## Document control

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Summary of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>October 2006</td>
<td>First issue as a RailCorp document. Includes content from C 2514, TS 3645, TS 3655, CSI 039, RC 2411, RC 3361, RTS 3620, RTS 3640, RTS 3643, RTS 3648, TS 3655, RAP 5138, RAP 5140, CTN 02/10, CTN 02/16, CTN 03/04, CTN 05/01, CTN 05/06, CTN 05/25, CTN 06/02.</td>
</tr>
<tr>
<td>2</td>
<td>April 2007</td>
<td>Addition of rerailing priority assessment; Inclusion of omitted competency; Inclusion of standard method for installing and measuring punchmarks; Minor corrections; change in maximum length for use of rail in/rail out process; inclusion of information on classification of recycled rail and requirement to classify immediately after removal; Inclusion of restriction on crowing oxy-cut rail ends; Minor changes to approved products</td>
</tr>
<tr>
<td>3</td>
<td>October 2007</td>
<td>Addition of notification requirements for defective components, Correction of error in bolt hole dimensions</td>
</tr>
<tr>
<td>4</td>
<td>May 2008</td>
<td>C8-2.2 - Addition of CAUTION regarding excessive grease on rail head; C9-10 - Addition of CAUTION regarding excessive friction modifier on rail head.</td>
</tr>
<tr>
<td>4.1</td>
<td>May 2009</td>
<td>Complete document – Format Change; C5-9 Temporary Joints for emergency use - Removal of restriction on use of Robel clamps with Bow Plates and inclusion of condition that two Robel clamps be used with Bow Plates; C7-1 - Anchoring of Welded Track on Bridges – Inclusion of requirements for use of anchors on concrete and masonry structures; C8-2.4 – Figures 29 and 30 changed</td>
</tr>
<tr>
<td>4.2</td>
<td>December 2009</td>
<td>Various - Changes to titles; C4-2 - Additional information regarding rail damage from CTN 09/09; C4-3 - New paragraph on rail damage from work trains from CTN 09/13; C4-4 to C4-9 - re-numbered; C4-6 - Addition of more detail regarding unloading rails in the four-foot; New C5-10 – Identifying swage fasteners; C5-11 and C5-12 renumbered; Change &quot;Engineering Standards &amp; Services&quot; to &quot;Chief Engineers Division&quot;</td>
</tr>
<tr>
<td>4.3</td>
<td>February 2011</td>
<td>C5-5, C6-1, C6-2, C6-3, C6-4, C6-6 and C12 - only closures less than 6m in length need be crowded; C5-12 additional detail in use of Insulated Plate Joints; C7-1 – includes requirements for expansion of ballast top openings; Appendix A - Addition of new rail product</td>
</tr>
<tr>
<td>4.4</td>
<td>August 2011</td>
<td>C3 - Competencies updated to current National Competencies</td>
</tr>
<tr>
<td>4.5</td>
<td>April 2012</td>
<td>Reformatted to new template – Page numbering converted to continuous numbering. Separate document control on individual chapters removed; C5-4 - Correction of error in tolerances for saw cutting rail ends; C5-5 - Correction of error in tolerances for mismatching rail ends; C5-12 - Addition of reference to Hercules joint</td>
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<tr>
<td>4.6</td>
<td>April 2013</td>
<td>Changes detailed in summary table below</td>
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## Summary of changes from previous version

<table>
<thead>
<tr>
<th>Summary of change</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control changes</td>
<td>Document control</td>
</tr>
<tr>
<td>Updated National Competencies</td>
<td>3</td>
</tr>
<tr>
<td>Changed restriction on placement of insulated joints near bridge ends</td>
<td>C6-4</td>
</tr>
<tr>
<td>New chapter - Operation and maintenance of 3.1 series TORFMA and GFL</td>
<td>10</td>
</tr>
<tr>
<td>Chapters renumbered</td>
<td>11, 12, 13</td>
</tr>
<tr>
<td>Inclusion of approved bow plates and junction plates</td>
<td>Appendix A</td>
</tr>
<tr>
<td>Updating approved products table to match ESC 220</td>
<td></td>
</tr>
</tbody>
</table>
Contents

Chapter 1 General ...........................................................................................................................6
  C1-1 Purpose ..........................................................................................................................6
  C1-2 Context ..........................................................................................................................6
  C1-3 How to read the Manual .................................................................................................6
  C1-4 References .....................................................................................................................7

Chapter 2 Management Requirements .........................................................................................8
  C2-1 Civil Maintenance Engineer ..........................................................................................8
  C2-2 Renewals Manager .........................................................................................................8
  C2-3 Team Manager / Renewals Production Manager ...........................................................9
  C2-4 Determining Rail replacement priorities ......................................................................9

Chapter 3 Competencies .............................................................................................................11

Chapter 4 General Precautions ..................................................................................................12
  C4-1 Unauthorised removal of portable rail connections ......................................................12
  C4-2 Avoiding rail damage ...................................................................................................12
  C4-3 Rail damage from work trains ......................................................................................13
  C4-4 Paint marking of rails ....................................................................................................14
  C4-5 Using rail bonds ............................................................................................................16
  C4-6 Protecting track during rail unloading ........................................................................17
  C4-7 Installing and measuring punch marks .......................................................................18
  C4-8 Tolerances on punch marks ..........................................................................................20
  C4-9 Reporting Defective Components ...............................................................................20

Chapter 5 Installing and repairing rail joints .............................................................................21
  C5-1 Description ...................................................................................................................21
  C5-2 Repairing mechanical joints (insulated or non-insulated) ...............................................21
  C5-3 Removing fishbolts .......................................................................................................22
  C5-4 Installing joints ............................................................................................................23
  C5-5 Replacing an existing joint ..........................................................................................24
  C5-6 Cutting in a joint to correct a misalignment ...................................................................25
  C5-7 Plating rail defects .......................................................................................................25
  C5-8 Installing temporary joints ............................................................................................26
  C5-9 Using rail clamps ...........................................................................................................26
  C5-10 Identifying swage fasteners ........................................................................................26
  C5-11 Installing swage fasteners ..........................................................................................26
  C5-12 Installing Benkler insulated joints ..............................................................................26

Chapter 6 Installing rail ..............................................................................................................26
  C6-1 Rail Installation Requirements .......................................................................................26
  C6-2 Installing rail closures using the “Rail in = Rail out” process .......................................26
  C6-3 Installing rail closures by free welding .........................................................................26
  C6-4 Installing Bonded Insulated Joints .................................... ............................................26
  C6-5 Installing GIJs by free welding ......................................................................................26
  C6-6 Repairing broken rails using the “Rail in = Rail out” process .......................................26
  C6-7 Installing rail longer than 15m ......................................................................................26

Chapter 7 Installing rail anchors ................................................................................................26
  C7-1 Installing anchors ..........................................................................................................26
Chapter 1  General

C1-1  Purpose
This manual provides requirements, processes and guidelines for the installation and repair of rail, rail joints, rail lubrication and rail anchors.

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 rail installation and 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.

This manual is part of a series of seven (7) rail manuals

- TMC 221 - Rail Installation & Repair
- TMC 222 - Rail Welding
- TMC 223 - Rail Adjustment
- TMC 224 - Rail Defects & Testing
- TMC 225 - Rail Grinding
- TMC 226 - Rail Defects Handbook
- TMC 227 - Surface Defects in Rails

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.

Before you look at the job, check out Chapter 4 - General Precautions, for issues that apply to all rail 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:

The following joint placement and installation requirements are extracted from RailCorp Standard ESC 220.

- Mechanical joints shall be constructed with a gap of 6mm between rail ends at design neutral temperature of 35°C.

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

C1-4.1 Australian and International Standards

Nil

C1-4.2 RailCorp Documents

ESC 220 – Rail and Rail Joints
ESC 250 – Turnouts & Special Trackwork
TMC 001 – Civil Technical Competencies and Engineering Authority
TMC 203 – Track Inspection
TMC 211 – Track Geometry and Stability
TMC 222 – Rail Welding
TMC 223 – Rail Adjustment
TMC 224 – Rail Defects & Testing
TMC 225 – Rail Grinding
TMC 231 – Sleepers & Fastenings

C1-4.3 RailCorp Drawings

207-1096
207-1098
Chapter 2  Management Requirements

C2-1  Civil Maintenance Engineer

Mechanical Joints

1. Ensure that a system is in place to record the location of mechanical joints in the configuration records (“Track Data”). Accurate documentation is particularly important because of the use of this information in Welded Track Stability Analysis and, potentially, in risk assessment associated with rail failures.

Rail lubrication

1. Arrange for the assessment of lubrication effectiveness at intervals consistent with traffic variation (nominally 5 years). If excessive curve wear is evident and lubricators are functioning correctly, arrange a review of the positioning of lubricators by applying the guidelines in Chapter 12.

2. Ensure that appropriate systems are in place to identify and protect or remove rail lubricators in preparation for ballasting, re-railing and other mechanised track maintenance operations such as tamping, re-sleepering, sledding, ballast cleaning and ballast regulating etc.

3. Ensure that rail lubricator mechanisms are adjusted when rail size is upgraded.

Dipped Weld Straightening

1. Ensure careful supervision of any dipped weld straightening work.

2. Ensure that dipped weld straightening work is integrated with rail grinding activities.

C2-2  Renewals Manager

Rail lubrication

1. Ensure that appropriate systems are in place to identify and protect, or remove rail lubricators in preparation for ballasting, re-railing and other mechanised track maintenance operations such as tamping, re-sleepering, sledding, ballast cleaning and ballast regulating etc.

Installing rail

1. Ensure that appropriate planning and notification is undertaken when proposing to change rail size from 53 to 60kg/m. The 13mm increase in height between 53 and 60kg/m rails will affect, among other things, the setting of tamping tools, structure and OHW clearances, and electric train stop arm heights.

Maintaining Rail adjustment during rerailing

1. Arrange with the Maintenance Team Manager or Civil Maintenance Engineer for a track stability assessment to be undertaken, if, after installing rail using the procedure in Section C6-7, and checking the rail adjustment as required in Step 23, there has been more than 10mm of creep in either direction on either rail.

2. Consider the effect on track stability when planning the staging of rail removal works. For example, night rerailing might cause excess steel in the next section to be rerailed, causing a track to buckle if the next day is hot.
C2-3  

Team Manager / Renewals Production Manager

Competent staff

1. Ensure that staff (both RailCorp and external) have the appropriate competencies to undertake activities documented in this manual.

Defective components

New or recently installed track components or tools are sometimes defective, or otherwise fail to meet specified requirements. In some circumstances it will be necessary to recall the product and take action with the supplier.

If you are notified by your field staff that potentially defective components or tools have been supplied:

1. Raise an NCR. (NCR Form attached as Appendix B).
2. Conduct an assessment of the non-conforming product by inspection and, if practical, test sample at least 2-3 other such items from the same batch.
3. This will help to determine the extent of the problem.
4. Forward the NCR to:
   Ilya Soyfer, Logistics Support Engineer in Track Services
   (phone 8922 1148 (2 1148)
   fax 8922 1154 (2 1154)
   email ilya.soyfer@railcorp.nsw.gov.au.
5. If there is any immediate concern, contact should be made by phone.
6. Track Services will investigate the failure and its implications and take other actions as required. This may include:
   • Quarantine all product to avoid installation
   • Allow installed product to remain in track under special conditions
   • Remove all product from track etc.

If this occurs official notification will be by the issue of a Civil Technical Note

C2-4  

Determining Rail replacement priorities

Civil Maintenance Engineers and Planning Engineers

When determining rail replacement requirements and establishing priorities when resources are limited, use the following criteria:

There are five criteria by which programmed major rail replacement is to be considered:-

1. Rail Head Loss - as determined by the wear limits.
2. Rail Testability - where the rail is unable to be tested ultrasonically giving rise to an increase in the risk of broken rails.
3. Wide Gauge - where curve wear is the major contribution to wide gauge outside base operating standards. This criterion usually applies in conjunction with criterion 1.
4. Excessive Internal Rail Defects - where there is a heightened risk of a broken rail and where the cost of defect removal is a significant maintenance burden.

5. Rail Head Defects - Where the head defects, which could include surface damage, wheelburns or dipped welds is not economical to repair by normal maintenance.

The priorities for rerailing for comparison between categories may be determined from Table 1.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Priority 1</th>
<th>Priority 2</th>
<th>Priority 3</th>
<th>Priority 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Priority Detail</td>
<td>Safety Concern</td>
<td>Safety Priority</td>
<td>Economic Priority</td>
<td>Opportunistic Priority</td>
</tr>
<tr>
<td>Control of condition is possible only by special measures eg speed restriction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rail Head Loss</td>
<td>At or below condemning</td>
<td>within 4mm of condemning</td>
<td>within 6mm of condemning</td>
<td>within 9mm of condemning</td>
</tr>
<tr>
<td>Rail Testability</td>
<td>Medium or greater Defects may not be detected</td>
<td>Small Defects may not be detected</td>
<td>Uncorrectable surface damage due to rail contact fatigue</td>
<td>Cost of surface damage correction &lt; rerailing cost</td>
</tr>
<tr>
<td>Wide Gauge</td>
<td>≥ 32mm (Note 1)</td>
<td>≥ 29mm (Note 1)</td>
<td>≥ 25mm (Note 1)</td>
<td>≥ 20mm (Note 1)</td>
</tr>
<tr>
<td>Excessive Internal Defects (defects per track km)</td>
<td>Defects ≥ 9/km per year or problem with critical defects (Note 2)</td>
<td>Defects ≥ 5/km per year</td>
<td>Defects ≥ 4/km per year</td>
<td>Defects ≥ 2/km per year</td>
</tr>
<tr>
<td>Extensive Head Repair Defects</td>
<td>Damage to track will occur in short term</td>
<td>Damage to track will occur in medium term</td>
<td>Damage to track will occur in long term</td>
<td>Damage will only occur in very long term</td>
</tr>
</tbody>
</table>

Table 1 – Rerailing priorities

Note: 1. Where wide gauge cannot be controlled by other measures such as regauging or resleepering.

2. Critical defects are those where a rail break would not be a clean square break generally all defects except Transverse Defects and Defective Welds. Bolt hole defects are to be specifically excluded from consideration because correction of the problem may be to remove the joints by CWR rather than by rerailing.
## 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>Install or repair rail joints</td>
<td>TLIB2121A - Maintain rail joints OR TLIS2044A - Carry out rail installation</td>
</tr>
<tr>
<td>Cut rail using Oxy/LPG acetylene (DOES not include trimming rail ends prior to welding)</td>
<td>TLIW3035A - Heat and cut materials using oxy-LPG equipment for the rail industry OR TLIW3015A - Weld rail using aluminothermic welding process</td>
</tr>
<tr>
<td>Grind rails</td>
<td>TLIW2012A - Grind rails OR TLIW3015A - Weld rail using aluminothermic welding process</td>
</tr>
<tr>
<td>Crow rail ends</td>
<td>TLIB2121A - Maintain rail joints OR TLIS2044A - Carry out rail installation</td>
</tr>
<tr>
<td>Install or remove rail or rail closures</td>
<td>TLIS2044A - Carry out rail installation</td>
</tr>
<tr>
<td>Certify plain track during or after rerailing</td>
<td>TLIS2044A - Carry out rail installation AND TLIB3094B - Check and repair track geometry</td>
</tr>
<tr>
<td>Use rail bonds</td>
<td>TLIS2044A - Carry out rail installation AND Trained and assessed as competent by a Signal Engineer</td>
</tr>
<tr>
<td>Install or remove rail anchors</td>
<td>TLIB2121A - Maintain rail joints OR TLIS2034A - Install and repair rail fastening systems</td>
</tr>
<tr>
<td>Install or repair rail lubricators</td>
<td>TLIS2012A - Install and service rail lubrication equipment</td>
</tr>
<tr>
<td>Install or repair Wheel Squeal Applicators</td>
<td>TLIS2012A - Install and service rail lubrication equipment AND Additional training in installing and maintaining Wheel Squeal applicators</td>
</tr>
<tr>
<td>Straighten dipped welds</td>
<td>TLIB3094B - Check and repair track geometry AND Trained in use of Weld straightener</td>
</tr>
</tbody>
</table>
Chapter 4  General Precautions

C4-1  Unauthorised removal of portable rail connections

Removal or relocation of portable rail-connecting equipment from track is hazardous. If you break the connection between the portable rail connection and the rail you could become part of the 1500 volt circuit. This could result in:

- Serious or FATAL injury to the person breaking the portable rail connection; and
- Injury to personnel working on or near the overhead wiring in the absence of the required protective rail connection.

If accidental damage or disconnection occurs, electrical staff must be advised immediately.

If it is necessary for a portable rail connection to be relocated for work to proceed, arrangements must be made with electrical staff.

WARNING
DO NOT INTERFERE WITH, OR REMOVE, the connection to rail of portable rail-connecting equipment without the proper authority.

C4-2  Avoiding rail damage

Maintenance and project staff MUST ensure that their work does not cause damage to rails and particularly to the rail foot. Any impact to the rail foot is a potential problem. Small notches and bruising can cause a broken rail years into the future.

Staff planning and supervising work on track MUST ensure the machinery used and the method of usage do not result in damage to the rail and particularly the rail foot. Some examples of matters with damage potential are:

- the stabilising feet and front bucket on backhoes when excavating
- vibrating the rail when carrying out track adjustment (DO NOT hit the rail foot during the vibration process)
- steel tracked machinery using existing track to access an excavation
- tamping tools hitting the rail foot
- damage from an incident such as a derailment of a track machine

All instances of damage should be reported to maintenance staff.

IMPORTANT
When working near rail, fishplates or trackplates take extreme care.
DO NOT damage rail, fishplates or track plates
DO NOT partially cut the rail (rail saw or gas cutting)
DO NOT damage the rail by hammer bruising or notching
DO NOT damage rail with off-track plant
If using oxy/gas equipment to burn off bolts etc, be careful not to damage the surrounding components (rail, plates etc)
If rail components are damaged, repair or replace
Rail damage from work trains

Rails damaged by wheel slip are a continuing problem in RailCorp. The damage caused by large wheel burns is obvious. Smaller scuffs and skids, which may appear innocuous, can cause a hard and brittle layer on the rail surface. This hard layer has been linked to the development of squats, which are now a major problem.

Figure 1 – Wheel slip damage from a work train

A significant amount of wheel slip damage is caused by work trains. There are a number of possible reasons for this:

- Overloading of work trains e.g. spoil trains
- Stopping and starting on steep grades
- Unloading ballast uphill on steep grades
- Unloading ballast too heavily, so that stones cover the rails
- Defective / underpowered locomotives
- Incorrect load setting for work trains
- Locomotives marshalled together which have incompatible slip control systems
- Driver error
- Sanding system not operating

To minimize the risk of wheel slip damage by work trains, follow the steps detailed below:

Planning work

1. Ensure there is sufficient locomotive power for worst case that can occur including:
   - Grades in the reverse direction
   - Grades adjacent to the planned work area
   - Localised track irregularities including those arising during the track upgrading work.
   - The additional load imposed by the work involved such as ploughing ballast or dragging rails.
   - Spoil removal (including if spoil is denser than normal)
2. In any case it is good practice to:
   o avoid uphill movements by loaded work trains on steep grades, as much as possible
   o Avoid stopping and starting work trains on steep uphill grades

**During work**

1. Avoid stopping and starting work trains on steep uphill grades
2. Do not overload work trains
3. Do not unload excessive ballast
4. Ensure that work train drivers are fully briefed to avoid wheel slip damage. A suitable flyer is available for this purpose. (See attached).
5. Communicate with work train drivers and monitor the performance of work train locomotives. An extra person may be required for this task. If the work train locomotive appears to be having difficulty, an alternative work method should be found.

**After work**

1. If any wheel slip damage has occurred or is detected, it should be reported to the relevant track maintenance manager. Even small scuffs and skids may be important.
2. Arrange repairs if possible. Early wheel slip damage repairs will minimize the risk of defects developing later. Large wheel burns should be repaired by wire feed or closure. Skids and scuffs should be repaired by rail grinding to remove visible damage plus at least 0.5mm from the head of the rail.

**C4-4 Paint marking of rails**

Track staff place paint markings on rails to identify specific things. NO OTHER paint marks are permitted on rails. If marking of track is required for other purposes, it must be on the sleepers or ballast ONLY.

The following colours are used for the purposes defined in Table 2 below.

<table>
<thead>
<tr>
<th>Type &amp; Colour</th>
<th>Location &amp; direction</th>
<th>Meaning</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLOURO PINK Stripe</td>
<td>Head to Foot Vertical</td>
<td>Wire Feed welding has been carried out but not yet tested</td>
<td>Mark from the top surface of the foot to the rail head excluding the running surface and cover at least 150mm either side of the weld and both sides of the rail NEVER use pink to pre-mark rail locations for wire feed or thermit repair</td>
</tr>
<tr>
<td>BLUE Stripe</td>
<td>Head to Foot Vertical</td>
<td>Rail has PASSED Ultrasonic test</td>
<td></td>
</tr>
<tr>
<td>YELLOW Stripe</td>
<td>Head to Foot Vertical</td>
<td>Rail has FAILED Ultrasonic test</td>
<td>The whole defect is to be marked and the mark should be at least 300mm wide. For long defects &gt;300mm long intermittent paint marking can be used in between the marked ends</td>
</tr>
<tr>
<td>Type &amp; Colour</td>
<td>Location &amp; direction</td>
<td>Meaning</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------</td>
<td>----------------------</td>
<td>--------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>BLUE Stripe</td>
<td>Web Horizontal</td>
<td>Switch has NO arris</td>
<td>Mark web ONLY. paint the switch to create a single stripe along the web from about 1.5m to 2m from the tip.</td>
</tr>
<tr>
<td>PINK Stripe</td>
<td>Web Horizontal</td>
<td>Switch HAS arris</td>
<td></td>
</tr>
<tr>
<td>WHITE paint stripe</td>
<td>Foot Longitudinal</td>
<td>Rail (full lengths or closures)</td>
<td>Mark the rail with a paint stripe about 200mm long on one side of the rail foot at each end of the rail length but leaving the end itself clear for about 200mm. For rails longer than 4 metres that are likely to be subsequently cut up into closures paint a stripe every 3 metres along the rail.</td>
</tr>
<tr>
<td>BLUE paint stripe</td>
<td>Foot Longitudinal</td>
<td>Rail (full lengths or closures)</td>
<td></td>
</tr>
<tr>
<td>GREEN paint stripe</td>
<td>Foot Longitudinal</td>
<td>Rail (full lengths or closures)</td>
<td></td>
</tr>
<tr>
<td>BLUE dots</td>
<td>Web</td>
<td>Weld has PASSED weld alignment test</td>
<td>Put a paint dot on the web on both sides of the weld area on both sides of the rail 100mm from the weld.</td>
</tr>
<tr>
<td>YELLOW dots</td>
<td>Web</td>
<td>Weld has FAILED weld alignment test</td>
<td></td>
</tr>
<tr>
<td>Paint dot</td>
<td>Foot or sleeper plate</td>
<td>sleeper marking</td>
<td>Mark the rail foot or sleeper plate at the sleeper with a dot of paint about 30-40mm diameter A variety of colours can be used to indicate the year of marking.</td>
</tr>
<tr>
<td>WHITE</td>
<td>General marking -</td>
<td>used for any general marking of the rails</td>
<td></td>
</tr>
</tbody>
</table>

Table 2 – Paint codes for rails

There other markings on rail that appear as paint markings.

1. Dye penetrant testing of switch tips will appear as white with red/pink staining.

2. Solacoat heat protection paint used for track stability is always coloured white and is continuous along the rail. Its use is very limited. When this is applied any other paint codings on the rail must be left clear or re-applied. If the previous marking is white, a 300mm space of unpainted rail is to be left on either side.
**C4-5  Using rail bonds**

In some circumstances temporary rail bonds may be placed around a rail break to keep track circuits working in connection with the following work:

- Pulling back for expansion or creep.
- Welding of joints.
- Renewing of defective fishplates.
- Replacing a length of rail less than 5 metres.

**C4-5.1 Conditions of Use**

Whether temporary bonding can or cannot be used depends on where you want to use it. The circumstances are summarised in Table 3 below but you MUST get specific advice from the local Signal Maintenance Engineer, who is accountable for determining approved use.

<table>
<thead>
<tr>
<th>Location</th>
<th>Permitted</th>
<th>Comments / Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double rail AC track circuit areas</td>
<td>✓</td>
<td>In conjunction with shorting bonds placed across both rails (4 foot) of the line either side of the break (Where required)</td>
</tr>
<tr>
<td>Single line electrified areas</td>
<td>✗</td>
<td>special arrangements required to maintain the traction return current</td>
</tr>
<tr>
<td>Interlocked areas (General)</td>
<td>✗</td>
<td>temporary bonding is to be placed by a qualified signalling representative</td>
</tr>
<tr>
<td>interlocked areas (where outer home signals are provided and the intervening track circuits do not impact on the operation of the Interlocking)</td>
<td>✓</td>
<td>Subject to advice from the Signal Engineer</td>
</tr>
<tr>
<td>multiple line electrified areas</td>
<td>✓</td>
<td>only one rail may be broken at any one time between adjacent traction substations</td>
</tr>
<tr>
<td>non electrified areas</td>
<td>✓</td>
<td>When you want to make multiple breaks, you can only make one break on each rail at one time, Two breaks can be made if the breaks are on opposite rails (eg square joints)</td>
</tr>
</tbody>
</table>

**Table 3 – Use of Temporary Rail Bonds**

**Special Situations**

If Temporary Bonding is not permitted then the work will be treated as rerailing by Signalling staff. For rerailing, appropriate Network Rules and Signalling Maintenance Procedures will to be applied by Signalling staff.

Once installed and the rail break is made DO NOT remove the bonds until the break has been welded out or permanent bonds installed.
C4-5.2 Bonds

Signalling discipline staff provide approved rail bonds. They will generally be restricted to two 6 metre bonds and two 2 metre shorting bonds per work team.

Temporary rail bonds are tagged and inspected for condition every 6 months by Signalling discipline staff. DO NOT use any bonds that are not tagged or that are overdue for inspection (previous inspection date is on the tag). DO NOT use bonds if there is evidence of damage to the cable or rail clips.

C4-6 Protecting track during rail unloading

When rail is being unloaded from rail trains, track and trackside equipment can be damaged unless care is taken.

1. Inspect the whole of the area over which unloading will take place.
2. Note all signal cables, troughing, impedance bonds etc., and provide packing to protect them during unloading.
3. Remove, or protect, rail lubricators and take-off's etc.
4. If the rails are not going to be installed within four weeks, plan the unloading location along the track so the rails don’t interfere with trackside equipment.
5. Arrange the unloading method so that rails are not dragged along the ground whilst they are being unloaded.
6. Move unloaded rails to the cess or six foot, clear of the structure gauge and below the level of the adjacent tracks.
7. If the rails have to be left in the four-foot make sure they are well clear of the running rails, stood upright on their feet and spiked to sufficient sleepers to ensure they will not move.
8. If rails are unloaded onto concrete sleepers and cannot be moved out of the four-foot, hold them down with non-conducting restraining straps.

Use a strap on each end of the length of rails and, depending on the rail length, one or more straps evenly spaced along the length. Place the straps around the rail. Rail can move outward if you don't (see Figure 2).

You must satisfy yourself that you use enough restraining straps to stop the rails from moving.

![Figure 2 – Poorly restrained rail](image-url)
9. Where practical, DO NOT unload rails in areas with guard rails. It is critical that
the rails cannot short out the track circuits. This is difficult to achieve with
certainty in guard rail areas.

10. Ensure that any rails laid in the four-foot or cess do not make contact (or
electrical contact) with the running rails or guard rails. For example you could
make a connection if you touched the sleeper plates.

C4-7 Installing and measuring punch marks

Punch marks are installed in rails to allow measurement of rail movement. They need to
be placed accurately to avoid damage to rail and to allow accurate repeatable
measurement.

C4-7.1 Installing punch marks

1. Place a punch mark on the outside head of the rail (as near to the top of the
face as possible) at least 300mm beyond one end of the section of rail to be
removed.

2. Place one end of a non-conductive measuring tape on the top of the rail head
as close to the punch mark as possible.

3. Stretch the tape along the rail head, keeping it as straight and flat as possible.

4. Place a second punch mark on the outside head of the rail (as near to the top of
the face as possible) at least 300mm beyond the other end of the section of rail
to be removed (for ease of measurement and recording put it at the nearest ½
metre or 1 metre measurement (e.g. 3.000m, 3.500m etc. depending on the
length of rail you are removing)

5. Use a paint pen to mark a white circle around each punch mark to help locating
the punchmarks in the future. (see Figure 4)

![Punch mark distance](image)

**Figure 3 - Location of punch marks**

C4-7.2 Measuring punch marks

1. Locate the punch marks. They should be on the outside head of the rail near
the top of the face about 300mm either side of the closure and be marked with a
white paint circle.
2. Place one end of a non-conductive measuring tape on the top of the rail head as close to one of the punch marks as possible.

3. Stretch the tape along the rail head to the second punch mark keeping it as straight and flat as possible.

4. Measure the distance between the 2 marks to the nearest mm and record the measurement.

C4-7.3 Punch marks and tensors

If tensors will be installed with saddle (yoke) over the rail head and adjustment is being maintained using punch marks (the Rail in = Rail out method), measurement of the distance between punch marks may be difficult. One method of maintaining "steel in - steel out" under these circumstances is as follows:

1. Establish punch marks.

2. Measure and record the distance between the punch marks before removing the rail section.

3. Remove the rail section.

4. Measure and record the distance between punch marks after removing the rail section.

5. Insert the closure rail.

6. Weld one end of the closure.

7. Set up rail tensors at remaining gap. DO NOT pull rail.

8. Transfer the change in measurement to new punch marks across the remaining gap and within the tensors. (See Figure 5).

Example;  
Original distance between punch marks 5 000mm  
Distance after removing rail section 5 023mm  
Change in distance +23mm  
Transfer to new punchmarks (200mm +23mm = 223mm)  
Operate the tensors to bring the measured distance between the punch marks to 200mm ± 3mm  
At the end of the process confirm that the original distance (5000mm) has been maintained (± 3mm)
C4-8 Tolerances on punch marks

When the Rail in = Rail out process is being used to maintain rail adjustment in CWR track during rail installation or broken rail repair, the allowable tolerances on before and after measurements of the punch marks are as follows:

Rail installation At the completion of the work the punch marks should be within ±3mm of the distance they were apart before work commenced.

Broken rail repair At the completion of the work the punch marks should be within ±3mm of the distance they were apart before work commenced minus the gap caused by the break.

Where this tolerance is exceeded a readjustment may be required. Any uncorrected locations must be advised to the Civil Maintenance Engineer because of welded track stability implications.

C4-9 Reporting Defective Components

New or recently installed track components or tools are sometimes defective, or otherwise fail to meet specified requirements. In some circumstances it will be necessary to recall the product and take action with the supplier.

To ensure that appropriate investigation is undertaken and action is taken by field staff, engineering and logistics staff, follow the process below.

If you suspect that track components or tools that have been delivered to you are defective, report the defect to your Team Manager who will investigate and report the problem in accordance with the requirements of Section C2-3.
Chapter 5 Installing and repairing rail joints

C5-1 Description

The rail joint is a weak part of the track structure. Common defects at rail joints include:

- Bad Top or "Holes".
- "Pumping" of the formation.
- Loose or broken fishbolts.
- Broken fishplates.
- "Battered" rail ends.
- Cracked or broken rail ends.

Uncorrected defects will get worse and may cause other types of defects to develop.

Essential maintenance at joints includes:

1. Keeping fishbolts tight.
   
   Do not overtighten fishbolts. Bolts are sufficiently tight when the spring washer becomes flat. (The rail must be able to expand or contract).

2. Keeping sleepers around joints well packed.
   
   If the joint is not firmly packed it will "dip" as a train passes over it. This increased stress on the rail, fishplate and fishbolts.

C5-2 Repairing mechanical joints (insulated or non-insulated)

1. Establish key technical risks from incorrect adherence to standards

<table>
<thead>
<tr>
<th>Track Element</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Track geometry</td>
<td>- Incorrect gauge after the work</td>
</tr>
<tr>
<td></td>
<td>- Top and Line defects after the work</td>
</tr>
<tr>
<td></td>
<td>- Superelevation defects after the work</td>
</tr>
<tr>
<td>Rail geometry</td>
<td>- Rail profile mismatch</td>
</tr>
<tr>
<td></td>
<td>- Rail end mismatch causing foul joints</td>
</tr>
<tr>
<td></td>
<td>- Incorrect Rail gaps</td>
</tr>
<tr>
<td>Track Clearances</td>
<td>- Equipment left foul during work</td>
</tr>
<tr>
<td></td>
<td>- Site obstructions</td>
</tr>
<tr>
<td>Track structure</td>
<td>- Fastenings, Sleeper plates, Track Stability</td>
</tr>
<tr>
<td></td>
<td>- Joint integrity, foul joints, fastenings, signalling and electrical integrity</td>
</tr>
<tr>
<td></td>
<td>- Sleeper pattern, fastenings</td>
</tr>
<tr>
<td></td>
<td>- Rail condition</td>
</tr>
</tbody>
</table>

2. Examine joint visually to determine extent of external damage.

3. Check crippling with a 1m straight edge.

4. If the rail ends are crippled, remove all the cripple. Cut back to where no light can be seen between the straight edge and rail and install a new joint (see Section C5-4).
5. Determine which of the following repair methods is appropriate.

**C5-2.1 Repair without pulling the joint apart**

1. Remove wheel scale.
2. Replace broken, damaged or bent fishbolts and tighten loose fishbolts.
3. Check the condition of ferrules in the boltholes where bolts are being replaced. Replace damaged or worn ferrules if required.
4. Replace swage fastenings if they are broken, damaged or loose. Check the condition of ferrules (in mechanical insulated joints) in the boltholes where swage fastenings are being replaced. Replace damaged or worn ferrules if required. The method of installing swage fastenings is described in Section C5-11.
5. Remove rail end flow by filing or grinding back square to the rail end.

Flowing metal on rail ends reduces the expansion allowance and also causes rail end chipping when rails close up during hot weather.

**C5-2.2 Repair by pulling the joint apart**

1. Remove fishbolts using the method described in Section C5-3.
2. Remove fishplates (and insulating material in mechanical insulated joints).

**Note 1:** Bonding around joints may be undertaken in some circumstances. Refer to Section C4-4.

**Note 2:** Insulated joint repairs that require the joint to be dismantled may only be carried out in conjunction with a Signal Electrician

3. Remove all rust, scale or dirt from the rail fishing surfaces, rail ends and fishplates.
4. Replace joint insulation material (end posts, ferrules and liners) in insulated joints.
5. Replace cracked or broken fishplates, or fishplates with excessive wear on the fishing surface
6. Reassemble the joint. The method of removing and installing swage fastenings is described in Section C5-11.

**C5-3 Removing fishbolts**

1. Remove fishbolts by undoing the nut with a spanner or impact wrench.
2. If nuts are seized and cannot be undone, burn off the nut and bolt using the following method:
   - Heat the nut AND bolt with an oxy/propane torch. Be careful to get the bolt hot.
   - Cut the nut and bolt from the side. DO NOT direct the torch from the top as the flame could damage the web of the rail.
3. If the fishplates or rail are damaged by the cutting flame, they must be replaced.
C5-4 Installing joints

The following joint placement and installation requirements are extracted from RailCorp Standard ESC 220.

- Mechanical joints shall be constructed with a gap of 6mm between rail ends at design neutral temperature of 35°C.
- Joints shall be installed suspended between adjacent ties.
- Joints shall be no closer to each other than 6 m except in turnouts where shorter lengths (minimum 2.2m) may be used if necessary.
- Joints are not permitted in continuously welded track.
- Permanent mechanical joints are not permitted on bridges.
- Temporary mechanical joints on bridges are limited to no more than 7 days.
- The following restrictions apply to installation of joints in proximity to bridge approaches:
  - NOT within 30m of a transom top opening with spans less than 18m.
  - NOT within 60m of a transom top opening with one or more spans ≥18m long.
  - NOT within 30m of a ballast top opening ≥ 4.27m long.

Joints shall be anchored as required in Chapter 7.
Permanent joints shall be fastened through all six boltholes, except for temporary rail joints. (See Section 9 for temporary joints).
Rail ends shall be saw cut to the following tolerances:
  - Vertical - ≤ 1mm variation in the height of the rail.
  - Horizontal - ≤ 0.5mm variation in the width of the rail.

Boltholes shall be drilled square to the web.
The size and location of boltholes for the installation of mechanical rail joints shall be in accordance with the dimensions detailed in Figure 6 and Figure 7.
The following configurations are specifically prohibited:
- Joints bored wide or tight giving a false reading of rail adjustment.
- Slotted plates (except as temporary or emergency rail joints).
- Rail Inserts.
- Rails with flame cut ends, except in temporary or emergency rail joints (see Section C5-8) or as part of the process of aluminothermic rail welding.
- Rails with flame cut boltholes, except in temporary or emergency rail joints (see Section C5-8).

![Figure 6 - Bolthole locations - 53 & 47kg rail](image-url)
C5-5  Replacing an existing joint

1. Mark the rail either side of damaged joint and measure.

   NOTE: Restrictions apply to the placement of joints and welds, and to the length of closures. Refer to Section C5-4 for joints, Engineering Manual TMC 222 - Rail Welding, for welds and Section C6-2 for closures.

2. Cut or saw the rail and remove the damaged joint

3. Crow rail ends if they are in a curve of <500m radius

4. Measure and cut a new rail closure from rail with a profile that matches the existing as closely as possible. Crow the closure if the track is in a curve of <500m radius and the closure is < 6m in length.

5. Bore boltholes in rail end of the new joint to suit (plain or insulated).

6. Assemble the joint (including insulation as required).

7. Adjust the track. The method of track adjustment is described in Engineering Manual TMC 223 - Rail Adjustment.

8. Install a weld at the other end of the closure rail (or repeat steps to measure and cut, bore boltholes and assemble joint).

9. Re-install fastenings/anchors

10. Replace joint sleepers or rebore, regauge, space and square up.


12. Check fastening/anchor pattern - On dogspered track, anchoring in the vicinity of the joints must be effective and adequate and if any anchors are not bearing against the sleepers they must be knocked off, and replaced correctly.

13. Check the rail end mismatch. The following limits apply:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical mismatch</td>
<td>1.0 mm</td>
</tr>
<tr>
<td>Horizontal mismatch</td>
<td>0.5 mm</td>
</tr>
</tbody>
</table>
14. Grind rail to profile (if required).
15. Measure track geometry.
16. Lift and line track as required.
17. Replace rail bonds (if required).
18. Certify the track using the procedure in Engineering Manual TMC 211 - Track Geometry and Stability. If work has not been completed satisfactorily, assess whether a speed restriction is required using the operating limits in Engineering Manual TMC 203 - Track Inspection.

C5-6 Cutting in a joint to correct a misalignment

1. Cut the rail using a rail saw or oxy. If it is suspected that there is too much steel, use oxy to cut the rail, since a rail saw is likely to jam as the rail continues to expand.
2. Establish a gap of approximately 6mm
   
   If the rail continues to move toward the oxy cut, remove more rail by oxy-cutting. Since you don’t know how much the rail will move up, do not remove too much. Keep the gap as close to the standard joint gap (6mm) as possible – just in case there are locked in stresses elsewhere and it moves back during the repair, which could leave you short of steel and requiring use of rail tensors.
3. Reline the track to design alignment.
4. If the track is a long way off line, relining will cause the gap to close up again. Continue oxy-cutting till no more movement occurs.
5. Saw cut both rail ends. Remove at least 3mm of rail from each oxy-cut end, if the rail is saw cut within 8 hours of the oxy-cutting. If the saw cutting is delayed more than 8 hours, remove at least 25mm from each oxy-cut rail end.

   **Note:** If trains need to run over flame cut rail ends, the joint is classed as a "Temporary Joint" and dealt with according to the requirements of Section 9.
6. Bore boltholes in rail end of the new joint to suit
7. Assemble the joint.
8. Adjust the track. The method of track adjustment is described in Engineering Manual TMC 223 - Rail Adjustment.

C5-7 Plating rail defects

1. Identify the location of rail defect.
2. Remove all rust, scale or dirt from the rail fishing surfaces.
3. Determine if rail clamps can be used (See Section C5-9).
4. Install fishplates and clamps if they can be used.
5. If rail clamps cannot be used, mark the location of boltholes with punch marks (4 back holes only). Only 2 boltholes (one each side of the defect) are required if the plated defect is removed in accordance with the operating limits in
Engineering Manual TMC 224 - Rail Defects & Testing). If the defect is not removed within the time limits specified, 4 bolts MUST be installed.


7. Assemble the joint using fishbolts or swage fastenings.

8. If the defect is at a weld use a pair of bow plates.


C5-8 Installing temporary joints

C5-8.1 Installation requirements

The following design requirements are extracted from RailCorp Standard ESC 220.

Only use Temporary joints in the following circumstances:

- During rail laying, to allow train operations, prior to welding into CWR.
- During track restoration, to allow train operations, prior to full repair of track.

Temporary Joints for construction

4-hole joints

Where rail is required to be joined as a temporary measure during track construction or rerailing, and it is intended that the joint will be welded, the bolthole on each rail nearest each rail end shall not be drilled. The joint will be fastened through the remaining 4 boltholes. To limit damage to the rail and to the track, these temporary joints shall not remain in track longer than 30 days if installed on concrete sleepers, or 12 months if installed on timber sleepers.

Slotted plates

Slotted fishplates may be used as an interim measure during the laying of rail, or in emergencies if a rail breakaway occurs and the track cannot be adjusted before use.

They shall be removed as soon as the rail can be adjusted correctly. This will occur, preferably, on the same day that the rail is laid.

Slotted fishplates must have properly prepared (machined) holes. Flame cut holes are not permitted.

Temporary Joints for emergency use

Emergency use of flame cut rail ends

Maximum speed of trains over a flame cut rail end is 20km/h.

Replace as soon as possible, but within 24 hours, by welding in a new section or replacing the affected rail with a saw cut rail.

Emergency use of flame cut boltholes

Flame cut boltholes may be used in an emergency to effect temporary repairs. A speed restriction of 10km/h shall be placed on the section and the track continuously monitored until the flame cut bolthole is removed.
C5-9 Using rail clamps

The following requirements are extracted from RailCorp Standard ESC 220.

Approved rail clamps may be used to clamp fishplates to create a temporary joint at a broken rail or to plate a rail defect. Conditions apply to their use. Approved plates and clamps are detailed in Appendix A and approved configurations are detailed in Table 4.

<table>
<thead>
<tr>
<th>Rail Joints</th>
<th>Conditions of use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clamps</td>
<td>Plates</td>
</tr>
<tr>
<td>G-Clamps (2 required)</td>
<td>Standard Fishplates, Bow plates</td>
</tr>
<tr>
<td>Robel Clamps (1 or 2 required)</td>
<td>Standard Fishplates, Bow plates</td>
</tr>
<tr>
<td>G-Clamps (2 required)</td>
<td>Bow plates</td>
</tr>
</tbody>
</table>

Table 4 - Approved Non-bolted joints

G-clamps

Use G-clamps to hold fishplates to rails when plating broken rails or rail defects or to hold bow plates when plating broken or defective aluminothermic welds.

Robel Rail Clamps

Robel rail clamps may be used on 47, 53 and 60kg rail in place of G-clamps for plating broken rails or to plate a rail defect.

1. Install Robel rail clamps with locking nuts in accordance with the manufacturer’s instructions, which are included in each kit. (See Figure 8)

2. Mount the clamp directly at the rail joint by using two fishplates. (See Figure 9 and Figure 10), or

3. Mount two clamps, one on each end of the fishplates (see Figure 10).

4. When bow plates are used it may be possible to clamp each end of the plates with Robel clamps

The clamp is robust, however care should be taken to reduce damage to the bolt thread and locking flaps. Store them in a dry location to minimise corrosion and secure them in the rear of vehicles.
Figure 8 - Robel rail clamp

Figure 9 - Simplified schematics showing operation of nut locking device, safety locking flap and bar
One clamp is sufficient when it can be placed in the centre of the fishplate, which is also placed centrally at the break (or joint).

When location of sleepers and the break (or joint) coincide, it may be possible to place a clamp on each end of the fishplate. The fishplates must be placed centrally at the break (or joint). It may be necessary to re-space the sleepers to fit the clamps.

C5-10 Identifying swage fasteners
All approved Huck swage fasteners are now supplied with a “Lazy H” symbol stamped onto the head of the bolt. They may also display three or six radial marks along with referencing symbols. These markings are acceptable as long as they are accompanied by the Lazy H symbol stamped on the head.

Figure 10 - Typical Installations

Figure 11 – Head of Huck bolt showing Lazy H
C5-11 Installing swage fasteners

The following requirements are extracted from RailCorp Standard ESC 220.

Swage fasteners may be used in lieu of conventional fishbolts to provide a high strength fastening at fixed mechanical rail joints.

Swage fasteners may only be used with fishplates meeting or exceeding the mechanical and chemical properties of AS 1085.2 (2002) (RailCorp approved plates).

The following placement and installation requirements apply:

1. Swage fasteners may only be applied to joints designed for no rail movement.
2. Swage fastened mechanical joints may be used within turnouts and between adjacent turnouts and diamonds but they must not be used directly adjacent to CWR plain track.
3. The application of the swage fasteners is to be restricted to trackwork in good condition, where the contacting surfaces and components of the joint can support the high clamping forces involved.
4. Swage fastener heads and collars must be fitted with washers made from cast or formed high strength steel to spread the clamping forces of the collar. The collar must not be larger than 1.5mm in diameter than the shaft size of the swage fastener.

Prohibited Configurations

Swage fasteners may not be used in open track in lieu of welding.
Swage fasteners may not be used where axle loads > 25t operate.
Swage fasteners are not recommended for locations where a high level of 25t axle load traffic operates.

Swage fasteners consist of a high tensile bolt with concentric grooves for the collar attachment. The collar, representing the nut, is swaged (pressed) onto the concentric grooves. An installation tool applies direct tension to an annular grooved bolt against a locking collar pulling the work pieces together. The collar is then swaged to cold flow the metal into the grooves. Clamp force is created by tension without applying torque. On completion of collar swage a portion of the bolt separates leaving a permanent vibration resistant connection.

1. Check that contacting surfaces are clean and bearing evenly.
2. Check that bolt holes line up correctly.
3. Insert swage fasteners (Use special "thread head" swage bolts with thread and nut where bolts can only be inserted from collar end) fitted with correct washers under head and collars.
4. Use ferrules if holes are too big for swage bolts.
5. Ensure that bolt heads and collars do not contact mild steel or insulating material as the high contact pressure may cause yielding and subsequent reduction in clamping force. Separate with high strength steel washers that may be ordered with swage fasteners.
1. Insert pin into prepared hole, place collar over pin.

2. Tool pulls on pintail removing sheet gap and anvil swages collar into locking grooves.

3. Pintail breaks at predetermined point and tool pushes off collar.

4. Pintail is ejected and tool is ready for next installation.

**Figure 12 - The installation cycle.**

6. Swage lock collars with appropriate tool in the recommended sequence. With six hole fishplated joints, partially swage bolts 1 and 4, fully swage bolts 2, 5, 6 and 3, then fully swage bolts 1 and 4.

   - Partially swage bolts 1 and 4:
     1 2 3 4 5 6
     O O O O O O

   - Fully swage bolts, 2, 5, then 6 and 3:
     1 2 3 4 5 6
     ● ● ● ● ● ●

   - Fully swage bolts 1 and 4:
     1 2 3 4 5 6
     ● ● ● ● ● ●
After completing the installation,

1. Check that all components are firmly tightened and swage fasteners are seated evenly.

2. Check swage fasteners using correct swage gauge for length of bolt and collar diameter.

3. Remove any swage fastener that does not provide a firm contact on track components.

One loose swage fastener could result in a joint failure, because the reduced friction force would allow joint sliding under thermal expansion or contraction of rail.

C5-12 Installing Benkler insulated joints

"Benkler" insulated joints are approved Insulated plate joints that are installed using swage fasteners.

![Figure 13 – Benkler joint and installation tool](image)

Another approved Insulated plate joint is the Hercules joint. Insulated plate joints may only be used as follows:

| The following requirements are extracted from RailCorp Standard ESC 220. |
|---|---|
| 1. | Shall not be used in mainline track except in an emergency or as a temporary measure to suit short term construction staging. |
| 2. | May only be used in the turnout rails within turnout systems on all operating classes. (This excludes any direct connection with CWR plain track). |
| 3. | Shall be fastened through six boltholes. |
| 4. | Shall be anchored as for mechanical insulated joints. |
| 5. | Curved track sections with insulated joints shall be formed in the field from straight fishplate pieces. |
| 6. | Rail ends must be square. |
To install a Benkler joint use the following steps:

1. Check that all parts are in the kit. The following parts are provided:

<table>
<thead>
<tr>
<th>Part</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Huckbolts</td>
<td>6</td>
</tr>
<tr>
<td>Huckcollars</td>
<td>6</td>
</tr>
<tr>
<td>Insulated fishplates</td>
<td>2</td>
</tr>
<tr>
<td>End post</td>
<td>1</td>
</tr>
<tr>
<td>Ferrules</td>
<td>6 x 30mm, 6 x 32mm</td>
</tr>
<tr>
<td>Washer plates</td>
<td>4</td>
</tr>
</tbody>
</table>

2. Check that all installation tooling is available, correctly assembled and in working condition.

3. Check that the surface of the rail is clean and free from dirt, rust or scale. Each surface should be vigorously cleaned with a wire brush, either hand held or power driven.

4. Check that the rail ends are square, and not battered or dipped.

5. If joints are being installed to replace an existing joint, check the size, location and condition of the boltholes. The size and location of holes is shown in Figure 6 for 53kg rail and Figure 7 for 60kg rail.

6. If new joints are being installed, drill three (3) boltholes in each rail end. The size and location of holes is shown in Figure 6 for 53kg rail and Figure 7 for 60kg rail.

7. Assemble all parts as shown
   - Install the insulating end post between the rail ends.
   - Butt the rails tightly against the end post.
   - Insert the correct ferrules (see Table 5) in the boltholes so that the flat section of each ferrule bears against the rail web from the same direction, as shown in Figure 15.
Table 5 – Ferrule sizes

<table>
<thead>
<tr>
<th>Rail size</th>
<th>Hole dia</th>
<th>Ferrule part no</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>Ø 30mm</td>
<td>F30mm</td>
</tr>
<tr>
<td>53</td>
<td>Ø 32mm</td>
<td>F32mm</td>
</tr>
</tbody>
</table>

Figure 15 – Placement of ferrule

- Fit the insulated bars to the rail taking care to ensure the correct orientation of the bars. All writing and Identification marks must be the right way up and facing away from the rail web and the ribs facing towards rail web.
- Fit the washer plates to insulating bars with the rail fastener cut outs facing down.
- Line up all the holes.
- Insert Huckbolts through the holes in the washer plates, insulating bars and rail web from the same direction as the flat section of the ferrules. This will mean that the bolts are all facing in the same direction and is intended to ensure that the ferrules are not displaced as the Huckbolts are passed through the connection.
- Fit collars to all bolts prior to any bolt being driven. Ensure that all collars are fitted with the tapered head facing away from the rail.

8. Fasten the Huckbolts following the steps detailed in Section C5-11.

9. Remove excess material from the insulating end post (See Figure 16).
# Chapter 6 Installing rail

## C6-1 Rail Installation Requirements

**The following design requirements are extracted from RailCorp Standard ESC 220.**

<table>
<thead>
<tr>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Drilling of holes in rails should be minimised.</td>
</tr>
<tr>
<td>2. Except for holes associated with rail joints, the centre of drilled holes shall be within 5 mm of the neutral axis of the rail and for rail sizes of 41 kg/m and greater shall not be greater than 27 mm in diameter.</td>
</tr>
<tr>
<td>3. Rail shall be installed on plain track with a cant of 1 in 20 towards the centreline of the track.</td>
</tr>
<tr>
<td>4. The minimum rail length to be installed is 110m, welded from shorter lengths by flashbutt welding. In-situ aluminothermic welds should be kept to a minimum. Short lengths shall not be used except in emergencies.</td>
</tr>
<tr>
<td>5. The up and down rail of track shall be the same rail size.</td>
</tr>
<tr>
<td>6. Resilient fastenings only are to be used with 60kg/m rail.</td>
</tr>
<tr>
<td>7. When replacing 53 kg/m with 60 kg/m rail, allowance is to be made for the 13mm increase in rail height. Tolerances must be checked in relation to vertical structure clearance, overhead wiring clearances and electric train stop arm heights.</td>
</tr>
</tbody>
</table>

**Recycled rails used for rerailing must meet the following requirements extracted from RailCorp Standard ESC 220.**

<table>
<thead>
<tr>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rail wear shall meet the classification limits given in Table 6</td>
</tr>
<tr>
<td>2. Rail shall be ultrasonically tested and have any defects removed.</td>
</tr>
<tr>
<td>3. Rail surface defects (such as wheelburns) shall be removed or corrected.</td>
</tr>
<tr>
<td>4. All cripples or dipped welds shall be removed or corrected.</td>
</tr>
<tr>
<td>5. Rails with more than 6 aluminothermic welds in a 100m length shall be graded no better than ‘Red’.</td>
</tr>
<tr>
<td>6. Rail shall not have excessive rust.</td>
</tr>
<tr>
<td>7. Joint boltholes shall be cropped (if the inner holes have been used).</td>
</tr>
<tr>
<td>8. Rail shall meet the limits for proximity of welds.</td>
</tr>
<tr>
<td>9. Rail end straightness, twist and other rail distortions shall meet the requirements for installation of aluminothermic welds or mechanical joints.</td>
</tr>
<tr>
<td>10. Gauge face angle shall not exceed 26° to the vertical when the worn face is within 15mm of the lower edge of the rail head. (see Figure 17)</td>
</tr>
</tbody>
</table>
11. The maximum allowable rate of change of rail head sections where it is necessary to grind one rail to match the next shall be 1 in 500. (see Figure 18)

Maximum slope for grinding 1:500

```
<table>
<thead>
<tr>
<th>Rail Section Kg/m</th>
<th>Original dimensions</th>
<th>Category 1 (White Rail)</th>
<th>Category 2 (Blue Rail)</th>
<th>Category 3 (Red Rail)</th>
<th>Category 4 (Green Rail)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rail Width mm</td>
<td>Rail Depth mm</td>
<td>Rail Width mm</td>
<td>Rail Depth mm</td>
<td>Rail Width mm</td>
</tr>
<tr>
<td>60 Kg/m</td>
<td>70</td>
<td>44</td>
<td>≥ 66.5</td>
<td>≥ 35</td>
<td>≥ 63.5</td>
</tr>
<tr>
<td>53 Kg/m *</td>
<td>70</td>
<td>40</td>
<td>≥ 66.5</td>
<td>≥ 35</td>
<td>≥ 63.5</td>
</tr>
<tr>
<td>50 Kg/m</td>
<td>70</td>
<td>40</td>
<td>≥ 66.5</td>
<td>≥ 35</td>
<td>≥ 63.5</td>
</tr>
<tr>
<td>47 Kg/m *</td>
<td>70</td>
<td>37</td>
<td>≥ 66.5</td>
<td>≥ 33</td>
<td>≥ 63.5</td>
</tr>
<tr>
<td>41 Kg/m *</td>
<td>63</td>
<td>35</td>
<td>≥ 60</td>
<td>≥ 30</td>
<td>≥ 57</td>
</tr>
<tr>
<td>80 lb/ yard AS (1937) &quot;B&quot; (new)</td>
<td>64</td>
<td>≥ 60</td>
<td>≥ 30</td>
<td>≥ 57</td>
<td>≥ 30</td>
</tr>
<tr>
<td>80 lb/ yard AS (1928) &quot;A&quot; (old)</td>
<td>70</td>
<td>≥ 66.5</td>
<td>≥ 27</td>
<td>≥ 63.5</td>
<td>≥ 30</td>
</tr>
<tr>
<td>80 lb/ yard AS (1916) (old)</td>
<td>70</td>
<td>≥ 66.5</td>
<td>≥ 27</td>
<td>≥ 63.5</td>
<td>≥ 30</td>
</tr>
<tr>
<td>80 lbs/ yard AA (1907)</td>
<td>64</td>
<td>≥ 60</td>
<td>≥ 30</td>
<td>≥ 57</td>
<td>≥ 35</td>
</tr>
</tbody>
</table>
```

Table 6 – Rail Category by Wear Limit
The following placement and installation requirements extracted from ESC 220 apply to closures and bonded insulated joints installed by welding.

### General

1. Rail ends or Aluminothermic welds may not be located closer than 1.2 m from the centre of a bonded insulated joint.

2. Aluminothermic welds may not be placed within 2.2 metres of any weld (flashbutt or aluminothermic) or mechanical joint on plain track (main line or siding) except as indicated below.

3. In turnouts, aluminothermic welds may be placed closer than 2.2 metres to a minimum distance of 1.2m to a flashbutt weld, aluminothermic weld or mechanical rail joint, provided that:
   - The flashbutt weld or joint has no internal defects.
   - The rail length is well secured by two ties with the ties held by more than two rails such that they will not be able to skew if the rail breaks in two places.
   - The aluminothermic weld is ultrasonically tested within 6 hours of completion.

4. Aluminothermic welds may be installed opposite each other on adjacent rails as long as gauge side of each weld is ground prior to passage of trains.

5. Aluminothermic welds are not permitted on a sleeper.

### Closures

1. The minimum length of a closure to be welded into track is 2.2 metres except as indicated below:
   - In turnouts, closures shorter than 2.2 metres to a minimum length of 1.2m may be used, provided that:
     - The closure is well secured by two ties with the ties held by more than two rails such that they will not be able to skew if the rail breaks in two places.
     - The aluminothermic welds are ultrasonically tested within 6 hours of completion.

2. A flame cut rail end which has been left in track more than 12 hours must be re-cut immediately prior to welding, removing a minimum of 25mm.

3. The closure must conform to existing rail with a maximum 5mm mismatch in height (unless the rail is being welded using a junction weld in which case appropriate limits apply) and 5 mm in gauge wear.

4. For curves of 500m radius and under, closures of less than 6m in length must have the last 600mm of each end crowed to the correct curvature.

### Welding near boltholes

1. Rail ends which have been part of mechanical joints in service in the track are to be removed and replaced with a closure where rail ends have wear >0.3mm or any indication of damage.

2. Boltholes that are being, or have been, used in track to form a mechanical joint must be closely examined and if there is any damage, no matter how slight, then all the boltholes must be removed. If there is no damage then they may be treated as if they were unused.
3. Boltholes that have not been used in track to form a mechanical joint shall be dealt with as follows:

- 4 hole pattern - Rails with the 4 hole pattern where only the outer 2 holes are bored on each rail end can be welded straight into track provided that the first bolthole is maintained at a minimum of 80mm from the weld.
- 6 Hole Pattern - Rails which have all 3 holes bored on each rail end must be cut behind the first bolthole so that a minimum of 80mm is achieved from the weld to the first bolthole (see Figure 19).

![Figure 19 - Minimum distance of bolthole from weld](image)

**Welding near signal bonding holes**

Aluminothermic welds may not be placed within 80mm of any holes drilled in the rail web for attachment of signalling bonds. This includes holes currently in use, those no longer in use and those that have been plugged.

**Note:** The end of the cut rail cannot be located after the weld has been completed. When testing welds for compliance the measurement from the weld collar to the bolthole or bonding hole shall be 70mm.

### C6-2 Installing rail closures using the "Rail in = Rail out" process

The "Rail in = Rail out" process may be used to replace rail lengths up to 15m. This allows replacement of flashbutt welded rail lengths (13.47m). Use the process described in Section C6-7 to replace longer rail lengths

**Note:** this process is also used to:

- Replace defective welds, or
- Repair or remove rail defects

1. Establish key technical risks from incorrect adherence to standards

<table>
<thead>
<tr>
<th>Track Element</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability &amp; Interface</td>
<td>- Shorting out insulated joints caused by incorrect clip type or scrap left behind</td>
</tr>
<tr>
<td>Track geometry</td>
<td>- Incorrect gauge after the work</td>
</tr>
<tr>
<td></td>
<td>- Top and Line defects after the work</td>
</tr>
<tr>
<td></td>
<td>- Superelevation defects after the work</td>
</tr>
<tr>
<td>Rail geometry</td>
<td>- Rail profile mismatch</td>
</tr>
<tr>
<td></td>
<td>- Rail end mismatch causing foul joints</td>
</tr>
<tr>
<td></td>
<td>- Incorrect Rail gaps</td>
</tr>
<tr>
<td></td>
<td>- Rail Damage due to off-track plant</td>
</tr>
<tr>
<td>Track Element</td>
<td>Risk</td>
</tr>
<tr>
<td>----------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>Track Clearances</td>
<td>- Equipment left foul during work</td>
</tr>
<tr>
<td></td>
<td>- Site obstructions</td>
</tr>
<tr>
<td></td>
<td>- Rails foul</td>
</tr>
<tr>
<td>Track structure</td>
<td>- Fastenings, Sleeper plates, Track Stability</td>
</tr>
<tr>
<td></td>
<td>- Joint integrity, foul joints, fastenings, signalling and electrical integrity</td>
</tr>
<tr>
<td></td>
<td>- Track Stability and adjustment</td>
</tr>
<tr>
<td></td>
<td>- Rail condition</td>
</tr>
<tr>
<td></td>
<td>- weld integrity</td>
</tr>
<tr>
<td></td>
<td>- ballast profile</td>
</tr>
</tbody>
</table>

2. Place and measure the distance between 2 punch marks using the method described in Section C4-7.1.

3. Record the measurement.

4. Establish, mark and record the length of defective rail to remove.

5. Fully anchor 10 sleepers either side of the section of rail to be removed.

6. Remove fastening/anchors from the rail section to be removed.

7. Cut rail and remove the defective section.

When rails are removed from the track they are to be classified and then painted at the ends, while still bright, with the following colours:

- White, Blue or Red – suitable for use in track in accordance with Section C6-1 and Table 6.
- Green - Condemned rails to be used as scrap.

8. Select a closure rail to match rail wear on the existing track.

9. Cut the new closure to correct length.

10. Crow closure to match the curvature if the track is in a curve of <500m radius and the closure is less than 6m in length.

11. Insert the closure.

12. Install an aluminothermic weld on one end of closure.

13. Attach rail tensors around the remaining rail end.

14. Transfer the punch marks inside the tensors using the method described in Section C4-7.3

15. Pull the rails together until the 2 punch marks on the rail are the measured distance apart.

16. Cut the free end of the closure, if necessary, to establish the correct welding gaps.

17. Install an aluminothermic weld.

18. Remove the rail tensors.
19. Reinstall fastenings/anchors and remove anchor points.
20. Grind the closure rail to match the profile of the existing rail.
21. Measure the distance between the 2 marks to the nearest mm, using the method described in Section C4-7.2, and record the measurement.
22. Assess the rail movement by checking the “before and after” measurements of the punch marks. If the change in measurement exceeds the limits in Section C4-8, inform the Civil Maintenance Engineer.
23. Clean or grind the rail head to ensure contact between train wheels and the rail to complete signal circuits.
24. Certify the track using the procedure in Engineering Manual TMC 211 - Track Geometry and Stability. If work has not been completed satisfactorily, assess whether a speed restriction is required using the operating limits in Engineering Manual TMC 203 - Track Inspection.

C6-3 Installing rail closures by free welding

This method of installing closures is used either when ‘free welding’ closures during conversion of long welded rail to CWR, or in rerailing, when a number of 110m lengths of rail are free welded together before adjustment.

The process follows the same sequence as the "Rail in = Rail out" process detailed in Section C6-2 without the requirement to record adjustment.

Establish key technical risks from incorrect adherence to standards (See Section C6-2.

1. Establish, mark and record the length of defective rail to remove.
2. Remove fastening/anchors from the rail section to be removed.
3. Cut rail and remove the defective section.

When rails are removed from the track they are to be classified and then painted at the ends, while still bright, with the following colours: -

- White, Blue or Red – suitable for use in track in accordance with Section C6-1 and Table 6
- Green - Condemned rails to be used as scrap.

4. Select a closure rail to match rail wear on the existing track.
5. Cut the new closure to the correct length.
6. Crow the closure to match the curvature if the track is in a curve of <500m radius and the closure is less than 6m in length.
7. Insert the closure.
8. Install an aluminothermic weld on one end of closure.
9. Cut the free end of the closure, if necessary, to establish the correct welding gaps.
10. Install an aluminothermic weld.
11. Grind the closure rail to match the profile of the existing rail.
12. Clean or grind the rail head to ensure contact between train wheels and the rail to complete signal circuits.

13. Certify the track using the procedure in Engineering Manual TMC 211 - Track Geometry and Stability. If work has not been completed satisfactorily, assess whether a speed restriction is required using the operating limits in Engineering Manual TMC 203 - Track Inspection.

C6-4 Installing Bonded Insulated Joints

The following Design requirements are extracted from RailCorp standard ESC 220

1. Locations of insulated joints shall be determined to suit the requirements of signal circuiting.

2. Insulated joints shall be installed suspended between adjacent ties with the insulating post placed centrally between the sleepers.

3. Bonded insulated joints shall be welded into the track as rail closures.

4. Insulated joints of any type should not be installed on transom top bridges or within 10m of bridge ends and preferably not within 30m. Insulated joints may only be installed within 10m of a bridge end with the approval of the Chief Engineer Track.

5. Where 53kg and 60kg insulated joints are to be installed with resilient fastenings, low profile clips are to be used to avoid fouling the bolts.

6. When used with timber bearers with PZ 147 and Type 1 baseplates, low profile clips may still become foul of the joint bolts or plates. Where this is the case the offending clips are to be removed, subject to leaving at least one clip at each track plate set on opposite sides of the rail from one side of the joint to the other (see Figure 20).

![Figure 20 – clip arrangement if low profile clips are foul](image)

Insulated joint arrangements are detailed in drawings 207-1098 (plain track) and 207-1096 (turnouts).
1. Establish key technical risks from incorrect adherence to standards

<table>
<thead>
<tr>
<th>Track Element</th>
<th>Risk</th>
</tr>
</thead>
</table>
| Reliability & Interface| - Shorting out insulated joints caused by incorrect clip type or scrap left behind  
                       | - Rail bonding if joints not welded out                               
                       | - Impact on traction return if temporarily removed.                   |
| Track geometry         | - Incorrect gauge after the work                                      
                       | - Top and Line defects after the work                                  
                       | - Superelevation defects after the work                               |
| Rail geometry          | - Rail profile mismatch                                               
                       | - Rail end mismatch causing foul joints                               
                       | - Incorrect Rail gaps                                                 
                       | - Rail Damage due to off-track plant                                  |
| Track Clearances       | - Equipment left foul during work                                     
                       | - Site obstructions                                                   
                       | - Rails foul                                                          |
| Track structure        | - Fastenings, Sleeper plates, Track Stability                         
                       | - Joint integrity, foul joints, fastenings, signalling and electrical integrity 
                       | - Track Stability and Adjustment                                      
                       | - Rail condition                                                     
                       | - weld integrity                                                     
                       | - ballast profile                                                    |

2. Check Glued Insulated Joint for correct versine and visually inspect for any obvious faults.

**Note:** Old unused GIJs

Old joints should not be used without some testing to establish that they have retained their structural integrity.

DO NOT use joints with severe rust damage (Pitting of >0.5mm around the rail).

On the rail head and gauge corner there is a concern that severe contact stresses may promote cracking. Any rust >0.2mm that would not be removed in service by wheels is not acceptable. The surface rust should be able to be removed by grinding. Rust on the web and foot of the rail would not be able to be removed since the loss of section would fail the rail anyway.
The following Design requirements are extracted from RailCorp standard ESC 220

Bonded insulated joints shall be pre-curved to suit the radius of the track in accordance with Table 7.

### 3.43m Bonded Insulated Joints

<table>
<thead>
<tr>
<th>Curve Radius</th>
<th>Measured Full Midordinate of Track</th>
<th>Versine to be Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>196 - 326 m</td>
<td>7.5 - 4.5 mm</td>
<td>6</td>
</tr>
<tr>
<td>326 - 980 m</td>
<td>4.5 - 1.5 mm</td>
<td>3</td>
</tr>
<tr>
<td>980 - straight</td>
<td>1.5 - 0 mm</td>
<td>0</td>
</tr>
</tbody>
</table>

### 4.57m Bonded Insulated Joints

<table>
<thead>
<tr>
<th>Curve radius</th>
<th>Measured Full Midordinate of Track</th>
<th>Versine to be Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>217 - 326 m</td>
<td>12.0 - 8.0 mm</td>
<td>10</td>
</tr>
<tr>
<td>326 - 1305 m</td>
<td>8.0 - 2.0 mm</td>
<td>5</td>
</tr>
<tr>
<td>1305 - straight</td>
<td>2.0 - 0 mm</td>
<td>0</td>
</tr>
</tbody>
</table>

**Table 7 - BIJ configurations**

1. If the GIJ is being installed on worn rail, have the GIJ supplied with a matching worn rail shape. This can be achieved by either sending a length of rail with a matching worn profile to the GIJ supplier, or by machining a new GIJ to match the required profile.

2. Check Signalling requirements.

3. Place and measure the distance between 2 punch marks using the method described in Section C4-7.1.

4. Record the measurement.

5. Establish, mark and record length of rail to remove.

6. Fully anchor 10 sleepers either side of the section of rail to be removed.

7. Remove fastening/anchors from rail section to be removed.

8. Cut rail and remove section.

9. No crowing is required if the Glued Insulated Joint is manufactured with the required curvature.

10. Insert new Glued Insulated Joint.

11. Install an aluminothermic weld on one end of closure.

12. Attach rail tensors around the remaining rail end.

13. Transfer the punch marks inside the tensors using the method described in Section C4-7.3
14. Pull the rails together until the 2 punch marks on the rail are the measured distance apart.

15. Cut the free end of the closure if necessary, to establish the correct welding gaps.

16. Install an aluminothermic weld.

17. Remove the rail tensors.


19. Remove anchor points.

20. Grind the closure rail to match the profile of the existing rail.

21. Measure the distance between the 2 marks to the nearest mm, using the method described in Section C4-7.2, and record the measurement.

22. Assess the rail movement by checking the “before and after” measurements of the punch marks. If the change in measurement exceeds the limits in Section C4-8, inform the Civil Maintenance Engineer.

23. Clean or grind the rail head to ensure contact between train wheels and the rail to complete signal circuits.

24. Certify the track using the procedure in Engineering Manual TMC 211 - Track Geometry and Stability. If work has not been completed satisfactorily, assess whether a speed restriction is required using the operating limits in Engineering Manual TMC 203 - Track Inspection.

C6-5 Installing GIJs by free welding

1. This method of installing GIJs is used either when 'free welding' during construction, or in rerailing, when GIJs are installed before adjustment.

2. The process follows the same sequence as the "Rail in = Rail out" process detailed in Section C6-4 without the requirement to record adjustment.

C6-6 Repairing broken rails using the "Rail in = Rail out" process

1. Establish key technical risks from incorrect adherence to standards

2. Accurately measure and record the distance between the 2 broken rail ends (the rail must be measured from the head to head).

3. Place and measure the distance between 2 punch marks using the method described in Section C4-7.1.

4. Record the measurement.

5. Establish, mark and record length of rail to remove.

6. Use a rail template to mark the rail with chalk where it is to be cut.

   (the minimum distance between the marks is to be 2.2 metres + distance A which is the length recorded between the 2 broken rail ends).
7. Remove fastening/anchors from rail section to be removed.
8. Cut and remove the broken sections.
9. Select a closure rail to match rail wear on existing track.
10. Cut new closure to correct length.

\[
\text{Closure Length} = \text{Distance between trimmed rail ends} - A - 1.5 \times W
\]

Where
\[
\begin{align*}
A &= \text{Original gap between rail ends} \\
W &= \text{Single Weld Gap} \quad (25\text{mm for SKVF or Boutet})
\end{align*}
\]

11. Crow closure to match the curvature if the track is in a curve of <500m radius and the closure is less than 6m in length.
12. Insert the closure.
13. Install an aluminothermic weld on one end of closure.
14. Attach rail tensors around the remaining rail end.
15. Transfer the punch marks inside the tensors using the method described in Section C4-7.3
16. Pull the rails together until the 2 punch marks on the rail are the correct distance apart.

\[
\text{Correct distance between punch marks} = B - A
\]

Where
\[
\begin{align*}
B &= \text{original distance between the punch marks} \\
A &= \text{the original gap recorded in the broken rail}
\end{align*}
\]

17. Trim the free end of the closure, if necessary, to establish the correct welding gap.
18. Install an aluminothermic weld.
19. Remove the rail tensors.
20. Reinstall fastenings/anchors.
21. Grind closure rail to match the profile of the existing rail.
22. Measure the distance between the 2 marks to the nearest mm, using the method described in Section C4-7.2, and record the measurement.
23. Assess the rail movement by checking the “before and after” measurements of the punch marks. If the change in measurement exceeds the limits in Section C4-8, inform the Civil Maintenance Engineer.
24. Clean or grind the rail head to ensure contact between train wheels and the rail to complete signal circuits.
25. Certify the track using the procedure in Engineering Manual TMC 211 - Track Geometry and Stability. If work has not been completed satisfactorily, assess whether a speed restriction is required using the operating limits in Engineering Manual TMC 203 - Track Inspection.
**C6-7 Installing rail longer than 15m**

Use the following procedure to remove or install rail longer than 15m using manual methods and off track plant.

1. Establish key technical risks from incorrect adherence to standards.

2. Ensure that preparation for rerailing has been completed.
   - Mark out the length of rail to be replaced.
   - Cut or saw new rail.
   - Bore new rail ends (if required).
   - Crow new rail ends (in curves <500m radius).
   - Arrange any sleeper renewal, and straighten and space sleepers (if required).
   - Remove excess ballast around sleeper plates (or rail seat in concrete sleepers).
   - Place new rail in position in the ‘four foot’.

3. Arrange removal of ancillary equipment from track in the work area.
   - This may include signal and electrical gear, rail lubricators, temporary walkways level crossing etc from track in work area.

4. Install Anchor points at each end of site (in CWR) - See Figure 21.

*Figure 21 - Maintaining rail adjustment in track adjoining major rail renewal*
5. Install Creep Control marks on each rail not less than 55 m from the cut-in point at each end of site (CWR track only) - See Figure 21.

If there is a fixed point (e.g. elastic fastened transom top bridge, turnout or level crossing) less than 55m from the rerailing site use the fixed point as the creep control point.

6. Remove the rail length from track using the following steps:

**For timber:**

- Remove anchors with hammer and place them clear of the work area.  
  Note: These will be replaced back on to the new rail later.
- Undo joints (or cut rail if CWR) using pneumatic wrench or spanner.
- Remove fishbolts and plates for reclamation.
- Remove dogspikes (and lockspikes if new plate is being installed or adzing is required) using claw wedge and hammer or spike puller, OR
- Remove resilient fastenings using a hammer or panpuller.
- Remove the rail length from track using off-track plant and stack for recycling.

**For concrete:**

- Cut the rail (using a rail saw).
- Remove resilient fastenings using a hammer or panpuller.
- Remove the rail length from track using off-track plant and stack for recycling.

When rails are removed from the track they are to be classified and then painted at the ends, while still bright, with the following colours: -

- White, Blue or Red – suitable for use in track in accordance with Section C6-1 and Table 6
- Green - Condemned rails to be used as scrap.

7. Prepare sleeper for replacement rail by using the following steps:

**Timber (if adzing required):**

- Remove excess crib ballast using a ballast router (scarifier).
- Clean sleepers using a broom.
- Adze sleepers to provide a flat surface for the sleeper plates using a sleeper adzer.
- Layout new plates in the four foot (timber).
- bore holes in sleepers for new plates and/or cross bore using multi spindle borer or single boring machine, checking gauge of track.
- Place plates on sleepers.

8. Stand dogspikes on one side of the sleeper plate to hold it in place. With pandrol plates, stand lockspikes to hold the plates in position.

**Timber (no adzing)**

- Cross bore (if required) using multi spindle borer or single boring machine.
- Clean plate surface using a broom.
- Stand dogspikes and lock spikes manually.
Concrete:
- Check insulating pads for wear. Replace pads where required to maintain gauge.

9. Cut or Saw the existing rail end to remove bolt holes for welding (see Section C6-1 for limits) or to create a new joint (see Section C6-1 for restrictions on reuse of existing joints).

10. Install replacement rail with off-track plant.

11. Install fastenings.

On timber
- Drive dogspikes, OR place and clip up fastenings.

On concrete
- Install 1 in 4 clips to the rail to tie the track.
- Layout clips and biscuits.
- Place biscuits between rail and pandrol lug.
- Place remaining clips into position for driving.

12. Bore the existing rail ends (if required).

13. Crow the rail ends to match the curvature if the track is in a curve of <500m radius.

14. Measure and record the rail temperature.

15. Calculate and record the correct gap required (see Engineering Manual TMC 223 - Rail Adjustment).

16. Move the rails to obtain the correct gap.

17. Join the rail ends using plain or junction plates, or welds as required.

18. Grind the new rail ends to match profile of existing rail.

19. Clean or grind the rail head to ensure contact between train wheels and the rail to complete signal circuits.

20. Reinstall fastenings/anchors to correct pattern.

21. Install Glued Insulated Joints (where required).

22. Adjust Track (see TMC 223) (if adjusting prior to re-introducing traffic, do this instead of “move rails” in Step 16 above). This includes the track between the cut-in point and the creep control points.

23. Check the creep control points following the adjustment.

24. If there has been more than 10 mm of creep in either direction on either rail arrange for a track stability assessment to be undertaken by the Maintenance Team Manager.

The Maintenance Team Manager’s assessment should determine what additional adjustment is required.
The staging of rail removal works should consider the effect on track stability. For example, night rerailing might cause excess steel in the next section to be rerailed, causing a track to buckle if the next day is hot.

25. Update Creep control points to reflect any changes in track adjustment.

26. Restore ballast profile.

27. Check and correct fastening effectiveness, sleeper packing, spacing and skew (especially at joints).

28. Measure track geometry for top, line and alignment and correct by lifting and lining as necessary.

29. Arrange reinstallation of ancillary equipment, signal and electrical gear rail lubricators temporary walkways, level crossings, recover all excess materials and arrange rail set to pick up replaced rail.

30. Certify the track using the procedure in Engineering Manual TMC 211 - Track Geometry and Stability. If work has not been completed satisfactorily, assess whether a speed restriction is required using the operating limits in Engineering Manual TMC 203 - Track Inspection.
Chapter 7 Installing rail anchors

C7-1 Installing anchors

Track that is continuously welded and fastened using resilient fastenings does not require anchoring as resilient fastenings provide the necessary resistance to longitudinal movement.

For anchoring of timber sleepers and bearers fitted with non-resilient fastenings, the following requirements apply.

<table>
<thead>
<tr>
<th>The following requirements are extracted from RailCorp standard ESC 220</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welded track shall meet the following minimum anchoring requirements.</td>
</tr>
<tr>
<td>Double (or box) anchor every fourth sleeper except at mechanical joints (See Figure 22).</td>
</tr>
<tr>
<td>Double anchor every second sleeper for a total distance of 32 sleepers either side of mechanical joints, starting at the second sleeper from the joint.</td>
</tr>
<tr>
<td>Basic anchoring is to be so that sleepers are anchored on both sides on each rail (double or box anchor), except for steep grades as detailed below.</td>
</tr>
<tr>
<td>On track with a falling grade steeper than 1 in 80 in the direction of traffic, or at other locations where considered necessary to control rail creep, the anchoring shall be increased by adding single anchoring each second sleeper (or on every sleeper, if necessary) throughout the welded rail length, to prevent rail creep.</td>
</tr>
</tbody>
</table>

Insulated Joints in Welded Track

At mechanical insulated joints EVERY sleeper is to be double anchored for a distance of 32 sleepers on each side of the joint. (See Figure 23)

Glued Insulated Joints are treated as if they were plain track, and anchored in the same pattern as the track in which they are placed (eg 1 in 4 when laid in 110m rails or CWR, or every 2nd if within 32 sleepers of a turnout).

<table>
<thead>
<tr>
<th>The following requirements are extracted from RailCorp standard ESC 250</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turnouts (See Figure 24)</td>
</tr>
<tr>
<td>• Double anchor every second sleeper for 32 sleepers (ie a total of 16 anchored sleepers) in front of the switch, commencing from the first sleeper from the switch.</td>
</tr>
<tr>
<td>• Double anchor every second sleeper/timber for 32 sleepers/timbers (ie a total of 16 anchored sleepers/timbers) behind the crossing, commencing from the first timber after the crossing that has plain track fastenings.</td>
</tr>
<tr>
<td>• Double anchor every second timber on the through rails and turnout rails between the heel of the switch and the front legs of the crossing.</td>
</tr>
</tbody>
</table>

Diamonds (See Figure 25)

• Double anchor every second sleeper/timber for 32 sleepers/timbers (ie a total of 16 anchored sleepers/timbers) behind the crossing, commencing from the first timber after the crossing that has plain track fastenings.
• Double anchor every second timber between the "V" and "K" crossings.
Catchpoints (See Figure 26)

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

The following requirements are extracted from RailCorp standard ESC 220

Anchoring of Welded Track on Bridges (See Figure 27)

Steel openings

Transom top steel openings with spans <18m

- Standard anchoring for welded rails on open track as detailed above shall be used on welded rails on these bridges.

Transom top steel openings with spans ≥18m long but < 80m.

- For a distance of 60m from a bridge end, the track shall be double anchored on every second sleeper.
- On the bridge the track shall be double anchored to every second transom for half the span length, commencing at the fixed end.

Ballast top steel openings with spans ≥ 4.27m long but <80m

- Standard anchoring for welded rails on ballasted track shall be used on welded rails on these bridges.

Transom top steel openings with spans ≥80m

- Between expansion switches the rails are to be double anchored to every fourth transom.

Concrete and masonry openings

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

Concrete structures with spans < 25m

Standard anchoring for welded rails on open track as detailed above shall be used on welded rails on these structures.

Concrete structures with spans ≥ 25m

An assessment shall be made of the expansion needs and appropriate zero toe-load clips installed. Proposals shall be submitted to the Chief Engineer Track for approval.

Note: whilst the expansion of concrete is similar to that of steel there is a difference in the temperature variation expected in concrete.

Ballast top openings

Standard anchoring for welded rails on open track as detailed above shall be used on welded rails on Ballast Top openings with spans <40m in length.

For Ballast Top openings with spans ≥40m in length the requirements for expansion of the rails and the ballast must be considered.
When existing 110m lengths of rail are welded into longer lengths or welded into continuous lengths, the additional anchoring that was installed at the removed mechanical joints may be removed, providing the minimum anchoring pattern meets the requirements above.

If joints are anchored to standard and are consistently pulling apart, rail adjustment should be reviewed and corrected as appropriate.
Double Anchor every fourth sleeper
Double Anchor every second sleeper for 32 sleepers
Mech. Joints
Double Anchor every second sleeper for 32 sleepers
Double Anchor every fourth sleeper

Square Joints

Double Anchor every fourth sleeper
Double Anchor every second sleeper for 34 sleepers
Mech. Joint
Double Anchor every second sleeper for 34 sleepers
Double Anchor every fourth sleeper

Staggered Joints
(Shown as for 110m lengths)

Double Anchor every second sleeper for 34 sleepers
Mech. Joint
Adjust anchoring opposite joint to maintain pattern

Insulated Joints

Figure 22 - Anchoring of ballasted welded track

Figure 23 - Arrangement of anchors at mechanical insulated joints

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Issued April 2013
Page 53 of 106
Version 4.6

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Figure 24 - Anchoring of turnouts

Double Anchor every second sleeper for 32 sleepers ahead of Switches.

Double Anchor every second timber between Switch Heel & End of Crossing.

Double Anchor every second sleeper/timber for 32 sleepers after Crossing.

Figure 25 - Anchoring of diamonds

Double Anchor every second timber.

Double Anchor every second timber.

Double Anchor every second timber.

Double Anchor every second timber.

Figure 26 - Anchoring of Catchpoints

Double Anchor every second sleeper for 32 sleepers ahead of Catchpoint.

Double Anchor every second sleeper for 32 sleepers behind Catchpoint.

Anchor pattern as for plain track.
Spans < 18m
Total bridge length < 30m

Spans ≥ 18m but <80m

Figure 27 - Anchoring of transom top bridges
Chapter 8 Installing and maintaining rail lubricators

C8-1 Description

Trackside rail lubricators are installed to provide controlled lubrication for the rail/wheel interface, allowing for reduced wear, energy consumption and operating noise.

They deliver a metered quantity of lubricant from a reservoir to a location on the gauge face of the rail head where it is picked up by wheel flanges of passing vehicles. The lubricant must be picked up by the wheel flange and deposited further along the gauge face as the wheel progresses in the direction of travel, providing lubrication in the contact area of the wheel flange and the gauge face of the rail.

The distribution of lubricant must be performed efficiently, so that it is carried by the wheels as far as possible along the rail in the direction of travel with a minimum of wastage at the greasing plate and along the track.

C8-1.1 Lubricator types

The information in this document is specific to the two common lubricator types in use on RailCorp’s network. They are:

P&M (Fessl) – the most common older type lubricator which exists as a bolt-on or clamp-on type. These are not approved for new installations

Figure 28 - P&M lubricator
RTE 25 – an improved version of the P&M lubricator. This is the preferred lubricator.

Figure 29 - RTE 25 Lubricator

Where differences exist in inspection and maintenance or installation procedures, they are noted in the following sections.

C8-1.2 Lubricator components

C8-1.2.1 Reservoir
There are a number of different types and sizes in service ranging from the M-4 with a 9-kg capacity to the M-7 with a 100-kg capacity. Figure 29 shows an M6 reservoir.

C8-1.2.2 Filling connections
There are two types of filling connections:

Bayonet type
Is the oldest and most common type in service. Take care when filling that the connection does not come undone and that the washer is in good condition.
Cam lock type
This type has a lever action that locks the hose to the filling valve. They are cleaner and cannot come undone.

C8-2 Servicing and maintaining rail lubricators
Maintenance servicing and repair of lubricators is carried out at regular intervals related, generally to the density of rail traffic and the size of the lubricant reservoir.

The standard maintenance service includes the following requirements.

C8-2.1 Main Container

1. Check the level of grease in the main container.
   If the indicator rod doesn’t stick out it is empty. If it sticks out 300mm it is full.

2. Fill main container if required
   Refill the lubricator reservoir using a grease transfer pump with a standard Cam lock or bayonet type fitting attached to the fitting on the outlet side of the reservoir. Pump grease in until the indicator rod sticks out approximately 200mm from the back of the reservoir.

   **WARNING**
   DO NOT stand behind the main container when filling it. The back could break and fly off with considerable force

   ![Figure 30 – Filling the reservoir](image)

3. Always screw the winder fully in before tightening the lock nut.
4. If the lubricator is close to the end of the sleeper remove the hose when trains are to pass as the hose could foul the trip arm.
5. Check for leaks at the hose connections. Leaks can be the result of loose hose fittings or damaged hoses.
6. Tighten all back cover bolts. Check reservoir for damage such as cracks especially near the back cover bolts.

C8-2.2 Pump Assembly

1. Check plunger condition and replace plungers if necessary. If the pump is not operating replace the assembly with an exchange service unit.
2. Check plunger heights and adjust as required.
3. Check height of plungers to establish that passing wheels actuate pumps. If the plunger height is too low adjust the pump casting to obtain correct height.
4. Activate plungers to ensure grease is delivered to the greasing plate. This may require the pump to be primed to remove air locks.

CAUTION
DO NOT place excess grease on the top of rail. It may reduce rail friction.

C8-2.3 Greasing Plate Assembly

1. Inspect condition of blade(s) for wear and leaks around cork stops. Repair or replace damaged parts. Check plates for loose fittings and faulty gaskets. Tighten fittings and replace gaskets if necessary. Adjust grease plate to correct height after service is complete.
2. Adjust blade height and tighten bolts.
3. Visually examine the greasing plate for wear and/or damage.
4. Check height of greasing plate. Adjust as required.
5. Remove excessive grease and prime greasing plate.
6. Adjust greasing plate height as required.

C8-2.4 General

1. Replace any damaged hoses.
2. Tighten all rail clamps, hose clamps and bolts.
3. Clean waste material from rail and rail lubricator.
4. Wash the greasing plate, anchor block and pumps and main container.

Figure 31 - Result of not enough Rail Lubrication - Rough gauge face and flaking
1. Inspect the rail surface in the vicinity of lubricators prior to ultrasonic examination of rails by rail flaw detection vehicles. This is necessary in order to stop rail curve grease interfering with rail testing.

2. Turn off lubricators at any location where a build up of grease on the head of the rail has occurred at least 24 hours prior to the scheduled inspection of the rail flaw detection car.

   If this is not practical the lubricator may be turned off more than 24 hrs ahead of the rail flaw inspection.

   In some locations 24hrs may not be sufficient time for the grease to be removed prior to testing and problems with testing may still be experienced. In such cases the lubricators may be turned off further in advance up to a maximum of one week prior to testing. This time should be kept to a minimum since additional rail wear may occur.

3. The lubricators should be turned back on as soon as practicable after the rail flaw inspection.
C8-4 Removing lubricators for track maintenance

Rail lubricators can suffer considerable damage during ballasting, re-railing and other mechanised track maintenance operations such as tamping, re-sleepering, sledding, ballast cleaning and ballast regulating etc. They need to be removed or adjusted before these activities.

C8-4.1 Removing lubricators for rerailing, reballasting and major track maintenance activities

C8-4.1.1 RTE Lubricators

1. Remove ‘4-foot’ clamps from the pump.
2. Remove one end of the grease delivery hose from the blade(s).
3. Remove the main container by sliding it on the ballast. The main container may have to be emptied of grease to allow it to be moved.
4. Remove the blade assembly.
5. Place all components in a secure location away from the worksite.

C8-4.1.2 P&M Type clamp on lubricators

1. Loosen the grease delivery hose clamps and remove grease delivery hose(s) from blade(s).
2. Loosen the anchor block retaining clamps and rail clamps and withdraw the anchor block and main container.

Note: The main container is still attached to the anchor block.

C8-4.1.3 P&M Type bolt on lubricators

1. Screw the winder into the back of the reservoir and tighten the retaining nut. This will stop grease from leaking from the main delivery hose.
2. Remove the grease cap from the main attachment bolt.
3. Remove the main attachment bolts.
4. Slide the assembly (blade and pump) away from the rail.
5. Place all components in a secure location away from worksite.
C8-5 Installing lubricators

C8-5.1 Installation requirements

The following requirements are extracted from RailCorp standard ESC 220

- Lubricators shall be installed in accordance with manufacturer’s instructions.
- All trackside lubricators must be clamped to the rail. New installations are not permitted to be fixed by bolting through the rail.
- Under very severe grade conditions (more than about 1:50 in either braking or climbing direction), lubricators on the Up and Down rails should not be positioned any closer than 0.5 km of each other.
- Installation should consider environmental aspects. If standard lubricant is used an appropriate mat should be placed to prevent contamination of the ballast and the environment.

Figure 34 – completed RTE 25 lubricator installation

C8-5.2 Installing RTE lubricators

1. After rerailing, determine whether the rail size and lubricator components are compatible.

When rail is changed from 53kg to 60kg it will be necessary modify lubricators by replacing the mounting brackets so that they can work effectively on the new rail size.

2. Determine the correct location to fit the lubricator in relation to Tangent Point (T.P.) on the correct rail. The location of lubricators is determined by using the guidelines in Chapter 12.

C8-5.2.1 Site preparation

1. Clean out 3 sleeper bays to a depth of 75mm.

2. At the first bay in the direction of travel dig a hole at the end of the sleeper for the main reservoir so that it will sit below the level of the rail at the end of the sleeper.
C8-5.2.2 Blade assembly

1. Install the shim into the back of the slot of the blade mounting frame with the small leg facing out. (See Figure 35).

2. Install the blade (with the slots to the back) into the slot of the blade mounting frame onto the small leg of the shim. (See Figure 35).

3. Install the angle into the slot

4. Tighten the three bolts across the top of the blade mounting frame.

C8-5.2.3 Installation of blade assembly to rail

1. Position the Rail Clamp Sets at approximately 700mm centres, ensuring that the frame is clear of any rail fastenings and plates leaving both loose. (see Figure 36)

2. Fit the half nut to the mounting bracket. (See Figure 37)

3. Install a tapered washer, thick end down.
4. Install a flat washer.
5. Install the blade assembly.
6. Install a tapered washer thick end to top.
7. Install flat and spring washers.
8. Install the full nut.
9. Tighten foot brackets bolts.

![Figure 37 - Blade assembly to foot / mounting bracket]

C8-5.2.4 Installation of pump to rail

1. Position the Rail Clamp sets at approximately 275mm centres, centrally located in the first sleeper bay.
2. Fit the pump unit onto the mounting bolts.
3. Install flat spring washers.
4. Install full nut and tighten.

The plunger stroke is pre-set at the Factory during assembly to a mid-point position, so, before fully tightening locknuts, position pump unit so that top of plunger is approximately level with the top surface of the rail. This position does not have to be accurate at this time as the plunger stroke's final adjustment is made later.

5. Tighten foot /mounting bracket bolts.
C8-5.2.5 Installing hoses

1. Fit two small hoses to the through arms of the tee piece.
2. Fit long hose to the tee piece.
3. Fit hose clamps to each end of hoses.
4. Fit the two short hoses to the blade assembly.
5. Feed the hose under the rail and connect to the pump.
C8-5.2.6 Installing Reservoir

1. Dig hole so that the reservoir will be below rail height and at the end of the sleepers opposite the pump.

[Image: Reservoir position]

2. Fit the 65mm hose to the reservoir and clamp.

3. Fill the pump until the grease is near the end of the hose.

4. Connect the hose to the pump (don’t forget the clamp).

5. Complete filling.

It is important that air is not introduced into the pump unnecessarily at the time of installation.

It is very important that during this filling and fitting procedure no dirt at all is introduced into the grease line as it can cause the plunger to jam or malfunction and damage the pump.

C8-5.2.7 Initial purging

1. Loosen the plunger adjuster locknut at the front of the pump and set to maximum stroke with the indicator dimple uppermost.

2. Let off the reservoir spring compression screw completely to pressurise the grease up to the pump inlet.

3. Move the plunger fully down and up by foot or with a wooden handle, to begin pumping grease into the delivery hose and up to the distributor blades.

   If air is trapped in the pump body it may be necessary to move the plunger rapidly up and down to dispel it, but still on full strokes. If the pump still does not prime, check that inlet grease is available at pressure from the reservoir by loosening the hose clamp and wriggling the hose to let some of the grease pass out. Repeat the purging procedure with full strokes approx. 1-2 per second.

4. When grease has travelled through the connecting hose to the distributor blades, continue to pump until it protrudes 3 to 6 mm above the blade upper surface where it would normally reach during operation by train wheels.
C8-5.3 Adjustment

1. Set the plunger and blade height to the correct operating height (See Table 8).

<table>
<thead>
<tr>
<th>Item</th>
<th>Settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plunger height (above top of rail head)</td>
<td>2 - 3mm</td>
</tr>
<tr>
<td>Blade height (below top of rail head)</td>
<td>15 - 20mm</td>
</tr>
</tbody>
</table>

Table 8 - Plunger and blade settings

C8-5.3.1 Blade (See Figure 41)

1. Loosen the three bolts.
2. Loosen lock nuts on adjustment screws.
3. Turn adjustment screws until the blade is at the correct height. (See Table 8)
4. Tighten the three bolts.
5. Tighten all the lock nuts.

C8-5.3.2 Pump (See Figure 42)

1. Loosen adjusting screw lock nut.
2. Turn Adjusting screw until plunger is correct height (See Table 8).
3. Tighten lock nut.
4. If not high enough then loosen mounting nuts and raise the pump.
5. If too high then loosen mounting nuts and lower the pump.

Note: If the rail head is very thin, use the next lower rail size bracket eg on worn 60kg then use 53 kg brackets which will lower the pump approximately 10mm.
1. Clean up the worksite after the lubricator is operating correctly.

**C8-5.4 P&M Type bolt on lubricators**

DO NOT reinstall P&M Type bolt on lubricators after the rail size has changed from 53kg to 60kg.

Install a new RTE 25 lubricator.

If you are rerailing without changing rail size use the following procedure to reinstall a P&M Type bolt on lubricator.

**C8-5.4.1 Site preparation**

1. Dig out one bay to the end of the sleeper to a depth of 200mm on the field side.
2. Dig from the end of the sleeper to enable the main container to be positioned below rail height.

**C8-5.4.2 Location and drilling**

1. Mark the centre of the bay.
2. Mark the centre of the web 362 mm each side of the centre of the bay.
3. Mark the web up from the bottom of the foot 60mm for 47kg, 72mm for 53kg, 80mm for 60kg.
4. Drill the two holes 32-mm dia.
C8-5.4.3 Fitting

Figure 43 - anchor block with pumps

1. Place the anchor block on the field side of the rail.
2. Place mill board packer and the blade back plate on the gauge side of the rail.
3. Fit the main attachment bolts from the gauge side through the blade back plate and screw them into the anchor block.

Figure 44 - main attachment bolt

4. Fill the backing plate grease space with grease.

Figure 45 - Back plate

5. Fit the blade and holding plate to the back plate using the 2 holding screws.
6. Attach pumps to each side of the anchor block.
C8-5.4.4 Reservoir and hose connections

7. Place the reservoir in the ballast hole.

8. Cut 65mm hose into 1 @ 150mm long and 1 @ 400mm long.

1. Attach both hoses to the 90° elbow.

2. Attach the long hose to the reservoir.

3. Fill the reservoir until grease comes to near the end of the hose attached to the anchor block.

C8-5.4.5 Adjustment

1. Adjust height of blade by sliding the blade up then tighten the holding bolts.

2. Loosen the pump attachment bolts and slide the pump up until the plunger is 2-3mm above rail height.

3. Tighten bolts.
4. Install caps and holding bolts.

5. Clean up the worksite after the lubricator is operating correctly.

C8-5.5 P&M Type clamp on lubricators

DO NOT reinstall P&M Type clamp on lubricators after the rail size has changed from 53kg to 60kg.

Install a new RTE 25 lubricator.

If you are rerailing without changing rail size use the following procedure to reinstall a P&M Type clamp on lubricator.

1. Remove excess ballast and position main container into correct location.

2. Fit two (2) rail clamps to the foot of the rail. Do not tighten.

3. Fit the anchor block and tighten rail clamps.

4. Tighten the anchor block retaining bolts.

5. Position and fit rail clamps for blade(s). Do not tighten.

6. Fit blade(s).

7. Fit millboard packing between the rail and the greasing plate assembly and assemble to rail. (when re-installing always fit new packing).

8. Fit new cork stops between the blade assembly and the rail in the grooves provided. Partially tighten blade retaining bolts.

9. Adjust the height of the blade(s) by loosening the four (4) height adjusting bolts and moving the blade(s) up or down.

10. Tighten the blade retaining bolts and blade height adjusting bolts.

11. Fit the grease delivery hose(s).

12. Check the pump plunger heights and adjust if necessary.

   This is done by releasing the two retaining bolts in each pump and moving the complete pump casting up or down. When correctly positioned, tighten the retaining bolts.

   The correct plunger height setting is between 1mm and 5mm (for C4 grease) or between 2mm and 4mm (for M4, M5, M6, M7 and M30 grease).

   Generally, the required plunger heights above the running surface of the rails are: 3.2mm in Summer when the lubricant is less viscous (runnier), and 4.4mm in Winter when the lubricant is more viscous. However, it is essential to check visually whether lubricant is migrating to the running surface of the rails. If this occurs, the height of the plungers must be reduced and the resultant lubricant distribution checked again after 4-10 trains.

13. Fill the main container with approved grease. Filling is carried out either by mechanical or pneumatic operation of pumping grease into the main container via a non-return valve.

14. Activate the plungers by depressing with a hammer handle. This should deliver a bead of grease along the greasing plate. If no grease is present, pumps are
likely to contain air and this MUST be bled. (Note: The pump can be primed while filling if assistance is available to depress plungers).

15. Loosen both bolts securing the pumps to the main container (or anchor block) and allow air to be dispelled. Reset the plunger heights and re-tighten bolts. This procedure may need to be repeated until all air is expelled.

16. Clean up the worksite after the lubricator is operating correctly.
Chapter 9 Installing and maintaining wheel squeal applicators

C9-1 Description

The RTE /Flutek top of rail anti wheel squeal applicator uses the existing track side lubricator pump, clamping system modified reservoir and distribution assembly with the addition of a control system that regulates the amount of product supplied to the track and returns the excess to the reservoir.

![Figure 48 - Wheel squeal applicator unit](image1)

![Figure 49 - Friction modifier applied to rail](image2)

C9-2 How the system works

The unit is a flow control system that is connected in the hose line between the lubricator pump and the distribution assembly.

The unit allows the desired amount of friction modifier to go to the track and the excess product is returned to the Reservoir.

The unit will only operate when:

1. The unit is turned on (Standby mode).
2. The pump is pumping and has generated the required pressure.

Electrically the system is powered by two (2) 12v12ah batteries hard wired together to produce 24v12ah.
Overload protection is provided by a 5amp fuse located on front panel.

Under voltage protection for the timers and relays is provided via a voltage sensor that is preset and should not be readjusted.

C9-3 Installing the reservoir and applicator

To be determined

C9-4 Installing the control unit

Remove the unit from the carton and place it in the required location:

- within 1.5m from track,
- level, with access to front / back of cabinet.

C9-4.1 Hose Connections

All hose connection are:

- at the rear of the cabinet,
- 16mm standard hose fittings,
- to be secured with 25 mm worm drive hose clamps.

![Figure 50 - Hose connections](image)

Note: Prime the lubricator and all hoses with product before connecting to the unit.

1. Connect 16mm hose from the pump output fitting to the centre (supply) fitting on the cabinet.
2. Connect 16mm output hose from the rear right (to track) fitting to the 16mm inlet fitting on the applicator fitted to the track.
3. Connect 16mm output hose from rear left (to tank) fitting to the 16mm fitting on the side of the outlet pipe of the reservoir.

C9-4.2 Battery Pack

The battery pack contains two 12v 12ah batteries connected to supply 24v12ah.
C9-4.2.1 Connecting the battery pack

1. Place the battery pack in the tray.
2. Plug in the connection between the battery pack lead and the control lead (only goes one way).

C9-4.2.2 Battery Charging

1. Unplug the battery pack from the control unit.
2. Plug the lead into the charger lead.
3. Plug the charger into a 240V wall outlet and turn on.

C9-5 Operation of the applicator control unit

1. Use the lock tool (key) supplied to unlock door.
   - Turn the left lock clockwise.
   - Turn the right lock anti-clockwise.
2. Plug the battery pack power line into the power lead.
3. Turn On/Off switch to the ON position (1). The Red (on) light will illuminate to indicate power is on and the system is in standby mode.
4. When the pump starts pumping, the system will automatically start & run a cycle when a pressure of 26psi/1.8 bar is sensed in the hose.

C9-6 System Test
Before starting test procedures ensure that the unit is turned on and that the low battery light is not illuminated.

C9-6.1 Electrical test only
1. Press the red test button once. The system will go through a full electrical cycle.
2. The unit will return to Standby mode after the cycle has stopped.

During this test, product will not flow to the track as the lubricator pump is not activated

C9-6.2 Full system test
1. Start the lubricator by depressing the plunger on the lubricator pump.
2. When the activating pressure is reached, the unit will operate and product will flow to the track.
3. The unit will then go into Wait time.
4. If pressure is still in the line (ie the pump is still operating), the unit will operate again.
5. If the pump has stopped and the pressure has decreased, the unit will return to Standby mode.

C9-7 Specification

C9-7.1 Factory pressure settings
- The system bypass is preset to release at 30-32psi (2.1-2.2bar) (not adjustable) and this will be indicated by the gauge on the control panel when the lubricator pump is operating.
- The activation hose pressure is preset to 25psi (1.7bar).

C9-7.2 Electrical system
- The system is 24 volt DC.
- A Voltage sensor is installed to protect the timers.
- There are two timers in the system:
  - the run timer is triggered by the pressure switch, and
  - the opening timer operates the valve to allow product to flow to the track

C9-8 Adjustments

C9-8.1 Activation pressure
The activation pressure can be adjusted using the pressure sensor knob.
Take care when adjusting the pressure control, as the unit will either not operate or continually operate.

![Pressure Sensor](image)

**Figure 53 - Pressure sensor adjustment**

- If the pressure is increased the unit will take longer to sense and activate the system. The system will not activate if too much pressure (>32psi (2.2bar)) is applied because the bypass is preset to 32psi (2.2bar).
- If the pressure is decreased below 20psi it is possible that the system may not shut down in the desired time (even if the pump has stopped) and will keep restarting until it drains down to 18psi.

### C9-9 Timers

There are two timers in the system:

![Timers](image)

**Figure 54 Timers**

#### C9-9.1 Run timer

The Run timer is the timer on the left side of the control and controls how long the cyclic timer operates.

**Adjustment**

- The bottom black knob selects the range of times in seconds, minutes, hours, and days.
- The top red knob selects the percentage 1-10 of the range of times.
C9-9.2 **Cyclic timer**

The cyclic timer is next to the run timer and has two adjustment ranges

- One controls the OFF time.
- The other controls the ON time.

**Adjustment**

- The top black knob selects the range of ON time.
- The top red knob selects the percentage 1-10 of that range.
- The bottom black knob selects the range of the OFF time.
- The bottom red knob selects the percentage 1-10 of that range.

C9-10 **Maintenance**

The maintenance requirements are similar to that of the track side lubricators with the addition of the following:

1. Change the battery every week (this is dependent on the traffic conditions).
2. Fill the reservoir every 6 to 8 weeks using approved friction modifier (see approved rail products in Appendix A).

   **CAUTION**
   
   DO NOT place excess friction modifier on the top of rail. It may reduce rail friction.

3. Replace the rubber distribution pad as required (approximately every 6 months).
4. Set the plunger higher than for a track side lubricator.
Chapter 10 Operation and maintenance of 3.1 series TORFMA and GFL

C10-1 Operation - how they work

Figure 55 - 3.1 Series Unit
Figure 56 - Schematic of 3.1 Series unit

Tank or Reservoir
These are containers that hold product to be delivered to rail by the pump.

Reservoirs hold approximately 16 litres that has to be pumped in. They have a back pressure.

Tanks can hold up to 100 litres but only 60 litres is normally used. They only have pressure due to the “head” of product and air pressure.

Wheel Sensor
The wheel sensor is an inductive sensor which is mounted to the rail foot on the gauge side a few sleepers before the distribution units or blades. When a magnetic material such as a wheel passes over the sensor within range an electrical pulse is generated. The electric pulse is sent via the connecting cable to the electronic package. 24V DC power is supplied to the sensor to increase the detection range to 40mm.
Temperature Sensor
The temperature sensor is a thermocouple mounted in a hose clamp tightened around the strainer through which the product passes into the control box. As the temperature varies the voltage output of the thermocouple varies and this voltage is measured by the electronic package via connecting wires.

Battery
The battery stores and supplies 24V DC power to run the systems and is enclosed in the Control Box. If the battery is in good condition and fully charged it should maintain the system through approximately two weeks of bad weather.

Solar Recharge
Two 12V solar panels are connected in series and power produced is directed through a 24V voltage regulator to the battery circuit to replenish power in the system.

Solid State Relay
This is an electronic relay which supplies full 24V power from the battery when directed by a small 5V signal current from the Electronic Package. When the signal current is turned off EMF is drained from the motor circuit to stop the motor overrunning. There is a 5A replaceable fuse contained in the Relay.
Figure 63 - Solid state relay in Control Box

Figure 64 - Pulleys and belt on motor and pump

Motor/Gearbox
This is a 24V DC motor driving an integrated 120:1 gearbox to produce 25 RPM at the output shaft to drive the pump via the toothed belt.

Pump
The pump is a positive displacement gear pump that draws product from the tank or Reservoir and pumps it to track via the Control Box.

Toothed Drive Belt
The drive belt connects the motor to the pump via pulleys which are locked to the shafts by a grubscrew. The belt provides a safety release if the pump locks such that major damage will not result to the pump or motor.

Strainer
The strainer contains a fine stainless mesh filter through which the product flows from the pump to remove any overly large contaminants or lumps of gluggy product prior to passing through the system. It is located after the pump hose before entry to the Control box.

Pressure Relief Valve
The Pressure Relief Valve is connected off the delivery line from the pump and sets the maximum system pressure at 125 psi (formerly 40 psi on the TORFMA Series 3) to protect components in the event of a blockage. If the maximum pressure is reached the valve opens and directs product back to the tank or reservoir. The higher pressure is
definitely required for GFL Series 3.1 whereas the TORFMA units operated reasonably well on 40 psi due to a much lower viscosity of the TOR product than curve grease.

**Pressure Sensor and Pressure Gauge**

The pressure sensor provides voltage outputs, varying proportionally with the pressure, to the electronic package for data collection and download.

The Pressure gauge gives a mechanical pressure readout on the Control panel for the benefit of staff on site.

**Flow Meter**

Product being delivered to rail passes through the flow meter. The flow meter has two (2) oval gears inside which rotate as the product passes. Each time the gears rotate through a full cycle (one millilitre) a pulse is generated which is sent via connecting wiring to the Electronic Package.

![Figure 67 - Flow meter on back of control box](image)

![Figure 68 - Electronic package inside control box](image)

**Electronic Package**

The Electronic Package monitors the incoming signals from the sensors above and is loaded with firmware and operational parameters to determine the product quantity delivered and manner in which the overall system operates. It has three processors on the PCB to enable product delivery, data collection and download all to happen at the same time plus RAM to hold a few days’ data. A modem is mounted on the package to facilitate the download of data to the remote server via the mobile network through an aerial mounted on the control box.

Each time the unit dials in to download data it collects the setup parameters which are set on the webpage for that unit and loads them to its memory as operational parameters. The electronic package thereafter operates based on those parameters.

The setup parameters downloaded are:

- **First Wheel Trigger** – The number of wheels to pass over the wheel sensor before any product is delivered.
- **Next Wheel Trigger** – The number of wheels over the wheel sensor after the first delivery till a second dose of product is delivered.
- **Grams to Dispense** – The amount of product (millilitres) to be dispensed each delivery.
- **Minute to download** – The minute of the hour for the package to dial in and download data.
- **Minimum Impulse Length** – Minimum length of impulse from wheel sensor to be recognised as a valid wheel.
• **Minimum Time Between Triggers** - Minimum time between valid wheel sensor impulses for it to be counted.

• **Low Voltage Alert Threshold** – Minimum voltage at which machine will operate normally. If the voltage falls below this setting then No product will be delivered but monitoring will continue until 18V at which time machine will shut down. To turn off the machine remotely the threshold is set at 29V

• **Motor Timeout** – A max run time of the pump drive motor can be set to allow better control of product delivery particularly where small quantities need to be delivered. Reliance on the flow meter alone tends to supply excess Top of Rail product with short trains.

• **Train Timeout** – Time after the last wheel of a train has passed before machine closes off counting of product flow and writes “Train Passed” Summary Data.

NOTE: Any product delivered after the “Train Passed” row will be considered to be delivered for the next train. This includes any product delivered from pushing the Manual Pump button.

![Figure 69 - Control Panel](image)

**Control Panel**

The control panel is inside the control box. The panel provides manual controls plus a voltmeter, fuse, wheel sensor indicator light, pressure gauge, LCD screen and a programming port or ports.

- Press the voltmeter button to check the battery voltage noting that if the solar panel is connected the actual battery voltage will not be given. Unplug the solar panel to check battery voltage.
- Press the “Pump on” button to manually operate the pump
- Press the “Train on” button to simulate a train wheel passing the wheel sensor.
- Press the “Grams flow” button to simulate 1ml of product passing through the flow meter
- Switch the machine off or Reboot it with the Black On/Off switch
- Unscrew the cap of the fuse holder to replace the fuse. Only the voltmeter will work if the fuse is blown.
- Read the pressure on the pressure gauge or note the pressure increases when the pump is running.
The LCD screen shows status of the electronic package (Waiting, Train On, Downloading) plus temperature, time and date.

The Settings button under the LCD Screen will show the main operational parameters if it is pressed when the electronic package is in “waiting” mode.

Pressing the Link button forces the electronic package to attempt a download.

The “Reset” button has been reassigned and now inserts a “Pot Filled” row of Data so that the server can keep track of how much product is left in the Tank or Reservoir. Percentage full is shown on website.

C10-2 Repair tasks

As detailed in TMC 203, examination and investigation of faults in the operation of these units may result in one or more of the following repair tasks

C10-2.1 Battery Replace

1. Open Control Box door
2. Turn off unit using Black On/Off switch on Control Panel
3. Disconnect battery plug from control Box
4. Remove battery tray
5. Replace battery in tray with fully charged battery
6. Replace tray in Control Box
7. Replace battery plug to socket being careful to line up key
8. Turn On/Off switch back on
9. Check replacement battery is well charged by volt meter

C10-2.2 Electronic package test and replace

This task is not recommended for Track Staff

1. Turn off unit by On/Off switch
2. Remove Control Box lid by 4 screws on the outside corners and place to the side being careful not to damage the aerial cable
3. Check all wiring to plugs are firm. If not then replace and tighten.
4. Turn unit back on and test if fault is rectified
5. If not, turn off again
6. Disconnect plugs from end of electronic package and unscrew aerial cable
7. Disconnect programming cables from back of face panel and cable from LCD Screen
8. Replace Electronic Package
9. Reconnect plugs, cables, and aerial
10. Turn on and check if fault is rectified then turn back off.
11. Allocate the TORFMA package number stuck on the Package to this site via the Website
12. Write TORFMA package number on the Control Box lower lip
13. Replace the Control Box lid
14. Turn unit On by the On/Off Switch
C10-2.3 Flow meter back flush

1. Remove the hose to track from the flow meter hosetail.
2. Push the “Pump On” button and confirm the flow meter is jammed.
3. Remove the hose from the pump from the strainer hosetail.
4. Place the hose from the pump on the flow meter hosetail and tighten clamp.
5. Press the “Pump On” button for a few short bursts to attempt to have product flow freely out the strainer hosetail onto a rag or dish. If it does not flow freely then consider the back flush as failed.
6. If product flows freely then hold the “Pump on” button for a few seconds to flush rubbish from the strainer.
7. Remove the pump hose from the flow meter and replace it on the strainer and tighten clamp.
8. Press the “Pump On” button for a few seconds to confirm product flows freely from the flow meter.
9. If it does not flow or continue to flow freely then repeat the procedure once more.
10. If it does flow freely then replace the hose to track.
11. Turn the “On/Off” Switch off then back on to reboot unit.
12. Confirm that everything appears correct.

C10-2.4 Flow meter Clean

This task is not recommended for Track Staff.

C10-2.5 Flow meter Repair/Replace

This task is not recommended for Track Staff.

C10-2.6 Fuse test and replace

1. The fuse holder is located on the Control panel of the control box.
2. Turn Off the “On/Off” switch.
3. Unscrew the cap off the fuse holder and the fuse should come with it.
4. Withdraw the fuse and examine it for signs it has blown or test with a multimeter.
5. Replace the fuse with a 20mm long x 5mm dia x 5 Amp slow blow fuse.
6. Screw the fuse holder cap back on the holder firmly.
7. Turn the “On/Off” switch back on.

C10-2.7 Grub Screw Tighten

Series 3.0 units

1. Remove the pump/motor cover or at least lift it up.
2. Turn the motor shaft till the flat lines up with the pulley grub screw in the boss then tighten the grub screw firmly with the allen key.
3. Turn the pump shaft till the flat is lined up with the pulley grub screw in the boss then tighten the grub screw firmly with the allen key.
4. Replace the Pump/Motor Cover.
Series 3.1 units

1. Remove the side cover of the pump/motor mount/cover closest to the pump
2. Loosen the union connecting the pump to the tank outlet pipe
3. Undo the 2 x 10mm bolts at the top of the mount/cover
4. Remove the pump/motor mount/cover and plug the outlet pipe with rag or similar.
5. Turn the motor shaft till the flat lines up with the pulley grub screw in the boss then tighten the grub screw firmly with the allen key
6. Turn the pump shaft till the flat is lined up with the pulley grub screw in the boss then tighten the grub screw firmly with the allen key.
7. Remove the rag from the outlet pipe and mate the two halves of the union then screw it lightly together.
8. Line up the mount/cover with the holes for the 2x10mm bolts at the top and screw them in firmly.
9. Tighten the union firmly.
10. Replace the mount/cover side plate.

C10-2.8 Hose blocked

1. Measure the length of 16mm hose required
2. Undo hose clamps each end of the hose to be replaced
3. If required, slit the hose end lengthwise over the T-piece with a sharp knife.
4. Remove the old hose and replace with the new, leaving the far end disconnected.
5. Bleed product through the hose by pressing the "Pump On" button till it comes out the disconnected end
6. Replace the far end and ensure hose clamps are tight at each end.

C10-2.9 Motor test or replace

This task is not recommended for track staff

C10-2.10 Modem and Sim Card check or replace

This task is not recommended for track staff

C10-2.11 Pump bleed

1. Remove the pump hose from the strainer hosetail.
2. Lay it down on the ground or as low as possible.
3. Press "Pump On" button until product is flowing from the open hose end.
4. Replace the hose to the strainer hosetail and tighten clamp
5. Press "Pump On" button to confirm there is pressure build-up in the hose

C10-2.12 Pump drive belt replace or tension

Series 3.0 units

1. Remove the pump/motor cover or at least lift it up.
2. Loosen the bolts mounting the motor.
3. Remove the belt and inspect for lost teeth.
4. Replace the belt if it is reasonable or install a new belt.
5. Push a small timber block between the motor and pump to tighten the belt.
6. Tighten the motor mount bolts firmly.
7. Replace the pump/motor cover.

Series 3.1 units
1. Remove the side cover of the pump/motor mount/cover closest to the pump.
2. Loosen the union connecting the pump to the tank outlet pipe.
3. Undo the 2 x 10mm bolts at the top of the mount/cover.
4. Remove the pump/motor mount/cover and plug the outlet pipe with rag or similar.
5. Loosen the bolts mounting the motor and, if provided, loosen the belt tensioner bolt.
6. Remove the belt and inspect for lost teeth.
7. Replace the belt if it is reasonable or install a new belt.
8. Push a small timber block between motor and pump to tighten the belt or, if provided, tighten the belt tensioner bolt.
9. Tighten the motor mount bolts firmly.
10. Remove the rag from the outlet pipe and mate the 2 halves of the union then screw it lightly together.
11. Line up the mount/cover with the holes for the 2x10mm bolts at the top and screw them in firmly.
12. Tighten the union firmly.
13. Replace the mount/cover side plate.

C10-2.13 Pump un-jam
1. Remove the side cover of the pump/motor mount/cover closest to the pump on the 3.1 series unit.
2. Clamp vice grips onto the pump shaft firmly.
3. Turn shaft anticlockwise approximately half a turn. You will need to do this in a few smaller steps.
4. Remove the vice grips.
5. Confirm pump is free by pressing the “Pump On” button and spinning the pump by the motor.
6. Replace the mount/cover side plate on the 3.1 series unit.

C10-2.14 Reboot electronic package
1. Turn “On/Off” switch off
2. Wait for approximately 5 seconds
3. Turn “On/Off” switch on
C10-2.15 Reservoir or tank fill

Series 3.0 units
1. Connect hand or motor pump to the camlock fitting at the front of the reservoir and ensure you are using the follower plate in the bucket.
2. Pump product in until pressure starts to increase suddenly or the measuring stick in the back of the reservoir indicates the diaphragm has reached the back of the reservoir.
3. Do not stop just because some product comes out of the hole at the reservoir back – this is leakage.
4. Disconnect the pump.
5. Press the “Pot Filled(Reset)” button just under the LCD screen and confirm “Pot Filled” shows in screen.
6. Press “Pump On” button and confirm that the pressure rises.

Series 3.1 units
1. Open the lid of the tank and confirm level is below the 60litre knob.
2. If GFL, push the remaining grease and mix it toward the pump end as much as possible.
3. Open buckets and pour TOR product or scoop curve grease by scraper or gloved hand from the buckets till the product is level with the 60 litre knob.
4. Scrape remainder of each bucket into the next bucket or to the tank using plastic scraper and gloved hands.
5. Heap curve grease as much as possible to the pump end of the tank.
6. Press the “Pot Filled(Reset)” button just under the LCD screen and confirm “Pot Filled” shows in screen.
7. Press “Pump On” button and confirm that the pressure rises.

C10-2.16 Relay replace or repair

This task would not generally be recommended for track staff
1. Turn off unit by the “On/Off” switch.
2. Remove control box lid by 4 screws on the outside corners and place to the side being careful not to damage aerial cable.
3. Check that all wiring to plugs are firm. If not then replace and tighten.
4. Check if the relay works now by pressing the “Pump On” button.
5. If not then remove the plugs from the relay.
6. Unscrew the relay cover and check if the fuse is blown. Replace if necessary.
7. Check the terminals to the pump using a multimeter. If they are shorted then the relay will need repair and must be replaced at this time.
8. Replace plugs to the relay.
9. Replace the control box lid.
10. Turn unit on by the “On/Off” Switch.

C10-2.17 Strainer clean
1. Unscrew the hexagonal cap off the Y strainer.
2. Remove the mesh screen from inside.
3. Clean or replace the screen.
4. Reinsert the screen into the strainer.
5. Locate the cap over the mesh screen end.
6. Tighten the cap firmly.

C10-2.18 Solar Panel clean or replace cover sheet
This task would not generally be recommended for track staff
1. Unplug cable from the voltage regulator box.
2. Mark panel mount to post reference for line up to the sun.
3. Remove panel frame from post by loosening 8mm retaining bolt and retreat from track.
4. Attempt to clean cover using detergent, degreaser etc. depending on what is on it.
5. If the cleaning doesn’t work, replace the cover.
6. Drill pop rivets from the bottom corners of the frame.
7. Remove frame end.
8. Pull the polycarbonate cover sheet out of the frame (It is sometimes very difficult).
9. Insert a new cover sheet then remove plastic protective film.
10. Pop rivet the frame end on.
11. Replace frame on post, line up to mark and tighten retaining bolt.
12. Replace solar cable plug to regulator box.

C10-2.19 Solar panel setup
1. Examine site to establish best orientation of panel. This is preferably North facing to get 3hrs midday sun uninterrupted with panel 30 to 60 degrees to horizontal.
2. If this is not possible establish next best for 3 hours uninterrupted sun and higher angle to horizontal facing either Morning or Afternoon sun.
3. If better result can be achieved by tree trimming then do so.
4. Lock panel in position with the 8mm retaining bolt and see how it goes over the following week or so.

C10-2.20 Solar panel test and repair
This task would not generally be recommended for track staff
1. Point the panel to full sun
2. Connect ammeter between voltage regulator and battery which is low. Power output should be 600MA at best.
3. Check wiring at voltage regulator and replace/ reconnect if required.
4. Check voltage regulator and replace if faulty.
5. Check panel output and replace if faulty.
6. Check power LED’s and replace if faulty.
**C10-2.21 Solar cable repair or replace**

This task would not generally be recommended for track staff

1. Check continuity of both wires of cable using multimeter at plug pins.
2. If faulty disassemble plugs and check solder connections.
3. If solder is OK but cable is still faulty then replace cable.

**C10-2.22 Wheel sensor mount inspection**

1. Ensure sensor head is at least 10mm away but not significantly more from the rail gauge face.
2. As a train passes ensure the sensor does not detect the rail and miss wheels due to being too close.
3. Check top of sensor head is around 35mm below the running surface.
4. Ensure mount is securely attached to rail foot using spring washer under J bolt nut.
5. Ensure the bolts holding the aluminium angle bracket to the mount are firm with spring washers.
6. Ensure the sensor body is firmly bolted to the angle bracket.
7. Ensure the green sensor head steps away from the rail face.

**C10-2.23 Wheel sensor wiring inspection**

1. Take off the sensor head by unscrewing the three philips screws.
2. Check the three wires inside are all firmly screwed into their connections.
3. Replace the sensor head.

**C10-2.24 Wheel sensor body inspection or replacement**

1. Visually inspect sensor head for damage.
2. If wheels have hit and damaged the head a lower angle bracket may be required.
3. If green sensor head wobbles on the body then it may need replacement.
4. If damage is apparent and it is not working correctly then replace the head.

**C10-2.25 Wheel sensor reset**

1. Turn off the unit at the control box
2. Pull out the wheel sensor plug from the control box
3. Turn the unit on at control box then turn it off again
4. Replace the wheel sensor plug.
5. Turn the unit on at the control box
Chapter 11 Straightening Dipped Welds

C11-1 Description
Weld straightening reduces the effect of dynamic loads by removing short wave rail geometrical irregularities. This in turn reduces the development and growth of rail corrugation as well as the rate of degradation of track geometry and component quality. Weld straightening can be carried out as part of rail grinding (to reduce the amount of grinding required) or to address individual defects in the track.

C11-2 Track conditions required for weld straightening
The following conditions must be met for weld straightening:

Rail sections forming the weld must be 53kg/m or 60kg/m.

1. Do not straighten:
   - transposed rail,
   - welds joining 'French' rails which include Longwy and Micheville,
   - wide gap and junction welds,
   - rails approaching reportable wear limits, as described in Engineering Manual TMC 203 - Track Inspection, as the benefit will not be realised, or
   - welds with centre boltholes present that prevent ultrasonic testing (centre boltholes are too close to the weld - see Figure 70).

2. Welds can be straightened only if ultrasonic defect indications fall below the size classification in Engineering Manual TMC 224 - Rail Defects & Testing. Any "below size" indications must, however, be checked after bending to ensure that their magnitude has not increased significantly.

3. Low rails with excessive rail flow can only be straightened after flow has been removed with a rail profile grinder or similar.

4. The magnitude of ‘dip’ of the weld suitable for straightening may not be less than 0.5mm and no greater than 3mm.

5. The rail temperature must be within the range of 15°C to 50°C. Note that other restrictions apply in hot weather as per Engineering Manual TMC 211 - Track Geometry and Stability.

6. Where practical, weld straightening should be carried out in conditions that will allow weld replacement of any welds broken by the process. These conditions may include suitable rail temperature, weather conditions (dry), sufficient possession time etc.
C11-3 Procedure for weld straightening

C11-3.1 Equipment
The equipment required to carry out the weld straightening should include, but is not limited to:

- Approved dipped weld straightening machine, currently a modified Geismar JA 100 joint straightener and rail tensor unit.
- Plant to transport the dipped weld straightening machine.
- Welding kit and closures for replacement of broken welds.
- Ultrasonic testing kit.
- Relevant safety PPE and first aid etc.
- Rail grinding machine.

C11-3.2 Resources
The resources required to carry out the weld straightening and associated support work should include:

- Operators of the weld straightening machine.
- Welding staff.
- Ultrasonic rail flaw detection personnel.
- Necessary equipment for the procedure adopted.

C11-3.3 Method
Use the following procedure for straightening dipped welds:

1. Set up appropriate safe working, including pre-work brief and protection plan.
2. Assess the track conditions prior to commencement of any weld straightening (see Section 3) to determine whether straightening can be undertaken.
3. Ultrasonically test the weld and rail either side of the weld using the procedure laid out in Engineering Manual TMC 224 - Rail Defects & Testing (including foot testing). Classify any deal with any defects found in accordance with the requirements of TMC 224.
4. Measure the magnitude of the dip with a feeler gauge and a 1m straight edge (1.2m for modified Geismar JA 100 joint straightener) centrally located over the weld and directly above the web.
5. Mark the required lift on the foot of the rail where the operator can read it once the equipment is in place. This value may be greater than the level of dip depending on the metal removal planned in the follow up grinding e.g. corrugation grinding.
6. Install punch marks on the field side of the railhead (as near to the top of the face as possible) at a minimum of 2.2m either side of the weld. These are to be used as rail adjustment reference marks if the weld breaks.

7. Measure and record existing track superelevation and twist prior to straightening.

8. Carry out the straightening operations in accordance with the procedures laid down for the equipment used. Procedures for the modified Geismar JA 100 joint straightener are contained in Section C11-4.

9. If a weld breaks during the straightening procedure, install a closure in accordance with the requirements of Chapter 6.

10. If 2 (or more) of the first 10 welds fail during the process, stop straightening and review the process.

11. When the lifting process is completed, measure and record the size of the finished dip. Note: a corrected weld cannot be left peaked by more than 0.3mm and therefore must be ground.

12. Place a spot of white paint on the foot of the weld to identify that the weld has been straightened.

13. Tamp a minimum of 4 sleepers either side of the weld to maintain the lift achieved by the weld straightening.

14. Record the following information about each straightened weld on the Weld Straightening Record form shown in Section C11-5:
   - Location information - Weld No, Track, km, Rail
   - U/S output
   - Weld information Rail temp, Rail Section, Rail Age
   - Dip information - Before, After Lift 1, After lift 2, After lift 3, Final

Keep the Weld Straightening Record forms as part of the configuration record until the rail is replaced.
15. Grind the rail as soon as reasonably practicable after straightening in accordance with the requirements of Engineering Manual TMC 225 - Rail Grinding. This will prolong the benefit of the dipped weld straightening process.

**C11-4**  
**Weld Straightening using the modified Geismar JA 100 Joint Straightener**

This procedure is to be used as part of the overall procedure in Section C11-3.

![Figure 72 - Machine in travel mode - wheels down, jaws up](image)

![Figure 73 - Lift in progress - rear ram down](image)
C11-4.1 Method

1. Place machine at work site
2. Remove Pandrol clips either side of the weld to be straightened. Remove rail anchors (where fitted) to allow fitting of jaws
3. Set machine jaws over deepest point of the lift (centre of weld)
4. Secure jaws with locking pins and stand clear of jaws before lifting starts.
5. Take up the slack in the jaws by increasing the pressure level.
   
   Lifts are only to be measured with the pressure gauge. Do not use the ruler as this has been found to be inaccurate on the current machine.
6. Using the pressure-limiting valve, take the pressure to 350 bar using a slow and constant rhythm.
7. Once the required pressure is obtained, release the pressure quickly, as the longer the rail is held at the lift, the further it bends. This could then cause a peak to be left in the track.
8. Re-measure the dip after the first lift. If a second lift is required, increase the lift pressure to 400 bar using the same procedure as above.
9. Re-measure the dip after the second lift. If further lifting is required, lift to a pressure of 450 bar using the same procedure as above.
10. DO NOT carry out more than 3 lifts per weld. This may mean that, in some instances, the total dip may not be completely removed. These locations could be considered for be re-lifting at a later date.
11. If an out of tolerance lift has occurred i.e. >1mm peak, use a profile grinder to remove the defect.
12. Record the bar pressure achieved in all of the lifts in the "Comments" column of Weld Straightening Record form.

Note: When traversing a curve with the equipment, use caution as the machine ram can jam on the railhead derailing the machine.

C11-4.2 Equipment

Plant and tools required on site prior to weld straightening:

- Rail bending machine
- Tamping resources
- Appropriate transport and lifting equipment
- Rail closures to suit rail type and wear profile.
- Full set of welding equipment including oxy/LP gas and weld safety equipment including hot metal bin, and consumables
- Rail borer / Bow plate / fish plates & G clamps or Robel clamps for emergency repairs
- Rail shears and motor
- Rail tensors
- Rail saw
- Rail Grinder ‘profile’ (hand or small rail mounted)
- Fire fighting equipment

C11-4.3 Maintenance of Machine

Conduct a daily pre-operational visual inspection when the machine is in use.

Service the service motor and pumps every 3 months.
## C11-5  Weld Straightening Record Form

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weld No</td>
<td>Track</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>
Chapter 12 Rail Lubrication Guidelines

C12-1 General

These guidelines are intended for use in establishing or improving the performance of trackside lubrication.

They should be applied for the establishment of lubrication, the review and improvement of existing lubrication and for diagnosis of problems.

The best application of the guidelines will be achieved by seeking expert advice from the lubrication specialists in RailCorp's Chief Engineers division.

Note: Gauge face lubrication is not normally effective in reducing wheelsqueal. Other friction modification techniques are required to control squeal.

C12-2 Improvement strategies

There are two identified strategies for improving the performance of trackside lubrication:

13. Improvements in grease transfer by placing trackside lubricators on moderate curves in advance of the sharp curves that are the main target.

14. Improvements in the lubricant used by choosing a high performance product (albeit a more expensive one).

Both strategies will result in an increase in lubricant travel and a reduced friction coefficient on the gauge face of the rail. The outcome is:

- a reduction in the number of lubricators needed,
- a reduction in the amount of lubricant required, and
- a reduction in rail wear and a reduction in wheel wear

There is also less lubricant contamination of the rail surface and less lubricant wasted. This means better locomotive adhesion and braking, and less rail damage from wheelburns and lubricant induced crack propagation.

The application of the first strategy involves, simply, a review of the existing lubricator location and the repositioning of lubricators to suit. A 'before and after' inspection needs to be carried out which includes the taking of friction measurements.

The decision to adopt the use of high performance lubricant will depend on the cost benefit trade-off where the cost of using a better lubricant is weighed against the benefits. In the metropolitan area the biggest savings arise from reductions in wheel wear of passenger trains, which significantly outweigh the additional cost of the product. Only high performance lubricant is now used in the metropolitan area.
C12-3  Where is lubrication required?

The following requirements are extracted from RailCorp standard ESC 220

Rail lubrication systems (number, location and spacing of lubricators, and type of lubricant) shall be designed to meet the following performance requirements:

- The friction coefficient on the gauge face of the high rails should be <0.30 and preferably ≤0.25 if metropolitan passenger trains are involved.
- The friction on the running surfaces of both high and low rails should be >0.35 (>0.40 preferred) and >0.40 on grades steeper than 1 in 50. A lower friction level is acceptable on the rail surface in the immediate area of the lubricator (within 50m).
- It is also desirable that the difference in the running surface friction between the high and low rails should be ≤0.15.

Lubrication is required wherever there is potential for significant wear, including:

- curves of 800m radius or sharper depending on track design, wheel and rail profiles and train operations,
- other curves exhibiting, or with a history of, gauge face wear on the high rail, or
- situations where flanging noise is a problem

The wear can arise from wheels or rails, evidenced by the condition of the gauge face of the rail or from the presence of metal flakes on the foot of the rail.

The primary determinant for the need for lubrication will be the curvature. Rails in curves above about 600-800m radius generally will not require lubrication. Within this curvature range the main factor is the type of traffic. Freight vehicles will be superior to passenger vehicles and freight with steering bogies will be superior again. In addition, freight vehicles have harder wheels so they are less sensitive to wear than passenger trains.

C12-4  Lubricants

Only approved lubricants (see Error! Reference source not found.) should be used. All lubricants used in RailCorp should be of a high performance type. The exception is for special environmental areas, where a biodegradable lubricant may be required.

C12-5  Locating Lubricators

Lubricator positioning has been found to be the most important factor in the performance of a gauge face lubricant. If at all possible, lubricators need to be located in moderate radius feeder curves ahead of the sharper curves that are the main target. Positional alternatives are:

1. Within the transition at the beginning of the curve in the direction of travel of medium radius curves with radii in the range 400m-600m. On single lines, place lubricators at the beginning of curves in the direction of the heaviest traffic. The ideal position within the transition is where wheel flanging is just beginning to occur. This will usually be closer to the TRS than the tangent point.

2. Within the body of relatively shallow curves, with radii greater than 600 m and up to about 1000 m, as long as there are some indications of very minor wheel flanging and no indication of heavy wheel flanging. This is an ideal location for lubricators on single lines where the lubricator is servicing both directions.
Lubricators should not be positioned in tangent track or the low rails of curves or on very wide radius curves (greater than 1000m radius) since no flanging will occur.

Where possible, lubricators should not be positioned at curves with radii less than about 300 m. If this is the only alternative the best position is within the transition area where flanging is just beginning to occur.

Where located in the transition, lubricators should be positioned at the beginning of the curve for the direction of travel. For single line tracks they can be positioned either at the start or the end of the curve.

Where the desirable wide radius curves are not available the widest radius available should be selected. Carry distances and lubrication effectiveness will, however, be reduced.

### C12-6 Spacing of Lubricators

In track containing relatively sharp curves, the above positioning of lubricators will generally lead to efficient lubrication distances from the lubricator of:

- Up to 8 -10km in timber sleepered track with moderate grade and curvature.
- Up to 5 - 7km on timber sleepered track under severe grade braking conditions (more than about 1:50), or a high proportion of sharp curves (<300m).
- Up to 5 - 6km on concrete sleepered track with moderate grade and curvature.
- Up to 3 - 4km on concrete sleepered track under severe grade braking conditions (more than about 1:50), or a high proportion of sharp curves (<300m).

For single lines, travel distances either side of the lubricator should be reduced by about 20 - 30%.

Under very severe grade conditions (more than about 1:50 in either braking or climbing direction), lubricators on the Up and Down rails should not be positioned any closer than 0.5km of each other.

Distances are based on about 40 - 50% of the track being serviced by the lubricator. Where, for example, long sections of tangent track are interposed between curves, then travel distances will be proportionally increased.

These distances are based on the use of high performance lubricant in areas of metropolitan passenger traffic. Actual distances will depend on the particular track situation involved and the type and mix of traffic and should always be verified by testing prior to and after implementation.

### C12-7 Performance Review – friction, smoothness, filings, noise, rail wear

Testing should be carried out to verify the lubrication strategy proposed for a particular area. This can be done using portable lubricators.

The friction testing should be carried out with a tribometer, and cover at least 100m in each track section to be assessed. There must also be a visual examination of the gauge face and the top of rail and for any signs of wear debris. Note the gauge face of the rail should be smooth in texture and display good coverage of the lubricant.
Chapter 13 Crowing rails

Rail ‘crowing’ (or bending) is necessary when rail ends are created or short rail closures (< 6m) are fitted in curves <500m radius.

The objective of crowing rails is to produce a radius that will match the designed radius of the track in which the rail closures or rail ends are placed.

Successful rail crowing is largely based on applying a series of sets spaced at equal distances along the rail, and applying the same bending force at each point.

NOTE: DO NOT crow rail ends that have been oxy-cut. Crow the rail first, then if necessary cut it to length by oxy cutting.

Using the Buda and bottle jack

3. Support the rail on two or three points during the bending procedure. Fishplates make ideal supports.

4. The initial point of application should be as near to the end of the rail as the bending mechanism will allow.

5. Extend the bottle jack until the rail starts to bend.

The amount of force applied at each of the bend points is largely a matter of trial and error.

6. When it is considered that sufficient bend has been applied place a chalk mark on the piston of the jack adjacent to the edge of the cylinder.

This chalk mark acts as a reference point for all further sets. It is important that the rail is bent by an even amount at each set point.

7. Place a chalk mark at the first point where the bottle jack is applied.

8. After the first bend is made, push the Buda along the rail until the centre lines up with the chalk mark.

9. Re-apply the bottle jack and again mark its new location with chalk.

10. Repeat the procedure for the full length of the rail.

11. Measure the amount of curvature (or radius) applied to the crowed rail by stringlining the rail from one end to the other and measuring the middle ordinate from the stringline to the rail.

12. Check the evenness of the curve by measuring the versine at the quarter points of the stringline. Versines at the quarter points should be half the value of the middle ordinate.

It may be necessary to crow a rail several times before the desired curvature is achieved.

13. If the rail has been over-crowed, the curvature may be reduced by recrowing the rail in the opposite direction.
## Appendix A  Approved rail products

The following requirements are extracted from RailCorp standard ESC 220

<table>
<thead>
<tr>
<th>Common Item Name</th>
<th>Description</th>
<th>Standard/ Drawing</th>
<th>Manufacturer/ Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rails</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rails</td>
<td>Railway rails; head hardened and plain carbon; 50, 53 and 60kg/m</td>
<td>AS 1085.1</td>
<td>One Steel</td>
</tr>
<tr>
<td>Flashbutt welded rail lengths</td>
<td>Railway rails; head hardened and plain carbon; 50, 53 and 60kg/m</td>
<td>AS 1085.20</td>
<td>VAE Railway Systems (VAE)</td>
</tr>
<tr>
<td>Deep Head Hardened 60kg Rails</td>
<td>AS60 HSH Deep Head Hardened Rails</td>
<td>AS 1085.1 and RT23</td>
<td>RailCorp Rail Fabrication Centre (BRFC)</td>
</tr>
<tr>
<td>Junction rails</td>
<td>Rails, Junction 60 kg HH rail to 53 kg rail; 2743mm long</td>
<td>RailCorp L 5353</td>
<td></td>
</tr>
<tr>
<td>Junction rails</td>
<td>Rails, Junction 53 kg rail to 47 kg rail</td>
<td>RailCorp L 5354</td>
<td></td>
</tr>
<tr>
<td><strong>Fishplates</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOW Plates</td>
<td>Steel; bowed for welded joint 47kg rail (pairs)</td>
<td>TKL A3B12988C</td>
<td>Vossloh Cogifer Australia (VCF)</td>
</tr>
<tr>
<td>BOW Plates</td>
<td>Steel; bowed for welded joint 53kg rail (pairs)</td>
<td>VCF Westray Eng</td>
<td>VCF Westray Eng</td>
</tr>
<tr>
<td>BOW Plates</td>
<td>Steel; bowed for welded joint 60kg rail (pairs)</td>
<td>TKL A3B12990E Westray CP822-3</td>
<td>VCF Westray Eng</td>
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<tr>
<td>Fish Plates</td>
<td>Joint bar, rail Steel; 47kg; 6 holes:</td>
<td>TKL A2B12122/B AS 1085.2</td>
<td>VCF</td>
</tr>
<tr>
<td>Fish Plates</td>
<td>Joint bar, rail Steel; 50kg; 6 holes:</td>
<td>BHP 2300 AS 1085.2</td>
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</tr>
<tr>
<td>Fish Plates</td>
<td>Joint bar, rail Steel; 53kg; 6 holes</td>
<td>SRA appr DWG AS 1085.2, AS 1442</td>
<td></td>
</tr>
<tr>
<td>Fish Plates</td>
<td>Joint bar, rail Steel; 60kg; 6 holes</td>
<td>AS 1085.2, AS 1442 SRA appr Dwg BHP 2301</td>
<td></td>
</tr>
<tr>
<td>Slotted Fish Plates</td>
<td>Joint bar, rail Steel; 50kg; slotted; 6 holes</td>
<td>AS 1085.2</td>
<td></td>
</tr>
<tr>
<td>Slotted Fish Plates</td>
<td>Joint bar, rail Steel; 53kg; slotted; 6 holes</td>
<td>AS 1085.2 Westray CP437</td>
<td>Westray</td>
</tr>
<tr>
<td>Slotted Fish Plates</td>
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<td>AS 1085.2</td>
<td></td>
</tr>
<tr>
<td>Junction Fish Plates</td>
<td>Junction Plate 41kg/53kg (pairs)</td>
<td>Westray CP867-1</td>
<td>Westray Eng</td>
</tr>
<tr>
<td>Junction Fish Plates</td>
<td>Junction Plate 47kg/53kg (pairs)</td>
<td>TKL A2B09396C Westray CP479A</td>
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<tr>
<td>Junction Fish Plates</td>
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<td>TKL A2B08721G Westray CP478A</td>
<td>VCF Westray Eng</td>
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<tr>
<td>Junction Fish Plates</td>
<td>Bowed Junction Plate 53kg/60kg (pairs)</td>
<td>TKL A2B113191A</td>
<td>VCF</td>
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<tr>
<td><strong>Rail Fastenings</strong></td>
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<td></td>
</tr>
<tr>
<td>Fishbolts</td>
<td>Bolt, fishplate M22; 115mm lg; heat treated; oval neck; cup head; c/w hex nut &amp; spring washer;</td>
<td>RSA Dwg 205A 323D AS 1085.4 (WASHER TO AS 1085.7)</td>
<td>Greg Sewell Forgings</td>
</tr>
<tr>
<td>Fishbolts</td>
<td>Bolt, fishplate M24; 140mm lg; heat treated; oval neck; cup head; c/w hex nut &amp; spring washer;</td>
<td>RSA Dwg 205A 323D AS 1085.4 (WASHER TO AS 1085.7)</td>
<td>Greg Sewell Forgings</td>
</tr>
<tr>
<td>Swage lock fasteners</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pin, Huck</td>
<td>1&quot; dia pin; Round Head; Fishplate</td>
<td>C50LR-BR32-64</td>
<td>Alcoa</td>
</tr>
</tbody>
</table>
### Common Item Name | Description | Standard/ Drawing | Manufacturer/ Supplier
--- | --- | --- | ---
**Pin, Huck**<br>1" dia pin; Thread Head; Fishplate | | C50LH-BR32-64 | Alcoa
**Lock Collar**<br>1 “Lock Collar for 1” (32) pins | | LC-2R32G | Alcoa
**Avdelock swage Fastenings**<br>Avdelock swage Fastenings | | PDS 5 Product Data Sheet No 25 RT | Avlock Acument Global Technologies
**Washer**<br>24mm structural washer for 1” (32)bolts (pack under collar only) | | M24 | Huck

### Rail Clamps

| **Robel Clamps**<br>Rail clamp for mechanical rail joint; nut locking device with safety locking flap and safety locking bar; | | Robel part number 68.05 | Robel

| **G-Clamps**<br>Rail Clamp C “G” Type; Steel | | 177A-26A |

### Insulated Joints

| **Insulated Fish Plates**<br>Steel; 53kg; 6 holes; for mechanical insulated joints | | RIC M04-216-39P91 Thermit 06-141C Westray CP522-1 | Thermit Australia, Westray Eng.

| **Field assembled Insulated joint kit**<br>Thermit MT kit; 60kg rail; c/w 2 joint bars, endpost, 6 ferrules, bolts, nuts & washers; 4 faceplates and insulation | | Thermit 06-093C | Thermit Australia

| **Insulated joint kit**<br>Benkler kit-53kg-MK1HT; c/w 2 insulated fish plates, endpost, collar, ferrules, washer plates, huck bolts | | AS 1085.2 & AS 1085.12 | Alcoa

| **Insulated joint kit**<br>Benkler kit-60kg-mk2ht; c/w insulated fish plates; endpost/collars/ferrules/washer plates, huck bolts | | AS 1085.2 & AS 1085.12 | Alcoa

| **Insulated Joints**<br>Norfast ‘Hercules’ NIJ 630 series joints (to be used with AS60 rail) | | Norfast NIJ-6 | Norfast / Martinus Rail

| **Double Glued Insulated Joint**<br>Double joint; 60kg; 4.58m lg; 0 versine; head hardened; 15° or 90° cut; | | Thermit 06-193C | Thermit Australia

| **Double Glued Insulated Joint**<br>Double joint; 60kg; 4.58m lg; 5 versine; head hardened; 15° or 90° cut; | | Thermit 06-193C | Thermit Australia

| **Bonded Insulated Joints**<br>47kg; 4.57m lg; 0 versine; Std. Carbon; | | AS 1085.12 | BRFC

| **Bonded Insulated Joints**<br>50kg; 3.43m lg; 0 versine; std. carbon; | | AS 1085.12 | BRFC

| **Bonded Insulated Joints**<br>53kg; 3.43m lg; 0 versine; head hardened; 15° cut; | | AS 1085.12 | BRFC

| **Bonded Insulated Joints**<br>53kg; 3.43m lg; 3 versine; head hardened; 15° cut; | | AS 1085.12 | BRFC

| **Bonded Insulated Joints**<br>53kg; 3.43m lg; 6 versine; head hardened; 15° cut; | | AS 1085.12 | BRFC

| **Bonded Insulated Joints**<br>53kg; 4.57m lg; 0 versine; head hardened; 15° cut; | | AS 1085.12 | BRFC

| **Bonded Insulated Joints**<br>53kg; 4.57m lg; 5 versine; head hardened; 15° cut; | | AS 1085.12 | BRFC

| **Bonded Insulated Joints**<br>53kg; 4.57m lg; 10 versine; head hardened; 15° cut; | | AS 1085.12 | BRFC
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<th>Common Item Name</th>
<th>Description</th>
<th>Standard/ Drawing</th>
<th>Manufacturer/ Supplier</th>
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<td>60kg; 3.43m lg; 0 versine; head hardened; 15° cut;</td>
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<td>BRFC</td>
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**Rail Lubrication**

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<td>Existing Applications only</td>
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<td>Tamper</td>
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<td>Rail Track Equipment P/L</td>
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<tr>
<td>RTE 25 (clamp-on type)</td>
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<td>Rail Track Equipment P/L</td>
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<table>
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<th>Lubricants</th>
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<tr>
<td>ROCOL Rail Curve Grease</td>
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<td>All Lubricators</td>
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**Wheel Squeal applicators**

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<td>Control unit</td>
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**Product**

<table>
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<tr>
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<th>Description</th>
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<td>Tramsilance Friction Modifier</td>
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**Rail Anchors**

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<th>Rail anchors</th>
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<tr>
<td>To suit 47 and 53kg/m rail</td>
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**Rail Templates**

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<th>Template</th>
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<td>41kg Rail bolthole marking for drilling and cutting</td>
<td>SPC 202</td>
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<tr>
<td>47kg Rail bolthole marking for drilling and cutting</td>
<td>SPC 202</td>
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</tr>
<tr>
<td>53kg Rail bolthole marking for drilling and cutting</td>
<td>SPC 202</td>
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</tr>
<tr>
<td>60kg Rail bolthole marking for drilling and cutting</td>
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# Appendix B  Non-Conformance Report

## Non-Conformance Report

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<th>NCR No:</th>
<th>Date:</th>
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</thead>
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### 1. Non-Conformance Description

**Send to:** Track Service/Supply Contracts Manager/Logistics

<table>
<thead>
<tr>
<th>Business Unit:</th>
<th>Manager/Supervisor:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part Description:</td>
<td>Supplier:</td>
</tr>
<tr>
<td>Part No:</td>
<td>Supplier Contact Name:</td>
</tr>
</tbody>
</table>

**Non-Compliance Details:**

[Blank Line]

**Inspection/Tests Conducted:**

[Blank Line]

**Recommendation:**

[Blank Line]

<table>
<thead>
<tr>
<th>Name/Position:</th>
<th>Phone No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date:</td>
<td></td>
</tr>
</tbody>
</table>

### 2. Track Services Assessment

**Send to:** Originator/Supply Contracts Manager/Logistics; Issue an CAR

- [ ] Acceptable
- [ ] Acceptable with repairs
- [ ] Acceptable without repair to Engineering concession
- [ ] Not acceptable - Corrective Action Report has been initiated  
  **CAR No**

**Comments:**

[Blank Line]

<table>
<thead>
<tr>
<th>Name/Position:</th>
<th>Phone No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date:</td>
<td></td>
</tr>
</tbody>
</table>

### 3. Originator

**Action to be taken:**

- [ ] Place in service
- [ ] Return to Supplier for repair
- [ ] Quarantine the stock

**Comments:**

[Blank Line]

<table>
<thead>
<tr>
<th>Name/Position:</th>
<th>Phone No</th>
</tr>
</thead>
<tbody>
<tr>
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