## Document control

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date of Approval</th>
<th>Summary of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>October, 2006</td>
<td>First issue as a RailCorp document. Includes content from TS 22 000 2 01 SP, C 2009, C 2011, C 2107, C 2430, C 2435, C 2436, C 2437, C 2438, C 2439, C 2440, C 2441, C 2442, C 2443, C 2444, C 2445, C 2446, C 2447, C 2508, C 3102, C 3210, C 3215, TS 3102, TS 3655, AP 5134, CSI 018, CSI 025, RC 2411, RC 2436, RC 2442, RC 2508, Draft RC 4801, RTS 3432, RAP 5108, RAP 5133, RAP 5134, RAP 5135, RAP 5138, RAP 5139, RAP 5140, RAP 5141, RAP 5142, RAP 5701, CTN 01/05, CTN 01/07, CTN 01/11, CTN 02/01, CTN 02/07, CTN 03/01, CTN 04/01, CTN 04/04, CTN 04/07, CTN 04/09, CTN 04/10, CTN 04/11, CTN 04/15, CTN 04/25, CTN 04/27, CTN 05/02, CTN 05/05, CTN 05/10, CTN 05/15, CTN 05/18, CTN 06/04, CTN 06/06, CTN 06/08.</td>
</tr>
<tr>
<td>2</td>
<td>April, 2007</td>
<td>Additional reference; Minor corrections; inclusion of CME accountabilities for LXing sighting points; clarification of requirements for attendance on Track Recording Car; Inclusion of CME accountabilities for review of Defect Management System; Removal of requirement to have Maintain Points &amp; Crossing Competency to certify turnouts after examination; Minor change to competency for Swingnose crossing examination; Correction of alignment measurement; Clarification of measurement of line; additional explanation of checkrail effectiveness; additional explanation of rail dimensions; Changes to BOS numbers; addition of 8m line measurement; addition of 47kg corrosion limits and correction of others; Addition of information on dealing with false readings; Minor correction; inclusion of requirements of CTN 06/05; Changes to ballast deficiency table; Additional information about dealing with fixed points; Additional requirements for checking obstructions to sighting distances; Minor corrections; additional guidance on measuring dip at crossings; inclusion of VAE Expansion switches; additional guidance of assessment of manual point lever effectiveness; revision of slip examination procedure; addition of VAE Swingnose examination procedures; addition of requirements to check tip of swingnose with switch tip gauge; inclusion of content of CTN 05/20.</td>
</tr>
<tr>
<td>3</td>
<td>October, 2007</td>
<td>Minor change to references, Addition of rounding of measurements; addition of initial review requirements for tight gauge, Minor change (emphasis) in Table 12), Minor change to Figure 31</td>
</tr>
</tbody>
</table>
| 4        | May, 2008        | C2-1.1 – Inclusion of requirements for Integrated Walking; C2-2.1 – additional requirement for Team Managers to report non-attendance on Track Recording runs; C5-3 – Addition of Absolute Superelevation limit; C5-4 – Correction of error in Rail Wear table; C7-3.1 – Additional patrol procedure for Ancillary lines; C7-4.1 Additional issues for Engine Patrol; C9-2 – Add check of movement of Friction Buffer Stops; C11-2 – Add check of movement of Friction Buffer Stops; C11-9 – Wording change to clarify maintenance limits; C19-2 – Clarification of measurement conventions for platform clearances; C19-3 – Correction of
<table>
<thead>
<tr>
<th>Revision</th>
<th>Date of Approval</th>
<th>Summary of change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>error on measurement interval; C19-4 inclusion of requirement to measure at 50m intervals on curves; Correction of errors in Figure 32; C23-3 – Addition of check of line of open switch; Form STW 1 - Minor change to clarify response requirement</td>
</tr>
<tr>
<td>4.1</td>
<td>December, 2008</td>
<td>Chapter 1 - Minor Correction to out-of-course inspections; Chapter 2 - Additional requirements for notification of staff not attending Track Recording runs; Additional defects in C5-8 Insulated joints; Addition of explanation of Manual Trackstab adjustments in C13-1.1; Inclusion of additional requirements in C16-1.1 for checking around insulated joint keys; C23-17.2.2 added measurement of splice rail opening for VAE Swing Nose crossings; Form Clear 2 - Minor addition for clarification; Form STW 1 - Minor change to clarify response requirement</td>
</tr>
<tr>
<td>4.2</td>
<td>May, 2009</td>
<td>Complete document – Format Change; Section C2-1.2 Addition of requirement to provide a “route plan” for each Mechanised Patrol; C7-3 – Change to Track Magnets Health Warning to reflect reduced danger to pacemakers; addition of inspection and response requirements from TMC 521 Level Crossings Manual; C7-5.2 - Addition of definitions of Critical Trackwork and Critical locations for Mechanised Track Patrol Detailed Review; C9-2 – Change to Track Magnets Health Warning C9-2 and C9-3 – addition of inspection and response requirements from TMC 521 Level Crossings Manual; C11-7 – Change to Track Magnets Health Warning; C12-5.1 – Added limit on distance between creep control marks; C12-6 – addition of anchoring on concrete structures; C20-4 and C20-5 – addition of inspection and response requirements from TMC 521 Level Crossings Manual; Section C23-10 - Change to Figure 55 to clarify slope of landing area</td>
</tr>
<tr>
<td>4.3</td>
<td>December, 2009</td>
<td>Various - Changes to titles; C2-1.1 - add CME responsibilities for nomination of sidings for examination; C5-1 – New section on Mandatory Limits and responses and guidelines; limits and responses categorised into mandatory and guidelines; New section C5-15 - Siding limits and responses; C7-3.1 (10) Additional information regarding switch defects from CTN 09/06; C11-1 – Addition of information from CTN 09/01; C20-4 - Added requirement to measure flare opening; Form LX 1 - Added measurement of guard rail flare</td>
</tr>
<tr>
<td>4.4</td>
<td>July, 2010</td>
<td>C1-4 – Additional references; C2-2.1 – Addition of requirements for AK Car Operator to report non-attendance by civil maintenance representatives and report Emergency defects to IOC; New heading C4-10.1 – “Measurement in crossings; new section C4-10.2 “Switch measurement”; C5-2 – clarification of application of limits to speed bands; C5-1 to C5-14 – Change XPT to passenger in speed headings; Sect C5-13.2 – correction of typo; changes to LXing limits to match TMC 521; C6-1.3.2, C6-1.4.2, C6-1.5.2 – Minor change to wording for clarity; C-7.2.1.2 – Added requirement to slow Hi-rail patrol over Level Crossings to conduct examination; C9-2 – Addition of reference to TMC 404, Addition of Boundary signs; C11-2 – Addition of Boundary signs; C12-5.3 - Addition of advisory maximum</td>
</tr>
<tr>
<td>Revision</td>
<td>Date of Approval</td>
<td>Summary of change</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>4.5</td>
<td>February, 2011</td>
<td>C4-1 – Additional detail on use of metallic objects - from CTN 10/13; C9-2.6 Inclusion of check for damage from rail bond welds; C11 - Inclusion of inspection of switch pad protectors in sidings turnouts (includes content from CTN 10/16); C12 - Correction of error in creep example page 5; C14 - Changes to reflect use of ultrasonic depth gauge to measure rail foot thickness; and change in measuring intervals; addition of requirement to complete NIL return if no defects are found; Form 2, Form WTSA 1, Form WTSA 2, Form WTSA 3, Form WTSA 4, Form Rail 1, Form Rail 2, Form Rail 3, Form Rail 4, Form Clear 1, Form Clear 2, Form LX 1, Form Drain 1 and Form STW 6 - Inclusion of examiner's name</td>
</tr>
<tr>
<td>4.6</td>
<td>August, 2011</td>
<td>C2-1.3 and C2-1.4 – addition of requirements for IOC to call out staff for emergency examinations; Competencies updated to current National competencies; C7-3.1 added check for untested aluminothermic welds (flouro pink marking); C14-1 – added reference to additional rail wear gauges. Inclusion of new rail wear angle gauge and procedures for use; C18-3 – New section on examination of resilient baseplates; C20-4 – added diagram explaining flangeway width and guardrail effectiveness measurement;</td>
</tr>
</tbody>
</table>
| 5.0      | June 2012       | C2-1.1 clarification in “For Clearance Examination” allowing the exemption for all clearances >KE+300mm not just track centres; C2-2.1 Addition of requirement for CME to manage assessment of areas where track recording car has flat lined and guidelines for assessment; C3 Removal of requirement for Check & Repair Track Geometry for Post Irregularity examinations, Certify plain track after track examination, Certify turnouts & special trackwork after track examination; C5-1 Changes to Mandatory Limits and Responses. Clarification of guideline actions.C5-2 Change to response table for inspection response to P3 defects.C5-3 Changes to “Response to Base Operating Conditions”. Note to allow 20/20 speed column to be used when assessing BOCS limits on 25kph turnout roads. C5-5.2 New rail wear limit table including some changes to limits and notes on actions. C5-10.2 New guidelines for insulator and pad wear on concrete sleepers. C5-11.2 Further Information for assessing ballast defects. Changes to guideline priorities for excess ballast.C5-12 Changes to Turnout Defect Limits and Responses for: Gauge through crossing, Checkrail flangeway width. C5-12.1.3 Clarification of where to take checkrail effectiveness and crossing gauge measurements. C5-12.2.2 Changes to limits and responses for: Gauge at switch tip, switch slope, switch tip height, switch component condition, checkrail bolts, housed points. C5-13 Changes to level crossing defect table. C5-15 Changes to Siding Limits and responses; C6-1 – Clarification of assessment & correction requirements for track geometry.6-1.2. Changes to correction of tight gauge. C6-1.3 Short twist. Changes to AK chord lengths and
<table>
<thead>
<tr>
<th>Revision</th>
<th>Date of Approval</th>
<th>Summary of change</th>
</tr>
</thead>
</table>
|          |                 | inspection requirements, C6-1.4 Long Twist. Changes to AK chord lengths and inspection requirements, C6-1.5 Top. Changes to AK chord lengths and inspection requirements, C6-1.7 Changes to AK chord lengths and inspection requirements; C11-10 changes to action to be taken section.; C11-9 Changes to siding maintenance limits. (table 8) some acceptance limits that are contained in TMC203 “Track Geometry Manual” and TMC251 “Turnout Manual” and were contradictory to the limits in those manuals have been removed and referenced to the appropriate manual; C11-10 Reference made to use 20 kph main line limits for defects not found in the siding BOC’s; C12-5.3 Updated to include reference to “revised alignment” on new WTSA forms; C12-7 Changed from “report worst ballast loss in 500mts section” to “report all ballast loss in 500mts section; Added extra information on reporting ballast, foul ballast and pumping track on new WTSA forms; Note inserted to highlight the need to record and report to CME severe bog holes where sleepers are not supported and ballast is not in contact with sleeper; C12-8 Updated misalignment triggers to include detail on how to record on new WTSA form. Removed the need to collect some information that is now not required during field inspection; C13-1 Changes to table 13 to comply with new WTSA software. Correction of Table 11 to remove 500m jointed which is not applicable; C13-6. Updated information on entering all ballast loss into analysis to comply with new WTSA software; C13-7. Updated disturbance information to allow the use of the lower % loss for time based or tonnage for both primary and secondary; Clarification in where to access disturbance records and information; Updated generally to reflect changes in the software replacing references to TrackStab. Table 13 changes to reflect changed capabilities in the new WTSA software; C16-2 Note added to clarify recording of Insulated joints that require supplementary patrol. Note added to refer Insulated joints with severe spark gap erosion to signals staff so bonding can be checked; C18-2 Instruction on what to examine in concrete sleeper inspection; C23-4 Updated to include instruction on where to measure checkrail effectiveness to ensure uniformity due to different crossing nose profiles. Removed the requirement to also measure gauge at the back legs of the crossing. Removed the requirement to measure flangeway depth and clearance at either end of the checkrail; C26 - Clarification of retention period for inspection records to separate from State Records requirements; Form 2 - Addition of how found and who found information; Form WTSA 2 - Added new WTSA field sheet; Form Rail 3 - Added priority column to form; Form STW 1 - Removed old tolerances for crossing measurement. Removal of “bolts torque applied”. Added question on type of crossing (manganese Y/N). Added question on switch type when using switch tip gauge. Requirement to record all twist defects.

5.1 July 2012 C5-12.2.2 correction of typo in table instances of “>5mm” should be “<5mm” relating to switch tip width.
<table>
<thead>
<tr>
<th>Revision</th>
<th>Date of Approval</th>
<th>Summary of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.2</td>
<td>August, 2012</td>
<td>C5-12.2.2 Correction of typo in table under Housed Points Flangeway Clearance (mm), “&gt;49” changed to “&gt;50” &amp; “&lt;39” changed to “≤ 39”</td>
</tr>
<tr>
<td>5.3</td>
<td>April, 2013</td>
<td>Changes detailed in summary table below</td>
</tr>
</tbody>
</table>

### Summary of changes from previous version

<table>
<thead>
<tr>
<th>Summary of change</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control changes</td>
<td>Document Control</td>
</tr>
<tr>
<td>Deleted individual forms from TOC</td>
<td></td>
</tr>
<tr>
<td>Reformatted to new template – Page numbering converted to continuous numbering. Separate document control on individual chapters removed</td>
<td>All</td>
</tr>
<tr>
<td>Addition of TOC Manual as a reference</td>
<td>C1-4</td>
</tr>
<tr>
<td>Changes to management requirements for clearance examination and review to reflect changes in responsibilities for clearance assessment. Inclusion of infringing speed signs and equipment attached to tunnel walls in locations to be listed by CME for clearance examination</td>
<td>C2-1.1</td>
</tr>
<tr>
<td>Change to operating limits for general condition of sleepers</td>
<td>C5-10.1</td>
</tr>
<tr>
<td>Change to operating limits for checkrail flangeway depth in crossings</td>
<td>C5-12.2.1</td>
</tr>
<tr>
<td>Item 14 – Inclusion of reference to TOC Manual as location of permant speed signs</td>
<td>C9-2</td>
</tr>
<tr>
<td>Minor change to clarify influence of reconditioning and ULX works on stability loss Clarification on the use of tonneage information for determining track stability loss due to track disturbance</td>
<td>C13-7</td>
</tr>
<tr>
<td>Rewrite to include TORFMA units and content of FM BCNT 20121126 Inspection procedures</td>
<td>C17</td>
</tr>
<tr>
<td>Complete chapter revision to reflect changes in responsibilities for clearance assessment and introduction of visual Inspection of platform clearances</td>
<td>C19</td>
</tr>
<tr>
<td>Added inspection of steel in-bearers</td>
<td>C23-6.1.3</td>
</tr>
<tr>
<td>Added Index to forms Form Clear 2 – changes to reflect changed examination requirements Form Rail 4 - Alterations to include TORFMA inspection Form Rail 5 – New form for lubrication inspection</td>
<td>Appendix 1</td>
</tr>
</tbody>
</table>
# Contents

## Chapter 1  General
- C1-1 Purpose ....................................................................................................................... 12
- C1-2 Context .......................................................................................................................... 12
- C1-3 How to read the manual ............................................................................................... 12
- C1-4 References .................................................................................................................... 13
- C1-5 Introduction ................................................................................................................... 13

## Chapter 2  Management Requirements
- C2-1 Track Examination ....................................................................................................... 15
- C2-2 Track Recording ............................................................................................................. 22
- C2-3 Recording and Reporting of Defect Detection and Removal ......................................... 23
- C2-4 Management & Reporting of Welded Track Stability Assessment ................................ 25
- C2-5 Management of Operating Limits and Responses ......................................................... 27
- C2-6 Management of District Waivers ................................................................................... 27

## Chapter 3  Competencies

## Chapter 4  Methods of Measurement
- C4-1 Use of Non Metallic Tapes ........................................................................................... 29
- C4-2 Gauge ............................................................................................................................ 29
- C4-3 Cross Level/Superelevation ............................................................................................ 30
- C4-4 Alignment ..................................................................................................................... 31
- C4-5 Line ................................................................................................................................ 31
- C4-6 Rail Level ....................................................................................................................... 33
- C4-7 Rail Top ......................................................................................................................... 33
- C4-8 Clearance to Structures ................................................................................................ 33
- C4-9 Track Centres ............................................................................................................... 34
- C4-10 Turnouts and Special Trackwork ................................................................................. 34
- C4-11 Measuring Rail Dimensions ....................................................................................... 36

## Chapter 5  Defect Limits and Responses
- C5-1 Mandatory Limits and Responses ............................................................................... 37
- C5-2 Standard Defect Categories and Responses ................................................................. 37
- C5-3 Response to Base Operating Conditions ..................................................................... 38
- C5-4 Track Geometry Defects ............................................................................................... 39
- C5-5 Rail Wear Defects ......................................................................................................... 40
- C5-6 Rail Surface Condition Defects ..................................................................................... 41
- C5-7 Rail Lubricator Defects .................................................................................................. 42
- C5-8 Rail Joint Defects .......................................................................................................... 42
- C5-9 Insulated Rail Joints Defects ......................................................................................... 43
- C5-10 Sleeper Condition Defects ......................................................................................... 45
- C5-11 Ballast Defects .......................................................................................................... 46
- C5-12 Turnouts and Special Trackwork Defects .................................................................. 49
- C5-13 Level Crossings Defects ............................................................................................. 56
- C5-14 Transit Space Defects ................................................................................................. 56
- C5-15 Siding Limits and Responses ....................................................................................... 58
<table>
<thead>
<tr>
<th>Chapter 6</th>
<th>Assessment of Base Operating Conditions</th>
<th>61</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6-1</td>
<td>Track Geometry</td>
<td>61</td>
</tr>
<tr>
<td>C6-2</td>
<td>Rail Wear</td>
<td>66</td>
</tr>
<tr>
<td>C6-3</td>
<td>Rail Condition</td>
<td>69</td>
</tr>
<tr>
<td>C6-4</td>
<td>Sleepers</td>
<td>69</td>
</tr>
<tr>
<td>C6-5</td>
<td>Ballast</td>
<td>70</td>
</tr>
<tr>
<td>C6-6</td>
<td>Turnouts</td>
<td>70</td>
</tr>
<tr>
<td>C6-7</td>
<td>Level Crossings</td>
<td>73</td>
</tr>
<tr>
<td>C6-8</td>
<td>Transit Space</td>
<td>73</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 7</th>
<th>Track Patrol</th>
<th>75</th>
</tr>
</thead>
<tbody>
<tr>
<td>C7-1</td>
<td>Patrol Methods</td>
<td>75</td>
</tr>
<tr>
<td>C7-2</td>
<td>Examination Requirements</td>
<td>75</td>
</tr>
<tr>
<td>C7-3</td>
<td>Walking and Hi-Rail Patrol Procedures</td>
<td>78</td>
</tr>
<tr>
<td>C7-4</td>
<td>Engine Patrol Procedures</td>
<td>85</td>
</tr>
<tr>
<td>C7-5</td>
<td>Mechanised Track Patrol Procedure</td>
<td>88</td>
</tr>
<tr>
<td>C7-6</td>
<td>Supplementary Patrol Procedure</td>
<td>90</td>
</tr>
<tr>
<td>C7-7</td>
<td>Adjacent Track Patrol Procedures</td>
<td>91</td>
</tr>
<tr>
<td>C7-8</td>
<td>Night Patrol Procedures</td>
<td>91</td>
</tr>
<tr>
<td>C7-9</td>
<td>Wet Weather Patrol</td>
<td>92</td>
</tr>
<tr>
<td>C7-10</td>
<td>Heat Patrol</td>
<td>93</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 8</th>
<th>Front of Train Examination</th>
<th>94</th>
</tr>
</thead>
<tbody>
<tr>
<td>C8-1</td>
<td>Examination Requirements</td>
<td>94</td>
</tr>
<tr>
<td>C8-2</td>
<td>Examination Procedure</td>
<td>94</td>
</tr>
<tr>
<td>C8-3</td>
<td>Action to be Taken</td>
<td>94</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 9</th>
<th>Detailed Walking Examination</th>
<th>95</th>
</tr>
</thead>
<tbody>
<tr>
<td>C9-1</td>
<td>Examination Requirements</td>
<td>95</td>
</tr>
<tr>
<td>C9-2</td>
<td>Examination Procedure</td>
<td>95</td>
</tr>
<tr>
<td>C9-3</td>
<td>Action to be Taken</td>
<td>101</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 10</th>
<th>Post Irregularity Examination</th>
<th>103</th>
</tr>
</thead>
<tbody>
<tr>
<td>C10-1</td>
<td>Examination Procedure</td>
<td>103</td>
</tr>
<tr>
<td>C10-2</td>
<td>Action to be Taken</td>
<td>103</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 11</th>
<th>Siding Inspection</th>
<th>104</th>
</tr>
</thead>
<tbody>
<tr>
<td>C11-1</td>
<td>Track Patrol in Sidings</td>
<td>104</td>
</tr>
<tr>
<td>C11-2</td>
<td>Detailed Walking Examination of Plain Track in Sidings</td>
<td>104</td>
</tr>
<tr>
<td>C11-3</td>
<td>Inspection of Turnouts in Sidings</td>
<td>105</td>
</tr>
<tr>
<td>C11-4</td>
<td>Inspection of Clearances in Sidings</td>
<td>105</td>
</tr>
<tr>
<td>C11-5</td>
<td>Inspection of Sleepers in Sidings</td>
<td>105</td>
</tr>
<tr>
<td>C11-6</td>
<td>Inspection of Drainage in Sidings</td>
<td>105</td>
</tr>
<tr>
<td>C11-7</td>
<td>Inspection of Track Magnets</td>
<td>105</td>
</tr>
<tr>
<td>C11-8</td>
<td>Yard and Siding Categories</td>
<td>106</td>
</tr>
<tr>
<td>C11-9</td>
<td>Siding Maintenance Requirements</td>
<td>106</td>
</tr>
<tr>
<td>C11-10</td>
<td>Action to be Taken</td>
<td>107</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 12</th>
<th>Track Stability Measurement</th>
<th>108</th>
</tr>
</thead>
<tbody>
<tr>
<td>C12-1</td>
<td>Special Infrastructure Situations</td>
<td>108</td>
</tr>
<tr>
<td>C12-2</td>
<td>Preparation for Measurement</td>
<td>108</td>
</tr>
</tbody>
</table>
Chapter 18  Sleeper Inspection ..............................................................170
C18-1  Timber Sleeper Inspection ..........................................................170
C18-2  Concrete Sleeper Inspection ......................................................171
C18-3  Resilient Baseplate Inspection ..................................................171
C18-4  Definition of Condition ..............................................................174
C18-5  Action to be Taken .................................................................175

Chapter 19  Clearance Examination .....................................................176
C19-1  Inspection Procedure .................................................................176
C19-2  Detailed Inspection of Clearance to Platforms .......................176
C19-3  Civil Maintenance Engineer and Team Manager review ............180
C19-4  Mid Cycle Visual Inspection of Clearance to Platforms ...........180
C19-5  Inspection of Clearance to Structures .......................................180
C19-6  Inspection of Track Centres ......................................................180
C19-7  Inspection of Track Centres at Clearance Points ....................183
C19-8  Inspection of Rail Level ............................................................185
C19-9  Action to be Taken .................................................................185

Chapter 20  Level Crossing Examination ..............................................186
C20-1  Examination Requirements ......................................................186
C20-2  Crossing Types .........................................................................186
C20-3  Equipment ..............................................................................186
C20-4  Examination Procedure ...........................................................186
C20-5  Action to be Taken .................................................................188

Chapter 21  Special Track Inspection Issues .........................................189
C21-1  Hot Weather Inspection Issues ..................................................189

Chapter 22  Track Recording .................................................................191
C22-1  Field Duties Prior to Track Recording .......................................191
C22-2  Action required During Recordings .........................................191
C22-3  Distribution of Recording Graphs ...........................................191
C22-4  Defect Examination & Repair ..................................................192
C22-5  Missing Inspections .................................................................192
C22-6  Track Recording Analysis ........................................................192

Chapter 23  Turnout & Special Trackwork Examination ......................193
C23-1  Examination Requirements ......................................................193
C23-2  Equipment ..............................................................................193
C23-3  Switch Examination .................................................................193
C23-4  Crossing and Checkrail Examination ......................................199
C23-5  Gauge & Superelevation ...........................................................201
C23-6  Bearer Condition .................................................................202
C23-7  General Condition .................................................................204
C23-8  For Supplementary Patrol .......................................................204
C23-9  Action to be Taken .................................................................205
C23-10 Catchpoints Examination .......................................................205
C23-11 Housed Points Examination ..................................................206
C23-12 Switch Examination Olympic Park .......................................209
C23-13 Expansion Switch Examination ...........................................210
C23-14  Switch Lever Examination ........................................................................................................ 213
C23-15  Diamond Examination .................................................................................................................. 214
C23-16  Single and Double Slip Examination .......................................................................................... 216
C23-17  Swingnose Crossing Inspections ................................................................................................. 217
C23-18  Special Tangential Turnout Examination Requirements .......................................................... 223

**Chapter 24  Drainage Examination** ........................................................................................................ 225
C24-1    Examination Requirements ........................................................................................................ 225
C24-2    Examination Procedure ............................................................................................................... 225
C24-3    Action to be Taken ........................................................................................................................ 226
C24-4    Assessment of Condition ............................................................................................................ 226

**Chapter 25  Track Inspections by CME and Team Manager** ................................................................. 228

**Chapter 26  Records** .............................................................................................................................. 229

**Appendix 1  Examination forms** ............................................................................................................ 230

**Form Index** ........................................................................................................................................... 230
Chapter 1 General

C1-1 Purpose
This manual provides requirements, processes and guidelines for the inspection of track and for the response to track defects. It includes all inspections undertaken during track examination, track recording and special inspections.

C1-2 Context
This manual is part of RailCorp's engineering standards and procedures publications. More specifically, it is part of the Civil Engineering suite that comprises standards, installation and maintenance manuals and specifications.

To assure the on-going safety of the track and to effectively manage the repair of condition and replacement of components, RailCorp carries out a schedule of inspections.

The schedule of inspections and their frequencies are detailed in RailCorp engineering standard ESC 100 - Civil Technical Maintenance Plan. Each inspection in the Civil Technical Maintenance Plan references a Service Schedule.

Track Service Schedules which provide a summary of the elements of the inspection, are contained in TMC 101 - Track and Right of Way Service Schedules. Each Service Schedule references a Manual.

This manual contains requirements, process and guidelines for the management of track assets and for carrying out examination activities. It also provides operating limits against which the condition of track is measured, and mandatory actions required when limits are reached.

The manual is written for the persons undertaking installation and maintenance activities.

It also contains management requirements for Civil Maintenance Engineers and Team Managers needing to know what they are required to do to manage track inspection activities on their area.

C1-3 How to read the manual
The best way to find information in the manual is to look at the Table of Contents starting on page 7. Ask yourself what job you are doing? The Table of Contents is written to reflect work activities.

When you read the information, you will not need to refer to RailCorp Engineering standards. Any requirements from standards have been included in the sections of the manual and shown like this:

<table>
<thead>
<tr>
<th>Extract from RailCorp Standard ESC 220.</th>
</tr>
</thead>
<tbody>
<tr>
<td>− Rails longer than 220m</td>
</tr>
<tr>
<td>− Rails longer than 27.4m with resilient fastenings more than 1 in 3 (unless the rails have been correctly adjusted in accordance with requirements for CWR)</td>
</tr>
</tbody>
</table>

Reference is however made to other Manuals.
C1-4 References

C1-4.1 Australian and International Standards
Nil

C1-4.2 RailCorp Documents

ESC 100 – Civil Technical Maintenance Plan
ESC 220 – Rail and Rail Joints
TMC 001 – Civil Technical Competencies and Engineering Authority
TMC 101 – Track and Right of Way Service Schedules
TMC 211 – Track Geometry and Stability
TMC 215 – Transit Space – (Not Yet Published)
TMC 221 – Rail Installation & Repair
TMC 223 – Rail Adjustment
TMC 224 – Rail Defects & Testing
TMC 225 – Rail Grinding
TMC 226 – Rail Defects Handbook
TMC 231 – Sleepers & Fastenings
TMC 404 – Recognising Geotechnical Problems
TMC 521 – Level Crossing Manual
SPC 201 – Measurement Gauges
OS 001 IM – Train Operating Conditions (TOC) Manual

C1-5 Introduction

To assure the on-going safety of the track and to effectively manage the repair of condition and replacement of components, RailCorp carries out a schedule of inspections. Each inspection targets identified aspects of track and is carried out at a frequency that has been established through analysis and experience to identify signs of the track wearing out or varying from design. These inspections allow RailCorp staff to program repairs whilst the track is still safe for normal operation.

The inspections include:

Track Patrol

A visual inspection of the track either by Walking, Hi-rail vehicle at slow speed, Engine Patrol or Mechanised Track Patrol vehicle.

The patrollers look for signs that the track is deteriorating, particularly where immediate action is required to maintain track safety. This involves looking for obstructions, track geometry defects, broken rails, signs of earthworks or drainage failure and the visibility and security of track signage. Detailed inspection is undertaken during the patrol when visual signs are identified.

Patrol staff will take action to protect the track (stop or slow down trains) if bad defects are found.
Detailed Walking Examination
A walking inspection of track is conducted to view the track behaviour in detail. This inspection provides information on the condition of all aspects of the track and its components.

Engine Inspection
An inspection is conducted from the cab of a train to assess the effect of track condition on the ride comfort of trains. Some types of track geometry variations are best found by this inspection. The inspection is also an opportunity for track staff to find out from train crew areas that drivers consider need attention.

Detailed Examinations
Specific elements of track are examined, measured and recorded at scheduled intervals. The elements include turnouts, insulated rail joints, rails, lubrication, level crossings, drainage and clearance to structures beside and above the track.

The examinations form an important part of the process of measuring condition, assessing performance and determining how quickly the different parts of the track are wearing out. The extent and timing of repair and replacement is determined from the information recorded.

Track Geometry Recording Car
The rail mounted recording car (commonly known as the AK car) operate on RailCorp lines at scheduled intervals. They record the condition of the track geometry, compare it to established standards and provide real time information to track staff of locations where maintenance work is required to correct variations in rail level, alignment and gauge. The recording software also applies statistical techniques to assess the overall condition in comparison to standards and other locations on the RailCorp network.

Misalignment Prevention
When rail track heats up in extreme Summer temperatures it will misalign (also known as a buckle) if it is not properly controlled. Track in NSW is designed to resist buckling at high temperatures by maintaining the right amount of rail in track, stopping the rail from moving and bunching up and providing resistance to the sideways movement that occurs when track buckles. To provide assurance that the design conditions are maintained during the summer period track stability examination, analysis and correction is conducted between August and October each year.

This involves inspection of rail adjustment, ballast profile and condition, fastening condition and areas of potential concern, analysis of contribution of these factors to the overall stability and programmed, prioritised improvement at identified locations.

Heat Patrol
During the hotter months of the year, when temperatures reach 38°C, staff conduct patrols of the track to detect early signs of instability leading to misalignments. These patrols are normally conducted by hi-rail or the front of a train so that track can be inspected in a short period of time in the hottest part of the day.

Out of Course Inspections
In addition to the programmed inspections mentioned above, RailCorp staff conduct special inspections of track in periods of extreme rainfall and flooding, bushfires and at locations where track conditions warrant more frequent monitoring, to provide assurance of the on-going safety of the infrastructure.
Chapter 2  Management Requirements

RailCorp has in place a Defect Management System for the track defects. The system includes periodic and 'on-event' examination of track for geometry and condition, recording of defects, limits and mandatory responses to the occurrence of defects and management of their removal.

Management requirements for the Defect Management System are detailed below

C2-1  Track Examination

C2-1.1  Civil Maintenance Engineer

Civil Maintenance Engineers must establish systems to ensure:

1. Cyclic examinations are undertaken at the minimum frequencies established in ESC 100 – Civil Technical Maintenance Plan.
   These are the minimum frequencies. At locations where obvious deterioration occurs at higher rates due to such factors as curvature, usage, axle load or speed, more frequent inspections should be scheduled. These additional inspections may be reduced in scope to address only those parts of the inspection affected by the additional factors.

2. 'On event' examinations are undertaken when the initiating event occurs.

3. Any increase in the frequency of any examinations required to suit local conditions is established and recorded.

4. Monitor the effectiveness of the patrol regime.

5. Take action to require additional patrols where circumstances require.

6. The frequency and details of any special examination required in addition to those specified is established and recorded.

7. A Length Examination Schedule detailing the mode, frequency and timing of all planned examinations, is established and recorded.

8. The position responsible for the examination of each length is nominated.

9. Staff undertaking examination tasks have the required competencies.

10. Where persons carry out any part of the track examination system but have not achieved all the required competencies ensure that such persons are competent to perform the particular examinations required.

11. Team Managers are fully meeting their responsibilities in relation to the Track Examination System.

12. Necessary reports to the Senior Management are correctly supplied.

For Integrated Track Patrol

To implement "Integrated Track Patrol" for plain track, turnouts and special trackwork in their district, the Civil Maintenance Engineer must:

1. Assess plain track, turnouts and special trackwork in accordance with the applicability requirements documented in ESC 100 – Civil Technical Maintenance Plan. Document nonconforming locations where applicability requirements are not met.

2. Review nonconforming locations to include those that can be managed by implementing Supplementary Patrols as prescribed under the "Integrated Track Patrol Regime" in ESC 100.
3. Where geotechnical examination at a specific location is assigned to track patrol, arrange for the geotechnical condition to be reviewed by the Principal Geotechnical Engineer to determine whether the condition can be managed by this new regime and, if required, develop and implement additional examination of the geotechnical risk location.

4. Identify and assess the risk at locations in the clearance register or with potential to breach Base Operating Clearance Standards. Develop and implement a management plan where required.

5. Establish methods to manage any lockspike degradation or failure. (Indicators may be lockspike throat wear, sleeper plate movement, gauge widening, usually in sharp curves, wet areas or tunnels).

6. Manage any other tasks that are not requirements of the track patrol service schedules, but are packaged with track patrol for convenience.

To implement "Integrated Track Patrol" for plain track, turnouts and special trackwork on Ancillary lines in their district, the Civil Maintenance Engineer must:

1. In consultation with the Maintenance Team Manager, list all ancillary lines and determine whether the ancillary line meets applicability requirements documented in ESC 100 – Civil Technical Maintenance Plan.

2. Consider each ancillary line individually.

3. If in doubt, physically examine.

4. Consider defect history from TES examinations and AK car examination.

5. Assess potential for rapid deterioration or failure.

**Note:** Special emphasis should be focussed on managing the risks of spread road, track geometry defects, broken plates and bolts that have the potential to cause derailment.

On the basis of the assessment above the Civil Maintenance Engineer may implement the "Integrated Track Patrol" regime on applicable lengths, inclusive of additional examinations to manage nonconforming locations.

The Civil Maintenance Engineer must:

1. Program the appropriate combination of Walking Patrol, Hirail Patrol, Mechanised Track Patrol, Engine Patrol and Supplementary Patrol, to comply with the requirements of ESC 100 – Civil Technical Maintenance Plan, TMC 101 – Track Service Schedules and other requirements of this Manual.

2. Keep a local record of the program that demonstrates that the programmed tasks meet these requirements.

**For Mechanised Track Patrol**

1. Ensure rail view cameras are used to assess rail continuity where MTP track and easement imagery cannot be captured due to low light conditions.

2. Where MTP is being considered, assess the lighting in each dive and tunnel structure jointly with the Manager Track Recording. Where both MTP imagery and Engine Patrol is ineffective, additional walking patrols must be conducted. The district should consider whether it is cost effective to provide suitable lighting at these specific locations.

**For Integrated Walking Patrol**

Where the requirements for the implementation of "Integrated Track Patrol" have been met, Integrated Walking may be introduced for plain track, turnouts and special trackwork in the following circumstances:

1. The Mechanised Track Patrol vehicle is available to meet the inspection schedule.
2. Walking Patrols are conducted on each track separately

In addition the Civil Maintenance Engineer must:

1. Carry out a review of tasks and time required for the 90 day walk and allocate appropriate time to conduct the examination.

2. Since track is inspected less frequently, assess current repair strategies and adjust where required to ensure defects are managed appropriately. The practice of frequently inspecting defects (and not removing them) may need to change for some types of defects. For example, replace loose chair studs and checkrail bolts when found to avoid accumulation of loose studs and loss in redundancy.

3. Emphasise with patrol staff the following changed requirements:
   ~ For single rail traction return sections and sections without track circuits, patrol staff to be extra vigilant on detecting a bang or similar indication of a discontinuity from EP (on engine and MTP vehicle), particularly looking for unexpected discontinuities. These should be followed up with inspection of the location by foot.
   ~ look for indications of lock spike failure and worn rail plate holes.
   ~ when Ancillary Lines are patrolled, check mainline turnouts connected to the Ancillary Line for loose or broken chairs and bearer fasteners.

4. Arrange for alternate examination methods for discrete locations as follows:
   ~ At locations such as level crossings, guard rails, glued insulated joints and turnouts alternate signals circuit paths may result in doubtful detection of rail breaks by track circuits. At these discrete locations it is practical to compensate by MTP rail view camera imagery review.
   ~ If MTP identifies a potential problem with ballast covering fastenings, arrange a follow up walking inspection to determine an appropriate response.
   ~ For specific locations where there is potential for track movement near structures or where narrowing of centres may occur, develop and manage appropriate control measures. One possible method includes the use of centreline marking and follow up examination to monitor for movement. In combination with track stability examinations and track clearance inspections this would provide sufficient control.

Where Variations to Patrol Methods Have Been Approved:

1. For Night Patrols, provide patrol staff a schedule of any known hazard locations outside the immediate area of the track surrounds so they can direct special attention to those locations.

2. Civil Maintenance Engineers may approve the use of Engine Patrols to replace a single standard patrol opportunity lost due to strike/loss of possession, subject to the following additional requirements:
   ~ Individual patrol requirements must be reviewed by the Civil Maintenance Engineer for the patrol area.
   ~ The Civil Maintenance Engineer must keep a written record of the use of engine patrols including, date, locations patrolled by engine, last normal patrol date, and special inspections or patrol methods used.
   ~ The Civil Maintenance Engineer must forward written advice of these details to the Chief Engineer Track within 24 hrs.

For Siding Examination

1. Ensure all RailCorp sidings are nominated for examination

2. Ensure the RailCorp portion of private sidings are nominated for examination
For Rail Wear and Condition
1. Ensure arrangements are in place to conduct visual examination of all vertical split head rail defects in daylight, if the defect has been found at night and full requirements for inspection cannot be carried out.

For Examination of Similar Flexure Turnouts
1. Determine that default TMP examination of 6 months may be varied based on the actual wear experienced on the high rail stockrail. (See Section C23-1.)

For Sleeper Condition
1. Ensure that locations where Pandrol ties have been used at less than 1 in 2 on backcanted dogsplaked track are assessed. If any problems are being experienced with clips breaking corrective action must be taken.

For Clearance Examination
1. Provide examination staff with:
   
   For Platform and structure clearance
   - A list of structures known to be within a lateral clearance of 2500mm of the track centre line. On curves of ≤ 800m radius, the limit for recording is to be increased to 3000mm to allow for the vehicle displacement and the effect of superelevation.
   - The design clearance for each of those structures in the form of:
     - A form “Clear 1” that contains the location of each measurement point and the design horizontal, vertical clearance and superelevation at each, at maximum intervals of 10 metres.
     - If the structure has no survey information then the form will list the horizontal and vertical clearance at both ends of the structure and at 10m intervals.
   - If the information is not yet available in this form then provide the design clearance for each of those structures. In the form of:
     - The kilometrage of the Sydney and country ends of each structure.
     - The clearance to the gauge face of the nearest rail at both ends of the structure and at 10m intervals.
     - The designed superelevation at each clearance measurement point and whether the structure is convex or concave.

   For track centre examination.
   - The design track centres for each measurement location in the form of:
     - A form “Clear 2” which has details of each measurement location and design track centres and superelevation for each length.
     Locations must be at the nearest survey mark to the tangent points on straights. If the straight is more than 250m long, take intermediate locations at not more than 250m intervals. On curves the locations must be at maximum intervals of 50m.
   - If the information is not yet available in this form then provide the design track centres and superelevations for each length:

   At approved clearance infringement locations
   - Written advice detailing the required clearances, examination frequency, special actions, etc. at locations where there is an approved infringement of the structure gauge. This includes:
     - Locations where permanent speed signs have been located closer to the track than Kinematic Envelope +200.
     - Locations in tunnels where cables and supporting equipment have been
installed closer to the track than Kinematic Envelope +200.

At restricted vertical clearance locations

~ Locations of special survey plaques at structures with restricted clearances together with the necessary instructions, detailing restrictions on track lifts and additional monitoring.

For non electrified lines

~ A list of structures on non-electrified lines, where the vertical clearance is less than 5000mm (5250mm for curved track) within 2135mm of either side of the track centre line.

For Clearance points

~ Details of designed lateral clearances at clearance points.
~ A list of locations where clearance examination is not necessary. This occurs where the design clearance for the appropriate rolling stock on the particular line exceed the minimum track design clearance by 300mm or more.

Note Civil maintenance Engineers may determine that clearance examination is not necessary in certain locations. This occurs where the design clearance for the appropriate rolling stock on the particular line exceed the minimum track design clearance by 300mm or more.

2. Review Clearance Examination.

~ Review all Platform, Structure and Track Centre clearance examination sheets for clearances outside of tolerance detailed in Chapter 19.
~ Confer with the Team Manager for the area and plan for the rectification of locations that fall outside of tolerance or ensure other controls are in place.
~ Ensure areas outside of tolerance and agreed actions and or controls are recorded into a defect management system.

For Track Stability

1. Determine locations, in addition to curves and tangent points, where alignment measurement is required.
2. Be satisfied that welded track is maintained for maximum stability during the summer period.
3. Ensure that Team Leaders undertake Heat Patrols when required.
4. Be satisfied that air temperatures are being monitored and WOLO requirements have been implemented when warranted.

For Level Crossing Examination

2. Arrange for permanent marks to be painted on rails at the S_2 and S_3 sighting points assessed in (1) above.
3. Arrange for marking of the location on the road approach of the S_1 sighting point.

C2-1.2 Team Managers

1. Team Managers are accountable for the satisfactory completion of track examinations in their area. This includes:
   ~ Ensuring the satisfactory completion of the mandatory examinations and any additional track examinations required.
   ~ Ensuring that persons carrying out examinations (or parts of examinations) are competent to do so.
~ Spot checking of track conditions and comparison with examination records for accuracy of measurement, recording and assessment of action taken in response to the information observed and recorded.
~ Undertaking pre-summer inspections of their area (See Chapter 21).
~ Ensuring the Team Leader obtains the necessary reports in relation to the following activities which may affect the performance of the track:
  - examinations of the Length by Track Recording Cars,
  - examination of Bridges, and
  - other necessary reports related to the Length.
~ Providing assistance to Track Examination staff where required.
~ Referring matters beyond the resources of the area to the Civil Maintenance Engineer.
~ Providing track examination staff with the technical information and tools required for the various examinations.
~ Ensuring the work or protection identified to maintain a safe track is satisfactorily implemented.

2. Where Integrated Track Patrol is implemented on a length, Team Managers must:
~ Provide a “route plan” for each Mechanised Patrol which shows the critical trackwork\(^1\) and any critical locations\(^2\) to be examined. The plan should be adjusted to include any critical outstanding defects and any additional critical locations found during earlier patrols or during engine patrols.
~ Manage the nomination of locations that require Supplementary Patrol.
  Check Examination forms from Detailed Walking, Timber Sleeper Inspection, Inspection of Insulated Joints and Turnout Examination for locations nominated for Supplementary Patrol.
  Check with Rail Flaw Detection Operators and receive Weekly Defect Summary Reports for heeled switches with strong crack predictors nominated for Supplementary Patrol.
~ Enter locations and details of components, defects or conditions requiring Supplementary Patrol into Teams3.

**Teams3 entry**

*In the Proposed Action drop down box select Supplementary Patrol. (In addition to the normal method of recording the defect)*

*On Patrol when additional examinations are required, generate a list by filtering the Supplementary Patrol action in the Proposed Action column. Use the function print filtered defects then choose track inspection report to produce a list of all conditions requiring supplementary examination.*

1. Critical trackwork
   - Turnouts, diamonds, junctions, catchpoints, expansion switches, GIJs or mechanical joints and any other special track features. Note that GIJs in concrete sleepered track that are well supported and not subject to high impacts such as from end batter may be exempted from the critical trackwork category.

2. Critical locations
   - Any locations where there are known or suspected track condition problems such as poor tie condition, outstanding geometry defects, pumping bridge ends and any locations found on engine patrols that require more detailed checking.
3. The Team Manager is to check the following:
   ~ A minimum of 5% of each Team Leader’s inspection sheets per month.
   ~ The actual progress of each Team Leader in line with the schedule each month.
   ~ A minimum of 5% of all jobs carried out by either the Team Leader or the maintenance team.

4. Team Managers are to record the details of checks and inspections made in a note book or diary which must be kept up to date and available for personal reference and examination by the Civil Maintenance Engineer.

5. Team Managers are to ensure that track conditions affecting equipment at interlocked points as detected and notified by signalling staff on Form 2 Weekly Defect Summary Report are entered in Teams3 and dealt with in the same way as any track defect. Team Managers may review priorities in line with other track defects.

   Signalling staff are required to record sufficient information on the form so that track staff can accurately locate the site and assess the priority of the defect. The "ACTION TAKEN, PROPOSED OR REQUESTED" column is used by signalling staff to explain the problem and includes a target date for repair.

C2-1.3 Team Leader

The Team Leader is responsible for:

1. The completion of track examinations in accordance with the schedule.
2. Personally carrying out the required examinations or delegating (where necessary) examinations to competent staff.
3. Fully explaining to staff delegated to carry out track examinations their duties and responsibilities and ensuring these examinations are satisfactorily completed.
4. Reporting to the Team Manager all matters beyond the resources of Team Leader and any other reports required.
5. Taking action in response to faults identified during track examinations which could include immediate action to stop or slow down trains to maintain a safe track.
6. Arranging additional track examinations whenever there is any reason to suspect that the safety of the Length may be affected.

   This circumstance will arise during periods of extremely hot weather, extremely cold weather, severe storms, prolonged wet weather, snow, flood or fire or any other reasonable reason.

   Additional examinations may also be required as a result of "call outs" based on reports from train drivers or the public.

   Whilst notification of such events will, normally, be provided by the Infrastructure Operations Centre, Team Leaders should use their own initiative to contact the IOC to establish whether an examination is required.

7. Maintaining up to date records of all examinations on the appropriate forms.

C2-1.4 Infrastructure Operations Centre

Track staff may need to undertake out-of-course examinations of track infrastructure. These may be required during periods of extremely hot weather, extremely cold weather, severe storms, prolonged wet weather, snow, flood or fire or any other reasonable reason, or they may be considered necessary as a result of reports from train drivers or the public.

In circumstances where emergency examinations of track are required, IOC staff will take appropriate action to contact staff in the affected locations and arrange for the inspections to be undertaken.
C2-2  Track Recording

C2-2.1  Summary of Responsibilities

Manager Track Recording

1. The Manager Track Recording is responsible for:
   ∼ Programming and operation of the Track Recording Car.
   ∼ Completeness and accuracy of recording.
   ∼ Provision of a printed Emergency Defect list.

Civil Maintenance Engineer

1. Civil Maintenance Engineers must ensure that a system is in place to:
   ∼ Monitor the frequency of track recording on all tracks on their area.
   ∼ Check that all kilometre posts are correctly located and visible to car crews prior to recording runs.
   ∼ Take action to address late or non testing.
   ∼ Manage attendance of field staff on recording runs.
   ∼ Provide clear instructions concerning the distribution of the defect list and graphs at the end of the run when Team Managers are rostered on other than their own Length.
   ∼ Manage the removal of defects.
   ∼ Manage the assessment of track condition.
   ∼ Manage the recording and reporting of defect control and track condition.
   ∼ Maintain track safety whilst defects remain in track.

2. Determine the method and arrange inspection of track geometry for crossing loops and other areas (including flat line locations) that have been missed in the Track Recording run. Track that has not been recorded can be assessed by a combination of methods. The methods used will be determined by the track configuration (plain track or turnout etc), general track condition, sleeper type and the frequency of missed previous runs. Options include:
   ∼ Evaluate the ride of a train over the section.
   ∼ Detailed walking examination of the missed section.
   ∼ Review all uncorrected defects from previous run.
   ∼ Review previous graphs for defect growth patterns.
   ∼ Manual measurement of potential defects.
   ∼ Use of a track measurement trolley.
   ∼ Using MTP recording if available to determine and evaluate top and twist defects.

3. Provide clear instructions concerning the distribution of the defect list and graphs at the end of the run when Team Managers are rostered

4. Give high priority to their attendance on Track Recording runs. Whilst it may be difficult, it is to be expected that Civil Maintenance Engineers should ride over all track of consequence at least annually or conduct a detailed review of recording graphs.

5. Maintain a record of track with condition indices exceeding the limits in (3) below, assessment of the locations and planned remedial actions.
Team Manager

1. The Team Manager is responsible for:
   ~ Attending recording runs (when required).
   ~ Inspection and removal of defects.
   ~ Recording and reporting of defect removal.
   ~ Monitoring and ensuring the safety of outstanding defects.

2. Team Managers must accompany all track recording runs. It is acceptable to roster Team Managers to cover multiple track lengths, but each Team Manager should ride over all his/her track at least annually.
   If Team Managers are rostered to attend a track recording run, but are unable to attend for whatever reason, they must contact the Infrastructure Operations Centre (IOC) as soon as possible, so that alternative arrangements can be made.

3. Assess any significant track sections (over 50m) including turnout areas, but excluding turnouts, reported with condition indices exceeding:
   ~ Track surface > 45
   ~ TCI >70

4. Plan rectification work needed to raise the section to the required standards. Priority will depend on track speed.

5. Forward details of the work required and a proposed plan of rectification to the Civil Maintenance Engineer within four weeks of the run.

Team Leaders

1. Team Leaders should accompany the car of their track Length when possible. Since they will normally be “on the ground” during recording runs to assess any defects found, this may not always be possible.

RailCorp AK Car Operator

If at any time during the recording run no civil maintenance representative is in attendance the AK Operator must contact IOC to arrange for alternative staff. In the event of an Emergency defect and no civil staff are present, the AK operator must recontact IOC and advise of the defect detected. IOC must then contact the appropriate civil representative to determine the correct action.

Infrastructure Operations Centre

If no one is accompanying the car the Infrastructure Operations Centre operator will:

1. Make arrangements for an alternative RailCorp employee to attend the track recording run
2. Make an IFMS incident report.
3. If an emergency defect is detected by the track recording vehicle, the IOC will immediately investigate the defect. The IOC in discussion with the track staff will determine what action is necessary based on the size of the defect and any facts the AK Car staff can shed such as ride quality experience by them at the time the defect was detected.

C2-3 Recording and Reporting of Defect Detection and Removal

All track defects that are detected MUST be recorded in an identifiable Defect Management System. Multiple systems are not precluded.

An auditable trail must exist for all actionable defects from detection/notification to investigation, assessment, repair programming, repair action and certification.
The ‘System’ must include, as a minimum, the following details:

- Defect
- Type
- Size
- Location (line, track and kilometres)
- Date found
- Source of information
- Action required (includes investigation, assessment, repair)
- Programmed action date (includes investigation, assessment, repair)
- Repair action
- Repair date
- Repair agency
- Review of performance

Civil Maintenance Engineers must:

1. Ensure that the Defect Management System is satisfactorily managed by the Team Manager.
2. Monitor the level of track defects, assess the impact on track performance and take appropriate action.
3. Review records and defects for trend identification at least annually. The outcomes must be considered in the development of district maintenance strategies and Asset Management Plans.

At any time the Civil Maintenance Engineer must be able to demonstrate, through the Defect Management System, current status of all defects recordable on the system.

C2-3.1 Use of Electronic Systems

Electronic systems may be used to record and manage defects.

RailCorp's Teams3 recording system is approved for use.

Where electronic systems are used the requirement within this manual for reports to be signed does not apply as long as there is certification that examinations have been carried out in accordance with the requirements of the manual and the defect has been entered into a Defect Management System. Similarly, reports in the formats detailed in the manual do not need to be reproduced as long as the information required in the report is contained within the electronic system.

C2-3.2 Source of Information

Defect Management Systems will contain defects from the following formal examination and reporting systems:

- Track Examination System
- Track Patrol
- Other Examinations (actionable defects)
- Welded Track Stability Priority 1
- Rail Flaw Detection System
- Track Geometry Recording Car Examination
- Reports from train drivers
− Field Inspections by Supervising Officers
− All track defects affecting signalling reliability at interlocked points as found by
  signalling staff (eg rail movement affecting points detection, A & B timber problems
  etc).

**C2-4 Management & Reporting of Welded Track Stability Assessment**

**Civil Maintenance Engineer**

Each Civil Maintenance Engineer must:

1. Establish programs to measure welded track stability prior to the summer season,
   and, where it has been identified that curve pull-ins are a problem, prior to winter
   works programs.

2. Ensure that all staff involved in measurement have appropriate tools - thermometers,
   gap gauges, alignment survey data etc. and that all tools are checked and
   calibrated.

3. Ensure that all staff involved in measurement are aware of requirements for
   consistency in measuring and recording and have copies of measurement
   procedures.

4. Establish programs to analyse welded track stability prior to the summer season,
   including:
   − Analysis software tested and/or readied for use
   − Technical staff appropriately schooled in use of the software, data entry and
     checking of information

5. Establish a recording system to monitor progress of measurement, analysis and
   removal of Priority 1 stability locations.

6. Monitor the recording system regularly to verify accuracy.

7. Ensure analysis is completed and additional analysis of bunching points is carried
   out.

8. Determine locations where analysis and assessment of lengths <500m is to be used.
   It is appropriate to assess anomalous sections ie where there is a section that has
   an adjustment that is uncharacteristic of the average result for the normal 500m
   section.

9. Have systems in place to ensure that any area where adjustment control has been
   found to be lost is classified as non-standard track.

10. Have systems in place to ensure that non-standard track is dealt with as a Priority 1
    stability defect. Where track which is non-standard due to loss of adjustment control,
    has other stability problems such as ballast deficiency, poor ballast condition or
    recent disturbance then the repair/protection requirement MUST be treated with
    additional urgency.

11. Ensure that any errors in welding during the year are considered in the track stability
    analysis process.

12. Arrange detailed Secondary analysis of all Priority 1 locations to determine
    appropriate corrective action.

13. Arrange check of track alignment on sharp curves that:
    − Have a history of winter pull-in (check in mid to late November)
    − Have been disturbed by resleepering/ resurfacing etc (check in mid to late
      November or one week after the activity whichever is the later)
    − Appear to have pulled in from visual inspection on track patrol (check when
      observed).

WTSA inspections are normally carried out in July – September each year. Curves
may pull in after initial measurements are taken. Curves may also pull in after track resurfacing, resleepering etc has occurred.

14. Arrange alternative centre line marking of curves if the initial track position is established ie when the track is resurfaced or measured for WTSA. Instruct track patrollers to check for track movement during routine patrols.

15. Review WTSA if curves have pulled in significantly.

16. Establish programs to correct identified priority locations.
   ~ Verify competent staff and other resources are available.
   ~ Field staff to be given refresher training in corrective techniques - track adjustment, ballasting etc, where required.
   ~ Strategies in place for dealing with fire bans eg equipment for fire fighting available and staff briefed.

17. Provide Weekly Reports to the Chief Engineer Track (commencing at a time specified each year by the Chief Engineer Track but generally early September) detailing progress in measurement, analysis of track and correction of WTSA priorities. The reports are detailed in Form WTSA 4.

18. Establish contingency planning to prevent the occurrence of, or moderate the impact of, misalignments.
   ~ What if it gets hot before analysis complete? Identify areas likely to be critical, recently disturbed track, areas with history of problems or gross ballast deficiencies. Determine strategies to be used eg early WOLO, heat speeds etc.
   ~ Dealing with priorities identified but not corrected. How are these managed? Determine strategies to be used eg early WOLO, heat speeds. Management system must deal with a moving target

19. Establish programs to provide protection at locations of suspected instability during hot weather.

20. Implement special protective actions (including speed restrictions) when:

<table>
<thead>
<tr>
<th>% Stability loss due to track disturbance and ballast deficiencies ONLY</th>
<th>Air temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>55%</td>
<td>25°C</td>
</tr>
<tr>
<td>40%</td>
<td>30°C</td>
</tr>
</tbody>
</table>

Other appropriate actions should be determined in accordance with local factors.

21. Ensure arrangements are in place for liaison with visiting teams for compliance to WTSA requirements.

22. Brief patrol staff on monitoring track in summer eg disturbance, damage, loss of profile, heat wriggles.

23. Arrange staff seminars to reinforce work methods to be used for work in hot weather and to gain commitment for action plans.

**Team Managers**

The Team Manager will:

1. Check completed track stability field measurement sheets for obvious errors and anomalies.
2. Carry out some random checks of the measurements to satisfy themselves of the accuracy of the field sheets.
C2-5  **Management of Operating Limits and Responses**

The Civil Maintenance Engineer is the minimum level of authority permitted to issue the authority to operate at speeds other than default speed over non-complying track conditions detailed in Chapter 5.

C2-6  **Management of District Waivers**

C2-6.1  **Risk Assessment Guidelines for Ballast on Track**

C2-6.1.1  **Detailed Walking or Special Sleeper Inspection**

At any locations where detailed walking or a sleeper inspection is incomplete due to ballast on track inhibiting the inspection of fastenings and sleepers, and for which the inspection becomes overdue and outside of allowable tolerances, a District Waiver may be issued by the Civil Maintenance Engineer for the sleeper/ fastening component of the inspection, subject to the following:

1. A risk assessment must be carried out which includes consideration of
   ~ Track geometry/ formation/ drainage
   ~ Track recording car information
   ~ Defect records
   ~ Sleeper condition records
   ~ Knowledge of inspection staff

2. Where a detailed examination of ties has been carried out within the last 12 months and the results show the track is tied for 5 years - then the district waiver can extend full completion of the detailed walking or special sleeper inspection for 12 months from the last detailed inspection, or six months from the scheduled inspection whichever is the longer.

3. Where a detailed examination of ties has been carried out within the last 12 months and the results show the track is only tied for 12 months – then the district waiver can extend full completion of the detailed walking or special sleeper inspection for a maximum of three months but in any case not more than 9 months from the detailed sleeper inspection.

4. Where tie condition is unknown or does not meet the above then no extension of the inspections may be granted at district level beyond that permitted in the specified tolerances for the inspections excepting that – where the tolerance has already been exceeded (or will be exceeded within 28 days) then an emergency waiver may issued permitting an extension of a maximum of 28 days to allow time for further investigations and or correction and or additional waivers from a higher authority and provided that: - a speed restriction is imposed to reduce the track speed by 25% or 10kph whichever gives the lower speed.

5. Notwithstanding any of the above, where evidence of gauge widening becomes apparent immediate action is to be taken to inspect the track sufficient to establish its gauge security.

C2-6.2  **Track Patrol**

No special risk assessment is required to address ballast on track for the track patrol inspection. It is noted that Track Patrol must register as a defect any location with ballast on the track that inhibits visibility of sleepers and fastenings.
# Chapter 3 Competencies

NOTE: These competencies may enable activities to be carried out in other manuals. For a comprehensive list of all activities that are covered by a given competency see Engineering Manual TMC 001 - Civil Technical Competencies and Engineering Authority.

<table>
<thead>
<tr>
<th>To carry out this work</th>
<th>You need these competencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking patrol</td>
<td>TLIB3100A - Visually inspect track infrastructure</td>
</tr>
<tr>
<td>Hi-rail patrol</td>
<td>TLIB3100A - Visually inspect track infrastructure</td>
</tr>
<tr>
<td>Engine patrol</td>
<td>TLIB3100A - Visually inspect track infrastructure</td>
</tr>
<tr>
<td>Mechanised Track Patrol (Engine patrol)</td>
<td>TLIB3100A - Visually inspect track infrastructure</td>
</tr>
<tr>
<td>Mechanised Track Patrol - Detailed Review</td>
<td>Track Examination Competencies AND Training in Video Track Examinations and associated requirements of Mechanised Track Patrol</td>
</tr>
<tr>
<td>Supplementary patrol</td>
<td>TLIB3100A - Visually inspect track infrastructure</td>
</tr>
<tr>
<td>Wet Weather patrol</td>
<td>TLIB3100A - Visually inspect track infrastructure</td>
</tr>
<tr>
<td>Heat patrol</td>
<td>TLIB3100A - Visually inspect track infrastructure</td>
</tr>
<tr>
<td>Night patrol</td>
<td>TLIB3100A - Visually inspect track infrastructure</td>
</tr>
<tr>
<td>Front of train examination</td>
<td>TLIB3100A - Visually inspect track infrastructure</td>
</tr>
<tr>
<td>Track Examination</td>
<td>TLIB3100A - Visually inspect track infrastructure AND TLIB3099A - Examine track infrastructure</td>
</tr>
</tbody>
</table>

*Track Examination includes the following activities:*

- Detailed Walking, Welded Track Stability Examination, Welded Track Stability Analysis, Siding Examination, Track Recording Car Examination, Track Clearances Examination, Track Centres Examination, Rail Wear and Condition Examination, Visual Examination of VSH Rail Defects, Rail Corrosion Examination, Examination of Insulated Joints, Examination of Mechanical Joints, Examination of Rail Lubricators, Detailed Tie Examination, Ballast Examination, Examination of Special Track Layouts, Special Turnout Examination, Special Switch Timber Examination, Inspection of Crossing Condition, Visual Examination of High Rail Tangential Switches, Wear Examination of High Rail Tangential Switches, Expansion switch examination, Operational Examination of Expansion switch, Surface Drainage Examination, Sub-Surface Drainage Examination

<table>
<thead>
<tr>
<th>Swingnose crossing inspections</th>
<th>Track Examination Competencies AND Training in Swingnose crossing inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post irregularity examinations</td>
<td>Track Examination Competencies</td>
</tr>
<tr>
<td>Certify plain track after track examination</td>
<td>Track Examination Competencies</td>
</tr>
<tr>
<td>Certify turnouts &amp; special trackwork after track examination</td>
<td>Track Examination Competencies</td>
</tr>
<tr>
<td>Check Rail Lubricators prior to operation of rail flaw detection vehicles</td>
<td>TLIS2012A - Install and service rail lubrication equipment</td>
</tr>
<tr>
<td>Service Rail Lubricators</td>
<td>TLIS2012A - Install and service rail lubrication equipment</td>
</tr>
</tbody>
</table>

© Rail Corporation
Issued April 2013

**UNCONTROLLED WHEN PRINTED**

Version 5.3
Chapter 4  Methods of Measurement

C4-1 Use of Non Metallic Tapes

Using metallic tapes can result in electrocution or track circuit failures.

Some of the safety risks include:
- Electrocution from overhead wiring and high voltage lines and making contact between rails and overhead wiring structures.
- Small electric shocks from track circuit voltages.

Some of the reliability risks include:
- Signal failures due to short circuit across the track.
- Signal failure due to short circuit across insulated joints (both open track and turnouts).
- Tripping of trains at line speed.

DO NOT use Steel tapes, metal reinforced linen tapes and long steel rules when taking measurements:
- Between rails of same or different tracks.
- Near live exposed electrical equipment.
- Between rail and overhead wiring structures.
- Between OHW structures and fencing or metallic troughing.

Only use non-conducting tapes and sticks that have been electrically tested, approved and branded, when working around electrical equipment.

If you have to use metallic objects, conduct an assessment of the potential risks (both for safety and reliability) involved.

You must consider whether the equipment that they are using may form a conductive bridge between the rail and any adjacent metallic structure (including other rails). There are many items of equipment that could be at issue; for example, a spirit level, track bar or grinding bar. Even a steel gap gauge could form a short circuit across an insulated joint. Adjacent conductive equipment could include, steel bridge columns, bridge girders, metal structures supporting platforms or metal edging on platforms.

C4-2 Gauge

Gauge is measured 16mm below the top of the rail.

Where gauge variation is suspected:
1. Check gauge at 2m intervals with an accurate gauge board and record details of measurements.

The rails must be bearing against the outside holding device before measurement.

When assessing Tight gauge, flow is to be included. When assessing wide gauge use the gauge point as reference excluding flow. The principle is that the worst potential case needs to be measured. Rail flow provides the worst scenario for tight gauge. When measuring wide gauge, any flow lip may detach at any time, meaning that the gauge point will become the widest point.
WARNING
There are two types of measuring board available:
One type has straight lugs that sit against the rail flow. The second type has a
machined lug that measures at the gauge point under the rail flow.
When flow is present this could result in measurement differences of up to ~5mm
between the two boards.

To measure the rail gauge using an accurate Gauge Board:
1. Place the Gauge Board across the rails at right angles. Allow the spring-loaded end
to rest tightly against the gauge face of the rail.
2. Read the measurement of the gauge from the scale provided on the board.
3. Assess any rail play that is evident and add this to the static gauge as measured.
   This will ensure that the gauge as measured accurately reflects the true loaded
gauge at the location.

To check for rail play:
1. Examine the upper surface of the tie. If there is any evidence of the sleeper plates
   moving then the gauge may not be secure.
2. Additional rail play can arise due to:
   ~ Movement between rail foot and edge of plate or fastening.
   ~ Movement between lockspike and plate.
   Such possible movements need to be considered in the assessment of gauge and
gauge security. Areas where rapid failure is possible must have urgent action taken
to secure the track against potential spread even if the actual measured gauge falls
within allowable tolerances.

C4-3 Cross Level/Superelevation

Measure cross level and superelevation with an accurate standard track combination
gauge and level. Other devices may be used to determine cross level, but their accuracy
should be determined by comparison with an accurate standard combination track gauge
and level.

Where cross-level variation is suspected:
1. Check and record cross-level values at 2m intervals.
2. Calculate the variation value between each 2m interval and at 14m intervals.
3. Obvious weak spots such as joints should be separately measured and assessed.

To measure cross level and using an accurate gauge and cross level board:
1. Check that the board is correctly calibrated. A correctly calibrated board should
   measure an opposite reading when reversed 180 degrees in the same location. Eg
   +15 and −15.
2. Use the correct datum rail. This is the down rail on tangent track and the low rail on
curves.
3. Place the board across the rails at right angles ensuing both ends sit securely on the
top of the rail head.
4. Turn the superelevation dial until the bubble is centred.
5. Record the measurement as displayed on the board insuring that they are recorded
   as + or −.
C4-4  **Alignment**

Measure alignment to survey marks from the gauge face of the nearest rail.

Using a Measuring Tape and Plumb Bob:

1. Locate the first survey mark in the area that you consider requires measurement. Check the mark to determine whether the distance of the track alignment is marked on it. If it isn’t, you may need to check with the CME’s office before you start measuring.

2. Mark the point on the rail that is square to the survey mark. To do this accurately, have someone hold one end of your tape measure or string against the survey mark.

   Move the other end backwards and forwards on the rail until you identify the shortest distance between the survey mark and the rail.

3. Have someone place the zero mark of the tape measure on the survey mark or the rail (whichever is highest) and hold it there.

4. Drop your plumb bob down on the other mark and extend the tape out to just past the plumb bob line.

5. With your eye carefully positioned over the top of the plumb bob line, place the tape next to the line. Move the tape slowly up and down the string until you find the smallest measurement that lines up with the plumb bob line. This line is the distance from the survey mark to the rail.

6. Repeat this procedure for all of the survey marks around the curve, or over the distance that you wish to measure.

C4-5  **Line**

Measure line of the line rail using stringlining methods.

The outer rail (or high rail) of curves is the line rail. On tangent track, either rail may be used as the line rail, but the same rail shall be used throughout the tangent.

Measure offsets in mm to the nearest 1mm. Where the measurement is visually not exactly to a neat mm, note the + or - error.

Where visible irregularities are evident:

1. Visually locate the central point of the alignment irregularity.

2. Using a 5 metre tape measure, measure off and mark four 2 metre intervals on each side of the central point of the irregularity. This will produce 8 measurement intervals about the trouble spot.

3. Number each measurement station. The central point of the irregularity will be station N°5.

4. Stretch an 8m stringline from station N°1 to station N°5, making sure the string is referenced to the gauge face of the line rail at a point 16mm below the running surface.

5. Measure and record the distance from the string to the gauge face of the rail (16mm below the running surface) at station N°3. This is the middle ordinate (or radius) measurement for station N°3.

6. Move the stringline forward and stretch it from station N°2 to station N°6. Measure and record the middle ordinate (or radius) opposite station N°4.

7. Move the stringline forward and stretch it from station N°3 to station N°7. Measure and record the middle ordinate (or radius) opposite station N°5.

8. Move the stringline forward and stretch it from station N°4 to station N°8. Measure
and record the middle ordinate (or radius) opposite station N°6.

9. Move the stringline forward once more stretching it from station N°5 to station N°9. Measure and record the middle ordinate (or radius) opposite station N°7.

10. You will now have mid-ordinate (or radius) measurements from station N°3 to station N°7 (5 measurements).

11. Where alignment irregularities cover a significant length of track, increase the number of measurement stations. As a general rule, stringlining should cover a distance of at least 8m either side of any noticeable irregularity in track alignment.

If you use a Radius Rule to measure the mid-ordinate, you can read the radius in metres directly from the rule. (See Figure 1).

If, however, you use a tape measure to measure the mid-ordinate the reading will be in mm. You can convert the mid-ordinate value in mm to radius (in m) by using Table 1 below.

<table>
<thead>
<tr>
<th>Middle Ordinate mm</th>
<th>Radius m</th>
<th>Middle Ordinate mm</th>
<th>Radius m</th>
<th>Middle Ordinate mm</th>
<th>Radius m</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0</td>
<td>2,000</td>
<td>19.0</td>
<td>420</td>
<td>42.0</td>
<td>190</td>
</tr>
<tr>
<td>5.5</td>
<td>1,500</td>
<td>20.0</td>
<td>400</td>
<td>44.5</td>
<td>180</td>
</tr>
<tr>
<td>8.0</td>
<td>1,000</td>
<td>21.0</td>
<td>380</td>
<td>47.0</td>
<td>170</td>
</tr>
<tr>
<td>9.0</td>
<td>900</td>
<td>22.0</td>
<td>360</td>
<td>50.0</td>
<td>160</td>
</tr>
<tr>
<td>10.0</td>
<td>800</td>
<td>23.0</td>
<td>340</td>
<td>53.5</td>
<td>150</td>
</tr>
<tr>
<td>11.5</td>
<td>700</td>
<td>25.0</td>
<td>320</td>
<td>57.0</td>
<td>140</td>
</tr>
<tr>
<td>13.5</td>
<td>600</td>
<td>26.5</td>
<td>300</td>
<td>61.5</td>
<td>130</td>
</tr>
<tr>
<td>14.5</td>
<td>550</td>
<td>28.5</td>
<td>280</td>
<td>66.5</td>
<td>120</td>
</tr>
<tr>
<td>16.0</td>
<td>500</td>
<td>31.0</td>
<td>260</td>
<td>73.0</td>
<td>110</td>
</tr>
<tr>
<td>16.5</td>
<td>480</td>
<td>33.5</td>
<td>240</td>
<td>80.0</td>
<td>100</td>
</tr>
<tr>
<td>17.5</td>
<td>460</td>
<td>36.5</td>
<td>220</td>
<td>89.0</td>
<td>90</td>
</tr>
<tr>
<td>18.0</td>
<td>440</td>
<td>40.0</td>
<td>200</td>
<td>100.0</td>
<td>80</td>
</tr>
</tbody>
</table>

*Table 1 – Versine and Radius measurements*

As in Table 1, the radius can be calculated for an 8 metre chord using the formula:

\[
R = \frac{8000}{V}
\]

Where \( R \) = Radius of curve in metres

and \( V \) = Middle ordinate in millimetres

*Figure 1 – Radius rule*
C4-6  Rail Level
Using a Level Board or string and bubble:
1. Locate the survey mark that you wish to measure from.
2. Put one end of the Level Board (or string) on the survey mark or the rail (whichever is highest) and have someone hold it there.
3. Hold the other end level and square to the rail.
4. Measure the distance down to the survey mark or the rail (whichever is lowest) with a tape measure remembering to keep the Level Board (or string) level.
5. When you are measuring rail level, the lower rail is the datum rail. If you have measured the higher rail with the process listed above, you should now measure the difference in cross level or superelevation of the two rails. This measurement must be subtracted from your rail level measurement, to give the level of the datum rail above or below the survey mark.

C4-7  Rail Top
Measure longitudinal level with a chord of specified length. Take the measurement at the centre of the head.

Where visible irregularities are evident:
1. Visually locate the central point of the rail top irregularity. This will often be a joint.
2. Using a 5m tape measure, measure off and mark two 3 metre stations on each sides of the central point of the irregularity. This will produce 4 measurement intervals about the trouble spot.
3. Number each measurement station. The central point of the irregularity will be station N°3.
4. Stretch a 6m stringline from station N°1 to station N°3, making sure the stringline contacts the running surface in the middle of the rail head at each end of the stringline.
5. Measure and record the distance from the string to the middle of the rail head at station N°2.
6. Move the stringline forward and stretch it from station N°2 to station N°4. Measure and record the middle ordinate opposite station N°3.
7. Move the stringline forward once more stretching it from station N°3 to station N°5. Measure and record the middle ordinate opposite station N°4.
8. Where top irregularities cover a significant length of track, increase the number of measurement stations. As a general rule, stringlining should cover a distance of at least 6m either side of any noticeable irregularity in rail top.

C4-8  Clearance to Structures
Using a Measuring Tape and Plumb Bob:
1. Locate the survey mark that you wish to measure from.
2. Mark the point on the near rail that is square to the survey mark.
   To do this accurately, have someone hold one end of your tape measure or string against the survey mark.
   Move the other end backwards and forwards on the rail until you identify the shortest distance between the survey mark and the rail.
3. Have someone place the zero mark of the tape measure on the survey mark or the rail (whichever is highest) and hold it there.
4. Drop your plumb bob down on the other mark and extend the tape out to just past the plumb bob line.

5. With your eye carefully positioned over the top of the plumb bob line, place the tape next to the line. Move the tape slowly up and down the string until you find the smallest measurement that lines up with the plumb bob line. This line is the distance from the survey mark to the rail.

6. Record this measurement.

7. Repeat this procedure for all of the survey marks over the distance that you wish to measure.

8. To determine the distance to the track centreline, add 718mm (half of a gauge measurement) to the measurement on the scale.

C4-9 Track Centres
Using a non-conductive tape measure (e.g. cloth, fibreglass):
1. Measure the distance from the gauge face of one rail of one track to the gauge face of the corresponding rail on the adjacent track

2. DO NOT measure adjacent rails of two adjacent tracks.

C4-10 Turnouts and Special Trackwork
C4-10.1 Measurement in Crossings
Flangeway width is the distance between the gauge side of a running rail and the guard face of a check rail or the guard face of a wing rail, measured 16mm below the top of the rail.

Flange way depth is the height of the running surface of the rail above the top of the blocks at checkrails and in ‘V’ and ‘K’ crossings.

Checkrail effectiveness is the distance from the guard face of checkrail to the gauge face of the nose of crossing, measured square to the running rail at the nose of the crossing.

C4-10.2 Switch Measurement
Measurement of switch tips for acceptance or during track examination involves the measurement of switch tip width, depth of top of switch below top of stock rail and switch angle. The measurements are taken as explained in Figure 3 below. Note that the acceptance and operating limits apply to conventional, undercut and tangential switches.
These measurements are difficult to take accurately, particularly switch tip width and angle. Use the Switch Tip Profile Gauge detailed in SPC 201 and demonstrated in Figure 4 and in Section C23-3.

Figure 3 – Measurement of switch tip profile

Figure 4 – Using profile gauge to measure of switch tip profile
C4-11  Measuring Rail Dimensions

The measurement points shown in Figure 6 and Figure 5 are used for assessment of rail wear and corrosion.

<table>
<thead>
<tr>
<th>Measurement Point</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Rail head height – measured 16mm in from side of head</td>
</tr>
<tr>
<td>B</td>
<td>Rail head width – measured 16mm down from top of head</td>
</tr>
<tr>
<td>E</td>
<td>Rail web thickness – measured at narrowest point</td>
</tr>
<tr>
<td>F</td>
<td>Rail foot (flange) thickness – measured 16mm in from edge</td>
</tr>
<tr>
<td>G</td>
<td>Rail foot width – measured edge to edge</td>
</tr>
<tr>
<td>Gauge Face Angle</td>
<td>Measured at right angles to the plane of the sleeper</td>
</tr>
</tbody>
</table>

Table 2 – Rail measurement points

Figure 5 – Gauge face angle

Figure 6 – Rail measurement locations
Chapter 5  Defect Limits and Responses

C5-1 Mandatory Limits and Responses

Since the initial publication of these limits in October 2006, in order to limit the potential impact on reliability until the effectiveness of the new limits have been proven by trial, inspection staff were authorised by Engineering Waiver to follow current directions for the assessment and correction of track geometry and condition defects.

Following a review of the effectiveness of the Base Operating standards some parts of this chapter are now mandatory and default inspection assessment and repair responses must be applied.

These sections are listed in Table 3 below and detailed in the following pages:

<table>
<thead>
<tr>
<th></th>
<th>Track Geometry Defects</th>
<th>ALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>C5-4.1</td>
<td>Rail Surface Condition Defects</td>
<td>PART</td>
</tr>
<tr>
<td>C5-6.1</td>
<td>Rail Lubricator Defects</td>
<td>ALL</td>
</tr>
<tr>
<td>C5-7.1</td>
<td>Sleeper Condition Defects</td>
<td>ALL</td>
</tr>
<tr>
<td>C5-10.1</td>
<td>Turnouts and Special Trackwork Defects</td>
<td>PART</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3 – Mandatory limits

The remaining operating limits and responses in this chapter shall be used as Guidelines.

Where limits and responses are provided as guidelines, they are provided as advice but priorities can be altered after consideration of the cause, component condition and growth potential of the defect and its potential to effect safety and/or reliability.

C5-2 Standard Defect Categories and Responses

All defects are categorised in one of six standard defect categories as follows:

<table>
<thead>
<tr>
<th>Response Category</th>
<th>Inspect and verify response</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency 1 (E1)</td>
<td>Prior to passage of next train</td>
<td>Prior to passage of next train</td>
</tr>
<tr>
<td>Emergency 2 (E2)</td>
<td>Within 2 hrs or before the next train, whichever is the greater</td>
<td>Within 24 hrs</td>
</tr>
<tr>
<td>Priority 1 (P1)</td>
<td>Within 24 hrs</td>
<td>Within 7 days</td>
</tr>
<tr>
<td>Priority 2 (P2)</td>
<td>Within 7 days</td>
<td>Within 28 days</td>
</tr>
<tr>
<td>Priority 3 (P3)</td>
<td>Within 28 days</td>
<td>Program for repair</td>
</tr>
<tr>
<td>Normal (N)</td>
<td>Nil</td>
<td>Routine inspection</td>
</tr>
</tbody>
</table>
C5-3  

**Response to Base Operating Conditions**

1. Do not impose speed restriction immediately.
2. Inspect defect within the time period shown for Response category or as directed in Chapter 6 Assessment of Base Operating Conditions.
3. If you cannot inspect within the time period shown, a speed restriction must be applied to reduce the priority of the defect or permission gained from the CME.
4. Assess the defect using the assessment guidelines. The purpose of the initial assessment is to confirm the defect exists and to determine the component condition and cause of the defect and any potential for rapid failure.
5. If there is potential for rapid failure at the time of assessment then this must be considered in deciding on the action to be taken. Additional monitoring, more urgent repair or lower speeds may be required as a result.
6. Once the defect is confirmed it must be placed in a defect management system.
7. If the guidelines allow you to change the response category you may do so. If the guidelines do not give you options, then within the response period you must address the defect by one or more of the following:
   - Correct the defect
   - Do sufficient work on the defect to move it “UP” the table – i.e. its not perfect but its better – the response time is deferred
   - Decrease the speed, moving the defect response to the “LEFT” of the table
   - Get permission from the CME for the uncorrected defect to remain.

**Example**

<table>
<thead>
<tr>
<th>Short Twist</th>
<th>Track Speed (Normal /Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Manual 2m</td>
</tr>
<tr>
<td>&lt;12</td>
<td>N</td>
</tr>
<tr>
<td>12 –13</td>
<td>N</td>
</tr>
<tr>
<td>14 - 15</td>
<td>N</td>
</tr>
<tr>
<td>16</td>
<td>N</td>
</tr>
<tr>
<td>17 – 18</td>
<td>N</td>
</tr>
<tr>
<td>19 – 20</td>
<td>P2</td>
</tr>
<tr>
<td>21 - 22</td>
<td>P1</td>
</tr>
<tr>
<td>23</td>
<td>E2</td>
</tr>
<tr>
<td>&gt; 23</td>
<td>E1</td>
</tr>
</tbody>
</table>

**Note.** When a defect is found and the track speed lies between two speed bands in the tables, apply the response for the HIGHER speed band. **Exception:** If turnout roads are 25kph the 20/20 column can be used.
### Example

A 22mm Short Twist defect is found on a track which has a track speed of 50km/h. The Mandatory Response is **E2**, NOT **P1**.

<table>
<thead>
<tr>
<th>Short Twist</th>
<th>Track Speed (Normal /Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual 2m</td>
<td>20/20 40/40 60/60 80/90 100/115 115/160</td>
</tr>
</tbody>
</table>

| 19 – 20 | P2 | P2 | P1 | E2 | E2 | E2 |
| 21 – 22 | P1 | P1 | E2 | E2 | E2 | E1 |
| 23      | E2 | E2 | E2 | E2 | E1 | E2 |
| > 23    | E1 | E1 | E1 | E1 | E1 | E1 |

### C5-4 Track Geometry Defects

#### C5-4.1 Mandatory Limits

<table>
<thead>
<tr>
<th>Wide Gauge</th>
<th>Tight Gauge</th>
<th>Track Geometry Defects</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 21</td>
<td>&lt; 10</td>
<td>2.7m 2m DO NOT USE</td>
</tr>
<tr>
<td>21 – 22</td>
<td>10</td>
<td>16 – 18 12 – 13</td>
</tr>
<tr>
<td>23 – 26</td>
<td>11 – 12</td>
<td>19 – 21 14 – 15</td>
</tr>
<tr>
<td>27 – 28</td>
<td>13 – 14</td>
<td>22 – 23 16</td>
</tr>
<tr>
<td>29 – 30</td>
<td>15 – 16</td>
<td>24 – 25 17 – 18</td>
</tr>
<tr>
<td>31 – 32</td>
<td>17</td>
<td>26 – 27 19 – 20</td>
</tr>
<tr>
<td>33 – 34</td>
<td>18</td>
<td>28 – 29 21 – 22</td>
</tr>
<tr>
<td>35 – 37</td>
<td>19 – 20</td>
<td>30 – 31 23</td>
</tr>
<tr>
<td>&gt; 37</td>
<td>&gt; 20</td>
<td>&gt; 31 &gt; 23</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Short Twist</th>
<th>Track Speed (Normal /Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.2m DO NOT USE</td>
<td>20/20 40/40 60/60 80/90 100/115 115/160</td>
</tr>
<tr>
<td>14m</td>
<td>29 – 33 31 – 35 32 – 36 34 – 38</td>
</tr>
<tr>
<td>13.2m DO NOT USE</td>
<td>34 – 38 36 – 40 37 – 41 39 – 43</td>
</tr>
<tr>
<td>14m</td>
<td>39 – 43 41 – 46 42 – 46 44 – 49</td>
</tr>
<tr>
<td>14m</td>
<td>44 – 49 47 – 52 47 – 52 50 – 55</td>
</tr>
<tr>
<td>14m</td>
<td>50 – 56 53 – 59 53 – 59 56 – 62</td>
</tr>
<tr>
<td>14m</td>
<td>57 – 60 60 – 64 60 – 63 63 – 66</td>
</tr>
<tr>
<td>14m</td>
<td>61 – 66 65 – 70 64 – 69 67 – 72</td>
</tr>
<tr>
<td>14m</td>
<td>&gt; 66 &gt; 70 &gt; 69 &gt; 72</td>
</tr>
</tbody>
</table>

Not in a Transition In a Transition

<table>
<thead>
<tr>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>20/20 40/40 60/60 80/90 100/115 115/160</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Track Geometry Defects</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 29</td>
</tr>
<tr>
<td>29 – 33</td>
</tr>
<tr>
<td>34 – 38</td>
</tr>
<tr>
<td>39 – 43</td>
</tr>
<tr>
<td>44 – 49</td>
</tr>
<tr>
<td>50 – 56</td>
</tr>
<tr>
<td>57 – 60</td>
</tr>
<tr>
<td>61 – 66</td>
</tr>
<tr>
<td>&gt; 66</td>
</tr>
</tbody>
</table>

© Rail Corporation
Issued April 2013

UNCONTROLLED WHEN PRINTED

Version 5.3
### C5-4.2 Guidelines

Nil

### C5-5 Rail Wear Defects

#### C5-5.1 Mandatory Limits

When a reportable limit (as shown in the guidelines below) is reached the Civil Maintenance Engineer is to be notified. Action is to be taken to enable rerailing prior to reaching condemning limits. This must consider: the head loss compared to max permitted; the impact of surface condition; if 53kg/m rail is involved the potential for Vertical Split Head defects.

If condemning limits are exceeded the Chief Engineer Track is to be notified.

#### C5-5.2 Guidelines

<table>
<thead>
<tr>
<th>Axle Load Max</th>
<th>Sleeper type</th>
<th>Rail kg/m</th>
<th>Curve Wear head width “B”</th>
<th>Tangent Wear Head depth “A”</th>
<th>Head Loss Max % Curve radius</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Condemn</td>
<td>Report-able</td>
<td>Condemn</td>
</tr>
<tr>
<td>23t</td>
<td>All</td>
<td>47</td>
<td>48</td>
<td>52</td>
<td>26</td>
</tr>
<tr>
<td>25t</td>
<td>All</td>
<td>53</td>
<td>48</td>
<td>54</td>
<td>26</td>
</tr>
<tr>
<td>Passenger</td>
<td></td>
<td>53</td>
<td>46</td>
<td>54</td>
<td>24</td>
</tr>
<tr>
<td>25t</td>
<td>Timber 60SC</td>
<td>46</td>
<td>48</td>
<td>52</td>
<td>26</td>
</tr>
<tr>
<td>25t</td>
<td>Timber 60HH</td>
<td>46</td>
<td>48</td>
<td>52</td>
<td>26</td>
</tr>
<tr>
<td>25t</td>
<td>Concrete 60SC</td>
<td>46</td>
<td>48</td>
<td>52</td>
<td>24</td>
</tr>
<tr>
<td>30t</td>
<td>Concrete 60HH</td>
<td>48</td>
<td>48</td>
<td>52</td>
<td>26</td>
</tr>
<tr>
<td>25t</td>
<td>Concrete 60HH</td>
<td>46</td>
<td>46</td>
<td>52</td>
<td>24</td>
</tr>
</tbody>
</table>

CME’s should also regularly review head loss limits using the AK rail profile system.
### Rail Wear Angle

<table>
<thead>
<tr>
<th>Rail Wear Angle</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 24°</td>
<td>20/20, 40/40, 60/60, 80/90, 100/115, 115/160</td>
</tr>
<tr>
<td>24° - 26°</td>
<td>P3, P3, P3, P3, P3, P3</td>
</tr>
<tr>
<td>≥ 26°</td>
<td>P2, P2, P1, P1, E2, E2</td>
</tr>
</tbody>
</table>

### C5-6 Rail Surface Condition Defects

#### C5-6.1 Mandatory Limits

<table>
<thead>
<tr>
<th>Rail Wear Angle</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 24°</td>
<td>20/20, 40/40, 60/60, 80/90, 100/115, 115/160</td>
</tr>
<tr>
<td>24° - 26°</td>
<td>P3, P3, P3, P3, P3, P3</td>
</tr>
<tr>
<td>≥ 26°</td>
<td>P2, P2, P1, P1, E2, E2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rail Corrosion</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>20/20, 40/40, 60/60, 80/90, 100/115, 115/160</td>
</tr>
<tr>
<td>53</td>
<td>E F G E F G E F G</td>
</tr>
<tr>
<td>47</td>
<td>17 14 146 15 13 146 14 13 127 As new dimensions</td>
</tr>
<tr>
<td>13-15</td>
<td>6-10, 130-139, 11-13, 6-10, 130-139, 10-12, 6-10, 115-120</td>
</tr>
<tr>
<td>&lt;13</td>
<td>&lt;6, &lt;130, &lt;11, &lt;6, &lt;130, &lt;10, &lt;6, &lt;115</td>
</tr>
</tbody>
</table>

#### C5-6.2 Guidelines

<table>
<thead>
<tr>
<th>Fish Scaling; Spalling</th>
<th>Rail Contact fatigue</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>No surface cracking in gauge corner or on rail head</td>
<td>No visible cracking on rail head</td>
<td>N N N N N N N</td>
</tr>
<tr>
<td>Fish Scaling present: Gauge Corner, and Top of rail head</td>
<td>Cracks visible</td>
<td>P3 P3 P3</td>
</tr>
<tr>
<td>Minor Spalling Present: Gauge Corner, and Top of rail head</td>
<td>Cracks 1mm deep or TDS potentially hidden during ultrasonic testing</td>
<td>P2 P2 P2</td>
</tr>
<tr>
<td>Significant Spalling Present: Gauge Corner, and Top of rail head</td>
<td>TDM potentially hidden during ultrasonic testing</td>
<td>P1 P1 E2 E2</td>
</tr>
<tr>
<td>TDL potentially hidden during ultrasonic testing</td>
<td>E2 E1 E1 E1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wheel Burns</th>
<th>Surface Squats</th>
<th>Notches</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Wheel Burns</td>
<td>TBD</td>
<td>TBD</td>
<td>N N N N N N N</td>
</tr>
<tr>
<td>Indents or Head Flow Visible</td>
<td>TBD</td>
<td>TBD</td>
<td>P3 P3 P3 P2 P2 P2</td>
</tr>
<tr>
<td>Indents 1mm or signs of minor ballast disturbance</td>
<td>TBD</td>
<td>TBD</td>
<td>P2 P2 P2 P1 P1 P1</td>
</tr>
<tr>
<td>Indents 2mm or ballast disturbance or minor track geometry deterioration</td>
<td>TBD</td>
<td>TBD</td>
<td>P1 P1 E2 E2 E2 E2</td>
</tr>
</tbody>
</table>

© Rail Corporation
Issued April 2013
UNCONTROLLED WHEN PRINTED
Version 5.3
C5-7 Rail Lubricator Defects

C5-7.1 Mandatory Limits

<table>
<thead>
<tr>
<th>Rail Lubrication</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir level</td>
<td>Indicator arm</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Blade</td>
<td>Height (below top of rail head)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>holes</td>
<td>Open</td>
</tr>
<tr>
<td></td>
<td>Closed</td>
</tr>
<tr>
<td>Wear</td>
<td>Replace Blade</td>
</tr>
<tr>
<td>Pump</td>
<td>Brackets</td>
</tr>
<tr>
<td>Pump Body</td>
<td>Damaged</td>
</tr>
<tr>
<td>Plunger height</td>
<td>Head contamination - Too much</td>
</tr>
<tr>
<td></td>
<td>Rain dry - Too little</td>
</tr>
<tr>
<td></td>
<td>P&amp;M 2-3mm</td>
</tr>
<tr>
<td></td>
<td>RTE25 1-3mm</td>
</tr>
<tr>
<td>Bolts</td>
<td>Loose</td>
</tr>
</tbody>
</table>

C5-7.2 Guidelines
Nil

C5-8 Rail Joint Defects

C5-8.1 Mandatory Limits
Nil

C5-8.2 Guidelines

<table>
<thead>
<tr>
<th>Rail Joints</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishplate Cracks (includes broken and cracked plates at insulated joints)</td>
<td></td>
</tr>
<tr>
<td>No visible crack in either fishplate</td>
<td>20/20</td>
</tr>
<tr>
<td>Visible crack in 1 fishplate - other location</td>
<td>P2</td>
</tr>
<tr>
<td>Visible crack in 1 fishplate - bottom of fishplate</td>
<td>P2</td>
</tr>
<tr>
<td>Visible crack in both fishplates - other location</td>
<td>P2</td>
</tr>
<tr>
<td>Visible crack in both fishplates - bottom of fishplate</td>
<td>P1</td>
</tr>
<tr>
<td>1 fishplate broken, other with no crack</td>
<td>E2</td>
</tr>
<tr>
<td>1 fishplate broken, other with visible crack</td>
<td>E1</td>
</tr>
<tr>
<td>Both fishplates broken</td>
<td>E2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sleeper Support at Fish-Plated Joint</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective joint support</td>
<td>20/20</td>
</tr>
<tr>
<td>Pumping joint, &lt; 10mm</td>
<td>N</td>
</tr>
<tr>
<td>10 - 12mm joint movement</td>
<td>P3</td>
</tr>
<tr>
<td>&gt;12mm joint movement</td>
<td>P2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rail Joint Adjustment at Fish-Plated Joint</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective fish bolts / swaged fastenings</td>
<td>20/20</td>
</tr>
<tr>
<td>fish bolts / swaged fastenings Visibly bent</td>
<td>N</td>
</tr>
<tr>
<td>fish bolts / swaged fastenings Bent &gt; 5mm</td>
<td>P3</td>
</tr>
<tr>
<td>Joint Gaps 15 - 20mm</td>
<td>P3</td>
</tr>
<tr>
<td>Joint Gaps 20 - 30mm</td>
<td>P3</td>
</tr>
<tr>
<td>Joint Gaps &gt; 30mm</td>
<td>P3</td>
</tr>
</tbody>
</table>
## Rail Joints

### Ineffective Fish Bolts and Swage Fastenings at Fish-Plated Joint

<table>
<thead>
<tr>
<th>Track Speed (Normal / Passenger) km/hr</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>No ineffective fastenings</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2 on each side effective</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
</tr>
<tr>
<td>1, 2 or 3 effective on 1 side, and 1 on the other side</td>
<td>P1</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
</tr>
<tr>
<td>0 effective on 1 side and 2 or 3 on other side</td>
<td>P1</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
</tr>
<tr>
<td>0 effective on 1 side and 0 or 1 on other side</td>
<td>E2</td>
<td>E1</td>
<td>E1</td>
<td>E1</td>
<td>E1</td>
<td>E1</td>
</tr>
</tbody>
</table>

### Loose Fish Bolts and Swage Fastenings at Fish-Plated Joint

<table>
<thead>
<tr>
<th>Track Speed (Normal / Passenger) km/hr</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>No loose fastenings</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2 on each side remaining tight</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
</tr>
<tr>
<td>2 or 3 loose on 1 side, and 1 tight on the other side</td>
<td>P3</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
</tr>
<tr>
<td>1 on each side remaining tight</td>
<td>P2</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
</tr>
<tr>
<td>0 effective on 1 side and 1 on other side, but with sufficient integrity to provide lateral and vertical support</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
</tr>
<tr>
<td>All bolts loose, vertical and lateral support lost</td>
<td>E1</td>
<td>E1</td>
<td>E1</td>
<td>E1</td>
<td>E1</td>
<td>E1</td>
</tr>
</tbody>
</table>

### Rail End Condition at Fish-Plated Joint

<table>
<thead>
<tr>
<th>Track Speed (Normal / Passenger) km/hr</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gauge face misalignment &lt;1mm</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Gauge face misalignment 1 to 3mm</td>
<td>P2</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
</tr>
<tr>
<td>Gauge face misalignment &gt; 3mm</td>
<td>P1</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
</tr>
</tbody>
</table>

### Rail End Condition at Fish-Plated Joint

<table>
<thead>
<tr>
<th>Track Speed (Normal / Passenger) km/hr</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rail ends not battered</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Dip 3 - 4mm and / or Gauge face flow 3 - 5mm</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
</tr>
<tr>
<td>Dip &gt; 4mm and / or Gauge face flow &gt; 5mm</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
</tr>
</tbody>
</table>

## C5-9 Insulated Rail Joints Defects

### C5-9.1 Mandatory Limits

Nil

### C5-9.2 Guidelines

#### Insulated Rail Joints

<table>
<thead>
<tr>
<th>Loss or failure of insulation material - Mechanical &amp; Glued</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>No insulation material failure</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Insulation material visibly cracked or disintegrated</td>
<td>P2</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
</tr>
<tr>
<td>Components fail to insulate (generally causing signal failure)</td>
<td>E2</td>
<td>E1</td>
<td>E1</td>
<td>E1</td>
<td>E1</td>
<td>E1</td>
<td></td>
</tr>
</tbody>
</table>
## Insulated Rail Joints

<table>
<thead>
<tr>
<th>Rail head flow across joint -</th>
<th>Rail head wear/damage around the key</th>
<th>Metal conductors, metal particles, brake dust about joint</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>No head flow</td>
<td>No visible damage</td>
<td>No contamination</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Flow on either rail with potential to provide &lt; 6mm gap (mechanical), or &lt; 4mm gap (glued) between rail ends</td>
<td>Visible damage</td>
<td></td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
</tr>
<tr>
<td>Flow on either rail with potential to provide &lt; 4mm gap (mechanical), or &lt; 3mm gap (glued) between rail ends</td>
<td>Visible about joint</td>
<td></td>
<td>P3</td>
<td>P3</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
<td>P1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Joint Gap Movement - Mechanical</th>
<th>Joint Gap Movement - Glued</th>
<th>Adhesive Failure - Glued</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>No joint closing</td>
<td>No joint closing / opening</td>
<td>No failure</td>
<td>20/20</td>
</tr>
<tr>
<td>Insulation key being squeezed out; Joint pulling apart - visible gap at insulation key</td>
<td>Visible gap or sign of movement</td>
<td>Evidence of failure: rust stain between fishplate &amp; rail minor movement between plate and rail (normally between joint and 1st hole)</td>
<td>P3</td>
</tr>
<tr>
<td>Gap between rails &lt; 6mm; Joint pulling apart - bent bolts</td>
<td>Movement &gt; 1 mm</td>
<td>Movement between plate and rail evident under load Movement between plate and rail extending beyond 1st hole</td>
<td>P2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Partial Insulation Failure - Glued</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>No evidence of failure</td>
<td>20/20</td>
</tr>
<tr>
<td>Insulation test fails for 1 plate to rail combination (Failure of both would give a signal failure)</td>
<td>P1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ineffective Drainage around Joint - Mechanical and Glued</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>No ineffective drainage</td>
<td>20/20</td>
</tr>
<tr>
<td>Water lying in joint vicinity</td>
<td>P2</td>
</tr>
<tr>
<td>Water contacting foot of rail near joint</td>
<td>P1</td>
</tr>
</tbody>
</table>
## C5-10 Sleeper Condition Defects
### C5-10.1 Mandatory Limits

#### Track Inspection TMC 203

**C5-10 Sleeper Condition Defects**

**C5-10.1 Mandatory Limits**

<table>
<thead>
<tr>
<th>Sleeper condition</th>
<th>Spacing (mm)</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consecutive Missing Sleepers</td>
<td>Not at joint At a Joint</td>
<td>Not at joint At a Joint</td>
</tr>
<tr>
<td>Nil Nil</td>
<td>&lt; 900</td>
<td>&lt; 700</td>
</tr>
<tr>
<td>1</td>
<td>900 - 1200 700 - 900</td>
<td>P2 P2 P1 P1 P1 P1</td>
</tr>
<tr>
<td>2</td>
<td>1200 - 1500 900 - 1200</td>
<td>E2 E2 E2 E2 E2 E2</td>
</tr>
<tr>
<td>&gt;2</td>
<td>≥1500 ≥1200</td>
<td>E2 E2 E1 E1 E1 E1</td>
</tr>
</tbody>
</table>

**Clusters of Consecutive Ineffective Sleepers**

<table>
<thead>
<tr>
<th>Curves R&lt;1000m</th>
<th>Well tied</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2 (only at isolated locations)</td>
<td>≥5 years</td>
<td>N N N N N N</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>≥1 year</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>≥28 days</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>Not securely tied</td>
</tr>
<tr>
<td>&gt;5</td>
<td>&gt;4</td>
<td>Not securely tied</td>
</tr>
</tbody>
</table>

**General Condition Description Timber Sleepers**

<table>
<thead>
<tr>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wide Moderate Sharp</td>
</tr>
<tr>
<td>Tangents &amp; Curves R&gt;1000m Curves 400≤R ≤ 1000m Curves R &lt; 400</td>
</tr>
<tr>
<td>&gt; 65% good &gt; 65% good &gt; 65% good</td>
</tr>
<tr>
<td>35 to 65% effective 45 to 65% effective 50 to 65% effective</td>
</tr>
<tr>
<td>NA</td>
</tr>
<tr>
<td>Not securely tied</td>
</tr>
</tbody>
</table>

1. Where % of sleepers is referenced, this should be determined over a minimum of 20 sleepers.
2. Sleepers that are relied upon to be effective to meet the criteria for consecutive ineffective sleepers must have sufficient strength and remaining life to remain effective for the life specified in the general condition category.
### Sleeper condition

<table>
<thead>
<tr>
<th>Rail Movement relative to sleeper, including effect of rail roll</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal</td>
<td>Vertical</td>
</tr>
<tr>
<td>0 - 5 mm</td>
<td>0 - 2 mm</td>
</tr>
<tr>
<td>6 - 8 mm</td>
<td></td>
</tr>
<tr>
<td>9 - 10 mm</td>
<td>3 - 4 mm</td>
</tr>
<tr>
<td>11 - 12 mm</td>
<td>5 - 6 mm</td>
</tr>
<tr>
<td>&gt; 12 mm</td>
<td>&gt; 6 mm</td>
</tr>
</tbody>
</table>

### Concrete sleeper component condition

<table>
<thead>
<tr>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>20/20</td>
</tr>
<tr>
<td>Squeezed out missing or failed insulators</td>
</tr>
<tr>
<td>Severely worn sleeper pads</td>
</tr>
</tbody>
</table>

**Note.** To prevent damage to sleepers & the rail foot insulators and pads that have failed on a faceshould be replaced within a nominal period of 6 months.

### C5-11 Ballast Defects

#### C5-11.1 Mandatory Limits

Nil

#### C5-11.2 Guidelines

When assessing ballast deficiency the main consideration should be the potential for the loss to affect track geometry.

WTSA should be used during the summer period to assist in deciding on priority. New ballast deficiencies in summer especially on recently disturbed track pose significant misalignment risk.

In winter ballast deficiencies on curves increase the risk of curve pull in.

Consider the location of the deficiency e.g. High rail shoulder is more critical in summer than low rail shoulder.

Consider other problems at the location that make the situation worse. e.g. Pumping track.
### Ballast Deficiency R<400m

<table>
<thead>
<tr>
<th>Shoulder Profile</th>
<th>Crib Profile</th>
<th>Combined Profile</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>20/20</td>
</tr>
<tr>
<td>Timber</td>
<td>Concrete</td>
<td>Timber</td>
<td>Concrete</td>
</tr>
<tr>
<td>1</td>
<td>1 - 2</td>
<td>1</td>
<td>1 - 2</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 - 5</td>
<td>5 - 6</td>
<td>6 - 7</td>
<td>≥8</td>
</tr>
<tr>
<td>6 - 7</td>
<td>≥8</td>
<td>≥7</td>
<td>≥8</td>
</tr>
<tr>
<td>7 - 8</td>
<td>≥8</td>
<td>≥7</td>
<td>≥8</td>
</tr>
<tr>
<td>8 - 9</td>
<td>≥8</td>
<td>≥7</td>
<td>≥8</td>
</tr>
</tbody>
</table>

### Ballast Deficiency R>400m

<table>
<thead>
<tr>
<th>Shoulder Profile</th>
<th>Crib Profile</th>
<th>Combined Profile</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>20/20</td>
</tr>
<tr>
<td>Timber</td>
<td>Concrete</td>
<td>Timber</td>
<td>Concrete</td>
</tr>
<tr>
<td>1</td>
<td>1 - 2</td>
<td>1</td>
<td>1 - 2</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 - 5</td>
<td>5 - 6</td>
<td>6 - 7</td>
<td>10</td>
</tr>
<tr>
<td>6 - 7</td>
<td>≥8</td>
<td>≥7</td>
<td>12</td>
</tr>
<tr>
<td>7 - 8</td>
<td>≥8</td>
<td>≥7</td>
<td>14</td>
</tr>
<tr>
<td>8 - 9</td>
<td>≥8</td>
<td>≥7</td>
<td>16</td>
</tr>
</tbody>
</table>
### Excess Ballast (all track)

<table>
<thead>
<tr>
<th>Ballast Profile</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profile as specified</td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Surplus ballast in excess of specified profile exists</td>
<td></td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
</tr>
<tr>
<td>Potential to interfere with correct function of track or signalling components. Potential to interfere with operations.</td>
<td></td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
</tr>
<tr>
<td>Note. If practical remove offending ballast at the time of inspection.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prevents proper detailed inspection of track or signal components</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CME Risk assessment and local waiver</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CME Risk assessment and local waiver</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CME Risk assessment and local waiver</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CME Risk assessment and local waiver</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CME Risk assessment and local waiver</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CME Risk assessment and local waiver</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Poor Drainage and / or Ballast Condition

<table>
<thead>
<tr>
<th>Ballast Profile</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal fines in ballast</td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Fines in ballast, visible contamination on surface of ballast</td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
</tr>
<tr>
<td>Ballast fouled by fines and debris</td>
<td></td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
</tr>
<tr>
<td>Ballast fills with water during rain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ballast Visible foul and unable to maintain track within geometry maintenance limits lower than P1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetition of alignment defects to P1 at same location</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturated contaminants visible after rain</td>
<td></td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
</tr>
<tr>
<td>Ballast visibly pumping and unable to maintain track within geometry maintenance limits lower than E2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleeper flexing or ballast voids completely filled with contaminants</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetition of track geometry defects E2, E1 at same location</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetition of alignment defects to E2 at same location</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## C5-12 Turnouts and Special Trackwork Defects

### C5-12.1 Mandatory Limits

#### C5-12.1.1 Switches and Stockrails

<table>
<thead>
<tr>
<th>Switch rail throat opening (mm)</th>
<th>Switch Rail Open Throw (mm)</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back of Switch Rail to Stock Rail</td>
<td>Switch Rail Toe to Stock Rail</td>
<td>20/20</td>
</tr>
<tr>
<td>45 – 50</td>
<td>95 – 100</td>
<td>N</td>
</tr>
<tr>
<td>42 – 45</td>
<td>90 – 94</td>
<td>N</td>
</tr>
<tr>
<td>40 – 41</td>
<td>86 – 89</td>
<td>N</td>
</tr>
<tr>
<td>37 – 39</td>
<td>82 – 85</td>
<td>P3</td>
</tr>
<tr>
<td>35 – 36</td>
<td>80 – 81</td>
<td>P2</td>
</tr>
<tr>
<td>&lt; 35</td>
<td>&lt; 80</td>
<td>E2</td>
</tr>
</tbody>
</table>

**Heel block condition and vertical support**

<table>
<thead>
<tr>
<th>Conventional Turnouts with fixed heels</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>20/20</td>
<td>40/40</td>
</tr>
<tr>
<td>Cracked</td>
<td>Vertical movement of switch tip is evident</td>
</tr>
<tr>
<td>Broken but still effective</td>
<td>&gt; 2mm horizontal and &gt; 4 mm vertical movement of switch tip</td>
</tr>
<tr>
<td>Missing / Broken and ineffective</td>
<td>E1</td>
</tr>
</tbody>
</table>

#### C5-12.1.2 Bearers

<table>
<thead>
<tr>
<th>Bearer Condition</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cluster of Consecutive Ineffective Bearers</td>
<td>Well tied</td>
</tr>
<tr>
<td>0-1</td>
<td>≥5 years</td>
</tr>
<tr>
<td>2</td>
<td>≥1 year</td>
</tr>
<tr>
<td>3</td>
<td>≥28 days</td>
</tr>
<tr>
<td>4-5</td>
<td>Not securely tied</td>
</tr>
<tr>
<td>&gt;5</td>
<td>Not securely tied</td>
</tr>
</tbody>
</table>

### Ineffective Bearers

<table>
<thead>
<tr>
<th>R &gt; 350m:</th>
<th>R &lt; 350m</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in 6</td>
<td>1 in 7</td>
<td>N</td>
</tr>
<tr>
<td>1 in 5</td>
<td>1 in 6</td>
<td>N</td>
</tr>
<tr>
<td>1 in 4</td>
<td>1 in 5</td>
<td>P3</td>
</tr>
<tr>
<td>1 in 3</td>
<td>1 in 4</td>
<td>P2</td>
</tr>
<tr>
<td>1 in 2</td>
<td>1 in 3</td>
<td>P1</td>
</tr>
</tbody>
</table>
### C5-12.1.3 Crossings

#### C5-12.2 Guidelines

#### C5-12.2.1 Crossings

---

<table>
<thead>
<tr>
<th>Failed concrete bearers</th>
<th>Track Speed (Normal /XPT) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20/20</td>
</tr>
<tr>
<td>0</td>
<td>N</td>
</tr>
<tr>
<td>1</td>
<td>P2</td>
</tr>
<tr>
<td>2</td>
<td>P1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>V Crossing Effectiveness (mm)</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20/20</td>
</tr>
<tr>
<td>1398 – &lt;1400</td>
<td>P2</td>
</tr>
<tr>
<td>1396 – &lt;1398</td>
<td>P3</td>
</tr>
<tr>
<td>1389 – &lt;1396</td>
<td>N</td>
</tr>
<tr>
<td>1386 – &lt;1389</td>
<td>N</td>
</tr>
<tr>
<td>1384 – &lt;1386</td>
<td>P3</td>
</tr>
<tr>
<td>1382 – &lt;1384</td>
<td>P2</td>
</tr>
<tr>
<td>&lt;1382 mm</td>
<td>E2</td>
</tr>
</tbody>
</table>

Note. Checkrail effectiveness and gauge measurements at “V” & "K" crossings should be taken at a point just behind (nominally 150mm) the point of the crossing to ensure that varying crossing nose shapes do not effect consistency of measurement. For “K” crossings this point may have to be further away to allow the measuring board to be square to the measurement point.

Note. Where there is evidence of wheel wear on the gauge face of the crossing nose despite satisfactory checkrail effectiveness measurements this could indicate movement under load. If this is the case then the potential rail play should be assessed and incorporated into static measurements to determine priority.
### Crossings

#### Track Speed (Normal / Passenger) km/hr

<table>
<thead>
<tr>
<th>Check Rail Flangeway Width (mm)</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 50</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>E2</td>
<td>E2</td>
</tr>
<tr>
<td>49 - 50</td>
<td>P3</td>
<td>P3</td>
<td>P2</td>
<td>P2</td>
<td>P1</td>
<td>P1</td>
</tr>
<tr>
<td>39 – 48</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>&lt;39</td>
<td>P3</td>
<td>P3</td>
<td>P2</td>
<td>P2</td>
<td>P1</td>
<td>P1</td>
</tr>
<tr>
<td>&lt; 38</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>E2</td>
<td>E2</td>
</tr>
</tbody>
</table>

#### Check Rail Flangeway Depth (mm)

<table>
<thead>
<tr>
<th>Track Speed (Normal / Passenger) km/hr</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 45</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>42 - 45</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
</tr>
<tr>
<td>40 - 41</td>
<td>P3</td>
<td>P2</td>
<td>P3</td>
<td>P3</td>
<td>P2</td>
<td>P2</td>
</tr>
<tr>
<td>38 - 40</td>
<td>P2</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
</tr>
<tr>
<td>35 - 37</td>
<td>P1</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
</tr>
<tr>
<td>&lt;35</td>
<td>E2</td>
<td>E1</td>
<td>E1</td>
<td>E1</td>
<td>E1</td>
<td>E1</td>
</tr>
</tbody>
</table>

#### Crossings Vertical wear (mm)

<table>
<thead>
<tr>
<th>Crossing nose</th>
<th>Wing rail</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 3</td>
<td>&lt; 5</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>3 – 4</td>
<td>5 – 8</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
</tr>
<tr>
<td>5 – 6</td>
<td>9 – 10</td>
<td>P2</td>
<td>P2</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
</tr>
<tr>
<td>&gt; 6</td>
<td>&gt; 10</td>
<td>P1</td>
<td>P1</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
</tr>
</tbody>
</table>

#### Check Rail Height of above rail (mm)

<table>
<thead>
<tr>
<th>Track Speed (Normal / Passenger) km/hr</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 25</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>26 – 28</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
</tr>
<tr>
<td>29 – 30</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
</tr>
<tr>
<td>30 – 31</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
</tr>
<tr>
<td>32 – 37</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
</tr>
<tr>
<td>&gt; 37</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E1</td>
<td>E1</td>
<td>E1</td>
</tr>
</tbody>
</table>

#### Cracks in Cast

<table>
<thead>
<tr>
<th>Crossing nose</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-critical</td>
<td>≥ 2</td>
<td>N</td>
<td>N</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
</tr>
<tr>
<td>Critical</td>
<td>&lt; 2</td>
<td>P3</td>
<td>P3</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
</tr>
<tr>
<td>Manganese - Fine surface cracks visible</td>
<td>&lt; 1</td>
<td>P2</td>
<td>P2</td>
<td>P1</td>
<td>P1</td>
<td>E2</td>
<td>E2</td>
</tr>
<tr>
<td>Fully (not affecting the running surface) Manganese - Elongated cracks</td>
<td>&lt; 1</td>
<td>P2</td>
<td>P2</td>
<td>P1</td>
<td>P1</td>
<td>E2</td>
<td>E2</td>
</tr>
<tr>
<td>No unworn nose</td>
<td></td>
<td>P1</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E1</td>
<td>E1</td>
</tr>
<tr>
<td>Fully (affecting the running surface)</td>
<td></td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E1</td>
<td>E1</td>
</tr>
</tbody>
</table>

#### Metal flow on crossing nose causing lip (mm)

<table>
<thead>
<tr>
<th>Track Speed (Normal / Passenger) km/hr</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 1</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>P3</td>
<td>P3</td>
</tr>
<tr>
<td>1 to 2</td>
<td>P3</td>
<td>P3</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
</tr>
<tr>
<td>&gt;2</td>
<td>P2</td>
<td>P2</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
</tr>
</tbody>
</table>

#### Crossing Nose Break

<table>
<thead>
<tr>
<th>Track Speed (Normal / Passenger) km/hr</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 - 15</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>P3</td>
<td>P3</td>
</tr>
</tbody>
</table>
### Crossings

<table>
<thead>
<tr>
<th>Track Speed (Normal / Passenger) km/hr</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 - 20</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P2</td>
<td>P2</td>
</tr>
<tr>
<td>20 - 25</td>
<td>P2</td>
<td>P2</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
</tr>
<tr>
<td>&gt;25</td>
<td>P1</td>
<td>P1</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
</tr>
</tbody>
</table>

### Check rail bolts

<table>
<thead>
<tr>
<th>Track Speed (Normal / Passenger) km/hr</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loose</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
</tr>
<tr>
<td>1 Missing / Ineffective</td>
<td>P2</td>
<td>P2</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
</tr>
<tr>
<td>2 Missing / Ineffective</td>
<td>P1</td>
<td>P1</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
</tr>
<tr>
<td>≥3 Missing / Ineffective</td>
<td>E2</td>
<td>E1</td>
<td>E1</td>
<td>E1</td>
<td>E1</td>
<td>E1</td>
</tr>
</tbody>
</table>

### Swing nose clearance (mm)

<table>
<thead>
<tr>
<th>Track Speed (Normal / Passenger) km/hr</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>&gt; 1 to 2</td>
<td>P2</td>
<td>P2</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
</tr>
<tr>
<td>&gt;2</td>
<td>P1</td>
<td>P1</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
</tr>
</tbody>
</table>

### Diamond Crossing

#### Variation from design (mm)

<table>
<thead>
<tr>
<th>Track Speed (Normal / Passenger) km/hr</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagonal Length - Diagonal Width</td>
<td>Theoretical Crossing Point</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 6 0 - 2 0 - 5</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>&gt; 6 to 12 &gt; 2 to 3 &gt; 5 - 15</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
</tr>
<tr>
<td>&gt; 12 &gt; 3 &gt; 15</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
</tr>
</tbody>
</table>

### C5-12.2.2 Switches and Stockrails

**Note.** Limits below apply to manual turnout examination only. Tight gauge applies to the switch tip only. Wide gauge applies to the machined section of the switch. Otherwise gauge limits are as per plain track limits.

#### Switches

<table>
<thead>
<tr>
<th>Track Speed (Normal / Passenger) km/hr</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tight Gauge at Switch Tip (mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 - 4 0 - 5</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>5 - 6 6 - 10</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>P3</td>
<td>P3</td>
</tr>
<tr>
<td>7 - 8</td>
<td>N</td>
<td>N</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
</tr>
<tr>
<td>9 - 10 11 - 20</td>
<td>P3</td>
<td>P3</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
</tr>
<tr>
<td>11 - 12 11 - 15</td>
<td>P2</td>
<td>P2</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
</tr>
<tr>
<td>12 &gt; 21 16 - 20</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>E2</td>
<td>E2</td>
</tr>
<tr>
<td>&gt;12 &gt;25 &gt;20</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E1</td>
<td>E1</td>
</tr>
</tbody>
</table>
### Switch face slope

<table>
<thead>
<tr>
<th>Conventional facing switch for gauge face of switch</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>passes switch tip gauge</td>
<td>20/20</td>
</tr>
<tr>
<td>Marginal failure with no more than 1mm variation between top and bottom of gauge</td>
<td>E1</td>
</tr>
<tr>
<td>Marginal failure with more than 1mm variation between top and bottom of gauge With 20km/hr may be reclassified as E2 if no evidence of switch being hit or part climbed by wheel</td>
<td>E1</td>
</tr>
</tbody>
</table>

**Notes.** *For trailing switches consideration must be given to possible facing movements.*

For tangential switches guidance for switch face slope is given in Section C23-12.

### Switch tip height (mm)

<table>
<thead>
<tr>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>20/20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conventional Facing</th>
<th>Tangential Undercut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meets switch tip gauge height and width</td>
<td>P3</td>
</tr>
<tr>
<td>Fails switch tip height no more than -3mm but width 2mm narrower than gauge -5mm but width 4m narrower than gauge see Figure 7</td>
<td>P2</td>
</tr>
<tr>
<td>Fails switch tip height no more than -4mm but width 2mm narrower than gauge -6mm but width 4m narrower than gauge see Figure 7</td>
<td>P1</td>
</tr>
<tr>
<td>Sits high of machined section of stockrail</td>
<td>E2</td>
</tr>
<tr>
<td>Failing the above</td>
<td>E2</td>
</tr>
</tbody>
</table>

**Note.** Switch tip height and width applies to facing movements only. For trailing switches consideration must be given to possible facing movements.
Figure 7 switch tip gauge showing allowance for narrower switch if above height

<table>
<thead>
<tr>
<th>Stock Rail Creep at Switch (mm)</th>
<th>Switch Opening (mm)</th>
<th>Conventional and Tangential Turnouts</th>
</tr>
</thead>
<tbody>
<tr>
<td>trailing and facing points</td>
<td></td>
<td>Track Speed (Normal / Passenger) km/hr</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20/20</td>
</tr>
<tr>
<td></td>
<td>0 to 2</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>&gt; 2 to 4</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>1 to 2</td>
<td>P3</td>
</tr>
<tr>
<td></td>
<td>&gt; 4 to 6</td>
<td>P2</td>
</tr>
<tr>
<td></td>
<td>&gt; 6</td>
<td>P2</td>
</tr>
</tbody>
</table>

| Switch Component condition      |                     | Track Speed (Normal / Passenger) km/hr |
|                                 |                     | 20/20 | 40/40 | 60/60 | 80/90 | 100/115 | 115/160 |
| Rail Brace / Chair              | Switch bearing Stops|                     |
| Cracked / loose Rail braces visibly moving, bolts or fastenings not tight | Cracked / loose. Note. If potential to cause signal failure repair immediately | P3     | P3     | P3     | P3     | P3      | P3      |
| 1 only Broken / Ineffective     | 1 only Missing / Ineffective | P3     | P3     | P3     | P3     | P3      | P3      |
| 2 consecutive Broken / Ineffective | 2 consecutive Missing / Ineffective | P2     | P2     | P1     | P1     | P1      | P1      |
| > 2 consecutive Broken / Ineffective | > 2 consecutive Missing / Ineffective | P1     | P1     | E2     | E2     | E2      | E2      |

| Switch Blade Vertical Support   | Switch Blade Vertical Support |                     |
| Vertical clearance to track plates on A & B Timbers (mm) | Switch tip movement under load. (Heel block pumping) | Track Speed (Normal / Passenger) km/hr |
|                                 | 20/20 | 40/40 | 60/60 | 80/90 | 100/115 | 115/160 |
| 0 to 1                          | No movement | N     | N     | N     | N     | N       | N       |
| 2 to 3                          | Vertical movement is evident 3-6 mm | P3     | P3     | P3     | P3     | P3      | P3      |
| > 3                             | Vertical movement is evident >6 mm | P2     | P2     | P2     | P2     | P2      | P2      |
### Switch Blade Head Mating Surface fit with Stock Rail at the switch tip. (mm)

<table>
<thead>
<tr>
<th></th>
<th>non interlocked</th>
<th>Interlocked</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 1</td>
<td>N</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>&gt; 1 to 2</td>
<td>P3</td>
<td>P3</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
<td></td>
<td>P2</td>
</tr>
<tr>
<td>&gt; 2 trailing</td>
<td>P2</td>
<td>P2</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td></td>
<td>P1</td>
</tr>
<tr>
<td>&gt; 2 facing</td>
<td>P1</td>
<td>P1</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
<td></td>
<td>E2</td>
</tr>
</tbody>
</table>

### Housed Points

<table>
<thead>
<tr>
<th>Height of Housing above Stockrail (mm)</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width of Housing (mm)</td>
<td>20/20</td>
</tr>
<tr>
<td>Flare at end of Housing (mm)</td>
<td></td>
</tr>
<tr>
<td>Vertical Clearance between Switch Tip and Housing (mm)</td>
<td>20/20</td>
</tr>
<tr>
<td>25 - 31</td>
<td>N</td>
</tr>
<tr>
<td>32 – 33</td>
<td>P3</td>
</tr>
<tr>
<td>34 – 35</td>
<td>P2</td>
</tr>
<tr>
<td>36 – 37</td>
<td>P1</td>
</tr>
<tr>
<td>≥38</td>
<td>E1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Housed Points</th>
<th>Flangeway Clearance (mm)</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width of Housing (mm)</td>
<td>20/20</td>
<td>40/40</td>
</tr>
<tr>
<td>Flangeway Clearance (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 50</td>
<td>E2</td>
<td>E2</td>
</tr>
<tr>
<td>48 - 50</td>
<td>P3</td>
<td>P3</td>
</tr>
<tr>
<td>41 - 47</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>40-41</td>
<td>P3</td>
<td>P3</td>
</tr>
<tr>
<td>≤ 39</td>
<td>P1</td>
<td>P1</td>
</tr>
</tbody>
</table>

**Note: 1** The width of housing is limited by the shimming adjustment available (about 10mm). Once the housing has worn to about 140mm it will need to be replaced. Urgency will be determined by the flangeway clearance.

**Note: 2** The impact of the wheels on the flare should be assessed and a priority given based on this. Normally the flare will “wear in” to give minimal impact. Care should be taken when shimming the housing not to create an impact point on the flared ends.

**Note: 3** The 3mm clearance allows free movement of the switch. Speed restrictions will not have any impact on this clearance. The minimum priority set should be P2. More urgent attention may be required if point operation is affected.

**Note: 4** The requirements for switch blade clearances for non-interlocked points are not normally applicable for main line turnouts. The limits for sidings should be used if required see (Section C5-15)

### C5-12.2.3 Switch Tension.

The requirements for switch tension for manually operated points are not normally applicable for main line turnouts. The limits for sidings should be used if required (see Section C5-15).
C5-13  Level Crossings Defects

C5-13.1  Mandatory Limits
Nil

C5-13.2  Guidelines

<table>
<thead>
<tr>
<th>Wide Gauge (mm)</th>
<th>Guard Rail Effectiveness to Gauge face of Opposite rail (mm)</th>
<th>Flangeway Clearance (mm)</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 10</td>
<td>1,375 - 1,380</td>
<td>&gt; 55</td>
<td>20/20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>40/40</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>60/60</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>80/90</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>100/115</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>115/160</td>
</tr>
<tr>
<td>11 - 15</td>
<td>&gt;1,385 - 1,390</td>
<td>P3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>P3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>P3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>P3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>P2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>P2</td>
<td></td>
</tr>
<tr>
<td>15 (20 if due to curve wear)</td>
<td>&gt;1,390</td>
<td>P2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>P2</td>
<td></td>
</tr>
<tr>
<td>&gt; 20 (25 if due to curve wear)</td>
<td>Evidence of wheels striking end of checkrail / flangeway material</td>
<td>P2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Evidence of wheels striking end of guard rail / flangeway material</td>
<td>P2</td>
<td></td>
</tr>
</tbody>
</table>

* Untapered steel guard rails must be recorded as defects and reported to the Civil Maintenance Engineer.

C5-14  Transit Space Defects

C5-14.1  Mandatory Limits
Nil

C5-14.2  Guidelines

<table>
<thead>
<tr>
<th>Clearances other than at Platforms</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral (includes Track Centres)</td>
<td>20/20</td>
</tr>
<tr>
<td>Temporary</td>
<td>Approved Infringement</td>
</tr>
<tr>
<td>&gt; 200</td>
<td>Approved clearances</td>
</tr>
<tr>
<td>&gt; 125-200</td>
<td>&gt; 75 - 100</td>
</tr>
<tr>
<td>&gt; 100-125</td>
<td></td>
</tr>
<tr>
<td>&gt; 50-100</td>
<td>Approved Clearance less 25, if clearances &gt; 50</td>
</tr>
<tr>
<td>0 - 50</td>
<td>0 - 50</td>
</tr>
<tr>
<td>&lt; 0</td>
<td>&lt; 0</td>
</tr>
</tbody>
</table>
# Transit Space

## Platform Clearances

<table>
<thead>
<tr>
<th>Variation from design (mm)</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction in clearance Towards platform</td>
<td>Increase in clearance - Away from platform</td>
</tr>
<tr>
<td>straight curves</td>
<td>straight curves</td>
</tr>
</tbody>
</table>

See Section C19-2

## Platform Height

<table>
<thead>
<tr>
<th>Height of Platform above Actual Rail Level (mm)</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Access Platforms</td>
<td>Level Access Platforms</td>
</tr>
</tbody>
</table>

See Section C19-2

## Track alignment and superelevation relative to design for Overhead Wiring

<table>
<thead>
<tr>
<th>Track Speed (Normal / Passenger) km/hr</th>
<th>20/20</th>
<th>40/40</th>
<th>60/60</th>
<th>80/90</th>
<th>100/115</th>
<th>115/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 x super PLUS 1 x alignment &lt; 30 mm</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2 x super PLUS 1 x alignment = 30 to &lt; 40 mm</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
</tr>
<tr>
<td>2 x super PLUS 1 x alignment = 40 to &lt; 50 mm</td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
</tr>
<tr>
<td>2 x super PLUS 1 x alignment = 50 to &lt; 60 mm</td>
<td>P2</td>
<td>P2</td>
<td>P2</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
</tr>
<tr>
<td>2 x super PLUS 1 x alignment &gt; 60 mm</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>E2</td>
<td>E2</td>
<td>E2</td>
</tr>
</tbody>
</table>

## Track Position relative to OHW

### Rail Level relative to design

<table>
<thead>
<tr>
<th>Rail Level relative to design</th>
<th>Unrestricted areas in Restricted Height Areas</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>20/20</td>
<td>40/40</td>
<td>60/60</td>
</tr>
<tr>
<td>TBD</td>
<td>TBD</td>
<td></td>
</tr>
</tbody>
</table>

## Track Position relative to OHW

<table>
<thead>
<tr>
<th>Alignment to survey Superelevation variation from design</th>
<th>Track Speed (Normal / Passenger) km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>20/20</td>
<td>40/40</td>
</tr>
<tr>
<td>TBD</td>
<td>TBD</td>
</tr>
</tbody>
</table>
### C5-15 Siding Limits and Responses

#### C5-15.1 Mandatory Limits

Nil

#### C5-15.2 Guidelines

##### C5-15.2.1 Geometry

<table>
<thead>
<tr>
<th>Track Geometry</th>
<th>Twist</th>
<th>Gauge</th>
<th>Siding Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Super (Var from design) mm</td>
<td>Top (6m chord) mm</td>
<td>Short (2m) mm</td>
<td>Long (14m) mm</td>
</tr>
<tr>
<td>≤ 40</td>
<td>≤ 25</td>
<td>≤ 17</td>
<td>≤ 40</td>
</tr>
<tr>
<td>41 - 60</td>
<td>28 - 30</td>
<td>53 – 59</td>
<td>29 – 30</td>
</tr>
<tr>
<td>61 – 66</td>
<td>31 - 32</td>
<td>60 – 64</td>
<td>31 – 32</td>
</tr>
<tr>
<td>67 – 71</td>
<td>33 - 34</td>
<td>21 – 22</td>
<td>65 – 70</td>
</tr>
<tr>
<td>72 – 75</td>
<td>35 - 40</td>
<td>23</td>
<td>35 – 37</td>
</tr>
<tr>
<td>&gt;75</td>
<td>&gt; 40</td>
<td>&gt; 23</td>
<td>&gt;70</td>
</tr>
</tbody>
</table>

**Note 1.** Assessment of wide gauge should also include thorough examination of fastening, ties and rail foot condition. Higher priorities and more urgent action should be considered regardless of the actual measured gauge when potential for spread road is evident. Ballast covering ties and fastenings must be cleared to enable detailed examination. If detailed examination is not possible the CME must be informed and a risk assessment carried out to determine action.

#### C5-15.2.2 Ties Bearers

<table>
<thead>
<tr>
<th>Ties / Bearers</th>
<th>Clusters of Consecutive Ineffective Sleepers</th>
<th>Fastenings securing points levers to A&amp;B timbers. Number of secure fastenings</th>
<th>Secondary</th>
<th>Primary</th>
<th>Focal Points or Signalled</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2</td>
<td></td>
<td>4</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>3</td>
<td>N</td>
<td>N</td>
<td>P3</td>
</tr>
<tr>
<td>3 (isolated locations)</td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>P3</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>2</td>
<td>P3</td>
<td>P2</td>
<td>P2</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>1 or 0</td>
<td>P1</td>
<td>E2</td>
<td>E2</td>
</tr>
<tr>
<td>&gt;5</td>
<td></td>
<td></td>
<td>E2</td>
<td>E1</td>
<td>E1</td>
</tr>
</tbody>
</table>
### C5-15.2.3 Turnouts

**Switches**

<table>
<thead>
<tr>
<th>Switch profile</th>
<th>Switch tip height</th>
<th>Secondary</th>
<th>Primary</th>
<th>Focal Points or Signalled</th>
</tr>
</thead>
<tbody>
<tr>
<td>No spalling or broken pieces</td>
<td>Meet mainline switch tip gauge limits</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Minor spalling permissible</td>
<td>Minor non-conformance if no switch tip contact (because of protection from switch protectors)</td>
<td>N</td>
<td>N</td>
<td>P2</td>
</tr>
<tr>
<td>Major chipping switch fails</td>
<td>Switch tip sits higher than stockrail</td>
<td>P2</td>
<td>P1</td>
<td>E2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rod tension on switch at 3mm opening (tonne)</th>
<th>Switch rods</th>
<th>Secondary</th>
<th>Primary</th>
<th>Focal Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thornley</td>
<td>Heavy duty</td>
<td>≥ 0.25</td>
<td>≥ 0.4</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.16 - 0.24</td>
<td>0.3 – 0.39</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.12 – 0.15</td>
<td>P3</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt; 0.12</td>
<td>OK if not critical</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Easy to open</td>
<td>Bent but still closes</td>
<td>P2/P1/E2</td>
</tr>
</tbody>
</table>

**Switch Rail Open Throw (mm)**

<table>
<thead>
<tr>
<th>Switch Rail Toe to Stock Rail</th>
<th>Secondary</th>
<th>Primary</th>
<th>Focal points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual levers only</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;100</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>100-96</td>
<td>N</td>
<td>N</td>
<td>P3/P3/P2</td>
</tr>
<tr>
<td>95-90</td>
<td>P3</td>
<td>P3</td>
<td>P2/P3/P1</td>
</tr>
<tr>
<td>89 – 85</td>
<td>P1</td>
<td>P1</td>
<td>E2/P1/E2/E1</td>
</tr>
<tr>
<td>&lt; 85</td>
<td>E2</td>
<td>E2</td>
<td>E1/P2/P1/E2</td>
</tr>
</tbody>
</table>

**Heel block condition and vertical support**

**Conventional Turnouts with fixed heels**

| Cracked                                              | P3        | P3      | P2/P3/P1     |
| Vertical movement of switch tip < 2mm is evident     |           |         |              |
| Broken but still effective                           | P2        | P2      | P1/P2/P3     |
| > 2mm horizontal and > 4 mm vertical movement of switch tip | E2/E2     | E2/E2  | E2/P1/P3/P2  |

<table>
<thead>
<tr>
<th>Heel Bolts</th>
<th>Heel block vertical support Movement of Switch Tip (mm)</th>
<th>Secondary</th>
<th>Primary</th>
<th>Focal Points or Signalled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolts tight</td>
<td>No movement</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>75% Bolts tight</td>
<td>Vertical movement is evident</td>
<td>P3</td>
<td>P3</td>
<td>P3/P2/P1</td>
</tr>
<tr>
<td></td>
<td>&gt;2 horizontal opening;</td>
<td>P3</td>
<td>P2</td>
<td>P2</td>
</tr>
<tr>
<td></td>
<td>&gt;4 vertical movement</td>
<td>P3</td>
<td>P2</td>
<td>P2</td>
</tr>
</tbody>
</table>
Crossings

<table>
<thead>
<tr>
<th>Checkrail Effectiveness Tight</th>
<th>Checkrail Effectiveness Wide</th>
<th>Secondary</th>
<th>Primary</th>
<th>Focal Points or Signalled</th>
</tr>
</thead>
<tbody>
<tr>
<td>1386</td>
<td>1397</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>1384 – &lt;1386</td>
<td>1398 – 1400</td>
<td>N</td>
<td>P3</td>
<td>P2</td>
</tr>
<tr>
<td>1382 – &lt;1384</td>
<td>&gt;1400</td>
<td>P2</td>
<td>P2</td>
<td>P1</td>
</tr>
<tr>
<td>&lt;1382</td>
<td></td>
<td>E2</td>
<td>E2</td>
<td>E1</td>
</tr>
</tbody>
</table>

Note. Checkrail effectiveness and gauge measurements at “V” & “K” crossings should be taken at a point just behind (nominally 150mm) the point of the crossing to insure that varying crossing nose shapes do not effect consistency of measurement. For “K” crossings this point may have to be further away to allow the measuring board to be square to the measurement point.

Note. Where there is evidence of wheel wear on the gauge face of the crossing nose despite satisfactory checkrail effective measurements this could indicate movement under load. If this is the case then the potential rail play should be assessed and incorporated into static measurements to determine priority.

Gauge through crossing

<table>
<thead>
<tr>
<th>Tight</th>
<th>Wide</th>
<th>Secondary</th>
<th>Primary</th>
<th>Focal Points or Signalled</th>
</tr>
</thead>
<tbody>
<tr>
<td>1431</td>
<td>&lt;1442</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>1428 – &lt;1431</td>
<td>1442 – 1444</td>
<td>N</td>
<td>P3</td>
<td>P2</td>
</tr>
<tr>
<td>1426 – &lt;1428</td>
<td>&gt;1444</td>
<td>P2</td>
<td>P2</td>
<td>P1</td>
</tr>
<tr>
<td>&lt; 1426</td>
<td></td>
<td>E2</td>
<td>E2</td>
<td>E1</td>
</tr>
</tbody>
</table>

Flangeway width

<table>
<thead>
<tr>
<th>Tight</th>
<th>Wide</th>
<th>Secondary</th>
<th>Primary</th>
<th>Focal Points/ Signalled</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 38</td>
<td>&lt;49</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>38 – 36</td>
<td>49 – 51</td>
<td>N</td>
<td>P3</td>
<td>P2</td>
</tr>
<tr>
<td>&lt; 36</td>
<td>&gt;51</td>
<td>P2</td>
<td>P2</td>
<td>P1</td>
</tr>
</tbody>
</table>

C5-15.2.4 Bolts

Bolts should be sufficient to secure each element of the infrastructure.

Missing or loose bolts should be prioritised and replaced/tightened in accordance with their impact on the infrastructure.
Chapter 6 Assessment of Base Operating Conditions

C6-1 Track Geometry

The specified inspection responses assume that the defect is initially identified by a track recording vehicle or by a person without the appropriate competency to inspect and determine the required action. Under these circumstances, it will be necessary for a person with track examination competencies to assess the defect within the specified time and to instigate the required action.

If detected by a person with track examination competencies then assessment must take place at the time of detection.

The mandatory actions are based on geometry defect considerations only. The condition of track components or potential for rapid deterioration may require more urgent response or lower speeds limits until repaired. This is particularly relevant at gauge defects caused by failure of fastenings.

It should be noted that more restrictive criteria may be imposed due to the application of other base operating requirements (e.g. overhead wiring or clearance requirements).

Guidance on speed restrictions to be applied is given in the following sections. However attention should be given to any outstanding defects when carrying out engine inspections to address rough riding conditions. Additional speed restrictions should be imposed if rough riding is found.

The Track Recording Car measures defects to 0.1mm. The base operating limits for geometry are only categorised to the nearest mm. Readings from the Track Recording Car are to be rounded to the nearest mm. (eg 15.1mm becomes 15mm, 15.5mm becomes 16mm, 15.6mm becomes 16mm etc)

Note that the track can be inspected prior to the track geometry car run to review previously identified defects. Defects can be pre-inspected and appropriate action determined in advance. If the track geometry car simply confirms the pre-inspection findings then no further inspection is required in response to the geometry car finding.

Assessing “False” Track Recording Car Readings

The Track Recording Car may give readings that, on initial examination, appear larger than expected (e.g. 40mm wide gauge). Action is required to Inspect and verify the defect in field and, if it is verified as a “false” reading, sign it off as requiring no action. Field verification is not required if staff on the car confirm that the recording for that parameter was not valid. In this case the area covered by the invalid recording should be treated as if it was not recorded. Ludicrous readings e.g. 120mm wide gauge should be treated as invalid. Some defects can be “field verified” by ride on the car itself as indicated in the following sections.

When apparent “false” recordings are classified as E1, the mandatory response is normally “Inspect and Verify before the next train.” Team Managers may extend the Inspect and Verify response period, if they are satisfied by discussion with the operators on the car, by observation of the ride of the car, by knowledge of the track and by close observation of the recording trace, that the defect is a “false” recording. The defect can only be “signed off” after it has been verified by inspection.

The use of this method requires the Team Manager or their representative to hold Track Examination competencies and be present on the Track Recording Car during the recording run.
When assessing defects it should be noted that the Track Recording Car measures the track under loaded conditions. When field staff locate the defect by static measurements that are similar to those found by the AK car the defect size located by the car should be used to determine priority unless otherwise specified in the following assessment instructions.

Track recording graphs must be reviewed as well as a field examination to determine “false” recordings.

CME’s and Team Managers should review “false” defects to prevent actual defects from being dismissed as “false” This can be done by checking current graphs, comparison to previous graphs or spot checking of “false” defects in the field.

C6-1.1 Wide Gauge

C6-1.1.1 Initial Review

Emergency level defects (E1 and E2) for wide gauge MUST be reviewed as Emergency Defects.

Arrange an immediate inspection (if necessary call staff out). If there is good reason to believe the track is secure against further widening (for example it is on concrete sleepered track) and is no more than 37mm wide then the inspection can be downgraded to meet the requirements of a Priority 1 (P1) ie within 24hrs.

Inspection

1. Verify the gauge measured including any play available. Wide gauge excludes head flow.

2. In assessing wide gauge the issues to be considered are:
   ~ The track must be well secured against further widening.
   ~ The high rail must meet the requirements of the rail wear standard including gauge face angle.
   ~ Gauge variation must not be such as to affect ride (should be seen on the versine trace on the graphs, by observing the alignment of the high rail or by observing traffic). 

   If the above conditions are met then no speed restriction should be required pending correction. Otherwise a speed restriction in line with the track condition must be applied.

3. An assessment should be made to determine if there are any locations where gauge has widened significantly between geometry car inspection runs. This assessment should be carried out when the full graphical report becomes available. Such locations are to be the subject of a special inspection using the guidelines above.

C6-1.1.2 Correction

Wide gauge defects are to be corrected in accordance with the standard guidelines.

If, however, the gauge has only been given a Priority (P2) and no problems are found during the inspection then correction can be deferred and the situation reviewed at the next geometry car inspection.

C6-1.2 Tight gauge

Tight gauge defects are shown on the defect list as gauge with a minus sign in front eg -13mm (note that wide gauge defects are shown without the minus sign).
C6-1.2.1 Initial Review
Emergency level defects (E1 and E2) for tight gauge reported by the Track Recording Car may be reviewed as Priority 1 (P1) defects, ie within 24hrs.

C6-1.2.2 Inspection & Assessment
1. Verify the gauge measured and confirm it is genuine. Tight gauge should include head flow but temporary narrow gauge due to switches not being fully closed (until the train passes) is not considered to be tight gauge.
2. Assess if there are any infrastructure problems arising from the tight gauge such as fastenings working loose or rail rolling out under load. An appropriate speed restriction should be applied if problems with the infrastructure are found.
3. Assess the length over which tight gauge is to be found and whether there are any signs of vehicle hunting. This can be seen as wear marks on the gauge face of both rails staggered between rails at intervals of 5m to 20m (from the mark on one rail to the next mark on the same rail). If evidence of hunting is found the speed of affected traffic should be restricted to no more than 80kph. Confirm by visual observation of different types of traffic. Normally only freight vehicles are affected and in most areas of the metropolitan system there is already a blanket restriction of 80kph for freight traffic.

C6-1.2.3 Correction
1. Tight gauge is to be corrected in accord with the standard guidelines.
2. If hunting is found then the track should be corrected within 7. If this is not done a reassessment should take place to ensure that the speed restriction is affective in stopping hunting. If it is not then a further reduction in speed should be imposed. Again the defect should be corrected within 7 days or a further review undertaken.
3. Tight gauge 13-14mm on lines with speed greater than 80km/hr which do not exhibit P1 or E2 problems (as detailed above) do not need to be corrected at the P2 correction timeframe but should be programmed for correction via future rail grinding programs. As resources permit tight gauge at levels of 11mm to 12mm should also be corrected.

C6-1.3 Short Twist
Short twist for track geometry defects are determined using a 2m chord on the car. Defects may be shown as positive or negative. Their absolute value determines their defect status.

C6-1.3.1 Initial Review
Emergency Level defects (E1 and E2) for short twist are to be reviewed as Emergency Defects. A check should be made with track geometry car operating staff to ascertain if the recordings are correct. If they are then the short twist should be the subject of an immediate assessment. This should consider the deterioration potential of the location if known. Apply a speed restriction reflecting the size of the defect and the deterioration potential.

C6-1.3.2 Inspection
Short twist defects are to be inspected in accordance with the standard guidelines. Where Emergency Level (E1 and E2) defects have already been assessed (eg on the track recording car) and a speed restriction applied, further inspection within the inspection response time is not necessary.
Verify the twist measured using manual methods (2m chord). In assessing the defect the issues to be considered are:

- The track geometry under loaded conditions
- The stability of the track and the potential for further deterioration.
- The alignment of the track.

Apply appropriate speed restriction if there is potential for rapid deterioration. It is not mandatory to place a speed if the defect is assessed as having no potential for rapid deterioration and is corrected with the standard period allowed for action. Monitoring may also be required until correction and should be determined by considering the deterioration potential of the defect.

C6-1.3.3 Correction
Short Twist defects are to be corrected in accord with the standard guidelines.

C6-1.4 Long Twist
Long twist for track geometry defects is determined using a 14m chord on the geometry car. Defects may be shown as positive or negative. Their absolute value determines their defect status.

C6-1.4.1 Initial Review
Emergency Level (E1 and E2) defects for long twist are to be reviewed as Emergency Defects. A check should be made with track geometry car operating staff to ascertain if the recordings are correct. If they are then a speed restriction of 20kph should be applied. Correction at least sufficient to reduce the defect below emergency level should be carried out within 24 hours.

C6-1.4.2 Inspection
Long twist defects are to be inspected in accordance with the standard guidelines. Where Emergency Level (E1 and E2) defects have already been assessed (eg on the track recording car) and a speed restriction applied, further inspection within the inspection response time is not necessary.

Verify the twist measured using manual methods (14m chord). In assessing the defect the issues to be considered are:

- The track geometry under loaded conditions
- The stability of the track and the potential for further deterioration
- The alignment of the track
- If the twist ramp is mainly due to a designed transition

Where the twist arises predominantly from the inherent design of the transition ramp and the offending ramp is observably smooth then apply the long twist limits for transitions. These limits provide an additional allowance of 3mm.

Apply appropriate speed restriction if there is potential for rapid deterioration. It is not mandatory to place a speed if the defect is assessed as having no potential for rapid deterioration and is corrected with the standard period allowed for action. Monitoring may also be required until correction and should be determined by considering the deterioration potential of the defect.

C6-1.4.3 Correction
Long Twist defects are to be corrected in accordance with the standard guidelines.
C6-1.5  Top

Top track geometry defects are determined using a 6m chord. Defects may be shown as positive or negative. Their absolute value determines their defect status.

C6-1.5.1  Initial Review

Emergency Level (E1 and E2) defects for top are to be reviewed as Emergency Defects. A check should be made with track geometry car operating staff to ascertain if the recordings are correct. If they are then top should be the subject of an immediate assessment. This should consider the deterioration potential of the location if known. Apply a speed restriction reflecting the size of the defect and the deterioration potential.

C6-1.5.2  Inspection

Top defects are to be inspected in accordance with the standard guidelines. Where Emergency Level (E1 and E2) defects have already been assessed (eg on the track recording car) and a speed restriction applied, further inspection within the inspection response time is not necessary.

Verify the top measured using manual methods (6m chord). In assessing the defect the issues to be considered are:

- The track geometry under loaded conditions.
- The stability of the track and the potential for further deterioration.
- The presence of other geometry defects and factors affecting the ride of trains.

Apply appropriate speed restriction if there is potential for rapid deterioration. It is not mandatory to place a speed if the defect is assessed as having no potential for rapid deterioration and is corrected within the standard period allowed for action. Monitoring may also be required until correction and should be determined by considering the deterioration potential of the defect.

C6-1.5.3  Correction

Top defects are to be corrected in accordance with the standard guidelines.

C6-1.6  Superelevation

Track recording car graphs should be assessed for variation from design superelevation. This should be done in post-analysis. By observation the defect would normally be seen as a variation from smooth. Where deviations from design superelevation are found compliance with BOCS is recommended (but check that the calibration on the Track Geometry Recording Car is not in error).

C6-1.7  Line

Line track geometry defects are determined using a 8m chord measured at mid-ordinate and comparing the actual versine against the design versine. Defects may be shown as positive or negative. Their absolute value determines their defect status.

C6-1.7.1  Initial Review

Emergency Level (E1 and E2) defects for line are to be reviewed as Emergency Defects. The degree of concern will relate directly to the jerk experienced by persons on the track geometry car (considering the speed of the car). If the defect registered by the track geometry car is genuine then an immediate speed restriction is recommended in line with the ride performance. In the absence of such an assessment apply the default speed restriction limits.
C6-1.7.2 Inspection

Line defects are to be inspected in accordance with the standard guidelines. Where Emergency Level (E1 and E2) defects have already been assessed (eg on the track recording car) and a speed restriction applied or where the team manager or their representative on the car has determined that it was a false recording, further inspection is not necessary.

Verify the line measured by assessing the ride/dynamic performance of trains either from a front of train or by observing trains passing over the site at track speed. The requirement for a speed restriction will depend primarily on this assessment. Line defects should be re-classified and a revised priority allocated on the basis of this assessment. In the absence of such an assessment a speed restriction should be applied to bring the operating speed to no more than the BOCS default speed.

In analysing the cause of the problem and corrective action the defect should be assessed by manual measurements or by using the data from the track geometry car.

C6-1.7.3 Correction

Line defects may be difficult to correct within short timeframes. Reclassified line defects are to be corrected with priority based on consideration of the effects of any speed restriction imposed. All line defects outstanding are to be monitored during routine track patrol and during scheduled front of engine inspections.

C6-2 Rail Wear

Confirm head losses for P1 and P3 by detailed measurement, excluding head flows, and make assessment based on detailed head area.

C6-2.1 Relaxation of Condemning Limits

When rail wear (either tangent wear "A" or Curve wear "B") reaches P3 level (formerly called the Reportable limit) continual review and assessment is required so that rerailing may be undertaken before the condemning (P1) level is reached.

When rail tangent wear (reduction in head height) on 60kg/m rail reaches P3 level (formerly called Reportable limit) assess the location and operating conditions to determine whether rail wear may be permitted beyond the condemning (P1) level. Assess the total allowable % head loss in accordance with Table 4. Calculate the head loss from head width and height in accordance with Section C6-2.2.
<table>
<thead>
<tr>
<th>Sleeper Type</th>
<th>Axle Load</th>
<th>Curvature</th>
<th>Condemning limit (% Head loss)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>60 HH</td>
</tr>
<tr>
<td>Concrete Sleepers</td>
<td>30 Tonne</td>
<td>200 - 300m</td>
<td>47%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>300 - 400m</td>
<td>51%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>400 - 600m</td>
<td>58%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>600m or greater</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>25 Tonne</td>
<td>200 - 300m</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>300 - 400m</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>400 - 600m</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>600m or greater</td>
<td>60%</td>
</tr>
<tr>
<td>Timber Sleepers with elastic</td>
<td>30 Tonne</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>fastenings (In Face)</td>
<td>25 Tonne</td>
<td>200 - 300m</td>
<td>41%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>300 - 400m</td>
<td>44%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>400 - 600m</td>
<td>48%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>600m or greater</td>
<td>52%</td>
</tr>
<tr>
<td>Timber Sleepers with</td>
<td>25 Tonne</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>dogspikes</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4 - Allowable Head Loss on 60kg/m rail

Note 1: NA - no reduction in curve wear limit is allowed.
Note 2: Notwithstanding the % head loss limits above the maximum tangent wear limit for 60kg rail is for a head depth of 24mm.
Note 3: Once 60kg and 53kg rails reach the [P3] level which are limiting wear limits for potential VSH defect development, the following options are possible in order extend the limits to the [P1] values specified in Section C5-5.2 or for 60kg rail the head loss values in Table 4:
- Grind the rails to the profiles specified in Engineering Manual TMC 225.
- Ensure that no defects are developing in the rails by taking special care with the ultrasonic inspection.

C6-2.2 Calculation of Head Loss

Where it is necessary to establish the percentage loss of area of the rail head in 60kg/m or 53kg/m rail, the following method may be used:
1. Measure the remaining head width and head depth using the method in Section C14-1.
2. Determine head loss values by referring to Table 5 for 60kg/m rail or Table 6 for 53kg/m rail.
3. More accurate determinations can be made directly using rail profile measuring systems.
### Table 5 - Loss of rail head area (%) 60kg/m rail

<table>
<thead>
<tr>
<th>Remaining Head Depth</th>
<th>Loss of Head Area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60kg/m rail</td>
</tr>
<tr>
<td></td>
<td>Remaining Head Width</td>
</tr>
<tr>
<td></td>
<td>45</td>
</tr>
<tr>
<td>34</td>
<td>47</td>
</tr>
<tr>
<td>33</td>
<td>49</td>
</tr>
<tr>
<td>32</td>
<td>51</td>
</tr>
<tr>
<td>31</td>
<td>53</td>
</tr>
<tr>
<td>30</td>
<td>56</td>
</tr>
<tr>
<td>29</td>
<td>57</td>
</tr>
<tr>
<td>28</td>
<td>59</td>
</tr>
<tr>
<td>27</td>
<td>61</td>
</tr>
<tr>
<td>26</td>
<td>63</td>
</tr>
<tr>
<td>25</td>
<td>62</td>
</tr>
<tr>
<td>24</td>
<td>63</td>
</tr>
<tr>
<td>23</td>
<td>65</td>
</tr>
<tr>
<td>22</td>
<td>67</td>
</tr>
<tr>
<td>21</td>
<td>65</td>
</tr>
<tr>
<td>20</td>
<td>66</td>
</tr>
<tr>
<td>19</td>
<td>63</td>
</tr>
</tbody>
</table>

### Table 6 - Loss of rail head area (%) 53kg/m rail

<table>
<thead>
<tr>
<th>Remaining Head Depth</th>
<th>Loss of Head Area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>53kg/m rail</td>
</tr>
<tr>
<td></td>
<td>Remaining Head Width</td>
</tr>
<tr>
<td></td>
<td>45</td>
</tr>
<tr>
<td>34</td>
<td>39</td>
</tr>
<tr>
<td>33</td>
<td>42</td>
</tr>
<tr>
<td>32</td>
<td>44</td>
</tr>
<tr>
<td>31</td>
<td>46</td>
</tr>
<tr>
<td>30</td>
<td>48</td>
</tr>
<tr>
<td>29</td>
<td>50</td>
</tr>
<tr>
<td>28</td>
<td>52</td>
</tr>
<tr>
<td>27</td>
<td>54</td>
</tr>
<tr>
<td>26</td>
<td>56</td>
</tr>
<tr>
<td>25</td>
<td>58</td>
</tr>
<tr>
<td>24</td>
<td>60</td>
</tr>
<tr>
<td>23</td>
<td>63</td>
</tr>
<tr>
<td>22</td>
<td>64</td>
</tr>
<tr>
<td>21</td>
<td>61</td>
</tr>
<tr>
<td>20</td>
<td>66</td>
</tr>
<tr>
<td>19</td>
<td>63</td>
</tr>
</tbody>
</table>

© Rail Corporation
Issued April 2013

UNCONTROLLED WHEN PRINTED
C6-3  Rail Condition
C6-3.1 Fishplates - (Includes Broken and Cracked Plates at Insulated Joints)
To be determined.
C6-3.2 Sleeper Support at Fish-Plated Joint
To be determined.
C6-3.3 Rail Joint Adjustment at Fish-Plated Joint
Review risk of wheel climb for E1, E2 and P1 (track curvature, horizontal angle at joint, foulness of joint, joint vertical and lateral integrity).
C6-3.4 Loose or Ineffective Fish Bolts and Swage Fastenings at Fish-Plated Joint
Assess joint for E1 and E2, restrict or stop trains depending on support conditions, max speed 20km/h, observe site prior to passage of each train until ineffective bolts are replaced.
Note: The BOS tables are based on 6 hole fishplates;
C6-3.5 Rail End Condition at Fish-Plated Joint
To be determined.
C6-3.6 Rail Contact Fatigue
To be determined.
C6-3.7 Wheel Burns
Assess E2 P1 and P2 to establish if speed restriction is required to control damage, Review Rail Maintenance strategy and arrange corrective grinding within 3 months.
C6-3.8 Rail Surface Condition - Fish Scaling and Spalling
Assess P1 and P2 to establish if speed restriction is required to control damage, Review Rail Maintenance strategy and arrange corrective grinding within 3 months.
C6-3.9 Insulated Rail Joints
To be determined.
C6-4  Sleepers
C6-4.1 Missing Sleepers or Excessive Spacing
Repair within P1 within 7 days unless assessed by Civil Maintenance Engineer in consideration of current operations or after placement of appropriate operational restrictions (eg speed, axle load).
C6-4.2 Ineffective Clusters
Assess E1 to establish if continued operation should be permitted dependent on traffic type, boarded speed, track geometry, local risk factors detailed assessment of sleeper condition and deterioration potential. Monitor each train until repaired.
Apply immediate speed restriction on E2 to reduce impact dependent on traffic type, boarded speed, track geometry, local risk factors detailed assessment of sleeper condition and deterioration potential. Monitor at appropriate interval until repaired.
Assess need for speed restriction on $P_1$ and $P_2$ dependent on traffic type, boarded speed, track geometry, local risk factors, detailed assessment of sleeper condition and deterioration potential. Monitor weekly until repaired.

C6-4.3 Ineffective Sleepers at Joints
Assess $E_1$ to establish if continued operation should be permitted dependent on traffic type, boarded speed, track geometry, local risk factors detailed assessment of sleeper condition and deterioration potential. Monitor each train until repaired.

Assess need for speed restriction on $P_2$ dependent on traffic type, boarded speed, track geometry, local risk factors, detailed assessment of sleeper condition and deterioration potential. Monitor each patrol until repaired.

C6-5 Ballast
C6-5.1 Ballast Profile Deficiencies
$P_1$ May be reduced to $P_2$, depending on current and expected weather conditions and other stability loss factors.

C6-5.2 Excess Ballast, Poor Drainage and / or Ballast Condition
To be determined.

C6-6 Turnouts
The applicability of these requirements may vary depending on whether the turnout is a conventional or tangential type.

C6-6.1 Tight Track Gauge at Switch Tip
C6-6.1.1 Inspection
The inspection should:

1. Verify the gauge measured and confirm it is genuine. Tight gauge should include head flow but temporary narrow gauge due to switches not being fully closed (until the train passes) is not considered to be tight gauge.

2. Assess if there is any infrastructure problems arising from the tight gauge such as fastenings working loose or rail rolling out under load. An appropriate speed restriction should be applied if problems with the infrastructure are found.

C6-6.1.2 Correction
See plain track geometry.

C6-6.2 Wide Track Gauge
C6-6.2.1 Inspection
The inspection should:

1. Verify the gauge measured and confirm it is genuine.

2. See plain track geometry.

C6-6.2.2 Correction
1. Monitor in line with deterioration potential.

2. See plain track geometry.
C6-6.3  Switch Throat to Stockrail

C6-6.3.1  Correction
Additional action may be required for signalling purposes where the switch rail throat opening dimension is less than 50mm.

C6-6.4  Switch Rail Toe to Stock Rail

C6-6.4.1  Correction
Additional action may be required for signalling purposes.

C6-6.5  Bearers
Assess $E_1$ to establish if continued operation should be permitted dependent on traffic type, boarded speed, track geometry, local risk factors detailed assessment of bearer condition and deterioration potential.

Apply immediate speed restriction to $E_2$ to reduce impact dependent on traffic type, boarded speed, track geometry, local risk factors detailed assessment of bearer condition and deterioration potential. Monitor at appropriate interval until repaired.

Consider requirement for speed restriction for $P_1$ and $P_2$ depending on traffic type, speed, track geometry, local risk factors, detailed assessment of bearer condition and deterioration potential. Monitor weekly until repaired.

C6-6.6  Component condition
Heel Blocks, Rail Brace / Chair, Switch bearing Stops.

To be determined.

C6-6.7  Switch Blade Damage
To be determined.

C6-6.8  Stock Rail or Switch Rail Gauge Face Wear Angle (Conventional)
To be determined.

C6-6.9  Stock Rail or Switch Rail Gauge Face Wear Angle (Tangential)
To be determined.

C6-6.10  Switch Rail Angle
To be determined.

C6-6.11  Stock Rail Gauge Face Wear
To be determined.

C6-6.12  Switch Tip Height (Conventional)
To be determined.

C6-6.13  Switch Tip Height (Tangential)
To be determined.

C6-6.14  Switch Gauge Corner Radius
To be determined.
C6-6.15 **Switch Width and Wear at Tip (Conventional)**

For P1, E2 and E1, as part of specified inspection determine the cause and risk of derailment.

C6-6.16 **Switch Blade Head Mating Surface Fit With Stock Rail**

Report to signalling representative.

C6-6.17 **Check Rail Effectiveness**

The main effectiveness of the checkrail is its ability to protect the crossing nose. Wheel contact with the crossing nose is therefore a vital observation to be made during inspections. Any sign of excessive damage to the crossing nose is reason for replacement/adjustment of the checkrail regardless of the check rail wear.

C6-6.18 **Gauge Through Crossing**

*To be determined.*

C6-6.19 **Height of Check Rail**

*To be determined.*

C6-6.20 **Check Rail Flangeway Width / Depth**

Flangeways should be checked for blockages and cleared where blocked.

These will normally be measured in response to other problems.

C6-6.21 **Crossing Nose - Vertical Wear**

*To be determined.*

C6-6.22 **Wing Rail - Vertical Wear**

*To be determined.*

C6-6.23 **Cracks in Cast Crossings**

1. Non critical - means cracks longitudinally or vertically that may eventually cause a crossing to need repair.
2. Critical - means cracks longitudinally or vertically that may lead to a piece of crossing eventually lifting or breaking out and affecting the running surface integrity.
3. Fully (not affecting the running surface) - means a crack that runs the full section of the crossing such that the crossing is in two pieces, all fastenings are secure and does not impact on the running surface (eg Tang area of crossing).
4. Fully (affecting the running surface) - means a crack that runs the full section of the crossing such that the crossing is in two pieces and fastening are not secure or the break affects running surface integrity.
5. Rail Bound Manganese Crossings- elongated cracks - have the potential to develop into broken rails.
6. For P1, E2 and E1, include assessment of derailment potential within required inspection and respond accordingly.

C6-6.24 **Crossing nose - Gauge Face Wear**

*To be determined.*
C6-6.25 Crossing Nose Break
Non critical - means cracks longitudinally or vertically that may eventually cause a crossing to need repair.

For P1, E2 and E3, include assessment of derailment potential within required inspection and respond accordingly.

C6-6.26 Check Rail Bolts

1. The end bolts of all checkrails should be effective.
2. Crossing Bolts - assess individual defects for the effectiveness of the bolts. Ineffective bolts include missing or broken bolts. Loose bolts should be tightened. Missing or ineffective bolts should be replaced.

C6-6.27 Swing Nose Clearance

To be determined.

C6-6.28 Diamond Crossover

To be determined.

C6-7 Level Crossings
C6-7.1 Assessment

Where there is evidence of wheels striking end of checkrail material, assess the cause. It may be due to wide gauge or a reduction in flangeway clearance. In either case the sleepers and/or fastenings may be ineffective. Look for signs of movement.

Inspect for debris and other material in the flangeway to assess the risk of impact on wheel flanges (density, strength and level of compaction of debris). Default response is P1 Priority.

C6-8 Transit Space
C6-8.1 Assessment

The Base Operating limits are the minimum conditions for the passage of Rollingstock operating under normal operating conditions only. It does not include any extra clearance between Rollingstock and Infrastructure to allow for any people or objects to protrude from either vehicle or structure.

It should be noted that more restrictive criteria may be imposed due to the application of other standards (e.g. overhead wiring or clearance requirements).

Specified inspection responses presuppose the defect is initially identified by track recording vehicle or by a person without appropriate competency to inspect and determine the required action. Under these circumstances, it will be necessary for a competent worker to assess the defect within the specified time and to instigate the required action.

C6-8.2 Temporary Operational Infringements of Lateral Kinematic Plus 200mm or Vertical Kinematic Plus 100mm

For locations where no clearance waivers are in place and where Operational Infringements are encountered when the defined lateral safety clearance margin beyond the appropriate rolling stock outline is reduced below 200mm or when the defined vertical safety clearance margin beyond the appropriate rolling stock outline is reduced below 100mm. These Operational Infringements are not to be approved to remain permanent.
Seek approval from the Civil Maintenance Engineer if the infringement is to remain for a temporary duration.

Assess hazard for E2, impose restrictions and correct.

Assess risk of further deterioration for P1 and develop an appropriate inspection and response program.

Assess risk of further deterioration for P2 in clearance and verify response.

Infringements may be caused by a combination of alignment variation from design or superelevation variation from design.

If there are recent scrape marks or gouges on minimum clearance track to structures, including platforms, treat the incident as an E2 Priority. In addition, consult with Network Control if a vehicle is suspected as the cause of the problem.

Speed must be low enough (considering track condition) to ensure there are no excessive vehicle dynamics;

C6-8.3 Approved Operational Infringements of Less than Kinematic Plus 100mm or of Vertical Kinematic Less than 100mm

For locations where clearance waivers are in place covering permanent Operational Infringements when the defined safety clearance margin beyond the appropriate rolling stock outline is reduced below 100mm.

Assess hazard for E2, impose restrictions and correct. Examine maintenance procedures and modify as appropriate.

Assess risk of further deterioration for P1 and develop an appropriate inspection and response program. Examine maintenance procedures and modify as appropriate.

Assess risk of further deterioration for P2 in clearance and verify response.

Infringements may be caused by a combination of alignment variation from design or superelevation variation from design.

Refer to Infringement Authorisation for specific limits and conditions.

If there are recent scrape marks or gouges on minimum clearance track to structures, including platforms, treat the incident as an E2 defect. In addition, consult with Network Control if a vehicle is suspected as the cause of the problem.

C6-8.4 Platform Lateral and Vertical Clearance

Assess hazard for E2, impose restrictions and correct. Examine maintenance procedures and modify as appropriate.

Assess risk of further deterioration for P1 and develop an appropriate inspection and response program. Examine maintenance procedures and modify as appropriate.

Assess risk of further deterioration for P2 in clearance and verify response.

Consult with Operations where movement is away from platforms for P1 and E2 defects.

C6-8.5 Alignment with Respect to Overhead Wiring

Calculate the sum of the alignment variation (if any) with twice the super variation (if any).

Have the site checked by electrical maintenance staff where the alignment variation results in a P2, P1 or E2 defect.
Chapter 7  Track Patrol

Track Patrol is a visual examination of the track and right of way which ensures:

− there are no obstructions to train movements or signalling equipment within (or potentially within) the structure gauge;
− there is continuity of Rails (i.e. no broken rails or joints, or loose or foul joints);
− there are no imminent failures of track fastenings;
− there are no major track geometry defects (of derailment potential) without suitable protection;
− there are no major deficiencies in the supporting track structure (resulting from earthworks, bridges, structures, culverts, etc.);
− that permanent and temporary speed signs are visible to train/track vehicle operators (are present, facing the right direction, not obscured by trees, graffiti etc.);
− that temporary speed signs have been placed correctly, are accurate (have all the right plates in the right order and working lights) and, are standing securely.

C7-1  Patrol Methods

Track Patrol in RailCorp is undertaken by a number of methods. These include:

− Walking Patrol (including Adjacent Track Patrol and Night Patrol)
− Hi-rail Patrol (including Night Patrol)
− Engine Patrol
− Mechanised Track Patrol
− Supplementary Patrol

These patrol methods may be applied in combination by Civil Maintenance Engineers in accordance with criteria detailed in ESC 100 – Civil Technical Maintenance Plan to form an Integrated Track Patrol regime.

C7-2  Examination Requirements

1. The default patrol method is ‘Standard Track Patrol’.
2. Integrated Track Patrol may be implemented by Civil Maintenance Engineers
3. The Chief Engineer Track may approve the substitution of ‘Standard Track Patrol’ by Night Patrols and Adjacent Track Patrols.

C7-2.1  Standard Track Patrol

Track Patrols are carried out in daylight hours by walking or by Hi-rail vehicles (where they are permitted).

C7-2.1.1  Walking Patrol

1. Where a walking patrol is to be carried out, two tracks may be examined by walking on one track whilst examining both tracks. Where adjacent tracks are separated (eg. at island platforms) it is not possible to patrol one track from the other and each track is to be patrolled separately.
2. Alternate the direction of walking patrol so that the tracks are walked over equally.
C7-2.1.2  **Hi-Rail Patrol**

1. Where a track patrol is carried out using a Hi-rail vehicle, the nominal speed is to be 20 kph, however the maximum and average speed of patrol will be determined by local conditions and will vary from length to length. e.g. Track with known good sleepers and fastenings may be patrolled at a higher speed than track of poor sleepers and fastenings.

2. When a track vehicle is used to patrol multiple tracks, each line is to be patrolled separately.

3. At poor GIJ condition locations that are nominated for Supplementary Patrol, slow the Hi-Rail vehicle down to a speed necessary to conduct the examination, to increase the opportunity to detect broken GIJ plates on the field side of rails.

   This requirement applies to poor condition GIJ’s in plain track and at the boundaries of turnouts and special track work.

4. At turnouts and special trackwork, slow the Hi-Rail vehicle down to a speed necessary to conduct the examination), to increase the opportunity to detect broken plates and rails. The purpose is to increase visibility from the HiRail cab.

5. At Level Crossings slow the Hi-Rail vehicle down to a speed necessary to conduct the examination.

C7-2.2  **Engine Patrol**

Track Patrol may be carried out from the front of an engine instead of by walking or by track vehicle. This may only occur:

− Where patrol by engine is included in an Integrated Track Patrol regime, OR
− when a patrol opportunity is lost due to strike/ loss of possession etc, a single standard patrol may be replaced by an Engine Patrol, OR
− to supplement routine patrols such as during special events.

The primary purpose of the patrol by engine is to identify critical hazards or potentially critical hazards requiring attention in the short term. A secondary purpose is to identify lower priorities that can be reviewed in more detail in the walking patrol.

Engine Patrols are not Front of Train Examinations and should be undertaken on the slowest train service. If, however, the fastest and slowest services coincide, the inspections can be combined.

Any serious safety issues identified must be followed up with a site inspection.

C7-2.3  **Mechanised Track Patrols**

Mechanised Track Patrols may be used as part of an Integrated Track Patrol regime approved Civil Maintenance Engineers.

Mechanised Track Patrol utilises a Special Patrol Vehicle (SPV) to allow patrollers to conduct an Engine Patrol while also recording track imagery utilising various camera views. The patrol includes a detailed review of the recorded imagery within a 24 hour period.

1. Track Patrols are to be carried out in daylight hours.

2. The SPV is to have a patroller present conducting an engine patrol observing the track and noting any locations of concern for immediate action or for further assessment during the Detailed Review. Patrollers will not normally leave the SPV during patrols.
3. Where possible patrollers on the vehicle and conducting the Detailed Review should be familiar with the territory being examined. Should this not be possible then the patrollers must be briefed on what to look out for by a patroller familiar with the territory.

4. Supplementary inspections of any suspect conditions are to be arranged where required.

5. In the event of a loss of patrol from the SPV, the patrol frequency (including latitude) detailed in ESC 100 - Civil Technical Maintenance Plan must be maintained. This can be achieved by obtaining an emergency Walking Patrol or by re-running the SPV with same day inspection.

6. If next day playback is affected (or for any other failure to meet the maximum patrol frequency) an emergency inspection of any outstanding Supplementary Patrol locations is to be carried out that night and a Walking Patrol of the full section conducted the following day.

7. Where track view and easement view imagery cannot be captured due to low light conditions, rail view cameras must be used to assess rail continuity.

8. In tunnels and dives lighting may not be effective enough for MTP imagery and Engine Patrol. In this case additional walking patrols must be conducted.

**C7-2.4 Supplementary Patrol**

Supplementary Patrol is a site specific Walking Patrol used to patrol locations of identified poor condition as part of an Integrated Track Patrol regime. It is used in the following locations:

- Timber sleepered track that is not well tied or providing adequate vertical support.
- Glued Insulated Joints in poor condition with poor geometry, formation failure, chipped rail ends or evidence of heavy impact (extensive whitened ballast, plates working loose, or poor sleepers.
- Turnouts & special trackwork in poor condition with flogging joints, joints with poor lateral support, poor fastenings & bearers at crossing/checkrail, heeled switches with flogging heels or with strong crack predictors.
- K crossings on curves.

While all examinations provide opportunities to detect conditions requiring additional examination, the prime examinations for triggering Supplementary Patrol are the Detail Tie Examination, the Examination of Special Track Layouts, Examination of Insulated Joints, and Ultrasonic Examination of Turnouts.

**C7-2.5 Non Standard Track Patrols**

**C7-2.5.1 Adjacent Track Patrol**

An Adjacent Track Patrol is a daytime inspection in which the track is inspected from an adjoining track but no more than a distance equivalent to two track widths.

**C7-2.5.2 Night Patrol**

In the metropolitan area patrol in daylight hours may not be possible in some locations. In such locations Track Patrol may be routinely carried out at night by using an on-rail vehicle, provided:

- There is adequate lighting to detect infrastructure defects. Hand torches alone are generally not considered adequate for this purpose (Note 1). Extra lighting equipment would normally be fitted to an on-rail vehicle.
- Inspection of plain track may be undertaken by track vehicle, but critical areas such as turnouts and diamonds are to be examined on foot using extra lighting provided by the on-rail vehicle.
− inspection of tracks adjacent to the track the on-rail vehicle is on may be undertaken on-foot using torches and using the additional lighting provided by the vehicle.
− There must be at least one daytime inspection per week of each track. This can be carried out from the front of an engine. This is required to provide an additional level of assurance and cover long-sight geometry, right of way and other issues along the track.

Note 1: Approval may be given by the Chief Engineer Track for the use of torches at night in detailed patrol inspections of special elements of the track such as turnouts & crossovers. In these inspections only the area in the immediate vicinity of the torch needs to be examined (no zonal aspects are considered).

Tunnels and similar areas fitted with permanent lighting may be patrolled in the same manner as for daylight patrols without any special approval.

C7-3 Walking and Hi-Rail Patrol Procedures

C7-3.1 During the Patrol

1. Examine for obstructions to train movements or signalling equipment within (or potentially within) the structure gauge. Look for:
   ~ Track movement that results in narrowing of track centres, or fouling of platforms and other structures
   ~ Movement of structures
   ~ Ballast or rubbish in points or train stops
   ~ Visible indications of rail vehicles scraping structures.
   ~ Trees or other objects that may fall on the track,
   ~ Material or equipment foul of the track.

Watch out for trip arm infringements eg animals, rocks, ballast, sleepers etc. The trip infringement sits between 400mm and 700mm out from the gauge face and between 50mm and 300mm above rail height (see Figure 8).

2. Examine for obstructions to the wheel path of the train (e.g. in flangeways)

3. Examine rail condition. Look for:
   ~ Broken rails, joints, breakaways, and loose or foul joints, fishbolts and fishplates.
   ~ Visual indicators of Vertical Split Head rail defects.

The defect can be identified by a flattening out of the rail head and widening of the shiny portion of the rail (the contact band) (see Figure 9). Note that other conditions such as wear patterns on closures, the wheel contact point after a
weld and adverse rail loading can indicate the same change in wear pattern. This may also be accompanied by rust stains down the web if the cracking has reached the surface on the underside of the rail head near the web, see Figure 10.

![Figure 9 – Indications of VSH defect](image)

![Figure 10 – Rust band under head of rail](image)

- Visible indications of excessive rail wear.
- Visual indications of wheel burns.
- Visual indications of squats.
Squat defects in rails are one of the various types of rail defects.

- They are easily identified visually as they appear as dark shadowy areas on the crown of the head with an associated widening of the running band (see Figure 11) and sometimes surface cracking or spalling. Squats are not, however, reported by the ultrasonic testing vehicle unless they develop into other defects (which is rare).

- Squats should not be confused with wheelburns or corrugations. Wheelburns usually occur in pairs whereas squats are normally only present on one rail. Whilst squats can be cyclic they are not as regular as corrugations (see Figure 12).

- The defective area seems darkened because of the sub-surface cracking which typically occurs on the horizontal plane, approximately 3-5mm below the rail surface, and which causes a depression on the rail surface.
4. Examine insulated joints. Areas with the potential to deteriorate rapidly causing signal failures are the main target, especially the high rail of sharp curves and mechanical insulated joints with the potential to close up in hot weather. Other locations may be nominated. Look for:
   ~ Rail end flow debris across the key that could short circuit the joint.
   ~ Any evidence of cracking or rust stains indicating cracking between the joint gap and the first bolt hole at the bottom of the plates.
   Glued Insulated Joints break in the plates generally between the joint gap and the first bolt hole. Once one side breaks the other side can break fairly rapidly. The cracks develop at the bottom of the plate on the outside or the inside corner. On the outside the cracks are visible but not if they start on the inside of the plate.
   Where overflow of glue inhibits the visual inspection scrape it off to facilitate examination.
   ~ Evidence of movement occurring between the rail and the plate particularly in the area between the joint gap and the first bolt hole.
   ~ Build up of grease, filings wheel scale or other debris across the key that could short circuit the joint.
   ~ Squeezed out keys.
   ~ Broken, visibly cracked or missing joint insulation material.

5. Examine for untested wire feed or aluminothermic welds (fluoro pink marking).

6. Examine for failures of sleepers and fastenings. Look for:
   ~ Broken or defective sleepers.
   ~ Chemical reagents on the track which could affect concrete ties/slabs.
   ~ Obvious indications of wide gauge including:
     - irregular horizontal alignment of one rail;
     - wear pattern of the rail head approaching the gauge face;
     - back canting of rails; lifting of the inside spikes or outside edges of the sleeper plates planing into the timber;
     Problems have been experienced with Pandrol plated ties being used in dogspered track with rail backcanting, where the Pandrol clips have broken after a short time. This is caused by the Pandrol clips bearing the load that would normally be distributed among a number of sleepers.
   ~ Rail play under load; loose outside spikes, movement of the rail between the inner and outer spikes, movement of the rail and sleeper plate assembly on the timber.
   ~ Missing spikes or resilient fastenings and insulators.
   If sleepers and fastenings are not visible during Routine Track Patrol this MUST be registered in the Defect Control System. The priority for removal depends on the patroller’s knowledge of the condition of the sleepers.

7. Examine for failure of transoms and broken, missing or loose lockspikes, or plate play on transoms.
   Pay particular attention to bridge ends particularly if there is track pumping in the adjoining ballasted track. Lockspikes may corrode due to moisture (see Figure 13). Moisture damage also occurs in the transoms.
   If evidence of failure is found, report this to the Team Manager who will arrange a more detailed inspection to check if other spikes are sheared off (these can be sheared off below the plate but still appear solid in the plate). If in doubt sample spikes should be extracted and checked for damage and corrosion.
8. Check track geometry. Look for:
   ~ Major defects in top, line, twist or superelevation that could cause a derailment.
   ~ Pumping or unstable track.

9. Examine for major deficiencies in supporting track structure. Check for:
   ~ signs that embankments or cuttings are slipping.
   ~ Signs that under track crossings are settling and causing track geometry defects.
   ~ Signs that excavations close to the track are collapsing.
   ~ Obvious defects in track geometry that will indicate that bridges or culverts have failed.
   ~ Erosion of embankments or cutting faces.

10. Examine mainline special layouts. Look for:
    ~ Obstructions in points, crossings or flangeways.
    ~ Swingnose crossings will not operate properly when there are obstructions or a build up of material between the point and wing rails. Check that no spillage of coal, ballast or other product has occurred. All spillage should be removed.
    ~ Visibly worn or broken switch noses.
    ~ Any arris, notching or cracking on the foot of 53kg/m switches from 1.5m to 3m back from the tip.

    Broken switches can arise from wear on the inside of the switch. The inside of the switch becomes ragged and notched. The most likely evidence of failure will be signs of a crack running along the foot and up the web (see Figure 14). There may be grease on the foot but any cracking on the web should be visible. The head of the rail will be the last part of the rail to fail.

    Particular focus needs to be directed at switches which are heavily used. Switches that are subject to high lateral loads are more likely to suffer from this defect. High lateral loads will arise from a well used turnout road or where the main line switch is on a curve.

    This defect condition does not affect 60kg/m switches of either conventional or undercut design.
Defect originating from worn notched edge on the inside of the switch

Rusted area shows where crack has been present prior to failure

Figure 14 – Switch defect

~ Switches laying open or pumping heels.
~ Defective fastenings including chairs, studs or bolts.
   NOTE: When undertaking patrol on Ancillary Lines adjacent to main line tracks on which the Extended Walking Track Patrol regime is operating, inspect any mainline turnouts that connect to the Ancillary line for loose or broken chairs and fasteners.
~ Cracked/broken crossings or checkrails.
~ Loose/broken crossing or checkrail bolts.
   Examine fastenings between raised check rail and the supporting chairs
~ Damaged crossing nose.
~ Signs that gauge at crossing is incorrect.

11. Check ballast condition. Look for:
~ Fouled ballast.
~ Obvious ballast deficiencies.

12. Check all piped drainage, sump covers, grates, surface drains and inlets of waterways when visible from the four foot. Look for:
~ Obviously ineffective drainage.
~ Evidence of boggy track or locations where water pools.
~ Blocked culverts or waterways.
~ Any water ponding in drains.
~ Any sediment, debris or weeds blocking waterways or inlets to waterways.
~ Sump cover and grates not in position.
~ Blocked grates.
~ Any evidence of track formation, cutting or embankment failure, such as earth movement, track subsidence or ground cracks.

13. Examine permanent and temporary speed signs. Check that:
~ Signs are in place, facing the right direction, not obscured by trees, dirt, graffiti etc.
Temporary speed signs are correctly placed before and after the location they are protecting, have the correct plates in the right order, that the lights are working and that the signs are standing securely.

14. Check for breaches of fencing, unsecured gates or signs of unauthorised access.

15. Check Level Crossings for major misalignment in panel levels i.e. panel or corner of panel sitting obviously high. (Note – Defect Limits and Responses for Level Crossings are documented in TMC 521 – Level Crossing Manual.)

16. Examine the condition of track magnets (where fitted). Note that this examination is not required on every Patrol
~ Check Trip gear signage is present and legible.
~ Check that the complete set of magnets is present on each track.
~ Arrange replacement of defective signage.
~ Arrange replacement of missing/damaged magnets.

If any magnets or signs are missing or damaged, they should be identified on the diagram provided in TMC 231 and reported to the Team Manager for replacement within 24 hours.

**WARNING**
A magnetic field occurs around these magnets. Bringing electronic watches or equipment (Laptops, etc), credit cards/passes etc with magnetic strips to within 300mm of the magnets will result in the data being destroyed irrespective of the exposure time.

Remove wallets, watches etc before working with the magnets
Staff with pacemakers MUST NOT place pacemakers any closer than 500mm metres to this equipment.
DO NOT place hearing aids within 125mm of the magnet.

17. Check for ineffective safety barriers.

18. Check for damage to equipment including that of other disciplines.

Pay special attention to the following issues in preparation for and during the Summer period. Track problems can affect the reliability of Signalling equipment in the summer period. Problems arise from the movement of steel in the hot weather, from summer storms and even from ballasting work carried out for WTSA.

1. Anchoring

Anchoring of turnouts and special trackwork is important to prevent the movement of steel especially where there are non-elastic fastenings. Catchpoint areas are particularly vulnerable. Anchoring is required within and adjacent to turnouts and special trackwork. Additional anchors should be considered to prevent movement of steel.

2. Bolts in Turnouts

Chair bolts must be tight in the switch area of turnouts to resist longitudinal movement of steelwork (as well as lateral movement and to prevent breakage).

3. Insulated Joint Gap and Clips

Make sure that small movements of the rail are not going to cause shorting, either from clips too close to fishbolts or from the joint gap where there is rail end flow.

4. Switch Movement and Flow

Check that rail flow on the stockrail will not affect switch or stockrail movement in the heat. Remove stockrail flow for at least 25mm beyond the switch tip.

Check that there is still travel available for the switch before the end of the stockrail
undercut or joggle. At least 25mm beyond the switch tip should be available for longitudinal movement.

5. New Ballast

Thick layers of new ballast left in the four foot can cause signal failures from “sagging track” especially if heavily contaminated with fine dust. New ballast should be ploughed off. If this can’t be done check with signal staff as to whether the track section involved is sensitive to sagging.

Make sure ballast laid out does not foul signalling equipment especially at points and trainstops. Also make sure hopper doors are fully shut, not just at the conclusion of the work but if any turnouts are traversed between ballasting locations. Check point areas if any spillage is suspected. After possession work, inspect point areas that could be affected by ballasting work (including with off-track plant).

6. Drainage

Poor drainage can affect turnouts and special trackwork (from pumping track) and open track where “track sagging” can result. Signal staff can identify vulnerable locations. Check for evidence of boggy track or locations where water pools. Note that flogging heels on heeled switches is an area of particular vulnerability.

During colder weather be on the lookout for
- Curve pull-ins & affect on clearances and on OHW in electrified areas.
- Broken bolts in turnouts.
- Insulated joint problems including broken or bent bolts, broken plates or bonding glue cracking and breaking away from the rail at glued insulated joints.

C7-3.2 Actions

1. Tick the method of patrol and record all examination results on Form 2 "Examination of Length”.

2. Assess any defects found or investigated during a track patrol according to the "Limits and Responses" tables in Chapter 5. The following are typical actions:
   - Take appropriate protective action if defects require immediate action, OR
   - Repair the defect personally.
   - Include repair action in a work program.
   - Report the fault to the Team Leader or Team Manager as appropriate.
   - Monitor the fault during future examinations until further deterioration requires action.

3. Enter ALL track defects found into Teams3 or List the defects on Form 2 "Weekly Defect Summary Report”.

C7-4 Engine Patrol Procedures

C7-4.1 During the Engine Patrol

The primary purpose of patrol by engine is to identify critical hazards or potentially critical hazards requiring attention in the short term (those that could cause problems before the next similar patrol). A secondary purpose is to identify lower priorities that can be reviewed in more detail in the walking patrol.

The detection of defects from an engine will be more successful if you:
- Focus on critical hazards. i.e. don’t direct attention to low priority matters such as excess ballast.
- Direct your attention to hazards appropriate to the infrastructure being traversed. e.g. at crossings look out for badly damaged nose and listen/feel for bad thump.
− Use a variety of senses. e.g. listen for wheels thumping over rail irregularities, the worse it is the bigger the thump.
− Consider environmental, seasonal and traffic factors. e.g. after high wind there may be rubbish on track or trees leaning over.
− Bear in mind track history. e.g. look out for known bogholes.
− BE AWARE that some hazards are more critical in some locations than others. Broken rails and broken joints are more critical in areas with single rail traction return sections and sections without track circuits than they are in sections in which both rails carry signal circuits (the circuits will detect broken rails).

Details of each hazard are shown in Table 7.

<table>
<thead>
<tr>
<th>No</th>
<th>Hazard</th>
<th>Condition/Location</th>
<th>Detection</th>
<th>Comments/Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Obstruction to vehicle</td>
<td>Platforms</td>
<td>Visual</td>
<td>Appears too close</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Noise</td>
<td>noise of scraping</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New work</td>
<td>Visual</td>
<td>Unstable material or leaning structures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>General</td>
<td>Visual/Noise</td>
<td>Object strikes train</td>
</tr>
<tr>
<td>2.</td>
<td>Obstruction to wheels</td>
<td>Turnouts</td>
<td>Visual</td>
<td>Objects in flangeway</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Noise</td>
<td>Wheel impact noise</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level Crossing</td>
<td>Visual</td>
<td>Objects/material in flangeway</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Noise</td>
<td>Wheel impact noise</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New work</td>
<td>Visual</td>
<td>Soil, ballast or rocks</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Noise</td>
<td>Wheel impact noise</td>
</tr>
<tr>
<td>3.</td>
<td>Train trip</td>
<td>General</td>
<td>Ride</td>
<td>Train trips</td>
</tr>
<tr>
<td>4.</td>
<td>Broken rail</td>
<td>Turnout</td>
<td>Visual</td>
<td>Visible gap in rail</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Noise</td>
<td>Impact noise</td>
</tr>
<tr>
<td>5.</td>
<td>Broken joint</td>
<td>Glued joint</td>
<td>Visual</td>
<td>Visible gap in rail</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Noise</td>
<td>Impact noise</td>
</tr>
<tr>
<td>6.</td>
<td>Broken joint or breakaway</td>
<td>Mechanical joint</td>
<td>Visual</td>
<td>Large gap in rail</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Noise</td>
<td>Impact noise</td>
</tr>
<tr>
<td>7.</td>
<td>Loose bolts</td>
<td>Crossing or joint.</td>
<td>Noise</td>
<td>Jingling of loose bolts</td>
</tr>
<tr>
<td>8.</td>
<td>Track geometry Top</td>
<td>Turnouts</td>
<td>Visual</td>
<td>Discoloured ballast</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ride</td>
<td>Train dips</td>
</tr>
<tr>
<td></td>
<td></td>
<td>General</td>
<td>Visual</td>
<td>Discoloured ballast</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ride</td>
<td>Train dips</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bridge ends</td>
<td>Visual</td>
<td>ramp at bridge</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ride</td>
<td>Train lifts or drops</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ULXs</td>
<td>Visual</td>
<td>Trenching</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ride</td>
<td>Train dips</td>
</tr>
<tr>
<td>9.</td>
<td>Track geometry Line</td>
<td>Turnouts</td>
<td>Visual</td>
<td>Elbow apparent</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ride</td>
<td>Train jerks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>General</td>
<td>Visual</td>
<td>Elbow apparent</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ride</td>
<td>Train jerks</td>
</tr>
</tbody>
</table>
C7-4.2

During Walking Patrol

In view of the restrictions in terms of the detail that can be inspected by engine you need to place additional emphasis during the walking inspection on those hazards not easily detected by engine. These include:

Plain Track
- cracking of rails and joint plates
- foul joints
- missing or loose bolts
- wheel scale or debris that could cause short circuit of insulated joints
- small wheelburns or squats
- defective ties
- ineffective rail fastenings or other conditions which could cause wide gauge
- small scale track support deficiencies

Turnouts
- obstructions in points, crossings or flangeways
- damaged or open switches or pumping heels
- defective fastenings including chairs, studs or bolts
- cracked, broken crossings or checkrails
- damaged crossing nose
- loose bolts
− gauge at crossing

Right of Way
− damaged fencing or unsecured gates
− signs of unauthorised access

C7-4.3 Actions
1. Tick the method of patrol and record all examination results on Form 2 "Examination of Length".
2. Assess any defects found or investigated during an Engine Patrol according to the "Limits and Responses" tables in Chapter 5. The following are typical actions:
   ∼ Take appropriate protective action if defects require immediate action, OR
   ∼ Repair the defect personally.
   ∼ Include repair action in a work program.
   ∼ Report the fault to the Team Leader or Team Manager as appropriate.
   ∼ Monitor the fault during future examinations until further deterioration requires action.
3. Enter ALL track defects found into Teams3 or List the defects on Form 2 "Weekly Defect Summary Report".

C7-5 Mechanised Track Patrol Procedure
Mechanised Track Patrol utilises a Special Patrol Vehicle (SPV) to conduct a front of Engine examination while also recording track imagery and a detailed review of the recorded imagery.

Carry out the Mechanised Track Patrol in accordance with the attached guidelines.

Mechanised Track Patrol involves two specific activities.

C7-5.1 Engine Patrol
1. Conduct Engine Patrol from the SPV using the Engine Patrol procedure in Section C7-4.
2. Nominate, if required, any locations requiring review immediately after the recording. These must then be reviewed immediately (not left until the next day).
3. Record defects as "Points of Interest".

C7-5.2 Detailed Review
1. Get a copy of the "route plan" from the Team Manager which shows the “critical trackwork” and any “critical locations” to be examined.

   Note
   Critical trackwork
   turnouts, diamonds, junctions, catchpoints, expansion switches, GJs or mechanical joints and any other special track features. Note that GJs in concrete sleepered track that are well supported and not subject to high impacts such as from end batter may be exempted from the critical trackwork category.

   Critical locations
   any locations where there are known or suspected track condition problems such as poor tie condition, outstanding geometry defects, pumping bridge ends and any locations found on engine patrols that require more detailed checking.

2. Use several different camera configurations for the review.
3. Inspect all tracks using the “easement view” at a review speed of no more than 60km/hr.

4. Inspect all tracks using the “track view” at a review speed in line with its configuration and condition. The speed of the detailed “track view” review over critical trackwork and any critical locations should be slow enough to enable observation of these areas in detail to the satisfaction of the patrollers. In any case the speed is to be no greater than walking pace.

5. Use “Rail View” for all areas of low light where track view is not effective.

6. Review the “rail views” for critical trackwork and any critical locations at a slow enough speed to enable observation of these areas in detail to the satisfaction of the patrollers but in any case the speed is to be no greater than walking pace. Use the “rail views” with particular care to check:
   - the plates and bolts of mechanical and glued joints,
   - the condition and fitting of switch tips,
   - the condition of any heel joints present in switches, and
   - the condition of crossing noses and bolting.

7. Listen to the recorded sound, where practicable, to check for impact/loose bolts in:-
   - mechanical and glued joints,
   - the switch area,
   - any heel joints present in switches, and
   - crossings & checkrails.

8. Review Points of Interest Priority 1 and Priority 2 and any review areas nominated by the Team Manager at a speed and using the views appropriate for the type of defect condition.

9. Where available, use Rail Check reports as an aid in identification of defects. These reports should be produced, if possible at an interval of once per week for each section of track on those weeks where Mechanised Track Patrol replaces Foot Patrols. The defect reports are to be made available for viewing in the proceeding week’s AIMS inspection.

C7-5.3 Actions

1. Arrange supplementary on-site inspections, where required, of any suspect conditions.

2. Tick the method of patrol and record Engine Patrol examination results on Form 2 "Examination of Length".

3. Tick the method of patrol and record Detail Review on Form 2 "Examination of Length".

4. If the SPV system fails or does not allow "Points of Interest" to be recorded indicate this in the “Other Inspections” space on Form 2.

5. Assess any defects found or investigated during a Mechanised Track Patrol according to the "Limits and Responses" tables in Chapter 5.

6. Arrange protection or correction of any serious safety issues identified during either the Engine Patrol or the Detailed Review.

7. Complete Detail Review and certification by next day (within 24 hours) or a shorter period where specified in the Track Recording and Certification timetable. In most cases certification will be the day after the recording.

8. Enter ALL track defects found into Teams3 or List the defects on Form 2 "Weekly Defect Summary Report". This is done by the person undertaking Detail Review.

9. If the SPV system fails or does not allow "Points of Interest" to be recorded the
person undertaking the Engine Patrol is to enter the defects noted on the Engine Patrol into Teams3 or List the defects on Form 2 “Weekly Defect Summary Report”.

C7-6

Supplementary Patrol Procedure

Use the procedures for Standard Track Patrol in Section C7-3 with the following variations:

1. Get a Track Inspection Report from your Team Manager before undertaking the patrol. The Report lists all defects that should be inspected during the patrol.
2. Limit the inspection to the items being examined.

For Supplementary Patrol of Glued Insulated Joints

1. Examine GIJ visually for broken, bent or loose bolts, worn cracked or broken fishplates.
2. Examine GIJ visually for adjustment problems, joint pulling apart or closing up, ineffective anchoring.
3. Examine GIJ visually for failure of glue (in glued joints).
4. Examine track 2m either side of GIJ key for sleeper condition, sleeper spacing and presence of rail fastenings.

For Supplementary Patrol of Turnouts and Special Trackwork

1. Examine for obstructions to train movements or signalling equipment within (or potentially within) the structure gauge.
2. Examine for obstructions to the wheel path of the train (e.g. in flangeways).
3. Examine for continuity of rails (i.e. no broken rails or joints or breakaways, or loose or foul joints).
4. Examine for visual indicators of VSH rail defects.
5. Visually examine crossing for signs of changes in gauge, checkrail effectiveness and flangeway clearances.
6. Visually examine crossing for condition and security of crossing bolts and wear.
7. Visually examine condition and fit of switches including height, tip profile, width, wear angle and rail creep and fit of the switches relative to the stockrails.
8. Look for rail flow on the gauge face of the stockrail or obstruction between the switch and stockrail.
9. Visually examine switch area for condition of stockrails, loose studs, loose or cracked chairs.
10. Visually examine switch area for condition of heel joints - joint pumping, cracked heel block, loose or missing heel bolts, fouled heel joint, loose spikes under the heel joint, overtightened bolts.
11. Examine for visual indications of wheel burns and squats in rails.
12. Examine for untested wire feed welds (flouro pink marking) or new untested thermit welds.
13. Examine for imminent failures of bearers or track fastenings.
14. Examine for major geometry defects or potential derailment locations.
15. Examine for major deficiencies in supporting track structure (resulting from earthworks, bridges, structures, culverts, etc.)

For Supplementary Patrol of Plain Track

1. Examine for loss in continuity of rails (i.e. broken rails or joints or breakaways, or loose or foul joints).
2. Examine for visual indicators of VSH rail defects.
3. Examine for visual indications of wheel burns and squats in rails.
4. During colder weather be on the lookout for:
   ~ curve pull-ins and effect on clearances and on OHW in electrified areas,
   ~ Insulated joint problems including broken or bent bolts, broken plates or bonding glue cracking and breaking away from the rail at glued insulated joints.
5. Where centre line marking of curves has been undertaken to identify curve pull-in, check if the track has moved.
6. Examine for untested wire feed welds (fluoro pink marking) or new untested thermit welds.
7. Examine for imminent failures of sleepers and track fastenings.
8. Examine for major geometry defects or potential derailment locations.
9. Examine for major deficiencies in supporting track structure (resulting from earthworks, bridges, structures, culverts, etc.)

C7-6.1 Actions
1. Tick the method of patrol and record all examination results on Form 2 "Examination of Length”.
2. Assess any defects found or investigated during a track patrol according to the "Limits and Responses” tables in Chapter 5. The following are typical actions:
   ~ Take appropriate protective action if defects require immediate action, OR
   ~ Repair the defect personally.
   ~ Include repair action in a work program.
   ~ Report the fault to the Team Leader or Team Manager as appropriate.
   ~ Monitor the fault during future examinations until further deterioration requires action.
3. Attach a signed off copy of the Track Inspection Report to the weekly Form 2 Examination of length.
4. Enter ALL track defects found into Teams3 or List the defects on Form 2 "Weekly Defect Summary Report”.

C7-7 Adjacent Track Patrol Procedures
Use the procedures for Standard Track Patrol in Section C7-3.

C7-8 Night Patrol Procedures
Night patrol is intended to fulfil all of the requirements of daytime track patrol covering what can be observed in a localised area of the track and limited surrounds.
1. Get the schedule of any known hazard locations outside the immediate area of the track surrounds from the Civil Maintenance Engineer so that you can direct special attention to those locations.
2. Use the procedure for Standard Track Patrol in Section C7-3.
3. Carry out a supplementary engine inspection in daylight focussing on hazards not easily observable on night patrol including:
   ~ Long-sight track geometry problems such as long slacks or alignment problems,
   ~ Signage visibility,
   ~ Drainage problems including water pooling,
Embankments and cuttings,
Right of way issues such as fencing, signs of trespass.

C7-8.1 Actions
1. Tick the method of patrol and record all examination results on Form 2 "Examination
   of Length".
2. Assess any defects found or investigated during a Night patrol according to the
   "Limits and Responses" tables in Chapter 5. The following are typical actions:
   - Take appropriate protective action if defects require immediate action, OR
   - Repair the defect personally.
   - Include repair action in a work program.
   - Report the fault to the Team Leader or Team Manager as appropriate.
   - Monitor the fault during future examinations until further deterioration requires
     action.
3. Enter ALL track defects found into Teams3 or List the defects on Form 2 "Weekly
   Defect Summary Report".

C7-9 Wet Weather Patrol
1. Examine surface drainage systems for general effectiveness, scouring, rockfalls,
   ponding.
2. Examine sub drainage systems for general effectiveness, ponding, outlet blockage,
   sumps overflowing, pipe rupture.
3. Examine Track and Right of Way for water on/over track, backing-up behind
   embankments fences culverts, undertrack pipes or trash racks.
4. Examine Track and Right of Way for debris obstructing culverts, drains, undertrack
   pipes or underbridges.
5. Examine Right of Way for potential slips or mud-slides (including ineffective or
   damaged retaining walls).
7. Examine Right of Way for silt entering waterways or other drainage systems.
8. Examine tunnel drainage systems for effectiveness.
9. Examine flow control, water energy dissipation systems and sedimentation basins
   for effectiveness.

C7-9.1 Actions
1. Record all examination results on Form 2 "Examination of Length".
2. Assess any defects found or investigated during a Wet Weather Patrol according to
   the "Limits and Responses" tables in Chapter 5. The following are typical actions:
   - Take appropriate protective action if defects require immediate action, OR
   - Repair the defect personally.
   - Include repair action in a work program.
   - Report the fault to the Team Leader or Team Manager as appropriate.
   - Monitor the fault during future examinations until further deterioration requires
     action.
3. Enter ALL track defects found into Teams3 or List the defects on Form 2 "Weekly
   Defect Summary Report".
C7-10  

**Heat Patrol**

**C7-10.1 Examination Requirements**

1. Carry out a Heat Patrol on all timber sleepered welded track when the AIR temperature reaches or is forecast to reach 38°C. The purpose of the inspection is to detect signs of misalignments.
2. Carry out the patrol between 1430 and 1800 hours.
3. Carry out the patrol by walking, Hi-rail, or the front (or back) of trains.

**C7-10.2 Examination Procedure**

1. Examine Track for possible early indications of misalignment; alignment variations or kicks.
2. Examine Track for locations where ballast profile is not to standard.
3. Examine Track for "trigger points" for misalignment; poor weld or rail alignment; poor rail profile matching; straight closures in curves; variations in alignment and gauge; glued insulated joints.
4. Examine Track for locations where track has been disturbed recently and not noted on Stability Loss List.
5. Pay particular attention to locations known to have a high loss of stability based on the Welded Track Stability Analysis.

**C7-10.3 Actions**

1. If a misalignment is found, make arrangements to immediately protect rail traffic.
2. Record all examination results on Form 2 "Examination of Length".
3. Note all locations where there is any indication of potential misalignment and check the current Welded Track Stability Analysis.
   - Report the fault to the Team Leader or Team Manager as appropriate.
   - Monitor the fault during future examinations until further deterioration requires action.
4. Enter ALL track defects found into Teams3 or List the defects on Form 2 "Weekly Defect Summary Report".
Chapter 8  Front of Train Examination

C8-1  Examination Requirements

1. Front of Train Examination is a non specific examination which assists in the assessment of track by enabling the reaction of trains to the track structure to be observed (preferably at the maximum allowable speed).

2. Front of Train Examination is to be carried out from the driver's compartment of the fastest train over the length, if this is practical.

C8-2  Examination Procedure

This inspection is required to check the riding qualities of all tracks as a guide to more detailed inspection requirements.

1. Examine Train reaction to track condition that may indicate geometry defects (top, line, twist, superelevation or support deficiencies associated with earthworks or bridges.

2. Note any rough or irregular riding of the train. Check these locations during normal walking inspection.

3. Examine Train reaction to track that may indicate the presence of a broken rail or fastening.

4. Examine placement, visibility and condition of speed signs, whistle boards and the like.

5. Check for obstructions to drivers visibility of signals, including trees and other objects.

C8-3  Action to be Taken

1. Tick the method of patrol and record all examination results on Form 2 "Examination of Length".

2. Assess any defects found or investigated during a Front of train examination according to the "Limits and Responses" tables in Chapter 5.

3. Enter ALL track defects found into Teams3 or List the defects on Form 2 "Weekly Defect Summary Report".
Chapter 9  Detailed Walking Examination

C9-1  Examination Requirements

1. Detailed walking examination of each track length is a thorough examination of the components of the track structure and the right of way to ensure that the components are satisfactory and contribute to a safe railway.

2. Detailed walking examination may be progressively carried out in conjunction with Walking Track Patrols, provided the required patrol frequency is maintained.

3. Walking track for the purpose of marking sleepers for renewal, turnout examinations, examination of welded track stability etc. is additional to the requirements of detailed examination but may be combined with the Detailed Walking Examination provided the overall requirements of the Detailed Examinations are not overlooked.

C9-2  Examination Procedure

1. **Examine Ties** for general condition
   - What is the urgency for spot renewal — say within 3 months, 6 months, 12 months — will they last to the next PRS pass?
   - How is the gauge - wide? How much?
   - Can the sleepers stand re-adzing or reboring?
   - Is the sleeper splitting?
   - Is the spacing correct?
   - Are the sleepers skewed?
   - Are the sleepers firmly packed?
   - Are sleepers pumping because of foul ballast?
   - Are there sufficient good sleepers in the area to guarantee gauge?
   - On concrete sleepers are the insulators squeezed out and need replacing?

2. **Examine Fastenings** for general condition including loose, missing or ineffective fastenings, rail play and evidence of backcanting, locations listed for wide gauge and where ballast prevents routine examination of fastenings.

   Pandrol plated track is not fit and forget. It requires proper inspection and maintenance.

   Warning signs of developing problems may be missed if the fastenings are covered with ballast or if staff are not aware of danger signs.

   On site warning signs can include:
   - Signs of plate movement on the timber in any direction.
   - Broken, missing or bent lockspikes.
   - The shiny contact band on the top of the high rail locally narrowed towards the gauge face.
   - Sharpened curvature.

3. **Examine Turnouts** for condition and fit of geometry and components including switches, crossings, bearers, fastenings and manual levers (where fitted).
   - Is the top and line of the main and turnout tracks satisfactory?
   - Is the gauge correct?
   - Is there any longitudinal movement?
~ Is there any side movement of the rails and plates showing?

~ At switches in interlocked turnouts:
  - Does it fit the stockrail?
  - Is there overflow on the end?
  - Has it chipped off in places?
  - Is the point sharp and safe? Or is there a blunt ramp which could cause a derailment?
  - Is the foot of the switch worn on the slide chairs?
  - Does the switch ride higher or lower than the stock rail?
  - Are all the studs firmly in place? Are they correct?

~ On heeled switches:
  - Is the heel loose? Is it foul? Is it pumping? Is it in line?
  - Does the point of the switch rise up under load? (Indicating heel may need lifting and packing.)

~ Have you observed the switch moving, was it satisfactory?

~ Has the local Signal Interlocking Representative requested any work? Has it been done?

~ At stockrails
  - Are they correct to gauge?
  - Are they worn below the switch when it is closed?
  - Have they got excessive overflow that will result in the switch tip chipping out from contact with the overflow?

~ At V and K Crossings
  - Is the flangeway clearance correct?
  - Is there overflow on gauge side of flangeway?
  - Is the gauge correct?
  - Is the distance from the checkrail to the crossing nose correct?
  - Is the crossing worn? How much?
  - Is it saddled or broken?
  - Is it correctly packed?
  - Is it drained correctly?
  - Are the timbers sound? Are they pumping?
  - Is the checkrail loose? Clearance?
  - Are all bolts tight?
  - Has it been built up? when?
  - Is it correct hand? Right or left hand point rail?

~ In General
  - What type of chairs?
  - Are they cracked or broken?
  - Are they worn on top?
  - Do they need replacement?
  - Are the closure rails securely spiked and correct to gauge?
  - Are the bearers in need of renewal? Which ones and length?
  - Is the ballast sufficient? If not how much is needed?
  - Is the ballast clean?
  - Is top and line good through the turnout and on the approaches?
  - Are there any insulated joints? If so are they in good order?
- Are normal joints in good order?
- Is the whole turnout welded up? If not should it be welded up?
- Is there an anchor point at each end of turnouts?

4. **Examine Track at Friction Buffer Stops.**
   - Has the buffer moved?
   - Is the slide path clear of ballast and obstacles

5. **Examine Level Crossings** for geometry, fit and condition of ties, fastenings, flangeways and crossing surface.
   - Are level crossing signs okay? Can they be clearly seen by approaching traffic?
   In addition look for the following in accordance with TMC 521 – Level Crossings
   - Visible signs of differential levels in crossing surface between adjacent panels, or between panels and rail head level or adjacent road surface level
   - Gaps between panels
   - Loose end restraint fastenings.

6. **Examine Rails** for fit, condition and adjustment, rail joints, insulated joints, lubricators, rail wear, wheel burns and other visible defects and condition of guard rails (where fitted).
   - Is there sign of gauge face damage? If so what is the age of the rail and the section?
   - Any wheel burns or squats?
   - Any visible cracks?
   - Is the rail back-canted?
   - Is there any pitting of the surfaces - particularly in the fillets under the head? - or the fillets between web and flange?
   - Are there visual indicators or VSH rail defects, including flattening out of the rail head and widening of the shiny portion of the rail (the contact band), or rust stains down the web?
   - Is rail wear approaching the limit?
   - Are there any corrugations?
   - Are there any signs of surface defects that will need corrective grinding?
   - check for oxy nicks or molten metal on the rail foot from recent rail bond welding. Surface damage from rail bond molten metal can be ground out taking a minimum of 0.5mm below any visible damage. If the rail is oxy nicked it must be welded out.
   - Is the rail working between the spikes?
   - Is the sleeper plate working?
   - Are the welds in good condition?
   - Are lubricators working efficiently?
   - What is the urgency of renewal?

7. **Rail Ends**
   - Is there any end-flow?
   - Is the end battered and/or chipped?
   - Are bolts loose? Why? Is it because of wear or poor washers?
   - Are the joint sleepers packed well?
   - Is the joint in good line and level?
Is it adequately drained?
Is it anchored correctly?
Is it in adjustment?
What should be done to improve it?
Are the bolts bent or worn?
Are the spring washers effective?
Is the joint frozen?
Is the rail end bent down?
Are the rails pulling?
Is adjustment necessary?
Is the expansion gap correct? If not, is it tight or wide?
Are the anchors effective?
Are anchors correctly fitted?
Are the sleepers sound?
Have the sleepers moved in the ballast?
Is the sleeper pattern correct?
Is the ballast sufficient?
Is it clean and sharp, or foul?

8. Rail Lubricators
Are the lubricators working properly?
Is there too much grease being pumped out?
Are the lubricator mountings loose?
Is there obvious damage, bent/broken blades?
Is the lubricator delivering grease to the rail head only?
Does the lubricator deliver excessive grease to the rail head?
Are insufficient amounts of grease deposited around gauge faces of outer rails on curves?
Does the tank need filling?
Are there signs of excessive curve wear; shiny wear marks on the gauge face and/or steel shavings along the rail foot indicating insufficient lubrication?
Are more lubricators required or do the existing ones need replacing?

9. Examine Drainage for condition including cess drains (particularly in cuttings) and tunnel drainage systems (where applicable).
Are the cesses clean? Are they adequate?
Are mitre drains clean?
Are top cutting drains clean?
Are cross drains clean?
Any sign of silting or overflow?
Are inlets and outlets of culverts clean?
Is the culvert broken?
Is there any water pooling near toe of embankments?
Is there any stagnant water on the tracks?
Is there water running from buildings, roads or gutters? Is it from outside property?
~ If so have you investigated and reported it?
~ Are drainage sumps silted up?
~ Are the sumps too high? Is water backed up in cesses?

~ Are any cutting faces slipping?
~ Are there any new rockfalls in cesses?
~ Is any embankment moving? Are there any cracks in the ground?

11. **Examine Ballast** for condition and profile including fouled ballast, pumping or unstable track and inadequate ballast profiles.
~ Is it clean?
~ Is there sufficient crib and shoulder ballast?
~ Are turnouts adequately ballasted?
~ Where is ballast required? (Give kilometrage from and to and quantity?)
~ Should shoulders be removed and replaced with new ballast?
~ Should the six-foot be removed and new ballast supplied?
~ Does the drainage require attending to before ordering new ballast?

12. **Examine Right of Way**. Look for:
~ Condition of fencing and gates.
~ Evidence of vermin.
~ Evidence of rubbish or redundant material.
~ Firebreak condition, fire hazard control.
~ Access roads.
~ Vegetation fouling or with the potential to foul the track.
~ Undermining of track or structures.
~ Condition of access roads - effectiveness of roadway drainage, erosion and scour, condition of under-road pipes and culverts, vegetation encroachment and other possible obstructions.
~ Evidence of noxious plants.
~ Fire hazards.
~ Vegetation restricting sighting distances at signals and level crossings, and trees or shrubs with potential for dislodging material and/or obstructing the track.
~ Evidence of unauthorised or uncontrolled access through fencing or gates - opportunities for stock to gain access, damaged, corroded, loose or missing fence panels or components, security at gates; locks, chains and hinges, gates left open.
~ Examine condition of insulating fence panels in fences (where fitted).
~ Examine condition and function of swing-back netting on fences (where fitted).
~ Examine condition of fence signage (where fitted).
13. **Examine Permanent and Temporary Speed Signs** and other trackside safety signs for visibility, security and clearances, including:

- Condition of painted surfaces or protective coatings, cleanliness and visibility of the sign and condition of indicator lamps and batteries (where fitted).
- Integrity of the sign mountings, mechanical connections and fastenings or corrosion of metal components.
- Where RailCorp boundary signs exist, examine them for position, security and visibility. If there is any doubt as to the position of the sign it should be resurveyed. If there are visible track defects immediately adjacent to the sign the position of the boundary should be confirmed.

14. **Examine Permanent Speed Signs** for correctness of position, speed shown, track indicated etc at least once per year.

The current reference to the location of Permanent Speed Signs is RailCorp Engineering Manual OS 001 IM “Train Operating Conditions (TOC) Manual”

15. **Examine Track geometry**

- Is there any visual irregularity in the top and line of the track?
- Is it in need of attention?
- Has the cross level been checked with the board?
- Are the joints down? If so - why?
- Is gauge irregular and causing bad line?
- Is top and line poor through turnouts or approaches to them?
- What needs to be done immediately?
- Is the line poor at the joints? If so - why?
- Can it wait until the next tamping program?

16. **Monitor Welded Track Performance** and note deficiencies in preparation for annual Track Stability Analysis.

17. **Examine Undertrack Structures** for conditions effecting track geometry.

- Is the waterway clear?
- Is top and line good over the bridge?
- What is condition of transoms?
- On steel bridges are the bed-plates clear of rubbish?
- Is water being trapped in any member?
- Is there any sign of extensive scouring or undermining?
- Are sleepers in need of packing on bridge approaches?

18. **Examine Track Magnets** for condition and security (where fitted). Note that this examination is NOT required on every Detailed Walking Examination.

- Check that magnets are undamaged and correctly secured to sleepers. Condition and installation details are documented in Engineering Manual TMC 231 - Sleepers & Fastenings.
  
  Examine epoxy mounts on concrete sleepers for cracking or separation.

  The magnets are ceramic magnets and like all ceramics they are quite brittle and will easily break, and suffer a loss of magnetic strength, if they suffer a strong impact. Any sign of strike damage therefore should be a cause for concern and possible change-out of the magnet.
Arrange replacement or repair of damaged fastenings.
Check signs are undamaged and secure.
If any signs are loose they should be made secure.
If any magnets or signs are missing or damaged, they should be identified on the diagram provided in TMC 231 and reported to the Team Manager for replacement.

Repairs or replacements are required within 24 hours.

**WARNING**
A magnetic field occurs around these magnets. Bringing electronic watches or equipment (Laptops, etc), credit cards/passes etc with magnetic strips to within 300mm of the magnets will result in the data being destroyed irrespective of the exposure time. Exposures in the 300mm to 600mm range from the magnets will not result in the data being immediately destroyed, but should also be avoided.

Remove wallets, watches etc before working with the magnets
Staff with pacemakers **MUST NOT** place pacemakers any closer than 500mm metres to this equipment.

**DO NOT** place hearing aids within 125mm of the magnet.

19. **Housekeeping**
- Is there good material about?
- Is there re-useable material about? scrap material?
- Has all released material been sorted, or is it lying covered with grass?
- Is the released material ready for loading?
- Are recovered rails correctly branded?
- Are there old sleepers about?
- Are walkways level?
- Is the length tidy?
- Are there any tools lying about?

20. **New Works**
- Are there any new works on your section that affect the track? If so, do you know what they are and who is doing them?
- If new work has recently started, is it properly protected?
- Are there any major repairs being done by other disciplines that could affect the track or structures? Is the track properly protected?

21. **Track Evaluation Car Reports**
- Have identified defects been satisfactorily corrected?
- What was the cause of the defects?
- Will the defect re-occur?
- Is any long term action required?

**C9-3** **Action to be Taken**
1. Tick the method of patrol and record all examination results on Form 2 "Examination of Length".
2. Assess any defects found or investigated during a detailed walking examination according to the "Limits and Responses" tables in Chapter 5. At Level Crossings Limits and Responses are found in TMC 521.
3. Action any defects found. The following are typical actions:
   ~ Take appropriate protective action if defects require immediate action, OR
   ~ Repair the defect personally.
   ~ Include repair action in a work program.
   ~ Report the fault to the Team Leader or Team Manager as appropriate.
   ~ Monitor the fault during future examinations until further deterioration requires action.

4. Enter ALL track defects found into Teams3 or List the defects on Form 2 "Weekly Defect Summary Report".
Chapter 10  Post Irregularity Examination

This examination is a detailed visual examination of track and right of way conducted where there has been a derailment, accident or some other irregular event and there is a concern that the track may be damaged.

Its purpose is to assess condition and certify the track fit for operation.

C10-1 Examination Procedure

1. Examine Ties and Fastenings for damage including:
   - Ties for broken or split ties, back-canting, rail play.
   - Broken or missing rail clips.
   - Broken or missing dogspikes, lockspikes or anchors.

2. Examine Turnouts for:
   - Debris or obstructions in switches or crossings.
   - Loose or broken chairs, studs and bolts.
   - Damaged switches, checkrails, crossings or bearers.
   - Damaged point lever or interlocking equipment.

3. Examine Rails, Guard Rails and Joints for:
   - Cracked/broken, notched, bruised or crippled rail.
   - Cracked, bent or broken fishplates.
   - Bent or broken bolts.
   - Damaged joint insulation.

4. Examine Track for debris or obstructions and damage to:
   - Structures; bridges, culverts, tunnels, etc.
   - Rail lubricators.
   - Fencing.
   - Drainage systems.

5. Examine Ballast for:
   - Profile deficiencies.
   - Disturbance/track stability loss.

6. Examine Track Geometry for top, line, gauge, superelevation and twist defects.

7. Examine Track for:
   - Reduced clearance to structures, platforms, tracks.
   - Relationship to overhead wiring (where applicable).

C10-2 Action to be Taken

1. Repair defects (where time and resources are available) or report/arrange corrective action.

2. Certify track safe for train operations.
Chapter 11  Siding Inspection

Sidings are examined to meet the requirements of ESC 100 - Civil Technical Maintenance Plan.

Some inspections are identical to inspections conducted on mainline track. For other inspections the procedures vary. Where nominated in the TMP and accompanying Service Schedules, undertake the Siding inspections by following the procedures detailed below.

Note that where private sidings are involved there is still a section of track maintained by RailCorp between the privately maintained section and the main line that needs to be considered as per the relevant interface agreements.

C11-1  Track Patrol in Sidings

Patrol track in sidings in accordance with the procedures in Section C7-3.

Make sure that sleepers and fastenings are visible. Check whether gauge is secure. Other irregularities of importance include the condition of joints and track geometry irregularities, especially track twist.

C11-2  Detailed Walking Examination of Plain Track in Sidings

1. Visually inspect plain track to detect indications of:
   ~ wide gauge;
   ~ top defects;
   ~ alignment defects;
   ~ track centre or track clearance defects;
   ~ ballast deficiencies;
   ~ drainage deficiencies.

2. Where geometry defects are suspected, take measurements using the procedures in Chapter 4.

3. Where visual inspection indicates alignment variation, measure track centre clearances and clearance to any adjacent structure using the procedures in Chapter 4.

4. Visually inspect plain track for evidence of badly worn rails, foul joints, loose or broken bolts etc.

5. Examine track at Friction Buffer Stops to check that the buffer has not moved and that the slide path clear of ballast and obstacles

6. Visually inspect mechanical and insulated joints for condition and effectiveness.

7. Check for broken or ineffective ties, ineffective fastenings, wide gauge, back canted rails.

   Whilst all track fastenings and sleepers should be able to be inspected, it is particularly important to ensure that any unplated track in critical locations (where there will be a significant impact on operations) should be kept clear of ballast, dirt or other material so they can be inspected.

8. Note locations of ballast deficiencies or excesses.

9. Examine Right of Way for condition

   Check condition of fencing, vegetation and access roads. Pay special attention to walkways where shunting staff are required to work.
10. Examine railway signs for condition and security
   This includes Permanent Speed signs, Safety signs and Boundary signs.
   Where RailCorp boundary signs exist, examine them for position, security and
   visibility. If there is any doubt as to the position of the sign it should be resurveyed.
   If there are visible track defects immediately adjacent to the sign the position of the
   boundary should be confirmed.

11. Examine Permanent Speed signs for correctness of signs (for position, speed
    shown, track indicated etc. Note that this examination is not required on every
    Detailed Walking Examination.

12. Examine the condition and security of track magnets (where fitted) in accordance
    with the procedures in Section C11-7. Note that this examination is not required on
    every Detailed Walking Examination.

13. Check condition of siding drainage.

14. Check for scrap or objects fouling track or walkways. etc.

C11-3 Inspection of Turnouts in Sidings

Use the turnout examination procedures in Chapter 23 to examine turnouts in sidings with
the following variations:

1. Visually examine turnouts for switch profile and fit, condition of slide chairs and
   studs. Use a switch tip profile gauge to check switches when visible profile
   irregularities are detected.

2. Check and adjust, where necessary, manually controlled non-interlocked point
   levers.

3. Turnouts that have a crossing rate of 1:8.25, or sharper, should be fitted with switch
   pad protectors. Check for signs of wheel flange wear at or near the switch tip. This
   will give an indication of severity. If the track in front of the switch is curved the
   hazard is elevated. Where this evidence exists, note it for attention.

4. Where a switch pad protector is fitted check of it is worn by inspecting for wheel
   flange contact at the switch tip. If there is wheel flange contact on the tip or near to it
   the switch pad protector should be replaced (alternatively double sided switch pads
   can be rotated if the other side is unworn).

C11-4 Inspection of Clearances in Sidings

Examine clearances to structures in accordance with the procedures in Chapter 4.

C11-5 Inspection of Sleepers in Sidings

Examine the condition of sleepers in accordance with the procedures in Chapter 18.

C11-6 Inspection of Drainage in Sidings

Examine the condition and function of surface and sub-surface drains in accordance with
the procedures in Chapter 24.

This includes open drains, sub surface drainage, pipes and sumps and drainage
structures such as trash racks, sedimentation basins and flow control structures

C11-7 Inspection of Track Magnets

Check Trip gear magnets are correctly secured to sleepers

Examine epoxy mounts on concrete sleepers for cracking or separation.

Arrange replacement or repair of damaged fastenings.
WARNING
A magnetic field occurs around these magnets. Bringing electronic watches or equipment (Laptops, etc), credit cards/passes etc with magnetic strips to within 300mm of the magnets will result in the data being destroyed irrespective of the exposure time. Exposures in the 300mm to 600mm range from the magnets will not result in the data being immediately destroyed, but should also be avoided.
Remove wallets, watches etc before working with the magnets
Staff with pacemakers MUST NOT place pacemakers any closer than 500mm metres to this equipment.
DO NOT place hearing aids within 125mm of the magnet.

C11-8 Yard and Siding Categories
Four main categories of track have been defined in order to set appropriate examination and maintenance requirements. These are:

Signalled Track
All turnouts and catchpoints that are interlocked and all rail which passes signalling current.
- Signalled is intended to refer to main yards. Some minor tracks can be signalled but still classified at a lesser importance e.g. little used sidings.

Focal Points
Locations at which a number of alternate routes diverge/converge. If not signalled already, such locations are normally connected to signalled trackwork.

Primary Trackwork
All the areas of the yard where rollingstock passes over regularly.

Secondary Trackwork
Non-critical areas of track infrequently used.

C11-9 Siding Maintenance Requirements
Sidings should be programmed for maintenance or renewal so that track component condition can be maintained in the condition detailed in Table 8, the track geometry limits in TMC211 and turnout limits in TMC251.

<table>
<thead>
<tr>
<th>Siding maintenance requirements</th>
<th>Signalled</th>
<th>Focal Points</th>
<th>Primary</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plain Track Defects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bogholes</td>
<td>No bogholes, no pumping track</td>
<td>Minor only allowed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pumping joints</td>
<td>No pumping joints</td>
<td>Minor pumping only allowed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pumping Heels</td>
<td>No pumping heels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pooling water</td>
<td>No pooling water</td>
<td></td>
<td>Must not remain 24hrs after rain</td>
<td></td>
</tr>
<tr>
<td>Cleanliness &amp; corrosion</td>
<td>No ballast or material on fastenings, rail foot or sleepers</td>
<td>No ballast or material on fastenings, rail foot or sleepers except LXings</td>
<td>Granular, only permissible if ties/ fastenings examined 24 monthly</td>
<td></td>
</tr>
<tr>
<td>Insulation to earth</td>
<td>Not shorted to earthed metalwork</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foul Joint</td>
<td>NA</td>
<td></td>
<td>≤ 3mm</td>
<td></td>
</tr>
</tbody>
</table>
## Siding maintenance requirements

<table>
<thead>
<tr>
<th>Asset</th>
<th>Signalled</th>
<th>Focal Points</th>
<th>Primary</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crossings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nose</td>
<td>Nose &amp; wings to standard if build up as required</td>
<td>OK as long as safe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fabrication</td>
<td>Worn chocks &amp; rivets not permissible</td>
<td>OK as long as safe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plating (turnouts &amp; plain track)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>No non-standard plating</td>
<td>Non-standard plating permissible if functionally OK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxy-cut</td>
<td>No oxycut rails or plates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slotted Plates</td>
<td>No slotted plates</td>
<td>Machine slotted plates only</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inserts</td>
<td>No inserts</td>
<td>Temporary inserts only</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switches</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switches</td>
<td>Square within 8mm</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switch rod bolts</td>
<td>Bolts tight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switch rods</td>
<td>Not worn bent or damaged</td>
<td>OK if not critical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulated Joints</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulated Joint Gap</td>
<td>≥ 3mm Gap (including potential expansion)</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulated Joint fouling by fastenings</td>
<td>No contact must be able to arise even if rail moves longitudinally by 10mm</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walkways</td>
<td>Clean level even and dry</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 8 – Siding Maintenance Standards**

### C11-10 Action to be Taken

1. Record all details on Form 2 “Examination of Length.
2. Assess any defects found or investigated during a Siding examination according to the "Limits and Responses" table in TMC203 C5-15. When other defects are located in sidings and are not listed in the siding section in C5-15, Chapter 5 mainline limits in the 20 kph speed band can be used as a guideline.
3. List the defects on Form 2 – "Weekly Defect Summary Report."
Chapter 12  Track Stability Measurement

This chapter details procedures for the examination of rail adjustment and alignment for welded track, along with ballast profile and anchors. The results of these examinations are recorded in the field and later used to calculate the stability of welded track by using Welded Track Stability Analysis.

The examination is necessary to enable calculations to be made to identify locations of potential track misalignment and to allow corrective work to be undertaken.

C12-1 Special Infrastructure Situations

Reduced requirements for WTSA measurement and analysis apply at the following locations.

- Tunnels – no WTSA review is required for track more than 50m inside a tunnel.
- Fixed Track – slab track or transom top bridges - no WTSA review of the fixed track is required (though the interface with timber could cause a fixed point analysis requirement).
- Expansion Switches - provide a point of relief for track adjustment variations. If immediately abutting dogspiked track they can be treated as a joint. On elastic fastened track they can provide relief from consideration of a fixed point if they occur at the interface.
- Slow speed loops and refuges - reduced WTSA inspection requirements may be applied to existing loops and refuges meeting the following requirements:
  - The Civil Maintenance Engineer must approve each location for which the full WTSA is to be waived. This is to ensure there are no local peculiarities that require special consideration.
  - Loops must be visually inspected and assessed at the same time as the pre-summer WTSA analysis, and defects prioritised. The basis for the assessment is provided Section C12-11.
  - Maximum authorised speed in the loop must be 35 kph or less.

C12-2 Preparation for Measurement

1. Conduct a visual inspection prior to gap measurement to ensure joints are working. Repair any frozen joints.
2. Check the visibility and condition of survey monuments and plaques. They must be kept free of ballast and visible at all times for checking purposes. If monuments are damaged or it is suspected that they have moved or are unreliable, report the matter so that a check survey can be made by surveyors.

C12-3 Measurement Procedure

1. Carry out the inspections on 500m sections of track, between kilometre and half-kilometre posts.
2. Record inspection details on Form WTSA 1 when the analysis is completed manually, and on Form WTSA 2 when computer analysis is to be used.

C12-4 Measuring Rail Gaps

1. Measure the rail temperature at each 500m (kilometre and 0.5 kilometre post) along the track.
   Ensure your rail thermometer is accurate. They should be calibrated annually.
   Place the rail thermometer on the shady side of the rail web.
2. Record the temperature reading and kilometrage on the form. More than one temperature reading may be required if part of the rail is shaded or in a cutting, to give an average temperature for the rail length.

3. Measure gaps at ALL rail joints for the up and down rails, including mechanical insulated joints (end post not to be counted as part of gap). DO NOT measure glued insulated joints or joints within a turnout.

4. The following are non standard track configurations and cannot be measured as LWR.

<table>
<thead>
<tr>
<th>Extract from RailCorp Standard ESC 220.</th>
</tr>
</thead>
<tbody>
<tr>
<td>− Rails longer than 220m</td>
</tr>
<tr>
<td>− Rails longer than 27.4m with resilient fastenings more than 1 in 3 (unless the rails have been correctly adjusted in accordance with requirements for CWR)</td>
</tr>
</tbody>
</table>

5. Record gap measurement and kilometrage on the form for each of the Up and Down rails separately.

C12-4.1 Advice on Gap Measurement

Problems often arise in the measurement of rail gaps, which can, if left uncorrected, give wrong assessments. Use the following tips to minimise these problems.

C12-4.1.1 Suitable Temperatures

In general, 25-35°C is the most suitable range for Gap measurements. This is based on the normal temperature range of theoretically correct gap measurements, which should vary between 0 and 12mm.

C12-4.1.2 Large Gaps (>20mm)

Gap gauge goes up to 20mm and bent bolts in joint can increase the size of the gap. If gaps are larger than 20mm, re-measure the full 500m section at a higher rail temperature, when the rail gap has reduced by at least 2mm from the original reading.

C12-4.1.3 Zero Gaps

Re-measure the full 500m section at a lower rail temperature, when a minimum gap of 2mm occurs. If the rail temperature has cooled by 10°C or more, and there is still no gap, make arrangements to adjust locally and record measurements. This will correct local rail compression, which could otherwise result in a misalignment.

C12-4.1.4 Frozen Joints

If a frozen joint is suspected, repeat rail gap measurement at different temperatures to assess joint movement.

**WARNING**

Zero gaps at rail temperatures less than 35°C are an indication of excess compressive stress, poor rail adjustment and potential misalignment

C12-5 Measuring Rail Adjustment in CWR

Record the adjustment of CWR using two main indicators:

1. Measurement of rail creep at each creep control reference point.
2. Measurement of track alignment compared to survey information.

C12-5.1 Measuring Rail Creep:

1. Locate the creep control reference points established on both sides of the track at
the km and 0.5km posts or at other locations such as OHW stanchions. If the marks vary from the standard 500m interval, the analysis will remain valid as long as it is conducted using the actual distance between measuring points rather than the default 500m.

2. The maximum length between creep control marks shall be 700m unless approved by the Chief Engineer Track.

3. Record the kilometrage of the creep control reference point (or check the accuracy of the recorded kilometrage).

4. Locate the punch marks on the outside heads of both rails.
   
   Areas that have been adjusted could have two creep measurements. (one each side of each creep peg)

   Ensure string line is pulled tight and is not “blowing in the wind.”

   Ensure string line is not caught on rail, ballast shoulder or any other obstruction

   Measure and record the amount of rail creep for each rail on the appropriate form.

   Always fill out the form in the down direction, ie. with the Sydney end at the top of the page.

5. The following are non standard track configurations and cannot be measured as CWR.

<table>
<thead>
<tr>
<th>Extract from RailCorp Standard ESC 220.</th>
</tr>
</thead>
<tbody>
<tr>
<td>− Rails longer than 220m which have not been adjusted</td>
</tr>
<tr>
<td>− Rails longer than 220m with no creep marks or pegs</td>
</tr>
<tr>
<td>− Rails longer than 220m with no alignment information available.</td>
</tr>
</tbody>
</table>

6. On the recording sheet, indicate any rail movement with an arrow pointing UP the page if the creep is toward Sydney, and DOWN the page if the creep is away from Sydney.

**C12-5.2 Damaged or Missing Creep Pegs/Marks**

Damaged or missing creep pegs are useless and must not be used. We are generally measuring fairly small values of creep so if a creep peg is loose or has been moved only 20mm this is fairly significant.

Report damaged pegs to the Civil Maintenance Engineer for replacement.

For this analysis you should use the greater of 20mm on each rail or the historic rail creep from previous records.

Damaged pegs should be recorded as Priority 1 defect and fixed immediately when observed throughout the year and noted for future WTSA reference and/or correction.
Recording Tangent Creep (Double Punch Marks)

Sheet shows prior to re-adjustment

Creep Pegs or Mast

String Line

To Sydney

0 10

0 10

35

15

20

40

5

500m or selected creep section

Left figure is the Sydney Side Creep and is measured on Sydney side of Creep peg or mast

Direction of Creep is indicated by an arrow

Right figure is the Country Side Creep and is measured on Country side of Creep peg or mast

Measured Creep

Punch marks

© Rail Corporation Page 111 of 253
Issued April 2013
UNCONTROLLED WHEN PRINTED
Version 5.3
Calculating Amount of Tangent Creep

A minus figure indicates too much steel & a plus figure indicates not enough steel

Creep Pegs or Mast

String Line

Creep results

Punch marks

35mm Creep into section

(-20) - (+35) = -15
20 - 35 = -15

(-40) - (0) = -40
0 - 40 = -40

0mm Creep into or out of section

20mm Creep out of section

20 or +20

15 or +15

5m Creep out of section

15mm Creep into section

(+20) - (-15) = +5
20 - 15 = +5

(+15) - (-5) = +20
15 + 5 = +20

15mm Creep out of section

(0) - (+20) = 0
20 - 20 = 0

(-15) - (+20) = -35
-15 - 20 = -35

20mm Creep into section

20 or +20

20 or +20

15mm Creep out of section

20mm Creep out of section

20mm Creep into section

20mm Creep into section

20mm Creep into section
C12-5.3  Measuring Track Alignment

1. Measure track alignment every 20m on curves (or as many reference points as possible, or as determined by the Civil Maintenance Engineer. Measurements should be no more than 50m apart. No alignment measurement is required on straights.

Alignment reference points usually consist of:
~ plaques on platforms, structures, OHWS, or
~ pegs or pipes in the cess or
~ monuments in the ‘6 foot’

When measuring track alignment, ensure:
~ plumbob is sufficiently heavy to negate any wind.
~ plumbob is centred directly above the reference mark and not touching it in any way.
~ do NOT sit the plumbob in pipe and hold string up.
~ the tape or measuring bar from the rail to the reference mark or plumbob string is horizontal.
~ the tape does not touch the ballast or any other obstruction.

**WARNING:**
DO NOT use metal tapes near live exposed electrical equipment, between rail and overhead wiring structures or between OHW structures and fencing or metallic troughing.

2. Record the distance from the running face of the rail to the reference point on the appropriate form.

3. If the survey alignment figures are known, calculate and record the difference in the two readings, the “alignment error” on the form.

Enter a positive number if the curve has moved further from its centre (pushed out), or a negative number if the curve has moved closer to its centre (pulled in).

**WARNING:**
Be careful when calculating “alignment error” on curves where the reference marks are in a different position to normal (eg on the outside of the curve).

4. Some track has deliberately been continuously welded “off design line”. If this is the case and the “off line” position at time of adjustment is known and documented then it can be considered as an “interim design” and is acceptable. This information will be recorded in the “revised alignment” column on the WTSA form and if present on the form should be used when calculating “alignment error”.

5. If, for any reason, the alignment cannot be established note this on the form.

C12-5.4 Damaged or Missing Survey Pegs

Do NOT use measurements from survey pegs that are obviously damaged.

Record damaged or missing survey pegs on the field sheets and report them for replacement.

Measurements should be no more than 50m apart.

If there are insufficient reliable survey pegs around a curve you will have to treat the track as non-standard.
The Alignment Error in these cases are negative (−) as the track moved in towards the centre of the curve

Figure 15
The Alignment Error in these cases are positive (+) as the track moved out away from the centre of the curve

Figure 16
This figure shows positive (+) and negative (-) Alignment Errors as one track moved out away from the centre of the curve and the other moved in toward the centre of the curve.

Figure 17
C12-6 Rail Anchor Examination

1. Check the anchor pattern and number and compare this with the following requirements:

---

**Extract from RailCorp Standard ESC 220.**

- Welded track shall meet the following minimum anchoring requirements.
- Double (or box) anchor every fourth sleeper except at mechanical joints.
- Double anchor every second sleeper for a distance of 32 sleepers either side of mechanical joints, starting at the second sleeper from the joint.
- Basic anchoring is to be so that sleepers are anchored on both sides on each rail (double or box anchor), except for steep grades as detailed below.
- On track with a falling grade steeper than 1 in 80 in the direction of traffic, or at other locations where considered necessary to control rail creep, the anchoring shall be increased by adding single anchoring each second sleeper (or on every sleeper, if necessary) throughout the welded rail length, to prevent rail creep.

**Insulated Joints in Welded Track**

- At mechanical insulated joints EVERY sleeper is to be double anchored for a distance of 32 sleepers on each side of the joint.
- Glued Insulated Joints are treated as if they were plain track, and anchored in the same pattern as the track in which they are placed (eg 1 in 4 when laid in 110m rails or CWR, or every 2nd if within 32 sleepers of a turnout).

**Turnouts**

- Double anchor every second sleeper for 32 sleepers (ie a total of 16 anchored sleepers) in front of the switch, commencing from the first sleeper from the switch.
- Double anchor every second sleeper/timber for 32 sleepers/timbers (ie a total of 16 anchored sleepers/timbers) behind the crossing, commencing from the first timber after the crossing that has plain track fastenings.
- Double anchor every second timber on the through rails and turnout rails between the heel of the switch and the front legs of the crossing.

**Diamonds**

- Double anchor every second sleeper/timber for 32 sleepers/timbers (ie a total of 16 anchored sleepers/timbers) behind the crossing, commencing from the first timber after the crossing that has plain track fastenings.
- Double anchor every second timber between the "V" and "K" crossings.

**Catchpoints:**

- Double anchor the catchpoint rail every second sleeper for 32 sleepers (ie a total of 16 anchored sleepers) in front of the switch, commencing from the first sleeper from the switch.
- Double anchor the catchpoint rail every second sleeper/timber for 32 sleepers/timbers (ie a total of 16 anchored sleepers/timbers) behind the heel commencing from the first timber after the heel that has plain track fastenings.
Extract from RailCorp Standard ESC 220.

Anchoring of Welded Track on Bridges

Steel openings

Transom top openings with spans <18m
- Standard anchoring for welded rails on open track as detailed above shall be used on welded rails on these bridges.

Transom top openings with spans ≥18m long but < 80m
- For a distance of 60m from a bridge end, the track shall be double anchored on every second sleeper.
- On the bridge the track shall be double anchored to every second transom for half the span length, commencing at the fixed end.

Ballast top steel openings with spans ≥ 4.27m long but <80m
- Standard anchoring for welded rails on ballasted track shall be used on welded rails on these bridges.

Transom top or Ballast top steel openings with spans ≥80m
- Between expansion switches the rails are to be double anchored to every fourth transom.

Concrete and masonry openings

For concrete and other track structures an assessment shall be made of the expansion requirements of the bridge structure as they affect rails.

Concrete structures with spans < 25m
- Standard anchoring for welded rails on open track as detailed in Section ESC 220 shall be used on welded rails on these structures.

2. Check the fit of anchors tight up against the sides of sleepers.

3. Check the anchor effectiveness. Are they sprung? Remove a few and test their spring action by driving them back on. Anchors that require little or no effort to replace have lost their spring and are ineffective.

4. Check for visible signs of rail creep through the anchors. (Look for marks on the rail flange indicating movement; anchors on one side of sleeper all drifted away from the sleeper edge; skewed sleepers; wide/tight rail joints).

5. Where resilient fastenings are used, look for evidence to indicate that rails have 'crept' through the sleepers (Look for marks on the rail flange indicating movement).

6. Record the inspection results each 500 metres.

Tick the "OK" column on the manual form (the Yes/No answers on the computer form) if the anchoring and fastenings for the 500metre section are satisfactory.

Determine and record the percentage not effective, if anchors and fastenings are not working properly.
7. If any defects are identified, record all defects in the 500metre section in the appropriate column on the manual form, or the Yes/No and Remarks column of the computer form, using the following example as a guide:

<table>
<thead>
<tr>
<th>Type of anchor</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resilient Fastening</td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td>20% ineffective</td>
</tr>
<tr>
<td>Fair Type Anchor</td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td>Incorrect Pattern</td>
</tr>
<tr>
<td></td>
<td>Creep Indications</td>
</tr>
<tr>
<td></td>
<td>Ineffective/missing</td>
</tr>
</tbody>
</table>

C12-7 Ballast Examination

1. Identify locations where ballast deficiencies exist; even if they are only a few metres long - this may be where pedestrians or stock regularly cross the line and destroy the ballast shoulder or it may be damaged by vehicles or perhaps digging for cables. Single cribs left bare for signal rodding are normally ignored.

2. Estimate and record all deficiencies on the form, showing Crib or Shoulder deficiencies in Tonnes per 20 metres. Use Table 9 and Table 10 for guidance.

   **NOTE:** WTSA software calculates stability loss from ballast loss in tonnes/20m. It cannot, however distinguish between timber and concrete sleepers. For the purposes of establishing stability loss use the t/20m figures on the RIGHT of Table 9 and Table 10. If you are ordering ballast to remove deficiencies use the t/20m figures on the LEFT of Table 9 and Table 10.

3. For shoulder ballast deficiencies on curves, indicate whether the deficiency is on the HIGH or LOW rail by writing H or L next to the tonneage figure eg. 5t/20m(H).

4. Provide details in the comments column including location of ballast deficiencies and action needed for repair (eg regulator, manual boxing up).

5. Note all areas of foul ballast, poor formation. Record these by ticking the FB column on the form and providing details in the comments column.

   **NOTE:** where severe bog holes occur and the sleepers are being supported by the rail and not bearing on the ballast underneath or where the ballast around the sleeper is not in contact with the edge of the sleeper, notation should be made in the remarks column and the location reported to the Civil Maintenance Engineer who will arrange for special assessment and appropriate priority.

6. Note all areas of severe white rounded ballast. Record these by ticking the BR column on the inspection form and provide details in the comments column.

7. Note any pumping bridge end, pumping joints or pumping sleepers. Record these by ticking the PJ column on the inspection form and provide details in the comments column.
NOTE: Severely pumping ridge ends are a significant misalignment risk. If bridge ends or other locations are pumping to the extent that the ballast is offering little support then this should be noted in the remarks column so that a further 10% can be added to the stability loss.

<table>
<thead>
<tr>
<th>For Ordering Ballast</th>
<th>SHOULDER - CONCRETE AND TIMBER SLEEPERS</th>
<th>For WTSA SOFTWARE Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>16t/20m</td>
<td>Nil each Side</td>
<td>16t/20m</td>
</tr>
<tr>
<td>12t/20m</td>
<td>Half Shoulder one side - Nil other side</td>
<td>12t/20m</td>
</tr>
<tr>
<td>8t/20m</td>
<td>Half shoulder both sides</td>
<td>8t/20m</td>
</tr>
<tr>
<td>4t/20m</td>
<td>Full Shoulder one side - Half other side</td>
<td>4t/20m</td>
</tr>
<tr>
<td>-</td>
<td>Full Shoulder both sides</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 9 - Assessment of Shoulder ballast profile Timber and Concrete sleepers
### Table 10 - Assessment of Crib Ballast Profile Timber and Concrete Sleepers

<table>
<thead>
<tr>
<th>For Ordering Ballast</th>
<th>CRIB - TIMBER SLEEPERS</th>
<th>For WTSA SOFTWARE Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>10t/20m</td>
<td>Nil in Crib</td>
<td>10t/20m</td>
</tr>
<tr>
<td>5t/20m</td>
<td>Half Full Crib</td>
<td>5t/20m</td>
</tr>
<tr>
<td>-</td>
<td>Full Crib</td>
<td>-</td>
</tr>
</tbody>
</table>

**CRIBS HEAVY DUTY CONCRETE SLEEPERS (Type 5 & 6)**

| 18t/20m              | Nil in Crib             | 10t/20m                 |
| 9t/20m               | Half Full Crib          | 5t/20m                  |
| -                    | Full Crib               | -                       |

**CRIBS MEDIUM DUTY CONCRETE SLEEPERS**

| 13t/20m              | Nil in Crib             | 10t/20m                 |
| 7t/20m               | Half Full Crib          | 5t/20m                  |
| -                    | Full Crib               | -                       |

---

**C12-8 Misalignment Triggers**

1. Record the location of potential misalignment triggers on the measurement form. These locations may not show up as a priority in the Welded Track Stability analysis over 500m.

Misalignment triggers include:

- Poor Rail/Weld alignment arising from incorrect crowing, rail end alignment, poor rail profile matching, straight closures in curves, track alignment (including gauge) glued insulated joints etc. Record by ticking the SA column.

- Rail surface including dipped welds, dipped joints. Record by ticking the SA column.

- Multiple wheel burns and corrugations, etc. Record by ticking the RC column.

**NOTE** If the corrugations are severe to the extent that they are causing disturbance to the ballast (severe pumping or white rounded ballast) notation should be made in the comments column so that an extra 10% can be added to the final stability loss.
Rail bunching at fixed points due to changes in fastener, sleeper or rail type, bridges, turnouts, level crossings or where welds are caught against sleepers etc. Record in RB column.

Local disturbances due to undertrack crossings, culverts etc.

Ballast pushed up in crib or deficiency behind sleeper.

Anchor points left on.

Curves less than 400m radius. Tight radius curves have a higher misalignment risk, particularly if they are continuously welded on dogs spiked sleepers. Particular attention must be paid to these locations to correct any track instability or potential misalignment triggers.

During the field inspection make notes in the remarks column where sleeper skewing, localised ballast pushing by sleepers, irregular sleeper spacing etc., occur.

Take special care to note any small timber sleeper panels in concrete sleepers (including where adjoining timber or concrete tied turnouts).

Identify and record locations requiring special assessment including all previous misalignment sites and Non Standard Welded Track.

Provide details of all misalignment triggers in the comments column.

C12-9 Inspection for Old Welds at Fixed Points

During the WTSA inspection staff should be on the lookout for old aluminothermic welds within 70m of any bunching point location. The concern is with old welds where there are suspicions that the “steel in = steel out” process may not have been used. This would not include welds installed when the rail was laid.

If suspicious old welds have been identified at a bunching point then check adjustment either by cutting the rail or by using the VERSE system in accordance with the procedures in Engineering Manual TMC 223 - Rail Adjustment. If adjustment control records are available for the welds, the adjustment check is not required.

C12-10 Ties and Painted Rails

Show on the form with arrows, type of ties:- C = concrete, T = timber, and if rails are painted or not.

C12-11 Guidelines for the Assessment of Crossing Loops

Mandatory assessment of Crossing loops MUST include:

1. Check of ballast profile.
2. Check of rail joints (are they working, are gaps reasonable for the temperature).
3. Check for signs of:
   ~ Creep/bunching.
   ~ Sleepers bunched up or skewed.
   ~ Ballast pushed up in cribs or deficiency behind sleepers.
   ~ Welds jamming on sleepers or sleeper plates.
4. Check for foul ballast or glassy ballast bed.
5. Check for any location where track is severely weakened by disturbance or ballast condition.
6. Check for pumping sleepers.
7. If track is not jointed then check:
   ~ Have there been any stability problems with the loop in the last 3 years. If YES then loop must be adjusted.
   ~ If there has been any welding in the last 12 months, then check that no steel has been added (Steel in/Steel out). If there are any concerns regarding adjustment it has to be checked.
   ~ Has track been disturbed eg tamping, PRS.
8. Deficiencies identified MUST be assessed and prioritised considering:
   ~ Speed of the crossing loop.
   ~ Proximity of main line (will loop be foul of main line if it buckles).
Chapter 13  Welded Track Stability Analysis

The field information gathered in Welded Track Stability measurement is used to calculate the amount of "lost Track Stability" for each nominal 500m section of welded track.

Special procedures are included for adjustment analysis of sections less than 500m.

The following analysis can be carried out manually or by computer using the WTSA program.

Figure 18 - Welded Track Stability Analysis process

C13-1  Rail Adjustment - Long Welded Rail

The analysis of rail gaps is based on the information gathered in Chapter 12.

For sections of track less than 500m in length replace Steps 1 - 4 below with the steps in Section C13-1.2.
1. Calculate the average length of rail for each 500metre section from the number of rail gaps in section.

   Example:
   For 5 rail gaps - Average rail length is 100m.
   For 4 rail gaps - Average rail length is 125m.

2. Calculate the average rail gap for the 500m section by totalling the length of all gaps and dividing by the number of rail gaps in that section.

   Example:
   For 4 gaps with total gap measuring 40mm - the average rail gap is 10mm.
   For 10 gaps with total gap measuring 36mm - the average rail gap is 3.6mm.

3. Use Table 11 - Jointed Welded Rail - Gap Analysis to determine from the average rail length and average rail gap what the Theoretical Measured Temperature for that 500 metre section should have been.

   Example:
   Average rail length = 125m  
   From Table 11, Theoretical Measured Temperature is 32°C
   Average gap = 10mm

4. Calculate the Rail Temperature Error.

   The Rail Temperature Error for the 500m section will be the difference between the Actual Measured Rail Temperature and the Theoretical Measured Temperature from Table 11.

   Rail Temp Error = Actual Measured Temp - Theoretical Measured Temp.

   If the Rail Temperature Error is a minus number then the effective neutral temperature for the rail has been reduced by poor adjustment. In other words, there is likely to be an excess of steel.

   Example:
   Actual measured rail temp = 28°C
   Theoretical temperature = 32°C
   Rail Temperature Error = 28-32 = -4°C
   Effective Neutral Rail Temperature = 35-4 = 31°C
   (35°C is the design neutral temperature.)
### Table 11 - Jointed Welded Rail - Gap Analysis

<table>
<thead>
<tr>
<th>No. Gaps /500m</th>
<th>Theoretical Measured Temperature (°C)</th>
<th>Average Rail Gap (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>33 (15)</td>
<td></td>
<td>44 42 41 38 35 32 29 27 25 20 8 n.a. n.a.</td>
</tr>
<tr>
<td>36 (14)</td>
<td></td>
<td>43 42 40 37 35 33 30 27 25 20 10 n.a. n.a.</td>
</tr>
<tr>
<td>38 (13)</td>
<td></td>
<td>43 41 40 37 35 33 30 28 26 21 13 n.a. n.a.</td>
</tr>
<tr>
<td>42 (12)</td>
<td></td>
<td>42 41 40 37 35 33 30 29 27 22 16 n.a. n.a.</td>
</tr>
<tr>
<td>45 (11)</td>
<td></td>
<td>42 41 39 37 35 33 31 29 27 24 18 n.a. n.a.</td>
</tr>
<tr>
<td>50 (10)</td>
<td></td>
<td>42 40 39 37 35 33 31 30 28 25 19 n.a. n.a.</td>
</tr>
<tr>
<td>56 (9)</td>
<td></td>
<td>41 40 38 36 35 34 32 30 29 26 21 14 n.a.</td>
</tr>
<tr>
<td>63 (8)</td>
<td></td>
<td>40 39 38 36 35 34 32 30 30 27 23 16 9</td>
</tr>
<tr>
<td>71 (7)</td>
<td></td>
<td>39 38 37 36 35 34 33 31 30 28 24 18 12</td>
</tr>
<tr>
<td>83 (6)</td>
<td></td>
<td>39 38 37 36 35 34 33 32 31 29 26 21 16</td>
</tr>
<tr>
<td>100 (5)</td>
<td></td>
<td>38 37 36 36 35 34 34 33 31 30 27 23 19</td>
</tr>
<tr>
<td>125 (4)</td>
<td></td>
<td>37 37 36 36 35 34 34 33 32 31 29 26 22</td>
</tr>
<tr>
<td>167 (3)</td>
<td></td>
<td>37 37 36 36 35 34 34 33 33 32 30 28 25</td>
</tr>
<tr>
<td>250 (2)</td>
<td></td>
<td>37 36 36 35 35 35 34 34 33 32 31 29 27</td>
</tr>
<tr>
<td>500 (1)</td>
<td></td>
<td>NA</td>
</tr>
</tbody>
</table>

5. Determine the loss of track stability from the rail temperature error for LWR using Table 12 - % Loss of Track Stability.

The values for stability loss in Table 12 are derived from the following formulae:

For Jointed Welded Rail (LWR) \( \% \text{ Stability Loss} = (-3.3368) \times \text{Rail Temperature Error} \)

For Continuous Welded Rail (CWR) \( \% \text{ Stability Loss} = (-2.5151) \times \text{Rail Temperature Error} \)

For all positive values of rail temperature error (CWR and JWR) \( \% \text{ Stability Loss} = 0 \)
### Loss of Track Stability (% of total stability) (based on single rail only)

<table>
<thead>
<tr>
<th>Rail Temperature Error</th>
<th>Jointed Welded Rail</th>
<th>Continuous Welded Rail</th>
<th>Rail Temperature Error</th>
<th>Jointed Welded Rail</th>
<th>Continuous Welded Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
<td>3</td>
<td>2</td>
<td>-16</td>
<td>53</td>
<td>40</td>
</tr>
<tr>
<td>-2</td>
<td>7</td>
<td>5</td>
<td>-17</td>
<td>57</td>
<td>43</td>
</tr>
<tr>
<td>-3</td>
<td>10</td>
<td>8</td>
<td>-18</td>
<td>60</td>
<td>45</td>
</tr>
<tr>
<td>-4</td>
<td>13</td>
<td>10</td>
<td>-19</td>
<td>63</td>
<td>48</td>
</tr>
<tr>
<td>-5</td>
<td>17</td>
<td>13</td>
<td>-20</td>
<td>67</td>
<td>50</td>
</tr>
<tr>
<td>-6</td>
<td>20</td>
<td>15</td>
<td>-21</td>
<td>70</td>
<td>53</td>
</tr>
<tr>
<td>-7</td>
<td>23</td>
<td>18</td>
<td>-22</td>
<td>73</td>
<td>55</td>
</tr>
<tr>
<td>-8</td>
<td>27</td>
<td>20</td>
<td>-23</td>
<td>77</td>
<td>58</td>
</tr>
<tr>
<td>-9</td>
<td>30</td>
<td>23</td>
<td>-24</td>
<td>80</td>
<td>60</td>
</tr>
<tr>
<td>-10</td>
<td>33</td>
<td>25</td>
<td>-25</td>
<td>84</td>
<td>63</td>
</tr>
<tr>
<td>-11</td>
<td>37</td>
<td>28</td>
<td>All positive values</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>-12</td>
<td>40</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-13</td>
<td>43</td>
<td>33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-14</td>
<td>47</td>
<td>35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-15</td>
<td>50</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 12 - % Loss of Track Stability**

6. Record this figure on Form WTSA 3 (for manual analysis) as the result for the 500metre section.

   **Example:**
   
   For Rail Temp Error of -40°C
   
   Loss of Track Stability is 13%

7. Repeat the process separately for the Up and Down rail. This will give two separate results. The Combined Loss of Track Stability due to rail adjustment is the sum of the separate results.

8. Check the comments column of the measurement sheet to ensure that there were no frozen joints.

   If there were any frozen joints, or joints with a zero gap reading, or a gap reading which shows the joint is fully open and pulling on the bolts, then the correct adjustment cannot be calculated. Determine stability loss from Table 13 - Influence of Non Standard or Special Track Conditions.

9. The following are non standard track configurations and cannot be analysed as LWR. Analyse them as Non Standard track. (see Table 13)

   **Extract from RailCorp Standard ESC 220.**

   - Rails longer than 220m with resilient fastenings more than 1 in 3 (unless the rails have been correctly adjusted in accordance with requirements for CWR).
   
   - Rails longer than 27.4m with resilient fastenings more than 1 in 3 (unless the rails have been correctly adjusted in accordance with requirements for CWR).
<table>
<thead>
<tr>
<th>Condition</th>
<th>Stability Loss</th>
<th>WTSA program</th>
<th>If Applicable manually adjust by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frozen joints, zero gaps, fully open &amp; pulling on bolts</td>
<td>10% each rail</td>
<td>Covered by &quot;Adverse Conditions&quot; in JWR screen</td>
<td></td>
</tr>
<tr>
<td>Jointed welded rail on resilient fastenings &gt;1 in 3 sleepers resilient fastened</td>
<td>10% each rail</td>
<td>Covered by non-standard checkbox in JWR screen. Defaults to priority one when checked.</td>
<td></td>
</tr>
<tr>
<td>No creep pegs</td>
<td>Calculate using -20mm (creep into the section) tangent creep on each rail for the tangent creep component of adjustment[1]</td>
<td>When missing is selected in the creep box -20 creep is used in the analysis.</td>
<td></td>
</tr>
<tr>
<td>Alignment details for CWR not known</td>
<td>Calculate using -50mm Average Alignment Error for Curve Creep component of adjustment</td>
<td>Covered by WTSA software which defaults to – 50mm when the alignment missing box is ticked curve creep.</td>
<td></td>
</tr>
<tr>
<td>Foul ballast, pumping joints, poor formation</td>
<td>minimum 10% for Track Disturbance</td>
<td>WTSA software actually adds 10% if the Foul ballast or Pumping Joints boxes are ticked regardless of whether there is a disturbance of &gt;10% existing.</td>
<td>Secondary analysis can reduce final stability result if 10% loss for foul ballast is cumulative with track disturbance.</td>
</tr>
<tr>
<td>Ballast Condition - rounded/disturbed/pulverised</td>
<td>ADD 10% Stability loss to PRELIMINARY result</td>
<td>WTSA Software adds 10% if the Ballast Condition box is ticked.</td>
<td></td>
</tr>
<tr>
<td>Bad ballast disturbance (This would be appropriate at pumping bridge ends where the sleepers have been flogging and ballast is loose and providing no support to the sleepers)</td>
<td>ADD an additional 10% manually to the FINAL Stability loss (this is extra to the 10% added to the preliminary result)</td>
<td>Additional manual adjustment required</td>
<td>Add 10% to FINAL Result</td>
</tr>
<tr>
<td>Transom top steel underbridges without expansion switches, with span ≥40m and with elastic fastenings</td>
<td>10% Stability loss to be added to PRELIMINARY result</td>
<td>WTSA software adds 10% when Bridge factor box is ticked.</td>
<td></td>
</tr>
<tr>
<td>Elbows or sharp alignment in the rail</td>
<td>10% Stability loss to be added to PRELIMINARY result</td>
<td>WTSA software adds 10% when the SA box is ticked</td>
<td></td>
</tr>
<tr>
<td>Concrete sleepered track</td>
<td>Stability Improved Reduce PRELIMINARY result by 33%</td>
<td>Built in to infrastructure inputs to software.</td>
<td></td>
</tr>
<tr>
<td>Rail Corruations causing vibration of track and may also be causing degraded ballast sufficient to cause track disturbance</td>
<td>10% Stability loss to be added to PRELIMINARY result</td>
<td>WTSA software adds 10% when the RC box is ticked</td>
<td></td>
</tr>
<tr>
<td>Severe Rail Corruations, causing major disturbance,</td>
<td>ADD an additional 10% manually to the FINAL Stability loss (this is extra to the 10% added to the preliminary result)</td>
<td>Additional manual adjustment required</td>
<td>Add 10% to FINAL Result</td>
</tr>
<tr>
<td>Joints are evenly spaced at intervals of 55m or less and the joints are working correctly</td>
<td>Stability Improved additional benefit of 5°C credited to the track adjustment for each rail in SECONDARY analysis.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 13 - Influence of Non Standard or Special Track Conditions
Note 1. Whilst 20mm is the default assumed Tangent Creep, a level in keeping with historic creep rates is preferable where this is known. This should include consideration of the length of time since creep control was lost. (eg. 3 years at an average of 5mm/year would give 15mm)

C13-1.1 WTSA Software Manual Adjustments

The WTSA software program used in RailCorp for the analysis has been updated to reflect some of the additional factors detailed in Table 13 above.

When undertaking Welded Track Stability Analysis, if any of the non standard conditions detailed in Table 13 are present in the section being analysed, tick the appropriate checkboxes in the WTSA Data Entry Screen or manually add the nominated % Stability Loss to the PRELIMINARY or FINAL result (whichever is appropriate).

C13-1.2 Supplementary Analysis of Track Lengths < 500m

This method allows assessment of track of length less than 500 metres. The WTSA software has been set up to calculate the stability loss due to rail temperature error over the actual length of each nominated section. When manual calculation is performed the following may be used to determine the rail temperature error for track of any length. All of the other processes in WTSA remain the same.

The method is appropriate for use to assess anomalous sections ie where there is a section that has an adjustment which is uncharacteristic of the average result for the normal 500 metre section. For example:

— All joints closed at one end of a 500 metre section.
— Track is totally confined by fixed points and the adjustment is different to the rest of the 500 metres.

Civil Maintenance Engineers will determine locations where this method of analysis may be used

1. Calculate the rail temperature error for any rail length by the following formula:

\[ E = T_a - 35 + \frac{85.5 \times (G - 6N)}{L} \]

where \( L \) = length of rail

\( E \) = rail temperature error in \(^{\circ}\)C

\( T_a \) = measured rail temperature

\( G \) = total gap (ie sum of gaps in mm)

\( N \) = number of gaps

Coefficient of linear expansion used = 1.17E-5 mm/mm degree

2. In addition because of the inherent statistical variations involved in using distances shorter than 500m use the following factor to reduce the apparent excess steel:

for 250m or less 1.25 \(^{\circ}\)C per rail

for 500m or more nil

for 250m to 500m a linear interpolation ie \( \frac{500 - L}{200} \)
**Example**

for a length of 300 metres, with gaps 5mm, 10mm, 5mm on one rail, at a temperature of 30°C

\[
L = 300 \\
T_a = 30 \\
G = 5+10+5=20 \\
N = 3 \text{ gaps}
\]

hence \( E = 30 - 35 + \frac{85.5 \times (20 - 6 \times 3)}{300} \)

\[
= -5+(85.5 \times 2/300) \\
= -5+0.6 \\
= -4.4
\]

now for 300m the statistical variation factor = \((500-300)/200 = 1.0\)

hence the modified rail temperature error = -4.4+1.0 = -3.4

3. Determine the calculation of stability loss for rail adjustment for each rail from Section C13-2.3. The remaining WTSA process is unchanged.

Note: The formula is only valid for Standard Welded Track and should not be used for Non-Standard Track ie 1 gap in 300 metres. The track in such cases should be treated as Non-Standard Track.

**C13-2 Rail Adjustment - Continuous Welded Rail**

The analysis of tangent and curve creep is based on the information gathered in Chapter 12.

For sections of track less than 500m in length replace all steps in Section C13-2.1 and C13-2.2 below with the steps in Section C13-2.4.

**C13-2.1 Tangent Creep**

1. Calculate the net tangent creep from the recorded measurements of rail creep.

   The result is calculated by comparing the amount and direction of the creep at either end of the track section being analysed. The analysis assumes the rails have been correctly installed and maintained.

   If additional rail has moved into the section then the stress is compressive (−).

   If rail has moved out of the section then the stress is tensile (+).

   **Example 1:**

   Creep direction
   km post -10mm -25−(−10) = -15mm Additional rail in section
   1/2km post -25mm Net tangent creep = -15mm

   **Example 2:**

   Creep direction
   km post -10mm +25−(−10) = +35mm Less rail in section
   1/2km post +25mm Net tangent creep = +35mm

   **NOTE:** Creep towards Sydney is negative while creep away from Sydney is positive.

2. Read the equivalent Temperature Error for the 500m section due to the amount of Tangent Creep from Table 14 - Continuous Welded Rail - Creep Analysis.

   **Example:**

   Tangent Creep = -15mm
   From Table 2 - Temperature Error = -3°C.
NOTE 1: When the Tangent Creep is negative (-), the Temperature Error is also negative (-) ie the effective neutral temperature of the rail has been lowered.

2: When the Tangent Creep is positive (+), the temperature error is positive (+) ie the effective neutral temperature has been raised.

<table>
<thead>
<tr>
<th>Tangent Creep - CWR - Temperature Errors(°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creep (mm)</td>
</tr>
<tr>
<td>------------</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>25</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>35</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>45</td>
</tr>
<tr>
<td>50</td>
</tr>
</tbody>
</table>

Table 14 - Continuous Welded Rail - Creep Analysis

C13-2.2 Curve Creep

Determine the Temperature Error due to Curve Creep for each curve in the 500m section as follows:

1. Calculate the Curve Alignment Index for each curve or portion of curve in the 500m section.

\[
\text{Curve Alignment Index} = \frac{\text{Radius}}{\text{Length of Curve in 500m section}}
\]

This Index can be calculated initially and entered on the field recording sheets for the section.
### Curve creep - C.W.R. - Temperature error (°C)

<table>
<thead>
<tr>
<th>Alignment Index</th>
<th>15</th>
<th>25</th>
<th>50</th>
<th>75</th>
<th>100</th>
<th>125</th>
<th>150</th>
<th>175</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6</td>
<td>4</td>
<td>7</td>
<td>14</td>
<td>21</td>
<td>29</td>
<td>36</td>
<td>43</td>
<td>50</td>
<td>57</td>
</tr>
<tr>
<td>0.8</td>
<td>3</td>
<td>5</td>
<td>11</td>
<td>16</td>
<td>21</td>
<td>21</td>
<td>32</td>
<td>37</td>
<td>43</td>
</tr>
<tr>
<td>1.0</td>
<td>3</td>
<td>4</td>
<td>9</td>
<td>13</td>
<td>17</td>
<td>21</td>
<td>26</td>
<td>30</td>
<td>34</td>
</tr>
<tr>
<td>1.2</td>
<td>2</td>
<td>4</td>
<td>7</td>
<td>11</td>
<td>14</td>
<td>18</td>
<td>21</td>
<td>25</td>
<td>29</td>
</tr>
<tr>
<td>1.4</td>
<td>2</td>
<td>3</td>
<td>6</td>
<td>9</td>
<td>12</td>
<td>15</td>
<td>18</td>
<td>21</td>
<td>24</td>
</tr>
<tr>
<td>1.6</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>8</td>
<td>11</td>
<td>13</td>
<td>16</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>1.8</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>7</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>17</td>
<td>19</td>
</tr>
<tr>
<td>2.0</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>9</td>
<td>11</td>
<td>13</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>2.2</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>2.4</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>11</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>2.6</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>2.8</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>3.0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>7</td>
<td>9</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>3.5</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>4.0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>4.5</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>5.0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>6.0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7.0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>8.0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>9.0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>10.0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>11.0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>12.0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>13.0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>14.0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>15.0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>16.0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>17.0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>18.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

*Table 15 - Continuous welded rail - Curve Creep analysis*
2. Calculate the Temperature Error from the effect of movement of the curve in the 500m section using Table 15 - Continuous welded rail - Curve Creep analysis:

Example:
Curve 300m long
Radius 900m

Curve Alignment Index = \( \frac{900}{300} = 3 \)

Average Alignment Error = \(-40\)mm
(where alignment error is taken over the worst 100m, being that which is the greatest negative or least positive alignment error)

From Table 15:
Temperature Error = \(-3^\circ \)C for 500m section.

3. If there is more than one curve, or portions of curves, in the 500m section, add the Curve Creep results for each curve to give the total Lateral Creep Temperature Error for the 500m section.

C13-2.3 Loss of Track Stability

1. Calculate the Total Rail Temperature Error for each 500m.

\[ \text{Total Rail Temperature Error} = \text{Longitudinal Creep (Tangent) Temperature Error} + \text{Lateral Movement (Curve Creep) Temperature Error} \]

2. Read the Loss of Track Stability for the Total Rail Temperature Error for CWR from Table 12 - % Loss of Track Stability.

Example:

\[ \text{Total Rail Temperature Error} = -3^\circ \text{C} + -3^\circ \text{C} = -6^\circ \text{C} \]

From Table 12 - loss of track stability is 15%.

3. Repeat the process separately for the Up and Down rails giving two separate results.

The Total or Combined Track Stability Loss due to rail adjustment in the 500m section is the sum of the two results.

4. Record the results on Form WTSA 3 (for manual analysis).

5. The following are non standard track configurations and cannot be analysed as CWR. Analyse them as Non Standard track (see Table 13).

<table>
<thead>
<tr>
<th>Extract from RailCorp Standard ESC 220.</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Rails longer than 220m that have not been adjusted.</td>
</tr>
<tr>
<td>- Rails longer than 220m with no creep marks or pegs.</td>
</tr>
<tr>
<td>- Rails longer than 220m with no alignment information available.</td>
</tr>
<tr>
<td>- Rails longer than 27.4m with resilient fastenings more than 1 in 3 (unless the rails have been correctly adjusted in accordance with requirements for CWR).</td>
</tr>
</tbody>
</table>

6. All non standard welded track is to be treated as a Priority 1.

C13-2.4 Supplementary Analysis of Track Lengths < 500m

This method allows assessment of track of length less than 500metres. Calculation is available to determine the rail temperature error for CWR track of any length. All of the other processes in WTSA remain the same.
The method is appropriate for use to assess anomalous sections ie where there is a section that has an adjustment which is uncharacteristic of the average result for the normal 500 metre section. For example:

- creep into a section is confined to a smaller part of the section by turnouts or more creep resistant track structure eg dogspike track running into Pandrol track
- track is totally confined by fixed points and the adjustment is different to the rest of the 500 metres.

Civil Maintenance Engineers will determine locations where this method of analysis may be used.

C13-2.4.1 Tangent Creep

1. Calculate the rail temperature error due to tangent creep for any rail length by the following formula:

\[ E_t = \frac{C_t \times 85.5}{L} \]

where

- \( L \) = length of rail
- \( E_t \) = rail temperature error in \(^{\circ}\)C due to tangent creep
  (-ve means too much steel)
- \( C_t \) = net tangent creep in mm
  (-ve means net creep into section)

Coefficient of linear expansion used \( = 1.17 \times 10^{-5} \) mm/mm degree

Note: If small lengths are being analysed the accuracy of the creep recordings needs to be very good otherwise the validity of the calculation is overwhelmed by the errors in measurement.

C13-2.4.2 Curve Creep

1. Calculate the rail temperature error due to curve creep for any rail length by the following formula:

\[ E_c = \frac{A \times 85.5 \times L_c}{L \times R} \]

where

- \( L \) = length of section to be analysed
- \( E_c \) = rail temp error in degrees C due to curve creep
  (-ve means too much steel)
- \( A \) = average alignment error in mm
  (pullin is considered negative)
- \( L_c \) = length of curve in m (must be within \( L \))
- \( R \) = radius in m

Coefficient of linear expansion used \( = 1.17 \times 10^{-5} \) mm/mm degree

C13-2.4.3 Loss of Track Stability

1. Determine the Total Rail Temperature Error as in Section C13-2.3 using the errors for Tangent Creep and Curve Creep derived above.

2. Calculate the stability loss for rail adjustment for each rail. The remaining WTSA process is unchanged.

C13-3 Assessment of Bunching Points and Fixed Points

Bunching points are locations where the steel may bunch up because of differences in the longitudinal creep behaviour of the track when moving from a weaker track structure to a stronger tack structure in the direction of travel. Bunching points attract a standard
stability loss of 10% (This can be entered into the WTSA software by ticking the "rail bunching" checkbox).

Where the amount of bunching is considered to be extreme, then (in addition to the entering the automatic stability loss) conduct a Fixed Point Analysis. Guidance on when to consider that the interface requires a fixed point analysis is given in Table 16 below. The table describes the interface between dogspiked timber sleepered track and various other configurations; and between elastic fastened timber track and various other configurations.

<table>
<thead>
<tr>
<th>INTERFACE from</th>
<th>Analysis requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete sleepered track</td>
<td>Standard 10% loss plus Fixed Point Analysis</td>
</tr>
<tr>
<td>Turnouts, Crossovers etc</td>
<td>Standard 10% loss plus Fixed Point Analysis</td>
</tr>
<tr>
<td>Transom top elastic fastened track or small level crossing</td>
<td>Standard 10% loss plus Fixed Point Analysis</td>
</tr>
<tr>
<td>Substantial solid level crossing</td>
<td>Standard 10% loss plus Fixed Point Analysis</td>
</tr>
<tr>
<td>Elastic fastened plain timber track</td>
<td>Standard 10% loss Not applicable</td>
</tr>
</tbody>
</table>

Table 16 – Guidelines for Fixed Point analysis

In unusual situations where there is severe creep of rails or fastenings occurring (as found on some very steep heavy trafficked areas) then Civil Maintenance Engineers should give special consideration to any additional requirements.

C13-3.1 Fixed Point Analysis

Locations nominated above as requiring fixed point analysis must be the subject of an additional assessment to review the likely impact on track adjustment. If no assessment is carried out track adjustment must be calculated assuming that incoming rail creep is confined to the track between the creep point and the bunching point.

C13-3.2 Treatment of Small Sections Between Fixed Points

Where the length of track between fixed points (eg between turnouts or bridges) is more than 200m, creep points must be installed and monitored. For lengths up to 1000m, place a creep point in the centre of the section. For lengths greater than 1000m place creep points starting 500m from one end.

C13-3.3 Assessment for Fixed Point Analysis

Is the bunching point really a location where steel has been bunching?

Factors to be considered include:

- Creep in the section has been stable for at least 3 years, or has reduced in that time
- Single line track with no particular reason to bunch, as traffic is similar in both directions.
— Are there indications on sleepers/fastenings that steel has been passing through the "bunching point".

If it can be established that the location is not actually causing steel to bunch then the bunching point adjustment calculation is not required. Alternatively, if only some of the steel is creeping through the bunching point, a reduced level of creep can be used in the analysis.

C13-3.4 Calculation for Fixed Point Analysis

If the fixed point defines a length that is very short, then the result may be exaggerated by small errors in measurement of creep. In this case the level of creep should be re-assessed based on the creep history. If there has been a recent change in the creep measured, it should be re-measured to confirm.

In any case the calculation should assume that the incoming steel is confined between the creep point and the bunching point. The minimum length to be used is 165m. If the adjusted length is less than 165m, use 165m. If greater than 165m then use the actual length. This is necessary because where the track length is short then the measurement accuracy will have a misleading effect on the adjustment error calculated.

C13-4 Rail Adjustment - Winter Deficiencies

When the analysis is carried out in Summer/Autumn rail adjustment analysis will indicate areas of potential breakaways.

For both CWR and JWR track a separate defect is registered for each 500m section which has a Rail Temperature Error in excess of + 8°C and remedial action is to be programmed before Winter.

C13-5 Stability Loss - Anchors

1. Determine stability loss due to anchor condition using the information from the examination of anchors in Chapter 12 and using Table 17 - Influence of Anchor Conditions.

<table>
<thead>
<tr>
<th>Type of Anchor</th>
<th>Condition</th>
<th>Loss of Stability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastic Fastening</td>
<td>Good</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>20% Ineffective</td>
<td>5%</td>
</tr>
<tr>
<td>Fair Type Anchor</td>
<td>Good</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Ineffective / Missing</td>
<td>8%</td>
</tr>
</tbody>
</table>

Table 17 - Influence of Anchor Conditions

2. Record on Form WTSA 3 (for manual analysis) the worst result for each 500m section as representative of the weakest point in that section.

C13-6 Stability Loss - Ballast

1. Determine stability loss due to ballast profile and condition using the information from the examination of ballast in Chapter 12 and using Table 18.

2. Add the crib result and the shoulder result to determine the stability loss.
3. Analyse all ballast loss as reported by field staff. The worst combined result (crib + shoulder) for the 500m Section, again representing the weakest point in the Section will be used to determine total stability loss.

4. If any areas have been noted as having foul ballast, poor formation or pumping joints, add a % loss of Track Stability as indicated in Table 13 to the Ballast Deficiencies Result.

**C13-7 Stability Loss - Track Disturbances**

Any track disturbance since last May or planned before April next year must be factored in to the calculations.

Information on locations of track disturbance should be available on records obtained from Team Managers, Civil Maintenance Engineers and Asset Engineers.

**NOTE.** There are two methods of calculating the effect of track disturbance on track stability loss. Tables 19 & 20 use a time based method while Table 21 uses tonnage. The lower stability loss % when comparing both methods should be used for both primary and secondary analysis.

Track Disturbance includes:
- Resleepering (manual or mechanised).
- Resurfacing.
- Ballast cleaning and reconditioning.
- Underline Crossings (ULX)
- Indicate if a Dynamic Track Stabiliser is used.

1. Establish the type, extent and timing of the major work activity.

**Table 19 - Influence of Major Track Disturbance** indicates loss of track stability for major track disturbances. Depending upon the timing of major works and the type of work, variations to the impact on track stability will occur. There is a "look-ahead" period in the assessment, which is carried out in August/September to ensure that account is taken of works scheduled for the summer ahead. These are more significant than those during the past months even though the critical situation has not yet occurred.

Table 20 - Summer Updating Analysis - Influence of Major Track Disturbance is the Summer Updating Analysis and is used to update the analysis during the summer period as the effect of track disturbance is reduced as time passes.

**Notes**
2. Mechanised timber resleepering and concrete resleepering are included in the Tie and Surfacing category. Steel sleepers are not included. This work generally
involves a greater amount of disturbance to sleepers being replaced and also the adjacent sleepers.

3. Reconditioning and Underline Crossings by excavation are to be treated similarly to ballast cleaning.

### Table 19 - Influence of Major Track Disturbance.

<table>
<thead>
<tr>
<th>Months since work performed</th>
<th>Manual PRS</th>
<th>Surfacing Ballast Stab</th>
<th>Tie &amp; Surfacing Ballast Stab</th>
<th>Ballast Cleaning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>W/out With</td>
<td>W/out With</td>
<td>W/out With</td>
<td>W/out With</td>
</tr>
<tr>
<td>Over 6</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
</tr>
<tr>
<td>5 to 6</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
</tr>
<tr>
<td>4 to 5</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
</tr>
<tr>
<td>3 to 4</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
</tr>
<tr>
<td>2 to 3</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
</tr>
<tr>
<td>1 to 2</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
</tr>
<tr>
<td>0 to 1</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
</tr>
<tr>
<td>Any future work planned</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
</tr>
</tbody>
</table>

Table 20 - Summer Updating Analysis - Influence of Major Track Disturbance
4. Effect of tonnage on track disturbance.

Table 21 provides a comparison of reduction in track stability loss due to traffic tonnage.

<table>
<thead>
<tr>
<th>Tonnage (000 GT)</th>
<th>Manual PRS</th>
<th>Surfacing Ballast Stab</th>
<th>Tie &amp; Surfacing Ballast Stab</th>
<th>Ballast Cleaning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>W/out</td>
<td>With</td>
<td>W/out</td>
<td>W/out</td>
</tr>
<tr>
<td>0</td>
<td>20</td>
<td>24</td>
<td>14</td>
<td>26</td>
</tr>
<tr>
<td>125</td>
<td>11</td>
<td>14</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>500</td>
<td>6</td>
<td>8</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>1000</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2000</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 21 - Affect of Tonneage on Track Disturbance

Note: Completion date is required NOT starting date.

5. Determine an appropriate Track Stability Loss using Table 19. Where tonnage information is available Table 21 can be used to determine Track Stability Loss as part of the Primary Analysis.

6. Record all disturbances for the 500m section. Different activities are not cumulative.

Example:

If ballast cleaning is set for next March (28% result) and surfacing in September (24% result) the loss of Stability would be the worst ie. 28% loss of stability (not 52%).

The use of a Ballast Stabilising Machine in conjunction with resurfacing works provides an immediate improvement in track stability. Table 19, Table 20 and Table 21 indicate the percentage of stability loss to be added when a Ballast Stabilising Machine is used.

Note: Because of the restrictions placed on the use of the BSM in some locations, some track which has been resurfaced may not have been stabilised. If non stabilised track occurs in a 500m section then it must be separately noted and the maximum disturbance value used.

Additional precautions should be taken regarding protecting the worksite at the time of major work in accordance with district or division instructions.

7. Deal with areas subject to ongoing disturbance e.g. pumping joints as shown in Table 13.

C13-8 Stability Loss - Track Condition

The general condition of track can be measured by the Track Condition Index (TCI) provided by the Track Recording Car. Poor sleeper condition, formation problems, geometry variations as well as causing a deterioration to the TCI also cause the track to lose lateral stability. The deteriorated track conditions often provide the "trigger" mechanism for misalignment.

1. Table 22 - Influence of General Track Condition indicates the loss of Track Stability for track condition. Use the worst TCI for each 500m section, excluding turnout assessments, as the basis for determining the Stability Loss.
Table 22 - Influence of General Track Condition

<table>
<thead>
<tr>
<th>TCI</th>
<th>Loss of Stability</th>
<th>TCI</th>
<th>Loss of Stability</th>
<th>TCI</th>
<th>Loss of Stability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 45</td>
<td>0</td>
<td>56</td>
<td>4</td>
<td>67</td>
<td>9</td>
</tr>
<tr>
<td>46</td>
<td>1</td>
<td>57</td>
<td>5</td>
<td>68</td>
<td>9</td>
</tr>
<tr>
<td>47</td>
<td>1</td>
<td>58</td>
<td>5</td>
<td>69</td>
<td>9</td>
</tr>
<tr>
<td>48</td>
<td>1</td>
<td>59</td>
<td>6</td>
<td>70</td>
<td>9</td>
</tr>
<tr>
<td>49</td>
<td>2</td>
<td>60</td>
<td>7</td>
<td>71</td>
<td>9</td>
</tr>
<tr>
<td>50</td>
<td>2</td>
<td>61</td>
<td>7</td>
<td>72</td>
<td>9</td>
</tr>
<tr>
<td>51</td>
<td>2</td>
<td>62</td>
<td>7</td>
<td>73</td>
<td>9</td>
</tr>
<tr>
<td>52</td>
<td>3</td>
<td>63</td>
<td>8</td>
<td>74</td>
<td>10</td>
</tr>
<tr>
<td>53</td>
<td>3</td>
<td>64</td>
<td>8</td>
<td>75</td>
<td>10</td>
</tr>
<tr>
<td>54</td>
<td>3</td>
<td>65</td>
<td>8</td>
<td>Over 75</td>
<td>10</td>
</tr>
<tr>
<td>55</td>
<td>4</td>
<td>66</td>
<td>8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Record the result on Form WTSA 3, (for manual analysis) or enter directly into the WTSA software.

C13-9 Stability Loss - Preliminary Result

The addition of individual results will give a preliminary assessment of track stability loss due to:

- Down rail adjustment %
- Up rail adjustment %
- Anchors %
- Ballast deficiencies %
- Track disturbance %
- Track condition %

Preliminary Stability Assessment %

NOTE: When the analysis is applied to 500m of concrete sleepered track the Preliminary Stability Assessment may be reduced by the amount indicated in Table 13 due to the increased lateral stability of concrete sleepered track.

C13-10 Location Factor in WTSA Analysis

1. Determine a Location Factor for each 500m section adding factors selected from Table 23 - Location factor.

Each 500 metres of track has its own unique characteristics. The features of the 500m section will affect the track stability beyond those described in Section C13-9 above.

There will be different location factors for each 500m and they will be in the range 1.00 to 1.42.

Location factors will generally remain constant year after year and can be calculated once by the Civil Maintenance Engineer.

2. Record the Location factors on Form WTSA 3 or enter into the WTSA software as a fixed entry.
3. Review the location factors annually. The factors need only be altered if there is a significant change.

<table>
<thead>
<tr>
<th>Curvature</th>
<th>0 - 400m</th>
<th>0.20</th>
<th>Increased stability loss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>400 - 800m</td>
<td>0.12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>800 - 1600m</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1600+</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Grade</td>
<td>&gt; 1:60</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>between 1:60 and 1:120</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt; 1:120</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Single line (traffic in both directions)</td>
<td>Yes</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Heavy braking zone</td>
<td>Yes</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Steady braking zone</td>
<td>Yes</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Non braking zone</td>
<td>Yes</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Rail bunching points in section e.g. crossovers, level crossings, fastening type changeover, bridges, etc.</td>
<td>Yes</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>0.00</td>
<td></td>
</tr>
</tbody>
</table>

**Table 23 - Location factor**

**C13-11 Primary Analysis Final Result**

1. Adjust the preliminary Stability Assessment.

   Final Stability Assessment Preliminary = Stability Assessment x Location Factor.

2. Record the results.

**C13-12 Stability Limits**

1. Compare the Primary Analysis Final Result with the following tolerances:

<table>
<thead>
<tr>
<th>Priority 1</th>
<th>55% loss or greater</th>
<th>Location requires immediate attention or evasive action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Priority 2</td>
<td>40% to 55% loss</td>
<td>Location requires programmed attention or evasive action.</td>
</tr>
</tbody>
</table>

**C13-13 Secondary Analysis**

1. Inspect/review the priority locations to confirm the accuracy of the input data.

   The primary analysis accumulates the loss of stability due to all aspects that may occur over 500m of track.

2. Assess the cumulative effects within the 500m section.

   Experience has shown that some defects occur at different points within the 500m such that their effects are not, in fact, cumulative as assumed in the analysis.
3. Amend the primary stability loss result to reflect the review.
4. Re-evaluate the effect of track disturbances.
   Table 21 provides a comparison of reduction in track stability loss due to traffic tonnage.
5. Re-calculate the location factor as set out in Section C13-10, reassessing all contributing factors.
6. Where there is an indication that the track adjustment varies significantly over the 500m section an analysis should be carried out over a shorter length (the worst section) using the methods in Section C13-1.2 or C13-2.4.
7. Determine the most appropriate corrective action.

**C13-14 Additional Tools**

Additional tools may be used in Secondary Analysis. These tools include:

**C13-14.1 Stress Measurement Device (Verse System)**

Use the procedure in TMC 223:

1. When the track adjustment has been determined for a uniform 500m section then the total creep shown for the section can be reduced to 2/3 of the difference between that predicted by the creep points and the Verse System.
2. When the track adjustment has been determined for a section up to a fixed point then the total creep shown for the section (up to the fixed point) can be reduced to 2/3 of the difference between that predicted by the creep points and the Verse System.
3. When the track adjustment has been determined for an isolated location of potential adjustment error within a section such as at a curve pullin (where otherwise the creep would be OK) then the total creep shown for the section would remain unchanged. If the test result showed less creep than predicted by the alignment and tangent creep information then the methodology above (ie a reduction of 2/3 the difference) can be applied.

In all three situations above the creep marks for the section should be updated to reflect the calculated changes to adjustment.

**C13-14.2 Credit for Interspersed Concrete Sleepers**

A pro-rata allowance based on 100% concrete providing a 25% saving in stability loss, can be used for review in secondary analysis. This will only apply where sleeper spacing is consistent to a tolerance of one sleeper where there has been an adjustment to
spacing. For example concrete installed at 1 in 3 (allowing for some odd locations of 1 in 4 and 1 in 2) could attract a saving of (25%/3 = 8.3% stability benefit). The minimum spacing that can be considered is 1 in 4 (allowing odd locations of 1 in 5 when the tolerance is considered).

C13-14.3 Credit for Painted Rail
A saving of 10°C is permitted when full compliance to the painting requirements is achieved in accordance with the procedure in Engineering Manual TMC 211 - Track Geometry and Stability.

C13-15 Action to be Taken
1. Assess the Final % Stability Loss
2. Take appropriate assessment or evasive action according to the "Limits and Responses" table in Section C2-4.

C13-16 Control of the Correction Process
When WTSA priorities are corrected the stability loss must be recalculated to ensure the priority has been reduced below P1 level preferably below P2 level to avoid having a priority again the following year).

C13-17 Non Standard Welded Track - Priorities for Corrective Action
When non-standard welded track is encountered it must be dealt with as a Priority 1 location. Since there is no general indication of the amount of stability loss due to rail adjustment it is necessary to examine and take action on a priority basis.

For general guidance the following order of priority (highest first) is suggested as a general rule. Local circumstances will dictate whether or not the order is appropriate.

1. Dogspiked track CWR - no alignment or creep
2. Dogspiked track CWR - no alignment
3. Dogspiked track LWR > 220m
4. Dogspiked track CWR - alignment no creep
5. Resilient fastened track - CWR no alignment or creep
6. Resilient fastened track - CWR no alignment
7. Resilient fastened track - LWR
8. Resilient fastened track - CWR alignment no creep
9. Concrete sleepered track - CWR no alignment or creep
10. Concrete sleepered track - CWR no alignment
11. Concrete sleepered track - LWR
12. Concrete sleepered track - CWR alignment no creep

Within these priorities individual locations can be ranked in order of concern eg:

1. curves < 400m radius
2. fixed points (approach side)
3. curves 400 - 800m radius
4. track disturbance
Chapter 14  Rail Wear and Condition Examination

The following examination (preventive maintenance) tasks are undertaken to meet the requirements of ESC 100 - Civil Technical Maintenance Plan.

C14-1 Rail Wear Examination

When performing this type of inspection, examiners need to have the following equipment:

− A rail wear gauge for the rail size (or sizes) being examined.
− Combination gauge (fitted with wear angle indicator).
− Rail Measuring callipers.

1. Examine track visually to find locations that are showing signs of wear. Carefully look for rail wear by visually scanning the gauge face and running surfaces of rails.

   NOTE: Rail wear is not usually confined to a single point on a rail. If wear is detected, checks at intervals along the rail for the duration of wear. This will often mean checking wear for the full length of curves.

   Where isolated rail wear is identified, look for the factors that are causing it. These will often include irregularities in track alignment and superelevation.

2. Where rail wear is evident, mark the rail with a permanent mark at intervals of 10m throughout the affected area.

3. Use the rail wear gauge to check the extent of reduction in head width of 53 and 47kg rails at each marked interval. Follow-up measurements are taken at the same points on subsequent examinations.

   To check reduction in head width, place the wide portion of the template over the running surface of the rail. The additional recess in the template is designed to allow for use of the gauge when head flow is present. The recessed section of the gauge is placed over the outer edge of the rail. (See Figure 19 and Figure 20).

   If the gauge cannot be placed so that the upper portion of the template touches the running surface, the extent of reduction in head width is satisfactory.

   If the upper portion of the template touches the running surface of the rail, wear has reached reportable limits and is to be noted as unsatisfactory. Further measurement of head width with calipers is necessary.

   Where a rail wear gauge is not available (45, 41 and 31 kg rails) use rail calipers (See Figure 21 – measurement "B") and compare measurements to the P3 Limits in Section C5-5.

Figure 19 - Checking head width(B) with rail wear gauge
4. Use the appropriate rail wear gauge to check the extent of reduction in head depth of 60, 53, 50 and 47kg rails at each marked interval.

To check reduction in head depth, place the narrow portion of the template against the gauge face of the rail. The recess in the template will allow rails with head flow to be checked. The recess is placed over the upper edge of the rail. (See Figure 22 and Figure 23).

If the gauge cannot be placed so that the template contacts the gauge face, the extent of reduction in head depth is satisfactory.

If the template touches the gauge face, wear is approaching condemning limits and is to be noted as unsatisfactory. Further measurement of head width with calipers is necessary.

Where a rail wear gauge is not available (45, 41 and 31 kg rails), use rail calipers (See Figure 21 – measurement "A") and compare measurements to the P3 Limits in Section C5-5.
5. Use the rail wear angle reporting gauge to check the rail wear angle at each marked interval.

Place the gauge on a 25mm square non-metallic rod (timber or equivalent) spanning the track.

Put the “Reporting – 24” end of the gauge against the gauge face of the rail. If there is a space between the rail and the gauge BELOW the touching point, (see Figure 24) then the rail wear angle is satisfactory. If there is no space or a there is space between the rail and the gauge ABOVE the touching point (see Figure 25), the rail wear is above the reporting limits and must be reported.

If the rail wear angle is above the reporting limits, reverse the gauge and check the rail wear angle against the “condemning – 26” end of the gauge. (Note the gauge will now sit on the opposite side of the bar and you will need to move the bar 25mm along the track to measure the same point). If

A Track Examiner’s Combination Gauge has a sliding jaw with an attachment for measuring the wear angle of rails. If there is a space between the rail and the gauge ABOVE the touching point (see Figure 26), the rail wear is above the condemning limits and must be reported.
C14-1.1 Measurement of Tangent Wear When Curve Wear is Present

If any curve wear is present, measurement of tangent wear cannot be undertaken from the gauge side of the rail (the measuring point 16mm in from the gauge face will be in the head web transition region and give a false reading).

Measure the tangent wear by taking measurements of the rail head height with the callipers located on the field side of the rail.

If a flow lip exists particularly on the high rails take the measurements of the rail head width with the callipers, but the width of the flow lip is to be estimated and noted.
If rail is found to be at or below the reportable wear limits, and the wear measurements are found to be impeded by curve wear or flow on the gauge side, or flow on the field side, use the 'Railmate' (or equivalent) system to take the head profile of the rail. The rail wear measurements will be based on the ‘Railmate’ outputs.

C14-1.2 Actions
1. Record the location and extent of the worn area by noting the commencement and the end of the “Reportable Wear” where the rail dimensions are below P3 limits detailed in Section C5-5.
2. Record the worst example of head width and depth reductions on the inspection Form Rail 1 "Inspection of Rail Wear" together with the rail type and date of rolling of the rail.
3. Assess any defects found according to the “Limits and Responses” tables in Section C5-5.
4. Arrange appropriate protection and/or correction.
5. List the defects on Form 2 "Weekly Summary of Defects Report" or transfer to Teams3 directly from Form Rail 1.

C14-2 Rail Condition Examination
Examine the rail for visual evidence of defects.

The reportable conditions include:
- Gauge corner fatigue damage (visible as fishscaling and or spalling.)
- Surface damage due to wheelburns.
- Squats.
- Cracking or spalling of the rail head.
- Rail contact fatigue.
- Rail corrugations.
- Vertical split head defects.
- Rail damaged by plant and equipment.

Further information on rail defects is available in TMC 226 "Rail Defects Handbook”.

C14-2.1 Actions
1. Record any defects found on Form Rail 1 "Inspection of Rail Wear."
2. Assess any defects found according to the “Limits and Responses” tables in Section C5-6.
3. Arrange appropriate protection and/or correction.
4. List the defects on Form 2 "Weekly Summary of Defects Report" or transfer to Teams3 directly from Form Rail 1.

C14-3 Rail Corrosion Examination
This examination is normally undertaken in tunnels and other locations where corrosion is an actual or potential problem (including electrolytic corrosion).

The examination should, preferably, be carried out on a wet day to confirm the locations of water ingress into the tunnel.
1. Remove ballast and debris from the rail foot.
2. Examine head, web and foot of rails for evidence of corrosion.
3. Where there is evidence of corrosion mark the rail with a permanent mark at intervals of no more than 5m throughout the affected area. This will allow progressive measurements to be taken to indicate the rate of deterioration. Pick the worst spots, even if they are close together.

4. Scrape the rails free of sand, dirt and grease, and chip off any rust. Use a wire brush where necessary.

5. Inspect the rail both before and after cleaning with the wire brush, carefully searching for cracks or flaws.

6. Pay particular attention to the fillets under the head and above the flange.

7. Check rail ends, both at fishplates and welded joints, for cracks starting from bolt holes, as well as fillet cracks.

8. Examine dogspikes for excessive throat-cutting or corrosion. It is necessary to draw a number of dogspikes for this examination - especially just near the portals.


10. Examine sleeper plates for corrosion, wear on the surface in contact with the rail flange, and for enlargement of the dogspike holes.

11. Where there is evidence of corrosion of the head, measure the head width (measurement "B" Figure 27) and depth (measurement "A") with the rail wear gauges or with standard vernier callipers (jaws cut back to 16mm long).

12. Where there is evidence of corrosion of the web, measure thickness (measurement "E") with ‘transfer callipers’. Select the worst position to take this measurement.

13. Where there is evidence of corrosion of the foot, measure thickness (measurement "F") and width (measurement "G") with an ultrasonic depth gauge or callipers.

14. Measure foot thickness and width where the rail rests on a sleeper plate, or sleeper. If callipers are being used to take the measurement you will need to move the sleeper or lift the rail off the sleeper plate to do this. Where there is considerable corrosion, a number of sleepers should be moved to obtain the worst condition. If an ultrasonic depth gauge is being used there is no need to lift the rail off the sleeper plate or move the sleeper. Measure the thickness of the foot on each side, and record the smaller measurement.

Using an ultrasonic depth gauge, measurement of foot thickness can be made on rail with continuous rubber support or in other situations where moving the rail may cause damage to components.

An inspection of the rail foot thickness (measurement "F") shall be carried out on the rail foot whenever rail is removed in the tunnel areas, such as for rail defect removal. If a high level of corrosion is found in any such case the details are to be reported to the Chief Engineer Track.

Track inspection staff are asked to keep a special eye on the area involved during their routine patrol and detailed walking inspections.
C14-3.1 Actions

1. Record the results on Form Rail 2 "Examination of Rail Corrosion". Make sure the worst dimensions in the area are recorded.
2. Where no corrosion is found during the examination, complete a "NIL" return.
3. Assess any defects found according to the "Limits and Responses" tables in Section C5-6.
4. List the defects on Form 2 "Weekly Summary of Defects Report" or transfer to Teams3 directly from Form Rail 2.
5. Arrange appropriate protection and/or correction.
Chapter 15 Examination of Mechanical Joints

Mechanical joints in welded track are to be maintained to a high standard of top and line to avoid rail end damage.

Removal of fishplates for crack detection is not necessary where ultrasonic rail flaw detection services operate.

C15-1 Examination Procedure

1. Examine rail joints for satisfactory operation as a sliding joint to accommodate designed rail movement of the welded rail.
   Look for signs of frozen joints or excessive joint gap. Remove fishplates, grease joint and arrange any further action required if joint is frozen.

2. Note any tight joints due to rail creep caused by traction forces and make arrangements for any necessary adjustment.

3. Where there is evidence of undue stress of the fishbolts such as marked bending, replace all fishbolts.

4. If it is noted that the rail end is damaged, bent down, or otherwise deformed, arrange any necessary work to restore the joint to the required standard.

6. Check sleeper support at the joint.

7. Check fishplates for cracks.

8. Examine rail joints for broken, missing or loose bolts or swage fasteners.

9. Remove any end flow on rails.

10. If fishplates are removed and rail defects are found, protect, report and remove them in accordance with the requirements of TMC 224 “Rail Defects & Testing”. If possible the whole joint is to be removed and the rail continuously welded.

11. Check rail joints for alignment and profile. Where there is a mismatch at the gauge faces (commonly known as a “foul joint”) as shown in Figure 28, measure the amount of mismatch and respond according to the “Limits and Responses” table in Section C5-8. The priority will depend on the joint situation (high rail in facing direction is of most concern), the degree the 3mm limit is exceeded and any evidence of hitting wheels on the gauge corner.

![Figure 28 – Foul joint](image-url)
C15-2  **Action to be Taken**

1. Record all examination details on Form 2 "Examination of Length."

2. Assess any defects found according to the "Limits and Responses" tables in Section C5-8.

3. Arrange appropriate protection and/or correction.

4. List the defects on Form 2 "Weekly Summary of Defects Report" or transfer to Teams3 directly from Form 2.

5. When a mechanical joint fault has been identified, if possible, carry out the necessary repairs using the procedures in Engineering Manual TMC 221 - Rail Installation & Repair.

6. If repairs are beyond the capacity of the examination team:
   - Take appropriate protective action if defects require immediate action, OR
   - List the defects on the Form 2 "Weekly Defect Summary Report".
Chapter 16  Examination of Insulated Joints

The examination of Insulated Joints includes non-operational joints, particularly redundant glued insulated joints.

During examination it is necessary to look at the overall performance of the joint. This includes checking rail adjustment, insulation performance of the joint and the mechanical integrity of the joint, as well as rail wear, the holding ability of fastenings and the soundness of the sleepers and ballast bed.

Areas with the potential to deteriorate rapidly causing signal failures are the main target, especially the high rail of sharp curves and mechanical insulated joints with the potential to close up in hot weather.

If a defect is suspected in the portion of a component that is screened from view, the component must be removed for detailed examination.

If any defect is detected then it is essential that components are examined.

The inspection is performed by visually examining each insulated joint and looking for the following conditions.

C16-1  Examination Procedure

C16-1.1  At the Insulation Post

1. Check the rail for wear as detailed in Chapter 14.
2. Visually check the rail for damage caused by wheel burns, shelling or other surface defects which may cause cracking. End batter of rails causes rail steel to flow across the joint which ultimately will bridge the joint.
3. Visually check the area around the joint key for defects which may cause cracking or steel pieces that may short the insulation key.
4. Check for loss of the insulation key, squeezing out due to rail movement, or visible cracking and disintegration of the key.
5. At Glued Insulated Joints check for signs of failure of the glue with a visible crack line at the endpost or under the fishplates. If cracking is detected, the joint is to be treated as a mechanical insulated joint and anchored accordingly.
6. When there is loss of bond evident in redundant glued insulated joints because of failure of the epoxy glue, the GIJ should be given priority for replacement (not because of signal failure but because of fatigue loading of joint plates).

Figure 29 – No Surface Defects – No action required
C16-1.2 At the Plates

1. Visually inspect for any build up of grease or foreign matter, in particular metal pieces, wires and slivers that can cause electrical bridging. Slivers originating from wheel burns or skids tend to settle around the joint because of magnetic attraction.

2. Visually check for cracks or fractures in the fishplates. Cracks can be difficult to detect. Rusty traces are often a good indication of their presence. Cracks may occur around boltholes or near the rail joint.

3. Fishplate Bolts may be loose, bent, cracked or broken. Tapping bolts gives an indication of loose or broken bolts if a rattling sound is present or bolts drop out.

4. Visually inspect bolts for damage or cracks. Cracks can be detected by rusty traces that originate from cracks.

C16-1.3 Associated Trackwork

1. Track fastenings may be loose, cracked or broken. Loose plates are caused by missing, damaged or loose clips and spikes. Pulling and tapping will reveal any loose components. Damaged components can be visually detected. Cracks can be detected by rusty traces which originate from cracks.

2. Check that fastenings have been correctly installed at insulated joints. Track fastenings can short-circuit the insulation by coming into contact with the fishbolts. This is particularly the case with resilient fastenings. Installation requirements are detailed in Engineering Manual TMC 221.

3. Visually inspect sleepers for condition. They may be ineffective, and not support the joint adequately or hold the rail firm. Look for broken portions, splitting, decayed or loose spike holes caused by spike hole decay or severe end splitting.
4. Visually inspect ballast for profile and condition. Ballast can be at the incorrect level (i.e. above or below the upper sleeper level) or it can be degraded. Degraded or foul ballast will not support the joint and leads to “pumping” or “hanging” sleepers. Pumping sleepers give little support to the joint as the pumping action will displace the generally foul ballast under each load. Hanging sleepers are not in contact with the ballast and give no support to the joint.

5. Excessive ballast heaped around the joint provides potential for short circuiting of the insulation and should be removed.

6. Visually inspect for poor drainage that is indicated by water logged ballast or mud reaching the surface of the ballast bed. Moisture could cause electrical bridging of joint.

C16-1.4 At Mechanical Insulated Joints

In addition to the aspects detailed above for Glued Insulated Joints, the following examination is required:

1. If defects are suspected, dismantle the mechanical insulated joint. A Signalling representative MUST to be present during this examination.

2. Examine the condition of end posts, liners and ferrules.

3. On dogspiked track, check the anchoring pattern in accordance with the installation requirements in Section C12-6. Mechanical Insulated joints are not an expansion joint and therefore may need extra anchors to reduce the tension loads on the joint.

C16-1.5 At Glued (or bonded) Insulated Joints

At locations outside of turnouts & special trackwork, examine the track condition within the area of each Glued Insulated Joint (GIJ). If there is excessive pumping indicated by one or more of the following, record as GIJ requiring Supplementary Track Patrol.

1. Visible evidence of top or twist conditions (that may be assessed as P2 or worse) affecting the joint.

2. Visible signs of formation failure affecting the joint ie heaving beyond the ends of the sleepers or between the sleepers.

3. Bog holes affecting the joint ie track and ballast fouled and/or with mud pumping through the ballast.

4. Chipped rail ends at GIJs and/or evidence of heavy impact (extensive whitened ballast).

5. GIJ plates working loose.

6. Timber sleepers that do not meet "good sleeper" condition within 2 metres of the GIJ.

7. Timber transoms that do not meet "effective transom" condition within 2 metres of the GIJ.

---

Figure 32 - Poor support conditions- supplementary patrol of GIJ required
C16-2 Action to be Taken

1. Record all examination results on Form Rail 3 "Inspection of insulated joints"
2. If the GIJ condition meets the requirements for Supplementary Patrol, mark the entry on Form Rail 3.
3. Assess any defects found according to the "Limits and Responses" tables in Section C5-9.
4. When an insulated joint fault has been identified, if possible, carry out the necessary repairs.
5. If repairs are beyond the capacity of the examination team:
   ~ Take appropriate protective action if defects require immediate action, OR
   ~ List the defects on "Weekly Summary of Defects Report" or transfer to Teams3 directly from Form Rail 3.

Note If not OK is ticked on the inspection form then the column “Is supplementary patrol required” must be answered with Y or N. Guidance on conditions that require supplementary patrol is found in section C16-1.5

Note If insulated joints are affected by severe spark erosion the location should be referred to signals staff so bonding can be checked.
Chapter 17 Examination of rail lubricators

The following examination (preventive maintenance) tasks are undertaken to meet the requirements of ESC 100 - Civil Technical Maintenance Plan.

C17-1 Examination procedure - (mechanical plunger type lubricators)

Check the operation of each lubricator and record the results on Form Rail 4 “Examination of Rail Lubricators / TORFMA”. The key aspects to check when inspecting a lubricator unit include:

C17-1.1 At the Lubricator

Main Container
1. Check the grease status of the main container. Does it need filling?
2. Check the main container for signs of damage especially for cracks around bolt holes in the back cover.
3. Check that the filler valve is clean and has a cover fitted.

Pump Assembly
1. Check plunger condition.
2. Check plunger height above rail.
3. Activate plungers to ensure grease is being delivered to blade.

Greasing Plate Assembly
1. Check blade for signs of wear.
2. Check blade height below rail head.
3. Observe rail around lubricator grease plate for excessive grease delivery to the rail head and adjacent track structure.
4. Observe rail around lubricator greasing plate for insufficient grease delivery.

General
1. Check hoses for obvious damage.
2. Check all hoses, blade ends and pumps for grease leakages.

C17-1.2 Rail adjacent to lubricator in the curve

1. Check that grease is being carried around curve providing adequate lubrication to protect the curve.
2. Observe for indications of severe wear, in the form of steel shavings along the rail foot and around rail anchors, or rough surface on the gauge face.
3. If a lubricator is not functioning satisfactorily or rails are showing signs of excessive wear, record appropriate information. If lubricators are found to be functioning correctly the lubrication strategy should be reviewed and may need to be modified.

C17-2 Examination procedure - TORFMA/GFL units (electronic control electric pump type)

Check the operation of each GFL and TORFMA unit and record the results on Form Rail 4 “Examination of Rail Lubricators / TORFMA”. The key aspects to check when inspecting a GFL or TORFMA unit include:
C17.2.1 Off site checks

Basic functionality can be established offsite from the Website. Refer to Website Instructions for detailed instructions.

1. Check Website for faults indicated

Every alert is not necessarily a fault or the fault may be so short term that it’s not even worth noting. Parameters are set to try and make sure all actual faults result in alerts. The example in Figure 34 below indicates 11 locations with alerts.

![Figure 34 – Summary showing alerts and product remaining (EXAMPLE ONLY)](image)

In the example in Figure 35 above the unit is operating correctly except for a moment around 1400.

![Figure 35 – Example of operation](image)

In the example in Figure 36 above there is an actual fault. Hardly any product is being delivered.

![Figure 36 – Example operation showing a fault](image)

Check the Website regularly for faults not necessarily able to be determined by Alert Parameters. Such faults include wheel sensor partial failure as shown in Figure 37 below.
Figure 37 – Example showing a wheel sensor failure

2. Check Website for percentage (%) of product remaining

The summary page of the website (see Figure 34) shows product remaining as a percentage which will be a good guide if, when filled, the “Pot Filled button” is pressed. Make sure the button is only pressed if the reservoir or tank is actually filled. Due to the high viscosity of the product the flowmeter is not 100% accurate. Curve grease does not flow and so when filling the tank of a GFL as much grease as possible should be heaped toward the tank end above the pump.

NOTE: Fill tanks or reservoirs before they get down to 10%. The units will be much more reliable if they are not let run empty.

3. Check the Voltage graph

In the example in Figure 38 below, if there is a solar panel installed it is not charging the battery. The battery is nearly flat and needs replacement before the unit fails.

Figure 38 – Example of voltage graph

C17-2.2 Checks on site at the GFL/TORFMA unit

Tank
1. Check reservoir as per main container in C17-1.1 above
2. Check the fill level of the tank. Does it need filling?
3. Check the grease. Does it need mixing and trowelling toward the pump end?

This may be needed so the grease can be pumped. When filling the tank heap as much product as possible toward the tank end above the pump. If this is done the pump will generally draw grease properly till the tank is about 50% full.

Refill tanks on GFL’s before the tank falls to around 50% full, or using gloves and plastic scraper push the remaining grease and heap it against the tank end above the pump.

Battery
1. Check the battery voltage. Is it 23V or above when the button is pressed?
2. Check the wires. Are wires to the battery in good condition?
Wheel Sensor and pump

1. Check the wheel sensor. Open the control box lid and watch while a train passes. Does the wheel sensor light flash when each wheel passes over?

   If there is no train passing, use the “Train On” button to simulate a train by pressing it multiple times, each press is one wheel, or wave a magnetic object (e.g. a spanner) directly (<40mm) over the sensor a number of times (~20) to simulate passing wheels.

2. Check that the wheel sensor operates the machine.
   - Does the pump turn on and the pressure gauge rise after a few wheels have passed?
   - Does the pump deliver product to the rail?
   - Does the pump turns off again after a few seconds and cycle as per the settings through the train.

   If there is no train passing, use the “Pump On” button to simulate a train by pressing it multiple times, each press is one wheel, or wave a magnetic object (e.g. a spanner) directly (<40mm) over the sensor a number of times (~20) to simulate passing wheels.

3. Check the belt driving the pump. Does it drive smoothly or jump?

Solar Panel

1. Check the solar panel is facing the correct direction. Does it get full sun without being shaded significantly for 3 hours per day?

2. Check the polycarbonate cover sheet. Is it very dirty or graffiti covered?

3. Check the LED charge lights. Are they brightly lit when panel is in full sun?

GFL blades (curve lubricators with dual 16 port blades)

1. Check the blades for port blockage. Are at least 75% of the ports open and delivering? i.e. 24 of 32

   All of the total 32 ports (2 blades each with 16 ports) are open and delivering an even very small bead of grease. Note that virtually no grease is being left on the blades.

   Correct operation of a GFL unit is achieved when at least twelve (12) ports on a 16 port blade are dispensing curve grease in small droplets as shown in Figure 39. If less than twelve ports are operating, as shown in Figure 40, then the blade should be swapped out and cleaned.
Figure 39 - This GFL blade has fourteen of the sixteen ports operational (small globules of lubricant are clearly seen) and so can remain in service.

Figure 40 - This GFL blade has only nine operating ports with the remaining seven ports blocked. It should be changed out and cleaned.

NOTE: Grease delivery is only monitored at the exit from the machine. If blades are partially blocked lubrication may still be poor even though the ideal quantity of grease is being delivered. The grease will be delivered as larger beads through the open ports and will be more likely to cause running surface contamination or be wasted into the ballast.

2. Check the blade height. Is the top edge of the blade just below the shiny surface of the gauge face and not being hit?
3. Check the blade setup. Is the blade edge fitted up snugly to the gauge face?
4. Check the grease delivery. Is almost all grease being picked up by wheels?
Distribution units (TOR)
1. Check TORFMA distribution units for leakage or worn rubber pad.
   Check that the rubber pads are fitted flush to the field side of the rail and that the top surface of the rubber has not been damaged to an extent that the product runs over top and down the back of the distribution unit. Adjust the fit to the rail and/or replace the rubber pads if this is the case.
2. Check the rubber pad retaining plates. Are they fitted well to the field side of the rail?
   Correct operation of a TORFMA unit is achieved when the blades apply a small puddle of product to the top of the rail head, as shown in Figure 41.

General
1. Check for leaks around fittings and hoses on the control box and to the track. Leaks which do not result in “no delivery” from the flow meter will not be detected by sensors or meters.
2. Check for signs of visible damage, e.g. wheel strike causing bent blades or damaged wheel sensors, loose hoses leading to leakage, graffiti or vandalism (especially on the solar panel),

![Obvious puddle of TORFM on Top of Rail](image)

*Figure 41* - This TORFMA unit is operating correctly as seen by the small puddle of TramSilence applied to the top of the rail when simulating a train passby.

**C17-2.3 Rail adjacent to lubricator in the curve**
1. Check that grease is being carried around curve providing adequate lubrication to protect the curve.
2. Observe for indications of severe wear, in the form of steel shavings along the rail foot and around rail anchors, or rough surface on the gauge face.
3. If a lubricator is not functioning satisfactorily or rails are showing signs of excessive wear, record appropriate information.
4. If severe wear is present and the lubricators are found to be functioning correctly, the lubrication strategy should be reviewed and may need to be modified.
C17-3 **Lubrication Distribution Test (Finger Wipe Test)**

In order to assess the distribution of GFL and TORFMA product across the rail head and along the rail length, use the finger print test at the locations listed on Form Rail 5 “Lubrication Inspection Sheet”. An example of how to fill in the inspection sheet is provided in Figure 42.

Use the following procedure:

1. With a clean protected* finger, wipe along the portion of the rail head under test (i.e. running surface, gauge corner or gauge face) for a distance of 50mm,  
   * Operators should wear disposable gloves when performing this test to prevent contact between the grease and skin.
2. Dab the accumulated product (Rocol / TramSilence) onto the appropriate section of the inspection sheet,
3. Tick the appropriate box to indicate the level of product that this represents (on a scale from “wet” to “dry”)

<table>
<thead>
<tr>
<th>Track</th>
<th>Km</th>
<th>Location on Rail</th>
<th>Finger Print</th>
<th>Wet</th>
<th>Good</th>
<th>Reasonable</th>
<th>Poor</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP</td>
<td>6.060</td>
<td>Running Surface</td>
<td><img src="image1" alt="Finger Print" /></td>
<td><img src="image2" alt="Finger Print" /></td>
<td><img src="image3" alt="Finger Print" /></td>
<td><img src="image4" alt="Finger Print" /></td>
<td><img src="image5" alt="Finger Print" /></td>
<td><img src="image6" alt="Finger Print" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gauge Corner</td>
<td><img src="image7" alt="Finger Print" /></td>
<td><img src="image8" alt="Finger Print" /></td>
<td><img src="image9" alt="Finger Print" /></td>
<td><img src="image10" alt="Finger Print" /></td>
<td><img src="image11" alt="Finger Print" /></td>
<td><img src="image12" alt="Finger Print" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gauge Face</td>
<td><img src="image13" alt="Finger Print" /></td>
<td><img src="image14" alt="Finger Print" /></td>
<td><img src="image15" alt="Finger Print" /></td>
<td><img src="image16" alt="Finger Print" /></td>
<td><img src="image17" alt="Finger Print" /></td>
<td><img src="image18" alt="Finger Print" /></td>
</tr>
</tbody>
</table>

*Figure 42 - Sample Lubrication Inspection Sheet showing how to complete the required fields*

C17-4 **Action to be taken**

1. Record all examination details on Form Rail 4 “Examination of Rail Lubricators / TORFMA”.
2. Assess any defects found according to the "Limits and Responses" tables in Chapter 5 and this chapter.
3. Repair lubricator defects if possible or otherwise arrange for repairs.
4. If repairs are beyond the capacity of the examination team
   ~ Take appropriate protective action if defects require immediate action, OR
   ~ List the defects on the Form 2 "Weekly Defect Summary Report".

C17-5 **Fault detection**

Fault detection is undertaken:

1. **From the website** - The Server generates Alerts shown on Website giving us the ability to detect almost all faults remotely and to do some basic troubleshooting to establish possible repair tasks required to be carried out.
2. **Visually when on site** - take note of operation of unit as a train passes or simulate a train using the “Train On” button and check operation against what is expected.

C17-5.1 **From the website**

Note: Not every Red Alert in the summary is a failure.

The set operation parameters may have only been exceeded for one data row and the settings may be such that alternate trains are likely to produce an alert.
Pressure alerts

Pressure alerts are generated according to the “Product Flow Rate” graph which compares calculated product delivery per train in wheels/ml (green symbols) to actual delivery (blue symbols).

In the graph in Figure 43 above delivery is excellent except for between 1400 and 1530. No or virtually no delivery occurred in this period but then either track staff visited and fixed the unit or it self-rectified.

The Pressure Flow graph (Figure 44) allows us to troubleshoot. It shows that the unit lost pressure around 1400 but recovered around 1530. This suggests that product level near the pump may be getting low or there was a small pocket of air trapped in the grease when it was last refilled.

PRESSURE ALERT – High pressure Low delivery

Figure 45 below shows a typical fault till 1400 that it was corrected from about 1400 and back to working normally.
Note that till around 1400 the blue and red symbols are both high. The red is the pressure and the blue is the wheels per ml at pump off/valve close. This means that the pump is operating to build up pressure but no or virtually no product is being registered as delivered to track. This indicates a flow meter jam or less likely, flow meter failure or a blockage in the delivery line to track.

**PRESSURE ALERT – Low pressure Low delivery**

![Figure 46 – Example of Low pressure Low delivery display](image)

In Figure 46 above the blue symbols are high and the red symbols are low indicating Low Pressure No delivery. Possible faults are motor fail, pump relay fail, jammed pump, belt fail, belt loose, loose grub screw in belt drive pulley, blocked filter, air in system, tank/reservoir empty or hose from pump disconnected.

The most likely are tank/reservoir empty or air in system.

**C17-5.1.2 Voltage alerts**

These occur when unit voltage falls below a set parameter.

![Figure 47 – Example of voltage graph](image)

In Figure 47 above the graph of voltage history shows a battery failure on 13th March. The alert was sent when the voltage dropped below the threshold setting of 20V and product delivery ceased when the unit shut down at 18V. This particular unit has no Solar panel which can be seen from no charging cycles being present. In this case the battery was replaced with a good charged battery, which is shown by the resumption of good operating voltage.

If the unit is fitted with a solar panel, possible faults include dirty polycarbonate cover sheet, voltage regulator failure, extended bad weather or shading of the panel, damage to leads or plugs between the panel and body, flat battery or bad battery.
C17-5.1.3  No Response Alert
This occurs when the unit fails to dial-in within the set parameter time period. This may not be a fault with the unit but may result from a Server or Website fault, unit turned off or simply congestion from too many units dialling in.
If there is a fault with the Unit then it may be “stuck in download”, electronic package “dead”, failed electronic package, failed SIM card or it may result from a flat battery which has died too quickly for a voltage alert to be generated.

C17-5.1.4  No train alert
This occurs if the unit has not detected any trains within the set parameter time period.
This may not be a fault with the unit but may be a result of no trains due to possession or track affected by a possession in another area.
Possible unit faults are wheel sensor dislodged, wheel sensor incorrectly mounted, wheel sensor damaged including cable or wheel sensor not working correctly.

C17-5.2  On site
Follow the procedure in C17-2.2 to check on the operation of the unit on site.
If the unit does not seem to operate correctly note what seems wrong….No pressure, No delivery to track, wheel sensor light not flashing, is LCD screen showing Download for an extended period, Is the LCD screen blank, etc.

C17-6  Fault investigation
This is invariably done by a site visit but backed up by knowing the symptoms from the website unless the fault has been visually identified in the first place. Keep in mind there may be more than one fault or one fault may have caused another. Use the following table to investigate faults.

<table>
<thead>
<tr>
<th>Action</th>
<th>Observation</th>
<th>Response</th>
<th>Observation</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure Alert</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Pressure - Low/No Delivery</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Press Pump On Button</td>
<td>Confirm pressure</td>
<td>Yes - Continue</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gauge rises</td>
<td>No - Go to Low pressure/No delivery</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Does product freely appear on the rail?</td>
<td>Yes - confirm the Website still indicates the fault</td>
<td>Does the Website still indicate fault?</td>
<td>Yes – Go to Repair Task Flowmeter Repair Replace</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No – Then it has Self-rectified</td>
<td></td>
</tr>
<tr>
<td>Remove Hose to track from Flowmeter</td>
<td>Yes - Go to Repair Task Hose Blocked</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Press Pump On button</td>
<td>Does product flow freely from Flowmeter hosetail?</td>
<td>Yes - Go to Repair Task Flowmeter Backflush</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No - Perform Repair Task Flowmeter Backflush</td>
<td>Does Flowmeter Backflush result in product flowing freely from Strainer?</td>
<td>Yes – Continue</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No – Go to Repair Task Flowmeter Clean.</td>
<td></td>
</tr>
<tr>
<td>Action</td>
<td>Observation</td>
<td>Response</td>
<td>Observation</td>
<td>Response</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
<td>----------</td>
<td>-------------</td>
<td>----------</td>
</tr>
<tr>
<td>Press Pump On button for a few seconds</td>
<td>Does product flow freely from Flowmeter hosetail?</td>
<td>Yes – Fault is rectified</td>
<td>Does Backflush Flowmeter result in product flowing freely from Strainer?</td>
<td>Yes – Continue</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No – Perform Repair Task Flowmeter Backflush again.</td>
<td></td>
<td>No – Go to Repair Task Flowmeter Clean.</td>
</tr>
<tr>
<td><strong>Low Pressure Low/No Delivery</strong></td>
<td>Press pump on button for a few seconds</td>
<td>Confirm Pressure Gauge does not rise</td>
<td>Yes – Continue</td>
<td>Does the Website still indicate fault?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes – Check wire Electrical Package to Relay</td>
<td>No – Then it has self-rectified</td>
<td></td>
</tr>
<tr>
<td>Inspect Unit</td>
<td>Is there sufficient Battery power 23V+?</td>
<td>Yes – Continue</td>
<td>No – Perform Task Battery Replace</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Check this without Solar panel connected.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Is there sufficient product in Reservoir or Tank?</td>
<td>Yes – Continue</td>
<td>No – Perform Repair Task Fill Reservoir or Tank then continue.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Are all Hoses in place and not leaking significantly?</td>
<td>Yes – Continue</td>
<td>No – Reinstate Hoses</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Was Hose from Pump to Strainer in place?</td>
<td>Yes – Continue</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Is the pump drive belt in place and tensioned?</td>
<td>Yes – Continue</td>
<td>No – Perform Task</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pump Drive Belt Replace or Tension</td>
<td>Strainer Clean then continue</td>
<td></td>
</tr>
<tr>
<td>Press Pump On Button for a few seconds</td>
<td>Does the Pump Motor shaft turn?</td>
<td>Yes – Continue</td>
<td>Does Motor shaft turn now?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No – Inspect wiring then Perform Task Relay Replace or Repair</td>
<td>Yes – Continue</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Motor Test or Replace.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Does the Motor Drive Pulley turn?</td>
<td>Yes – Continue</td>
<td>No – Perform Task</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grub screw Tighten Pulley to shaft</td>
<td>Pump Unjam</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Does the Pump Drive Belt turn the pump?</td>
<td>Yes – Continue</td>
<td>No – Check belt?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Does the belt jump over teeth?</td>
<td>Yes – Perform Task</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Does the Pump drive Belt jump teeth as it turns pump?</td>
<td>Yes – Perform Task Pump Drive Belt Replace or Tension</td>
<td>No - Continue</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Does the Pressure gauge show rising Pressure</td>
<td>Yes – Continue</td>
<td>No – Perform Task Pump Bleed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Is product now delivered to track?</td>
<td>Yes – Continue</td>
<td>No – Go to High Pressure No Delivery</td>
<td></td>
</tr>
</tbody>
</table>
### Action

<table>
<thead>
<tr>
<th>Watch train pass or press Train on button to simulate a train. Confirm correct operation as per settings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Response</strong></td>
</tr>
<tr>
<td>Yes – repair complete No – Contact Expert</td>
</tr>
</tbody>
</table>

### Voltage alert

Voltage fallen below set parameter, generally 20V

<table>
<thead>
<tr>
<th>Press Voltmeter button</th>
<th>Is Voltage 23V+ with solar panel in sun?</th>
<th>Yes – Unplug Solar panel Is voltage now low after pump is run for a shot time?</th>
<th>Yes – Continue No – Advise Possible Error</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Is Solar Panel cover sheet Graffiti’d or dirty?</td>
<td>Yes – perform Task Solar Panel clean or replace polycarbonate cover sheet. No – Continue</td>
<td></td>
</tr>
<tr>
<td>Does Solar Panel get clear sun for 3 hours per day in current orientation?</td>
<td>Yes – Continue No – perform Task Solar Panel Setup</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is solar Panel Cable to Control Box connecting properly?</td>
<td>Yes – Continue No – Perform Task Solar Cable Repair or Replace</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are both Charging LEDs in Voltage regulator case lit while in sun?</td>
<td>Yes – Continue No – Perform Task Solar Panel Test and Repair</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has there been an extended period of poor weather?</td>
<td>Yes – Perform Task Battery Replace. No – * Mark the battery taken out as suspect and perform task Battery Replace</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* If the battery taken out already is marked suspect then do not recharge but discard.

### NO RESPONSE ALERT

Unit has failed to Dial in within the time Parameter set

<table>
<thead>
<tr>
<th>Press Battery Test Button</th>
<th>Is the Battery Voltage 23V+?</th>
<th>Yes – Continue No – Go to Voltage fallen below Set Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspect Site</td>
<td>Does the unit appear to be working normally</td>
<td>Yes – Note as working correctly then Continue No – Note unit as Failed then continue</td>
</tr>
<tr>
<td>Inspect the LCD Screen on the Control Panel</td>
<td>Is the screen Blank?</td>
<td>Yes – Perform Task Reboot Electronic Package Is the screen still blank after the reboot? Yes – Perform Task Fuse test and replace then continue No - Continue</td>
</tr>
<tr>
<td></td>
<td>Is the screen still blank?</td>
<td>Yes – Perform Task Electronic package test and replace No - Continue</td>
</tr>
<tr>
<td></td>
<td>Does the screen show Downloading for an extended period of time?</td>
<td>Yes - Perform Task k Reboot Electronic Package No - Continue</td>
</tr>
<tr>
<td>Action</td>
<td>Observation</td>
<td>Response</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
<td>----------</td>
</tr>
<tr>
<td>Press the Link button until the screen flashes</td>
<td>Does the unit show Downloading on the LCD screen</td>
<td><strong>Yes – Continue</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>No - Perform Task</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reboot Electronic Package</td>
</tr>
<tr>
<td>Does the unit Download data to the Server</td>
<td>Yes – Repair Complete</td>
<td>Note: Congestion on the server may prevent download first time so try twice.</td>
</tr>
<tr>
<td>Does the unit now Download data to the Server</td>
<td>Yes – Repair</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Complete</td>
<td></td>
</tr>
<tr>
<td>NO TRAIN ALERT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit has not detected any trains within the set parameter time period or a lesser period expected to be a fault</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consider Track operating conditions</td>
<td>Does this track have periods of this length where it is normal for no trains to be running?</td>
<td>Yes – Ignore Alert</td>
</tr>
<tr>
<td></td>
<td>Is there a Track possession?</td>
<td>Yes – Ignore alert</td>
</tr>
<tr>
<td></td>
<td>Are trains definitely running in this period of no detection?</td>
<td>Yes – Inspect</td>
</tr>
<tr>
<td>Check Battery</td>
<td>Is the Battery maintaining good voltage while train passes?</td>
<td>Yes – Continue</td>
</tr>
<tr>
<td>Inspect train passing</td>
<td>Does each wheel passing result in light on panel flashing?</td>
<td>Yes – Continue</td>
</tr>
<tr>
<td></td>
<td>Does each wheel passing result in light on panel flashing?</td>
<td>Yes – Continue</td>
</tr>
<tr>
<td></td>
<td>Does each wheel passing result in light on panel flashing?</td>
<td>Yes – Continue</td>
</tr>
<tr>
<td></td>
<td>Is the power LED in the top of the Sensor Body Lit?</td>
<td>Yes – Continue</td>
</tr>
<tr>
<td></td>
<td>Does Data now show wheel detection is correct?</td>
<td>Yes – Repair complete</td>
</tr>
<tr>
<td></td>
<td>Does Data now show wheel detection is correct?</td>
<td>Yes – Repair complete</td>
</tr>
</tbody>
</table>
Chapter 18  

Sleeper Inspection

C18-1  
Timber Sleeper Inspection

1. Inspect the sleepers for condition.
   If sleepers and fastenings are not visible, they HAVE NOT BEEN INSPECTED.
   (Visible means sufficient to establish that each sleeper is bearing and that sleepers provide adequate resistance to spread road.)

2. If ballast or other material is covering the sleepers and fastenings you MUST remove it.

3. If you cannot remove it you MUST record that the inspection is incomplete and tell your supervisor (Move it up the line to someone who can arrange to get it removed).

4. When the material has been removed you MUST complete your inspection.

Important

You MUST be able to show:
- A sign off that ALL sleepers have been inspected within the required cycle, OR
- Evidence (entries in Teams3, emails etc) that any section that can’t be inspected has been reported up the line for action, and that action is planned to remove the obstruction.

5. Test all sleepers for drumminess.

6. Check for loose spikes or fastenings.

7. Determine whether sleepers are good, effective, ineffective or failed in accordance with the definitions detailed in Section C18-4.1.
   Local opinion and knowledge will assist in this aspect.

8. Assess the groupings of failed, missing and ineffective sleepers and determine repair actions according to the "Limits and Responses" table in Section C5-10.

9. Identify locations where timber sleepered track (including transoms) is not well tied for at least 5 years or where sleepers and transoms at that location do not provide adequate vertical support. Record these locations as requiring Supplementary Track Patrol.

10. Mark sleepers that are to be renewed with paint.
    Mark the sleeper with a daub of paint in the four-foot and also a daub of the same coloured paint on the flange of the rail on the four-foot side of the Down rail.
    Use one of the following colours:
    LIGHT GREEN, LIGHT GREY, LIGHT BLUE, or LIGHT PINK
    The colour to be used for each year is to be decided by the Team Manager but should be different from recent years.

11. Mark sleepers that require immediate renewal by routine maintenance with yellow chalk in addition to the paint mark.

12. Pay special attention to the general pattern of deterioration. It may be necessary to arrange early renewal of sleepers in certain locations ahead of the renewal team program to avoid clusters of ineffective sleepers.

13. Take a realistic approach to marking to ensure that sections of the track do not reach the state where all sleepers will eventually require renewal at the one time. This will occur if marking is too heavy or too light.
14. The marking should require no more than 25% renewal in each half kilometre by a Production team and preferably only 20%.

15. The recommended renewal rates for a 5yr cycle are 25% total or 5% p.a. i.e. every fourth sleeper.

16. Check sleeper spacing. Where sleepers have become bunched up due to rail creep, etc., it may be more practical to place an additional sleeper than to re-space over some distance. Provide an additional paint mark on the rails in such cases.

C18-2 **Concrete Sleeper Inspection**

Concrete sleepers are less prone to failure but require inspection to insure there is no damage to the sleeper or the associated fastenings, insulators and pads.

Inspect concrete sleepers for the following.

1. Check for sleepers that have been dislodged/knocked down by trackwork.
2. Check for sleepers that have been severely damaged.
3. Check that the shoulders of the sleeper are not corroded or damaged
4. Check for any missing fastenings.
5. Check for corroded fastenings.
6. Check for over sprung/ineffective fastenings. This may also indicate that the pad or rail seat are worn.
7. Check for worn, incorrectly inserted or squeezed out insulators.

**NOTE:** If insulators are worn on a face there is a high likelihood that the pads under the rail will also be worn.

8. Check that the pads under the rail are not severely worn. Gauge readings on track recording graphs can be reviewed to assist in determining if there are areas of potential pad damage. If pads are severely worn then check to determine if the rail seat on the sleeper itself is worn/backcanted.

C18-3 **Resilient Baseplate Inspection**

Resilient baseplates are basically maintenance free if they have been correctly installed. During examination:

1. Examine baseplate installations for missing, worn, damaged or incorrectly placed clips, rail pads and insulators

   Check for loose fastenings, washer uncompressed, screwspikes lifted

   Check the double helical spring washers to ensure the correct gap between the coils is achieved.

   ![Figure 48: Pad cracked. Washer compression](image)
2. Examine baseplate installations for derailment or impact damage
3. Examine baseplate casting for cracks or visual faults
4. Examine rubber insert in baseplates for delamination, cracks, holes or other signs of deterioration that may indicate a potential full-depth failure of the rubber moulding. The rubber in the baseplates may be overstressed and may crack. This may lead to the potential failure of the fastenings.

![Figure 49: Cracked rubber insert](image1)

![Figure 50: Rubber de-bonded](image2)

5. Check for excessive water around the fasteners due to blocked drains, seepage, leakage etc. There is potential for water to affect rail and fastenings
6. Check for metal objects or rubbish jammed between the rail and track support (slab or sleeper)
7. Check for excessive build-up of grease on the fasteners
8. Check the torque of the screwspikes/bolts on a random basis. Approximately 20 to 50 fixations should be checked

<table>
<thead>
<tr>
<th>Track Form</th>
<th>Recommended Screwspike Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Slab with cast in HDPE dowel using Ss8 screwspike &amp; Fe6 washer</td>
<td>250 - 270Nm</td>
</tr>
<tr>
<td>Timber sleeper Based on 19mm pre drilled hole in Tallow wood using Ss8 screwspike &amp; Fe6 washer</td>
<td>250 - 270Nm</td>
</tr>
<tr>
<td>Polymer Sleeper with cast in Nylon Dowel Ss8 screwspike &amp; Fe6 washer</td>
<td>160- 180Nm</td>
</tr>
</tbody>
</table>

Table 24 – Recommended torque

9. In corrosive areas examine the conditions of all components of the baseplate and its fixation.
10. In wet areas remove one or more baseplate installations to monitor corrosion
11. Identify and record all defects and compare to Current Defect List noting new and deteriorating defects and defects that have been removed
C18-4  Definition of Condition

C18-4.1  Timber Sleepers

<table>
<thead>
<tr>
<th>Condition</th>
<th>Sleepers that are broken, missing or do not give <strong>vertical</strong> support to the rails.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failed / missing sleepers</td>
<td>Sleeper/fastening system provides <strong>vertical</strong> support and <strong>lateral</strong> restraint. Restraint must allow no lateral movement of the fastenings relative to the timber. The sleeper must provide gauge restraint and must be one piece that will not separate along its length or transversely.</td>
</tr>
<tr>
<td>Effective sleeper</td>
<td>Sleepers should not be excessively backcantled more than 1 in 30. For double shouldered sleeper plates this is equivalent to backcantling into the timber on the outer edge of the plate of 5mm. For Pandrol Plates this is equivalent to backcantling into the timber on the outer edge of the plate of 6mm. For both plates this is approximately equal to ½ the plate thickness.</td>
</tr>
<tr>
<td>Good sleeper</td>
<td>Is an effective sleeper that will remain effective for at least 5 years under normal operating conditions prevailing at the time of the inspection. ie If the track normally carries 10MGT of 21t axle load traffic at 115km/h then a good sleeper will continue to carry the same amount of traffic and remain effective for at least 5 years.</td>
</tr>
<tr>
<td>Ineffective sleeper (Poor sleeper)</td>
<td>Sleeper that is not effective. Timber sleepers with rot, or holes through which ballast can be seen are not satisfactory. At least 300mm is required between rail foot and sleeper ends for effective tamping.</td>
</tr>
</tbody>
</table>

(For the purposes of assessment effective sleepers includes good sleepers).

(For the purposes of assessment ineffective sleepers include those that are missing or failed).

C18-4.2  Concrete Sleepers

Concrete sleepers are considered “failed” when the following conditions are identified:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Curve radius</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 350m</td>
</tr>
<tr>
<td>Ballast abrasion</td>
<td>&gt;20mm</td>
</tr>
<tr>
<td>Cracks</td>
<td>Continuous through sleeper</td>
</tr>
<tr>
<td>Spalling</td>
<td>&gt;15% along sleeper length</td>
</tr>
<tr>
<td>Chemical damage</td>
<td>&gt;20% cross section affected</td>
</tr>
<tr>
<td>Tamper damage</td>
<td>&gt;20% cross section lost</td>
</tr>
<tr>
<td>Wear at rail toe (side insulators)</td>
<td>TBD</td>
</tr>
<tr>
<td>Insulating effectiveness of rail pads, side insulators, toe clip insulators</td>
<td>TBD</td>
</tr>
</tbody>
</table>
C18-4.3 Sleeper Fastenings

Fastenings, when they deteriorate or are damaged, have the same impact as ineffective sleepers. Check the condition of the fastenings in the following table. If they are classed as ineffective, determine how many and how they are spaced, then check the Operating limits for ineffective sleepers.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Curve radius</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;600m</td>
</tr>
<tr>
<td><strong>Resilient Fastenings</strong></td>
<td></td>
</tr>
<tr>
<td>Loss of Toe load</td>
<td>Clips keep falling out</td>
</tr>
<tr>
<td>Section loss</td>
<td>5%</td>
</tr>
<tr>
<td><strong>Dogspikes</strong></td>
<td></td>
</tr>
<tr>
<td>Section loss</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Screwspikes (24mm)</strong></td>
<td></td>
</tr>
<tr>
<td>Section loss</td>
<td>TBD</td>
</tr>
<tr>
<td><strong>Screwspikes (27mm)</strong></td>
<td></td>
</tr>
<tr>
<td>Section loss</td>
<td>TBD</td>
</tr>
<tr>
<td><strong>Lockspikes</strong></td>
<td></td>
</tr>
<tr>
<td>Section loss</td>
<td>5%</td>
</tr>
<tr>
<td><strong>Lockscrews</strong></td>
<td></td>
</tr>
<tr>
<td>Section loss</td>
<td>TBD</td>
</tr>
<tr>
<td><strong>Dogscrews</strong></td>
<td></td>
</tr>
<tr>
<td>Section loss</td>
<td>TBD</td>
</tr>
<tr>
<td><strong>Sleeper Plate</strong></td>
<td></td>
</tr>
<tr>
<td>Wear or damage</td>
<td>Allows rail movement beyond horizontal or vertical limits for an effective sleeper</td>
</tr>
</tbody>
</table>

C18-5 Action to be Taken

1. Record all examination locations on Form 2 "Examination of Length", or keep other detailed records of locations examined.
2. If timber sleeper condition meets the requirements for Supplementary Patrol, mark the entry on Form 2.
3. Action any defects found or investigated during a sleeper examination according to the "Limits and Responses" table in Section C5-10.
   ~ Take appropriate protective action if defects require immediate action, OR
   ~ Include repair action in a work program.
   ~ Report the fault to the Team Leader or Team Manager as appropriate.
   ~ Monitor the fault during future examinations until further deterioration requires action.
4. List the defects on Form 2 "Weekly Summary of Defects Report" or transfer to Teams3 directly from inspection records.
5. When sleeper marking, record the number of sleepers marked each half kilometre for renewal.
6. Use the recorded information to develop Asset Management Plans.
Chapter 19  Clearance Examination

This chapter details the procedure for inspection of:

− Lateral and vertical clearances at platforms.
− Lateral clearance to structures in all areas.
− Vertical clearance to overhead structures.
− Track centres between adjacent tracks.
− Track centres at clearance points associated with catchpoints
− Mid cycle visual inspection of platforms

The lateral clearance examination is required for all tracks where there are structures that could infringe on the structure gauge. "Structures" include retaining walls, rock faced cuttings, bridge members, tunnel walls, overhead wiring masts and signals.

C19-1  Inspection Procedure

When performing this type of inspection, the examiner is to have the following equipment available.

− a non metallic tape measure, laser or other suitable measuring equipment,
− a plumb bob, spirit level or other suitable equipment,
− a board for measuring superelevation,
− a list of structures to be examined and applicable design clearances, track centres and superelevation for the length provided by the Civil Maintenance Engineer,
− a list of approved infringements to the structure gauge detailing the required clearances, special actions, etc. provided by the Civil Maintenance Engineer.

C19-2  Detailed Inspection of Clearance to Platforms

Examination staff

1. Measure and record the clearances between track and survey plaques at all platforms.

At platforms survey plaques are normally provided, detailing the correct position of the adjacent track. The design information from each survey plaque is listed on the measurement form.

Measure and record horizontal and vertical distance from survey plaques to rail at each survey plaque. (See Figure 52).

− Measure horizontal clearance to the gauge face of the nearest rail.
− Measure vertical clearance to the low rail.

− If survey plaques are not provided take the horizontal and vertical measurements from the coping at maximum intervals of 10 metres. (See Figure 54)

Measure and record superelevation at each measurement location. Use the methods of measurement in Section C4-3 and Section C4-8.

Record dimensions on Form Clear 1 if available or the old form if not.
2. Measure and record the clearances between the track and the platform coping at all platforms.

At the survey plaques, measure the horizontal clearance from the track to the face of the coping and the vertical distance from the track to the top of the coping. (See Figure 54) Use the method of measurement in Section C4-8.

Record the dimensions on Form Clear 1.

3. Measure the vertical and horizontal clearance to any protrusions (signal troughing, pipes etc) on the platform wall that stick out further than the edge of the coping. (See Figure 55). Pick the worst example/s to measure. Use the method of measurement in Section C4-8.

Record the dimensions on Form Clear 1.
4. It may also be necessary to measure clearances to structures located on platforms.

5. Calculate variations and conduct an initial assessment.

**Alignment (platform gap)**

Calculate variations between actual and design measurements.

Record the variations on the examination form.

Record the variations as + or -. (+ is where there is an increased clearance between track and structure – is where there is a decreased clearance. (See Figure 53)

Determine at the time of the examination any locations where the horizontal clearance is reduced by more than -30mm and assess if there are any signs where rapid deterioration is possible and/or where immediate action is required. (e.g. Signs of track pulling in on curves especially in winter, platforms leaning etc.)

**Superelevation**

Calculate variations between actual and design measurements at each survey mark.

Record the variations on the examination form.

Record the variations as + or – (+ is where the superelevation variation increases the clearance between the track and the structure – is where the variation decreases the clearance. (See Figure 53)

Determine at the time of the examination any locations where the superelevation variation is greater than -15mm and assess if there are any signs where rapid deterioration is possible and/or where immediate action is required. (e.g. Severe bog holes, severe top defects in rail closest to the structure, areas where recent excavation work has been performed)

**Combined effects of Alignment and superelevation**

When the alignment error is more than 25mm check also if the combined clearance is reduced by more than 30mm by including 50% of any contributing superelevation. Where the above tolerances have been exceeded the combined effects of the superelevation error and alignment error should also be considered in setting priorities and in determining the need for any operating restrictions pending correction (about 50% of the super error contributes to the alignment).

**Team Manager**

Review all inspection sheets for obvious errors.

Ensure all variations outside of tolerance listed above have been assessed and appropriately actioned.

Forward completed examination sheets to CME

**Civil Maintenance Engineer**

Review all examination sheets to ensure that any areas which fall outside the following limits are identified and actioned. The track design alignment and the relationship to the coping should be considered. The track may infringe the design
alignment but still be clear of the actual platform coping

Alignment
The default minimum clearance is that the track must not be more than 20mm closer to the platform edge than the design alignment.

Superelevation
The default minimum clearance is that the track must not have superelevation more than 10mm from design in the direction tilting the train towards the platform.

Combined alignment and superelevation
Where tolerances have been exceeded the combined effects of the superelevation error and alignment error can be considered in setting priorities and in determining the need for any operating restrictions pending correction. For standard access allow 70% of the super error and for level access allow 80% of the super error which contributes to the alignment.

The combined impact of the alignment and factored superelevation error should be considered in relation to the surveyed alignment and coping position. Strategies for future maintenance should consider this relationship. The priority is to ensure that safe clearance to the coping is not compromised. Some issues to be considered are:

~ The track may be too close to the surveyed alignment but clear of the platform coping. This would be satisfactory in the short term but strategies would need to be put in place to correct the track alignment in the event of any coping adjustment.

~ The track may be satisfactory with regard to the surveyed alignment but is too close to the actual coping. An assessment of the current situation would need to be conducted which may require short term measures such as a speed restriction or closer monitoring. In the longer term correction may require an adjustment to the coping or a realignment of the track.

The default is that the combined alignment and factored super errors should not exceed 25mm tilting towards the coping.

Where the platform gap compared to the design alignment is more than 30mm tilting the train away from the platform then this should be considered in setting corrective maintenance priorities for track resurfacing. Stakeholders should be advised where the actual gap to the coping is beyond the standard for its position by more than 30mm and the contributing factors for this (track relative to design alignment or platform coping).

Height (platform step)
Over time track level may creep up. For track at Level Access platforms the maximum permitted level shall be -100mm (ie a level of 1100mm rail to coping for straight track). For Standard Access platforms the track is to be maintained between -20mm and +100mm of design:

Where Standard Access platform locations are low to design, consideration should be given to whether the platform is to be converted to Level Access. If this is the case then, where practical, an integrated design should be developed between platform works and trackwork to achieve the revised grading. This may involve staging over a number of years with interim heights somewhere between Standard Access and Level Access. Agreement with relevant stakeholders must be obtained for such arrangements.

In any case track should not be lifted just to bring it back to standard access from a position intermediate between standard access and level access. However track lifting should be undertaken if the track is so low as to be outside the tolerances for level access.

Where track is otherwise out of tolerance a review should be undertaken as to whether the track or platform is at fault. A design review should be initiated to
determine the best solution.

Note that maintenance actions for track must consider the variation along the platform. Track vertical alignment must be smooth. Localised track lifts cannot be used to accommodate local variations in coping position.

Note: Measurement convention (+ means track is lower than design rail level) – see Figure 53 below.

C19-3 Civil Maintenance Engineer and Team Manager review

1. Review all areas where the Civil Maintenance Engineer has determined that tolerances have been exceeded. Visual Inspection of locations and review of previous measurements may assist in determining action and priority.

2. Plan for rectification or other control of exceedents.

3. Ensure that all defects and applicable action and/or controls are recorded in a defect management system.

C19-4 Mid Cycle Visual Inspection of Clearance to Platforms

Team manager

1. Conduct a visual inspection of each platform to check that there have been no major changes to clearances caused by.
   ~ Platforms being resurfaced.
   ~ Additions to platform coping.
   ~ Severe bog holes or obvious changes in track surface which could reduce clearance.

2. If changes have occurred arrange for platform clearance measurements to be taken and actioned at the affected location as detailed in C19-2.

C19-5 Inspection of Clearance to Structures

Examination staff

1. Check the clearances at listed structures.

2. Measure the clearance at each indicated point using the method of measurement in Section C4-8.

   If no survey points exist for the listed structure measure clearance to the structure at either end and at maximum intervals of 10 metres.

   DO NOT assume that all structures are vertical. If there is an overhang, use a plumb bob or other method to establish the position relative to the track.

3. Measure the cross-level or superelevation at each measurement point using the method of measurement in Section C4-3.

4. Record track clearance and superelevation variations on Form Clear 1 “Clearance Examination” as +/- mm from design.

Civil Maintenance Engineer

1. Review clearance measurements against minimum clearance requirements.

2. Plan for rectification or other control of identified defects.

3. Ensure that all defects and applicable action and/or controls are recorded in a defect management system.

C19-6 Inspection of Track Centres

Examination staff

1. Check the clearances at listed locations and complete Form Clear 2.
Track centres are to be measured at the nearest survey mark to the tangent points on straights. If the straight is more than 250m long, take intermediate measurements at not more than 250m intervals.

Track centres are to be measured at maximum intervals of 50m on curves.

2. Measure track centres using the method of measurement in Section C4-9.

3. Measure the superelevation/cross-level for both tracks at each inspection point using the method of measurement in Section C4-3.

4. If there is any visible variation in line or superelevation between inspection points that would bring vehicles closer together, measure track centres and superelevation at these points as well.

5. Record track centre and superelevation variations on Form Clear 2 "Inspection of Track Centres and Rail Level" as +/- mm from design. Note + is when the variation increases track centre clearance – is when the variation reduces track centre clearance.

6. Where separate tolerances have been provided by the Civil Maintenance Engineer for specific locations use those tolerances. Otherwise determine if there are variations of greater than -30mm in track centre measurements and/or a combined error of – 20mm in super variations. Calculate the total change as detailed in Figure 56 for tangent track and Figure 57 for curved track. Record the total change on Form Clear 2.

   If the total loss of track centre clearance exceeds - 90mm then report the location to the CME

7. At those locations also assess if there is potential for rapid deterioration where immediate action is required. (e.g. Where there is evidence of curves pulling in, loss of superelevation in the two inner “six foot” rails due to bog holes or excavation work etc)

Team Manager.

1. Review all inspection sheets for obvious errors.

2. Ensure all variations outside of tolerance listed above have been assessed and actioned as required.

3. Forward completed examination sheets to the Civil Maintenance Engineer

Civil Maintenance Engineer

1. Review all field sheets from track centre examination and determine appropriate action and/or control for areas that infringe on the design clearance envelope.

2. Ensure all defects and appropriate action and/or controls are entered into a defect management system.
**Convention:** Down rail is datum rail  
Where the Down Rail is lower than the Up Rail, Superelevation is positive (+)

\[
T_C \text{ (Design)} = 4000 \text{mm} \\
T_C \text{ (Actual)} = 3955 \text{mm} \\
T_C \text{ (Variation)} = -45 \text{mm (45mm loss of clearance)}
\]

\[
S_{\text{design}} \text{ (Down Track)} = 0 \\
S_{\text{actual}} \text{ (Down Track)} = -10 \text{mm} \\
S_{\text{variation}} \text{ (Down Track)} = -10 \text{mm (10mm loss of clearance)}
\]

\[
S_{\text{design}} \text{ (Up Track)} = 0 \\
S_{\text{actual}} \text{ (Up Track)} = +15 \text{mm} \\
S_{\text{variation}} \text{ (Up Track)} = -15 \text{mm (15mm loss of clearance)}
\]

**Total loss.**  
\[
T_C \text{ (Variation)} = -45 \text{mm} \\
\text{Total Super variation} = -10 + -15 = -25 \\
\text{Total loss due to superelevation} = -25 \times 3 = -75 \\
\text{Total Variation in Track Centres} = -45 + -75 = -120 \text{ mm}
\]

*Figure 56 - Calculation of Variation in Track Centres - Tangent track*

\[
T_C \text{ (Design)} = 3900 \text{mm} \\
T_C \text{ (Actual)} = 3870 \text{mm} \\
T_C \text{ (Variation)} = -30 \text{mm (30mm loss of clearance)}
\]

\[
S_{\text{design}} \text{ (Down Track)} = 50 \\
S_{\text{actual}} \text{ (Down Track)} = 35 \text{mm} \\
S_{\text{variation}} \text{ (Down Track)} = -15 \text{mm (15mm loss of clearance)}
\]

\[
S_{\text{design}} \text{ (Up Track)} = 60 \\
S_{\text{actual}} \text{ (Up Track)} = 80 \text{mm} \\
S_{\text{variation}} \text{ (Up Track)} = -20 \text{mm (20mm loss of clearance)}
\]

**Total loss.**  
\[
T_C \text{ (Variation)} = -30 \text{ mm} \\
\text{Total Super variation} = -15 + -20 = -35 \\
\text{Total loss due to superelevation} = -35 \times 3 = -105 \\
\text{Total Variation in Track Centres} = -30 + -105 = -135 \text{ mm}
\]

*Figure 57 - Calculation of Variation in Track Centres - Curved track*
C19-7 Inspection of Track Centres at Clearance Points

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

The clearance points may be protected by use of catchpoints, fixed signals, track circuits and insulated joints, etc.

The clearance at catchpoints should be checked at the time of the detailed examination of catchpoints and is listed on Form STW 2 “Catchpoint examination”

At all other locations:

1. Check the clearances at listed. The list shows:
   ~ Location
   ~ Designed track centres
   ~ Superelevations.

   The inspection is carried out at locations where either track has an allowable speed greater than 20kph.

   If there are catchpoints, locate the clearance point by measuring 3.8m along the track from the catch point throwoff rail (see Figure 58).

   If there are NO catchpoints but a clearance peg (white peg) is provided, measure clearance at this point (see Figure 59).

   If there are NO catchpoints and NO clearance peg, locate the clearance point by measuring 3m along the track from the insulated joint (see Figure 60).

![Figure 58 – Clearance Point location – with catchpoints](image-url)
2. Check track centres by measuring the distance from the gauge faces of the up or down rails of adjacent tracks. 
   Note: DO NOT measure track centres from adjacent rails of adjacent tracks. Use a non-conductive tape measure for measuring track centres.
3. Record track centre variations on the inspection form as +/- mm from design. (See Form Clear 2).
   The track centres clearance required at the clearance point is 3.65m. If the measured clearance is less than 3.65m notify the Civil Maintenance Engineer.
4. Measure and record the superelevation/cross-level for both tracks at each inspection point. (See Form Clear 2).
5. Calculate changes in clearances due to changes in track centres and superelevation.
6. Check the direction of the throw-off rail.
   If the throwoff rail of the catchpoint is NOT parallel to, or leading away from the adjacent track (see Figure 61), notify the Civil Maintenance Engineer.
C19-8 **Inspection of Rail Level**

Designed rail levels beneath all structures and under overhead wiring are listed for each length.

1. Check rail levels by measuring the vertical distance from the survey mark, monument, plaque or survey peg to the running surface of the datum rail using the method of measurement in Section C4-6.

2. Where special survey plaques are provided at structures with restricted clearances, measure the distances of the rails from the plaques instead of the actual clearances.

C19-9 **Action to be Taken**

**Examination staff:**

1. Record all examination results on Form Clear 1 "Clearance Examination", Form Clear 2 "Inspection of Track Centres and Rail Level" or Form STW 2 – "Catchpoint Examination."

2. Assess any defects found or investigated during the inspection that are outside the limits stated in this chapter.

   1. Take appropriate protective action or corrective action as stated in this chapter.

   2. List defects and appropriate action or controls in Teams3 or other defect management system.

**Team Manager:**

1. Check field sheets for errors

2. Ensure defects outside the limits stated in this chapter are assessed.

3. Ensure that all defects and actions and/or controls are entered in Teams3 or other complying defect management system.

**Civil Maintenance Engineer:**

1. Check that all exceedents outside the limits stated in this chapter are assessed

2. Determine appropriate actions or controls in consultation with team managers.

3. Ensure that clearance infringements are to be managed in accordance with the requirements of TMC 215 Transit Space Manual.
Chapter 20  Level Crossing Examination

C20-1 Examination Requirements
Level crossings are to be examined to identify defects in:
− conditions of ties and fastenings;
− rail condition;
− crossing surface;
− guard rail flangeways and guard rail effectiveness;
− top and alignment;
− drainage;
− condition of signs, gates, grids and fences.

C20-2 Crossing Types
There are two distinct types of level crossing construction:

Modular (or Special) - These are manufactured in concrete or rubber modular sections and assembled on site.

Non-Modular - These are constructed from materials such as sleepers, ballast, bitumen and in-fill concrete.

Most pedestrian crossings are non-modular types.

C20-3 Equipment
When performing this type of inspection, the Track Examiner should carry the following equipment:
− a combination cross-level/gauge board;
− a 5m tape measure;
− a bar to clean out flanges.

C20-4 Examination Procedure
Examine all level crossings, whether sealed or not.
1. Measure and record gauge through the level crossing at 2m intervals.
2. Identify, measure and record any rail play.
   In Modular Crossings, look for modules coming into contact with rails, rubbing marks or rusty spots on galvanised components.
   At bitumen paved crossings; look for cracks in the bitumen around the running rails or guard rails, compressed 'humps' of bitumen behind the running rails.
   Where rail play is suspected, insert a bar through the flangeway and lever it in an attempt to widen the gauge. Record approximate values for rail play on the inspection form.
3. Measure and record flangeway clearance and depth for both guard rails through the crossing at 2m intervals.
4. Measure and record guardrail effectiveness for both guard rails through the crossing at 2m intervals (see Figure 62). Take the measurement from the face of the guard rail nearest the running rail to the gauge face of the opposite running rail. Take the measurement for both guard rails.
The Down guardrail effectiveness measurement is measured from the downside guard rail to up rail and vice versa.

![Diagram of guardrail effectiveness measurement](image)

**Figure 62 – Measurement at level crossings**

5. Visually inspect each end of the guard rails for “hit” marks. Measure and record the width of the flare opening at each end of each guard rail.

6. Visually examine, assess and record the general condition of ties and fastenings.

![Image of corroded plates and fastenings](image)

**Figure 63 – Corroded plates and fastenings**

7. Check the height of the roadway surface relative to rail level.

8. Visually examine, assess and record the fit of components and condition of modular crossings. Look for:
   - Visible signs of differential levels in crossing surface between adjacent panels, or between panels and rail head level or adjacent road surface level
   - Visible signs of localized road surface wear, indicating possible differential loading
   - Gaps between panels
   - Loose end restraint fastenings
   - Movement of panels under road traffic loading.

Note that, except for ‘sitting obviously high’ and ‘movement under load’, the above
are indicators only of possible loss of vertical restraint. If the indicators exist, further examination is required to determine if there are any vertical restraint issues.

9. Visually examine, assess and record the condition of the roadway surface of Non-Modular Crossings.
   Look for pot holes, lifting timbers or other ineffective components.

10. Visually examine rail top and line. If there are visible irregularities, measure and record the extent of defects.

11. Examine condition and visibility of level crossing signs and condition of fences and gates.

12. Examine rail webs and flanges for evidence of rail corrosion. Use a bar to inspect rust flakes through the flangeways.


14. Examine sighting distances on passive level crossings (crossings without lights and bells) for vegetation or other sight obstructions.

   This is best achieved by paint marking the sighting points on the rail. Stand at the sighting point and look towards the level crossing. You must be able to see the point where the vehicle driver will be sitting when he is looking for a train (Where the Level Crossing is protected by a Stop Sign this will be 5m back from the level crossing. If the Level Crossing is not protected by a Stop sign the vehicle driver’s sighting point will be some distance back from the Level Crossing. This needs to be defined for each level crossing and marked on the road approach). The method of determining sighting distances is detailed in RailCorp Engineering Manual TMC 521 - Level Crossing Manual.

   Note: Sighting points are required for both road approaches and for all track approaches to the level crossing.

C20-5 Action to be Taken

1. Record all examination results on Form LX 1 Level Crossing Examination.

2. Assess any track geometry defects found or investigated during the inspection according to the "Limits and Responses" table in Section C5-4.1.

3. Assess other defects found or investigated during the inspection according to the "Limits and Responses" table in Section C5-13 and the limits and responses in TMC 521.

4. Take appropriate protective action or corrective action.

5. List the defects on Form 2 "Weekly Summary of Defects Report" or transfer to Teams3 directly from Form LX 1.
Chapter 21  Special Track Inspection Issues

Staff involved in inspection and maintenance planning need to be aware of issues that require special attention during inspections at various times of the year.

C21-1  Hot Weather Inspection Issues

C21-1.1 Pre-Season Inspection

Special inspections are required before the commencement of the summer period, and during the summer period when rail temperatures approach the maximum levels.

1. Carry out a Walking inspection of the track to spot check that the Welded Track Stability measurement has been correctly completed.
   ~ Dogspikes and other fastenings are effective to resist side thrust.
   ~ The expansion gaps at rail joints are correctly measured.
   ~ Any indications of sleepers that are loose and need packing, or are centre bound, are corrected.
   ~ The anchors are holding firmly against sleepers and sufficient anchors provided so that the resilient fastenings are not allowing the rail to move.
   ~ The track is adequately ballasted especially on the shoulder.
   ~ The ballast around all sleepers is properly boxed up.
   ~ Any indications of hard foul ballast that could provide a glassy surface for easy lateral movement of sleepers have been recorded and corrective action programmed for completion prior to the hottest periods.
   ~ The Track Stability Analysis is correct and corrective action is completed or is programmed for completion.
   ~ Recent track maintenance work has been properly completed.
   ~ Locations of non-standard welded track have been appropriately identified and dealt with.

2. During the inspection check that appropriate attention is to be paid to the potential of misalignment triggers such as:
   ~ Poor Rail/Weld alignment arising from incorrect crowing, rail end alignment, poor rail profile matching, straight closures in curves, track alignment (including gauge) glued insulated joints etc.
   ~ Rail surface and track geometry defects including poor top, twists, dipped welds, dipped joints, wheel burns and corrugations, pumping sleepers etc.
   ~ Rail bunching at fixed points due to changes in grade, changes in fastener, sleeper or rail type, bridges, turnouts, level crossings etc.
   ~ Rail bunching due to stopping and starting of trains at signals, platforms etc.
   ~ Local disturbances due to undertrack crossings, culverts etc.
   ~ Curves less than 400m radius. Tight radius curves have a higher misalignment risk, particularly if they are continuously welded on dogspiked sleepers. Pay particular attention to these locations to correct any track instability or potential misalignment triggers.

3. Check that full track stability has been restored at all previous misalignment sites (say, 3-5 years).
C21-1.2 Track Inspection Issues in Summer

Track problems can affect the reliability of Signalling equipment in the summer period. Problems arise from the movement of steel in the hot weather, from summer storms and even from ballasting work carried out for WTSA.

Track staff involved in inspection and maintenance should be alert for such problems and should work with Signal discipline staff to secure the reliability of the infrastructure.

The following issues require special attention during summer months:

Anchoring

Anchoring of turnouts and special trackwork is important to prevent the movement of steel especially where there are non-elastic fastenings. Catchpoint areas are particularly vulnerable. Anchoring is required within and adjacent to turnouts and special trackwork. Additional anchors should be considered to prevent movement of steel.

Bolts in Turnouts

Chair bolts must be tight in the switch area of turnouts to resist longitudinal movement of steelwork (as well as lateral movement and to prevent breakage).

Insulated Joint Gap and Clips

Make sure that small movements of the rail are not going to cause shorting, either from clips too close to fishbolts or from the joint gap where there is rail end flow.

Switch Movement and Flow

Check that rail flow on the stockrail will not affect switch or stockrail movement in the heat. Remove stockrail flow for at least 25mm beyond the switch tip.

Check that there is still travel available for the switch before the end of the stockrail undercut or joggle. At least 25mm beyond the switch tip should be available for longitudinal movement.

New Ballast

Thick layers of new ballast left in the four foot can cause signal failures from “sagging track” especially if heavily contaminated with fine dust. New ballast should be ploughed off. If this can't be done check with signal staff as to whether the track section involved is sensitive to sagging.

Ballast Trains & possession work

Make sure ballast laid out does not foul signalling equipment especially at points and trainstops). Also make sure hopper doors are fully shut, not just at the conclusion of the work but if any turnouts are traversed between ballasting locations. Check point areas if any spillage is suspected. After possession work, inspect point areas that could be affected by ballasting work (including with off-track plant).

Drainage

Poor drainage can affect turnouts and special trackwork (from pumping track) and open track where “track sagging” can result. Signal staff can identify vulnerable locations. Track staff should be on the lookout for evidence of boggy track or locations where water pools. Note that flogging heels on heeled switches is an area of particular vulnerability.
Chapter 22 Track Recording

The prime function of the Track Recording Car is to provide detailed information to district and district management on the condition of main lines.

The Track Condition information provided is a guide to the overall condition of track. By comparison with earlier reports it indicates any changes in track condition and is a guide to the quality of work done between reports.

The Track Recording Car is required to operate on a cycle of examinations as detailed in ESC 100 - Civil Technical Maintenance Plan.

C22-1 Field Duties Prior to Track Recording

When you are notified that the car will be recording on your length:

1. Obtain Track Recording program for area from the Manager Track Recording
2. Check kilometre posts in area of recording run to establish they are correctly located and visible to car crews.
3. Obtain clear instructions about the distribution of the defect list and graphs at the end of the run.

C22-2 Action required During Recordings

1. Travel on the Track Recording car on your track length.
2. Monitor Track Recording graphs as they are being recorded.
3. Compare the current recording with the last recording to check the effectiveness of work completed, to look for repeats and to compare the general track condition.
4. Note Locations where recording has failed (derailed trolley etc).
5. Note recording car errors, particularly those showing as defects. Arrange to have these signed off on the recording run by the operator.
6. Identify and record defects and compare to Current Defect List noting new and deteriorating defects and defects that have been removed.
7. Where Emergency level (E1 and E2) defects in short twist, long twist or top are recorded check with the Track Recording Vehicle operators that the defect is genuine.
8. Arrange immediate PROTECTIVE action for EMERGENCY level defects during the run, pending further corrective actions in accordance with the "Limits and Responses" tables in Chapter 5.

C22-3 Distribution of Recording Graphs

At the end of each Length or as otherwise agreed, the car will stop and all copies or recording graphs and Priority Location Lists will be provided to the field representative on the car.

1. Take copies of recording graph and computer disk from the recording car.
2. Distribute or arrange distribution of Emergency and Priority 1 defect listings lists in accordance with instructions provided by the Civil Maintenance Engineer.
   The distribution must be carried out quickly to allow prompt attention to all Emergency and Priority 1 locations.
3. Distribute or arrange distribution of copies of graphs and computer disk to appropriate staff in accordance with instructions provided by the Civil Maintenance Engineer.
The Recording Graphs are to be distributed as follows:

- Original to the Civil Maintenance Engineer.
- 1 copy to Team Manager
- other copies are to be distributed as required by the Civil Maintenance Engineer.

4. Notify the Civil Maintenance Engineer of any location that has not been inspected because of recording failure or possession shortfall etc, so that alternative inspections can be arranged.

**C22-4 Defect Examination & Repair**

1. Locate defects in the field and assess according to the "Limits and Responses" table in Chapter 5.
2. Take appropriate protective action or corrective action.
3. Update Defect Listing and program repairs required.

**C22-5 Missing Inspections**

Inspection of Main lines and Crossing Loops by the Track Recording Car is a fundamental requirement. Whilst the Track Recording Car is generally able to maintain the inspection cycle for main lines it may sometimes miss Crossing Loops.

If directed by the Civil Maintenance Engineer, undertake a manual inspection of track geometry.

1. Measure twist and gauge using portable track recording equipment or the "trackmaster" measuring board.
2. Assess top and line visually, supplemented with stringline measurements if required.
3. Assess rail play visually.
4. Mark and record all Emergency level (E1 and E2) and Priority 1 (P1) for appropriate maintenance action.

**C22-6 Track Recording Analysis**

The Track Recording Car provides an assessment of general track condition. This is reported by the car as Track surface and Track Condition Index (TCI) and is often an indicator of significant track problems.

1. Analyse Track Recording graphs for Track Condition Index (TCI).
2. Examine locations with high Track surface or TCI for planning of rectification work.
   - Inspect any significant track sections (over 50m) excluding turnouts reported with condition exceeding:
     - Track surface > 32
     - TCI > 70
3. Compile a record of track with high Track surface or TCI, including assessment of the locations and planned remedial actions.
4. Forward details of the work required and a proposed plan of rectification to the Civil Maintenance Engineer.
Chapter 23  Turnout & Special Trackwork Examination

Turnout & Special Trackwork Examination is a detailed examination of turnouts and diamond crossings, catchpoints and expansion switches.

C23-1  Examination Requirements

Turnouts and other special trackwork are to be examined at the frequencies documented in ESC 100 - Civil Technical Maintenance Plan.

These are the minimum frequencies. At locations where obvious deterioration occurs at higher rates due to such factors as curvature, usage, axle load or speed more frequent inspections should be scheduled. These additional inspections may be reduced in scope to address only those parts of the inspection affected by the additional factors.

Particular attention is drawn to any similar flexure turnouts (ie where the outside rail nominally the 'high rail' is the stockrail) which are subject to curve wear. For such cases, the fit of the switch against the stockrail, the condition of the switch, the stockrail and the switch tip height, width and angle should be assessed more frequently. These additional examinations may be conducted and recorded as part of the Detailed Walking Examination in Chapter 9.

For tangential turnouts additional examination requirements are detailed in Section C23-18.

C23-2  Equipment

When performing this type of inspection the examiner is to carry the following equipment:
− a light hammer,
− a 5m tape measure,
− a combination cross level/gauge board,
− a switch nose profile gauge,
− a 400mm bar for checking switch lever tension (if applicable),
− a housed points clearance gauge (if applicable),
− appropriate forms.

C23-3  Switch Examination

Switches should swing freely at the heel without being too loose and heels should not be so tight that they would cause springing or bending. Slide chairs should be clean and well oiled with even support to the switch throughout its length. All switch studs should make light and even contact with the back of the switch. The “A”, “B” and “C” chairs particularly should be firm and solid without any lateral movement. The switch should fit snugly against the stock rail along the machined portion of the back edge and should be crowned where necessary to ensure a neat fit. The point of the switch should be smooth and sharp, not blunt or chipped.

1. Check Switch profiles of BOTH switches with a switch nose profile gauge using the following procedure:
   ~ Set the box section Track Supervisor's combination gauge on the adjacent stockrails directly above the top of the arc on the switch nose.
   ~ Set the switch tip profile gauge on the box section so that nib of the gauge contacts the gauge face of the stockrail. (See Figure 64).
To check switch height:

- Place the gauge directly above the head of the stockrail with the nib contactng both the gauge face of the stockrail and the top of the switch.

- If the gauge is observed to be touching the running surface of the stockrail, the switch height is O.K. (See Figure 65).

- If there is a space between the gauge and the stockrail, the switch is too high.

- Measure and record the size of the space.

- This check is only valid if the heel of the switch is definitely not ‘pumping’. If the switch is too high, look for causes.

- Check the chairs. Taller chairs further back may be lifting the switch up.
If the switch nose is rising under load – check the heel block.

To check switch width:

- Observe the gauge where the nib should contact the gauge face of the stockrail. (See Figure 66).
- If the nib fails to make contact leaving a space, the switch is too wide (‘blunt’).
- Measure and record the size of the space.

![Figure 66 - Checking Switch Tip Width](image)

To check the slope of the switch:

- Observe the spaces between the gauge and the face of the switch. (See Figure 67).
- If there is a space gradually increasing toward the lower face of the switch, the slope is O.K.
- If the space becomes wider towards the top of the switch face, the slope of the switch is too flat.
- Record this condition.

2. Examine the switch tip for damage.

- Visually inspect the switch foot and web and check visually for any signs of
cracking or severe notching from about 1.5m to 3m back from the tip.
Wipe off any surface dirt/ grease should be from the outside of the switch first.

A severe notch is where there is a sharp notch of 3mm or more or a rounded
notch of 4mm or more (see Figure 68).

![Figure 68 - Notching in switch](image)

~ Visually examine the inside of the open switch.
Make arrangements to have the points reversed so that inside of the other
switch can also be visually examined.

**CAUTION:**
DO NOT put any part of your body or anything else between the switch and the
stockrail unless appropriate protective arrangements are made. Worksite
supervisors should review the protection required but it would at least require
having the points secured and clipped by the signaller.

![Figure 69 - Cracked switch initiation](image)

~ If cracking is discovered take immediate to protect the affected route as follows.

<table>
<thead>
<tr>
<th>Crack size &amp; location</th>
<th>Switch Support Condition</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small crack limited to the foot area</td>
<td>well supported</td>
<td>Maximum speed 20km/hr</td>
</tr>
<tr>
<td></td>
<td>not well supported</td>
<td>Maximum speed 10km/hr</td>
</tr>
<tr>
<td>Crack is into the web but clear of the head of the rail</td>
<td>switch is well supported</td>
<td>Maximum speed 10km/hr with continuous monitoring until replaced</td>
</tr>
<tr>
<td></td>
<td>not well supported</td>
<td>Close the road</td>
</tr>
</tbody>
</table>

For anything worse than the above | Close the road |

3. Examine the bearing of the switch along its full length on the plates. It should bear
evenly on all plates.
This is particularly important for undercut stock rails in 60 kg conventional and
tangential turnouts due to the angle of the undercut.
More than 1-1.5mm vertical clearance between the switch and plate at the “A” or “B” timber can lead to lock and/or detection failures since the switch will move sideways as well as down under load and may not always drive to a consistent position against the stockrail.

Uneven bearing on plates through the length of the switch, in particular on the longer switches, leads to high frictional loads, scoring on those few plates on which the switch is bearing and failure of the switch to lay correctly up to the stock rail. Again since there will be lateral movement when the switch is under load, detection failures can result.

4. Examine the fit of switch and stockrail.
   If either switch does not fit correctly, look for the cause. Look for rail flow on the gauge face of the stockrail or for some obstruction between the switch and stockrail.

   A 6.1m switch with 155 heel centres should fit tightly fit tightly against the stockrail from the nose to a point 2.615m along the switch.

   If the switch is opening up, check
   ~ If studs are correct length or are damaged, and replace if necessary.
   ~ If heel block bolts are loose.

   If the Switch is not closing properly, check for:
   ~ loose switch stud bolts or studs not placed in the correct order. Studs should be properly adjusted so that each is bearing against the web of the switch in the closed position
   ~ foreign material (eg ballast, old bolts, old studs, etc sometimes gets between the stockrail and the switch). This stops the switch from closing correctly.
   ~ bad top. If the heel of a switch is at a low point on the rail, the point may rise up away from the stockrail when a train passes.
   ~ rail wear. If the gauge face of the stockrail is worn, there will be a gap between the top of the switch and the stockrail.

5. Examine the line of the open switch.
   ~ Check that the open switch does not have a narrow "belly" opening in the middle (see Figure 70).

   Figure 70 – Open Switch with narrow "belly"

6. Check for evidence of stockrail creep at switches. Look for:
   ~ Shiny marks in front of switches.
   ~ Shiny marks on rail brace plate or chairs.
   ~ Bent twisted or broken heel blocks.
   ~ Points out of square.

7. Check the switch studs and chairs along the length of the switches for soundness.
   Tap the studs and chairs with a light hammer.
   Record details of loose studs, loose or cracked chairs.
These studs (also called stop blocks) are made to fit each particular type of switch and most are made to left and to right hand patterns. It is essential you provide for the correct pattern for each item.

8. Check bolt condition in the switch area including:
   ~ Holding down bolts/spikes.
   ~ Rail brace bolts/switch stops.
   ~ Nib bolts (that hold the rail brace to the brace plate in some timbers).

Loose bolts can be seen when the washer is not fully compressed.

Tighten or report loose or missing bolts or conditions that are non-standard such as multiple washers. Both chair bolts and stud bolts are important.

Note the locations of any broken bolts and check if the holes are misaligned. Record if there is a restriction to longitudinal movement of the timber such as a point motor attached.

9. Check the fit of the stockrails on the plates.
   Record the condition as a defect if the stockrail is not supported by the plate. ie there is a gap between the stockrail and the plate.

10. Check the heel joint. Look for:
    ~ Evidence of the joint pumping. (This condition will cause the nose of the switch to lift under load and possibly derail a vehicle).
    ~ Cracked heel block.
    ~ Loose or missing heel bolts.
    ~ Fouled heel joint. Never allow overflow across a heel joint. Cut it out with rail saw, hack saw or grind it out. If left unattended it could fail the points.
    ~ Loose spikes under the heel joint.
    ~ Overtightened bolts. (This condition may make it excessively difficult to operate the point reversing lever).

In tangential turnouts:
    ~ If the heel blocks (stress transfer blocks) and their bolts are not kept tight there is a danger that there will be excessive longitudinal movement of the switch blades. In extreme cases this will result in loss of detection at the switch toes.

11. Check points operating gear for excess ballast and obstructions

At non-interlocked points

In addition to the examination of the switch condition detailed in steps 1 to 11 above:

1. Check the switch travel clearance of both switches at the nose of the switch (See Figure 71 and Figure 72).

   Measure and record the distance from the back of an open switch nose to the gauge face of the stockrail.
C23-4 Crossing and Checkrail Examination

Inspect crossings and checkrails using the following procedures.

1. Check the 'checkrail effectiveness' dimension for both the main line and turnout legs of the crossings.

Measure the distance from the 'checking face' of the checkrail to the 'gauge face' of the crossing nose at the Practical Point of the crossing. Checkrail effectiveness and gauge measurements at “V” & “K” crossings should be taken at a point just behind (nominally 150mm) the actual point of the crossing to insure that varying crossing nose shapes do not effect consistency of measurement. For “K” crossings this point may have to be further away to allow the measuring board to be square to the measurement point.

Checkrail effectiveness dimensions are critical. If the dimension is allowed to significantly narrow, it becomes likely that a wheel flange will strike the practical point of the crossing.
12. Check the gauge of both the mainline and turnout sides of crossings.

Measure and record the distance between the gauge faces of the crossing and its checkrail carrier at points 16mm below the running surfaces of the rails. (See Figure 74).

13. Visually inspect the nose of the crossing and adjacent wing rails for excessive wear. Wear is excessive when a visible 'saddle' has been worn into the crossing nose or rail flow is evident on the inside faces of wing rails or crossing nose. Record wear of crossings.

14. Measure the dip at the crossing by placing a stringline from one wing to the other over the front of the nose. Measure the dip with callipers. Record the dip measurement.

15. Measure and record flangeway clearances (R) (See Figure 74 and Figure 76) for both the main line and turnout at a point opposite the practical point of the crossing on both sides.
C23-5 **Gauge & Superelevation**

1. Set up a series of permanent inspection points on each turnout at 2m intervals, starting at a point 6m clear of the points and finishing 6m clear of the crossing.

   Mark each inspection point with white paint and give it a number. Start the numbering with station N°1 in front of the points.

   Mark the main line and crossover track at diamonds commencing with stations No.1 Main and No.1 Crossover on the Sydney end of the track work.

   This will simplify inspections and help maintenance teams locate defects.

16. Measure gauge and superelevation at each inspection point through turnouts.

   Alternatively use a turnout measuring trolley equipped with continuous recording capability to measure and record gauge and superelevation electronically.

   At crossovers, continue measurements through the connecting track for the full length of the crossover.

   Assess changes in superelevation over 14 metres.

17. Check for indications of rail play.

   Rail play is any potential movement of the rail across the tie and, in particular, movement which will make the track gauge widen under load.

   Rail play can be:
   - Where there is no plate and the tie is ‘planed’ by the rail or has a shoulder of timber raised at the outer rail flange.
   - Where the timber has been ‘planed’ by movement of a track plate.
   - Where there is movement of the rail across a plate or between fastenings.

   If rail play is observed measure and record TOTAL AMOUNT OF GAUGE WIDENING POSSIBLE.

18. Examine line through the turnout. If there are visible defects, check the line by stringlining.
C23-6 **Bearer Condition**

Examine condition of ties (bearers), fastenings and plates.

C23-6.1 **Definition of Condition**

C23-6.1.1 **Timber Bearers**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failed / missing bearers</td>
<td>Are those that are broken, missing or do not give <strong>vertical</strong> support to the rails.</td>
</tr>
<tr>
<td>Effective bearers</td>
<td>Bearer/fastening system where the required fastenings are in place and which provides <strong>vertical</strong> support and <strong>lateral</strong> restraint. Restriction must allow no lateral movement of the fastenings relative to the bearer. The bearer must provide gauge restraint and must be one piece that will not separate along its length or transversely. Timber bearers must have a flat rail plate seat. Timber Bearers may not have more than 20% loss from any part. A timber bearer that can be re-drilled will become effective again. It must have sufficient material between the rail fastenings (in the &quot;four foot&quot;) to withstand centre bound conditions.</td>
</tr>
<tr>
<td>Ineffective bearer</td>
<td>Bearer that is not effective. Timber bearers with rot or holes through which ballast can be seen are not satisfactory. At least 300 mm is required between the rail foot and bearer ends for effective tamping. (For the purposes of assessment ineffective bearers include those that are missing or failed).</td>
</tr>
</tbody>
</table>

C23-6.1.2 **Concrete Bearers**

Examine concrete bearer fastening systems for evidence of corroded or broken screwspikes

Corrosion may be found on plain (non-galvanised) screwspikes installed in older concrete turnouts. Where galvanised screwspikes have been used, no problems have been found. (See Figure 77 below)

Pay close attention to ungalvanised screwspikes, especially in areas of higher corrosion potential. eg near the sea, where coal dust is common and in wet areas.

Where any broken screwspikes are found or if corrosion is suspected, sample check other spikes by unscrewing.

Care is needed in removing the screwspikes in case they are rusted in or severely corroded, in which case they may fail.

If corrosion is found replace all the screwspikes with the galvanised type.
C23-6.1.3 Steel in-bearers

VAE steel in-bearers are designed to be installed in pairs.

The bearers are attached to the switch and stockrail with chair plates that are assembled to the bearers with insulating pads and insulating bushes on both the top and bottom of the assembly.

There are 8 plates attached to the switch assembly; two have forged horns and the other 6 have K clips that are bolted with D bolts that clamp the plates securely to the stock rails. (See Figure 78)
During turnout examination:

1. Check all bolts attaching the chair plates to the steel bearers for the correct tightness and that the insulating bushes are intact and not damaged. Torque settings for bolts are shown in Table 25.

<table>
<thead>
<tr>
<th>Bolt type connection</th>
<th>Bolt size</th>
<th>Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolts without insulation</td>
<td>M20</td>
<td>400Nm</td>
</tr>
<tr>
<td>Bolts with insulation bushes</td>
<td>M20</td>
<td>180Nm</td>
</tr>
<tr>
<td>Bolts with K Clips</td>
<td>M24</td>
<td>450Nm</td>
</tr>
<tr>
<td>Chair plate horn bolts</td>
<td>M27</td>
<td>450Nm</td>
</tr>
</tbody>
</table>

Table 25 - Torque settings for bolts

2. Check for damage to the bearers from dragging equipment or vehicle damage
3. Check that the horn chair plate is securely attached to the stock rail on both stockrails
4. Check on the ballast condition and the support for the steel in-bearers
5. Report any obvious debris inside the in-bearer and if the drain hole is blocked.

C23-7 General Condition
Check for general condition of trackwork including:

− Ballast deficiencies.
− Drainage.
− Rail wear.

C23-8 For Supplementary Patrol
Identify locations where any of the following conditions occur and record these locations as requiring Supplementary Patrol:

1. Joints with poor vertical support (flogging joint) within turnout, indicated by one or more of the following:
   − Visible evidence of poor top or twist conditions (that may be assessed as P2 or worse) affecting the joint.
   − Visible signs of formation failure affecting the joint. ie. “heaving” beyond the ends of sleepers or between sleepers.
   − “Bog Holes” affecting the joint. ie. track and ballast fouled and/or with mud actively pumping through the ballast.
   − Chipped or battered rail ends at the rail joint and/or evidence of heavy impact (extensive whitened ballast).
   − Loose bolts in joint, indicating Fish plates working loose.

2. Joints with poor lateral support within turnout ie sleepers/bearers/fastenings failed, or poor fastenings & bearers at crossing/checkrail. Indicated by bearers and sleepers not satisfying all of the following criteria:
   − Effective bearers as assessed in this examination.
   − Sleepers are well tied for at least 5 years or provide adequate vertical support.

3. Locations with heeled switches (jointed) with the following conditions:
   − Flogging heels or poor track condition in the area of the heel, as defined in 1. Above.
   − Heels damaged in other ways e.g. deformation or excessive wear in heel block.
4. Locations with K crossings on curves.

**C23-9 Action to be Taken**

1. Record all examination results on Form STW 1 for turnouts, Form STW 2 for catchpoints, or Form STW 3 and for diamonds. Where Turnout measuring trolleys are used, the print out of the trolley recording of gauge and superelevation may be used instead of the form. Attach the record to the form.

   For Single and Double Slips use Form STW 3 and Form STW 4.

2. Assess any defects found or investigated during the examination according to the "Limits and Responses" table in Section C5-12.

3. If the turnout condition meets the requirements for Supplementary Patrol, mark the entry on Form STW 1.

4. Take appropriate protective action or corrective action.

5. List the defects on Form 2 "Weekly Defect Summary Report" or transfer to Teams3 directly from Form STW 1, Form STW 2, Form STW 3 or Form STW 4.

**C23-10 Catchpoints Examination**

1. Examine the switch area as for turnouts in Section C23-3.

2. Check the condition and security of the throw-off rail and derail block.

3. The examination of clearances at catchpoints detailed in Section C19-7 may be conducted in conjunction with the examination of catchpoint condition.

4. Check the landing area for derailed trains. It should have a square even descent using ballast (See Figure 79 and Figure 80).

   ![Figure 79 – Well shaped landing area](image)

   This area of ballast should be sloped so that the grade is no steeper than 1 in 4 from level with top of sleeper to landing area
5. Record the results of the examination and take appropriate action in accordance with Section C23-8.

C23-11 Housed Points Examination

1. Carry out the switch examination in C23-3 above.
2. Check housing clearances using the housed points clearance gauge.
   ~ Check flangeway clearances on the housing checkrail, at a point 400mm in front of the nose of the switch, and at points 400mm and 2m behind the nose of the switch. (See Figure 82 and Figure 83).
Figure 82 - Check with gauge for new housing width and flange clearance

If any slack is detected when the gauge is inserted, measure and record the actual clearance.

Figure 83 - Checking flangeway clearance

Check the height of the housing above the stockrail by placing the gauge across the running surface of the stockrail and observing the height of the upper surface of the housing in relation to the gauge. (See Figure 84 and Figure 85). If the housing is found to be above the level of the gauge, measure and record the amount of additional height.

Figure 84 - Check with gauge for height of housing above rail level

Figure 85 - Checking housing height
Check the clearance between the underside of the housing and the top of the switch at various points along the length of the switch by inserting the gauge turned on its flat side between the housing and the switch. The switch must be in the open position when this check is being made. (See Figure 86 and Figure 87).

If the gauge cannot be inserted, the clearance is insufficient. Record this as a defect condition.

Figure 86 - Check with gauge for switch clearance

Figure 87 - Checking clearance between housing and top of switch

Check the flare at the leading and trailing ends of the checkrail and housing. Measure the clearance between the checking faces of the checkrail, housing and the stockrail. (See Figure 88 and Figure 89).

Record the clearance.

Figure 88 - Standard housing
3. Check for obvious problems on and around the housing, including:
   ~ Loose or broken bolts
   ~ Loose studs.
   ~ Loose fastenings on the stockrail chairs.
   ~ Damaged switch noses, etc.
4. Record the results of the examination and take appropriate action in accordance with Section C23-8.

C23-12 Switch Examination Olympic Park

For the tangential turnouts at Olympic Park (and at other nominated locations) where the main line route has been bent to a sharp curve special inspection arrangements are to be implemented as indicted below.

C23-12.1 Switch Surface Damage

1. Inspect the high rail switch.
2. Check for spalling or chipping of the switch in the area from the tip to a point 2m from the tip.
3. Assess any spalling or chipping found against the following limits
   Damage in the first 2m from the tip of the switch blade, deeper than 17mm from the running surface and which extends more than 100mm along the blade, or consecutive areas of damage less than 100mm apart forming a length more than 100mm.
   Damage in the first 2m from the tip of the switch blade, deeper than 19mm from the running surface
4. Report defects immediately to the Civil Maintenance Engineer.

C23-12.2 Wear Angle Limit

1. Take electronic profiles of the switch fitted against the stockrail at the following distances from the switch tip:
   ~ 30mm, 300mm, 600mm, 900mm, 1200mm, 1500mm, 1800mm and 2100mm
2. Assess the profiles taken to determine the level of wear and compliance with the following limits:
No part of the running surface of the switch blade, between 17mm and 30mm from the head of the rail, is to form a plane at an angle < 40° to the horizontal (see Figure 90).

![Figure 90 - Rail Wear angle](image)

3. Report defects immediately to the Civil Maintenance Engineer.

**C23-13 Expansion Switch Examination**

1. Check and record the gauge at the expansion switch. Measure the gauge at 2 metre intervals commencing 6m in front of the expansion switch tips and ending 8m past the switch tips. The gauge should not be more than 6mm tight or wide.

2. Check the running face condition of the switch rail, including tip profile and wear angle of the switch rail relative to the stockrail using the method detailed in Section C23-3. Repair or replace switch rail and stock rail if required.

3. Look for rail flow on the gauge face of the stockrail or obstruction between the switch and stockrail.

4. Examine switch area for condition of stockrails

5. Examine for evidence of switch rail movement relative to the stock rail.

   The switch should move with changes in temperature. If there is no evidence of movement, determine cause of binding and repair.

6. Check that the Neutral position is midway between the two transoms and that both the switch tip and stock rail punch mark adopt the Neutral position when allowance is made for ambient temperature using the design information supplied for that location. (See Figure 92).

   If the stock rail punch mark varies from the correct Neutral position by more than 50mm or the switch tip position relative to the stock rail punch mark varies by more than 50mm after allowance for temperature, adjust the rail/s to relocate the switch rail point and stock rail punch mark into the correct Neutral position.

Where VAE Expansion switches are installed, undertake the following additional examination tasks. Refer to Figure 91 for general description.

7. Check each base plate for loose, broken or missing screw spikes.

   Report loose, broken or missing screw spikes to the Team Manager for investigation and repair or replace as required.
8. Examine for loose or broken D bolts along length of switch rail. (See Figure 93)
   Report loose or broken D bolt assemblies to the Team Manager for investigation and
   repair or replace as required.
9. Check the wear between the switch rail foot and the D bolt assembly.
   If the gap between switch rail foot and D bolt assembly is more than 3mm, then
   replace D bolt assemblies and / or switch rail.
10. Check each base plate for IBAV spring pins that are working loose. (See Figure 93)
    Report loose or missing IBAV spring pins to the Team Manager for investigation and
    repair or replace as required.
11. Examine for evidence of loose or broken safety roller assembly bolts. (See Figure
    94)
    Report loose or broken safety roller assembly bolts to the Team Manager for
    investigation and repair or replace as required.
12. Check the safety roller spring tension / adjustment and adjust if required. 
    The distance from the switch rail foot to the safety roller spring is to be between 5
    and 7mm.
    If worn or seized, replace safety roller assembly.
14. Examine safety rollers for evidence of corroded or broken rollers springs.
    If corroded or broken, replace all safety roller assemblies in expansion switch.
15. Lubricate the interface between the D bolt assembly and switch rail foot with railway
    switch point lubricant (ROCOL BIO-SPL) or equivalent dry film lubricant.
16. Check the change in level between top of consecutive transoms, measured next to
    the base plates along the Up rail. Repeat for the Down rail.
    If the change in level is greater than 3mm replace and shim transoms where
    required, ensuring the level between transoms is within ±2mm.
17. Visually examine the base plates and IBAV spring plates for fractures in the plates
    and welds.
    Report cracked or broken plates and welds to Team Manager.
18. Record the following information on Form STW 5:
    ~ Tip Condition
    ~ Switch Angle
    ~ Opening
    ~ Bolt tightness
    ~ Condition of ties
    ~ Condition of plates, bolts, screwspikes and fastening assemblies
    ~ Condition of safety roller assemblies (if fitted)
19. Take appropriate action in accordance with Section C23-9.
location of Safety roller
switch tip
switch rail
D bolt
base plate
IBAV spring plate
failed D bolt assembly
base plate
screw spike

Figure 91 – VAE Expansion switches

Figure 92 – Neutral position
C23-14  Switch Lever Examination

1. Check the tension of the switch operating lever on both switches of manually controlled points (Thornley levers, ball levers, throw-over levers). (See Figure 95 and Figure 96).

   Insert a 400mm bar between the stockrail and switch at a point just beyond separation of the switch and stockrail. Lever the bar against the switch in an attempt to prize it open. Make a judgment on how easy or difficult it is to open.
If the switch opens easily there will be insufficient tension available to keep the switch closed under traffic

2. Compare the result with the limits in Section C5-15.
3. Take appropriate action in accordance with Section C23-9.

![Figure 95 - Checking Spring Lever Tension](image)

![Figure 96 - Checking Spring Lever Tension](image)

**C23-15 Diamond Examination**

2. Measure all side and diagonal dimensions when the examination of crossings reveals potential problems with the geometry of the diamond. Compare the measurements with design tolerances.
3. Check the alignment of the 'V' assembly checking face and checking wingrail face with a stringline or straightedge.
   'K' Crossings have running AND checking surfaces.
4. Examine any insulated joints in the fully checked area of the diamond.

Check that the chock between the rails has not worn through the end post. If there is external evidence of wear, such as squeezed end post, worn or bent bolts, loose plates or loose bolts the joint should be pull the joint apart to check the condition of the end post.
5. Record the results of the examination on Form STW 3 and take appropriate action in accordance with Section C23-9.
Running Rail

Check Rail

Failed End Post not visible from above

Fishplate

Chock

Curved end of Chock wears End Post Insulator

End Post worn by chocks on either side

Running Rail

Chock

Check Rail

Figure 98 - Example of a Failed Insulated Joint in a fully checked Diamond

C23-16 Single and Double Slip Examination

Slips are a combination of switches and stockrails, and diamond crossings.


2. Examine the switch components and turnout rails not included in the diamond examination using the procedures in Sections C23-3 and C23-5. The components are numbered in accordance with the convention in Figure 99.

3. Take gauge and superelevation measurements from 6m in front of S1 and S2 points to 6m past the front of S3 and S4 points. (Mark S3 and S4 Point location on the form). For Double slips also take gauge and superelevation measurements from 6m in front of S5 and S6 points to 6m past the front of S7 and S8 points. (Mark S7 and S8 Point location on the form). Main line measurements are not required because they have been measured and recorded in the diamond examination.

4. Record the results of the diamond examination on Form STW 3 and the remainder of the slip examination on Form STW 4 and take appropriate action in accordance
C23-17 Swingnose Crossing Inspections

Follow the procedures detailed in C23-4 and C23-5.

Additional inspection procedures for the swingnose crossing are detailed as follows. Photos of the PRE and VAE swingnose crossings with explanatory notes is provided in Figure 100 and Figure 101.

Note: When Level 1 and 2 inspections are undertaken, signalling staff are required to be on hand to operate the swing nose in reverse and normal positions and to check adjustments.

C23-17.1 During Level 1 Examinations:

C23-17.1.1 For PRE Installations

1. Check bearing of crossing nose rails on plates.
   The two crossing nose rails (the point rail and tongue rail) bear on the crossing plates. If there is clearance between the crossing plate and the rails, the geometry needs to be adjusted.

2. Check fastening condition.
   The majority of fastenings are huck bolts. If they are loose or broken they should be replaced.
3. Check fit of rail stops.

Rail stops are attached to the wing rails for the length of the point rail and tongue rails. There should be no clearance between the web of the point rail and tongue rail and the rail stops when the swing nose is operated in the normal and the reverse positions. If clearance exists between the rail web and rail stops the cause should be investigated and corrected.

4. Check crossing for wear.

Although there is no crossing throat as in standard turnouts, there is still a discontinuity at the transition point between the wing rail and the point rail where wheel transfer occurs. Wear will occur on the point rail and wing rail at this point.

Place a 1 metre straight edge along the rail with the centre at the tip of the point rail. Move the straight edge around the gauge corner to the gauge point, checking 3 or 4 times. If the surface is smooth and nothing sticks up or out, then the wear is satisfactory. If wear is unsatisfactory, build up the worn running faces or replace the wing rail and point rail.

If it doesn't trip the gauge face angle gauge on the track supervisors' board you don't have any more of a problem than with open track.

5. Check rail head wear and gauge face angle on the point rail, tongue rail, splice rail, wing rail, closure rail and stock rail in accordance with the requirements for plain track in Chapter 14. Look for abnormal rail wear patterns.

C23-17.1.2 For VAE Installations

1. Check bearing of crossing nose rails on plates

The two crossing nose rails (the point rail and splice rail) bear on the switch plates. If there is clearance between the switch plates and the rails, the geometry needs to be adjusted.

2. Check fastening condition.

The majority of fastenings are bolts and nuts. If they are loose or broken they should be tightened or replaced.

Wing rail, point rail and splice rail K clips and wing rail braces are fastened to the crossing frame with T-bolts, nuts and double helix spring washers that may break or become loose.

Wing rail braces are fastened to the wing rail with countersunk bolts that may shear off or become loose.

3. Check fit of rail stops.

Rail stops are attached to the crossing frame for the length of the point rail and splice rails. There should be no excessive clearance between the web of the point rail and splice rail and the rail stops when the swing nose is operated in the normal and the reverse positions. If clearance exists between the rail web and rail stops the cause should be investigated and corrected. This may include adjustment of the crossing frame rail stops and point rail / splice rail stops.

4. Check crossing for wear.

Although there is no crossing throat as in standard turnouts, there is still a discontinuity at the transition point between the wing rail and the point rail where wheel transfer occurs. Wear will occur on the point rail and wing rail at this point.

Place a 1 metre straight edge along the rail with the centre at the tip of the point rail. Move the straight edge around the gauge corner to the gauge point, checking 3 or 4 times. If the surface is smooth and nothing sticks up or out, then the wear is satisfactory. If wear is unsatisfactory, build up the worn running faces or replace the wing rail and point rail.
If it doesn't trip the gauge face angle gauge on the track supervisors board you don't have any more of a problem than with open track.

5. Check rail head wear and gauge face angle on the point rail, splice rail, wing rail, closure rail and stock rail in accordance with the requirements for plain track in Chapter 14. Look for abnormal rail wear patterns.

C23-17.1.3 Common
1. Examine for ballast accumulation around swing nose. Remove excessive ballast.
2. Examine for obstructions or build up of material between the point and the wing rails.
3. Examine for Rolling contact fatigue defects (surface checking / cracks, spalls, scale or squats).
4. Check for any cracking which may indicate a section of the nose or wing could break out.
5. Record the results of the examination on Form STW 6 and take appropriate action in accordance with Section C23-8.

C23-17.2 During Level 2 Detailed Examinations:

C23-17.2.1 For PRE Installations
1. Check fastening condition.
   The crossing frame is attached to be concrete bearers with screw spikes. As with standard turnouts these may become loose or break. The double helix spring washers are not effective if they are not fully compressed. Replace loose or broken screw spikes and double helix spring washer assemblies.
2. Check in the following locations for evidence of loose or broken huck bolts:
   ~ Crossing plate rail brace to rail stop, wing rail A, B and F chocks, point rail fabricated heel block, wing rail/splice rail C and D heel blocks.
   If they are loose or broken they should be replaced.
3. Examine crossing plates and rail brace brackets for evidence of cracking.
   The crossing plates are subject to stresses at the rail seats under the swing nose as are the rail brace bracket welds. Report cracking for repair or replacement of the crossing assembly.

C23-17.2.2 For VAE Installations
1. Check the point rail/splice rail connection.
   The point rail/splice rail connection is a sliding joint. Check the joint for security as follows:
   ~ Check that the opening at the tip of the splice rail is \(\leq 2\text{mm}\)
   ~ Bolts, castellated nut, dished washer and disc spring are fitted and tight.
   ~ Split pins are inserted in the castellated nuts. Replace the split pin if it has worn 25% through.
   ~ Clearance of sliding joint has altered, indicating loss of pre-load of the joint fasteners. Replace sliding joint disc springs (dished washers) if required and tighten.
   Additional security is provided at the point rail/splice rail connection by a safety clamp. Examine the safety clamp for loose or broken fastenings. Replace loose or broken bolts, nuts and washers and tighten.
2. Check the heel block / anti creep block for evidence of loose or broken huck bolts:
   Examine for evidence of loose rail stop brackets (point rail / splice rail to crossing frame). Check the rail stop brackets for damage and replace if required. Replace rail stop bracket bolt, nut and spring washer and tighten.

3. Examine for evidence of loose switch stops (splice rail to point rail). Check the switch stops for damage and replace if required. Tighten loose switch stop fasteners and fit new split pins if required.

4. Check the crossing frame and anti-creep brackets for evidence of cracking.
   The crossing frame is subject to stresses in the webs, rail seats (switch plates) and other loaded sections. These locations should be visually examined for evidence of cracking. Report fractures for repair or replacement of the crossing assembly.
   Visually examine anti-creep brackets for evidence of fractures.

C23-17.2.3 Common

1. Check bearer condition.
   Examine crossing bearers and ties for evidence of degradation. Replace damaged bearers and ties.

2. Check geometry.
   Swing Nose crossings are particularly sensitive to variations in surface geometry and line. Special care needs to be taken in the measurement and assessment of top and line.

3. Check wing rail / point rail gauge face for wear.
   Check for rail head overflow greater than 1mm adjacent to the point rail. This could stop the nose closing properly. Remove if overflow is greater than 1mm. Ensure that swing nose detection and locking is adjusted prior to return of the crossing to traffic.

4. Check rail head wear and gauge face angle on the point rail, tongue rail, splice rail, wing rail, closure rail and stock rail in accordance with the requirements for plain track in Chapter 14. Look for look for excessive rail wear.

5. Check the profile of the front of the swingnose with a switch nose profile gauge using the procedure in Section C23-3.

6. Check that the swing nose locates against the switch stops in the forward and reverse positions. Replace worn switch stops.

7. Record the results of the examination Form STW 6 on and take appropriate action in accordance with Section C23-8.
Figure 100 - PRE Swing Nose Crossing
Figure 101 - VAE Swing Nose Crossing
C23-18 Special Tangential Turnout Examination Requirements

C23-18.1 PRE Turnouts

C23-18.1.1 Switches

1. Check for Broken slide baseplates.
   Broken baseplate jaws indicate that voids are present under the bearers.
   Broken slide tables indicate either that the bearers are becoming indented or that the baseplate was incorrectly seated at the time it was secured to the bearer.

2. Examine Switch soleplates on timber sleepers.
   Slide baseplate end stops that become detached from the soleplate must be replaced.
   Slide baseplate end stops which become worn because the baseplate(s) are not securely held down cannot easily be repaired. Arrange to replace the complete soleplate and the supporting bearer.
   Soleplate insulation fittings which are damaged must be replaced.

C23-18.2 TKL Turnouts

C23-18.2.1 Switches

TKL Rail uses the “Schwihag System” of inner stockrail bracing clips and special elevated side tables.

Make sure all clip legs are fitted to their corresponding thrust abutments.

Slide plates should be lubricated regularly or when the slide surfaces of the tables show signs of bright metallic streaks or rust.

C23-18.2.2 Crossings

Built up frogs Should be visually inspected for signs of excess wear or flow of the nose or wing-rails.

C23-18.3 VAE Turnouts

C23-18.3.1 Switches

1. Check lubrication of chairs and operation of switch.
2. Check pins and keys of the inside fastening system for damage or breakage.
3. Check for any broken Pandrol clips especially around the heel area of the switch.
4. Check connecting rods and fittings to switch.
5. Inspect switch blade for wear. Grind off metal overflow if necessary.
6. Check switch stop bolts.

C23-18.3.2 Crossings

1. Check crossing for running condition, any signs of loose Huck bolts.
2. Check nose and wingrails for metal flow, grind if required.
3. Check plating for any broken Pandrol dips.
C23-18.3.3 Guardrails

1. Check the gauge between guardrail to crossing in two (2) places:
   ~ One just behind nose of crossing.
   ~ Two just past knee of wingrail.
   Adjust if required by inserting shims provided.

2. Check bolts and Pandrol dips on the guardrails and plating.

C23-18.3.4 General Requirements

1. Check turnout for loose bolts and any Pandrol clips that have broken.
2. Check line and top of turnout.
3. Check cross level throughout turnout but especially at the crossing.
4. Check insulating bush assemblies for damage.
Chapter 24 Drainage Examination

This chapter details the procedures for drainage examination as part of the Track Examination System.

In this context, drainage is defined as:
- The surface flow of water away from the track structure and cess.
- Top and side drains along the railway reserve to direct water away from the rail track formation to recognised water courses.
- Pipes installed expressly to collect water from between or beside tracks and direct it away to a recognised side drain or water course.
- Waterways constructed under the track, whether pipes, culverts, or similar.

Without regular inspections and routine maintenance of drains, they may eventually become blocked with either sediment, debris or weed growth. If drains are allowed to become blocked or damaged they will fail in their function of draining the formation. They may even make matters worse, as water standing or ponding in parts of the drainage system may seep into the formation, via pipe slots or through the base of drainage trenches. This may lead to softening and loss of firm support for the track.

C24-1 Examination Requirements

Detailed inspections of all the components of drainage systems are best carried out prior to the wettest period of the year.

Study available plans and records to establish what drainage was actually installed. If no records exist the following assumptions should be made (i.e. the types of drainage that should be encountered in various locations):
- Cuttings; cess drains, catch drains on the high side of the cutting and mitre drains at regular intervals. In newer or recently upgraded cuttings subsoil drains may be found.
- Embankments; graded shoulders and catch drains.
- Platforms; subsurface type drains in the six foot and/or along the edge of the platform base.
- Turnouts; graded shoulders, cess and/or subsurface drains.
- Tunnels; open drains along the sides or centre drains. In newer or recently upgraded tunnels there may be either centre or side subsurface drains.
- Bridges; weep holes in abutments, and in ballast top bridges there may be weep holes in the parapet wall and/or subsurface drains.
- Other track location; graded shoulders.

C24-2 Examination Procedure

1. Examine general track area. Look for:
   - Bog holes, heaves and slips.
   - Foul ballast, mud pumping and its severity i.e. mud around the sleeper ends or mud volcanos.
   - Poor track alignment (line) and level (top) at locations where foul ballast or mud pumping exists.
   - Erosion or slipping of cutting or embankment faces or evidence of track formation failure.
2. Examine all surface drains. Look for:
   ~ Water ponding in drains or near the track or at the base of cuttings and embankments.
   ~ Erosion of drainage channels, inlets or outlets.
   ~ Blocked drains due to weed growth, debris from track maintenance (old sleepers and rails) and or sediment build-up.
3. Examine each sump or pit of a drainage system. Look for:
   ~ Blocked sumps, grates and/or covers. Is it working or is it filled with silt or rubbish?
   ~ The amount of sediment in silt traps.
   ~ Broken pipes or sumps.
   ~ Missing sump covers or grates as well as covers and grates not correctly replaced after track maintenance work.
4. Examine all waterways. Look for:
   ~ condition of each waterway. Is the inlet clean? Is the invert clear of sediment, debris and weed growth?
   ~ the physical condition of each structure, pipe etc. This can only be checked by looking through the pipe etc. Has it changed since the last inspection?
5. Record the condition of each drain or asset whether satisfactory or unsatisfactory and the occurrence and extent of any of the above defects.
6. Note the location and type of drain being inspected.
7. Note any work required to restore the drainage to a satisfactory condition.
8. Record any other works required as a result of drainage.
   e.g. slipping of cutting or embankment faces, track formation failure, failure of structures adjacent to the track.

C24-3 Action to be Taken
1. Record all examination results on Form Drain 1 “Examination of Drainage.”
19. Assess any defects found or investigated during the examination in accordance with Section C24-4.
20. Take appropriate protective action or corrective action.
21. List the defects on Form 2 "Weekly Defect Summary Report" or transfer to Teams3 directly from Form Drain 1.

C24-4 Assessment of Condition
1. Assess whether the drain being inspected is satisfactory or unsatisfactory.
   If a drain does not appear to be blocked and seems to be transporting water adequately (i.e. there is no water ponding or evidence of water ponding) the drain is satisfactory.
   If the drain is blocked with sediment, debris, or weed growth to such an extent that water is unable to flow through the drain, it is unsatisfactory.
   ~ Clear any drain considered to be blocked > 50%.
   ~ Clear any waterway opening greater than 300mm such as pipes, culverts etc including underbridges where siltage or blockage > 25%.
22. If the drain is unsatisfactory note why this is so.
23. In order to establish to what extent the condition of the existing drainage system is affecting the track formation and/or its supporting earth structures (e.g. cuttings and embankments), it may be necessary to examine track recording data to establish whether there has been any repeated problems for top and line in areas corresponding with poor drainage. If so this may suggest the likelihood of more severe problems in the future if the drainage system is not repaired.

24. Areas may be ranked according to the effect they have on the surrounding track formation or surrounding earth structures.

25. For example the following situations are listed in order of decreasing importance:
   ~ Bog holes, heaves (i.e. severe formation failures).
   ~ Slips and slumping of slopes (saturation of slopes).
   ~ Mud pumping up through ballast, top and line problems.
   ~ Foul ballast plus top and line problems.
   ~ Water ponding alongside track or at the base of earth structures.
   ~ Erosion of cutting face (i.e. ineffective catch drains).
   ~ Minor blockages and sediment build-up.
   ~ Rubbish lying in drains.
Chapter 25  Track Inspections by CME and Team Manager

Civil Maintenance Engineers and Team Managers carry out track inspections for the following purposes:

1. To ensure that track defects and irregularities are observed and rectified quickly, efficiently and economically, to maintain the tracks in a safe condition for the passage of trains. This includes the inspection of temporary supports for bridges.

26. To collect information for the preparation of the following programs in the area:
   ~ Resurfacing program.
   ~ Rerailing and resleepering program.
   ~ Turnout renewal program.
   ~ Ballast program.
   ~ Ballast re-conditioning program.
   ~ Cutting and embankment improvement program.
   ~ Vegetation management program.

27. To collect information and plan the work routine for each of the teams on the area, and for the issuing of the necessary instructions to carry out the work.

28. To observe and check whether the planned routine given to team leaders is being carried out - checking the productivity of the staff.

29. To gather information and plan the supply of stores and equipment.

30. To inspect tools and plan their adequate use and supply.

31. To observe work methods of team leaders and to instruct them in the correct methods of working to meet the demands of efficiency, economy and safety.

32. To discuss work problems and problems involving human relations with the staff.

33. To plan and check the work of mechanical equipment, to see that machines are being used correctly and efficiently, and that they are adequately maintained. To see that fuel, oil and spare parts are being maintained.

34. To ensure that the quality of the trackwork carried out by renewals teams is up to the required standard.

35. To check that the various administrative functions for which team leaders are responsible are being correctly carried out.

36. To see that good housekeeping habits are being practiced.
Chapter 26  Records

In all cases, inspection personnel are to report the results of preventive maintenance examinations to their Civil Maintenance Engineer or other nominated officer (where applicable).

Details required are:

− Date service or examination was carried out.
− Name of the person performing the service or examination.
− Asset identification which will include Equipment Description, Line Section, Track and kilometrage.
− Details of any new defects or previously recorded defects that have deteriorated further including:
  ∼ nature of defect
  ∼ size
  ∼ location
  ∼ assessment of condition
  ∼ any action taken

Detailed reports are to be compiled in approved formats and retained.

All records of the Track Examination System (including all completed examination forms and reports of defects on Weekly Report forms) must be retained on site for a minimum of three (3) years for audit purposes. Note that there are separate requirements for longer term retention and archiving of inspection records specified by the State Records Act of 1998.
### Appendix 1  Examination forms

<table>
<thead>
<tr>
<th>Form No.</th>
<th>Form Name</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form 2</td>
<td>Examination of Length</td>
<td>232</td>
</tr>
<tr>
<td>Form 2</td>
<td>Weekly Defect Summary Report</td>
<td>232</td>
</tr>
<tr>
<td>Form WTSA 1</td>
<td>WTSA Manual Analysis Input</td>
<td>233</td>
</tr>
<tr>
<td>Form WTSA 2</td>
<td>WTSA CWR Field Sheet</td>
<td>235</td>
</tr>
<tr>
<td>Form WTSA 3</td>
<td>WTSA Manual Analysis</td>
<td>236</td>
</tr>
<tr>
<td>Form WTSA 4</td>
<td>WTSA Weekly Report</td>
<td>237</td>
</tr>
<tr>
<td>Form Rail 1</td>
<td>Inspection of Rail Wear</td>
<td>238</td>
</tr>
<tr>
<td>Form Rail 2</td>
<td>Examination of Rail Corrosion</td>
<td>239</td>
</tr>
<tr>
<td>Form Rail 3</td>
<td>Inspection of insulated joints</td>
<td>240</td>
</tr>
<tr>
<td>Form Rail 4</td>
<td>Inspection of Rail Lubricators</td>
<td>241</td>
</tr>
<tr>
<td>Form Clear 1</td>
<td>Clearance Examination</td>
<td>243</td>
</tr>
<tr>
<td>Form Clear 2</td>
<td>Inspection of Track Centres</td>
<td>244</td>
</tr>
<tr>
<td>Form LX 1</td>
<td>Level Crossing Examination</td>
<td>245</td>
</tr>
<tr>
<td>Form Drain 1</td>
<td>Examination of Drainage</td>
<td>246</td>
</tr>
<tr>
<td>Form STW 1</td>
<td>Turnout Examination</td>
<td>247</td>
</tr>
<tr>
<td>Form STW 2</td>
<td>Catchpoint Examination</td>
<td>249</td>
</tr>
<tr>
<td>Form STW 3</td>
<td>Diamond Examination</td>
<td>250</td>
</tr>
<tr>
<td>Form STW 4</td>
<td>Slip Examination</td>
<td>251</td>
</tr>
<tr>
<td>Form STW 5</td>
<td>Expansion Switch Examination</td>
<td>252</td>
</tr>
<tr>
<td>Form STW 6</td>
<td>Turnout Inspection - Swingnose Crossing</td>
<td>253</td>
</tr>
</tbody>
</table>
# Examination of Length

**Form 1**

<table>
<thead>
<tr>
<th>Date</th>
<th>Track examined</th>
<th>Track</th>
<th>Up/ Down</th>
<th>Examination type</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>From</td>
<td>To</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**WEEK ENDING:** ..................................  
**LENGTH:** ........................................

**Other examinations completed during week (e.g. Turnouts etc.)**

---

**For Detail Walking and Sleeper Inspections – Do any track sections require Supplementary Patrol?**

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
</table>

**If YES, which Sections?**

---

My signature in the right hand column confirms that the above length has been examined as stated, to the best of our ability in accordance with RailCorp requirements. At any location where defects were found, appropriate corrective action has been taken or necessary protection applied. The defects have been entered in Teams3 (or recorded on the Weekly Defect Summary Report).
## Weekly Defect Summary Report

**WEEK ENDING:** ………… **NAME:** ………… **SIGNATURE:** ………… **POSITION:** …………

- **How found:** FP Foot Patrol. EP Engine Patrol. HP High Rail Patrol. MTP Mechanised Track Patrol. DW Detailed Walk

<table>
<thead>
<tr>
<th>Date</th>
<th>Defect Type</th>
<th>KM</th>
<th>Track</th>
<th>Priority</th>
<th>Size</th>
<th>How Found</th>
<th>Details of Work required or completed &amp; Other Comments</th>
<th>Who Found initial</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

© Rail Corporation
Issued April 2013

UNCONTROLLED WHEN PRINTED
**WTSA Manual Analysis Input**

**Form WTSA 1**

### Rail Adjustment Inspection:

<table>
<thead>
<tr>
<th>Km</th>
<th>Name/Signature</th>
<th>Date</th>
<th>Up Rail</th>
<th>Down Rail</th>
<th>Alignment</th>
<th>Combined Stability Loss %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Creep (CWR)</td>
<td>Gaps (LWR)</td>
<td>LINE:</td>
<td>Gaps (LWR)</td>
<td>Creep (CWR)</td>
<td>Error in direction of arrow</td>
</tr>
<tr>
<td>Creep</td>
<td>Analysis</td>
<td>Temp</td>
<td>Analysis</td>
<td>Gap</td>
<td>TRACK:</td>
<td>Gap</td>
</tr>
<tr>
<td>Tangent Creep</td>
<td>Av Rail Length</td>
<td>Av Rail Length</td>
<td>Tangent Creep</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tangent Temp Error</td>
<td>Av. Rail Gap</td>
<td>Av. Rail Gap</td>
<td>Tangent Temp Error</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Rail Temp Error</td>
<td>Rail Temp Error</td>
<td>Rail Temp Error</td>
<td>Total Rail Temp Error</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss of Stability</td>
<td>Loss of Stability</td>
<td>Loss of Stability</td>
<td>Loss of Stability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tangent Creep</td>
<td>Av Rail Length</td>
<td>Av Rail Length</td>
<td>Tangent Creep</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tangent Temp Error</td>
<td>Av. Rail Gap</td>
<td>Av. Rail Gap</td>
<td>Tangent Temp Error</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Rail Temp Error</td>
<td>Rail Temp Error</td>
<td>Rail Temp Error</td>
<td>Total Rail Temp Error</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss of Stability</td>
<td>Loss of Stability</td>
<td>Loss of Stability</td>
<td>Loss of Stability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tangent Creep</td>
<td>Av Rail Length</td>
<td>Av Rail Length</td>
<td>Tangent Creep</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tangent Temp Error</td>
<td>Av. Rail Gap</td>
<td>Av. Rail Gap</td>
<td>Tangent Temp Error</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Rail Temp Error</td>
<td>Rail Temp Error</td>
<td>Rail Temp Error</td>
<td>Total Rail Temp Error</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss of Stability</td>
<td>Loss of Stability</td>
<td>Loss of Stability</td>
<td>Loss of Stability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tangent Creep</td>
<td>Av Rail Length</td>
<td>Av Rail Length</td>
<td>Tangent Creep</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tangent Temp Error</td>
<td>Av. Rail Gap</td>
<td>Av. Rail Gap</td>
<td>Tangent Temp Error</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Rail Temp Error</td>
<td>Rail Temp Error</td>
<td>Rail Temp Error</td>
<td>Total Rail Temp Error</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss of Stability</td>
<td>Loss of Stability</td>
<td>Loss of Stability</td>
<td>Loss of Stability</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

© Rail Corporation
Issued April 2013

UNCONTROLLED WHEN PRINTED

Page 233 of 253
Version 5.3
## WTSA Manual Analysis Input

### Ballast Inspection

<table>
<thead>
<tr>
<th>KM</th>
<th>Ballast profile</th>
<th>Order details</th>
<th>Line:</th>
<th>Anchor analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shoulders t/20m</td>
<td>Cribst/20m</td>
<td>Total</td>
<td>Date Ordered</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Anchors Inspection

Examiners Name/Signature: ........................ Date: ....................

Examiners Name/Signature: ........................ Date: ........................
## WTSA CWR Field Sheet

**Form WTSA 2**

### Description

<table>
<thead>
<tr>
<th>Description</th>
<th>Basecode</th>
<th>Measured by</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>KM Identification</td>
<td>2012 Up Rail Creep</td>
<td>2012 Dn Rail Creep</td>
<td>Align Design</td>
<td>Align Revised</td>
</tr>
</tbody>
</table>

###errors

### Notes

- **IA**: Ineffective Anchors
- **FB**: Foul Ballast
- **PJ**: Pumping Joints
- **RB**: Rail Bunching
- **SA**: Sharp Alignment
- **RC**: Rail Corrugation
- **BR**: Round Ballast

---

© Rail Corporation  
Issued April 2013  
Version 5.3  
Page 235 of 253  
UNCONTROLLED WHEN PRINTED
## WTSA Manual Analysis

Form WTSA 3

<table>
<thead>
<tr>
<th>Km</th>
<th>Track Disturbance</th>
<th>Ballast</th>
<th>Anchor</th>
<th>Rail Adjustment</th>
<th>Track Condition</th>
<th>Loss of Stability Assessment</th>
<th>Action Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Activity</td>
<td>Result</td>
<td>Result</td>
<td>Creep Result</td>
<td>Gap Result</td>
<td>Creep Result</td>
<td>Gap Result</td>
</tr>
</tbody>
</table>

| Team Manager Name/Signature | ____________________ | Date ____________________ |
|-----------------------------|------------------------|

| Team Leader Name/Signature | ____________________ | Date ____________________ |
|---------------------------|------------------------|

© Rail Corporation
Issued April 2013

UNCONTROLLED WHEN PRINTED

Page 236 of 253
Version 5.3
# W.T.S.A Weekly Report

**Form WTSA 4**

<table>
<thead>
<tr>
<th>Area</th>
<th>Week Ending</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>TRACK SECTION</th>
<th>TOTAL TRACK (km)</th>
<th>MEASUREMENT</th>
<th>ANALYSIS</th>
<th>CORRECTION OF No.1 PRIORITY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Outstanding (km)</td>
<td>Planned Completion Date</td>
<td>Complete (%)</td>
<td>Planned Completion Date</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| TOTALS        |                  |              |           |                             |                            |                          |              |                            |
## Inspection of Rail Wear

**Form Rail 1**

<table>
<thead>
<tr>
<th>Kilometrage</th>
<th>Down Rail</th>
<th>Up Rail</th>
<th>Kilometrage from to</th>
<th>Wear angle</th>
<th>Head width</th>
<th>Head depth</th>
<th>Rail section</th>
<th>Date rolled</th>
<th>Rail Condition</th>
<th>Date of inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Examination of Rail Corrosion

**Form Rail 2**

<table>
<thead>
<tr>
<th>Track</th>
<th>Rail UP/DOWN</th>
<th>Length</th>
<th>Examiners Name/signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tunnel</td>
<td>Portals - from</td>
<td>Km to Km</td>
<td>Date examined</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>KM section</th>
<th>Head Height &quot;A&quot;</th>
<th>Head Width &quot;B&quot;</th>
<th>Web Thickness &quot;E&quot;</th>
<th>Foot Thickness &quot;F&quot;</th>
<th>Foot Width &quot;G&quot;</th>
<th>Fastening condition</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Examination of Rail Corrosion**

© Rail Corporation

Issued April 2013

UNCONTROLLED WHEN PRINTED
### Inspection of Insulated Joints

**Form Rail 3**

<table>
<thead>
<tr>
<th>Kilometrage</th>
<th>Track</th>
<th>Rail</th>
<th>Glue</th>
<th>Mechanical</th>
<th>Benkler</th>
<th>OK</th>
<th>NOT OK</th>
<th>Details of Faults</th>
<th>Supplementary Patrol Required</th>
<th>Date Inspected</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Examination of Rail Lubricators / TORFMA

**Form Rail 4**

<table>
<thead>
<tr>
<th>Kilometrage</th>
<th>Track</th>
<th>Rail</th>
<th>Lubricator Type</th>
<th>Visible Damage</th>
<th>If Yes – damage description</th>
<th>Function check – Correct operation (Y/N)</th>
<th>GFL Only Ports Operational</th>
<th>Date of inspection &amp;/or filling</th>
<th>Reservoir was</th>
<th>Date repairs carried out</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Lubrication Inspection Sheet

**Form Rail 5**

<table>
<thead>
<tr>
<th>Kilometrage</th>
<th>Track</th>
<th>Location on Rail</th>
<th>DOWN Rail</th>
<th>UP Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Finger Print</td>
<td>Wet</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Running surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gauge Corner</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gauge Face</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Running surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gauge Corner</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gauge Face</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Running surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gauge Corner</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gauge Face</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Running surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gauge Corner</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gauge Face</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Running surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gauge Corner</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gauge Face</td>
<td></td>
</tr>
</tbody>
</table>
## Clearance Examination

<table>
<thead>
<tr>
<th>Kilometrage</th>
<th>Horizontal clearance to structure</th>
<th>Vertical clearance to structure</th>
<th>Superelevation</th>
<th>Clearance to edge of platform coping</th>
<th>Clearance to protrusions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Design Actual Variation</td>
<td>Design Actual Variation</td>
<td>Design Actual Variation</td>
<td>Direction of super (Actual) Horizontal Vertical Horizontal Vertical</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Track needs aligning</td>
<td>To plaque Away from plaque</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Inspection of Track Centres

### Form Clear 2

<table>
<thead>
<tr>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Examiner’s Name/signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
</tr>
</tbody>
</table>

### Tracks Measured:

<table>
<thead>
<tr>
<th>Kilometrage</th>
<th>Track centres</th>
<th>TRACK “A”</th>
<th>Track layout</th>
<th>TRACK “B”</th>
<th>Total of Super Variation (A &amp; C)</th>
<th>Difference in Track Centre due to Superelevation (D x 3)</th>
<th>Total Track Centre Variation (E + B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>Actual</td>
<td>Variation</td>
<td>Design</td>
<td>Actual</td>
<td>Variation</td>
<td>Design</td>
<td>Actual</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

© Rail Corporation  Page 244 of 253
Issued April 2013
UNCONTROLLED WHEN PRINTED
Version 5.3
# Level Crossing Examination

**Form LX 1**

**LEVEL CROSSING** ...........................................  **Start Km:** ...............  **End Km:** ...............  **Examiners Name/Signature** ...........................................  **Date**  

## Down Track or Single Track

<table>
<thead>
<tr>
<th>STATION</th>
<th>Gauge</th>
<th>Guard Rail Effectiveness</th>
<th>Flangeways</th>
<th>Rail top</th>
<th>Track Alignment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Actual</td>
<td>Y N</td>
<td>Width</td>
<td>Depth</td>
<td>Down Rail</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Up Rail</td>
<td></td>
<td>Up Rail</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Are variations visible</td>
<td></td>
<td>Are variations visible</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Down Rail</td>
<td>Y N</td>
<td></td>
<td>Y N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Up Rail</td>
<td>Y N</td>
<td></td>
<td>Y N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total Gauge</td>
<td>Y N</td>
<td></td>
<td>Y N</td>
</tr>
</tbody>
</table>

### General Condition

#### Sleepers

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Fastenings

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Rail corrosion

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Level crossing signs

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Fences and gates

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Roadway surface

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### General Condition

#### Sleepers

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Fastenings

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Rail corrosion

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Level crossing signs

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Fences and gates

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Roadway surface

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Up Track

<table>
<thead>
<tr>
<th>STATION</th>
<th>Gauge</th>
<th>Guard Rail Effectiveness</th>
<th>Flangeways</th>
<th>Rail top</th>
<th>Track Alignment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Actual</td>
<td>Y N</td>
<td>Width</td>
<td>Depth</td>
<td>Down Rail</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Up Rail</td>
<td></td>
<td>Up Rail</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Are variations visible</td>
<td></td>
<td>Are variations visible</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Down Rail</td>
<td>Y N</td>
<td></td>
<td>Y N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Up Rail</td>
<td>Y N</td>
<td></td>
<td>Y N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total Gauge</td>
<td>Y N</td>
<td></td>
<td>Y N</td>
</tr>
</tbody>
</table>

### General Condition

#### Sleepers

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Fastenings

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Rail corrosion

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Level crossing signs

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Fences and gates

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Roadway surface

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### General Condition

#### Sleepers

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Fastenings

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Rail corrosion

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Level crossing signs

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Fences and gates

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Roadway surface

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sighting Obstruction assessment</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the LXing have Active Protection?</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>If NO complete the Sighting Obstruction Assessment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Is Sighting unobstructed from ALL sighting points?</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comments</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

© Rail Corporation  
Issued April 2013  
UNCONTROLLED WHEN PRINTED  
Page 245 of 253  
Version 5.3
## Examination of Drainage

### Form Drain 1

**Length** ..........................  
**Examiners Name/Signature** ..........................

<table>
<thead>
<tr>
<th>Kilometrage</th>
<th>Description of DRAINS / ASSETS</th>
<th>* Surface Drainage &amp; Water Courses</th>
<th>Culvert, Pipe &amp; Sump Drains</th>
<th>Date of Inspection</th>
<th>Comments / Works Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>From</td>
<td>To</td>
<td>Condition</td>
<td>Inlet</td>
<td>Outlet</td>
<td>Structure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T/S OK Not OK T/S OK Not OK T/S OK Not OK OK Not OK</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**LEGEND:**  
T/S Column refers to which side of the track the item is on.  
D = Downside;  
U = Upside;  
C = Centre or Six Foot;  
DC = Between Down tracks;  
UC = Between Up tracks.

* This column is to be used for all Cess, Top, and Mitre drains and Water Courses.
## Turnout Examination

**Form STW 1 — Page 1 of 2**

<table>
<thead>
<tr>
<th>Line:</th>
<th>Location:</th>
<th>Track From/To:</th>
<th>Team:</th>
<th>Km:</th>
<th>I.D.No:</th>
<th>Name/Signature:</th>
<th>MIMS Equipment No:</th>
<th>Date:</th>
</tr>
</thead>
</table>

### V Crossing

<table>
<thead>
<tr>
<th>Should be</th>
<th>Measurement (mm)</th>
<th>OK (Y/N)</th>
<th>If &quot;Not O.K.&quot;, give details, action required, priority (When must repairs be completed?)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gauge</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Line</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turnout</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Checkrail Effectiveness</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Line</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turnout</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Flangeway Clearance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Line</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turnout</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Does Crossing Nose Need Building Up?</th>
<th>Yes/No</th>
<th>Dip at Crossing: mm</th>
<th>Details action and priority of crossing defects.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Are Bolts/Fastenings Effective?</strong></td>
<td>Yes/No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manganese crossing</td>
<td>Y / N</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Points

<table>
<thead>
<tr>
<th>Switch Fitting Correct?</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition of Heel (Transfer block)?</td>
<td>Left</td>
<td>Right</td>
</tr>
<tr>
<td>Evidence of stockrail creep?</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Switches bearing on plates?</td>
<td>Left</td>
<td>Right</td>
</tr>
</tbody>
</table>

### For Manual Points ONLY

<table>
<thead>
<tr>
<th>Switch clearance</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lever effectiveness</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Switch Tip

<table>
<thead>
<tr>
<th>Height</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width</td>
<td>Left</td>
<td>Right</td>
</tr>
<tr>
<td>Angle</td>
<td>Left</td>
<td>Right</td>
</tr>
</tbody>
</table>

| Do Switches need grinding? | YES | NO |

### Housed Points

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Size</th>
<th>OK (Y/N)</th>
<th>If &quot;Not O.K.&quot;, give details, action required, priority (When must repairs be completed?)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;A&quot;</td>
<td>mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;B&quot;</td>
<td>mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;C&quot;</td>
<td>mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;D&quot;</td>
<td>mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;E&quot;</td>
<td>mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;F&quot;</td>
<td>mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;G&quot;</td>
<td>mm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### General

<table>
<thead>
<tr>
<th>OK (Y/N)</th>
<th>If &quot;Not OK.&quot;, give details</th>
<th>Stockrails</th>
<th>OK (Y/N)</th>
<th>If &quot;Not OK.&quot;, give details</th>
<th>Work Required</th>
<th>Target Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage</td>
<td></td>
<td>LH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ties/Bearers</td>
<td></td>
<td>RH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ballast</td>
<td></td>
<td>Studs/Chairs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alignment</td>
<td></td>
<td>Rails</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anchors</td>
<td></td>
<td>Sec</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fastenings</td>
<td></td>
<td>Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Checkrails &amp; bolts</td>
<td></td>
<td>Cond</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Turnout Examination

| I.D.No: ............ | Form STW 1 – Page 2 of 2 |

#### Main Gauge

<table>
<thead>
<tr>
<th>STATIONS</th>
<th>Tight</th>
<th>Wide</th>
<th>Play</th>
<th>Total widening</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT 1</td>
<td>1</td>
<td>15</td>
<td>22</td>
<td>29</td>
</tr>
<tr>
<td>PT 2</td>
<td>1</td>
<td>16</td>
<td>23</td>
<td>30</td>
</tr>
<tr>
<td>PT 3</td>
<td>1</td>
<td>17</td>
<td>24</td>
<td>31</td>
</tr>
<tr>
<td>PT 4</td>
<td>1</td>
<td>18</td>
<td>25</td>
<td>32</td>
</tr>
<tr>
<td>PT 5</td>
<td>1</td>
<td>19</td>
<td>26</td>
<td>33</td>
</tr>
<tr>
<td>PT 6</td>
<td>1</td>
<td>20</td>
<td>27</td>
<td>34</td>
</tr>
<tr>
<td>PT 7</td>
<td>1</td>
<td>21</td>
<td>28</td>
<td>35</td>
</tr>
</tbody>
</table>

**Calculate worst short twist & list all short twist defects:**

**Calculate worst long twist & list all long twist defects:**

#### Secondary Gauge

<table>
<thead>
<tr>
<th>STATIONS</th>
<th>Tight</th>
<th>Wide</th>
<th>Play</th>
<th>Total widening</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT 1</td>
<td>8</td>
<td>15</td>
<td>22</td>
<td>29</td>
</tr>
<tr>
<td>PT 2</td>
<td>9</td>
<td>16</td>
<td>23</td>
<td>30</td>
</tr>
<tr>
<td>PT 3</td>
<td>10</td>
<td>17</td>
<td>24</td>
<td>31</td>
</tr>
<tr>
<td>PT 4</td>
<td>11</td>
<td>18</td>
<td>25</td>
<td>32</td>
</tr>
<tr>
<td>PT 5</td>
<td>12</td>
<td>19</td>
<td>26</td>
<td>33</td>
</tr>
<tr>
<td>PT 6</td>
<td>13</td>
<td>20</td>
<td>27</td>
<td>34</td>
</tr>
<tr>
<td>PT 7</td>
<td>14</td>
<td>21</td>
<td>28</td>
<td>35</td>
</tr>
</tbody>
</table>

**Calculate worst short twist & list all short twist defects:**

**Calculate worst long twist & list all long twist defects:**

#### Bearers

<table>
<thead>
<tr>
<th>RM Priority</th>
<th>MPM Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.8</td>
<td>3.0</td>
</tr>
<tr>
<td>3.2</td>
<td>3.4</td>
</tr>
<tr>
<td>3.6</td>
<td>3.8</td>
</tr>
<tr>
<td>4.0</td>
<td>4.2</td>
</tr>
<tr>
<td>4.4</td>
<td>4.6</td>
</tr>
<tr>
<td>4.8</td>
<td>5.0</td>
</tr>
<tr>
<td>6.0</td>
<td></td>
</tr>
</tbody>
</table>

**Does Turnout require Supplementary Patrol:**

- **YES**
- **NO**

**Number Req’d:**

- **RM**
- **MPM**
## Catchpoint Examination

**Form STW 2**

<table>
<thead>
<tr>
<th>Line:</th>
<th>Location:</th>
<th>Track From/To:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team:</td>
<td>Km:</td>
<td>I.D.No:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Name/Signature:</td>
</tr>
</tbody>
</table>

**MIMS Equipment No:**

| STATIONS | 1 | 2 | 3 | PT | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|-----------|---|---|---|----|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|
| GAUGE     | Tight | | | | | | | | | | | | | | | | | | | | | |
|           | 0 | | | | | | | | | | | | | | | | | | | | | |
|           | Wide | | | | | | | | | | | | | | | | | | | | | |
|           | Play | | | | | | | | | | | | | | | | | | | | | |
|           | Total gauge widening | | | | | | | | | | | | | | | | | | | | | |
| SUPER     | Design | | | | | | | | | | | | | | | | | | | | | |
|           | Actual | | | | | | | | | | | | | | | | | | | | | |

### Switch Tip

- **Height**
- **Width**
- **Angle**
- **For Manual Points ONLY**
  - Switch clearance
  - Lever effectiveness

### Points

- **Switch tipping correctly**
- **Condition of Heel (Transfer block)**
- **Evidence of stockrail creep?**
- **Doe switch need grinding?**
- **Switches bearing on plates?**

### General

- **Drainage**
- **Ballast**
- **Alignment**
- **Anchors**
- **Fastenings**
- **Bolts**
- **Derail block**

### Bearers

- **Turnout Timbers**

**Number Req’d:**

| 2.8 | 3.0 | 3.2 | 3.4 | 3.6 | 3.8 | 4.0 |

### Throw off Rail

- **Throw off Rail Direction**
- **Clearance Point**

### Work Required

- **Tighten bolts & studs**
- **Mechanised Resurfacing**
- **Remove excess ballast**
- **Weld out mechanical joints**
- **Weld out insulated joints**
- **Renew /replace catchpoint**
- **Recondition track**
- **Pick up scrap**

### Target Date

| Yes/No | Yes/No | Yes/No | Yes/No | Yes/No | Yes/No | Yes/No |

**NOTE** Throw Off Rail must be parallel or leading away from adjacent Track.

---

© Rail Corporation
Issued April 2013

UNCONTROLLED WHEN PRINTED

Version 5.3
# Diamond Examination

**Form STW 3**

<table>
<thead>
<tr>
<th>Line:</th>
<th>Location:</th>
<th>Track From/To:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team:</td>
<td>Km:</td>
<td>I.D.No:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MIMS Equipment No:</th>
<th>Date:</th>
</tr>
</thead>
</table>

| STATIONS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| MAIN GAUGE | Tight | 0 | Wide | Play | Total gauge widening | Design | Actual |
| SUPER GAUGE | Main Line | Main Line | Sec Line | Sec Line | Checkrail Effectiveness | Checkrail Effectiveness | Sec Line | Sec Line | Flangeway Clearance | Flangeway Clearance | Main Line | Main Line | Turnout | Turnout | Does Crossing Nose Need Building Up? | Yes/No | Dip at Crossing: ___ mm | Does Crossing Nose Need Building Up? | Yes/No | Dip at Crossing: ___ mm |

| SECONDARY GAUGE | Main Line | Main Line | Sec Line | Sec Line | Checkrail Effectiveness | Checkrail Effectiveness | Sec Line | Sec Line | Flangeway Clearance | Flangeway Clearance | Main Line | Main Line | Turnout | Turnout | Does Crossing Nose Need Building Up? | Yes/No | Dip at Crossing: ___ mm | Does Crossing Nose Need Building Up? | Yes/No | Dip at Crossing: ___ mm |

### "V1" Crossing (Sydney End)

- **Measurement (mm):**
  - Main Line
  - Sec Line
- **OK. (Y/N):**
- **If "Not OK.", give details, action required:**

### "V2" Crossing (Country End)

- **Measurement (mm):**
  - Main Line
  - Sec Line
- **OK. (Y/N):**
- **If "Not OK.", give details, action required:**

### "K1" Crossing

- **Measurement (mm):**
  - (Q + R)\(a\)
  - (Q + R)\(b\)
- **OK. (Y/N):**
- **If "Not OK.", give details, action required:**

### "K2" Crossing

- **Measurement (mm):**
  - (Q + R)\(c\)
  - (Q + R)\(d\)
- **OK. (Y/N):**
- **If "Not OK.", give details, action required:**

### Work Required

<table>
<thead>
<tr>
<th>General</th>
<th>OK. (Y/N)</th>
<th>If &quot;Not OK.&quot;, give details</th>
<th>Work Required</th>
<th>Target Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage</td>
<td>Rails</td>
<td>Mechanised Resurfacing</td>
<td>Yes/No</td>
<td></td>
</tr>
<tr>
<td>Ties/Bearers</td>
<td>Plates Type</td>
<td>Remove excess ballast</td>
<td>Yes/No</td>
<td></td>
</tr>
<tr>
<td>Ballast</td>
<td>Cond</td>
<td>Weld out mechanical joints</td>
<td>Yes/No</td>
<td></td>
</tr>
<tr>
<td>Alignment</td>
<td>Checkrails &amp; bolts</td>
<td>Weld out insulated joints</td>
<td>Yes/No</td>
<td></td>
</tr>
<tr>
<td>Anchors</td>
<td>Fastenings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bearers</td>
<td>Renew /replace diamond</td>
<td></td>
<td>Yes/No</td>
<td></td>
</tr>
<tr>
<td>Turnout Timbers</td>
<td>2.8 3.0 3.2 3.4 3.6 3.8 4.0 4.2 4.4 4.6 4.8 5.0 6.0</td>
<td>Pandrol Plate Diamond</td>
<td>Yes/No</td>
<td></td>
</tr>
<tr>
<td>Number Req'd:</td>
<td></td>
<td>Recondition track</td>
<td>Yes/No</td>
<td></td>
</tr>
</tbody>
</table>
# Slip Examination

**Form STW 4**

<table>
<thead>
<tr>
<th>Line:</th>
<th>Location:</th>
<th>Track From/To:</th>
<th>Team:</th>
<th>Km:</th>
<th>I.D.No:</th>
<th>Name/Signature:</th>
<th>MIMS Equipment No:</th>
<th>Date:</th>
</tr>
</thead>
</table>

## Tight Gage

<table>
<thead>
<tr>
<th>STATIONS</th>
<th>Tight</th>
<th>0</th>
<th>Wide</th>
<th>Play</th>
<th>Total gauge widening</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Single Slip – Points S1 & S2

### Switch Tip S1 & S2

<table>
<thead>
<tr>
<th>Height</th>
<th>Width</th>
<th>Angle</th>
<th>Evidence of stockrail creep?</th>
<th>Switch Tip S1 &amp; S2 OK?</th>
<th>Points S1 &amp; S2 OK?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td>Left</td>
<td>Left</td>
<td>Yes/No</td>
<td>OK (Y/N)</td>
<td>OK (Y/N)</td>
</tr>
<tr>
<td>Right</td>
<td>Right</td>
<td>Right</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Switch Tip S3 & S4

<table>
<thead>
<tr>
<th>Height</th>
<th>Width</th>
<th>Angle</th>
<th>Evidence of stockrail creep?</th>
<th>Switch Tip S3 &amp; S4 OK?</th>
<th>Points S3 &amp; S4 OK?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td>Left</td>
<td>Left</td>
<td>Yes/No</td>
<td>OK (Y/N)</td>
<td>OK (Y/N)</td>
</tr>
<tr>
<td>Right</td>
<td>Right</td>
<td>Right</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Double Slip – Points S5 & S6

### Switch Tip S5 & S6

<table>
<thead>
<tr>
<th>Height</th>
<th>Width</th>
<th>Angle</th>
<th>Evidence of stockrail creep?</th>
<th>Switch Tip S5 &amp; S6 OK?</th>
<th>Points S5 &amp; S6 OK?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td>Left</td>
<td>Left</td>
<td>Yes/No</td>
<td>OK (Y/N)</td>
<td>OK (Y/N)</td>
</tr>
<tr>
<td>Right</td>
<td>Right</td>
<td>Right</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Double Slip – Points S7 & S8

### Switch Tip S7 & S8

<table>
<thead>
<tr>
<th>Height</th>
<th>Width</th>
<th>Angle</th>
<th>Evidence of stockrail creep?</th>
<th>Switch Tip S7 &amp; S8 OK?</th>
<th>Points S7 &amp; S8 OK?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td>Left</td>
<td>Left</td>
<td>Yes/No</td>
<td>OK (Y/N)</td>
<td>OK (Y/N)</td>
</tr>
<tr>
<td>Right</td>
<td>Right</td>
<td>Right</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Expansion Switch Examination

**Form STW 5**

<table>
<thead>
<tr>
<th>STATIONS</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STOCKRAILS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GAUGE</strong></td>
<td>Tight</td>
<td>0</td>
<td>Wide</td>
<td>Play</td>
<td>Condition</td>
<td>Left</td>
<td>Right</td>
<td></td>
</tr>
<tr>
<td><strong>CREEP</strong></td>
<td>Total Widening</td>
<td>Left</td>
<td>YES</td>
<td>NO</td>
<td>Right</td>
<td>YES</td>
<td>NO</td>
<td></td>
</tr>
</tbody>
</table>

**STATIONS**

<table>
<thead>
<tr>
<th>Line:</th>
<th>Location:</th>
<th>Team:</th>
<th>Km:</th>
<th>I.D.No:</th>
<th>Name/Signature:</th>
<th>MIMS Equipment No:</th>
<th>Date:</th>
</tr>
</thead>
</table>

**STATIONS**

<table>
<thead>
<tr>
<th>STATIONS</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STOCKRAILS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GAUGE</strong></td>
<td>Tight</td>
<td>0</td>
<td>Wide</td>
<td>Play</td>
<td>Condition</td>
<td>Left</td>
<td>Right</td>
<td></td>
</tr>
<tr>
<td><strong>CREEP</strong></td>
<td>Total Widening</td>
<td>Left</td>
<td>YES</td>
<td>NO</td>
<td>Right</td>
<td>YES</td>
<td>NO</td>
<td></td>
</tr>
</tbody>
</table>

**Relative to Neutral Punch Marks**

- **Neutral Punch Mark (Central Between Transoms)**
  - Left: mm
  - Right: mm

- **Switches (max. 50mm)**
  - Left: mm
  - Right: mm

- **Stockrails (max. 50mm)**
  - Left: mm
  - Right: mm

**Relative to Neutral Punch Mark**

- **Neutral Punch Mark (Central Between Transoms)**
  - Left: mm
  - Right: mm

**Relative to Switch Opening (max. 2mm)**

- **Switches Sliding effectively**
  - Left: YES | NO
  - Right: YES | NO

**Do Switches Require Grinding**

- **Left**: YES | NO
- **Right**: YES | NO

**SWITCH TIPS**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>Left</td>
<td>Right</td>
</tr>
<tr>
<td>Width</td>
<td>Left</td>
<td>Right</td>
</tr>
<tr>
<td>Angle</td>
<td>Left</td>
<td>Right</td>
</tr>
</tbody>
</table>

**D BOLT ASSEMBLY (for VAE Expansion switches)**

<table>
<thead>
<tr>
<th>Wear (Between switch foot &amp; D Bolt assembly)</th>
<th>Left mm</th>
<th>Right mm</th>
</tr>
</thead>
</table>

**SAFETY ROLLERS (for VAE Expansion switches)**

| Safety Rollers | Left | Right |

**IBAV ASSEMBLY (for VAE Expansion switches)**

<table>
<thead>
<tr>
<th>Springs</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Plates</td>
<td>Left</td>
<td>Right</td>
</tr>
</tbody>
</table>

**GENERAL**

<table>
<thead>
<tr>
<th>Alignment</th>
<th>Fastenings</th>
<th>Work Required</th>
<th>Yes</th>
<th>No</th>
<th>Target Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rails</td>
<td>Plates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lubrication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Swingnose Crossing Inspection

**Form STW 6**

<table>
<thead>
<tr>
<th>Location:</th>
<th>Track:</th>
<th>I.D. No.:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Track Inspection TMC 203</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Swingnose

<table>
<thead>
<tr>
<th>Gauge</th>
<th>Mainline</th>
<th>1435 ±3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turnout</td>
<td>1435 ±3</td>
<td></td>
</tr>
</tbody>
</table>

#### Tip

<table>
<thead>
<tr>
<th>Swingnose Measurement</th>
<th>Should Be</th>
<th>OK</th>
<th>Not OK</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gauge</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mainline</td>
<td>1435 ±3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turnout</td>
<td>1435 ±3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

##### Swingnose Measurement

- **OK:** If "O.K.", give details, work required, and priority (When must repairs be completed?)
- **Not OK:**

#### General

<table>
<thead>
<tr>
<th>General</th>
<th>L*</th>
<th>OK</th>
<th>Not OK</th>
<th>If not OK give details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is swingnose free of built up ballast and other material?</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is point rail or splice rail (tongue rail in PRE) bearing on the switch plates?</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are all bolts, clips, nuts, split pins tight and effective (not loose / broken) in wing rail, crossing frame, point rail, tongue rail, splice rail?</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wear of wing rail and point rail at the transition point</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are there signs of abnormal wear on the rail head running surface and gauge face on point rail, splice rail and wing rail</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are there signs of excessive wear on the rail head running surface and gauge face on point rail, splice rail and wing rail</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rolling contact fatigue defects (surface checking / cracks, spalls, scale or squats) on point rail, splice rail, wing rail</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fit of point rail and splice rail against the crossing frame rail stops in the normal and reverse position</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bearer condition</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition of screw spikes and washers</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rail head overflow on wing rail / point rail gauge face adjacent to the point rail</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### PRE only

- **Condition of huck bolts at the following locations - F chock, crossing plate, rail brace to rail stop, wing rail A, B and F chocks, point rail fabricated heel block, wing rail / splice rail C and D heel blocks | 2 | | | |
- **Condition of crossing plates | 2 | | | |
- **Fit of swing nose against the switch stops in the forward and reverse positions. | 2 | | | |

#### VAE only

- **Fit of splice rail to point rail switch stops. | 1 | | | |
- **Crossing frame condition | 2 | | | |
- **Point Rail / Splice Rail Sliding Joint | 2 | | | |
  - Are fasteners, castle nut and split pins fitted and tight? | 2 | | | |
  - Are safety clamp fasteners satisfactory? | 2 | | | |
- **Condition of anti-creep brackets | 2 | | | |
- **Condition of heel block / anti creep block huck bolts | 2 | | | |
- **Condition of rail stop brackets (point rail / splice rail to crossing frame) | 2 | | | |
- **Condition of switch stops (splice rail to point rail). | 2 | | | |

L is Level of Examination