 + 5
	Class III	- 16 + 5	- 16 + 5
	Class IV	- 16 + 5	- 16 + 5
	♣ Class I tolerances shall apply when the track has been relaid, reconditioned or undergone major fettle.		

	Tolerance		
	Work class	Running lines	Depots & sidings
2.1.7 Maximum rail level plates Maximum permitted vertical deviation of the running surface from the maximum rail level mark on the plate. Note that the running surface should normally be 50mm below level mark. At platforms and other locations where track position is limited by clearance requirements or where a standard concession has been granted, the effects of S1156 must be considered when determining the actual track geometry which can be applied.	Class I	- 50 - 55	- 50 - 55
	Class II ♣	- 25 - 75	- 25 - 75
	Class III	- 10 - 100	- 10 - 100
	Class IV	- 10 - 100	- 10 - 100
	♣ Class I tolerances shall apply when track has been relaid.		



2.2 Lateral			
	Tolerance		
	Work class	Running lines	Depots & sidings
2.2.1 Lateral alignment (long base 10 metre chord versine) Maximum variation between regular overlapping 10 metre versines measured at 5 metre intervals. Allowance must be made for designed transition curves.	Class I	2	2
	Class II ♣	8	18
	Class III	10	20
	Class IV	10	20
	♣ Class I tolerances shall apply when track has been relaid.		
2.2.2 Lateral alignment (short base versine - 1 metre straightedge) - not joints Maximum error in lateral alignment measured using a 1 metre straightedge. Allowance must be made for designed track curvature.	Class I	0.5	0.5
	Class II ♣	2	5
	Class III	3	6
	Class IV	3	6
	♣ Class I tolerances shall apply when track has been relaid.		



	Tolerance		
	Work class	Running lines	Depots & sidings
2.2.3 Straightness lateral alignment (1 metre straightedge) - all joints Maximum permitted error in straightness of alignment of joint using a 1 metre straightedge. Allowance must be made for designed track curvature.	Class I - Plated	1	1
	Class I - Welded	0.5	0.5
	Class II ♣	1.5	3
	Class III	2	5
	Class IV	2	5
	♣ Class I tolerances shall apply if new rail is jointed to new rail		
Maximum allowable lateral step between running rail ends in the direction of running.	Class I Plated	0 + 1	0 + 1
	Class I Welded	0.5	0.5
	Class II ♣	0 + 1	- 1 + 2
	Class III	- 3 + 2	- 3 + 2
	Class IV	- 3 + 2	- 3 + 2
	♣ Class I tolerances shall apply when new plates and rails are installed.		
2.2.4 Lateral position of running edge Maximum permitted deviation from engineer's marked lateral position, provided that the geometric tolerances are not exceeded. At platforms and other locations where track position is limited by clearance requirements or where a standard concession has been granted, the effects of the clearance standard S1156 must be clarified wherever possible in advance of any work.	Open sections.		
	Class I	+ 10	+ 10
	Class II ♣	+ 10	+ 15
	Class III	+ 10	+ 20
	Class IV	+ 10	+ 20
	Sub-surface sections		
	Class I	+ 6	+ 6
	Class II ♣	+ 9	+ 15
	Class III	+ 10	+ 20
	Class IV	+ 10	+ 20
	Tube sections		
	Class I	+ 4	+ 4
	Class II ♣	+ 8	+ 8 ♦
	Class III	+ 10	+ 10 ♦
	Class IV	+ 10	+ 10 ♦
	♣ Class I tolerances shall apply when track has been conditioned or undergone major fettle.		
	♦ Concreted track tolerances only.		

**2.3 Cross level (cant)**

	Tolerance		
	Work class	Running lines	Depots & sidings
Maximum permitted deviation from marked cant averaged over 5 sleepers. Note that variation in cross level must meet the standards for two metre twist (see 3.3 Table 1.4) and ten metre twist (see 3.3 Table 1.5). At platforms and other locations where track position is limited by clearance requirements or where a standard concession has been granted, the effects of the clearance standard S1156 must be considered when determining the actual track geometry which can be applied.	Class I at any location	- 3 + 3	- 3 + 3
	Class II ♣ Open & SS	- 10 + 10	- 20 + 20
	Class II Tube	- 10 + 8	- 10 + 8 ♦
	Class III Open & SS	- 15 + 15	- 20 + 20
	Class III Tube	- 12 + 10	- 12 + 10 ♦
	Class IV Open & SS	- 15 + 15	- 20 + 20
	Class IV Tube	- 12 + 10	- 12 + 10 ♦
	♣ Class I tolerances shall apply when track has been resleepered. ♦ Concreted track tolerances only.		
Maximum allowable variation between marked design cant in tube section locations where the designed cant gradient is steeper than 1 in 400.	Class I	- 2 + 2	- 2 + 2
	Class II	- 2 + 2	- 2 + 2
Maximum deviation from design - variation sleeper to sleeper	Class I ♣	1	1
	Class II ♣	1	1
	♣ Shall apply when track has been resleepered.		

**2.4 Twist 2 metre base (cross level variation)**

	Tolerance		
	Work class	Running lines	Depots & sidings
The maximum values of twist on a 2 metre base. Voids should be measured where possible or estimated and included in the twist calculation. See 3.3 Table 1.4 for method of measurement. Class I values are deviations from the twist in a designed cant gradient. Class II, III and IV values include any twist in the designed cant gradient.	All lines except defined lines		
	Class I	4	4
	Where cant gradients are 1 in 500 or less		
	Class I	2	2
	Where cant gradients are steeper than 1 in 500		
	Class II ♣	12	18
	Class III	20	20
	Class IV	20	20
	The defined lines:		
	District Line – East Putney to Wimbledon		
	Class I Where cant gradients are 1 in 500 or less	4	4
	Class I Where cant gradients are steeper than 1 in 500	2	2
	Class II ♣	12	18
	Class III	18	19
	Class IV	18	19
	♣ Class I tolerances shall apply where track has been relaid or reconditioned.		

**2.5 Twist 10 metre base (cross level variation)**

	Tolerance		
	Work class	Running lines	Depots & sidings
2.5.1 10 metre twist, ballasted track The maximum values of twist on a 10 metre base. Voids should be measured where possible or estimated and included in the twist calculation. See 3.3 Table 1.5 for method of measurement.	Class I	The maximum values of 10 metre twist are dictated by the track geometric design and the crosslevel limitations, see 3.3 Table 2.3.	
	Class II ♣	30 (1 in 333)	30 (1 in 333)
	Class III	33 (1 in 300)	33 (1 in 300)
	Class IV	33 (1 in 300)	33 (1 in 300)
	♣ Class I tolerances shall apply when track has been relaid.		

2.5.2 10 metre twist, concrete track The maximum values of the twist on a 10 metre base. Voids should be measured where possible or estimated and included in the twist calculation. See 3.3 Table 1.5 for method of measurement.	Class I	The maximum values of 10 metre twist are dictated by the track geometric design and the crosslevel limitations, see 2.3.	
	Class II ♣	35 (1 in 286)	35 (1 in 286)
	Class III	37 (1 in 270)	37 (1 in 270)
	Class IV	37 (1 in 270)	37 (1 in 270)
	♣ Class I tolerances shall apply when track has been reconditioned.		

3 Gauge

3.1 Running rail – gauge (dynamic), plain line (see Table 13.1 for junctionwork)

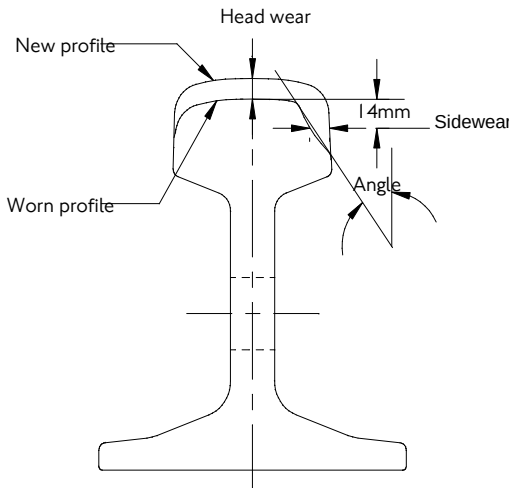
	Tolerance		
	Work class	Running lines	Depots & sidings
The maximum permitted deviations from the Nominal Gauge (see table below) making allowance for estimated rail movement under traffic. The gauge is measured at points 14mm below the running surface of the rails. Track measuring gauges normally allow for this but due allowance must be made for any irregularities e.g. lipping of the running face which would affect the measurement. See 3.4 Table 3.1 regarding assessment of dynamic gauge from a measurement of static gauge.	Class I	-3, +3	-3, +3
	Class II ♦	-5, +11	-5, +11
	Class III	-7, +22	-7, +22
	Class IV	-7, +22	-7, +22
	♦ Class I tolerances shall apply when nature of the work can accommodate regauging e.g. renewal of rail and rail support or renewal of sleepers		
Nominal Gauge for running lines and sidings			
Track radius	Gauge	Track radius	Gauge
Radius > 200m	1435	100m > radius ≥ 80m	1447
200m > radius ≥ 160m	1438	80m > radius ≥ 70m	1450
160m > radius ≥ 130m	1441	radius < 70m	1453
130m > radius > 100m	1444		

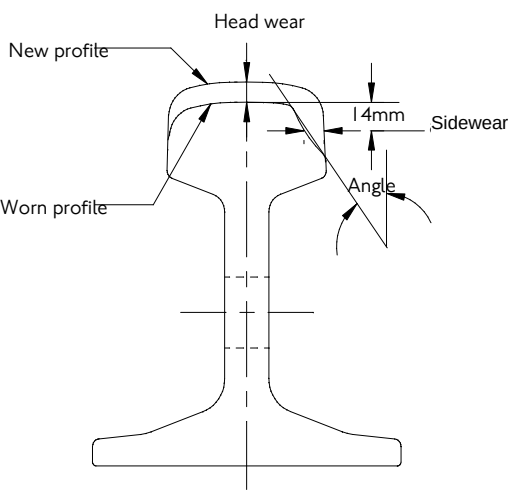
3.2 Running rail – variation in gauge

	Tolerance		
	Work class	Running lines	Depots & sidings
Maximum permitted variation in gauge over 1m.	Class I	1	1
	Class II ♣	2	3
	Class III	2	3
	Class IV	2	3
	♣ Class I tolerances shall apply when the nature of the work can accommodate regauging e.g. renewal of rails and support or renewal of sleepers		

4 Rail condition

4.1 Running rail - side wear as measured with the head wear and side wear gauge

	Tolerance												
	Work class	Running lines and depots											
4.1.1 Running rail - side wear on track used by LU stock only <u>and</u> which is outside fishplate limits	Headwear mm	≤ 1	≤ 2	≤ 3	≤ 4	≤ 6	≤ 8	≤ 10	≤ 12	≤ 14	≤ 16	≤ 18	≤ 19
	Class I	None allowed											
	Class II ♣	7	6	6	5	4	3	2	2	1	0	0	0
	Class III	9	8	8	7	6	5	4	3	2	1	0	0
	Class IV	9	8	8	7	6	5	4	3	2	1	0	0
	♣ Class I tolerances shall apply when new rail is installed.												
Maximum permitted side wear as measured 14mm below the running surface of the rail head. The allowable sidewear is a function of the headwear with reference to the profile of a new rail. Applies to track used by LU stock only which is outside of ±1.5metres of the centreline of a rail joint.	Running rail - side wear												
													
See S1157 for restrictions on turning or transposing rail.													

	Tolerance									
	Work class	Running lines and depots								
4.1.2 Running rail - side wear at fishplates or on track used by TOC stock	Headwear mm	≤ 1	≤ 2	≤ 3	≤ 4	≤ 6	≤ 8	≤ 10	≤ 11	> 11
Maximum permitted side wear as measured 14mm below the running surface of the rail head. The allowable side wear is a function of the headwear with reference to the profile of a new rail. Applies within fishplate limits i.e. ±1.5 metres of the centreline of the joint. See S1157 for restrictions on turning or transposing rail.	Class I	None allowed								
	Class II ♣	6	4	3	2	1.5	1	0	0	0
	Class III	8	6	5	4	3	2	1	0	0
	Class IV	8	6	5	4	3	2	1	0	0
	♣ Class I tolerances shall apply when new rail is installed. Running rail - side wear 									

4.2 Running rail –Side wear

	Tolerance		
	Work class	Running lines	Depots & sidings
Maximum permitted side wear on running edge. Measured with standard side cut 'go/no-go' gauge. Limiting values in mm of clearance between gauge and web of rail. Note: currently this gauge should only be used to measure stock rail wear at switch tips; see Handbook 4 for method of use. See S1157 for restrictions on turning or transposing rail.	Class I	None allowed	None allowed
	Class II ♣	5	5
	Class III	3	3
	Class IV	3	3
	♣ Class I tolerances shall apply when new rail is installed.		

4.3 Running rail – chair gall

	Tolerance		
	Work class	Running lines	Depots & sidings
Maximum permitted depth of chair gall on the underside of the rail.	Class I	None allowed	None allowed
	Class II ♣	1	1
	Class III	2	2
	Class IV	2	2
	♣ Class I tolerances shall apply when new rail is installed.		

4.4 Running rail - headwear as measured with the headwear and sidewear gauge

	Work class	Running lines and depots											
4.4.1 Running rail - headwear on track used by LU stock only <u>and</u> which is outside fishplate limits Maximum permitted head wear allowable (excluding rail gall) based on a nominal rail depth of 145mm for 95RBH rail and 159mm for 56E1 rail. The allowable headwear is a function of the sidewear (see also 3.3 Table 4.1.1). Applies to track used by LU stock only, which is outside of <u>±1.5</u> metres of the centre line of a rail joint.	Sidewear mm	0	≤ 1	≤ 2	≤ 3	≤ 4	≤ 5	≤ 6	≤ 7	≤ 8	≤ 9	≤ 10	≤ 11
	Class I	None allowed											
	Class II ♣	16	14	12	8	6	4	3	1	0	0	0	0
	Class III	18	16	14	12	10	8	6	4	2	1	0	0
	Class IV	18	16	14	12	10	8	6	4	2	1	0	0
	♣ Class I tolerances shall apply when new rail is installed.												

4.4.2 Running rail - headwear at fishplates or on track used by TOC stock Maximum permitted head wear allowable(excluding rail gall) based on a nominal rail depth of 145mm for 95RBH rail and 159mm for 56E1 rail. The allowable headwear is a function of the sidewear (see also 3.3 Table 4.1.2). Applies within fishplate limits i.e. ± 1.5 metres of the centreline of the joint, or on track used by TOC stock.	Sidewear mm	≤ 0	≤ 1	≤ 2	≤ 3	≤ 4	≤ 5	≤ 6	≤ 7	≤ 8	≤ 10	≤ 11	
	Class I	None allowed											
	Class II ♣	10	8	4	3	2	1.5	1	0	0	0	0	
	Class III	12	10	8	6	4	3	2	1.5	1	0	0	
	Class IV	12	10	8	6	4	3	2	1.5	1	0	0	
	♣ Class I tolerances shall apply when new rail is installed.												

4.5 Corrugations (long wavelength > 100 mm pitch)

	Tolerance		
	Work class	Running lines	Depots & sidings
Maximum depth of corrugation in mm measured using a feeler gauge and 300mm straightedge or other suitable gauge.	Class I	None allowed	None allowed
	Class II ♣	0.35	0.40
	Class III	0.40	0.45
	Class IV	0.40	0.45
	♣ Class I tolerances shall apply when new rail is installed.		

4.6 Corrugations (short wavelengths – 20mm to 100 mm)

Maximum depth of corrugation in mm between 20 and 100mm pitch, using a feeler or other suitable gauge to measure the gap between the rail head and a 300mm straightedge.	Class I	None allowed	None allowed
	Class II ♣	0.08	0.15
	Class III	0.08	0.15
	Class IV	0.08	0.15
	♣ Class I tolerances shall apply when new rail is installed.		

5 Rail Joints

(see also 3.3 tables 2.1.3, 2.1.4, 2.1.5)

5.1 Assembly – all plated joints

	Tolerance		
	Work class	Running lines	Depots & sidings
Incomplete assemblies, e.g. with defective or missing bolts. Maximum number per 100-metre length.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	None allowed	None allowed
	Class IV	None allowed	None allowed
Note: All individual joints must meet the tolerances in 3.3 Table 5.2.			

5.2 Bolt assembly - all plated joints

	Tolerance		
	Work class	Running lines	Depots & sidings
Maximum number of missing, defective or not properly tightened bolts in any one pair of rail joints.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	None allowed	None allowed
	Class IV	None allowed	None allowed
Note: All individual joints must meet the tolerances in this section.			

5.3 Bolt security- all plated joints

	Tolerance		
	Work class	Running lines	Depots & sidings
Number of bolts not tightened in accordance with the engineering standards (see 3.3 Tables 5.4, 5.5 and 5.6), cracked, bent or otherwise defective or the incorrect type installed: maximum number per 100 metres length of track. See Note in Table 5.2 above.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	None allowed	None allowed
	Class IV	None allowed	None allowed

**5.4 Bolt tightness**

	Tolerance		
	Work class	Running lines	Depots & sidings
5.4.1 Bolt tightness- fishplated joints (non-insulated) Maximum permitted deviation in Nm from the required torque of 270Nm. See note in Table 5.2 above.	Class I	± 30	± 30
	Class II	± 30	± 30
	Class III	± 30	± 30
	Class IV	± 30	± 30

5.4.2 Bolt tightness - tight joints Maximum permitted deviation in Nm from the required torque of 1300Nm. See note in Table 5.2 above.	Class I	0 + 50	0 + 50
	Class II	0 + 50	0 + 50
	Class III	0 + 50	0 + 50
	Class IV	0 + 50	0 + 50

5.4.3 Bolt tightness - insulated joints (all types) Maximum permitted deviation in Nm from the torque shown below See note in Table 5.2 above. Glued joints generally use multi-groove locking pins. Where bolts are used, they shall be torqued to 1020 Nm. Bolts in Tenconi running rail joints shall be torqued to 1200 Nm. Bolts in Tenconi 33C1 check rail joints shall be torqued to 520 Nm.	Class I	0 + 50	0 + 50
	Class II	0 + 50	0 + 50
	Class III	0 + 50	0 + 50
	Class IV	0 + 50	0 + 50

5.4.4 Bolt tightness - elsewhere Maximum permitted deviation in Nm from the required torques, which are shown below	Class I	± 30	± 30
	Class II	± 30	± 30
	Class III	± 30	± 30
	Class IV	± 30	± 30
Black bolts for slide chairs, crossings and switch blocks.		475 Nm	(350 lb ft)
High tensile steel fishbolts and steel transfer block bolts.	25mm dia	881 Nm	(650 lb ft)
	29mm dia	1020 Nm	(750 lb ft)
High tensile steel slide chair or baseplate bolts.	25mm dia	881 Nm	(650 lb ft)
	29mm dia	881 Nm	(650 lb ft)
Bolts securing locked wheel ramps.	25mm dia	900 Nm	(660 lb ft)

5.5 Fishplates - all plated joints

	Tolerance		
	Work class	Running lines	Depots & sidings
Cracked or broken fishplates	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	None allowed	None allowed
	Class IV	None allowed	None allowed

**5.6 Rail expansion gaps**

										Tolerance											
										Work class			Running lines			Depots & sidings					
5.6.1 Short rail gap - all plated joints The maximum deviation from the calculated average gap (average for the total rail length) shall be: The minimum allowable gap in short rail track shall be calculated as in the table below.										Class I			0 + 2			0 + 2					
										Class II ♣			0 + 4			0 + 4					
										Class III			0 + 4			0 + 4					
										Class IV			0 + 4			0 + 4					
										A rapid rise in temperature can occur in February, therefore work should be attempted before this date. ♣ Class I tolerances shall apply if new rails are installed.											
										Expansion allowance - sum of rail gaps mm For 18.3m or 13.7m rails the total allowance shall be as shown. This assumes that the full length of each rail is free to expand and contract. For 36.6m rails the total allowance shown shall be halved unless the rails are free to move over their full length (e.g. if fitted with Panlock or wood keys).											
Track length (metres)		20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400
-10°C		11	21	32	42	53	63	74	84	95	105	116	126	137	148	158	169	179	190	200	211
0°C		9	17	26	35	44	52	61	70	79	87	96	105	114	122	131	140	149	157	166	175
10°C		6	13	19	26	32	39	45	52	58	64	71	77	84	90	97	103	109	116	122	129
20°C		4	8	12	17	21	25	29	33	37	41	46	50	54	58	62	66	70	75	79	83
30°C		2	4	6	7	9	11	13	15	17	18	20	22	24	26	28	29	31	33	35	37

5.6.2 Long rail gap - plated joints The maximum permitted gap in plated joints in long welded rail:	Class I	0.5	0.5
	Class II ♣	5	5
	Class III	7	7
	Class IV	7	7
	♣ Class I tolerances shall apply when new rails have been installed or after any seasonal adjustments have taken place.		

**5.7 Rail joint position**

	Tolerance		
	Work class	Running lines	Depots & sidings
5.7.1 Plated joints - sleeper distance The maximum permitted variance in position for joints normally located centrally between sleepers.	Class I Straight track	± 15	± 15
	Class I Curved track	± 35	± 35
	Class II Straight track	± 15	± 15
	Class II Curved track	± 35	± 35
	Class III	± 100	± 100
	Class IV	± 100	± 100

5.7.2 Plated joints - stagger The maximum longitudinal stagger of opposite fishplated rail joints on straight track.	Class I	10	10
	Class II	10	10
	Class III	50	100
	Class IV	50	100
The maximum longitudinal stagger of opposite fishplated rail joints on curved track.	Class I	65	65
	Class II	65	65
	Class III	75	75
	Class IV	75	75

5.7.3 Welded joints - longitudinal positioning The minimum distance from the welded joint to an assembled chair or baseplate. The joint is normally positioned centrally between sleepers. However, a flash butt weld is permitted to be closer than this if the underside of the foot (FB) or the underside of the foot and the web (BH) are fully ground.	Class I	75	75
	Class II	75	75
	Class III	75	75
	Class IV	75	75

5.8 Rail foot wear at fishing surface (fishplate fretting): Rail Condition / Notch Depth

	Tolerance		
	Work class	Running lines	Depots & sidings
The maximum fishplate fretting on the fishing surface at a fishplated joint (see 3.4 Table 5.8 for diagram and illustration)	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	None allowed	None allowed
	Class IV	None allowed	None allowed

6 Track fastenings

6.1 Running rail support - baseplates and chairs

	Tolerance		
	Work class	Running lines	Depots & sidings
6.1.1 Baseplates and chairs – defective			
Maximum number of baseplates/chairs defective, cracked or broken in one rail in a group of 5 sleepers or bearers.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	3	3
	Class IV	3	3
Maximum number of baseplates/chairs defective, cracked or broken per 100 metres of track.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	7	15
	Class IV	7	15
Defects include wear, e.g. fretting from clips on baseplate housings, and on chair jaws such that keys cannot be retained securely See clause 3.4 Table 6.1 for actions where the Class III/IV quantities are present in particular configurations			

6.1.2 Baseplates and chairs - voiding Allowable number of voids between chair/baseplate and sleeper, timber, pitblock or rail.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	None allowed	None allowed
	Class IV	None allowed	None allowed

6.1.3 Baseplates and chairs - longitudinal positioning Maximum variance in installed longitudinal positioning of baseplates and chairs installed to pit blocks.	Class I	± 10	± 10
	Class II	± 10	± 10
	Class III	± 10	± 10
	Class IV	± 10	± 10

6.2 Pandrol housings (concrete sleepers)

	Tolerance		
	Work class	Running lines	Depots & sidings
Maximum number of sleepers in a group of 5 with missing or defective housings in one rail.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	3	3
	Class IV	3	3
Maximum number of Pandrol housings defective, cracked or broken per 100 metres of track.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	10	15
	Class IV	20	30

6.3 Screwspikes, bushes, rail pads

	Tolerance		
	Work class	Running lines	Depots & sidings
Maximum number of screwspikes/bushes or rail pads missing, defective, or not secure per 5 adjacent sleepers or bearers on one rail.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	4	4
	Class IV	4	4
Maximum number of screwspikes/bushes or rail pads missing, defective, or not secure per 100 metres of track.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	15	20
	Class IV	15	20
Clearance between screwspike and top of chair when tightened to top of nylon bush.	Class I	5 + 3	5 + 3
	Class II	5 + 3	5 + 3
	Class III	5 + 3	5 + 3
	Class IV	5 + 3	5 + 3
Note: the numbers shown for 5 adjacent sleepers/bearers and 100m may be read as additional to any screwspikes omitted: i) to avoid fouling of four-foot switch mechanisms or trainstops; ii) from baseplates used as a temporary measure during tube station track reconditioning, where the baseplate size precludes use of all screwspike holes. This is subject to any unused holes in the pitblock being plugged and there being (a) one screwspike on each side of the rail, securely inserted in sound timber; (b) at least 50mm between any hole and the edge of the pitblock; (c) pit sleepers in place on a 1 in 4 basis and not more than 4m apart. See clause 3.4 Table 6.3 for actions where the Class III/IV quantities are present in particular configurations			

6.4 Keys, clips

	Tolerance		
	Work class	Running lines	Depots & sidings
6.4.1a Keys (wood, steel or Panlock) - applies also to check rails			
Maximum number of keys missing, defective, or not secure per 5 adjacent sleepers or bearers on one rail.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	1	1
	Class IV	1	1
Maximum number of keys missing, defective, or not secure per 100 metres of track.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	5	7
	Class IV	5	7
Note: at a trip cock site only Panlock keys or wooden keys secured by nails at each end shall be used (wooden keys secured by nails are preferred) - see standard S1158. See clause 3.4 Table 6.4.1 for actions where the Class III/IV quantities are present in particular configurations			

6.4.1b Keys - steel

Entry of steel key to chair when correctly installed.	Class I	M25 Mx 40	M25 Mx 40
	Class II	M25 Mx 40	M25 Mx 40
	Class III	M25 Mx 40	M25 Mx 40
	Class IV	M25 Mx 40	M25 Mx 40
M = minimum entry, Mx = maximum entry			
Allowable number of Panlock keys not installed to manufacturer's specification.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	None allowed	None allowed
	Class IV	None allowed	None allowed



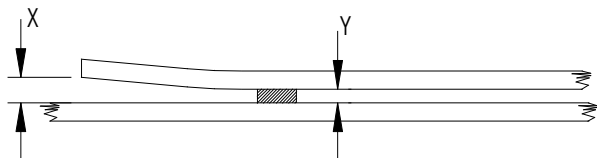
	Tolerance		
	Work class	Running lines	Depots & sidings
6.4.2 Mixed keys Maximum number of steel keys in a wood key site or vice versa per 100 metres of track section.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	4	4
	Class IV	8	16

6.4.3 Resilient flat bottom clips and clip insulators			
Maximum number of clips or insulators missing, defective, or not secure per 5 adjacent sleepers or bearers on one rail.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	1	2
	Class IV	1	2
Maximum number of clips or insulators missing, defective, or not secure or not installed to manufacturer's specification per 100 metres of track.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	10	15
	Class IV	10	15
See clause 3.4 Table 6.4.3 for actions where the Class III/IV quantities are present in particular configurations			

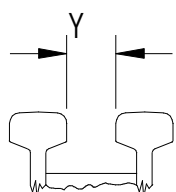
7 Check rail

7.1 Check rail flangeway, plain line (see Table 13.6.2 for junctionwork)

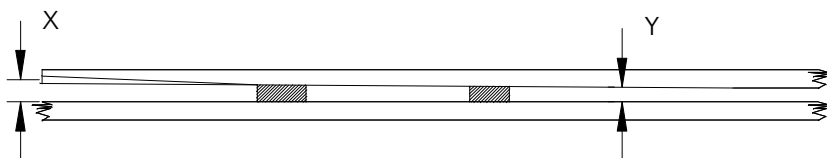
	Tolerance		
	Work class	Running lines, depots & sidings	
		X value	Y value
Maximum deviation of the flangeway gap from the nominal dimensions shown in the drawings below.	Class I	-0	-0, +3
“X” is the flare opening: must not be less than value shown below; no upward limit. “Y” is the parallel flangeway.	Class II ♣	-0	- 3, +5
	Class III	-0	- 3, +5
	Class IV	-0	- 3, +5
	♣ Class I tolerances shall apply if new running rail and check rail are installed.		



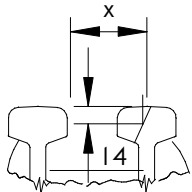
BH standard check rail end



End view



FB and 33C1 standard check rail end



End view

Location of check rail	X value		Y value
	BH	FB, 33C1	
Checked curves less than 200m radius	89mm minimum	75mm minimum	(1)
Cover checks e.g. trip cock tester	89mm minimum	75mm minimum	(2)

(1) for nominal value, subtract 1388mm from track gauge shown in Table 3.1 for radius concerned.
(2) for nominal value, subtract 1391mm from track gauge shown in Table 3.1 for radius concerned.

7.2 Check rail height, plain line (see Table 13.6.1 for junctionwork)

	Tolerance		
	Work class	Running lines	Depots & sidings
Maximum height of the top surface of the check rail above the adjacent running rail head. (Except where the item for Junctionwork check rails applies for the safe passage of a negative shoe – see 3.3 Table 13.6.1)	Class I	0 + 13	0 + 13
	Class II ♣	0 + 20	0 + 20
	Class III	0 + 25	0 + 25
	Class IV	0 + 25	0 + 25
	♣ Class I tolerances shall apply if new running rail and check rail are installed.		

**7.3 Check rail - joint assembly**

	Tolerance		
	Work class	Running lines	Depots & sidings
Maximum number of missing or defective bolts per joint.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	None allowed	None allowed
	Class IV	None allowed	None allowed

7.4 Check rail - bolt security - plated joints

	Tolerance		
	Work class	Running lines	Depots & sidings
Maximum number of bolts per joint not tightened in accordance with the Engineer's nominal specified torque of 270Nm (or other relevant specified torque).	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	None allowed	None allowed
	Class IV	None allowed	None allowed
Note: For Tenconi insulated joints in 33C1 check rail the specified bolt torque is 520Nm.			

7.5 Check rail - Check block assembly - bullhead rail

	Tolerance		
	Work class	Running lines	Depots & sidings
Incomplete assembly, missing or defective bolts.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	None allowed	None allowed
	Class IV	None allowed	None allowed

7.6 Check rails– bolt or clamp security – flat bottom running rail

	Tolerance		
	Work class	Running lines	Depots & sidings
Maximum number of: - bolts in association with blocks; - clamps in association with 33C1 check rail; - bolts in association with 33C1 check rail per 100 metres of track or in one cover check rail in junctionwork, not tightened in accordance with the engineer's instructions	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	None allowed	None allowed
	Class IV	None allowed	None allowed



8 Adjustment/expansion switches

8.1 Adjustment/expansion switches - assembly

	Tolerance		
	Work class	Running lines	Depots & sidings
Number of defective/missing/loose clamp assemblies or stock rail to chair bolted assemblies.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	None allowed	None allowed
	Class IV	None allowed	None allowed

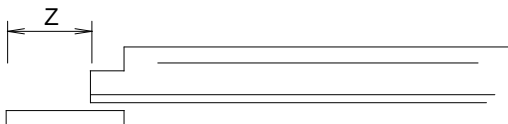
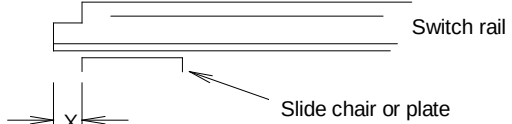
8.2 Adjustment/expansion switches - bolt security

	Tolerance		
	Work class	Running lines	Depots & sidings
Number of clamp assembly bolts per assembly, not tightened in accordance with the engineering standards.	Class I	None allowed	N/A
	Class II	None allowed	N/A
	Class III	None allowed	N/A
	Class IV	None allowed	N/A
See section 3.3 Table 5.4 for bolt tightness			

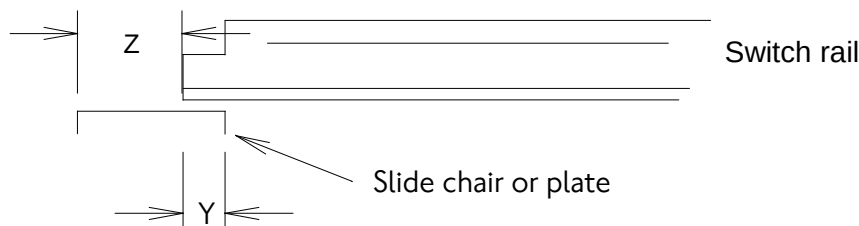
8.3 Adjustment switch to stock rail fit

	Tolerance		
	Work class	Running lines	Depots & sidings
Gap between the stock rail and the switch rails measured at the tip.	Class I	1	N/A
	Class II ♣	3	N/A
	Class III	4	N/A
	Class IV	4	N/A
♣ Class I tolerances shall apply when a new stock and switch are installed.			

8.4 Adjustment switch tip

	Tolerance			
	Work class	Running lines	Depots & sidings	
8.4.1 Longitudinal position Maximum and minimum permitted dimension Z as shown in diagram below. See 3.3 Table 8.4.2 & 8.4.3 for limiting position applicable for Class II, III and Class IV works.	Dimension Z			
	Work class	Running lines only		
	Class I	Rail temp (°C)	Max	Min
	Also Class II (where new switches have been installed)	-9 to -4	21	15
		-4 to zero	18	12
		zero to 4	16	10
		4 to 9	13	7
		9 to 13	11	5
		13 to 17	8	2
		17 to 22	6	Nil
		22 to 27	3	-3
Designed position				
Rail temp (°C)	'Z' (end of switch rail to edge of slide surface)			
-9 to -4	18			
-4 to zero	15			
zero to 4	13			
4 to 9	10			
9 to 13	8			
13 to 17	5			
17 to 22	3			
22 to 27	nil			
				
				

	Work class	Running lines	Depots & sidings
8.4.2 Longitudinal position - switch tip overhang Maximum overhang X as shown in diagram above.	Dimension X		
	Work class	Running lines only	
	Class I	Dimension Z tolerances apply	
	Class II	Dimension Z tolerances apply	
	Class III & IV BH	115	
	Class III & IV FB	127	

	Tolerance																					
	Work class	Running lines only																				
8.4.3 Switch tip overlap	Dimension Y																					
Minimum overlap (dimension Y) of switch tip with slide chair or plate	Class I	See below (Design pos'n)																				
	Class II	See below (Design pos'n)																				
	Class III	65																				
	Class IV	65																				
Adjustment switch (LU switch rail type)																						
																						
<table><tr><th colspan="2">Design position</th></tr><tr><th>Rail temp (°C)</th><th>Dimension Z</th></tr><tr><td>-9 to -4</td><td>18</td></tr><tr><td>-4 to zero</td><td>15</td></tr><tr><td>zero to 4</td><td>13</td></tr><tr><td>4 to 9</td><td>10</td></tr><tr><td>9 to 13</td><td>8</td></tr><tr><td>13 to 17</td><td>5</td></tr><tr><td>17 to 22</td><td>3</td></tr><tr><td>22 to 27</td><td>nil</td></tr></table>			Design position		Rail temp (°C)	Dimension Z	-9 to -4	18	-4 to zero	15	zero to 4	13	4 to 9	10	9 to 13	8	13 to 17	5	17 to 22	3	22 to 27	nil
Design position																						
Rail temp (°C)	Dimension Z																					
-9 to -4	18																					
-4 to zero	15																					
zero to 4	13																					
4 to 9	10																					
9 to 13	8																					
13 to 17	5																					
17 to 22	3																					
22 to 27	nil																					
Note: Class I work tolerance on dimension Z is $\pm 3\text{mm}$																						

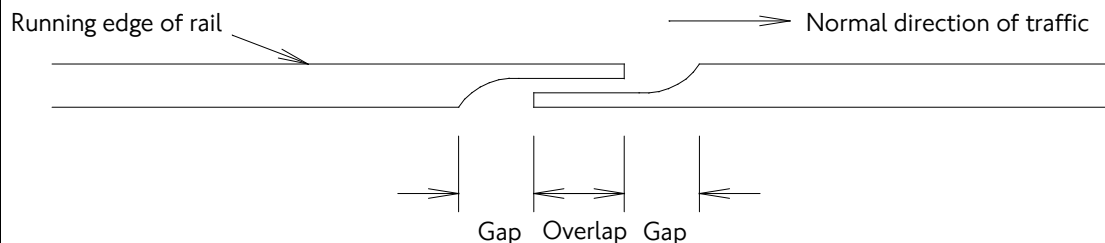
8.5 Expansion switch gaps and overlaps (Network Rail scarf type)

Tolerance						
	Work class	Running lines only				
		Rail	Overlap		Gap	
		temp (°C)	Max	Min	Max	Min
	Class I	-9 to -4	645	639	121	115
		-4 to zero	648	642	118	112
		zero to 4	650	644	116	110
		4 to 9	653	647	113	107
		9 to 13	655	649	111	105
		13 to 17	658	652	108	102
		17 to 22	660	654	106	100
		22 to 27	663	657	103	97
	Class II	-9 to 4	651	633	127	109
		-4 to zero	654	636	124	106
		zero to 4	656	638	122	104
		4 to 9	659	641	119	101
		9 to 13	661	643	117	99
		13 to 17	664	646	114	96
		17 to 22	666	648	112	94
		22 to 27	669	651	109	91
	Class III & IV	-9 to -4	654	630	130	106
		-4 to zero	657	633	127	103
		zero to 4	659	635	125	101
		4 to 9	662	638	122	98
		9 to 13	664	640	120	96
		13 to 17	667	643	117	93
		17 to 22	669	645	115	91
		22 to 27	672	648	112	88

Designed position

Rail Temp (°C)	Overlap	Gap
-9 to -4	642	118
-4 to zero	645	115
zero to 4	647	113
4 to 9	650	110
9 to 13	652	108
13 to 17	655	105
17 to 22	657	103
22 to 27	660	100

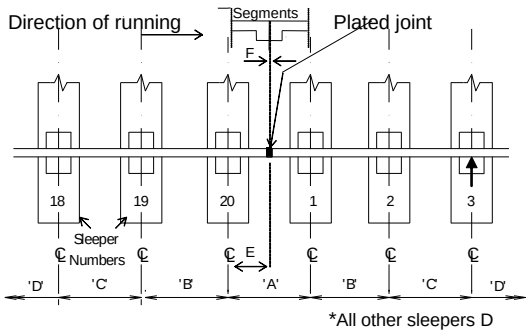
Expansion switch (NR scarf joint type)



9 Sleepers (to be read as including pitblocks where appropriate)

9.1 Sleeper spacing, plain line (see Table 13.7.1 for junctionwork)

	Tolerance		
	Work class	Running lines	Depots & sidings
Maximum permitted variation from the nominal sleeper spacings shown below	Class I ♣	± 25	± 25
	Class II ♦ ♥	± 75	± 100
	Class III ♦	± 100	± 150
	Class IV ♦	± 100	± 150
Note: In Tube sections the sleeper spacings "C" and "D" shall be reduced to not greater than 750mm where track radius is below 400m, and not greater than 550mm where radius is less than 200m. ♣ ± 15 at plated joints; welded joints are treated as continuous rail. ♦ Tolerance reduced by 50mm at plated joints. ♥ Class I tolerances to apply when track is resleepered.			

Track type	Sleeper spacing (mm)						
	A	B	C	D	E	F	
1. Tube track							
a) Tunnels constructed with 20" Cast Iron segment width	666 +10 - 0	530 +20 - 30	915	1016	333 +10 - 0	Seg joint +/-10	
b) Tunnels constructed with 18" Concrete segment width	666 +10 - 0	530 +20 - 30	915	915	-	-	
2. Open/sub surface track							
a) Short rails	666	660	678	787	-	-	1. Welded joints are treated as continuous rail 2. Sleeper numbering refers to the installation of 18.288m (60ft) rail length. *Sleeper numbers 10 & 11 will be in adjacent tunnel segments. The sleeper centre spacing dimension will be 508mm. 3. Dimensions E and F are measured from the centre of the end post. 4. Dimensions applicable to Bullhead and Flatbottom rail. 5. Where six-hole insulated rail joints are used dimension A shall be: • 754mm for wood sleepers with Pan 11 baseplates; • 630mm for concrete sleepers with Pandrol e or PR clips; • 610mm for concrete sleepers with Pandrol Fastclip.
b) Long rails	666	730	770	770	-	-	
c) CWR	610	610	610	610	-	-	
	See also Note 5						

Note regarding direct-fix configuration:

Where direct fix is used rather than sleepers, the rail support spacing shall be selected within the range 500mm to 800mm. The selected spacing shall allow adequate clearance between baseplate anchor bolts and cast-iron tunnel segment flanges and shall be appropriate for six-hole insulated joints if used.

Taken over 100m cells the support spacing shall be generally uniform and subject to the tolerances shown above. Where site configuration means that variations in sleeper spacing are required they shall be suitably transitioned to avoid sudden variations in track stiffness.

**9.2 Sleeper squareness**

	Tolerance		
	Work class	Running lines	Depots & sidings
Maximum permitted deviation of sleeper from square to the running edges of the rail measured across the four-foot and not cumulative with Table 9.1 above.	Class I	30	30
	Class II ♣	40	40
	Class III	75	75
	Class IV	75	75
	♣ Class I tolerances shall apply when new sleepers are installed.		

9.3 Sleepers – condition, plain line (see Table 13.7 for bearers in junctionwork)

	Tolerance		
	Work class	Running lines	Depots & sidings
9.3.1 Chair or baseplate indentation Maximum permitted depth of indentation of the chair or baseplate into the top surface of an individual sleeper.	Class I	None allowed	None allowed
	Class II ♣	3	4
	Class III	8	10
	Class IV	8	10
	♣ Class I tolerances shall apply when a new sleeper is installed.		

9.3.2 Redundant screwspike holes Maximum permitted number of redundant screwspike holes in an individual sleeper which have not been satisfactorily plugged.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III ♣	4	4
	Class IV ♣	4	4
	♣ None allowed if a new sleeper is installed.		
Note: Screwspikes used for lateral restraint to temporarily-stored rails must be removed when no longer required and the holes plugged – see 3.4 Table 9.3.2.			

9.3.3 Condition of timber sleepers Maximum number of ineffective sleepers in a group of 5	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III ♣	3	3
	Class IV ♣	3	3
	♣ 3 consecutive sleepers are not allowed.		
Maximum number of ineffective sleepers per 100 metres of track.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	5	10
	Class IV	10	20
Note: An ineffective sleeper is defined as cracked, rotten or broken providing inadequate vertical or lateral restraint to baseplate or rail.			

9.3.4 Condition of concrete sleepers Maximum number of ineffective sleepers in a group of 5.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III ♣	3	3
	Class IV ♣	3	3
	♣ 3 consecutive sleepers are not allowed.		
Maximum number of ineffective sleepers per 100 metres of track.	Class I	None allowed	None allowed
	Class II	None allowed	None allowed
	Class III	5	15
	Class IV	10	30



Note: An ineffective sleeper is defined as cracked or broken providing inadequate vertical or lateral restraint to rail.

Document Sharing Hub

**10 Ballast****10.1 Ballast level**

	Tolerance		
	Work class	Running lines	Depots & sidings
Maximum permitted deviation of the top of the ballast or ash bed between sleepers from the upper surface of the sleeper, except where track equipment requires extra clearance.	Class I	0 + 25	0 + 25
	Class II ♣	- 50	- 50
	Class III	- 75	- 75
	Class IV	- 75	- 75
	♣ Class I tolerances shall apply where beds have been reballasted.		
Maximum permitted number of consecutive beds with low ballast (75mm from the upper surface of the sleeper).	Class I	None allowed	None allowed
	Class II ♣	2	2
	Class III	2	2
	Class IV	2	2
	♣ Class I tolerances shall apply where beds have been reballasted.		
Where equipment or materials such as cables are laid along the track, tripping hazards shall be assessed and the limits shown above adjusted as necessary to maintain risks ALARP.			

10.2 Ballast shoulder profile

	Tolerance		
	Work class	Running lines	Depots & sidings
Maximum permitted deviation of the width or height of the ballast shoulder from that shown in the figure below.	Class I	0 + 75	0 + 75
	Class II ♣	- 50	- 50
	Class III	- 100	- 100
	Class IV	- 100	- 100
The figure is based on the requirements of S1157.	♣ Class I tolerances shall apply if significant reballasting takes place.		