TMC 211

TRACK GEOMETRY & STABILITY

Version 4.8

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NSW Transport RailCorp

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## Document control

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<tr>
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<tr>
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<td>October 2006</td>
<td>First issue as a RailCorp document. Includes content from C 2009, C 2010, C 2108, C 2200, C 2501, C 4601, RC 4800, C 4610, C 4641, TS 2621, TS 3202, TS 3103, TS 3104, TS 3105, TS 3106, TS 3107, TS 3108, TS 3109, TS 3208, RTS 3640, CTN 05/07, CTN 05/27</td>
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<td>Complete document – Format Change; C1-4.2 Additional References; C19-2 – Addition of reference to Network Rule NWT 312 Infrastructure Booking Authority; Appendix E - Correction of references CCS Desk IOC in Speed Restriction Notice</td>
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<td>C8-3 – Changed “Renewals” staff to “Any” staff</td>
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<td>February 2011</td>
<td>C17-3 – Deletion of examples of DTS obstructions – inclusion of reference to TMC 300; 20.2 - Deletion of reference to NSG 604 for orientation of Permanent Speed Signs – replaced by reference to ESC 210; App A and App B - Correction of reference error; Logo change</td>
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<td>C3 - Competencies updated to current National Competencies; C4-2.2 – Correction of error in acceptance limits for general height for mechanised resurfacing (+ and - need to be reversed - Reduction of limit from +150mm to +100mm; addition of requirements to consider impact of track lifts on ballast top bridges; C17-5.7 - Addition of note regarding twist measurement ; C18-5.6 - Addition of twist measurement requirements</td>
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Chapter 1 General

C1-1 Purpose
This manual provides requirements, processes and guidelines for the maintenance of track geometry and stability, including summer and winter work practices, prevention and correction of misalignments and the use of permanent and temporary speed signs.

C1-2 Context
The 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.

Manuals contain requirements, process and guidelines for the management of track assets and for carrying out examination, construction, installation and maintenance activities.

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 geometry and stability repair activities on their area, and production managers needing to know what they are required to do to manage the renewal activity their teams are undertaking.

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 4. 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:

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

C1-4.1 Australian and International Standards

Nil

C1-4.2 RailCorp Documents

RailCorp Network Rule NWT 312 "Infrastructure Booking Authority"
RailCorp Network Rule NSG 604 “Indicators and Signs”
Safe Notice 006-2005 “Temporary speed restrictions
OS 001 IM – Train Operating Conditions Manual (TOC Manual)
ESC 210 – Track Geometry & Stability
ESC 215 – Transit Space
ESC 230 – Sleepers and Track Support
ESC 240 – Ballast
TMC 001 – Civil Technical Competencies and Engineering Authority
TMC 203 – Track Inspection
TMC 223 – Rail Adjustment
TMC 300 – Structures General
SPC 213 – Track Side Signs
RailCorp Drawing CV0218653 – Standard Speed Sign Fixings
Chapter 2  Management Requirements

C2-1  Prevention of misalignments

C2-1.1  Welding controls

Civil Maintenance Engineers must have systems in place to:

1. Ensure that welding controls to verify that adjustment has been maintained in CWR are operating properly and any deficiencies are remedied. Special attention should be paid to any welding work done during winter and especially as the warmer season approaches.

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

Team Managers must:

1. Review records of welding and adjustment, including verification that testing shows checking by Rail Flaw Detection operators that punch marks are correct.

C2-1.2  Loss of adjustment control

Civil Maintenance Engineers must have systems in place to:

1. Ensure that any area where adjustment control has been found to be lost is classified as non-standard track.

2. 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.

3. Ensure that ALL bunching points are subject to additional review where bunching is suspected.

4. Ensure that any small timber sleeper panels in concrete sleepers (including where adjoining timber or concrete tied turnouts) are treated as timber for WTSA analysis and correction.

C2-1.3  Resurfacing on sharp curves

Civil Maintenance Engineers must have systems in place to ensure special care is taken when resurfacing is carried out on sharp curves to guard against pull-ins. This may include:

1. avoiding resurfacing sharp curves in the colder months if practicable,

2. making sure there is a full ballast profile and preferably with a winrow of ballast outside of the ends of the sleepers (but not above rail level),

3. using the dynamic track stabilizer if possible,
4. monitoring track where resurfacing has been carried out especially after a cold snap to ensure it has not pulled in,
5. applying additional speed restrictions in hot weather, or
6. avoiding stopping the work in the middle of the curve. Doing so will create an interface between disturbed -non disturbed track that will be a point of weakness and a potential misalignment trigger.

C2-1.4 Painting of rails
If painting of rails is being considered to reduce rail temperatures, Civil Maintenance Engineers must:

1. Obtain agreement from the Chief Engineer Track regarding the strategy to be used.
2. Arrange a detailed examination prior to painting to ensure that existing paint marks and stickers are identified and protected or re-established.
3. Ensure that the process and the conditions of use as detailed in Section C7-4 are applied.
4. Review all other implementation issues, especially environmental and OH&S.

C2-1.5 Steel In = Steel Out
Team Managers must:

1. Keep a register of steel out - steel in for each area.
2. Check adjustment sheets and transfer plus or minus steel for each 500m section to the WTSA sheets.

C2-1.6 Rail adjustment procedure
Civil Maintenance Engineers must;

1. Review any request for adjustment if the track is more than 15mm off correct alignment.

Team Managers must:

1. Provide team leaders undertaking rail adjustment with creep punching requirements

C2-1.7 Control of the correction process
When WTSA priorities are corrected, Civil Maintenance Engineers must:

1. Arrange for the stability loss to 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).
2. Arrange for a record showing the work carried out and the revised stability loss at below P1 level.
C2-1.8 **Pre-Summer Review**

Civil Maintenance Engineers must:

1. undertake a review to identify any areas requiring special measures.
2. Establish strategies before the end of September each year to deal with early hot weather should it arise.

Areas which have historically had problems and areas where upgrading work has just taken place should be targeted.

Special attention should be given to areas such as:

- Curves less than 400m radius. Tight radius curves have a higher misalignment risk particularly if they are continuously welded on dog-spiked sleepers.
- Previous misalignment sites (say within the last 4 years) should be thoroughly checked before the end of September each year to ensure rail adjustment is correct, the track is on line and the factors which led to the previous misalignment/s have been corrected.
- Areas that have been highlighted as a potential misalignment trigger site. These locations should be monitored to ensure that their condition might not affect the track stability.

Follow the guidelines in Section C7-1 to arrange monitoring of vulnerable curves.

C2-2 **Work in summer months**

General restrictions apply to work on track in summer months. The restrictions are detailed in Section C8-4.

Civil Maintenance Engineers may authorize work in summer by the issue of written instructions that will detail the special actions to be taken prior to, during and after the work to maintain track stability.

1. The instructions should consider:
   
   - The need for the work.
   - An assessment of the risk of misalignment and potential consequences during or after the work.
   - The work method.
   - Site protection during and after the work.
   - The level of supervision and reporting.
   - Contingency plans.

   For the assistance of Civil Maintenance Engineers a set of general guidelines is attached as C8-11. The written authorisation may cover:

   - A period of work, a range of activities or a series of sites.
   - A single date, single activity or single location.
   - A combination of the above.

   These special instructions authorising work during summer months will be current for one summer only and must be reissued each year when required.

2. Maintain a record of the special authorisations issued.

3. Retain details of any compliance checks of these instructions for audit purposes.
Team Managers:

1. Have the authority to stop any work being carried out on their area that could adversely impact on track stability and the safety of the running line.

C2-3 Application of Heat Speeds

Civil Maintenance Engineers and Maintenance Team Managers may waive the need for Heat Speeds after resurfacing work in some circumstances (see Section C8-9) on days where the forecast (or actual) maximum air temperature does not exceed 30°C (25°C before 15 November).

Civil Maintenance Engineers may nominate another person to make the decision. In this case the delegated person must be in possession of the Track Examination competency.

C2-4 WOLO Management

Special maintenance practices are adopted for welded track when the AIR temperature reaches 38°C OR is forecast (by the Bureau of Meteorology) to reach 38°C (35°C prior to 15 November).

The special practices include:

1. WOLO Speed Restrictions. Details of WOLO provisions are in Chapter 9.

2. Inspection of lengths (Heat Patrols). Details of Heat Patrol procedures are in TMC 203 - Track Inspection.

Civil Maintenance Engineers are responsible for ensuring that WOLO speed restrictions are imposed when required. They must:

1. Make sure WOLO systems are in place and staff are aware of their responsibilities to cover the requirements of the IOC procedures.

2. Ensure that procedures are in place for Heat Patrol to be undertaken between 1430 and 1800 hours on days when WOLO conditions are imposed. Use some thought and local knowledge as to when this is done.

Where WOLO has been applied to a zone but some parts of the zone are substantially cooler than the initiation temperature then the Civil Maintenance Engineer can waive the inspection requirements.

Inspection is only required when the temperature is predicted to or actually reaches the applicable trigger temperature.

3. Review the level of speed restriction on all tracks, including concrete sleepered track, if the air temperature reaches or exceeds OR is forecast to reach or exceed 43°C, and take appropriate action.

4. Determine prior to the summer season, nominated sections where WOLO conditions are to allow for concrete sleepered track and inform the Infrastructure Operations Centre so that the combined list can be compiled. Care must be taken to ensure the concrete sleepers in these sections are continuous (turnouts and other fixed points excepted).

5. Nominate a District Coordinator to facilitate coordination for late initiation or for early removal of WOLO. The coordinator needs to be contactable for special holiday periods such as Christmas and New Year. Notify the IOC of the current
coordinator and any changes to that role. The default contact will be the Civil Maintenance Engineer.

6. Ensure that systems are in place to inform track staff of the WOLO conditions to be applied to various lengths of concrete sleepered track.

7. Determine if a temporary speed restriction ("C Speed") is required, in accordance with the procedure in Section C8-8, on specific sections or sites where stability is of concern.

The Infrastructure Operations Centre is the central coordination and communication point between the maintainers and Network Control.

The Infrastructure Operations Manager MUST:

1. Review and republish the WOLO Operating Procedure each year, prior to the end of September.

2. Follow the requirements of the WOLO Operating Procedure.

3. Send WOLO questionnaire forms to all maintainers when the forecast temperature will exceed the WOLO nominated temperature less 5°C. At weekends/public holidays provide the zone forecast temperature information verbally or SMS text message to the nominated WOLO representatives.

If there is uncertainty as to whether WOLO is required because one of the Team Managers has not responded to the IOC text message then the IOC will contact the District Coordinator for guidance. If the IOC is unable to contact the District Coordinator and the temperature is forecast to get within 1°C of the initiation temperature in any part of the zone then WOLO will be implemented.

The IOC will keep Team Managers informed of temperature changes that occur during the day. If WOLO has not been initiated but during the day temperatures approach the trigger temperature the IOC will contact the District Coordinator and seek advice. If the initiation temperature is exceeded (non-transitory) and no contrary advice has been given by the District Coordinator then WOLO will be applied.

4. Co-ordinate and issue the WOLO NIN to the Rail Management Centre for distribution.

5. Confirm with the relevant Network Control (Train Control Board) that they have received the WOLO wire.

6. Confirm to maintainers that the WOLO NIN has been issued and that Network Control confirmed that they have received the WOLO wire.

7. Ensure Network Control have been advised that WOLO boards have been exhibited, and when they are removed.

C2-5 Train Inspection Sites

RailCorp has a network of train inspection sites throughout the rail network. These sites monitor (or inspect) passing trains and detect and report on various parameters of the train.

Train inspection sites in RailCorp areas are maintained by the Train Monitoring Systems Unit (TMSU).
The location of all train inspection sites currently installed throughout the RailCorp network is documented in the Train Operating conditions (TOC) Manual.

Civil Maintenance Engineers must:

1. Ensure that staff responsible for maintenance in the area where train inspection sites are located are aware of:
   - track condition requirements,
   - maintenance requirements, and
   - contact details of the Train Monitoring Systems Unit (TMSU):
     - located off Columbia Lane at Strathfield. The TMSU can be contacted on:
       - Phone – 9752 8043
       - Pager – 132222, No. 3626
       - Mobile – 0413 005 996, 0409 668 940 or 0412 479 081

   Advise the TMSU prior to track maintenance or renewal of the nature and timing of the works. It is preferable that advice of the works is provided at least 1 week in advance. However, in instances where this is not possible (for example, for emergency maintenance works), advice should be provided as early as possible. TMSU staff will arrange for equipment to be disconnected and removed (if necessary), and/or will arrange for the maintenance works to be supervised.

2. Ensure that staff responsible for planning track maintenance and renewal works in the area where train inspection sites are located are aware of:
   - maintenance requirements,
   - removal and replacement requirements, and
   - contact details of the TMSU.

When planning possessions for the works, an allowance should be made for disconnection and removal of the train inspection equipment, if necessary, as well as the replacement of this equipment once the maintenance works are complete. Guidelines on how much time should be allocated for this task are provided in Section C13-3.2. If there is any special concerns or conditions (for example, if site lighting will be required), these issues should be discussed and resolved with the TMSU when planning the works.

3. Arrange appropriate supervision of work through train inspection sites to ensure that equipment that cannot be removed is not damaged during the works.

   Background information is detailed in Section C13-3.

   Track maintenance requirements are detailed in Section C13-3.3.

C2-6 Requirements for certifying track after work

Civil Maintenance Engineers are responsible for ensuring that systems are in place for the appropriate certification of track in accordance with the requirements of Chapter 19 of this manual. They must ensure that work on track is certified by persons with appropriate competencies.

There are special requirements for certification of work on turnouts.

When resurfacing work is planned on a turnout, the condition of the turnout must be assessed using the guidelines below. If the operation of lifting, packing and lining of the
turnout or special trackwork may change the fit of switch and crossing components, then the location is to be nominated as a “vulnerable turnout”.

_Guidelines for determination of “Vulnerable Turnouts”_

To assess a turnout, or other item of special trackwork (diamonds, slips, catchpoints or expansion switches) for nomination as a “vulnerable turnout”, consider the following issues:

- Will the work affect the way switches sit on plates?
  Are the switch heels or A& B bearers in a hole and need lifting?
- Will the work damage the adjustment of turnout components?
  Are turnout components loose? Can this be corrected by tightening bolts etc before the work?
- Will the work affect the gauge and back to back at crossings?
  This may occur if bearers are slewed during the work?
- Will lifting and lining to provide superelevation or through crossovers have an effect on the bearing of the steelwork on the plates?
  Are bearers bowed?
- Will the work affect the fit of switches against stockrails?
  Could the switch stay open, especially if not interlocked?

If, in the opinion of the Civil Maintenance Engineer, or a competent person delegated by him/her, resurfacing work has the potential to meet any of the above criteria, the turnout or other item of special trackwork (diamond, slip, expansion switch or catchpoint) MUST be nominated in the resurfacing program as a “vulnerable turnout”. Certification of track after work on a “vulnerable turnout” MUST be undertaken by a person with appropriate competencies as nominated in Chapter 3.

If no nomination is made, the turnout is to be treated as a “vulnerable turnout”.

The majority of turnouts and special trackwork in RailCorp’s system are in fair to good condition and will not fall into the category of “vulnerable turnouts”.

Resurfacing Production Managers are responsible for ensuring that systems are in place for the appropriate certification of track in accordance with the requirements of Chapter 19 of this manual. They must:

- Make sure that they know which turnouts on the program have been nominated as “vulnerable turnouts”.
- Make all reasonable efforts to communicate with maintenance staff to ensure that nomination is made for all turnouts and special trackwork on the turnout resurfacing program.
- Provide personnel with the appropriate competencies or seek assistance in getting personnel with appropriate competencies to certify turnouts after resurfacing.
# 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>Lift and line plain track and restore plain track alignment (Manual Methods)</td>
<td>TLIB3094B - Check and repair track geometry</td>
</tr>
<tr>
<td>Resurface plain track</td>
<td>TLIB3094B - Check and repair track geometry</td>
</tr>
<tr>
<td>Make changes to track geometry affecting clearances, overhead wiring, station platforms or track adjustment</td>
<td>TLIB3094B - Check and repair track geometry</td>
</tr>
<tr>
<td>Maintain track at Train Inspection Sites</td>
<td>TLIB3094B - Check and repair track geometry</td>
</tr>
<tr>
<td>Undertake Defensive Measures for Summer Track Stability –, Centre line marking of curves, Applying Heat Speeds</td>
<td>TLIB3094B - Check and repair track geometry</td>
</tr>
<tr>
<td>Special Inspection/ Monitoring of Sharp Curves prior to Summer</td>
<td>TLIB3100A - Visually inspect track infrastructure</td>
</tr>
<tr>
<td>Analyse Track Stability using manual analysis techniques</td>
<td>TLIB3099A - Examine track infrastructure</td>
</tr>
<tr>
<td>Control adjustment to prevent misalignments</td>
<td>TLIB3102A - Adjust rail</td>
</tr>
<tr>
<td>Check adjustment at misalignments</td>
<td>TLIB3102A - Adjust rail</td>
</tr>
<tr>
<td>Repair misalignments (except track adjustment component)</td>
<td>TLIB3094B - Check and repair track geometry</td>
</tr>
<tr>
<td>Install Permanent Speed Signs</td>
<td>TLIB3094B - Check and repair track geometry</td>
</tr>
<tr>
<td>Impose and remove Temporary Speeds</td>
<td>TLIB3094B - Check and repair track geometry</td>
</tr>
<tr>
<td>Resurface turnouts or other special trackwork by manual methods or tampers</td>
<td>TLIB3094B - Check and repair track geometry</td>
</tr>
<tr>
<td>Certify plain track during or after resurfacing</td>
<td>TLIB3094B - Check and repair track geometry</td>
</tr>
<tr>
<td>Certify turnouts and special trackwork (EXCEPT “Vulnerable turnouts”) during or after resurfacing</td>
<td>TLIB3094B - Check and repair track geometry</td>
</tr>
<tr>
<td>Certify “Vulnerable turnouts” during or after resurfacing</td>
<td>TLIB3094B - Check and repair track geometry AND TLIB3095A - Check and repair points and crossings</td>
</tr>
</tbody>
</table>
Chapter 4  Construction and maintenance acceptance limits

C4-1  Construction and upgrading for plain ballasted track

The following construction acceptance limits are extracted from RailCorp Standard ESC 210.

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

- **Mandatory Requirement - MUST be met**: MR
- **Guideline - preferred where practical**: G

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

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

A visual examination is required of alignment and surface geometry between survey points. Any deviations from smooth alignment or surface shall be measured in accordance with, and meet the requirements of, the unevenness criteria in Table 5.

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

Where interfaces exist between new construction and existing track appropriate variations in tolerances are acceptable. These will depend on the time the interface will exist between stages of upgrading activity, the track speed, traffic etc. They may not exceed the maintenance acceptance levels for unevenness specified in Table 5 or the Base Operating limits for track geometry for the relevant track speed specified in Engineering Manual TMC 203 – Track Inspection.
C4-1.1 Accuracy to Survey

The following construction acceptance limits are extracted from RailCorp Standard ESC 210.

Survey marks shall be provided as specified in ESC 210. The survey marks and the information provided will form the primary source of information for assessing compliance.

Installed track shall conform to the basic surveyed design within the tolerances for alignment and level detailed in Table 1.

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

Table 1 - Construction Survey Acceptance limits

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

2. Additional restrictions on height tolerance may be required to suit overhead wiring. For example in areas of fixed tension the allowable tolerance would be normally restricted to - 10 to + 50.

3. Note: Measurement convention (+ means track is lower than design rail level) - see Figure 1 below

---

Figure 1 - Measurement conventions
Civil Maintenance Engineers may accept the following limited variations:

4. At standard access platforms odd exceptions up to ±15mm.
5. Odd exceptions (up to 25mm Main Line and 35mm sidings) provided these do not compromise track adjustment.
6. Odd marginal exceptions.
7. Odd marginal exceptions provided that a review of the track twist (long and short) is undertaken.
8. Odd marginal exceptions provided the level must not exceed the design rail level.

The total number of exceptions for all geometry parameters that can be agreed by the Civil Maintenance Engineer should not exceed 5% of locations.

### C4-2 
**Maintenance**

The following maintenance acceptance limits are extracted from RailCorp Standard ESC 210.

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

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

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

### C4-2.1 
**Gauge of Track**

The following maintenance acceptance limits are extracted from RailCorp Standard ESC 210.

The limits in Table 2 shall be applied when new sleepers are installed (at each sleeper) or track is cross bored or regauged.

<table>
<thead>
<tr>
<th>Gauge</th>
<th>Main line mm</th>
<th>Sidings mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variation to design gauge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wide</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Tight (including head flow)</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Limiting tight gauge</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1430mm</td>
<td></td>
</tr>
<tr>
<td>Variation in 1m (due to rail wear)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>maximum deviation at a discontinuity (eg a joint)</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2 - Maintenance Acceptance limits for gauge

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

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

Work shall be carried out to correct “foot gauge” ± 5mm. (See Table 3).
Civil Maintenance Engineers may authorise the following limited variations:

1. Correction of wide gauge on curve worn rail by tightening the “foot gauge.
2. Greater than 5mm tight gauge where rail flow is present.

Gauge must not exceed the BOS limits without appropriate protective action.

The maximum deviation at a discontinuity such as at a joint (“foul joint”) shall be in accordance with Table 2. Particular care is required to ensure that new joints cut into the track have matching profiles at the gauge face and running surface.

### C4-2.2 Accuracy to Survey

**The following maintenance acceptance limits are extracted from RailCorp Standard ESC 210.**

Track on which maintenance work has been undertaken shall conform to the basic surveyed design within the tolerances for alignment and level detailed in Table 4.

<table>
<thead>
<tr>
<th>Operating Class</th>
<th>Variation from design</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Main line mm</td>
<td>Sidings mm</td>
<td></td>
</tr>
<tr>
<td>Alignment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alignment at platforms</td>
<td>±15</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Alignment at restricted clearance locations <em>(Note 1)</em></td>
<td>±15</td>
<td>±15</td>
<td></td>
</tr>
<tr>
<td>Alignment general <em>(Note 2)</em></td>
<td>±15</td>
<td>±25</td>
<td></td>
</tr>
<tr>
<td>Superelevation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superelevation <em>(Note 3)</em></td>
<td>±6</td>
<td>±8</td>
<td></td>
</tr>
<tr>
<td>Track Surface</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height at platform for level access *(Note 6) <em>(Note 7)</em></td>
<td>–25*(Note 5)* to +15</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Height at platform for standard access <em>(Note 7)</em></td>
<td>–0*(Note 5)* to +50</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Height at other restricted height clearance locations <em>(Note 6)</em></td>
<td>–25 to +50</td>
<td>–25 to +50</td>
<td></td>
</tr>
<tr>
<td>General height, only applicable to mechanised resurfacing</td>
<td>–100*(Note 2)* to +50</td>
<td>–100*(Note 2)* to +50</td>
<td></td>
</tr>
</tbody>
</table>

Table 4 - Maintenance Survey Acceptance limits

1. Where separate construction tolerances have been supplied as part of a Transit Space Infringement Approval these will take precedence.
2. will depend on the overhead wiring configuration in the area. Allowances above 50mm can only be utilised after confirmation with the Electrical Maintenance
3. Before any significant track lifting is carried out including any mechanised resurfacing the track maintainer shall check with the Electrical Maintenance Authority to ensure that the proposed lift will meet electrical clearance requirements. Any proposed lifts shall also consider the loading on ballast top bridge structures and the impact on any ballast retaining structures such as wingwalls. The requirements do not apply to manual fettling of short term settlement locations.

4. Note: Measurement convention (+ means track is lower than design rail level) see Figure 1.

5. Over time the track level will rise as a result of maintenance resurfacing. When track maintenance is carried out any lifts that will take the rail level above the tolerances should be minimised.

Civil Maintenance Engineers may approve the following limited variations:

Note 6. Odd exceptions (up to 25mm Main Line and 35mm sidings) provided they are not on curves less than 600m radius (due to impact on track adjustment).

7. Odd marginal exceptions for mechanised surfacing provided that a review of the impact on the track twist (long and short) is undertaken.

8. Approval for work to proceed if tolerance cannot be achieved as track is too high. A minimum lift only is to be applied.

9. Resurfacing maintenance lifting can be used to correct track that is too low to design.

Ballast cleaning, reconditioning or platform raising would be required to lower track that is too high to design. If track is too high then minimum lift strategies must be applied for any maintenance resurfacing required pending correction.

10. Stakeholders must be advised where tolerances are exceeded and must be consulted on corrective strategies.

Available survey information includes survey plaques, marks on masts etc as well as F Sheets (or G sheets). Where survey is required and is not available advice must be obtained from the Civil Maintenance Engineer on the procedure to be adopted.

### C4-2.3 Unevenness

The following maintenance acceptance limits are extracted from RailCorp Standard ESC 210.

<table>
<thead>
<tr>
<th>Operating Class</th>
<th>Main line mm</th>
<th>Sidings mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line Tangent</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Mid-ordinate (mm) from overlapping chords and maximum versine (mm) for 8m chord with 2m overlap</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curve</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Mid-ordinate variation (mm) in successive overlapping chords for 8m chord with 2m overlap</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Twist

| Track twist over 2m \(^{(1)} \) | 6 | 10 |
| Track twist over 14m \(^{(1)} \) | 12 | 20 |

### Track Surface

| mid-ordinate of 6m chord | 6 | 10 |

**Table 5 - Maintenance Acceptance limits**

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

2. Irrespective of any allowances in the table above the Base Operating limits for track geometry for the relevant track speed specified in TMC 203 must not be exceeded.

---

**C4-2.4 Mechanised Surfacing**

*The following maintenance acceptance limits are extracted from RailCorp Standard ESC 210.*

Where mechanised surfacing is undertaken track geometry shall conform to the basic surveyed design within the tolerances for alignment and level detailed in Table 4.

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

**Alignment** use overlapping chords as per Table 5.

**Surface** use overlapping chords or a “Level” to determine compliance to Table 5.

Superelevation shall be checked against the tolerances in Table 4 at the following locations:

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

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

Where mechanised surfacing is undertaken track geometry shall be controlled by reference to survey plaques on structures. The location of geometry change points must also be used including TP, TRS, CTP, CTRS, Ea points. These must be located or marked prior to work commencing. Design superelevation must be available before work commences either from survey marks or from G Sheets or other source data unless advice has been obtained from the Civil Maintenance Engineer on the procedure to be adopted.

The limits provided in this section assume that laser technology and sophisticated smoothing algorithms are used including manual adjustment for curve compensation.
where required. On this basis individual locations between specified survey points are assumed to be automatically aligned to an acceptable intermediate tolerance.

C4-2.5 Manual Maintenance

The following maintenance acceptance limits are extracted from RailCorp Standard ESC 210.

Where Manual maintenance activities are undertaken track geometry shall conform to the Unevenness Criteria in Table 5 and with the following survey acceptance criteria from Table 4.

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

Track twist is to be checked for 2m and 14m chord lengths against Twist criteria in Table 5.

On multiple tracks with centres less than 4000mm, where variations in the superelevation roll the vehicles towards each other, the sum of the variations in superelevation shall not exceed 12mm.

Where activities DO NOT involve changes to alignment (such as corrective lifting of track) then alignment checks are not required except:

- at platforms or restricted clearance locations
- if there is any indication that the track may have moved during maintenance or shows visible alignment irregularity. Particular care is needed with sharper curves (less than 600m radius).

Check Top unevenness visually to ensure a smooth vertical alignment against the tolerance for Track Surface in Table 5. If in doubt use chord measurements or a Level to measure compliance.

Survey heights are not required to be taken where small sections are lifted and the track either side provides an even reference.

Where manual lining takes place line unevenness is to be assessed using overlapping chords as per Table 5.

Where short transitions are part of the track geometry design, care must be taken to ensure twist criteria are met.

For manual work methods, if the geometric requirements for alignment, superelevation, twist and top limits cannot reasonably be met then at least the Base Operating limits for track geometry for the relevant track speed specified in Engineering Manual TMC 203 must be met, and the ride of the first train over the section observed.

C4-3 Construction and upgrading limits for fixed track

The following construction acceptance limits are extracted from RailCorp Standard ESC 210.

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

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

### C4-3.1 Accuracy to Survey

The following construction acceptance limits are extracted from RailCorp Standard ESC 210.

Track Control Marks shall be provided as specified in Section 8.2 of ESC 210. The survey marks and the information provided shall form the primary source of information for assessing compliance.

Installed track shall conform to the basic surveyed design within the tolerances for alignment and level detailed in Table 6.

<table>
<thead>
<tr>
<th></th>
<th>Variation from design</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Main line (mm)</td>
</tr>
<tr>
<td></td>
<td>Sidings (mm)</td>
</tr>
<tr>
<td><strong>Alignment</strong></td>
<td></td>
</tr>
<tr>
<td>Alignment at platforms</td>
<td>± 4</td>
</tr>
<tr>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Alignment at restricted clearance locations (Note 1)</td>
<td>± 5</td>
</tr>
<tr>
<td></td>
<td>± 10</td>
</tr>
<tr>
<td>Alignment general</td>
<td>± 8</td>
</tr>
<tr>
<td></td>
<td>± 15</td>
</tr>
<tr>
<td>Variation in alignment between stations up to 20m apart</td>
<td>± 8</td>
</tr>
<tr>
<td></td>
<td>± 15</td>
</tr>
<tr>
<td><strong>Superelevation</strong></td>
<td></td>
</tr>
<tr>
<td>Superelevation variation from design</td>
<td>± 5</td>
</tr>
<tr>
<td></td>
<td>± 8</td>
</tr>
<tr>
<td><strong>Track Surface</strong></td>
<td></td>
</tr>
<tr>
<td>Height at platform relative to design rail level</td>
<td>± 10</td>
</tr>
<tr>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Height at other restricted height clearance locations relative to design rail level</td>
<td>– 0 to + 20</td>
</tr>
<tr>
<td></td>
<td>– 0 to + 35</td>
</tr>
<tr>
<td>General height relative to design rail level (Note 2)</td>
<td>± 20</td>
</tr>
<tr>
<td></td>
<td>± 30</td>
</tr>
<tr>
<td>Variation in level between stations up to 20m apart</td>
<td>± 15</td>
</tr>
<tr>
<td></td>
<td>± 20</td>
</tr>
<tr>
<td><strong>Gauge</strong></td>
<td></td>
</tr>
<tr>
<td>Gauge</td>
<td>± 3</td>
</tr>
<tr>
<td></td>
<td>± 5</td>
</tr>
</tbody>
</table>

Table 6 - Construction survey acceptance limits for fixed track

1. Where separate construction tolerances have been supplied as part of a Transit Space Infringement Approval these shall take precedence.
2. Additional restrictions on height tolerance may be required to suit overhead wiring.

Note: Measurement convention (+ means track is lower than design rail level) – see Figure 1.
C4-4  Track Condition Indices

The following acceptance limits are extracted from RailCorp Standard ESC 210.

This section details limiting Track Condition Indices (TCI) to be met at the completion of construction, upgrading and maintenance work.

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

The individual parameter TCI must not be greater than that shown in Table 7.

<table>
<thead>
<tr>
<th>Indicies – Construction and renewal</th>
<th>Top + Twist</th>
<th>Gauge</th>
<th>Line</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain Track</td>
<td>17</td>
<td>6</td>
<td>8</td>
<td>31</td>
</tr>
<tr>
<td>Turnouts</td>
<td>Not applicable</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Indicies - Maintenance (following resurfacing)</th>
<th>Top + Twist</th>
<th>Gauge</th>
<th>Line</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mainline</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tangent Track and curves ≥ 800 radius</td>
<td>NA</td>
<td></td>
<td>8</td>
<td>NA</td>
</tr>
<tr>
<td>Curved Track &gt;240m but &lt; 800m radius</td>
<td>NA</td>
<td></td>
<td>10</td>
<td>NA</td>
</tr>
<tr>
<td>Turnouts</td>
<td>Not applicable</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7 - Track Condition Index Limits

Track Condition Indicies should be assessed after the operation of, nominally, 100,000 Gross Tonnes of typical traffic.

If second hand rail is used the gauge index should be excluded from the assessment.

The ‘totals’ are a guide only. To conform to these standards no individual index should exceed the prescribed value in each parameter. It is not sufficient for the ‘total’ to be not exceeded.
C4-5

Track Code Maintenance Targets

The following construction acceptance limits are extracted from RailCorp Standard ESC 210.

The primary measure for the assessment of the maintenance status of each main line track code shall be the Track Surface measure which comprises the sum of the top and twist PCIs. Targets for line codes are based on the track speed for the section (nominally the 80% percentile highest speed). Because this is a statistical measure sections less than about 3km may be higher and hence an additional adjustment in target is to be made of between 0 to 3 points for track lengths 0 to 3km on a pro rata basis. The targets are detailed in Table 8.

For assessing local maintenance targets the limits shown in Table 8 for track lengths < 0.5 may be applied.

<table>
<thead>
<tr>
<th>Track Speed</th>
<th>Track Surface (top + twist)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of track section (km)</td>
<td>≥ 3</td>
</tr>
<tr>
<td>Main line</td>
<td></td>
</tr>
<tr>
<td>≤ 60</td>
<td>25</td>
</tr>
<tr>
<td>61 - 70</td>
<td>24</td>
</tr>
<tr>
<td>71 - 80</td>
<td>23</td>
</tr>
<tr>
<td>81 - 89</td>
<td>22</td>
</tr>
<tr>
<td>≥ 90</td>
<td>21</td>
</tr>
<tr>
<td>Slow speed loops</td>
<td></td>
</tr>
<tr>
<td>≤ 60</td>
<td>26</td>
</tr>
</tbody>
</table>

Table 8 - Track Code Maintenance Targets

The overall target upper limits for RailCorp for all main lines are detailed in Table 9.

<table>
<thead>
<tr>
<th>Top</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Track Surface</td>
<td>23</td>
</tr>
<tr>
<td>Track Condition Index TCI</td>
<td>45</td>
</tr>
</tbody>
</table>

Table 9 - RailCorp Track Condition Targets
C4-6  

**Ballast profile**

The construction and maintenance acceptance limits detailed in Table 10 are extracted from RailCorp Standard ESC 240 Ballast.

<table>
<thead>
<tr>
<th>Operating Class</th>
<th>Ballast shoulder width (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Design</td>
</tr>
<tr>
<td></td>
<td>Minimum</td>
</tr>
<tr>
<td>Main line</td>
<td></td>
</tr>
<tr>
<td>CWR and LWR</td>
<td>400</td>
</tr>
<tr>
<td>Siding</td>
<td></td>
</tr>
<tr>
<td>CWR and LWR</td>
<td>400</td>
</tr>
<tr>
<td>Loose Rail</td>
<td>300</td>
</tr>
</tbody>
</table>

Table 10 - Ballast shoulder width design and acceptance limits

C4-7  

**Sleeper spacing**

C4-7.1  

**Spacing in open track**

Sleepers shall be spaced in accordance with the requirements of Table 11 which have been extracted from RailCorp standard ESC 230 Sleepers and Track Support.

<table>
<thead>
<tr>
<th>Operating Class</th>
<th>Sleeper Spacing (mm)</th>
<th>Tolerance (spacing or skew) (mm)</th>
<th>Tolerance Limit/ m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timber</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALL Track (mainline &amp; sidings)</td>
<td>600&lt;sup&gt;Note 3&lt;/sup&gt;</td>
<td>± 20&lt;sup&gt;Note 2&lt;/sup&gt;</td>
<td>10/6 (±50mm)</td>
</tr>
<tr>
<td>Concrete</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALL Track (mainline &amp; sidings)</td>
<td>600</td>
<td>± 20&lt;sup&gt;Note 2&lt;/sup&gt;</td>
<td>10/6 (±50mm)</td>
</tr>
<tr>
<td>Maximum spacing (Sidings ONLY)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;25T Axle load</td>
<td>720</td>
<td>± 20</td>
<td>11/7.920 (±60mm)</td>
</tr>
<tr>
<td>25T</td>
<td>650</td>
<td>± 20</td>
<td>16/11 (±80mm)</td>
</tr>
<tr>
<td>30T</td>
<td>600</td>
<td>± 20</td>
<td>10/6 (±50mm)</td>
</tr>
</tbody>
</table>

Table 11 - Concrete sleeper spacing

Note 1. Installation tolerance for new or face resleepering of track sections
2. Up to 50mm for spacing to allow for missing a thermit weld (only over two sleepers)
3. Except at rail joints (See Section C4-7.2)
### Spacing at rail joints

Spacing of sleepers at rail joints in plain ballasted track shall be adjusted in accordance with Table 12 which have been extracted from RailCorp standard ESC 230 Sleepers and Track Support.

<table>
<thead>
<tr>
<th>Rail (Kg/m)</th>
<th>Design Spacing (mm)</th>
<th>Acceptance Tolerance (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Timber</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60 Insulated</td>
<td>430</td>
<td>± 20</td>
</tr>
<tr>
<td>53 Insulated</td>
<td>430</td>
<td>± 20</td>
</tr>
<tr>
<td>53 Mechanical</td>
<td>510</td>
<td>± 20</td>
</tr>
<tr>
<td>Glued Insulated Joints (any rail size)</td>
<td>600</td>
<td>± 20</td>
</tr>
<tr>
<td>All Others</td>
<td>510</td>
<td>± 20</td>
</tr>
<tr>
<td><strong>Concrete</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glued Insulated Joints (any rail size)</td>
<td>600</td>
<td>± 20</td>
</tr>
</tbody>
</table>

*Table 12 - Sleeper spacing at joints*
Chapter 5  Misalignments

Misalignments pose a serious derailment risk to rail traffic. They also may cause long delays to rail traffic.

C5-1  Definition of reportable misalignments

A misalignment (heat buckle) is a lateral movement of the track due to heat where the track has overcome the resistance provided by the ballast. Once the initial ballast resistance has been overcome there is a likelihood that further buckling will occur. Normally the displacement of the track would be more than 15mm to be considered to have overcome the ballast resistance.

Misalignments do not include:

- Small movements of the track taking up the available gap between sleeper end and ballast where the gap has been created by vertical track movement (such as at a dipped weld).
- Movement of the rail in a worn sleeper plate within the plate shoulders.
- Alignment errors or deviations not caused by heat expansion of the track (such as a curve pull-in).

In rare cases misalignments may also occur by the track buckling upwards. This is also to be considered a misalignment.

Figure 2 - Misalignment in tangent track
C5-2 Causes of Misalignment

Misalignments are NOT “caused” by hot weather.

- Properly constructed and maintained track should not misalign in the normal range of temperatures.
- Misalignments will occur during hot weather if there is something wrong with the track.
- Misalignments are caused by poor track condition.
- Poorly maintained or operated trains may also contribute to a misalignment.

Analysis of previous misalignments shows that track disturbance and/or rail adjustment are the principal causes. Other factors, such as minor ballast deficiency, when combined with these may then trigger a misalignment.

The following situations can contribute to a misalignment. Frequently the cause is a combination of several factors.

1. Poor rail adjustment (the most common cause).
   This generally arises from curves pulling in, rail creep or incorrect adjustment of rails especially when using the Steel in - Steel out method incorrectly.

2. Closed rail joints below 35ºC rail temperature.
   This is due to poor adjustment, non standard track, incorrectly bored joints, frozen joints etc.

3. Loss of adjustment control.
   Installing closures in CWR without correct use of the “rail out = rail in” process will alter rail adjustment by an unknown amount, resulting in increased misalignment potential.
   Likewise loss of creep marks, or alignment pegs mean that adjustment cannot be assessed. Loss of adjustment will go undetected leading to an increased potential for misalignments.
4. Poor rail/weld alignment.

This arises from, incorrect crowing, poor rail end alignment, poor rail profile matching, straight closures in curves, poor track alignment, or a sharp "kink" in curves.

5. Rail surface and track geometry.

Poor top, twists, dipped welds, dipped joints, wheel burns, corrugations, pumping sleepers, or insufficient superelevation are initiators for misalignments because the create additional lateral forces from rail vehicles.

6. Rail bunching locations.

These occur due to changes in grades, fastenings, sleepers, rails, bridges, turnouts, level crossings, train braking and acceleration locations or welds against sleepers. Track at these locations will lose adjustment, and if they are sufficiently localised they will be missed in the track stability analysis.

7. Inadequate and poor ballast.

This arises from sleepers not properly boxed up after PRS or fettling, shoulder ballast being knocked down; foul hard ballast, glassy ballast surface from contamination, rounded or pulverised ballast or "Nattery" ballast.

8. Inadequate and poor anchor patterns and holding.

This will occur if anchors are not hard up against the sleepers, not sufficient in number to retard the longitudinal movement of the rail, are missing or are ineffective.


Sleeper movement will occur due to sleepers being centre bound, or skewed, glassy ballast under sleepers, insufficient ballast.

10. Timber sleeper panels in concrete sleepered track.

Any small timber sleeper panels in concrete sleepers (including where adjoining timber or concrete tied turnouts) will be vulnerable.

11. Short timber sections in between turnouts.

Any small timber sleeper panels in between turnouts can still cause problems if not adjusted. These smaller sections can be an issue.

12. Local track disturbances.

Due to digging near or under the track, re-sleepering, resurfacing, lifting & packing, lining, vehicle and plant bumping the track, vehicles and plant driving up onto the ballast shoulder or track.


Specific attention is drawn to major adjustment disturbances such as from derailment damage.

14. Resurfacing on sharp curves.

Special care is needed if resurfacing is carried out on sharp curves to guard against pull-ins.
Machine tamping of the ballast in hot weather, which breaks the bond between the bottom of the sleeper and at sleeper ends with the ballast. When this is done at locations where the compressive stress in the rail is excessive, a misalignment may occur.

15. Resleepering.

Partial resleepering without properly packing and boxing up the sleepers which may cause a misalignment where there is compressive stress in the rail.

16. Trains exceeding speed boards.

As a result of one or more of the above conditions, the track stability may be reduced.

This instability may develop rapidly into a misalignment due to dynamic loading from trains. In other cases, misalignments develop with increased temperature over a period of days or weeks. During this time, evidence of reducing stability may be observed as slight variations in alignment and this is referred to as an incipient misalignment.
Chapter 6 Preventing Misalignments

Misalignments are prevented by:

1. Adjusting rails to be stress free at a temperature of 35°C (See Section C6-1) and holding them firmly in place by:
   - Anchors & fastenings or resilient fastenings.
   - Good sleepers – firmly fastened to the rail.
   - A full profile of good clean draining, firmly compacted ballast.

   Welded Track Stability relies heavily on control of rail adjustment ALL YEAR. It is not just a summer exercise.
   - In CWR, creep pegs are used to monitor changes.
   - If uncontrolled rail welding occurs, adjustment control is LOST.
   - If unreported, the loss of control is INVISIBLE.
   - It is essential that all rail welding activities are properly controlled and reported to the relevant person.
   - This is particularly important in colder weather, when uncontrolled rail welding will add steel.

2. Undertaking Welded Track Stability Examination and Analysis prior to summer to detect and correct locations that are vulnerable to misalignment (See Section C6-2).

3. Adopting defensive measures prior to and during summer at locations that are vulnerable to misalignment (See Chapter 7).

4. Adopting Summer work practices that limit the disturbance to track, particularly the bond between sleeper and ballast. (See Chapter 8).

5. Initiating reductions in speed (WOLO and heat speeds) and heat patrols on hot days. (See Chapter 8).

C6-1 Control of adjustment

C6-1.1 Rail In = Rail Out

Follow the procedures in Engineering Manual TMC 223 - Rail Adjustment to control adjustment when replacing rail using “Rail in = Rail out” process.

- This is exactly as it says - close enough is not good enough - get it right.
- Re-adjustment of the 500m section is the preferred method.
- “Rail in = Rail out” is not re-adjustment - it merely attempts to keep the adjustment the same.
- Punch mark the rail before commencing work and record it on the welding forms.
- Make allowance for any gap if repairing a broken rail.
- Use the shortest practical distance between the punch marks.
- Use rail adjusting jacks if rail temperature is less than 35°C.
- If rail temperature is greater than 35°C you will be removing steel - this may result in curve pull-in in cooler months. Consideration should be given to re-adjusting this properly when the rail temperature is lower.
- Measure punch marks at completion of work. If error is greater than 5mm - DO IT AGAIN.
• Adjustment sheets must be checked, and plus or minus steel for each 500m section must be transferred to the WTSA sheets.
• A register of “Rail in = Rail out” for each area must be kept by the Team Manager.

C6-1.2 Adjustment for major renewals
Follow the procedures in TMC 223 to control adjustment when undertaking major renewals. This includes:
• Anchor points created at ends of remaining track.
• Creep points created at least 55m from the interface.
• Adjust new track and 55m either side.
• Record any creep movement and report to the Team Manager.

C6-1.3 Rail adjustment procedure
Follow the procedures in TMC 223 to undertake rail adjustment.
• Check and record alignment. Get the Civil Maintenance Engineer's approval to adjust if more than 15mm off correct alignment.
• Establish anchor points (32 Sleepers in a row with anchors).
• Ensure that rails are fully de-stressed. When resilient fastenings are used they must all be removed between the anchor points when adjusting.
• Ensure rail gaps are correctly determined.
• Monitor quarter points.
• Restore anchors properly.
• Reverse anchor points if adjusting next section of track (DO NOT leave anchor point on and adjust each side).
• Consult Team Manager re creep punching requirements.
• Include all details on weld/adjustment return.

C6-2 Track stability assessment and correction
Follow the procedure in Engineering Manual TMC 203 - Track Inspection to complete measurement and analysis of Welded Track Stability.

For each priority location, determine the appropriate corrective action and program it. You will need to consider the improvement in stability each action will give.

WARNING.
This may not necessarily be the major factor identified by the TrackStab program and it often may be a combination of corrective actions.

C6-2.1 Ballast deficiencies
This does not always mean getting a ballast train.

Depending on the length of the ballast deficiency it may be possible to rectify the problem with:
• boxing up with shovels,
• a few buckets of ballast in a Front End Loader, or
• re-profiling with a ballast regulator.
C6-2.2 Anchor problems

Whilst the anchor pattern or problem should be fixed, due to the minor effect on stability this will rarely fix the problem on its own and priority corrective action should be addressed elsewhere.

Correct rail anchoring will reduce rail creep and stability losses occurring in the first place, but once they have occurred, simply rectifying the rail anchoring will not fix the problem.

Of course, if re-adjustment is necessary, make sure any rail anchoring issues are addressed at the same time.

C6-2.3 Track Disturbance

Use of a Dynamic Track Stabiliser will help. Otherwise it is time based and will have to be managed by appropriate speed restrictions.

If the work has not been started it can be postponed or altered to ensure the track stability loss after the work can be managed. You will need to get authorisation from the Civil Maintenance Engineer if the stability limits will be exceeded by the work.

C6-2.4 Rail Adjustment

You must decide whether the rail adjustment loss is due to actual rail adjustment (gaps and tangent creep) or due to the track being off line, or a combination of both.

If the track is off line, it will probably require resurfacing machines to pull it back to design line. Small problems may be able to be fixed manually or with earthmoving equipment.

**WARNING**

If you don't use a tamper/liner machine there will be little or no packing and consolidation of the ballast around the relined sleepers and the track may be more unstable than if you did nothing.

Resurfacing track to restore it to design line will add a disturbance factor and may not initially improve the stability loss, however this disturbance loss will dissipate with time whereas a rail adjustment problem is not going to go away.

**WARNING**

Ensure when pulling track to design line that it does not infringe structure clearances or reduce track centres below minimum levels. In double track areas with reversing curves, this may take a considerable amount of planning and effort to pull both tracks back to design line.

On sharp curves it may be necessary to also cut and adjust the track in conjunction with resurfacing to get it back on design line

**WARNING**

Track that has recently been resurfaced will still be relatively loose and is liable to pull back in overnight. If possible re-lining work on sharp curves should be delayed until no further frosts are expected. There is a fine balancing act between waiting for the last overnight frosts and not being caught by the first very hot days!
If the track has a history of pull-ins additional measures should be taken to stabilise the curve. e.g.:

- extra ballast on the shoulder of the LOW rail.
- DTS or other compaction.
- Install ballast "keels".
- Temporary adjustment out of line.
- Convert CWR to jointed track.
- If track is off line but is well bedded-in with marginal stability loss, you may be able to obtain an Engineering Waiver.

If the rail adjustment loss is due to rail creep or gap problems, this will require re-adjustment of the full 500m section. Follow the requirements of TMC 203 Rail Adjustment Manual to undertake any rail adjustment activities.

- Unless the rail adjustment problem is positively confined to a lesser area, the whole section between creep pegs must be re-adjusted - NOT 110m, 220m or 440m but the WHOLE 500m.
- Where possible, consider doing 2 x 250m adjustments.

Creep for the 500m section must be re-zeroed. If not previously established this will require dual creep punch marks/pegs (See TMC 203 Rail Adjustment Manual).

- Do NOT re-zero punch marks applying to adjoining 500m section if this has not been fully re-adjusted.
- Use a centre punch for creep punch marks, NOT a cold chisel.

**C6-2.5 Test Cuts**

Test cuts are fine for confirming the adjustment (or lack of it) at a particular point.

A test cut does not constitute re-adjustment.

**C6-2.6 Other Factors**

**C6-2.6.1 Stability losses due to poor formation, bog holes or pumping joints**

Either rectify the problem or manage it.

**C6-2.6.2 Track deliberately adjusted off line**

It is permissible to deliberately adjust track when it is not on the design alignment.

If this is done, there still must be some way of measuring and recording the track alignment - this may be relevant to the existing pegs but with different measurements, or new pegs may be installed.

All future WTSA analysis must be calculated with respect to the measurements taken when the track was adjusted.

The altered alignment MUST be carefully managed. It will require consideration in stability analysis and special instructions to resurfacing gangs.

This process is NOT RECOMMENDED. The paperwork will get lost or forgotten. Do the job properly!
C6-2.6.3 Glazed ballast bed.

To be determined.

C6-2.6.4 Sleepers and fastenings are defective.

To be determined.

C6-2.6.5 Insufficient superelevation or sharp "kink" in curves.

To be determined.
Chapter 7  **Summer Track Stability – Defensive Measures**

When track has been recognised as vulnerable to misalignment, even after action has been taken to reduce stability loss, some more extreme defensive measures may be appropriate.

**C7-1  Special inspection/ monitoring of sharp curves**

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.

Track alignment MUST be checked on curves that:

1. have a history of winter pull-in (check in mid to late November),
2. have been disturbed by resleepering/ resurfacing etc. (check in mid to late November or one week after the activity whichever is the later), or
3. appear to have pulled in from visual inspection on track patrol (check when observed).

As an alternative centre line marking of curves (see Section C7-2 below) can be carried out when the initial track position is established ie when the track is resurfaced or measured for WTSA. Routine track patrols should then check if the track has moved.

Where curves have pulled in significantly a review of WTSA must be conducted.

**C7-2  Centre line marking of curves**

Curve pull-in, especially after resurfacing is a major trigger for misalignments. It is often difficult to detect on patrols. One method to improve detection is to mark the centre line of the curve with white spray paint. If the curve pulls in the line will be broken and the pull-in becomes obvious. It isn’t necessary to mark the full curve; 2 – 3 metres is sufficient. This must be done at a number of spots around the curve where the worst pull-in is likely to occur. Any track movement is visible as a mismatch between the paint on the sleeper and that on the ballast.

**C7-3  Heat Speeds**

Speed restrictions should be imposed on track with stability loss more than 55% at lower than the normal WOLO temperature of 38ºC at any time after 1 October each year.

- Where loss of stability due to track disturbance AND ballast deficiencies ONLY, exceeds 55%, apply appropriate speed restrictions when ambient temperature exceeds 25ºC.
- Where loss of stability due to track disturbance AND ballast deficiencies ONLY, exceeds 40% (but less than 55%), apply appropriate speed restrictions when ambient temperature exceeds 30ºC.
- Otherwise use the graph in Figure 5 to establish appropriate speed restrictions.

Speed restrictions can be applied:

- Over long sections of track by applying WOLO at lower temperatures.
- Over short sections of track with temporary speed restrictions. "C" speeds may be used.

**Figure 5 - Guide to applying Heat Speeds**

### C7-4 Painting the rail

Painting the rail can reduce rail temperatures by up to 10°C. Reduced rail temperature results in a decrease in the risk of misalignment.

This must not be taken into account in the WTSA analysis unless specifically authorised, but can be assessed when considering corrective action. Painting results in a highly variable contribution due to factors such as number of coats of paint, age/cleanliness, quality of workmanship, etc. Each location will need to be assessed for its rail temperature reduction capability on a yearly basis.

It is important to note, however, that full application of the paint will result in the Track Recording Car being unable to record the rail head profile. The following conditions must be observed:

1. Agreement must be obtained from the Chief Engineer Track regarding the strategy to be used.
2. Existing paint marks showing signalling equipment connections, rail defects, tested welds, wire feed welds (tested or untested), sleeper marking and any other other painted indication must be re-established. New welds not yet tested will also need to be marked and Weld Identification stickers protected. This will require a detailed examination prior to painting.

3. The running surface of the rail head and the gauge face of the high rail on curves must not be painted.

4. Only plain track in open areas may be painted (not joints, turnouts, level crossings etc).

5. Paint may not be applied to areas where the rail is contaminated with grease, dirt or sand, or where there is evidence that the rail is being affected by an abnormal level of corrosion.

6. All other implementation issues, especially environmental and OH&S, must be reviewed.

The operating platform contains a painting applicator and frame work to support paint hoses, heavy duty extensions, spray guns and pressure variable adjustment swivel spray tip holders.

![Figure 6 - Operating platform attached to hi rail](image)

**C7-5**  
**Dealing with low stability track**

Where track has demonstrated from current or past experience that it will not remain stable after correction of curve pull-ins then repeated attempts to pull the track out will not help and will reduce the stability of the track still further. The problem is normally associated with timber sleepers on sharp curves (often associated with steep grades and heavy traffic) and a weak ballast structure such as a “glazed bed” or poor quality ballast.

The recommended long term strategy is to install heavy duty concrete sleepers. When resurfacing is needed because of irregular geometry then try to organise it for autumn (rather than winter or summer). Otherwise, the short term approach should be to increase the track stability at these locations rather than try to line them out. If track does not need resurfacing because of irregular geometry, then the following strategies should be adopted:

- temporary adjustment to suit current alignment (but noting readjustment may be required at some point), or
- rail painting to achieve lower maximum rail temperature.
These measures should be supplemented by additional stability measures such as:

- ballast paddles/keels,
- extra ballast on ends of sleepers (but below rail height),
- extra ballast on sleepers provided sleepers are in good condition and noting it will have to be removed after summer to facilitate the next sleeper inspection,
- extra ballast compaction.
Chapter 8  Summer Work Practices

This chapter describes the DO’S and DON’TS of track maintenance in the summer season.

Unless directed otherwise, the summer period lasts from 1 November to 31 March.

C8-1  Inspection

During the summer period maintenance staff carrying out track inspections should focus on:

- spotting and highlighting trigger areas where potential misalignment may occur, and
- carrying out spot checks of the Welded Track Stability forms to make sure the information supplied on them is correct and completed appropriately.

C8-2  Maintenance

During the summer period the main task of the track maintenance staff is the maintenance of the track to its maximum stability.

Track disturbance during the summer months reduces track stability and increases the risk of it misalignment. Whilst it is preferable to avoid track disturbance, it may however be necessary in certain circumstances. During and after this track disturbance, maintenance staff must be satisfied that the track has been maintained to its maximum stability and must comply with the requirements detailed in Sections C8-7 to C8-3 below.

The following activities can affect track stability:

- Any disturbance to rails, sleepers or ballast.
- Resurfacing.
- Rerailing.
- Resleepering.
- Ballast cleaning.
- Earthworks and drainage.
- Welding & CWR.
- Trenching or installing cables under or alongside the track.
- Repairing rail defects.
- Damaging ballast shoulder/profile with plant/road vehicles or by repeated walking down shoulder.

ALL staff when working on or near the track must beware of:

- Bumping the track eg with earthmoving plant.
- Knocking down or removing ballast profile eg with trucks or earthmoving equipment running along the ballast shoulder or climbing up the ballast shoulder.
- Undermining the ballast profile by excavation eg excavation under or alongside the track.

Before commencing any work that will affect track stability, you must check:

- What is the current stability loss?
- When you do the work, what will the stability loss be when you’ve finished?
• What actions are you taking to make sure the track won’t buckle after the work is done?
• Remember it will take some time for the track to bed down again.

C8-3 Visiting staff in summer

Any staff working or planning work that will affect track or track stability in the defined summer period (1st November to 31st March) MUST know the requirements for working in summer months.

Local track maintenance staff must be formally notified of any work being done on or about the track.

Before commencing any work, the Project Supervisor and the Civil Maintenance Engineer MUST ensure WTSA requirements have been addressed and arrangements are in place with all visiting gangs. They MUST agree on:

1. The allowable scope of work.
2. The WTSA stability loss at the work location, both before AND after the work.
3. The effect of the work on stability.
4. Any actions required to control the risk of misalignments, eg DTS, speeds.
5. Reporting requirements, including WHO, WHERE, HOW, HOW SOON and HOW OFTEN records of work are to be forwarded to maintenance personnel.

Adjustment and welding records must be available to maintainers in a timely manner. There must be clear arrangements as to how WTSA matters are to be handled.

6. Arrangements for dealing with “out of course” events that may affect track stability.
   
   e.g. Regulator breaks down and ballast is deficient – who does what?
   
   e.g. What happens if track adjustment is not complete when possession runs out?

7. Arrangements for contacting responsible maintenance and renewals staff if “out of hours” problems arise.

NOTE: When resurfacing in sharp curves, it is important to avoid stopping the work in the middle of the curve. Doing so will create an interface between disturbed -non disturbed track that will be a point of weakness and a potential misalignment trigger.

Special attention must be paid by maintenance staff to work locations where adjustment may not have been completed (eg rerailing, reconditioning).

C8-4 Authority to work in summer

Civil Maintenance Engineers can authorise work in summer by issuing written instructions which will detail the special actions to be taken prior to, during, and after the work to maintain track stability. Guidelines for the development of local instructions are detailed in Section C8-11.
C8-5 **Green Card "Safety Net"**

In the absence of written authorisation from the Civil Maintenance Engineer, the "safety net" "Work in Summer Months" restrictions apply to the following activities:

Note: the Team Manager has the authority to stop any work being carried out within the rail corridor that could adversely impact on the track stability and the safety of the running line.

1. Manual resleepering
2. Mechanised resleepering
3. Mechanised resurfacing
4. Fettling, manual lifting and lining

DO NOT carry out ballast cleaning, track jacking, reconditioning etc when the rail temperature is above 38°C.

Rail adjustment and rail defect removal may continue during the summer period when the rail temperature allows adjustment and if there is no TOTAL FIRE BAN.

Simplified instructions for Team Leaders are included as Appendix . These instructions have also been reproduced on plastic card to be distributed to and carried by all Team Leaders, or staff acting as Team Leaders during the summer season. An "actual size" version of the "Green Card" is included as Appendix .

C8-6 **Recording and reporting work details**

Any staff carrying out work affecting track stability MUST report full details of the work to the Team Manager. In particular:

1. Welding/adjustment returns MUST show all adjustment details, and/or steel in/steel out measurements.
2. Any disturbance.
3. Alignment measurements.

In CWR track, the alignment of track is a vital component of track stability. Even more critical to the maintenance of track stability is knowledge of the alignment of track at the time that the track is adjusted.

When any work is being undertaken that alters the track adjustment in CWR track (eg rail adjustment, resurfacing etc), “Before” AND “After” alignment measurements MUST be recorded.

C8-7 **Report any incidents**

Report immediately any incidents or unplanned works that occur without the prior knowledge of the Team Manager. This includes:

- Bumping or disturbing track.
- Uncontrolled rail welding.
- Disturbing ballast.
- Changing track alignment on curves.
- Failing to complete planned rail adjustment.
C8-8  Heat Speed after work in summer months

A ‘C’ speed restriction (Heat speed) must be applied to the work area after mechanised resleepering and resurfacing as follows:

<table>
<thead>
<tr>
<th>Normal Speed Board Speed</th>
<th>Temporary Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>100-160 km/hr</td>
<td>80 km/hr</td>
</tr>
<tr>
<td>75-95 km/hr</td>
<td>60 km/hr</td>
</tr>
<tr>
<td>40-70 km/hr</td>
<td>40 km/hr</td>
</tr>
<tr>
<td>Under 40 km/hr</td>
<td>No reduction</td>
</tr>
</tbody>
</table>

1. The speed applies to all traffic.
2. The speed will apply for seven (7) days or until 100,000 tonnes of traffic has passed, whichever is less. The Civil Maintenance Engineer may extend this period.
3. Where the Dynamic Track Stabiliser (DTS) is used during resurfacing the speed restriction may be removed after one (1) day.
4. When mechanised resleepering and resurfacing is carried out on fully concrete sleepered track and where the dynamic track stabiliser is used a speed restriction is NOT required. This is conditional on a full ballast profile being achieved following the work.

The CME or Team Manager for the area concerned must be notified of the use of or proposed use of the waiver in each instance.

C8-9  Heat Speed exemption for cooler days

The speed restriction for timber sleepers where the dynamic stabiliser has been used is not required on days where the forecast (or actual) maximum air temperature does not exceed 30°C (25°C before 15 November). This decision must only be made by the CME (or his nominee) or the Team Manager.

The use of this exemption is conditional on the other requirements of Chapter 8 being met and a full ballast profile being achieved following the work.

C8-10  Mandatory application of C-Speed restrictions

The following mandatory requirements apply to the use of all daylight hours speed restrictions, known as C Speeds or “heat speeds”.

1. Temporary Speed signs are to be placed and notified in accordance with the requirements of Chapter 21.
2. C speeds MUST always be issued as 1000 to 2000hrs.
3. The speed restriction when applied, will include the use of an additional plate attached to both the Warning and Caution Boards indicating ‘1000 to 2000’.
Guidelines for Local Instructions

Track Disturbance in the summer months reduces track stability and increases the risk of misalignment. Whilst it is preferable to avoid this disturbance, it may be necessary in particular circumstances, for example:

- Planned maintenance.
- Availability of resources (staff, machines, contract, possession).
- Track condition problems (TCI's, track geometry defects, track alignment, track stability, geotechnical problems etc.).
- Coordination with other works (bridge renewals, CWR, rail grinding, rerailing etc.).

When considering whether work should proceed at any location, the Civil Maintenance Engineer must:

1. Assess the probability of misalignment.
   - What is the current % loss of track stability?
   - What changes will occur in % loss of track stability due to the work?
   - Is the work at a location where a misalignment is more likely to occur (eg. on a curve, at a fixed point etc.)?
   - Is the degree of disturbance due to the type of work sufficient to cause a misalignment?

2. Assess the consequences of doing/not doing the work.
   - Is the condition that exists such that not doing the work is likely to present a significant safety/service risk?
   - If a misalignment occurs, what is the potential result in terms of safety/service (eg. sharp curves, high banks, multiple tracks, high speed etc.)?

When, having considered the above, the Civil Maintenance Engineer assesses that the work should proceed the following options need to be examined in the formulation of the written instructions.

3. Reduce the probability of misalignment during the work.
   - Avoid work when rail temperature is high by working at night or early morning.
   - Minimise the track disturbance.
   - Reinstall track progressively during the work, by packing and boxing up.
   - Increase the neutral temperature of the rail by removing steel.
   - Reduce lateral dynamic forces by imposing speed restrictions at the worksite.
   - Monitor rail gaps and temperature during the work against established limits. Cease work when limits are exceeded.
   - Monitor worksite for any signs of track movement.

4. Reduce the probability of misalignment subsequent to the work
   - Apply a speed restriction to reduce lateral dynamic forces.
   - Add extra ballast.
   - Use the ballast stabiliser.
   - Increase the neutral temperature of the rail by removing steel.
   - Monitor the performance of the track after the work by special inspections to detect incipient misalignment.

5. Reduce the consequences of a misalignment due to the work.
6. Define the procedures and limitations of the written instructions.

- The instructions must define what limits apply to the work and work methods.
  
  (e.g. how many sleepers/spacing, temperature limits rail and air, resleepering method etc.)

- The degree and method of supervision must be defined.
  
  (e.g. Team Leader performing and supervising as instructed by the Team Manager, Team Manager providing direct on site supervision. Level and frequency of reporting progress to Civil Engineering representative etc.)

- Limits on work locations and features must be described.
  
  (e.g. The instruction applies to one location or, no work on curves < 300m radius, no work where final stability loss will be more than 50% etc.)

- Site protection and contingency procedures are to be documented.
  
  (e.g. speed restrictions to apply, Inspections of sites at say 35°C etc.)
Chapter 9  WOLO

A WOLO Speed Restriction is a temporary reduction in the speed of trains, for one day only, when the AIR temperature is high, or is forecast to be high.

When the AIR temperature on any day reaches or exceeds 38°C (35°C in the Blue Mountains Zone) OR is predicted to reach or exceed 38°C a WOLO Speed Restriction MUST be applied unless special circumstances apply.

Note: Prior to 15 November the WOLO Speed Restriction MUST be applied when the AIR temperature reaches or exceeds 35°C OR is forecast to reach or exceed 35°C. This additional restriction is applied because of the general existence of priority Welded Track Stability locations in spring.

C9-1  What speed restriction is applied

(This is provided for information ONLY. The primary source is the Train Operating Conditions (TOC) Manual)

When WOLO conditions are in force the speed of any train must not exceed the appropriate WOLO speed specified in Table 13.

<table>
<thead>
<tr>
<th>Train Type</th>
<th>Ruling Train Speed*</th>
<th>WOLO Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger trains (all types) and light locomotives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 km/h or more</td>
<td></td>
<td>90 km/h</td>
</tr>
<tr>
<td>95 km/h</td>
<td></td>
<td>85 km/h</td>
</tr>
<tr>
<td>90 km/h</td>
<td></td>
<td>80 km/h</td>
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<tr>
<td>85 km/h</td>
<td></td>
<td>75 km/h</td>
</tr>
<tr>
<td>80 km/h</td>
<td></td>
<td>70 km/h</td>
</tr>
<tr>
<td>75 km/h</td>
<td></td>
<td>65 km/h</td>
</tr>
<tr>
<td>70 km/h or less</td>
<td>Allowable Track speed but not exceeding 60 km/h</td>
<td></td>
</tr>
</tbody>
</table>

| Freight trains containing all loaded vehicles. OR |
|-------------------------------------------------|---------------------|---------------------|
| Freight trains containing one or more empty vehicles, all of which must have an allowable empty vehicle speed exceeding 80 km/h |
| NOTE: For the purpose of this rule, a loaded vehicle is one with a gross mass of 30 tonnes or more |
| 90 km/h or more                                |                     | 80 km/h             |
| 85 km/h                                        |                     | 75 km/h             |
| 80 km/h                                        |                     | 70 km/h             |
| 75 km/h                                        |                     | 65 km/h             |
| 70 km/h or less                                | Allowable Track speed but not exceeding 60 km/h |

| Freight trains containing one or more empty vehicles, which are restricted to an allowable empty vehicle speed of 80 km/h or lower |
| NOTE: For the purpose of this rule, a loaded vehicle is one with a gross mass of 30 tonnes or more |
| 80 km/h or less.                                | Allowable Track speed but not exceeding 50 km/h |

*The ruling train speed shall be the allowable track speed or the allowable vehicle speed as specified in the SECTION PAGES, whichever is the lesser

Table 13 - WOLO Speed Restriction

The restrictions will generally apply from 1200 to 2000 hours, although they can be imposed earlier if considered necessary.
C9-2 When is the speed restriction applied

A WOLO speed restriction is applied to reduce the stresses imposed on nominated sections of welded track by trains at speed, at times when stresses are already imposed by extreme temperatures.

Prior to 15 November each year a WOLO speed restriction MUST be applied when the AIR temperature reaches or exceeds 35°C OR is forecast to reach or exceed 35°C.

From 15 November each year a WOLO speed restriction MUST be applied when the AIR temperature reaches or exceeds 38°C OR is forecast to reach or exceed 38°C, except in the Intercity Blue Mountains zone where the temperature for initiation remains at 35°C for the full year.

Notwithstanding any of the above requirements, a WOLO wire does not need to be applied if the welded track stability analysis, correct to the day in question, shows that all tracks in the area have less than 10% loss of stability.

When the air temperature reaches or exceeds OR is forecast to reach or exceed 43°C, Civil Maintenance Engineers are to review the level of speed restriction on all tracks, including concrete sleepered track, and take appropriate action.

The nominated sections change each year because of the continuing installation of concrete sleepers. A list will be compiled each year by the Infrastructure Operations Centre from information provided by the Civil Maintenance Engineers and published, prior to the start of the summer period, in a Civil Technical Note.

Care must be taken to ensure the concrete sleepers in these sections are continuous or have been otherwise reviewed (turnouts and other fixed points excepted).

All staff should be made aware of the WOLO conditions to be applied to various lengths of concrete sleepered track.

The standard telegram is to be compiled by the Infrastructure Desk of the Rail Management Centre using the current “WOLO Operating Procedure”.

Civil Maintenance Engineers may, at any time, choose to apply a temporary speed restriction (“C Speed”) in accordance with the procedures in Section C8-8 on specific sections or sites where stability is of concern. At such locations Warning and Caution Boards must be erected and the speed restriction advertised in accordance with the system detailed in the Network Rules and Section C8-10.

C9-3 How is WOLO put on and taken off

RailCorp is divided into four (4) standard zones. A WOLO speed restriction may be applied to any or all zones in accordance with these procedures. The speed restriction will apply to all nominated sections on lines within any zone, ie WOLO is applied to the entire zone. The zones are detailed in Table 14.

<table>
<thead>
<tr>
<th>WOLO Zones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Zone</td>
</tr>
<tr>
<td>Central/Sydney Terminal - Springwood</td>
</tr>
<tr>
<td>Strathfield - Cowan</td>
</tr>
<tr>
<td>Central - Wynyard – Hornsby (North Shore)</td>
</tr>
<tr>
<td>Redfern - Helensburgh</td>
</tr>
</tbody>
</table>
### WOLO Zones

<table>
<thead>
<tr>
<th>Zone Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sutherland - Cronulla</td>
</tr>
<tr>
<td>Sydenham - Bankstown - Regents Park</td>
</tr>
<tr>
<td>Tempe - Glenfield Junction</td>
</tr>
<tr>
<td>Metropolitan Goods Lines</td>
</tr>
<tr>
<td>Clyde - Carlingford</td>
</tr>
<tr>
<td>Blacktown - Richmond</td>
</tr>
<tr>
<td>Lidcombe - Regents Park - Glenlee</td>
</tr>
<tr>
<td>Granville - Cabramatta</td>
</tr>
<tr>
<td>Intercity Blue Mountains Zone</td>
</tr>
<tr>
<td>Springwood - Bowenfels</td>
</tr>
<tr>
<td>Intercity North Zone</td>
</tr>
<tr>
<td>Cowan - Newcastle</td>
</tr>
<tr>
<td>Intercity Illawarra Zone</td>
</tr>
<tr>
<td>Helensburgh to Port Kembla</td>
</tr>
<tr>
<td>Coniston to Nowra</td>
</tr>
</tbody>
</table>

#### Table 14 - WOLO speed restriction zones

WOLO conditions are imposed and removed using the Infrastructure Operations procedures implemented through the Infrastructure Desk in the Rail Management Centre. These procedures include issuing a NIN (Network Incident Notification) stating WOLO Zones enforced or removed once advice has been received from the Civil Maintenance Representative.

The speed restriction should be removed as soon as practicable when a substantial weather change has occurred. Because of the time lag involved in the reduction of rail temperature when AIR temperature reduces, and because of local factors the WOLO wire should not be removed immediately the AIR temperature falls below 38°C.

WOLO boards are in use at locations detailed in the TOC manual. The signs are a reminder only and have been installed where the frequency of trains and the varied origin and distribution of trains may make it difficult to notify all drivers. Infrastructure maintenance staff are responsible for the operation and maintenance of the WOLO boards. They must ensure they are shown correctly when WOLO conditions apply.

### C9-4 Where do the official forecasts come from

Up to date temperature forecasts are to be obtained from appropriate Bureau of Meteorology Offices or from remote monitoring stations.

The Infrastructure Desk of the Rail Management Centre are to monitor temperatures throughout the day, through the WOLO period in accordance with the Infrastructure Operations procedures.
Chapter 10 Misalignment repairs

This chapter sets out procedures necessary to carry out temporary and permanent repairs to misalignments on welded track.

C10-1 Protect the site

When a misalignment is located the first priority is for the protection of traffic.

1. Check the size of the misalignment. Will trains be able to pass over the site at reduced speed?
2. Will the pantographs on electric trains remain connected to the Overhead Wiring?
   If a large track movement has occurred the location of overhead wires should be checked.
3. What are the clearances to other tracks and/or structures? Can trains pass safely?

STOP trains if the track is not safe. If it is safe for trains to pass over the misalignment at a reduced speed, make appropriate arrangements.

When a misalignment has occurred, the following actions are required.

C10-2 Before disturbing the site

1. Some information that is required for the misalignment report will be destroyed during the repair process. The following information MUST be gathered before you disturb the track:
   o Measure the size and length of the misalignment.
   o Check anchor effectiveness.
   o Check ballast profile.
   o Look for bunching points such as welds jammed against sleepers.
   o Look for misalignment initiators such as poor weld alignment.
2. Before cutting the track, punchmark both rails either side of the proposed cut and measure and record the distance between punchmarks so that the track adjustment at the time of misalignment can be determined.
3. Before changing the alignment beyond the immediate area that has misaligned, check and record track alignment to survey.

C10-3 Temporary repairs to misalignments

Remember, these are guidelines for temporary repairs only.

Restore smooth line by either:

- Spraying water onto the rail to drop its temperature,
- Slewing the track out to a smooth line, or
- Cutting and removing rail.
1. Cool the rails (if possible).
   Water is great! If available water will rapidly lower the rail temperature and assist repairs.
   Spray it over the rails at and adjacent to the misalignment. You may be able to reline the track to its correct alignment.

2. Slew the track out to a smooth line.
   Slew the track out on both sides of the misalignment to a curve of best fit where it will remain without further movement.
   Start the slew some distance away from the centre of the misalignment, working from each side towards the misalignment point. The greater the distance over which the slew is made the easier the curve will be.
   The curve radius MUST be ≥ 160m.
   Remember that ballast must be moved from the inside to the outside to make sure that the ballast profile can be restored on the outside of the curve.

3. Cut the rails and remove steel.
   Before cutting the track, punchmark both rails either side of the proposed cut and measure and record the distance between punchmarks. This will enable accurate measurement of how much steel is removed and calculation of adjustment error.
   Cut the rails. The rails will need to be oxy cut if they are still in compression as a rail saw blade will jam. Continue to remove steel until the rail stops expanding. You have removed excessive compression from the rail and temporary repairs may proceed.
   Remember; oxy cut rail ends must be saw cut before they are plated.

4. Restore the track to the correct alignment.
   Before changing the alignment beyond the immediate area that has misaligned, check and record track alignment to survey.

5. CHECK the alignment by stringlining to ensure it is safe for the passage of trains.
   The curves of the temporary slew must be ≥ 160m radius.

6. CHECK Track centres.
   You may need to get information from the CME regarding track centres.

7. CHECK the location of overhead contact wires.
   Ensure not more than 50mm off line or 25mm over design superelevation if under overhead wiring (if both vary from design, there is a combined effect - check the geometry acceptance limits in Chapter 4.)
   Advise an Electrical Engineering representative if the track cannot be pulled back to within 75mm of its original position.

8. CHECK superelevation.
9. CHECK clearances to structures.
   Misalignments fouling structures or the face of cuttings require the track to be eased out far enough away from the point of misalignment to permit pulling in, to clear the structure or cutting at the point of fouling. This pulling out must not foul other structures.

   Minimum clearance to structures is 2.135m on tangent track (more on curves).

10. Pack and box up.
   Beater pack and box up sleepers around the misalignment location.
   Move ballast from low rail to high rail if necessary. As a temporary measure additional ballast in the 'four-foot' will help weigh the track down and provide resistance to buckling.

   If the track is to remain in the temporary position until measures are taken to restore it to its correct alignment, any additional ballast required must be ordered and correctly spread when received.

11. Apply suitable speed restrictions.

12. Complete a misalignment report and send it to the appropriate officers.

C10-4 Checking adjustment if no major realignment (only relining area of misalignment)

1. Put the "kick" back on line.

2. Check the track adjustment at least at the misalignment location and a minimum of 55m each side (minimum total of 110m). Record rail temperature and gap measurements.

3. Use the result from (2) plus the measurement of steel removed (which is found by remeasuring the punchmarks and calculating the change in length) to determine the adjustment at the time of misalignment.

4. Ask the Civil Maintenance Engineer if you need assistance.

5. To determine why adjustment is in error, further investigation may be required. This may include checking alignment, creep etc.

C10-5 Checking adjustment if major realignment is required

1. Measure and record actual alignment to survey marks before disturbing the track.

2. Measure and record actual alignment to survey marks after realignment of track.

3. Send the alignment information to the CME (or technical office if the CME directs) for review.

4. If track has been cut to help correction of the misalignment, carry out the steps in Section C10-4 above and send the information to the CME (or technical office) as well.
C10-6  Permanent repairs to misalignments

1. Establish, from the investigation and stability analysis carried out after the misalignment, the appropriate action to effect permanent repairs to the misalignment.

2. Carry out the permanent repairs as soon as possible. This will generally include:
   - Proper re-adjustment of the affected length. Minimum length of adjustment is 110m.
   - Placing the track in correct alignment.
   - Restoring the ballast profile and consolidate if possible.
   - Ensuring track is correctly anchored.
   - Packing and boxing up all sleepers.

3. Extra caution should be observed as once a misalignment has occurred it is more likely to misalign again. Track adjoining the misaligned area within the same curve should also be considered. Additional measures could include:
   - Temporary adjustment short of steel.
   - Additional ballast especially on the outside of the sleeper ends.
   - Painting the rails.
   - Use of ballast paddles/keels.
   - Temporary joints on dogspiked track.
Chapter 11 Reporting of misalignments

C11-1 Management & reporting of misalignments

Team Manager

1. Report any misalignments to the Civil Maintenance Engineer no later than 08:30 the following day. This report is to contain the following information as a minimum:
   - Date misalignment occurred.
   - Location of misalignment, line, track, kilometrage.
   - Current track status, speeds applied.
   - Apparent cause.

2. Complete a misalignment form (Form MIS 1 – See Appendix) for each misalignment following the procedure in Section C11-3.

3. Forward the completed form to the Civil Maintenance Engineer as soon as practical after the misalignment.

Civil Maintenance Engineer

1. Check the information in the report and sign it.

2. Send the completed form to the Chief Engineer Track within two days of the occurrence of any misalignment (this can be an interim report pending further investigation).

3. Conduct a full misalignment investigation for each misalignment on mainline track. Complete a Misalignment Investigation Report (Form MIS 2 – See Appendix). The report need not be sent in but should be kept by the Civil Maintenance Engineer (these will be reviewed as part of the audit process). The findings of the investigation should be included on the Misalignment Report.

C11-2 Records

Team Manager

1. Maintain a record of locations where misalignments have occurred on their track. This register should be checked at the beginning of every summer. All misalignments for the previous 3 years should be given very close attention during the Welded Track Stability Analysis.

Civil Maintenance Engineer

1. Maintain a register of dates, and locations of previous misalignments.

2. Maintain copies of completed misalignment forms.

3. Use this information at the start of each summer period to see if any locations or work practices should come under close scrutiny during the forth coming summer period.
Chief Engineer Track

1. Maintain a register showing the dates and locations of all misalignments and a copy of Misalignment Reports.

2. Review the stability performance at the end of each summer period to locate areas of possible improvement and take appropriate action.

C11-3 Completing a Misalignment Report

Record the following information using the Misalignment Form (Form MIS 1).

This Report Form provides for most information to be placed in boxes for subsequent analysis. Most of the sheet is self explanatory. Where more explanation is believed necessary it is given below:

1. District.
2. Track Base Code.
3. The date of the misalignment.
4. Station to Station.
5. Kilometrage.
6. Track Up/Down/Single/etc.
7. Who detected the misalignment?
8. At what time was it detected?
9. Who was the misalignment reported to?
10. The magnitude of the misalignment’s lateral displacement in millimetres (mm) over a length of chord in metres (m).

Measure the length of the misalignment to the nearest 5m (rounded up).

Measure the lateral displacement to the nearest 25mm (rounded up). If the misalignment is displaced more than 150mm, rounding to the next 100mm is satisfactory.

The following track description details are required:

11. The radius of the track.

Where the radius is known it should be shown. Treat the transitions as part of the curve.

12. The rail section in kg/m.

13. The length of the rail.

14. The type of sleepers.

15. The type of fastenings.

Where there is a mixture of fastening the most predominante type should be shown.
16. The condition of the sleepers.

17. The anchor pattern (if applicable).

For the purpose of this information treat sleepers with elastic fasteners as if they are anchored.

18. The air temperature at time of incident. Is it actual or estimated?

19. The rail temperature when inspected.

20. What was the last type of track disturbance to occur, and when was it carried out?

In considering this section ask the following questions:

- When was the track last resurfaced?
- When was the track last resleepered?
- Show the date if known.

21. Was the shoulder or crib ballast deficient?

Only consider the ballast profile within 10 m of the misalignment location.

22. Were the rails out of correct adjustment?

The adjustment of the site can only be determined by carrying out an adjustment (normally of 110m over the area of the misalignment). Use the adjustment error for the calculation of Track Stability at the Time of Misalignment (see 27 (o) below). Since the calculation is based on the alignment of the track prior to buckling put track back on its assessed alignment prior to the adjustment check.

The only way to decide if adjustment was correct is cut the rail, remove anchors and vibrate the rail using the procedure in Engineering Manual TMC 223 - Rail Adjustment. If the track is on a curve the track must also be on correct alignment.

To show that the rail was not cut but the adjustment is correct is not a complete analysis of the misalignment.

Also ask who placed the last 5 welds in the section of track? What was their work practice? Was it to measure the track and replace the same amount of steel that was removed? Could they have performed an adjustment weld when the track was off line? Is there any documentation to support your opinions?

23. Have the rails crept?

24. Were any anchors ineffective? (if applicable)

25. Were any fastenings ineffective?

26. Was track off its correct alignment?

This means prior to the misalignment. If track is curved it refers to the full length of the curve. If the track is straight track, more than 50m from the end of a curve the answer is not applicable so answer NO.

As well as answering yes or no, consider the question if the curve is off alignment which gang last resurfaced here. When? Do they have records showing they put the track on correct alignment?
Curve transitions should be treated as if they were part of the true curve. Track within 20 m of the TP should be treated as if it were part of the curve.

27. The following details from the Track Stability Analysis are required:

   o **Pre-summer Calculations** - are the calculations completed at the beginning of summer to determine priority locations, i.e. the original WTSA figure calculated.

   o **Calculations at the Time of Misalignment** - are the calculations at the time the misalignment occurred. They are determined AFTER alignment, adjustment, ballast, anchors and track disturbance has been checked. They will vary from the pre-summer calculations for the following reasons:

      ■ If any work was performed because the track was identified as a WTSA priority location, and/or
      ■ Changes in the stability factor as a result of work performed.
      ■ If the track has been disturbed or consolidation under traffic has occurred since the original calculation was carried out
      ■ If the track adjustment is different from predicted by the WTSA analysis.

   Last T.C.I. and Location Factor need only be included if they have changed since the original calculation was carried out.

   This calculation should indicate the principle reasons for the misalignment. If the stability loss shown in this area totals < 50 it is probable that some of the contributory factors have been overlooked

   o **Calculations after repair** - are the revised calculations after the track has been repaired, i.e. re-adjusted or ballasted etc. The misalignment itself would constitute a track disturbance of approximately 20%.

28. The following general details relating to the misalignment are required to be reported in the lower portion of the form:

   o Details of the last train over the site prior to the misalignment.
   o What was the apparent cause of causes of the misalignment?
   o What immediate corrective action was necessary to restore traffic?
   o What steel was removed to correct misalignment, and at what temperature was it removed? Punch marks should be used.
   o Was a speed restriction imposed?
   o What train delays resulted from the misalignment?
   o What further corrective action is proposed to stabilise track?
   o Any other comments or details which may be relevant?

The Civil Maintenance Engineer must review the report and be satisfied as to its accuracy and the adequacy of action taken to correct the failure.
Chapter 12 Winter Work Practices

When colder weather approaches use the following inspection and maintenance processes to deal with cold weather hazards.

C12-1 Inspection

During scheduled inspections look for:

1. Curve pull-ins and effect on clearances and on OHW in electrified areas.

   Curve pull-in, is an issue of concern in Winter, specially after resurfacing. It is often difficult to detect on patrols. One method to improve detection is to mark the centre line of the curve with white spray paint. If the curve pulls in the line will be broken and the pull-in becomes obvious. It isn’t necessary to mark the full curve; 2 – 3 metres is sufficient. This must be done at a number of spots around the curve where the worst pull-in is likely to occur. Any track movement is visible as a mismatch between the paint on the sleeper and that on the ballast.

2. broken bolts in turnouts.

3. Anchoring around points (ahead and behind) is effective.

4. Mechanical joint problems:
   - Breakaways.
   - Broken plates.
   - Broken or bent bolts.
   - Broken bolts in turnouts.

   Breakaways are due to a deficiency of steel in the track for the following reasons:
   - Alteration to correct rail adjustment by smooth lining, if the track is pulled outwards, causing high tensile stresses in the rails in cold weather breaking the joint bolts.
   - Track creep causing high tensile stresses in the rails at the point from where the track has crept.
   - High lifts of track without adjustment of the rails.

5. Insulated joint problems:
   - Broken or bent bolts.
   - Broken plates.
   - Bonding glue cracking and breaking away from the rail at glued insulated joints.
   - Short circuit because of interference by clips. Make sure there is adequate clearance between clips and fishplates/bolts, particularly if there is rail movement. Are low profile clips being used?

C12-2 Maintenance

1. Make sure there are systems in place to deal with broken rails so that delays are avoided.
2. Rail welders must make sure they follow correct procedures when placing rail closures. Make sure Rail In = Rail Out.

3. Make sure that correct ballast profile is restored following resurfacing or track disturbance. This will help guard against curve pull-in due to poor ballast profile, and help avoid excessive ballast requirements for WTSA.

4. Make sure that Rail lubricators are adjusted for colder weather as lubricant may become stiffer in colder weather.

5. Production and Track staff should consider centre line marking of curves following resurfacing so any curve pull-in is observable.

6. Track staff should consider checking rail adjustment at bunching points at the interface of concrete and timber sleepers sleepers. This can be done as the opportunity arises in possessions and closedowns during the winter. It can be carried out using without cutting the rails by using the Verse system as detailed in Engineering Manual TMC 223.

C12-3 Resurfacing on sharp curves

Special care is needed if resurfacing is carried out on sharp curves to guard against pull-ins. Make sure there is a full ballast profile and preferrably with a winrow of ballast outside of the ends of the sleepers (but not above rail level). The Dynamic Track Stabilizer should be used if possible. When planning resurfacing if practicable the colder months should be avoided. Where resurfacing has been carried out track should be monitored especially after a cold snap to ensure it has not pulled in.

On lines which feature sharp curves, where alignment is difficult to maintain, it is recommended that additional measures be taken to stabilize the tracks, including:

- Use of dynamic stabilizer when tamping.
- Additional ballast especially on shoulders (but clear of train trips).
- Additional speed restrictions in hot weather.
- When resurfacing in sharp curves, it is important to avoid stopping the work in the middle of the curve. Doing so will create an interface between disturbed -non disturbed track that will be a point of weakness and a potential misalignment trigger.
Chapter 13 General Work Practices

C13-1 Work practices affecting clearances

To avoid incidents of trains tripping:

1. **DO NOT** place any material (rails, sleepers, ballast etc.) above superelevated rail height for a distance of at least 750mm away from gauge face of both up and down rails.

2. If you have run out ballast, remove any work infringements prior to the running of trains.

C13-2 Changes to track geometry

You may be asked to correct track alignment or superelevation on track that is not on design alignment or have design superelevation. Whilst returning track to design geometry is desirable, it may affect other infrastructure such as overhead wiring, station platforms and rail adjustment that may have been adjusted to operate with the track “off design”.

C13-2.1 Changes affecting overhead wiring

**DO NOT** make ANY changes to existing superelevation or alignment greater than the limits detailed in Table 15 unless you have consulted with and have the approval of the Electrical Maintenance Engineer.
<table>
<thead>
<tr>
<th>Change</th>
<th>±25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superelevation</td>
<td></td>
</tr>
<tr>
<td>Alignment</td>
<td>±50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OR Combination of</th>
<th>Superelevation</th>
<th>Alignment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>±20</td>
<td>±10</td>
</tr>
<tr>
<td></td>
<td>±15</td>
<td>±20</td>
</tr>
<tr>
<td></td>
<td>±10</td>
<td>±35</td>
</tr>
</tbody>
</table>

Table 15 – Geometry changes affecting OHW

C13-2.2 Changes to track geometry affecting station platforms

DO NOT make ANY changes to existing horizontal or vertical alignment of track at platforms by more than 50mm (but which still comply with survey limits in Chapter 4) unless you notify the local station manager and the Program Manager Station Capital Works.

C13-2.3 Changes to track geometry affecting track adjustment

DO NOT make ANY changes to track alignment that will require correction of the track adjustment until appropriate arrangements have been made with maintenance staff for the work to be undertaken.

C13-3 Track Maintenance at Train Inspection Sites

RailCorp has a number of train inspection sites throughout the rail network. These sites monitor (or inspect) passing trains and detect and report on various parameters of the train. They include:

- High Speed Weighbridges (Figure 8).
- Wheel Condition Monitoring (WILD) Detectors (Figure 9).
- Automatic Equipment Identification (AEI) readers (Figure 10 and Figure 11).
- Dragging Equipment Detectors (Figure 12).
- Hot Box / Hot Wheel Detectors (Figure 13).

Their locations are detailed in OS 001 IM – Train Operating Conditions Manual (TOC Manual).

![Figure 8 - High speed weighbridge](image)
![Figure 9 - WILD Detector](image)
Special conditions apply to track maintenance at train inspection sites to:

- Ensure that adequate track maintenance is done through the site, and
- Minimise the chance of damage to the train inspection equipment as a result of track works.

## C13-3.1 General Requirements

Use the following general procedures when planning track maintenance works that impact on a train inspection site:

1. Advise the Train Monitoring Systems Unit (TMSU) prior to the works of the nature and timing of the works. The more notice the better.

2. TMSU staff will arrange for equipment to be disconnected and removed (if necessary), and/or will arrange for the maintenance works to be supervised.

3. Allow for disconnection and replacement of the train inspection equipment in possession planning.
### C13-3.2 Site requirements

<table>
<thead>
<tr>
<th>Components</th>
<th>Weighbridge</th>
<th>AEI Reader</th>
<th>Hot Box / Hot Wheel Detector</th>
<th>WILD</th>
<th>Dragging Equipment Detector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheel sensors</td>
<td>Wheel sensors</td>
<td>Antennae</td>
<td>Hot Box and Hot Wheel Detectors</td>
<td>Contact closures</td>
<td>Accelerometers</td>
</tr>
<tr>
<td>Transducers</td>
<td>Presence loops</td>
<td>Wheel sensors</td>
<td>Wheel sensors</td>
<td>Cabling</td>
<td>Strain gauges</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Attached to</td>
<td></td>
<td></td>
<td>Cabling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sleepers</td>
<td></td>
<td></td>
<td>Mounting brackets</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attachment</th>
<th>Components</th>
<th>Wheel sensors</th>
<th>Wheel sensors</th>
<th>Wheel sensors</th>
<th>Attached to</th>
<th>Clamped to each rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolted or clamped to the track</td>
<td>Transducers</td>
<td>Presence loops</td>
<td>Hot Box Detectors</td>
<td>Partial removal includes the removal of the contact closures and cabling only</td>
<td>Partial removal includes the removal of the accelerometers, strain gauges, cabling and other sensitive equipment but leaves the mounting blocks attached to the rail</td>
<td></td>
</tr>
<tr>
<td>Bolted or clamped to the track</td>
<td></td>
<td></td>
<td></td>
<td>Attached to sleepers</td>
<td>Clamped to each rail</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transducers</th>
<th>Presence loops</th>
<th>Hot Box Detectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cannot be removed</td>
<td>Clamped to the track</td>
<td>Clamped to the rail or mounted on sleeper ends</td>
</tr>
<tr>
<td>Low mount Antennae</td>
<td>Hot Wheel Detectors</td>
<td></td>
</tr>
<tr>
<td>Mounted on sleeper ends</td>
<td>Clamped to the rail or mounted on sleeper ends</td>
<td></td>
</tr>
<tr>
<td>High mount Antennae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mounted on posts alongside the track</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do not need to be removed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Removal</th>
<th>Complete 2 hours</th>
<th>Complete 1 hour</th>
<th>Complete 2 hours</th>
<th>Complete 2 hours</th>
<th>Complete 2 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Partial 1 hour</td>
<td>Partial 1 hour</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Reinstall | Complete 2 hours | Complete 1 hour | Complete 2 hours | Complete 2 hours | Complete 2 hours |
|           |                  | Complete 2 hours |                  |                  |                  |
|           | Partial 1.5 hours | Partial 1.5 hours |                  |                  |                  |

<table>
<thead>
<tr>
<th>Special requirements</th>
<th>Closely supervise to avoid damage to transducers</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Track condition Requirements</th>
<th>Pumping ≤5mm</th>
<th>NIL</th>
<th>NIL</th>
<th>NIL</th>
<th>Pumping ≤10mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Track condition consistent over the weighbridge site and 100m on each side</td>
<td></td>
<td></td>
<td></td>
<td>Must show even tracking on the rails based on the wear pattern on the head of the rail.</td>
</tr>
</tbody>
</table>

Table 16 – Train Monitoring Equipment
## C13-3.3 Track Maintenance Procedures

<table>
<thead>
<tr>
<th>Track Maintenance Activity</th>
<th>Type of Train Inspection Site</th>
<th>Dragging Equipment Detector</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grinding</strong></td>
<td>Weighbridge</td>
<td>AEI Reader</td>
</tr>
<tr>
<td></td>
<td>Remove wheel sensors prior to grinding</td>
<td>Partially remove DED</td>
</tr>
<tr>
<td></td>
<td>Remove wheel sensors and cabling before very heavy corrective grinding (e.g. to remove over 1mm of rail head).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Verify that the grinding wheels will clear the equipment before grinding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Use turnout grinder with smaller diameter grinding wheels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lift or remove gauge face wheels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Closely supervise works</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grind finish through the site should be fine, to avoid a rough surface over the array</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Tamping</strong></td>
<td>Remove all track mounted equipment</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ballast Regulation</strong></td>
<td>Remove cabling and wheel sensors</td>
<td>Remove HBD/HWD equipment</td>
</tr>
<tr>
<td><strong>ReBallasting</strong></td>
<td>Remove cabling and wheel sensors</td>
<td>Remove HBD/HWD equipment</td>
</tr>
<tr>
<td></td>
<td>DO NOT drop ballast directly on the section of rail containing the weighbridge transducers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>New ballast should be manually spread over this section of track, under close supervision</td>
<td></td>
</tr>
<tr>
<td><strong>Resleepering</strong></td>
<td>Remove cabling and wheel sensors</td>
<td>Remove HBD/HWD equipment</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rerailing</strong></td>
<td>Remove cabling and wheel sensors</td>
<td>Remove HBD/HWD equipment</td>
</tr>
<tr>
<td></td>
<td>Cut out the sections of rail and re-install in the new rail</td>
<td></td>
</tr>
</tbody>
</table>

Table 17 - Summary of Track Maintenance Requirements
Working with Track Cable Protectors

Plating of track cables enables resurfacing around cables (See Figure 14).

Mark ALL cables on track prior to resurfacing to ensure that operators are aware cables are approaching. Where plates are installed but cables are not correctly fastened operators must be verbally warned of this in addition to the on track paint markings. Where possible cable ties etc. should be added prior to resurfacing occurring.

Where plate and cable location is still not clear to operator, place a team member on the ground to give the operator appropriate guidance.

Ballast regulating over plated cables MUST be carefully managed. DO NOT use ploughs or wings over Track Cable Protectors or exposed cables.

When brooming over cables operate continuously for at least one metre either side of a cable. Where cables are located close together, broom across all cable groups without stopping.

The broom can only be used with rotation turned off unless signal staff are available to restore damaged cables. If signal staff are available and full brooming is to be carried out then the broom level should be checked before brooming over plated cables. (The brooms SHOULD be 25mm above sleeper level.)

Figure 14 – Cable protectors

Do not disturb/force existing connections.

Report any abnormalities such as loose connections, rusted connections, overheated connections, or exposed cables to local Signal electrician or Signal Trouble.
Chapter 14 Lifting Track (Manual Methods)

C14-1 Finding twists

A twist is a variation in cross level over a given distance.

Twists are designed to occur:

- Through transitions.
- Through compound tangent points, (if there is a change of superelevation).
- Through tangent points on non-transitioned curves.

On straight track and circular curves the cross level should remain the same.

Cross level on tangent track should be zero.

Check and record track geometry to confirm defects.

To locate a short twist:

A 'short' twist is measured over 2 metres.

i. Select a datum rail (on curves it is always the inner rail).
ii. Take accurate cross level measurements at 2 metre intervals along the rails.
iii. Each of these intervals are then referred to as a station. These stations are then numbered 1, 2, 3, 4, etc. Measurements are recorded at each station for comparison.
iv. When the datum rail is LOW (lower than the other rail) the cross level is POSITIVE. e.g. plus (+) 3mm.
v. When the datum rail is HIGH (higher than the other rail) the cross level is NEGATIVE. e.g. minus (-) 3mm.
vi. Compare the cross levels between each station.

To locate a long twist

A 'long' twist is measured over 14 metres.

i. Mark out 2 metre stations over a long distance (at least 40 metres).
ii. Measure and record accurate cross level measurements at each station.

iii. Compare the variation between every seventh station (e.g. Station 1 - 8 ; 2 - 9 etc.).
C14-2  

**Eliminating a twist**

**Case 1** - Low point at the joint on rail “A”; too much cross level variation (bad top) at low point; good top on rail “B”.

![Figure 15 - Low point on rail “A” at the joint](image)

Select rail “B” as the reference rail.

1. Select and mark Jacking points.
2. Remove excess ballast.
3. Install Jacks (where required).
   - On curves, place the lifting jack under the high side of each rail.
4. Place an accurate cross level board across the rails.
5. Jack rail “A” to the correct cross level.
6. Pack sleeper.
   - When fettling, sleepers must be properly beater packed, i.e., they must be packed for the full length, except for 450mm in the centre, which must be loose packed and no hollows left.
   - Mechanical fishplated joints require considerably more fettling than the rest of the track and should be given special attention.
   - Shovel packing is not allowed on ballasted track.
7. Measure Top and Twist and compare to the acceptance limits for geometry in Section C4-2.
8. If further lifting is required, repeat the steps (5) - Jack Rails and (6) - Pack Sleeper as described above.
9. Remove Jacks (where required).
10. Relocate Jacks and repeat steps (1) to (9) if more track is to be lifted.
11. Measure and record geometry.
12. Restore ballast profile.
   - All ballast must be replaced and the sleepers properly boxed up to meet the ballast profile limits in Section C4-6.
13. Certify Track (See Chapter 19).
Case 2 - Bad top on both rails. Too much variation in cross level.

1. Select the datum rail.
2. Find high points each end of bad top.
3. Select and mark Jacking points.
   Use jack points 10 sleepers apart (6 to 7 with concrete sleepers).
4. Remove excess ballast.
5. Install Jacks.
   On curves, place the lifting jack under the high side of each rail.
6. At the first jack lift datum rail to level with high points.
7. Place an accurate cross level board across the rails.
8. Jack the other rail to correct cross level.
   When fettling, sleepers must be properly beater packed, ie, they must be packed for the full length, except for 450mm in the centre, which must be loose packed and no hollows left.
   Shovel packing is not allowed on ballasted track.
10. Repeat steps (4) to (9) at each jack point until bad top is removed.
11. Measure Top and Twist and compare to the acceptance limits for geometry in Section C4-2.
12. If further lifting is required, repeat steps (6) to (9).
13. Remove Jacks.
14. Relocate Jacks and repeat process if more track is to be lifted.
15. Measure and record geometry.
16. Restore ballast profile.
   All ballast must be replaced and the sleepers properly boxed up to meet the ballast profile limits in Section C4-6.
17. Certify Track (See Chapter 19).
C14-3 Applying superelevation ramps

C14-3.1 Non-transitioned curves

Apply superelevation gradually to take cross level from zero on the straight track to full superelevation on the curve.

1. Apply 1/2 of the superelevation at the tangent point.
2. Ramp it gradually down to zero on the straight track.
3. Ramp it gradually up to full superelevation on the curve.

To apply the lift:

1. Select the datum rail
   On curves, use inner rail as datum rail.
2. Select and mark Jacking points.
   Use jack points 10 sleepers apart. (6 to 7 with concrete sleepers).
3. Calculate the amount of superelevation to be applied at each jack point
   o Count the number of sleepers between the start and finish of the ramp (this will depend on the ramp rate to be applied).
   o Divide the number of sleepers by the number of sleepers between jack points to find the number of jack points.
   o Divide the amount of superelevation required on the curve by the number of jack points needed.

   Example, for timber sleepers: - 36m ramp, 60mm Super change
   Number of sleepers in 36m ramp = ramp length ÷ sleeper centres
   = 36000mm ÷ 600mm
   = 60 sleepers
   Number of jack points needed = 60 ÷ 10
   = 6.

   Amount of superelevation to apply at each jack point = Super change ÷ Jack points
   = 60mm ÷ 6 = 10mm.

   Therefore the superelevation must be increased by 10mm at each jack point.

4. Remove excess ballast.
5. Install Jacks.
   On curves, place the lifting jack under the high side of each rail.
6. Lift datum rail first to correct top defects.
7. Place an accurate cross level board across the rails.
8. Lift the outer rail at each jacking point by the calculated amount.
9. Use accurate cross level gauge to check cross level.

When fettling, sleepers must be properly beater packed, ie, they must be packed for the full length, except for 450mm in the centre, which must be loose packed and no hollows left.

Shovel packing is not allowed on ballasted track.

11. Remove Jacks.

12. Relocate Jacks and repeat Steps (2) to (11) if more track is to be lifted.

13. Measure and record geometry and compare to the acceptance limits for geometry in Section C4-2.

14. Restore ballast profile.

All ballast must be replaced and the sleepers properly boxed up to meet the ballast profile limits in Section C4-6.

15. Certify Track (See Chapter 19).

C14-3.2 Compound curves

Similarly, when the two curves forming a compound curve need different amounts of superelevation the gradual change is made through the compound tangent point or CTP.

Apply 1/2 of the superelevation change at the Compound Tangent Point (CTP).

To apply the lift:

1. Select the datum rail.
   
   On curves, use inner rail as datum rail.

2. Select and mark Jacking points.
   
   Use jack points 10 sleepers apart. (6 to 7 with concrete sleepers).

3. Calculate the amount of superelevation to be applied at each jack point.
   
   o Count the number of sleepers between the start and finish of the ramp (this will depend on the ramp rate to be applied).
   
   o Divide the number of sleepers by the number of sleepers between jack points to find the number of jack points.
   
   o Divide the amount of superelevation difference between the two curves by the number of jack points needed.

   Example - Curve 1 90mm super - Curve 2 60mm super, Ramp rate 1:500
   
   Change in superelevation = 90mm - 60mm = 30mm
   
   Length of ramp needed = 30mm x 500 = 15000mm = 15m
   
   No. of sleepers in 15m ramp = (length ÷ sleeper centres)
   
   = 15000 ÷ 600 = 25
   
   No. of points needed = 25 ÷ 10
   
   = 2.5 - Round it off to the next whole number = 3
   
   Amount of change in superelevation at each jack point = 30mm ÷ 3 = 10mm

4. Remove excess ballast.
5. Install Jacks.
   On curves, place the lifting jack under the high side of each rail.

6. Lift datum rail first to correct top defects.

7. Place an accurate cross level board across the rails.

8. Lift the outer rail at each jacking point by the calculated amount.

9. Use accurate cross level gauge to check cross level.

    When fettling, sleepers must be properly beater packed, ie, they must be
    packed for the full length, except for 450mm in the centre, which must be loose
    packed and no hollows left.
    Shovel packing is not allowed on ballasted track.

11. Remove Jacks.

12. Relocate Jacks and repeat Steps (2) to (11) if more track is to be lifted.

13. Measure and record geometry and compare to the acceptance limits for
    geometry in Section C4-2.

14. Restore ballast profile.
    All ballast must be replaced and the sleepers properly boxed up to meet the
    ballast profile limits in Section C4-6.

15. Certify Track.

C14-3.3 Transitions
In transitioned curves, superelevation is ramped from zero cross-level at the tangent point
to full superelevation at the TRS.

To apply the lift:

1. Select the datum rail.
   On curves, use inner rail as datum rail.

2. Select and mark Jacking points.
   Use jack points 10 sleepers apart. (6 to 7 with concrete sleepers).

3. Calculate the amount of superelevation to be applied at each jack point.
   o Count the number of sleepers between the TP and TRS.
   o Divide the number of sleepers by the number of sleepers between jack
     points to find the number of jack points.
   o Divide the amount of superelevation needed at the TRS by the number of
     jack points needed.

4. Remove excess ballast.
5. Install Jacks.
   On curves, place the lifting jack under the high side of each rail.
6. Lift datum rail first to correct top defects.
7. Place an accurate cross level board across the rails.
8. Lift the outer rail at each jacking point by the calculated amount.
9. Use accurate cross level gauge to check cross level.
    When fettling, sleepers must be properly beater packed, ie, they must be
    packed for the full length, except for 450mm in the centre, which must be loose
    packed and no hollows left.
    Shovel packing is not allowed on ballasted track.
11. Remove Jacks.
12. Relocate Jacks and repeat Steps (2) to (11) if more track is to be lifted.
13. Measure and record geometry and compare to the acceptance limits for
    geometry in Section C4-2.
14. Restore ballast profile.
    All ballast must be replaced and the sleepers properly boxed up to meet the
    ballast profile limits in Section C4-6.
15. Certify Track (See Chapter 19).

C14-4 Applying a "running lift"

Factors to consider before starting.

- Is there enough ballast available?
- Is there any height restriction such as an overbridge or overhead wiring?
- Will the amount of lift on the datum rail be enough to correct cross-level on the
  other rail?

To apply a Run-in ramp:

1. Choose a "datum" rail.
   On straight track, either rail can be chosen, as long as the same one is used for
   the full length.
   On curved track, the inner rail must be used.
2. Decide on the amount of lift to be applied to the existing high points in the track.
   The lift should be at least 15mm. This leaves a space under each sleeper so
   that the ballast can be properly packed underneath.
3. Select an existing high point on the datum rail to use a reference point.
4. Calculate the ramp length.
   
   Example - for ramp rate: 1:1000.
   For every 1mm of lift you need a ramp of 1000mm or 1 metre.
   e.g. If you want to lift the track 20mm you need a ramp length of 20 metres.

5. Mark the point where the ramp will begin.

6. Mark the amount of lift to be applied at the high point on the sleepers.

7. Mark jacking points on the head of the rail.
   
   Use jack points 10 sleepers apart. (6 to 7 with concrete sleepers).

8. Insert the jacks into the first jack holes.

9. Lift the jack until the required amount of lift is achieved.

10. Check the cross-level with a cross-level gauge.

11. Lift the other rail until the cross-level is correct.

12. Pack the sleepers firmly to hold the rails at the correct levels.

   When fettling, sleepers must be properly beater packed, ie, they must be packed for the full length, except for 450mm in the centre, which must be loose packed and no hollows left.

   Shovel packing is not allowed on ballasted track.

13. Insert the jacks into the next two jacking points.

14. Continue the lifting process in this way until you reach the last high point.

To apply a Run out ramp:

15. Calculate the length of ramp needed.

16. Insert the jacks into the first jack holes past the last high point.

17. Lift the jack until the required amount of lift is achieved.

18. Check the cross-level with a cross-level gauge.

19. Lift the other rail until the cross-level is correct.

20. Pack the sleepers firmly to hold the rails at the correct levels.

21. Continue lifting and packing along the ramp.

22. Measure and record geometry and compare to the acceptance limits for geometry in Section C4-2.

23. Restore ballast profile.

   All ballast must be replaced and the sleepers properly boxed up to meet the ballast profile limits in Section C4-6.

24. Certify Track (See Chapter 19).
Chapter 15 Restoring track alignment (manual methods)

1. Determine existing alignment of track from survey monuments.
2. Establish where realignment is required.
3. Check adjustment to determine if realignment can be done (See Engineering Manual TMC 223 - Rail Adjustment).
4. Arrange track adjustment if there is insufficient or too much steel to complete alignment correctly.
5. Pull track to correct alignment at survey points (existing or new) to meet the geometry acceptance limits in Chapter 4.
   This may be done manually with lining bars or using machinery.
   A large slew may cause sleepers to be moved onto ballast that is:
   - Loosely packed.
   - Too tightly packed at the centre ("centre-bound").
   - Too tightly packed at the ends ("end-bound").

   This could lead to twists and “rough-riding” and be very dangerous. It is good practice to lift and level when slewing track.
   When slewing track between trains, make sure there is a smooth transition between the slewed track and the existing track.
7. Working from aligned track at survey points or fixed points (turnouts level crossings, bridge ends etc), line track between survey points 10 sleepers at a time with lining bars using manual lining methods detailed in 16.
8. Check that alignment of track to survey monuments meets the geometry acceptance limits in Chapter 4.
9. Repeat the steps above till lining is completed.
   It may not be practical to get the alignment of existing track to conform to the standards in the track possession period.
   If the final position of wire or track is not within the accepted tolerances of the design alignment, the Civil and Electrical Engineering Maintenance Engineer must document and approve the variation. Inform the Team Manager of the variation and keep the records until the track is correctly relocated with the wire.
10. Check adjustment.
11. If the line of the two rails is different after slewing, the gauge will be incorrect.
    Check it carefully and correct it.
12. Check that all track centres and horizontal clearances meet the design requirements for the location.
13. Lift and pack track (See Chapter 14).
14. Measure and record geometry and compare to the acceptance limits for geometry in Section C4-2.
15. Restore ballast profile.

All ballast must be replaced and the sleepers properly boxed up to meet the ballast profile limits in Section C4-6.

16. Certify Track (See Chapter 19).
Chapter 16 Lining track (manual methods)

1. Locate area to be relined.
   - Measure variations in versine using a stringline.
   - Record the results and draw up a graph.
   - Check the graph to find out exactly where the problems are.

2. Check rail adjustment before beginning any lining work (See Engineering Manual TMC 223 - Rail Adjustment).
   - A curve cannot be slewed “out”, ie away from the centre if there is not enough steel available.
   - A curve cannot be slewed “in” ie towards the centre, if there is too much steel.

3. Excavate ballast from sleeper ends in the area to be relined.

4. Line the track ten sleepers at a time.
   - When lining near fixed objects (eg bridges, level crossings etc) start from the object and move outwards gradually.
   - If the track is firmly held by the track ballast, lift the track to break the ballast seal.
   - DO NOT use jacks to force the track over to line.
   - DO use lining bars held almost vertically.
   - Group staff with bars and bar across to line.
   - Pull the flat portions before the sharp portions to allow the length of steel to adjust itself.
   - Take care to ease the track over gradually throughout the length of the “pull” and to avoid kinks or elbows that would introduce excessively sharp radius and abrupt changes of direction.

5. Move another 10 sleepers and repeat barring.

6. Continue barring across rail until alignment is achieved.

7. Use the stringline to check that pulls bring the track as near as possible to the correct middle ordinate detailed in the geometry acceptance limits in Chapter 4.

8. Correct any errors.

9. Check track alignment.
   - Any changes in track alignment will affect rail adjustment. Check it carefully after every operation and correct any error in adjustment as soon as possible.

10. Lift and pack track (See Chapter 14).

11. Measure and record geometry and compare to the acceptance limits for geometry in Section C4-2.

12. Restore ballast profile.
   - All ballast must be replaced and the sleepers properly boxed up to meet the ballast profile limits in Section C4-6.

13. Certify Track (See Chapter 19).
Chapter 17 Plain track resurfacing

C17-1 Planning

1. Consider the key technical risks of undertaking resurfacing. This includes:
   - Work in Summer Months. (See Chapter 8)
   - Winter work practices. (See Chapter 12)
   - Damage to trackside signal equipment (Bondwire, potheads train trip arms, points detection) from material placement or movement, tampers and regulators.
   - Impact on signal equipment adjustment especially at points,
   - Damage to train monitoring equipment. (See Chapter 13)
   - OHW alignment/clearance. (See Chapter 13)
   - Top, twist, line and/or superelevation defects after the work.
   - Clearances to structures.
   - Equipment foul during work.
   - Site obstructions.
   - Ballast condition and profile.
   - Sleeper support (packing) and fastenings.

C17-2 Work preparation

1. Inspect the worksite to identify and confirm Work Scope.

2. Inspect site to determine if work can be undertaken, including:
   - Assessment of ballast availability.
     It is important there is enough ballast under the sleepers after resurfacing otherwise slacks and holes will quickly develop.
     As a 'rule of thumb' about 3 to 4 tonnes of ballast should be run out per 20m of track to be resurfaced.
   - Assessment of sleeper condition, spacing and skew.
     During resurfacing the machinery relies on the rail being securely fastened to the sleepers. As the machine lifts the rail, the sleeper must also rise to allow for packing of the ballast beneath it. If sleepers do not lift the track cannot be tamped.
     Defective or ineffective sleepers should be renewed beforehand if resurfacing is to be worthwhile.
     Any resleepering after the track has been resurfaced will disturb the track and possibly reintroduce 'top' and 'line' defects back into the track.
   - Amount of Lift.
     Consider the amount of lift required to restore the track. Will clearances be affected? How far above the monument/plaques is the track already? What about overhead wiring? Are there limited lift areas?
Alignment required?

Consider what pulls or changes to super are required and any how this will impact on Overhead Wiring.

Consider whether track adjustment will be required because of re-alignment.

3. Review general track condition for evidence that finish standards may not be achievable.

eg bog holes, mud in ballast, cesses full of muck or grass and not flowing, water being discharged onto track foul ballast or inadequate ballast depth, rail adjustment, fish bolts tight & not bent, frozen joints.

4. Measure and record rail gaps before and after all surfacing and lining operations together with the rail temperature at the time of working.

Where the net variation is more than the effect of 5°C temperature, the track MUST be adjusted.

During the months of temperature extremes (hot or cold) DO NOT make general lifts when the rail temperature is below 15°C or above 38°C.

5. Obtain relevant survey information or arrange for site survey if required.

Give special attention to locating tangent points, transition points, compound tangent points and changes in superelevation.

DO NOT disturb survey pegs.

6. Assess weather conditions related to track stability issues for summer working (See Chapter 8).

C17-3 Protect / remove obstructions

1. Arrange removal of track side rail lubricators, bridge end guard rails, modular level crossing panels, board walks etc.

2. Liaise with local Signals and Electrical Engineering staff and advise about proposed tamping kilometreges. Seek advice and obtain information about the locations of buried or unmarked cables or other sensitive equipment.

3. Perform detailed site Inspection to locate, mark and protect non-movable track obstructions including buried or non-obvious obstructions and visible obstructions within the tamping and ballast regulating interference zones.

(e.g. In-track Signalling Equipment including 'Pot Heads' - Boot Leg Risers, Cabling and Earth Straps, Impedance Bonds, Train Stops, Level Crossings, Checkrails, etc), need to be visible to resurfacing machine operators.

These interference zones are defined as:

For Tamping

- the area between each tie, either side of both rail flanges. *(to be determined)*
- the area xmm below tie level. *(to be determined)*
- the area zmm above tie level extending ymm either side of each rail head. *(to be determined).*
Specific obstructions which must be marked for tampers include:

<table>
<thead>
<tr>
<th>Obstructions</th>
<th>Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cables fastened to ties</td>
<td>CAUTION - operator guidance required:</td>
</tr>
<tr>
<td>49” rail bonds</td>
<td></td>
</tr>
<tr>
<td>Impedance bonds</td>
<td></td>
</tr>
<tr>
<td>A&amp;B timbers (interlocked points)</td>
<td>NO TAMPING ALLOWED:</td>
</tr>
<tr>
<td>Impedance bonds (duomatic tampers)</td>
<td></td>
</tr>
<tr>
<td>Train stops timbers (duomatic tampers)</td>
<td></td>
</tr>
<tr>
<td>Early warning (earth slip) detectors</td>
<td></td>
</tr>
</tbody>
</table>

**CAUTION - operator guidance required:**
- A&B timbers (interlocked points)
- Impedance bonds (duomatic tampers)
- Train stops timbers (duomatic tampers)
- Early warning (earth slip) detectors

**NO TAMPING ALLOWED:**
- Any area at or above tie level for the full width of the track,
- Any area between the ends of ties and the ballast toe.

Specific obstructions that must be marked for regulators include:
- Impedance bonds,
- Train stops,
- Cables fastened to top of ties,
- Earth straps or other cables fastened to rail web,
- “pot heads” and other signalling installations.

**For Stabilising**
- Any location where stabilising is not permitted due to possibility of causing infrastructure damage – see TMC 300 Chapter 5-1 for examples of specific obstructions to be avoided.
- 7 metres either side of the “A” bearer of interlocked points

Locations are marked as follows:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Paint Colour</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tamping</td>
<td>Orange</td>
<td>CAUTION, tie may be tamped subject to supervision and detailed instruction/guidance</td>
</tr>
<tr>
<td></td>
<td>Red</td>
<td>NO TAMPING ALLOWED. Tamper operator must be guided past the obstruction</td>
</tr>
<tr>
<td>Regulating</td>
<td>Orange</td>
<td>NO REGULATING ALLOWED within 2m of the obstruction</td>
</tr>
<tr>
<td>Stabilising</td>
<td>Orange</td>
<td>NO STABILISING ALLOWED within 2m of the obstruction</td>
</tr>
</tbody>
</table>

All marks must be clearly visible to tamper, regulator and DTS operators.
C17-4 Setting up

1. Measure and mark out track geometry including critical points of change in Curvature, track alignment offsets, track lift offsets.

2. Locate and mark points of zero or restricted lift.

3. Locate and mark points of zero or restricted line adjustment.

4. Establish start and end points and ramping methods.

Apply the following requirements to determine start and end points and ramping methods for smooth tamping/lining near fixed points:

- NO tamping (except for turnout tampers) within 5m of the A and B timbers of interlocked points.
- NO ramping-out work within 20m of any fixed point.
- NO ramping-in work within 20m of any fixed point currently in a slack.
- Where ramping-in from fixed points is allowed, begin work as close to the fixed point as possible. Where necessary, remove bridge guard rails. Double tamp each tie within 10m of the fixed point.
- Where practicable, it is desirable to finish work on straight track. It is easier to make a visual assessment of the smoothness/uniformity of the resulting longitudinal, cross level and lining ramps. Avoid finishing work in transitions or near compound tangent points.

5. Measure and record track alignment, track centres, superelevation and rail level at each survey mark.

Record the 'Before Measurements' on the 'Resurfacing Before and After Sheet';

C17-5 Tamping

C17-5.1 Track lifting - starting work on open track

1. Check cross level and identify any existing high points or slacks.

2. If there is any variation between the existing cross level and that designed for the track section, ramp from the existing to designed cross levels at a rate of 5mm each 8 sleepers (1:1000).

3. Depending on the condition of the existing longitudinal level, follow one of these procedures:

   **Start tamping working away from an existing high point**

   i. Stand the machine with the lift measuring trolley on the high point. Make sure the lift reference A Point (front trolley) is in the slack ahead of the high point. Raise the lift reference A point (at the front trolley) just enough to activate the basic lift indicator lights over each rail.

   ii. Commence tamping work with this basic lift adjustment. Gradually adjust the basic lift at the lifting reference A point (front trolley) upwards or downwards at the rate of 5mm each 8 sleepers until the desired basic lift for continuous tamping is achieved.
**Start tamping working toward an existing high point**

i. Stand the machine with the lift reference a point (front trolley) on the high point. Make sure the lift measuring trolley is in the slack ahead of the high point.

ii. Raise the lift reference A point (at the front trolley) just enough to activate the basic lift indicator lights over each rail.

iii. Commence tamping work with this basic lift adjustment. Gradually adjust the basic lift at the lifting reference A point (front trolley) upwards or downwards at the rate of 5mm each 8 sleepers until the desired basic lift for continuous tamping is achieved.

**Start tamping near a short slack**

i. Stand the machine so that the short slack is located between the lift reference A point (front trolley) and the lift measuring trolley.

ii. Raise the lift reference A point (at the front trolley) just enough to activate the basic lift indicator lights over each rail.

iii. Commence tamping work with this basic lift adjustment. Gradually increase the basic lift adjustment at the lifting reference A point (front trolley) at the rate of 5mm each 8 sleepers until the desired basic lift for continuous tamping is achieved.

4. Check the resulting ramp to make sure longitudinal and cross levels have been run-in at uniform rates which conform to the geometry acceptance limits in Chapter 4.

**C17-5.2 Track lifting - starting work at fixed points**

1. Check cross level and identify any existing high points or slacks.

2. If there is any variation between the existing cross level and that designed for the track section, ramp from existing to designed cross levels at a rate of 5mm each 8 sleepers (1:1000).

3. Depending on the condition of the existing longitudinal level, follow one of these procedures:

**Start tamping working away from an existing high point**

i. Stand the machine with the lift measuring trolley on the high point. Make sure the lift reference A Point (front trolley) is in the slack ahead of the high point. Raise the lift reference A point (at the front trolley) just enough to activate the basic lift indicator lights over each rail.

ii. Commence tamping work with this basic lift adjustment. Gradually adjust the basic lift at the lifting reference A point (front trolley) upwards or downwards at the rate of 5mm each 8 sleepers until the desired basic lift for continuous tamping is achieved.

**Start tamping working toward an existing high point**

i. Begin work at least 20m clear of fixed point and follow procedures described for open track.

**Start tamping near a short slack**

i. Stand the machine so that the short slack is located between the lift reference A point (front trolley) and the lift measuring trolley.

ii. Raise the lift reference A point (at the front trolley) just enough to activate
the basic lift indicator lights over each rail.

iii. Commence tamping work with this basic lift adjustment. Gradually increase the basic lift adjustment at the lifting reference A point (front trolley) at the rate of 5mm each 8 sleepers until the desired basic lift for continuous tamping is achieved.

4. Check the resulting ramp to make sure longitudinal and cross levels have been run-in at uniform rates which conform to the geometry acceptance limits in Chapter 4.

**C17-5.3 Track lining - starting work on open track and at fixed points**

1. Begin the lifting run-in ramp with the lining electrical circuit switched on, but with the track slewing hydraulic control circuit off. This will allow the lining indicator dial to be monitored without actually slewing the track.

2. Watch the lining indicator dial while running-in the basic lift and cross level. When the indicator shows zero before beginning the tamping cycle, (no track line error), switch the hydraulic control circuit on and commence continuous lining operations.

**C17-5.4 Continuous tamping/lining operation**

1. Set tamping depth to suit the sleeper/rail combination.

2. Activate the automatic application of superelevation and lining compensation increments.

   If automatic application of increments is not available, manually select the appropriate reference rail for superelevation and lining compensation and adjust relevant digital potentiometers in line with adjustment values displayed on the track.

3. Start the tamping cycle (drop workheads) with tamping tools evenly located either side of each sleeper to be tamped.

   If necessary on sharp curves, adjust the lateral position of the workheads so that tamping tools clear the rail flanges.

   Avoid dropping the workheads while the machine is moving. This can damage track ties, tamping tools and workheads as well as interfere with the correct spacing and anchoring of track ties.

   Note: Make sure the correct tamping depth is achieved before activating the squeeze cycle.

   Note: Observe marks indicating tamping obstructions and any instructions given to avoid obstacles.

4. Observe instrument readings. Check basic lift, cross level and lining indicators show zero at completion of the squeeze cycle.

   If indicators fail to show that basic lift, cross level and lining conditions have been achieved at the end of each tamping cycle, notify the job supervisor and investigate cause.

   In smooth lining mode, track slews in both directions should be indicated with no bias toward either side of the track. If the lining gauge indicates consistent
slews required in one direction only, inform the job supervisor and arrange to check lining calibration.

C17-5.5 Track lifting - ramping-out work on open track

1. Locate section of track with reasonably good longitudinal level, cross level and alignment.

2. Commencing with the existing cross level at the run-out site, ramp the applied cross level to existing track at the rate of 5mm each 8 sleepers (1:1000).

3. Lower lift reference “A” point at the rate of 5mm each 8 sleepers (1:1000) until lift indicator lights over each rail show no basic lift is applied.

4. Check the resulting ramp to make sure longitudinal and cross levels have been run-out at uniform rates which conform to the geometry acceptance limits in Chapter 4.

C17-5.6 Track lining - ramping-out work on open track

Track lining work is run-out at the same time as longitudinal and cross levels.

1. Watch the lining indicator dial while running out the lift and cross level.

2. When a point is reached where the indicator dial shows no track slew is required as part of the tamping cycle, switch off the track liner circuits.

C17-5.7 Monitoring tamping performance

1. Measure and record track alignment, track centres, superelevation and rail level at each survey mark.

Take measurements close enough to the tamping machines to ensure prompt and appropriate responses are achieved.

2. Check cross level continuously behind tamping machines.

NOTE: It is important to check for long and short twists including in the adjacent un-tamped track for 14m. Steep transitions are particularly critical.

3. Identify and record any variations from the geometry acceptance limits in Chapter 4.

   o correct or protect any defects if corrective action cannot be taken immediately.
   o Hand tamp or protect any locations unable to be machine tamped (due to obstructions, work-head reach or accessibility, etc).
   o correct or protect any defects bought about by the resurfacing process (eg broken sleepers, fallen or skewed sleepers, loose fastenings, broken bonds, etc).

Record these locations or deficiencies on the ‘Resurfacing Before and After Sheet’.
C17-6 Ballast regulating
1. Undertake ballast regulating and brooming to restore ballast profile to agreed scope.
2. Observe marks indicating ballast regulating obstructions and any instructions given to avoid obstacles.
3. Manage and minimise dust generation.
4. DO NOT plough ballast into bridge openings, over retaining walls or into watercourses, etc.
5. Manually tidy-up work where needed.
6. Check ballast shoulder measurements, assess variations from the ballast profile acceptance limits in Chapter 4 and record any deficiencies on ‘Resurfacing Before and After Sheet’.
7. Avoid over-brooming – ballast level with sleepers – does not have to be perfectly clean. A few odd stones on sleepers is OK.
8. Excess ballast winrow on the ends of and just outside sleepers is beneficial but must not be higher than superelevated rail height.

C17-7 Ballast stabilising
1. Undertake ballast stabilising (where available).
2. Observe marks indicating ballast stabilising “no go areas” and any instructions given to avoid obstacles
3. Record stabilisation areas and untreated areas on ‘Resurfacing Before and After Sheet’.

C17-8 Follow up works
1. Arrange rail adjustment (if required).
2. Arrange Inspection of track connections and bonding connections.
3. Arrange for refitting of track side rail lubricators, bridge end guardrails and modular level crossing panels.

C17-9 Certify track
1. Certify track for proposed track speed (See Chapter 19).
   At the end of each possession prior to the resumption of train operations the work area must be inspected to certify that the track is safe for train operations.
2. Apply appropriate speed restriction in consultation with maintenance representative and erect the appropriate temporary speed signs. (See Chapter 21)
C17-10  Documentation and handover

Complete documentation sign off and handover (where required).

Forward “before and after sheets” and Certification form to the maintenance representative immediately, or at least within one shift.

C17-11  Quality Inspection

There is no requirement in production resurfacing operations for a handover. There is nevertheless a need for inspections of the quality of the works to assess compliance with the Works Agreement and arrange corrective actions if appropriate.

Quality Inspection comprise visual examination of:

1. Ballast – compliance to agreement including:
   - shoulder and crib profile,
   - finishing off,
   - high ballast, including potential for obstruction to train trips,
   - obstruction of equipment,
   - drop through bridges.

2. Sleepers and fastenings:
   - loosening or absence of,
   - bunching or out of square,
   - damaged,
   - untamped,
   - dropped sleepers with plate under rail foot,
   - damaged fishplates.

3. Equipment:
   - damage to trainstops, smothered, missing, broken), negative connections, impedance bonds, turnouts, point equipment, bonds, spark gap connections, channel iron, tuning units, track connections, kilometre and creep pegs, survey marks, signals, potential shorting of track circuits (fastenings, plates etc)

4. Environment – compliance to agreement of:
   - fence condition,
   - waterway obstruction,
   - damage to access roads through vehicle traffic,
   - discarded parts, material or litter (site cleanliness),
   - damage to trees, shrubbery, landscaping,
   - oil spillage,
   - disposal of solid or liquid waste.

The Quality Inspection also includes assessment of finished track geometry including:

1. Surface – design and relative.
2. Alignment – to design and relative.
3. Superelevation – to design and relative.
Chapter 18 Resurfacing Turnouts

C18-1 Planning

Establish key technical risks from incorrect adherence to standards. (see Chapter 17)

C18-2 Work preparation

1. Inspect the worksite to identify and confirm work scope.

2. Assess ballast availability to ascertain if the resurfacing can be undertaken.

   Is the ballast bed sufficient to allow adequate packing and support of the bearers or is the bed mostly mud or dirt and will the track be made unstable by lifting it from this compacted bed?

   Just surface ballasting in conditions like this is insufficient and achieves little. The turnout should be left alone until reconditioning of the ballast bed is completed.

3. Assess bearer condition, spacing and skew to ascertain if the resurfacing can be undertaken.

   Are the bearers in good condition?

   Bearers should be sound enough to withstand the tamping process and hold the fastenings.

   Rotten or spike killed timbers allow excess lateral movement of the rails and plates etc when the lining forces are applied. This gives an indication to the machine that it is lining correctly but only the rails are moving and the timbers are not, therefore, the lining system appears to be inaccurate.

4. Assess fastening condition to ascertain if the resurfacing can be undertaken.

   Ineffective fastenings eg. loose dog spikes, lock spikes, cup heads, fishplates and bolts etc. Broken S.R. chairs, switch studs, C.R. chairs and bolts, crossing bolts etc.

   Are the fastenings effective enough to hold the rails to the bearers to enable the bearers to be lifted from the ballast bed when the lifting and lining forces are applied to the rails?

   Crossing bolts should be tightened (or replaced) to reduce movement when lifting with the hooks under the wing rails etc.

5. Review general track condition for evidence that finish standards may not be achievable (see Chapter 17).

6. Obtain relevant survey information or arrange for site survey if required.

7. Assess weather conditions related to track stability issues for summer working.
C18-3  Protect / remove obstructions
1. Perform detailed site inspection to identify and mark out and paint around services and immovable obstructions (eg in-track signalling equipment including 'pot heads' - boot leg risers, impedance bonds, train stops, level crossings, cabling and earth straps, checkrails, a & b bearers, points rodding, etc), to be visible to resurfacing machine operators.

2. Identify 'NO GO' zones, where tamping is not permitted:
   - Impedance bonds,
   - Train Inspection equipment,
   - Train stop timbers, and
   - Early warning detector (earth slip) mounting sleepers.

3. Arrange removal of ballast to allow the lifting hooks to engage properly on rails.

C18-4  Setting up
1. Mark out fixed points for resurfacing ramps, on main line –in and –out of the turnout, crossover, catchpoint, etc., and on the turnout roads.

2. Mark out limitations of working within the kinematic envelope to ensure adjacent tracks are not fouled by the resurfacing works.

3. Mark the first and last bearers for the operator in order for him to adjust the workhead depth and engage "long bearers on" switch and down pressure on straight rail side etc.

4. Measure and mark out track geometry including critical points of turnout (points, crossing or nose of frog, track centres, etc) and grading.

5. Record 'before measurements' on 'resurfacing before and after sheet'.

6. Lock out switches to provide tamping of turnout roads and when changing from track to track.

C18-5  Tamping
1. Set up machines and manage in-ramp.

2. Commence tamping, consolidate and restore track geometry.
   - Always use the 'straight rail as datum rail for lining turnouts.
   - Only one rail can be lined. The position of all the others is determined by gauge and their anchoring on the long bearers.
   - Only 2 rails can be levelled longitudinally. All others are determined by their attachment to and condition of the long bearers.
   - Only 2 rails can be brought to correct cross level. All others are effected by their attachment to and the condition of, the long bearers.
   - Unless unavoidable, traffic should not be allowed to pass over the unpacked leg of the turnout as the geometry of the other track can be disturbed.
C18-5.1 Setting tamping depth

When tamping concrete turnout bearers, set the tamping tynes to a depth of 550mm below rail. This allows for a depth of 445 to 450mm to the underside of the bearer and an additional 100mm for the tamping tyne operation.

Restore the tamping depth to normal for timber turnout bearers.

Failure to set the additional depth for concrete will cause damage to the concrete ties and failure to reset the depth for timber may cause the tynes to punch through the capping.

C18-5.2 Tamping turnouts

1. Construct a ramp of suitable lift and length to position 'A' using the LH rail as the datum for lift and line etc. and correcting cross-levels on the RH rail.

2. Use the RH lifting hook under the outside rail as far as possible for extra support before transferring to the stockrail after passing the heel block. (to avoid damage to the switch rail by lifting it).

3. Beware of interlocking gear. If possible, arrange for the Signal Sectionman to remove the switch rods, channel iron and other obstructions from between the A, B and C bearers in order to do a more thorough resurfacing job. If this is not possible then the tamper must be positioned over the bearers closest to this area which can be tamped (or at least, insert the workheads) in order to achieve lift. The points are then held at correct height by the operator while the ground crew insert jacks on each side of the track to support this unpacked section. The jacks are more effective if placed under the ends of the bearers where they are out of the way when manual packing of these bearers is carried out after the machine has moved clear.

4. The overhanging weight of the turnout will be starting to become critical and will require support at 'X'. It may also be necessary to apply 'down-pressure' to the LH lifting ram to counteract.

5. Jacks should be evenly spaced and wound up adjacent to the lifting point until the desired lift is achieved.

The jacks should be spaced far enough apart so that there are enough jacks to complete the full turnout. Keeping in mind that the heaviest part of the turnout is in the area of the crossing and checkrails and so jack spacing may have to be decreased.

If full extension of a jack is reached before the desired track height is obtained, then another jack is inserted in the next bay. (Be sure to fill the bay with ballast to pack the jack in order to utilise full lifting capability). The first jack can then be removed for use elsewhere.

When winding jacks up to assist the machine and the weight is too great to allow the jack to be wound further, move forward to the next jack and wind it up to relieve some of the weight on the jack adjacent to the lifting point.

6. When tamping through the primary track (e.g. main) the workheads should not be moved completely to the outside of the running rail in order to tamp the turnout rail. Not only can this endanger the machine by causing an obstruction (if on the "six foot" side) but also achieves inadequate packing. It isn't long before the turnout rail becomes out of reach and this tamping action only causes the timbers to be "centre-bound", so the whole process is then a wasted exercise.
7. As the checkrail carrier is lifted by the jacks, ballast should be shovelled in where necessary to fill the cribs and hand packed for additional support in readiness for tamping later on.

8. Don't continue to correct the cross-level of the crossing if the error is due to excessive wear. This could result in the overlifting of that rail on either side of the crossing and the check rail carrier of the turnout.

Rail wear factors must be considered when determining lift and cross-level targets.

9. Once past the area of the crossing, continue on to position 'B'. A run-out ramp can then be constructed from 'B' to "marry-in" with the existing track of fixed point.

C18-5.3 Tamping turnout leg

1. After the run-out ramp is completed set the machine back, reverse the points and position the machine at position 'C' and tamp only (squeeze) the turnout leg/check-rail carrier through the jacks (with 'lift' and 'line' switched off) towards position 'D'.

The turnout track can only be packed while the jacks are in place to support the geometry, as any attempt to correct the top and cross level will only disturb the position of the other.

2. At this point, only the RH workhead needs to be used until past the crossing area.

3. Pick up the "lift" and "line" again once past the long bearers and construct the necessary ramp out to "marry-in" with the existing track.

4. The operator should be guided through the jacks in order to swing the tamping tool away to avoid damaging the jacks.

C18-5.4 Tamping crossovers

1. Construct a ramp of suitable length and lift to position `A' using the L.H. rail as datum etc. and tamp towards position `B' correcting cross-levels on the R.H rail.

2. Remember - tamp the lower track first if uneven track levels.

3. At the area of the first long bearer the cross-over will have to be supported at `S' and lifting assisted with jacks.

4. Continue tamping through the crossing towards `B' ensuring support at `S' at all times and hand packing of the cross-over leg for temporary support.

5. When using jacks to assist machine to achieve correct cross-level, over-lifting of the check-rail carrier on the adjacent track will occur if the long bearers are bowed (warped).

6. Complete the lifting/levelling and lining operation to `B' then construct the run-out ramp to marry in with the existing track.

7. Reverse the points, transfer the machine to the other track and set the points to normal.
8. Construct a ramp of suitable length and lift to match the supported track at `C' using the RH rail as datum, and supporting the crossover leg at "S".

9. Care must be taken to ensure that the lift matches with the supported height at `S' and the `lining switched off while tamping through the areaa of the crossing or long bearers.

10. Pick up the `lift' and `line' again once past the long bearers and construct the run-out ramp through position 'D' to marry-in with the existing track.

**C18-5.5 Tamping diamonds**

1. Construct a ramp of suitable length and lift to position ‘A’ using the LH rail as datum as in a conventional turnout.

2. However, with this type of crossover you have 2 diagonally opposite over-hangs to consider and support, and, if necessary, assisted by the jacks.

3. Continue through the area of the crossings and long timbers towards ‘B’ then construct your run-out ramp to marry-in with the existing track.

4. **NOTE:** In most diamonds it may be necessary to tamp each side individually (i.e. one workhead at a time) with a separate lift for each workhead insertion due to the bearers being at an obscure angle to the rails.

5. Construct a ramp as before to `match' the supported height of the diamond using the RH rail as datum up to 3 or 4 sleepers before the first long bearer.

6. Tamp only (squeeze) through the diamond and long bearer area, then pick up the 'lift' and `'line' again when past the long timbers to marry-in with the existing track.

**C18-5.6 Monitoring tamping performance**

1. Measure track geometry, particularly for twists, through the turnout, crossover or catchpoint, to ensure it meets the requirements of the geometry acceptance limits in Chapter 4

2. Measure twist at 2m intervals from at least 14m before the points/switches to at least 14m past the last long bearer, to ensure it meets the requirements of the geometry acceptance limits in Chapter 4.

3. Report, correct or protect any locations unable to by tamped (due to obstructions, work-head reach or accessibility, etc) and report or correct any defects bought about by the resurfacing process (eg broken timber bearers, loose fastenings, etc).

4. Manually tamp areas of the turnout, crossover or catchpoints using jacks for lifting, particularly where that portion of the turnout is not accessible by machines.

**C18-6 Ballast regulating**

1. Regulate ballast, restore ballast profile and broom track. Ballast profile is to be restored to agreed scope and the requirements of Section C4-6.
2. Ensure all indicated immovable obstructions are protected and avoided. Ensure that dust generation is managed and minimised. Also ensure that ballast is not ploughed into bridge openings, over retaining walls or into watercourses, etc.

3. Record ballast shoulder measurements and any deficiencies on 'Resurfacing Before and After Sheet'.

4. Clean out ballast through switch area, around points rodding and through crossing checkrails, and ensure operability of turnout is verified.

C18-7 Follow up works
1. Arrange testing of points equipment by a signalling representative.

2. Arrange inspection of track connections and bonding connections.

C18-8 Certify track
1. Certify track for proposed track speed (See Chapter 19).

   At the end of each possession prior to the resumption of train operations the work area must be inspected to certify that the track is safe for train operations.

2. Apply appropriate speed restriction in consultation with maintenance representative and erect the appropriate temporary speed signs. (See Chapter 21)

C18-9 Documentation and handover
1. Complete documentation sign off and handover. (where required)

   Forward “before and after sheets” and Certification form to the maintenance representative immediately, or at least within one shift.
Chapter 19 Certifying track

C19-1 Introduction

Track certification is the process of determining the maximum safe speed for the track.

Track needs certification:

1. When doing any work that affects or may affect track geometry, structure, stability or clearances.
2. When carrying out routine track inspections.
3. When checking reported defects after an incident or a driver's report.
4. As a result of unusual environmental events (eg extreme rainfall, fire, flooding, high winds etc).

The following sections detail the requirements for certification of track after work that affects or may affect track geometry, structure, stability or clearances (Item 1 above).

Certification of track as a result of Items 2, 3 or 4 includes additional activities not covered by the competencies detailed below.

Persons undertaking certification activities must:

- understand the requirements of the work and the impact of the activity on the safe and reliable operation of rail traffic over the track,
- measure and assess relevant aspects of infrastructure condition, and
- certify the track with appropriate restrictions if necessary.

In addition persons undertaking certification activities are reminded of the requirements of RailCorp Network Rule NWT 312:

"…………. The Maintenance Representative must use an Infrastructure Booking Authority (IBA) form (NRF 003) to detail work that requires infrastructure equipment to be:

- temporarily booked out of use, or
- permanently removed, or
- newly commissioned, or
- booked back into use.

Maintenance Representatives must compile the IBA form before equipment is removed or commissioned…………..

"………….If infrastructure has been certified as working correctly, the relevant section of the IBA form must be signed………….

Completing and signing the Infrastructure Booking Authority (IBA) form constitutes certification that the civil infrastructure that was disarranged or disconnected or which could have been affected, has been examined and is safe and fit to restore to normal use.
C19-2 **What to certify**

Some activities in the rail corridor do not impact on the current or future condition of the track.

The following activities are examples of work that DOES NOT require certification of the track after the work:

- Track inspections.
- Survey.
- Picking up rubbish.
- Cleaning flangeways.
- Maintenance of signalling equipment or OH wiring.
- Manual rail flaw testing.
- Work in the right of way outside the clearance envelope that does not involve excavation or erection of structures.

Track certification **IS** required for ALL other work on or adjacent to track infrastructure that affects or may affect track geometry, structure, stability or clearances.

C19-3 **How to Certify**

**C19-3.1 Planning**

Establish what activity you are certifying. It may be a simple activity or a large job that is a combination of activities.

Consider the impact of the work on the safety and reliability of the infrastructure if the work is not undertaken correctly, either during or after the work.

This is visually obvious when the work, for example, directly affects track geometry. It is not, however, quite as obvious when the work affects, say, the track structure below the ballast. Work such as drainage excavation may appear of good quality but be poorly compacted and lead to rapid failure of track support and to poor track geometry.

Guidance on the issues to be considered is provided in Section C19-5. The issues have been combined in logical groupings that relate to the effect of the work on parts of the infrastructure. The groupings are shown in Table 18.

<table>
<thead>
<tr>
<th>Infrastructure group</th>
<th>Work impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability &amp; Interface</td>
<td>Effect of work on reliability through causing signal failures, tripping trains and slowing trains through speed restrictions due to poor quality work.</td>
</tr>
<tr>
<td>Track geometry</td>
<td>Effect of work on top, line, twist, gauge, both in current condition or potential short term deterioration due to poor support.</td>
</tr>
<tr>
<td>Rail geometry</td>
<td>Effect of work on rail profile, rail end mismatch and joint alignment and on potential rail failure due to rail damage.</td>
</tr>
<tr>
<td>Turnout geometry &amp; structure</td>
<td>Effect of work on switch and crossing geometry, limits and tolerances. Effect of work on component integrity and operation of the turnout as a system.</td>
</tr>
</tbody>
</table>
Table 18 – Grouping of work impacts

<table>
<thead>
<tr>
<th>Infrastructure group</th>
<th>Work impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Track clearances</td>
<td>Effect of work on clearances at rail level and on the greater clearance envelope, including material left foul during or after the work and infrastructure installed to incorrect clearance.</td>
</tr>
<tr>
<td>Track structure above formation</td>
<td>Effect of work on rail, sleeper, transom, fastening and ballast integrity and on the integrity of the track system that may result in track structure or geometry failure, including damage to components due to work activities.</td>
</tr>
<tr>
<td>Track structure below ballast</td>
<td>Effect of work on formation and earthworks integrity and on the integrity of the track system which it supports, that may result in track structure or geometry failure.</td>
</tr>
</tbody>
</table>

C19-3.2 Assess geometry condition

If the work activity does not involve track disturbance above formation level, examine track geometry visually. If no geometry disturbance is evident, geometry measurements are not necessary. If, however, the track appears to have been disturbed, track geometry measurements are required.

If the work activities involve track disturbance above formation level, track geometry measurements are required.

1. Establish the extent of the area over which geometry measurements are required.
2. Measure and record geometry condition.
   - For track geometry construction or maintenance activities, measure in accordance with the requirements of Chapter 4 - Construction and maintenance acceptance limits.
   - For activities that do not include restoration of track geometry to construction or maintenance acceptance limit condition, measure geometry parameters of gauge, alignment/line, top, twist and superelevation as required.
3. Compare the measurements to the acceptance limits.
   - For track geometry construction or maintenance activities, compare the results to the limits in Chapter 4.
   - For activities that do not include restoration of track geometry to construction or maintenance acceptance limit condition, or if the work does not meet the construction or maintenance acceptance limit, compare the results to the Base Operating limits in TMC 203 - Track Inspection.
4. If any of the geometry conditions exceed limits for a given speed, take the appropriate protective or corrective action nominated in the limits and responses table in TMC 203.
C19-3.3 Assess geometry condition in turnouts

Similarly, if the work activities involve track disturbance above formation level in turnouts and special trackwork, track geometry measurements are required.

1. Measure and record geometry condition the same as for plain track in Section C19-3.2.
   - Measure geometry parameters of gauge, alignment/line, top, twist and superelevation as required.

2. If a turnout or other special trackwork has:
   - been nominated as a “vulnerable turnout”, OR
   - there is visible evidence that the track geometry work on the turnout has affected the condition and fit of components, OR
   - components (switches & stockrails, crossings checkrail units, plates or bearers have been repaired or replaced,

   take additional special trackwork measurements for each of the following areas, if affected:

   **Switch**
   - Switch Tip height, width and angle
   - Switch opening (if not being certified by the Signals representative)
   - Switch fitting against stockrail
   - Housed Points clearances
   - Expansion Switch Opening

   **Crossing**
   - Checkrail effectiveness
   - Flangeway clearances

3. Compare the measurements to the acceptance limits.

4. If any of the geometry conditions exceed limits for a given speed, take the appropriate protective or corrective action nominated in the limits and responses table in TMC 203.

C19-3.4 Other factors to consider when certifying track safe

In addition to consideration of geometry, assess the significance of the following factors to determine if track is safe for the passage of trains.

C19-3.4.1 Reliability & Interface.

1. Damage to trackside signal equipment (bondwire, potheads train trip arms).
   - Did the work involve movement of machines (on or off track plant) on the track?
   - Is there any sign that trackside equipment has been damaged?
   - Is there any sign that trackside equipment has been damaged from material placement (rail, ballast, sleepers etc)?

2. Impact on signal equipment adjustment especially at points
   - Was work undertaken at or near points?
   - Is there any sign that points or stockrails have been moved?
3. Ballast fouling signal equipment.
   o Has ballast been moved or laid on track?
   o Is there any ballast fouling points operation?
   o Is there any ballast laid in open track that may foul train trip arms?

4. Incorrect clip type shorting out insulated joints.
   o Did the work involve placement of fastenings or movement of rails at insulated joints?
   o Have the correct low profile clips been installed?

5. Material shorting out insulated joints.
   o Has any material been left behind that is or could be used to short out joints (e.g., sleeper plates, fastenings, scrap)

6. Poor construction of mechanical insulated or Benkler style joints resulting in signal failure.
   o Did the work involve installing insulated joints?
   o Have they been installed correctly?
   o Will they fail if rail movement occurs?

7. Rail bonding.
   o Has rail bonding been installed or reinstalled around mechanical joints if they haven't been welded out?
   o Has rail bonding been checked for damage?

8. Impact on electrical traction.
   o Did work require removal and reconnection of traction return bonding?
   o Was it correctly replaced?

9. OHW alignment and clearances.
   o Did the work involve changes to alignment or rail level?
   o Are the OHW alignment and clearances satisfactory?

10. Wheel slip due to excess rail grease or grease on head of rail.
    o Did the work involve changes to rail lubricators?
    o Have the lubricators been correctly adjusted?

11. Potential blockage of drainage flow leading to sagging track circuits.
    o Has drainage been blocked by the work?
    o Have spoil heaps or material been left in drainage channels?
    o Have drainage channels and cesses been sloped to avoid ponding?

C19-3.4.2 Rail geometry

1. Rail profile mismatch.
   o Did the work involve inserting rail closures?
   o Has the rail profile of the closure been matched with the existing rail, or ground to suit?
2. Rail end mismatch.
   - Have rail profiles been matched at rail ends to remove foul joints?

3. Rail alignment.
   - Did the work involve inserting rail closures or welding out joints?
   - Have the rail ends been crowed to provide smooth alignment?

4. Joint integrity.
   - Have rail gaps been correctly installed?
   - Are the joints working?
   - Have the plates and fishbolts (or swage bolts) been correctly installed and are they secure?

5. Rail Damage.
   - Is there any evidence that the rail may have been struck during the work? (hammers or other tools, machinery etc)
   - Is there any evidence that the rail may have been cut or notched by cutting or welding equipment during the work?

C19-3.4.3 Turnout geometry & structure
1. Switch and crossing component defects after the work.
   - Did the work occur at or adjacent to turnouts or other special trackwork?
   - Are crossing bolts tight and effective?
   - Is the switch fitting correctly against the stockrail and bearing evenly on the plates?
   - Are the Heels properly secured?
   - Have any components been damaged during the work?

2. Turnout fails to operate as a system.
   - Has the turnout been tested to ensure that it is operational?

C19-3.4.4 Track clearances
1. Ballast foul of wheels leading to derailment.
   - Has ballast been disturbed during the work?
   - Has ballast been laid out during the work?
   - Has it been cleared to the level of the top of sleeper in the 4-foot?
   - Has it been lowered below trip height on the shoulders?

2. Material (sleepers, ballast & rails) left foul in preparation for work.
   - Is the track area clear of ALL obstructions?

3. Material & equipment left foul during work.
   - Is the track area clear of ALL obstructions?

4. Track alignment fouling clearances to structures.
   - Do the clearances to structures meet transit space requirements?
5. Flangeways obstructed.
   - Are flangeways or switch openings clear of ballast or other obstructions?

6. Earthworks and structures fouling transit space.
   - Have the earthworks and structures been constructed to meet design clearance requirements?
   - Are the clearances satisfactory?

7. Works fouling transit space.
   - The above issues are also relevant during the work, when track needs to be certified for train operation, particularly if work is incomplete.
   - Is any temporary support, formwork or falsework fouling clearances?

8. Size & location of temporary baulks fouling clearances.
   - Did the work involve installation of track baulks?
   - Are the baulks clear of transit space requirements?

C19-3.4.5 Track structure above formation

1. Sleeper condition, spacing and skew.
   - Did the work involve changes to or disturbing sleepers?
   - Does the sleeper condition meet the Operating Limits?
   - Does sleeper spacing and skew meet Maintenance Limits or Operating Limits?

2. Turnout bearer condition, spacing and skew.
   - Did the work involve changes to or disturbing bearers?
   - Does the bearer condition meet the Operating Limits?
   - Does bearer spacing and skew meet the design limits for the turnout or the Operating Limits?

3. Transom pattern, skew and attachment.
   - Did the work involve changes to or disturbing transoms?
   - Does the transom condition meet the Operating Limits?
   - Does bearer transom and skew meet the design limits for the structure or the Operating Limits?
   - Are the transoms correctly and securely attached to the structure?

4. Fastenings, Sleeper plates.
   - Did the work involve changes to or disturbing sleeper fastenings or sleeper plates?
   - Is there any sign that fastenings have been damaged by the work (hit by tools or run over by machines)?
   - Are the fastenings secure, insulators and pads ALL fitted and secure, sleeper plates fitted and hard up against sleeper?

5. Sleeper support (packing).
   - Did the work involve disturbing track geometry and sleepers?
   - Have ALL sleepers and/or bearers been packed, either by machines of by hand?
6. Transom support (packing).
   - Did the work involve disturbing track geometry and transoms?
   - Has packing been used to alter transom levels? Is it secure?

7. Track Adjustment & Stability.
   - Did the work reduce track stability – was the ballast/sleeper bond disturbed deliberately or accidentally (bumping or crossing the track)?
   - Have corrective and/or defensive measures been adopted?
   - Have anchors and ballast profile been re-established?
   - Has WTSA analysis been revised to include changes due to the work?

8. Ballast condition, depth and profile.
   - Did the work involve disturbing ballast profile deliberately or accidentally?
   - Did the work involve changing ballast condition deliberately or accidentally?
   - Were ballast shoulders or cribs excavated? Have they been restored?
   - Were ballast shoulders fretted away by machinery movements? Have they been restored?
   - Was ballast fouled by spoil heaps during adjacent excavation, or by dumpers crossing tracks?

9. Track condition during work.
   - The above issues are also relevant during the work, when track needs to be certified for train operation, particularly if work is incomplete. Sleeper condition, spacing and skew, fastening effectiveness and sleeper support are critical even at slow speed.

C19-3.4.6 Track structure below ballast

For the following issues, arrange follow-up inspections by an engineer or geotechnical staff if any structure or earthworks has been affected by the work.

1. Capacity of earthworks to support track or retain earthworks from fouling track.
   - Are there signs that the ability of the earthworks to support the track has been affected?
   - Are there signs that the embankment will fail because it has been undercut or badly constructed?
   - Are there signs that the cutting has been undercut or badly constructed?

2. Formation condition and strength.
   - Are there signs that the formation is not adequately compacted to support the track? Will it sink under traffic?

3. Impact on foundation excavation on earthworks supporting track.
   - Is there evidence that excavations for trackside structures have weakened the embankment supporting the track?

4. Impact of excavation on earthworks supporting track.
   - Is there evidence that excavations alongside the track have weakened the embankment supporting the track?
5. Capacity of temp support to support track.
   - Did the work involve installation of temporary support?
   - Was it constructed to an authorised design?
   - Has it been properly installed?

C19-4 Certifying track after major works

In addition to the track certification activities in Section C19-3, when major renewals have been undertaken:

1. Where practical, arrange a Track Recording Car evaluation prior to the handover. The results of this record are to comply with the standards applied in Chapter 4.

2. Measure the track again after the passing of a minimum of 200,000 tonnes of trailing load traffic. Correct any defect found to the original standard.
## C19-5 Certification issues associated with work activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Reliability &amp; Interface</th>
<th>Safety and Reliability Issues arising from Work Activities</th>
<th>Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Track geometry</td>
<td>Rail geometry &amp; condition</td>
</tr>
</tbody>
</table>
| Install Sleepers | • Shorting out insulated joints (eg sleeper plates, fastenings, scrap left behind)  
• Damage to trackside signal equipment (Bondwire, potheads train trip arms) from material placement or movement, off track plant, and hi rails  
• Ballast fouling train trip arms. | • Incorrect gauge after the work  
• Top, twist, line and/or superelevation defects after the work | • Rail Damage | NA | • Sleepers and equipment foul during work.  
• Site obstructions | • Sleeper pattern, skew, fastenings, Sleeper plates,  
• sleeper support (packing)  
• Ballast profile,  
• Track Stability | NA |
| Rebore and Regauge Track | NA | • Incorrect gauge after the work  
• Line defects after the work | • Rail Damage | NA | • Equipment foul during work  
• Site obstructions | • Sleeper pattern, fastenings | NA |
| Install and Maintain Track Fastening Systems | • Shorting out insulated joints (eg sleeper plates, fastenings, scrap left behind)  
• Damage to trackside signal equipment (Bondwire, potheads train trip arms) from material placement or movement | • Incorrect gauge after the work  
• Line defects after the work | • Rail Damage | NA | • Equipment foul during work  
• Site obstructions | • Fastenings, Sleeper plates  
• Track Stability | NA |
| Install and Maintain Rail Joints | • Incorrect clip type  
• Shorting out insulated joints (eg sleeper plates, fastenings, scrap left behind)  
• Poor construction of fibre or Benkler style joints resulting in signal failure | • Top, twist, line and/or superelevation defects after the work | • Rail profile mismatch  
• Rail end mismatch  
• Joint alignment  
• Rail gaps | NA | NA | • Joint integrity  
• Foul joints  
• Fastenings  
• Signalling and electrical integrity  
• Track Stability | NA |
| Ballast Track | • Ballast fouling points operation  
• Trains tripping on high ballast  
• Ballast fouling train trip arms or with potential to foul at later date.  
• Loose ballast on gunnels of rail wagons falling onto track fouling points or train trips  
• Damage to trackside signal equipment (Bondwire, potheads train trip arms) from material placement or movement | • Top, twist, line and/or superelevation defects after the work | • Rail Damage | NA | • Ballast foul  
• Site obstructions | • Ballast profile  
• Track Stability | NA |
<table>
<thead>
<tr>
<th>Activity</th>
<th>Reliability &amp; Interface</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Track geometry</td>
</tr>
<tr>
<td>Install Rails</td>
<td>• Rail bonding if joints not welded out</td>
<td>• Incorrect gauge after the work</td>
</tr>
<tr>
<td></td>
<td>• Impact on traction return if temporarily removed.</td>
<td>• Top, twist, line and/or superelevation defects after the work</td>
</tr>
<tr>
<td></td>
<td>• Shorting out insulated joints (eg sleeper plates, fastenings, scrap left behind)</td>
<td></td>
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<tr>
<td></td>
<td>• Damage to trackside signal equipment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Ballast fouling train trip arms</td>
<td></td>
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<tr>
<td>Load/Unload Rail</td>
<td>• Damage to trackside signal equipment (Bondwire, potheads train trip arms) from material placement or movement, off track plant, and hi rails</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>• Ballast fouling train trip arms.</td>
<td></td>
</tr>
<tr>
<td>Restore Top And Line</td>
<td>• Damage to signal equipment by tampers and regulators.</td>
<td>• Top, twist, line and/or superelevation defects after the work</td>
</tr>
<tr>
<td></td>
<td>• Ballast fouling train trip arms or with potential to foul at later date.</td>
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<tr>
<td></td>
<td>• OHW alignment and clearances</td>
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<tr>
<td>Plain Track Resurfacing</td>
<td>• Damage to trackside signal equipment (Bondwire, potheads train trip arms, points detection) from material placement or movement, tampers and regulators.</td>
<td>• Top, twist, line and/or superelevation defects after the work</td>
</tr>
<tr>
<td></td>
<td>• Impact on signal equipment adjustment especially at points</td>
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<tr>
<td>Install And Maintain Rail Lubricators</td>
<td>• Clearance to train trips.</td>
<td>NA</td>
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<td></td>
<td>• Wheel slip due to excess rail grease or grease on head of rail</td>
<td></td>
</tr>
<tr>
<td>Maintain Surface Drainage Systems</td>
<td>• Damage to trackside signal equipment (Bondwire, potheads train trip arms) from material placement or movement or off track plant</td>
<td>NA</td>
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<td></td>
<td>• Potential blockage leading to sagging track circuits</td>
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<tr>
<td>Activity</td>
<td>Reliability &amp; Interface</td>
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</tr>
</tbody>
</table>
| Maintain Earthworks | • Potential for work method to create future instability  
• Damage to trackside signal equipment (Bondwire, potheads train trip arms) from material placement or movement or off track plant | Safety | • Top, twist, line and/or superelevation defects after the work | | | • Earthworks clear of transit space  
• Equipment foul during work  
• Site obstructions | • Track condition during work  
• Sleeper condition, spacing, skew and support  
• Ballast condition and profile  
• Track Stability | • Earthworks capacity to support track  
• Earthworks capacity to remain clear of track |
| Recondition Track Formation And Ballast | • Rail bonding if joints not welded out  
• Impact on traction return if temporary removed.  
• Damage to trackside signal equipment (Bondwire, potheads train trip arms) from material placement or movement, off track plant, and hi rails  
• Impact on signal equipment adjustment especially at points | Safety | • Top, twist, line and/or superelevation defects after the work | | • Rail Damage | • Clearances to structures  
• Equipment foul during work  
• Site obstructions | • Sleeper condition, spacing, skew and support  
• Track Stability  
• Ballast condition and profile | • Formation condition and strength |
| Install Turnouts/Special Track Layouts | • Damage to trackside signal equipment (Bondwire, potheads train trip arms) from material placement or movement, off track plant, and hi rails  
• Impact on signal equipment adjustment especially at points | Safety | • Incorrect gauge after the work  
• Top, twist, line and/or superelevation defects after the work | • Rail profile mismatch  
• Rail end mismatch  
• Joint alignment  
• Rail Damage | • Switch and crossing geometry defects and Component defects after the work  
• Turnout fails to operate as a system. | • Clearances to structures  
• Equipment foul during work  
• Site obstructions | • Fastenings  
• Turnout bearer condition spacing and skew  
• Bearer support (packing)  
• Ballast condition & depth | • Formation condition and strength |
| Maintain Turnouts/Special Track Layouts | • Damage to trackside signal equipment (Bondwire, potheads train trip arms) from material placement or movement, off track plant, and hi rails  
• Impact on signal equipment adjustment especially at points | Safety | • Incorrect gauge after the work  
• Top, twist, line and/or superelevation defects after the work | • Rail profile mismatch  
• Rail end mismatch  
• Joint alignment  
• Rail Damage | • Switch and crossing geometry defects and Component defects after the work  
• Turnout fails to operate as a system. | • Clearances to structures  
• Equipment foul during work  
• Site obstructions | • Fastenings  
• Turnout bearer condition spacing and skew  
• Bearer support (packing)  
• Ballast condition & depth | • Formation condition and strength |
| Turnout Resurfacing | • Damage to trackside signal equipment (Bondwire, potheads train trip arms, points detection) from material placement or movement, tampers and regulators  
• Impact on signal equipment adjustment especially at points  
• OfW alignment/clearance | Safety | • Top, twist, line and/or superelevation defects after the work | | • Rail Damage | • Clearances to structures  
• Equipment foul during work  
• Site obstructions | • Ballast condition and profile  
• Sleeper support (packing)  
• Fastenings | NA |
### Safety and Reliability Issues arising from Work Activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Reliability &amp; Interface</th>
<th>Safety</th>
<th>Track geometry</th>
<th>Rail geometry &amp; condition</th>
<th>Turnout structure &amp; geometry</th>
<th>Track Clearances</th>
<th>Track structure above formation</th>
<th>Track structure below ballast</th>
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<tbody>
<tr>
<td>Install Transoms</td>
<td>• Incorrect clip type</td>
<td>• Rail Damage</td>
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<td>NA</td>
<td></td>
<td>• Equipment foul during work</td>
<td>• Transom pattern</td>
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<td>• Track circuit interference through incorrect placement of</td>
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<td>• Transom support</td>
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<td>• Damage to trackside signal equipment (Bondwire, potheads)</td>
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<td>• Transom attachment</td>
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<td>Install &amp; Maintain Retaining Walls</td>
<td>• Potential for work method to create future instability</td>
<td>• Rail Damage</td>
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<td>NA</td>
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<td>• Structures clear of transit</td>
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<td>and support and profile</td>
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<tr>
<td>Install Trackside Structures (OHW, Signal</td>
<td>• Potential for work method to create future instability</td>
<td>• Rail Damage</td>
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<td>• Track condition</td>
<td>• Track Stability</td>
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<td>structures etc)</td>
<td>• Damage to trackside signal equipment (Bondwire, potheads</td>
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<td>Undertake trackside excavation (not undertrack)</td>
<td>• Potential for work method to create future instability</td>
<td>• Rail Damage</td>
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<td>• Track Stability</td>
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<tr>
<td>Construct Platforms</td>
<td>• Potential for work method to create future</td>
<td>• Rail Damage</td>
<td></td>
<td></td>
<td>NA</td>
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<td>• Platform clear of transit</td>
<td>• Track condition</td>
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<td>• Equipment foul during work</td>
<td>• Sleeper condition</td>
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</tbody>
</table>

**Safety and Reliability Issues arising from Work Activities**

- **Safety**: Rail Damage, Equipment foul during work, Site obstructions, Transom pattern, skew, Fastenings, Transom support (packing), Transom attachment, Capacity of earthworks to support track or retain earthworks from fouling track.
### Safety and Reliability Issues arising from Work Activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Safety</th>
<th>Reliability &amp; Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install undertrack Structures</td>
<td>• Rail Damage</td>
<td>• Potential for work method to create future instability</td>
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<tr>
<td></td>
<td></td>
<td>• Damage to trackside signal equipment (Bondwire, potheads train trip arms) from material placement or movement or off track plant</td>
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<td>• Material fouling trip arms</td>
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<td>• Top, twist, line and/or superelevation defects after the work</td>
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<td>• Support adequate to maintain track geometry</td>
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<tr>
<td>Install undertrack crossings</td>
<td>• Equipment foul during work</td>
<td>• Potential for work method to create future instability</td>
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<td>• Site obstructions</td>
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<td>• Track condition during work</td>
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<td>• Sleeper condition and support</td>
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<td>• Ballast condition, support &amp; profile</td>
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<td></td>
<td></td>
<td>• Track Stability</td>
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<tr>
<td>Install overtrack Structures</td>
<td>• Structures clear of transit space</td>
<td>• Impact of excavation on earthworks supporting track</td>
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<td></td>
<td>• Equipment foul during work</td>
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<td></td>
<td></td>
<td>• Site obstructions</td>
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<tr>
<td>Install And Maintain Temporary Support For Bridges</td>
<td>• Track condition during work</td>
<td>• Impact of excavation on earthworks supporting track</td>
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<td>• Sleeper condition and support</td>
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<td>• Ballast condition, support &amp; profile</td>
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<tr>
<td>Install And Maintain Temporary Track Support</td>
<td>• Track condition during work</td>
<td>• Impact of excavation on earthworks supporting track</td>
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<td>• Sleeper condition and support</td>
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<td>• Ballast condition, support &amp; profile</td>
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<td>• Track Stability</td>
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<td></td>
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<td>• Capacity of temp support to support track</td>
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</tbody>
</table>

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Issued April 2013
<table>
<thead>
<tr>
<th>Activity</th>
<th>Reliability &amp; Interface</th>
<th>Safety</th>
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<tbody>
<tr>
<td></td>
<td><strong>Track geometry</strong></td>
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<td><strong>Rail geometry &amp; condition</strong></td>
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<td><strong>Turnout structure &amp; geometry</strong></td>
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<td><strong>Track Clearances</strong></td>
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<td><strong>Track structure above formation</strong></td>
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<td><strong>Track structure below ballast</strong></td>
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<tr>
<td>Install / Repair Structure Components</td>
<td>• Potential for work method to create future instability</td>
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<td></td>
<td>• Damage to trackside signal equipment (Bondwire, potheads train trip arms) from material placement or movement or off track plant</td>
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<td></td>
<td>• Track circuit interference through incorrect placement of bolts and fastenings</td>
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<td>• Material fouling trip arms</td>
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<td>• Incorrect gauge after the work</td>
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<td>• Top, twist, line and/or superelevation defects after the work</td>
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<td></td>
<td>• Rail Damage</td>
<td>NA</td>
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<td>NA</td>
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<tr>
<td>Install / Repair Level Crossings</td>
<td>• Damage to trackside signal equipment (Bondwire, potheads train trip arms) from material placement or movement or off track plant</td>
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<td>• Material fouling trip arms</td>
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<td>• Road surface level &amp; condition</td>
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<td>• Panels secure</td>
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Chapter 20 Permanent Speed Signs

C20-1 Speed sign description

The following construction acceptance limits are extracted from RailCorp Standard ESC 210.

Plain track Speed Signs

Plain track Speed Signs are described in RailCorp’s Network Rule NSG 604 “Indicators and signs”.

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

Three Speed Regime

These signs are rectangular (see Figure 17). They:

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

If only a blue background speed sign appears under a yellow background speed sign:

- the blue background speed sign will apply for XPT, Xplorer, Hunter, and Endeavour trains, and
- all electric multiple unit trains.

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

Two Speed Regime

These signs have a pointed left side: They

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

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

Figure 18 - Examples of pointed permanent track speed signs

**Turnout Speed Signs (Normal, XPT and MU)**

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

- Turnout Speed Signs shall include the prefix "X". They are required where the default turnout speed of 25km/h is not suitable, including when the turnout is traversed in the trailing direction.

**Restricted Location speed signs**

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

**Description**

Restricted Location speed signs:
- have BLACK text on a YELLOW background for all rail traffic.
- No provision is made for higher speeds for XPT, Xplorer, Endeavour, Millennium trains or Multiple Unit trains.

**Application**

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

Sydney Yard type signs are currently approved for use in Sydney Yard ONLY.
C20-2 Placement rules

The following construction acceptance limits are extracted from RailCorp Standard ESC 210.

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

Placement of Plain track, Repeater and Turnout Speed Signs.

Orientation

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

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

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

Lateral and vertical

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

Where practical, signs are to be placed in the following “Standard” position."

- The sign shall be placed within the following envelope.
- The closest part of sign shall be no closer to the gauge face of nearest running rail than 1800mm. This means that the centre of the support post, where used, must be at least 2030mm from the gauge face of nearest running rail.
- The closest part of sign is to be no further than 3000mm from the gauge face of nearest running rail.
- The bottom of lowest sign is to at least 1000 mm above Rail Level.
- The top of highest sign to be no more than 3200mm above Rail Level.
- At locations where lateral clearances are restricted, the lateral and vertical tolerances may be reduced provided minimum transit space requirements are met.
- Consistent positioning is preferred. For example, in an area where speed signs are generally placed on OHW masts, placement of a speed sign on a stand-alone post should be at a height and lateral placement consistent with the location of the signs on the masts.

Sighting

- Speed signs shall be clearly visible to a driver for a minimum of 6 seconds.

Mounting

- A Speed sign may be mounted on its own post (old rail, 50mm galvanised pipe or equivalent), or on overhead wiring structures if they are within the lateral placement envelope. Details of preferred methods of attachment are provided in RailCorp Drawing CV0218653 – Standard Speed Sign Fixings.
- Signs must NOT be mounted on signal posts or signal structures

Placement of Restricted Location speed signs

Orientation

- City Underground type signs are placed on the left-hand side of the line in the direction of travel
- Sydney Yard type signs are placed in the CENTRE of the Four foot of the track to which it applies
Lateral and vertical

- City Underground type signs shall be attached to the tunnel wall.
- For City Underground type signs the bottom of the sign shall be between 1000 mm and 1500 mm above rail level.
- Sydney Yard type signs shall be placed on a sleeper. The top of the sign shall be no higher than rail level.

Sighting

- City Underground type signs shall be clearly visible to a driver for a minimum of 100 m.
- Sydney Yard type signs shall be clearly visible to a driver for a minimum of 50 m.

Figure 19 - Placement envelope for permanent speed signs
In some locations physical constraints will prevent the placement of speed signs as far from the track as described in Figure 19 above. In these circumstances the requirements following apply;

**The following requirements are extracted from RailCorp Standard ESC 215.**

In locations where physical constraints prevent placement of speed signs outside Kinematic Envelope + 200, they may be placed so that the closest part of the sign is at Kinematic Envelope + 0.

Civil Maintenance Engineers shall be notified of any locations where speed signs are located inside Kinematic Envelope + 200.

Where signs have to be located between tracks with tight track centres they may be placed lower down than shown in Figure 19. The bottom of the signs must still be at least 100mm above rail level and must meet the requirements for driver visibility.

Where configuration approval has been obtained for reduced clearance:

- The installation position of the signs shall be confirmed by survey
- The clearance requirements must be met for both the actual and the designed position of the track
- A 50mm galvanised post (or equivalent) should be used and must be secured in place such that it would not be bent or dislodged if the speed sign itself is hit by a train.
- It is recommended that the post is located in a position such that it will still be compliant should current speed signs be replaced with the new generation square signs
- Should speed signs be replaced or renewed at any time the clearances must be reconfirmed by survey.

**C20-3 Longitudinal positioning**

- Signs are to be placed within ±10m of their advertised location. Note that the advertised location may vary from the original design location because of sighting, clearance or obstruction issues or because of location of support posts.
- Signs are to be placed so that they do not obstruct the view of other signs and signals.
Chapter 21 Temporary Speeds

C21-1 Introduction
Temporary speed signs are placed on the infrastructure to advise (or warn) train drivers and track vehicle operators of changes in speed or other conditions. They are applied in accordance with RailCorp’s Network Rule NSG 604 and Network Procedure NPR 713.

This document details the requirements for the appearance and location of the signs and management of the placing and removal of speed restrictions.

For completeness some information from NSG 604 has been included in italics.

C21-2 Policy
Temporary Speed signs are placed on the running line for the safe passage of trains during track and bridge repairs or where track is below standard. They are also placed on track as a precaution in hot weather to reduce the likelihood of a misalignment.

C21-2.1 Location
The locations of Temporary Speed Restriction signs are notified to drivers through:

- Verbal warnings by Network Control.
- Distribution of notices by Network Control.
- Publication in RICSpeed.

The Description and meaning of temporary Speed Restriction signs is detailed in the Network Rules NSG 604 “Indicators and Signs.”

C21-2.2 Usage rules

The following rules are extracted from NSG 604: Indicators and Signs

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

Temporary speed restriction signs take precedence over permanent speed signs.

Temporary speed restrictions may be imposed, altered or withdrawn only by competent civil staff. Network Control officers may at any time reduce the speed of trains if it is considered necessary, until the track can be assessed by civil staff.

- Network Control Officers must warn Drivers and track vehicle operators entering an affected portion of the network about speed restrictions until:
- the Maintenance Representative says that they can travel at normal speed, or
- temporary speed restriction signs have been installed, or
- affected portions of track are protected by Handsignallers. If temporary speed restrictions are continued, the Civil Maintenance Representative must advertise the restrictions in RICSpeed.
C21-3 Description

The following Description and meaning of temporary speed restriction signs are extracted from NSG 604 Indicators and Signs

Temporary speed restriction signs are placed to tell drivers and track vehicle operators about speed restrictions that have been placed on portions of track.

When signs are placed at temporary speed restrictions they must include:

- A WARNING sign with Speed Plates,
- A CAUTION sign with Speed Plates AND
- A CLEARANCE sign

When Temporary Speed Restriction signs are placed within 2500m of an existing temporary speed restriction they must ALSO include:

- additional CAUTION signs with Speed Plates

Flashing lights must be used on Temporary Speed Restriction signs in the areas bounded by:

- Helensburgh, Macarthur, Emu Plains and Cowan,
- Newcastle, Fassifern and Telarah
- Thirroul and Unanderra:

At some locations Temporary Speed Restriction signs will need additional signs, including:

- DIRECTIONAL ARROW plates or TRACK INDICATOR plates
- DISTANCE TO CAUTION plates

C21-3.1 Warning sign

A sign with the word WARNING in BLACK letters on a YELLOW reflectorised background.

A Speed plate (or plates) is attached at the BOTTOM of the sign to show the speed limit that applies in the affected portion.

A Directional Arrow plate or Track Indicator plate is attached BELOW the Speed plates to show that the speed applies on an adjoining track.

Where FLASHING LIGHTS are required, a BLUE flashing light is installed at the TOP of the sign.

Figure 20 - Warning sign – Examples of combinations
C21-3.2 Caution sign

A sign with the word CAUTION in RED letters on a YELLOW reflectorised background.

A Speed plate (or plates) is attached at the TOP of the sign to show the speed limit that applies in the affected portion.

A Directional Arrow plate or Track Indicator plate is attached BELOW the sign to show that the speed applies on an adjoining track.

Where FLASHING LIGHTS are required, an AMBER flashing light is installed at the TOP of the sign.

Figure 21 - Caution sign – Examples of combinations

C21-3.3 Clearance sign

A sign with the word CLEARANCE in BLACK letters on a WHITE reflectorised background.

Speed plates, Directional Arrow plates or Track Indicator plates are NOT required.

Where FLASHING LIGHTS are required, a WHITE flashing light is installed at the TOP of the sign.

Figure 22 - Clearance sign – Possible combinations

C21-3.4 Speed Plates

Speed Plates are fixed on Warning and Caution signs to indicate the reduced speed of trains.

The speed shown is to be a multiple of 10kph.

When both Normal and Passenger Train Speed Plates are used, the Normal Speed Plate is to be on the top of the Passenger Train Speed Plate.
Speed Plates have:

- BLACK text on a YELLOW background
- BLACK text on a WHITE background

Normal Speed Plate
(applies to ALL rail traffic)

Speed Plate for Passenger trains

C21-3.5 Directional Arrow plates and Track Indicator plates

Directional Arrow plates are attached to Warning and Caution signs to indicate to drivers, particularly through junctions, that the location of the speed restriction is on the Left/Right diverging track as indicated by the arrow.

In complex junctions, the Directional Arrow plates will not be enough to clearly indicate to drivers the track on which the speed restriction is located.

In these cases use a Track Indicator plate to show in letters the track on which the speed restriction applies.

Directional Arrow plates have a WHITE arrow on a BLUE background.
Track Indicator plates have BLACK text on a WHITE background.

C21-3.6 Intermediate Warning signs

Safe Notice 006 2005 Temporary speed restrictions trial of intermediate WARNING signs permits the use of Intermediate Warning signs

"at locations where Drivers may approach the caution sign for a temporary speed restriction without having passed the normal warning signs. For example, locations where:

- Trains may enter the affected line from a maintenance centre, yard, siding or
- A change of train crew is likely............"
C21-3.6.1 Description

Intermediate Warning signs consist of

- A Warning board
- Speed plate (or plates if required)
- Arrow plate (if required)
- Blue flashing light (where required)
- Distance to Caution Sign

C21-3.6.2 Detail of “Distance to Caution” Sign

BLACK text on a WHITE background.

Final 2 numbers (00) and lettering “TO CAUTION” prepainted on sign

First 2 (or 1) numerals applied by hand to suit distance. (Note that distances are in 100m steps)

C21-3.6.3 When to use

Use at the following locations ONLY:

- Track joining marshalling and stabling yards and sidings (Where the “Warning Sign” would fall inside the yard), including Sydney Yard.
- Locations where private (non-RIC) track joins onto RIC track (Where the “Warning Sign” would need to be situated on private property).
- Within 2500m of Central Station (Where the “Warning Sign” would appear on the other side of the station, technically on a different track, in a different direction).
- Terminus stations (e.g. Newcastle, Bomaderry, Carlingford, Cronulla, Richmond) or significant terminating locations (e.g. Macarthur).
- Driver sign on points, or relief points.

C21-3.6.4 Placement

- Place on the secondary track before it enters the main line on which the speed applies.
- DO NOT place it on main line where sufficient distance is available for placement of Standard Warning signs at 2500m.
- Place in the same lateral and vertical position as Standard Warning signs.
- Place longitudinally at a multiple of 100m back from the “Caution” sign.
- Place at locations where maximum track speed is not more than 40kph (to allow drivers to read the sign).

C21-4 Placement Rules

The Placement Rules describe the location of Temporary Speed Restriction signs relative to the track.
C21-4.1 Orientation

The following rules are extracted from NSG 604, Indicators and Signs

- Temporary Speed Restriction signs are placed on the left-hand side of the line in the direction of travel.
- In Bi-Directional signalling areas, Temporary Speed Restriction signs are placed on the left-hand side of the line in the right running direction and on the right-hand side of the line for trains travelling in the wrong running direction.
- In single line areas, Temporary Speed Restriction signs are placed on the left-hand side of the line in each direction of travel.

C21-4.2 Longitudinal

- Warning signs are to be placed within ± 100m of the nominated location.
- Caution signs are to be placed within - 50m + 10m of the nominated location (in the direction of travel).
- Clearance signs are to be placed within - 10m + 50m of the nominated location (in the direction of travel).
- Signs are to be placed so that they do not obstruct the view of other signs and signals.

C21-4.3 Lateral and vertical

Where practical, signs are to be placed in the following “Standard position.” (See Figure 23).

- The sign is to be placed within the following envelope. Closest part of sign is to be no closer to the gauge face of nearest running rail than 1800 mm. This means that the centre of the support post must be at least 1900mm from the gauge face of nearest running rail.
- Closest part of sign is to be no further than 3000mm from the gauge face of nearest running rail. Signs may be attached to OHW masts but they MUST be positioned on the inner side (closer to the track). They MUST NOT be placed in the web of the mast.
- Bottom of lowest sign is to between Rail Level and 500mm above rail level.
- Top of highest sign to be no more than 2800mm above Rail Level.
- At locations where lateral clearances are restricted, the lateral and vertical tolerances may be reduced provided minimum transit space requirements are met.

C21-4.4 Sighting

- The face of the sign must be at right angles to the track. On a curve it may be turned slightly to reflect the headlight of the approaching train.
- The sign to be clearly visible to a driver for a minimum of 200m.
C21-5 Field Management

C21-5.1 Applying speed restrictions

Speed restrictions are required when it is established that the track condition is (or will be) unsuitable for normal speed.
The limits of speed restriction, speed change and/or length of restriction, may alter during the various stages of a construction and/or repair period. If so, the management of these specific alterations must be in accordance with the following requirements.

When such a restriction is required, it is necessary to manage the imposition and removal of the speed restriction so that train drivers are aware of the speed and its location by communication as well as by the presence of Temporary Speed Restriction signs.

### C21-5.1.1 Types of Temporary speed Restrictions

- **'A' speeds** - Speed Restrictions that must be observed ALWAYS (24 hours per day).
- **'B' speeds** - Speeds required only for daylight (working) hours.
- **'C' speeds or 'Heat' speeds** - Speed Restrictions are applied in summer months in accordance with the requirements of Section C8-8.
  - C speeds MUST always be issued as 1000 to 2000hrs.
  - A sign plate is applied to the Warning and Caution boards.
  - Lights must be fitted in the areas where lights are required.

### C21-5.1.2 Emergency Speed Restrictions

Civil Team Leaders and Team Managers have the authority to impose temporary speed restrictions without reference to other supervisory staff, if, in their opinion, track or a structure is unsafe for the passage of trains at the published speed.

In an emergency, all Civil field staff have the authority to impose a restriction in the absence of any other assistance and they must immediately report their action to their manager.

Staff from disciplines other than Civil DO NOT have the authority to impose Temporary Speed Restrictions because of track problems, except in an emergency, when they can impose a speed restriction until a competent Civil worker is available to confirm the need for the action.

If a speed restriction is required for the next train follow Steps 1 to 8.

1. **Contact Network Control to advise of the speed restriction location and details.**
   
   When speed restrictions are applied verbally, in the event of a Breakaway or Misalignment, it may be some time before Warning, Caution and Clearance signs are erected. Network Control advises drivers of speed restriction by issuing a CAN notice.

2. **Erect Temporary Speed restriction signs.**
   
   Temporary Speed restriction signs should be erected as soon as possible after advising Network Control.
   
   - Construct signs with appropriate speed signs, indicator signs and lights (if required).
   - Please note that Warning, Caution and Clearance signs and speed plates, directional arrows and Track Indicator plates are available through Clyde.
Warehouse and are purchased in accordance with RailCorp Specification SPC 213 - - Track Side Signs.

- Place signs in the following sequence - Clearance, Caution then Warning signs (Beware of underground cables when installing posts for Temporary Speed Restriction signs).
- Check height and lateral placement of signs.
- Check drivers’ visibility of signs.
- Alter placement of the signs or remove site obstructions (if required).
- Ensure no other speed restrictions are within 2500m. If other speed restrictions exist it may be necessary to alter the existing signs and any additional signs will have to comply with the requirements for speed restrictions within 2500m of each other.

3. Compile a Speed Restriction Notice (Form TSR1 - see Appendix E), sign it, and send it (by fax) to Rail Management Centre Shift Manager 9 4438 (9379 4438), confirming that signs (and lights) have been erected.

4. Fax a copy of the Speed Restriction Notice Form TSR1 to the IOC (Signal/Civil Trouble Office).

   Contact details for the IOC are
   - Phone 9 5555 (9379 5555)
   - Free Call 1800 043 141
   - Fax 9 5533 (9379 5533)

5. Contact the Civil Maintenance Engineer’s Office and advise details of speed. Ensure Report portion (Part 2) of Speed Restriction Notice Form TSR1 is completed.

6. The Civil Maintenance Engineer will arrange timely updating of RICSpeed to reflect new Temporary Speed restrictions.

7. All Temporary Speed restrictions that will be imposed for more than 24 hours are to be entered into RICSpeed.

8. Field Supervising Officers must check that the entries in RICSpeed are correct for their sections and any omissions or alterations are to be immediately advised to the Civil Maintenance Engineer’s office.

**C21-5.1.3 Temporary Speeds for Planned Work**

When it is known in advance that speed restrictions will be required because of work that is planned, and the speed restriction can be advertised in RICSpeed one week in advance, then the steps are:

1. Contact the Civil Maintenance Engineer’s Office and advise details of speed to be imposed. ENSURE Report portion (Part 2) of the Speed Restriction Notice Form TSR1 is completed.

2. The Civil Maintenance Engineer will arrange updating of RICSpeed to reflect the proposed Temporary Speed Restriction.

   - Planned Temporary Speed Restrictions are to be entered into RICSpeed a week in advance where possible.

3. Erect Temporary Speed restriction signs on the agreed date.

4. Compile a Speed Restriction Notice Form TSR1, sign it, and send it (by fax or email) to Incident Information Management System (IIMS), confirming that signs (and lights) have been erected.
5. Fax a copy of the Speed Restriction Notice Form TSR1 to the IOC (Signal/Civil Trouble Office).

C21-5.1.4 Using Intermediate Warning signs

Where it is not possible to place a Warning sign at 2500m from the site to be protected by speed restriction, and it has been established that an Intermediate Warning sign can be used, the following additional steps are required to prepare the “Distance to Caution” sign for use:

To add the numbers to the front of the sign:

1. Determine the distance between the “Intermediate Warning” sign and the “Caution” sign. (must be a multiple of 100 metres).
2. Make the number(s) to add to the preprinted “Distance to Caution” sign by:
   - Selecting self-adhesive numerals that have been pre-cut. These can be placed on the sign on the day.
   - Printing the numerals on the sign “freehand” using permanent marker or paint.

C21-5.2 Altering speed restrictions

When a restriction is to be altered either in length or speed follow Steps 1 to 4.

1. Compile a Speed Restriction Notice Form TSR1 showing the altered arrangements, sign it, and send it (by fax) to Rail Management Centre Shift Manager.
2. Fax a copy of the Speed Restriction Notice Form TSR1 to the IOC (Signal/Civil Trouble Office).
3. Alter the speeds or location of warning, caution and clearance signs as required.
4. Contact the Civil Maintenance Engineer's Office and advise details of speed. ENSURE Report portion (Part 2) of Speed Restriction Notice Form TSR1 is completed.

The Civil Maintenance Engineer will arrange timely updating of RICSpeed to reflect altered Temporary Speed restrictions.

C21-5.3 Removing speed restrictions

When a restriction is to be removed follow Steps 1 to 4.

1. Compile a Speed Restriction Notice Form TSR1 showing the removal of the speed restriction, sign it, and send it (by fax) to Rail Management Centre Shift Manager.
2. Send a copy by fax to the IOC (Signal/Civil Trouble Office).
3. Remove signs in the following sequence - Warning, Caution then Clearance.
4. Contact the Civil Maintenance Engineer's Office and advise removal.

The Civil Maintenance Engineer will arrange timely updating of RICSpeed to reflect altered Temporary Speed restrictions.
Chapter 22 Kilometre Posts

C22-1 Placement of posts

The following construction acceptance limits are extracted from RailCorp Standard ESC 210.

The location should be as close as is reasonably practicable to the design location of the km and ½ km points. Where alignment designs relate to existing track on which kilometre and half kilometre posts have been previously installed, no alterations in longitudinal location are required. They shall, however, be reviewed to determine if alteration of lateral placement is required to meet the requirements of Figure 24.

Figure 24 – Lateral placement of kilometre posts

Where physical restraints prevent placement of the posts as detailed in Figure 24, or where access requirements would interfere with the placement, Civil Maintenance Engineers may authorize a variation.
Chapter 23 Components and equipment

C23-1 LED warning lights on temporary speed signs

C23-1.1 Description

<table>
<thead>
<tr>
<th>Product Description</th>
<th>LED Warning Light, Model ‘Trafi-LITE’ series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part Numbers</td>
<td>RIC Special - White Light. Part number TL-FCRIC</td>
</tr>
<tr>
<td></td>
<td>RIC Special - Blue Light. Part number TL-FBRIC</td>
</tr>
<tr>
<td></td>
<td>RIC Special - Amber Light. Part number TL-FARIC</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Dorman Traffic Products Limited</td>
</tr>
<tr>
<td>Supplier:</td>
<td>Road Management Solution (RMS)</td>
</tr>
<tr>
<td></td>
<td>10 Endeavour Road, Caringbah NSW 2229</td>
</tr>
</tbody>
</table>

Figure 25 - LED Warning light

Figure 26 - Access keys (can be separately purchased)
### MIMS Stockcode numbers

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<tr>
<th>Stockcode</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>001907484</td>
<td>LIGHT, WARNING TYPE; CLEAR/WHITE; 6VDC; 190MM DIA LENS; SINGLE SIDED; BOLT/BRACKET MOUNT; POLYCARBONATE BASE; 350MM H; BS3163-2; (TRAFLITE, DORMAN BRAND);</td>
</tr>
<tr>
<td>001907492</td>
<td>LIGHT, WARNING TYPE; BLUE; 6VDC; 190MM DIA LENS; SINGLE SIDED; BOLT/BRACKET MOUNT; POLYCARBONATE BASE; 350MM H; BS3163-2; (TRAFLITE, DORMAN BRAND);</td>
</tr>
<tr>
<td>001907500</td>
<td>LIGHT, WARNING TYPE; AMBER/YELLOW; 6VDC; 190MM DIA LENS; SINGLE SIDED; BOLT/BRACKET MOUNT; POLYCARBONATE BASE; 350MM H; BS3163-2; (TRAFLITE, DORMAN BRAND);</td>
</tr>
</tbody>
</table>

The MIMS Stockcode number for the recommended batteries is:

<table>
<thead>
<tr>
<th>Stockcode</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>001899582</td>
<td>Lantern batteries</td>
</tr>
</tbody>
</table>

#### C23-1.2 Guide to the maintenance and use of LED Warning Lights

1. The lights are directional. Check that the light is facing the right direction when it is installed.

2. Check to see that the light is working when you first use it, and regularly when it is in service.

   The lights provide an initial 1 second flash of light when first turned on, to signify that they are turned on and that the light source is working. Since the lights are photoelectrically controlled, they will not work in daylight. Place a cover over the light to test that it is working.

3. Clean the surface regularly (at least every 6 months).

   The efficiency of a warning light can be significantly reduced by the accumulation of dirt and dust on the front lens. Take care in cleaning the lenses to avoid scratching. Use a soft cloth and detergent.

4. The LED light source for these warning lights should last for many years and is impervious to shock and the like. If an LED should fail, they generally can't be replaced in the field.

5. Visually check the brightness using the method in (2) above.

   The brightness of the warning light decreases as the battery voltage reduces. If access to Electrical Test equipment is available check the under-load battery voltage and replace once the voltage drops to 4.7 Volts.
MAINTENANCE OF WELDED TRACK IN SUMMER

1 NOVEMBER - 31 MARCH

MANUAL RESLEEPERING

Your Civil Maintenance Engineer may provide written instructions for this work which will be specific to your work area or location.

If you do not have these instructions, the following procedures MUST be applied:

1. DO NOT resleeper unless
   - The maximum forecast AIR temperature is less than 35°C.
   - The welded track stability loss will be less than 40% after the work
   - The worksite has enough ballast to provide a FULL ballast profile when work is completed

2. During resleepering
   - DO NOT renew more than 1 sleeper in 6 in one day.
   - DIG sleepers in, BEATER PACK each sleeper and BOX up ballast to full profile as you are going
   - DON'T wait till all sleepers are in before you pack and box up
   - DO NOT apply a running lift to the track
   - DO slow the trains while you are working (until you pack and box up the track is not stable enough to allow full speed).
   - STOP resleepering if it gets too hot. That is when:
     - Rail Temperature reaches 38°C
     - The rail gaps on and near the job close up
     - The track any sign of moving (apply a speed)
Appendix A  Green Card (Large)

MAINTENANCE OF WELDED TRACK IN SUMMER

1 NOVEMBER - 31 MARCH

MECHANISED RESLEEPERING

Your Civil Maintenance Engineer may provide written instructions for this work which will be specific to your work area or location.

If you do not have these instructions, the following procedures MUST be applied:

1. DO NOT resleeper unless
   - The maximum forecast AIR temperature is less than 35ºC.
   - The welded track stability loss will be less than 40% after the work has been completed and the speed restriction removed.
   - The worksite has enough ballast to provide a FULL ballast profile when work is completed

2. During resleepering
   - DO NOT renew more than 1 sleeper in 6 in one day.
   - On STRAIGHTS and FLAT CURVES more than 1200m radius you can resleeper 1 in 4 (if in doubt about radius only put in 1 in 6).
   - DO NOT apply general lifts
   - Minimum maintenance lifts of no more than 20mm are to be applied
   - DO beater pack and box up insulated joints, bridge ends and other locations where machines can't reach.
   - STOP resleepering if it gets too hot. That is when:
     - Rail Temperature reaches 38ºC
     - The rail gaps on and near the job close up
     - The track shows any sign of moving

3. A 'C' speed restriction must be applied to the worksite for at least seven days or 100,000 tonnes between 1000 and 2000 hours daily. Normal speed should be reduced as follows

<table>
<thead>
<tr>
<th>Normal Speed Board Speed</th>
<th>Temporary Speed</th>
</tr>
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<tbody>
<tr>
<td>100 - 160 km/hr</td>
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<td>60 km/hr</td>
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<td>40 km/hr</td>
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<tr>
<td>Under 40 km/hr</td>
<td>No reduction</td>
</tr>
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4. Where a Ballast Stabiliser is used the speed restriction may be removed after one day

Extract from TMC 211
Version 4.8, Issued April 2013
Appendix A Green Card (Large)

MAINTENANCE OF WELDED TRACK IN SUMMER

1 NOVEMBER - 31 MARCH

MECHANISED RESURFACING

Your Civil Maintenance Engineer may provide written instructions for this work which will be specific to your work area or location.

If you do not have these instructions, the following procedures MUST be applied:

1. DO NOT resurface unless
   • The maximum forecast AIR temperature is less than 35ºC.
   • The welded track stability loss will be less than 40% after the work has been completed and the speed restriction removed.
   • The worksite has enough ballast to provide a FULL ballast profile when work is completed

2. During resurfacing
   • DO NOT apply general lifts
   • Minimum maintenance lifts of no more than 20mm are to be applied
   • DO beater pack and box up insulated joints, bridge ends and other places where the machines can't reach
   • STOP resurfacing if it gets too hot. That is when:
     − Rail Temperature reaches 38ºC
     − The rail gaps on and near the job close up
     − The track shows any sign of moving

3. A ‘C’ speed restriction must be applied to the worksite for at least seven days or 100,000 tonnes between 1000 and 2000 hours daily. Normal speed should be reduced as follows

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4. Where a Ballast Stabiliser is used the speed restriction may be removed after one day.
Appendix A  Green Card (Large)

MAINTENANCE OF WELDED TRACK IN SUMMER

1 NOVEMBER - 31 MARCH

FETTLING, MANUAL LIFTING AND LINING

Your Civil Maintenance Engineer may provide written instructions for this work which will be specific to your work area or location.

If you do not have these instructions, the following procedures MUST be applied:

1.  DO NOT disturb the track by fettling unless
   • The maximum forecast AIR temperature is less than 35°C.
   • The welded track stability loss will be less than 40% after the work
   • The worksite has enough ballast to provide a FULL ballast profile when work is completed

2.  During fettling
   • DO NOT disturb the track any more than absolutely necessary.
   • DO NOT do running lifts
   • DO NOT apply general lifts
   • DO NOT lift track any more than 20mm
   • DO beater pack each sleeper and box up ballast to full profile as you are going
   • DO slow the trains while you are working (until you pack and box up the track is not stable enough to allow full speed).
   • STOP fettling if it gets too hot. That is when :
     − Rail Temperature reaches 38°C
     − The rail gaps on and near the job close up
     − The track shows any sign of moving (apply a speed)
MAINTENANCE OF WELDED TRACK IN SUMMER
1 NOVEMBER - 31 MARCH

MECHANISED RESLEEPERING

Your Civil Maintenance Engineer may provide written instructions for this work which will be specific to your work area or location.

If you do not have these instructions, the following procedures MUST be applied:

1. DO NOT resleeper unless:
   - The maximum forecast AIR temperature is less than 35°C.
   - The welded track stability loss will be less than 40% after the work has been completed and the speed restriction removed.
   - The worksite has enough ballast to provide a FULL ballast profile when work is completed

2. During resleepering
   - DO NOT renew more than 1 sleeper in 6 in one day.
   - On STRAIGHTS and FLAT CURVES more than 1200m radius you can resleeper 1 in 4 (in doubt about radius only put in 1 in 6).
   - DO beater pack and box up insulated joints, bridge ends and other locations where machines can’t reach.
   - STOP resleepering if it gets too hot. That is when:
     - Rail Temperature reaches 38°C
     - The rail gaps on and near the job close up
     - The track shows any sign of moving

3. A speed restriction must be applied to the worksite for at least seven days or 100,000 tonnes between 1000 and 2000 hours daily. Normal speed should be reduced as follows:

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4. Where a Ballast Stabiliser is used the speed restriction may be removed after one day

MAINTENANCE OF WELDED TRACK IN SUMMER
1 NOVEMBER - 31 MARCH

MANUAL RESLEEPERING

Your Civil Maintenance Engineer may provide written instructions for this work which will be specific to your work area or location.

If you do not have these instructions, the following procedures MUST be applied:

1. DO NOT resleeper unless:
   - The maximum forecast AIR temperature is less than 35°C.
   - The welded track stability loss will be less than 40% after the work has been completed and the speed restriction removed.
   - The worksite has enough ballast to provide a FULL ballast profile when work is completed

2. During resleepering
   - DO NOT renew more than 1 sleeper in 6 in one day.
   - DIG sleepers in, BEATER PACK each sleeper and BOX up ballast to full profile as you are going
   - DON’T wait till all sleepers are in before you pack and box up
   - DO NOT apply a running lift to the track
   - DO slow the trains while you are working (until you pack and box up the track is not stable enough to allow full speed).
   - STOP resleepering if it gets too hot. That is when:
     - Rail Temperature reaches 38°C
     - The rail gaps on and near the job close up
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<tr>
<td>Under 40 km/hr</td>
<td>No reduction</td>
</tr>
</tbody>
</table>

4. Where a Ballast Stabiliser is used the speed restriction may be removed after one day

MAINTENANCE OF WELDED TRACK IN SUMMER
1 NOVEMBER - 31 MARCH

FETTLING, MANUAL LIFTING AND LINING

Your Civil Maintenance Engineer may provide written instructions for this work which will be specific to your work area or location.

If you do not have these instructions, the following procedures MUST be applied:

1. DO NOT disturb the track by fetting unless:
   - The maximum forecast AIR temperature is less than 35°C
   - The welded track stability loss will be less than 40% after the work has been completed
   - The worksite has enough ballast to provide a FULL ballast profile when work is completed

2. During fetting
   - DO NOT disturb the track any more than absolutely necessary.
   - DO NOT do running lifts
   - DO NOT apply general lifts
   - DO NOT lift track any more than 20mm
   - DO beater pack each sleeper and box up ballast to full profile as you are going
   - DO slow the trains while you are working (until you pack and box up the track is not stable enough to allow full speed).
   - STOP fetting if it gets too hot. That is when:
     - Rail Temperature reaches 38°C
     - The rail gaps on and near the job close up
     - The track shows any sign of moving (apply a speed)

MAINTENANCE OF WELDED TRACK IN SUMMER
1 NOVEMBER - 31 MARCH

MECHANISED RESURFACING

Your Civil Maintenance Engineer may provide written instructions for this work which will be specific to your work area or location.

If you do not have these instructions, the following procedures MUST be applied:

1. DO NOT resurface unless:
   - The maximum forecast AIR temperature is less than 35°C
   - The welded track stability loss will be less than 40% after the work has been completed and the speed restriction removed.
   - The worksite has enough ballast to provide a FULL ballast profile when work is completed

2. During resurfacing
   - DO NOT renew more than 1 sleeper in 6 in one day.
   - DIG sleepers in, BEATER PACK each sleeper and BOX up ballast to full profile as you are going
   - DON’T wait till all sleepers are in before you pack and box up
   - DO NOT apply a running lift to the track
   - DO slow the trains while you are working (until you pack and box up the track is not stable enough to allow full speed).
   - STOP resurfacing if it gets too hot. That is when:
     - Rail Temperature reaches 38°C
     - The rail gaps on and near the job close up
     - The track shows any sign of moving (apply a speed)

3. A speed restriction must be applied to the worksite for at least seven days or 100,000 tonnes between 1000 and 2000 hours daily. Normal speed should be reduced as follows:

<table>
<thead>
<tr>
<th>Normal Speed Board Speed</th>
<th>Temporary Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 - 160 km/hr</td>
<td>80 km/hr</td>
</tr>
<tr>
<td>75 - 95 km/hr</td>
<td>60 km/hr</td>
</tr>
<tr>
<td>40 - 70 km/hr</td>
<td>40 km/hr</td>
</tr>
<tr>
<td>Under 40 km/hr</td>
<td>No reduction</td>
</tr>
</tbody>
</table>

4. Where a Ballast Stabiliser is used the speed restriction may be removed after one day

Appendix B Green Card (Small)

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UNCONTROLLED WHEN PRINTED

Version 4.8
## Appendix C  Misalignment Report

### Misalignment Report (Form MIS 1)

<table>
<thead>
<tr>
<th>1. DISTRICT</th>
<th>2. TRACK BASE CODE</th>
<th>3. DATE</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>4. LINE BETWEEN</th>
<th>AND</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>5. KILOMETRAGE</th>
<th>7. METHOD OF DETECTION</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>6. TRACK</th>
<th>10. MISALIGNMENT DESCRIPTION</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Single (1)</th>
<th>Up Main (2)</th>
<th>Dn Main(3)</th>
<th>Up Sub(4)</th>
<th>Dn Sub(5)</th>
<th>Crossing Loop(6)</th>
<th>Up Local / Relief(7)</th>
<th>Dn Local Relief(8)</th>
<th>Siding or Refuge (9)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>8. TIME DETECTED</th>
<th>9. REPORTED TO</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Team Leader pervisor/Fettler (1)</th>
<th>Station Manager (2)</th>
<th>Team Manager / Engineer (3)</th>
<th>Other (4)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>11. RADIUS 0-400m(1)</th>
<th>400-800m (2)</th>
<th>800-1600m (3)</th>
<th>Over 1600m (4)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>12. RAIL SECTION (kg/m)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>13. LENGTH OF RAIL</th>
<th>14. SLEEPER TYPE</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Less than 13.7m(1)</th>
<th>13.7-55m(2)</th>
<th>55-110m(3)</th>
<th>110-220m(4)</th>
<th>220-550m (5)</th>
<th>Over 500m(6)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>15. FASTENINGS</th>
<th>16. SLEEPER CONDITION</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Dogspikes, Sleeper Plates Lockspikes(1)</th>
<th>Dogspikes, Sleeper Plates No Lockspikes(2)</th>
<th>Dogspikes, No Plates(3)</th>
<th>Pandrol Clips(4)</th>
<th>Other Resilient Fastenings(5)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>17. ANCHOR PATTERN</th>
<th>18. AMBIENT TEMPERATURE</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>1:1(1)</th>
<th>1:2(2)</th>
<th>1:3(3)</th>
<th>1:4(4)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>19. RAIL TEMPERATURE</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>20. TRACK DISTURBANCE</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Fettling(1)</th>
<th>Manual Resleepering(2)</th>
<th>Surfacing(3)</th>
<th>Tie and Surfacing(4)</th>
<th>Ballast Cleaning(5)</th>
</tr>
</thead>
</table>

|--------------|---------------------|--------------|------------|--------------|-------------|-----------------------------|

<table>
<thead>
<tr>
<th>Shoulder Deficiency(Y/N)</th>
<th>Is rail out of adjustment?(Y/N)</th>
<th>Have rails crept? (Y/N)</th>
<th>Were any anchors ineffective? (Y/N)</th>
<th>Were any fastenings ineffective? (Y/N)</th>
<th>Was track off its correct alignment? (Y/N)</th>
<th>Calculations(%)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Ballast</th>
<th>Time of Misalignment</th>
<th>After Repairs</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>LAST OCCASION</th>
<th>0-1Mth(1)</th>
<th>1-2Mths(2)</th>
<th>2-3Mths(3)</th>
<th>Over 3Mths(4)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>28. LAST TRAIN ID</th>
<th>APPARENT CAUSES</th>
</tr>
</thead>
</table>

|----------------|-------------|-------------------|-------------|------------|--------------|-------------|--------|

<table>
<thead>
<tr>
<th>UP RAIL mm</th>
<th>DN RAIL mm</th>
<th>RAIL TEMPERATURE ° C</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>SPEED RESTRICTION IMPOSED KM/H</th>
<th>TRAIN DELAYS</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>FURTHER CORRECTIVE ACTION PROPOSED</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>COMMENTS</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>TEAM MANAGER</th>
<th>CIVIL MAINTENANCE ENGINEER</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>DATE</th>
<th>DATE</th>
</tr>
</thead>
</table>

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Issued April 2013
## Appendix D  Misalignment Investigation Report

### Misalignment Investigation Report

<table>
<thead>
<tr>
<th>Investigation of systems &amp; processes:</th>
<th>Yes/No/Not Applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Undetected instability site</strong></td>
<td></td>
</tr>
<tr>
<td>Inspection</td>
<td></td>
</tr>
<tr>
<td>Have all Welded Track Stability inspections been completed?</td>
<td></td>
</tr>
<tr>
<td>In the case of non-welded track, have inspections been undertaken in conjunction with track patrol (as per C.2532)?</td>
<td></td>
</tr>
<tr>
<td>Are there errors in the basic information supplied in the inspection reports compared to the field information gathered at the time of the misalignment?</td>
<td></td>
</tr>
<tr>
<td>Has the inspecting officer performed satisfactorily when carrying out his inspection duties with respect to welded track stability?</td>
<td></td>
</tr>
<tr>
<td>Do the Standards and Procedures adequately provide for inspection in the case of this misalignment?</td>
<td></td>
</tr>
<tr>
<td>Has routine track patrol been effective?</td>
<td></td>
</tr>
<tr>
<td>Has the controlling officer provided adequate supervision to the welded track inspection program as specified in the standards?</td>
<td></td>
</tr>
<tr>
<td><strong>Analysis</strong></td>
<td></td>
</tr>
<tr>
<td>Was there a Welded Track Stability Analysis completed for this section of track prior to the summer?</td>
<td></td>
</tr>
<tr>
<td>Was there any alternative analysis or assessment completed?</td>
<td></td>
</tr>
<tr>
<td>Has the welded track stability analysis been properly computed?</td>
<td></td>
</tr>
<tr>
<td>Does the analysis as per the Standards properly provide for the situation in this case?</td>
<td></td>
</tr>
<tr>
<td>Have the analysis results been properly interpreted by field staff for this location?</td>
<td></td>
</tr>
<tr>
<td>Was Secondary Analysis required at this location?</td>
<td></td>
</tr>
<tr>
<td>If so, what was the action proposed appropriate?</td>
<td></td>
</tr>
<tr>
<td>In the case of non-welded track, were high risk locations identified prior to summer?</td>
<td></td>
</tr>
<tr>
<td><strong>Assurance</strong></td>
<td></td>
</tr>
<tr>
<td>Has this location been subject to previous misalignment in the past three years?</td>
<td></td>
</tr>
<tr>
<td>If so, was there special attention given to the inspection and analysis of the site prior to the summer period?</td>
<td></td>
</tr>
<tr>
<td><strong>Uncorrected Instability Location</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Elimination</strong></td>
<td></td>
</tr>
<tr>
<td>Did this location appear on a list of priority instability location for attention?</td>
<td></td>
</tr>
<tr>
<td>Had this location received any attention for the purpose of reducing the level of instability?</td>
<td></td>
</tr>
<tr>
<td>If not, was there a plan or program on hand to address the problem at this location?</td>
<td></td>
</tr>
<tr>
<td>Was the program as competently drawn, addressing priorities in sensible order?</td>
<td></td>
</tr>
<tr>
<td>If on the case of ballast deficiencies, was there a ballasting program and a programmed date of delivery?</td>
<td></td>
</tr>
<tr>
<td>If programs of elimination were late, are the reasons acceptable?</td>
<td></td>
</tr>
<tr>
<td><strong>Site Protection</strong></td>
<td></td>
</tr>
<tr>
<td>If the site was an identified priority location, were standard precautions enforced to restrict the speed of services across the site at the time of the misalignment?</td>
<td></td>
</tr>
<tr>
<td>Was a WOLO condition applied at the time of the misalignment?</td>
<td></td>
</tr>
<tr>
<td>If so, was a train speed still a factor?</td>
<td></td>
</tr>
<tr>
<td>Was the staff response to the identified misalignment satisfactory?</td>
<td></td>
</tr>
<tr>
<td>Was track patrol adequate for the location at the time of the misalignment?</td>
<td></td>
</tr>
<tr>
<td><strong>Poor Work Performance</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Procedures</strong></td>
<td></td>
</tr>
<tr>
<td>Was the misalignment related to work at the site prior to or on the day of the misalignment?</td>
<td></td>
</tr>
<tr>
<td>Were there adequate written instructions to staff outlining the procedures to be adopted for hot weather maintenance?</td>
<td></td>
</tr>
<tr>
<td>Was there a variation to normal hot weather procedures applied in this case?</td>
<td></td>
</tr>
<tr>
<td>Was any such variation properly issued in writing?</td>
<td></td>
</tr>
<tr>
<td><strong>Misalignment Investigation Report</strong> (Form MIS 2)</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>---</td>
</tr>
<tr>
<td><strong>Were the standard procedures as they were applied in this situation adequate for the purpose?</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Training</strong></td>
<td></td>
</tr>
<tr>
<td>Can the incident be directly related to the sub-standard performance by a member of staff operating within the maintenance system?</td>
<td></td>
</tr>
<tr>
<td>If so:</td>
<td></td>
</tr>
<tr>
<td>Were the staff involved in inspection work and routine track patrol at this site adequately briefed in their duties?</td>
<td></td>
</tr>
<tr>
<td>Has there been adequate opportunity for staff to be trained in the skills for inspection or maintenance prior to the current summer period?</td>
<td></td>
</tr>
<tr>
<td><strong>Supervision</strong></td>
<td></td>
</tr>
<tr>
<td>Has there been a breakdown in supervision at any level in the maintenance process?</td>
<td></td>
</tr>
<tr>
<td><strong>Production Work</strong></td>
<td></td>
</tr>
<tr>
<td>Has all production work in the area been completed according to standard?</td>
<td></td>
</tr>
<tr>
<td>Has there been adequate communication between production and maintenance staff?</td>
<td></td>
</tr>
<tr>
<td><strong>Incorrect Rail Adjustment</strong></td>
<td></td>
</tr>
<tr>
<td>Have tests shown that the rail was out of adjustment?</td>
<td></td>
</tr>
<tr>
<td>Was the degree of adjustment forecast by the Welded Track Stability Analysis?</td>
<td></td>
</tr>
<tr>
<td>Has the adjustment of rails in this section been properly executed and managed?</td>
<td></td>
</tr>
<tr>
<td>Are creep marks for CWR track properly maintained?</td>
<td></td>
</tr>
<tr>
<td>Has there been any recent rail welding work at or near the misalignment site?</td>
<td></td>
</tr>
<tr>
<td>Has this work been properly carried out with respect to rail adjustment?</td>
<td></td>
</tr>
<tr>
<td><strong>Nomination of Responsibilities:</strong></td>
<td></td>
</tr>
<tr>
<td>Have all reasonable steps or precautions been taken in a responsible manner in accordance with the standard practices applicable at the time to control the heat buckling hazard?</td>
<td></td>
</tr>
<tr>
<td>If not, the nominated responsibilities are:</td>
<td></td>
</tr>
<tr>
<td><strong>Recommendation</strong></td>
<td></td>
</tr>
<tr>
<td>With a view to preventing future misalignments of the type which has occurred in this case:</td>
<td></td>
</tr>
</tbody>
</table>
### Appendix E  Speed Restriction Notice

#### Part 1

**Speed Restriction Notice**  
*Form TSR1*

<table>
<thead>
<tr>
<th>From:</th>
<th>Contact phone no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date:</td>
<td></td>
</tr>
<tr>
<td><strong>To:</strong></td>
<td>List locations MUST include Network Control (9 4438 or 9379 4438), Civil Maintenance Engineer’s office, Signal/Civil Trouble Office IOC (Fax 9 5533 or 9379 5533) CCS Desk IOC (24077 or 8922 4077) Other addressees by local arrangement</td>
</tr>
<tr>
<td>FROM:</td>
<td>............... HOURS</td>
</tr>
<tr>
<td>A SPEED RESTRICTION OF</td>
<td>KM/HR LOCO AND FREIGHT AND</td>
</tr>
<tr>
<td>WILL BE IMPOSED BETWEEN</td>
<td>AND</td>
</tr>
<tr>
<td>BETWEEN:</td>
<td>KM AND</td>
</tr>
<tr>
<td>ON</td>
<td>UP/DOWN/SINGLE/LINE</td>
</tr>
<tr>
<td>THIS RESTRICTION IS CLASSIFIED AS</td>
<td>A</td>
</tr>
<tr>
<td>A = Always</td>
<td>B = daylight (working) hours</td>
</tr>
<tr>
<td>PLANNED REMOVAL DATE</td>
<td>REFLECTORISED SIGNS ARE</td>
</tr>
<tr>
<td>REASON:</td>
<td></td>
</tr>
<tr>
<td>SIGNED:</td>
<td></td>
</tr>
</tbody>
</table>

#### ALTERATION

<table>
<thead>
<tr>
<th>From:</th>
<th>Contact phone no.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ALTERED SPEEDS WILL APPLY</strong></td>
<td>KM/HR LOCO &amp; FREIGHT</td>
</tr>
<tr>
<td>BETWEEN</td>
<td>AND</td>
</tr>
<tr>
<td>BETWEEN</td>
<td>KM AND</td>
</tr>
<tr>
<td>ON</td>
<td>UP/DOWN/SINGLE/LINE</td>
</tr>
<tr>
<td><strong>ALTERED PLANNED REMOVAL DATE</strong></td>
<td></td>
</tr>
<tr>
<td>SIGNED:</td>
<td></td>
</tr>
</tbody>
</table>

#### REMOVAL

<table>
<thead>
<tr>
<th>From:</th>
<th>Contact phone no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>BETWEEN</td>
<td>AND</td>
</tr>
<tr>
<td>BETWEEN</td>
<td>KM AND</td>
</tr>
<tr>
<td>ON</td>
<td>UP/DOWN/SINGLE/LINE</td>
</tr>
<tr>
<td>FROM:</td>
<td>DATE AND</td>
</tr>
<tr>
<td><strong>NORMAL SPEED WILL BE RESUMED</strong></td>
<td></td>
</tr>
<tr>
<td>SIGNED:</td>
<td></td>
</tr>
</tbody>
</table>

#### Part 2

Not for transmission  
**to be completed by Team Manager and forwarded to Civil Maintenance Engineer**

**Brief comment:**

**Restriction planned to be lifted:**

**TO:** Civil Maintenance Engineer

**SIGNED:**  
(Team Manager)  
DATE: 

**Note 1.** Imposing and removing Temporary Speeds requires competency TDT B38 - Maintain Track Geometry (Chap.3 TMC 211). In an emergency, ALL Civil field staff have the authority to impose a restriction in the absence of any other assistance and they must immediately report their action to their manager (C21-5.1.2 in TMC 211).